hyd2o HYDROLOGY

WATTLE GROVE SOUTH

District Water Management Strategy

July 2024



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Executive Summary

Hyd2o was commissioned by Hesperia to prepare this District Water Management Strategy (DWMS) to support the proposed metropolitan region scheme (MRS) amendment for land within Wattle Grove known as the Wattle Grove South residential estate (herein referred to as the Amendment Area). This document has been prepared to specifically satisfy the requirements of Better Urban Water Management (Western Australian Planning Commission, 2008), and the Inland Waters scope of the Environmental Protection Authority's, Metropolitan Region Scheme Amendment 1388/57 Wattle Grove South, Instructions for Environmental Review (EPA, 2022).

The DWMS recognises the EPA's overarching objective

> "*to maintain the hydrological regime and quality of groundwater and surface water so that environmental values are protected".*

and specifically addresses the potential impacts and risks identified in EPA (2022) in the development of this document. To this extent the DWMS also addresses the potential impact of development of land in proximity to the Amendment Area identified as Urban Expansion and Urban Investigation areas in the North-East Sub-Regional Planning Framework (DPLH, 2018).

The proposed MRS amendment from 'Rural' to 'Urban' for the Amendment Area has been prepared by element Town Planners to facilitate future urban development of the area.

The Amendment Area has a total area of approximately 126 ha located within the City of Kalamunda. It is bound to the north by Crystal Brook Rd and Welshpool Rd East, and bounded to the south and west by the Tonkin Highway, with existing rural landholdings to the east. It currently comprises a mix of various rural landholdings and a turf farm. A former poultry farm is located within the Amendment Area on its south eastern boundary.

Topography across the Amendment Area varies between 21 mAHD in the west to a high of 35 mAHD at its eastern boundary, with a fall from east to west. The Amendment Area has good clearance to regional groundwater and existing culverts under Tonkin Hwy connect runoff from the area to downstream stormwater systems.

The environmental considerations and values of the nearby Greater Brixton St Wetland (GBSW) area are recognised as key factors which will ultimately guide the hydrological design of the Amendment Area. In this regard the DWMS builds on previous studies of the area including Semeniuk (2001) and Bourke (2017), together with current DBCA programs, and using site specific data to further improve the hydrological understanding of the area and then use these outcomes to inform future water management. The DWMS recognises the key hydrological mechanisms supporting the GBSW area as detailed in previous hydrological studies are incident rainfall on the wetland itself and surface water flows.

With respect to the Amendment Area's hydrological relationship to the GBSW area:

- Regional groundwater flow within the Amendment Area is predominately away from the GBSW area. Groundwater flow within the Amendment Area was found to be radial from a mound evident along the central western boundary adjacent to Tonkin Hwy. The groundwater flow direction within the Amendment Area was found to vary, generally ranging from flowing northwest to flowing south east and away from the GBSW area.

The groundwater mounding in this location is considered to be a result of local irrigation practices and geological factors.

- Shallow subsurface groundwater flow from the Amendment Area is estimated to represent only a very small proportion of flow to the GBSW area and is considered minor in the context of maintaining wetland hydrology.
- Although surface water flow from the Amendment Area contributes only a minor component of total inflow to the GBSW, the principle of maintaining pre and post development flow rates and volumes has been adopted as a key guiding criteria used to inform the Amendment Area's water post development management strategy and future design.
- Nutrient levels are relatively high in the GBSW area as a result of surrounding historical land uses. Nutrient input and export from the Amendment Area will be considerably reduced with land use change and the removal of the existing high nutrient application land uses such as rural and horticultural.
- Development of the Amendment Area provides the opportunity to improve the existing interfaces of drainage flow to the GBSW area. Flows currently to the GBSW from the Amendment Area do not have any water quality management control measures.

Maintaining post development recharge in the area of the groundwater mound has been adopted as a key principle for the proposed stormwater management system of the Amendment Area in order to meet EPA's Inland Waters objective of maintaining the existing hydrological regime and maintain existing groundwater flows at this location post development. The proponent is however committed to continue to work with agencies and the EPA toward any agreed alternative objective for the Amendment Area at this boundary for the benefit of the GBSW area should this be required. This can readily be achieved through the proposed adaptive management approach.

Ongoing monitoring during the pre and post development phases of the project will continue to provide data to build on existing datasets and improve the understanding of the wetland and its behaviour in a changing climate.

Development within the Amendment Area is recognised as an opportunity to counteract potential effects of climate change and future rainfall decline on the wetlands. Use of an adaptive management approach with flexibility built into the stormwater system and its infrastructure, coupled with decision making informed by a monitoring outcome loop will enable changes in stormwater management to be implemented over time to best suit downstream environmental needs.

In summary, land use change within the Amendment Area has the potential to provide improved future hydrological outcomes for the GBSW area in terms of both water quality and quantity.

Based on this assessment and given the timeframe over which the proposed development will ultimately occur within the Amendment Area, it is considered the water management processes of Better Urban Water Management (WAPC, 2008) applied within an adaptive management framework will be suitable for guiding water management for the Amendment Area toward improved hydrological outcomes for the GBSW area.

This document has been prepared in accordance with the principles and objectives of Better Urban Water Management (Western Australian Planning Commission, 2008), and

recognises and reflects the Amendment Area's relationship to the broader Wattle Grove Urban Expansion and Urban Investigation areas.

Implementation of the strategy detailed in this report will be undertaken in accordance with Better Urban Water Management through the development and implementation of a Local Water Management Strategy and Urban Water Management Plans for individual stages of development within the Amendment Area.

District Water Management Strategy Summary	
Water Supply	
Water Efficiency	• Promotion of 6 star building standards, water efficient fixtures, and fittings. • Use of water-wise plantings in POS and landscape rehabilitation areas.
Water Supply	• Lots: Water Corporation IWSS and rainwater tanks optional. • POS: Groundwater irrigation licencing and bores. • Construction: Temporary groundwater licencing where/if required.
Wastewater	• Water Corporation reticulated sewerage.
Stormwater	
Design & Management Approach	• Use of an adaptive management approach based on monitoring outcomes to inform future planning and decision making. • Post development stormwater flows from the Amendment Area maintained consistent with existing conditions and identified opportunities and constraints. • Locate stormwater management areas in areas of the existing groundwater mound to maintain the annual predevelopment groundwater recharge and flow direction in that area. • Use water quality controls and best management practice to provide improvements relative to current conditions under existing land use and improve downstream ecological conditions. • Implementation of flexible infrastructure arrangements to enable system adjustments to downstream environmental needs as/if required under climate change conditions.
Lot Scale	• Soakwells to be implemented where possible. • Lot connections to be implemented where required based on geotechnical considerations, minimising imported fill, and/or recharge considerations in the area of the existing groundwater mound. • Rainwater tanks (optional). • Water-wise landscaping.

District Water Management Strategy Summary	
Street Scale	• Rain gardens / biofiltration areas. • Swales / piped drainage. • Bottomless manholes / underground storage cells.
Estate Scale	• Establish water quality treatment areas for first 15 mm runoff via biofiltration, with areas to be located based on recharge considerations in the area of the existing groundwater mound. • Flood management areas to attenuate flows in accordance with agency requirements and capacity of downstream infrastructure. • Potential use of portions of the Dampier to Bunbury Natural Gas pipeline corridor for major event stormwater management. • Implementation of flexible outlet arrangements for stormwater management areas in design. • All habitable development levels to have suitable clearance above the 1% AEP flood levels of the local stormwater management system. • Post development performance monitoring and annual reporting.
Groundwater	
Fill & Subsoil	• Use of imported fill to be minimised. • Subsoil unlikely to be required due to groundwater depth
Acid Sulphate Soils	• Acid sulphate soils to be investigated as a separate process (if required) and reported at later stages of planning.
Implementation	
Process	• Ongoing groundwater and surface water predevelopment monitoring to inform future development planning and outcomes. • Coordination of monitoring and data sharing with key agencies. • Future stages of planning consistent with Better Urban Water Management (WAPC,2008) including preparation of LWMS's and UWMP's. Documents to reflect a flexible outcomes approach to facilitate adaptive change. • Establish agreed targets in consultation with agencies based on predevelopment monitoring outcomes at structure planning stage. • Post development groundwater and surface water monitoring programs and annual assessment reporting to inform water management planning for future stages and iterative adjustment.

1. Introduction

Hyd2o was commissioned by Hesperia to prepare this District Water Management Strategy (DWMS) to support the proposed metropolitan region scheme (MRS) amendment for land within Wattle Grove. The boundary of the Amendment Area is shown in Figure 1 in relation to the Urban Expansion and Urban Investigation areas identified in the North-East Sub-Regional Planning Framework (DPLH, 2018). The Amendment Area has a total area of approximately 126 ha located within the City of Kalamunda.

The amendment is subject to environmental assessment by the Environmental Protection Authority (EPA) under the Environmental Protection Act (1986). Hesperia is completing the Environmental Review required by the environmental assessment on behalf of WAPC.

The proposed rezoning of the Amendment Area has considered the opportunities and constraints of the existing environment and uses this information to inform the development of this document. This document provides an integrated total water cycle management approach to the rezoning application, with an assessment of the pre-development environment, development of water use sustainability initiatives, a stormwater management strategy, and nutrient and groundwater management strategy. The document also provides a plan for implementation applied within an adaptive management framework suitable for guiding water management toward achieving considerable improved hydrological outcomes for the area.

The DWMS recognises the EPA's overarching objectives for the Amendment Area and its proximity to the nearby Greater Brixton St Wetland (GBSW), and specifically addresses the potential impacts and risks identified in the Inland Waters scope of the Environmental Protection Authority's, Metropolitan Region Scheme Amendment 1388/57 Wattle Grove South, Instructions for Environmental Review (EPA, 2022). To this extent the DWMS also addresses the potential cumulative impacts of development of other land in proximity to the Amendment Area identified as Urban Expansion and Urban Investigation areas in the North-East Sub-Regional Planning.

A completed copy of the Department of Water & Environmental Regulation (DWER) DWMS Checklist for Developers is included as Appendix A together with the Environmental Protection Authority required work listing for Inland Water items to assist agencies in the review of this document.

1.1 Planning Context

This Amendment Area is currently zoned Rural under the Metropolitan Region Scheme. The MRS amendment proposes rezoning to Urban.

The Amendment Area is identified as an Urban Expansion area within the North-East Sub-Regional Planning Framework (DPLH, 2018), with key considerations identified for the Amendment Area detailed in the Framework as

- geotechnical analysis for connection to reticulated wastewater services;
- bushfire risk; and

- protection of significant environmental assets.

Better Urban Water Management (Western Australian Planning Commission (WAPC), 2008) provides guidance on the implementation of State Planning Policy 2.9 Water Resources (Government of WA, 2003).

The urban water management planning process for the Amendment Area is shown in Table 1. Three water management documents are likely to be required to facilitate the future development of the Amendment Area, this DWMS, a Local Water Management Strategy (LWMS) and an Urban Water Management Plan (UWMP) as summarised below in Table 1. Note that several urban water management plans are likely to be required for the Amendment Area depending on the ultimate staging of subdivision.

A DWMS for the Amendment Area was originally prepared by Hyd2o in 2021 to support the MRS Amendment application and submitted for agency review and assessment at that time. Following the EPA's determination that the amendment is subject to environmental assessment, the DWMS has been expanded to address the Inland Waters scope of the Environmental Protection Authority's, Metropolitan Region Scheme Amendment 1388/57 Wattle Grove South, Instructions for Environmental Review (EPA, 2022).

The DWMS has therefore been expanded beyond the scope typically required to meet Better Urban Water Management (WAPC, 2008) to address the requirements of the Environmental Impact Assessment, and supports the proposed development of the area as urban.

Table 1: Urban Water Management Process

Planning Phase	Planning Document	Urban Water Management Documents
MRS Amendment	MRS Amendment Environmental Review	Wattle Grove South District Water Management Strategy **THIS DOCUMENT**
Local Structure Plan/TPS Amendment	Local Structure Plan	Local Water Management Strategy **FUTURE PREPARATION**
Subdivision	Subdivision Application	Urban Water Management Plan/s **FUTURE PREPARATION**

1.2 Previous Studies and Relevant Documents

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

- Environmental Values and Pressures for the Greater Brixton St Wetlands on the Swan Coastal Plain, Advice in accordance with section 16(j) of the Environmental Protection Act 1986 (EPA, 2022a)
- Metropolitan Region Scheme Amendment 1388/57 Wattle Grove South Instructions for Environmental Review (EPA, 2022b)

- A Jewel in the Crown of a Global Biodiversity Hotspot (Lambers, 2019)
- A Vision for Conservation and Public Enjoyment of the Greater Brixton Street Wetlands and Eventual Yule Brook Regional Park (The Beeliar Group, 2018)
- Hydrological Function of the Greater Brixton Street Wetlands: Data Sourcing and Review (Bourke, 2017)
- Hydrological Study of the Greater Brixton Street Wetlands (Semeniuk, 2001)
- Better Urban Water Management (WAPC, 2008)
- Stormwater Management Manual for WA (DWER, 2022)
- Decision Process for Stormwater Management in WA (DWER, 2017)
- Guidelines for District Water Management Strategies (Department of Water, 2013)

1.3 Agency Consultation

EPA (2022a) identifies that a high level of protection and coordinated management is critical for the GBSW area, and that improvements to the coordination and management through shared and expanded partnerships would allow more holistic management of the GBSW area.

Development of this DWMS commenced in 2020, and the process has involved key stakeholders and government agencies at various stages to inform its progress and development. This input has assisted in identifying key areas of investigation and reporting in this document and the development and refinement of the ongoing monitoring program.

A summary of key agency consultation is provided in Table 2.

Table 2: Agency Consultation

Stakeholder	Timing	Type of Consultation
DBCA		
Rivers and Estuaries	June 2021	Monitoring program development input and advice regarding parameters/frequency and timing
	Sept 2021	Review and advice on initial DWMS pre EPA process
Biodiversity and Conservation Science	April 2022	Data sharing arrangement for current monitoring data from DBCA programs in the GBSW area Wanaping Block
	June 2022	Monitoring advice regarding installation of additional Amendment Area groundwater monitoring locations
DWER		
Swan Avon Region Planning Advice	July -Sept 2021	Review and advice on initial DWMS pre EPA process
Groundwater Assessment Section	October 2022	Provision of PRAMS reporting & datasets Monitoring advice regarding installation of additional Amendment Area groundwater monitoring locations
EPA Services	August 2022 –July 2024	Various briefings regarding scoping, and progress of monitoring and technical studies related to Inland Waters, including groundwater mapping and water balance modelling progress and outcomes. Provision of all Amendment Area monitoring datasets.
City of Kalamunda		
Engineering	October 2022	Installation approvals for additional groundwater monitoring locations. Agreement to share data.
City of Gosnells		
Engineering	January 2022	Data sharing of groundwater and geotech information from MKSEA Precinct 2 area
	October 2022	Installation approvals for additional groundwater monitoring locations in City of Gosnells. Agreement to share data.
Main Roads WA		
Environment Branch Planning and Technical Services	December 2022	Hydrological monitoring data sharing-with Main Roads Tonkin Highway Grade Separated interchanges project

2. Existing Environment

2.1 Land Use

The 126 ha Amendment Area is located in the suburb of Wattle Grove in the City of Kalamunda.

The Amendment Area is bound to the north by Crystal Brook Rd and Welshpool Rd East, and bounded to the south and west by the Tonkin Highway, with existing rural landholdings to the east (Figure 1).

Figure 2 shows an aerial photograph with existing land use and topography. The Amendment Area currently comprises a mix of various rural landholdings and a turf farm. A former poultry farm is located on its south eastern boundary, which has not been in active use for over 10 years.

The Dampier to Bunbury Natural Gas pipeline corridor (DBNGPC) runs within the Amendment Area along its Tonkin Highway boundary and is shown in Figure 2.

Natural surface elevations across the Amendment Area vary between 21 mAHD in the west to a high of 35 mAHD at its eastern boundary, with a general fall from east to west.

2.2 Climate

The south west of Western Australia has a Mediterranean climate of hot dry summers and cool wet winters.

Historical annual and seasonal rainfall for the Amendment Area are shown in Figure 3. Based on Bureau of Meteorology Station 009172 (Jandakot Aero), the long term average annual rainfall since 1973 has been 818mm. Since 2000, the average annual rainfall has declined to 758 mm, a reduction of 7%. The majority of rainfall occurs between the months of May and September.

Mean maximum temperatures range from 18.0 ºC in July to 31.8 ºC in January.

2.3 Geotechnical

2.3.1 Environmental Geology

The Amendment Area is predominately located to the west of the Darling Fault (Figure 4).

According to the Armadale 1:50 000 Environmental Geology Series Sheet 2033 I and 2133 IV (Jordan, 1986), the Amendment Area is characterised from west to east (Figure 4) as:

- Thin Bassendean Sand over cohesive materials of the Guildford Formation (S10) – white to pale grey sand at surface, over alluvial deposits of sandy clay to clayey sand of the Guildford Formation.
- Bassendean Sand (S8) – white to pale grey at surface, yellow at depth, fine to medium-grained, moderately sorted, subangular to surrounded, of eolian origin.
- Sand (Yoganup Formation) (S12) - yellow, fine grained sand with minor silt and clay, subangular and medium to coarse grained quartz, of colluvial origin.

2.3.2 Geotechnical Studies

Two geotechnical investigations have been undertaken by Douglas Partners within the bounds of the Amendment Area. The first was conducted in October 2020 and the second in November 2022. Combined, these investigations included excavation of 27 test pits, Perth sand penetrometer (PSP) testing adjacent to each test pit location, installation of 2 groundwater monitoring bores, and infiltration testing at seven locations. Testing locations were subject to property access availability, with sites shown in Figure 4.

The typical ground conditions as described by Douglas Partners (2020) were similar to the regional mapping as follows:

- **Topsoil** – dark grey-brown and grey-brown, sandy topsoil with silt and roots, between 0.1 m to 0.15 m in thickness. Overlying:
- **Bassendean Sand (light grey sand):**

  SAND SP – varying loose to dense, fine to medium grained, light grey and light yellow-brown, with trace silt encountered underlying the topsoil or surficial fill to depths of between 0.5 m and test pit termination depths of 2.5 m at some test locations.
- **Yoganup Formation (yellow-brown sand with various fines content):**

  The sand from the Yoganup Formation is yellow-brown and includes a fines content that increases with depth. When described based on its composition in accordance with AS 1726-2017, the sand is logged as 'Sand trace silt and clay' (up to 5% fines content) near surface, gradually transitioning with depth to 'Sand with clay' (5% to 12% fines content) and then 'Clayey Sand' (greater than 12% fines content):

  SAND SP-SM – generally medium dense to dense, light brown and yellow-brown sand, with low plasticity to non-plastic fines content of between approximately 5% to 12%, underlying topsoil or surficial fill at some test locations and present below the Bassendean sand at another location from 0.8 m depth. Loose sand was encountered at one location to at least 1.0 m depth. Fines content typically increases with depth.

  SAND/Clayey SAND SP-SC/SC – yellow-brown sand with clay/clayey sand (approximately 12% and greater content of low plasticity fines) was encountered from depths of between 0.1 m and 1.6 m extending to depths of between 0.6 m and termination depths of up to 2.5 m in some locations.

  Clayey SAND SC – yellow-brown low plasticity clayey sand was encountered from depths of between 0.6 m and 1.5 m extending to termination depths of up to 2.5 m in some locations.

  The exceptions to the above profile are some localised areas of gravelly sand, fill and coffee rock.

Groundwater was not observed in any test pits excavated on 28 October 2020 or 1 November 2022, to a depth up to 2.9 m.

Copies of the Douglas Partners geotechnical reports are included in Appendix B.

As property access availability has limited the extent of the geotechnical investigation area other sources of data such as bore logs have been used to supplement geotechnical data for this DWMS. Bore locations used to supplement geotechnical data in the north western corner of the Amendment Area are shown in Figure 4.

Extensive geotechnical testing has also been undertaken in close proximity to the Amendment Area for the Maddington Kenwick Strategic Employment Area (MKSEA) on the western side of Tonkin Hwy (Emerge, 2023).

2.3.3 Permeability Testing

Seven in situ infiltration tests were conducted by Douglas Partners at depths between 0.5 m and 1.3 m. In addition, Hyd2o conducted further tests to improve coverage and distribution over the remainder of the Amendment Area. Tests were carried out 27 October 2022 at three locations via a constant head method using a borehole permeameter.

Insitu testing locations are shown in Figure 4 with results summarised in Table 3 below. Douglas Partners soil permeability values ranged from 2.4 m/day to 34 m/day, with the higher rates associated with Bassendean Sands, and lower rates with the Yoganup Formation. Hyd2o tested areas ranged from approximately 12 to 29 m/day, similarly with areas of Bassendean Sands with higher rates.

Douglas Partners anticipate permeabilities will decrease following densification of the soils during earthworks. The Yoganup sand is anticipated to have a generally lower permeability following compaction, and is unlikely to form a suitably drained material for stormwater disposal unless specific additional drainage provisions are adopted. It was recommended clayey sand areas should be considered impermeable for drainage following earthworks.

Hyd2o permeability calculations for test sites HTS1 to HTS3 are contained in Appendix D.

Table 3: Insitu Field Permeability Testing (Hyd2o, Douglas Partners)

Test Site	Test Date	Depth (m)	Soil Description	K_s m/day
Hyd2o				
HTS1	27/10/2022	0.5	Fine to Medium Light Grey Sand	12
HTS2	27/10/2022	0.5	Fine White Sand	29
HTS3	27/10/2022	0.5	Fine to Medium Grey Sand	21
Douglas Partners				
TP3	28/10/2020	0.55	Sand, light grey trace silt, dense	25
TP4	28/10/2020	1.0	Sand, yellow-brown with clay/Clayey Sand (fines content increasing with depth), medium dense	6
TP9	28/10/2020	1.0	Sand, light grey, trace silt, dense	34
TP11	28/10/2020	1.0	Sand, with clay (fines content increasing with depth), dense	7
TP103	1/11/2022	1.0	SAND SP, trace silt, medium dense, pale grey	>20
TP108	1/11/2022	1.0	SAND SP-SM, with silt, loose to medium dense, yellow-brown	7.1
TP111	1/11/2022	1.3	Silty SAND SM, loose to medium dense, orange-brown	2.4

Further permeability investigations were then conducted by Douglas Partners in October 2023 via two boreholes installed to 15 m depth west of Tonkin Hwy adjacent to Boundary Road. Soil samples were collected at approximately 9.5 m, 12 m and 14 m below ground level and falling head permeability testing performed. The results of this investigation indicated a layer of sandy clay soil up to 2.9 m below ground level underlain by silty sands. The permeability tests indicated that the average vertical permeability of the deeper sandy soil to be between 0.26 and 0.42 m/day, indicating a horizontal permeability value (using a conversion factor of 10) of 2.6 m/day to 4.2 m/day.

The above methods used for this DWMS to determine permeability are typical of testing conducted to support development projects across Perth, and given the non-uniformity of soils and the spatial variability of the conductivity test results, are considered appropriate to inform this DWMS.

2.3.4 Geophysical Studies

GBG Group carried out two geophysical subsurface investigations across the Amendment Area. An initial study was conducted in December 2022, which included conducting Electrical Resistivity Tomography (ERT) along six transects, totalling approximately 3.5 km. A further study was conducted in October 2023 with a further seven transects undertaken across 3.5 km.

The objective of the investigation was to obtain subsurface electrical resistivity models for the assessment of interpreted material porosity and permeability, pertaining to geological units acting as aquifers and aquitards. The target depth of the investigation was 50m below ground level.

Transect locations are shown on Figure 5. The initial six transects in December 2022 were taken along Boundary, Brentwood, Crystal Brook and Victoria Roads, Johnson Place, and within the boundaries of 111 and 112 Victoria Road. The October 2023 transects were concentrated in areas adjacent to Tonkin Hwy,

Transect locations were identified and selected on the basis of interpreting previous geotechnical reports, groundwater monitoring data and bore logs, with a view to providing additional information which may assist in the interpretation of groundwater flow direction and perching in the vicinity of the GBSW area.

A copy of the GBG Group (2024) report is contained in Appendix C, with electrical resistivity sections shown in Figures 6 and 7. Sections located in MKSEA (Figure 7) are considered supplementary data to previous more detailed geotechnical studies in those areas.

Data from DWER's Water Information Reporting online database together with other monitoring bore logs and groundwater data were used to assist the interpretation process. These bore locations and logged profiles together with mapped groundwater levels and the base of the superficial aquifer are shown on the transect plots in Appendix C. Bore logs across the full depth of the superficial aquifer were limited to 2 locations; at the Turf Farm (WIR site 61601079) where the logs indicated clay from 3m below surface to the base of the superficial, and midway along Victoria Rd (site WIR 61607569) where sands and clay were recorded before encountering rock at approximately the base of the superficial.

The investigation found sections were generally non-uniform, indicating complex geology in proximity to the scarp.

Below the groundwater table, the low resistivity (high conductivity) zones were interpreted to represent saturated, more permeable materials. These areas near surface broadly aligned with geotechnical investigations. In many areas these more permeable materials extend to the typical depth used to inform development planning for a site.

A number of transects showed large areas of very high resistivity (low conductivity) below the groundwater table, and these are interpreted to represent low permeability areas. These occurred at approximately 10-15 mAHD extending to the base of testing at 50m depth. This was evident at the south end of the Brentwood Rd (Figure 6, T1) and Boundary Rd (Figure 6, T2) sections near Tonkin Hwy. Section from October 2023 testing (Figure 7) showed other areas of very high resistivity (low conductivity) near Tonkin Hwy.

Along Crystal Brook Rd, these large areas of very high resistivity (low conductivity) were largely absent, with the lower resistivity (high conductivity) areas extending to 50 m depth across much of the section. The Johnson Rd (Figure 6, T3) section similarly showed low resistivity (high conductivity) near Crystal Brook Rd with very high resistivity (low conductivity) to the north.

These results and the location of low permeability materials are further discussed in relation to regional groundwater level observations for the Amendment Area in Chapter 4.

2.3.5 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.

The presence of ASS has been a recognised issue of concern in Western Australia since 2003. The Department of Environment and Conservation and the WAPC have released guidance notes on ASS, covering the requirement for assessing sites and the management of sites where ASS is identified. ASS investigations are commonly required as part of the conditions of subdivision or as a requirement for a dewatering license application.

The WAPC's Bulletin 64 (WAPC, 2003) ASS risk mapping for the Amendment Area indicates it is located within an area of moderate to low risk of acid sulfate soils occurring within 3.0 m of natural soil surface.

Notwithstanding, following preparation of detailed engineering plans, further investigation will be undertaken to determine if there is the presence (and any likelihood of disturbance) of ASS and if so, an appropriate management plan will be prepared and implemented in accordance with agency requirements.

2.4 Water Sensitive Ecosystems

The Amendment Area contains two mapped resource enhancement wetlands located adjacent to Tonkin Hwy (Figure 6). These wetlands are largely cleared, with one historically filled and currently grassed as part of a turf farm. Immediately adjacent to the north western

corner of the Amendment Area at the Welshpool Rd and Tonkin Hwy intersection are several conservation category wetlands.

Based on A Methodology for the Evaluation of Wetlands on the Swan Coastal Plain, Western Australia (DBCA 2017), a wetland assessment found the values for both resource enhancement wetlands to be commensurate with that of a multiple use wetland. An application to DBCA to amend the Geomorphic Wetlands Swan Coastal Plain dataset is proposed to be undertaken at local structure planning stage.

The main environmentally significant feature in proximity to the Amendment Area is the conservation category Greater Brixton St Wetland (GBSW) area located on the western side of Tonkin Hwy. The GBSW area is one of the most important wetlands on the Swan Coastal Plain, recognised for its botanical biodiversity attributed to unique geological, geomorphic and hydrological characteristics (Lambers 2019, EPA 2022a).

The GBSW area is of international, national, and regional environmental significance and is listed on the Directory of Important Wetlands in Australia (Environment Australia 2001) and the Department of Climate Change, Energy, the Environment and Water's Register of the National Estate.

The GBSW comprises a series of seasonally inundated or seasonally waterlogged areas, with various areas mapped as either Conservation Category, Resource Enhancement or Multiple Use wetlands. The GBSW was previously spatially defined by the cadastral boundary of Bush Forever site BF387 and has recently been expanded (EPA, 2022a). The extent of the revised GBSW area is shown in Figure 8. The wetland is situated at the foot slopes of the Darling Scarp within the geomorphological unit known as the Pinjarra Plain.

Bush Forever site BF387 is approximately 181 ha in size and has been identified as one of the most important conservation areas on the Swan Coastal Plain, containing more than 550 native plant taxa, Declared Rare Flora, Priority Flora and Threatened Ecological Communities (Bourke, 2017).

Chapter 6 of this DWMS discusses the Amendment Area's hydrological relationship to the GBSW area in detail based on site specific investigations and the outcomes of previous studies of GBSW hydrology including Semeniuk (2001) & Bourke (2017).

2.5 Surface Water

The Amendment Area is located within the catchment of Yule Brook (Figure 9).

Yule Brook is a natural ephemeral watercourse at its headwaters which becomes a network of drains in its lower reaches that are part of the Water Corporation's Yule Brook Main Drain. The Yule Brook has a total catchment area of 56 km^2, most of which is highly modified and includes urban uses such as light to medium industry and high-density residential developments, as well as agricultural uses such as horticulture and poultry farming. The catchment is estimated to be more than 75% cleared (DWER & DBCA, 2016).

It includes Woodlupine Brook, Lesmurdie Brook and Whistlepipe Gully among its tributaries, ultimately flowing to the Canning River in Beckenham. Crystal Brook is also a tributary which has been previously modified to connect to Yule Brook north of the Amendment area. Historical aerial photography and mapping shows Crystal Brook previously flowed through the GBSW area pre 1900, with its current diversion having occured prior to 1953 (Lambers, 2019).

Water quality within Yule Brook varies both seasonally and annually (DWER & DBCA, 2016). Between 2006 and 2016, TN median concentration annually were estimated to range between 0.66 mg/L and 1.10 mg/L, while median TP ranged from 0.07 mg/L and 0.16 mg/L. TN was considered to have an emerging increasing long term trend and TP an emerging increasing short term trend. Overall DWER & DBCA (2016) reported the catchment was meeting its long term TN and TP targets of 1.0 mg/L and 0.1 mg/L respectively, however the Swan Canning Water Quality Improvement Plan (SCWQIP) provides a roadmap to further reduce nutrient inputs and sought a 25% in these targets.

Figure 10 delineates the Amendment Area sub catchments relative to the location of the GBSW area and Yule Brook, showing the key topographic catchment boundaries and existing stormwater pipes and open drains in the vicinity. The Amendment Area has three key outlets which drain under Tonkin Hwy located at the southern ends of Boundary Rd (2 x 900 mm diameter), Brentwood Rd (2 x 350mm diameter) and Victoria Rd (1 x 300 mm diameter). All of these outlets ultimately direct flow toward the GBSW area, albeit via different routes, and in many cases indirectly via constructed roadside trapezoidal drains.

The existing road drainage within the Amendment Area consists mainly of open swales and crossovers/culverts, with limited piped drainage. All of this drainage is well above the regional groundwater table and does not export regional groundwater from within the Amendment Area toward the GBSW area. DWER regional groundwater mapping for the Amendment Area is discussed in Section 2.6, with refined local mapping based on local groundwater levels and site specific data presented in Chapter 4.

Topographically, the majority of the Amendment Area is located in the catchment of the Brentwood Rd culverts. These culverts flow to open road side drains on the southern side of Tonkin Hwy before entering the wetlands approximately 1.8 km downstream.

Based on field inspection, the Amendment Area has no formal external drainage entering its boundary, with an open swale running along the northern boundary of Crystal Brook Road which acts as a cutoff for flow from any catchment to its north.

The Amendment Area represents approximately 2% of the total Yule Brook catchment area and 15% of the GBSW area subcatchment. The Amendment Area surface water contribution to the GBSW however is much less than 15% in part due to its sandy soils and deep groundwater table in comparison to other parts of the catchment. This is further discussed and quantified via water balance modelling in later sections of this DWMS.

2.6 Regional Groundwater Mapping

Until mid-2023, the Department of Water and Environmental Regulation's (DWER) online Perth Groundwater Map, provided two sets of groundwater contours across the Perth metropolitan area which are widely used to assist and inform land development planning:

a) Minimum groundwater level contours: contours based on May 2003 data, considered representative of a summer minimum groundwater condition.

b) Maximum groundwater level contours: contours based on the historical maximum recorded level at each bore over it entire period of record.

These contour data sets are shown in Figure 11 in relation to the Amendment Area. The DWER historical maximum contours did not cover the Amendment Area. In relation to the minimum groundwater level contour dataset, it estimated groundwater levels across the Amendment

Area ranged from approximately 11.5 mAHD in its north western corner to 16.0 mAHD in the elevated eastern boundary area. Groundwater flow was broadly mapped as being in a westerly direction.

In mid-2023, DWER revised the groundwater information reported on the Perth Groundwater Map to report only the Gnangara Jandakot maximum and minimum water table contours for 2019, and previous datasets were removed. Advice from DWER indicates these revised contours account for the declines and rises in water tables in recent decades and the impacts of current climate trends.

These contours are understood by Hyd2o to be based on the contouring of the actual recorded maximum groundwater levels at DWER bores in 2019, although the mapping does not necessarily maintain the integrity of data values at all groundwater sites during the mapping process. These contours are also shown in Figure 11.

These contours show a considerable shift in groundwater flow direction from the Amendment Area compared to previous DWER contouring. Groundwater flow is broadly mapped in a south westerly direction from the Amendment Area as opposed to westerly in previous mapping (Figure 11). This revised mapping is significant in the context that it shows groundwater flow from the Amendment Area being estimated by DWER to be largely not toward the GBSW area in comparison to previous published DWER mapping.

The Perth Groundwater Atlas (Department of Environment, 2004b) provided details of all DWER bores and groundwater levels used for the May 2003 summer minimum regional mapping process. The closest DWER bores used in this mapping process and their proximity to the Amendment Area are detailed in Figure 12. Hyd2o understand a similar dataset of bores has been used for the updated DWER 2019 mapping.

There is an absence of any bores within a 5km radius of the Amendment Area and no bores to the east. Due to the absence of bores in proximity to the Amendment Area, the DWER regional mapping levels and flow direction can be considered indicative only.

More detailed site specific investigations were therefore undertaken to provide refined local mapping of groundwater levels and flow directions. Hyd2o installed three bores within the Amendment Area in November 2020 at the commencement of a pre development monitoring program. A further 12 bores were installed in July 2022 and 4 additional bores in October 2022. Across the MRS amendment area and its immediate surrounds, Hyd2o currently monitor water levels at 23 bores, which includes other bores in the vicinity of the Amendment Area installed via other previous monitoring programs.

These bores together with other nearby previously monitored bores from local studies are used to map local groundwater level for the Amendment Area in Chapter 4.

2.7 Groundwater Use

The Amendment Area is located within the Shire of Kalamunda Groundwater Management Subarea. While DWER's Water Register indicates the superficial aquifer in this area still has water available for allocation, DWER have advised the aquifer is nearing full allocation.

Deeper aquifers such as the Leederville and Yarragadee are fully allocated in this area.

Based on review of DWER's Water Register the Amendment Area currently has 14 existing groundwater licences in the superficial aquifer with a total allocation of approximately 264,000 kL/yr.

This includes a superficial aquifer licence of 176,000 kL/yr for the existing turf farm.

Extracts from DWER's Water Register are included in Appendix E.

2.8 Nutrient Input & Output

The Urban Nutrient Decision Outcomes (UNDO) model is a conceptual decision support tool developed by DWER that evaluates nutrient reduction decisions for urban developments on the Swan Coastal Plain in south-west Western Australia. It is designed for ease-of-use by urban development proponents and for assessment by local and state government authorities.

The tool was developed by DWER as an industry standard to assess the nutrient impacts of urban development on the Swan Coastal Plain in a consistent and scientifically rigorous manner, and improve scientific understanding relating to nutrient issues, and efficiencies in the investment to manage nutrients. The tool is web-based, and provides users with the ability to implement a range of structural or non-structural design options to evaluate and reduce nutrients exported from an urban development.

Although UNDO doesn't include turf farms as a specified use in the model, bowling greens are included and have been used as a turf farm surrogate for this analysis, with the area increased to reflect the increased total annual nutrient application that would occur at a turf farm. The Department of Water (2010) Survey of Urban Nutrient Inputs on the Swan Coastal Plain report indicates nutrient application rates for turf farms as 432.8 kg/ha/yr for TN and 14.5 kg/hr/hr for TP, which are more than double that of a bowling green.

The existing land use model also reflects the existing use of septic tanks and livestock within the Amendment Area, but does not reflect any potential legacy uses such as the disused chicken sheds.

UNDO modelling results are summarised in Table 4. Nutrient inputs of 13,772 kg/yr of TN and 1,405 kg/yr of TP to the environment are estimated to occur annually from within the Amendment Area.

The resultant nutrient export was 329.2 kg/yr of TN and 18.8 kg/yr of TP. These export estimates consider soil types, groundwater gradients, and depth to groundwater in its calculation.

Modelling outputs of the Amendment Area's existing land use using UNDO are detailed in Appendix F.

Estimates of post development nutrient input and export rates following land use change are addressed in Section 8.4 of this DWMS.

Table 4: Amendment Area Nutrient Inputs and Outputs for Existing Land Use

Nutrient	Annual Input (kg/yr)	Annual Export (kg/yr)
Total Nitrogen (TN)	13,772	392.2
Total Phosphorous (TP)	1,405	18.8

3. Local Monitoring and Previous Programs

To assist in protecting the GBSW area, EPA (2022a) requires appropriate and site-specific investigations to be undertaken both in a local and regional context, supported by the best available scientific evidence.

The following Chapter provides a summary of previous and current monitoring programs conducted within the Amendment Area and its proximity to inform this process.

Previous programs and the data they provide have been used in this DWMS to inform the current Amendment Area monitoring program being undertaken and for the refinement of local groundwater mapping. These results have also assisted in the interpretation of regional and perched groundwater systems, and supplement water quality data at common sites.

The current Amendment Area monitoring program commenced with the installation of bores in October 2020 and is measuring groundwater and surface water levels and water quality. This monitoring program was commissioned and supported by Hesperia in recognition of the Amendment Area's proximity to the GBSW area.

The program has continued to be built upon in consultation with agency advice and has been ongoing for a period of more than 3 years.

3.1 Previous Programs in Vicinity of Amendment Area

3.1.1 GBSW Area Monitoring (Semeniuk, 2001)

Semeniuk (2001) detailed a hydrological study of the GBSW area undertaken on behalf of The Friends of Brixton Street Wetlands. The study aimed to identify and describe key aspects of hydrology important to maintaining vegetation and flora diversity.

The study included the installation of groundwater monitoring infrastructure in 1999 and monitored over an 18 month period. This included drilling at 6 locations and the installation of 34 piezometers along 8 transects. Locations are shown in Figure 13.

Key findings of the Semeniuk (2001) investigation are discussed in Section 6.1.

3.1.2 MKSEA Monitoring (Endemic, 2012)

Endemic (2012) reported the outcomes of predevelopment monitoring for the Maddington Kenwick Strategic Employment Area (MKSEA), which included monitoring of groundwater (11 bores), wetlands water levels (8 locations) and surface water (8 locations) during the 2009 to 2011 period. Endemic monitoring locations are shown in Figure 13.

Groundwater bores were installed in June 2009 and were installed to a maximum depth of 6m below surface. Individual bore depths varied depending on the superficial geology and groundwater depth encountered at each location. The shallowest bore depths were between 1m to 2.5m below ground level and these were bores within the GBSW area. Typically the shallow bore depths were limited by refusal, inferred as due to the presence of underlying calcrete.

3.1.3 MKSEA Precinct 3A Monitoring (Emerge, 2018)

Emerge Associates (2018) documented a Local Water Management Strategy to support the structure plan for the MKSEA Precinct 3A Outline Development Plan. A groundwater

monitoring program was undertaken across that site in 2016 to assess local hydrological characteristics.

Nine bores were installed in addition to 2 existing bores aiming to provide greater coverage and resolution of local groundwater data. The locations of all groundwater bores are shown in Figure 13.

3.1.4 Tonkin Highway Monitoring (360 Environmental, 2019)

Arup Pty Ltd undertook the installation of groundwater and surface water monitoring sites on behalf Main Roads in October 2019 as part of a preconstruction monitoring program related to the upgrade of Tonkin Hwy between Roe Hwy and Kelvin Rd.

A total of 5 monitoring bores and two surface water monitoring sites were established near the corner of Welshpool Rd and Tonkin Hwy (Figure 13). Bores are monitored 360 Environmental quarterly for levels and quality including physical parameters, hydrocarbons, nutrients, metals, cations, and anions.

3.1.5 MKSEA Precinct 1 Monitoring (Onging)

Twelve monitoring bores were installed within properties at Victoria Road Kenwick to assist hydrological investigations for the preparation of an Urban Water Management Plan within the MKSEA Precinct 1 area. Locations are shown in Figure 13.

Groundwater bores were installed and monitored in October 2022. Nested deep and shallow bores were installed at several locations to inform the characterisation of any perching and the regional groundwater table.

3.1.6 DBCA GBSW Area Monitoring (Ongoing)

DBCA have been undertaking hydrological monitoring to assist characterisation of the condition and function of GBSW in the Wanaping Block area near Brixton St.

This monitoring has been ongoing since 2016 and includes surface water monitoring at 11 locations and groundwater at 3 bores. Data loggers have been implemented to obtain high resolution water levels, supplemented with regular manual measurements. Water quality sampling is undertaken at the end of summer and spring for major ions, nutrients and stable isotopes. Monitoring locations are shown in Figure 13.

3.2 Amendment Area Monitoring Program (Urbaqua, 2019)

Urbaqua (2020) previously undertook a monitoring program over an area which included the Amendment Area on behalf of the City of Kalamunda from July 2019 to September 2020. This program initially installed a number of groundwater monitoring bores and identified six locations for surface water monitoring including the 2x900mm diameter culverts under Tonkin Hwy near the Welshpool Rd intersection. Monitoring locations are shown in Figure 13.

No monitoring of groundwater was undertaken which was agreed in consultation with DWER due to the depth of groundwater encountered during drilling. DWER urban development monitoring guidelines typically do not require predevelopment groundwater monitoring where the groundwater depth exceeds 5m.

With respect to surface water quality, the following summarises the results at the 2x900mm diameter culverts under Tonkin Hwy near Welshpool Rd:

- In situ pH ranged from 7.04 to 9.01, with the mean of 7.83 within the ANZECC (2000) guideline range of 6.5-8.0.
- Electrical Conductivity (EC) ranged from 1130 µs/cm to 1812 µs/cm (mean 1527 µs/cm), well above the ANZECC guideline range for freshwater of 120-300 µs/cm.
- Total Nitrogen (TN) ranged from 1.6 mg/L to 3.9 mg/L (mean 2.5 mg/L), consistently above the ANZECC (2000) guideline value of 1.2 mg/L.
- Total Phosphorus (TP) ranged from 0.08 mg/L to 0.21 mg/L (mean 0.13 mg/L) consistently exceeding the ANZECC (2000) guideline value of 0.065 mg/L.

DWER reviewed and assessed the Urbaqua (2020) monitoring report and provided written advice that the program undertaken was suitable and satisfied DWER's requirement for pre development monitoring for the area in accordance with Better Urban Water Management (WAPC, 2008) requirements.

Relevant data from the Urbaqua program has been included in the Amendment Area's FIELDAE water quality monitoring database and assessed accordingly as part of this DWMS.

3.3 Amendment Area Monitoring Program (2020- present)

In recognition of the Amendment Area proximity to the GBSW area, an additional monitoring program to the Urbaqua (2020) monitoring program was commenced by Hyd2o in November 2020.

This monitoring builds from Bourke (2017), which found that while many previous studies and monitoring programs had been undertaken in the area, there was still scope to improve the hydrological understanding of the area through additional monitoring.

This program remains ongoing and data from this program will continue to assist and support improvements in water management for the wetlands.

The program was developed in consultation with DBCA and DWER and was based on a review of previous reporting and data as described previously in this Chapter.

The program considered where possible to use historically monitored sites so existing datasets can be built on and used to assist analysis and interpretation. DBCA and Main Roads provided data to assist this process. DWER data was obtained from the Water Information Reporting (WIR) database, with DWER advising they did not have any further monitoring data to provide other than that which was publicly available via WIR for assessment.

The monitoring program includes:

- Sampling groundwater quality and levels within, upstream, and downstream of the Amendment Area, with the selection of sites to enable a review of data in the context of groundwater quality closer to the GBSW area.
- Surface water quality upstream and downstream of the Amendment Area, and within the GBSW area where stormwater inflow and outflows occur.

Monitoring locations are shown in Figure 14. A total of 12 bores were installed in July 2022 and a further 4 bores in October 2022 to build on the initial 3 bores installed in 2020. The initial bores were installed by eDrill, with Direct Push Probing (DPP) installing bores in 2022.

Paired deep and shallow bores exist at 8 locations. Sites for paired bores were based on a review of a deeper bore soil log which indicated the possibility that perching may occur at higher levels, or following a review of the historical hydrograph from a shallow bore which indicated it may be reporting a perched level and not representing the regional water table in that area.

Bore logs for all installed bores are included as Appendix G, with bore survey details contained as Appendix H. Tabulated construction details for all bores are included in Appendix G including screen intervals at each bore, and drill depths in m and mAHD. Bores were typically screened for 3m at the required depth with a bentonite seal.

Deep bores were typically drilled to 12-14 mAHD, which based on review of available DWER regional mapping of summer minimum levels and other nearby bore construction data and their recorded water levels indicated construction at that depth was into the top of the superficial aquifer. Hydrographs for three bores initially installed by Hyd2o (WG1, WG2 and WG3) are shown in Figure 15 reflecting a three year monitoring period and showing seasonal behaviour indicative of the regional groundwater table.

Across the MRS amendment area and its immediate surrounds, there are currently 23 bores which are being currently monitored monthly for water levels, and quarterly for water quality at 20 of these. This total number of bores exceeds DWER advice provided in October 2022, which advised 8-10 bores within the MRS amendment area would be adequate to inform an understanding of groundwater behaviour. A further 3 nearby DWER bores are also monitored monthly for water levels for correlation of results to longer term data. These three sites (SCC 05/08, SCC 06/08, SCC 09/08) are shown in Figure 14.

Table 5 provides a summary of the Amendment Area's pre development monitoring program. All monitoring data collected during the programme was managed in Hyd2o's FIELDAE monitoring database. All monitoring data collected to date is provided in Appendix I, inclusive of relevant data from other previous programs where sites in common have been used. All laboratory testing was conducted by NATA approved MPL Laboratories. Reports are contained as Appendix J together with Hyd2o sampling protocols and an MPL testing method summary.

With respect to water quality monitoring parameters, in addition to nutrients and heavy metals, monitoring for traces of common herbicides and pesticides was also undertaken for a short period based on DBCA's recommendation. All herbicide and pesticide monitoring result were below the limit of detection. Laboratory results of this testing is included in Appendix J

A further once off monitoring occasion in February 2023 was conducted as requested by DWER to conduct a full analysis suite which included additional parameters such as Bicarbonate, Total Dissolved Solids, Total Hardness, Total Alkalinity, Ions, Aluminium, Iron and Bromide. A summary table of this testing is included Appendix I, with laboratory results included in Appendix J. Further full analysis suite testing is proposed to be undertaken during winter 2024 in consultation with government agencies.

Data is assessed in Chapters 4 and 5 of this DWMS, and will continue to be assessed and reported on in future planning documents in accordance with the Better Urban Water Management (WAPC, 2008) framework and requirements. This data and its assessment and analysis forms an integral part of the proposed adaptive management approach detailed in later stages of this DWMS for water management of the Amendment Area.

Table 5: Ongoing Predevelopment Monitoring Program

Monitoring	Parameter	Location	Method	Frequency and Timing
Groundwater Level	Water Level (mAHD)	23 bores within and in proximity to the Amendment Area plus 3 DWER bores	Electrical probe or similar	Monthly
Groundwater Quality	Physical parameters, Nutrients, Heavy Metals Full Analysis Suite*	20 bores within and in proximity to the Amendment Area	Pumped bore sample	Quarterly (Aug 2022 to Apr 2023 Bi Monthly) * Periodic
Surface Water Quality	Flow, Physical parameters, Nutrients, Heavy Metals	3 Amendment Area outlets 1 Amendment Area inflow 5 downstream locations	Visual Estimate of Flow Grab sample via telescopic sampler	Up to 4 occasion in Winter (if flowing)

4. Local Groundwater Assessment

4.1 Local Groundwater Levels

Hyd2o oversaw the installation of 14 bores within the Amendment Area across three installation occasions dating from November 2020 to October 2022. Within the same time period a further 5 bores were installed in proximity to the Amendment Area. Bores installed comprise of both shallow and deep bores placed to capture both the superficial aquifer and any potential perched systems. All bore locations are shown in Figure 14, with lithological logs contained in Appendix G. The deep slotted bores are considered to represent the regional groundwater table.

Groundwater level hydrographs for all Hyd2o bores are contained as Appendix K.

Recorded groundwater levels on 27 October 2022 representative of a winter peak and 23 January 2023 representative of a summer condition for the Amendment Area are contoured in Figure 16, showing a groundwater mound evident along the central western boundary adjacent to Tonkin Hwy.

The calculation of average annual maximum groundwater level (AAMGL) contours and maximum groundwater level (MaxGL) contours for a site represents standard practice for land development projects to normalise recorded data and consider the variability in groundwater levels which occur across wet and dry periods. The Hyd2o bores together with the following additional 17 sites (refer Section 3.1) were used to map the AAMGL and MaxGL for superficial aquifer groundwater levels in proximity to the Amendment Area:

a) Main Roads bores along Tonkin Hwy (BH001, BH007, BH014, BH010)

b) Closest DWER bores (SCC 06-08, SCC 05-8, SCC 09-08, 675B)

c) DBCA bores in the GBSW area (WAN01, WAN02, WAN03)

d) MKSEA Precinct 1 Bores (MW201S, MW202D, MW203D, MW205D, MW208D)

e) Douglas Partners bore within the Amendment Area (Mbb).

Construction details and logs for these additional bores are also provided in Appendix G.

Recorded levels on 27 October 2022 and were used for AAMGL and MaxGL calculations which reflect a peak end of winter condition. Online data from two regional DWER bores (SCC 05-08 and SCC 09-08) were used to derive a correction factor to apply to the monitored data and determine the AAMGL and MaxGL over the Amendment Area. This correction factor is used to normalise short term site data to expected longer term annual groundwater level variations based on nearby bores with longer term record.

DWER bore hydrographs as monitored by Hyd2o are contained as Appendix K, with longer term hydrographs based on DWER recorded data contained in Appendix L.

Correction factor calculations are shown in Table 6 with the resulting AAMGL values for the Amendment Area bores shown in Table 7. It should be noted that peak winter water levels in 2022 exceeded the AAMGL condition at the DWER bores, which was a common occurrence across many areas of the Swan Coastal Plain in winter 2022.

Mapped AAMGL and MaxGL groundwater contours are shown in Figure 17 and Figure 18 in the immediate vicinity of the Amendment Area, with Figures 19 and 20 showing the AAMGL contouring extended over a wider area of the Swan Coastal Plain to provide context to

Amendment Area mapping results in comparison to DWER regional groundwater contouring.

AAMGL contours at the Amendment Area range from approximately 16 mAHD in the north eastern region to approximately 19 mAHD on the western boundary. Groundwater flow was found to be radial with a mound evident along the central western boundary adjacent to Tonkin Hwy. The groundwater flow direction within the Amendment Area was found to vary, generally ranging from flowing northwest to flowing south east and away from the GBSW area. Regional groundwater depth is shown as a depth to AAMGL map in Figure 19, with maximum seasonal levels within the Amendment Area ranging from 4m to 20m below natural surface.

Monthly monitoring has shown that the seasonal variation in water table across the Amendment Area varies. Bores WG1, WG2 and WG3 which have been part of the monitoring program since November 2020 have had an average seasonal fluctuation of 0.8m, 1.4m and 2.4m respectively (Figure 15). Mapping of estimated seasonal variation across the Amendment area is shown in Figure 22 based on estimating the Amendment Area average annual minimum groundwater level (AAMinGL). This shows the majority of the site as having a seasonal groundwater variation of less than 1.5m apart from in the north western corner near Tonkin Hwy, and considerably less seasonal variation than areas to the west near GBSW. This variability is attributed to a combination of factors including depth to groundwater, sub surface geology and soil permeability, and also proximity to areas of increased recharge.

Groundwater levels at the bores and the subsequent contour mapping are reflective of end of winter peak readings after two relatively wet years of rainfall (2021 and 2022). This is consistent with DWER bores SCC 05-08 and SCC 09-08 having reported winter 2022 groundwater level peaks at or near maximum readings for their longer term records.

While the contours in Figures 19 and 20 represent an average end of winter condition and some changes in flow direction may occur during other seasonal and interannual periods, the general direction of regional groundwater flow from the Amendment Area away from the GBSW wetland would remain, given the extent of the observed gradient.

Geological and geophysical data is used to assist the interpretation of these mapped contours in Section 4.2.

Table 6: AAMGL for DWER Bores & Amendment Area Correction Calculation

Bores	Period of Record	Groundwater Level (mAHD) Oct-22	AAMGL 2000-2022 (mAHD)	Correction Factor (m)
SCC 05-08	2010 - 2022	23.09	22.74	-0.35
SCC 09-08	2010 - 2022	11.20	10.77	-0.43
Correction Factor for Amendment Area Bores (Based on SCC 05-08 & SCC09-8)				-0.39
Other Nearby DWER Bores				
675B	2000 - 2022	-	15.90	-
SCC 06-08	2010 - 2022	-	6.55	-

Table 7: AAMGL for Regional Groundwater Table

Bore	Installed	Natural Surface (mAHD)	Monitored Date	Water Level (mAHD)	AAMGL (mAHD)	Depth to AAMGL Below Natural Surface (m)
Amendment Area Bores						
WG1	Hyd2o	31.45	Oct-22	16.81	16.42	15.03
WG2D	Hyd2o	25.47	Oct-22	17.98	17.59	7.88
WG3	Hyd2o	22.32	Oct-22	17.76	17.37	4.95
WG4D	Hyd2o	25.11	Oct-22	16.37	15.98	9.13
WG5D	Hyd2o	34.55	Oct-22	16.61	16.22	18.33
WG6	Hyd2o	24.64	Oct-22	18.80	18.41	6.23
WG7D	Hyd2o	22.90	Oct-22	17.43	17.04	5.86
WG9	Hyd2o	23.23	Oct-22	19.51	19.12	4.11
WG10D	Hyd2o	22.88	Oct-22	18.13	17.74	5.14
Mbb	Douglas Partners	31.25	Oct-22	17.61	17.22	14.03
Nearby Bores External to the Amendment Area						
WG8	Hyd2o	41.08	Oct-22	16.64	16.25	24.83
GW5D	Hyd2o	18.81	Oct-22	16.72	16.33	2.48
GW8D	Hyd2o	24.00	Oct-22	18.09	17.70	6.30
GW9D	Hyd2o	21.20	Oct-22	19.10	18.71	2.49
Other Monitoring Program Bores						
BH001	Main Roads	27.71	Nov-20	17.49	17.84 [2]	9.87
BH007	Main Roads	21.42	Nov-20	14.35	14.70 [2]	6.72
BH010	Main Roads	23.41	Nov-20	18.71	19.06 [2]	4.35
BH014	Main Roads	20.00	Nov-20	14.86	15.21 [2]	4.79
WAN01	DBCA	7.10	Oct-21	7.25	7.00 [1]	0.10
WAN02	DBCA	6.30	Oct-21	5.99	5.74 [1]	0.56
WAN03	DBCA	5.70	Oct-21	5.48	5.23 [1]	0.47
MW201S	MKSEA	23.14	Oct-22	18.98	18.59	4.55

Bore	Installed	Natural Surface (mAHD)	Monitored Date	Water Level (mAHD)	AAMGL (mAHD)	Depth to AAMGL Below Natural Surface (m)
MW202D	MKSEA	20.37	Oct-22	17.85	17.46	2.91
MW203D	MKSEA	26.90	Oct-22	18.50	18.11	8.79
MW205D	MKSEA	16.48	Oct-22	14.97	14.58	1.90
MW208D	MKSEA	15.15	Oct-22	12.59	12.20	2.95

1. Correction factor of -0.25m applied to 14 October 2021 reading for AAMGL based on SCC05-08 and SCC 09-08.
2. Correction factor of +0.35m applied to 26 November 2020 reading for AAMGL based on SCC05-08 and SCC 09-08.

4.2 Comparison with DWER Regional Mapping

The mapped AAMGL groundwater contours based on local bore data in Figure 17 are shown over a widened region around the Amendment Area in relation to DWER mapped regional minimum contours in Figure 19 and recent 2019 maximum contours in Figure 20.

Summarising the results of the mapping shown in Figure 19 and 20 in comparison to DWER regional contours:

- While contours are expected to differ given the considerable amount of additional local data used for the AAMGL mapping which was not available for DWER mapping, the mapped AAMGL groundwater contours show a broad general agreement in groundwater flow direction over the wider area with DWER regional mapping.
- In the region south west of the Amendment Area toward the GBSW area, DWER's 2019 maximum contours are mapped as flowing in a south westerly direction from the Amendment Area (Figure 20). DWER's minimum groundwater contour mapping shows flow in a westerly direction (Figure 19). The mapped AAMGL groundwater contours based on local data show flow in a south west direction and are more closely aligned in flow direction with the most recent DWER 2019 maximum contour mapping.
- Groundwater levels were found to vary considerably across all datasets. DWER datasets show minimum groundwater level contour mapping being higher than 2019 maximum contours in many areas. This is due to the absence of any local DWER bores in this area and data being extrapolated. The mapped local AAMGL contours are therefore appropriately considered a refinement of DWER regional mapping and more representative of local conditions being based on recorded local bore groundwater levels and not extrapolated contouring.
- To assess the validity of the mapped local AAMGL contours, several locations were identified where known surface expressions of groundwater exist, and mapping results compared against LIDAR data and observed ponding at those locations. These locations were not previously used in the mapping process and therefore provided an independent validation of local mapping. Once such verification location was the at the corner of Hale Rd and Kalari Rd Wattle Grove, where Hyd2o's AAMGL mapping estimated an AAMGL level of approximately 14 mAHD which was found to be consistent with DWER 1m LiDAR data and observed ponding at this location. The verification process highlighted many areas where differences in DWER mapped groundwater

contours and groundwater expression observations were present, with differences of up to 5m found in areas between Brentwood and Victoria Rd on the southern side of Tonkin Hwy. In all these locations the AAMGL contouring based on local data was found to more accurately represent historical observations.

- The major difference in the direction of groundwater flow based on local AAMGL mapping compared to DWER regional mapping was that groundwater flow was found to be radial within the Amendment Area with mounding evident along the central western boundary adjacent to Tonkin Hwy. The groundwater flow direction within the Amendment Area was found to vary, generally ranging from flowing northwest to flowing south east and away from the GBSW area which is different to DWER mapping which indicated a uniform flow direction to the west and south-west.

While is it not uncommon for site specific investigations based on local data to differ from DWER regional mapping, it is acknowledged that the proximity of the Amendment Area to the GBSW area requires further consideration of the factors which may be contributing to this outcome.

Figure 23 provides an assessment of the approximate extent of the observed local mound. This assessment was based on groundwater contouring of the same area without including bores in the Amendment Area and its immediate vicinity, and differencing this mapping from the local area contouring. The mound can be seen to centre around Tonkin Hwy and the turf farm and range up to 5m in height.

The following factors are identified as likely contributing to the observed groundwater mound occurring in this area:

- **Geology**

  As discussed in Section 2.3.4, GBG Group carried out a geophysical subsurface investigation across the Amendment Area in December 2022 and October 2023. This included conducting Electrical Resistivity Tomography (ERT) testing along a total of 13 transects. The investigation found sections were generally non-uniform even over small distances, reflecting the complex nature of the geology which occurs in proximity to the scarp. Results for the Brentwood Rd and Boundary Rd areas showed large areas of very high resistivity (low conductivity) below the groundwater table at approximately 10-15 mAHD extending to the base of testing at 50m depth. These very high resistivity (low conductivity) areas below the water table are interpreted as low permeability areas.

  This was also evident at other sections, predominately in areas near Tonkin Hwy. Along Crystal Brook Rd, these large areas of very high resistivity (low conductivity) were largely absent, with low resistivity (high conductivity) areas below the water table extending to 50 m depth across much of the section.

  Figure 24 provides a spatial representation of the areas of high resistivity (low conductivity) in relation to the Amendment Area estimated AAMGL. This mapping found that in many of the areas where the high resistivity (low conductivity) materials were present, mounded groundwater levels would reach or exceed the level of the low resistivity (low conductivity) materials, indicating an impact of these areas locally on flow direction and groundwater levels. This was observed to occur particularly in the areas near Tonkin Hwy.

Figure 24 also highlights these outcomes in the context of environmental geology mapping which shows more permeable sandy soils within the Amendment Area and less permeable soils associated with the Guildford formation to the west.

The local variability in sub surface geology and existence of localised high and low permeability areas is likely to be a major factor influencing local groundwater flow directions and levels within the Amendment Area, which is broadly observed in monitoring data as occurring toward more permeable soil types.

- **Irrigation**

  As detailed in Section 2.7, licencing within the superficial aquifer has a total allocation of 264,000 kL/yr, which includes a single licence allocation of 176,000 kL/yr. Abstraction and irrigation of this amount locally would be expected to result a considerable net extraction from the relevant aquifer. Groundwater data for the superficial aquifer over the monitoring period has however shown a considerable mound in the vicinity of this licence area rather than a reduction in levels locally.

  This indicates the application of water from a source other than the superficial aquifer in this area is likely to be occurring. Potential other sources include the use of deeper aquifers, such as the Leederville or scheme water.

  DWER's Water Information Reporting database (WIR site 61601079) indicates the presence of a private bore drilled in 1998 in this vicinity to approximately -41 m AHD and screened from -30 m AHD to -40 m AHD which would be representative of the Leederville Aquifer, and this is considered the likely source.

  Since April 2023, the turf production and its irrigation appears to have has ceased and groundwater levels in its immediate vicinity have been observed to reduce. Figure 25 shows the recent hydrographs at the nearest bores to the turf farm, in comparison to other nearby bores within and downstream of the Amendment Area. The falling hydrographs at bores WG6 and WG9 in comparison to other sites highlight the local impact of the previous irrigation on groundwater levels. The decline in groundwater level over summer 2023/24 has been observed to be greater at the nearby bores within the Amendment Area compared to those south of Tonkin Hwy which is interpreted as being representative of more permeable soils in the Amendment Area and groundwater flow more readily moving and normalising in this direction. Groundwater level and quality monitoring of these changes are ongoing.

While the previous turf farm irrigation and now cessation is not development related, it is acknowledged these changes in water application and recharge may affect groundwater levels and water quality locally.

The DWMS has been prepared consistent with acknowledging EPA Inland Waters objective of maintaining the existing hydrological regime, and therefore considers the existing environment under turf farm irrigation to represent the baseline condition for assessment, and representative of the local hydrological conditions in proximity to GBSW over many years. The DWMS respects the impact that potential changes in groundwater level and flow may have in this area and uses this to inform the development of the water management strategy for the Amendment Area detailed in Chapter 7.

The extent to which the ceased irrigation at the turf farm from the deeper aquifer will impact groundwater levels locally is difficult to quantify given the variable geology of the area. While both WG6 and WG9 have shown downward trends since irrigation ceased, other

nearby bores GW9D and WG3 have shown little impact. Groundwater levels will continue to be monitored as development proceeds and used to inform the water management strategy using an adaptive management approach.

Further assessment of these existing groundwater levels and the management of changes in flow direction as a result of land use change is detailed in Section 8.2.

4.3 Perched Groundwater Assessment

The remaining 6 bores installed by Hyd2o not used for regional groundwater mapping were used to assess the potential of perched groundwater within the Amendment Area. Maximum readings recorded at each bore are contained in Table 5.

A number of the shallow bores installed where soil profile indicated perching may occur were recorded dry on all occasions.

A large number of shallow bores were also constructed during previous studies (Semeniuk 2001, Endemic 2012) by hand auger techniques to a depth of refusal, with refusal typically recorded as being due to a hardpan or calcrete layer being encountered. Data recorded from these locations typically represent a perched groundwater level which temporarily forms for several months above the hardpan, rather than the regional groundwater table.

These locations identified via Semeniuk (2001) and Endemic (2012) were used to provide an indicative map of perched levels as shown in Figure 26 to compare with the regional water table. Table 5 summarises the locations and levels used for this analysis.

Figure 26 shows the differences in perched and regional groundwater elevations within the Amendment Area and in the GBSW area south of Tonkin Hwy where the regional water table is in closer proximity to natural surface.

The perched groundwater flow is observed to be typically in a south west direction. This mapping is broadly similar to that detailed in Emerge Associates (2018). In areas along the southern side of Tonkin Hwy adjacent to the Amendment Area boundary perching was found to occur 1m to 3m above the regional water table, while in some of the central and southern areas of the GBSW, the regional water table and perching were found to be closer in elevation. This finding is consistent with the hydrological behaviour of the GBSW area described in Semeniuk (2001).

The extent to which any regional water table interactions with the perched water table would occur is however also dependent on the presence and extent of hardpan layers within the GBSW area. Semeniuk (2001) and Endemic (2012) provide some detail to the extent of the hardpan layers, which is also supported by geotechnical investigations for MKSEA summarised in Emerge Associates (2023).

While some perching is evident in groundwater levels in the north western corner of the Amendment Area near Tonkin Hwy, no perching was evident at most bores.

There are a small number of unlined drains in the Amendment Area near Brentwood Rd near Crystal Brook Rd which are located below the perched water table in that area and drain toward the culvert under Tonkin Hwy and the GBSW area. Development within this area of the Amendment Area will provide an opportunity for treatment and improved management of any flows.

It is also noted anecdotal evidence from landholders in the Amendment Area have suggested groundwater levels in proximity to the Dampier to Bunbury Natural Gas Pipeline Corridor (DBNGPC) adjacent to Tonkin Hwy reduced following excavation for the pipeline.

Table 6: Locations & Levels for Mapping of Perched Groundwater

Bore	Installed By	Natural Surface (mAHD)	Monitored Date	Water Level (mAHD)	Depth Below Natural Surface (m)
Amendment Area Bores					
WG2S	Hyd2o	25.21	Aug-22	22.50 (Dry)	2.71
WG4S	Hyd2o	25.11	Aug-22	24.50	0.61
WG5S	Hyd2o	34.54	Aug-22	29.33 (Dry)	5.21
WG7S	Hyd2o	22.85	Aug-22	19.82 (Dry)	3.03
WG10S	Hyd2o	22.80	Oct-22	20.47	2.33
Bores External to Amendment Area					
Mba	Unknown	20.03	Oct-21	18.96	1.07
GW2	Endemic	13.41	Aug-11	13.41	0.00
GW3	Endemic	8.97	Aug-22	8.56	0.41
GW4	Endemic	12.53	Aug-11	12.53	0.00
GW5S	Endemic	18.84	July-21	18.55	0.29
GW8S	Endemic	24.00	Aug-22	21.06	2.94
GW9S	Hyd2o	21.19	Aug-22	19.70	1.49
GW12	Endemic	8.90	Aug-22	8.79	0.11
CellA T3A	Semeniuk	6.00	Oct-99	5.20	0.80
CellA T2C	Semeniuk	5.50	Aug-99	5.00	0.50
CellBF	Semeniuk	7.00	Oct-99	6.80	0.20

5. Surface Water and Groundwater Quality

5.1 Groundwater Quality

Groundwater quality monitoring by Hyd2o to inform the predevelopment environment baseline has comprised of sampling commencing in May 2021 with the number of bore locations expanding to include newly installed bores and bores external to the Amendment Area, particularly in reference to the GBSW area. Currently 20 bores within and in proximity to the Amendment Area are being monitored for water quality. Locations are shown in Figure 27 along with a general monitoring summary of each individual site.

Data to December 2023 is summarised below in Table 9 and is aggregated to reflect groundwater quality at either shallow or deep bores within the Amendment Area or west of Tonkin Hwy in proximity to the GBSW area. Data has also been supplemented with historical Endemic (2012) data collected from 2009 to 2011. Note that where longer term data via previous monitoring programs also exists, data summaries for only the most recent 2021-2023 monitoring conducted by Hyd2o is also provided in Table 9 and Figure 27.

Summary results via the FIELDAE database are provided in Appendix M for individual sites, with aggregated reporting at various scales (ie shallow/deep bores, Amendment Area/West of Tonkin Hwy) detailed in Appendix N.

General comparison to ANZECC (2000) guidelines for wetland ecosystems in south-west Australia and freshwater ecosystem trigger values is as follows:

- Median EC at both shallow and deep bores within the Amendment Area are higher than the respective medians of shallow and deep bores west of Tonkin Hwy. Only the median for shallow bores within the Amendment Area (2.25 mS/cm) fell outside the ANZECC guideline range (0.3 – 1.5 mS/cm).
- Median pH's for all bore groups, except for shallow bores west of Tonkin Hwy (7.11), have indicated some acidity and fall outside the ANZECC guideline range (7.0 – 8.5).
- Median TN readings at deep Amendment Area bores (3.65 mg/L) and shallow bores west of Tonkin Hwy (2.70 mg/L) exceeded the ANZECC guideline (1.50 mg/L). Within these aggregations WG9 and GW12 have reported high exceedances of 52.0 mg/L and 8.4 mg/L respectively during the monitoring period. GW5D reported the highest reading across the deep bores west of Tonkin Hwy (5.50 mg/L).
- The median NO_x-N values for shallow (0.17 mg/L) and deep (2.20 mg/L) Amendment Area bores exceeded the ANZECC guideline (0.1 mg/L). Within their aggregations, WG9 and GW3 have reported high readings of 44.0 mg/L and 7.55 mg/L respectively during the monitoring period. Medians for all aggregations fell within the ANZECC guideline for NH_3-N (0.9 mg/L).
- Medians for all aggregations fell within the ANZECC guideline for TP (0.06 mg/L) with the exception of the shallow bores west of Tonkin Hwy (0.15 mg/L). Within their aggregations WG9, GW12 and GW5D all reported the highest readings of 3.70 mg/L, 1.50 mg/L and 0.42 mg/L respectively.
- Medians for all aggregations fell within the ANZECC guideline for FRP (0.03 mg/L). Within their aggregations WG9, GW12 and GW9D all reported the highest readings of 2.9 mg/L, 0.68 mg/L and 0.06 mg/L respectively.

- Generally, medians for heavy metals across the bore sets fell within the 95% protection trigger value for freshwater ecosystems. The exceptions were median values for Cu and Zn for shallow bores west of Tonkin Hwy.
- Metal readings across the aggregations were generally higher across the bores west of Tonkin Hwy with notably high readings taken at GW5S, GW8S and GW12 (all shallow) as shown in Table 9. The highest metal readings across the deep bores west of Tonkin Hwy were generally reported at GW9D.

Based on groundwater quality monitoring to date nutrient levels in the regional water table appear highest around the Turf Farm and mounding on the Amendment Area western boundary to which WG9 (internal) and GW9D (external) are associated. Nutrient levels were also generally highest at GW5D which is notably downstream of GW9D in a northwest direction. Generally metal levels within the regional table fall within ANZECC trigger values however concentrations are most apparent at GW9D. GW9D is located in the vicinity of the Turf Farm at a cul-de-sac on Brentwood Rd enclosed by an elevated Tonkin Hwy and surrounding private properties.

For perched groundwater nutrient levels have generally been highest at GW3 and GW12. These bores are located furthest away from the Amendment Area and adjacent to the GBSW area with GW3 located in a road reserve and GW12 located within a rural property on Brook Rd. Metal concentrations have generally recorded highest at bore GW8S and GW12. Both GW8S and GW12 are located in areas slightly lower to an adjacent long existing road and levels may be a result of road runoff over time.

With respect to the poultry farm and disused chicken sheds near the Amendment Areas eastern boundary, water quality sampling at nearby bore WG2 and MBb do not indicate elevated nutrient levels relative to other bores, with median TN levels considerably lower than the Amendment Area median across all sites.

The chicken sheds will be subject to separate soil and groundwater investigations in in due course as planning progresses to determine if any remediation works are required.

With respect to ASS, while WAPC's Bulletin 64 (WAPC, 2003) ASS risk mapping for the Amendment Area indicates it is located within an area of moderate to low risk of acid sulfate soils occurring within 3.0 m of natural soil surface, DWER's review of February 2023's full analysis suite (Appendix I) indicated the likely presence of ASS within the groundwater fluctuation zone around bore GW5D located approximately 200 m west of the Amendment area on the southern side of Tonkin Hwy.

Further investigation of ASS will be required as planning progresses to determine the presence and extent of any ASS, and an appropriate management response and plan prepared and implemented in accordance with agency requirements.

5.2 Surface Water Quality

Surface water quality monitoring has been conducted since winter 2021, with sampling occurring at 9 locations when sites were observed to be flowing. Sampling was inclusive of locations upstream of the Amendment Area (SW1), outlets to cross Tonkin Hwy (SW2 to SW4) and locations downstream (west of Tonkin Hwy) to capture drainage flow paths across the GBSW area towards Yule Brook (SW5 to SW9). The majority of these sites are roadside open drains. Sampling locations are shown in Figure 28 along with a general monitoring summary for each individual site.

Data to December 2023 is summarised below in Table 10 and is aggregated to reflect surface quality upstream of the Amendment Area, leaving the Amendment Area, or downstream which is essentially west of Tonkin Hwy in proximity to GBSW. Data has also been supplemented with historical Endemic (2012) data collected from 2009 to 2010 as well as Urbaqua (2020) data collected from 2019 to 2020. Note that where longer term data via previous monitoring programs also exists, data summaries for only the most recent 2021-2023 monitoring conducted by Hyd2o is also provided in Table 10 and Figure 28.

Similarly to groundwater, summary results via the FIELDAE database are provided in Appendix M for individual sites, with aggregated reporting (upstream, Amendment Area, downstream) detailed in Appendix N.

General comparison to ANZECC (2000) for lowland river ecosystems in south-west Australia and freshwater ecosystem trigger values is as follows:

- Median EC at upstream sites fell within the ANZECC guideline range (0.12 – 0.3 mS/cm). Median EC at locations downstream was next highest with a value of 0.56 mS/cm and Amendment Area outlets recorded the highest median with a value of 1.086 mS/cm.
- Median pH across all sampling groups fell within the ANZECC guideline range (6.5 – 8).
- Median TN values for both the Amendment Area outlets (2.25 mg/L) and the locations west of Tonkin Hwy (1.80) exceeded the ANZECC guideline (1.2 mg/L). Outlet SW2 had a high exceedance value of 18 mg/L while SW7 recorded the highest reading for a downstream location (3.6 mg/L).
- The median value for NO_x-N across the Amendment Area outlets (0.97 mg/L) exceeded the ANZECC guideline (0.15 mg/L) with the highest reading recorded at SW2 (5.4 mg/L). The highest reading downstream was 1.30 mg/L at SW7.
- Median NH_3-N values across all sampling groups fell within the ANZECC guideline (0.9 mg/L). The highest Amendment Area outlet recording was at SW3 (0.77 mg/L) while the highest downstream reading was at SW7 (2.70 mg/L).
- Median TP across the Amendment Area outlets and downstream locations were 0.15 mg/L and 0.14 mg/L respectively, which exceed the ANZECC guideline (0.065 mg/L). The highest reading across the outlets was taken at SW3 (5.6 mg/L) which was a large exceedance while the highest reading downstream was taken at SW9 (0.32 mg/L).
- Median FRP across locations downstream of the Amendment Area (0.07 mg/L) marginally exceeded the ANZECC guideline (0.04 mg/L). The highest value recorded across the Amendment Area outlets occurred at SW2 (0.51 mg/L) while the highest value across the downstream locations occurred at SW9 (0.32 mg/L).
- Medians for heavy metals across all sampling groups fell within the 95% trigger value for freshwater species with the exception of Cu and Zn. Metal levels were generally consistent across sampling groups.
- The highest metals readings were most common at SW2 and SW4 for Amendment Area outlets while SW7 recorded the highest readings for across locations downstream.

Surface flow upstream of the Amendment Area represented by SW1 generally had the best quality with the least ANZECC guideline exceedances. For locations downstream, the highest nutrient and metal concentrations were at SW7, downstream of the GBSW area and prior to discharge to Yule Brook.

Table 9: Predevelopment Groundwater Quality Summary

Parameter	ANZECC Guide (2000)	Amendment Area Bores						Bores West of Tonkin Hwy					
		Shallow			Deep			Shallow			Deep		
		n	*Med.*	*Max.*	n	*Med.*	*Max.*	n	*Med.*	Max.	n	*Med.*	Max.
EC (mS/cm)	0.300 – 1.50[1]	8	2.249	3.622 (WG4S)	94	1.285	9.532 (WG3)	37 *21*	0.706 *0.632[3]*	26.6 (GW12) *4.92[3] (GW3)*	23	0.598	1.496 (GW9D)
pH	7.0 – 8.5[1]	8	5.86	6.95 (WG4S)	95	5.89	6.95 (MBb)	37 *21*	7.11 *6.68[3]*	8.18 (GW12) *7.44[3] (GW3)*	24	6.04	6.6 (GW9D)
TN (mg/L)	1.50[1]	6	0.84	14.0 (WG4S)	86	3.65	52.0 (WG9)	29 *18*	2.70 *2.15[3]*	8.40 (GW12) *8.20[3] (GW9S)*	21	0.62	5.50 (GW5D)
NO_x-N (mg/L)	0.1[1]	6	0.17	1.30 (WG4S)	86	2.20	44.0 (WG9)	28 *18*	0.46 *0.90[3]*	7.55 (GW3) *6.50[3] (GW9S)*	21	0.01	0.4 (GW9D)
NH_3-N (mg/L)	0.900[2]	7	0.01	0.32 (WG4S)	95	0.01	3.40 (MBb)	19 *19*	0.03 *0.03[3]*	0.18 (GW3) *0.18[3] (GW3)*	24	0.05	0.18 (GW5D)
TP (mg/L)	0.06[1]	6	0.05	0.25 (WG4S)	86	0.05	3.70 (WG9)	32 *18*	0.15 *0.16[3]*	1.50 (GW12) *1.40[3] (GW9S)*	21	0.05	0.42 (GW5D)
FRP (mg/L)	0.03[1]	7	0.01	0.01 (WG4S)	95	0.01	2.90 (WG9)	33 *19*	0.01 *0.06[3]*	0.68 (GW12) *0.31[3] (GW9S)*	24	0.01	0.06 (GW9D)
As (mg/L)	0.024[2]	7	0.001	0.001 (WG4S)	95	0.001	0.0051 (WG2)	32 *19*	0.003 *0.001[3]*	0.05 (GW12) *0.016[3] (GW9S)*	24	0.001	0.0062 (GW9D)
Cd (mg/L)	0.0002[2]	6	0.0001	0.00082 (WG4S)	86	0.0001	0.00045 (WG1)	31 *18*	0.0001 *0.0001[3]*	0.0034 (GW8S) *0.0001[3]*	21	0.0001	0.0001
Cr (mg/L)	0.001[2]	6	0.001	0.001 (WG4S)	86	0.001	0.0088 (WG4D)	31 *18*	0.001 *0.001[3]*	1.70 (GW12) *0.0018[3] (GW9S)*	21	0.001	0.0023 (GW9D)
Cu (mg/L)	0.0014[2]	6	0.001	0.001 (WG4S)	86	0.001	0.019 (WG9)	31 *18*	0.004 *0.0028[3]*	0.48 (GW12) *0.006[3] (GW9S)*	21	0.001	0.0099 (GW9D)
Pb (mg/L)	0.0034[2]	6	0.001	0.001 (WG4S)	86	0.001	0.042 (WG6)	31 *18*	0.001 *0.001[3]*	0.19 (GW5S) *0.001[3]*	21	0.001	0.0042 (GW5D)
Ni (mg/L)	0.011[2]	6	0.0016	0.0027 (WG4S)	86	0.003	0.019 (WG3)	31 *18*	0.006 *0.0052[3]*	0.98 (GW8S) *0.023[3] (GW9S)*	21	0.0085	0.035 (GW9D)
Hg (mg/L)	0.0006[2]	6	0.00005	0.00005 (WG4S)	86	0.00005	0.00031 (WG9)	31 *18*	0.00005 *0.00005[3]*	0.0006 (GW8S) *0.00005[3]*	21	0.00005	0.00005
Zn (mg/L)	0.008[2]	6	0.0034	0.046 (WG4S)	86	0.0072	0.061 (MBb)	31 *18*	0.01 *0.0059[3]*	1.90 (GW12) *0.019[3]* (GW3)	21	0.004	0.023 (GW9D)

1. ANZECC (2000) default trigger values for wetland ecosystems in south-west Australia
2. ANZECC (2000) trigger values for 95% level of species protection
3. Most recent three years of monitoring period (2021-2023) is shown in italics where longer term data via previous monitoring programs also exists
4. Med. – Median, Max. – Maximum, n. - Number of samples

Table 10: Predevelopment Surface Water Quality Summary

Parameter	ANZECC Guide (2000)	Upstream SW1			Amendment Area Outlets SW2, SW3, SW4			Downstream SW5, SW6, SW7, SW8, SW9		
		n	*Med.*	*Max.*	n	*Med.*	*Max.*	n	*Med.*	*Max.*
EC (mS/cm)	0.120 – 0.300[1]	2	0.260	0.352	30 *13*	1.086 *0.309[3]*	1.812 (SW2) *1.434[3] (SW2)*	29 *19*	0.56 *0.45[3]*	5.200 (SW7) *5.20[3] (SW7)*
pH	6.5 – 8.0[1]	2	7.90	8.19	30 *13*	7.53 *7.49[3]*	9.01 (SW2) *8.01[3] (SW2)*	29 *19*	7.34 *7.26[3]*	7.90 (SW7) *7.89 [3] (SW5)*
TN (mg/L)	1.20[1]	2	0.60	0.90	30 *13*	2.25 *1.80[3]*	18.00 (SW2) *18.00[3] (SW2)*	29 *19*	1.80 *1.60[3]*	3.60 (SW7) *3.50[3] (SW7)*
NO_x-N (mg/L)	0.15[1]	2	0.01	0.02	29 *13*	0.97 *0.72[3]*	5.40 (SW2) *5.40[3] (SW2)*	28 *19*	0.04 *0.03[3]*	1.30 (SW7) *1.10[3] (SW9)*
NH_3-N (mg/L)	0.900[2]	2	0.01	0.02	13 *13*	0.04 *0.04[3]*	0.77 (SW3) *0.77[3] (SW3)*	19 *19*	0.02 *0.02[3]*	2.70 (SW7) *2.70[3] (SW7)*
TP (mg/L)	0.065[1]	2	0.05	0.05	30 *13*	0.15 *0.15[3]*	5.60 (SW3) *5.60[3] (SW3)*	29 *19*	0.14 *0.08[3]*	0.32 (SW9) *0.32[3] (SW9)*
FRP (mg/L)	0.04[1]	2	0.01	0.01	30 *13*	0.02 *0.07[3]*	0.51 (SW2) *0.31[3] (SW2)*	29 *19*	0.07 *0.06[3]*	0.32 (SW9) *0.32[3] (SW9)*
As (mg/L)	0.024[2]	2	0.0015	0.002	16 *13*	0.001 *0.001[3]*	0.0047 (SW3) *0.0047[3] (SW3)*	22 *19*	0.0011 *0.001[3]*	0.004 (SW7) *0.003[3] (SW9)*
Cd (mg/L)	0.0002[2]	2	0.0001	0.0001	16 *13*	0.0001 *0.0001[3]*	0.0001 *0.0001[3]*	22 *19*	0.0001 *0.0001[3]*	0.0003 (SW7) *0.0003[3] (SW7)*
Cr (mg/L)	0.001[2]	2	0.001	0.001	16 *13*	0.001 *0.001[3]*	0.006 (SW2) *0.001[3]*	22 *19*	0.001 *0.001[3]*	0.006 (SW7) *0.002[3] (SW7)*
Cu (mg/L)	0.0014[2]	2	0.0035	0.004	16 *13*	0.005 *0.005[3]*	0.100 (SW4) *0.100[3] (SW4)*	22 *19*	0.0023 *0.002[3]*	0.013 (SW7) *0.004[3] (SW7)*
Pb (mg/L)	0.0034[2]	2	0.001	0.001	16 *13*	0.001 *0.001[3]*	0.005 (SW2) *0.003[3] (SW4)*	22 *19*	0.001 *0.001[3]*	0.001 *0.001[3]*
Ni (mg/L)	0.011[2]	2	0.001	0.001	16 *13*	0.001 *0.001[3]*	0.006 (SW4) *0.006[3] (SW4)*	22 *19*	0.0029 *0.002[3]*	0.019 (SW7) *0.019[3] (SW7)*
Hg (mg/L)	0.0006[2]	2	0.00005	0.00005	16 *13*	0.00005 0.00005[3]	0.0001 (SW2) 0.00005[3]	22 *19*	0.00005 *0.00005[3]*	0.0001 (SW7) *0.00005[3]*
Zn (mg/L)	0.008[2]	2	0.0135	0.017	16 *13*	0.018 *0.015[3]*	0.078 (SW4) *0.078[3] (SW4)*	22 *19*	0.013 *0.011[3]*	0.360 (SW7) *0.360[3] (SW7)*

1. ANZECC (2000) default trigger values for lowland river ecosystems in south-west Australia
2. ANZECC (2000) trigger values for 95% level of species protection
3. Most recent three years of monitoring period (2021-2023) is shown in italics where longer term data via previous monitoring programs also exists
4. Med. – Median, Max. – Maximum, n. - Number of samples

6. Relationship to Greater Brixton St Wetlands

EPA (2022a) identifies that a high level of protection and coordinated management is critical for the GBSW area, and expects future activities and development to be compatible with the protection of the environmental values of the GBSW area.

Proponents are required to demonstrate best practice environmental management with adaptability in design and approach to protect the environmental values and supporting ecological and hydrological processes of the GBSW.

This Chapter addresses the hydrological relationship of the Amendment Area with the GBSW area under existing land use. This information is assessed and presented in the context of previous studies and their findings. It also considers climate change and identifies the hydrological differences of the Amendment Area relationship to the GBSW area compared to the Maddington Kenwick Strategic Employment Area (MKSEA).

This information is used together with previous Chapters to identify constraints and opportunities to guide the development of the Water Management Strategy for the Amendment Area in Chapter 7.

6.1 Previous Hydrological Reports

Semeniuk (2001), undertaken on behalf of The Friends of Brixton Street Wetlands, identified and described key aspects of hydrology important to maintaining vegetation and flora diversity. The data collected during the study provided insight into groundwater and surface water processes, detailing the rapid groundwater recharge evident following episodic rainfall events.

Semeniuk (2001) reported that the wetlands were maintained by surface and near surface perching of direct precipitation and by infiltration. During periods of below average rainfall the regional groundwater was considered likely to play only a minor part on the maintenance of the GBSW area, with the major recharge mechanism for the wetlands identified as being direct precipitation, perching, infiltration and sub surface perching.

Endemic (2012) reported the outcomes of predevelopment monitoring for the MKSEA area. This study concluded the wetlands were a result of groundwater perching above a calcrete and/or clay layer with minimal interaction with the regional aquifer.

Bourke (2017) reported a further investigation of the then Department of Parks and Wildlife (DPaW) to develop an understanding of the local-scale hydrological function of the GBSW area under current climate and review predictions made in previous investigations such as Semenuik (2001). The study provided a robust review and evaluation of all previous hydrological data and its shortcomings across the GBSW area, with a detailed focus on the wetland area south of Bickley Rd known as the Brixton and Wanaping blocks.

The report found existing data to be typically limited by short monitoring periods and a lack of deeper bores below the shallow perching layer from which to characterise aquifer behaviour. Bourke (2017) also recognised mapping of the aquifers in the area were limited to regional-scale interpretations only.

Bourke (2017) reported that a common theme of previous investigations was that the GBSW area was predominately a surface water feature, reliant largely on incident rainfall and surface water inflow. Unlined open drains were identified as a key factor having a significant

negative impact on the hydrology of the area, particularly wetland hydro-period via changing the movement of surface and groundwater.

Common to all reports was that incident rainfall and perching was the dominant hydrological process for the GBSW area.

6.2 Existing Land Use Water Balance Modelling

A conceptual water balance was developed for the Amendment Area by Emerge Associates to consider the existing (predevelopment) environment. Modelling outcomes are used to assess the relationship of the Amendment Area with the GBSW area, and inform a baseline condition from which to assess potential impacts of land use change.

The Emerge Associates (2023) report detailing the development of the model and its outcomes is contained as Appendix O. The water balance model quantified key components of inflow and outflow from the Amendment Area as follows:

- Rainfall
- Irrigation inputs from aquifers and scheme water
- Rainfall and irrigation water interception
- Surface water runoff and drainage
- Upstream catchment inflows (including flows from Urban Expansion and Investigation (UEUI) areas identified in the North East Sub-Regional Planning Framework (DPLH, 2018).
- Groundwater throughflow
- Seasonal perched groundwater
- Evapotranspiration
- Recharge

Water balance reporting was done at an annual scale however model calculations of various inputs were performed at variable timescales from daily to hourly. A detailed description of all water balance parameters, assumptions and methodology is presented in Appendix O. The groundwater contours shown in Figure 17 were adopted for the water balance assessment on the basis of being representative of an average winter groundwater condition for the site, with flow directions being effectively similar to actual recorded data.

With respect to hydraulic conductivity, the rates within the water balance model were adopted on the basis of Hyd2o and Douglas Partners site specific testing (Section 2.3.3). Note the adopted rate for Bassendean Sand of 21 m/day is consistent with the range of rates presented in Gelsinary et al (2024) and Salama et al (2005), which reported a range of 4 to 72 m/day and mean of 28 m/day for Bassendean Sands. The adopted rates in the water balance model are also consistent with the range of values presented in CyMod Systems Pty Ltd (2014) for PRAMS modelling, with ranges for Bassendean Sands of 10-50 m/day and 0.1-1 m/day for Guildford Formation.

Modelling results are presented in Table 11 showing the balance of all inflows and outflows for the Amendment Area. Summarising the modelling results:

- Rainfall is the predominant source of inflow to the Amendment Area currently representing approximately 72.1% of the total inflow.

- Irrigation water is estimated to represent the second highest component (22.8%) of inflow. This is largely influenced by existing turf farm water use, which based on groundwater level monitoring observations is assumed to be abstracted from the Leederville aquifer
- There is relatively minor inflow from surface water catchments upstream of the Amendment Area (2.7%) or groundwater throughflow (2.5%).
- In relation to outflows, evapotranspiration totals 48.5% of all water loss.
- The second largest outflow is groundwater throughflow which is 27.5%, inclusive of perched shallow groundwater. Most of this throughflow is away from the GBSW area.
- Surface water outflows from the Amendment Area were found to only comprise a relatively minor component (7.8%) of the total outflow.

Figure 29 summarises the volumetric balance and shows the relationship of the overall water balance to the flows from the Amendment Area toward the GBSW area. The results estimate a total of 158,567 kL/yr of outflow from the Amendment Area broadly flowing toward the GBSW area. Of this 60,421 kL/yr is regional groundwater, representing 38% of the total.

The remaining 98,146 kL/yr is surface water, which is inclusive of 34,536 kL/yr flow from the catchment upstream of the Amendment Area. Of this surface water flow only approximately 32% flows directly to GBSW, with the majority (68%) flowing to MKSEA open roadside drains.

In the context of the GBSW area, this inflow contribution is relatively minor. By comparison, direct rainfall (annual average 758 mm/yr) alone on the surface of the GBSW area (215 ha) contributes 1,629,700 kL/yr. This result is consistent with Semeniuk (2001), Endemic (2012), and Bourke (2017) which report direct rainfall on GBSW to be the dominant inflow process.

Table 11: Predevelopment Water Balance Modelling (Emerge Associates, 2024)

Water Balance Component	**Predevelopment kL & % of total**
Inflows	
Rainfall	928,888 (72.1%)
Upstream catchment inflows	34,536 (2.7%)
Irrigation water application (of superficial aquifer origin)	84,655 (6.6%)
Irrigation water application (of Leederville aquifer origin)	176,000 (13.7%)
Irrigation water application (of scheme water origin)	32,500 (2.5%)
Groundwater throughflow (superficial aquifer)	32,212 (2.5%)
Total Inflows	**1,288,791 (100%)**

Water Balance Component	Predevelopment kL & % of total
Outflows	
Rainfall interception	95,346 (7.4%)
Irrigation water interception	29,316 (2.3%)
Groundwater abstraction (of superficial aquifer origin)	84,655 (6.6%)
Surface water runoff and drainage outflow (inclusive of upstream flows)	100,337 (7.8%)
Groundwater throughflow (superficial aquifer)	346,081 (26.9%)
Groundwater throughflow (perched groundwater)	7,280 (0.6%)
Evapotranspiration (of rainfall)	420,566 (32.6%)
Evapotranspiration (of irrigation water/scheme water)	205,209 (15.9%)
Total Outflows	**1,288,791 (100%)**

6.3 Water Quality Considerations

Lambers (2019) indicates the nutrient poor sediments and lack of nutrients as key drivers for the floral diversity observed in the GBSW area.

Semeniuk (2001) reported groundwater nutrient levels in the GBSW area closest to the Amendment Area (termed Cell D), as ranging from below 0.05 mg/L to 0.25 mg/L for Total Phosphorous (TP) and 1.3 to 8.7 mg/L for Total Nitrogen (TN) for the sampled locations.

Sampling undertaken by Endemic (2012) and recent Hyd2o monitoring are consistent with these results and provide a broadly similar range of values reflecting of the impacts of existing adjacent rural and horticultural land uses.

Nutrient input and export from the Amendment Area are expected to reduce post development as a result of land use change. Estimates of expected post development nutrient levels for the Amendment Area are detailed in Section 8.3.

6.4 Maddington Kenwick Strategic Employment Area

Environmental studies undertaken by Emerge Associates as part of the Maddington Kenwick Strategic Employment Area (MKSEA) further contribute to the overall understanding of the GBSW area and its surrounding environment, however it is important to recognise that the Amendment Area relationship with the GBSW area is considerably different to that of the MKSEA. Hydrological differences between the two locations and their relationship to the GBSW area are summarised as follows:

- The MKSEA area of 585 ha is approximately 5 times the size of the Amendment Area and directly fronts the GBSW area and a 2.5 km length of Yule Brook on both sides. The Amendment Area has no similar direct connection to these areas. The Tonkin Highway and Dampier to Bunbury Natural Gas Pipeline linear infrastructure corridors are located between the Amendment Area and the wetland area.
- Mapped wetlands represent 77% of the MKSEA , compared with 2% of the Amendment Area, with the Amendment Area's regional groundwater depth ranging from 5 m to 20 m below natural surface.
- Regional groundwater flow for the Amendment Area is predominantly away from the MKSEA and BGSW area.
- The MKSEA has a large prevalence of very shallow duplex soils and clays of low permeability, resulting in seasonal perching, waterlogging, and runoff.
- Unlined surface water drains in the MKSEA area intersect and drain regional and perched groundwater. This both affects runoff and water quality into the GBSW area and also impacts the wetland hydro-period by draining groundwater. These impacts are identified by Semeniuk (2001) and Bourke (2017) as key factors influencing the GBSW area hydrology. This is not the case within the Amendment Area, where unlined surface drains are located well above the regional groundwater table and do not drain the regional water table and mobilise these flows toward the GBSW area.

Notwithstanding the hydrological differences between MKSEA and the Amendment Area and their relationship with GBSW, land use change within MKSEA will similarly implement best practice water management with development, which provides an opportunity for collective improvement in overall water management for the natural environment.

6.5 Future Climate Considerations

Bourke (2017) reported that the decline in rainfall in south west WA of the last 30 years had likely already resulted in changes to the hydrological cycle of the GBSW area and that it would continue to do so in future. Semeniuk (2001) also considered the impact of longer term climate variability on vegetation as one of the most pressing issues from his study.

The Department of Water's (2015) Selection of Future Climate Projections for Western Australia report, provides average rainfall projections for Perth Airport to 2050 of approximately 580 mm for a dry climate scenario (Cdry), 640 mm for a median climate scenario (Cmid) and 720 mm for a wet climate scenario (Cwet).

Current rainfall trends for Perth Airport (DoW, 2015) are consistent with the Cdry scenario.

Given the finding of previous studies that the GBSW area is reliant largely on incident rainfall and surface water inflow, these climate impacts are considered to be significant in terms of the wetlands long term water balance.

Climate change considerations and potential benefits provided by land use change with an adaptive management approach in the Amendment Area are further addressed in post development water balance modelling in Section 10.

6.6 Constraints and Opportunities

Based on the above review and assessment of the Amendment Area's relationship with the GBSW area, and finding of site specific investigative studies detailed in Chapters 2 to 5, the following key Amendment Area hydrological conditions are identified:

- The key hydrological mechanisms supporting the GBSW area are broadly agreed across previous studies which identify the GBSW area as reliant largely on incident rainfall and surface water inflow.
- Site specific data collected since November 2020 has enabled refinement of local regional groundwater mapping which indicates groundwater flow within the Amendment Area is predominately away from the GBSW area. Groundwater flow was found to be radial with mounding evident along the central western boundary adjacent to Tonkin Hwy. The groundwater flow direction within the Amendment Area was found to vary, generally ranging from flowing northwest to flowing south east and away from the GBSW area.
- The Amendment Area has a very good clearance to the regional groundwater table and generally permeable soils at surface. This differs from the shallow groundwater area on the southern side of Tonkin Hwy, and there are no unlined open drains within the Amendment Area which drain regional groundwater and affect the hydrological behaviour of downstream environments.
- Paired groundwater bores have shown a general absence of perching across the majority of the Amendment Area, with the exception of some areas near Tonkin Highway and its Welshpool Road intersection, where clayey soils are present.
- Recent changes in local irrigation within the Amendment Area due to cessation of turf farm irrigation may impact groundwater levels locally and requires ongoing consideration to ensure no adverse impacts on the GBSW area.

On the basis of these characteristics, key constraints and opportunities are identified to assist and guide the development of an appropriate water management strategy in this document:

- While the Amendment Area contributes a relatively small component of surface water inflow to the GBSW area compared to its other sources, surface flows are recognised as a key component of the wetlands hydrological water balance and the principle of maintaining pre and post development flow rates and volumes to the GBSW area will be used to inform the water management strategy and design.
- The existing groundwater mound along Tonkin Hwy is recognised to represent the baseline condition for considering historical hydrological conditions of the Amendment Area in proximity to GBSW. Maintaining groundwater recharge and groundwater flow direction for this area is therefore considered a key principle to inform the water management strategy.
- Nutrient levels are relatively high in the GBSW area as a result of the adjacent historical rural and horticultural land uses. Nutrient input and export from the Amendment Area itself is also considered high under existing land, which includes a turf farm.

- The Amendment Area currently has no water sensitive measures or controls to actively improve and manage water prior to its discharge under existing land use to receiving environments.
- Declining rainfall in south west WA of the last 30 years has likely already resulted in changes to the hydrological cycle of the GBSW area and will continue to do so in future. No agency based management strategies are currently known to exist for managing the impacts of future reduced inflow to the GBSW area.

Ongoing monitoring and the use of adaptive management techniques are identified as key required elements of the strategy.

Opportunities for land use change to provide improved interfaces of surface and groundwater flows from the Amendment Area to GBSW, improve water quality, and to provide potential measures to assist in countering the effects of climate change and future rainfall decline on the wetlands are discussed in Chapters 7 and 10 of this report.

7. Proposed Water Management Strategy

The following Chapter details the proposed post development water management strategy for the Amendment Area. The key overarching principle guiding the development of the strategy is based on the EPA guidance statement for Inland Waters:

- To maintain the hydrological regime and quality of groundwater and surface water so that environmental values are protected.

This overarching principle together with the requirements of Better Urban Water Management (WAPC, 2008) and the Decision Process for Stormwater Management in WA (DWER, 2017) have been used to inform the development of the strategy.

7.1 Design Principles & Criteria

Key design principles and criteria for the Amendment Area are shown in Table 12 and have been established consistent with the key reference documents previously detailed in Section 1.2, and reflect the local area and surrounding conditions identified in Chapters 2 to 6 of this document.

These principles and criteria are used to inform the water management strategy for the Amendment Area to remain within the identified constraints and opportunities of the existing environment.

7.2 Water Supply Management

7.2.1 Fit for Purpose Water Source Planning

The Water Corporation's Integrated Water Supply System (IWSS) will supply potable water to future homes on the Amendment Area, via the extension of existing water supply infrastructure located in proximity.

With regard to Pubic Open Space (POS) irrigation, use of local groundwater is proposed. As discussed in Section 2.7, the Amendment Area is located within the Shire of Kalamunda Groundwater Management Subarea, and while water in the superficial is still available in this area, deeper aquifers such as the Leederville and Yarragadee are fully allocated.

Current licencing within the Amendment Area totals an allocation of approximately 264,000 kL/yr, including 176,000 kL/yr for the existing turf farm. Extracts from DWER's Water Register are included in Appendix E.

This existing licencing would exceed requirements for long term POS irrigation within the Amendment Area post development. Based on assuming development in the Amendment Area would provide 10% POS, and assuming an allocation provision of 6750 kl/ha/yr, this equates to a total of 85,000 kL/yr for POS irrigation being required.

Actual irrigation requirements are likely to be less given some of the POS areas will be vegetated conservation areas.

With respect to construction water requirements depending on ultimate staging considerations, some temporary licencing allocation from local groundwater may be sought from DWER. Discussions with DWER's Swan Avon region have indicated temporary licences are still issued in this groundwater sub area.

Table 12: Water Management Strategy Key Design Principles & Criteria

Strategy Elements	DWMS Method & Approach
Environmental	
GBSW area	• DWMS findings and outcomes to inform the local structure plan. • Use land use change to establish a net reduction in nutrient input and export from the Amendment Area relative to existing land use. • Surface water flows to the wetland to retain pre-development rates and volumes, with potential future modification to address future wetland needs in consultation with agencies if required • Establish stormwater management area locations in key locations to maintain predevelopment groundwater recharge and groundwater flow direction in the area of the existing groundwater mound. • Establish flexible outlet structures and use of engineering design to facilitate adaptive change. • Monitoring of outcomes and use of findings to facilitate/inform adaptive management.
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 Spaces. • Maximise infiltration where practicable.
Water Supply	• Minimise overall use of scheme water for non-drinking purposes. • Water Corporation IWSS for lots plus rainwater tanks (non-mandated). • Use of groundwater for POS irrigation.
Wastewater	• Water Corporation reticulated sewerage.
Stormwater	
Ecological Protection	• Combination of lot soakwells (15mm infiltration on site) and lot connection pits to be used. • Establishment of biofiltration areas for treatment and infiltration of first 15 mm road runoff, with area locations selected based on identifying preferred areas of recharge to maintain groundwater flow.
Serviceability	• Piped drainage system sized to convey 20% AEP event (1 in 5 year average recurrence interval).
Flood Protection	• Establish minimum habitable floor levels at 0.5m above the 1% AEP flood level of the local stormwater management system. • Overland flow paths within road reserves for safe conveyance of flows exceeding pipe drainage system capacity. • 1% average exceedance probability (AEP) events to continue to flow 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. Imported fill to be minimised. Use of subsoil drainage unlikely.
Acid Sulphate Soils & Contamination	• Management of any Acid Sulphate Soils to be handled as a separate process to the DWMS consistent with DER (2015a) requirements and reported in future water management planning documents.

7.2.2 Water Efficiency Measures

Water conservation measures will be implemented within the development and will be consistent with Water Corporation's Waterwise land development criteria, and include:

- Promotion of use of waterwise practices including water efficient fixtures and fittings (taps, showerheads, toilets and appliances, rainwater tanks, waterwise landscaping).
- Water efficiency consistent with Building Codes of Australia.
- Establish Waterwise Public Open Space and retention of existing vegetation and significant trees.
- Maximising on site retention and reuse of stormwater.

Further detail of water conservation measures will be provided at later stages of planning in accordance with Better Urban Water Management (WAPC, 2008) requirements.

7.2.3 Wastewater Management

Wastewater will be deep sewerage (reticulated) with management by Water Corporation.

7.3 Stormwater Management Strategy

It is recognised that land use change within the Amendment Area has the potential to provide improved hydrological outcomes for the GBSW area in terms of both water quality and quantity. Best practice urban water management approaches used to inform the proposed development considers EPA (2022a) and the Beeliar Group (2018) A Vision for Conservation and Public Enjoyment of the Greater Brixton Street Wetlands and Eventual Yule Brook Regional Park, and will include:

- Stormwater management improvement via the use of water sensitive urban design (WSUD) techniques in accordance with Better Urban Water Management (WAPC, 2008) and the Stormwater Management Manual for Western Australia (DWER, 2022), including the approach of managing small events and maximising infiltration at source. This will aim to mimic natural flow behaviour and provide overland flow across vegetated surfaces to help to maintain water flows and improve water quality.
- Post development stormwater volumes and flows to be managed relative to existing conditions particularly in relation to the GBSW area. This approach will be subject to adaptive management in consultation with agencies regarding opportunities for future increased flow volumes to mitigate climate change impacts on declining inflows and water levels at the wetlands if required. This is further discussed in Section 8.3.
- Locally tailoring the stormwater management approach (lot connections and use of soakwells) at different locations within the Amendment Area and positioning stormwater management areas in key locations to maintain predevelopment groundwater recharge and flow directions in the area of the existing groundwater mound.
- Maximise the use of existing areas and assets such as the Dampier to Bunbury Natural Gas Pipeline Corridor for major event stormwater management and minimise the provision of large scale standalone storage infrastructure within the Amendment Area.
- Land use types, densities and their locations, and water quality treatment areas to be selected to considerably reduce nutrient application and output, and improve water

quality relative to current conditions, with the aim of improving downstream ecological outcomes.

- Prioritising protection of existing environmental assets and significant trees in the Amendment Area via adopting approaches to minimise large scale trucking of fill.
- Establishing flexible outlet arrangements for the site to the downstream environment to enable adaptive change if necessary.
- Strategic ongoing monitoring and reporting at key locations to be used as a feedback loop with agencies to facilitate adaptive change.

Figure 30 provides a summary of the proposed water management strategy for the Amendment Area. The ultimate sizing and location of key infrastructure to achieve these outcomes is dependent on the Amendment Area's future local structure plan. Infrastructure sizing and its location will therefore be appropriately undertaken as part of the local structure planning process and documented in the supporting Local Water Management Strategy (LWMS) for the Amendment Area.

With respect to the use of BDNGPC easement for management of large stormwater events it should be noted that this is a standard practice which has been routinely employed within residential developments adjacent to the BDNGPC easement such as Ellenbrook, Henley Brook, Brabham and Solaris. This approach is aligned with the core stormwater practice of maximising multiple use characteristics of infrastructure and maintaining the pre development (existing) flows and flow paths for the Amendment Area.

It is important to note that in relation to the existing groundwater mound, the DWMS and its strategy has considered the existing environment under turf farm irrigation to represent the baseline condition for assessment, as it is representative of the local hydrological conditions of the Amendment Area in proximity to GBSW for over the last 20 years. This strategy has been adopted consistent with EPA Inland Waters objective of maintaining the existing hydrological regime, which is consistent with typical WSUD practice.

The proponent is however committed to continue to work with agencies and the EPA toward any agreed alternative objective for the Amendment Area at this boundary for the benefit of the GBSW area should this be required, and this can readily be achieved through the proposed adaptive management approach.

The ability of the strategy to deliver these outcomes is assessed in Chapter 8.

7.4 Groundwater Management Strategy

7.4.1 Fill and Subsoil Drainage

Future development levels for the Amendment Area are generally not dominated by fill requirements to achieve adequate separation to groundwater, given the proximity of groundwater levels to natural surface over much of the Amendment Area.

Subsoil drainage is considered unlikely to be required, however should any be needed in limited areas (for example due to impermeable underlying soils and localised perching), all flows would be treated via use of biofiltration systems prior to any off site discharge.

Finished lot levels and fill requirements are a detailed design issue to be addressed during the preparation of detailed engineering design drawings and preparation of the LWMS and

Urban Water Management Plans (UWMP) and will be ultimately submitted for further agency approvals at that stage.

7.4.2 Acid Sulphate Soils

Acid sulphate soil mapping has been previously discussed in Section 2.3.5 as being a moderate to low ASS risk across the Amendment Area.

Management of acid sulphate soils (ASS) will be addressed by a separate study if required depending on possible disturbance and excavation depths for engineering services. All assessment and management of ASS will be undertaken in accordance with the Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes Guideline (Department of Environment Regulation, 2015a) to better characterise ASS at the site.

Should any ASS Management Plan be required for ground disturbing works this will be prepared in accordance with the Treatment and Management of Soil and Water in Acid Sulfate Soils Landscapes Guideline (Department of Environment Regulation, 2015b).

Details regarding the outcomes of any ASS studies will be included as part of later water management planning document for the Amendment Area.

8. Assessment of Proposed Water Management Strategy

8.1 Post Development Stormwater Modelling

With respect to post development stormwater management, there is no overarching DWER regional or district stormwater strategy which covers the Amendment Area which defines a future arterial drainage strategy and acceptable discharge flow rates.

Consistent with accepted stormwater management practices, it is envisaged flow rates and paths will be required to be maintained post development. This implies flow from the Amendment Area will continue to be directed towards existing outlets under Tonkin Hwy.

The DBNGPC has been utilised for stormwater management in other developments. The location of the DBNGPC adjacent to Tonkin Hwy is well positioned in terms of location and elevation for potential stormwater management use particularly for major event flood storage. Its location is also considered strategic in the context of its proximity to the existing groundwater mound.

The land within the pipeline corridor is estimated be in excess of 4 ha, indicating its potential to provide a considerable stormwater management role for the development.

With regard to water quality management, the development will be required to treat the first 15mm of runoff in biofiltration systems prior to infiltration, and these systems will be distributed throughout the Amendment Area. Some of these systems will be located within road reserves and others will be integrated within POS areas. Locations will be identified at local structure planning stage with a key consideration being groundwater recharge and flow direction in the area of the existing groundwater mound.

Although the MRS is a regional planning mechanism that defines the future land use and does not provide for a structure plan level of detail, the implementation of the above strategy on an indicative concept plan for the Amendment area is shown in Appendix P.

This details indicative locations and approximate areas and sizes for stormwater management based on modelling using XP-Storm. This plan has been developed to inform the adopted approach to stormwater management post development and will be refined as part of the local structure planning process and LWMS.

Indicative areas and volumes for post development stormwater management based on this modelling are summarised in Table 13. This includes areas and volumes for water quality treatment of the first 15mm of runoff, and for flood storage for the 20% Annual Exceedance Probability (AEP) event (equivalent to a 5 year average recurrence interval) and the 1% AEP event (equivalent to a 100 year average recurrence interval).

Further details on the adopted stormwater management measures including their staging, distribution, sizing, location, and POS landscape integration will be detailed in the LWMS as a local structure plan is developed. Water quality treatment and detention areas and volumes for individual local catchments will be provided at LWMS stage based on refined modelling and further detailed consideration of geotechnical investigations.

These sizings will also reflect the outcomes of further agency discussions during the local structure planning and LWMS phases regarding adaptive management implementation and potential future use of stormwater runoff or other identified approaches to offset effects of declining rainfall on the GBSW area hydrology.

Table 13: Indicative Stormwater Management Area & Volume Requirements

Storm Event	Volume (m^3)	Area (ha)
Water Quality Treatment via Biofiltration		
15mm Event	2,474	0.71 ha
Additional Flood Storage Area		
Flood Storage Volume : 20% AEP Event	4,590	1.33 ha
Flood Storage Volume : 1% AEP Event	12,410	2.04 ha
Estimated Total Area for Stormwater Management		2.75 ha

8.2 Post Development Groundwater Flow

Chapter 4 detailed the calculation of groundwater levels and flow direction for the Amendment Area under existing land use. While the groundwater flow direction over the wider area was similar DWER regional mapping, within the Amendment Area the flow direction was different (Figures 16-18).

It is not uncommon for site specific investigations based on local data to differ from DWER regional mapping. Irrigation via deeper confined aquifers within the Amendment Area and highly variable subsurface geological conditions with a concentration of low permeability soils adjacent to Tonkin Hwy are considered key factors defining this outcome and the observed groundwater mound in this area.

This DWMS considers the existing environment under turf farm irrigation to represent the baseline condition for assessment, as this is representative of the local hydrological conditions of the Amendment Area in proximity to GBSW for over the last 20 years.

While the turf farm irrigation has recently ceased, this is not development related. It is acknowledged these recent changes in water application and recharge may affect groundwater levels locally, and therefore a key principle adopted for the water management strategy is based on locating stormwater management areas in areas of the existing groundwater mound to maintain the annual predevelopment groundwater recharge and flow direction in that area.

To assess the ability to achieve this outcome, Appendix Q details calculations of recharge for the site pre and post development on the basis of Emerge (2024) recharge estimates. The assessment considers recharge at various area scales, ranging from the whole Amendment Area, to a 29 ha area encompassing the existing mound, and the immediate localised 14 ha area of the turf farm.

Modelling results are summarised in Figure 31. The results indicate that there will be an overall minor increase in annual recharge across the Amendment Area post development, however implementation of a targeted stormwater management approach applied to the area of the existing mound can result in similar annual recharge pre and post development to that area. The strategy modelled to achieve this outcome was based on:

- Stormwater biofiltration and flood management areas to be focussed to the area of the mound adjacent to Tonkin Hwy.
- Lot soakwells to be adopted for almost all lots within the wider 50.5 ha contributing stormwater catchment for this area, with a small area of lot connections (Figure 31).

It is important to note the modelled strategy above is not a unique solution and various factors of catchment area, soakwell application, and lot connections can be applied to achieve a similar outcome. Alternative approaches such as supplementary Leederville aquifer recharge via irrigation to strategically located POS in this area or location of superficial irrigation POS bores outside this area can also be considered in consultation with agencies during the local structure planning process to replicate seasonal variation. Key agency discussions will be conducted in due course to determine the preferred method to achieve a desired outcome for this location.

These calculations will be refined in due course as part of the LWMS and used to inform the local structure planning process, and proposed land uses and their locations. It is possible some local scale changes to seasonal variation and levels as a result of changes to seasonal distribution of recharge may occur, however given existing geological conditions and groundwater gradients this is considered unlikely to change flow directions in this area.

This outcome has been used to inform post development water balance modelling in Appendix O and Section 8.3.

8.3 Post Development Water Balance Modelling

A conceptual water balance was developed for the Amendment Area by Emerge Associates to consider the post development environment. The Emerge Associates (2024) report detailing this modelling, its assumptions, and outcomes is contained as Appendix O. This modelling allows analysis and assessment of changes to the Amendment Area's hydrological water balance as a result of land use change by comparison with water balance modelling of the predevelopment (existing) environment detailed in Section 6.2.

Modelling assessed the impacts of the following key changes within the Amendment Area which would occur in a post development environment:

- the impact of the introduction of greater impervious surfaces with the Amendment Area and their impact of evapotranspiration. Quantification of this change was based on values presented in DWER's Perth Regional Aquifer Modelling System (PRAMS)
- changes to stormwater management within the Amendment Area with development and the introduction of a formalised drainage system. Modelling was undertaken reflective of the proposed stormwater strategy previously detailed in Section 7.3 and 8.1.
- changes in irrigation water use and aquifer abstractions. Currently there is a total abstraction allocation of 260,655 kL/yr of water from the Amendment Area annually.

Water balance modelling results are summarised in Table 14 showing the balance of all inflows and outflows for the Amendment Area post development in comparison to the water balance results under existing land use. Post-development, evapotranspiration in the Amendment Area is reduced, and a minor increase in surface water outflow was modelled. Given the predominately permeable surface soils in the Amendment Area and infiltration-based water management strategy, the increase in water volume results in an increase in groundwater recharge to the superficial aquifer. This will result in an increase in groundwater

outflow from the superficial aquifer which will leave the Amendment Area consistent with existing groundwater flow directions.

Modelling results are summarised compared to the predevelopment condition as follows:

- Overall there is an 9.6% reduction in total inflow and outflows for the Amendment Area post development. Rainfall remains the predominant source of inflow for the Amendment Area representing approximately 79.7% of the total inflow. Irrigation is the second largest component at 14.5%. Groundwater throughflow and upstream catchment inflows are relatively minor contributions at 2.7% and 3.0% respectively.
- Aquifer irrigation water use is reduced by 52.5% post development, which is largely reduced via removal of the existing turf farm.
- In relation to outflows, evapotranspiration is the largest volumetric reduction representing 48.5% of the total outflow for existing land use and 36.9% post development. Groundwater throughflow in the superficial aquifer is increased from 26.9% to 35.3% of total outflow.
- Surface water from the Amendment Area was marginally increased from 7.8% to 9.6% of total outflow.

Figure 32 summarises the post development modelling results and shows the relationship of the water balance to the flows from the Amendment Area toward the GBSW area. Overall the water balance indicates a combined total outflow (groundwater and surface water) of 169,412 kL/yr from the Amendment Area toward the GBSW area, a 10,850 kL/yr increase.

Surface water flow changes for flows directly to the GBSW area from the Amendment Area were negligible (-638 kL/yr), with the majority of flow change occurring where the site discharges to the MKSEA open drains (11,488 kL/yr) (Emerge Associates, 2024). In the context of the GBSW area, these increases are minor. By comparison, direct rainfall (annual average 758mm/yr) on the surface of the GBSW area (215 ha) contributes 1,629, 700 kL/yr.

The majority of the overall minor combined outflow increase results due to a modelled increase in groundwater throughflow (Figure 32). It is important to note however that the direction of the modelled flow increase is northwest and toward the far eastern extent of GBSW, and an area where regional groundwater is well below natural surface.

Notwithstanding, the minor increases to the GSBW area can be readily amended to existing levels during the local structure planning phase of the project by the refinement of stormwater modelling criteria and stormwater storage designs once a local structure plan is available. Further discussion with agencies will be conducted at this time to determine whether this is a desirable outcome given climate change considerations.

Note that these results do not include development of the other Urban Expansion and Investigation Area's (UEUI) in proximity to the Amendment Area. Further modelling addressing development of these areas and the cumulative impacts on water balance outcomes is discussed separately in Chapter 9.

With respect to the water balance outcomes in relation to Yule Brook, Swan River Trust and Department of Water (2011) report a total annual flow for the Brook to Canning River of approximately 7.9 GL/yr (7,900,000 kL/yr). The water balance flow increase estimate of 10,850 kL/yr to GBSW and MKSEA (Emerge Associates, 2024) represents only 0.14% of the Yule

Brook estimated annual flow and is therefore considered negligible in the context of interannual flow variability.

Table 14: Post Development Water Balance Modelling (Emerge Associates, 2024)

Water Balance Component	Pre Development (kL & % of total)	Post Development (kL & % of total)	Volume change to water balance component (%)
Inflows			
Rainfall	928,888 (72.1%)	928,888 (79.7%)	0.0%
Upstream catchment inflows	34,536 (2.7%)	34,536 (3.0%)	0.0%
Irrigation water application (of superficial aquifer origin)	84,655 (6.6%)	123,694 (10.6%)	+46.1%
Irrigation water application (of Leederville aquifer origin)	176,000 (13.7%)	0 (0%)	-100.0%
Irrigation water application (of scheme water origin)	32,500 (2.5%)	46,000 (3.9%)	+41.5%
Groundwater throughflow (superficial aquifer)	32,212 (2.5%)	32,212 (2.7%)	0.0%
Total Inflows	**1,288,791 (100%)**	**1,165,330 (100%)**	**-9.6%**
Outflows			
Rainfall interception	95,346 (7.4%)	63,529 (5.5%)	-33.4%
Irrigation water interception	29,316 (2.3%)	18,206 (1.6%)	-37.9%
Groundwater abstraction (of superficial aquifer origin)	84,655 (6.6%)	123,694 (10.6%)	+46.1%
Surface water runoff and drainage outflow (inclusive of upstream flows)	100,337 (7.8%)	111,422 (9.6%)	+11.0%
Groundwater throughflow (superficial aquifer)	346,081 (26.9%)	411,223 (35.3%)	+18.8%
Groundwater throughflow (perched groundwater)	7,280 (0.6%)	7,280 (0.6%)	0.0%
Evapotranspiration (of rainfall)	420,566 (32.6%)	312,427 (26.8%))	-25.7%
Evapotranspiration (of irrigation and scheme water)	205,209 (15.9%)	117,549 (10.1%)	-42.7%
Total Outflows	**1,288,791 (100%)**	**1,165,330 (100%)**	**-9.6%**

8.4 Post Development Nutrient Input & Output

Post development UNDO modelling of the Amendment Area is detailed in Appendix R, showing the positive impact land use change at the Amendment Area will have with respect to nutrient application and export in proximity to the GBSW area.

Modelling was performed on the indicative concept plan used for stormwater modelling in Appendix Q, as a representative indicator of the post development scenario.

Modelling results are shown in Table 15. The modelling results indicate land use change will result in nutrient inputs of 5148 kg/yr for TN and 891 kg/yr TP post development.

This indicates a considerable reduction in nutrient input within the Amendment Area (refer Section 2.8) as a result of land use change, with a 8624 kg/yr (63%) reduction in TN input and 514 kg/yr (37%) reduction in TP input annually.

The resultant nutrient export was 130.0 kg/yr of TN and 7.5 kg/yr export of TP following development. This represents a significant 61% reduction in TN export and a 60% reduction in TP export to the environment post development.

These reductions are likely to benefit downstream environments including the GBSW area and assist in achieving long term water quality targets for Yule Brook.

Table 15: Amendment Area Nutrient Inputs and Outputs for Proposed Land Use

Nutrient	Annual Input	Annual Export
Total Nitrogen (TN) (kg/yr)	5,148	130.0
% Change (compared to existing land use)	-63%	-61%
Total Phosphorous (TP) (kg/yr)	891	7.5
% Change (compared to existing land use)	-37%	-60%

8.5 Salinity and Sodicity

EPA (2022a) identifies the presence of soil salinity within the shallow soil profile and the presence of salt tolerance vegetation in the GBSW area southwest of Brixton Street known as the Wanaping Block. Soil salinity and sodicity have therefore been identified as a potential concern for the Amendment Area given its proximity to the GBSW area.

Soil salinity occurs via the concentration of soluble salts within the shallow soil profile and is often associated with near surface groundwater interactions. Salts can be naturally occurring, and are transported by the horizontal and vertical movement of water. Changes in groundwater levels and seasonal variations have the potential to transport increasing amounts of salt in the shallow soil profile. Soil sodicity occurs where the proportion of sodium

ions resulting from soil salinity are excessive, weakening the bonds between soil particles and leading to a loss of soil structure.

MBS Environmental (2024) detailed a technical assessment of the potential impacts of salinity and soil sodicity for the Amendment Area and its immediate surrounds based on the development of surface water and groundwater solute mass balances. A copy of the report is included as Appendix S and included an evaluation of predevelopment, post development and post development with climate change scenarios.

Key findings of the investigation and modelling are summarised as follows:

- Salinity and sodicity for post development scenarios for surface water discharge were predicted to be less than the pre-development. This represents a net reduction in risk to GBSW based on the modelling conducted.
- Post-development salinity of the surface water discharging to the north of the GBSW was predicted to be slightly brackish and decreasing to fresh in time under the climate change scenario. Surface water sodicity followed the same trend and was always low.
- The general trend of both salinity and sodicity in the superficial aquifer flowing to the GBSW area was constant and close to the pre-development scenario. Salinity was marginally brackish at all times. Predicted salinity and sodicity of the post development climate change scenario showed groundwater changing steadily from marginally brackish to fresh with low SAR values.

Overall, the assessment indicated that there is a low risk of increasing salinity and sodicity in the GBSW from development of the Amendment Area, with modelling predicting a decrease in both surface and groundwater.

The report noted the proximity of the Hartfield Park irrigated golf course and playing fields to the north of the Amendment Area as likely to have a much larger influence on salinity/sodicity within the GBSW area.

9. Cumulative Impact Assessment

The North-East Sub-Regional Planning Framework (DPLH, 2018), details additional Urban Expansion and Investigation (UEUI) areas located adjacent to the Amendment Area. These areas have been previously shown in relation to the Amendment Area boundary in Figure 1, and in Figures 9 to 11 in relation to surface water catchment mapping and DWER regional groundwater mapping.

The cumulative impact of potential development of these areas together with the Amendment Area was assessed by Emerge Associates (2024) via water balance modelling of land use change based on a typical urban subdivision outcome that is representative of the north east corridor of Perth extending across the full extent of the UEUI area.

A copy of the water balance modelling report is contained as Appendix O.

Modelling was based on adopting the same methodology as the predevelopment and post development water balance models established for the Amendment Area. Modelling considers that a significant proportion of the surface water catchments of the UEUI area are not located within catchments which contribute flow to the Amendment Area and GBSW area (Figure 10).

Changes within the UEUI area affecting the water balance were similar to those affecting the Amendment Area post development, including the introduction of greater impervious surfaces and its impact of evapotranspiration, changes to stormwater management within the UEUI area, and changes in irrigation water use. Key assumptions used for modelling of the UEUI area are detailed in Appendix O. Modelling assumptions for the UEUI area are representative of the extent and availability of data within that area, and the ability to reliably predict future conditions based on current knowledge. Where necessary these assumptions have been based on considered judgements with sensitivity testing for robustness, and therefore are not expected to significantly alter key model outcomes and findings.

Water balance modelling results are summarised in Table 16 showing the balance of all inflows and outflows for the Amendment Area post development considering the Amendment Area and UEUI areas developed in comparison to the water balance results under a predevelopment scenario.

Modelling results are summarised in comparison to the existing (predevelopment) condition (Table 11) and Amendment Area development only condition (Table 14) as follows:

- In relation to Amendment Area inflows, the water balance is only marginally changed to that of the Amendment Area only development condition with an increase in surface water inflow to the Amendment Area of 13,674 kl/yr. While this represents approximately a 40% increase in inflow to the Amendment Area from the upstream catchments, this increase represents a minor component of the overall water balance representing 4% of the total Amendment Area inflow.
- In relation to Amendment Area outflows, while most elements of the water balance remained unchanged compared to an Amendment Area only development condition, development of the UEUI area resulted in an increase in overall Amendment Area surface water outflow. Modelling indicated surface water outflows would increase by 24,759 kL/yr compared to the existing condition and 13,674 kL/yr compared to the

Amendment Area only development scenario. Of the additional 13,674 kL/yr as a result of UEUI development, 5,830 kL/yr is toward the GBSW area, with 7,844 kL/yr to the MKSEA open drains.

Based on these modelling results, the development of the UEUI area only minimally changes the overall water balance of the Amendment Area.

As discussed in Section 8.2, these outflow increases can be readily amended during the local structure planning phase for the Amendment Area and during more detailed evaluation of the UEUI areas and the development of its stormwater management strategy in due course. Measures to achieve balanced surface flow outcomes will be based on increasing Amendment Area infiltration/retention.

Further discussion with agencies is considered appropriate at that time to determine the most desirable outcome given climate change considerations for the GBSW area.

Table 16: Water Balance Modelling of Urban Expansion Area (Emerge Associates, 2024)

Water Balance Component	Predevelopment (kL)	Post Development (kL) with UEUI Developed	Change to water balance component (%)
Inflows			
Rainfall	928,888 (72.1%)	928,888 (78.8%)	0.0%
Upstream catchment inflows	34,536 (2.7%)	48,210 (4.1%)	+39.6%
Irrigation water application (of superficial aquifer origin)	84,655 (6.6%)	123,694 (10.5%)	+46.1%
Irrigation water application (of Leederville aquifer origin)	176,000 (13.7%)	0 (0%)	-100.0%
Irrigation water application (of scheme water origin)	32,500 (2.5%)	46,000 (3.9%)	+41.5%
Groundwater throughflow (superficial aquifer)	32,212 (2.5%)	32,212 (2.7%)	0.0%
Total Inflows	**1,288,791 (100%)**	**1,179,004 (100%)**	**-8.5%**
Outflows			
Rainfall interception	95,346 (7.4%)	63,529 (5.4%)	-33.4%
Irrigation water interception	29,316 (2.3%)	18,206 (1.5%)	-37.9%
Groundwater abstraction (of superficial aquifer origin)	84,655 (6.6%)	123,694 (10.5%)	+46.1%
Surface water runoff and drainage outflow (inclusive of upstream flows)	100,337 (7.8%)	125,096 (10.6%)	+24.7%
Groundwater throughflow (superficial aquifer)	346,081 (26.9%)	411,223 (34.9%)	+18.8%
Groundwater throughflow (perched groundwater)	7,280 (0.6%)	7,280 (0.6%)	0.0%
Evapotranspiration (of rainfall)	420,566 (32.6%)	312,427 (26.5%)	-25.7%
Evapotranspiration (of irrigation & scheme water)	205,209 (15.9%)	117,549 (10.0%)	-42.7%
Total Outflows	**1,288,791 (100%)**	**1,179,004 (100%)**	**-8.5%**

10. Climate Change Considerations

As detailed in Section 6.5, Bourke (2017) reported that the decline in rainfall in south west WA of the last 30 years had likely already resulted in changes to the hydrological cycle of the GBSW area and that it would continue to do so in future.

The Department of Water (2015) Selection of Future Climate Projections for Western Australia report, provides rainfall projections for Perth to 2050 for a dry climate scenario (Cdry), a median climate scenario (Cmid) and a wet climate scenario (Cwet).

DoW (2015) reports recent rainfall trends for Perth consistent with the Cdry scenario.

Water balance modelling results presented in previous sections of this document are based on current climate modelling outcomes. To consider the impacts of climate change on the outcomes of this modelling a future climate prediction dataset was obtained from DWER to assess the impacts of changes to the key water balance inputs of rainfall and evapotranspiration.

The DWER dataset provides predicted future climate data in daily intervals for three climate scenarios (Cwet, Cmid, Cdry) at time horizons of 2050 and 2100. Water balance modelling was performed for the Cdry scenario for both 2050 and 2100 time horizons, which was based on rainfall reductions of 4.4% and 34.5% respectively compared to the 2010-2020 baseline.

With the inclusion of climate change, these rainfall reductions reduce surface water runoff leaving the Amendment Area and result in decreases in groundwater recharge compared to previous post development modelling.

Modelling results are summarised below from Emerge Associates (2024) for both development of the Amendment Area only and Amendment Area and UEUI area scenarios with detailed modelling outcomes contained in Appendix O.

- For Amendment Area development only, the impact of climate change on the water balance is relatively small for the Cdry 2050 horizon modelling but more significant for the 2100 horizon. The most significant impact is seen in the surface water inflows and outflows from the Amendment Area, with outflows reduced by approximately 7.9% in the 2050 horizon and 58.7% by 2100 compared to the Amendment Area development scenario without climate change. It is important to note the reduction by 2050 equates approximately to the increase which would occur without climate change considerations for this scenario (Table 14).
- For the Amendment Area and UEUI areas developed, the results were broadly similar to the Amendment Area only development scenario, with surface water flows reducing by 9.7% for the 2050 horizon, and 60.4% by 2100 compared to the scenario without climate change.
- Groundwater throughflow as outflow from the Amendment Area was found to reduce by 5% in the Cdry 2050 horizon modelling and by 40% to 2100 under both development scenarios.

These results highlight the future challenges in managing the GBSW area under a climate change environment.

While the results indicate over the Cdry 2050 horizon reductions in surface flows and groundwater outflow from the Amendment Area will result in flows approximating existing conditions, considerable reductions are expected beyond this period.

Long term climate change impacts are therefore likely to be a larger threat to the GBSW area water balance than development within the Amendment Area.

In terms of reduced rainfall directly on the GBSW area, a 4.4% reduction in rainfall by 2050 (33 mm) on the wetland (215 ha) reduces this component of wetland inflow by 70,950 kL/yr. By 2100 (254 mm), the reduction is 546,100 kL/yr.

These changes are irrespective of development.

These future impacts may be partially offset by providing flexible outlet structures for stormwater areas post development and using an adaptive management approach as development proceeds. This can provide flexibility to adjust future stormwater outflows from the Amendment Area for the benefit of GBSW area hydrology.

11. Implementation Framework

11.1 Considerations and Requirements for Local Planning

This document supports the proposed amendments to the Metropolitan Region Scheme to rezone the Amendment Area from rural to urban. A number of additional water management planning documents will be required to progress further stages of planning and subdivision/development of the Amendment Area.

Local Water Management Strategy's (LWMS's) will be required for the Amendment Area to support the preparation of local structure plans. Subject to approval of a relevant LWMS, Urban Water Management Plan's (UWMP's) will then need to be prepared as a condition of subdivision. Given the size of the Amendment Area, several UWMP's are likely to be required to support individual subdivisions within the area.

The preparation of all these future plans and the contained recommendations will be consistent with this DWMS, Better Urban Water Management (WAPC 2008), Stormwater Management Manual Western Australia (DWER, 2022), and other relevant DWER and City of Kalamunda guideline documents.

Key additional information to be reported in the LWMS building on this DWMS will include:

- Continued assessment of groundwater and surface monitoring data via current monitoring programs, including local mounding impacts of turf farm irrigation cessation.
- Additional geotechnical reporting, including ASS investigations.
- Refinement of groundwater mapping if required based on additional monitoring data.
- Additional survey to confirm key infrastructure levels and details.
- Detailed engineering earthworks and refinement of post development catchments.
- Refinement of recharge calculations and utilise this information to inform the local structure plan development and land use locations (eg schools, POS areas), strategy refinements, and the location of key stormwater infrastructure.
- Detailed stormwater modelling of the local structure plan to refine volumes, locations, areas and levels and ensure water releases from the Amendment Area are consistent with downstream requirements to maintain the downstream water balance of the wetlands.
- Provide further details of flexible outlet structure arrangements and locations to facilitate adaptive management.
- Refinement of UNDO nutrient modelling based on the local structure plan.
- Outcomes of continued liaison with DBCA, DWER, City of Kalamunda and other key stakeholders.
- A post development monitoring program identifying key locations and targets based on pre development monitoring outcomes.
- A framework to facilitate adaptive management in consultation with agencies.

Based on the assessment of the proposed water management strategy detailed in this DWMS, it is considered that the impacts of land use change within the Amendment Area from a water management perspective can be readily managed via the Better Urban

Water Management (WAPC, 2008) process. Based on this assessment and given the timeframe over which the proposed development will ultimately occur within the Amendment Area, it is considered an adaptive management approach will be best suited for guiding water management within the Amendment Area toward achieving improved hydrological outcomes for the GBSW area.

Continued engagement and collaboration with DWER, DBCA, and key community stakeholders such as the Friends of Brixton St Wetland and The Beeliar Group is supported as part of the planning process to assist in ensuring the water management benefits to the GBSW area via land use change are maximised.

11.2 Implementing an Adaptive Management Approach

The key objective of this approach is the protection of the GSBW area in relation to surface and groundwater change, and the provision of opportunities to offset future climate change impacts. Table 17 provides a framework for the site to achieve this outcome aligned with the processes of Better Urban Water Management (WAPC, 2008).

The key to implementation of an adaptive management approach for the Amendment Area is the continued implementation of the current comprehensive monitoring program and the provision of a robust framework which will ensure outcomes of the monitoring process influence planning outcomes on an ongoing basis.

The approach will require active participation of key agencies and stakeholders and ensure a feedback loop of outcomes into the planning and implementation process. This will require flexibility to be embedded within stormwater infrastructure during initial design and construction, and flexibility to be provided within future prepared water management plans to allow adjustment.

The implementation of adaptive outlet structures on stormwater infrastructure presents an opportunity to partially mitigate climate change impacts on declining inflows and water levels within the GBSW area downgradient if required.

In relation to ongoing monitoring, it is recommended further collaboration with agencies such as DBCA be investigated to coordinate and align with existing programs and maximise data benefits.

Monitoring reporting is recommended annually with requirements detailed in Section 11.3.2. This should include a review of area climate over the previous period in the context of climate projections and its impact on GBSW hydrology.

Table 17: Adaptive Management Approach

Process	Action
Pre Development Monitoring	• Pre development monitoring program exceeding BUWM (WAPC, 2008) requirements in recognition of GBSW proximity. • Sites in accordance with Figure 14. • Groundwater levels monthly and groundwater quality quarterly (physical parameters, nutrients, metals). • Surface water flow and quality (as per groundwater parameters) opportunistically when flowing. • Data sharing and coordination with agency programs.
Water Management Planning	• LWMS and UWMP document development informed by monitoring outcomes and key principles of DWMS. • LWMS/UWMP documents and approvals to reflect a flexible outcomes approach to facilitate adaptive change. • Establish agreed targets in consultation with agencies based on predevelopment monitoring outcomes at structure planning.
Stormwater Infrastructure	• Implement adaptive/flexible outlet structures on stormwater infrastructure to enable changed performance based on monitoring outcomes.
Post Development Monitoring	• Key assessment sites in accordance with Figure 33. Other sites to be determined with agency consultation on completion of predevelopment program. • Groundwater levels monthly and groundwater quality quarterly (physical parameters, nutrients, metals). • Surface water flow and quality (as per groundwater parameters) opportunistically when flowing.
Reporting, Compliance, and Feedback Loop to Water Management Planning	• <u>Key Factors</u> Surface Water: Water quality targets and flow at discharge points under Tonkin Hwy Groundwater: water quality targets, groundwater levels and mound management at Tonkin Hwy interface Climate Change: Rainfall trends, GBSW groundwater levels • Annual Assessment: Performance evaluation, annual reporting, with outcomes and recommendations to influence water management planning. • Implement adaptive change measures if required: Flexible outlet structure operation changes, Iterative adjustments to water management planning for future stages. • Adaptive change measures to be agreed in consultation with agencies.

11.3 Monitoring

11.3.1 Pre Development Baseline

As discussed in Section 3.1, a predevelopment monitoring program was previously undertaken by Urbaqua for the Water Grove South area and accepted by DWER as satisfying their requirements for pre development monitoring.

Although no further predevelopment monitoring was necessary to meet DWER requirements at that time, due to the Amendment Area proximity to the GBSW area, Hyd2o commenced a supplementary monitoring program for the Amendment Area in November 2020.

This program has now run for 38 months and is ongoing. Across the Amendment Area and its immediate surrounds, there are currently 23 bores which are being monitored monthly for water levels, with 20 of these monitored quarterly for quality. A further 3 nearby DWER bores are monitored monthly for water levels for correlation of results to longer term data. Nine surface water sites are also monitored.

Monitoring locations are shown in Figure 14. This program provides:

- groundwater levels to inform the setting of future infrastructure.
- groundwater quality upstream and downstream of the Amendment Area for review this in the context of groundwater quality closer to the wetland.
- surface water quality upstream and downstream of the Amendment Area, and within the wetland where stormwater inflows occur.

A summary of data collected to date is provided in Chapters 4 to 5 and Appendices G to N of this report.

Monitoring data will continue to be collected and assessed in further detail in the Amendment Area's Local Water Management Strategy (LWMS) in accordance with Better Urban Water Management (WAPC, 2008) requirements.

The predevelopment program has been coordinated with DWER and DBCA and opportunities for synergies and data sharing assessed to maximise its overall benefit.

Ongoing monitoring during the pre and post development phases of the project will continue to provide an opportunity to build on existing datasets and improve understanding of the GBSW area and its behaviour in its changing environment.

11.3.2 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*".

Several programs for individual development areas within the Amendment Area are likely to be ultimately required depending on staging, and this will be determined in consultation with agencies at the appropriate stage of planning. Individual programs will be designed to operate over three year post development periods, with the timing for commencement of the program to be negotiated at UWMP stage with DWER and the City of Kalamunda. Given the staged process of development a considerably longer rolling monitoring program will ultimately result with a focus on the current development stage outcomes in the context of assessing whole of development performance outcomes.

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 based on its outcomes and reporting.

Post-development monitoring locations, final trigger values and contingency actions will be identified in the LWMS based on an assessment of the full pre-development (existing) monitoring dataset and consultation with agencies. Locations for groundwater monitoring will be based on predevelopment locations (including areas south of Tonkin Hwy near GBSW), with surface water monitoring based on key outlets from the Amendment Area and the performance of key stormwater infrastructure. Protection of the GBSW area and management of the existing groundwater mound will be key considerations in the establishment of these sites. A preliminary identification of key post development sites is shown in Figure 33, subject to completion and outcomes of the current monitoring program.

Interim water quality targets for the key post development assessment sites based on predevelopment monitoring data from 2021-2023 are shown in Table 18. These targets will be refined as monitoring progresses with final targets established and reported as part of the LWMS. Water level targets for groundwater level mound management will be appropriately established at LWMS stage based on consultation with agencies.

Note that while the nutrient targets are variable and at some locations exceed DWER & DBCA (2016) overall long term TN and TP targets of 1.0 mg/L and 0.1 mg/L for the Yule Brook catchment, the current targets reflect the Amendment Area's existing condition due to legacy land uses. Improvement in water quality is expected with land use change as development progresses.

Table 18: Interim Water Quality Targets

Parameter	Site	Interim Targets			
		pH	EC (mS/cm)	TN (mg/L)	TP (mg/L)
Surface Water	*ANZECC (2000) [1]*	*6.5-8.0*	*0.12-0.30*	*1.20*	*0.065*
	SW2	7.34	0.98	2.90	0.15
	SW3	7.38	0.23	1.80	2.90
	SW4	7.62	0.17	0.45	0.08
Groundwater	*ANZECC (2000) [2]*	*7.0-8.5*	*0.30-1.50*	*1.50*	*0.06*
	GW5D	4.55	0.67	1.30	0.05
	GW9D	6.52	0.63	1.75	0.05
	WG8D	5.33	0.85	1.50	0.28
	WG10D	6.30	0.33	2.90	0.05

1. ANZECC (2000) default trigger values for lowland river ecosystems in south-west Australia
2. ANZECC (2000) default trigger values for wetland ecosystems in south-west Australia

Annual reporting will be provided, detailing the previous 12 months of monitoring and assessing performance in the context of established targets, and providing recommendations for future monitoring, planning and development implications, and on any corrective actions (if required).

Reporting will also review the Amendment Area climate over the previous period in the context of climate projections and its impact on GBSW hydrology.

The post development monitoring program and its outcomes will provide additional information to inform later stages of planning using adaptive management.

All water quality testing will be conducted by a NATA approved laboratory.

11.4 Staging

Staging of stormwater works to maintain a functioning stormwater management system for the Amendment Area and the existing council drainage systems will be required.

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

Staging aspects of the development will be appropriately addressed in later stages of water management planning and include the identification of any temporary measures.

A key consideration during staging will be the management of the existing groundwater mound during the transition phase and ensuring any changes in land use and recharge are carefully managed. While not development related, the effects of the recent cessation of groundwater irrigation at the turf farm will be monitored and this data used to inform the transition process and future planning.

By ongoing assessment of monitoring data, adaptive management can be applied to mitigate potential impacts an provide improvements as development proceeds.

11.5 Implementation Responsibilities

Key implementation actions and responsibilities are detailed in Table 19. The development and implementation of a Local Structure Plan and accompanying Local Water Management Strategy will be the responsibility of the Amendment Area developer.

Ongoing funding and maintenance responsibilities will be appropriately detailed at LWMS and UWMP stages and will include a summary of responsibility for the developer, City of Kalamunda, DWER, and DBCA.

Table 19: Water Management Strategy Implementation Summary

Implementation Action	Responsibility			
	Developer	DWER	City of Kalamunda	DBCA
Ongoing Predevelopment monitoring program	✓			
Preparation of LWMS to support local structure planning	✓			
Review and approval of LWMS		✓	✓	✓
Preparation of UWMP(s) for individual development stages	✓			
Review and approval of UWMP(s)		✓	✓	✓
Construction of water management system and maintenance post construction until council handover	✓			
Conduct post development monitoring program and annual reporting	✓			
Review of monitoring data and annual reporting including adaptive management recommendations		✓	✓	✓
Long term water management system operation and maintenance			✓	

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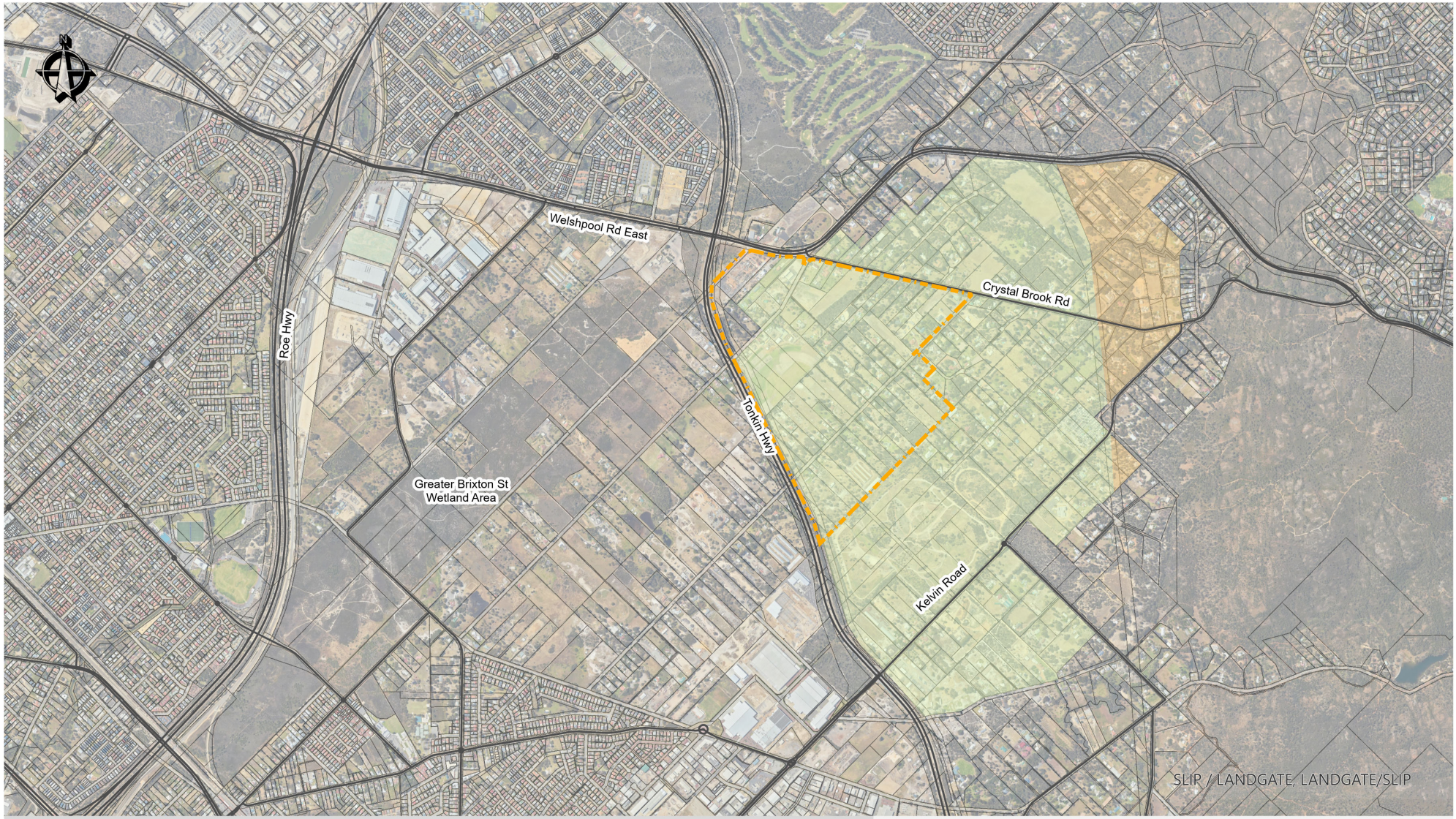
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FIGURES

Date: 30/01/2024 Job No. H22076



Amendment Area

Urban Expansion Area

Urban Investigation Area

0 250 500 750 1,000
Meters

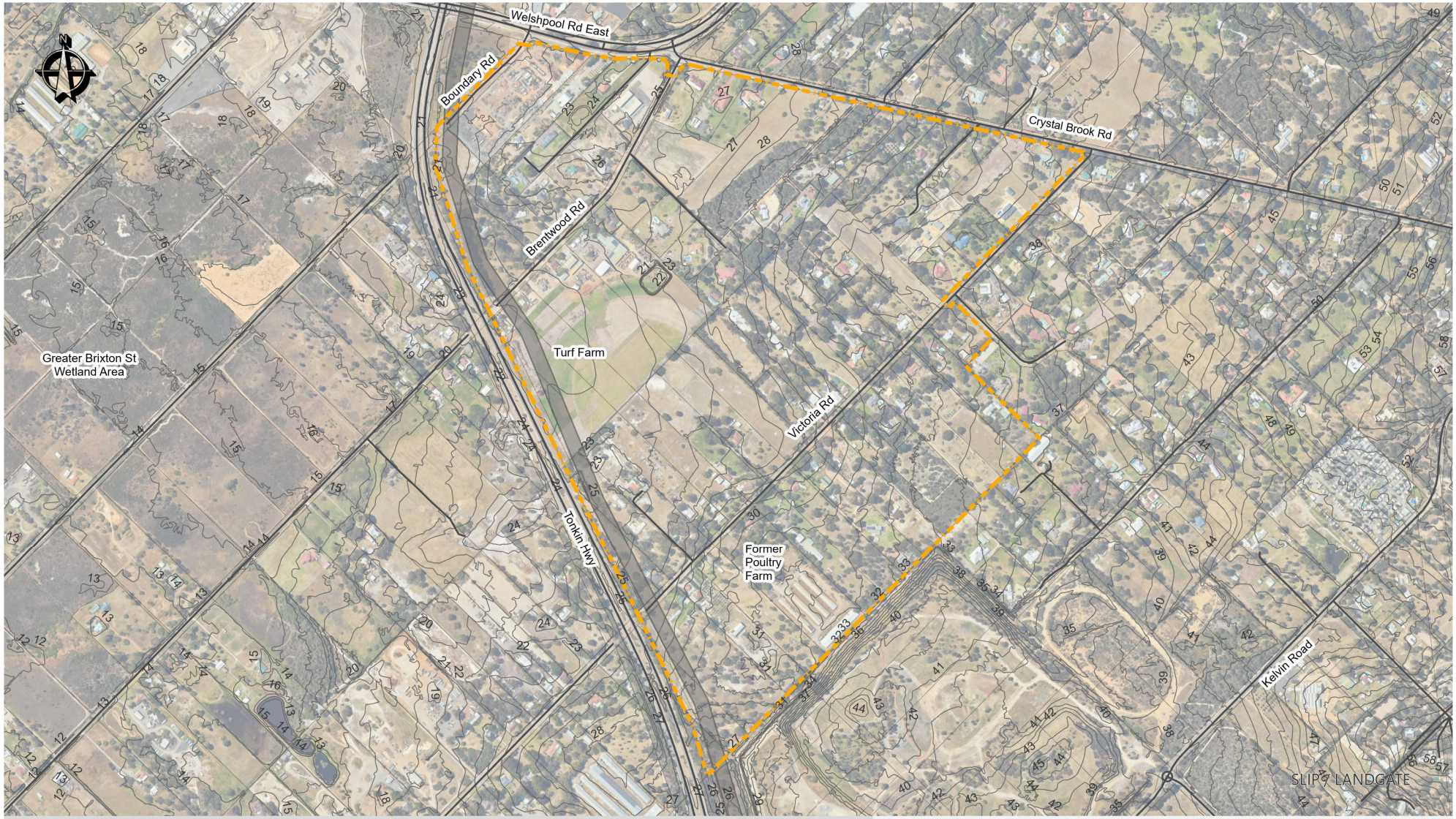
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Wattle Grove South District Water Management Strategy

Location Plan

Figure 1

Date: 18/07/2024 Job No. H22076



Amendment Area

DWER LiDAR Topography (mAHD)

Dampier to Bunbury Natural Gas Pipeline

0 125 250 375 500 Meters

Source of Data: Locate Mosaic, Landgate (LGATE-322)
WA Petroleum Pipeline Polygons (DMRIS-007)

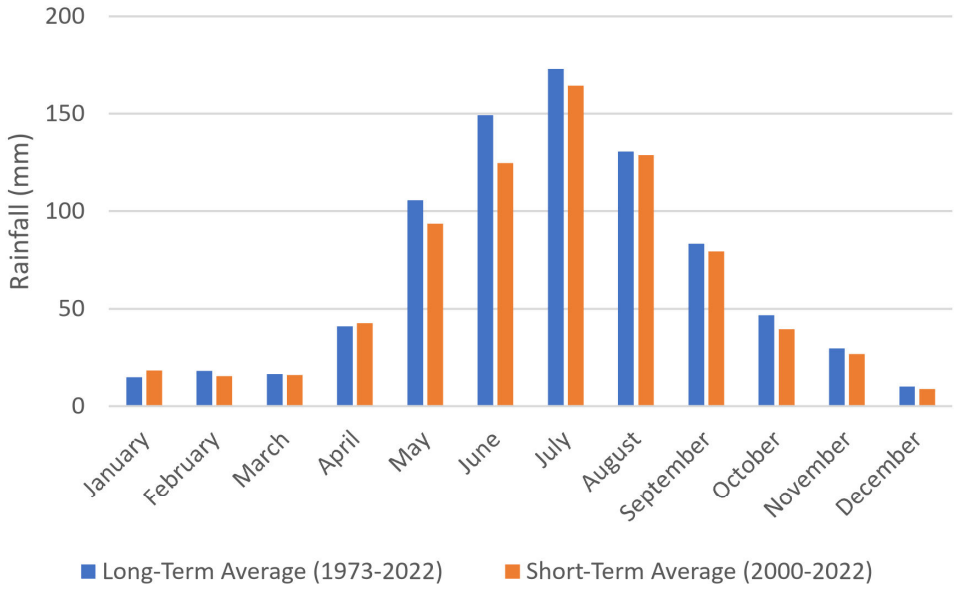
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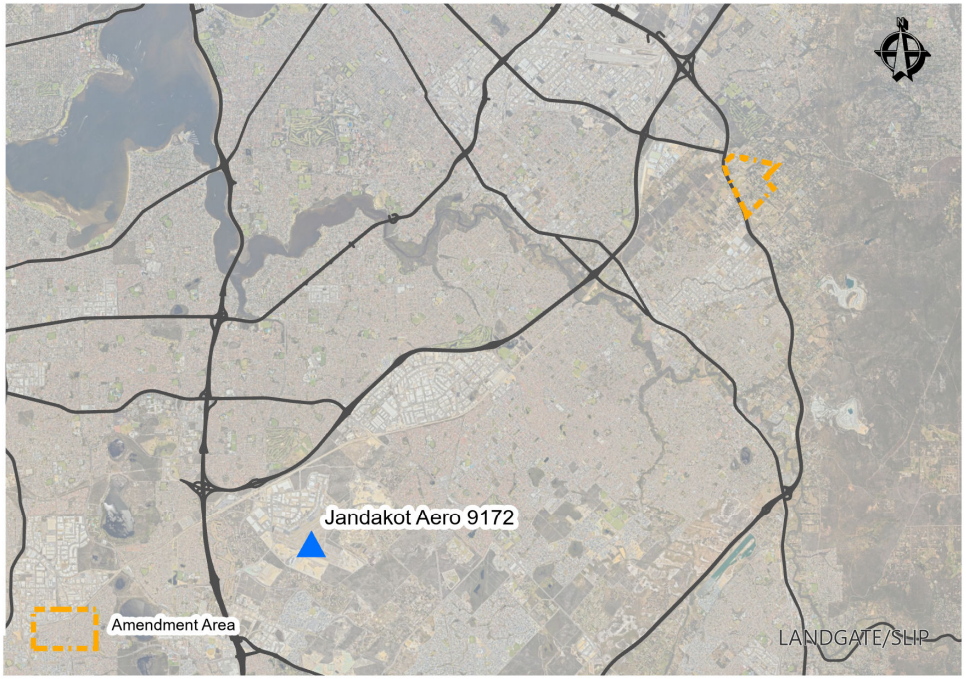
Wattle Grove South District Water Management Plan

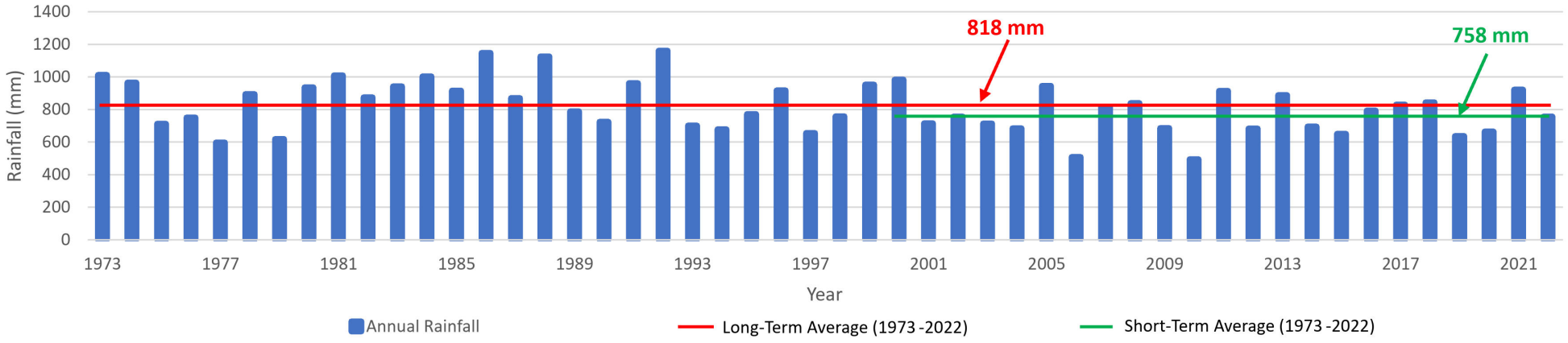
Amendment Area Conditions Plan

Figure 2

Date: 30/01/2024 Job No. H22076







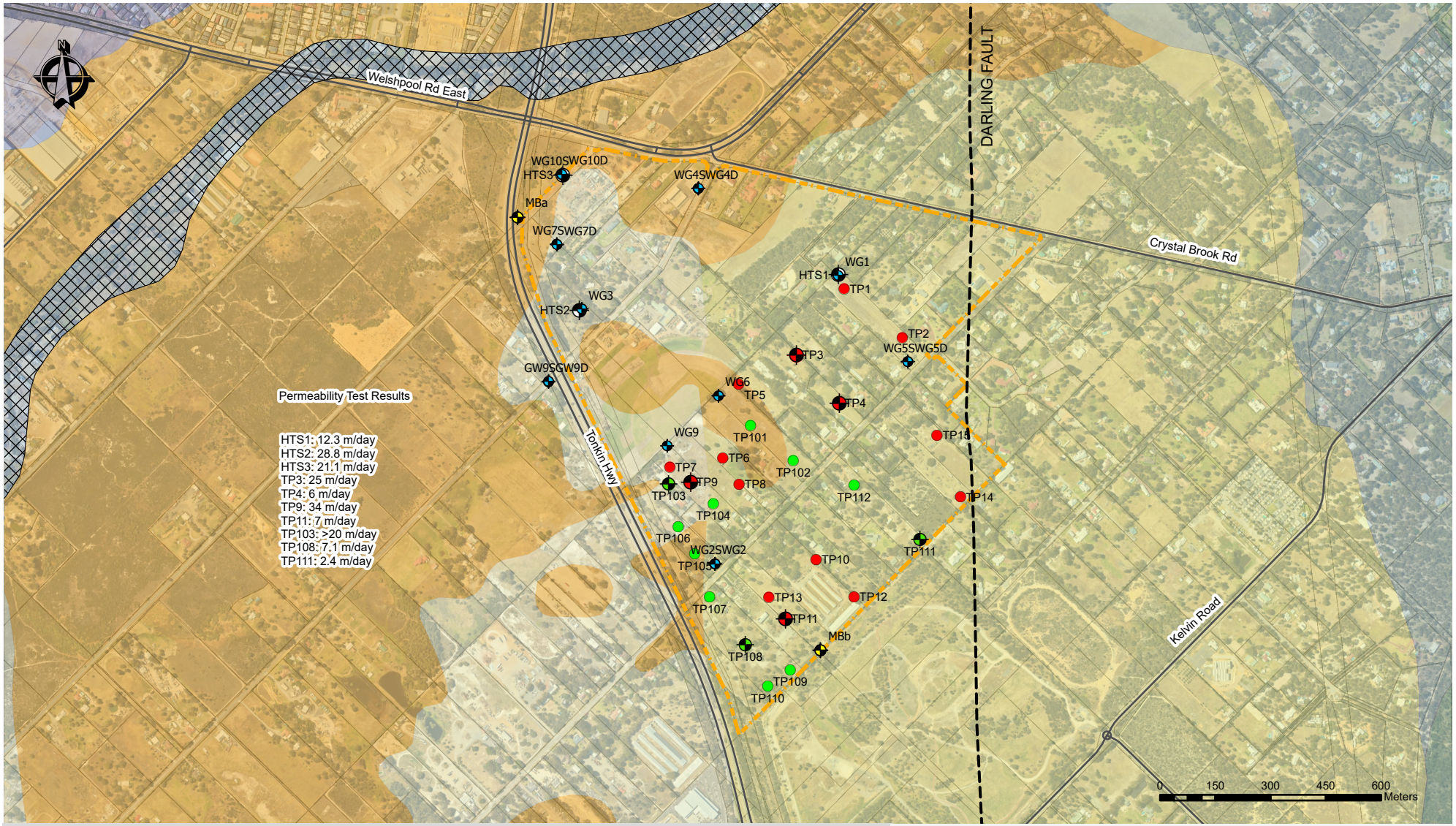
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Wattle Grove South District Water Management Strategy

Annual and Monthly Rainfall Data

Figure 3

Date: 18/07/2024 Job No. H22076



Amendment Area

Acid Sulphate Soils Risk

High to moderate risk

(Site : Low-Moderate Risk)

Environmental Geology

- S10 Thin Sand over Guildford Formation
- S8 Bassendean Sand
- S12 Sand (Yoganup Formation)

Geotechnical Investigation

- Site Bores Hyd2o
- Site Bores Douglas Partners
- Permeability Test: Hyd2o
- Test Pit + Permeability Test: Douglas Partners (Dec/2022)
- Test Pit: Douglas Partners (Dec/2022)
- Test Pit + Permeability Test: Douglas Partners (Nov/2020)
- Test Pit: Douglas Partners (Nov/2020)

hyd2o

Wattle Grove South District Water Management Strategy

Geotechnical Plan

Figure 4

Date: 30/01/2024 Job No. H22076



Amendment Area

Electrical Resistivity Tomography Transects (GBG Group, December 2022)

Electrical Resistivity Tomography Transects (GBG Group October 2023)

0 62.5 125 250 375 500

Meters

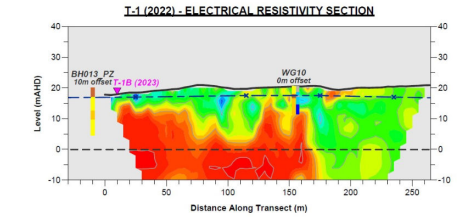
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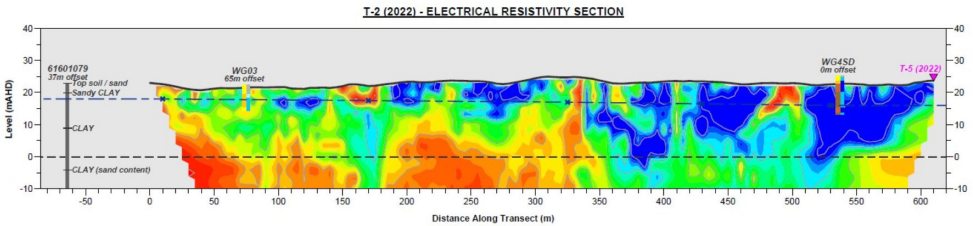
Wattle Grove South District Water Management Strategy

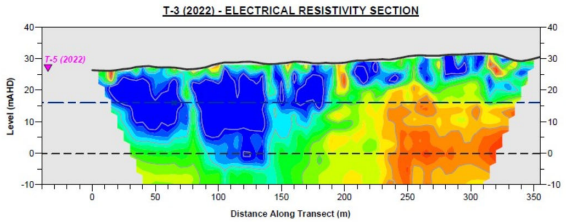
Geophysical Testing Locations

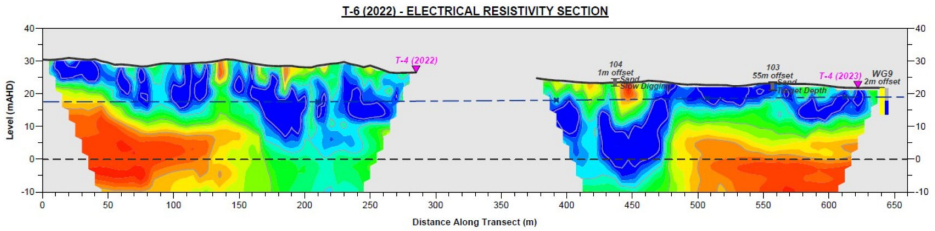
Figure 5

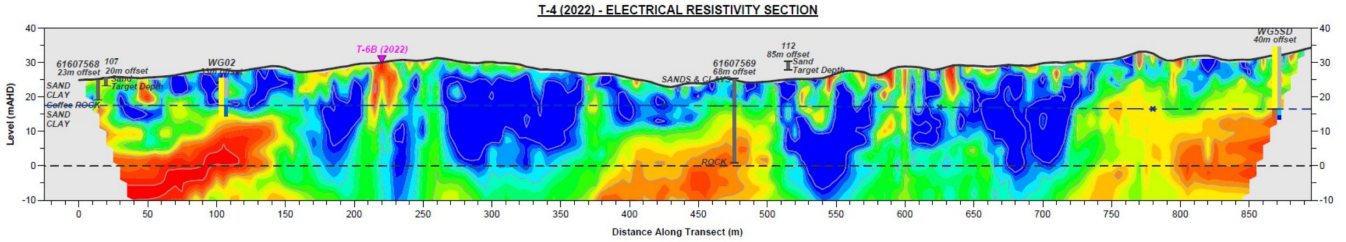
Date: 30/01/2024 Job No. H22076

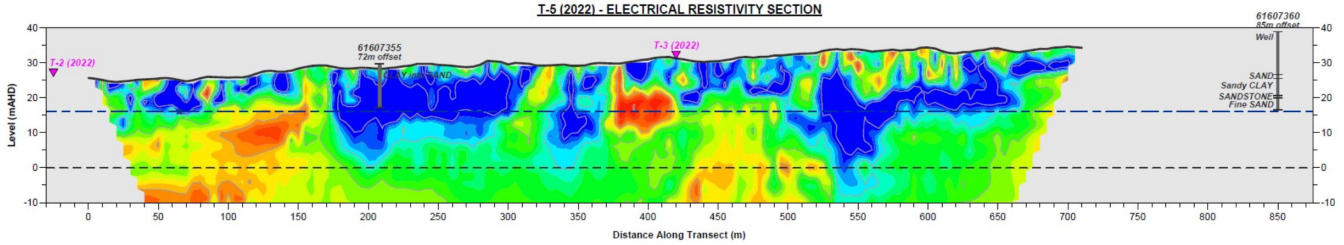


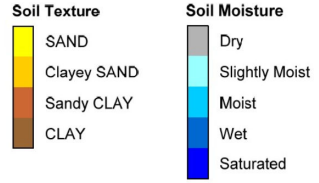


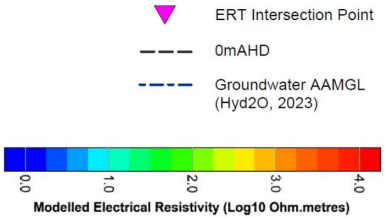














Amendment Area

Electrical Resistivity Tomography Transects (GBG Group, December 2022)

0 150 300 600 900 1,200 Meters

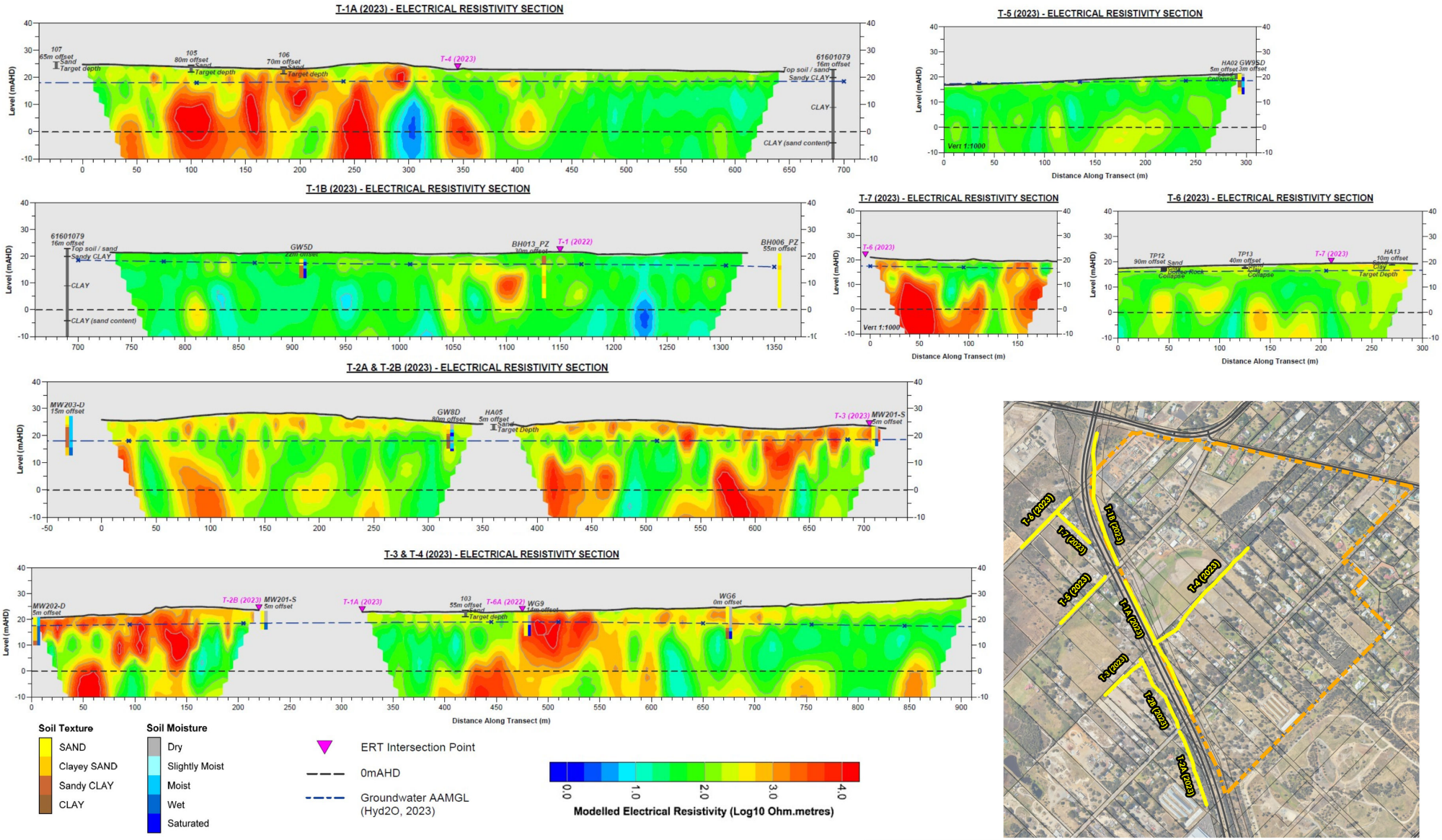
hyd2o

Wattle Grove South District Water Management Strategy

Geophysical Sections: December 2022

Figure 6

Date: 30/01/2024 Job No. H22076



Amendment Area

Electrical Resistivity Tomography Transects (GBG Group, October 2023)

0 150 300 600 900 1,200 Meters

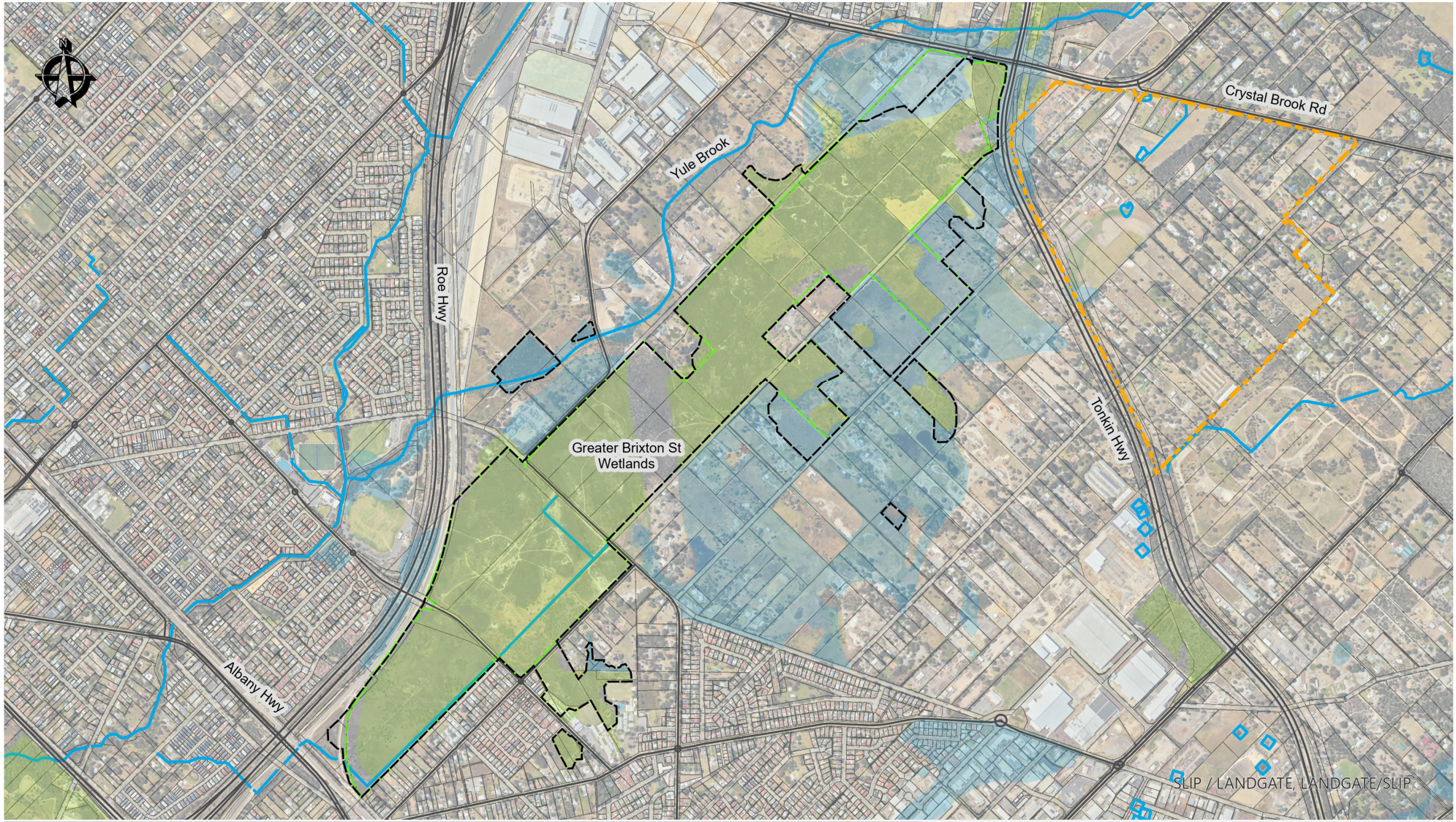
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Wattle Grove South District Water Management Strategy

Geophysical Sections: December 2023

Figure 7

Date: 30/01/2024 Job No. H22076



Amendment Area

(Bush Forever Site 387

Greater Brixton Street Wetland Area (EPA, 2022)

Wetlands

Conservation

Resource Enhancement

DWER Hydrography

0 200 400 600 800 Meters

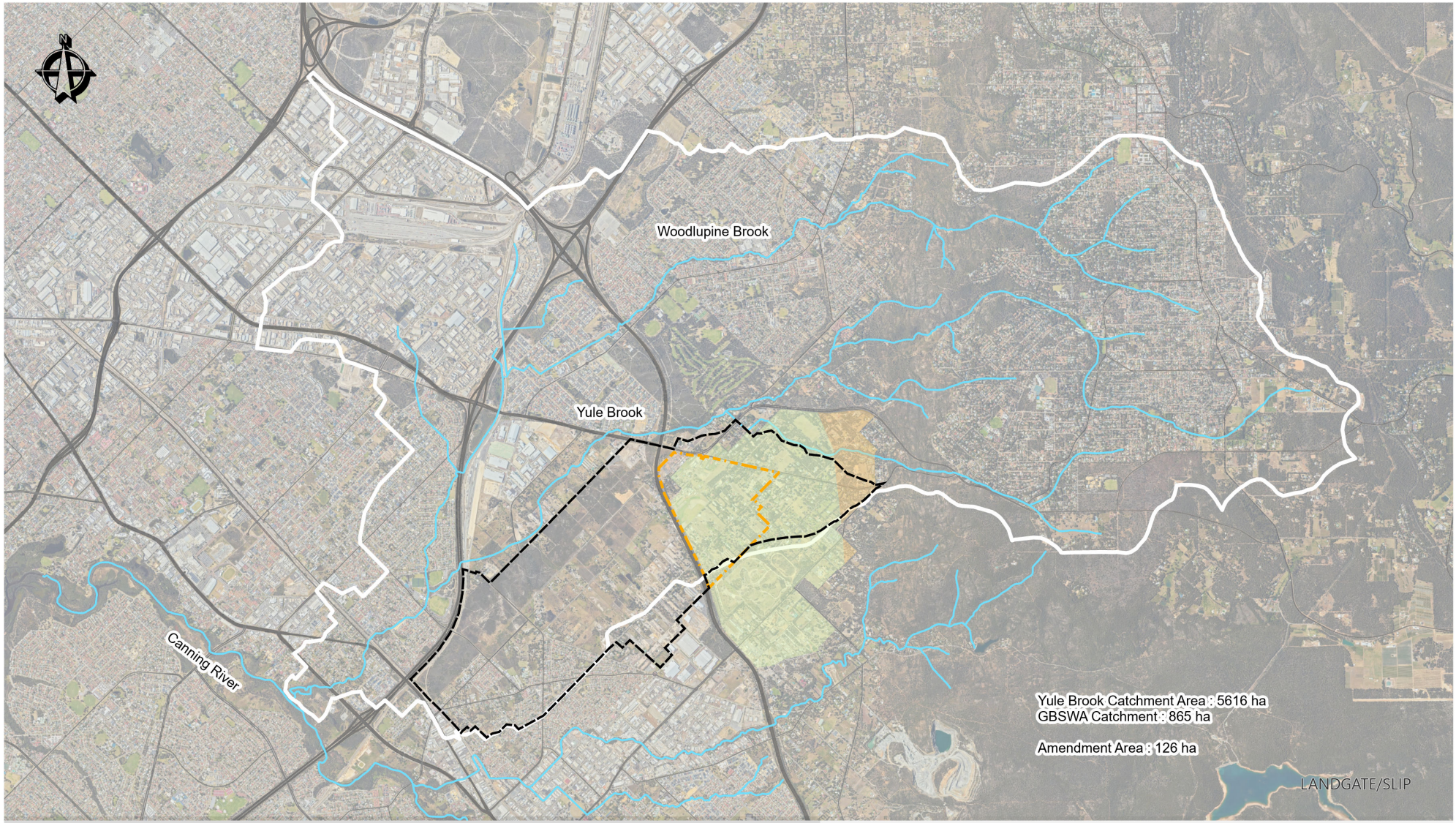
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Wattle Grove South District Water Management Strategy

Wetland Plan

Figure 8

Date: 30/01/2024 Job No. H22076



Amendment Area
Yule Brook Catchment
GBSWA Catchment
Watercourses
Urban Expansion Area
Urban Investigation Area

0 750 1,500 2,250 3,000 Meters

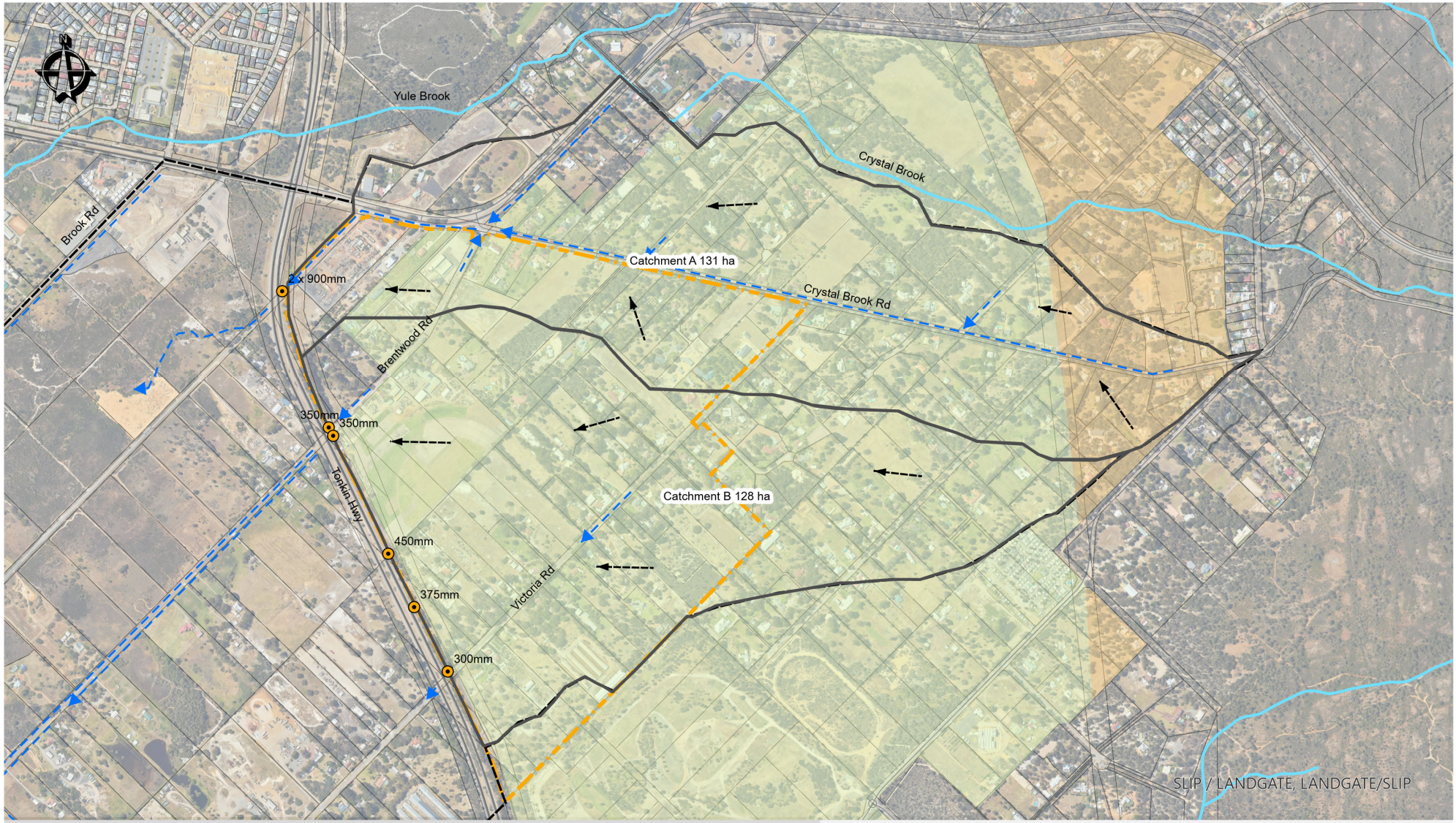
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Wattle Grove South District Water Management Strategy

Surface Water Plan : Yule Brook & GBSWA Catchments

Figure 9

Date: 30/01/2024 Job No. H22076



Amendment Area
GBSWA Catchment
Site Sub Catchments

Urban Expansion Area
Urban Investigation Area

Watercourses
Swales & Road Drainage Direction
Overland Flow
Stormwater Outlets under Tonkin Hwy

0 150 300 450 600 Meters

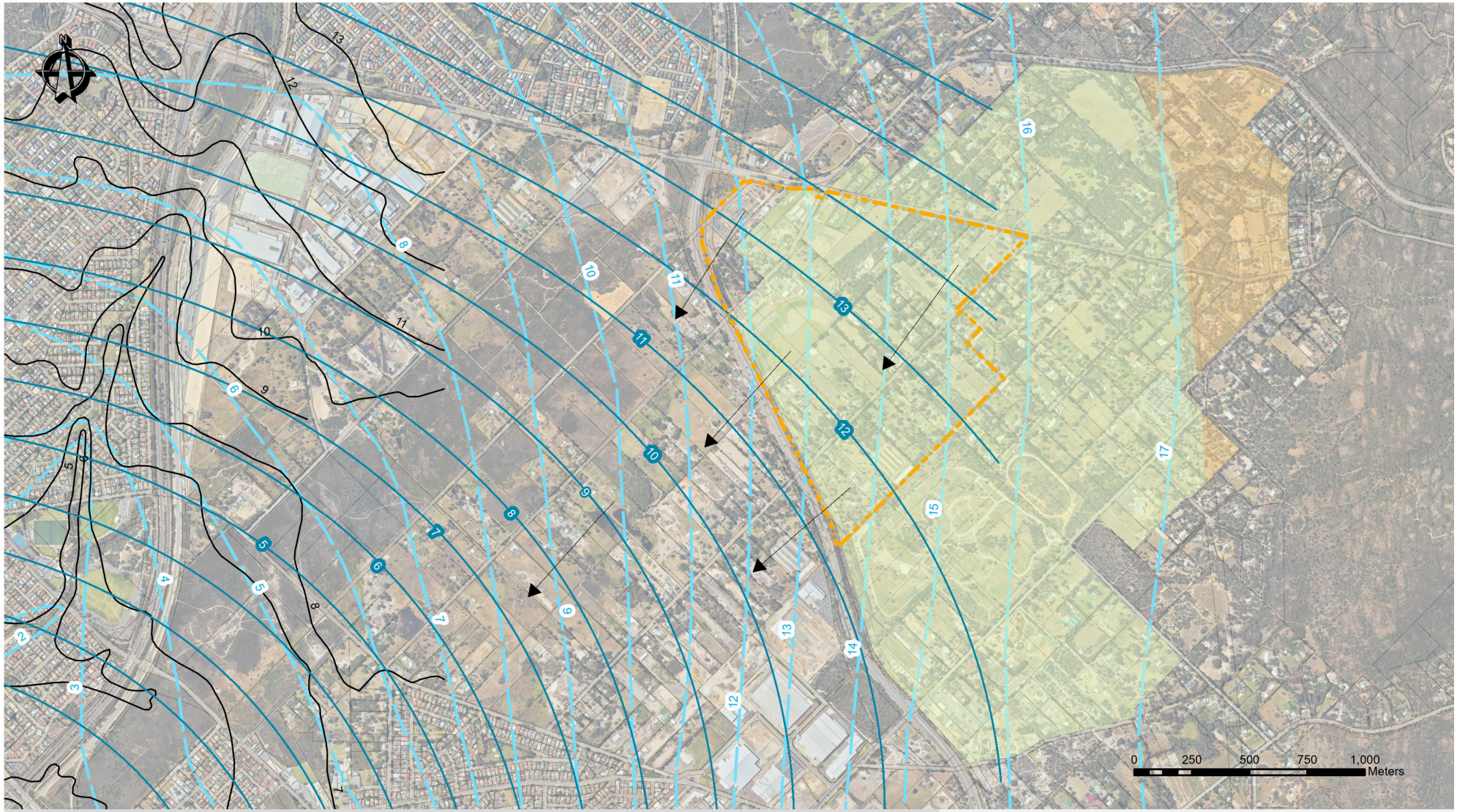
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Wattle Grove South District Water Management Strategy

Surface Water Plan : Amendment Area Sub Catchments

Figure 10

Date: 11/02/2024 Job No. H22076



Amendment Area
Urban Expansion Area
Urban Investigation Area

DWER Groundwater Contours Maximum Historical (mAHD)
DWER Groundwater Contours Minimum (May 2003) (mAHD)
DWER Gnangara Jandakot Water Table Contours 2019 Maximum (mAHD)
DWER 2019 Contours Groundwater Flow Direction (mAHD)

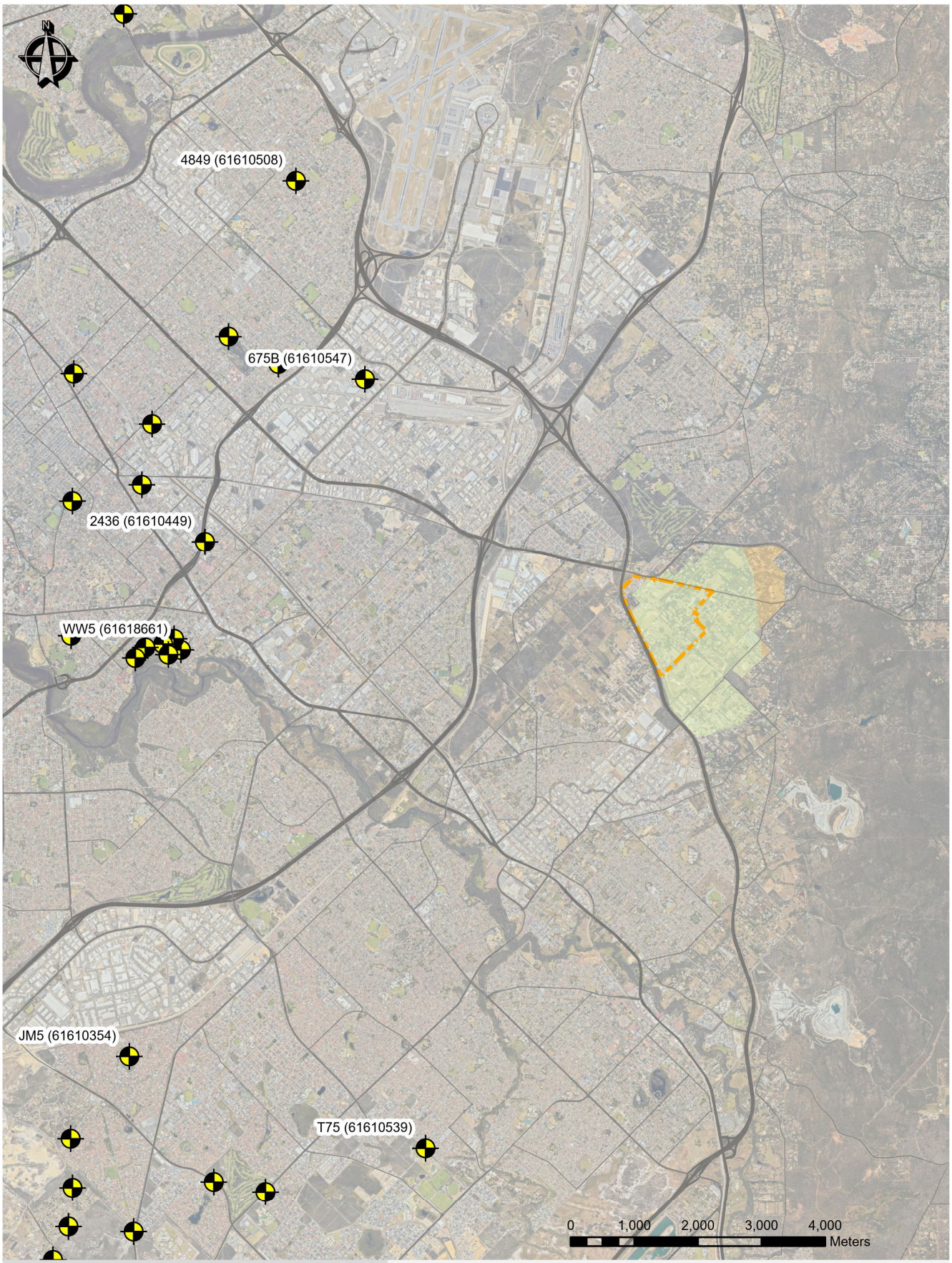
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Wattle Grove South District Water Management Strategy

Groundwater Plan : DWER Regional Mapping

Figure 11

Date: 30/01/2024 Job No. H22076



Amendment Area
Urban Expansion Area
Urban Investigation Area
DWER Bores Used for Regional Mapping (DoE, 2004)

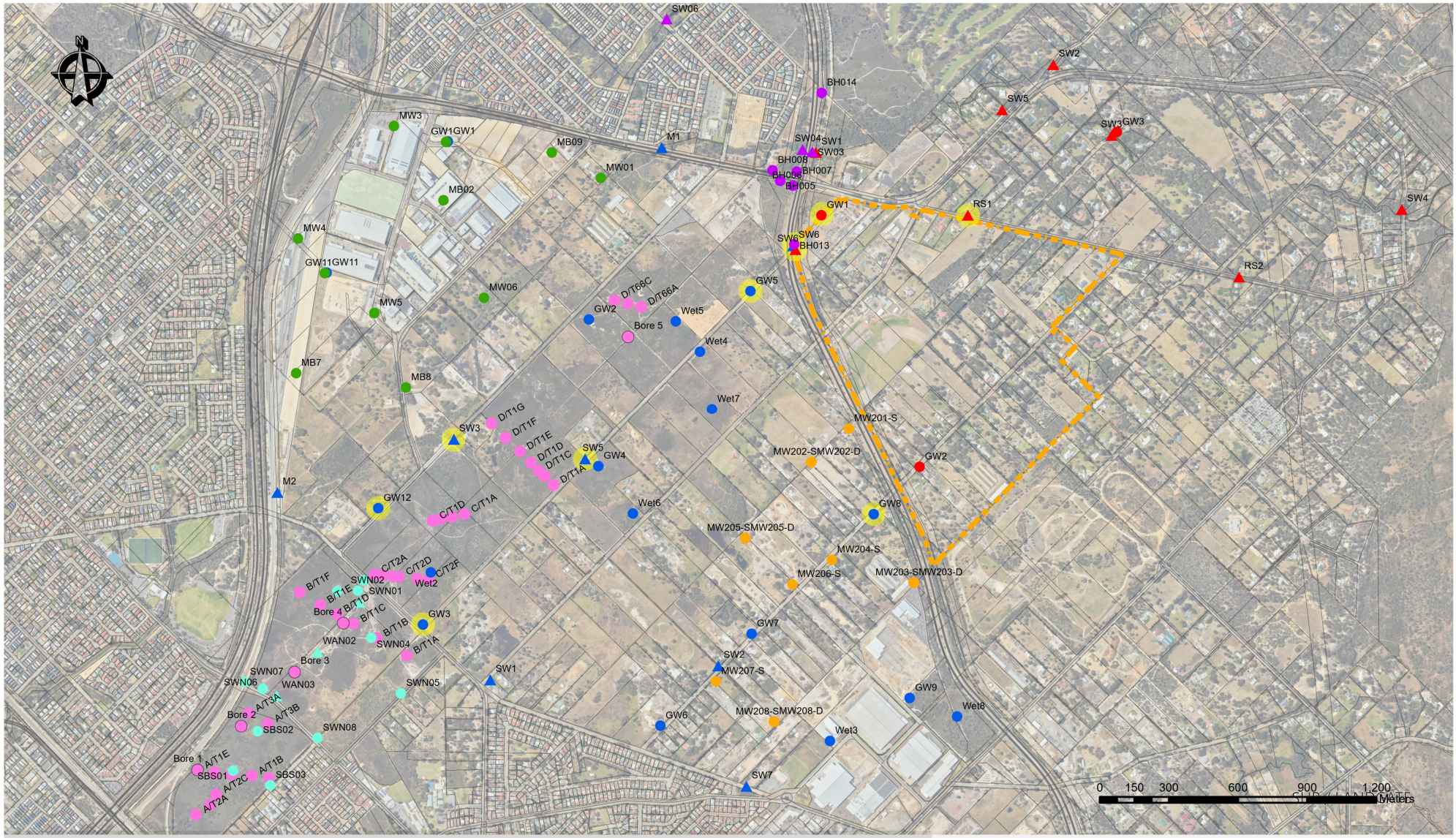
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Wattle Grove South District Water Management Strategy

Groundwater Plan : DWER Bore Used for Regional Mapping

Figure 12

Date: 30/01/2024 Job No. H22076



- Amendment Area
- DBCA SW (2016-2023)
- DBCA GW (2016-2023)
- Main Roads GW (2020-2021)
- Main Roads SW (2020-2021)
- MKSEA Precinct 1 GW (2022-2023)
- MKSEA Precint 3A GW (2016)
- MKSEA Endemic GW & Wetland (2009-2011)
- MKSEA Endemic SW (2009-2011)
- Semeniuk GW Piezometer (monitored 2001)
- Semeniuk GW Bores (monitored 2001)
- Urbaqua GW (monitored 2019-2020)
- Urbaqua SW (2019-2020)
- Previously Monitored Sites Part of Hyd2o Program (2021-2024)

SW : Surface Water
GW : Groundwater

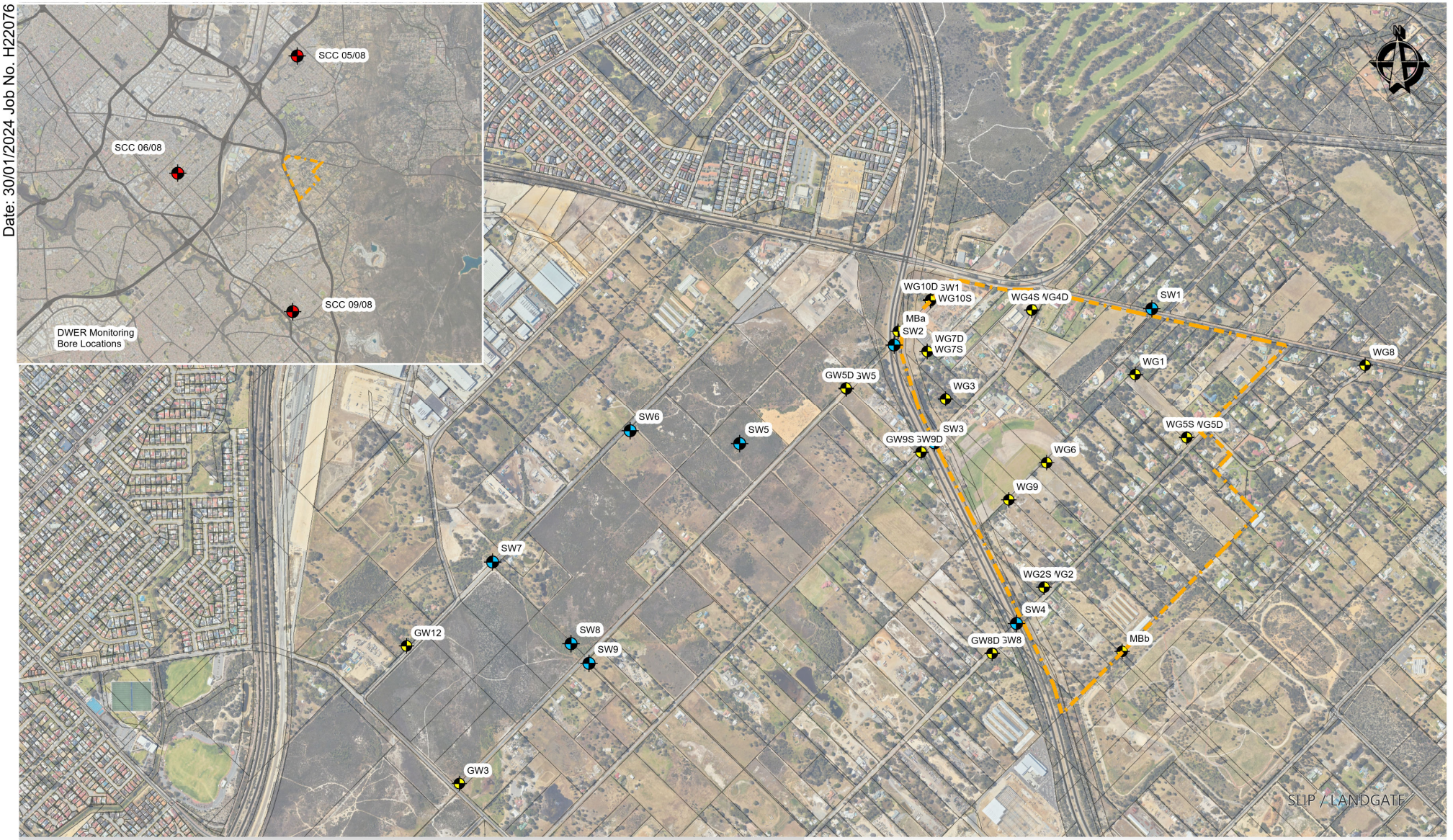
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Wattle Grove South District Water Management Strategy

Monitoring Locations from Other Programs Used to Inform Planning

Figure 13

Date: 30/01/2024 Job No. H22076



Amendment Area

Groundwater Monitoring Bores (S:Shallow, D:Deep)

Surface Water Monitoring Sites

DWER Nearby Bores

0 250 500 750 1,000 Meters

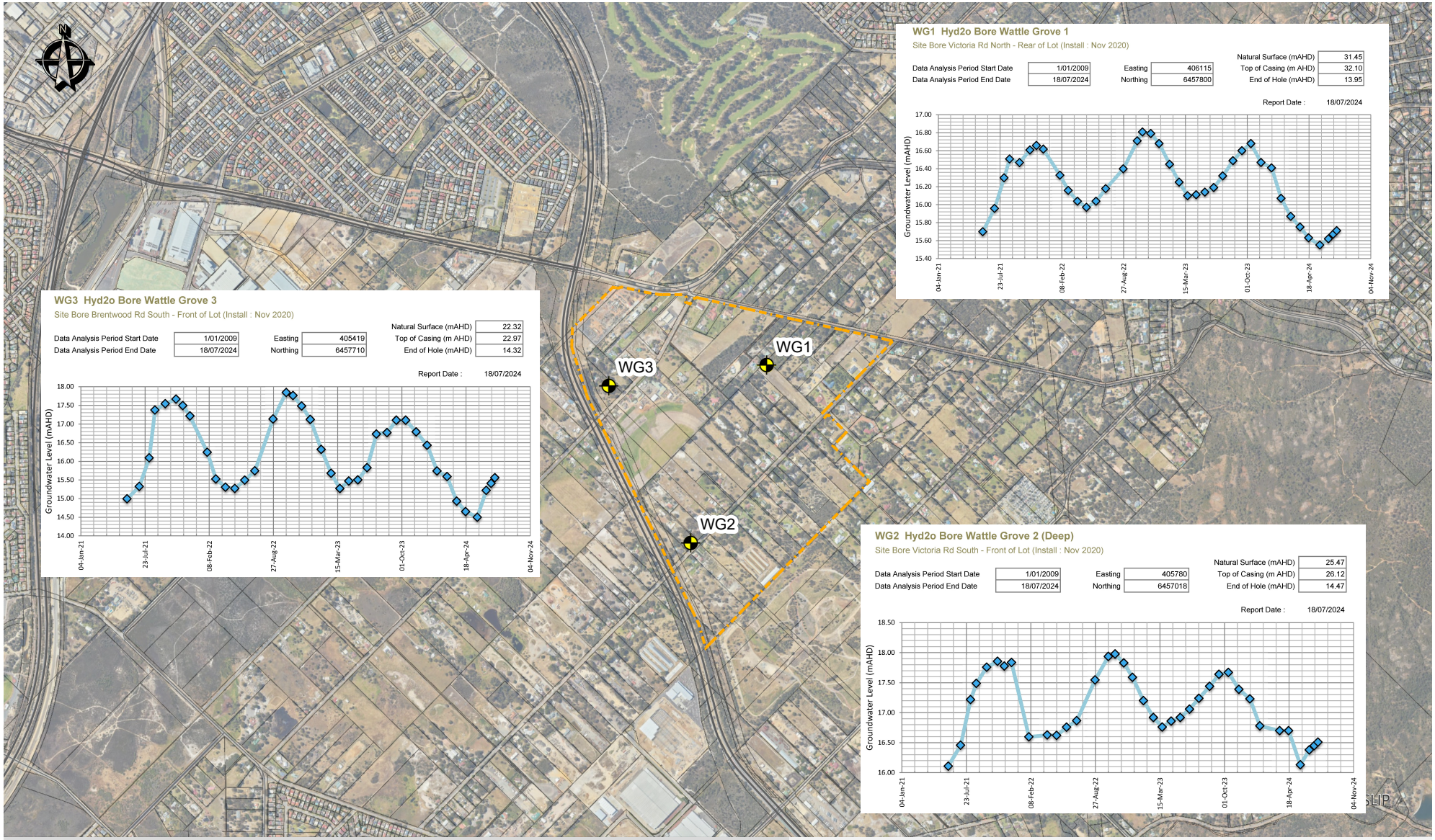
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Wattle Grove South District Water Management Strategy

Surface Water & Groundwater Monitoring Program Locations

Figure 14

Date: 18/07/2024 Job No. H22076



Amendment Area

Long Term Site Groundwater Monitoring Bores

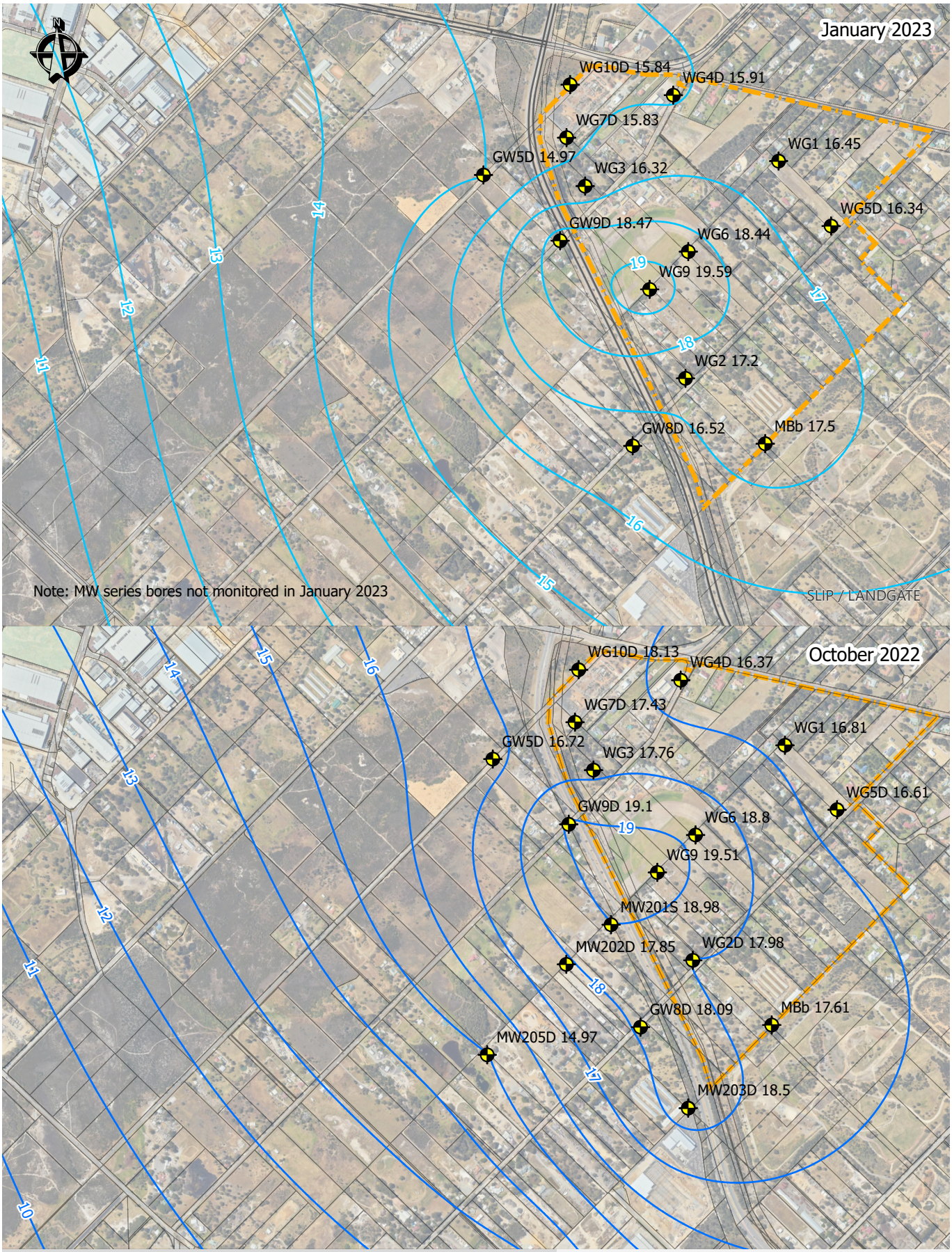
0 300 600 900 1,200 Meters

hyd2o

Wattle Grove South District Water Management Strategy

Groundwater Hydrographs for Longer Term Amendment Area Bores

Figure 15



Date: 18/07/2024 Job No. H22076

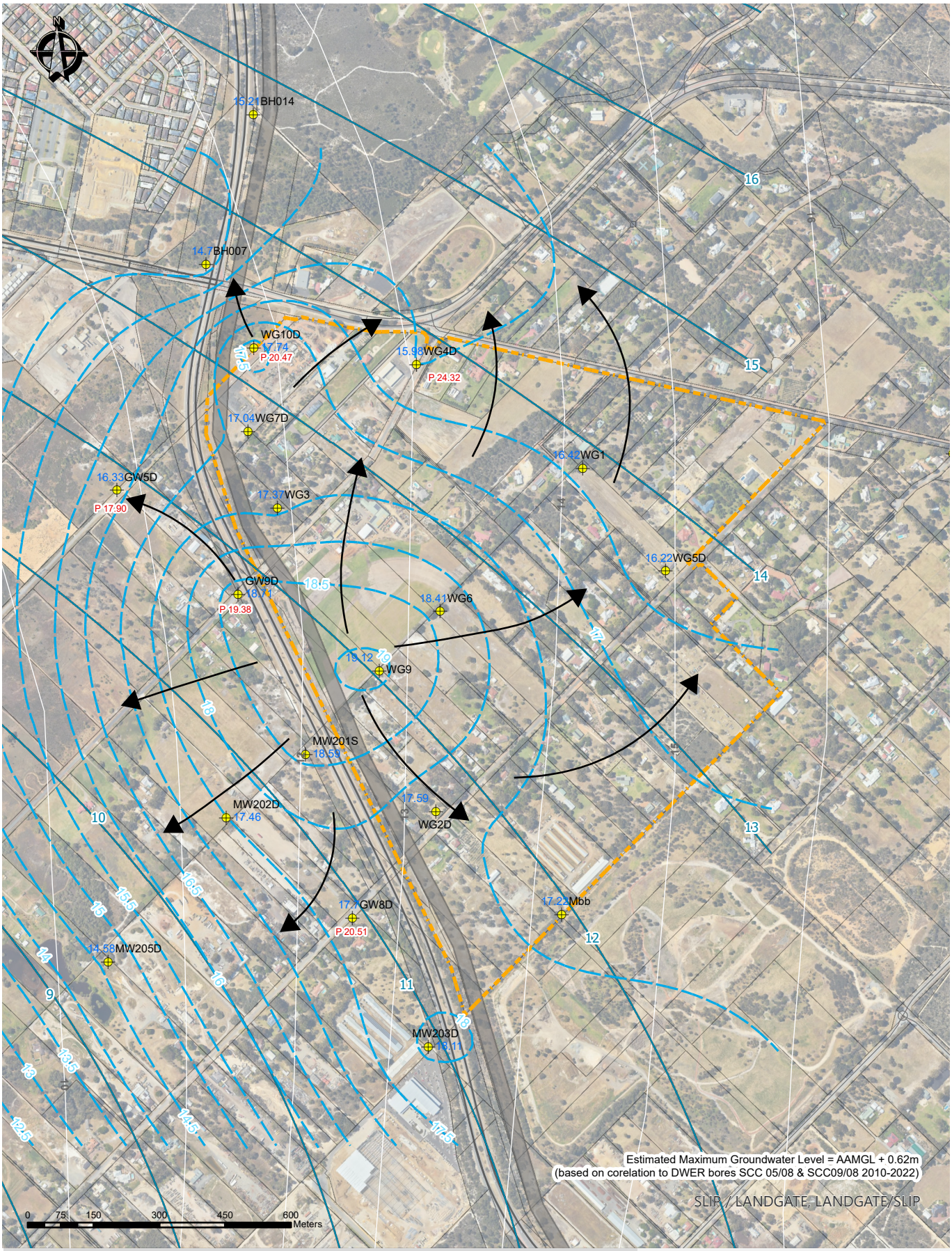
hyd2o

Wattle Grove South DWMS

Groundwater Plan: October 2022 and January 2023 Contours

Figure 16

Date: 18/07/2024 Job No. H22076



Amendment Area

Groundwater Sites & AAMGL (mAHD)

Groundwater AAMGL 0.5m Contours (mAHD)

DWER Groundwater Contours Minimum (2003) (mAHD)

DWER Water Table Contours 2019 Maximum (mAHD)

Regional Groundwater Flow Direction

P xx.xx Areas of Observed Perching 27 October 2022 (mAHD)

Dampier to Bunbury Natural Gas Pipeline

hyd2o

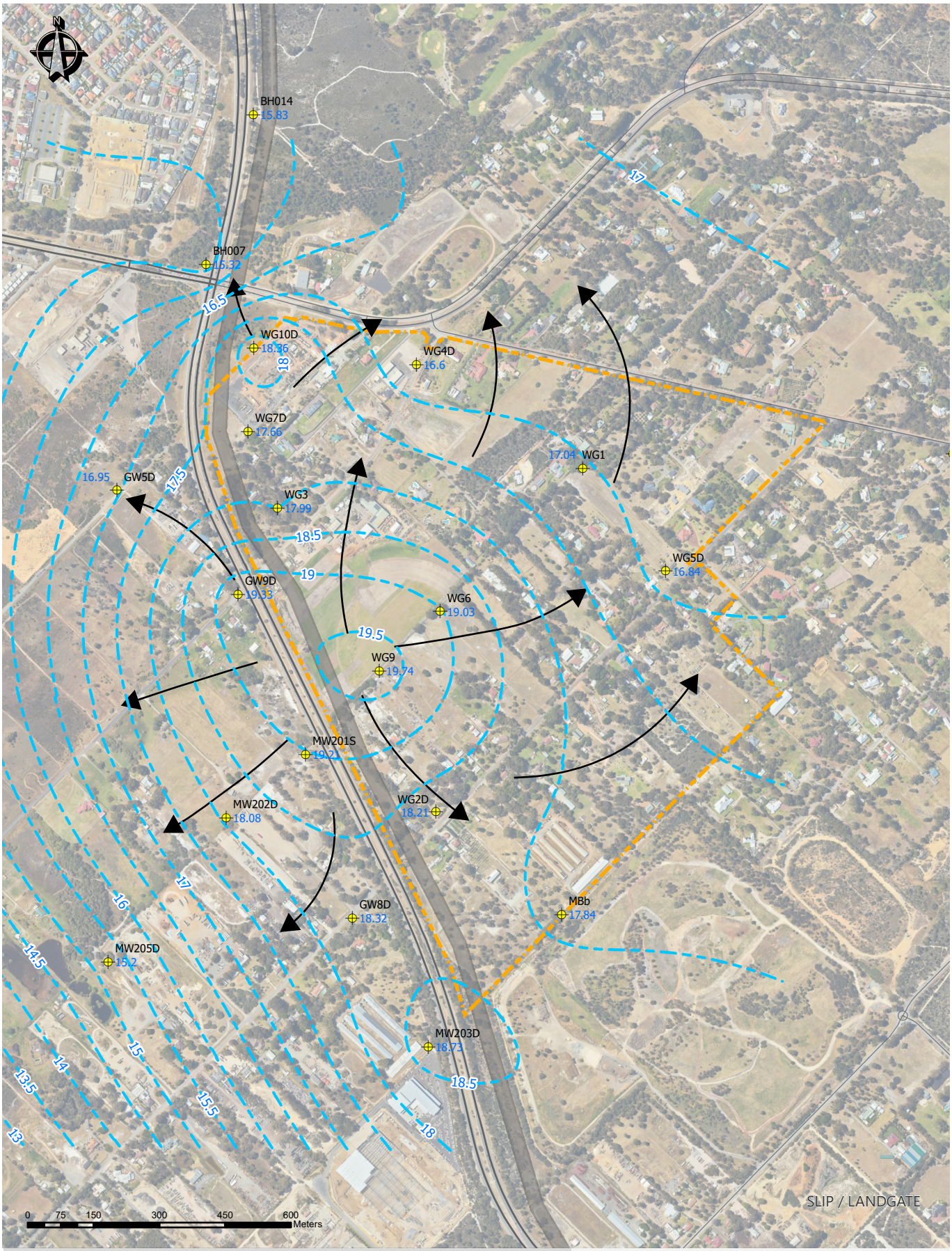
Wattle Grove South DWMS

Groundwater Plan

Local Groundwater Mapping - AAMGL

Figure 17

Date: 18/07/2024 Job No. H22076



Amendment Area

Groundwater Sites & MGL (mAHD)

Groundwater MGL 0.5m Contours (mAHD)

Regional Groundwater Flow Direction

Dampier to Bunbury Natural Gas Pipeline

hyd2o

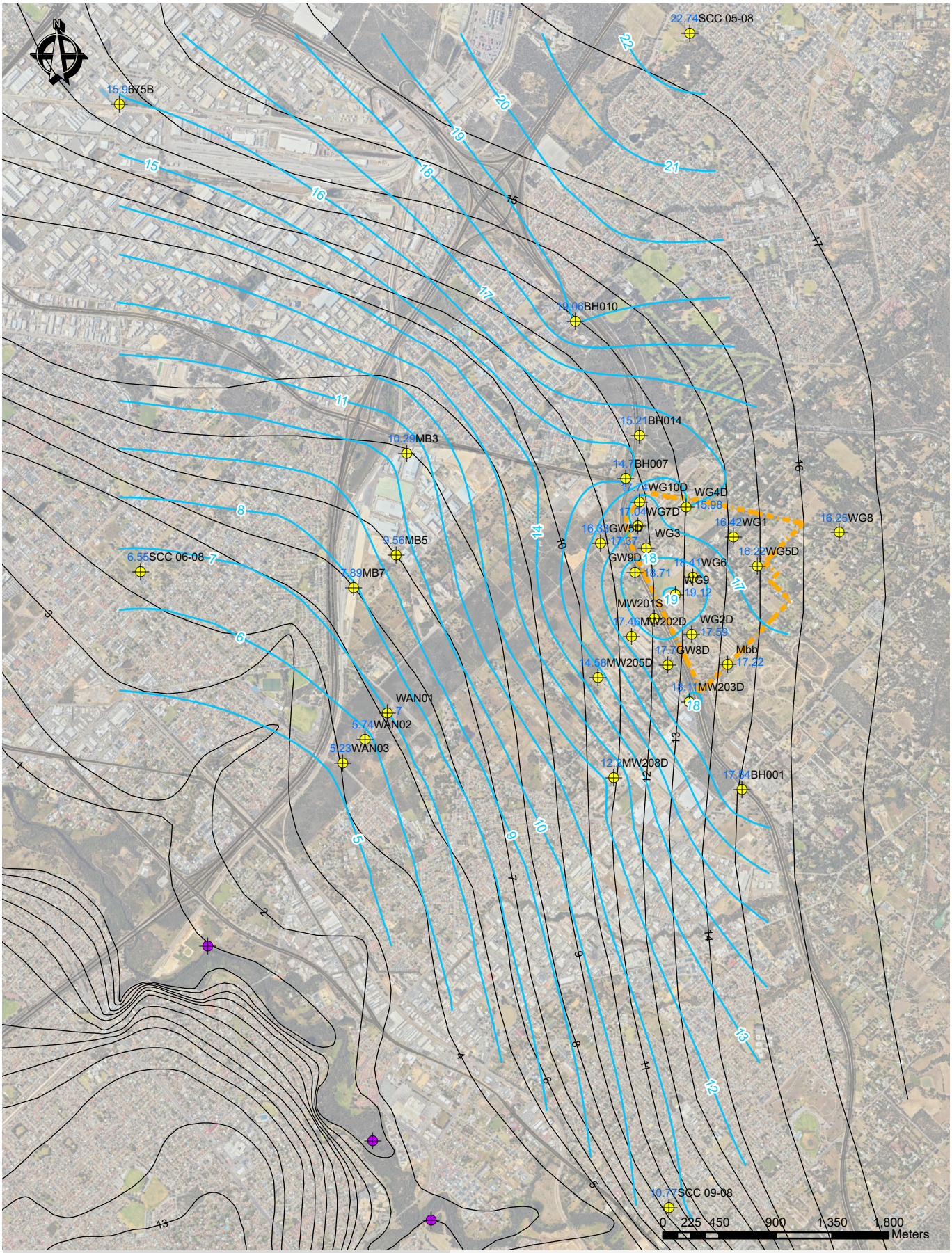
Wattle Grove South DWMS

Groundwater Plan:

Local Groundwater Mapping - MaxGL

Figure 18

Date: 30/01/2024 Job No. H22076



Amendment Area

Groundwater Bores & AAMGL Estimate (mAHD)

Canning River Location Used

Groundwater AAMGL Contours (mAHD)

DWER Groundwater Contours Minimum (2003)(mAHD)

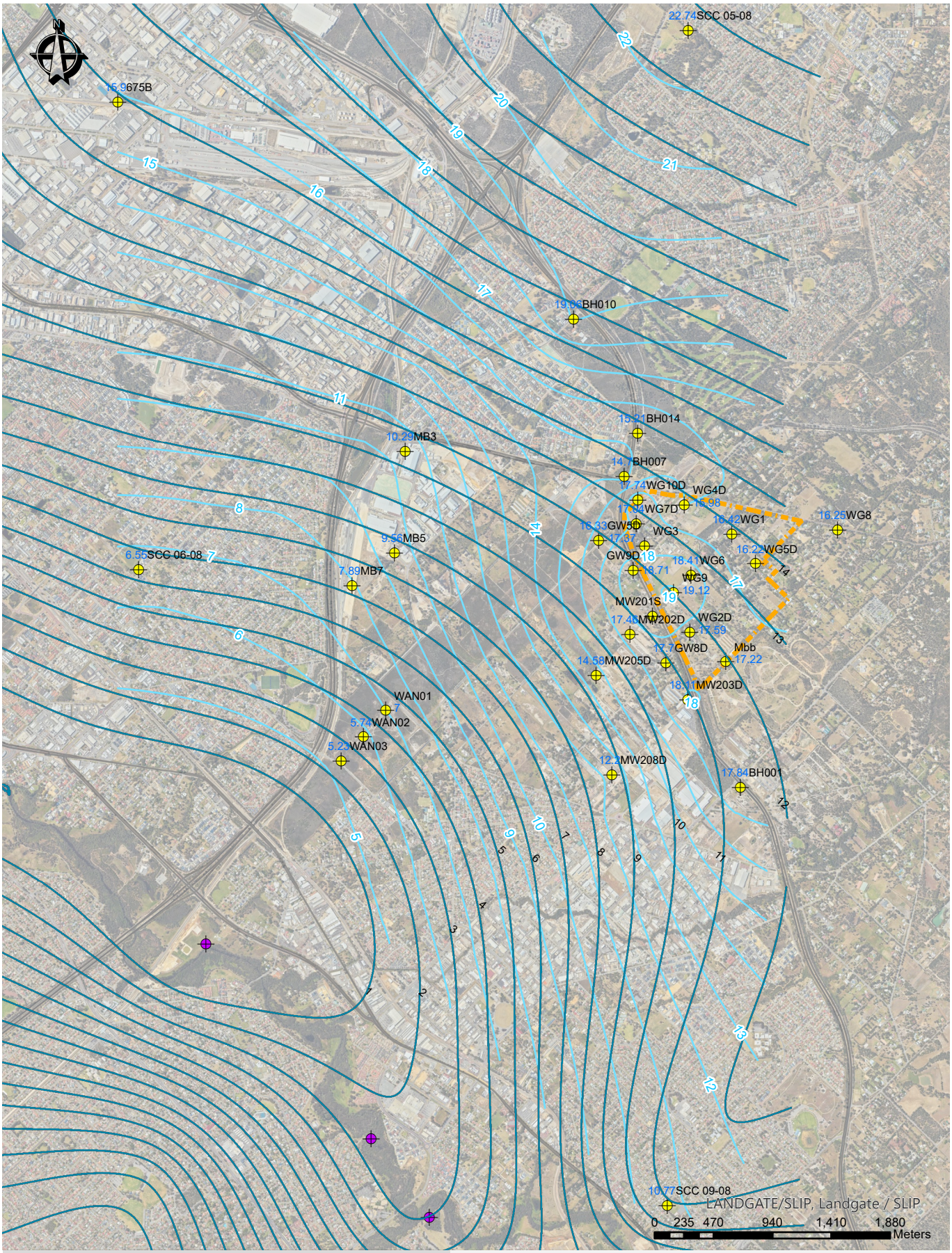
hyd2o

Wattle Grove South DWMS

Groundwater Plan: Regional Context for Local Mapping Comparison to DWER Minimum Contours (May 2003)

Figure 19

Date: 30/01/2024 Job No. H22076



Amendment Area

Groundwater Bores & AAMGL Estimate (mAHD)

Canning River Location Used

Groundwater AAMGL Contours (mAHD)

DWER Water Table Contours 2019 Maximum (mAHD)

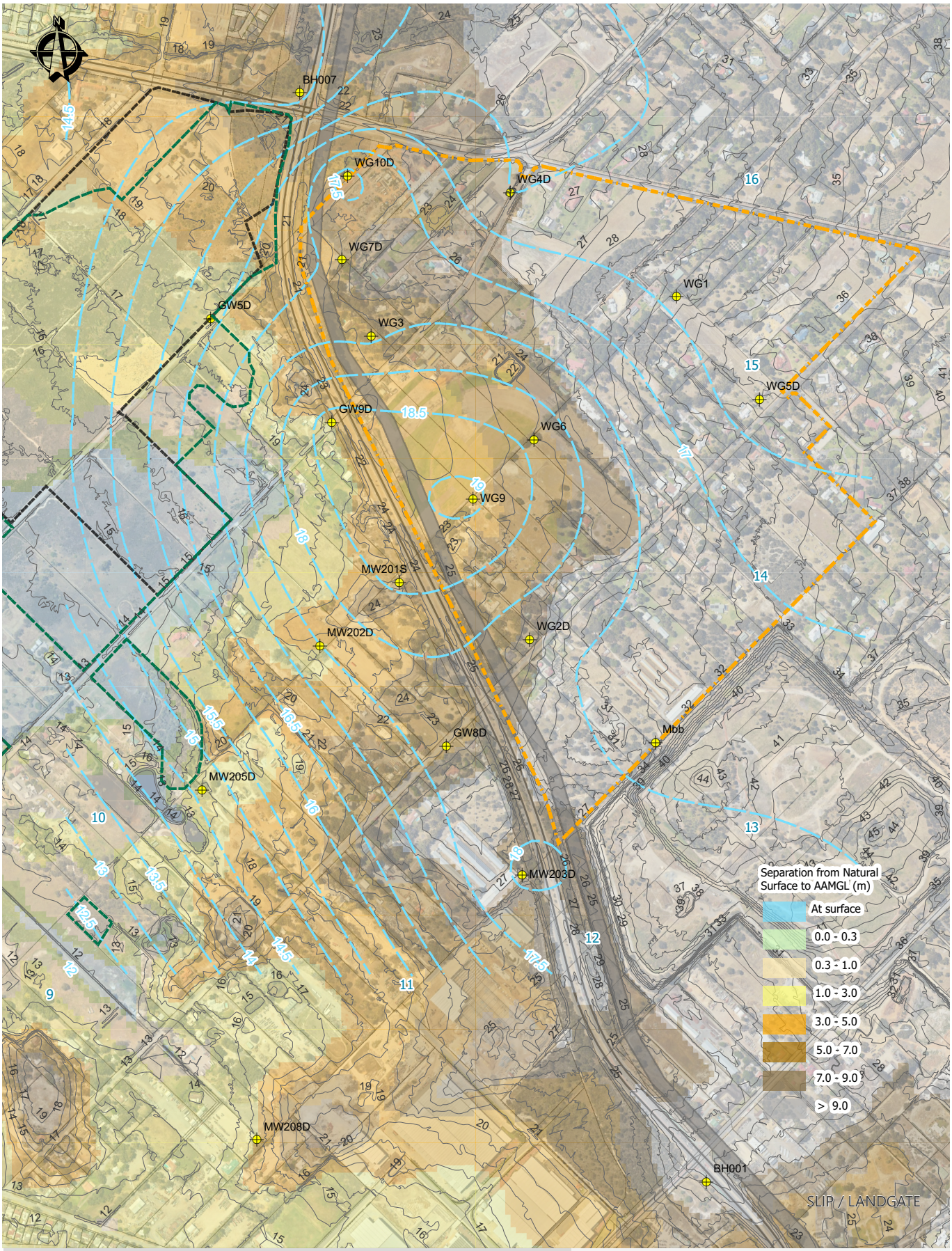
hyd2o

Wattle Grove South DWMS

Groundwater Plan: Regional Context for Local Mapping
Comparison to DWER Water Table Contours 2019 Maximum

Figure 20

Date: 18/07/2024 Job No. H22076



Amendment Area

GBSW Area

Bush Forever Site 387)

Groundwater Sites

Groundwater AAMGL 0.5m Contours (mAHD)

Dampier to Bunbury Natural Gas Pipeline

0 75 150 300 450 600 Meters

hyd2o

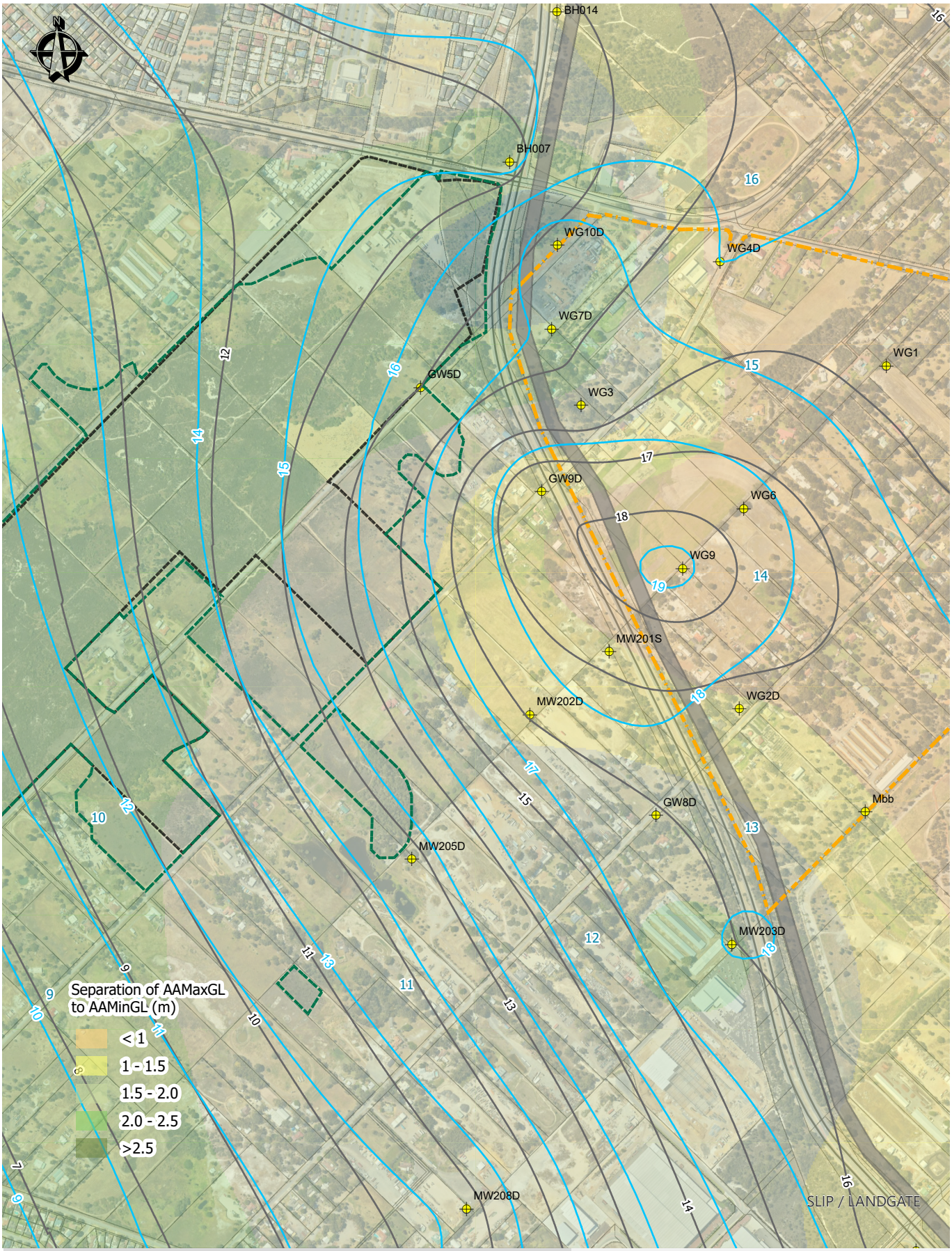
Wattle Grove South DWMS

Groundwater Plan

Depth to AAMGL

Figure 21

Date: 18/08/2024 Job No. H22076



Amendment Area
GBSW Area
Bush Forever Site 387)

Groundwater Sites
Groundwater AAMGL 1.0m Contours (mAHD)
Groundwater AAMinGL 1.0m Contours (mAHD)
Dampier to Bunbury Natural Gas Pipeline

0 75 150 300 450 600 Meters

hyd2o

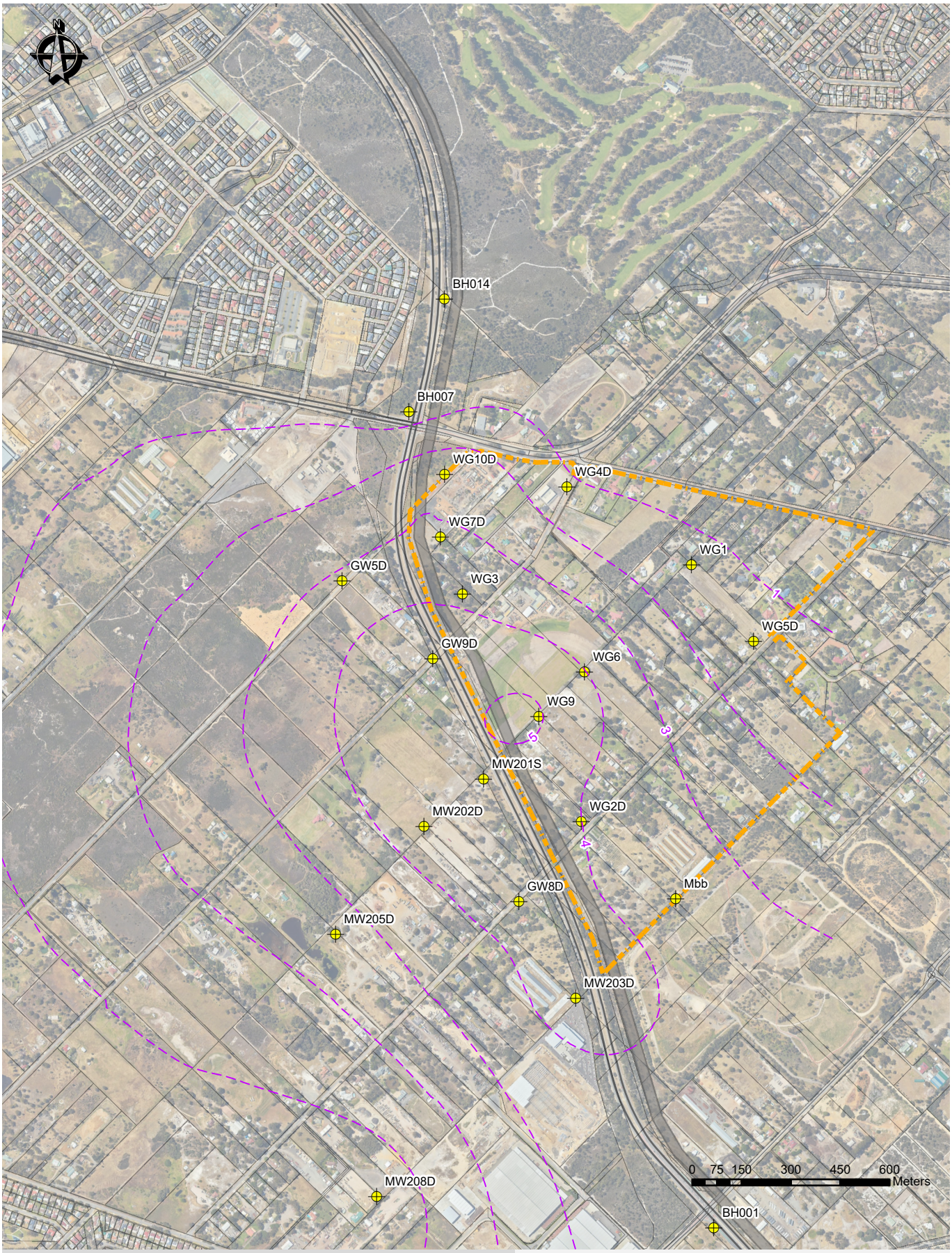
Wattle Grove South DWMS

Groundwater Plan

Seasonal Variation

Figure 22

Date: 18/07/2024 Job No. H22076



Amendment Area

Groundwater Bores

Derived local groundwater mound (m)
above wider area regional AAMGL groundwater levels

Dampier to Bunbury Natural Gas Pipeline

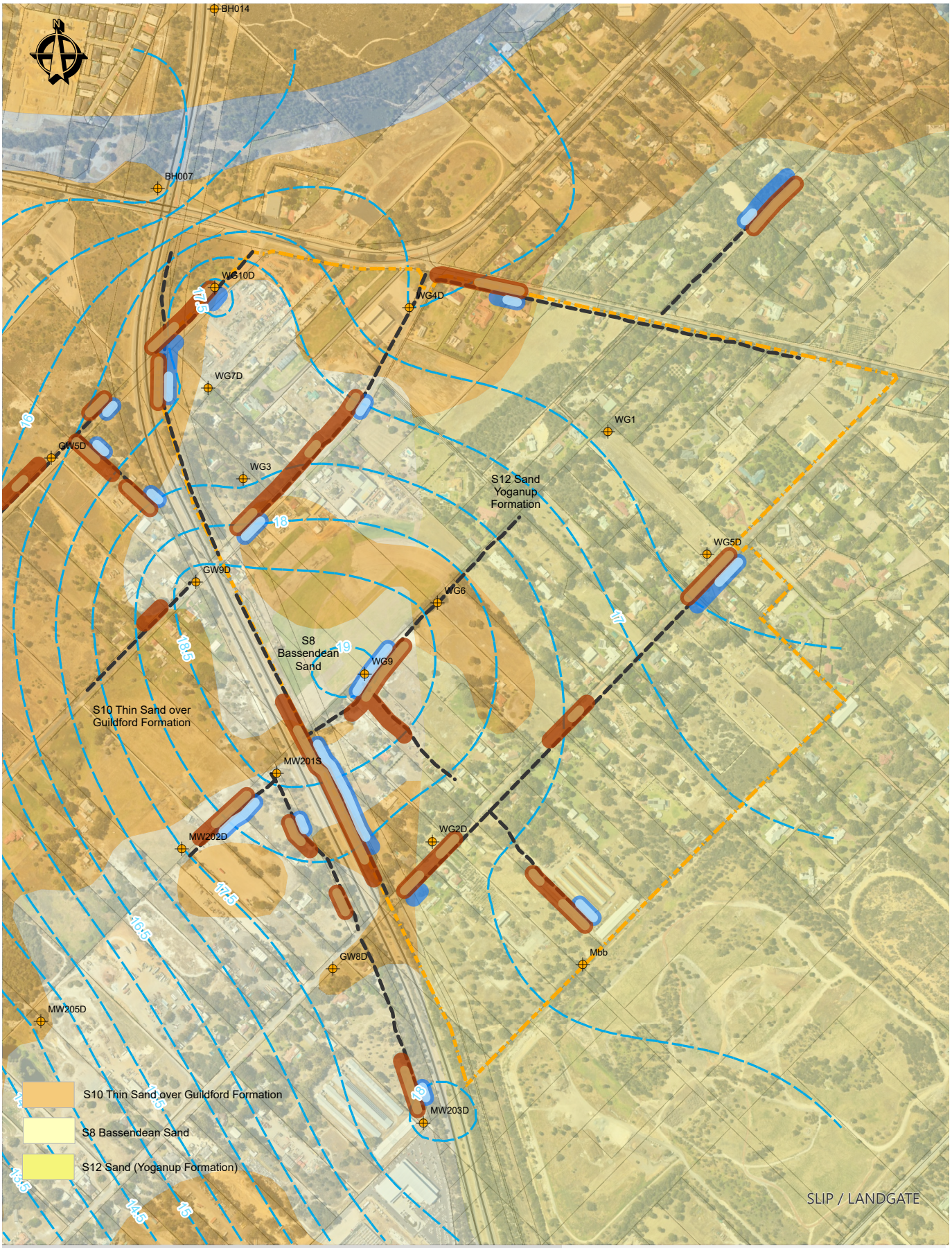
hyd2o

Post Development Groundwater Flow Assessment

Groundwater Plan : Local Mounding

Figure 23

Date: 18/07/2024 Job No. H22076



Amendment Area

Geophysical Transects

Area of High Resistivity/Low Conductivity (Wet) Above Base of Superficial (0 mAHD)

Area of High Resistivity/Low Conductivity (Wet) Above 10 mAHD

Groundwater AAMGL (mAHD)

Area of High Resistivity/Low Conductivity within 2m of AAMGL

Area of High Resistivity/Low Conductivity Extends to AAMGL

0 40 80 160 240 320 Meters

hyd2o

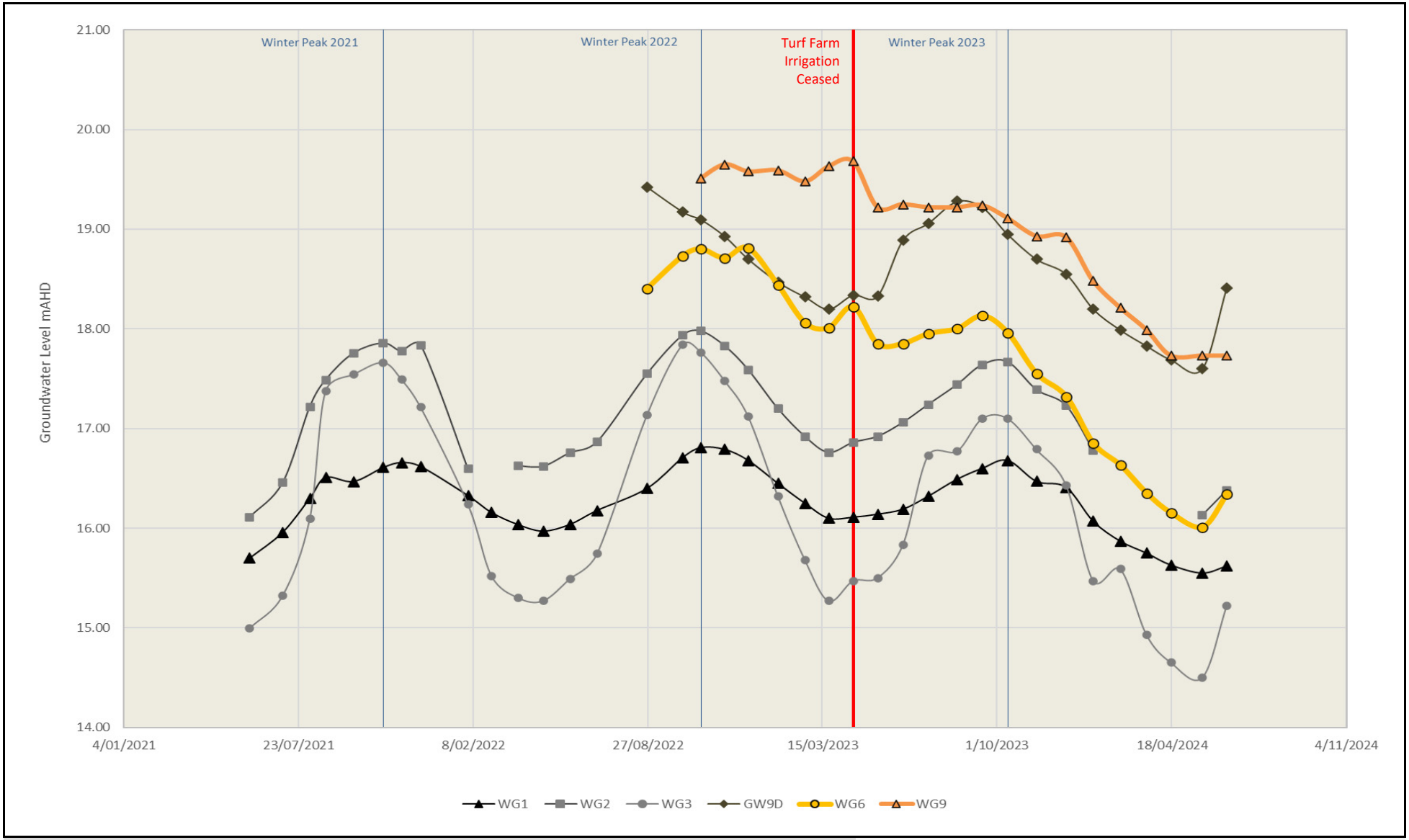
Wattle Grove South DWMS

Groundwater Plan

Geological & Geophysical Interpretation

Figure 24

Date: 18/07/2024 Job No H22076



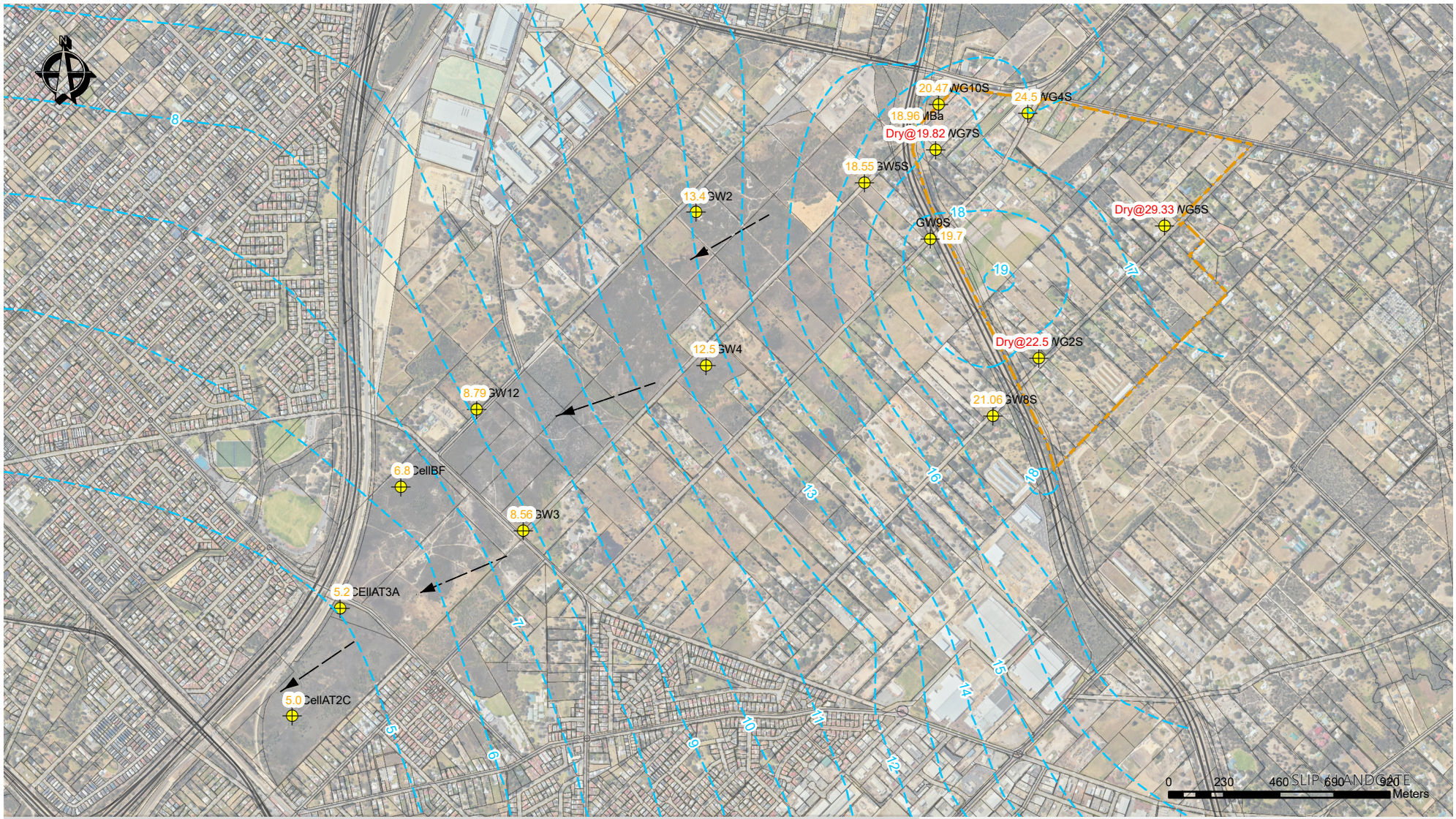
hyd2o

Wattle Grove South District Water Management Strategy

Bore Hydrographs in Area of Local Mounding

Figure 25

Date: 30/01/2024 Job No. H22076



Amendment Area

Shallow Bores with Potential Perching

Perched Water Level - Maximum Recorded (mAHD)

No Observed Perching - Dry Reading (mAHD)

Indicative Perched Flow Direction Based on Water Levels

Amendment Area Regional Groundwater AAMGL Contours (mAHD)

hyd2o

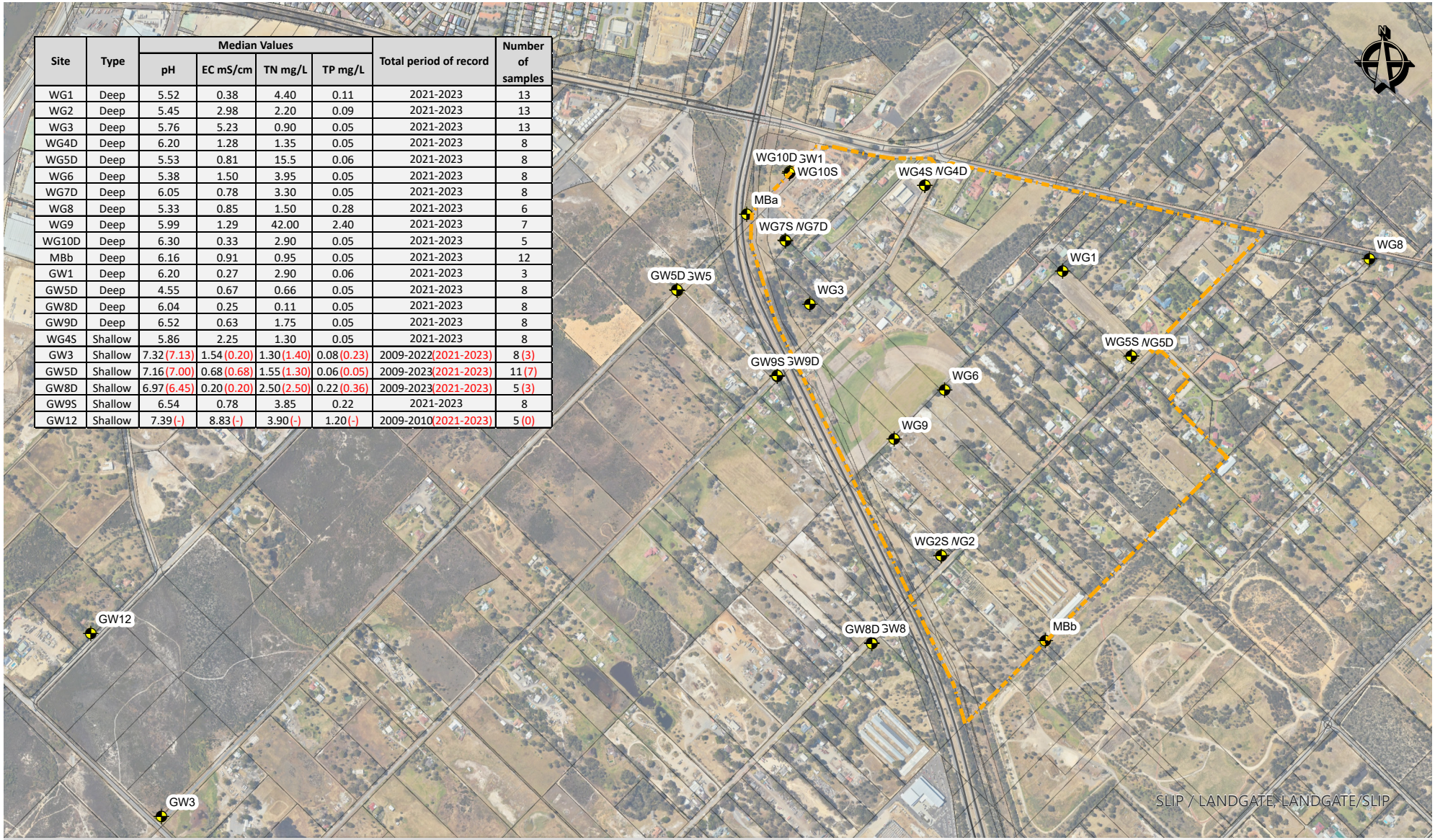
Wattle Grove South District Water Management Strategy

Groundwater Plan : Perched Water Assessment

Figure 26

Date: 18/07/2024 Job No. H22076

Site	Type	Median Values				Total period of record	Number of samples
		pH	EC mS/cm	TN mg/L	TP mg/L		
WG1	Deep	5.52	0.38	4.40	0.11	2021-2023	13
WG2	Deep	5.45	2.98	2.20	0.09	2021-2023	13
WG3	Deep	5.76	5.23	0.90	0.05	2021-2023	13
WG4D	Deep	6.20	1.28	1.35	0.05	2021-2023	8
WG5D	Deep	5.53	0.81	15.5	0.06	2021-2023	8
WG6	Deep	5.38	1.50	3.95	0.05	2021-2023	8
WG7D	Deep	6.05	0.78	3.30	0.05	2021-2023	8
WG8	Deep	5.33	0.85	1.50	0.28	2021-2023	6
WG9	Deep	5.99	1.29	42.00	2.40	2021-2023	7
WG10D	Deep	6.30	0.33	2.90	0.05	2021-2023	5
MBb	Deep	6.16	0.91	0.95	0.05	2021-2023	12
GW1	Deep	6.20	0.27	2.90	0.06	2021-2023	3
GW5D	Deep	4.55	0.67	0.66	0.05	2021-2023	8
GW8D	Deep	6.04	0.25	0.11	0.05	2021-2023	8
GW9D	Deep	6.52	0.63	1.75	0.05	2021-2023	8
WG4S	Shallow	5.86	2.25	1.30	0.05	2021-2023	8
GW3	Shallow	7.32 (7.13)	1.54 (0.20)	1.30 (1.40)	0.08 (0.23)	2009-2022 (2021-2023)	8 (3)
GW5D	Shallow	7.16 (7.00)	0.68 (0.68)	1.55 (1.30)	0.06 (0.05)	2009-2023 (2021-2023)	11 (7)
GW8D	Shallow	6.97 (6.45)	0.20 (0.20)	2.50 (2.50)	0.22 (0.36)	2009-2023 (2021-2023)	5 (3)
GW9S	Shallow	6.54	0.78	3.85	0.22	2021-2023	8
GW12	Shallow	7.39 (-)	8.83 (-)	3.90 (-)	1.20 (-)	2009-2010 (2021-2023)	5 (0)



Site

Groundwater Monitoring Bores

0 190 380 570 760 Meters

* Medians shown are for total period of available record
Recent 2021-2023 median is shown in red where longer term record at the site exists

hyd2o

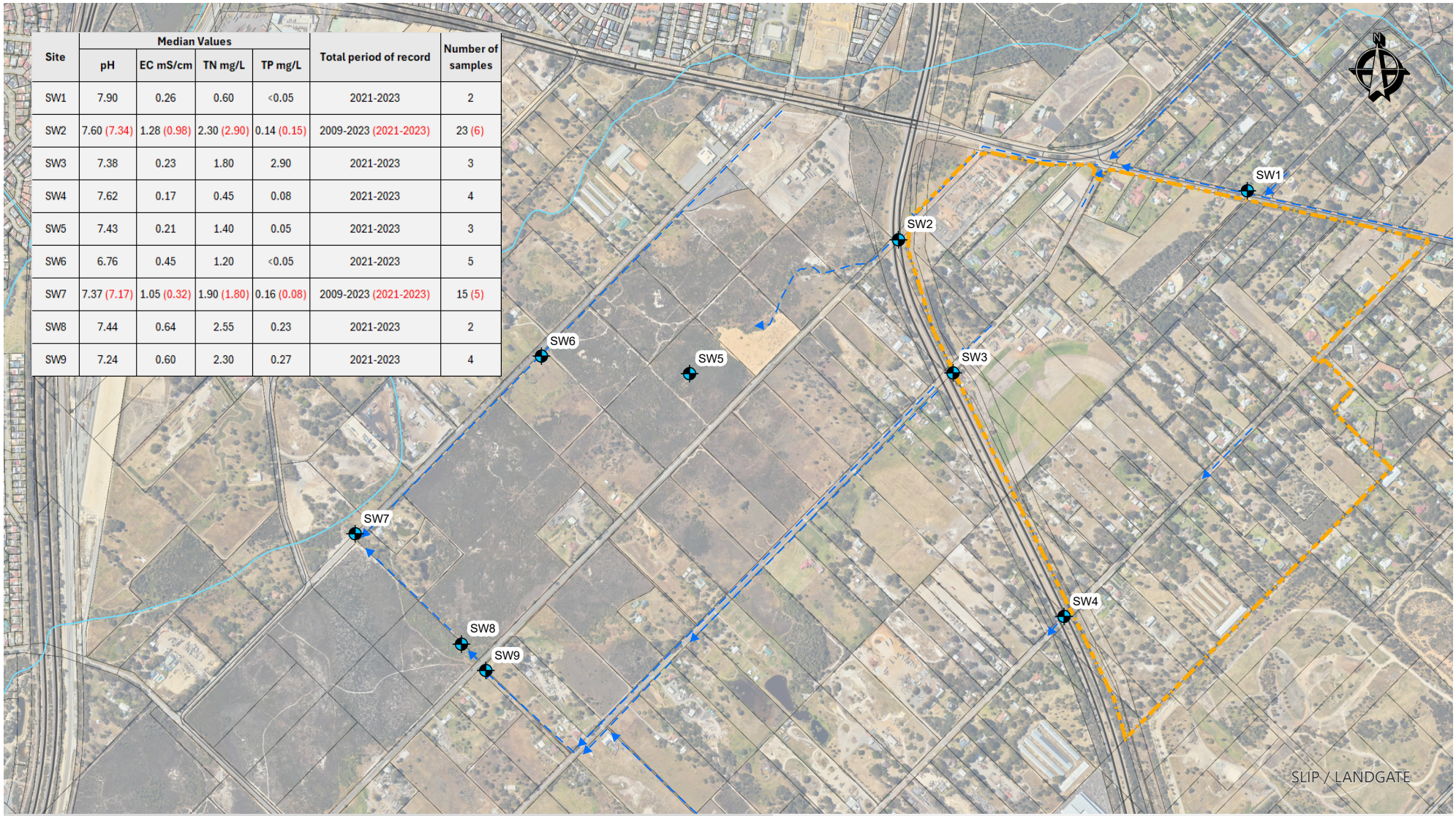
Wattle Grove South District Water Management Strategy

Water Quality Summary: Groundwater

Figure 27

Date: 30/01/2024 Job No. H22076

Site	Median Values				Total period of record	Number of samples
	pH	EC mS/cm	TN mg/L	TP mg/L		
SW1	7.90	0.26	0.60	<0.05	2021-2023	2
SW2	7.60 (7.34)	1.28 (0.98)	2.30 (2.90)	0.14 (0.15)	2009-2023 (2021-2023)	23 (6)
SW3	7.38	0.23	1.80	2.90	2021-2023	3
SW4	7.62	0.17	0.45	0.08	2021-2023	4
SW5	7.43	0.21	1.40	0.05	2021-2023	3
SW6	6.76	0.45	1.20	<0.05	2021-2023	5
SW7	7.37 (7.17)	1.05 (0.32)	1.90 (1.80)	0.16 (0.08)	2009-2023 (2021-2023)	15 (5)
SW8	7.44	0.64	2.55	0.23	2021-2023	2
SW9	7.24	0.60	2.30	0.27	2021-2023	4



Amendment Area

Surface Water Monitoring Sites

Swales & Road Drainage Direction

Watercourses

0 150 300 450 600 Meters

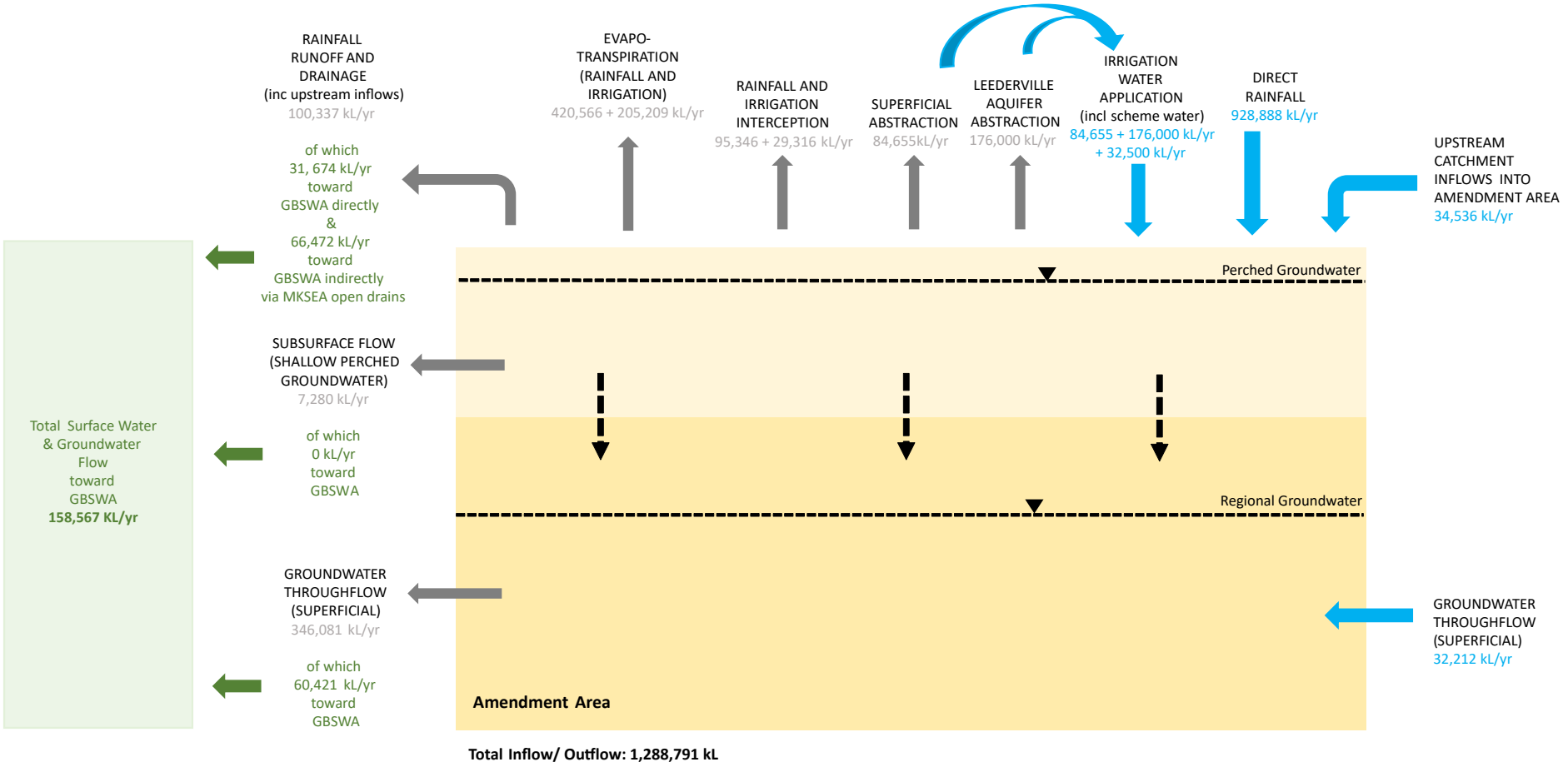
hyd2o

Wattle Grove South District Water Management Strategy

Water Quality Summary: Surface Water

Figure 28

Date: 17/02/2024 Job No. H22076



Source : Emerge Associates (2024) water balance model outcomes

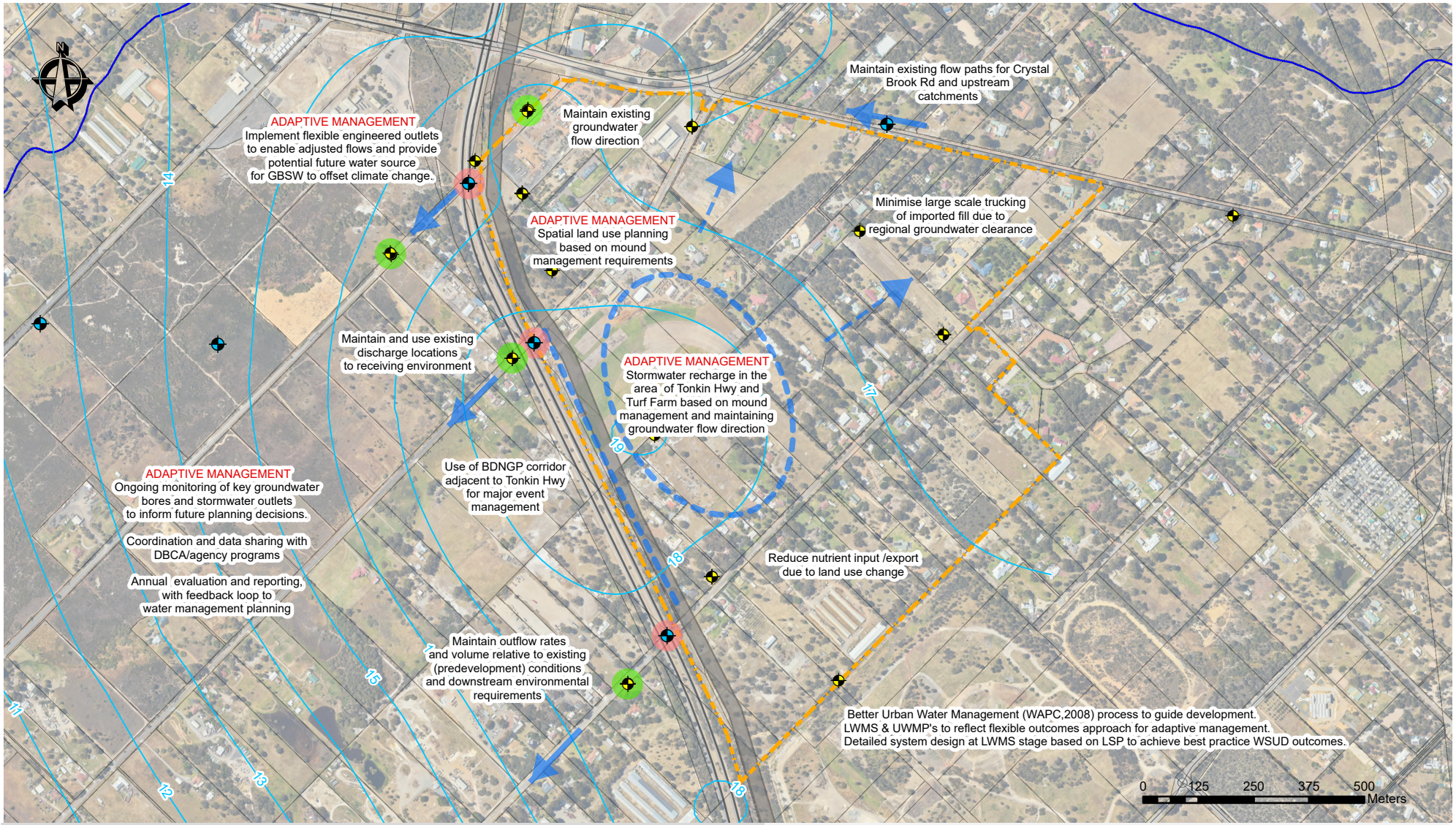
hyd2o

Wattle Grove South District Water Management Strategy

Water Balance Modelling Schematic: Existing Development

Figure 29

Date: 18/07/2024 Job No. H22076



Amendment Area

Existing Groundwater AAMGL 1m Contours (mAHD)

Groundwater Monitoring Bores

Surface Water Monitoring Sites

Key Groundwater Assessment Sites

Key Surface Water Assessment Sites

Dampier to Bunbury Natural Gas Pipeline

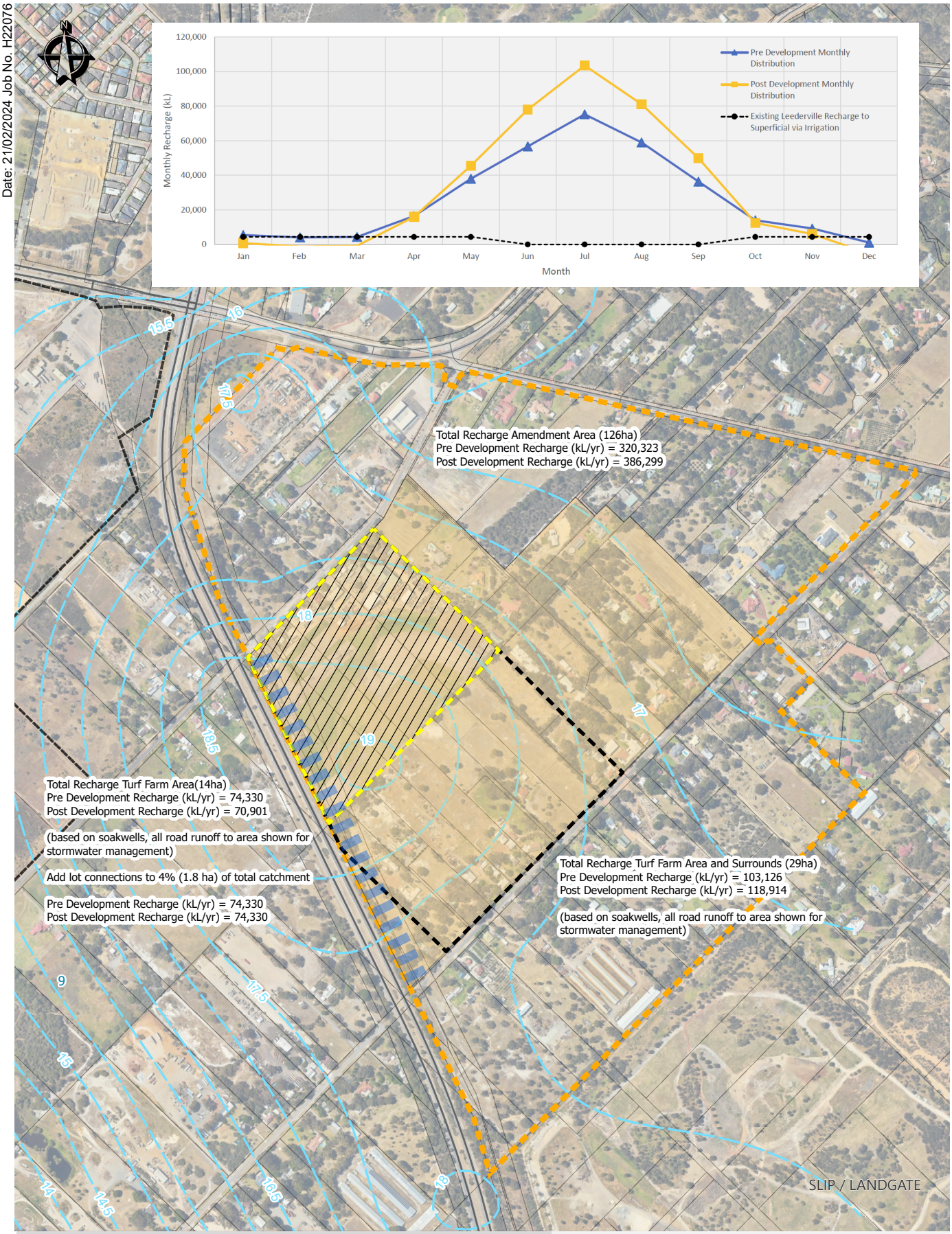
hyd2o

Wattle Grove South District Water Management Strategy

Post Development Stormwater Management Strategy : Key Elements

Figure 30

Date: 21/02/2024 Job No. H22076



Amendment Area (126 ha)

Turf Farm & Surrounds (~29 ha)

Turf Farm Area (~14ha)

Stormwater Catchment

Groundwater AAMGL 0.5m Contours (mAHD)

Area of Stormwater Infiltration for Mound Maintenance

0 37.5 75 150 225 300 Meters

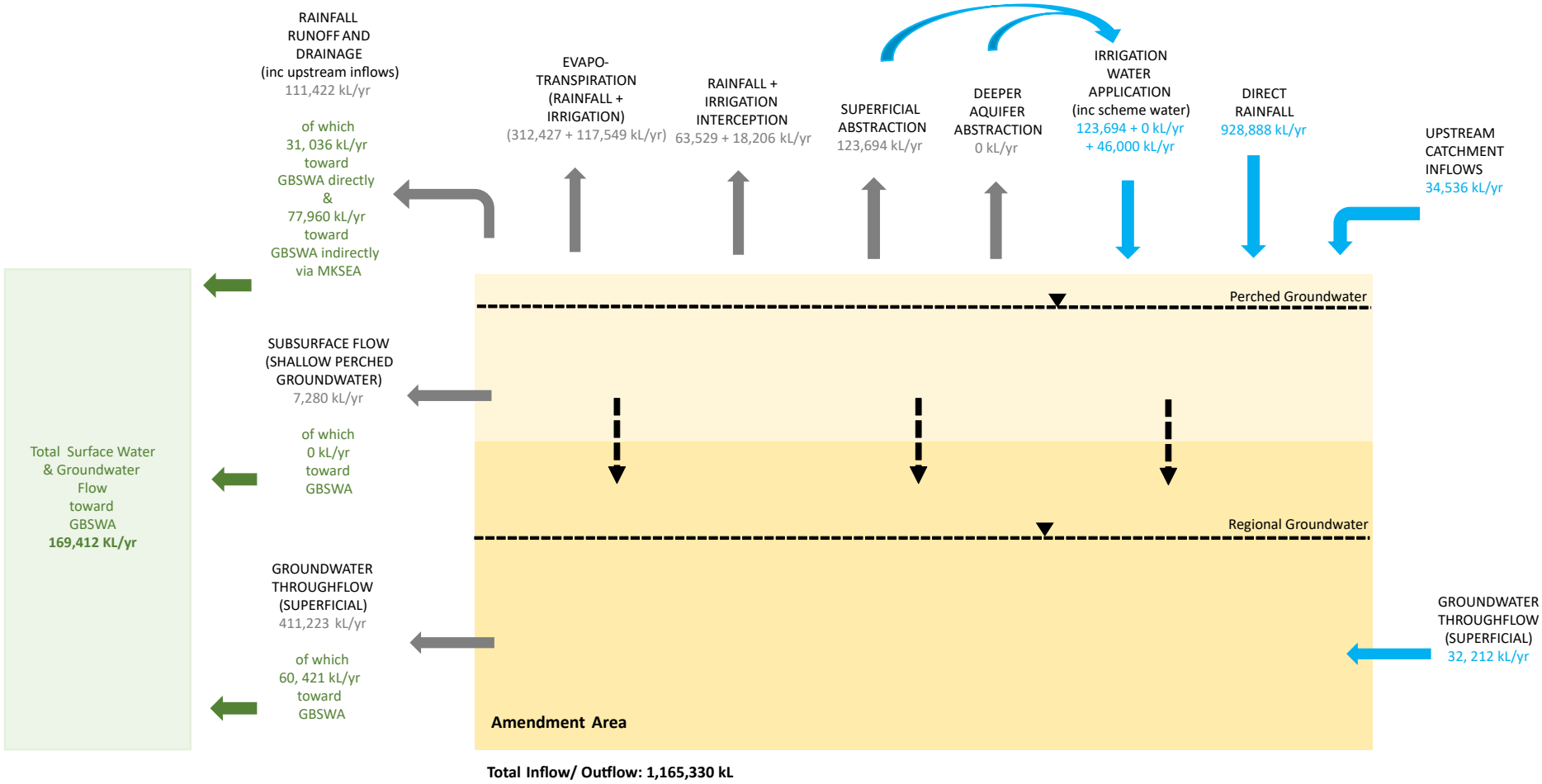
hyd2o

Wattle Grove South DWMS

Amendment Area Annual Recharge Pre & Post Development at Various Scales

Figure 31

Date: 17/02/2024 Job No. H22076



Source : Emerge Associates (2024) water balance modelling outcomes
Result shown is for Amendment Area development only without UE/UI area development

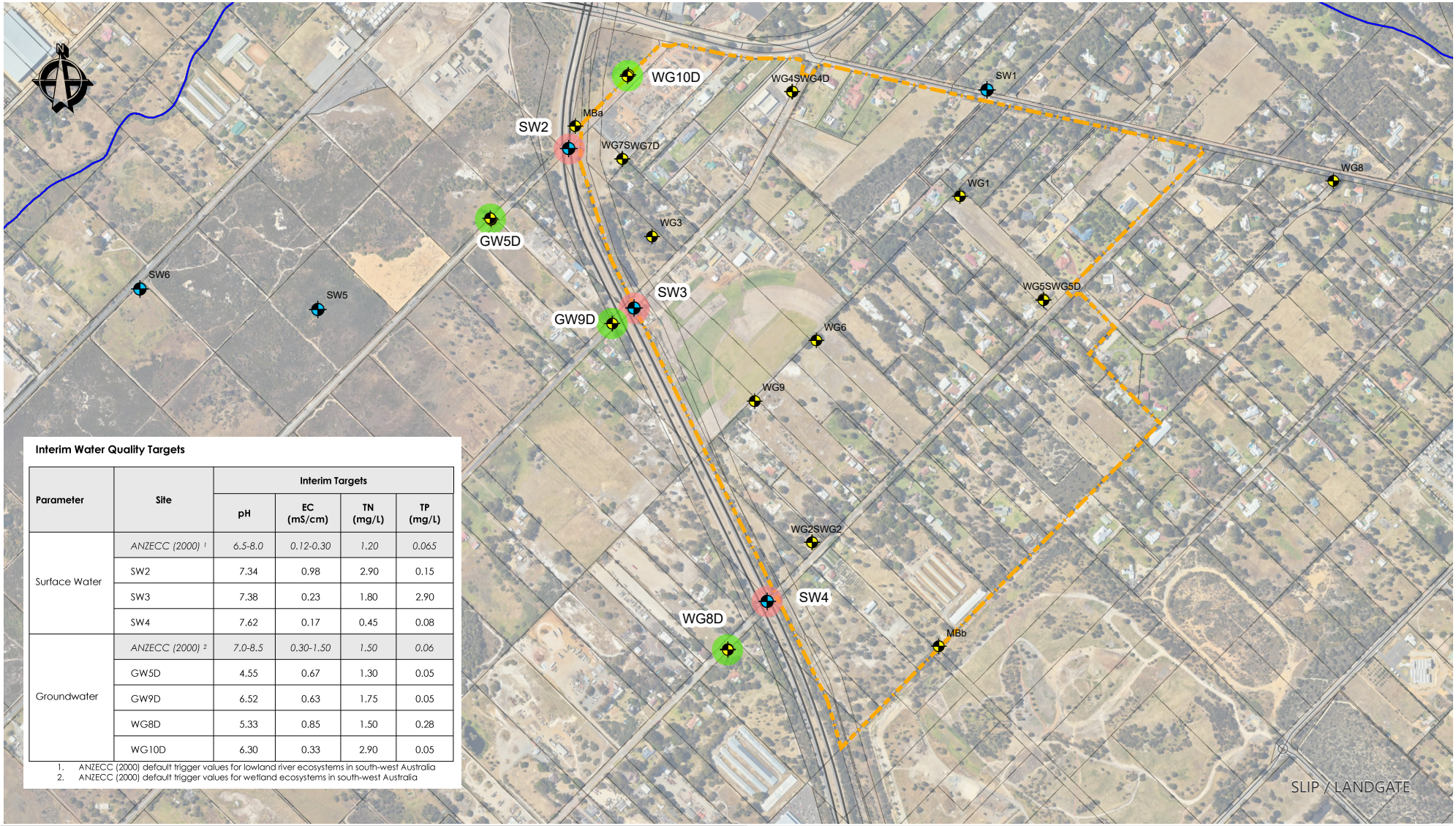
hyd2o

Wattle Grove South District Water Management Strategy

Water Balance Modelling Schematic: Post Development

Figure 32

Date: 21/07/2024 Job No. H22076



Interim Water Quality Targets

Parameter	Site	Interim Targets			
		pH	EC (mS/cm)	TN (mg/L)	TP (mg/L)
Surface Water	*ANZECC (2000) [1]*	*6.5-8.0*	*0.12-0.30*	*1.20*	*0.065*
	SW2	7.34	0.98	2.90	0.15
	SW3	7.38	0.23	1.80	2.90
	SW4	7.62	0.17	0.45	0.08
Groundwater	*ANZECC (2000) [2]*	*7.0-8.5*	*0.30-1.50*	*1.50*	*0.06*
	GW5D	4.55	0.67	1.30	0.05
	GW9D	6.52	0.63	1.75	0.05
	WG8D	5.33	0.85	1.50	0.28
	WG10D	6.30	0.33	2.90	0.05

1. ANZECC (2000) default trigger values for lowland river ecosystems in south-west Australia
2. ANZECC (2000) default trigger values for wetland ecosystems in south-west Australia

Amendment Area

Groundwater Monitoring Bores

Surface Water Monitoring Sites

Key Groundwater Assessment Sites

Key Surface Water Assessment Sites

0 125 250 375 500 Meters

hyd2o

Wattle Grove South District Water Management Strategy

Strategic Monitoring Locations for Adaptive Management

Figure 33

APPENDIX A
DWMS & EPA Scoping Checklist

	Inland Waters : Required Work
	1. Identify and assess the values and significance of hydrological and geological characteristics within the amendment area and surrounding area including for the broader Wattle Grove Urban Expansion and Urban Investigation area, particularly in relation to the GBSW, and describe these values in a local and regional context. 2. Identify and map wetlands and watercourses within and adjacent to the amendment area including urban expansion and urban investigation areas and through work from the instructions below identify any areas proposed to be impacted. 3. Map groundwater contours for the regional and perched groundwater tables over the amendment area using site specific monitoring data and monitoring data from other nearby bores including the Department of Water and Environmental Regulation (DWER) and Department of Biodiversity Conservation and Attractions (DBCA) sites to establish the groundwater flow direction. Assess results in comparison to previous regional mapping completed within the local area (amendment area, urban expansion and investigation areas). Liaise with DWER to obtain any monitoring data further to the publicly available data base. Additional long-term and extensive groundwater flow direction investigations (such as additional monitoring bores and an extended period of data collection) may be required to support groundwater flow mapping that is not consistent with the DWER mapping. Ensure that all superficial bores used in creating the regional groundwater contours are not perched, and represent the groundwater in superficial aquifer. 4. Map the surface water catchment for the amendment, urban expansion and urban investigation areas, and map the contribution of pre development surface water flows to the surrounding wetlands and water courses. 5. Describe the total water cycle for the amendment area in the context of it being within the Yule Brook Catchment and with consideration of the surrounding urban expansion and urban investigation area. Discuss the hydrology and hydrogeology, particularly as it relates to wetland and ecological diversity within and nearby to the amendment area. Include information and discussion on the water budget for the area, the existing drainage management practices and any known impacts on the wetlands and waterways in, and nearby to the amendment area. 6. Using a pre and post development water balance model, characterise the existing hydrology of the site and existing sub surface flow contribution to the GBSW; and assess the potential impacts (direct and indirect) of the proposed change in land use associated with the amendment, and urban expansion and investigation areas, on water quantity and quality of surface and ground waters and subsurface flow contribution in relation to nearby significant wetlands and waterways The following should be considered in the development of any model: • The model should be developed in consultation with DWER and DBCA and consider inputs of the PRAMS groundwater flow model inputs.

- Provide details of the existing geological and hydrogeological conditions used in conceptualising any modelling undertaken.
- The groundwater water balance and groundwater resources in the Superficial aquifer should consider PRAMS input parameters using the flow-net analysis with the Darcy equation. Groundwater throughflow from the site toward the GBSW should be calculated with consideration of the Darcy equation.
- Demonstrate the water balance is based on an understanding of both the groundwater minimum and maximum for the amendment area and the GBSW. The assessment of soil/sediment gravimetric and volumetric water contents, where perched aquifers are suspected, is also required to adequately inform the water balance.
    - Minimum data and information required to support an appropriate water balance is listed below with accompanying published data.
        - Minimum groundwater levels (collected April-May) – as shown in the published data logger data presented in WA wetlands conference poster (Bourke et. al. 2018).
        - Groundwater levels (minimum and maximum) presented in metres below ground level – required to assess wetland flora and fauna and terrestrial vegetation groundwater dependency and threats (e.g. waterlogging, acidification and salinisation). Lambers (2019).
        - Volumetric water content, water retention and hydraulic conductivity – see Davis and Cahill (2018) for horizontal hydraulic conductivity calculations using surface nuclear magnetic resonance (SNMR).
        - Water quality within GBSW is known to be spatially varying (Davis and Cahill 2018, and Lambers 2019). A spatial, temporal and lithological interpretation of water quality data is therefore required against water balance modelling outcomes to assess threats to wetland flora and fauna and terrestrial vegetation.

7. Calculate the additional recharge from the proposed change in land use associated with the amendment, and the resultant impact to the groundwater flow velocity and direction toward the GBSW. This should also include identification of the additional recharge from the urban expansion and investigation areas.
8. Demonstrate that predevelopment surface water and groundwater flows to the Yule Brook and GBSW are maintained post development as a result of the proposed change in land use associated with this amendment, and urban expansion and investigation areas.

	9. Estimate post development nutrient input and export rates resulting from the proposed change in land use, including through the use of DWER's Urban Nutrient Decision Outcomes (UNDO) model. 10. Predict the extent, severity and duration of potential impacts further to items 5 to 9, including changes to local and regional groundwater flows and levels, drawdown, local water quality and impacts to other groundwater users as a result of the proposed change in land use associated with the Amendment, and urban expansion and investigation areas, and provide measures to mitigate these impacts. 11. Determine the boundaries of wetlands and/or buffer requirements to wetlands within and adjacent to the amendment area proposed to be retained. Boundary and buffer studies should consider the characteristics of hydrology, hydric soils and wetland vegetation, and the water balance of the wetland/wetland dependent vegetation. 12. In the context of the below, items 6, 8 and 11 should model existing conditions of, and potential changes to, groundwater and surface water chemistry, particularly in relation to salinity and soil sodicity, that will result from the proposed change in land use associated with this amendment, and urban expansion and investigation areas. Research in the southern area of the GBSW has shown the area is characterised by aquifers with locally elevated salinities and a water table that fluctuates from at or above the surface, to below ground level and there may be a risk from the provision of more groundwater or surface water to the GBSW, as this may persist into summer months and concentrate solutes in the root zone as it evaporates. 13. Describe how the principles of water sensitive urban design will be incorporated and implemented in the amendment area, consistent with the *Better Urban Water Management* framework (WAPC, 2008) and the Stormwater Management Manual for Western Australia (DWER 2004-2007) and other relevant guidelines. 14. Detail and discuss how future drainage practices within the site, is to be managed, considering the broader catchment. This management should ensure the hydrological balance and water quality of significant wetlands and watercourses within and nearby to the amendment area (such as the GBSW and Yule Brook) will be maintained. 15. Describe how drainage management practices could be adapted in the future to mitigate impacts of climate change on significant wetlands and waterways, within and adjacent to the amendment areas. 16. Using the mitigation hierarchy, detail and discuss how development activities will avoid and manage mobilisation of potentially poor-quality groundwater resulting from past agricultural land uses.

	17. Describe the planning or other mechanisms that will ensure drainage management will protect significant wetlands and watercourses within and adjacent to the amendment area. 18. Describe the ongoing management requirements for the amendment area to ensure the hydrology of significant wetlands and watercourses within and nearby to the amendment area is maintained. 19. Prepare a district water management strategy in accordance with the Guidelines for district water management strategies (DoW, 2013). 20. Prepare a monitoring program including management objectives, baseline conditions, public reporting and measures to be implemented in the event of non-compliance to management objectives. 21. Based on the outcomes of the above and taking into consideration the principles of avoidance and minimisation, identify an environmentally acceptable area for development. 22. Provide a summary of residual impacts of future development and associated infrastructure within and adjacent to the amendment areas. 23. Describe any proposed avoidance, mitigation and management measures that demonstrate the EPA's objectives can be met. 24. Describe the planning mechanisms that are to be applied to ensure impacts are managed to meet the EPA's objectives.

District water management strategy guide

Use the guide below to assist with the completion of the DWMS. Tick the box where items have been met. If the item is not applicable to the DWMS, include N/A with explanation in the notes column. Provide any other relevant comments briefly in the notes column.

District water management strategy item	☑	**Notes**
Executive summary		
Describe proposed water management objectives and how the objectives will be met.	☑	Executive Summary & Table
Planning background and previous studies		
Map the location of the site.	☑	Location or site context plan Figure 1
State which planning document the strategy is supporting.	☑	District structure plan if available Section 1.1 Planning Context, Table 1
Provide references to the key state and/or local policies, guidelines, strategies and their relevance.	☑	Section 1.2 Previous Studies and Relevant Documents Chapter 12 References
Design criteria		
Recognise water management principles, objectives and design criteria.	☑	Chapter 1 Introduction Section 7.1 Design Principles & Criteria
Design objectives from previous water strategies and/or plans.	☑	Chapter 1 Introduction Section 7.1 Design Principles & Criteria
Pre-development environment (identification of assets, risks and constraints)		
Describe site characteristics: provide preliminary desktop assessments and/or field investigations (if required)	☑	Include existing data Chapters 2 - 6 and associated Figures & Appendices
Describe climate.	☑	Description Section 2.2
Describe and map topography, landform and geotechnical conditions.	☑	Aerial photo Section 2.1, Figure 2 Geotechnical plan Section 2.3 Figures 4 - 7 Acid sulfate soil risk mapping Figure 4 Section 2.3.5

District water management strategy item	☑	**Notes**
Describe the existing land use.	☑	Description Section 2.1
Identify environmental assets and their significance.	☑	Environmental plan plus supporting data where available Figure 8 Section 2.4
Detail the social, cultural and heritage considerations.		Adressed in other environmental assessment documentation
Describe the hydrology and hydrogeology of the area: • surface water • groundwater • water-dependent ecosystems • water resource issues.	☑	Surface water hydrology plan Section 2.5 & 5.2 Figures 9-10, 26 Groundwater and topographic contours plan (or depth to groundwater) Section 2.6 & 5.1 , Chapter 4, Figures 11-25 Waterways and wetlands plan Chapter 6, Figure 8 Indicative water balance (pre- and post-development water balances can be presented together – see below)Section 6.2, Appendix O, Figures 27 & 30
Describe existing drainage infrastructure and other infrastructure likely to affect management of water resources.	☑	Arterial drainage plan (if available) including local drainage Section 2.5, 7.3, & Section 8.1, Appendix P
Post-development water management		
Identify the proposed broad scale management strategies that will address water resource issues and meet the objectives and design criteria.	☑	Chapter 7, Figure 28
Calculate an indicative water balance.	☑	Indicative water balance. May be presented as a diagram including pre- and post-development volumes with explanatory notes Section 8.3,Chapters 9 & 10, Appendix O, Figure 30
Describe the impacts to water resources and/or impacts to proposed change in land use from water issues.	☑	Chapters 8-10
Surface water – Estimate land requirements for water management. – Identify water quality issues and scope for improvement. – Describe proposed strategy for management of small, minor and major surface flows.	☑	Include any existing data Section 8.1 Table 13 Section 8.4, Table 15, Appendix R Section 7.3
Describe groundwater levels, use, management and maintenance.	☑	Include data if available Section 7.4

District water management strategy item	☑	**Notes**
Identify water-dependent ecosystems	☑	Section 2.4, Chapter 6
Identify contamination issues – high risk acid sulfate soils, contaminated sites or areas with historical high nutrient and/or non-nutrient contaminants.	☑	Include data or plans if available Section 3 & 5. Figures 25 & 26, Appendices F-N, Tables 9 & 10
Water services and efficiency initiatives		
Describe potable water supply – options including details of technical, environmental and regulatory feasibility – regulatory approvals, technical investigations and any obtained written approvals – recommendations for water efficiency and conservation	☑	Written evidence if obtained Section 7.2.1
Identify wastewater servicing – options including preferred option, location, treatment process, level of treatment, disposal, buffers and infrastructure – approvals and investigations required and any obtained written approvals – recommendations for water efficiency and conservation	☑	Written evidence if obtained Section 7.2.3
Identify non-potable (fit-for-purpose) water supply – non-potable water source options. Highlight preferred option with consideration of pre and post development water balance – approvals and investigations required and any obtained written approvals – recommendations for water efficiency and conservation	☑	Written evidence if obtained Section 7.2.1 & 7.2.2

District water management strategy item	☑	Notes
Implementation framework		
Describe commitments and obligations for the next stage of the planning process (e.g. LWMS). Identify issues that need specialised investigation and management for the subsequent LWMS. Make recommendations for implementing the DWMS.	☑	Commitments and obligations may be displayed in table format Chapter 11, Table 18

APPENDIX B

Geotechnical Report
(Douglas Partners, 2020&2022)

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Preliminary Geotechnical Investigation

Proposed Wattle Grove Development
Precinct 1, Victoria Road, Wattle Grove

Prepared for
Hesperia Projects Pty Ltd

Project 96730.01
November 2020



Douglas Partners
Geotechnics | Environment | Groundwater

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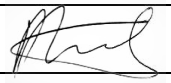
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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
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Geotechnics | Environment | Groundwater

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Report on Preliminary Geotechnical Investigation
Proposed Wattle Grove Development
Precinct 1, Victoria Road, Wattle Grove

1. Introduction

This report presents the results of a preliminary geotechnical investigation undertaken for a proposed residential development located at Precinct 1, Victoria Road, Wattle Grove. The investigation was commissioned on 26 October 2020 by Judd Dyer of Hesperia Projects Pty Ltd and was undertaken in accordance with Douglas Partners' proposal forwarded by email dated 19 October 2020.

It is understood that the proposed Wattle Grove Development site includes a commercial precinct, medium density residential land-use, a primary school and public open space. The proposed entire Wattle Grove development covers an area of approximately 110 ha, however for the purposes of this preliminary investigation, access was provided to a selection of properties in the south-eastern part of the development area along Victoria Road and designated as Precinct 1.

The aim of the investigation was to assess the subsurface soil and groundwater conditions at selected accessible locations within the site, in order to provide some preliminary geotechnical comments on:

- The possible presence of fill materials, unsuitable foundation materials, rock or coffee rock and the distribution of clayey soils, if encountered.
- The thickness of sand and inputs to a ground model to assist with preliminary earthworks design assumptions.
- The site suitability and improvements that may be required to support the proposed development, and if significant variation in the ground conditions are anticipated.
- Key geotechnical risks and opportunities to the development, including the presence of unsuitable soils for development, and the depth of sand which could possibly be mined for re-use.
- The site classification in accordance with the requirements of AS 2870-2011, and the likely earthworks requirements in terms of sand fill thicknesses to improve the classification to achieve ‘Class S’ and ‘Class A’.
- General site preparation requirements including comments on excavatability and earthworks to suitably prepare the ground for the proposed development.
- The suitability of the in situ material, from a geotechnical perspective, for re-use as structural fill, including the topsoil, sand, clay and uncontrolled fill.
- Parameters for pavement design, including a suitable California bearing ratio value based on field observations.
- The depth to groundwater and/or perched water.
- Permeability of the encountered soils at the site, to allow comments on stormwater disposal suitability, and general drainage conditions across the site.

The investigation included the excavation of 15 test pits, four infiltration tests and laboratory testing of selected samples. The details of the field work are presented in this report, together with comments and recommendations on the items listed above.

2. Site Description

The site of this preliminary geotechnical investigation comprises various accessible lots within Precinct 1 of the Wattle Grove Development area, situated along Victoria Road in Wattle Grove and covers an approximate area of 24 ha (refer to Drawing 1, Appendix B).

At the time of the investigation, the site generally comprised semi-rural residential lots with the exception of a disused poultry farm located towards the southern end of the site. Houses, sheds and other small structures occurred across the site along with several fenced paddocks. Abandoned machinery, hard wastes, and paved and gravel access tracks were observed within the lots at various locations. Vegetation generally consisted of short length grass and shrubs, with medium to tall sized trees.

Visual evidence of areas of fill, anticipated to be of an uncontrolled nature, and including variously granular, cohesive and organic soils, possibly with deleterious inclusions were noted in several areas of the site, along with some stockpiles and other mounds of soils.

The site surface levels generally fall to the west, with surface levels of approximately RL 36.5 m AHD in the east of the site falling to RL 22.7 m AHD in the west.

The Armadale 1:50,000 scale geological mapping which covers the site indicates the general area is underlain by (in a generally west to east direction):

- Bassendean Sand – white to pale grey at surface, yellow at depth, fine to medium-grained, moderately sorted, subangular to surrounded, of eolian origin.
- Thin Bassendean Sand over cohesive materials of the Guildford Formation – white to pale grey sand at surface, over alluvial deposits of sandy clay to clayey sand of the Guildford Formation.
- Sand (Yoganup Formation) - yellow, fine grained sand with minor silt and clay, subangular and medium to coarse grained quartz, of colluvial origin.

The Perth Groundwater Atlas (2004) indicates groundwater levels at the site were between RL 12.5 m AHD to RL 15.5 m AHD in May 2003 (i.e. over 10 m below the lowest level on the site).

Published acid sulfate soil risk mapping indicates the site is located within an area of moderate to low risk of acid sulfate soils occurring within 3.0 m of natural soil surface.

3. Field Work Methods

Field work for the investigation was carried out on 28 and 30 October 2020 and comprised:

- The excavation of 15 test pits (Locations 1 to 15).

- Perth sand penetrometer (PSP) testing adjacent to each test pit location.
- Four in situ infiltration tests (at Locations 3, 4, 9 and 11).

The test pits were excavated to a maximum depth of 2.9 m using a 5 tonne excavator attached with a 650 mm toothed bucket. Each test pit was logged in general accordance with AS 1726–2017 by an experienced Douglas Partners geotechnical engineer.

Perth sand penetrometer (PSP) tests were carried out adjacent to the test pits in accordance with AS 1289.6.3.3 to assess the in situ density of the shallow soils.

The infiltration tests were performed using the falling head method at depths of between 0.5 m and 1.0 m adjacent to test pit locations 3, 4, 9 and 11.

Test locations were determined using a handheld GPS and are marked on Drawing 1, Appendix B. Approximate surface elevations were obtained using publicly available LiDAR.

4. Field Work Results

4.1 Ground Conditions

Detailed logs of the ground conditions and results of the field testing are presented in Appendix C. Notes defining descriptive terms and classification methods are provided in Appendix A.

The ground conditions encountered within the test pits generally comprise:

- **Topsoil** – grey-brown, sandy topsoil with silt and roots, between 0.1 m to 0.15 m in thickness. The topsoil is fill at locations 1, 6 to 10 and 12 to 15. Overlying:
- **Bassendean Sand (light grey sand):**
  - **SAND SP** – generally medium dense to dense, light grey sand, with trace silt encountered underlying the topsoil or surficial fill to depths of between 0.8 m and test pit termination depths of 2.5 m at test locations 3, 5, 7, 8 and 9. The depth to the base of the sand is provided in Table 1, below.
- **Yoganup Formation (yellow-brown sand with various fines content):**

  The sand from the Yoganup Formation is yellow-brown and includes a fines content that increases with depth. When described based on its composition in accordance with AS 1726-2017, the sand is logged as ‘Sand trace silt and clay’ (up to 5% fines content) near surface, gradually transitioning with depth to ‘Sand with clay’ (5% to 12% fines content) and then ‘Clayey Sand’ (greater than 12% fines content):
  - **SAND SP-SM** – generally medium dense to dense, light brown and yellow-brown sand, with low plasticity to non-plastic fines content of between approximately 5% to 12%, underlying topsoil or surficial fill at test locations 1, 2, 4, 5 and 10 to 15, and present below the Bassendean sand at location 3 from 0.8 m depth. Loose sand was encountered at location 1 to at least 1.0 m depth. Fines content typically increases with depth.
  - **SAND/Clayey SAND SP-SC/SC** – yellow-brown sand with clay/clayey sand (approximately 12% and greater content of low plasticity fines) was encountered from depths of between 0.1 m

and 1.6 m extending to depths of between 0.6 m and termination depths of up to 2.5 m at locations 2 to 5, 10 to 12, 14 and 15.

- **Clayey SAND SC** – yellow-brown low plasticity clayey sand was encountered from depths of between 0.6 m and 1.5 m extending to termination depths of up to 2.5 m at locations 1, 2, 4, 14 and 15.

The exceptions to the above profile are:

- **Fill** – various fill materials generally consisting of sand, silty sand, clayey sand and sandy clay/silt were encountered to depths of between 0.2 m and to test pit termination depth of 2.9 m at locations 1, 6 to 10 and 12 to 14. The fill variously included deleterious inclusions such as wood, brick, glass, concrete and plastic at locations 6, 8 and 13.
- **Coffee Rock** – brown, cemented silty sand excavated as gravelly sand, with silt and cobbles. Encountered from 1.1 m to 1.8 m and 1.8 m to 2.4 m at test locations 5 and 8, respectively.

Table 1: Summary of Depth of Sand

Test Location	Ground Surface Level [1] (m AHD)	Depth to Base of Sand (m)	Level of Base of Sand [2] (m AHD)	Description (Geological Unit)
1	32.4	1.2	31.2	Yellow-brown, with silt, SP-SM (Yoganup Formation)
3	30.1	0.8	29.3	Light grey, trace silt, SP (Bassendean Sand)
4	30.9	0.4	30.5	Light brown, with silt, SP-SM (Yoganup Formation)
5	25.7	1.1	24.6	Light grey, trace silt, SP (Bassendean Sand)
7	23.8	>2.5	<21.3	Light grey, trace silt, SP (Bassendean Sand)
8	25.7	>2.5	<23.2	Light grey, trace silt, SP (Bassendean Sand)
9	24.1	>2.5	<21.6	Light grey, trace silt, SP (Bassendean Sand)
11	31.2	0.2	31.0	Yellow-brown, with silt, SP-SM (Yoganup Formation)
12	32.1	0.3	31.8	Yellow-brown, with silt, SP-SM (Yoganup Formation)
13	30.3	>2.5	<27.8	Yellow-brown, with silt, SP-SM (Yoganup Formation)
15	34.4	0.4	34.0	Yellow-brown, with silt, SP-SM (Yoganup Formation)

Notes for Table 1: [1]: Surface level obtained from publicly available LiDAR.
[2]: Level of Base of Sand = Surface Level – Depth to Base of Sand.

4.2 Groundwater

Groundwater was not observed in the test pits excavated on 28 October 2020, to a depth of up to 2.9 m. All test pits were immediately backfilled following sampling and logging, which precluded longer-term monitoring of groundwater levels.

Groundwater was measured at depths of between 13.5 m and 16.0 m on 5 November 2020, within two monitoring wells installed in the southern part of the site.

It should be noted that groundwater levels are affected by climatic conditions and land usage and will therefore vary with time.

4.3 Permeability

Four in situ infiltration tests using the falling head method were carried out at depths of between 0.5 m and 1.0 m at locations 3, 4, 9 and 11. Soil permeability values were estimated using a calculation derived from a method based on Hvorslev (1951). The results of the in situ testing are summarised in Table 2.

Table 2: Summary of Permeability Analysis

Test Location	Depth (m)	Estimated Permeability (m/day)	In situ Ground Conditions at Testing Depth
3	0.55	25	Sand, light grey trace silt, dense (Bassendean Sand)
4	1.0	6	Sand, yellow-brown with clay/Clayey Sand (fines content increasing with depth), medium dense (Yoganup Formation)
9	1.0	34	Sand, light grey, trace silt, dense (Bassendean Sand)
11	1.0	7	Sand, with clay (fines content increasing with depth), dense (Yoganup Formation)

Soil permeability is further discussed in Section 7.6.

5. Laboratory Testing

A geotechnical laboratory testing programme was carried out on selected soil samples by a NATA registered laboratory and included the determination of:

- the particle size distribution of seven samples; and
- the Atterberg limits and linear shrinkage of two samples.

Detailed test reports are given in Appendix D and the results are summarised in Table 3 (next page).

Table 3: Results of Laboratory Testing for Soil Identification and Site Classification

Test Location	Depth (m)	Fines (%)	Sand (%)	Gravel (%)	LL (%)	PL (%)	PI (%)	LS (%)	Material
3	0.6	4	96	0	-	-	-	-	Sand, light grey, trace silt (Bassendean Sand)
4	1.0	12	88	0	-	-	-	-	Sand, yellow-brown, with clay (Yoganup Formation)
6	0.8	23	63	14	-	-	-	-	Silty Sand, trace gravel (Fill)
11	1.1	9	91	0	-	-	-	-	Sand, yellow-brown, with clay (Yoganup Formation)
12	1.2	15	85	0	NO	NP	NP	0.5	Clayey Sand/Silty Sand, yellow-brown (Yoganup Formation)
14	0.4	14	86	0	-	-	-	-	Clayey Sand, yellow-brown (Yoganup Formation)
14	1.2	26	74	0	20	13	7	2.0	Clayey Sand, yellow-brown (Yoganup Formation)

Notes for Table 3:
- % fines is the amount of particles smaller than 75 µm.
- % sand is the amount of particles between 75 µm and 2.36 mm.
- % gravel is the amount of particles larger than 2.36 mm.
- LL: liquid limit.
- PL: plastic limit
- '-' means 'Not Tested'
- NP: Non-Plastic
- LS: linear shrinkage
- PI: plasticity Index
- NO: Not Obtainable

6. Proposed Development

It is understood that the proposed development of the site includes a commercial precinct, medium density residential land-use, a primary school and public open space.

7. Comments

7.1 Site Suitability

The investigation indicates that the site is generally underlain by sandy materials overlying sand with clay or clayey sand, as described in Section 4.1 above. Such ground conditions are generally considered suitable for the proposed land development. Possible geotechnical constraints imposed by the ground conditions include:

- The presence of loose sand as encountered at test location 1, and may also be present elsewhere within the site;

- Uncontrolled fill, as encountered at locations 1, 6 to 10 and 12 to 14, and anticipated to be elsewhere within the site based on observations made during the site walk-over. The fill is deeper than 2.9 m at test location 6; and
- Soils from the Yoganup Formation unit with relatively low permeability, in particular following densification during earthworks, with implications on stormwater disposal and other drainage applications.

The constraints regarding loose soils and uncontrolled fill can be managed with relative ease during typical earthworks site preparation procedures, as outlined further below. The presence of low permeability soils are likely to require civil design solutions, either with regard to the bulk earthworks design strategy, or the implementation of suitable drainage measures.

Sand with a generally low fines content, both the light grey sand of the Bassendean Sand unit and some shallow yellow-brown sand from the Yoganup Formation, was encountered from site surface overlying more clayey materials at most of the test locations, with these depths provided in Table 1, Section 4.1. The sand at these locations is considered suitable for excavation and re-use as structural fill without impacting the AS 2870 site classification. In particular, light grey sand with trace silt (Bassendean Sand) was identified to depths of greater than 2.5 m depth within the most western part for the investigated site.

From a drainage perspective, it is anticipated that only the Bassendean Sand would meet typical civil specifications regarding sand permeability (ie permeability greater than 5 m/day) following compaction from site preparation, with the sand from the Yoganup Formation generally not meeting such specification.

From a geotechnical standpoint, the land is physically capable of development, provided that the comments outlined in the subsequent subsections of this report are taken into consideration in the development plans.

It is emphasised that the test pits undertaken as part of this preliminary geotechnical investigation represent a small portion of the total development area, and as such, other varied ground conditions not encountered or discussed in this report may exist. It is recommended that further detailed geotechnical investigation of the development site is undertaken during the detailed design phase of the development.

7.2 Site Classification

Site classification is determined in accordance with AS 2870-2011 and is based on the expected ground surface movement and the depth to which this movement extends. The depth of soil suction at this site is assessed to be 1.8 m (HU, COCKS, VERHEYDE, 2019).

The shallow ground conditions encountered across the site are relatively variable. Ground conditions generally consist of sand overlying sand with clay or clayey sand materials, although clayey sand also occurs near ground surface in some parts of the site. Based on a visual and tactile assessment together with limited laboratory testing, the clayey sand forms a slightly reactive layer. Various uncontrolled fill materials were also encountered across the site.

Test locations with uncontrolled fill should be classified as 'Class P' in accordance with AS 2870-2011. Test locations with clayey materials within 1.8 m of surface are currently classified as 'Class S' which generally applies to the majority of the site in its current condition. Test locations with at least 1.8 m of non-reactive soil from surface (test locations 7, 8, 9 and 13), can be classified as 'Class A' following suitable site preparation as outlined in Section 7.4. The current site classification at test locations where clayey materials were encountered and the thickness of non-reactive fill required to improve the site classification, is shown in Table 4, below.

Table 4: Site Classification at Test Locations with Encountered Clayey Sand Materials

Test Location	Depth to Clayey Materials (m)	Current Site Classification [1]	Minimum Thickness of non-reactive fill required to improve site classification to 'Class A'[1] (m)
1	1.2	S	0.6
2	0.1	S	1.7
3	0.8	S	1.0
4	0.4	S	1.4
5	1.6	S	0.2
10	0.3	S	1.5
11	0.25	S	1.55
12	0.3	S	1.5
14	0.2	S	1.6
15	0.4	S	1.4

Notes for Table 4: [1] Thickness of sand required above existing surface level.

It is emphasised that the classifications provided above will need re-assessment if bulk earthworks for the proposed development include cutting the site.

7.3 Excavation Conditions

Based on the ground conditions described in Section 4.1, excavations associated with bulk earthworks, service trenches and foundations are anticipated to be undertaken through medium dense to dense sand (either fill or natural) and clayey sand following site preparation as described in Section 7.4. Coffee rock was encountered at test locations 5 and 8 however at these locations it was excavated with relative ease using a 5 tonne excavator. Stronger coffee rock could possibly occur elsewhere at the site.

It should be noted that some difficulty in excavating the fill encountered at test location 6 was encountered using a 5 tonne excavator, although more powerful excavators are anticipated to be

suitable. The fill thickness at this location was greater than 2.9 m (maximum reach of excavator used during the investigation).

In general, excavations should be readily achieved using typical earthmoving equipment (ie excavators, loaders, and scrapers). Consideration can be given to using larger excavators (greater than 20 tonne) with toothed buckets to excavate the fill encountered at test location 6, and through cemented materials such as coffee rock.

7.4 Site Preparation

Inspections of earthworks should be undertaken by an experienced geotechnical engineer, in general accordance with the guidelines set out for Level 2 inspections within AS 3798-2008, as a minimum requirement.

7.4.1 Site Stripping

All deleterious material, including vegetation, topsoil and uncontrolled fill (encountered at locations 1, 6 to 10 and 12 to 14), should be stripped from within development areas and either removed from site or stockpiled for possible treatment and re-use, if applicable (see Section 7.4.3). Uncontrolled fill should be removed to its full depth, and it is noted that at location 6, the fill extended deeper than 2.9 m.

Tree roots should also be removed, with the site grubbed to at least 0.5 m depth below surface level. Existing pavements, structures including their footings, associated buried services, soakwells and other infrastructure should be completely removed. Any excavations occurring from stripping and grubbing activities should be backfilled with material similar to the adjacent subgrade and suitably compacted.

7.4.2 Proof Compaction

Following site stripping and removal of all unsuitable materials, it is recommended that the exposed subgrade soils across the site should be compacted using a heavy (minimum of 14 tonne) smooth drum roller. All proposed building envelope and pavement areas should be compacted to target a minimum blow count of 8 blows per 300 mm penetration when tested with a PSP to a depth of not less than 1 m below the existing surface level, to ensure suitable densification of the identified loose sand across the site.

Any areas that show signs of excessive deformation during compaction should be continually compacted until deformation ceases. Alternatively, the poor-quality material could be excavated and replaced with suitable structural filling compacted to achieve not less than 8 blows per 300 mm rod penetration when tested using a PSP. Care should be taken not to operate heavy vibrating plant immediately adjacent to existing buildings and services.

Confirmation of site stripping and suitable compaction should be verified by a geotechnical engineer, prior to placement of any fill materials.

7.4.3 Re-use of Materials

The naturally occurring light grey sand (Bassendean Sand) is considered suitable for re-use as structural fill for urban development, and should form a well-drained material. The material should be free from organic matter and particles greater than 150 mm in size.

The naturally occurring yellow-brown sand (Yoganup Formation) is also considered suitable for re-use as structural fill. However the fines content of this sand, which generally increases with depth, is anticipated to preclude its re-use in applications requiring good drainage conditions. Following placement and compaction, the yellow-brown sand is expected to have a permeability below typical earthworks specifications of 5 m/day.

Sandy topsoil was recorded over a thickness of 100 mm and 150 mm within the test pits undertaken at the site. A general procedure for the re-use of sandy topsoil which is considered suitable for this site is:

- Stripping and stockpiling the topsoil, followed by removal of the bulk of the large organic particles by passing the topsoil through a screen with an aperture size of say 25 mm; and
- Blending the screened topsoil with clean sand. A preliminary blending ratio of approximately 2:1 (clean sand : topsoil/organic sand) is suggested at this stage, but this blending ratio should be refined following assessment of the material resulting from the screening operations.

The suitability of the screened material should also be regularly assessed by a geotechnical engineer (including the determination of organic content and particle size gradings) for approval prior to use as fill, which may also result in optimisation of the blending ratio.

Blended fill materials typically have a reduced permeability in comparison with clean sand, and therefore verification of the permeability of the blended material is suggested, prior to use. Any material considered unsuitable for use as fill by the geotechnical engineer should be removed from the site or used in non-structural areas.

Various uncontrolled fill materials were observed within the site including sand, silty sand, clayey sand and sandy clay/silt. Following excavation of uncontrolled fill materials during site stripping, it is recommended that the materials are assessed by a geotechnical engineer to assess their suitability of re-use. It is anticipated that most soil materials can be re-used somewhere within the site following suitable preparation, to limit off-site disposal costs. Prior to re-use, uncontrolled fill materials may require raking or screening to remove deleterious or large particles, and blending with other soils, subject to assessment and verification by a geotechnical engineer on a case by case basis.

7.4.4 Compaction

Materials approved by a geotechnical engineer for use as structural fill should be placed in layers within 2% of the optimum moisture content. Each layer should be compacted to achieve a dry density ratio of not less than 95% relative to modified compaction. The type of roller (smooth drum or pad foot) and the use of vibratory modes should be at the discretion of the earthwork's contractor based on the encountered subgrade, the depth to groundwater, and the size and type of compaction plant.

Compaction control in sand could be carried out using a Perth sand penetrometer (PSP) test in accordance with test method AS 1289.6.3.3. Sand should be compacted to achieve a minimum blow

count of 8 blows per 300 mm rod penetration to a depth of not less than 1 m below foundation level. This compaction level has not been directly correlated to a dry density of 95% relative to modified compaction. Lower blow counts than the above level may be acceptable provided that a correlation between Perth sand penetrometer (PSP) test and dry density ratio has been established by a NATA accredited laboratory and following review by a geotechnical engineer.

It is recommended that the compaction control of clayey materials is carried out using a nuclear surface moisture-density gauge, in accordance with AS 1289.5.8.1.

It is recommended that verification of the compaction works be undertaken by an experienced geotechnical engineer.

During construction, some loosening of the surface sands in foundation excavations is expected. Therefore, the top 300 mm in the base of any excavation should be re-compacted using a vibratory plate compactor prior to construction of any footings.

7.5 Pavement Design Parameters

Based on field observations and Douglas Partners' experience, it is suggested that a preliminary subgrade California bearing ratio (CBR) of 12% be considered for the design of flexible pavements on the natural sand encountered at the site, where a minimum of 0.5 m of sand exists below subgrade level. To achieve this CBR value, the sand subgrade should be compacted to achieve a dry density ratio of not less than 95% relative to modified compaction, as determined by AS 1289.5.2.1.

A presumptive design CBR value of 6% is suggested if clayey sand forms the subgrade of proposed pavement. Detailed laboratory testing could indicate the suitability to adopt of greater CBR design value for the encountered clayey sand.

It is recommended that subgrade be inspected by a suitably experienced geotechnical engineer prior to placement of the pavement layers to identify unsuitable subgrade materials, if any.

7.6 Site Drainage and Reactive Materials

The shallow soil conditions beneath the site generally comprise sand, trace silt to with silt, overlying sand with clay and clayey sand. Based on the infiltration testing undertaken, the estimated permeability rates for the sandy soils in their in situ (prior to any earthworks) conditions are:

- Bassendean Sand (Light grey, trace silt): 20 m/day;
- Yoganup Sand (Yellow-brown, with silt and increasing fines content): 5 m/day to 7 m/day.

These permeability values are anticipated to decrease following densification of the soils during earthworks. Based on our experience in similar ground conditions, following compaction the Yoganup sand is anticipated to have a generally low permeability, and is unlikely to form a suitably drained material for on-site stormwater disposal, unless specific additional drainage provisions are adopted.

The clayey sand should be considered impermeable for site drainage following earthworks.

In areas with shallow clearance to impermeable layers, water may pond as it infiltrates through the sand, collecting on the underlying sand with clay or clayey sand. Localised low-points in the underlying sand with clay and clayey sand surface may trap water, resulting in waterlogged conditions near surface. It is also expected that the infiltration capacity of the site soils will reduce due to compaction works during earthworks on-site. If soakwells are selected for stormwater disposal, the provision of measures such as overflow outlets should be considered. Some ponding of water at surface may occur during heavy or prolonged rainfall events, following densification of the sand during site works.

The clayey sand underlying the site is slightly reactive and therefore has some propensity to swell and shrink with moisture variation resulting in surface movement. It is recommended that attention be given to minimise moisture content changes within these clayey materials through the adoption of appropriate measures, such as ensuring that:

- The site is well drained, both during construction and throughout the life of structures on the site.
- Plumbing systems be maintained and repaired to avoid leaks beneath and around structures.
- No large trees be planted adjacent to structures.
- Irregular or excessive watering around the structures be avoided.

Further advice on footing maintenance on reactive sites is provided in the CSIRO note '*Building Technology File 18: Foundation Maintenance and Footing Performance – A Homeowner's Guide, 2012',* included in Appendix E.

7.7 Acid Sulfate Soils

7.7.1 General Comments

Published acid sulfate soil risk mapping indicates the site is located within an area of moderate to low risk of acid sulfate soils occurring within 3.0 m of natural soil surface. With reference to Department of Water and Environmental Regulation (DWER) endorsed guidelines, investigation of acid sulfate soil as part of a future subdivision of the site is recommended in areas of moderate to low risk for the following:

- Excavation of greater than 100 m^3 from below the natural water table; and/or
- Where dewatering (temporary or permanent) is proposed to be undertaken.

7.7.2 Location 6

A sample of the dark grey silty sand fill was collected at location 6 and submitted to a NATA accredited laboratory for analysis of the Chromium suite of testing to assess presence of acid sulfate soils. The calculated net acidity in the analysed sample was reported as 0.044 %S, which exceeds the DWER endorsed criteria for management. Consequently, on the basis of the single laboratory result, the dark grey silty sand fill encountered at location 6, would be considered as acid sulfate soil. Given the testing was limited to one sample, it is recommended that further sampling be undertaken of this material with due consideration to proposed earthworks to ascertain requirement further management (if required.

8. References

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Hu Y., Cocks G., Verheyde F. (2019). RE-assessment of TMI based climate zones in metropolitan Perth, WA. *Proceedings of 13th ANZ Conference on Geomechanics – Acosta-Martínez & Lehane (Eds.), Australian Geomechanics Society, Sydney, Australia*, ISBN 978-0-9946261-0-3, pp. 1053-1058.

Department of Environment (December 2004). *Perth Groundwater Atlas, Second Edition*.

9. Limitations

Douglas Partners (DP) has prepared this report for the Proposed Wattle Grove Development in accordance with DP's proposal dated 19 October 2020 and acceptance received from Hesperia Projects Pty Ltd dated 26 October 2020. The work was carried out under a Professional Services Agreement. This report is provided for the exclusive use of 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.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

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.

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Appendix A

About This Report

About this Report

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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

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

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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

Sampling Methods

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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.

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

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Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

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

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

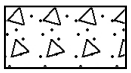
Symbols & Abbreviations

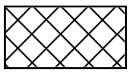
Graphic Symbols for Soil and Rock

General

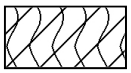

Asphalt

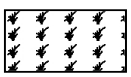

Road base

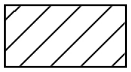

Concrete

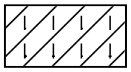

Filling

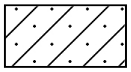
Soils


Topsoil

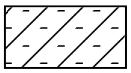

Peat

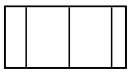

Clay

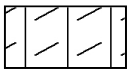

Silty clay

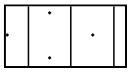

Sandy clay

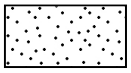

Gravelly clay

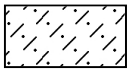

Shaly clay

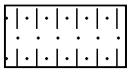

Silt


Clayey silt


Sandy silt


Sand

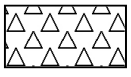

Clayey sand


Silty sand


Gravel

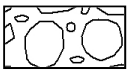

Sandy gravel


Cobbles, boulders

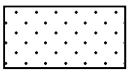

Talus

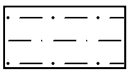
Sedimentary Rocks

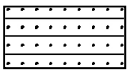

Boulder conglomerate

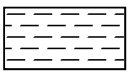

Conglomerate


Conglomeratic sandstone

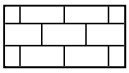

Sandstone


Siltstone

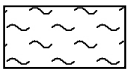

Laminite

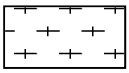

Mudstone, claystone, shale

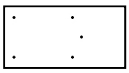

Coal


Limestone

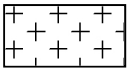
Metamorphic Rocks

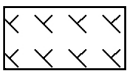

Slate, phyllite, schist

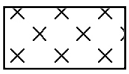

Gneiss

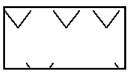

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite

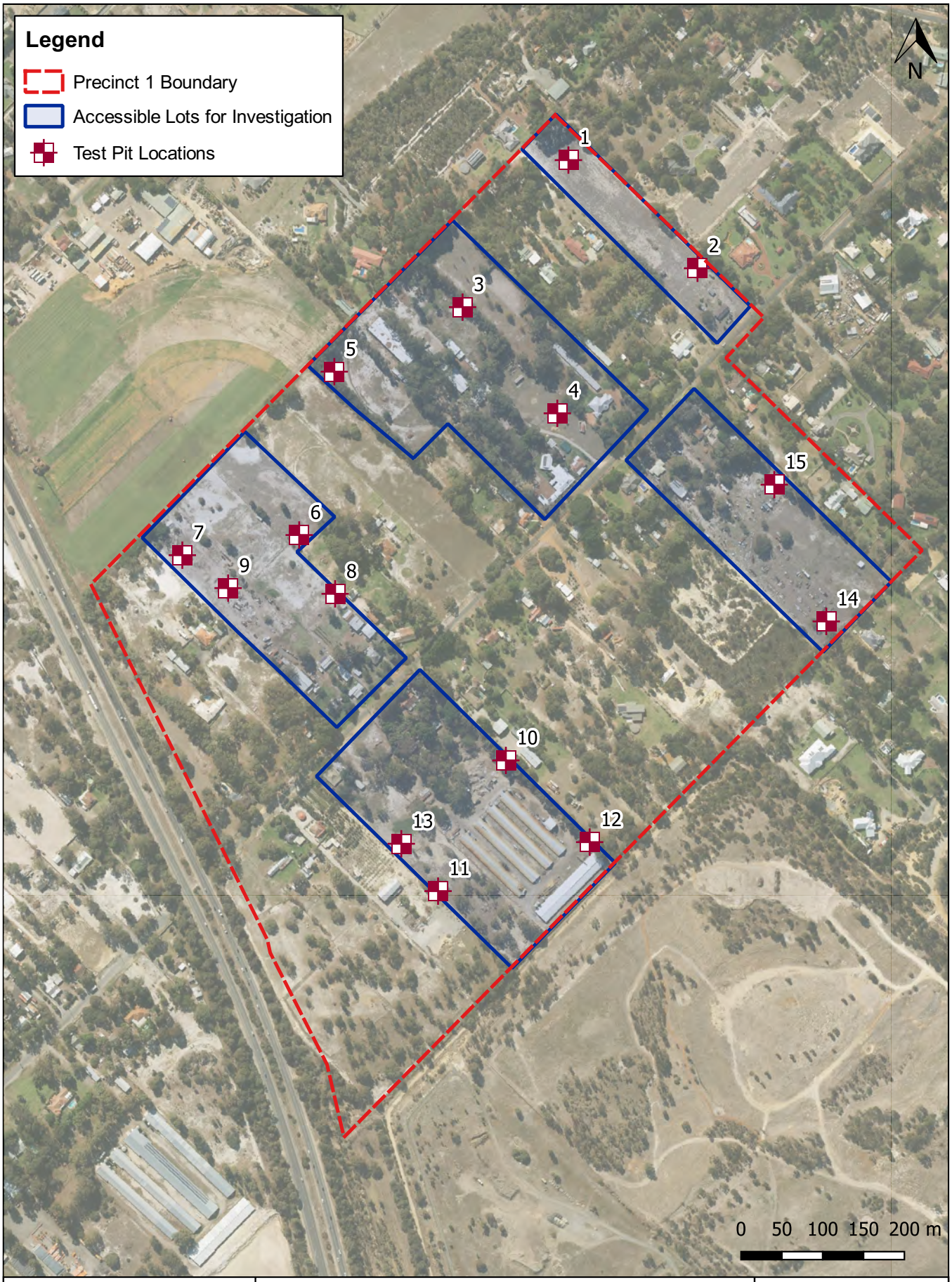

Dacite, epidote


Tuff, breccia


Porphyry

Appendix B

Drawing



Douglas Partners Geotechnics | Environment | Groundwater	**Test Location Plan** **Preliminary Geotechnical Investigation** **Precinct 1, Victoria Road, Wattle Grove**	PROJECT: 96730.01 Drawing No: 1 REV: 1
	CLIENT: Hesperia Projects Pty Ltd	DATE: 14/11/2020

Appendix C

Field Work Results

TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 32.4 m AHD*
EASTING: 406131
NORTHING: 6457764

PIT No: 1
PROJECT No: 96730.01
DATE: 28/10/2020
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)
32	0.1	FILL/Sandy TOPSOIL SP-SM: fine to medium grained, grey-brown, with silt, with roots, moist.		E	0.0 0.1				
	0.2	FILL/SAND SP-SM: fine to medium grained, light brown, with silt, moist.		E	0.3 0.4				
		SAND SP-SM: fine to medium grained, yellow-brown, with silt, moist, medium dense. - becoming loose from 0.7 m depth.							
31	1.2	Clayey SAND SC: fine to medium grained, yellow-brown, low plasticity clay, moist.							
30	2.5	Pit discontinued at 2.5m (Target depth)							
29									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2





RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.
LOGGED: YC
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained 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: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 35.6 m AHD*
EASTING: 406289
NORTHING: 6457631

PIT No: 2
PROJECT No: 96730.01
DATE: 28/10/2020
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)
35	0.1	TOPSOIL/SAND SP-SM: fine to medium grained, grey-brown, with silt, with roots, moist.		E	0.0 0.1				
		SAND/Clayey SAND SP-SC/SC: fine to medium grained, yellow-brown, with clay/clayey, low plasticity fines, moist, dense. - becoming medium dense from 0.5 m depth.		E	0.4 0.5				
34	0.8	Clayey SAND SC: fine to medium grained, yellow-brown, low plasticity clay, moist, medium dense.		D	2.3				
33	2.5	Pit discontinued at 2.5m (Target depth)							





RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.
LOGGED: YC
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained 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: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 30.1 m AHD*
EASTING: 406002
NORTHING: 6457584

PIT No: 3
PROJECT No: 96730.01
DATE: 28/10/2020
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)
30	0.1	TOPSOIL/SAND SP-SM: fine to medium grained, grey-brown, with silt, with roots, moist.		E	0.0 0.1				
		SAND SP: fine to medium grained, light grey, trace silt, moist, dense. Tree roots observed to 0.2 m depth.		B	0.3				
		- becoming yellow-brown, with silt from 0.6 m depth.		E	0.4 0.5				
29	0.8	SAND/Clayey SAND SP-SC/SC: fine to medium grained, yellow-brown, with clay/clayey, low plasticity fines, moist, medium dense.		D	0.6				
28	2.5	Pit discontinued at 2.5m (Target depth)							
27									





RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.
LOGGED: YC
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained 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: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 30.9 m AHD*
EASTING: 406118
NORTHING: 6457454

PIT No: 4
PROJECT No: 96730.01
DATE: 28/10/2020
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)
30	0.1	TOPSOIL/SAND SP-SM: fine to medium grained, grey-brown, with silt, with roots, moist.		E	0.0 0.1				
	0.4	SAND SP-SM: fine to medium grained, light brown, with silt, moist, dense.		D E	0.3 0.4				
	1	SAND/Clayey SAND SP-SC/SC: fine to medium grained, yellow-brown, with clay/clayey, low plasticity fines, moist, medium dense. Clay content increasing with depth.		D	1.0				1
29	1.5	Clayey SAND SC: fine to medium grained, yellow-brown, low plasticity clay, moist.							2
	2								
28	2.5	Pit discontinued at 2.5m (Target depth)							
	3								

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





RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.
LOGGED: YC
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained 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: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 25.7 m AHD*
EASTING: 405845
NORTHING: 6457505

PIT No: 5
PROJECT No: 96730.01
DATE: 28/10/2020
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)
25	0.15	TOPSOIL/Silty SAND SM: fine to medium grained, dark grey-brown, low plasticity silt, with roots, moist.		E	0.0 - 0.1				
		SAND SP: fine to medium grained, light grey, trace silt, moist, dense.		E	0.4 - 0.5				
	1.1	COFFEE ROCK: brown, excavated as gravelly sand, with silt, with cobbles. - tree root observed at 1.2 m depth.		D	1.3				
24	1.6	SAND/Clayey SAND SP-SC/SC: fine to medium grained, light brown, with clay/clayey, low plasticity fines, moist.		D	2.2				
	2.5	Pit discontinued at 2.5m (Target depth)							
23									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1; 2





RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.
LOGGED: YC
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained 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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Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 24.9 m AHD*
EASTING: 405802
NORTHING: 6457305

PIT No: 6
PROJECT No: 96730.01
DATE: 28/10/2020
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)
24	0.1	FILL/Sandy TOPSOIL: fine to medium grained, grey-brown, with silt, with roots, moist.		E	0.0 0.1				
	0.3	FILL/SAND SP-SM: fine to medium grained, light grey-brown and light brown, with silt, with gravel, moist, dense.							
	1	FILL/Silty SAND SM: fine to medium grained, dark grey mottled orange-brown, low plasticity silt, trace gravel, pockets of orange-brown sandy clay, trace of burnt wood, fragments of brick and glass. Hard digging with excavator using flat edged bucket.		D E	0.8 1.0 1.1				1
23	1.3	FILL/Clayey SAND SC: fine to medium grained, grey, low plasticity clay, with gravel, moist.							
	2								2
	2.6	FILL/Sandy CLAY CI: medium plasticity, brown, fine to medium grained sand, moist.							
22	2.9	Pit discontinued at 2.9m (Limit of excavator reach)							
	3								





RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.
LOGGED: YC
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained 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: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 23.8 m AHD*
EASTING: 405658
NORTHING: 6457280

PIT No: 7
PROJECT No: 96730.01
DATE: 28/10/2020
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)
23	0.05	FILL/Sandy SILT TOPSOIL ML: low plasticity, grey-brown, fine to medium grained sand, with roots, moist.		E	0.0				
					0.1				
				D	0.2				
	0.3	FILL/SILT ML: low plasticity, grey-brown, with sand, moist.		E	0.3				
		SAND SP: fine to medium grained, light grey, trace silt, moist, dense. Becoming grey-brown to dark grey-brown with depth.							
				E	0.6				
					0.7				
22	2.5	Pit discontinued at 2.5m (Target depth)							
21									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2





RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.
LOGGED: YC
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained 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: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 25.7 m AHD*
EASTING: 405846
NORTHING: 6457233

PIT No: 8
PROJECT No: 96730.01
DATE: 28/10/2020
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)
25	0.1	FILL/Sandy TOPSOIL: fine to medium grained, grey-brown, with silt, trace gravel, with roots, moist.							
		FILL/SAND SP-SM: fine to medium grained, grey-brown, with silt, trace gravel, moist, medium dense to dense. A brick found in fill.		D	0.4				
	0.6	SAND SP: fine to medium grained, light grey, trace silt, moist, dense.							
24	1.8	COFFEE ROCK: brown, excavated as gravelly sand, with silt, with cobbles.							
	2.4	SAND SP-SM: fine to medium grained, light brown, with silt, moist.							
23	2.8	Pit discontinued at 2.8m (Target depth)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1; 2





RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.
LOGGED: YC
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained 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: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 24.1 m AHD*
EASTING: 405715
NORTHING: 6457240

PIT No: 9
PROJECT No: 96730.01
DATE: 28/10/2020
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)
24	0.1	FILL/Sandy SILT TOPSOIL ML: low plasticity, grey-brown, fine to medium grained sand, with roots, moist.		E	0.0				
	0.2			E	0.1				
		FILL/SAND SP-SM: fine to medium grained, grey-brown, with silt, moist.			0.2				
		SAND SP: fine to medium grained, light grey, trace silt, moist, dense.		E	0.5				
					0.6				
23	1			D	1.1				1
22	2								2
	2.5	Pit discontinued at 2.5m (Target depth)							
21	3								





RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.
LOGGED: YC
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained 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: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 31.9 m AHD*
EASTING: 406055
NORTHING: 6457029

PIT No: 10
PROJECT No: 96730.01
DATE: 28/10/2020
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)
31	0.1	FILL/Sandy TOPSOIL: fine to medium grained, grey-brown, with silt, trace gravel, with roots, moist.							
	0.3	FILL/SAND SP-SM: fine to medium grained, grey-brown, with silt, trace gravel, moist, medium dense.							
	1	SAND/Clayey SAND SP-SC/SC: fine to medium grained, yellow-brown, with clay/clayey, low plasticity fines, moist, medium dense. Clay content increasing with depth.							1
30	2	- tree roots observed to 1.8 m depth.							2
	2.5	Pit discontinued at 2.5m (Target depth)							
29	3								

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





RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.
LOGGED: YC
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained 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: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 31.2 m AHD*
EASTING: 405972
NORTHING: 6456869

PIT No: 11
PROJECT No: 96730.01
DATE: 28/10/2020
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)
31	0.1	TOPSOIL/SAND SP-SM: fine to medium grained, grey-brown, with silt, with roots, moist.		E	0.0				
	0.25	SAND SP-SM: fine to medium grained, light brown, with silt, moist, dense.			0.1				
		SAND SP-SC: fine to medium grained, yellow-brown, with clay, low plasticity fines, moist, dense. Clay content increasing with depth.		E	0.4				
		- becoming medium dense from 0.5 m depth.			0.5				
30	1			E	0.9				1
					1.0				
				D	1.1				
29	2								2
				D	2.4				
	2.5	Pit discontinued at 2.5m (Target depth)							
28	3								





RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.
LOGGED: YC
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained 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: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 32.1 m AHD*
EASTING: 406158
NORTHING: 6456928

PIT No: 12
PROJECT No: 96730.01
DATE: 28/10/2020
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)
32	0.05	FILL/SAND SP-SM: fine to medium grained, yellow-brown, trace gravel, moist.		E	0.0				
	0.2				0.05				
	0.3	FILL/Sandy GRAVEL GP-GM: fine to medium sized gravel of crushed asphalt, dark grey-black, fine to medium grained sand, with silt, moist.		E	0.2				
					0.3				
		SAND SP-SM: fine to medium grained, light brown, with silt, moist, dense.		E	0.5				
					0.6				
31	1	SAND/Clayey SAND SP-SC/SC: fine to medium grained, yellow-brown, with clay/clayey, low plasticity fines, moist, medium dense. Clay content increasing with depth.		D	1.2				1
30	2								2
	2.5	Pit discontinued at 2.5m (Target depth)							
29	3								





RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.
LOGGED: YC
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained 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: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 30.3 m AHD*
EASTING: 405927
NORTHING: 6456927

PIT No: 13
PROJECT No: 96730.01
DATE: 28/10/2020
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)
30	0.1	FILL/Sandy TOPSOIL: fine to medium grained, grey-brown, with silt, with gravel, with roots, moist.							
		FILL/SAND SP-SM: fine to medium grained, grey-brown and brown, with silt, with gravel and cobbles, moist, dense. Concrete, plastic and bricks observed.		D	0.5				
29	1.3	SAND SP-SM: fine to medium grained, yellow-brown, with silt, moist, dense.		D	1.9				
28	2.5	Pit discontinued at 2.5m (Target depth)							
27									





RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.
LOGGED: YC
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained 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: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 35.5 m AHD*
EASTING: 406447
NORTHING: 6457199

PIT No: 14
PROJECT No: 96730.01
DATE: 28/10/2020
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)
35	0.1	FILL/Sandy TOPSOIL: fine to medium grained, grey-brown, with silt, with roots, moist.		E	0.0				
	0.2	FILL/SAND SP-SM: fine to medium grained, yellow-brown and grey-brown, with silt, moist.		E	0.1				
				E	0.2				
				B	0.3				
	0.6	SAND/Clayey SAND SP-SC/SC: fine to medium grained, yellow-brown, with clay/clayey, low plasticity fines, moist, dense.			0.4				
	1	Clayey SAND SC: fine to medium grained, yellow-brown, low plasticity clay, trace gravel, moist, medium dense. Clay content increasing with depth.							
34				D	1.2				
	2								
33	2.5	Pit discontinued at 2.5m (Target depth)							
	3								

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





RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.
LOGGED: YC
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained 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: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 34.4 m AHD*
EASTING: 406383
NORTHING: 6457366

PIT No: 15
PROJECT No: 96730.01
DATE: 28/10/2020
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)
34	0.1	FILL/Sandy TOPSOIL: fine to medium grained, grey-brown, with silt, with roots, with gravel, moist. Gravel is demolition rubble including brick and concrete.		E	0.0				
				E	0.1				
	0.4	SAND SP-SM: fine to medium grained, light brown, with silt, moist, dense.			0.2				
				E	0.4				
	0.7	SAND/Clayey SAND SP-SC/SC: fine to medium grained, yellow-brown, with clay/clayey, low plasticity fines, moist, dense.			0.5				
33	1	Clayey SAND SC: fine to medium grained, yellow-brown, low plasticity clay, trace gravel, moist, medium dense. Clay content increasing with depth.							
32	2								
	2.5	Pit discontinued at 2.5m (Target depth)							
31	3								

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





RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.
LOGGED: YC
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained 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 D

Laboratory Test Results

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

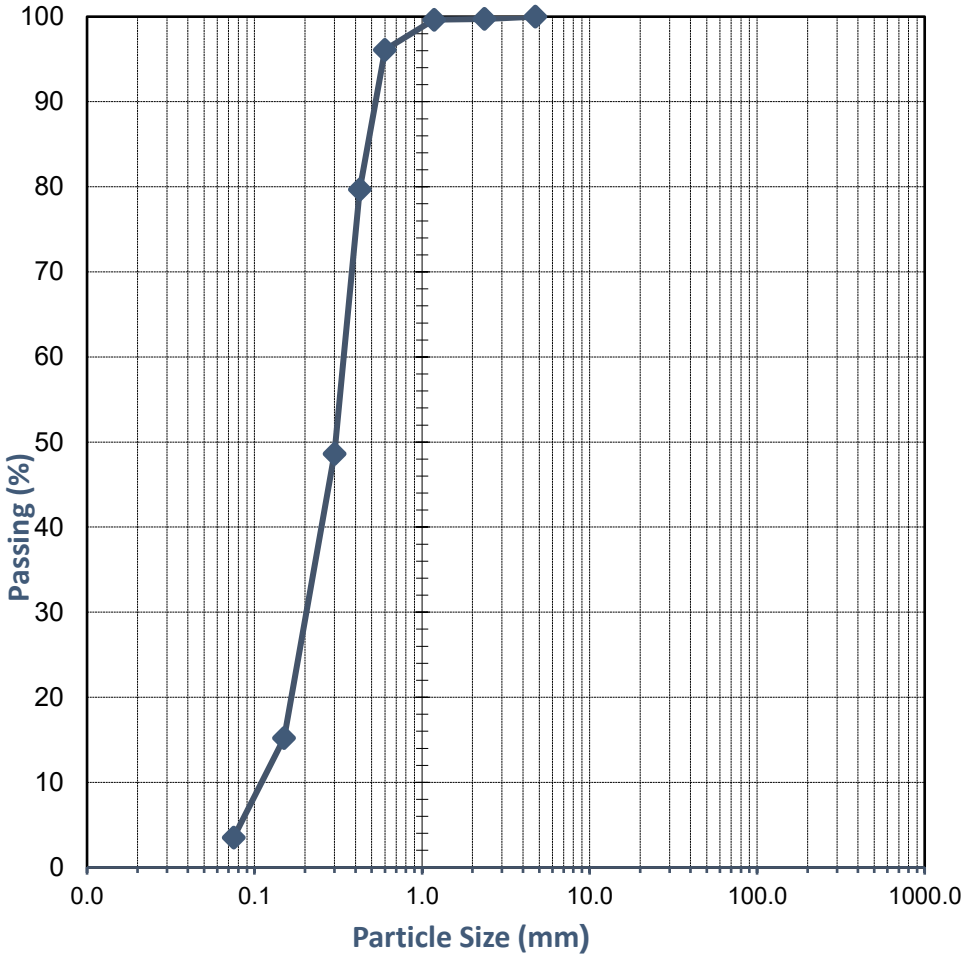
TEST REPORT - AS 1289.3.6.1

Client:	Hesperia Projects Pty Ltd	*Ticket No.*	S1949
Client Address:	-	*Report No.*	WG20/9963_1_PSD
Project:	Preliminary Geotechnical Investigation	*Sample No.*	WG20/9963
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	*Date Sampled:*	28-10-2020
Sample Identification:	TP3, 0.6m	*Date Tested:*	3/11-4/11/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	96
0.425	80
0.300	49
0.150	15
0.075	4



Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020

NATA ACCREDITATION

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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

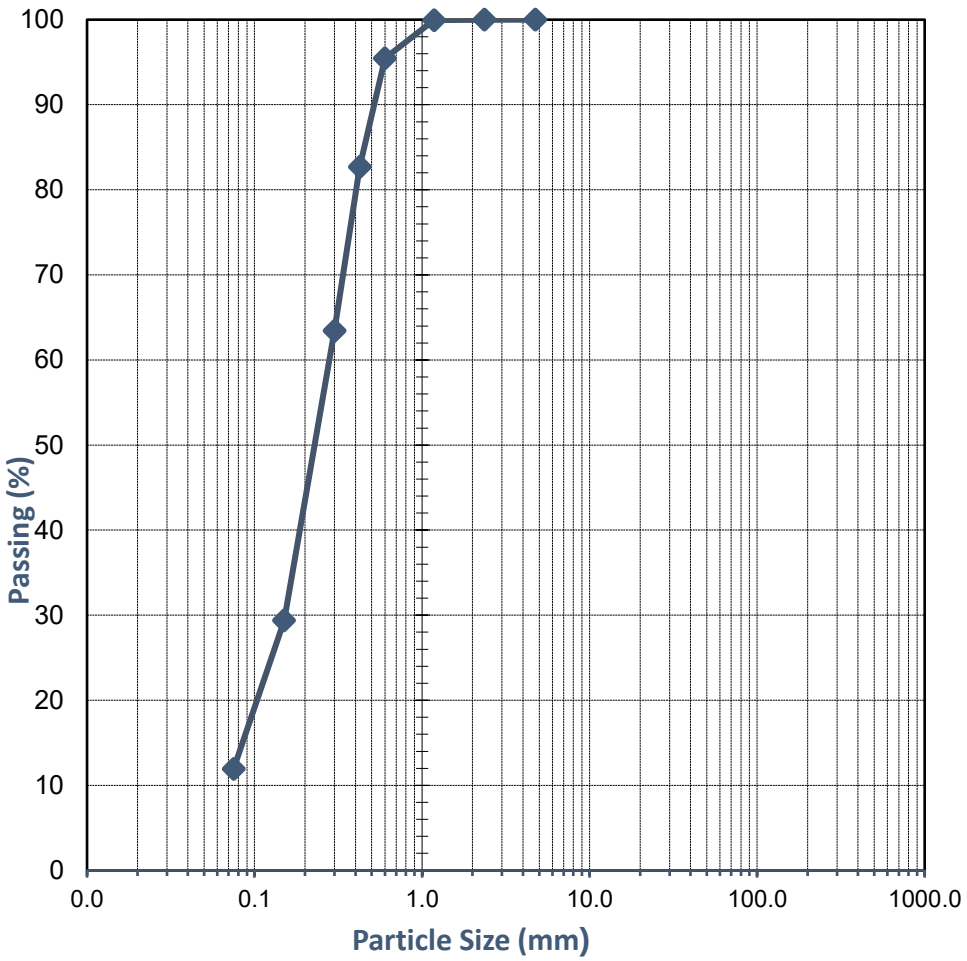
TEST REPORT - AS 1289.3.6.1

Client:	Hesperia Projects Pty Ltd	*Ticket No.*	S1949
Client Address:	-	*Report No.*	WG20/9964_1_PSD
Project:	Preliminary Geotechnical Investigation	*Sample No.*	WG20/9964
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	*Date Sampled:*	28-10-2020
Sample Identification:	TP4, 1.0m	*Date Tested:*	3/11-4/11/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	95
0.425	83
0.300	63
0.150	29
0.075	12



Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020

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SOIL | AGGREGATE | CONCRETE | CRUSHING

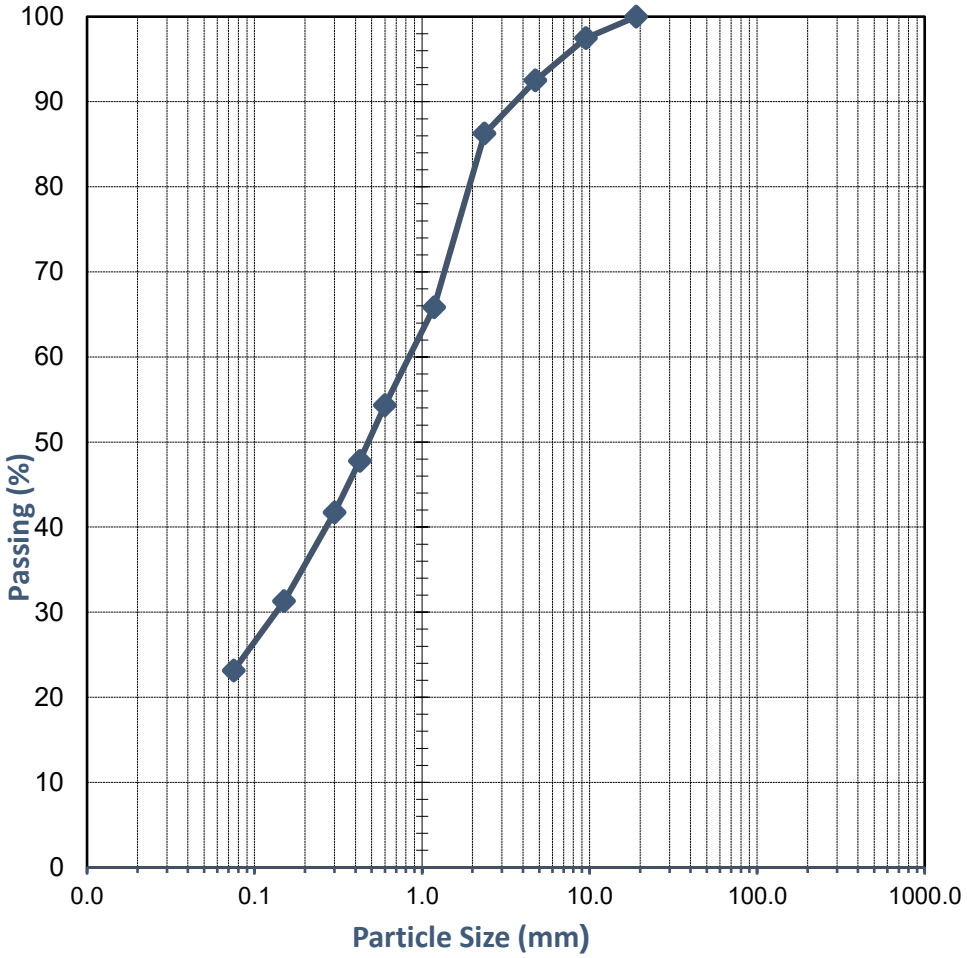
TEST REPORT - AS 1289.3.6.1

Client:	Hesperia Projects Pty Ltd	*Ticket No.*	S1949
Client Address:	-	*Report No.*	WG20/9965_1_PSD
Project:	Preliminary Geotechnical Investigation	*Sample No.*	WG20/9965
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	*Date Sampled:*	28-10-2020
Sample Identification:	TP6, 0.8m	*Date Tested:*	3/11-4/11/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: **Sampled by Client, Tested as Received**

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	100
9.5	97
4.75	93
2.36	86
1.18	66
0.600	54
0.425	48
0.300	42
0.150	31
0.075	23



Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020

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SOIL | AGGREGATE | CONCRETE | CRUSHING

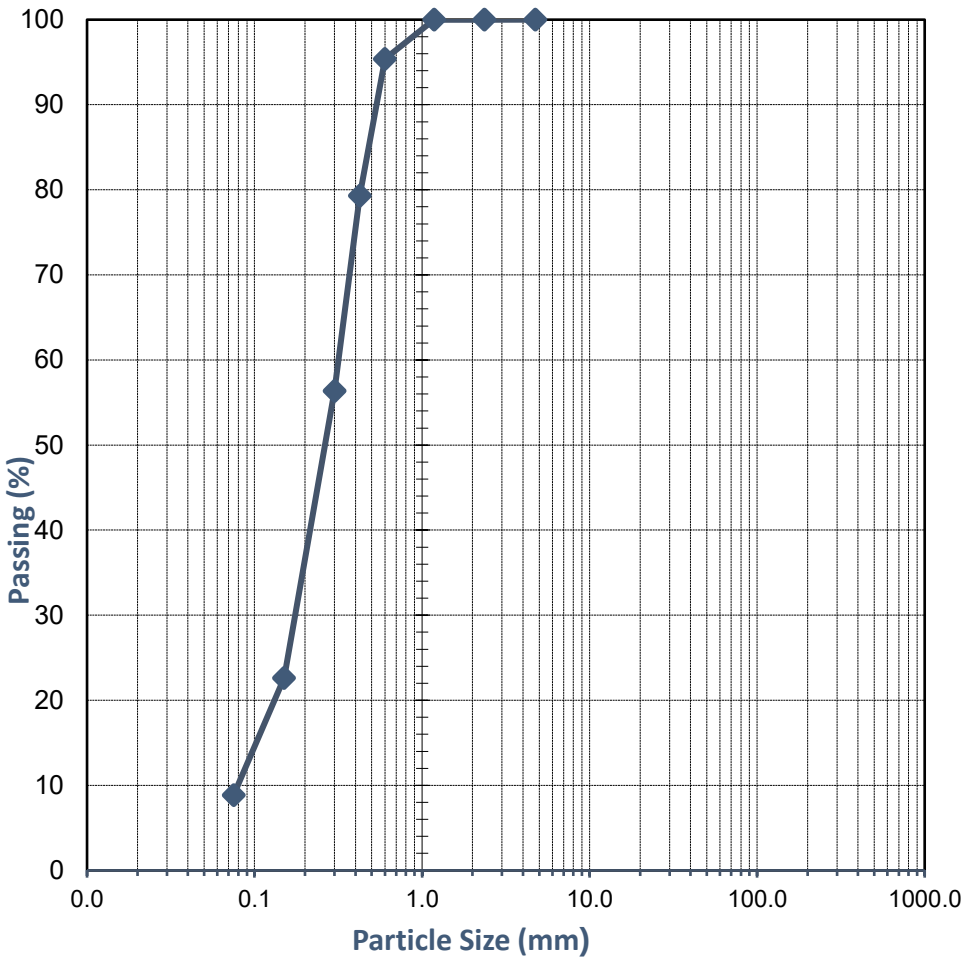
TEST REPORT - AS 1289.3.6.1

Client:	Hesperia Projects Pty Ltd	*Ticket No.*	S1949
Client Address:	-	*Report No.*	WG20/9966_1_PSD
Project:	Preliminary Geotechnical Investigation	*Sample No.*	WG20/9966
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	*Date Sampled:*	28-10-2020
Sample Identification:	TP11, 1.1m	*Date Tested:*	3/11-4/11/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	95
0.425	79
0.300	56
0.150	23
0.075	9



Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Hesperia Projects Pty Ltd	*Ticket No.*	S1949
Client Address:	-	*Report No.*	WG20/9967_1_PI
Project:	Preliminary Geotechnical Investigation	*Sample No.*	WG20/9967
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	*Date Sampled:*	28-10-2020
Sample Identification:	TP12, 1.2m	*Date Tested:*	4-11-2020

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50°C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**Not Obtainable**
AS 1289.3.2.1	**Plastic Limit (%)**	**Non-Plastic**
AS 1289.3.3.1	**Plasticity Index (%)**	**Non-Plastic**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**0.5**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**-**

Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020

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SOIL | AGGREGATE | CONCRETE | CRUSHING

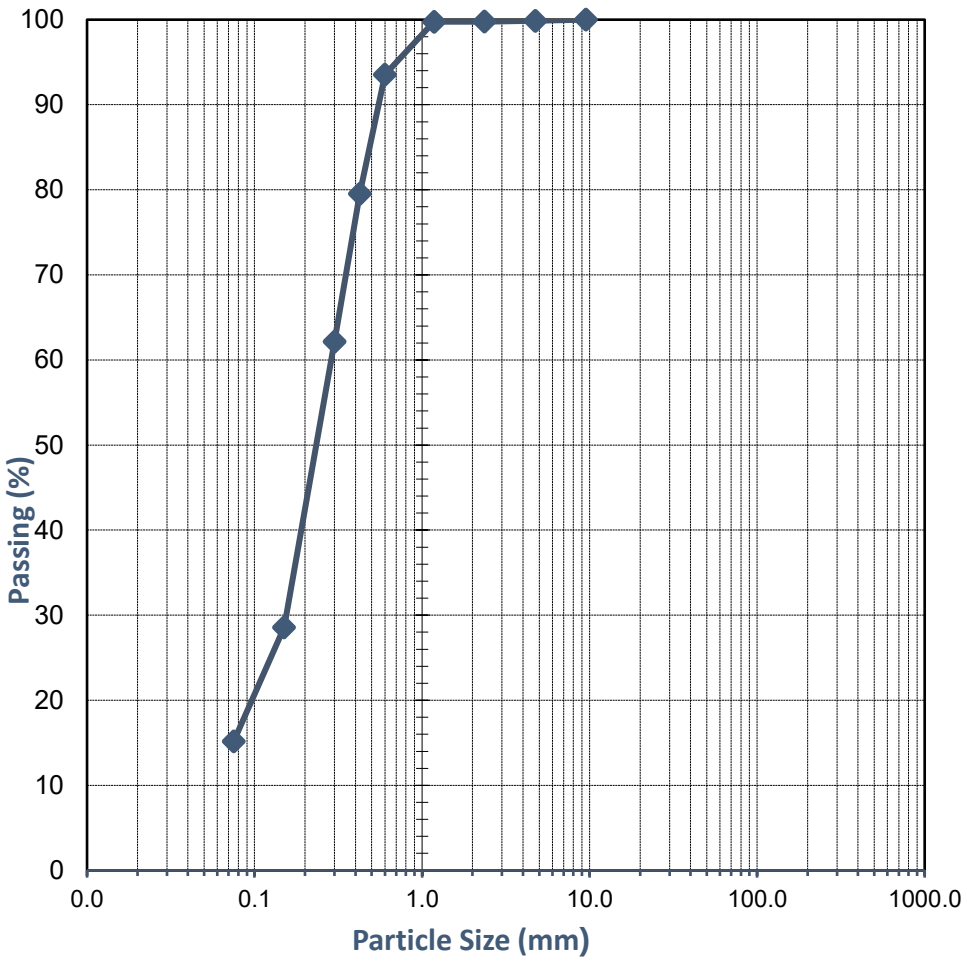
TEST REPORT - AS 1289.3.6.1

Client:	Hesperia Projects Pty Ltd	*Ticket No.*	S1949
Client Address:	-	*Report No.*	WG20/9967_1_PSD
Project:	Preliminary Geotechnical Investigation	*Sample No.*	WG20/9967
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	*Date Sampled:*	28-10-2020
Sample Identification:	TP12, 1.2m	*Date Tested:*	3/11-4/11/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	100
1.18	100
0.600	94
0.425	80
0.300	62
0.150	29
0.075	15



Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020

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SOIL | AGGREGATE | CONCRETE | CRUSHING

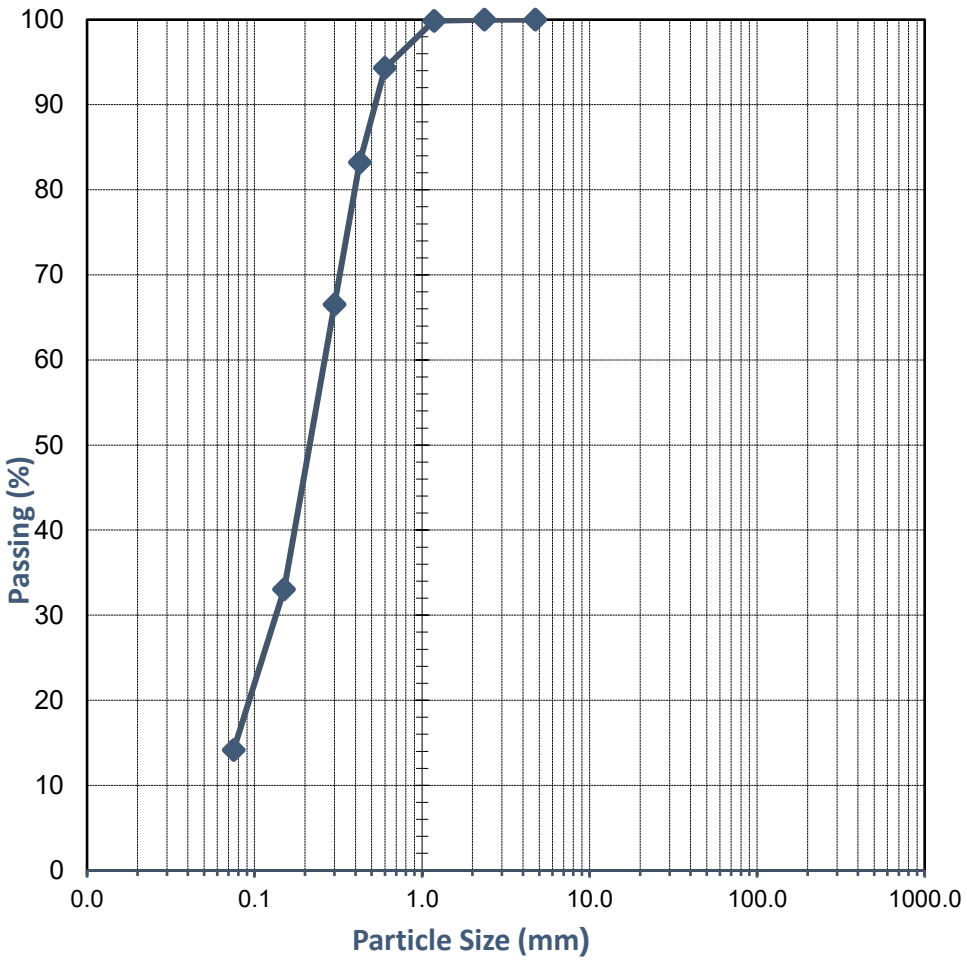
TEST REPORT - AS 1289.3.6.1

Client:	Hesperia Projects Pty Ltd	*Ticket No.*	S1949
Client Address:	-	*Report No.*	WG20/9968_1_PSD
Project:	Preliminary Geotechnical Investigation	*Sample No.*	WG20/9968
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	*Date Sampled:*	28-10-2020
Sample Identification:	TP14, 0.4m	*Date Tested:*	3/11-4/11/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	94
0.425	83
0.300	67
0.150	33
0.075	14



Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Hesperia Projects Pty Ltd	*Ticket No.*	S1949
Client Address:	-	*Report No.*	WG20/9969_1_PI
Project:	Preliminary Geotechnical Investigation	*Sample No.*	WG20/9969
Location:	Precinct 1Victoria Rd, Wattle Grove, WA	*Date Sampled:*	28-10-2020
Sample Identification:	TP14, 1.2m	*Date Tested:*	4-11-2020

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50°C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**20**
AS 1289.3.2.1	**Plastic Limit (%)**	**13**
AS 1289.3.3.1	**Plasticity Index (%)**	**7**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**2.0**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**-**

Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020

NATA

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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

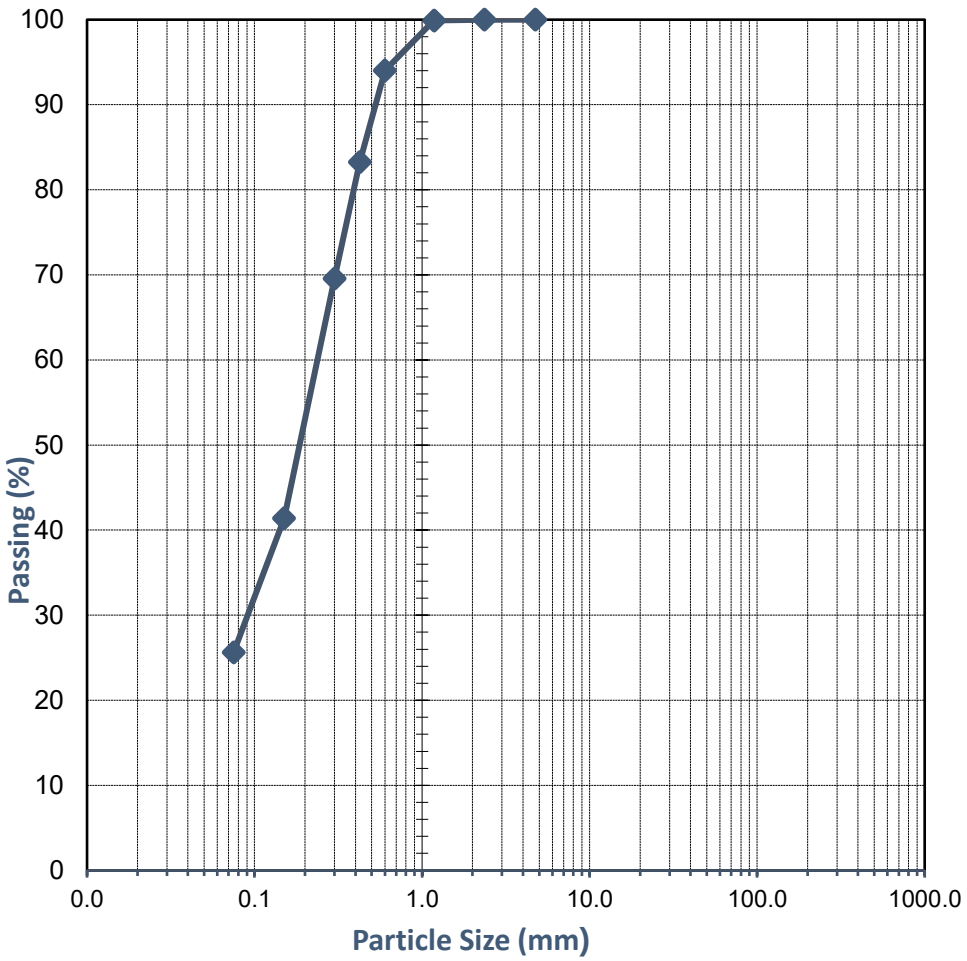
TEST REPORT - AS 1289.3.6.1

Client:	Hesperia Projects Pty Ltd	*Ticket No.*	S1949
Client Address:	-	*Report No.*	WG20/9969_1_PSD
Project:	Preliminary Geotechnical Investigation	*Sample No.*	WG20/9969
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	*Date Sampled:*	28-10-2020
Sample Identification:	TP14, 1.2m	*Date Tested:*	3/11-4/11/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	94
0.425	83
0.300	70
0.150	41
0.075	26



Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020

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CERTIFICATE OF ANALYSIS 252921

Client Details

Client	Douglas Partners Perth
Attention	Rob Shapland
Address	36 O'Malley St, Osborne Park, WA, 6017

Sample Details

Your Reference	**96730.01 - Wattle Grove Geo**
Number of Samples	1 Soil
Date samples received	09/11/2020
Date completed instructions received	09/11/2020

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	16/11/2020
Date of Issue	12/11/2020

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Results Approved By
Stacey Hawkins, Acid Soils Supervisor

Authorised By



Michael Kubiak, Laboratory Manager

sPOCAS field test		
Our Reference		252921-1
Your Reference	UNITS	TP6
Depth		0.8m
Date Sampled		28/10/2020
Type of sample		Soil
Date prepared	-	09/11/2020
Date analysed	-	10/11/2020
pH_F (field pH test)*	pH Units	5.8
pHFOX (field peroxide test)*	pH Units	2.0
Reaction Rate*	-	Medium

Chromium Suite		
Our Reference	UNITS	252921-1
Your Reference		TP6
Depth		0.8m
Date Sampled		28/10/2020
Type of sample		Soil
Date analysed	-	12/11/2020
pH $_{kcl}$	pH units	5.8
TAA	moles H^+ /t	24
S_{KCl}	%w/w S	NT
Chromium Reducible Sulfur	%w/w	0.006
ANC_{BT}	% $CaCO_3$	NT
S_{HCl}	%w/w S	NT
s-TAA	%w/w S	0.038
a-Chromium Reducible Sulfur	moles H^+ /t	<5
a-ANC_{BT}	moles H^+ /t	NT
s-ANC_{BT}	%w/w S	NT
Fineness Factor		1.50
S_{NAS}	%w/w S	NT
a-S_{NAS}	moles H^+ /t	NT
s-SNAS	%w/w S	NT
s-Net Acidity	%w/w S	0.044
a-Net Acidity	moles H^+ /t	28
Liming rate	kg $CaCO_3$ /t	2.1
s-Net Acidity without ANCE	% w/w S	0.044
a-Net Acidity without ANCE	moles H^+ /t	28
Liming rate without ANCE	kg $CaCO_3$ /t	2.1

Method ID	Methodology Summary
INORG-063	pH- measured using pH meter and electrode. Soil is oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.
INORG-064	Suspension Peroxide Oxidation Combined Acidity and Sulphate (SPOCAS) using ASSMAC guidelines.
INORG-068	Chromium Reducible Sulfur - Hydrogen Sulfide is quantified by iodometric titration after distillation to determine potential acidity. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.

QUALITY CONTROL: sPOCAS field test						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			09/11/2020	1	09/11/2020	09/11/2020		[NT]	[NT]
Date analysed	-			10/11/2020	1	10/11/2020	10/11/2020		[NT]	[NT]
pH_F (field pH test)*	pH Units		INORG-063	[NT]	1	5.8	5.8	0	[NT]	[NT]
pHFOX (field peroxide test)*	pH Units		INORG-063	[NT]	1	2.0	1.9	5	[NT]	[NT]

QUALITY CONTROL: Chromium Suite						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date analysed	-			12/11/2020	1	12/11/2020	12/11/2020		12/11/2020	[NT]
pH $_{kcl}$	pH units		INORG-064	[NT]	1	5.8	5.7	2	97	[NT]
TAA	moles H^+/t	5	INORG-064	[NT]	1	24	23	4	104	[NT]
S_{KCl}	%w/w S	0.005	INORG-064	[NT]	1	NT	NT		[NT]	[NT]
Chromium Reducible Sulfur	%w/w	0.005	INORG-068	[NT]	1	0.006	0.006	0	97	[NT]
ANC_{BT}	% $CaCO_3$	0.01	INORG-068	[NT]	1	NT	NT		[NT]	[NT]
S_{HCl}	%w/w S	0.005	INORG-068	[NT]	1	NT	NT		[NT]	[NT]
s-TAA	%w/w S	0.01	INORG-068	[NT]	1	0.038	0.036	5	[NT]	[NT]
a-Chromium Reducible Sulfur	moles H^+/t	5	INORG-068	[NT]	1	<5	<5	0	[NT]	[NT]
a-ANC_{BT}	moles H^+/t	5	INORG-068	[NT]	1	NT	NT		[NT]	[NT]
s-ANC_{BT}	%w/w S	0.01	INORG-068	[NT]	1	NT	NT		[NT]	[NT]
Fineness Factor			INORG-064	[NT]	1	1.50	1.50	0	[NT]	[NT]
S_{NAS}	%w/w S	0.005	INORG-068	[NT]	1	NT	NT		[NT]	[NT]
a-S_{NAS}	moles H^+/t	5	INORG-064	[NT]	1	NT	NT		[NT]	[NT]
s-SNAS	%w/w S	0.01	INORG-064	[NT]	1	NT	NT		[NT]	[NT]
s-Net Acidity	%w/w S	0.005	INORG-064	[NT]	1	0.044	0.042	5	[NT]	[NT]
a-Net Acidity	moles H^+/t	5	INORG-064	[NT]	1	28	26	7	[NT]	[NT]
Liming rate	kg $CaCO_3$/t	0.75	INORG-068	[NT]	1	2.1	2.0	5	[NT]	[NT]
s-Net Acidity without ANCE	% w/w S	0.005	INORG-064	[NT]	1	0.044	0.042	5	[NT]	[NT]
a-Net Acidity without ANCE	moles H^+/t	5	INORG-064	[NT]	1	28	26	7	[NT]	[NT]
Liming rate without ANCE	kg $CaCO_3$/t	0.75	INORG-064	[NT]	1	2.1	2.0	5	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Appendix E

CSRIO Note on Foundation Maintenance and Footing Performance

Foundation Maintenance and Footing Performance: A Homeowner's Guide

PUBLISHING

BTF 18-2011
replaces
Information
Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870-2011, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume, particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.

In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites, which may experience only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes

Notes

1. Where controlled fill has been used, the site may be classified A to E according to the type of fill used.
2. Filled sites. Class P is used for sites which include soft fills, such as clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soil subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise.
3. Where deep-seated moisture changes exist on sites at depths of 3 m or greater, further classification is needed for Classes M to E (M-D, H1-D, H2-D and E-D).

Tree root growth
Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation
Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay
Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

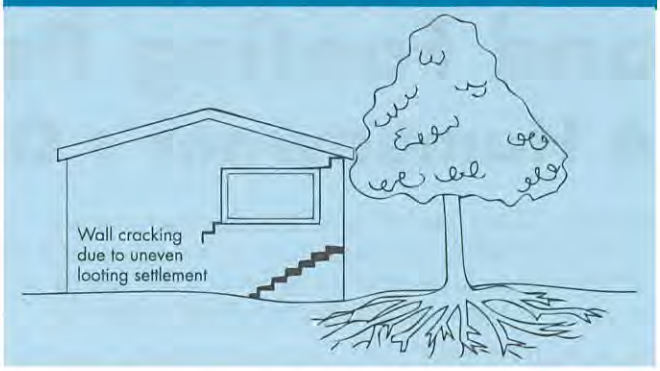
The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Trees can cause shrinkage and damage



Movement caused by tree roots
In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself
Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures
Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures
Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation causes a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures
Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem. Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870-2011.

AS 2870-2011 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing
Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage
In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

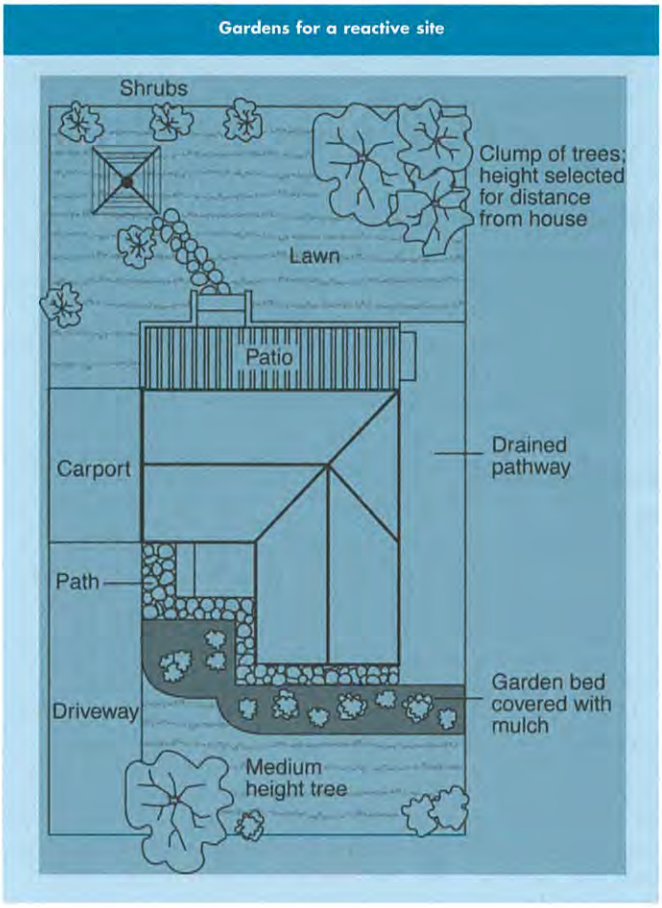
It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving should

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly.	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired.	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted.	15–25 mm but also depends on number of cracks	4



extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

The information in this and other issues in the series was derived from various sources and was believed to be correct when published.

The information is advisory. It is provided in good faith and not claimed to be an exhaustive treatment of the relevant subject.

Further professional advice needs to be obtained before taking any action based on the information provided.

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Integrated Practical Solutions

Report on
Preliminary Geotechnical Investigation

Proposed Residential Development
Victoria Road, Wattle Grove, WA

Prepared for
The Trustee for the Wattle Grove Trust

Project 96730.04
December 2022



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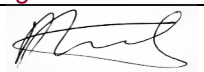
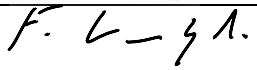
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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		6 December 2022
Reviewer		6 December 2022

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Appendix A: About This Report

Appendix B: Drawing 1
Results of Field Work

Appendix C: Laboratory Test Certificates

Report on Preliminary Geotechnical Investigation
Proposed Residential Development
Victoria Road, Wattle Grove, WA

1. Introduction

This report presents the results of a preliminary geotechnical investigation undertaken for a proposed residential development across various lots on Victoria Road, Wattle Grove, WA. The investigation was commissioned in an email dated 27 October 2022 by Hesperia Projects on behalf of The Trustee for the Wattle Grove Trust and was undertaken in accordance with Douglas Partners' proposal P96730.04.P.001.Rev1 dated 25 October 2022.

It is understood that the parcel of land to the east of Tonkin Highway will be redeveloped to include a commercial precinct, medium density residential land-use, a primary school site and public open space. At this stage, access has been provided to selected properties within the overall development area, to allow a preliminary geotechnical assessment of the ground conditions.

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

- the possible presence of fill materials, unsuitable foundation materials, rock or coffee rock and the distribution of clayey soils, if encountered;
- the site suitability and improvements that may be required to support the proposed development, and if significant variation in the ground conditions are anticipated;
- the site classification in accordance with the requirements of AS 2870-2011, and the likely earthworks requirements in terms of sand fill thicknesses to improve the classification to achieve ‘Class S’ and ‘Class A’;
- general site preparation requirements including comments on excavatability and earthworks to suitably prepare the ground for the proposed development;
- the suitability of the in situ material, from a geotechnical perspective, for re-use as structural fill;
- parameters for pavement design, including a suitable California bearing ratio value based on field observations;
- the depth to groundwater at the time of the investigation, if encountered;
- the permeability of the encountered soils at the site, to allow comments on stormwater disposal suitability, and general drainage conditions across the site.

The investigation included the excavation of twelve test pits and laboratory testing of selected samples. This investigation is subsequent to an earlier investigation across various other lots in the same proposed development area, with the results reported in Douglas Partners report 96730.01.R.001.Rev0, dated November 2020.

2. Site Description

The investigation was undertaken across various lots along Victoria Road in Wattle Grove, as indicated on Drawing 1.

The site typically consists of semi-rural residential allotments, and includes houses, sheds and other small structures, areas of hardstand and paddocks. Vegetation generally consisted of short length grass and shrubs, with medium to tall sized trees.

The 1:50 000 scale Armadale Environmental Geology map indicates that the shallow ground conditions across the site predominantly comprise soils of the Yoganup Formation, with some areas comprising Bassendean Sand, locally overlying clayey materials of the Guildford Formation at a shallow depth.

The site is undulating, with a high point at RL 33 m AHD at the eastern side, sloping down to RL 25 m AHD at the western side and RL 29 m AHD at the southern side of the site.

The Perth Ground water Atlas (2004) indicates that the regional groundwater level beneath the site in May 2003 (i.e. near seasonal low levels for that year) was between RL 13 m AHD and RL 15 m AHD, approximately 10 m to 16 m below the existing surface level. However, our experience indicates that shallower groundwater perched on the Guildford Formation is possible.

3. Field Work Methods

The field work for the current phase of the investigation was carried out on 1 November 2022 and comprised:

- the excavation of 12 test pits; and
- in-situ infiltration testing at three locations.

The test pits (test locations 101 to 112) were excavated using an 8 tonne backhoe with 450 mm wide toothed bucket, to depths of up to 2.5 m. The ground conditions were logged in accordance with AS 1726-2011 by a geotechnical engineer, and samples collect from selected locations for laboratory analysis. Perth sand penetrometer testing was carried out adjacent to each test pit location in accordance with AS 1289.6.3.3, to assess the in-situ density of the soils.

Test locations were determined using a differential GPS and site features and are marked on Drawing 1 in Appendix B. Surface elevations at the test locations were also obtained using a differential GPS, with a reported accuracy of 0.1 m, and are provided on the test pit logs in Appendix B.

4. Field Work Results

4.1 Ground Conditions

Logs of the ground conditions are presented in Appendix B, and should be read in conjunction with the notes defining descriptive terms and classification methods provided in Appendix A.

The ground conditions at the tested locations generally comprised either topsoil or uncontrolled fill overlying Bassendean Sand and Yoganup Sand, with cemented sand (coffee rock) encountered at several locations. Silty and clayey soils of the Yoganup Formation were encountered at four locations underlying the sand. A summary of the ground conditions encountered at the test locations is given below:

- **Uncontrolled FILL:**
    - **FILL (SAND SP) –** grey-brown, fine to medium grained, with silt, 0.25 m thick, encountered at location 103.
    - **FILL (Gravelly SAND SP-SM) –** brown and grey-brown, 0.1 m thick, encountered at location 106.
- **TOPSOIL (SAND SP, SP-SM) –** 100 mm to 150 mm thick, dark grey-brown and grey-brown, sand trace/with silt, roots and rootlets.
- **SAND SP –** pale grey and locally pale yellow-brown at depth, fine to medium grained, generally trace silt, generally loose to medium dense, at all test locations underlying the topsoil or fill to depths of between 0.5 m and test pit termination depths of up to 2.5 m.
- **Cemented SAND SP-SM (Coffee Rock) –** generally weakly to moderately cemented, dark brown, occurring as a layer of variable thickness at several locations within the sand layer (SP). Typically between approximately 0.2 m and 0.4 m in thickness.
- **SAND SP-SM –** yellow-brown, fine to medium grained, with silt, underlying the sand (SP) or cemented sand, at several locations.
- **Silty SAND SM / Silty Sandy GRAVEL GM / Sandy GRAVEL GP –** orange-brown and yellow-brown, fine to medium grained, fine to coarse sized, generally loose to medium dense, weakly cemented, underlying the sand (SP-SM) from a depth of between 0.6 m and 1.9 m at test locations 109 to 112.
- **Clayey Sandy GRAVEL GC –** fine to coarse sized, yellow-brown mottled grey, underlying the sandy gravel material from a depth of 1.8 m, at location 110.

4.2 Groundwater

No free groundwater was observed at the test locations 101 to 112 undertaken on 1 November 2022 to depths of up to 2.5 m. The test pits were immediately backfilled following sampling, which precluded longer-term monitoring of groundwater levels.

It should be noted that groundwater levels are affected by climatic conditions and land usage and will therefore vary with time.

4.3 Results of Infiltration Testing

In situ infiltration tests was undertaken at test locations 103, 108 and 111 using a falling head method, with a soil permeability value estimated from the results using a method based on a calculation by Hvorslev (1951). The results are summarised in Table 1 below.

Table 1: Summary of In Situ Infiltration Test Results

Test Location	Depth (m)	Measured Permeability		In situ Conditions of Tested Material
		(m/s)	(m/day)	
103	1.0	6.1×10^{-4}	>20	SAND SP, trace silt, medium dense, pale grey
108	1.0	8.2×10^{-5}	7.1	SAND SP-SM, with silt, loose to medium dense, yellow-brown
111	1.3	2.7×10^{-5}	2.4	Silty SAND SM, loose to medium dense, orange-brown

5. Laboratory Testing

A geotechnical laboratory testing programme was carried out on selected soil samples by a NATA registered laboratory, and comprised the determination of:

- the particle size distributions of 8 samples; and
- the Atterberg limits and linear shrinkage of two samples.

The test certificates are presented in Appendix C, with the results summarised in Table 2, next page.

Table 2: Results of Laboratory Testing for Soil Identification

Test Location	Depth (m)	Fines (%)	Sand (%)	Gravel (%)	LL (%)	PL (%)	PI (%)	LS (%)	Material
106	1.0	3	97	0	-	-	-	-	SAND SP, trace silt, grey
107	2.3	8	92	0	-	-	-	-	SAND SP-SM, with silt, pale yellow
108	1.5	9	91	0	-	-	-	-	SAND SP-SM, with silt, yellow-brown
110	1.0	3	33	64	-	-	-	-	Sandy GRAVEL GP, trace silt
110	2.0-2.5	23	35	42	37	16	21	8.5	Clayey Sandy GRAVEL GC, medium plasticity
111	1.3	17	83	0	-	-	-	-	Silty SAND SM, orange-brown
111	2.5	23	77	0	-	-	-	-	Silty SAND SM, orange-brown
112	1.5	17	83	0	NO	NP	NP	0	Silty SAND SM, orange-brown

Notes: Fines are particles smaller than 75 µm.
Sand is particles larger than 75 µm and smaller than 2.36 mm.
Gravel is particles larger than 2.36 mm and smaller than 63 mm.
PL: plastic limit LL: liquid limit PI: plasticity Index LS: linear shrinkage
NO: Not Obtainable NP: Non-Plastic
'-' not tested.

6. Proposed Development

It is understood that the proposed development of the site includes a commercial precinct, medium density residential land-use, a primary school and public open space.

7. Comments

7.1 Site Suitability

The results of the investigation indicate that shallow ground conditions across the site generally comprise topsoil and loose to medium dense sand (either fill or natural) overlying cemented sand (coffee rock) and clayey materials. Relatively shallow uncontrolled fill was encountered at isolated locations.

From a geotechnical standpoint, the land is considered to be physically capable of development provided that site preparation is undertaken as outlined in the following sections of this report.

7.2 Site Classification

Site classification is determined in accordance with AS 2870-2011 and is based on the expected ground surface movement and the depth to which this soil movement extends. The depth of soil suction change at this site is assessed to be 1.8 m.

The shallow ground conditions encountered across the site are variable from a site classification standpoint. Ground conditions generally consist of sand overlying silty sand and clayey sandy gravel materials. Based on a visual and tactile assessment together with limited laboratory testing, the clayey sandy gravel forms a slightly reactive layer. Various uncontrolled fill materials were also encountered across the site.

Following suitable site preparation as described in Section 7.4, the site would be classified as:

- 'Class A' where there is at least 1.8 m of sand present overlying any clayey materials.
- 'Class S' where there is at least 1.2 m of sand present overlying any clayey materials.

It is noted that AS 2870 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.

7.3 Excavation Conditions

Based on the ground conditions described in Section 4.1, excavations associated with bulk earthworks, service trenches and foundations are anticipated to be undertaken through medium dense to dense sand, silty sand and clayey sandy gravel. Coffee rock was encountered at several test locations however at these locations it was excavated with relative ease using an 8 tonne backhoe. Stronger coffee rock could possibly occur elsewhere at the site.

In general, excavations should be readily achieved using typical earthmoving equipment (ie excavators, loaders, and scrapers). Consideration can be given to using larger excavators (greater than 20 tonne) with toothed buckets to excavate through cemented materials such as coffee rock.

7.4 Site Preparation

Inspections of earthworks should be undertaken by an experienced geotechnical engineer, in general accordance with the guidelines set out for Level 2 inspections within AS 3798-2007, as a minimum requirement.

7.4.1 Site Stripping

All deleterious material, including vegetation, topsoil and uncontrolled fill (such as encountered at locations 103 and 106), should be stripped from within development areas and either removed from site or stockpiled for possible treatment and re-use, if applicable (see Section 7.4.3). Uncontrolled fill should be excavated to its full depth, and either removed from site or assessed by a geotechnical engineer for its possible suitability for re-use applications.

Tree roots should also be removed, with the site grubbed to at least 0.5 m depth below surface level. Existing pavements, structures including their footings, associated buried services, soakwells and other infrastructure should be completely removed. Any excavations occurring from stripping and grubbing activities should be backfilled with material similar to the adjacent subgrade and suitably compacted.

7.4.2 Proof Compaction

Following site stripping and removal of all unsuitable materials, it is recommended that the exposed subgrade soils across the site should be compacted using a heavy (minimum of 14 tonne) smooth drum roller. All proposed building envelope and pavement areas should be compacted to target a minimum blow count of 8 blows per 300 mm penetration when tested with a PSP to a depth of not less than 1 m below the existing surface level, to ensure suitable densification of the identified loose sand across the site.

Any areas that show signs of excessive deformation during compaction should be continually compacted until deformation ceases. Alternatively, the poor-quality material could be excavated and replaced with suitable structural filling compacted to achieve not less than 8 blows per 300 mm rod penetration when tested using a PSP. Care should be taken not to operate heavy vibrating plant immediately adjacent to existing buildings and services.

Confirmation of site stripping and suitable compaction should be verified by a geotechnical engineer, prior to placement of any fill materials.

7.4.3 Re-use of Materials

The naturally occurring light grey sand (Bassendean Sand) is considered suitable for re-use as structural fill for urban development, and should form a well-drained material. The material should be free from organic matter and particles greater than 150 mm in size.

The naturally occurring yellow-brown sand (Yoganup Sand) is also considered suitable for re-use as structural fill. However the fines content of this sand, which generally increases with depth, is anticipated to preclude its re-use in applications requiring good drainage conditions. Following placement and compaction, the yellow-brown sand is expected to have a permeability below typical local earthworks specifications of 5 m/day.

Sandy topsoil was recorded over a thickness of 100 mm and 150 mm within the test pits undertaken at the site. A general procedure for the re-use of sandy topsoil which is considered suitable for this site is:

- Stripping and stockpiling the topsoil, followed by removal of the bulk of the large organic particles by passing the topsoil through a screen with an aperture size of say 25 mm; and
- Blending the screened topsoil with clean sand. A preliminary blending ratio of approximately 2:1 (clean sand : topsoil/organic sand) is suggested at this stage, but this blending ratio should be refined following assessment of the material resulting from the screening operations.

The suitability of the screened material should also be regularly assessed by a geotechnical engineer (including the determination of organic content and particle size gradings) for approval prior to use as fill, which may also result in optimisation of the blending ratio.

Blended fill materials typically have a reduced permeability in comparison with clean sand, and therefore verification of the permeability of the blended material is suggested, prior to use. Any material considered unsuitable for use as fill by the geotechnical engineer should be removed from the site or used in non-structural areas.

Following excavation of uncontrolled fill materials during site stripping, it is recommended that the materials are assessed by a geotechnical engineer to assess their suitability of re-use. It is anticipated that most soil materials can be re-used somewhere within the site following suitable preparation, to limit off-site disposal costs. Prior to re-use, uncontrolled fill materials may require raking or screening to remove deleterious or large particles, and blending with other soils, subject to assessment and verification by a geotechnical engineer on a case by case basis.

7.4.4 Compaction

Materials approved by a geotechnical engineer for use as structural fill should be placed in layers within 2% of the optimum moisture content. Each layer should be compacted to achieve a dry density ratio of not less than 95% relative to modified compaction. The type of roller (smooth drum or pad foot) and the use of vibratory modes should be at the discretion of the earthwork's contractor based on the encountered subgrade, the depth to groundwater, and the size and type of compaction plant.

Compaction control in sand could be carried out using a Perth sand penetrometer (PSP) test in accordance with test method AS 1289.6.3.3, after the relationship between PSP blow counts and soil dry density ratio has been established by a NATA accredited laboratory and following review by a geotechnical engineer.

It is recommended that the compaction control of clayey materials is carried out using a nuclear surface moisture-density gauge, in accordance with AS 1289.5.8.1, noting however that clayey materials were encountered more than 1.8 m below existing ground level and might impact earthworks only if significant cutting of the site or relatively deep excavations are proposed.

It is recommended that verification of the compaction works be undertaken by an experienced geotechnical engineer.

During construction, some loosening of the surface sands in foundation excavations is expected. Therefore, the top 300 mm in the base of any excavation should be re-compacted using a vibratory plate compactor prior to construction of any footings.

7.5 Pavement Design Parameters

Based on field observations and Douglas Partners' experience, it is suggested that a preliminary subgrade California bearing ratio (CBR) of 12% be considered for the design of flexible pavements on the natural grey Sand (noted 'SP' in the logs in Appendix B) where a minimum of 0.5 m of sand exists below subgrade level. A presumptive design CBR value of 8% is recommended if the orange-brown and yellow-brown Silty Sand (SP-SM) of the Yoganup Formation is within 0.5 m of the proposed pavement subgrade level, unless results of further laboratory testing indicate the suitability to adopt of greater design CBR value. These design CBR values assumed that the sand subgrade is compacted to achieve a dry density ratio of not less than 95% relative to modified compaction, as determined by AS 1289.5.2.1.

It is recommended that subgrade be inspected by a suitably experienced geotechnical engineer prior to placement of the pavement layers to identify unsuitable subgrade materials, if any.

7.6 Site Drainage and Reactive Materials

The shallow soil conditions beneath the site generally comprise sand, trace silt to with silt, overlying sand with clay and clayey sand. Based on the infiltration testing undertaken, the estimated permeability rates for the sandy soils in their in situ (prior to any earthworks) conditions are:

- Bassendean Sand (light grey, trace silt): 20 m/day;
- Yoganup Sand (yellow-brown, with silt and increasing fines content with depth): 2 m/day to 7 m/day.

These permeability values are anticipated to decrease following densification of the soils during earthworks. Based on our experience in similar ground conditions, following compaction the Yoganup sand is anticipated to have a generally low permeability, and is unlikely to form a suitably draining material for on-site stormwater disposal, unless specific additional drainage provisions are adopted.

The clayey sandy gravel and silty sand should be considered impermeable for site drainage following earthworks.

In areas with shallow clearance to low permeability layers, water may pond as it infiltrates through the sand, collecting on the underlying silty sand SM (and to a lesser extent the sand with silt SP-SM). Localised low-points in the underlying silty sand surface may trap water, resulting in waterlogged conditions near surface. It is also expected that the infiltration capacity of the site soils will reduce due to compaction works during earthworks on-site. If soakwells are selected for stormwater disposal, the provision of measures such as overflow outlets should be considered. Some ponding of water at surface may occur during heavy or prolonged rainfall events, following densification of the sand during site works.

The clayey sandy gravel underlying the site is slightly reactive and therefore has some propensity to swell and shrink with moisture variation resulting in surface movement. It is recommended that attention be given to minimise moisture content changes within these clayey materials through the adoption of appropriate measures, such as ensuring that:

- The site is well drained, both during construction and throughout the life of structures on the site.
- Plumbing systems be maintained and repaired to avoid leaks beneath and around structures.
- No large trees be planted adjacent to structures.
- Irregular or excessive watering around the structures be avoided.

8. References

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9. Limitations

Douglas Partners (DP) has prepared this preliminary geotechnical report for the proposed Wattle Grove development at various lots on Victoria Road in Wattle Grove, WA in accordance with DP's proposal P96730.04 dated 25 October 2022 and acceptance received from Hesperia Projects on behalf of The Trustee for the Wattle Grove Trust dated 27 October 2022. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of The Trustee for the Wattle Grove Trust for the proposed Wattle Grove development at various lots on Victoria Road in Wattle Grove 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.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

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 of 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 fill 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 fill may contain contaminants and hazardous building materials.

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Appendix A

About This Report

About this Report

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Introduction

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

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

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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

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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.

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

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Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

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

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

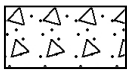
Symbols & Abbreviations

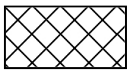
Graphic Symbols for Soil and Rock

General

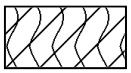

Asphalt

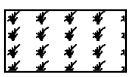

Road base

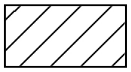

Concrete

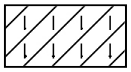

Filling

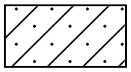
Soils


Topsoil

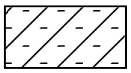

Peat

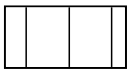

Clay

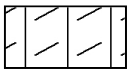

Silty clay

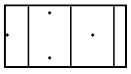

Sandy clay

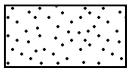

Gravelly clay

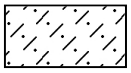

Shaly clay

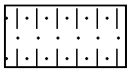

Silt


Clayey silt


Sandy silt


Sand

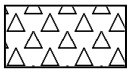

Clayey sand


Silty sand


Gravel

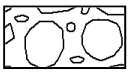

Sandy gravel


Cobbles, boulders

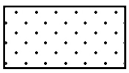

Talus

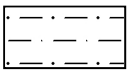
Sedimentary Rocks

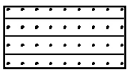

Boulder conglomerate

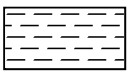

Conglomerate


Conglomeratic sandstone

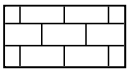

Sandstone


Siltstone

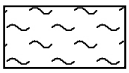

Laminite

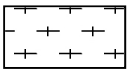

Mudstone, claystone, shale

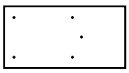

Coal


Limestone

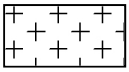
Metamorphic Rocks

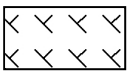

Slate, phyllite, schist

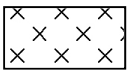

Gneiss

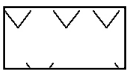

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite

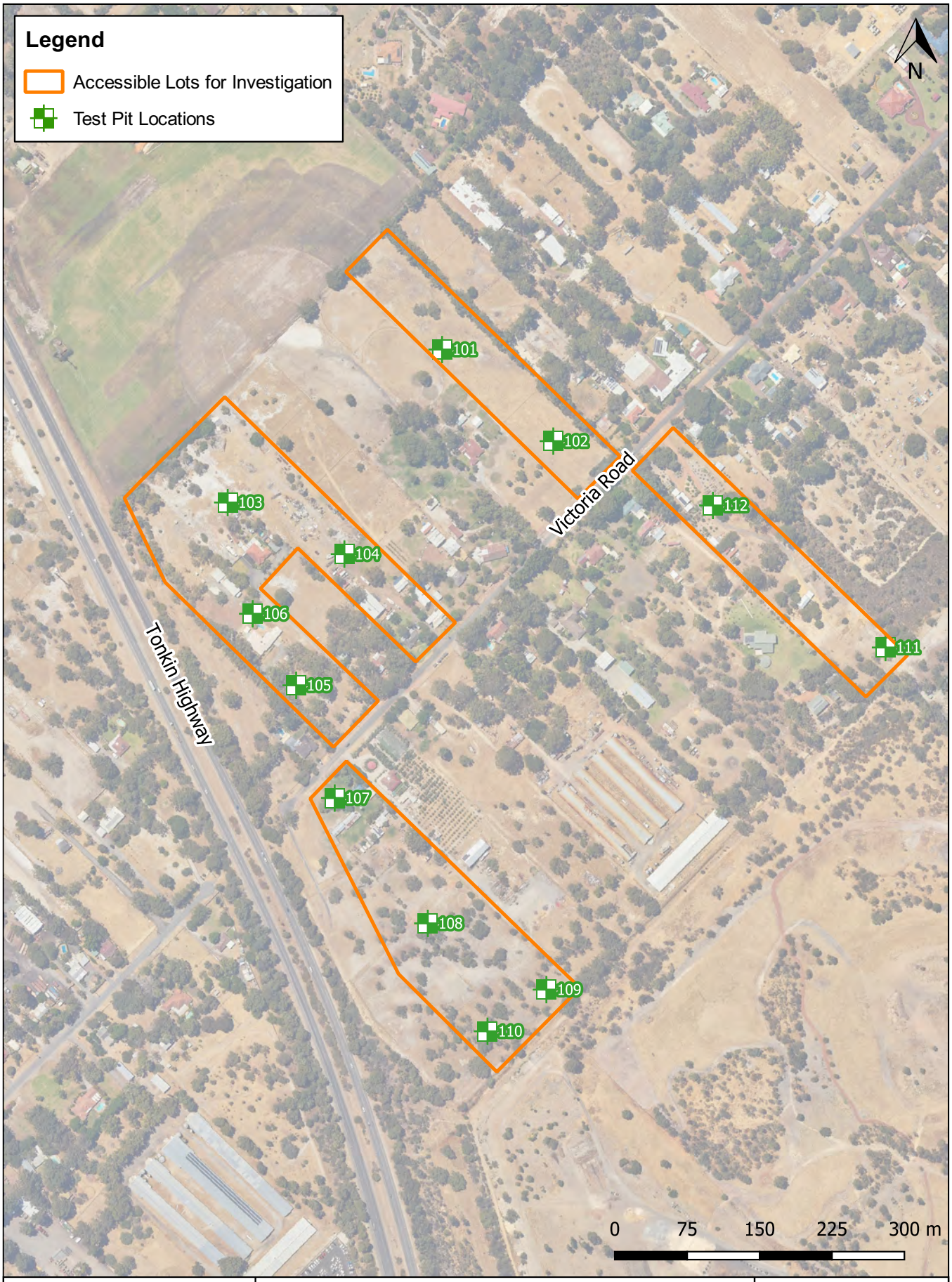

Dacite, epidote


Tuff, breccia


Porphyry

Appendix B

Drawing 1
Results of Field Work



Douglas Partners Geotechnics | Environment | Groundwater	**Test Pit Locations** **Preliminary Geotechnical Investigation** **Victoria Road, Wattle Grove, WA**	PROJECT: 96730.04 Drawing No: 1 REV: 0
	CLIENT: The Trustee for the Wattle Grove Trust	DATE: 29/11/2022

TEST PIT LOG

CLIENT: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 25.0 m AHD*
EASTING: 405877
NORTHING: 6457393

PIT No: 101
PROJECT No: 96730.04
DATE: 1/11/2022
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)
25	0.1	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, moist, topsoil.							
		SAND SP: fine to medium grained, pale grey, trace silt, moist, medium dense. Bassendean Sand.							
24	1								1
	1.2	Cemented Silty SAND SM: fine to medium grained, dark brown, moist, moderately to well cemented. Coffee rock.							
	1.6	SAND SP: fine to medium grained, pale brown, trace silt, moist. Bassendean Sand. - becoming pale grey from 1.8 m depth.							
23	2								2
	2.5	Pit discontinued at 2.5m (Target depth)		D	2.5				





RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ 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: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 25.5 m AHD*
EASTING: 405993
NORTHING: 6457298

PIT No: 102
PROJECT No: 96730.04
DATE: 1/11/2022
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)
25	0.1	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, moist, topsoil.							
		SAND SP: fine to medium grained, pale grey, trace silt, moist, medium dense. Bassendean Sand.							
	1								1
	1.1	Cemented Silty SAND SM: fine to medium grained, brown and dark brown, moist, weakly to moderately cemented. Coffee rock.							
24	1.5	SAND SP: fine to medium grained, pale grey, trace silt, moist. Bassendean Sand.							
	2								2
23	2.5	Pit discontinued at 2.5m (Target depth)							





RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ 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: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 23.5 m AHD*
EASTING: 405655
NORTHING: 6457234

PIT No: 103
PROJECT No: 96730.04
DATE: 1/11/2022
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)
23	0.25	FILL/TOPSOIL: SAND SP: fine to medium grained, grey-brown, trace silt, moist, medium dense, fill.							
		SAND SP: fine to medium grained, pale grey, trace silt, moist, medium dense. Bassendean Sand.		D	1.0				
22	2.5	Pit discontinued at 2.5m (Target depth)							





RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ 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
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TEST PIT LOG

CLIENT: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 24.5 m AHD*
EASTING: 405776
NORTHING: 6457181

PIT No: 104
PROJECT No: 96730.04
DATE: 1/11/2022
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)
24	0.15	FILL/SAND SP: fine to medium grained, grey-brown and brown, trace silt, moist, fill. Plastic wrap observed in fill.							
		SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.3 m depth.							
23	1								1
	2.0	Cemented Silty SAND SM: fine to medium grained, dark brown, moist, moderately to well cemented. Coffee rock.							
22	2								2
	2.2	Pit discontinued at 2.2m (Slow digging)							

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





RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ 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: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 24.4 m AHD*
EASTING: 405726
NORTHING: 6457045

PIT No: 105
PROJECT No: 96730.04
DATE: 1/11/2022
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)
24	0.1	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, moist, topsoil.		D	0.05				
		SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.3 m depth.							
23	1								1
	2								2
22	2.1	Cemented Silty SAND SM: fine to medium grained, dark brown and brown, moist, moderately to well cemented. Coffee rock.							
	2.5	Pit discontinued at 2.5m (Target depth)							





RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ 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: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 23.8 m AHD*
EASTING: 405681
NORTHING: 6457119

PIT No: 106
PROJECT No: 96730.04
DATE: 1/11/2022
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)
23	0.1	FILL/Gravelly SAND SP-SM: fine to medium grained, brown and grey-brown, fine to medium sized, with silt, moist, fill.							
		SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.3 m depth.							
	1			D	1.0				1
22									
	2								2
	2.5	Pit discontinued at 2.5m (Target depth)							
21									





RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ 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: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 25.7 m AHD*
EASTING: 405766
NORTHING: 6456928

PIT No: 107
PROJECT No: 96730.04
DATE: 1/11/2022
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)
25	0.1	TOPSOIL/SAND SP: fine to medium grained, dark grey-brown, trace silt, moist, topsoil.							
	1	SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.4 m depth.							1
24	1.6	Cemented Silty SAND SM: fine to medium grained, brown, moist, weakly to moderately cemented. Coffee rock.							
	1.85	SAND SP-SM: fine to medium grained, pale yellow, with silt, moist, weakly cemented. Bassendean Sand.		D	2.3				2
23	2.5	Pit discontinued at 2.5m (Target depth)							





RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ 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: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 29.5 m AHD*
EASTING: 405863
NORTHING: 6456798

PIT No: 108
PROJECT No: 96730.04
DATE: 1/11/2022
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)
	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, moist, topsoil.							
29		SAND SP: fine to medium grained, pale grey, trace silt, moist, medium dense. Bassendean Sand.							
	0.75	SAND SP-SM: fine to medium grained, yellow-brown, with silt, moist, loose to medium dense, weakly cemented. Yoganup Formation.		D	1.0				
28	1			D	1.5				
	2								
27	2.5	Pit discontinued at 2.5m (Target depth)							

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





RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ 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: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 29.6 m AHD*
EASTING: 405985
NORTHING: 6456730

PIT No: 109
PROJECT No: 96730.04
DATE: 1/11/2022
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)
	0.15	TOPSOIL/SAND SP: fine to medium grained, dark grey-brown, trace silt, moist, topsoil.							
29		SAND SP: fine to medium grained, pale grey, trace silt, moist, loose to medium dense. Bassendean Sand.							
	1	- becoming pale yellow-brown from 0.9 m depth.							
	1.2	SAND SP-SM: fine to medium grained, yellow-brown, with silt, moist, loose to medium dense, weakly cemented. Yoganup Formation.							
28		- trace pockets of Silty SAND SM from 1.7 m depth.							
	1.9	Silty Sandy GRAVEL GM: fine to coarse sized, yellow-brown and orange-brown, fine to medium grained, moist, loose to medium dense. Guildford Formation.		D	2.3				
	2								
	2.5	Pit discontinued at 2.5m (Target depth)							
27									





RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ 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: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 27.9 m AHD*
EASTING: 405924
NORTHING: 6456686

PIT No: 110
PROJECT No: 96730.04
DATE: 1/11/2022
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)
27	0.15	TOPSOIL/SAND SP-MS: fine to medium grained, dark grey-brown, with silt, moist, topsoil.							
		SAND SP: fine to medium grained, pale grey, trace silt, moist. Bassendean Sand.							
	0.6	Sandy GRAVEL GP: fine to coarse sized, brown and grey-brown, fine to medium grained, moist, medium dense to dense. Guildford Formation.		D	1.0				
26	1.8	Clayey Sandy GRAVEL GC: fine to coarse sized, yellow-brown mottled grey, medium plasticity, fine to medium grained, moist. Guildford Formation.		B	2.0				
25	2.5	Pit discontinued at 2.5m (Target depth)			2.5				

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





RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ 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: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 33.8 m AHD*
EASTING: 406337
NORTHING: 6457084

PIT No: 111
PROJECT No: 96730.04
DATE: 1/11/2022
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)
33	0.1	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, moist, topsoil.							
		SAND SP: fine to medium grained, grey-brown, trace silt, moist, medium dense. Yoganup Formation.							
	0.5	- becoming pale yellow-brown from 0.2 m depth.							
		SAND SP-SM: fine to medium grained, yellow-brown, with silt, moist, loose to medium dense. Yoganup Formation.							
	1								1
	1.1	Silty SAND SM: fine to medium grained, orange-brown, moist, loose to medium dense. Yoganup Formation.		D	1.3				
32	2								2
		- trace gravel from 2.2 m depth.							
	2.5	Pit discontinued at 2.5m (Target depth)		D	2.5				
31									

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





RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ 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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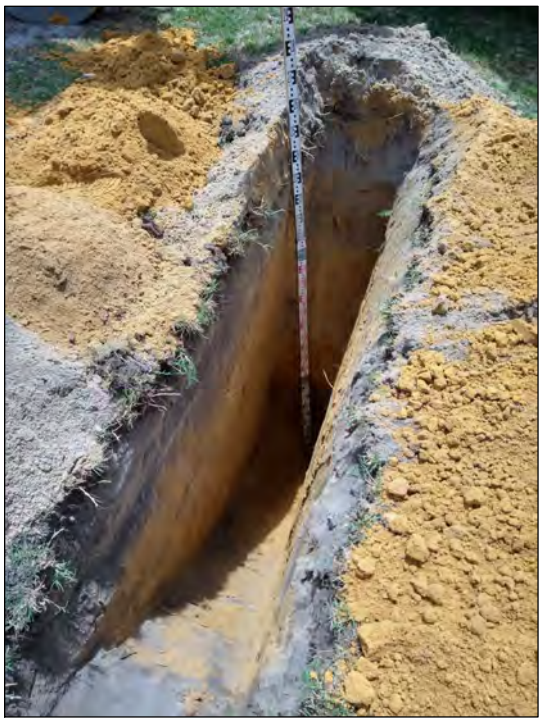
TEST PIT LOG

CLIENT: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 30.4 m AHD*
EASTING: 406158
NORTHING: 6457231

PIT No: 112
PROJECT No: 96730.04
DATE: 1/11/2022
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)
30	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, moist, topsoil.							
		SAND SP: fine to medium grained, grey-brown, trace silt, moist, medium dense. Yoganup Formation.							
	0.5	SAND SP-SM: fine to medium grained, yellow-brown, with silt, moist, medium dense, weakly cemented. Yoganup Formation.							
29	1.4	Silty SAND SM: fine to medium grained, orange-brown, moist, medium dense. Yoganup Formation.		D	1.5				
28	2.5	Pit discontinued at 2.5m (Target depth)							





RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ 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
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Appendix C

Laboratory Test Results

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

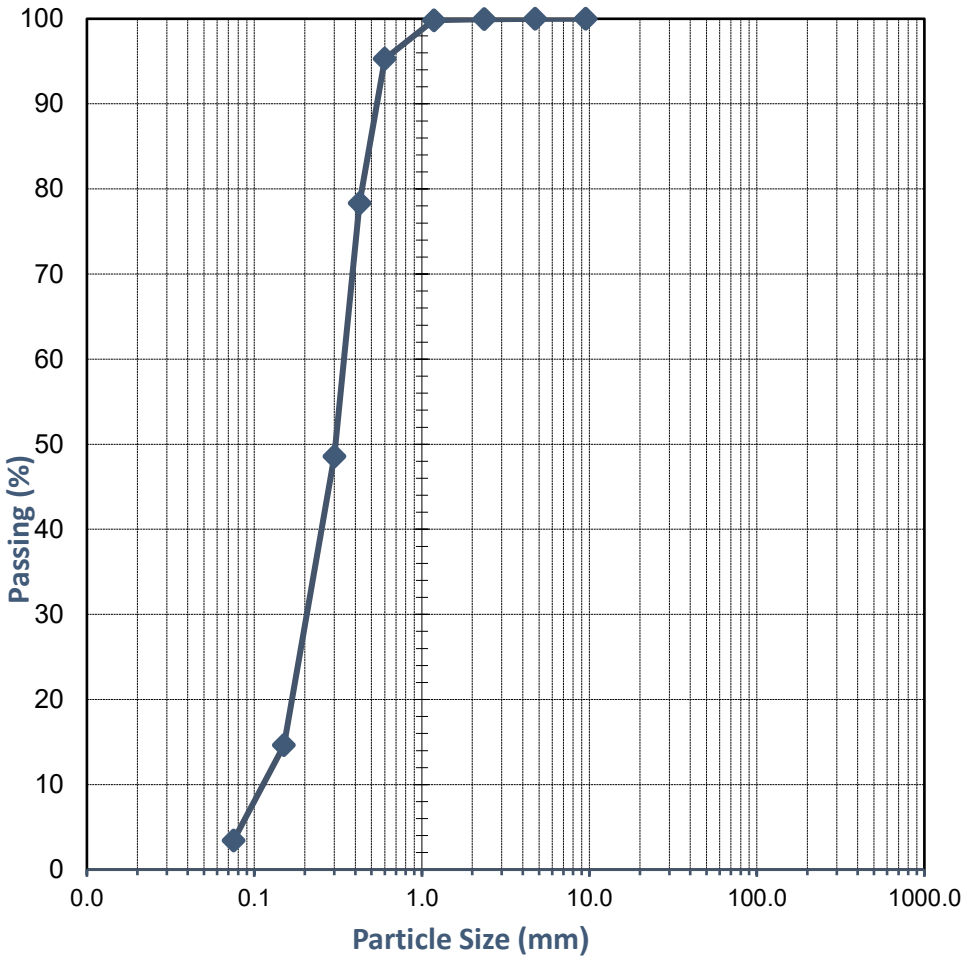
TEST REPORT - AS 1289.3.6.1

Client:	The Trustee for the Wattle Grove Trust	*Ticket No.*	S8061
Client Address:	-	*Report No.*	WG22.17764_1_PSD
Project:	Proposed Wattle Grove Development	*Sample No.*	WG22.17764
Location:	Victoria Road, Wattle Grove, WA	*Date Sampled:*	1/11/2022
Sample Identification:	TP 106, 1.0m	*Date Tested:*	23/11/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	100
1.18	100
0.600	95
0.425	78
0.300	49
0.150	15
0.075	3



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 23/November/2022

Accreditation No. 20599
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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

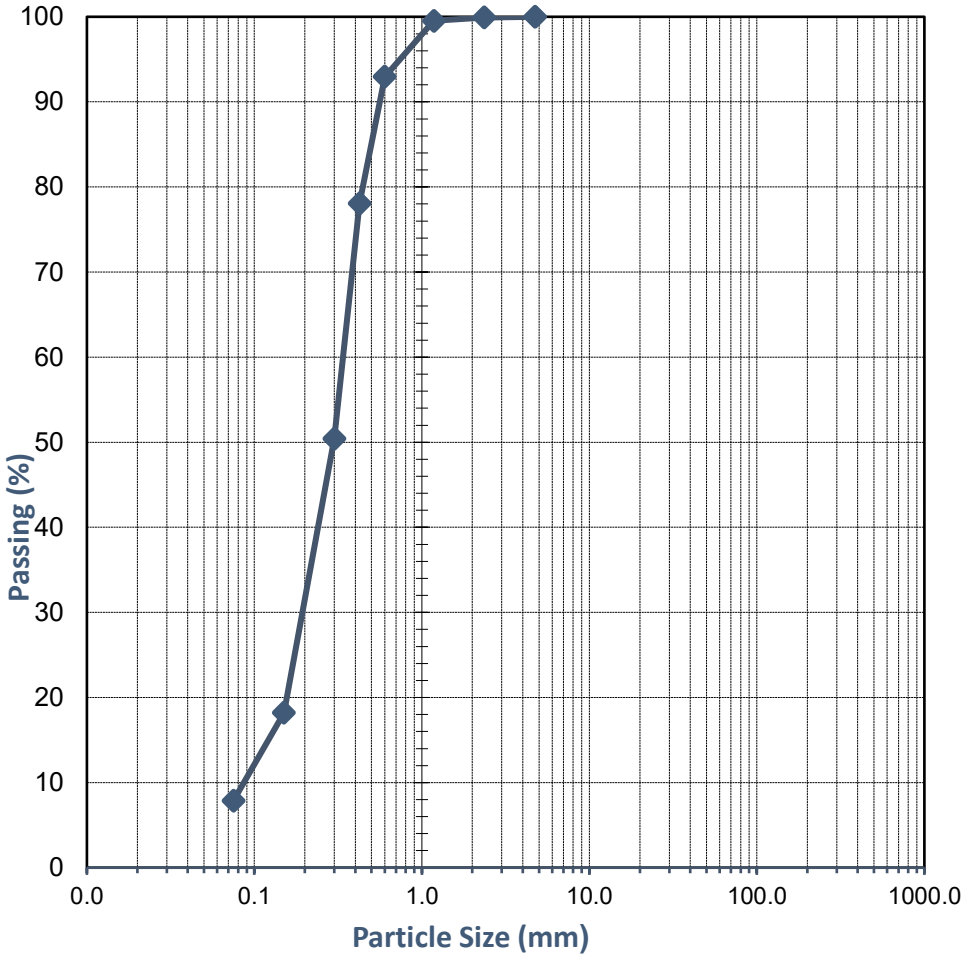
TEST REPORT - AS 1289.3.6.1

Client:	The Trustee for the Wattle Grove Trust	*Ticket No.*	S7965
Client Address:	-	*Report No.*	WG22.17228_1_PSD
Project:	Proposed Wattle Grove Development	*Sample No.*	WG22.17228
Location:	Victoria Road, Wattle Grove, WA	*Date Sampled:*	1/11/2022
Sample Identification:	TP107 2.3m	*Date Tested:*	10/11 - 11/11/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	93
0.425	78
0.300	50
0.150	18
0.075	8



Comments:

Approved Signatory:

Name: Natasha Bielawski

Date: 11/November/2022

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SOIL | AGGREGATE | CONCRETE | CRUSHING

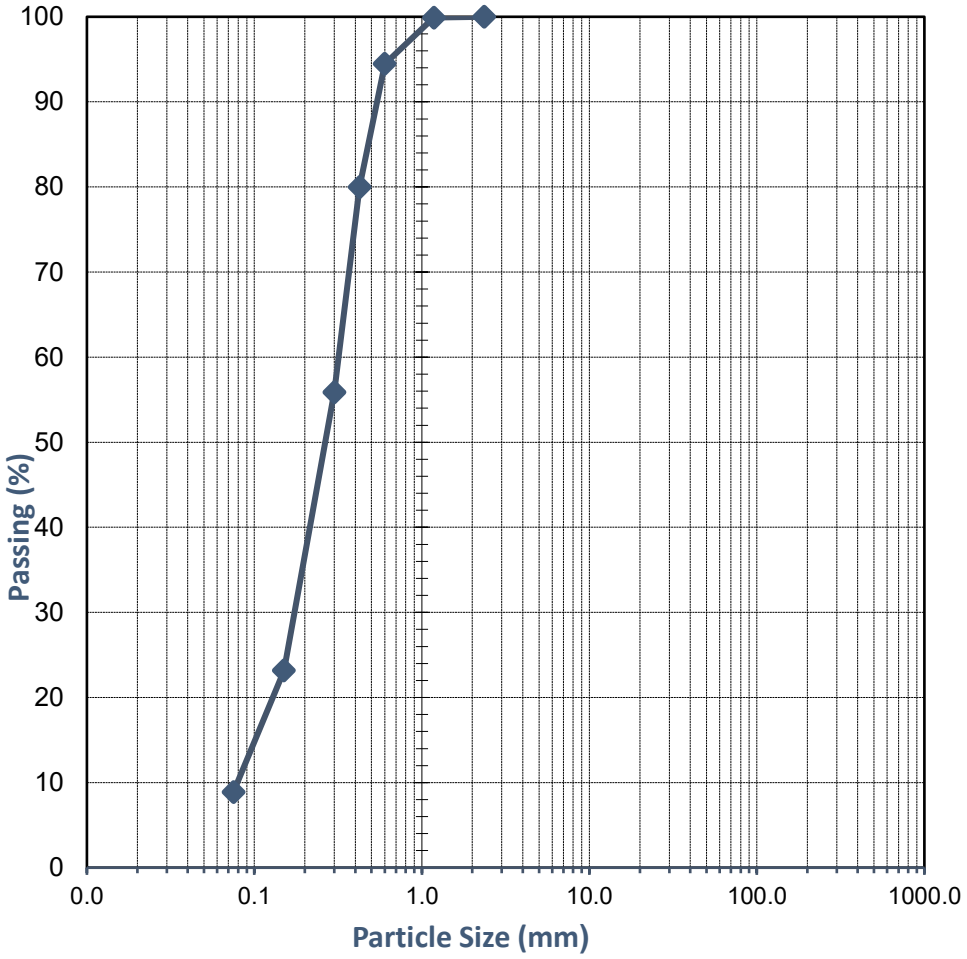
TEST REPORT - AS 1289.3.6.1

Client:	The Trustee for the Wattle Grove Trust	*Ticket No.*	S7965
Client Address:	-	*Report No.*	WG22.17229_1_PSD
Project:	Proposed Wattle Grove Development	*Sample No.*	WG22.17229
Location:	Victoria Road, Wattle Grove, WA	*Date Sampled:*	1/11/2022
Sample Identification:	TP108 1.5m	*Date Tested:*	10/11 - 11/11/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	100
0.600	94
0.425	80
0.300	56
0.150	23
0.075	9



Comments:

Approved Signatory:

Name: Natasha Bielawski

Date: 11/November/2022

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SOIL | AGGREGATE | CONCRETE | CRUSHING

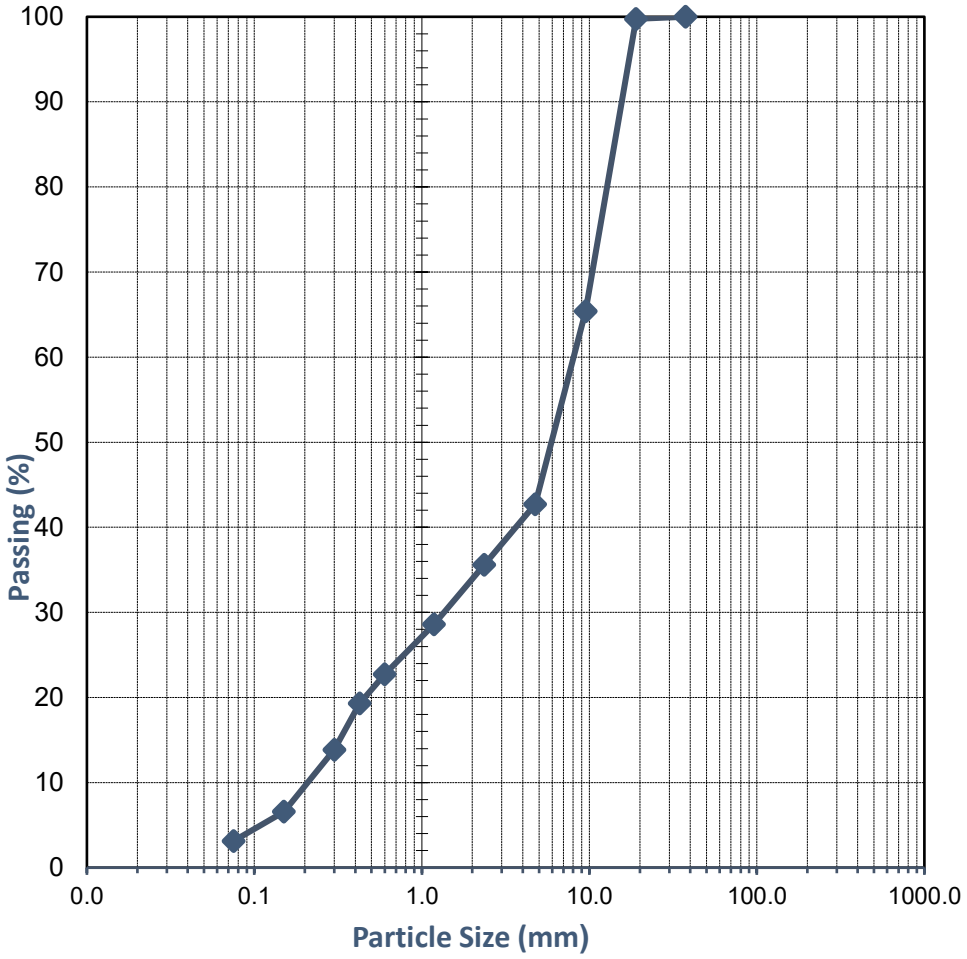
TEST REPORT - AS 1289.3.6.1

Client:	The Trustee for the Wattle Grove Trust	*Ticket No.*	S7965
Client Address:	-	*Report No.*	WG22.17230_1_PSD
Project:	Proposed Wattle Grove Development	*Sample No.*	WG22.17230
Location:	Victoria Road, Wattle Grove, WA	*Date Sampled:*	1/11/2022
Sample Identification:	TP110 1.0m	*Date Tested:*	10/11 - 11/11/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	100
19.0	100
9.5	65
4.75	43
2.36	36
1.18	29
0.600	23
0.425	19
0.300	14
0.150	7
0.075	3



Comments:

Approved Signatory:

Name: Natasha Bielawski

Date: 11/November/2022

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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	The Trustee for the Wattle Grove Trust	*Ticket No.*	S7965
Client Address:	-	*Report No.*	WG22.17231_1_PI
Project:	Proposed Wattle Grove Development	*Sample No.*	WG22.17231
Location:	Victoria Road, Wattle Grove, WA	*Date Sampled:*	1/11/2022
Sample Identification:	TP110 2.0-2.5m	*Date Tested:*	11/11/2022

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50^{o}C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**37**
AS 1289.3.2.1	**Plastic Limit (%)**	**16**
AS 1289.3.3.1	**Plasticity Index (%)**	**21**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**8.5**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**Cracked**

Comments:

Approved Signatory:

Name: Madhav Basnet

Date: 14/November/2022

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SOIL | AGGREGATE | CONCRETE | CRUSHING

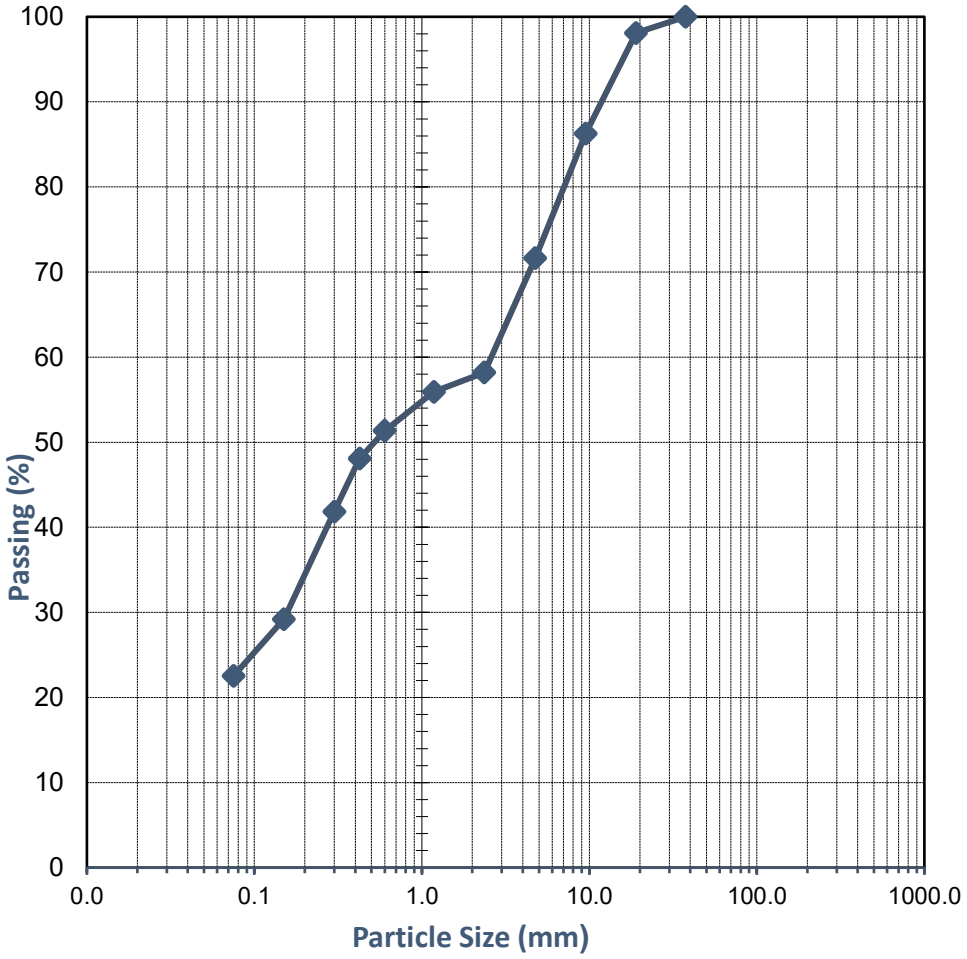
TEST REPORT - AS 1289.3.6.1

Client:	The Trustee for the Wattle Grove Trust	*Ticket No.*	S7965
Client Address:	-	*Report No.*	WG22.17231_1_PSD
Project:	Proposed Wattle Grove Development	*Sample No.*	WG22.17231
Location:	Victoria Road, Wattle Grove, WA	*Date Sampled:*	1/11/2022
Sample Identification:	TP110 2.0-2.5m	*Date Tested:*	10/11 - 11/11/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	100
19.0	98
9.5	86
4.75	72
2.36	58
1.18	56
0.600	51
0.425	48
0.300	42
0.150	29
0.075	23



Comments:

Approved Signatory:

Name: Natasha Bielawski

Date: 11/November/2022

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SOIL | AGGREGATE | CONCRETE | CRUSHING

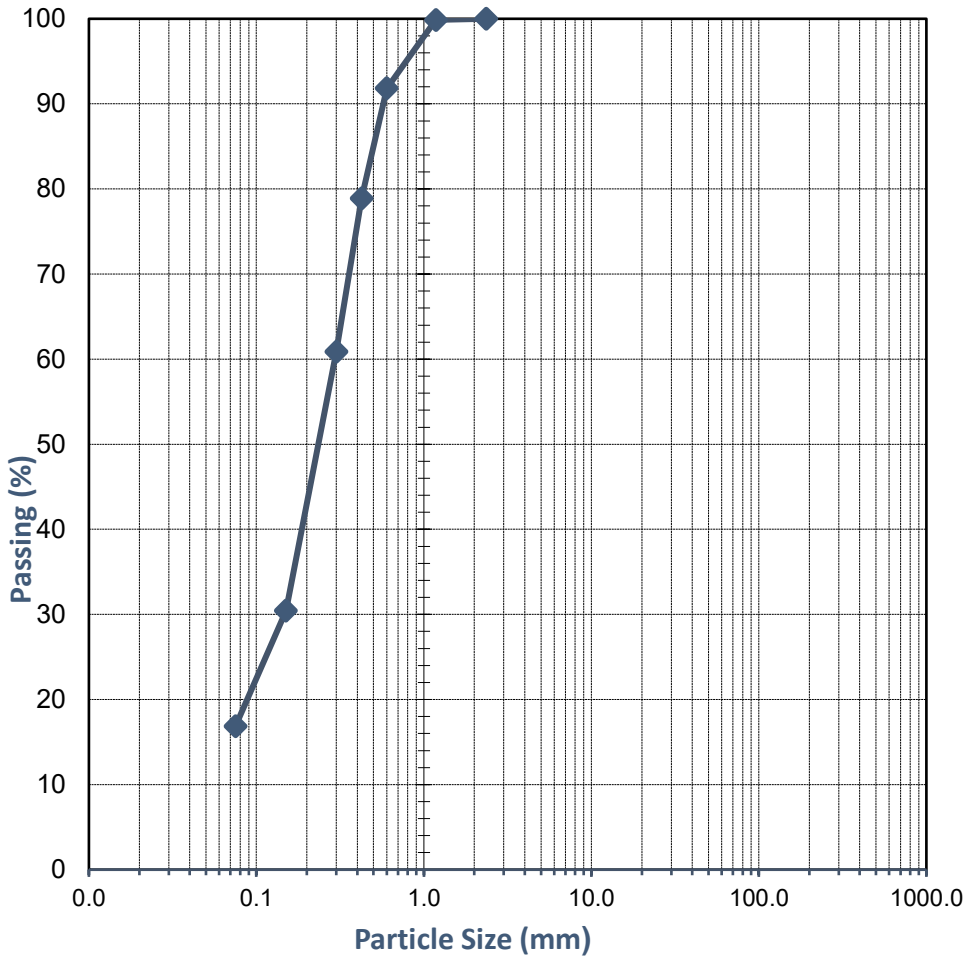
TEST REPORT - AS 1289.3.6.1

Client:	The Trustee for the Wattle Grove Trust	*Ticket No.*	S7965
Client Address:	-	*Report No.*	WG22.17232_1_PSD
Project:	Proposed Wattle Grove Development	*Sample No.*	WG22.17232
Location:	Victoria Road, Wattle Grove, WA	*Date Sampled:*	1/11/2022
Sample Identification:	TP111 1.3m	*Date Tested:*	10/11 - 11/11/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	100
0.600	92
0.425	79
0.300	61
0.150	30
0.075	17



Comments:

Approved Signatory:

Name: Natasha Bielawski

Date: 11/November/2022

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SOIL | AGGREGATE | CONCRETE | CRUSHING

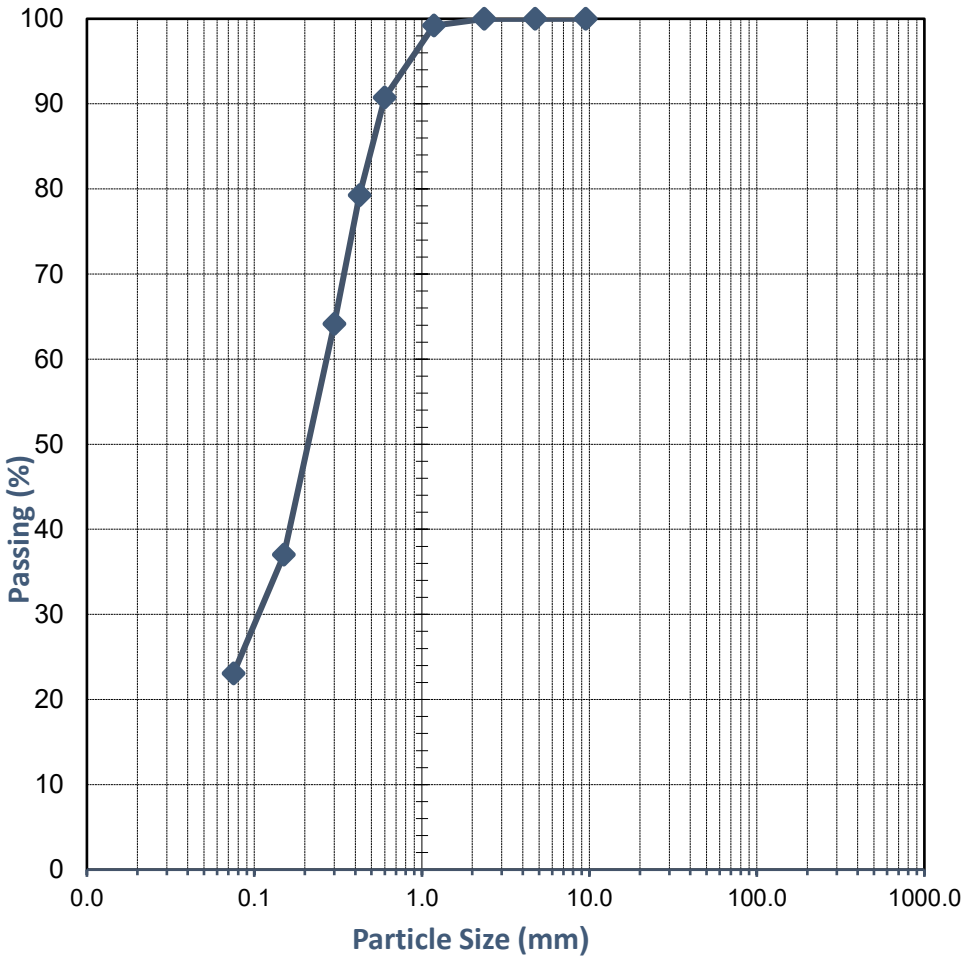
TEST REPORT - AS 1289.3.6.1

Client:	The Trustee for the Wattle Grove Trust	*Ticket No.*	S7965
Client Address:	-	*Report No.*	WG22.17233_1_PSD
Project:	Proposed Wattle Grove Development	*Sample No.*	WG22.17233
Location:	Victoria Road, Wattle Grove, WA	*Date Sampled:*	1/11/2022
Sample Identification:	TP111 2.5m	*Date Tested:*	10/11 - 11/11/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	100
1.18	99
0.600	91
0.425	79
0.300	64
0.150	37
0.075	23



Comments:

Approved Signatory:

Name: Natasha Bielawski

Date: 11/November/2022

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	The Trustee for the Wattle Grove Trust	*Ticket No.*	S7965
Client Address:	-	*Report No.*	WG22.17234_1_PI
Project:	Proposed Wattle Grove Development	*Sample No.*	WG22.17234
Location:	Victoria Road, Wattle Grove, WA	*Date Sampled:*	1/11/2022
Sample Identification:	TP112 1.5m	*Date Tested:*	11/11/2022

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50^{o}C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**Not Obtainable**
AS 1289.3.2.1	**Plastic Limit (%)**	**Non-Plastic**
AS 1289.3.3.1	**Plasticity Index (%)**	**Non-Plastic**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**0.0**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**-**

Comments:

Approved Signatory:



Name: Madhav Basnet

Date: 14/November/2022

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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

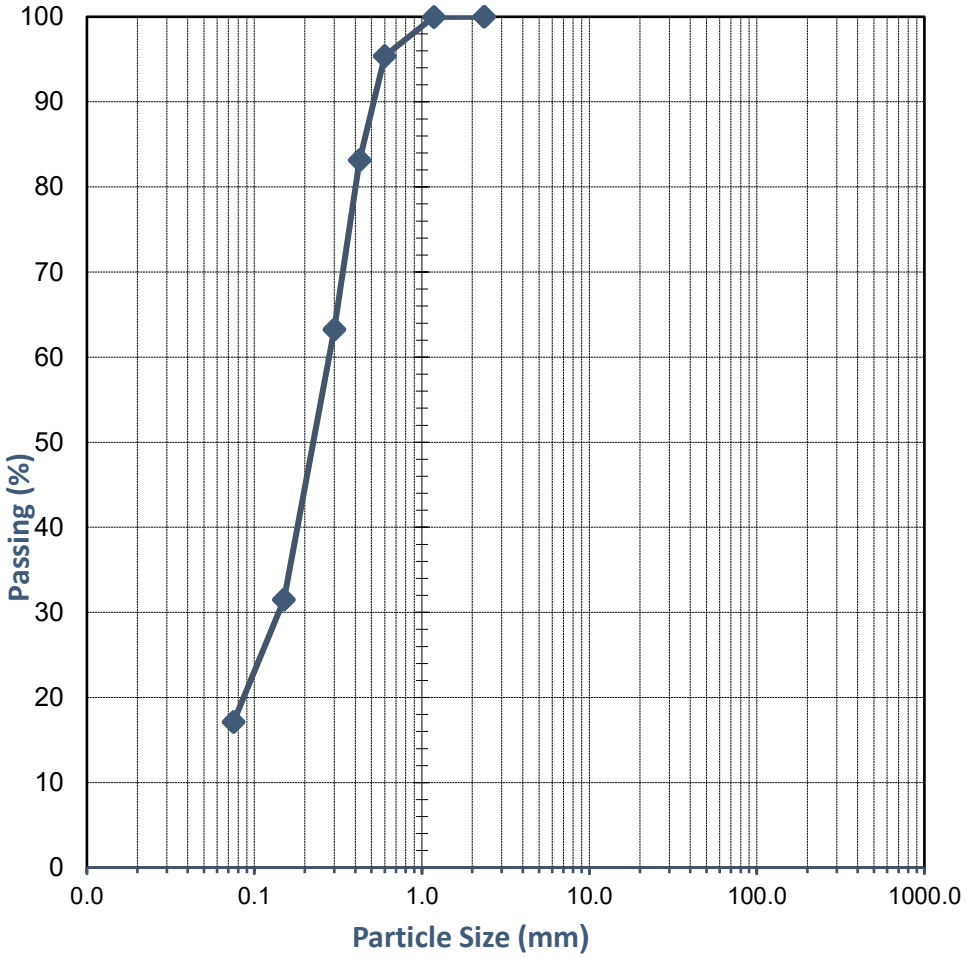
TEST REPORT - AS 1289.3.6.1

Client:	The Trustee for the Wattle Grove Trust	*Ticket No.*	S7965
Client Address:	-	*Report No.*	WG22.17234_1_PSD
Project:	Proposed Wattle Grove Development	*Sample No.*	WG22.17234
Location:	Victoria Road, Wattle Grove, WA	*Date Sampled:*	1/11/2022
Sample Identification:	TP112 1.5m	*Date Tested:*	10/11 - 11/11/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	100
0.600	95
0.425	83
0.300	63
0.150	32
0.075	17



Comments:

Approved Signatory:

Name: Natasha Bielawski

Date: 11/November/2022

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APPENDIX C

Geophysical Subsurface Investigation (GBG Group, 2024)

Report

Geophysical Subsurface Investigation for MRS Amendment 1388/57.

Wattle Grove Western Australia.

Date: 15 February 2024
Report Ref: 3098 Rev 7

DOCUMENT HISTORY

DETAILS

STATUS AND REVIEW

DISTRIBUTION

COMPANY DETAILS

CONTENTS

1. Introduction
2. Overview
3. Data Requirements
   3.1 Mandatory Data
   3.2 Optional Data
4. Data Formats
   4.1 Date Format
   4.2 Numeric Format
   4.3 Text Format
5. Example Files

This document describes the data requirements for the GBG Group API. Please read all sections carefully before submitting your data.

1 INTRODUCTION

2 INVESTIGATION SITE

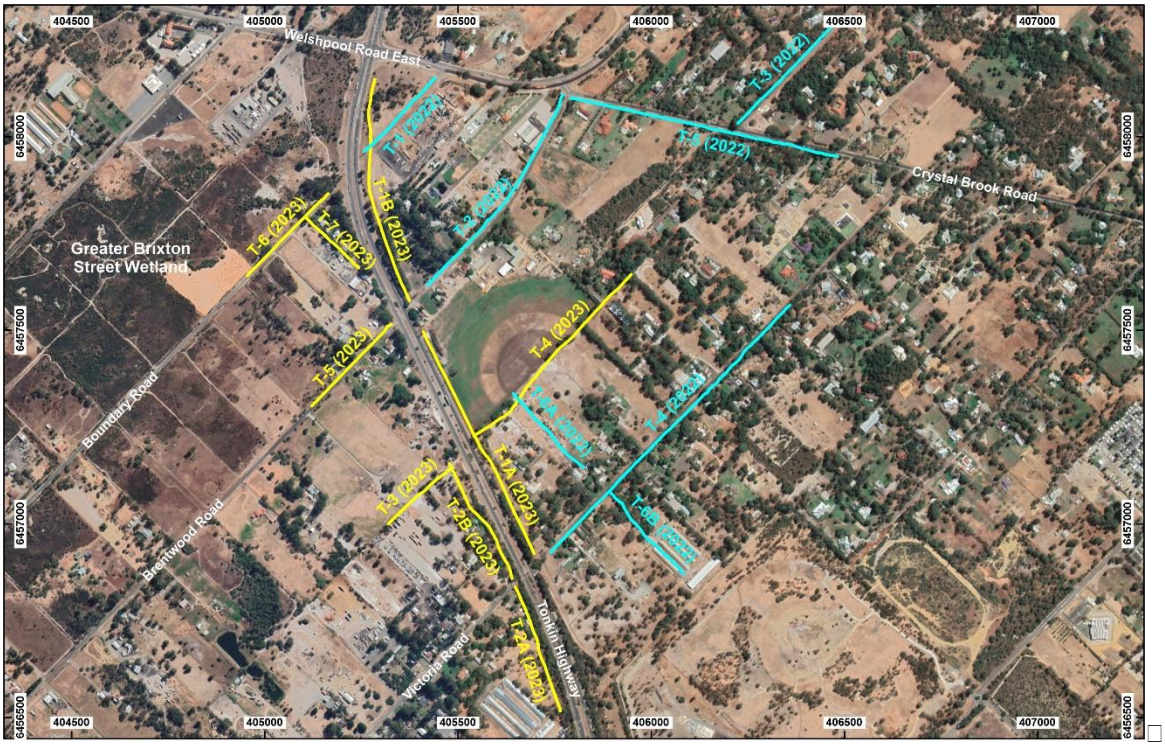


Figure 1: Acquired geophysical transects including from the phase 1 study in December 2022 (blue lines) and phase 2 study in October 2023 (yellow lines). Aerial image from Google Earth Pro.



Figure 2: Typical site conditions within the geophysical investigation area.

3 GEOPHYSICAL DATA ACQUISITION & PROCESSING

Table 1: Phase 1 (December 2022) Geophysical Transect Coordinates

Transect	Location	Length (m)	Start Coordinate		End Coordinate	
			East	North	East	North

Table 2: Phase 2 (October 2023) Geophysical Transect Coordinates

Transect	Location	Length (m)	Start Coordinate		End Coordinate	
			East	North	East	North

3.1 ELECTRICAL RESISTIVITY TOMOGRAPHY

On completion of the sequence the electrode array was “rolled along” with a half array overlap where

Table 3: ERT Acquisition Parameters (values in brackets for the Terrascan)

Acquisition Parameter	Value
Electrode “roll along”	
	D -D
M M	

3.2 SPATIAL POSITIONING

4 RESULTS AND INTERPRETATION

4.1 PRESENTATION OF RESULTS

Appendix A – Site Maps

- **3098-01**

Appendix B – Phase 1 (December 2022) ERT Sections *

- **3046-02**
- **3046-03**
- **3046-04**
- **3046-05**
- **3046-06**
- **3046-07**

Appendix C – Phase 2 (October 2023) ERT Sections *

- **3098-02**
- **3098-03**
- **3098-04**
- **3098-05**
- **3098-06**

4.2 ELECTRICAL RESISTIVITY SECTIONS

the subsurface material in Ohm metres (Ω.m) and

- D

The modelled resistivity values for this investigation ranged from less than 10 to greater than 10000Ωm

5 PROJECT SUMMARY

-
-
-

For and on behalf of
GBG GEOTECHNICS (AUSTRALIA)



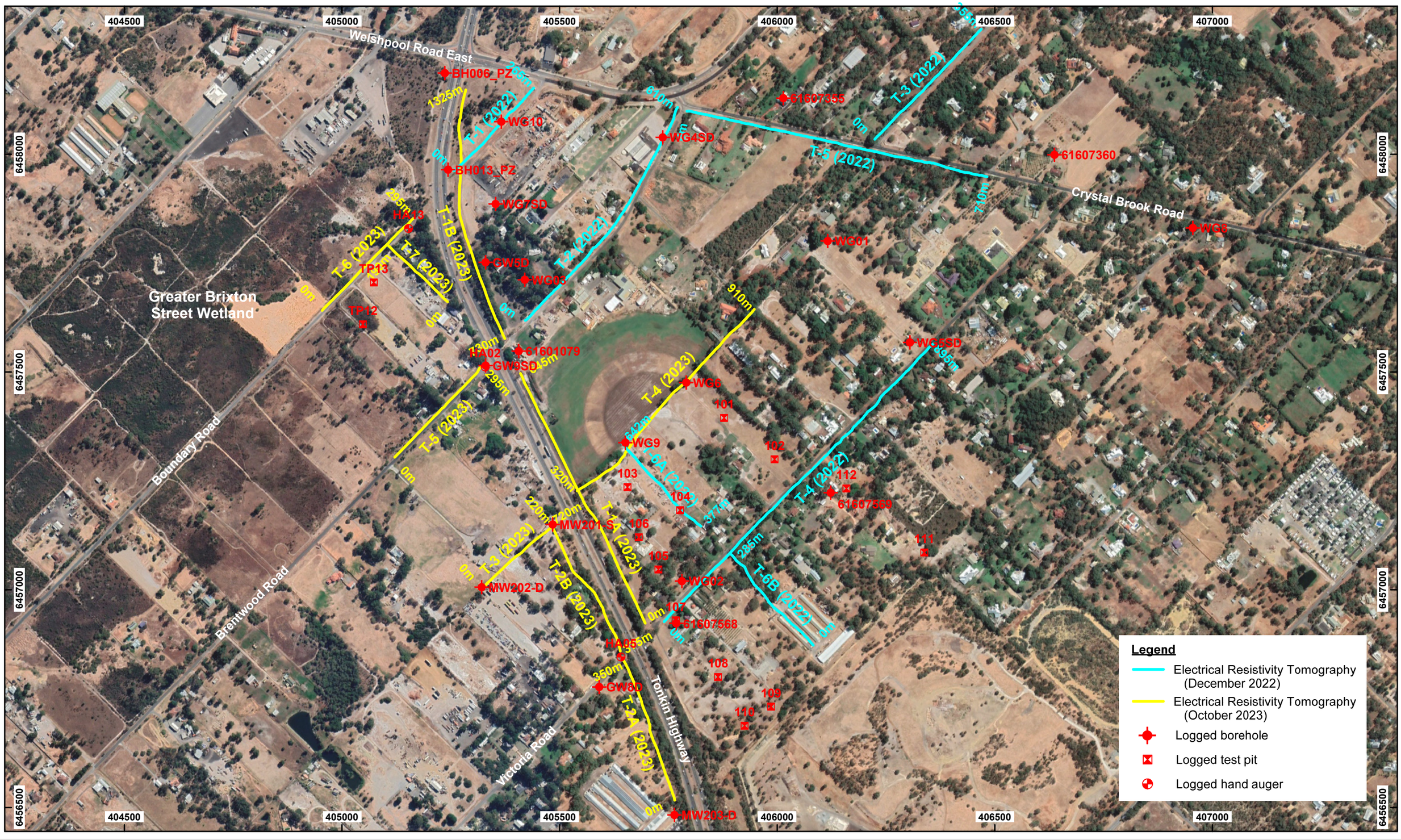
ANDREW SPYROU

APPENDIX A – INVESTIGATION SITE MAP

GBGGROUP

GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA - WATTLE GROVE WA

INVESTIGATION SITE MAP



Legend

- Electrical Resistivity Tomography (December 2022)
- Electrical Resistivity Tomography (October 2023)
- Logged borehole
- Logged test pit
- Logged hand auger

NOTES

Drawing to be used in conjunction with Report 3098.
Map Projection GDA2020 MGA Zone 50.
Aerial image from Google Earth Pro April 2022.

0 100 200 300 400
Distance (metres)

N

Date	24 November 2023	Paper Size	A3
Scale	1:8000	Drawn	AHWS
Drawing	3098-01	Revision	6

HESPERIA ON BEHALF OF WAPC

GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA, WATTLE GROVE WESTERN AUSTRALIA.

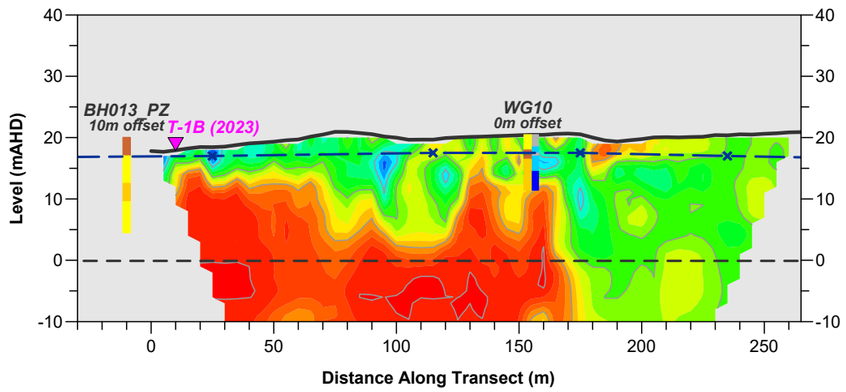
GBGGROUP
G B Geotechnics (Australia) Pty Ltd
ABN: 77 009 550 869
Phone: 08 9354 6300
Email: info@gbgoz.com.au
Web: gbg-group.com.au

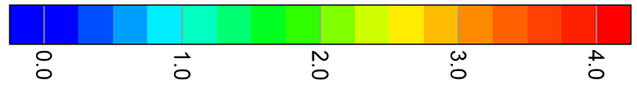
APPENDIX B – PHASE 1 (DECEMBER 2022) INTERPRETED GEOPHYSICAL SECTIONS

GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA - WATTLE GROVE WA

ELECTRICAL RESISTIVITY TOMOGRAPHY SECTIONS (PHASE 1, DECEMBER 2022)

T-1 (2022) - ELECTRICAL RESISTIVITY SECTION





Legend

- ERT Intersection Point
- 0mAHD
- Groundwater AAMGL (Hyd2O, 2023)

Logged Borehole*

Soil Texture

- SAND
- Clayey SAND
- Sandy CLAY
- CLAY

Soil Moisture

- Dry
- Slightly Moist
- Moist
- Wet
- Saturated

Interpreted Material Condition**

Modelled Resistivity		Sediment Grain Size	Ground Water Content	Rock Weathering
INCREASING ↑	High	Gravel	Dry	Fresh
	Medium	Sand	Moist	Moderately
	Low	Clay/Silt	Wet	Highly

Notes

* Refer to lithological logs for details.

** Interpreted material condition is based on generalised relationships of modelled resistivity with the subsurface and may vary due to local geological or hydrological conditions.

NOTES
Drawing to be used in conjunction with Report 3098.
Map Projection GDA2020 MGA Zone 50.
Elevation in metres AHD.

Date	8 December 2023	Paper Size	A3
Scale	H 1:2500, V 1:1000	Drawn	AHWS
Drawing	3046-02	Revision	7

HESPERIA ON BEHALF OF WAPC

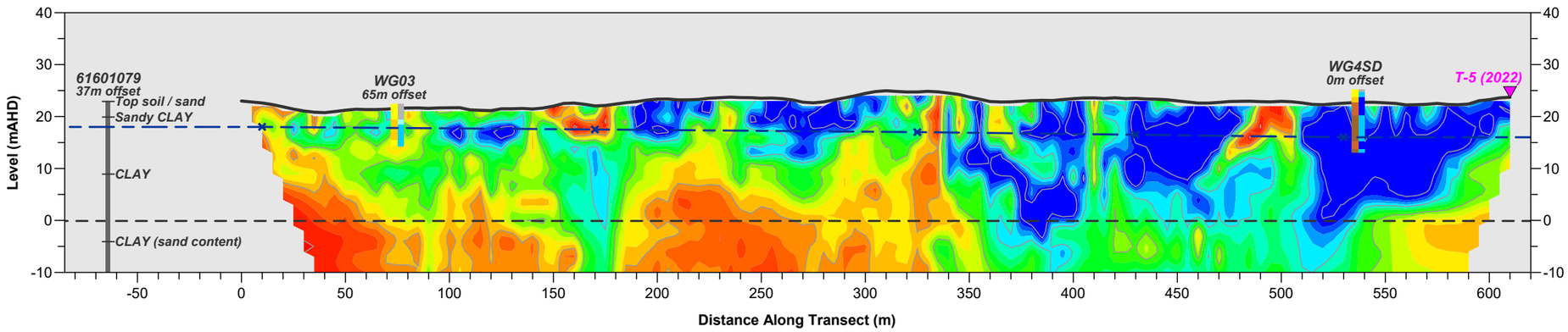
GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA, WATTLE GROVE WESTERN AUSTRALIA.

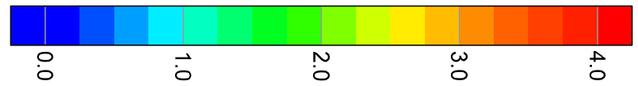
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GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA - WATTLE GROVE WA

ELECTRICAL RESISTIVITY TOMOGRAPHY SECTIONS (PHASE 1, DECEMBER 2022)

T-2 (2022) - ELECTRICAL RESISTIVITY SECTION





Legend

- ERT Intersection Point
- 0mAHD
- Groundwater AAMGL (Hyd2O, 2023)

Logged Borehole*

Soil Texture

- SAND
- Clayey SAND
- Sandy CLAY
- CLAY

Soil Moisture

- Dry
- Slightly Moist
- Moist
- Wet
- Saturated

Interpreted Material Condition**

Modelled Resistivity		Sediment Grain Size	Ground Water Content	Rock Weathering
INCREASING ↑	High	Gravel	Dry	Fresh
	Medium	Sand	Moist	Moderately
	Low	Clay/Silt	Wet	Highly

Notes

* Refer to lithological logs for details.

** Interpreted material condition is based on generalised relationships of modelled resistivity with the subsurface and may vary due to local geological or hydrological conditions.

NOTES
Drawing to be used in conjunction with Report 3098.
Map Projection GDA2020 MGA Zone 50.
Elevation in metres AHD.

Date	8 December 2023	Paper Size	A3
Scale	H 1:2500, V 1:1000	Drawn	AHWS
Drawing	3046-03	Revision	7

HESPERIA ON BEHALF OF WAPC

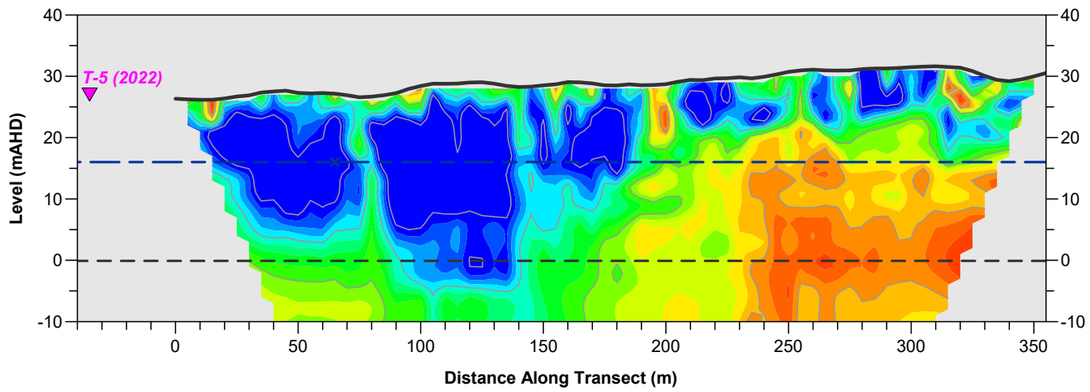
GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA, WATTLE GROVE WESTERN AUSTRALIA.

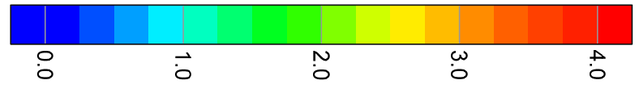
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GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA - WATTLE GROVE WA

ELECTRICAL RESISTIVITY TOMOGRAPHY SECTIONS (PHASE 1, DECEMBER 2022)

T-3 (2022) - ELECTRICAL RESISTIVITY SECTION





Legend

- ERT Intersection Point
- 0mAHD
- Groundwater AAMGL (Hyd2O, 2023)

Logged Borehole*

Soil Texture

- SAND
- Clayey SAND
- Sandy CLAY
- CLAY

Soil Moisture

- Dry
- Slightly Moist
- Moist
- Wet
- Saturated

Interpreted Material Condition**

Modelled Resistivity		Sediment Grain Size	Ground Water Content	Rock Weathering
INCREASING ↑	High	Gravel	Dry	Fresh
	Medium	Sand	Moist	Moderately
	Low	Clay/Silt	Wet	Highly

Notes

* Refer to lithological logs for details.

** Interpreted material condition is based on generalised relationships of modelled resistivity with the subsurface and may vary due to local geological or hydrological conditions.

NOTES
Drawing to be used in conjunction with Report 3098.
Map Projection GDA2020 MGA Zone 50.
Elevation in metres AHD.

Date	8 December 2023	Paper Size	A3
Scale	H 1:2500, V 1:1000	Drawn	AHWS
Drawing	3046-04	Revision	7

HESPERIA ON BEHALF OF WAPC

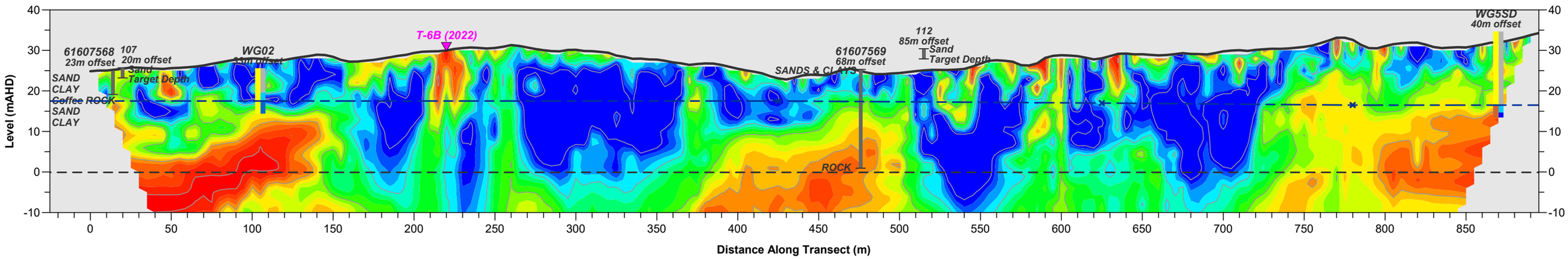
GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA, WATTLE GROVE WESTERN AUSTRALIA.

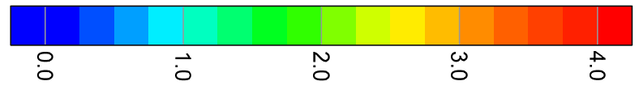
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GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA - WATTLE GROVE WA

ELECTRICAL RESISTIVITY TOMOGRAPHY SECTIONS (PHASE 1, DECEMBER 2022)

T-4 (2022) - ELECTRICAL RESISTIVITY SECTION





Legend

- ERT Intersection Point
- 0mAHD
- Groundwater AAMGL (Hyd2O, 2023)

Logged Borehole*

Soil Texture

- SAND
- Clayey SAND
- Sandy CLAY
- CLAY

Soil Moisture

- Dry
- Slightly Moist
- Moist
- Wet
- Saturated

Interpreted Material Condition**

Modelled Resistivity		Sediment Grain Size	Ground Water Content	Rock Weathering
INCREASING ↑	High	Gravel	Dry	Fresh
	Medium	Sand	Moist	Moderately
	Low	Clay/Silt	Wet	Highly

Notes

* Refer to lithological logs for details.

** Interpreted material condition is based on generalised relationships of modelled resistivity with the subsurface and may vary due to local geological or hydrological conditions.

NOTES
Drawing to be used in conjunction with Report 3098.
Map Projection GDA2020 MGA Zone 50.
Elevation in metres AHD.

Date	8 December 2023	Paper Size	A3
Scale	H 1:2500, V 1:1000	Drawn	AHWS
Drawing	3046-05	Revision	7

HESPERIA ON BEHALF OF WAPC

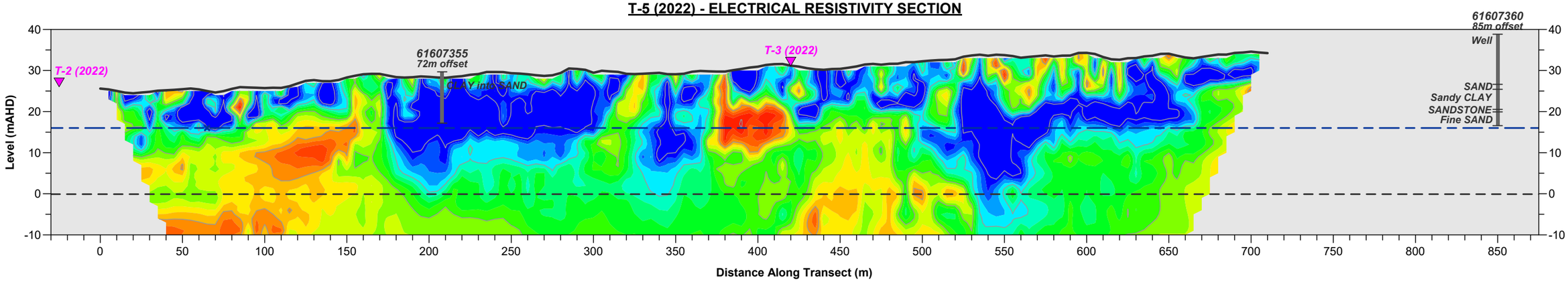
GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA, WATTLE GROVE WESTERN AUSTRALIA.

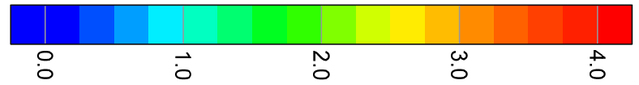
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GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA - WATTLE GROVE WA

ELECTRICAL RESISTIVITY TOMOGRAPHY SECTIONS (PHASE 1, DECEMBER 2022)

T-5 (2022) - ELECTRICAL RESISTIVITY SECTION





Legend

- ERT Intersection Point
- 0mAHD
- Groundwater AAMGL (Hyd2O, 2023)

Logged Borehole*

Soil Texture

- SAND
- Clayey SAND
- Sandy CLAY
- CLAY

Soil Moisture

- Dry
- Slightly Moist
- Moist
- Wet
- Saturated

Interpreted Material Condition**

Modelled Resistivity		Sediment Grain Size	Ground Water Content	Rock Weathering
INCREASING ↑	High	Gravel	Dry	Fresh
	Medium	Sand	Moist	Moderately
	Low	Clay/Silt	Wet	Highly

Notes

* Refer to lithological logs for details.

** Interpreted material condition is based on generalised relationships of modelled resistivity with the subsurface and may vary due to local geological or hydrological conditions.

NOTES
Drawing to be used in conjunction with Report 3098.
Map Projection GDA2020 MGA Zone 50.
Elevation in metres AHD.

Date	8 December 2023	Paper Size	A3
Scale	H 1:2500, V 1:1000	Drawn	AHWS
Drawing	3046-06	Revision	7

HESPERIA ON BEHALF OF WAPC

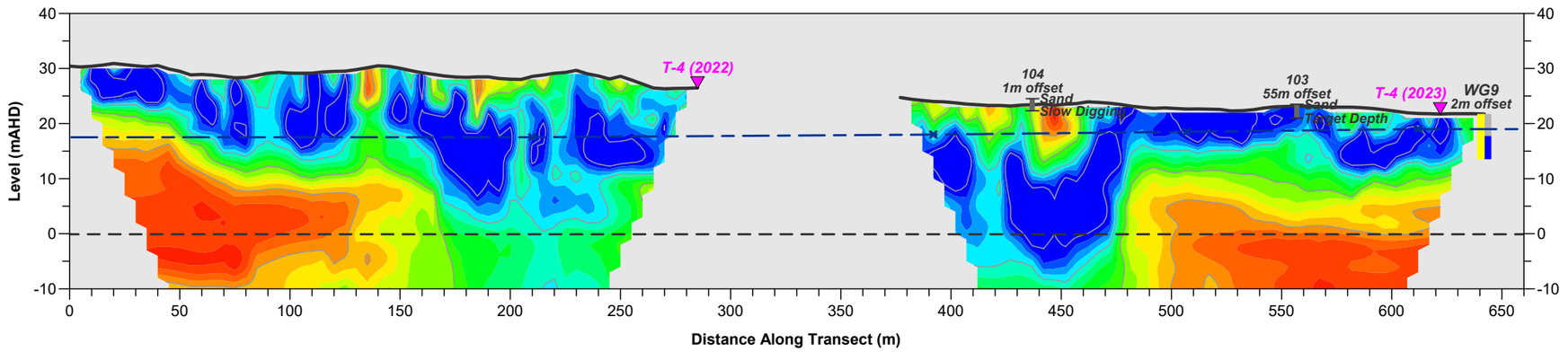
GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA, WATTLE GROVE WESTERN AUSTRALIA.

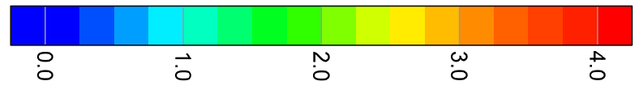
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GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA - WATTLE GROVE WA

ELECTRICAL RESISTIVITY TOMOGRAPHY SECTIONS (PHASE 1, DECEMBER 2022)

T-6 (2022) - ELECTRICAL RESISTIVITY SECTION





Legend

- ERT Intersection Point
- 0mAHD
- Groundwater AAMGL (Hyd2O, 2023)

Logged Borehole*

Soil Texture

- SAND
- Clayey SAND
- Sandy CLAY
- CLAY

Soil Moisture

- Dry
- Slightly Moist
- Moist
- Wet
- Saturated

Interpreted Material Condition**

Modelled Resistivity		Sediment Grain Size	Ground Water Content	Rock Weathering
INCREASING ↑	High	Gravel	Dry	Fresh
	Medium	Sand	Moist	Moderately
	Low	Clay/Silt	Wet	Highly

Notes

* Refer to lithological logs for details.

** Interpreted material condition is based on generalised relationships of modelled resistivity with the subsurface and may vary due to local geological or hydrological conditions.

NOTES
Drawing to be used in conjunction with Report 3098.
Map Projection GDA2020 MGA Zone 50.
Elevation in metres AHD.

Date	8 December 2023	Paper Size	A3
Scale	H 1:2500, V 1:1000	Drawn	AHWS
Drawing	3046-07	Revision	7

HESPERIA ON BEHALF OF WAPC

GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA, WATTLE GROVE WESTERN AUSTRALIA.

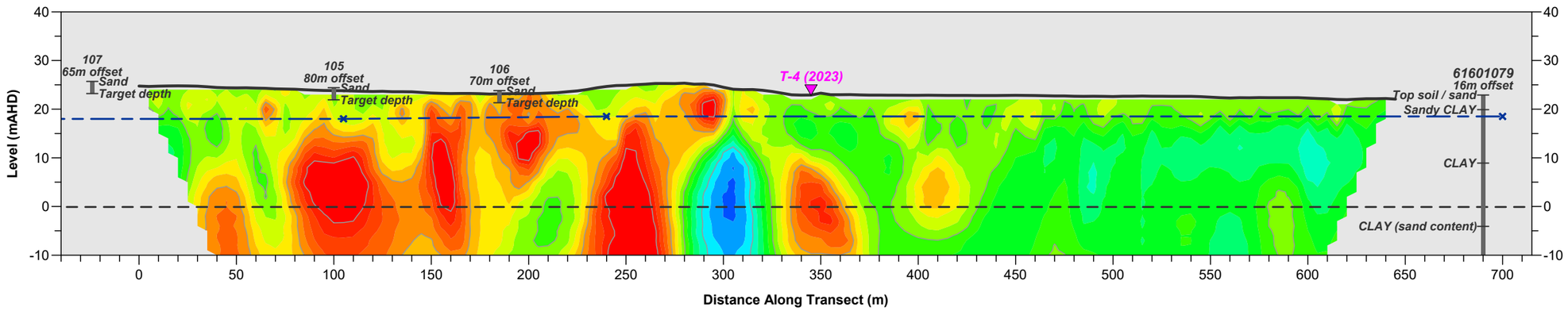
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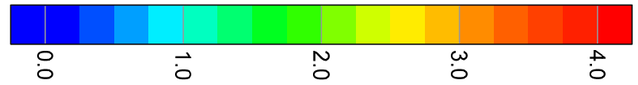
APPENDIX C – PHASE 2 (OCTOBER 2023) INTERPRETED GEOPHYSICAL SECTIONS

GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA - WATTLE GROVE WA

ELECTRICAL RESISTIVITY TOMOGRAPHY SECTIONS (PHASE 2, OCTOBER 2023)

T-1A (2023) - ELECTRICAL RESISTIVITY SECTION





Legend

- ERT Intersection Point
- 0mAHD
- Groundwater AAMGL (Hyd2O, 2023)

Logged Borehole*

Soil Texture

- SAND
- Clayey SAND
- Sandy CLAY
- CLAY

Soil Moisture

- Dry
- Slightly Moist
- Moist
- Wet
- Saturated

* Refer to lithological logs for details.

Interpreted Material Condition**

Modelled Resistivity		Sediment Grain Size	Ground Water Content	Rock Weathering
INCREASING ↑	High	Gravel	Dry	Fresh
	Medium	Sand	Moist	Moderately
	Low	Clay/Silt	Wet	Highly

Notes

* Refer to lithological logs for details.

** Interpreted material condition is based on generalised relationships of modelled resistivity with the subsurface and may vary due to local geological or hydrological conditions.

NOTES
Drawing to be used in conjunction with Report 3098.
Map Projection GDA2020 MGA Zone 50.
Elevation in metres AHD.

Date	8 December 2023	Paper Size	A3
Scale	H 1:2500, V 1:1000	Drawn	AHWS
Drawing	3098-02	Revision	7

HESPERIA ON BEHALF OF WAPC

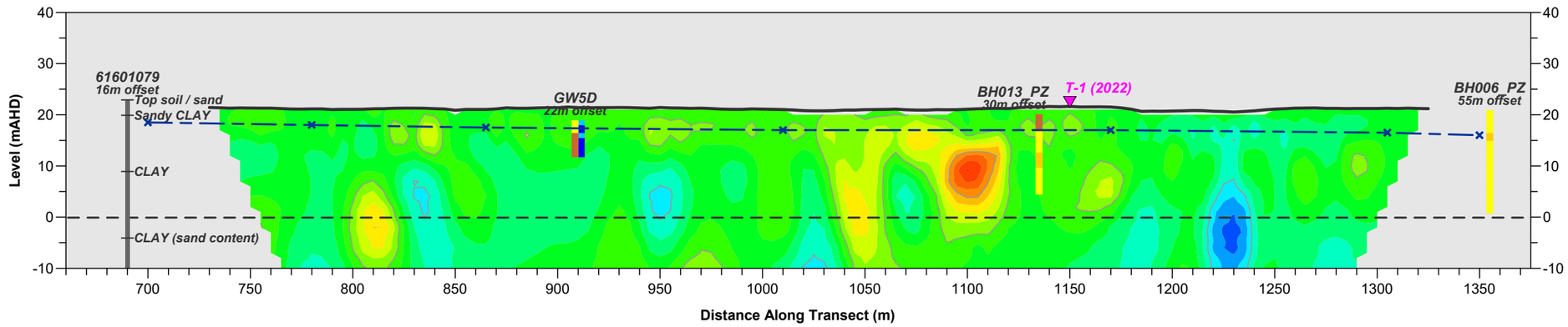
GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA, WATTLE GROVE WESTERN AUSTRALIA.

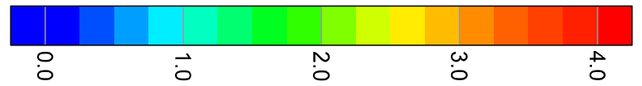
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GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA - WATTLE GROVE WA

ELECTRICAL RESISTIVITY TOMOGRAPHY SECTIONS (PHASE 2, OCTOBER 2023)

T-1B (2023) - ELECTRICAL RESISTIVITY SECTION





Legend

- ERT Intersection Point
- 0mAHD
- Groundwater AAMGL (Hyd2O, 2023)

Logged Borehole*

Soil Texture

- SAND
- Clayey SAND
- Sandy CLAY
- CLAY

Soil Moisture

- Dry
- Slightly Moist
- Moist
- Wet
- Saturated

* Refer to lithological logs for details.

Interpreted Material Condition**

Modelled Resistivity		Sediment Grain Size	Ground Water Content	Rock Weathering
INCREASING ↑	High	Gravel	Dry	Fresh
	Medium	Sand	Moist	Moderately
	Low	Clay/Silt	Wet	Highly

Notes

* Refer to lithological logs for details.

** Interpreted material condition is based on generalised relationships of modelled resistivity with the subsurface and may vary due to local geological or hydrological conditions.

NOTES
Drawing to be used in conjunction with Report 3098.
Map Projection GDA2020 MGA Zone 50.
Elevation in metres AHD.

Date	8 December 2023	Paper Size	A3
Scale	H 1:2500, V 1:1000	Drawn	AHWS
Drawing	3098-03	Revision	7

HESPERIA ON BEHALF OF WAPC

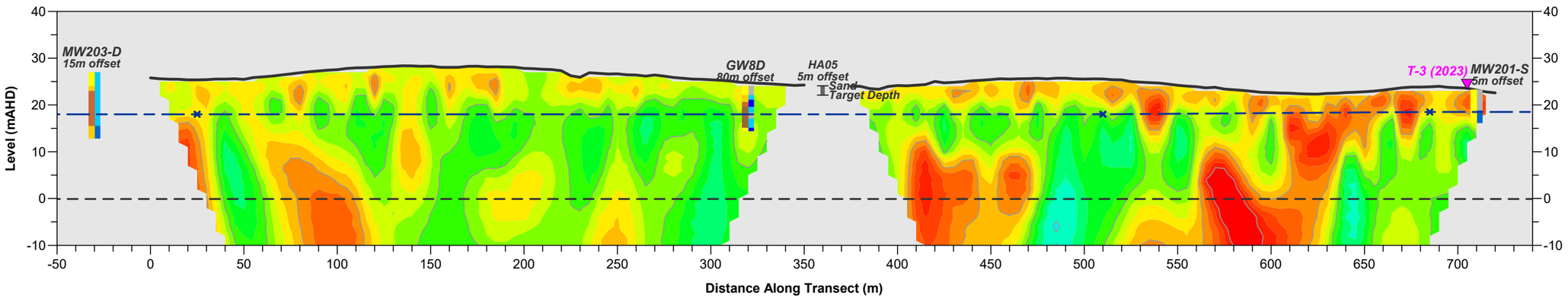
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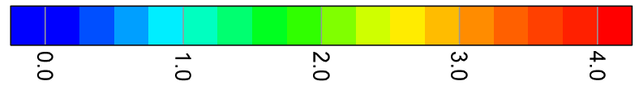
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GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA - WATTLE GROVE WA

ELECTRICAL RESISTIVITY TOMOGRAPHY SECTIONS (PHASE 2, OCTOBER 2023)

T-2A & T-2B (2023) - ELECTRICAL RESISTIVITY SECTION





Legend

- ERT Intersection Point
- 0mAHD
- Groundwater AAMGL (Hyd2O, 2023)

Logged Borehole*

Soil Texture	Soil Moisture
SAND	Dry
Clayey SAND	Slightly Moist
Sandy CLAY	Moist
CLAY	Wet
	Saturated

* Refer to lithological logs for details.

Interpreted Material Condition**

	Modelled Resistivity	Sediment Grain Size	Ground Water Content	Rock Weathering
INCREASING ↑	High	Gravel	Dry	Fresh
	Medium	Sand	Moist	Moderately
	Low	Clay/Silt	Wet	Highly

Notes

* Refer to lithological logs for details.

** Interpreted material condition is based on generalised relationships of modelled resistivity with the subsurface and may vary due to local geological or hydrological conditions.

NOTES
Drawing to be used in conjunction with Report 3098.
Map Projection GDA2020 MGA Zone 50.
Elevation in metres AHD.

Date	8 December 2023	Paper Size	A3
Scale	H 1:2500, V 1:1000	Drawn	AHWS
Drawing	3098-04	Revision	7

HESPERIA ON BEHALF OF WAPC

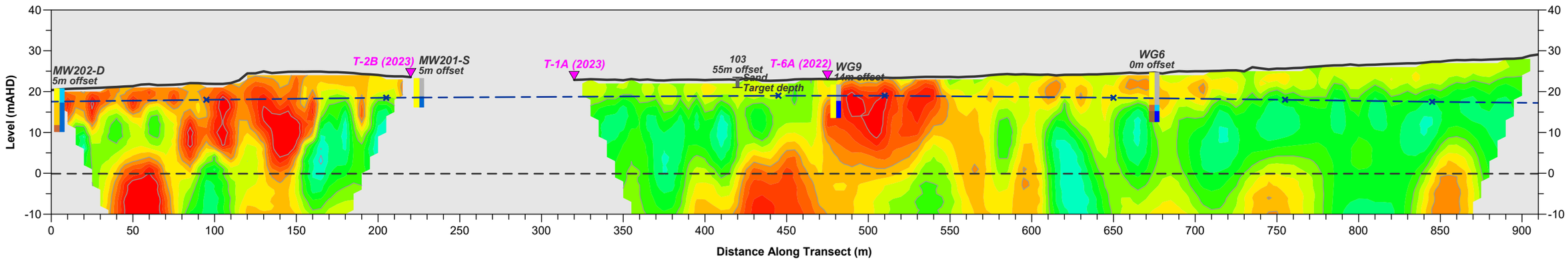
GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA, WATTLE GROVE WESTERN AUSTRALIA.

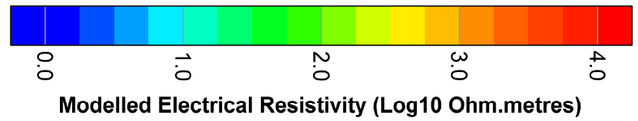
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GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA - WATTLE GROVE WA

ELECTRICAL RESISTIVITY TOMOGRAPHY SECTIONS (PHASE 2, OCTOBER 2023)

T-3 & T-4 (2023) - ELECTRICAL RESISTIVITY SECTION





Legend

- ERT Intersection Point
- 0mAHD
- Groundwater AAMGL (Hyd2O, 2023)

Logged Borehole*

Soil Texture

- SAND
- Clayey SAND
- Sandy CLAY
- CLAY

Soil Moisture

- Dry
- Slightly Moist
- Moist
- Wet
- Saturated

* Refer to lithological logs for details.

Interpreted Material Condition**

Modelled Resistivity		Sediment Grain Size	Ground Water Content	Rock Weathering
INCREASING ↑	High	Gravel	Dry	Fresh
	Medium	Sand	Moist	Moderately
	Low	Clay/Silt	Wet	Highly

Notes

* Refer to lithological logs for details.

** Interpreted material condition is based on generalised relationships of modelled resistivity with the subsurface and may vary due to local geological or hydrological conditions.

NOTES
Drawing to be used in conjunction with Report 3098.
Map Projection GDA2020 MGA Zone 50.
Elevation in metres AHD.

Date	8 December 2023	Paper Size	A3
Scale	H 1:2500, V 1:1000	Drawn	AHWS
Drawing	3098-05	Revision	7

HESPERIA ON BEHALF OF WAPC

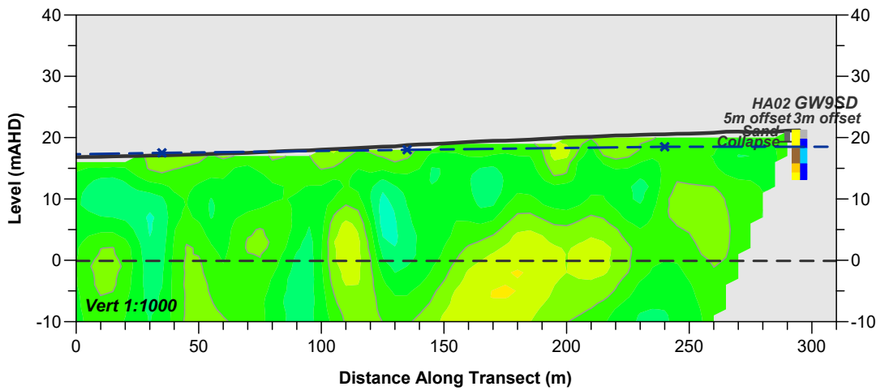
GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA, WATTLE GROVE WESTERN AUSTRALIA.

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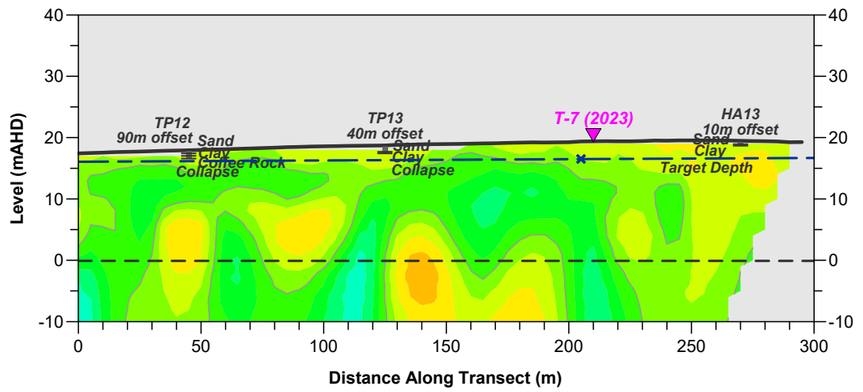
GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA - WATTLE GROVE WA

ELECTRICAL RESISTIVITY TOMOGRAPHY SECTIONS (PHASE 2, OCTOBER 2023)

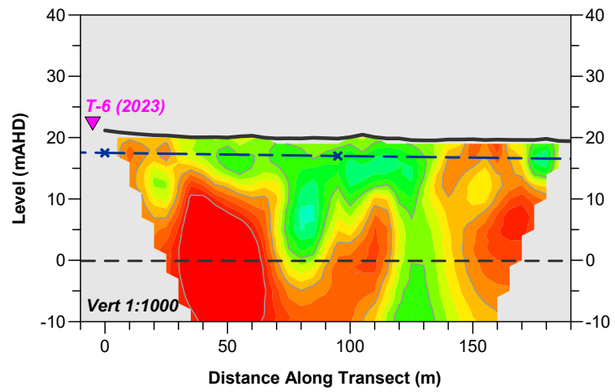
T-5 (2023) - ELECTRICAL RESISTIVITY SECTION

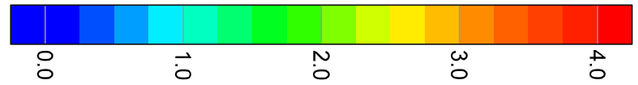


T-6 (2023) - ELECTRICAL RESISTIVITY SECTION



T-7 (2023) - ELECTRICAL RESISTIVITY SECTION





Legend

- ERT Intersection Point
- 0mAHD
- Groundwater AAMGL (Hyd2O, 2023)

Logged Borehole*

Soil Texture

- SAND
- Clayey SAND
- Sandy CLAY
- CLAY

Soil Moisture

- Dry
- Slightly Moist
- Moist
- Wet
- Saturated

* Refer to lithological logs for details.

Interpreted Material Condition**

Modelled Resistivity		Sediment Grain Size	Ground Water Content	Rock Weathering
INCREASING ↑	High	Gravel	Dry	Fresh
	Medium	Sand	Moist	Moderately
	Low	Clay/Silt	Wet	Highly

Notes

* Refer to lithological logs for details.

** Interpreted material condition is based on generalised relationships of modelled resistivity with the subsurface and may vary due to local geological or hydrological conditions.

NOTES
Drawing to be used in conjunction with Report 3098.
Map Projection GDA2020 MGA Zone 50.
Elevation in metres AHD.

Date	8 December 2023	Paper Size	A3
Scale	H 1:2500, V 1:1000	Drawn	AHWS
Drawing	3098-06	Revision	7

HESPERIA ON BEHALF OF WAPC

GEOPHYSICAL SUBSURFACE INVESTIGATION AT MRS AMENDMENT 1388/57 AREA, WATTLE GROVE WESTERN AUSTRALIA.

GBGGROUP
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APPENDIX D
Hyd2o Permeability Testing

Borehole Permeameter : Field Result Analysis

hyd2o HYDROLOGY

Project/Site	H21003 : Wattle Grove HTS1	
Location	406116	mE
	6457802	mN

TEST 1

r	7.5	cm
H	6.0	cm
time step	5	secs
H/r	0.80	
C	0.45	

Time (sec)	Level (cm)	Diff (cm)
0	**5.0**	
5	**15.0**	10.0
10	**15.0**	0.0
15	**25.9**	10.9
20	**25.9**	0.0
25	**38.6**	12.7
30	**38.6**	0.0
35	**38.6**	0.0
40	**47.0**	8.4
	Avg Diff (cm)	5.3
	q (cm^3/s)	9.8

TEST 2

r	7.5	cm
H	9.0	cm
time step	5	secs
H/r	1.20	
C	0.56	

Time (sec)	Level (cm)	Diff (cm)
0	**2.6**	
5	**14.0**	11.4
10	**27.5**	13.5
15	**27.5**	0.0
20	**38.7**	11.2
25	**38.7**	0.0
30	**47.0**	8.3
	Avg Diff (cm)	7.4
	q (cm^3/s)	13.8

TEST 3

r	7.5	cm
H	12.0	cm
time step	5	secs
H/r	1.60	
C	0.75	

Time (sec)	Level (cm)	Diff (cm)
0	**8.5**	
5	**20.5**	12.0
10	**31.5**	11.0
15	**42.7**	11.2
	Avg Diff (cm)	11.4
	q (cm^3/s)	21.3

METHOD 1 : Elrick and Reynolds (1992)

Ks (cm/s)	0.0145	Ks (cm/s)	0.0127	Ks (cm/s)	0.0153
Ks (m/day)	12.54	Ks (m/day)	10.98	Ks (m/day)	13.24
Average (m/day)	**12.25**				

METHOD 2 : Talsma and Hallam Method (recommended for low Ks only <2.9)

q (cm3/min)	588.4		829.4	cm3/min	1277.7	cm3/min
r (cm)	7.5		7.5	cm	7.5	cm
H (cm)	6.0		9.0	cm	12.0	cm
$0.5\sinh^{-1}(H/2r)$	0.20		0.28		0.37	
-sqrt((r/H)^2+0.25)	-1.35		-0.97		-0.80	
r/H	1.25		0.83		0.63	
Sum	0.10		0.15		0.19	
Sum*4.4*q	255.61		532.51		1073.47	
$2*pi*H^2$	226.19		508.94		904.78	
Ksat (cm/min)	1.1		1.0		1.2	
Ksat (m/day)	16.27		15.07		17.08	
Average (m/day)	**16.14**					

Borehole Permeameter : Field Result Analysis

hyd2o HYDROLOGY

Project/Site	H21003 : Wattle Grove HTS2	
Location	405413	mE
	6457705	mN

TEST 1

r	7.5	cm
H	10.0	cm
time step	5	secs
H/r	1.33	
C	0.66	

Time (sec)	Level (cm)	Diff (cm)
0	**4.9**	
5	**35.5**	30.6
10	**47.0**	11.5
		21.1
q (cm^3/s)		39.3

TEST 2

r	7.5	cm
H	8.0	cm
time step	5	secs
H/r	1.07	
C	0.56	

Time (sec)	Level (cm)	Diff (cm)
0	**6.5**	
5	**25.5**	19.0
10	**36.5**	11.0
Avg Diff (cm)		15.0
q (cm^3/s)		28.0

TEST 3

r	7.5	cm
H	9.0	cm
time step	5	secs
H/r	1.20	
C	0.56	

Time (sec)	Level (cm)	Diff (cm)
0	**5.1**	
5	**31.0**	25.9
10	**45.0**	14.0
Avg Diff (cm)		20.0
q (cm^3/s)		37.3

METHOD 1 : Elrick and Reynolds (1992)

Ks (cm/s)	0.0346	Ks (cm/s)	0.0312	Ks (cm/s)	0.0343
Ks (m/day)	29.93	Ks (m/day)	27.00	Ks (m/day)	29.59
Average (m/day)	**28.84**				

METHOD 2 : Talsma and Hallam Method (recommended for low Ks only <2.9)

q (cm3/min)	2359.3		1681.2	cm3/min	2236.0	cm3/min
r (cm)	7.5		7.5	cm	7.5	cm
H (cm)	10.0		8.0	cm	9.0	cm
$0.5\sinh^{-1}(H/2r)$	0.31		0.26		0.28	
-sqrt((r/H)^2+0.25)	-0.90		-1.06		-0.97	
r/H	0.75		0.94		0.83	
Sum	0.16		0.13		0.15	
Sum*4.4*q	1673.23		964.70		1435.62	
$2*pi*H^2$	628.32		402.12		508.94	
Ksat (cm/min)	2.7		2.4		2.8	
Ksat (m/day)	38.35		34.55		40.62	
Average (m/day)	**37.84**					

Borehole Permeameter : Field Result Analysis

hyd2o HYDROLOGY

Project/Site	H21003 : Wattle Grove HTS3	
Location	405368	mE
	6458072	mN

TEST 1

r	7.5	cm
H	6.0	cm
time step	5	secs
H/r	0.80	
C	0.45	

Time (sec)	Level (cm)	Diff (cm)
0	**6.8**	
5	**22.0**	15.2
10	**33.9**	11.9
15	**45.4**	11.5
20	**45.4**	0.0
25	**47.0**	1.6
		8.0
	q (cm^3/s)	15.0

TEST 2

r	7.5	cm
H	8.0	cm
time step	5	secs
H/r	1.07	
C	0.56	

Time (sec)	Level (cm)	Diff (cm)
0	**4.0**	
5	**17.0**	13.0
10	**30.0**	13.0
15	**46.0**	16.0
	Avg Diff (cm)	14.0
	q (cm^3/s)	26.2

TEST 3

r	7.5	cm
H	8.0	cm
time step	5	secs
H/r	1.07	
C	0.56	

Time (sec)	Level (cm)	Diff (cm)
0	**5.2**	
5	**18.0**	12.8
10	**31.5**	13.5
15	**44.6**	13.1
20	**47.0**	2.4
	Avg Diff (cm)	10.5
	q (cm^3/s)	19.5

METHOD 1 : Elrick and Reynolds (1992)

Ks (cm/s)	0.0222	Ks (cm/s)	0.0292	Ks (cm/s)	0.0218
Ks (m/day)	19.20	Ks (m/day)	25.20	Ks (m/day)	18.81
Average (m/day)	**21.07**				

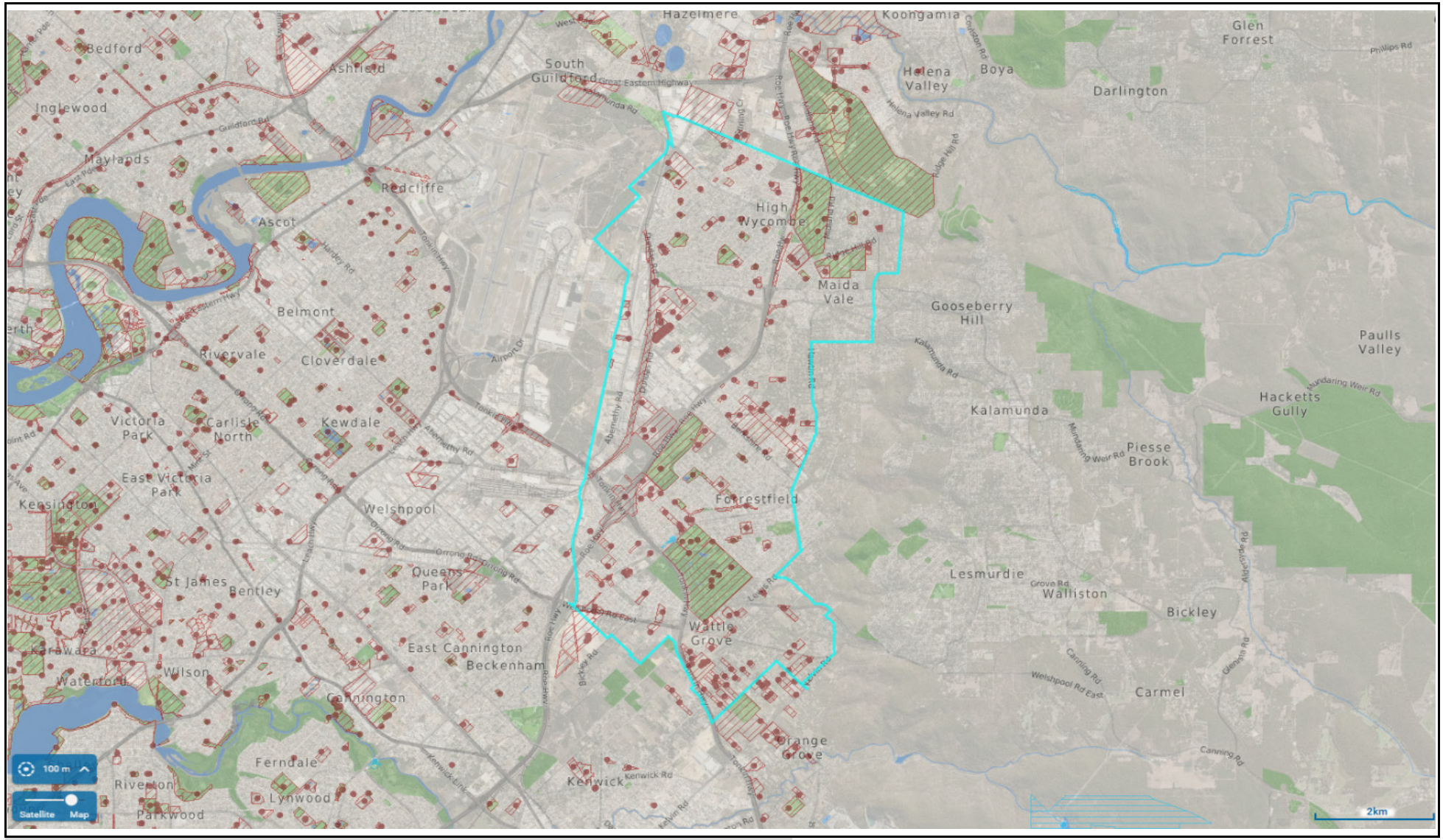
METHOD 2 : Talsma and Hallam Method (recommended for low Ks only <2.9)

q (cm3/min)	901.1		1569.1 cm3/min		1171.2 cm3/min
r (cm)	7.5		7.5 cm		7.5 cm
H (cm)	6.0		8.0 cm		8.0 cm
$0.5\sinh^{-1}(H/2r)$	0.20		0.26		0.26
-sqrt((r/H)^2+0.25)	-1.35		-1.06		-1.06
r/H	1.25		0.94		0.94
Sum	0.10		0.13		0.13
Sum*4.4*q	391.44		900.39		672.07
$2*pi*H^2$	226.19		402.12		402.12
Ksat (cm/min)	1.7		2.2		1.7
Ksat (m/day)	24.92		32.24		24.07
Average (m/day)	**27.08**				

APPENDIX E

DWER Water Register Extracts

Date : 29/1/2024 Job No: H22076



hyd2o

Wattle Grove South District Water Management Strategy

Water Register : Perth Superficial Shire of Kalamunda Sub Area

Appendix E

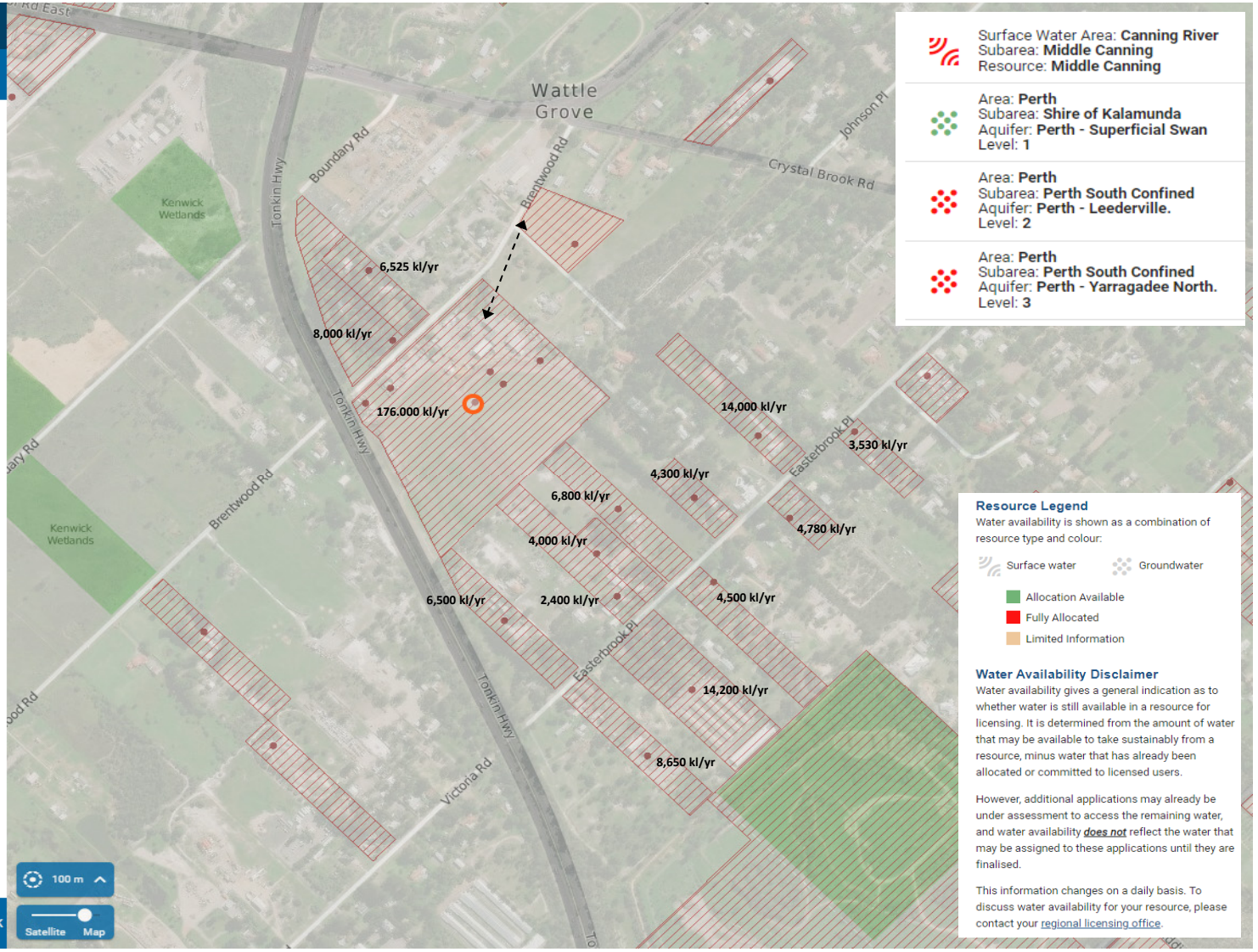
Date : 29/1/2024 Job No: H22076

Licence details

Selected 1 of 1

WRI_NUMBER:	203064
INSTRUMENT_TYPE:	Groundwater Licence
ISSUE_DATE:	5/7/2019
EXPIRY_DATE:	4/7/2029
LICENCE_ALLOCATION:	176000 KL
ALL_PARTIES:	Lovegrove, Richard
POSTAL_ADD:	41 Brentwood Rd Wattle Grove WA 6107 Australia
GW_AREA:	Perth
SUB_AREA:	Shire of Kalamunda
AQUIFER:	Perth - Superficial Swan
DIVISION:	
BASIN:	
RESOURC:	
LICENCE_ADDRESS:	LOT 303 ON DIAGRAM 100106; LOT 4 ON DIAGRAM 89357; LOT 213 ON PLAN 3380; LOT 53 ON DIAGRAM 61568; LOT 214 ON PLAN 3380
SECURITY_INT:	No
CONVICT_EXIST:	No
AGREE_EXIST:	No
NOTATIONS_EXIST:	No
DIRECTIONS_EXIST:	No

Instrument number: 203064 Track



APPENDIX F

Nutrient Input Assessment
Under Existing Land Use

Government of **Western Australia**
Department of **Water and Environmental Regulation**

Project:	Wattle Grove Pre Dev	Date:	16-Nov-21
		Version:	Version 1.2.0.19289

Subregion name: Predev Global

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	0	0.00	0.00	0.00
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	72	90.86	6369.57	1199.40
Public open space	25	31.55	6593.95	167.22
Road reserve	3	3.79	148.41	19.88

Total area (ha)	Total percent (%)
126.20	100
Nitrogen input	**Phosphorus input**
13771.95	1405.43
Nitrogen export	**Phosphorus**
329.17	18.78

Rural living

Landuse	Percent (%)	Area (ha)
Unrestricted	100	90.86
No livestock	0	0.00
No clearing apart from the housing pad	0	0.00

Total area (ha)	Total percent (%)
90.86	72
Nitrogen input (kg)	**Phosphorus input (kg)**
6369.57	1199.40

Note: Commercial horticultre is not permitted in the rural living zone, due to spray drift buffers.

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	0	0.00
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	0	0.00
Sport	0	0.00
Recreation	0	0.00
Golf course	0	0.00
Bowling green	100	31.55
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
31.55	25

Nitrogen input (kg)	Phosphorus input (kg)
6593.95	167.22

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	30	1.14
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	35	1.33
Road reserve - not fertilised	35	1.33

Total area (ha)	Total percent (%)
3.786	3

Nitrogen input (kg)	Phosphorus input (kg)
148.41	148.41

Soil and drainage information

Type of drainage	**Open channel drains**	**Does it contain imported fill?**	**No**
Soil type	**Pinjarra**	**Does subregion contain onsite sewage diposal system?**	**Y**
Depth to groundwater (m)	**10**	Type of system installed	**Septic tank**
Groundwater slope (%)	**0.1**	No. of units installed	**74**
Soil PRI	**19.3**		

Note: Please attach the results of soil tests to this report when submitting.

Summary: Nutrient stripping devices						
Treatment	**Name**	**Size (m²)**	**Treated area (ha)**	**Treating**	**N removed (kg/yr)**	**P removed (kg/yr)**
Load removed					**0.00**	**0.00**
Net export					**329.17**	**18.78**

Summary: Nutrient load exports			
Region	**Area (ha)**	**P export (kg/yr)**	**N export (kg/yr)**
Predev Global	126.20	18.78	329.17

PRE-TREATMENT LOAD (kg/yr)		LOAD REMOVED (kg/yr)		NET LOAD EXPORT (kg/yr)	
NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS
329.17	**18.78**	**0.00**	**0.00**	**329.17**	**18.78**

APPENDIX G
Monitoring Bore Details & Logs

FieldDAE
Field Data Analysis & Evaluation System

Hyd2o Monitoring Sites

	Site	Name / Type	Projected Coordinate System	Easting m	Northing m	Owner	Date Drilled	Driller	Headworks	Nat Surf mAHD	Top of Case mAHD	End of Hole mAHD	Bore Depth m	Screen Interval	Aquifer	Bore Condition	Comment/Description/Location
1	WG1	Hyd2o Bore Wattle Grove 1	GDA94 - MGA50	406115	6457800	Hesperia	19/11/2020	Edrill	Steel Casing	31.45	32.10	13.95	17.50	14.5-17.5 m	Superficial	Good	Site Bore Victoria Rd North - Rear of Lot (Install : Nov 2020)
2	WG2	Hyd2o Bore Wattle Grove 2 (Deep)	GDA94 - MGA50	405780	6457018	Hesperia	19/11/2020	Edrill	Steel Casing	25.47	26.12	14.47	11.00	8.0-11.0 m	Superficial	Good	Site Bore Victoria Rd South - Front of Lot (Install : Nov 2020)
3	WG2S	Hyd2o Bore Wattle Grove 2 Shallow	GDA94 - MGA50	405781	6457018	Hesperia	21/07/2022	DPP	Steel Casing	25.21	26.01	22.21	3.00	1.0-3.0 m	Shallow/Perched	Good	Site Bore Victoria Rd South - Front of Lot (Install : July 2022)
4	WG3	Hyd2o Bore Wattle Grove 3	GDA94 - MGA50	405419	6457710	Hesperia	19/11/2020	Edrill	Steel Casing	22.32	22.97	14.32	8.00	5.0-8.0 m	Superficial	Good	Site Bore Brentwood Rd South - Front of Lot (Install : Nov 2020)
5	WG4S	Hyd2o Bore Wattle Grove 4 Shallow	GDA94 - MGA50	405735	6458036	Hesperia	20/07/2022	DPP	Steel Casing	25.11	25.66	21.11	4.00	1.0-4.0 m	Shallow/Perched	Good	Site Bore Brentwood Rd North - Front of Lot (Install : Jul 2022)
6	WG4D	Hyd2o Bore Wattle Grove 4 Deep	GDA94 - MGA50	405736	6458037	Hesperia	20/07/2022	DPP	Steel Casing	25.11	25.73	13.11	12.00	9.0-12.0 m	Superficial	Good	Site Bore Brentwood Rd North - Front of Lot (Install : Jul 2022)
7	WG5S	Hyd2o Bore Wattle Grove 5 Shallow	GDA94 - MGA50	406304	6457567	Hesperia	20/07/2022	DPP	Steel Casing	34.54	35.14	29.24	5.30	2.3-5.3 m	Shallow/Perched	Good	Site Bore Victoria Rd North - Front of Lot (Install : July 2022)
8	WG5D	Hyd2o Bore Wattle Grove 5 Deep	GDA94 - MGA50	406304	6457566	Hesperia	20/07/2022	DPP	Steel Casing	34.55	35.13	14.55	20.00	17.0-20.0 m	Superficial	Good	Site Bore Victoria Rd North - Front of Lot (Install : Jul 2022)
9	WG6	Hyd2o Bore Wattle Grove 6	GDA94 - MGA50	405790	6457474	Hesperia	21/07/2022	DPP	Steel Casing	24.64	25.34	13.64	11.00	8.0-11.0m	Superficial	Good	Site Bore Victoria Rd Turf Farm North - Rear of Lot (Install : Jul 2022)
10	WG7S	Hyd2o Bore Wattle Grove 7 Shallow	GDA94 - MGA50	405351	6457885	Hesperia	20/07/2022	DPP	Steel Casing	22.85	23.50	19.85	3.00	1.0-3.0 m	Shallow/Perched	Good	Site Bore Boundary Rd South - Rear of Lot (Install : Jul 2022)
11	WG7D	Hyd2o Bore Wattle Grove 7 Deep	GDA94 - MGA50	405352	6457884	Hesperia	20/07/2022	DPP	Steel Casing	22.90	23.44	11.90	11.00	8.0-11.0 m	Superficial	Good	Site Bore Boundary Rd South - Rear of Lot (Install : Jul 2022)
12	WG8	Hyd2o Bore Wattle Grove 8	GDA94 - MGA50	406959	6457834	Hesperia	10/10/2022	DPP	Steel Casing	41.08	41.77	14.08	27.00	24.0-27.0 m	Superficial	Good	Upstream Bore Emanuel Crt North - Verge (Install : Oct 2022)
13	WG9	Hyd2o Bore Wattle Grove 9	GDA94 - MGA50	405651	6457338	Hesperia	10/10/2022	DPP	Steel Casing	23.23	23.86	17.23	6.00	3.0-6.0 m	Superficial	Good	Site Bore Victoria Rd Turf Farm South - Rear of Lot (Install : Oct 2022)
14	WG10S	Hyd2o Bore Wattle Grove 10 Shallow	GDA94 - MGA50	405364	6458074	Hesperia	11/10/2022	DPP	Steel Casing	22.80	23.60	19.80	3.00	1.5-3.0 m	Shallow/Perched	Good	Site Bore Boundary Rd North - Verge (Install : Oct 2022)
15	WG10D	Hyd2o Bore Wattle Grove 10 Deep	GDA94 - MGA50	405365	6458075	Hesperia	11/10/2022	DPP	Steel Casing	22.88	23.62	13.88	9.00	6.0-9.0 m	Superficial	Good	Site Bore Boundary Rd North - Verge (Install : Oct 2022)
16	MBa	Unknown Origin Bore (likely BH013 further below)	GDA94 - MGA50	405245	6457958	Hesperia	-	-	Steel Casing	20.03	20.61	-	-	-	Shallow/Perched	Good	Downstream Bore Boundary Rd South - Verge (Install : Unknown)
17	MBb	Douglas Partners Bore 1	GDA94 - MGA50	406067	6456783	Hesperia	-	DPP	Steel Casing	31.25	31.90	-	-	-	Superficial	Good	Site Bore Chicken Shed South - Rear of Lot (Install : Oct 2020)
18	GW1	Urbaqua Bore 1	GDA94 - MGA50	405363	6458071	City of Kalamunda	3/09/2019	Edrill	Steel Casing	22.99	23.49	14.99	8.00	5.0-8.0 m	Superficial	Good	Site Bore Boundary Rd North - Verge (Install : Sep 2019)
19	GW3	Endemic Bore 3	GDA94 - MGA50	403634	6456299	City of Gosnells	19/06/2009	Endemic	Steel Casing	8.97	9.65	7.33	1.60	-	Shallow/Perched	Poor	Downstream Bore Boundary Rd South - GBSWA (Install : Jun 2009)
20	GW5	Endemic Bore 5	GDA94 - MGA50	405055	6457747	City of Gosnells	19/06/2009	Endemic	Steel Casing	18.84	19.41	17.66	1.20	-	Shallow/Perched	Poor	Downstream Bore Boundary Rd North - GBSWA (Install : Jun 2009)
21	GW5D	Hyd2o Deep Bore next to Endemic 5	GDA94 - MGA50	405053	6457750	Hesperia	21/07/2022	DPP	Steel Casing	18.81	19.37	11.81	7.00	4.0-7.0 m	Superficial	Good	Downstream Bore Boundary Rd North - GBSWA (Install : Jul 2022)
22	GW8	Endemic Bore 8	GDA94 - MGA50	405590	6456777	City of Gosnells	19/06/2009	Endemic	Steel Casing	24.00	24.61	20.48	3.50	-	Shallow/Perched	Poor	Downstream Bore Victoria Rd North - Verge (Install : Jun 2009)
23	GW8D	Hyd2o Deep Bore next to Endemic 8	GDA94 - MGA50	405590	6456775	Hesperia	22/07/2022	DPP	Steel Casing	24.00	24.52	14.50	9.50	6.5-9.5 m	Superficial	Good	Downstream Bore Victoria Rd North - Verge (Install Jul 2022)
24	GW9S	Hyd2o Bore Wetlands 9 Shallow	GDA94 - MGA50	405329	6457512	Hesperia	22/07/2022	DPP	Steel Casing	21.19	21.81	18.19	3.00	1.0-3.0 m	Shallow/Perched	Good	Downstream Bore Brentwood Rd North - Verge (Install Jul 2022)
25	GW9D	Hyd2o Bore Wetlands 9 Deep	GDA94 - MGA50	405329	6457513	Hesperia	22/07/2022	DPP	Steel Casing	21.20	21.78	13.20	8.00	5.0-8.0 m	Superficial	Good	Downstream Bore Brentwood Rd North - Verge (Install Jul 2022)
26	GW12	Endemic Bore 12	GDA94 - MGA50	403440	6456803	City of Gosnells	19/06/2009	Endemic	Steel Casing	8.90	9.39	6.57	2.30	-	Shallow/Perched	Poor	Downstream Bore Brook Rd South - GBSWA (Install : Jun 2009)
27	SCC 05/08	DWER Bore 1	GDA94 - MGA50	405767	6461821	SCC	13/02/2008	WDR	Steel Casing	41.21	41.78	12.21	29.00	17.0-29.0 m	Superficial	Good	Long Term DWER Bore - Ilex Way Forrestfield (Install : Feb 2008)
28	SCC 06/08	DWER Bore 2	GDA94 - MGA50	401381	6457518	SCC	11/01/2008	-	Steel Casing	7.49	7.98	-4.51	12.00	3.0-12.0 m	Superficial	Good	Long Term DWER Bore - Crawford St, Cannington (Install : Jan 2008)
29	SCC 09/08	DWER Bore 3	GDA94 - MGA50	405600	6452440	SCC	14/01/2008	-	Steel Casing	12.62	13.21	0.87	11.80	2.75-11.75 m	Superficial	Good	Long Term DWER Bore - Banach St, Maddington (Install : Jan 2008)

Other Bores

1	WA01	DBCA Brixton Wetland Bore 1	GDA94 - MGA50	403354	6456394	DBCA	7/11/2016	DBCA	-	7.10	7.55	-0.40	7.50	4.5 -7.0 m	Superficial	Good	Installed within Greater Brixton Street Wetlands
2	WA02	DBCA Brixton Wetland Bore 2	GDA94 - MGA50	403176	6456183	DBCA	7/11/2016	DBCA	-	6.30	6.77	-0.70	7.00	4.0 - 7.0 m	Superficial	Good	Installed within Greater Brixton Street Wetlands
3	WA03	DBCA Brixton Wetland Bore 3	GDA94 - MGA50	402998	6455992	DBCA	7/11/2016	DBCA	-	5.70	6.17	-2.50	8.20	2.2 - 8.2 m	Superficial	Good	Installed within Greater Brixton Street Wetlands
4	BH005	Arup Bore 5	GDA94 - PCG94	66937	257229	Main Roads	3/10/2019	Edge Drilling	Steel Casing	20.40	20.30	0.45	19.95	3.95 - 19.95 m	Superficial	Good	Installed within Tonkin Hwy Reserve
5	BH006	Arup Bore 6	GDA94 - PCG94	67005	257195	Main Roads	4/10/2019	Edge Drilling	Steel Casing	20.81	20.74	0.86	19.95	3.95 - 19.95 m	Superficial	Good	Installed within Tonkin Hwy Reserve
6	BH007	Arup Bore 7	GDA94 - PCG94	67026	257277	Main Roads	8/10/2019	Edge Drilling	Steel Casing	21.42	22.11	1.47	19.95	3.95 - 19.95 m	Superficial	Good	Installed within Tonkin Hwy Reserve
7	BH008	Arup Bore 8	GDA94 - PCG94	66898	257282	Main Roads	7/11/2019	Edge Drilling	Steel Casing	20.43	20.98	0.48	19.95	3.95 - 19.95 m	Superficial	Good	Installed within Tonkin Hwy Reserve
8	BH013	Arup Bore 13	GDA94 - PCG94	67010	256973	Main Roads	11/10/2019	Edge Drilling	Steel Casing	20.00	21.26	4.55	15.45	9.45 - 15.45 m	Superficial	Good	Installed within Tonkin Hwy Reserve
9	BH014	Arup Bore 14	GDA94 - PCG94	67137	257614	Main Roads	15/10/2019	Edge Drilling	Steel Casing	20.00	22.37	5.00	15.00	9.0 - 15.0 m	Superficial	Good	Installed within Tonkin Hwy Reserve
10	MW201-S	MKSEA - DP Bore 1 Shallow	GDA94 - MGA50	405483	6457148	Hesperia	12/10/2022	DPP	Steel Casing	23.14	23.86	16.14	7.00	5.5 - 7.0 m	Superficial	Good	Installed within private property with acess via Victoria Rd (south of Tonkin)
11	MW202-D	MKSEA - DP Bore 2 Deep	GDA94 - MGA50	405320	6457004	Hesperia	13/10/2022	DPP	Steel Casing	20.37	21.02	9.87	10.50	8.5 - 10.5 m	Superficial	Good	Installed within private property with acess via Victoria Rd (south of Tonkin)
12	MW202-S	MKSEA - DP Bore 2 Shallow	GDA94 - MGA50	405319	6457002	Hesperia	13/10/2022	DPP	Steel Casing	20.35	21.02	15.35	5.00	3.5 - 5.0 m	Shallow/Perched	Good	Installed within private property with acess via Victoria Rd (south of Tonkin)
13	MW203-D	MKSEA - DP Bore 3 Deep	GDA94 - MGA50	405763	6456481	Hesperia	12/10/2022	DPP	Steel Casing	26.90	27.53	12.90	14.00	12.5 - 14.0 m	Superficial	Good	Installed within private property with acess via Victoria Rd (south of Tonkin)
14	MW203-S	MKSEA - DP Bore 3 Shallow	GDA94 - MGA50	405765	6456480	Hesperia	12/10/2022	DPP	Steel Casing	26.95	27.57	21.95	5.00	3.5 - 5.0 m	Shallow/Perched	Good	Installed within private property with acess via Victoria Rd (south of Tonkin)
15	MW204-S	MKSEA - DP Bore 4 Shallow	GDA94 - MGA50	405408	6456579	Hesperia	12/10/2022	DPP	Steel Casing	24.07	24.74	17.07	7.00	4.0 - 7.0 m	Shallow/Perched	Good	Installed within private property with acess via Victoria Rd (south of Tonkin)
16	MW205-D	MKSEA - DP Bore 5 Deep	GDA94 - MGA50	405033	6456675	Hesperia	13/10/2022	DPP	Steel Casing	16.48	17.18	6.48	10.00	8.5 - 10.0 m	Superficial	Good	Installed within private property with acess via Victoria Rd (south of Tonkin)
17	MW205-S	MKSEA - DP Bore 5 Shallow	GDA94 - MGA50	405034	6456674	Hesperia	14/10/2022	DPP	Steel Casing	16.47	17.22	12.47	4.00	2.5 - 4.0 m	Shallow/Perched	Good	Installed within private property with acess via Victoria Rd (south of Tonkin)
18	MW206-S	MKSEA - DP Bore 6 Shallow	GDA94 - MGA50	405237	6456474	Hesperia	12/10/2022	DPP	Steel Casing	19.98	20.61	14.98	5.00	3.5 - 5.0 m	Shallow/Perched	Good	Installed within private property with acess via Victoria Rd (south of Tonkin)
19	MW207-S	MKSEA - DP Bore 7 Shallow	GDA94 - MGA50	404905	6456053	Hesperia	13/10/2022	DPP	Steel Casing	12.96	13.66	8.96	4.00	2.5 - 4.0 m	Shallow/Perched	Good	Installed within private property with acess via Victoria Rd (south of Tonkin)
20	MW208-D	MKSEA - DP Bore 8 Deep	GDA94 - MGA50	405158	6455878	Hesperia	13/10/2022	DPP	Steel Casing	15.15	15.81	6.15	9.00	8.0 - 9.0 m	Superficial	Good	Installed within private property with acess via Victoria Rd (south of Tonkin)
21	MW208-S	MKSEA - DP Bore 8 Shallow	GDA94 - MGA50	405159	6455878	Hesperia	13/10/2022	DPP	Steel Casing	15.19	15.85	11.19	4.00	2.5 - 4.0 m	Shallow/Perched	Good	Installed within private property with acess via Victoria Rd (south of Tonkin)

Lithological Log

Hyd2o
Suite 6B 103 Rokeby Rd
Subiaco, WA 6008

PO Box 1055
Subiaco WA 6904

				Bore Name
Date :	**19-11-20**	Job Number :	H20072	
Client :	**Hesperia**	Start Hole :	**7.30 am**	
Project:	**Wattle Grove South**	End Hole :	**10.30 am**	
Easting	**406115**	Logged by :	**SO**	**WG01**
Northing	**6457799**	Total Depth :	**17.5 m**	
Datum:	AHD	RL Top of Casing :	**32.1 mAHD**	
Drill type:	Drill Rig RAB	RL Nat Surface :	**31.45 mAHD**	
Hole diameter:	2.5 Inch			

support	backfill	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)					Light Grey	Fine to Medium	Sand	None	Dry	
				2.0m	Light Brown					
				4.0m	Yellow Brown					
					Yellow					
				6.0m	Light Brown	Fine				
				8.0m						Chunks of silicrete/calcrete material - crumbles
				10.0m	White	Very Fine				
				12.0m		Fine to Medium				
		▽		14.0m	Light Grey	Medium to Large				
				16.0m	Light Grey Brown				Moist	
				18.0m						

COLOUR : Black, White, Biege
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	23-11-20
Stickup above NS (m)	0.65
Water Level bTOC (m)	15.72
Water Level bNS (m)	15.07

Lithological Log

Hyd2o
Suite 6B 103 Rokeby Rd
Subiaco, WA 6008

PO Box 1055
Subiaco WA 6904

				Bore Name
Date :	**19-11-20**	Job Number :	H20072	
Client :	**Hesperia**	Start Hole :	**10.30 am**	
Project:	**Wattle Grove Due Diligence**	End Hole :	**12.00 pm**	**WG02**
Easting	**405780**	Logged by :	**SO**	
Northing	**6457018**	Total Depth :	**11 m**	
Datum:	AHD	RL Top of Casing :	**26.12 mAHD**	
Drill type:	Drill Rig RAB	RL Nat Surface :	**25.47 mAHD**	
Hole diameter:	2.5 Inch			

support	backfill	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)				1.0m	Beige	Fine to Medium	Sand	None	Dry	
				2.0m	White Brown	Fine				
				3.0m	Light Grey					
				4.0m	White	Very Fine				Chunks of silicrete/calcrete material - crumbles
				5.0m						
				6.0m					Moist	
		▽		7.0m						
				8.0m		Fine to Medium				
				9.0m	Beige				Wet	
				11.0m						

COLOUR : Black, White, Biege
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	23-11-20
Stickup above NS (m)	0.65
Water Level bTOC (m)	9.18
Water Level bNS (m)	8.53

Lithological Log

Hyd2o
Suite 6B 103 Rokeby Rd
Subiaco, WA 6008

PO Box 1055
Subiaco WA 6904

Date :	**19-11-20**				
Client :	**Hesperia**	Job Number :	H20072	Bore Name	
Project:	**Wattle Grove South**	Start Hole :	**12.30 pm**	**WG03**	
Easting	**405419**	End Hole :	**2.00 pm**		
Northing	**6457710**	Logged by :	**SO**		
Datum:	AHD	Total Depth :	**8 m**		
Drill type:	Drill Rig RAB	RL Top of Casing :	**22.97 mAHD**		
Hole diameter:	2.5 Inch	RL Nat Surface :	**22.32 mAHD**		

support	backfill	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)				1.0m	White	Very Fine	Sand	None	Dry	
				2.0m	Beige	Fine to Medium				
				3.0m	White Grey	Fine			Slightly Moist	
		▽		4.0m	Beige	Fine to Medium	Clayey Sand		Moist	
				5.0m						
				6.0m		Very Fine				
				7.0m	White	Fine to Coarse	Sand			Quartz/Feldspar Minerals
				8.0m						

COLOUR :	Black, White, Biege Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue Composition : Solid , Blemish, Mottle
PARTICLE SIZE :	Fine, Medium, Course
TEXTURE :	Sand, Loamy Sand, Clayey Sand Silt, Loam, Sandy Loam, Clayey Loam Clay, Sandy Clay
ORGANICS :	High, Medium, Low
MOISTURE :	Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	23-11-20
Stickup above NS (m)	0.65
Water Level bTOC (m)	6.82
Water Level bNS (m)	6.17

Lithological Log

Hyd2o
Suite 1 387 Hay St
Subiaco, WA 6008

PO Box 1055
Subiaco WA 6904

Date :	**21-07-22**			Bore Name	
Client :	**Hesperia**	Job Number :	H21003		
Project:	**Wattle Grove DWMS**	Start Hole :	**12.30pm**		
Easting	**405781**	End Hole :	**2.00pm**		
Northing	**6457018**	Logged by :	**SO**	**WG2S**	
Datum:	AHD	Total Depth :	**5m**		
Drill type:	Drill Rig Auger	RL Top of Casing (mAHD) :	**26.01**		
Hole diameter:	2.5 inch	RL Nat Surface (mAHD) :	**25.21**		

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)				1.0m	Orange	Fine to Medium	Sand	Medium	Dry	
				2.0m				Low		
				3.0m						
					Beige Yellow	Fine	Clay			
				4.0m						
					Yellow					
				5.0m						
				6.0m						
				7.0m						
				8.0m						
				9.0m						
				10.0m						
				11.0m						
				12.0m						

COLOUR : Black, White, Beige
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

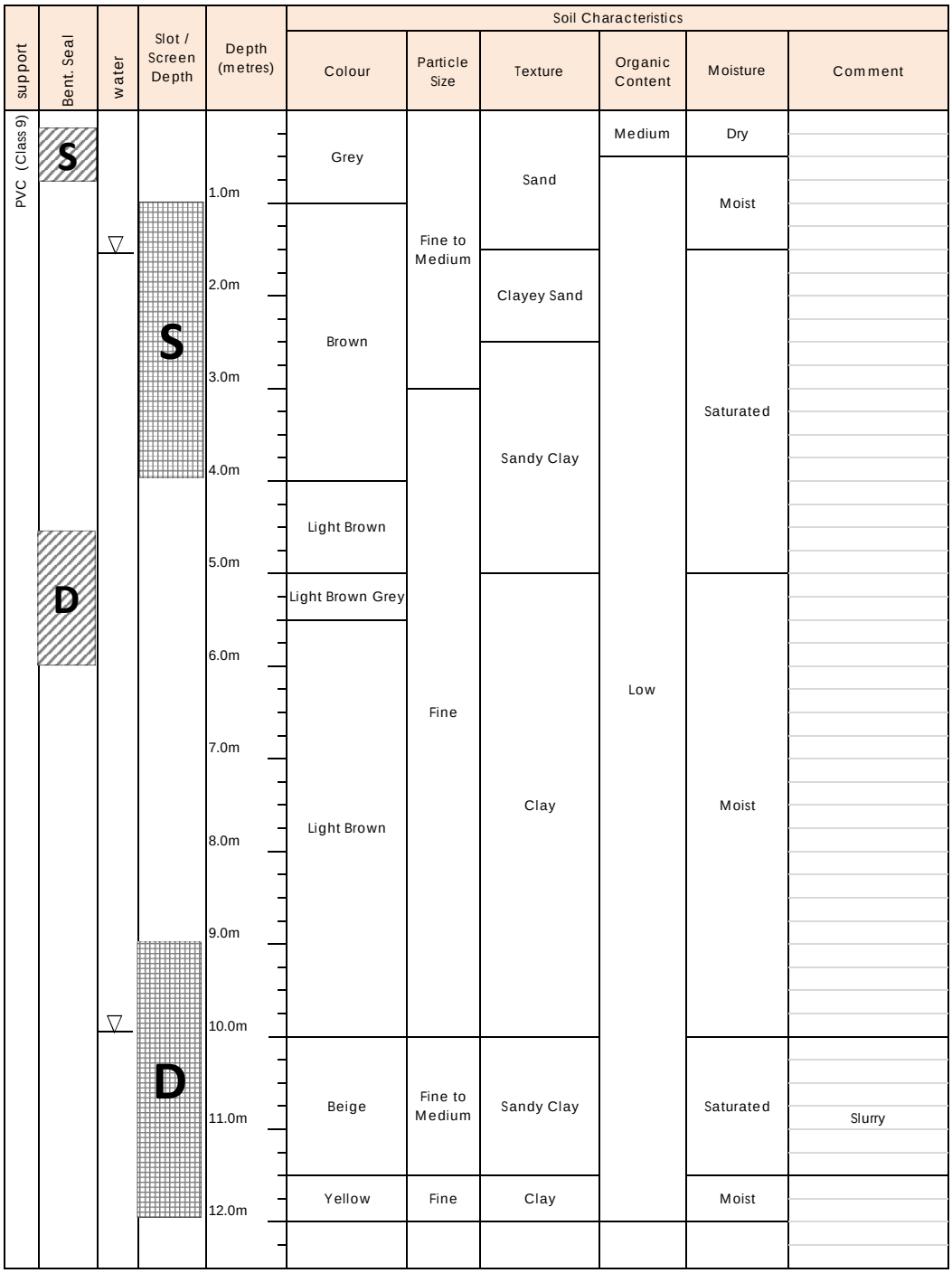
Date	26-08-22
Stickup above NS (m)	0.8
Water Level bTOC (m)	3.51 DRY
Water Level bNS (m)	2.71 DRY

Lithological Log

Hyd2o
Suite 1 387 Hay St
Subiaco, WA 6008

PO Box 1055
Subiaco WA 6904

Date :	**20-07-22**				Bore Name
Client :	**Hesperia**		Job Number :	H21003	
Project:	**Wattle Grove DWMS**		Start Hole :	**10.30am**	
Easting	**405736 D / 405735 S**		End Hole :	**12.30am**	**WG4S/D**
Northing	**6458037 D / 6458036 S**		Logged by :	**SO**	
Datum:	AHD		Total Depth :	**12m D / 4m S**	
Drill type:	Drill Rig Auger		RL Top of Casing (mAHD) :	**25.73 D / 25.66 S**	
Hole diameter:	2.5 inch		RL Nat Surface (mAHD) :	**25.11 D / 25.11 S**	



COLOUR : Black, White, Beige
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	26-08-22
Stickup above NS (m)	0.62 D / 0.55 S
Water Level bTOC (m)	9.82 D / 1.16 S
Water Level bNS (m)	9.20 D / 0.61 S

Lithological Log

Hyd2o
Suite 1 387 Hay St
Subiaco, WA 6008

PO Box 1055
Subiaco WA 6904

Date :	**20-07-22**				Bore Name
Client :	**Hesperia**	Job Number :	H21003		
Project:	**Wattle Grove DWMS**	Start Hole :	**1.30pm**		
Easting	**406304 D / 406304 S**	End Hole :	**5.00 pm**		**WG5S/D**
Northing	**6457566 D / 6457567 S**	Logged by :	**SO**		
Datum:	AHD	Total Depth :	**21m D / 5.3m S**		
Drill type:	Drill Rig Auger	RL Top of Casing (mAHD) :	**35.13 D / 35.14 S**		
Hole diameter:	2.5 inch	RL Nat Surface (mAHD) :	**34.55 D / 34.54 S**		

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)	S			1.0m	Brown Yellow	Fine	Sand	Medium	Dry	
				2.0m	Yellow					
			S	3.0m						
				4.0m	Light Brown					Crumbly sand
				5.0m						Frimer crumbles Some ironstone Probe refusal
				6.0m						
				7.0m	Grey					Tough drilling
				8.0m						Ground down calcrete to fine sand
				9.0m						
				10.0m						
				11.0m	Beige			Low		
				12.0m						
	D			13.0m						
				14.0m						
				15.0m						
				16.0m						
				17.0m						
		▽	D	18.0m						
				19.0m	Beige Grey		Sandy Clay		Moist	
				20.0m	Yellow					
				21.0m					Saturated	Slurry

COLOUR : Black, White, Biege
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	26-08-22
Stickup above NS (m)	0.58 D / 0.60 S
Water Level bTOC (m)	18.78 D / DRY at 5.81 S
Water Level bNS (m)	18.20 D / DRY at 5.21 S

Lithological Log

Hyd2o
Suite 1 387 Hay St
Subiaco, WA 6008

PO Box 1055
Subiaco WA 6904

Date :	**21-07-22**			Bore Name
Client :	**Hesperia**	Job Number :	H21003	
Project:	**Wattle Grove DWMS**	Start Hole :	**8.00am**	
Easting	**405790**	End Hole :	**10.00am**	
Northing	**6457474**	Logged by :	**SO**	**WG6**
Datum:	AHD	Total Depth :	**12m**	
Drill type:	Drill Rig Auger	RL Top of Casing (mAHD) :	**25.34**	
Hole diameter:	2.5 inch	RL Nat Surface (mAHD) :	**24.64**	

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics: Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)				1.0m	Beige	Fine to Medium	Sand	Medium	Dry	
					Brown	Fine				
				2.0m	Light Brown					
				3.0m	Beige					
				4.0m						
				5.0m	Light Brown	Fine to Medium				
				6.0m	Beige			Low		Clay Globules
				7.0m			Clayey Sand			
		▽		8.0m						
				9.0m	Grey	Fine	Sandy Clay		Moist	
				10.0m			Clay		Saturated	
				11.0m	Orange					
				12.0m						

COLOUR : Black, White, Biege
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

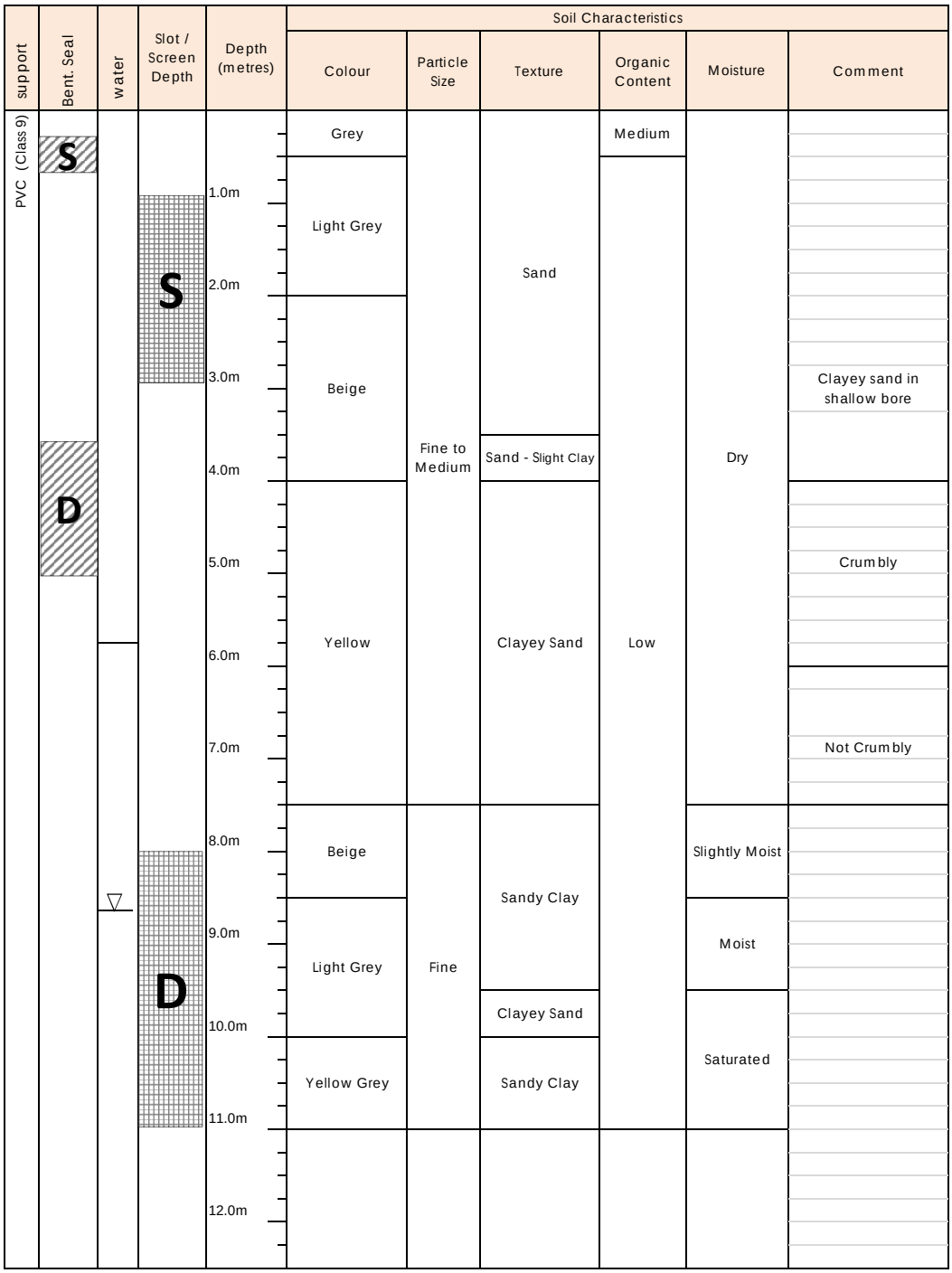
Date	26-08-22
Stickup above NS (m)	0.7
Water Level bTOC (m)	6.94
Water Level bNS (m)	6.24

Lithological Log

Hyd2o
Suite 1 387 Hay St
Subiaco, WA 6008

PO Box 1055
Subiaco WA 6904

Date :	**20-07-22**				Bore Name
Client :	**Hesperia**		Job Number :	H21003	
Project:	**Wattle Grove DWMS**		Start Hole :	**8.00am**	
Easting	**405352 D / 405351 S**		End Hole :	**10.00am**	**WG7S/D**
Northing	**6457884 D / 6457885 S**		Logged by :	**SO**	
Datum:	AHD		Total Depth :	**11m D / 3m S**	
Drill type:	Drill Rig Auger		RL Top of Casing (mAHD) :	**23.44 D / 23.50 S**	
Hole diameter:	2.5 inch		RL Nat Surface (mAHD) :	**22.90 D / 22.85 S**	



COLOUR :	Black, White, Biege
	Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
	Composition : Solid , Blemish, Mottle
PARTICLE SIZE :	Fine, Medium, Course
TEXTURE :	Sand, Loamy Sand, Clayey Sand
	Silt, Loam, Sandy Loam, Clayey Loam
	Clay, Sandy Clay
ORGANICS :	High, Medium, Low
MOISTURE :	Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	26-08-22
Stickup above NS (m)	0.54 D / 0.65 S
Water Level bTOC (m)	5.67 D / DRY at 3.68 S
Water Level bNS (m)	5.13 D / DRY at 3.03 S

Lithological Log

Hyd2o
Suite 1 387 Hay St
Subiaco, WA 6008

PO Box 1055
Subiaco WA 6904

Date :	**21-07-22**				
Client :	**Hesperia**		Job Number :	H21003	Bore Name
Project:	**Wattle Grove DWMS**		Start Hole :	**2.30pm**	
Easting	**405329**		End Hole :	**4.00pm**	**GW5D**
Northing	**6457750**		Logged by :	**SO**	
Datum:	AHD		Total Depth :	**7m**	
Drill type:	Drill Rig Auger		RL Top of Casing	**19.37**	
Hole diameter:	2.5 inch		RL Nat Surface :	**18.81**	

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics: Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)				1.0m	Grey	Fine to Medium	Sand	Medium	Moist	
					Beige			Low	Saturated	Probe refusal @ 1.5m
				2.0m	Light Brown	Fine to Large				Some clay and rocky fragments present - expected hardpan layer
				3.0m	Brown Grey	Fine to Medium	Sandy Clay		Moist	
		▽		4.0m	Grey				Saturated	
				5.0m						
				6.0m						
				7.0m						
				8.0m						
				9.0m						
				10.0m						
				11.0m						
				12.0m						

COLOUR :	Black, White, Biege
	Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
	Composition : Solid , Blemish, Mottle
PARTICLE SIZE :	Fine, Medium, Course
TEXTURE :	Sand, Loamy Sand, Clayey Sand
	Silt, Loam, Sandy Loam, Clayey Loam
	Clay, Sandy Clay
ORGANICS :	High, Medium, Low
MOISTURE :	Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	26-08-22
Stickup above NS (m)	0.56
Water Level bTOC (m)	2.32
Water Level bNS (m)	1.76

Lithological Log

Hyd2o
Suite 1 387 Hay St
Subiaco, WA 6008

PO Box 1055
Subiaco WA 6904

Date :	**22-07-22**		Job Number :	H21003	Bore Name
Client :	**Hesperia**		Start Hole :	**9.30am**	
Project:	**Wattle Grove DWMS**		End Hole :	**11.00am**	**GW8D**
Easting	**405590**		Logged by :	**SO**	
Northing	**6456775**		Total Depth :	**9.5m**	
Datum:	AHD		RL Top of Casing	**24.52**	
Drill type:	Drill Rig Auger		RL Nat Surface :	**24**	
Hole diameter:	2.5 inch				

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)					Beige Grey	Fine to Medium	Sand	Medium	Dry	
				1.0m	Beige					
					Brown Yellow					
				2.0m	Yellow					
					Grey		Clayey Sand		Moist	
				3.0m						
									Saturated	
				4.0m	Yellow Grey		Sandy Clay			
									Moist	
				5.0m		Fine		Low		
				6.0m					Dry	
		▽		7.0m			Clay			
									Moist	
				8.0m						
				9.0m						
					Beige	Fine to Medium	Sand		Saturated	
				10.0m						
				11.0m						
				12.0m						

COLOUR : Black, White, Beige
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

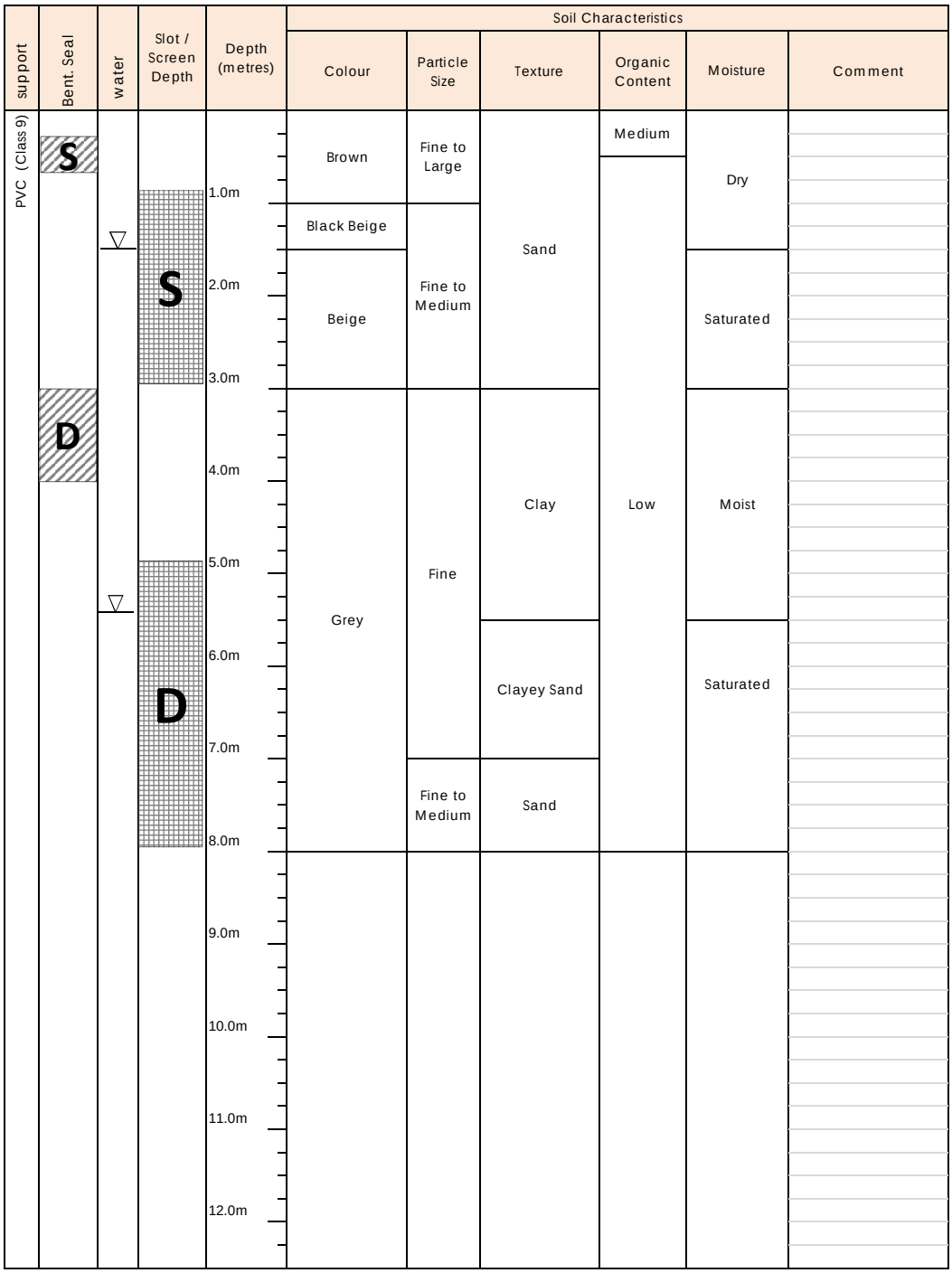
Date	26-08-22
Stickup above NS (m)	0.52
Water Level bTOC (m)	6.78
Water Level bNS (m)	6.26

Lithological Log

Hyd2o
Suite 1 387 Hay St
Subiaco, WA 6008

PO Box 1055
Subiaco WA 6904

Date :	**22-07-22**				Bore Name
Client :	**Hesperia**	Job Number :	H21003		
Project:	**Wattle Grove DWMS**	Start Hole :	**11.30am**		**GW9S/D**
Easting	**405329 D / 405329 S**	End Hole :	**1.30pm**		
Northing	**6457513 D / 6457512 S**	Logged by :	**SO**		
Datum:	AHD	Total Depth :	**8.0m**		
Drill type:	Drill Rig Auger	RL Top of Casing	**21.78 D / 21.81 S**		
Hole diameter:	2.5 inch	RL Nat Surface :	**21.20 D / 21.19 S**		



COLOUR :	Black, White, Beige
	Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
	Composition : Solid , Blemish, Mottle
PARTICLE SIZE :	Fine, Medium, Course
TEXTURE :	Sand, Loamy Sand, Clayey Sand
	Silt, Loam, Sandy Loam, Clayey Loam
	Clay, Sandy Clay
ORGANICS :	High, Medium, Low
MOISTURE :	Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	26-08-22
Stickup above NS (m)	0.58 D / 0.62 S
Water Level bTOC (m)	2.35 D / 2.11 S
Water Level bNS (m)	1.77 D / 1.49 S

Lithological Log

Hyd2o
Suite 1 387 Hay St
Subiaco, WA 6008

PO Box 1055
Subiaco WA 6904

Date :	**10-10-22**			Bore Name
Client :	**Hesperia**	Job Number :	H21003	
Project:	**Wattle Grove DWMS**	Start Hole :	**8.00am**	
Easting	**406954***	End Hole :	**12.00 pm**	**WG8**
Northing	**6457829***	Logged by :	**SO**	
Datum:	AHD	Total Depth :	**30m**	
Drill type:	Drill Rig Auger	RL Top of Casing (mAHD) :		
Hole diameter:	2.5 inch	RL Nat Surface (mAHD) :		

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)				2.0m	Grey - Orange			Medium		small amount feldspar stone fragments
				4.0m	Light Brown					more frequent feldspar stone fragments
				6.0m	Yellow					
				8.0m	Light Brown					Tight digging began
				10.0m	Bright Orange Brown	Fine			Dry	
				12.0m						
				14.0m	Light Brown		Sand	Low		
				16.0m						white crumbly fragments
				18.0m	Dark Beige					
				20.0m						
				22.0m	Beige					
				24.0m	Light Brown	Fine to Medium				Loose digging began
				26.0m					Moist	
				28.0m	Light Grey					
				30.0m	Light Brown	Fine				
				32.0m						
				34.0m						
				36.0m						
				38.0m						
				40.0m						



COLOUR :	Black, White, Biege
	Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
	Composition : Solid , Blemish, Mottle
PARTICLE SIZE :	Fine, Medium, Course
TEXTURE :	Sand, Loamy Sand, Clayey Sand
	Silt, Loam, Sandy Loam, Clayey Loam
	Clay, Sandy Clay
ORGANICS :	High, Medium, Low
MOISTURE :	Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	10-10-22
Stickup above NS (m)	0.7
Water Level bTOC (m)	25.19
Water Level bNS (m)	24.49

Lithological Log

Hyd2o
Suite 1 387 Hay St
Subiaco, WA 6008

PO Box 1055
Subiaco WA 6904

Date :	**10-10-22**			Bore Name
Client :	**Hesperia**	Job Number :	H21003	
Project:	**Wattle Grove DWMS**	Start Hole :	**1.00pm**	
Easting	**405650***	End Hole :	**3.00pm**	**WG9**
Northing	**6457336***	Logged by :	**SO**	
Datum:	AHD	Total Depth :	**8m**	
Drill type:	Drill Rig Auger	RL Top of Casing (mAHD) :		
Hole diameter:	2.5 inch	RL Nat Surface (mAHD) :		

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics: Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)		▽		1.0m	Grey	Fine to Medium	Sand	Medium	Dry	
					Beige	Fine				
				2.0m	Light Grey Brown	Fine to Medium		Low		
					Brown					
				3.0m						
				4.0m	Beige					
				5.0m						
				6.0m					Saturated	large clay chunks
				7.0m	White					
				8.0m						
				9.0m						
				10.0m						
				11.0m						
				12.0m						



COLOUR : Black, White, Beige
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	10-10-22
Stickup above NS (m)	0.61
Water Level bTOC (m)	4.14
Water Level bNS (m)	3.53

Lithological Log

Hyd2o
Suite 1 387 Hay St
Subiaco, WA 6008

PO Box 1055
Subiaco WA 6904

Date :	**11-10-22**				Bore Name
Client :	**Hesperia**		Job Number :	H21003	
Project:	**Wattle Grove DWMS**		Start Hole :	**8.30am**	
Easting	**405365**		End Hole :	**11.00am**	**WG10**
Northing	**6458073**		Logged by :	**SO**	
Datum:	AHD		Total Depth :	**9m**	
Drill type:	Drill Rig Auger		RL Top of Casing (mAHD) :		
Hole diameter:	2.5 inch		RL Nat Surface (mAHD) :		

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics: Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)	S			1.0m	Grey	Fine to Medium	Sand	Medium	Dry	
					Beige - White			Low		
		▽	S	2.0m	Beige - White with Orange				Moist	
				3.0m	Brown		Sandy Clay			
							Clay		Dry	
	D			4.0m		Fine	Sandy Clay		Moist	
					Grey Yellow		Clayey Sand			
		▽		5.0m	Grey	Fine to Medium				
				6.0m					Saturated	
			D	7.0m	Light Brown					
				8.0m	Grey					
				9.0m						
				10.0m						
				11.0m						
				12.0m						

COLOUR : Black, White, Beige
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

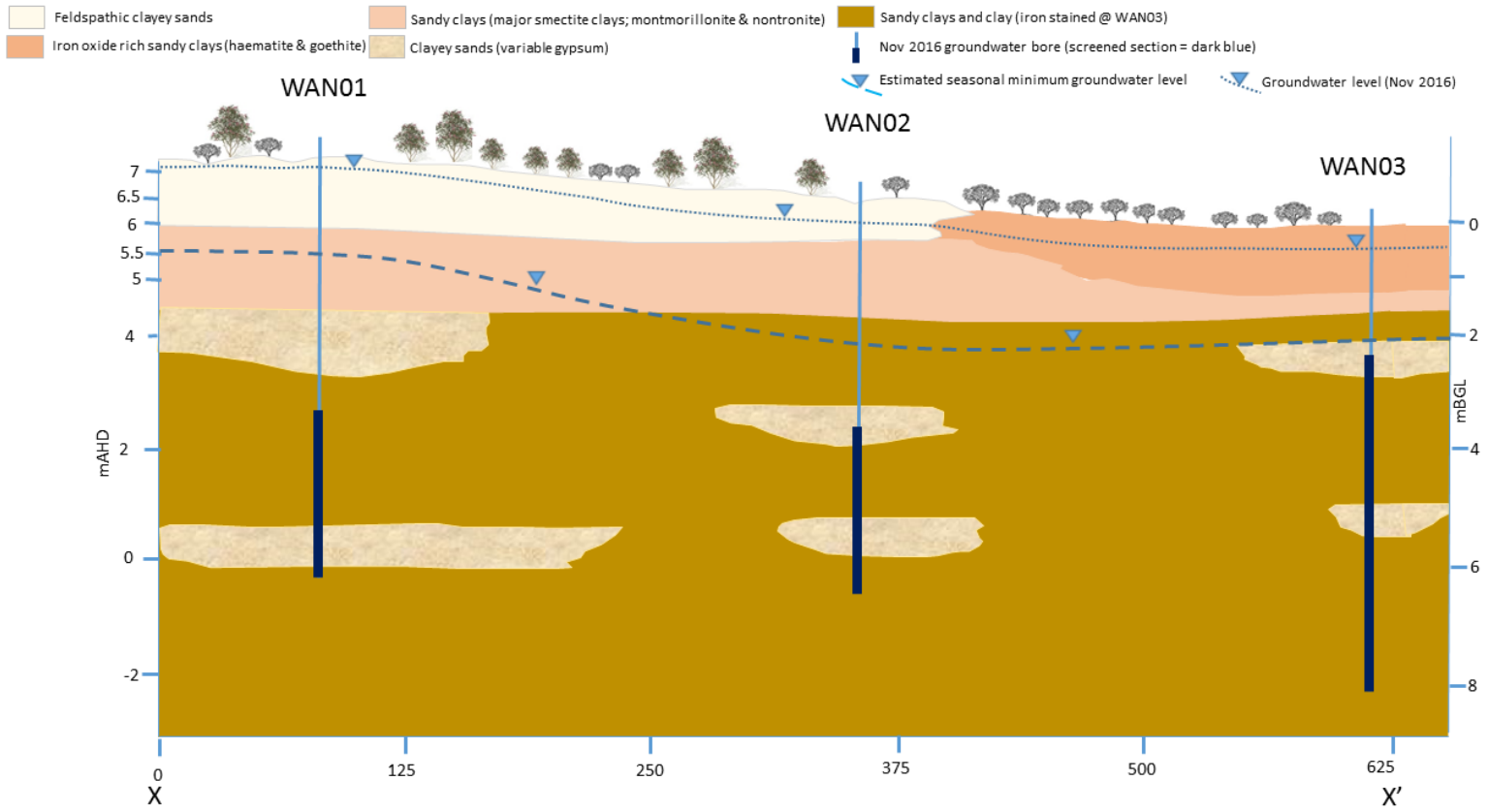
TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

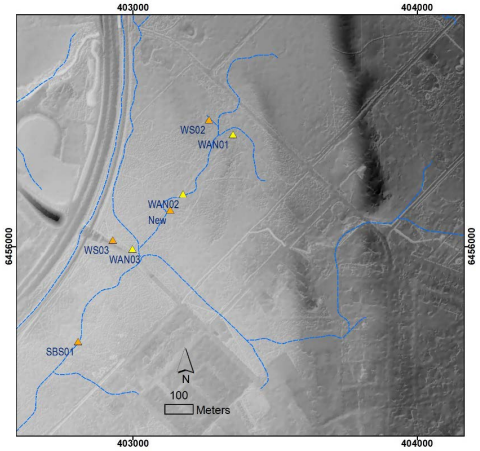
ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	
Stickup above NS (m)	
Water Level bTOC (m)	
Water Level bNS (m)	

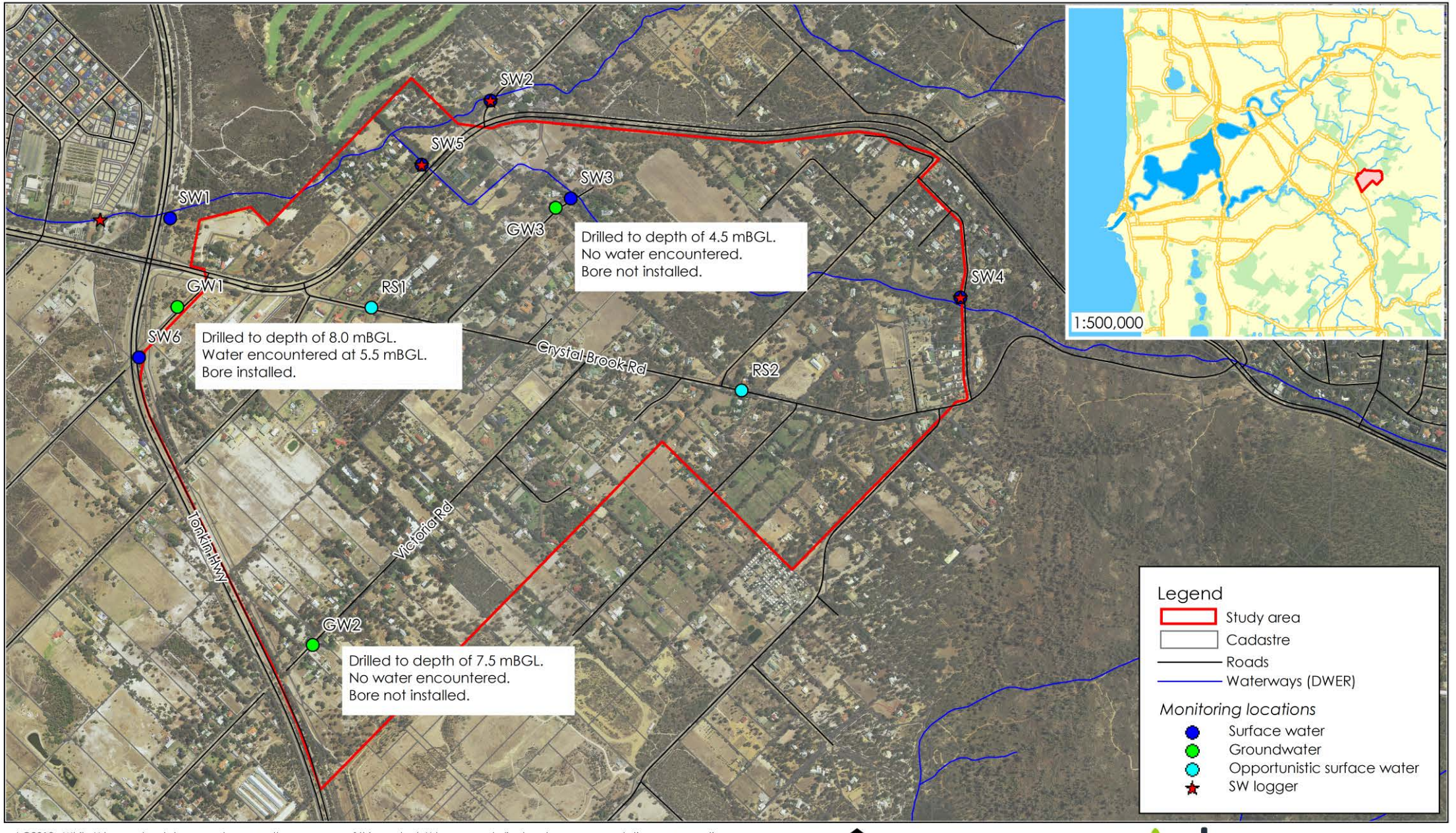




Drilling and construction summary

	WAN01	WAN02	WAN03
Drilling date	7/11/2016	7/11/2016	7/11/2016
Drilling start time (aprox)	8:30AM	12:00 noon	2:15PM
Depth hole (m)	7.5	7	8.2
Depth Bore (m)	7.5	7	8.2
Bore diametre (mm)	0.5	0.5	0.5
top of slotted section (m bgl)	4.5	4	2.2
bottom of slotted section m bgl)	7.5	7	8.2
bentonite seal from (m bgl)	1	1	1
bentonite seal to (m bgl)	1.5	1.5	1.5
gravel pack from (m bgl)	1.5	1.5	1.5
gravel pack to (m bgl)	7.5	7	8.2
Steel riser length	0.45	0.47	0.47
PVC stick up	0.32	0.25	0.33

City of Kalamunda - Wattle Grove South Monitoring
Figure 1 - Monitoring sites



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Data source: DWER, MRWA, DPLH, CoK, Created by: AT., Projection: MGA: zone 50.

0 500
metres
Scale 1:16,000 @ A4

urbaqua
land and water solutions

BOREHOLE LOG

Bore ID: GW1

CLIENT: City of Kalamunda	**DATE COMMENCED:** 3/9/2019
PROJECT: Wattle Grove Monitoring	**DATE COMPLETED:** 3/9/2019
LOCATION: Boundary Rd, Wattle Grove	**LOGGED BY:** AT
CONTRACTOR: eDrill	**INSTALLATION METHOD:** Rotary drill
HORIZONTAL DATUM: GDA94 Zone 50	**R.L. SURFACE (m AHD):** ~23
EASTING: 405,363	**TOTAL DEPTH (m):** 8
NORTHING: 6,458,076	**DIAMETER (mm):** 50

Depth BGL (m)	Sample Taken	Water	Graphic log	Lithology	Observations
1.0				0-3 m: Sand, grey, medium grained, well sorted, damp	
2.0					
3.0				3-5 m: Clayey sand, grey, fine-medium grained, well sorted, damp	
4.0					
5.0				5-8 m: Clayey sand, grey, wet/saturated	
		▽			Water encountered at 5.5 mBGL
6.0					
7.0					
8.0				Bore terminated	

NOTE:

- Monitor Well Screen
- Gravel Pack
- Bentonite Layer
- Sand Fill
- Cement Grout
- ▽ Water encountered



Figure 1: Samples collected at 0.5 m intervals during drilling



Figure 2: Drill rig on location

BOREHOLE LOG

Bore ID: GW2

CLIENT: City of Kalamunda	**DATE COMMENCED:** 3/9/2019
PROJECT: Wattle Grove Monitoring	**DATE COMPLETED:** 3/9/2019
LOCATION: Vicrtoria, Wattle Grove	**LOGGED BY:** AT
CONTRACTOR: eDrill	**INSTALLATION METHOD:** Rotary drill
HORIZONTAL DATUM: GDA94 Zone 50	**R.L. SURFACE (m AHD):** ~ 26
EASTING: 405,789.6	**TOTAL DEPTH (m):** 7.5 m
NORTHING: 6,456,982.4	**DIAMETER (mm):** 50

Depth BGL (m)	Sample Taken	Water	Graphic log	Lithology	Observations
				0-0.5: Sand, grey, medium grained, moderately sorted, damp	
				0.5-3.5: Clayey-sand, grey, medium-fine grained, well sorted, dry	
1.0					
2.0					
3.0					
				3.5-7.5 m: Clayey sand with clay bands Grey, well sorted, fine grained, dry	
4.0					
5.0					
6.0					
7.0					
				7.5 m: No water encountered, bore terminated	
8.0					

NOTE:

- Monitor Well Screen
- Gravel Pack
- Bentonite Layer
- Sand Fill
- Cement Grout
- ▽ Water encountered



Figure 1: Samples collected at 0.5 m intervals during drilling



Figure 2: Drill rig on location

BOREHOLE LOG

Bore ID: GW3

CLIENT:	City of Kalamunda	**DATE COMMENCED:** 3/9/2019	
PROJECT:	Wattle Grove Monitoring	**DATE COMPLETED:** 3/9/2019	
LOCATION:	Johnson Place, Wattle Grove	**LOGGED BY:** AT	
CONTRACTOR: eDrill		**INSTALLATION METHOD:** Rotary drill	
HORIZONTAL DATUM: GDA94 Zone 50		**R.L. SURFACE (m AHD):** ~36	
EASTING: 406,645.4		**TOTAL DEPTH (m):** 4.5	
NORTHING: 6,458,437.8		**DIAMETER (mm):** 50	

Depth BGL (m)	Sample Taken	Water	Lithology	Observations
			0 - 0.2 m: Sand, grey, medium grained, moderately sorted, damp	
			0.2 - 0.5 m: Loose gravelly-sand, coarse grained, poorly sorted, damp	
			0.5 - 1.5 m: Laterite, yellow/red, clayey-sand, damp	
1.0				
			1.5 - 4.5 m: Indurated clay, red/orange, dry	
2.0				
3.0				
4.0				
5.0				

NOTE:

- Monitor Well Screen
- Gravel Pack
- Bentonite Layer
- Sand Fill
- Cement Grout

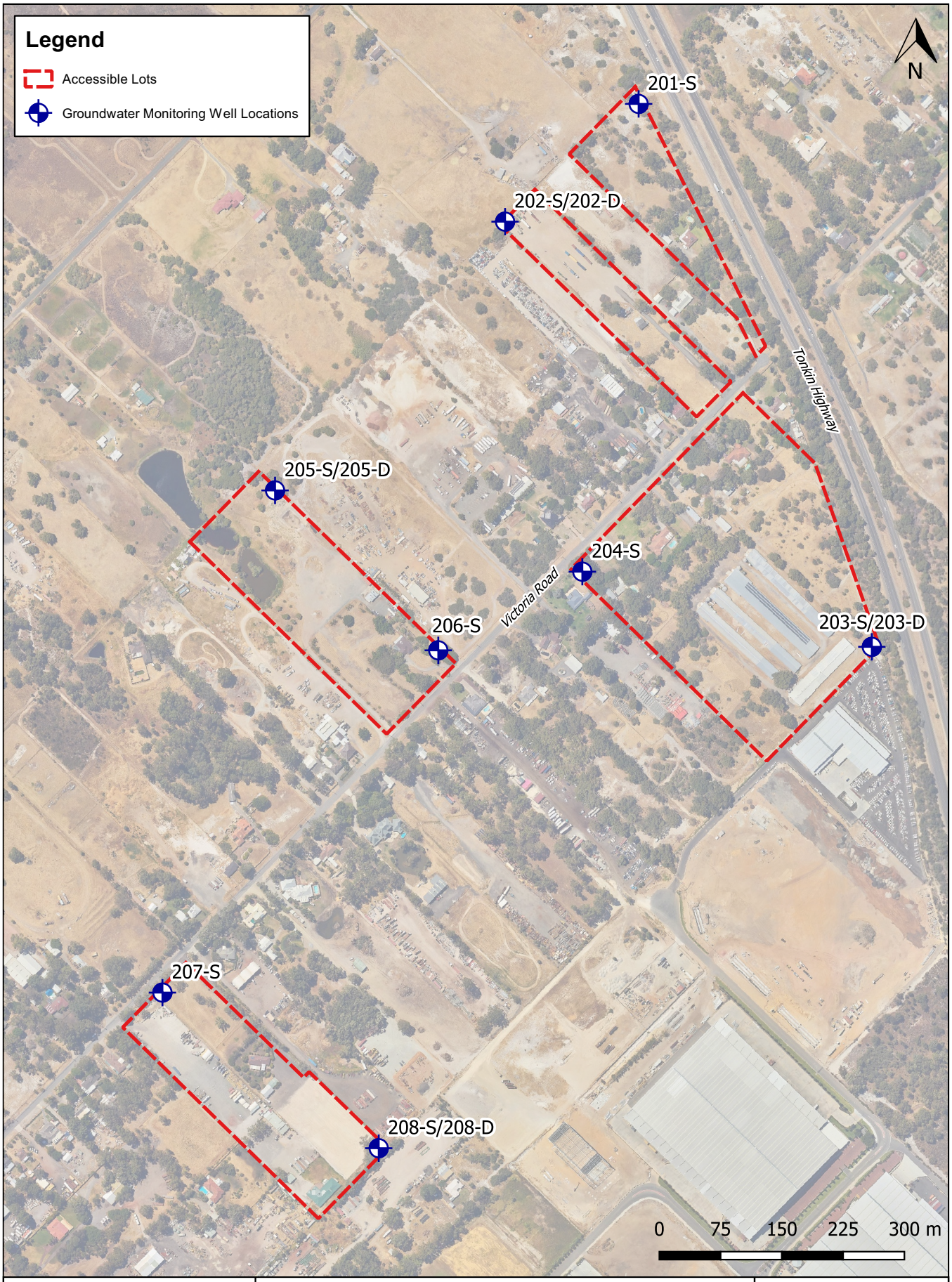
Water encountered



Figure 1: Samples collected at 0.5 m intervals during drilling



Figure 2: Drill rig on location



Douglas Partners Geotechnics / Environment / Groundwater	**Test Location Plan - Groundwater Monitoring Wells** **Proposed Industrial Development** **Victoria Road, Kenwick, WA**	PROJECT: 202795.02 Drawing No: 2 REV: 0
	CLIENT: Hesperia Property Pty Ltd	DATE: 19/11/2022

BOREHOLE LOG

CLIENT: Hesperia Property Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: Victoria Road, Kenwick, WA

SURFACE LEVEL: 23.2 m AHD*
EASTING: 405483
NORTHING: 6457148
DIP/AZIMUTH: 90°/--

BORE No: MW201-S
PROJECT No: 202795.02
DATE: 12/10/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
23	0	SAND SP: fine to medium grained, grey, trace silt, moist.							Top Cap
22	1								Backfill
21	2								
20	3								Bentonite Seal
19	4	- becoming brown from 4 m depth.						12-10-22	
18	5	- becoming wet from 4.5 m depth. - becoming grey from 5 m depth.							Gravel Pack 50 mm class 18 Slotted PVC Pipe
17	6								
16	7	7.0 Bore discontinued at 7.0m (Target Depth)							End Cap
15	8								
14	9								
13	10								
12	11								
11	12								
10	13								
9	14								

RIG: Geoprobe 7822DT **DRILLER:** DPP **LOGGED:** HM **CASING:**

TYPE OF BORING: Solid Flight Auger/Direct Push Probe

WATER OBSERVATIONS: Groundwater observed at 4.2 m depth. Observed at time of drilling and should be considered with caution.

REMARKS: Location coordinates are in MGA94 Zone 50 H. Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

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

BOREHOLE LOG

CLIENT: Hesperia Property Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: Victoria Road, Kenwick, WA

SURFACE LEVEL: 20.7 m AHD*
EASTING: 405320
NORTHING: 6457004
DIP/AZIMUTH: 90°/--

BORE No: MW202-D
PROJECT No: 202795.02
DATE: 13/10/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
20.5	0.2	TOPSOIL/SAND SP: fine to medium grained, brown, trace silt, trace rootlets, moist.							Top Cap
		SAND SP: fine to medium grained, grey, trace silt, moist.							
		- becoming brown with silt (SP-SM) from 2 m depth.							Backfill
17.2	3.5	Clayey SAND SC: fine to medium grained, grey, low to medium plasticity, wet.							Bentonite Seal
11.7	9.0	Sandy CLAY CL-CI: low to meduim plasticity, brown-black, fine to medium grained, wet.						13-10-22	Gravel Pack
									50 mm class 18 Slotted PVC Pipe
10.2	10.5	Bore discontinued at 10.5m (Target Depth)							End Cap

RIG: Geoprobe 7822DT **DRILLER:** DPP **LOGGED:** HM **CASING:**

TYPE OF BORING: Solid Flight Auger/Direct Push Probe

WATER OBSERVATIONS: Groundwater observed at 9.1 m depth. Observed at time of drilling and should be considered with caution.

REMARKS: Location coordinates are in MGA94 Zone 50 H. Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

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

BOREHOLE LOG

CLIENT: Hesperia Property Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: Victoria Road, Kenwick, WA

SURFACE LEVEL: 20.7 m AHD*
EASTING: 405319
NORTHING: 6457002
DIP/AZIMUTH: 90°/--

BORE No: MW202-S
PROJECT No: 202795.02
DATE: 13/10/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
20	0.2	TOPSOIL/SAND SP: fine to medium grained, brown, trace silt, trace rootlets, moist.							Top Cap
		SAND SP: fine to medium grained, grey, trace silt, moist.							Backfill
19	2	- becoming brown with silt (SP-SM) from 2 m depth.						13-10-22	Bentonite Seal
18	3								Gravel Pack
17	3.5	Clayey SAND SC: fine to medium grained, grey, low to medium plasticity, wet.							50 mm class 18 Slotted PVC Pipe
16	5.0	Bore discontinued at 5.0m (Target Depth)							End Cap

RIG: Geoprobe 7822DT **DRILLER:** DPP **LOGGED:** HM **CASING:**

TYPE OF BORING: Solid Flight Auger/Direct Push Probe

WATER OBSERVATIONS: Groundwater observed at 1.9 m depth. Observed at time of drilling and should be considered with caution.

REMARKS: Location coordinates are in MGA94 Zone 50 H. Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

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

BOREHOLE LOG

CLIENT: Hesperia Property Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: Victoria Road, Kenwick, WA

SURFACE LEVEL: 26.9 m AHD*
EASTING: 405763
NORTHING: 6456481
DIP/AZIMUTH: 90°/--

BORE No: MW203-D
PROJECT No: 202795.02
DATE: 12/10/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
26.7	0.2	TOPSOIL/SAND SP: fine to medium grained, brown, trace silt, trace rootlets, moist.							Top Cap
		SAND SP: fine to medium grained, grey, trace silt, moist. - becoming yellow-brown from 1 m depth.							
23.9	3.0	Clayey SAND SC: fine to medium grained, grey mottled orange brown, trace gravel, low to medium plasticity, moist.							
22.9	4.0	Gravelly Sandy CLAY CL-CI: low to medium plasticity, red-brown, fine to medium grained, fine to coarse sized, moist.							Backfill
20.9	6.0	Sandy CLAY CL-CI: low to medium plasticity, red-brown, fine to medium grained, trace gravel, moist.						12-10-22	
15.4	11.5	Clayey SAND SC: fine to medium grained, grey, low to medium plasticity, wet.							Bentonite Seal Gravel Pack 50 mm class 18 Slotted PVC Pipe
12.9	14.0	Bore discontinued at 14.0m (Target Depth)							End Cap

RIG: Geoprobe 7822DT **DRILLER:** DPP **LOGGED:** HM **CASING:**

TYPE OF BORING: Solid Flight Auger/Direct Push Probe

WATER OBSERVATIONS: Groundwater observed at 8.3 m depth. Observed at time of drilling and should be considered with caution.

REMARKS: Location coordinates are in MGA94 Zone 50 H. Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

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

BOREHOLE LOG

CLIENT: Hesperia Property Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: Victoria Road, Kenwick, WA

SURFACE LEVEL: 26.9 m AHD*
EASTING: 405765
NORTHING: 6456480
DIP/AZIMUTH: 90°/--

BORE No: MW203-S
PROJECT No: 202795.02
DATE: 12/10/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
26.9	0.2	TOPSOIL/SAND SP: fine to medium grained, brown, trace silt, trace rootlets, moist.							Top Cap
		SAND SP: fine to medium grained, grey, trace silt, moist.							Backfill
26	1	- becoming yellow-brown from 1 m depth.							Bentonite Seal
25	2								
24	3								Gravel Pack
	3.0	Clayey SAND SC: fine to medium grained, grey mottled orange brown, trace gravel, low to medium plasticity, moist.							
23	4								50 mm class 18 Slotted PVC Pipe
	4.0	Gravelly Sandy CLAY CL-CI: low to medium plasticity, red-brown, fine to medium grained, fine to coarse sized, moist.							
22	5								End Cap
	5.0	Bore discontinued at 5.0m (Target Depth)							
21	6								
20	7								
19	8								
18	9								
17	10								
16	11								
15	12								
14	13								
13	14								

RIG: Geoprobe 7822DT **DRILLER:** DPP **LOGGED:** HM **CASING:**

TYPE OF BORING: Solid Flight Auger/Direct Push Probe

WATER OBSERVATIONS: Groundwater not observed. Observation at time of drilling and should be considered with caution.

REMARKS: Location coordinates are in MGA94 Zone 50 H. Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

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

BOREHOLE LOG

CLIENT: Hesperia Property Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: Victoria Road, Kenwick, WA

SURFACE LEVEL: 24.0 m AHD*
EASTING: 405408
NORTHING: 6456579
DIP/AZIMUTH: 90°/--

BORE No: MW204-S
PROJECT No: 202795.02
DATE: 12/10/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
24	0.2	TOPSOIL/SAND SP: fine to medium grained, brown, trace silt, trace rootlets, moist.							Top Cap; Bentonite Seal
23	1	SAND SP: fine to medium grained, grey, trace silt, moist. - becoming pale grey from 0.5 m depth.							
22	2								
21	3								Gravel Pack
20	4	- becoming yellow-brown from 3.5 m depth.							50 mm class 18 Slotted PVC Pipe
19	4.5	Clayey SAND SC: fine to medium grained, grey mottled orange brown, trace gravel, low to medium plasticity, moist.							
18	5								
17	6	- becoming red-brown with iron cemented gravel zones from 5.5 m depth.							
16	7	7.0 Bore discontinued at 7.0m (Target Depth)							End Cap
15	8								
14	9								
13	10								
12	11								
11	12								
10	13								
	14								

RIG: Geoprobe 7822DT **DRILLER:** DPP **LOGGED:** HM **CASING:**

TYPE OF BORING: Solid Flight Auger/Direct Push Probe

WATER OBSERVATIONS: Groundwater not observed. Observation undertaken at time of drilling and should be considered with caution.

REMARKS: Location coordinates are in MGA94 Zone 50 H. Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Hesperia Property Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: Victoria Road, Kenwick, WA

SURFACE LEVEL: 16.5 m AHD*
EASTING: 405033
NORTHING: 6456675
DIP/AZIMUTH: 90°/--

BORE No: MW205-D
PROJECT No: 202795.02
DATE: 13/10/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	TOPSOIL/SAND SP: fine to medium grained, brown, trace silt, trace rootlets, moist.							Top Cap
		SAND SP: fine to medium grained, grey, trace silt, moist.							
	2.5	Clayey SAND SC: fine to medium grained, grey, low to medium plasticity, moist.							Backfill
		- becoming brown from 6.5 m depth.						13-10-22	
		- becoming wet from 7 m depth.							Bentonite Seal
									Gravel Pack
									50 mm class 18 Slotted PVC Pipe
	10.0	Bore discontinued at 10.0m (Target Depth)							End Cap

RIG: Geoprobe 7822DT **DRILLER:** DPP **LOGGED:** HM **CASING:**

TYPE OF BORING: Solid Flight Auger/Direct Push Probe

WATER OBSERVATIONS: Groundwater observed at 4.2 m depth. Observed at time of drilling and should be considered with caution.

REMARKS: Location coordinates are in MGA94 Zone 50 H. Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

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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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Hesperia Property Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: Victoria Road, Kenwick, WA

SURFACE LEVEL: 16.5 m AHD*
EASTING: 405034
NORTHING: 6456674
DIP/AZIMUTH: 90°/--

BORE No: MW205-S
PROJECT No: 202795.02
DATE: 14/10/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
16	0.2	TOPSOIL/SAND SP: fine to medium grained, brown, trace silt, trace rootlets, moist.							Top Cap
		SAND SP: fine to medium grained, grey, trace silt, moist.							Bentonite Seal
15	1	- becoming wet from 1 m depth.						14-10-22	
	2								Gravel Pack
14	2.5	Clayey SAND SC: fine to medium grained, grey, low to medium plasticity, moist.							50 mm class 18 Slotted PVC Pipe
	3								
13	4	4.0 Bore discontinued at 4.0m (Target Depth)							End Cap
12	5								
11	6								
10	7								
9	8								
8	9								
7	10								
6	11								
5	12								
4	13								
3	14								

RIG: Geoprobe 7822DT **DRILLER:** DPP **LOGGED:** HM **CASING:**

TYPE OF BORING: Solid Flight Auger/Direct Push Probe

WATER OBSERVATIONS: Groundwater observed at 1.1 m depth. Observed at time of drilling and should be considered with caution.

REMARKS: Location coordinates are in MGA94 Zone 50 H. Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

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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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Hesperia Property Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: Victoria Road, Kenwick, WA

SURFACE LEVEL: 20.0 m AHD*
EASTING: 405237
NORTHING: 6456474
DIP/AZIMUTH: 90°/--

BORE No: MW206-S
PROJECT No: 202795.02
DATE: 12/10/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
20	0.3	TOPSOIL/SAND SP: fine to medium grained, brown, trace silt, trace rootlets, moist.							Top Cap
19	1	SAND SP: fine to medium grained, grey, trace silt, moist.							Backfill
18	2.0	Gravelly SAND SP-SM: fine to medium grained, brown, fine to coarse sized, with silt, moist.							Bentonite Seal
17	3.0	SAND SP: fine to medium grained, yellow-brown, trace silt, wet.						12-10-22	Gravel Pack
16	4.0	Clayey SAND SC: fine to medium grained, grey, low to medium plasticity, wet.							50 mm class 18 Slotted PVC Pipe
15	5.0	Bore discontinued at 5.0m (Target Depth)							End Cap
14	6								
13	7								
12	8								
11	9								
10	10								
9	11								
8	12								
7	13								
6	14								

RIG: Geoprobe 7822DT **DRILLER:** DPP **LOGGED:** HM **CASING:**

TYPE OF BORING: Solid Flight Auger/Direct Push Probe

WATER OBSERVATIONS: Groundwater observed at 2.7 m depth. Observed at time of drilling and should be considered with caution.

REMARKS: Location coordinates are in MGA94 Zone 50 H. Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Hesperia Property Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: Victoria Road, Kenwick, WA

SURFACE LEVEL: 13.0 m AHD*
EASTING: 404905
NORTHING: 6456053
DIP/AZIMUTH: 90°/--

BORE No: MW207-S
PROJECT No: 202795.02
DATE: 13/10/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
13	0.4	TOPSOIL/SAND SP: fine to medium grained, brown, trace silt, trace rootlets, moist.							Top Cap Bentonite Seal
12	1	SAND SP: fine to medium grained, yellow-brown, trace silt, moist. - becoming wet from 1 m depth.							
11	1.5	Clayey SAND SC: fine to medium grained, grey, low to medium plasticity, wet.							Gravel Pack
10	2.5	Gravelly Sandy CLAY CL-CI: low to medium plasticity, grey mottled orange-red-brown, fine to medium grained, fine to coarse sized, moist.							50 mm class 18 Slotted PVC Pipe
9	3.0	Sandy CLAY CL-CI: low to medium plasticity, grey, fine to medium grained, moist.							
8	4.0	Bore discontinued at 4.0m (Target Depth)							End Cap
7	5								
6	6								
5	7								
4	8								
3	9								
2	10								
1	11								
0	12								
-1	13								
-2	14								

RIG: Geoprobe 7822DT **DRILLER:** DPP **LOGGED:** HM **CASING:**

TYPE OF BORING: Solid Flight Auger/Direct Push Probe

WATER OBSERVATIONS: Groundwater not observed. Observation undertaken at time of drilling and should be considered with caution.

REMARKS: Location coordinates are in MGA94 Zone 50 H. Surface level measured using a differential GPS with a reported accuracy of 0.5 m.

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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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Hesperia Property Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: Victoria Road, Kenwick, WA

SURFACE LEVEL: 15.2 m AHD*
EASTING: 405158
NORTHING: 6455878
DIP/AZIMUTH: 90°/--

BORE No: MW208-D
PROJECT No: 202795.02
DATE: 13/10/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
15	0.2	TOPSOIL/SAND SP: fine to medium grained, brown, trace silt, trace rootlets, moist.							Top Cap
		SAND SP: fine to medium grained, grey, trace silt, moist.							
14	1.0	- becoming wet from 0.5 m depth.							
		Gravelly SAND SP-SM: fine to medium grained, brown, fine to coarse sized, with silt, wet.							
13	2.0	Clayey SAND SC: fine to medium grained, grey-brown, low to medium plasticity, wet.						13-10-22	Backfill
12									
11									
10	5.0	Sandy CLAY CI: medium plasticity, grey, fine to medium grained, wet.							Bentonite Seal
9									
8	7.0	Clayey SAND SC: fine to medium grained, yellow-brown, low to medium plasticity, wet.							Gravel Pack
									50 mm class 18 Slotted PVC Pipe
7	9.0	Bore discontinued at 9.0m (Target Depth)							End Cap
6									
5									
4									
3									
2									
1									

RIG: Geoprobe 7822DT **DRILLER:** DPP **LOGGED:** HM **CASING:**

TYPE OF BORING: Solid Flight Auger/Direct Push Probe

WATER OBSERVATIONS: Groundwater observed at 2.5 m depth. Observed at time of drilling and should be considered with caution.

REMARKS: Location coordinates are in MGA94 Zone 50 H. Surface level measured using a differential GPS with a reported accuracy of 0.5 m.

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Hesperia Property Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: Victoria Road, Kenwick, WA

SURFACE LEVEL: 15.2 m AHD*
EASTING: 405159
NORTHING: 6455878
DIP/AZIMUTH: 90°/--

BORE No: MW208-S
PROJECT No: 202795.02
DATE: 13/10/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
15	0.2	TOPSOIL/SAND SP: fine to medium grained, brown, trace silt, trace rootlets, moist.							Top Cap
		SAND SP: fine to medium grained, grey, trace silt, moist.							Bentonite Seal
14	1.0	- becoming wet from 0.5 m depth.						13-10-22	
		Gravelly SAND SP-SM: fine to medium grained, brown, fine to coarse sized, with silt, wet.							
13	2.0	Clayey SAND SC: fine to medium grained, grey-brown, low to medium plasticity, wet.							Gravel Pack
									50 mm class 18 Slotted PVC Pipe
12	4.0	Bore discontinued at 4.0m (Target Depth)							End Cap
11									
10									
9									
8									
7									
6									
5									
4									
3									
2									
1									

RIG: Geoprobe 7822DT **DRILLER:** DPP **LOGGED:** HM **CASING:**

TYPE OF BORING: Solid Flight Auger/Direct Push Probe

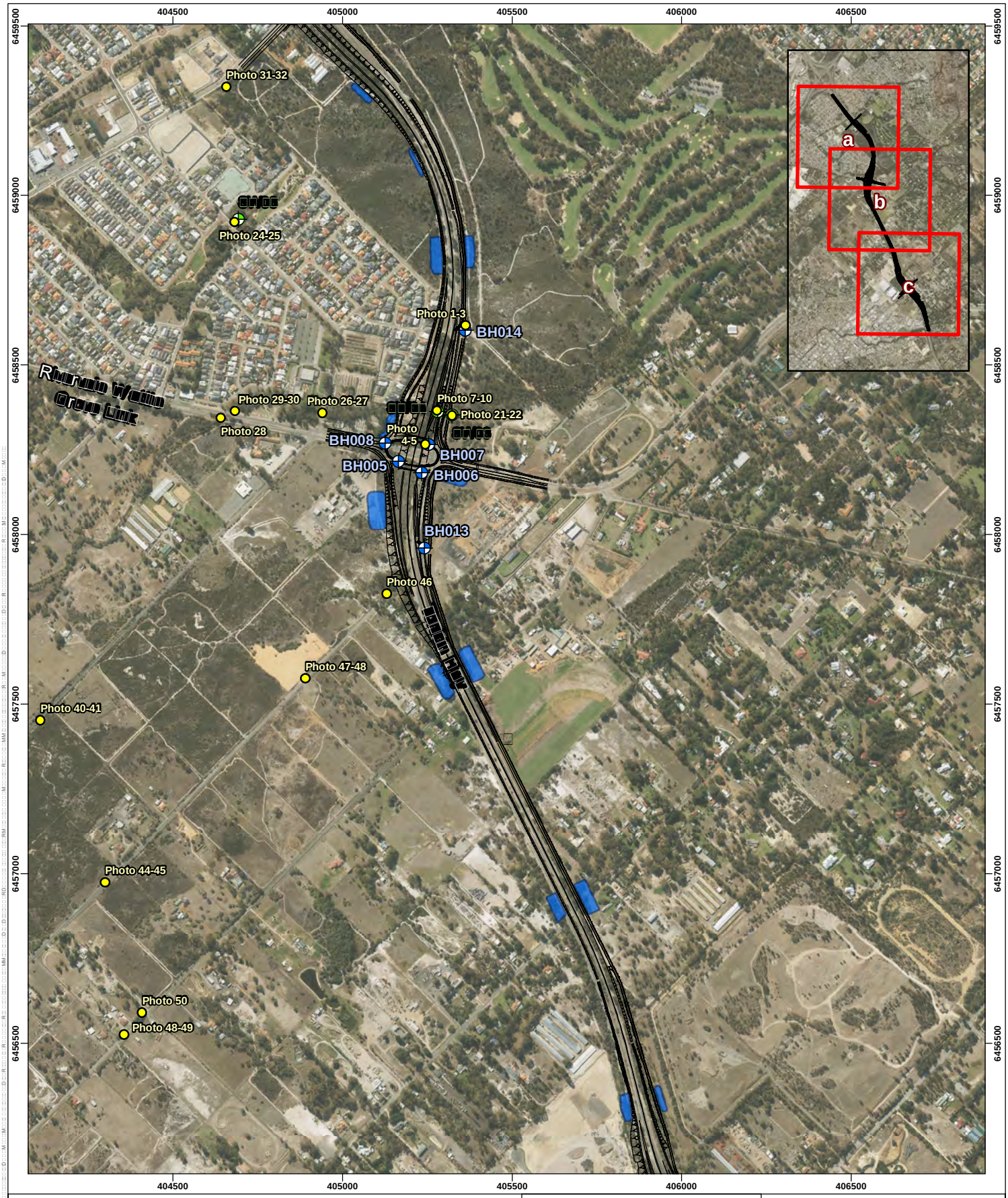
WATER OBSERVATIONS: Groundwater observed at 0.6 m depth. Observed at time of drilling and should be considered with caution.

REMARKS: Location coordinates are in MGA94 Zone 50 H. Surface level measured using a differential GPS with a reported accuracy of 0.5 m.

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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Legend

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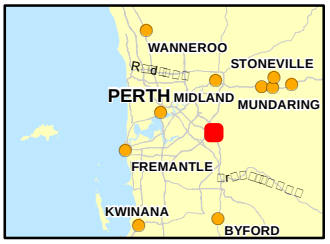
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LOCALITY MAP



Powered By SLIP ENABLER

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PROJECT ID	DATE
□□□□	□□□□□□□□□□

HORIZONTAL DATUM AND PROJECTION

□D□□□□□M□ □□□□□□□□

CREATED	CHECKED	APPROVED	REVISION
□□	□□	□□	□

Arup

Tonkin Highway

Tonkin Highway Monitoring Report

Figure 7b

Monitoring Locations

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ARUP

GROUNDWATER MONITORING STANDPIPE DETAILS

BH005_PZ

SHEET 1 OF 1

CLIENT	Main Roads WA	LOGGED BY	AI
PROJECT	Tonkin Highway Upgrade - Grade Separations	CHECKED BY	
		DRILLED DATE	03-Oct-19
CONTRACTOR	Edge Drilling	ANGLE	
DRILL MODEL		BEARING	-
DRILLER	MP, SS	HOLE DIAMETER	
LOCATION	Main,	GROUND LEVEL	RL 20.40mAHD
		LOCATION	66937.00 E 257229.00 N
		ELEVATION DATUM	Australian Height Datum (AHD)
		COORDINATE SYSTEM	Perth Coastal Grid 1994 (PCG94)

AQUIFER	STRATA				MATERIAL DESCRIPTION	WELL CONSTRUCTION	
						WELL CONSTRUCTION DETAIL	
Testing	R.L.	DEPTH	GROUP SYMBOL	LEGEND	SOIL OR ROCK TYPE	WATER LEVEL	BACKFILL MATERIAL / DESCRIPTION
	mAHD	m					
	18.90	1.50	CH		Sandy CLAY (CH)		Concrete plug from 0 to 0.3m 60mm PVC from 0 to 13.95m Gravel pack (1.2mm to 3.6mm size) from 0.3 to 12.95m
	17.40	3.00	SP		SAND (SP)		
	15.90	4.50	SP		SAND (SP)		
		5					
		10					
	9.90	10.50	SP		SAND (SP)		
	6.90	13.50	SP		SAND (SP)		Bentonite pellet plug from 12.95m to 13.45m Gravel pack (1.2mm to 3.6mm size) from 13.45 to 19.95m 60mm PVC (slotted) from 13.95 to 19.95m
		15					
	0.83	19.57					
	0.45	19.95	SP		Gravelly SAND (SP)		End of borehole
		20					

NOTES

End of borehole completed at 19.95m

See explanatory notes for details of abbreviations and basis of descriptions

JOB 266665

gINT v8.30.004 Licenced to Arup
Project : \\global.arup.com\australasia\per\projects\266000\266665-00 tonkin hwy grade\work\internal\design\geotech\97.gint\03 project files\tonkin-gseps-master-000.gpj
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ARUP

GROUNDWATER MONITORING STANDPIPE DETAILS

BH006_PZ

SHEET 1 OF 1

CLIENT	Main Roads WA	LOGGED BY	AI
PROJECT	Tonkin Highway Upgrade - Grade Separations	CHECKED BY	
		DRILLED DATE	04-Oct-19
CONTRACTOR	Edge Drilling	ANGLE	
DRILL MODEL		BEARING	-
DRILLER	MP, SS	HOLE DIAMETER	
LOCATION	Main,	GROUND LEVEL	RL 20.81mAHD
		LOCATION	67005.00 E 257195.00 N
		ELEVATION DATUM	Australian Height Datum (AHD)
		COORDINATE SYSTEM	Perth Coastal Grid 1994 (PCG94)

AQUIFER	STRATA				MATERIAL DESCRIPTION	WELL CONSTRUCTION	
Testing	R.L. mAHD	DEPTH m	GROUP SYMBOL	LEGEND	SOIL OR ROCK TYPE	WATER LEVEL	WELL CONSTRUCTION DETAIL: BACKFILL MATERIAL / DESCRIPTION
	19.31	1.50	SP		SAND (SP)		Concrete plug from 0 to 0.3m 60mm PVC from 0 to 13.95m Gravel pack (1.2mm to 3.6mm size) from 0.3 to 12.95m
	17.52	3.29	SM		Silty SAND (SM)		
	16.31	4.50	SC		Clayey SAND (SC)		
	14.81	6.00	SP		SAND (SP)		
	8.81	12.00	SP		SAND (SP)		Bentonite pellet plug from 12.95m to 13.45m Gravel pack (1.2mm to 3.6mm size) from 13.45 to 19.95m 60mm PVC (slotted) from 13.95 to 19.95m
	4.31	16.50	SP		SAND (SP)		
	0.86	19.95			End of borehole completed at 19.95m		End of borehole

NOTES

See explanatory notes for details of abbreviations and basis of descriptions

JOB 266665

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Log: 1.7.1 AUS PEIZOMETER LOG (rev 20May19)
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GROUNDWATER MONITORING STANDPIPE DETAILS

BH007_PZ

SHEET 1 OF 1

CLIENT	Main Roads WA	LOGGED BY	AI
PROJECT	Tonkin Highway Upgrade - Grade Separations	CHECKED BY	
		DRILLED DATE	08-Oct-19
CONTRACTOR	Edge Drilling	ANGLE	
DRILL MODEL	Landcruiser rig	BEARING	-
DRILLER	TC, MM	HOLE DIAMETER	
LOCATION	Main,	GROUND LEVEL	RL 21.42mAHD
		LOCATION	67026.00 E 257277.00 N
		ELEVATION DATUM	Australian Height Datum (AHD)
		COORDINATE SYSTEM	Perth Coastal Grid 1994 (PCG94)

AQUIFER	STRATA				MATERIAL DESCRIPTION	WELL CONSTRUCTION	
						WELL CONSTRUCTION DETAIL	
Testing	R.L.	DEPTH	GROUP SYMBOL	LEGEND	SOIL OR ROCK TYPE	BACKFILL MATERIAL	DESCRIPTION
	mAHD	m					
	19.92	1.50	SP		SAND (SP)		Concrete plug from 0 to 0.3m 60mm PVC from 0 to 13.95m Gravel pack (1.2mm to 3.6mm size) from 0.3 to 12.95m
	18.42	3.00	SC		Clayey SAND (SC)		
	16.92	4.50	SP		SAND (SP)		
	15.42	6.00	SC		Clayey SAND (SC)		
	13.92	7.50	SP		SAND (SP)		
	12.42	9.00	SC		Clayey SAND (SC)		
	10.92	10.50	SP		SAND (SP)		Bentonite pellet plug from 12.95m to 13.45m Gravel pack (1.2mm to 3.6mm size) from 13.45 to 19.95m 60mm PVC (slotted) from 13.95 to 19.95m
	6.42	15.00	SP		SAND (SP)		
	1.47	19.95			End of borehole completed at 19.95m		End of borehole

NOTES

See explanatory notes for details of abbreviations and basis of descriptions

JOB 266665

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gINT output page 1 of 1. Made 23Jan20 12:10

ARUP

GROUNDWATER MONITORING STANDPIPE DETAILS

BH008_PZ

SHEET 1 OF 1

CLIENT	Main Roads WA	LOGGED BY	AI
PROJECT	Tonkin Highway Upgrade - Grade Separations	CHECKED BY	
		DRILLED DATE	07-Nov-19
CONTRACTOR	Edge Drilling	ANGLE	
DRILL MODEL	Landcruiser rig	BEARING	-
DRILLER	MP, CK, TC	HOLE DIAMETER	
LOCATION	Main,	GROUND LEVEL	RL 20.43mAHD
		LOCATION	66898.00 E 257282.00 N
		ELEVATION DATUM	Australian Height Datum (AHD)
		COORDINATE SYSTEM	Perth Coastal Grid 1994 (PCG94)

AQUIFER	STRATA				MATERIAL DESCRIPTION	WELL CONSTRUCTION	
Testing	R.L. mAHD	DEPTH m	GROUP SYMBOL	LEGEND	SOIL OR ROCK TYPE	WATER LEVEL	WELL CONSTRUCTION DETAIL: BACKFILL MATERIAL / DESCRIPTION
	20.23	0.20	SP		Fill: SAND (SP)		Concrete plug from 0 to 0.3m
			SP		SAND (SP)		60mm PVC from 0 to 13.95m Gravel pack (1.2mm to 3.6mm size) from 0.3 to 12.95m
	18.93	1.50	SC		Sandy CLAY (SC)		
	17.43	3.00	SP		SAND (SP)		
		5					
		10					
	5.43	15 15.00	SM		Silty SAND (SM)		Bentonite pellet plug from 12.95m to 13.45m Gravel pack (1.2mm to 3.6mm size) from 13.45 to 19.95m 60mm PVC (slotted) from 13.95 to 19.95m
	0.48	20 19.95			End of borehole completed at 19.95m		End of borehole

NOTES

See explanatory notes for details of abbreviations and basis of descriptions

JOB 266665

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Log: 1.7.1 AUS PEIZOMETER LOG (rev 20May19)
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GROUNDWATER MONITORING STANDPIPE DETAILS

BH013_PZ

SHEET 1 OF 1

CLIENT	Main Roads WA	LOGGED BY	AI
PROJECT	Tonkin Highway Upgrade - Grade Separations	CHECKED BY	
		DRILLED DATE	11-Oct-19
CONTRACTOR	Edge Drilling	ANGLE	
DRILL MODEL		BEARING	-
DRILLER	JA, TC	HOLE DIAMETER	
LOCATION	Main,	GROUND LEVEL	RL 20.00mAHD
		LOCATION	67010.00 E 256973.00 N
		ELEVATION DATUM	Australian Height Datum (AHD)
		COORDINATE SYSTEM	Perth Coastal Grid 1994 (PCG94)

AQUIFER	STRATA				MATERIAL DESCRIPTION	WELL CONSTRUCTION	
						WELL CONSTRUCTION DETAIL	
Testing	R.L.	DEPTH	GROUP SYMBOL	LEGEND	SOIL OR ROCK TYPE	WATER LEVEL	BACKFILL MATERIAL / DESCRIPTION
	mAHD	m					
	18.50	1.50	CL		Sandy CLAY (CL)		Concrete plug from 0 to 0.3m 60mm PVC from 0 to 9.45m Gravel pack (1.2mm to 3.6mm size) from 0.3 to 8.45m
	17.00	3.00	SP		SAND (SP)		
		5					
	12.50	7.50	SC		Clayey SAND (SC)		Bentonite pellet plug from 8.45m to 8.95m Gravel pack (1.2mm to 3.6mm size) from 8.95m to 15.45m
		10					60mm PVC (slotted) from 9.45m to 15.45m
	9.50	10.50	SP		SAND (SP)		
	6.50	13.50	SP		SAND (SP)		
		15					
	4.55	15.45			End of borehole completed at 15.45m		End of borehole
		20					

NOTES UPDATE GROUND LEVEL

See explanatory notes for details of abbreviations and basis of descriptions

JOB 266665

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GROUNDWATER MONITORING STANDPIPE DETAILS

BH014_PZ

SHEET 1 OF 1

CLIENT	Main Roads WA	LOGGED BY	AI
PROJECT	Tonkin Highway Upgrade - Grade Separations	CHECKED BY	
		DRILLED DATE	15-Oct-19
CONTRACTOR	Edge Drilling	ANGLE	
DRILL MODEL		BEARING	-
DRILLER	JA, TC	HOLE DIAMETER	
LOCATION	Main,	GROUND LEVEL	RL 20.00mAHD
		LOCATION	67137.00 E 257614.00 N
		ELEVATION DATUM	Australian Height Datum (AHD)
		COORDINATE SYSTEM	Perth Coastal Grid 1994 (PCG94)

AQUIFER	STRATA				MATERIAL DESCRIPTION	WELL CONSTRUCTION	
						WELL CONSTRUCTION DETAIL	
Testing	R.L.	DEPTH	GROUP SYMBOL	LEGEND	SOIL OR ROCK TYPE	WATER LEVEL	BACKFILL MATERIAL / DESCRIPTION
	mAHD	m					
	18.50	1.50	SP		SAND (SP)		Concrete plug from 0 to 0.3m 60mm PVC from 0 to 9m Gravel pack (1.2mm to 3.6mm size) from 0.3 to 8m
	17.00	3.00	SC		Clayey SAND (SC)		
		5					
	12.50	7.50	SP		SAND (SP)		Bentonite pellet plug from 8m to 8.5m Gravel pack (1.2mm to 3.6mm size) from 8.5m to 15m 60mm PVC (slotted) from 9m to 15m
		10					
	6.50	13.50					
	6.29	13.72	SP CH		SAND (SP) CLAY (CH)		
		15					End of borehole
	4.55	15.45			End of borehole completed at 15m		
		20					

NOTES UPDATE GROUND LEVEL

See explanatory notes for details of abbreviations and basis of descriptions

JOB 266665

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APPENDIX H
Bore Survey Detail

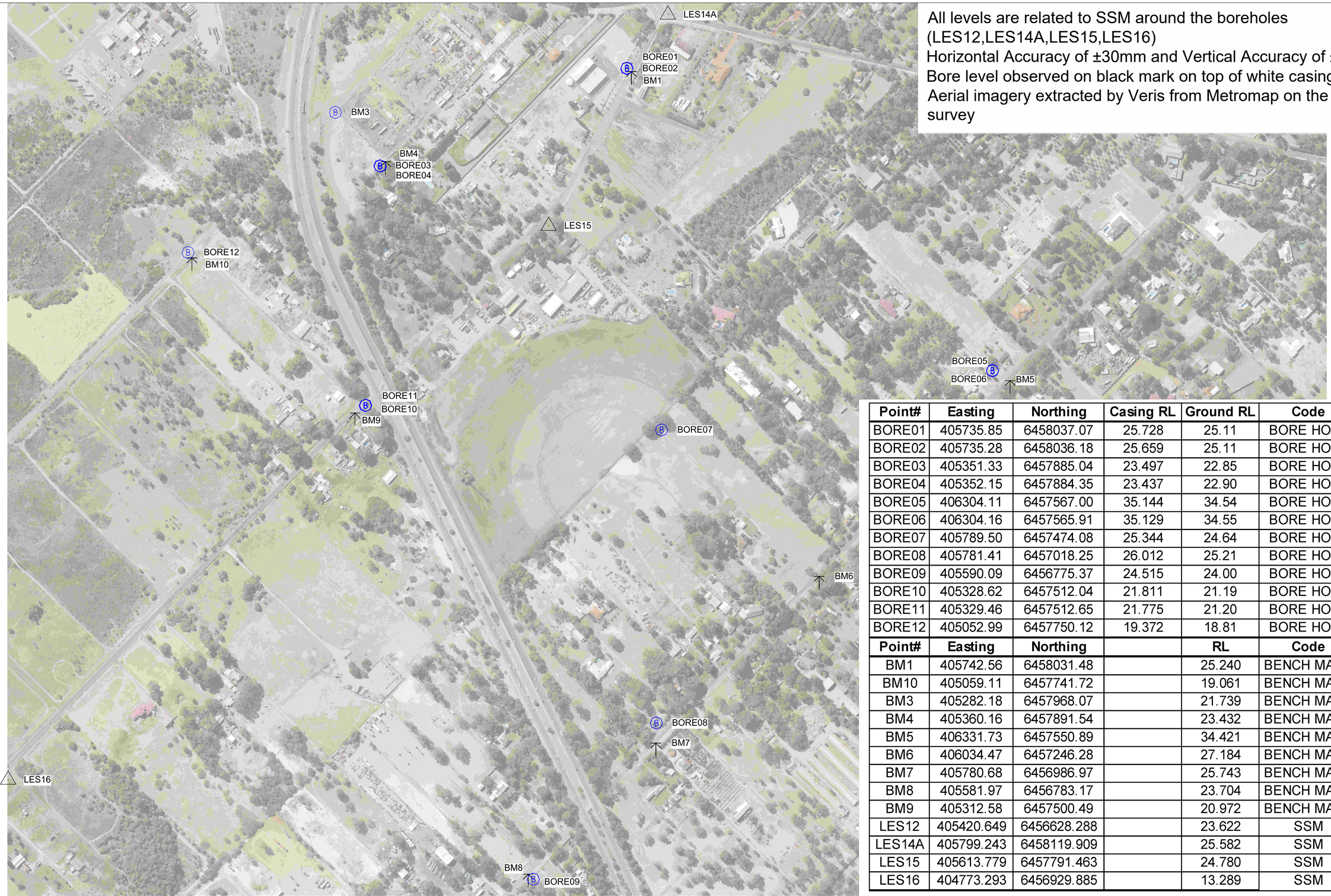
				GDA94 (MGA50)					AHD71							
Location	ID	Description	Development	Easting (m)	Horizontal Accuracy (m)	Northing (m)	Horizontal Accuracy (m)	Ellipsoidal Height (m)	Vertical Accuracy (m)	n Value (m)	AHD (m) T.O.C.	Height Pipe A.G.L. (m)	Surface Elevation (m)	SWL T.O.C. (m)	RWL (m)	Notes
Wattle Grove	WGG1	Piezometer	**	406115.254	0.020	6457799.939	0.020	1.224	0.020	-30.874	32.098	0.65	31.448	15.75	16.348	DGPS Control
Wattle Grove	WGG2	Piezometer	**	405780.404	0.020	6457018.024	0.020	-4.808	0.020	-30.925	26.117	0.65	25.467	9.12	16.997	DGPS Control
Wattle Grove	WGG3	Piezometer	**	405419.369	0.020	6457710.395	0.020	-8.007	0.020	-30.980	22.973	0.65	22.323	6.78	16.193	DGPS Control
Wattle Grove	MBc	Piezometer	N/A	406182.479	0.020	6456899.787	0.020	2.488	0.060	-30.845	33.333	0.60	32.733	16.84	16.493	DGPS Control
Wattle Grove	MBb	Piezometer	N/A	406066.860	0.020	6456783.321	0.020	1.026	0.020	-30.875	31.901	0.65	31.251	15.10	16.801	DGPS Control
Wattle Grove	Mba	Piezometer	N/A	405245.280	0.020	6457957.717	0.020	-10.401	0.020	-31.011	20.610	0.58	20.030	1.86	18.750	DGPS Control

*** Good Bore Development (Yield >=15L p/min.)

** Reasoanble Bore Development (Yield <15L p/min.)

* Poor Bore Development (Low yield or ran dry)

All levels are related to SSM around the boreholes (LES12,LES14A,LES15,LES16)
Horizontal Accuracy of ±30mm and Vertical Accuracy of ±3mm
Bore level observed on black mark on top of white casing
Aerial imagery extracted by Veris from Metromap on the day of survey



Point#	Easting	Northing	Casing RL	Ground RL	Code
BORE01	405735.85	6458037.07	25.728	25.11	BORE HOLE
BORE02	405735.28	6458036.18	25.659	25.11	BORE HOLE
BORE03	405351.33	6457885.04	23.497	22.85	BORE HOLE
BORE04	405352.15	6457884.35	23.437	22.90	BORE HOLE
BORE05	406304.11	6457567.00	35.144	34.54	BORE HOLE
BORE06	406304.16	6457565.91	35.129	34.55	BORE HOLE
BORE07	405789.50	6457474.08	25.344	24.64	BORE HOLE
BORE08	405781.41	6457018.25	26.012	25.21	BORE HOLE
BORE09	405590.09	6456775.37	24.515	24.00	BORE HOLE
BORE10	405328.62	6457512.04	21.811	21.19	BORE HOLE
BORE11	405329.46	6457512.65	21.775	21.20	BORE HOLE
BORE12	405052.99	6457750.12	19.372	18.81	BORE HOLE

Point#	Easting	Northing		RL	Code
BM1	405742.56	6458031.48		25.240	BENCH MARK
BM10	405059.11	6457741.72		19.061	BENCH MARK
BM3	405282.18	6457968.07		21.739	BENCH MARK
BM4	405360.16	6457891.54		23.432	BENCH MARK
BM5	406331.73	6457550.89		34.421	BENCH MARK
BM6	406034.47	6457246.28		27.184	BENCH MARK
BM7	405780.68	6456986.97		25.743	BENCH MARK
BM8	405581.97	6456783.17		23.704	BENCH MARK
BM9	405312.58	6457500.49		20.972	BENCH MARK
LES12	405420.649	6456628.288		23.622	SSM
LES14A	405799.243	6458119.909		25.582	SSM
LES15	405613.779	6457791.463		24.780	SSM
LES16	404773.293	6456929.885		13.289	SSM

SCALE 1:4000

40 0 100 200

ALL DISTANCES ARE IN METRES

NOTES

This plan has been prepared for the client and should not be used for any other purpose unless authorised by VERIS.

Prior to the commencement of any work, relevant authorities should be contacted for the location of underground services.

Due to overwriting some levels may be switched off for this plot only.

Levels are based on AHD.

This note is an integral part of this plan.

Rev.	Date	Description	Surveyor	Drawn	Approved
00	18/08/22	FIREST ISSUE	BL	AK	PR

veris
WESTERN AUSTRALIA
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veris.wa@veris.com.au

Client: Hesperia Property Pty Lt

Surveyed By: BL Survey Date: 17/08/2022

Drawn By: AK Drawn Date: 18/08/2022

Approved By: PR

Scale (A2): 1:4000

Hor Datum: MGA2020 Z50

Vert Datum: AHD_(Based_on_SSMs_LES12,LES14A,LES15,LES16)

GROUND WATER MONITORING WELL SURVEY

Brentwood and Victoria Roads

Wattle Grove

Job No 637149 Item No 000 Plan No 001 Rev 00

Sheet 1 of 1

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Path: V:\PROJECTS\06\637\637149\03-Survey\Plans\637149-000-001-00.dwg

Point#	Easting	Northing	Casing RL	Ground RL	Code	NOTE
WG8	406958.96	6457833.84	41.766	41.08	BORE HOLE	TOP OF CASING
WG9	405650.68	6457337.92	23.862	23.23	BORE HOLE	TOP OF CASING
WG10A	405364.46	6458073.56	23.597	22.80	BORE HOLE	TOP OF CASING (EAST)
WG10B	405365.23	6458074.51	23.615	22.88	BORE HOLE	TOP OF CASING (WEST)
Point#	**Easting**	**Northing**		**RL**	**Code**	**NOTE**
BM6	406034.47	6457246.28		27.184	BENCH MARK	EXISTING,DSPK IN BIT
BM11	405643.64	6457331.19		23.176	BENCH MARK	NEW, DSPK IN BIT
BM12	405884.59	6457085.48		28.985	BENCH MARK	NEW, TACKS IN WPEG
BM13	406938.21	6457800.47		41.062	BENCH MARK	NEW,DSPK IN BIT
BM14	406904.69	6457775.32		40.778	BENCH MARK	NEW, DSPK IN BIT

APPENDIX I

Tabulated Monitoring Program Data

Job: H21003 Wattle Grove Monitoring	DWER Monitoring Requirements (Sampling on 23/02/2023)																
	Field Results								Lab Results								
Bore ID	Temp (°C)	EC (mS/cm)	pH	DO (%)	DO (mg/L)	TDS (mg/L)	ORP (mV)	Water Level (mBTOC)	Total Anions (mg/L)	Total Cations (mg/L)	Ammonia as N (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Phosphate as P (mg/L)	Nitrate as N (mg/L)	Sulfate (mg/L)	Total Alkalinity as CaCO3 (mg/L)
WG1	25.6	0.341	5.34	61.8	5.06	219.70	170.2	15.85	66	1.8	0.005	0.5	40	0.005	3.5	15	11
WG2D	22.1	3.627	5.12	32.4	2.77	2489.50	36.6	9.20	1400	33	0.005	2.0	1200	0.005	0.81	120	11
WG3	26.1	9.532	5.70	18.9	1.48	6071.00	-157.5	7.29	3500	87	0.0071	6.7	3100	0.025	0.005	310	43
WG4S	29.0	2.251	5.59	15.3	1.17	1358.50	-0.3	2.24	780	20	0.055	1.6	480	0.005	0.005	270	30
WG4D	31.2	0.423	5.88	55.4	4.12	246.35	-17.9	9.91	630	15	0.005	1.2	320	0.005	0.4	280	24
WG5D	26.0	0.918	6.55	70.8	5.73	585.00	-38.1	18.95	240	140	0.019	0.5	200	0.005	12	23	25
WG6	21.2	1.354	5.21	57.6	5.05	949.00	75.9	7.28	460	12	0.005	1.0	390	0.005	3.3	63	5.2
WG7D	24.8	0.938	5.97	21.8	1.80	611.00	2.9	8.07	330	8	0.005	0.5	190	0.005	4.4	110	28
WG8	21.4	0.795	5.36	39.7	3.49	552.50	99.7	25.47	270	6.6	0.005	0.76	230	0.005	0.91	29	18
WG9	24.8	0.948	5.89	16.8	1.33	617.50	41.8	4.38	260	9.3	0.005	0.5	180	0.005	26	60	26
MBb	27.0	0.968	6.03	10.6	0.86	604.50	-117.1	14.64	400	150	0.3	0.5	130	0.005	0.05	120	150
GW5D	25.3	0.626	4.49	11.9	0.98	403.00	161.1	4.61	250	4.7	0.16	0.5	66	0.16	0.005	190	5
GW8D	28.1	0.323	6.33	22.5	1.75	198.90	-13.8	8.17	150	47	0.0095	0.9	59	0.005	0.005	49	47
GW9S	27.9	0.893	6.40	13.0	1.20	552.50	-8.7	3.06	280	110	0.11	0.5	110	0.18	2.1	56	110
GW9D	27.1	0.633	6.37	10.7	0.85	396.50	26.4	3.46	240	110	0.046	0.5	100	0.085	0.05	52	89
	Below limit of detection																

Job: H21003 Wattle Grove Monitoring	DWER Monitoring Requirements (Sampling on 23/02/2023)									
	Lab Results									
Bore ID	Aluminium (µg/L)	Arsenic (µg/L)	Iron (µg/L)	Manganese (µg/L)	Ca (mg/L)	Mg (mg/L)	K (mg/L)	Na (mg/L)	Silica (mg/L)	Hardness as CaCO3 (mg/L)
WG1	10	1.0	13	5.9	0.5	4.1	1.3	34	15	18
WG2D	14	1.0	250	100	4.2	140	11	490	28	570
WG3	10	1.9	9300	220	110	200	40	1500	60	1100
WG4S	10	1.0	1100	34	39	59	13	310	9.9	340
WG4D	10	1.0	39	19	43	37	11	220	5.2	260
WG5D	10	1.0	370	86	3.7	14	3.6	120	17	67
WG6	10	1.0	10	59	8.5	31	9.7	200	25	150
WG7D	15	1.0	47	5.2	17	18	5.1	130	19	120
WG8	10	1.0	10	510	4.2	14	3.6	120	33	69
WG9	100	1.1	19	13	31	32	34	97	21	210
MBb	10	1.0	6700	280	8.9	33	8.2	100	13	160
GW5D	870	1.0	6800	120	11	10	6.6	73	33	68
GW8D	10	1.0	3400	350	3.2	4.5	3.0	36	19	26
GW9S	110	5.4	1600	26	31	9.5	18	53	15	120
GW9D	32	1.2	380	14	20	14	19	62	19	110
	Below limit of detection									

FieldDAE
Field Data Analysis & Evaluation System

below limt of detection

Water Quality Monitoring Data

	Site Name/Type	Date	Site	Monitored By	Monitoring Comment	GWL bToC	GWL mAHD	T	EC	pH	DO	TN	TKN	NO3	NO2	Nox	NH3	TP	FRP	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn	Cl	Ca	Mg	K	Na	H as CaCO3
						mBToC	mAHD	°C	mS/cm	pH	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	Surface Water Site 7	30/06/2009	SW7	Endemic				12.80	1.300	6.45		3.10	1.800	1.300	0.048	1.300		0.28	0.180															
2	Surface Water Site 7	11/08/2009	SW7	Endemic				14.40	1.900	7.36		3.60	3.400	0.226	0.019	0.220		0.30	0.170															
3	Surface Water Site 2	11/08/2009	SW2	Endemic				16.40	1.334	7.30		5.20	1.900	3.389	0.013	3.400		0.17	0.025															
4	Surface Water Site 7	18/08/2009	SW7	Endemic					0.560	7.00		2.10	1.900	0.203	0.009	0.210		0.18	0.023	0.0040	0.0001	0.0010	0.0020	0.0010	0.0001	0.0050	0.0120							
5	Surface Water Site 2	18/08/2009	SW2	Endemic					0.440	7.30		3.30	2.400	0.881	0.015	0.900		0.63	0.510	0.0030	0.0001	0.0010	0.0020	0.0010	0.0001	0.0050	0.0300							
6	Endemic Bore 3	1/09/2009	GW3	Endemic		1.17	8.48																										
7	Endemic Bore 5	1/09/2009	GW5	Endemic		0.87	18.54																										
8	Endemic Bore 8	1/09/2009	GW8	Endemic		3.11	21.50																										
9	Endemic Bore 12	1/09/2009	GW12	Endemic		0.49	8.90																										
10	Endemic Bore 3	9/09/2009	GW3	Endemic				15.90	0.525	7.11		0.76	0.750	0.010	0.011	0.015		0.07	0.005	0.0500	0.0010	0.0020	0.0020	0.0170	0.0003	0.0050	0.0050							
11	Endemic Bore 5	9/09/2009	GW5	Endemic				16.40	0.653	7.23		3.80	3.800	0.010	0.005	0.015		0.07	0.005	0.0500	0.0010	0.0430	0.0170	0.0170	0.0005	0.0140	0.0050							
12	Endemic Bore 8	10/09/2009	GW8	Endemic				18.30	0.240	7.30		2.30	2.000	0.361	0.018	0.380		0.22	0.005	0.0500	0.0034	0.7400	0.1800	0.0680	0.0006	0.0890	0.3600							
13	Endemic Bore 12	9/09/2009	GW12	Endemic				15.50	8.830	7.39		3.90	3.900	0.010	0.005	0.005		0.99	0.680	0.0500	0.0010	0.0150	0.0130	0.0100	0.0004	0.0020	0.1400							
14	Surface Water Site 7	11/09/2009	SW7	Endemic				15.00	1.050	7.45		1.90	1.800	0.068	0.005	0.066		0.18	0.037	0.0020	0.0001	0.0060	0.0130	0.0010	0.0001	0.0140	0.0440							
15	Surface Water Site 2	11/09/2009	SW2	Endemic				17.00	0.796	7.87		2.30	1.600	0.768	0.005	0.770		0.27	0.150	0.0030	0.0001	0.0060	0.0160	0.0010	0.0001	0.0050	0.0540							
16	Surface Water Site 7	16/09/2009	SW7	Endemic				20.10	1.264	7.90		2.20	2.200	0.113	0.006			0.18	0.088															
17	Surface Water Site 2	16/09/2009	SW2	Endemic				16.80	1.058	7.81		4.00	4.000	2.431	0.007			0.14	0.090															
18	Endemic Bore 3	1/10/2009	GW3	Endemic		1.17	8.48																										
19	Endemic Bore 5	1/10/2009	GW5	Endemic		1.07	18.34																										
20	Endemic Bore 8	1/10/2009	GW8	Endemic		3.26	21.35																										
21	Endemic Bore 12	1/10/2009	GW12	Endemic		0.74	8.65																										
22	Endemic Bore 3	1/11/2009	GW3	Endemic		1.57	8.08																										
23	Endemic Bore 5	1/11/2009	GW5	Endemic		1.47	17.94																										
24	Endemic Bore 8	1/11/2009	GW8	Endemic		3.56	21.05																										
25	Endemic Bore 12	1/11/2009	GW12	Endemic		1.29	8.10																										
26	Surface Water Site 7	19/11/2009	SW7	Endemic				26.20	3.480	7.83		3.00	1.900	1.175	0.026	1.200		0.10	0.016															
27	Endemic Bore 3	25/11/2009	GW3	Endemic				20.60	2.258	7.25		1.20	1.200	0.045	0.100			0.17	0.081	0.0010	0.0001	0.0060	0.0070	0.0440	0.0001	0.0090	0.0850							
28	Endemic Bore 5	25/11/2009	GW5	Endemic				22.00	0.421	7.79		3.10	3.000	0.045	0.100			0.05	0.005	0.0130	0.0006	1.2000	0.4100	0.1900	0.0001	0.4200	1.1000							
29	Endemic Bore 8	25/11/2009	GW8	Endemic				21.60	0.148	7.55		2.80	2.400	0.248	0.100			0.09	0.160	0.0050	0.0001	1.0000	0.3800	0.0360	0.0001	0.9800	0.6100							
30	Endemic Bore 12	25/11/2009	GW12	Endemic				19.90	26.600	7.68		2.70	2.600	0.010	0.100			1.40	0.005	0.0190	0.0001	1.7000	0.4800	0.0880	0.0001	0.2000	1.9000							
31	Surface Water Site 7	14/06/2010	SW7	Endemic				11.80	1.534	7.79		1.20	1.200	0.010	0.010	0.010		0.19	0.120															
32	Endemic Bore 3	24/06/2010	GW3	Endemic				16.30	0.824	7.73			9.000	7.550	0.010	7.550		0.05	0.010	0.0002	0.0001	0.0010	0.0030	0.0001	0.0001	0.0040	0.0010							
33	Endemic Bore 5	24/06/2010	GW5	Endemic				15.50	0.783	7.27			2.800	0.580	0.010	0.580		0.10	0.010	0.0010	0.0001	0.0020	0.0050	0.0001	0.0001	0.0170	0.0010							
34	Endemic Bore 12	24/06/2010	GW12	Endemic				16.90	7.230	8.18			2.600	0.540	0.010	0.540		0.52	0.070	0.0050	0.0001	0.0020	0.0180	0.0010	0.0001	0.0260	0.0100							
35	Endemic Bore 3	1/07/2010	GW3	Endemic		1.87	7.78																										
36	Endemic Bore 5	1/07/2010	GW5	Endemic		1.57	17.84																										
37	Endemic Bore 8	1/07/2010	GW8	Endemic		4.05	20.56																										
38	Endemic Bore 12	1/07/2010	GW12	Endemic		2.64	6.75																										
39	Surface Water Site 7	9/07/2010	SW7	Endemic				12.00	0.477	7.01		1.50	1.300	0.220	0.010	0.220		0.12	0.090	0.0010	0.0001	0.0010	0.0030	0.0010	0.0001	0.0010	0.0120							
40	Surface Water Site 2	9/07/2010	SW2	Endemic				13.00	0.036	6.81		0.40	0.300	0.110	0.020	0.130		0.07	0.020	0.0010	0.0001	0.0020	0.0080	0.0050	0.0001	0.0010	0.0310							
41	Surface Water Site 7	13/07/2010	SW7	Endemic				12.60	0.750	7.89		1.90	1.700	0.160	0.010	0.160		0.13	0.030															
42	Surface Water Site 2	13/07/2010	SW2	Endemic				15.80	1.279	7.64		2.40	0.900	1.520	0.020	1.540		0.06	0.020															
43	Endemic Bore 3	1/08/2010	GW3	Endemic		1.42	8.23																										
44	Endemic Bore 5	1/08/2010	GW5	Endemic		1.27	18.14																										
45	Endemic Bore 8	1/08/2010	GW8	Endemic		3.73	20.88																										
46	Endemic Bore 12	1/08/2010	GW12	Endemic		1.79	7.60																										
47	Endemic Bore 3	1/09/2010	GW3	Endemic		1.47	8.18																										
48	Endemic Bore 5	1/09/2010	GW5	Endemic		1.37	18.04																										
49	Endemic Bore 8	1/09/2010	GW8	Endemic		3.90	20.71																										
50	Endemic Bore 12	1/09/2010	GW12	Endemic		1.74	7.65																										
51	Surface Water Site 7	1/09/2010	SW7	Endemic				18.70	2.815	7.37		1.40	1.400	0.010	0.010	0.010		0.14	0.150															
52	Surface Water Site 2	1/09/2010	SW2	Endemic				16.20	0.316	7.90		0.90	0.900	0.040	0.010	0.040		0.05	0.020															
53	Endemic Bore 3	23/09/2010	GW3	Endemic				18.20	5.530	7.38		1.20	1.100	0.060	0.010	0.060		0.08	0.010	0.0010	0.0001	0.0050	0.0050	0.0030	0.0001	0.0030	0.0340							
54	Endemic Bore 5	23/09/2010	GW5	Endemic				18.20	4.900	7.16		6.20	1.700	4.500	0.010	4.500		0.12	0.010	0.0020	0.0001	0.0140	0.0070	0.0080	0.0001	0.0050	0.2990							
55	Endemic Bore 12	23/09/2010	GW12	Endemic				16.70	2.076	7.24																							
56	Endemic Bore 3	1/10/2010	GW3	Endemic		1.67	7.98																										
57	Endemic Bore 5	1/10/2010	GW5	Endemic		1.57	17.84																										
58	Endemic Bore 8	1/10/2010	GW8	Endemic		4.21	20.40																										
59	Endemic Bore 12	1/10/2010	GW12	Endemic		1.79	7.60																										
60	Endemic Bore 3	1/11/2010	GW3	Endemic		1.92	7.73																										
61	Endemic Bore 5	1/11/2010	GW5	Endemic		1.77	17.64																										

62	Endemic Bore 8	1/11/2010	GW8	Endemic		4.46	20.15																													
63	Endemic Bore 12	1/11/2010	GW12	Endemic		2.09	7.30																													
64	Endemic Bore 3	1/12/2010	GW3	Endemic		2.07	7.58																													
65	Endemic Bore 5	1/12/2010	GW5	Endemic		1.77	17.64																													
66	Endemic Bore 8	1/12/2010	GW8	Endemic		4.65	19.96																													
67	Endemic Bore 12	1/12/2010	GW12	Endemic		2.49	6.90																													
68	Endemic Bore 3	15/12/2010	GW3	Endemic				26.00	20.100	8.17																										
69	Endemic Bore 12	15/12/2010	GW12	Endemic				25.00	20.980	6.98		8.40	8.300	0.050	0.020	0.080		1.50	0.090																	
70	Endemic Bore 3	1/06/2011	GW3	Endemic		1.22	8.43																													
71	Endemic Bore 5	1/06/2011	GW5	Endemic		1.42	17.99																													
72	Endemic Bore 8	1/06/2011	GW8	Endemic		4.36	20.25																													
73	Endemic Bore 12	1/06/2011	GW12	Endemic		0.64	8.75																													
74	Endemic Bore 3	1/07/2011	GW3	Endemic		1.17	8.48																													
75	Endemic Bore 5	1/07/2011	GW5	Endemic		0.72	18.69																													
76	Endemic Bore 8	1/07/2011	GW8	Endemic		3.26	21.35																													
77	Endemic Bore 12	1/07/2011	GW12	Endemic		0.59	8.80																													
78	Endemic Bore 3	1/08/2011	GW3	Endemic		0.87	8.78																													
79	Endemic Bore 5	1/08/2011	GW5	Endemic		0.67	18.74																													
80	Endemic Bore 8	1/08/2011	GW8	Endemic		3.11	21.50																													
81	Endemic Bore 12	1/08/2011	GW12	Endemic		0.49	8.90																													
82	Endemic Bore 3	1/09/2011	GW3	Endemic		1.02	8.63																													
83	Endemic Bore 5	1/09/2011	GW5	Endemic		0.67	18.74																													
84	Endemic Bore 8	1/09/2011	GW8	Endemic		3.41	21.20																													
85	Endemic Bore 12	1/09/2011	GW12	Endemic		0.49	8.90																													
86	Endemic Bore 3	1/10/2011	GW3	Endemic		1.07	8.58																													
87	Endemic Bore 5	1/10/2011	GW5	Endemic		0.82	18.59																													
88	Endemic Bore 8	1/10/2011	GW8	Endemic		3.48	21.13																													
89	Endemic Bore 12	1/10/2011	GW12	Endemic		0.59	8.80																													
90	Endemic Bore 3	1/11/2011	GW3	Endemic		1.37	8.28																													
91	Endemic Bore 5	1/11/2011	GW5	Endemic		0.92	18.49																													
92	Endemic Bore 8	1/11/2011	GW8	Endemic		3.76	20.85																													
93	Endemic Bore 12	1/11/2011	GW12	Endemic		1.09	8.30																													
94	Surface Water Site 2	20/08/2019	SW2	Urbaqua				18.50	1.542	8.41	122.0	1.70	0.700	0.940	0.030	0.970		0.16	0.020																	
95	Surface Water Site 2	3/09/2019	SW2	Urbaqua				17.60	1.130	7.86	82.0	1.60	0.800	0.840	0.010	0.840		0.18	0.030																	
96	Surface Water Site 2	17/09/2019	SW2	Urbaqua				22.10	1.405	9.01	152.0	2.30	1.400	0.970	0.010	0.980		0.09	0.010																	
97	Surface Water Site 2	1/10/2019	SW2	Urbaqua				24.30	1.325	8.11	148.0	2.10	0.600	1.500	0.030	1.500		0.15	0.010																	
98	Surface Water Site 2	10/07/2020	SW2	Urbaqua				17.50	1.438	8.08	137.0	2.90	1.200	1.700	0.010	1.700		0.08	0.010																	
99	Surface Water Site 2	24/07/2020	SW2	Urbaqua				17.50	1.684	7.35	113.0	3.90	0.400	3.500	0.030	3.500		0.16	0.010																	
100	Surface Water Site 2	7/08/2020	SW2	Urbaqua				14.10	1.617	7.04	82.0	2.80	0.600	2.200	0.030	2.200		0.21	0.010																	
101	Surface Water Site 2	21/08/2020	SW2	Urbaqua				16.90	1.743	7.60	132.0	3.30	0.400	2.900	0.010	2.900		0.13	0.020																	
102	Surface Water Site 2	4/09/2020	SW2	Urbaqua				18.60	1.812	7.46	107.0	2.20	0.700	1.500	0.010	1.500		0.05	0.010																	
103	Surface Water Site 2	25/09/2020	SW2	Urbaqua				18.20	1.575	7.37	107.0	2.00	1.200	0.810	0.010	0.820		0.06	0.010																	
104	Surface Water Site 2	6/05/2021	SW2	ASM and SO					0.240	6.80		1.20	0.800	0.310	0.013	0.320	0.042	0.05	0.022	0.0010	0.0001	0.0010	0.0060	0.0010	0.0001	0.0010	0.0470									
105	Surface Water Site 4	6/05/2021	SW4	ASM and SO					0.033	6.40		1.20	1.200	0.014	0.005	0.014	0.012	0.15	0.078	0.0010	0.0001	0.0010	0.1000	0.0030	0.0001	0.0060	0.0780									
106	Hyd2o Bore Wattle Grove 1	28/05/2021	WG1	GR and SO		16.40	15.70	21.00	0.289	5.46	73.4	5.50	0.700	4.700	0.005	4.800	0.005	0.12	0.005	0.0010	0.0001	0.0010	0.0050	0.0010	0.0001	0.0050	0.0190									
107	Hyd2o Bore Wattle Grove 2 (Deep)	28/05/2021	WG2	GR and SO		10.01	16.11	21.10	1.279	5.45	61.2	5.20	0.900	4.300	0.005	4.300	0.017	0.09	0.005	0.0010	0.0001	0.0010	0.0100	0.0010	0.0001	0.0120	0.0310									
108	Hyd2o Bore Wattle Grove 3	28/05/2021	WG3	GR and SO		7.98	14.99	21.70	5.233	5.55	32.8	1.70	1.500	0.210	0.005	0.210	0.110	0.20	0.047	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0190	0.0300									
109	Unknown Origin Bore	28/05/2021	Mba	GR and SO	dry	4.51	16.10																													
110	Douglas Partners Bore 1	28/05/2021	MBb	GR and SO	dry	15.70	16.20																													
111	Urbaqua Bore 1	28/05/2021	GW1	GR and SO	dry	8.73	14.76																													
112	Endemic Bore 5	28/05/2021	GW5	GR and SO	dry	1.70	17.71																													
113	Hyd2o Bore Wattle Grove 1	5/07/2021	WG1	GR and SO		16.14	15.96																													
114	Hyd2o Bore Wattle Grove 2 (Deep)	5/07/2021	WG2	GR and SO		9.66	16.46																													
115	Hyd2o Bore Wattle Grove 3	5/07/2021	WG3	GR and SO		7.65	15.32																													
116	Unknown Origin Bore	5/07/2021	MBa	GR and SO		2.42	18.19																													
117	Urbaqua Bore 1	5/07/2021	GW1	GR and SO		8.28	15.21																													
118	Endemic Bore 5	5/07/2021	GW5	GR and SO		0.86	18.55																													
119	DWER Bore 1	5/07/2021	SCC 05/08	GR and SO		19.68	22.10																													
120	DWER Bore 2	5/07/2021	SCC 06/08	GR and SO		1.56	5.91																													
121	DWER Bore 3	5/07/2021	SCC 09/08	GR and SO		4.78	8.43																													
122	Surface Water Site 1	5/07/2021	SW1	GR and SO				13.30	0.167	8.19	72.5	0.30	0.300	0.012	0.005	0.017	0.016	0.05	0.005	0.0010	0.0001	0.0010	0.0030	0.0010	0.0001	0.0010	0.0100									
123	Surface Water Site 2	5/07/2021	SW2	GR and SO				15.30	0.844	7.18	70.7	5.40	1.300	4.100	0.010	4.100	0.022	0.17	0.140	0.0010	0.0001	0.0010	0.0060	0.0010	0.0001	0.0010	0.0190									
124	Surface Water Site 4	5/07/2021	SW4	GR and SO				13.60	0.123	7.74	72.6	0.60	0.500	0.022	0.005	0.025	0.011	0.06	0.026	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0010	0.0040									
125	Surface Water Site 6	5/07/2021	SW6	GR and SO				14.80	0.215	7.34	73.0	1.30	1.100	0.240	0.005	0.240	0.006	0.05	0.005	0.0010	0.0001	0.0010	0.0020	0.0010	0.0001	0.0010	0.0080									
126	Surface Water Site 7	5/07/2021	SW7	GR and SO				14.00	0.278	7.48	69.7	1.60	1.400	0.200	0.005	0.200	0.007	0.08	0.065	0.0010	0.0001	0.0010	0.0020	0.0010	0.0001	0.0010	0.0120									
127	Surface Water Site 5	5/07/2021	SW5	GR and SO				13.40	0.188	7.43	85.5	1.20	1.200	0.005	0.005	0.005	0.007	0.05	0.005	0.0010	0.0001	0.0010	0.0020	0.0010	0.0001	0.0010	0.0080									
128	Surface Water Site 9	5/07/2021	SW9	GR and SO				13.90	0.452	7.27	69.0	2.60	1.600	1.100	0.011	1.100	0.009	0.32	0.320	0.0030	0.0001	0.0010	0.0040	0.0010	0.0001	0.0010	0.0130									
129	Surface Water Site 1	27/07/2021	SW1	GR and SO				14.10	0.352	7.60	75.6	0.90	0.800	0.017	0.005	0.017	0.011	0.05	0.005	0.0020	0.0001	0.0010	0.0040	0.0010	0.0001	0.0010	0.0170									
130	Surface Water Site 2	27/07/2021	SW2	GR and SO				14.20	0.690	7.09	68.2	18.00	13.000	5.400	0.007	5.400	0.032	0.43	0.310	0.0030	0.0001	0.0010	0.0060	0.0010	0.0001	0.0010	0.0360									

131	Surface Water Site 3	27/07/2021	SW3	GR and SO				14.80	0.227	7.38	59.4	2.80	2.100	0.640	0.076	0.720	0.770	5.60	0.170	0.0020	0.0001	0.0010	0.0050	0.0010	0.0001	0.0010	0.0150						
132	Surface Water Site 4	27/07/2021	SW4	GR and SO				14.20	0.213	7.50	62.9	0.30	0.300	0.005	0.005	0.005	0.005	0.09	0.021	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0010	0.0060						
133	Surface Water Site 5	27/07/2021	SW5	GR and SO				13.90	0.211	6.83	61.7	1.50	1.500	0.005	0.005	0.005	0.011	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0020	0.0250						
134	Surface Water Site 6	27/07/2021	SW6	GR and SO				14.10	0.736	5.67	57.5	1.20	1.000	0.210	0.005	0.210	0.500	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0060	0.0410						
135	Surface Water Site 7	27/07/2021	SW7	GR and SO				13.80	0.319	7.13	60.0	1.80	1.700	0.050	0.005	0.051	0.020	0.16	0.073	0.0020	0.0001	0.0010	0.0030	0.0010	0.0001	0.0020	0.0190						
136	Surface Water Site 8	27/07/2021	SW8	GR and SO				13.80	0.349	7.26	56.0	2.00	1.900	0.120	0.005	0.120	0.027	0.19	0.093	0.0020	0.0001	0.0010	0.0020	0.0010	0.0001	0.0020	0.0150						
137	Surface Water Site 9	27/07/2021	SW9	GR and SO				13.90	0.483	7.18	54.2	2.00	1.700	0.320	0.010	0.330	0.031	0.23	0.150	0.0020	0.0001	0.0010	0.0030	0.0010	0.0001	0.0020	0.0170						
138	Hyd2o Bore Wattle Grove 1	5/08/2021	WG1	GR		15.80	16.30																									
139	Hyd2o Bore Wattle Grove 2 (Deep)	5/08/2021	WG2	GR		8.90	17.22																									
140	Hyd2o Bore Wattle Grove 3	5/08/2021	WG3	GR		6.88	16.09																									
141	Unknown Origin Bore	5/08/2021	MBa	GR		1.66	18.95																									
142	Douglas Partners Bore 1	5/08/2021	MBb	GR		14.78	17.12																									
143	Urbaqua Bore 1	5/08/2021	GW1	GR		5.01	18.48																									
144	Endemic Bore 5	5/08/2021	GW5	GR		0.95	18.46																									
145	DWER Bore 1	5/08/2021	SCC 05/08	GR		19.56	22.22																									
146	DWER Bore 3	5/08/2021	SCC 09/08	GR		2.25	10.96																									
147	Hyd2o Bore Wattle Grove 1	23/08/2021	WG1	SO and GR		15.59	16.51	19.10	0.638	6.08	89.5	3.60	0.800	2.800	0.005	2.800	0.009	0.40	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0030	0.0070						
148	Hyd2o Bore Wattle Grove 2 (Deep)	23/08/2021	WG2	SO and GR		8.63	17.49	19.10	1.643	6.19	83.8	4.40	0.500	4.000	0.005	4.000	0.026	0.10	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0100	0.0250						
149	Hyd2o Bore Wattle Grove 3	23/08/2021	WG3	SO and GR		5.60	17.37	18.10	2.524	5.79	60.1	0.70	0.700	0.007	0.005	0.008	0.032	0.36	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0100	0.0120						
150	Unknown Origin Bore	23/08/2021	MBa	SO and GR		1.71	18.90																									
151	Douglas Partners Bore 1	23/08/2021	MBb	SO and GR		14.87	17.03	20.00	0.682	6.75	73.0	0.50	0.500	0.005	0.005	0.005	0.110	0.06	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0130	0.0170						
152	Urbaqua Bore 1	23/08/2021	GW1	SO and GR		5.71	17.78	19.50	0.327	6.68	76.0	2.90	0.300	2.500	0.005	2.500	0.005	0.06	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0010	0.0040						
153	Endemic Bore 5	23/08/2021	GW5	SO and GR		1.14	18.27	17.50	0.679	6.69	44.9	1.30	1.300	0.029	0.005	0.029	0.041	0.15	0.007	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0110	0.0030						
154	Endemic Bore 3	23/08/2021	GW3	SO and GR		1.12	8.53	18.00	0.277	7.44	46.8	1.40	1.400	0.034	0.005	0.039	0.062	0.23	0.042	0.0010	0.0001	0.0010	0.0020	0.0010	0.0001	0.0020	0.0170						
155	DWER Bore 1	23/08/2021	SCC 05/08	SO and GR		19.35	22.43																									
156	DWER Bore 3	23/08/2021	SCC 09/08	SO and GR		1.92	11.29																									
157	Surface Water Site 2	9/09/2021	SW2	GR				16.20	1.143	7.93	102.4	1.90	1.100	0.750	0.011	0.760	0.089	0.26	0.048	0.0010	0.0001	0.0010	0.0040	0.0010	0.0001	0.0010	0.0170						
158	Surface Water Site 3	9/09/2021	SW3	GR				13.90	0.309	7.55	70.4	1.10	1.000	0.073	0.024	0.097	0.200	2.90	0.100	0.0010	0.0001	0.0010	0.0050	0.0010	0.0001	0.0010	0.0110						
159	Surface Water Site 4	9/09/2021	SW4	GR				14.10	0.312	7.77	56.3	0.30	0.300	0.005	0.005	0.005	0.005	0.05	0.025	0.0010	0.0001	0.0010	0.0020	0.0010	0.0001	0.0010	0.0110						
160	Surface Water Site 5	9/09/2021	SW5	GR				14.30	0.245	7.89	70.7	1.40	1.400	0.005	0.005	0.005	0.016	0.13	0.007	0.0010	0.0001	0.0010	0.0020	0.0010	0.0001	0.0010	0.0050						
161	Surface Water Site 6	9/09/2021	SW6	GR				12.60	0.543	7.46	54.4	1.40	1.400	0.035	0.005	0.036	0.450	0.05	0.005	0.0010	0.0001	0.0010	0.0030	0.0010	0.0001	0.0020	0.0320						
162	Surface Water Site 7	9/09/2021	SW7	GR				12.30	5.200	4.40	56.8	3.50	3.500	0.028	0.005	0.031	2.700	0.05	0.005	0.0010	0.0003	0.0020	0.0040	0.0010	0.0001	0.0190	0.3600						
163	Surface Water Site 8	9/09/2021	SW8	GR				13.60	0.923	7.61	56.4	3.10	3.100	0.005	0.005	0.005	0.015	0.27	0.180	0.0020	0.0001	0.0010	0.0030	0.0010	0.0001	0.0020	0.0099						
164	Surface Water Site 9	9/09/2021	SW9	GR				13.30	1.112	7.20	55.9	3.40	3.400	0.005	0.005	0.005	0.015	0.31	0.200	0.0030	0.0001	0.0010	0.0020	0.0010	0.0001	0.0030	0.0110						
165	Hyd2o Bore Wattle Grove 1	24/09/2021	WG1	GR		15.63	16.47																									
166	Hyd2o Bore Wattle Grove 2 (Deep)	24/09/2021	WG2	GR		8.36	17.76																									
167	Hyd2o Bore Wattle Grove 3	24/09/2021	WG3	GR		5.43	17.54																									
168	Unknown Origin Bore	24/09/2021	MBa	GR		1.78	18.83																									
169	Douglas Partners Bore 1	24/09/2021	MBb	GR		14.72	17.18																									
170	Urbaqua Bore 1	24/09/2021	GW1	GR		5.70	17.79																									
171	Endemic Bore 5	24/09/2021	GW5	GR		1.36	18.05																									
172	DWER Bore 1	24/09/2021	SCC 05/08	GR		19.08	22.70																									
173	DWER Bore 3	24/09/2021	SCC 09/08	GR		2.05	11.16																									
174	Endemic Bore 3	24/09/2021	GW3	GR		1.29	8.36																									
175	Hyd2o Bore Wattle Grove 1	28/10/2021	WG1	GR&SO		15.49	16.61																									
176	Hyd2o Bore Wattle Grove 2 (Deep)	28/10/2021	WG2	GR&SO		8.26	17.86																									
177	Hyd2o Bore Wattle Grove 3	28/10/2021	WG3	GR&SO		5.31	17.66																									
178	Unknown Origin Bore	28/10/2021	MBa	GR&SO		1.65	18.96																									
179	Douglas Partners Bore 1	28/10/2021	MBb	GR&SO		14.53	17.37																									
180	Urbaqua Bore 1	28/10/2021	GW1	GR&SO		5.89	17.60																									
181	Endemic Bore 3	28/10/2021	GW3	GR&SO		1.25	8.40																									
182	Endemic Bore 5	28/10/2021	GW5	GR&SO		1.20	18.21																									
183	DWER Bore 1	28/10/2021	SCC 05/08	GR&SO		18.93	22.85																									
184	Hyd2o Bore Wattle Grove 1	18/11/2021	WG1	GR&SO		15.44	16.66	21.10	0.660	5.84	53.0	4.50	0.500	4.000	0.005	4.000	0.018	0.30	0.005	0.0010	0.0001	0.0010	0.0060	0.0010	0.0001	0.0020	0.0260						
185	Hyd2o Bore Wattle Grove 2 (Deep)	18/11/2021	WG2	GR&SO		8.34	17.78	20.50	1.300	6.10	28.5	2.70	0.700	2.000	0.006	2.000	0.079	0.15	0.018	0.0010	0.0001	0.0010	0.0020	0.0010	0.0001	0.0050	0.0440						
186	Hyd2o Bore Wattle Grove 3	18/11/2021	WG3	GR&SO		5.48	17.49	19.00	1.990	6.41	61.8	0.90	0.900	0.025	0.005	0.026	0.011	0.05	0.006	0.0010	0.0001	0.0010	0.0040	0.0010	0.0001	0.0080	0.0380						
187	Unknown Origin Bore	18/11/2021	MBa	GR&SO		1.88	18.73																									
188	Douglas Partners Bore 1	18/11/2021	MBb	GR&SO		14.43	17.47	21.70	0.491	6.19	20.1	0.70	0.700	0.027	0.005	0.028	0.200	0.12	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0050	0.0160						
189	Urbaqua Bore 1	18/11/2021	GW1	GR&SO		5.65	17.84	20.40	0.272	2.28	27.2	2.80	0.800	1.900	0.005	1.900	0.012	0.08	0.013	0.0010	0.0001	0.0010	0.0040	0.0010	0.0001	0.0010	0.0160						
190	Endemic Bore 3	18/11/2021	GW3	GR&SO		1.37	8.28	21.10	4.920	7.13	23.6	1.40	1.400	0.024	0.005	0.027	0.089	0.30	0.062	0.0010	0.0001	0.0010	0.0020	0.0010	0.0001	0.0020	0.0190						
191	Endemic Bore 5	18/11/2021	GW5	GR&SO		1.53	17.88	20.60	1.630	7.04	12.8	1.80	1.800	0.005	0.005	0.005	0.075	0.72	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0060	0.0040						
192	Endemic Bore 12	18/11/2021	GW12	GR&SO		1.10	8.29																									
193	DWER Bore 1	18/11/2021	SCC 05/08	GR&SO		18.88	22.90																									
194	Hyd2o Bore Wattle Grove 1	10/12/2021	WG1	GR		15.48	16.62																									
195	Hyd2o Bore Wattle Grove 2 (Deep)	10/12/2021	WG2	GR		8.28	17.84																									
196	Hyd2o Bore Wattle Grove 3	10/12/2021	WG3	GR		5.76	17.21																									
197	Unknown Origin Bore	10/12/2021	MBa	GR		2.38	18.23																									
198	Douglas Partners Bore 1	10/12/2021	MBb	GR		14.36	17.54																									
199	Urbaqua Bore 1	10/12/2021	GW1	GR		6.62	16.87																									

200	Endemic Bore 3	10/12/2021	GW3	GR		1.60	8.05																									
201	Endemic Bore 5	10/12/2021	GW5	GR		1.75	17.66																									
202	Endemic Bore 12	10/12/2021	GW12	GR		1.50	7.89																									
203	DWER Bore 1	14/12/2021	SCC 05/08	GR&SO		18.89	22.89																									
204	DWER Bore 3	14/12/2021	SCC 09/08	GR&SO		2.90	10.31																									
205	Hyd2o Bore Wattle Grove 1	2/02/2022	WG1	GR		15.77	16.33																									
206	Hyd2o Bore Wattle Grove 2 (Deep)	2/02/2022	WG2	GR		9.52	16.60																									
207	Hyd2o Bore Wattle Grove 3	2/02/2022	WG3	GR		6.73	16.24																									
208	Unknown Origin Bore	2/02/2022	MBa	GR		4.11	16.50																									
209	Douglas Partners Bore 1	2/02/2022	MBb	GR		14.61	17.29																									
210	Urbaqua Bore 1	2/02/2022	GW1	GR		8.41	15.08																									
211	Endemic Bore 3	2/02/2022	GW3	GR		1.80	7.85																									
212	Endemic Bore 5	2/02/2022	GW5	GR		1.86	17.55																									
213	DWER Bore 1	2/02/2022	SCC 05/08	GR		19.12	22.66																									
214	DWER Bore 3	2/02/2022	SCC 09/08	GR		4.58	8.63																									
215	Hyd2o Bore Wattle Grove 1	1/03/2022	WG1	SO&SS		15.94	16.16	25.80	0.382	6.02	57.4	5.30	1.600	3.700	0.007	3.700	0.025	0.36	0.018	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0010	0.0020						
216	Hyd2o Bore Wattle Grove 2 (Deep)	1/03/2022	WG2	SO&SS																												
217	Hyd2o Bore Wattle Grove 3	1/03/2022	WG3	SO&SS		7.45	15.52	22.20	8.413	6.01	43.6	0.90	0.900	0.005	0.005	0.050	0.031	0.18	0.005	0.0020	0.0001	0.0010	0.0010	0.0010	0.0001	0.0100	0.0160	0.20					
218	Unknown Origin Bore	1/03/2022	MBa	SO&SS		4.58	16.03																									
219	Douglas Partners Bore 1	1/03/2022	MBb	SO&SS		14.75	17.15	24.20	0.971	6.75	75.2	0.80	0.800	0.026	0.005	0.027	0.380	0.05	0.006	0.0010	0.0001	0.0010	0.0020	0.0010	0.0001	0.0040	0.0100	0.10					
220	Urbaqua Bore 1	1/03/2022	GW1	SO&SS	Dry	8.80	14.69																									
221	Endemic Bore 3	1/03/2022	GW3	SO&SS	Dry	1.80	7.85																									
222	Endemic Bore 5	1/03/2022	GW5	SO&SS	Dry	1.76	17.65																									
223	Endemic Bore 12	1/03/2022	GW12	SO&SS	Dry	2.67	6.72																									
224	DWER Bore 1	1/03/2022	SCC 05/08	SO&SS		19.24	22.54																									
225	DWER Bore 2	1/03/2022	SCC 06/08	SO&SS		2.87	4.60																									
226	DWER Bore 3	1/03/2022	SCC 09/08	SO&SS		4.97	8.24																									
227	Hyd2o Bore Wattle Grove 1	31/03/2022	WG1	GR		16.06	16.04																									
228	Hyd2o Bore Wattle Grove 2 (Deep)	31/03/2022	WG2	GR		9.49	16.63		2.500	5.40		4.10	1.900	2.200	0.005	2.200	0.020	0.35	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0030	0.0150	0.10					
229	Hyd2o Bore Wattle Grove 3	31/03/2022	WG3	GR		7.67	15.30																									
230	Unknown Origin Bore	31/03/2022	MBa	GR		4.58	16.03																									
231	Douglas Partners Bore 1	31/03/2022	MBb	GR		14.91	16.99																									
232	Urbaqua Bore 1	31/03/2022	GW1	GR	Dry	8.80	14.69																									
233	Endemic Bore 3	31/03/2022	GW3	GR	Dry	1.80	7.85																									
234	Endemic Bore 5	31/03/2022	GW5	GR	Dry	1.76	17.65																									
235	Endemic Bore 12	31/03/2022	GW12	GR	Dry	2.84	6.55																									
236	DWER Bore 1	31/03/2022	SCC 05/08	GR		19.32	22.46																									
237	DWER Bore 2	31/03/2022	SCC 06/08	GR		2.93	4.54																									
238	DWER Bore 3	31/03/2022	SCC 09/08	GR		5.22	7.99																									
239	Hyd2o Bore Wattle Grove 1	29/04/2022	WG1	GR		16.13	15.97																									
240	Hyd2o Bore Wattle Grove 2 (Deep)	29/04/2022	WG2	GR		9.50	16.62																									
241	Hyd2o Bore Wattle Grove 3	29/04/2022	WG3	GR		7.70	15.27																									
242	Unknown Origin Bore	29/04/2022	MBa	GR		4.48	16.13																									
243	Douglas Partners Bore 1	29/04/2022	MBb	GR		15.04	16.86																									
244	Urbaqua Bore 1	29/04/2022	GW1	GR	Dry	8.80	14.69																									
245	Endemic Bore 3	29/04/2022	GW3	GR	Dry	1.80	7.85																									
246	Endemic Bore 5	29/04/2022	GW5	GR	Dry	1.76	17.65																									
247	Endemic Bore 12	29/04/2022	GW12	GR	Dry	2.84	6.55																									
248	DWER Bore 1	29/04/2022	SCC 05/08	GR		19.40	22.38																									
249	DWER Bore 2	29/04/2022	SCC 06/08	GR	Construction - new grass near bore	2.75	4.72																									
250	DWER Bore 3	29/04/2022	SCC 09/08	GR		5.40	7.10																									
251	Hyd2o Bore Wattle Grove 1	30/05/2022	WG1	GR & SO		16.06	16.04	18.40	0.570	6.02	38.2	4.70	0.700	4.000	0.005	4.000	0.033	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0010	0.0040						
252	Hyd2o Bore Wattle Grove 2 (Deep)	30/05/2022	WG2	GR & SO		9.36	16.76	16.30	2.197	6.37	22.4	5.20	3.000	2.200	0.013	2.200	0.059	0.60	0.005	0.0010	0.0001	0.0010	0.0020	0.0010	0.0001	0.0100	0.0330	0.10					
253	Hyd2o Bore Wattle Grove 3	30/05/2022	WG3	GR & SO		7.48	15.49	18.60	4.840	5.69	14.9	1.10	0.900	0.210	0.005	0.210	0.048	0.06	0.020	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0150	0.0080	0.10					
254	Unknown Origin Bore	30/05/2022	MBa	GR & SO		2.62	17.99																									
255	Douglas Partners Bore 1	30/05/2022	MBb	GR & SO		15.13	16.77	18.10	1.645	6.15	8.8	4.60	4.600	0.005	0.005	0.005	3.400	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0120	0.0130	0.10					
256	Urbaqua Bore 1	30/05/2022	GW1	GR & SO		8.80	14.69																									
257	Endemic Bore 3	30/05/2022	GW3	GR & SO		1.80	7.85																									
258	Endemic Bore 5	30/05/2022	GW5	GR & SO		1.55	17.86	19.60	1.506	6.52	55.3	3.40	2.500	0.930	0.005	0.930	0.012	0.05	0.005	0.0010	0.0001	0.0010	0.0040	0.0010	0.0001	0.0100	0.0040	0.10					
259	Endemic Bore 12	30/05/2022	GW12	GR & SO		1.88	7.51																									
260	DWER Bore 1	30/05/2022	SCC 05/08	GR & SO		19.43	22.35																									
261	DWER Bore 2	30/05/2022	SCC 06/08	GR & SO		2.21	5.26																									
262	DWER Bore 3	30/05/2022	SCC 09/08	GR & SO		4.97	8.24																									
263	Hyd2o Bore Wattle Grove 1	30/06/2022	WG1	GR		15.92	16.18																									
264	Hyd2o Bore Wattle Grove 2 (Deep)	30/06/2022	WG2	GR		9.25	16.87																									
265	Hyd2o Bore Wattle Grove 3	30/06/2022	WG3	GR		7.23	15.74																									
266	Unknown Origin Bore	30/06/2022	MBa	GR		2.70	17.91																									
267	Douglas Partners Bore 1	30/06/2022	MBb	GR		15.11	16.79																									
268	Urbaqua Bore 1	30/06/2022	GW1	GR		8.80	14.69																									

269	Endemic Bore 3	30/06/2022	GW3	GR		1.79	7.86																										
270	Endemic Bore 5	30/06/2022	GW5	GR		1.44	17.97																										
271	Endemic Bore 12	30/06/2022	GW12	GR		1.79	7.60																										
272	DWER Bore 1	30/06/2022	SCC 05/08	GR		19.37	22.41																										
273	DWER Bore 2	30/06/2022	SCC 06/08	GR		2.02	5.45																										
274	DWER Bore 3	30/06/2022	SCC 09/08	GR		4.60	8.61																										
275	Hyd2o Bore Wattle Grove 1	26/08/2022	WG1	ASM & SO		15.70	16.40																										
276	Hyd2o Bore Wattle Grove 2 Shallow	26/08/2022	WG2S	ASM & SO	Dry	3.51	22.50																										
277	Hyd2o Bore Wattle Grove 2 (Deep)	26/08/2022	WG2	ASM & SO		8.57	17.55																										
278	Hyd2o Bore Wattle Grove 3	26/08/2022	WG3	ASM & SO		5.84	17.13																										
279	Hyd2o Bore Wattle Grove 4 Shallow	26/08/2022	WG4S	ASM & SO		1.16	24.50																										
280	Hyd2o Bore Wattle Grove 4 Deep	26/08/2022	WG4D	ASM & SO		9.82	15.91																										
281	Hyd2o Bore Wattle Grove 5 Shallow	26/08/2022	WG5S	ASM & SO	Dry	5.81	29.33																										
282	Hyd2o Bore Wattle Grove 5 Deep	26/08/2022	WG5D	ASM & SO		18.78	16.35																										
283	Hyd2o Bore Wattle Grove 6	26/08/2022	WG6	ASM & SO		6.94	18.40																										
284	Hyd2o Bore Wattle Grove 7 Shallow	26/08/2022	WG7S	ASM & SO	Dry	3.68	19.82																										
285	Hyd2o Bore Wattle Grove 7 Deep	26/08/2022	WG7D	ASM & SO		5.67	17.77																										
286	Unknown Origin Bore	26/08/2022	Mba	ASM & SO		1.85	18.76																										
287	Douglas Partners Bore 1	26/08/2022	MBb	ASM & SO		14.70	17.20																										
288	Urbaqua Bore 1	26/08/2022	Gw1	ASM & SO		3.38	20.11																										
289	Endemic Bore 3	26/08/2022	GW3	ASM & SO		1.09	8.56																										
290	Endemic Bore 5	26/08/2022	GW5	ASM & SO		1.12	18.29																										
291	Hyd2o Deep Bore next to Endemic 5	26/08/2022	GW5D	ASM & SO		2.32	17.05																										
292	Endemic Bore 8	26/08/2022	GW8	ASM & SO		3.55	21.06																										
293	Hyd2o Deep Bore next to Endemic 8	26/08/2022	GW8D	ASM & SO		6.78	17.74																										
294	Hyd2o Bore Wetlands 9 Shallow	26/08/2022	GW9S	ASM & SO		2.11	19.70																										
295	Hyd2o Bore Wetlands 9 Deep	26/08/2022	GW9D	ASM & SO		2.35	19.43																										
296	Endemic Bore 12	26/08/2022	GW12	ASM & SO		0.60	8.79																										
297	DWER Bore 1	26/08/2022	SCC 05/08	ASM & SO		19.15	22.63																										
298	DWER Bore 2	26/08/2022	SCC 06/08	ASM & SO		1.43	6.55																										
299	DWER Bore 3	26/08/2022	SCC 09/08	ASM & SO		1.76	11.45																										
300	Hyd2o Bore Wattle Grove 1	10/10/2022	WG1	SO & BL		15.39	16.71			5.90		4.40	1.000	3.300	0.005	3.300	0.010	0.16	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0010	0.0058		1.0	3.7	1.6	43	18
301	Hyd2o Bore Wattle Grove 2 Shallow	6/10/2022	WG2S	SO & BL	Dry	3.53	22.48																										
302	Hyd2o Bore Wattle Grove 2 (Deep)	6/10/2022	WG2	SO & BL		8.18	17.94	21.20	1.964	5.46	27.3	0.89	0.260	0.620	0.005	0.620	0.005	0.06	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0044	0.0041		3.3	80.0	9.0	310	340
303	Hyd2o Bore Wattle Grove 3	6/10/2022	WG3	SO & BL		5.13	17.84	20.20	2.843	5.76	17.6	0.65	0.650	0.005	0.005	0.005	0.005	0.05	0.005	0.0019	0.0001	0.0016	0.0010	0.0010	0.0001	0.0061	0.0053		30.0	54.0	20.0	520	300
304	Hyd2o Bore Wattle Grove 4 Shallow	6/10/2022	WG4S	SO & BL		1.28	24.38	19.00	1.711	5.94	17.4	1.30	0.290	0.960	0.005	0.960	0.014	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0015	0.0024		35.0	54.0	10.0	260	310
305	Hyd2o Bore Wattle Grove 4 Deep	6/10/2022	WG4D	SO & BL		9.50	16.23	19.30	0.786	6.29	33.6	1.60	0.480	1.200	0.005	1.200	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0017	0.0010	0.0001	0.0018	0.0089		59.0	21.0	7.8	64	230
306	Hyd2o Bore Wattle Grove 5 Shallow	6/10/2022	WG5S	SO & BL	Dry	5.81	29.33																										
307	Hyd2o Bore Wattle Grove 5 Deep	6/10/2022	WG5D	SO & BL		18.56	16.57	19.50	0.799	6.02	74.1	15.00	2.700	13.000	0.005	13.000	0.005	0.06	0.005	0.0010	0.0001	0.0010	0.0016	0.0010	0.0001	0.0053	0.0300		5.6	17.0	4.4	120	83
308	Hyd2o Bore Wattle Grove 6	6/10/2022	WG6	SO & BL		6.61	18.73	19.10	1.574	5.48	53.0	4.50	1.200	3.400	0.005	3.400	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0290	0.0001	0.0020	0.0022		9.6	42.0	9.2	240	200
309	Hyd2o Bore Wattle Grove 7 Shallow	6/10/2022	WG7S	SO & BL	Dry	3.70	19.80																										
310	Hyd2o Bore Wattle Grove 7 Deep	6/10/2022	WG7D	SO & BL		5.83	17.61	21.50	0.249	5.42	17.5	1.70	0.720	1.000	0.005	1.000	0.005	0.05	0.034	0.0010	0.0001	0.0014	0.0021	0.0011	0.0001	0.0035	0.0010		3.8	6.7	3.8	29	37
311	Unknown Origin Bore	6/10/2022	Mba	SO & BL		1.77	18.84																										
312	Douglas Partners Bore 1	6/10/2022	MBb	SO & BL		14.43	17.47	19.10	0.583	5.88	10.8	0.30	0.290	0.009	0.005	0.011	0.057	0.05	0.005	0.0012	0.0001	0.0010	0.0010	0.0010	0.0001	0.0055	0.0610		3.6	22.0	7.4	76	100
313	Urbaqua Bore 1	6/10/2022	GW1	SO & BL		5.43	18.06	21.40	0.254	6.20	60.9	3.20	0.630	2.600	0.005	2.600	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0010	0.0011		3.3	4.2	8.0	15	26
314	Endemic Bore 3	6/10/2022	GW3	SO & BL		1.29	8.36	19.00	0.499	6.68	21.4	5.80	1.600	4.000	0.250	4.300	0.180	0.05	0.013	0.0010	0.0001	0.0010	0.0027	0.0010	0.0001	0.0010	0.0038		86.0	3.8	6.9	26	230
315	Endemic Bore 5	6/10/2022	GW5	SO & BL		1.34	18.07	19.40	0.682	7.00	20.2	1.00	1.000	0.010	0.005	0.011	0.015	0.05	0.006	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0095	0.0010		97.0	6.9	8.5	46	270
316	Hyd2o Deep Bore next to Endemic 5	6/10/2022	GW5D	SO & BL		2.35	17.02	18.90	0.636	4.84	13.0	0.44	0.440	0.005	0.005	0.005	0.130	0.05	0.005	0.0020	0.0001	0.0010	0.0010	0.0013	0.0001	0.0190	0.0041		18.0	14.0	8.0	82	100
317	Endemic Bore 8	6/10/2022	GW8	SO & BL		3.95	20.66	19.40	0.198	6.45	19.8																						
318	Hyd2o Deep Bore next to Endemic 8	6/10/2022	GW8D	SO & BL		6.59	17.93	21.10	0.258	5.94	26.3	0.10	0.100	0.005	0.005	0.005	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0022	0.0035		1.7	4.4	1.3	37	23
319	Hyd2o Bore Wetlands 9 Shallow	6/10/2022	GW9S	SO & BL		2.31	19.50	19.90	0.706	6.36	21.5	8.20	2.300	5.800	0.056	5.900	0.005	0.15	0.150	0.0056	0.0001	0.0010	0.0060	0.0010	0.0001	0.0091	0.0120		51.0	9.7	17.0	53	170
320	Hyd2o Bore Wetlands 9 Deep	10/10/2022	GW9D	SO & BL		2.60	19.18			6.50		3.70	3.700	0.005	0.006	0.005	0.089	0.23	0.007	0.0013	0.0001	0.0010	0.0064	0.0010	0.0001	0.0260	0.0230		32.0	40.0	16.0	130	240
321	Endemic Bore 12	6/10/2022	GW12	SO & BL		0.96	8.43																										
322	DWER Bore 1	6/10/2022	SCC 05/08	SO & BL		18.84	22.94																										
323	DWER Bore 2	6/10/2022	SCC 06/08	SO & BL		1.69	6.29																										
324	DWER Bore 3	6/10/2022	SCC 09/08	SO & BL		1.86	11.35																										
325	Hyd2o Bore Wattle Grove 1	27/10/2022	WG1	SO & BL		15.29	16.81																										
326	Hyd2o Bore Wattle Grove 2 Shallow	27/10/2022	WG2S	SO & BL	Dry	3.51	22.50																										
327	Hyd2o Bore Wattle Grove 2 (Deep)	27/10/2022	WG2	SO & BL		8.14	17.98																										
328	Hyd2o Bore Wattle Grove 3	27/10/2022	WG3	SO & BL		5.21	17.76																										
329	Hyd2o Bore Wattle Grove 4 Shallow	27/10/2022	WG4S	SO & BL		1.34	24.32																										
330	Hyd2o Bore Wattle Grove 4 Deep	27/10/2022	WG4D	SO & BL		9.36	16.37																										
331	Hyd2o Bore Wattle Grove 5 Shallow	27/10/2022	WG5S	SO & BL	Dry	5.81	29.33																										
332	Hyd2o Bore Wattle Grove 5 Deep	27/10/2022	WG5D	SO & BL		18.52	16.61																										
333	Hyd2o Bore Wattle Grove 6	27/10/2022	WG6	SO & BL		6.54	18.80																										
334	Hyd2o Bore Wattle Grove 7 Shallow	27/10/2022	WG7S	SO & BL	Dry	3.72	19.78																										
335	Hyd2o Bore Wattle Grove 7 Deep	27/10/2022	WG7D	SO & BL		6.01	17.43																										
336	Hyd2o Bore Wattle Grove 8	27/10/2022	WG8	SO & BL		25.13	16.64																										
337	Hyd2o Bore Wattle Grove 9	27/10/2022	WG9	SO & BL		4.35	19.51																										

338	Hyd2o Bore Wattle Grove 10 Shallow	27/10/2022	WG10S	SO & BL		3.13	20.47																									
339	Hyd2o Bore Wattle Grove 10 Deep	27/10/2022	WG10D	SO & BL		5.49	18.13																									
340	Unknown Origin Bore	27/10/2022	Mba	SO & BL		1.81	18.80																									
341	Douglas Partners Bore 1	27/10/2022	MBb	SO & BL		14.29	17.61																									
342	Urbaqua Bore 1	27/10/2022	GW1	SO & BL		5.59	17.90																									
343	Endemic Bore 3	27/10/2022	GW3	SO & BL		1.43	8.22																									
344	Endemic Bore 5	27/10/2022	GW5	SO & BL		1.51	17.90																									
345	Hyd2o Deep Bore next to Endemic 5	27/10/2022	GW5D	SO & BL		2.65	16.72																									
346	Endemic Bore 8	27/10/2022	GW8	SO & BL		4.10	20.51																									
347	Hyd2o Deep Bore next to Endemic 8	27/10/2022	GW8D	SO & BL		6.43	18.09																									
348	Hyd2o Bore Wetlands 9 Shallow	27/10/2022	GW9S	SO & BL		2.43	19.38																									
349	Hyd2o Bore Wetlands 9 Deep	27/10/2022	GW9D	SO & BL		2.68	19.10																									
350	Endemic Bore 12	27/10/2022	GW12	SO & BL		1.16	8.23																									
351	DWER Bore 1	27/10/2022	SCC 05/08	SO & BL		18.69	23.09																									
352	DWER Bore 2	27/10/2022	SCC 06/08	SO & BL		1.78	6.20																									
353	DWER Bore 3	27/10/2022	SCC 09/08	SO & BL		2.01	11.20																									
354	Hyd2o Bore Wattle Grove 1	23/11/2022	WG1	AFR & SO		15.31	16.79	25.80	0.380	5.51	46.9	4.10	1.100	3.000	0.005	3.000	0.030	0.11	0.005	0.0010	0.0001	0.0010	0.0027	0.0010	0.0001	0.0010	0.0079		2.0	6.4	3.7	71	32
355	Hyd2o Bore Wattle Grove 2 Shallow	23/11/2022	WG2S	AFR & SO	Dry	3.51	22.50																									
356	Hyd2o Bore Wattle Grove 2 (Deep)	23/11/2022	WG2	AFR & SO		8.29	17.83	29.80	3.679	5.37	65.6	1.50	1.000	0.460	0.005	0.460	0.008	0.09	0.005	0.0010	0.0001	0.0010	0.0026	0.0010	0.0001	0.0063	0.0330		9.6	120.0	8.9	420	500
357	Hyd2o Bore Wattle Grove 3	23/11/2022	WG3	AFR & SO		5.49	17.48	21.30	5.037	5.64	11.8	0.61	0.600	0.010	0.005	0.011	0.005	0.05	0.015	0.0018	0.0001	0.0010	0.0010	0.0010	0.0001	0.0041	0.0067		79.0	92.0	26.0	820	580
358	Hyd2o Bore Wattle Grove 4 Shallow	23/11/2022	WG4S	AFR & SO		1.42	24.24	24.30	2.096	5.96	24.7	1.50	0.240	1.300	0.005	1.300	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0027	0.0160		35.0	53.0	9.7	270	300
359	Hyd2o Bore Wattle Grove 4 Deep	23/11/2022	WG4D	AFR & SO		9.47	16.26	23.40	1.273	6.65	79.4	3.80	3.400	0.450	0.005	0.450	0.034	0.15	0.005	0.0010	0.0001	0.0088	0.0023	0.0011	0.0001	0.0032	0.0060		70.0	31.0	9.4	120	300
360	Hyd2o Bore Wattle Grove 5 Shallow	23/11/2022	WG5S	AFR & SO	Dry	5.80	29.34																									
361	Hyd2o Bore Wattle Grove 5 Deep	23/11/2022	WG5D	AFR & SO		18.50	16.63	24.40	0.829	5.68	78.5	14.00	1.300	12.000	0.005	12.000	0.011	0.22	0.005	0.0010	0.0001	0.0025	0.0022	0.0010	0.0001	0.0017	0.0110		4.1	11.0	3.5	100	56
362	Hyd2o Bore Wattle Grove 6	23/11/2022	WG6	AFR & SO		6.63	18.71	20.40	1.408	5.23	45.3	3.70	0.470	3.200	0.005	3.200	0.005	0.05	0.007	0.0010	0.0001	0.0010	0.0013	0.0300	0.0001	0.0010	0.0013		12.0	32.0	10.0	220	160
363	Hyd2o Bore Wattle Grove 7 Shallow	23/11/2022	WG7S	AFR & SO	Dry	3.68	19.82																									
364	Hyd2o Bore Wattle Grove 7 Deep	23/11/2022	WG7D	AFR & SO		6.39	17.05	23.00	0.392	6.09	13.3	4.00	0.590	3.400	0.005	3.400	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0019	0.0010	0.0001	0.0018	0.0019		12.0	13.0	6.3	39	82
365	Hyd2o Bore Wattle Grove 8	23/11/2022	WG8	AFR & SO		25.13	16.64	21.90	0.869	5.70	46.6	3.90	2.800	1.000	0.006	1.100	0.022	1.60	0.007	0.0010	0.0001	0.0058	0.0075	0.0056	0.0001	0.0044	0.0180		12.0	14.0	4.6	120	85
366	Hyd2o Bore Wattle Grove 9	23/11/2022	WG9	AFR & SO		4.21	19.65	22.50	1.291	6.02	23.8	52.00	8.100	44.000	0.005	44.000	0.006	2.40	2.100	0.0010	0.0001	0.0020	0.0086	0.0052	0.0003	0.0045	0.0078		45.0	44.0	24.0	200	290
367	Hyd2o Bore Wattle Grove 10 Shallow	23/11/2022	WG10S	AFR & SO	Dry	3.20	20.40																									
368	Hyd2o Bore Wattle Grove 10 Deep	23/11/2022	WG10D	AFR & SO		5.73	17.89	22.90	0.130	6.29	52.1	1.40	0.320	1.100	0.005	1.100	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0010	0.0010		1.5	1.5	2.9	22	10
369	Unknown Origin Bore	23/11/2022	Mba	AFR & SO		2.13	18.48																									
370	Douglas Partners Bore 1	23/11/2022	MBb	AFR & SO		14.24	17.66	30.20	2.199	5.93	54.4	1.20	1.200	0.016	0.005	0.018	0.160	0.06	0.005	0.0014	0.0001	0.0027	0.0047	0.0014	0.0001	0.0032	0.0140		3.0	29.0	6.9	100	130
371	Urbaqua Bore 1	23/11/2022	Gw1	AFR & SO																												
372	Endemic Bore 3	23/11/2022	GW3	AFR & SO	Dry	1.53	8.12																									
373	Endemic Bore 5	23/11/2022	GW5	AFR & SO		1.56	17.85	23.20	0.632	6.89	31.8	1.00	0.980	0.020	0.005	0.020	0.039	0.05	0.009	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0041	0.0029		27.0	7.0	6.0	79	95
374	Hyd2o Deep Bore next to Endemic 5	23/11/2022	GW5D	AFR & SO		3.22	16.15	22.40	0.582	4.46	11.0	0.58	0.580	0.005	0.005	0.005	0.160	0.05	0.005	0.0016	0.0001	0.0010	0.0010	0.0010	0.0001	0.0066	0.0025		13.0	11.0	6.8	74	78
375	Endemic Bore 8	23/11/2022	GW8	AFR & SO	Water sitting at bottom	4.10	20.51																									
376	Hyd2o Deep Bore next to Endemic 8	23/11/2022	GW8D	AFR & SO		7.13	17.39	22.90	0.245	6.22	20.7	0.10	0.100	0.008	0.005	0.009	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0020	0.0018		4.0	4.0	2.8	37	27
377	Hyd2o Bore Wetlands 9 Shallow	23/11/2022	GW9S	AFR & SO		2.55	19.26	23.10	0.631	6.58	18.6	3.80	1.500	2.300	0.023	2.300	0.016	0.16	0.078	0.0033	0.0001	0.0018	0.0041	0.0010	0.0001	0.0096	0.0110		51.0	14.0	18.0	52	190
378	Hyd2o Bore Wetlands 9 Deep	23/11/2022	GW9D	AFR & SO		2.85	18.93	23.90	1.208	6.39	11.2	2.90	2.900	0.005	0.005	0.005	0.120	0.05	0.020	0.0015	0.0001	0.0011	0.0037	0.0010	0.0001	0.0280	0.0040		41.0	34.0	21.0	130	240
379	Endemic Bore 12	23/11/2022	GW12	AFR & SO		1.28	8.11																									
380	DWER Bore 1	23/11/2022	SCC 05/08	AFR & SO		18.65	23.13																									
381	DWER Bore 2	23/11/2022	SCC 06/08	AFR & SO		1.96	6.02																									
382	DWER Bore 3	23/11/2022	SCC 09/08	AFR & SO		2.54	10.67																									
383	Hyd2o Bore Wattle Grove 1	20/12/2022	WG1	AFR		15.42	16.68																									
384	Hyd2o Bore Wattle Grove 2 Shallow	20/12/2022	WG2S	AFR	Dry	3.51	22.50																									
385	Hyd2o Bore Wattle Grove 2 (Deep)	20/12/2022	WG2	AFR		8.53	17.59																									
386	Hyd2o Bore Wattle Grove 3	20/12/2022	WG3	AFR		5.85	17.12																									
387	Hyd2o Bore Wattle Grove 4 Shallow	20/12/2022	WG4S	AFR		1.68	23.98																									
388	Hyd2o Bore Wattle Grove 4 Deep	20/12/2022	WG4D	AFR		9.60	16.13																									
389	Hyd2o Bore Wattle Grove 5 Shallow	20/12/2022	WG5S	AFR	Dry	5.80	29.34																									
390	Hyd2o Bore Wattle Grove 5 Deep	20/12/2022	WG5D	AFR		18.62	16.51																									
391	Hyd2o Bore Wattle Grove 6	20/12/2022	WG6	AFR		6.53	18.81																									
392	Hyd2o Bore Wattle Grove 7 Shallow	20/12/2022	WG7S	AFR	Dry	3.68	19.82																									
393	Hyd2o Bore Wattle Grove 7 Deep	20/12/2022	WG7D	AFR		6.89	16.55																									
394	Hyd2o Bore Wattle Grove 8	20/12/2022	WG8	AFR		25.18	16.59																									
395	Hyd2o Bore Wattle Grove 9	20/12/2022	WG9	AFR		4.28	19.58																									
396	Hyd2o Bore Wattle Grove 10 Shallow	20/12/2022	WG10S	AFR	Mud	3.21	20.39																									
397	Hyd2o Bore Wattle Grove 10 Deep	20/12/2022	WG10D	AFR		6.20	17.42																									
398	Unknown Origin Bore	20/12/2022	Mba	AFR		2.97	17.64																									
399	Douglas Partners Bore 1	20/12/2022	MBb	AFR		14.30	17.60																									
400	Urbaqua Bore 1	20/12/2022	GW1	AFR																												
401	Endemic Bore 3	20/12/2022	GW3	AFR	Dry	1.57	8.08																									
402	Endemic Bore 5	20/12/2022	GW5	AFR	Water sitting at bottom	1.75	17.66																									
403	Hyd2o Deep Bore next to Endemic 5	20/12/2022	GW5D	AFR		3.81	15.56																									
404	Endemic Bore 8	20/12/2022	GW8	AFR	Water sitting at bottom	4.14	20.47																									
405	Hyd2o Deep Bore next to Endemic 8	20/12/2022	GW8D	AFR		7.48	17.04																									
406	Hyd2o Bore Wetlands 9 Shallow	20/12/2022	GW9S	AFR		2.72	19.09																									

407	Hyd2o Bore Wetlands 9 Deep	20/12/2022	GW9D	AFR		3.08	18.70																									
408	Endemic Bore 12	20/12/2022	GW12	AFR		1.66	7.73																									
409	DWER Bore 1	20/12/2022	SCC 05/08	AFR		18.72	23.06																									
410	DWER Bore 2	20/12/2022	SCC 06/08	AFR		2.31	5.67																									
411	DWER Bore 3	20/12/2022	SCC 09/08	AFR		3.60	9.61																									
412	Hyd2o Bore Wattle Grove 1	23/01/2023	WG1	AFR		15.65	16.45	24.60	0.468	5.96	47.2	3.80	0.320	3.500	0.005	3.500	0.005	0.05	0.006	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0012	0.0036		1.0	4.1	1.6	39	19
413	Hyd2o Bore Wattle Grove 2 Shallow	23/01/2023	WG2S	AFR	Dry	3.51	22.50																									
414	Hyd2o Bore Wattle Grove 2 (Deep)	23/01/2023	WG2	AFR		8.92	17.20	24.80	6.483	5.93	25.4	1.10	0.410	0.730	0.005	0.730	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0053	0.0140		6.2	140.0	11.0	500	580
415	Hyd2o Bore Wattle Grove 3	23/01/2023	WG3	AFR		6.65	16.32	28.30	8.508	5.53	23.9	0.43	0.420	0.005	0.005	0.005	0.005	0.05	0.008	0.0011	0.0001	0.0011	0.0023	0.0010	0.0001	0.0053	0.0130		55.0	88.0	25.0	770	500
416	Hyd2o Bore Wattle Grove 4 Shallow	23/01/2023	WG4S	AFR		1.96	23.70	36.30	3.622	6.95	-0.2	14.00	14.000	0.005	0.005	0.005	0.320	0.25	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0021	0.0038		27.0	53.0	7.5	300	280
417	Hyd2o Bore Wattle Grove 4 Deep	23/01/2023	WG4D	AFR		9.82	15.91	22.70	0.356	6.63	23.1	0.34	0.330	0.005	0.005	0.005	0.021	0.05	0.005	0.0010	0.0001	0.0010	0.0014	0.0010	0.0001	0.0026	0.0087		65.0	39.0	12.0	250	320
418	Hyd2o Bore Wattle Grove 5 Shallow	23/01/2023	WG5S	AFR	Dry	5.91	29.23																									
419	Hyd2o Bore Wattle Grove 5 Deep	23/01/2023	WG5D	AFR		18.79	16.34	24.20	1.564	5.74	35.1	15.00	1.700	13.000	0.005	13.000	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0063	0.0074		4.5	14.0	4.2	120	68
420	Hyd2o Bore Wattle Grove 6	23/01/2023	WG6	AFR		6.90	18.44	28.90	2.677	5.75	42.7	3.70	0.280	3.400	0.005	3.400	0.005	0.05	0.014	0.0010	0.0001	0.0010	0.0021	0.0200	0.0001	0.0014	0.0024		14.0	32.0	11.0	210	170
421	Hyd2o Bore Wattle Grove 7 Shallow	23/01/2023	WG7S	AFR	Dry	3.68	19.82																									
422	Hyd2o Bore Wattle Grove 7 Deep	23/01/2023	WG7D	AFR		7.61	15.83	30.80	0.820	6.18	16.5	1.10	0.100	1.100	0.005	1.100	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0014	0.0010	0.0001	0.0027	0.0012		6.6	8.9	4.4	51	53
423	Hyd2o Bore Wattle Grove 8	23/01/2023	WG8	AFR		25.33	16.44	24.90	1.599	5.48	41.5	2.30	1.400	0.840	0.006	0.840	0.041	0.28	0.008	0.0010	0.0001	0.0010	0.0042	0.0010	0.0001	0.0075	0.0210		4.9	14.0	3.7	120	71
424	Hyd2o Bore Wattle Grove 9	23/01/2023	WG9	AFR		4.27	19.59	27.50	2.056	6.65	16.2	42.00	4.700	38.000	0.011	38.000	0.005	3.70	2.900	0.0021	0.0001	0.0010	0.0120	0.0010	0.0001	0.0042	0.0040		26.0	33.0	16.0	110	200
425	Hyd2o Bore Wattle Grove 10 Shallow	23/01/2023	WG10S	AFR	Mud	3.20	20.40																									
426	Hyd2o Bore Wattle Grove 10 Deep	23/01/2023	WG10D	AFR		7.78	15.84	29.30	0.567	6.31	55.2	2.50	0.340	2.200	0.005	2.200	0.005	0.05	0.006	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0013	0.0013		3.2	4.7	3.6	22	27
427	Unknown Origin Bore	23/01/2023	Mba	AFR		4.08	16.53																									
428	Douglas Partners Bore 1	23/01/2023	MBb	AFR		14.40	17.50	31.80	1.311	6.11	23.8	0.45	0.440	0.010	0.005	0.010	0.480	0.09	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0077	0.0100		9.1	31.0	7.5	110	150
429	Urbaqua Bore 1	23/01/2023	GW1	AFR																												
430	Endemic Bore 3	23/01/2023	GW3	AFR	Dry	1.57	8.08																									
431	Endemic Bore 5	23/01/2023	GW5	AFR	Dry	1.75	17.66																									
432	Hyd2o Deep Bore next to Endemic 5	23/01/2023	GW5D	AFR		4.40	14.97	30.20	1.136	4.58	15.6	5.50	5.500	0.005	0.005	0.005	0.180	0.42	0.008	0.0013	0.0001	0.0010	0.0010	0.0010	0.0001	0.0054	0.0036		11.0	13.0	6.4	73	79
433	Endemic Bore 8	23/01/2023	GW8	AFR	Water sitting at bottom	4.14	20.47																									
434	Hyd2o Deep Bore next to Endemic 8	23/01/2023	GW8D	AFR		8.00	16.52	28.60	0.580	6.43	24.9	0.12	0.110	0.005	0.005	0.005	0.010	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0033	0.0031		1.7	3.5	2.9	38	18
435	Hyd2o Bore Wetlands 9 Shallow	23/01/2023	GW9S	AFR		2.91	18.90	29.40	1.282	6.50	27.5	3.90	1.600	2.300	0.014	2.300	0.110	0.46	0.055	0.0057	0.0001	0.0010	0.0038	0.0010	0.0001	0.0230	0.0120		35.0	14.0	18.0	61	
436	Hyd2o Bore Wetlands 9 Deep	23/01/2023	GW9D	AFR		3.31	18.47	27.20	1.496	6.54	12.0	1.50	1.500	0.005	0.005	0.005	0.056	0.05	0.014	0.0010	0.0001	0.0010	0.0054	0.0010	0.0001	0.0270	0.0039		26.0	21.0	23.0	79	
437	Endemic Bore 12	23/01/2023	GW12	AFR		2.18	7.21																									
438	DWER Bore 1	23/01/2023	SCC 05/08	AFR		18.85	22.93																									
439	DWER Bore 2	23/01/2023	SCC 06/08	AFR		2.55	5.43																									
440	DWER Bore 3	23/01/2023	SCC 09/08	AFR		4.52	8.69																									
441	Hyd2o Bore Wattle Grove 1	23/02/2023	WG1	AFR		15.85	16.25	25.60	0.341	5.34	61.8			3.500			0.005		0.005	0.0010								40	0.5	4.1	1.3	34	18
442	Hyd2o Bore Wattle Grove 2 Shallow	23/02/2023	WG2S	AFR	Dry	3.51	22.50																									
443	Hyd2o Bore Wattle Grove 2 (Deep)	23/02/2023	WG2	AFR		9.20	16.92	22.10	3.627	5.12	32.4			0.810			0.005		0.005	0.0010								1200	4.2	140.0	11.0	490	570
444	Hyd2o Bore Wattle Grove 3	23/02/2023	WG3	AFR		7.29	15.68	26.10	9.532	5.70	18.9			0.005			0.007		0.025	0.0019								3100	110.0	200.0	40.0	1500	1100
445	Hyd2o Bore Wattle Grove 4 Shallow	23/02/2023	WG4S	AFR		2.24	23.42	29.00	2.251	5.59	15.3			0.005			0.055		0.005	0.0010								480	39.0	59.0	13.0	310	340
446	Hyd2o Bore Wattle Grove 4 Deep	23/02/2023	WG4D	AFR		9.91	15.82	31.20	0.423	5.88	55.4			0.400			0.005		0.005	0.0010								320	43.0	37.0	11.0	220	260
447	Hyd2o Bore Wattle Grove 5 Shallow	23/02/2023	WG5S	AFR	Dry	5.91	29.23																									
448	Hyd2o Bore Wattle Grove 5 Deep	23/02/2023	WG5D	AFR		18.95	16.18	26.00	0.918	6.55	70.8			12.000			0.019		0.005	0.0010								200	3.7	14.0	3.6	120	67
449	Hyd2o Bore Wattle Grove 6	23/02/2023	WG6	AFR		7.28	18.06	21.20	1.354	5.21	57.6			3.300			0.005		0.034	0.0010								390	8.5	31.0	9.7	200	150
450	Hyd2o Bore Wattle Grove 7 Shallow	23/02/2023	WG7S	AFR	Dry	3.68	19.82																									
451	Hyd2o Bore Wattle Grove 7 Deep	23/02/2023	WG7D	AFR		8.07	15.37	24.80	0.938	5.97	21.8			4.400			0.005		0.005	0.0010								190	17.0	18.0	5.1	130	120
452	Hyd2o Bore Wattle Grove 8	23/02/2023	WG8	AFR		25.47	16.30	21.40	0.795	5.36	39.7			0.910			0.005		0.007	0.0010								230	4.2	14.0	3.6	120	69
453	Hyd2o Bore Wattle Grove 9	23/02/2023	WG9	AFR		4.38	19.48	24.80	0.948	5.89	16.8			26.000			0.005		2.200	0.0011								180	31.0	32.0	34.0	97	210
454	Hyd2o Bore Wattle Grove 10 Shallow	23/02/2023	WG10S	AFR	Dry	3.21	20.39																									
455	Hyd2o Bore Wattle Grove 10 Deep	23/02/2023	WG10D	AFR	Mud	9.02	14.60																									
456	Unknown Origin Bore	23/02/2023	Mba	AFR		4.67	15.94																									
457	Douglas Partners Bore 1	23/02/2023	MBb	AFR		14.64	17.26	27.00	0.968	6.03	10.6			0.050			0.300		0.005	0.0010								130	8.9	33.0	8.2	100	160
458	Urbaqua Bore 1	23/02/2023	GW1	AFR																												
459	Endemic Bore 3	23/02/2023	GW3	AFR	Dry	1.57	8.08																									
460	Endemic Bore 5	23/02/2023	GW5	AFR	Dry	1.75	17.66																									
461	Hyd2o Deep Bore next to Endemic 5	23/02/2023	GW5D	AFR		4.61	14.76	25.30	0.626	4.49	11.9			0.005			0.160		0.005	0.0010								66	11.0	10.0	6.6	73	68
462	Endemic Bore 8	23/02/2023	GW8	AFR	Dry	4.18	20.43																									
463	Hyd2o Deep Bore next to Endemic 8	23/02/2023	GW8D	AFR		8.17	16.35	28.10	0.323	6.33	22.5			0.005			0.010		0.005	0.0010								59	3.2	4.5	3.0	36	26
464	Hyd2o Bore Wetlands 9 Shallow	23/02/2023	GW9S	AFR		3.06	18.75	27.90	0.893	6.40	13.0			2.100			0.110		0.180	0.0054								110	31.0	9.5	18.0	53	120
465	Hyd2o Bore Wetlands 9 Deep	23/02/2023	GW9D	AFR		3.46	18.32	27.10	0.633	6.37	10.7			0.050			0.046		0.009	0.0012								100	20.0	14.0	19.0	62	110
466	Endemic Bore 12	23/02/2023	GW12	AFR		2.62	6.77																									
467	DWER Bore 1	23/02/2023	SCC 05/08	AFR		19.00	22.78																									
468	DWER Bore 2	23/02/2023	SCC 06/08	AFR		2.75	5.23																									
469	DWER Bore 3	23/02/2023	SCC 09/08	AFR		5.21	8.00																									
470	Hyd2o Bore Wattle Grove 1	22/03/2023	WG1	AFR		16.00	16.10	22.90	0.198	5.20	51.6	4.90	1.700	3.100	0.005	3.100	0.010	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0025	0.0001	0.0010	0.0029		0.9	5.4	1.7	40	24
471	Hyd2o Bore Wattle Grove 2 Shallow	22/03/2023	WG2S	AFR	Dry	3.51	22.50																									
472	Hyd2o Bore Wattle Grove 2 (Deep)	22/03/2023	WG2	AFR		9.36	16.76	23.90	4.195	5.01	15.4	1.60	1.200	0.400	0.005	0.400	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0037	0.0150		6.2	160.0	12.0	590	680
473	Hyd2o Bore Wattle Grove 3	22/03/2023	WG3	AFR		7.70	15.27	28.10	9.528	5.83	26.3	1.30	1.300	0.015	0.005	0.012	0.011	0.05	0.005	0.0012	0.0001	0.0010	0.0010	0.0013	0.0001	0.0082	0.0014		130.0	210.0	43.0	1600	1200
474	Hyd2o Bore Wattle Grove 4 Shallow	22/03/2023	WG4S	AFR		2.37	23.29	31.60	2.396	5.75	30.3																					
475	Hyd2o Bore Wattle Grove 4 Deep	22/03/2023	WG4D	AFR		10.44	15.29	24.90	1.636	5.56	35.2	1.10	0.780	0.300	0.005	0.300	0.008	0.06	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0015	0.0080		46.0	49.0	13.0	280	320

476	Hyd2o Bore Wattle Grove 5 Shallow	22/03/2023	WG5S	AFR	Dry	5.91	29.23																									
477	Hyd2o Bore Wattle Grove 5 Deep	22/03/2023	WG5D	AFR		19.07	16.06	23.30	0.766	5.37	50.8	16.00	1.800	14.000	0.005	14.000	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0036	0.0001	0.0024	0.0056		2.5	13.0	3.2	110	59
478	Hyd2o Bore Wattle Grove 6	22/03/2023	WG6	AFR		7.33	18.01	26.80	1.359	5.36	53.4	4.40	1.100	3.300	0.005	3.300	0.005	0.05	0.028	0.0010	0.0001	0.0010	0.0014	0.0200	0.0001	0.0017	0.0015		7.2	31.0	9.3	190	150
479	Hyd2o Bore Wattle Grove 7 Shallow	22/03/2023	WG7S	AFR	Dry	3.68	19.82																									
480	Hyd2o Bore Wattle Grove 7 Deep	22/03/2023	WG7D	AFR		8.50	14.94	28.10	1.021	6.01	36.6	5.50	1.200	4.300	0.005	4.300	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0014	0.0010	0.0001	0.0018	0.0016		16.0	21.0	4.8	130	130
481	Hyd2o Bore Wattle Grove 8	22/03/2023	WG8	AFR		25.57	16.20	22.70	0.839	5.13	22.8	1.50	0.510	0.990	0.005	0.990	0.005	0.79	0.007	0.0010	0.0001	0.0010	0.0033	0.0010	0.0001	0.0120	0.0230		2.7	16.0	3.6	120	74
482	Hyd2o Bore Wattle Grove 9	22/03/2023	WG9	AFR		4.23	19.63	26.50	0.777	5.88	15.4	43.00	11.000	32.000	0.050	32.000	0.050	2.40	2.300	0.0014	0.0001	0.0032	0.0190	0.0010	0.0001	0.0080	0.0036		30.0	26.0	35.0	81	180
483	Hyd2o Bore Wattle Grove 10 Shallow	22/03/2023	WG10S	AFR	Dry	3.21	20.39																									
484	Hyd2o Bore Wattle Grove 10 Deep	22/03/2023	WG10D	AFR	Mud	9.02	14.60																									
485	Unknown Origin Bore	22/03/2023	Mba	AFR		5.30	15.31																									
486	Douglas Partners Bore 1	22/03/2023	MBb	AFR		14.78	17.12	22.80	0.848	6.17	16.6	3.10	3.100	0.008	0.005	0.009	1.900	0.05	0.005	0.0011	0.0001	0.0010	0.0010	0.0010	0.0001	0.0048	0.0110		22.0	42.0	9.2	85	230
487	Urbaqua Bore 1	22/03/2023	GW1	AFR																												
488	Endemic Bore 3	22/03/2023	GW3	AFR	Dry	1.57	8.08																									
489	Endemic Bore 5	22/03/2023	GW5	AFR	Dry	1.75	17.66																									
490	Hyd2o Deep Bore next to Endemic 5	22/03/2023	GW5D	AFR		4.81	14.56	28.00	0.653	4.39	18.3	1.10	1.100	0.005	0.005	0.005	0.150	0.06	0.005	0.0010	0.0001	0.0010	0.0010	0.0021	0.0001	0.0100	0.0062		13.0	12.0	7.0	82	83
491	Endemic Bore 8	22/03/2023	GW8	AFR	Dry	4.18	20.43																									
492	Hyd2o Deep Bore next to Endemic 8	22/03/2023	GW8D	AFR		8.50	16.02	25.60	0.236	5.92	34.3	0.38	0.380	0.006	0.005	0.006	0.008	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0042	0.0048		2.9	3.9	2.8	37	23
493	Hyd2o Bore Wetlands 9 Shallow	22/03/2023	GW9S	AFR		3.16	18.65	31.30	0.845	6.44	24.7	3.40	2.200	1.100	0.080	1.200	0.084	0.27	0.200	0.0059	0.0001	0.0010	0.0030	0.0010	0.0001	0.0140	0.0075		38.0	12.0	19.0	71	140
494	Hyd2o Bore Wetlands 9 Deep	22/03/2023	GW9D	AFR		3.58	18.20	29.30	0.646	6.56	17.6	2.00	2.000	0.050	0.050	0.050	0.082	0.07	0.056	0.0062	0.0001	0.0023	0.0017	0.0010	0.0001	0.0350	0.0140		21.0	15.0	19.0	64	120
495	Endemic Bore 12	22/03/2023	GW12	AFR	Dry	2.82	6.57																									
496	DWER Bore 1	22/03/2023	SCC 05/08	AFR		19.12	22.66																									
497	DWER Bore 2	22/03/2023	SCC 06/08	AFR		2.96	5.02																									
498	DWER Bore 3	22/03/2023	SCC 09/08	AFR		5.49	7.72																									
499	Hyd2o Bore Wattle Grove 1	19/04/2023	WG1	AFR		15.99	16.11																									
500	Hyd2o Bore Wattle Grove 2 Shallow	19/04/2023	WG2S	AFR	Dry	3.51	22.50																									
501	Hyd2o Bore Wattle Grove 2 (Deep)	19/04/2023	WG2	AFR		9.26	16.86																									
502	Hyd2o Bore Wattle Grove 3	19/04/2023	WG3	AFR		7.50	15.47																									
503	Hyd2o Bore Wattle Grove 4 Shallow	19/04/2023	WG4S	AFR		2.20	23.46																									
504	Hyd2o Bore Wattle Grove 4 Deep	19/04/2023	WG4D	AFR		9.89	15.84																									
505	Hyd2o Bore Wattle Grove 5 Shallow	19/04/2023	WG5S	AFR	Dry	5.91	29.23																									
506	Hyd2o Bore Wattle Grove 5 Deep	19/04/2023	WG5D	AFR		19.05	16.08																									
507	Hyd2o Bore Wattle Grove 6	19/04/2023	WG6	AFR		7.12	18.22																									
508	Hyd2o Bore Wattle Grove 7 Shallow	19/04/2023	WG7S	AFR	Dry	3.68	19.82																									
509	Hyd2o Bore Wattle Grove 7 Deep	19/04/2023	WG7D	AFR		8.41	15.03																									
510	Hyd2o Bore Wattle Grove 8	19/04/2023	WG8	AFR		25.56	16.21																									
511	Hyd2o Bore Wattle Grove 9	19/04/2023	WG9	AFR		4.18	19.68																									
512	Hyd2o Bore Wattle Grove 10 Shallow	19/04/2023	WG10S	AFR	Dry	3.21	20.39																									
513	Hyd2o Bore Wattle Grove 10 Deep	19/04/2023	WG10D	AFR	Dry	8.99	14.63																									
514	Unknown Origin Bore	19/04/2023	Mba	AFR	Blocked																											
515	Douglas Partners Bore 1	19/04/2023	MBb	AFR		14.92	16.98																									
516	Urbaqua Bore 1	19/04/2023	GW1	AFR																												
517	Endemic Bore 3	19/04/2023	GW3	AFR	Dry	1.57	8.08																									
518	Endemic Bore 5	19/04/2023	GW5	AFR	Dry	1.75	17.66																									
519	Hyd2o Deep Bore next to Endemic 5	19/04/2023	GW5D	AFR		4.92	14.45																									
520	Endemic Bore 8	19/04/2023	GW8	AFR	Dry	4.18	20.43																									
521	Hyd2o Deep Bore next to Endemic 8	19/04/2023	GW8D	AFR		8.31	16.21																									
522	Hyd2o Bore Wetlands 9 Shallow	19/04/2023	GW9S	AFR		3.07	18.74																									
523	Hyd2o Bore Wetlands 9 Deep	19/04/2023	GW9D	AFR		3.44	18.34																									
524	Endemic Bore 12	19/04/2023	GW12	AFR		2.41	6.98																									
525	DWER Bore 1	19/04/2023	SCC 05/08	AFR		19.19	22.59																									
526	DWER Bore 2	19/04/2023	SCC 06/08	AFR		2.52	5.46																									
527	DWER Bore 3	19/04/2023	SCC 09/08	AFR		5.34	7.87																									
528	Hyd2o Bore Wattle Grove 1	17/05/2023	WG1	AFR		15.96	16.14																									
529	Hyd2o Bore Wattle Grove 2 Shallow	17/05/2023	WG2S	AFR	Dry	3.51	22.50																									
530	Hyd2o Bore Wattle Grove 2 (Deep)	17/05/2023	WG2	AFR		9.20	16.92																									
531	Hyd2o Bore Wattle Grove 3	17/05/2023	WG3	AFR		7.47	15.50																									
532	Hyd2o Bore Wattle Grove 4 Shallow	17/05/2023	WG4S	AFR		2.28	23.38																									
533	Hyd2o Bore Wattle Grove 4 Deep	17/05/2023	WG4D	AFR		9.87	15.86																									
534	Hyd2o Bore Wattle Grove 5 Shallow	17/05/2023	WG5S	AFR	Dry	5.91	29.23																									
535	Hyd2o Bore Wattle Grove 5 Deep	17/05/2023	WG5D	AFR		18.99	16.14																									
536	Hyd2o Bore Wattle Grove 6	17/05/2023	WG6	AFR		7.49	17.85																									
537	Hyd2o Bore Wattle Grove 7 Shallow	17/05/2023	WG7S	AFR	Dry	3.68	19.82																									
538	Hyd2o Bore Wattle Grove 7 Deep	17/05/2023	WG7D	AFR		8.23	15.21																									
539	Hyd2o Bore Wattle Grove 8	17/05/2023	WG8	AFR		25.53	16.24																									
540	Hyd2o Bore Wattle Grove 9	17/05/2023	WG9	AFR		4.64	19.22																									
541	Hyd2o Bore Wattle Grove 10 Shallow	17/05/2023	WG10S	AFR	Dry	3.21	20.39																									
542	Hyd2o Bore Wattle Grove 10 Deep	17/05/2023	WG10D	AFR	Mud	8.99	14.63																									
543	Unknown Origin Bore	17/05/2023	Mba	AFR	Blocked																											
544	Douglas Partners Bore 1	17/05/2023	MBb	AFR		14.90	17.00																									

545	Urbaqua Bore 1	17/05/2023	GW1	AFR																												
546	Endemic Bore 3	17/05/2023	GW3	AFR	Dry	1.57	8.08																									
547	Endemic Bore 5	17/05/2023	GW5	AFR	Dry	1.75	17.66																									
548	Hyd2o Deep Bore next to Endemic 5	17/05/2023	GW5D	AFR		5.01	14.36																									
549	Endemic Bore 8	17/05/2023	GW8	AFR	Dry	4.18	20.43																									
550	Hyd2o Deep Bore next to Endemic 8	17/05/2023	GW8D	AFR		8.23	16.29																									
551	Hyd2o Bore Wetlands 9 Shallow	17/05/2023	GW9S	AFR		3.10	18.71																									
552	Hyd2o Bore Wetlands 9 Deep	17/05/2023	GW9D	AFR		3.45	18.33																									
553	Endemic Bore 12	17/05/2023	GW12	AFR		2.72	6.67																									
554	DWER Bore 1	17/05/2023	SCC 05/08	AFR		19.21	22.57																									
555	DWER Bore 2	17/05/2023	SCC 06/08	AFR		2.45	5.53																									
556	DWER Bore 3	17/05/2023	SCC 09/08	AFR		5.33	7.88																									
557	Hyd2o Bore Wattle Grove 1	15/06/2023	WG1	AFR		15.91	16.19	18.30	0.352	5.32	35.0	4.20	0.790	3.400	0.005	3.400	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0023	0.0001	0.0010	0.0058		0.8	4.5	1.6	52	21
558	Hyd2o Bore Wattle Grove 2 Shallow	15/06/2023	WG2S	AFR	Dry	3.51	22.50																									
559	Hyd2o Bore Wattle Grove 2 (Deep)	15/06/2023	WG2	AFR		9.06	17.06	19.40	3.176	5.17	29.9	2.20	0.200	2.000	0.006	2.100	0.013	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0025	0.0024		5.4	100.0	10.0	340	440
560	Hyd2o Bore Wattle Grove 3	15/06/2023	WG3	AFR		7.14	15.83	18.80	8.698	6.06	19.0	1.30	1.300	0.005	0.005	0.005	0.200	0.08	0.005	0.0016	0.0001	0.0010	0.0010	0.0021	0.0001	0.0012	0.0026		93.0	150.0	33.0	1200	860
561	Hyd2o Bore Wattle Grove 4 Shallow	15/06/2023	WG4S	AFR		1.37	24.29	18.20	2.247	5.61	22.7	0.37	0.160	0.200	0.005	0.210	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0012	0.0030		42.0	62.0	11.0	270	360
562	Hyd2o Bore Wattle Grove 4 Deep	15/06/2023	WG4D	AFR		9.37	16.36	18.40	1.909	5.82	29.7	9.20	1.200	8.100	0.005	8.100	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0055	0.0061		67.0	47.0	11.0	240	360
563	Hyd2o Bore Wattle Grove 5 Shallow	15/06/2023	WG5S	AFR	Dry	5.91	29.23																									
564	Hyd2o Bore Wattle Grove 5 Deep	15/06/2023	WG5D	AFR		18.94	16.19	18.60	0.680	5.29	57.7	17.00	2.700	14.000	0.005	14.000	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0026	0.0001	0.0028	0.0130		3.6	15.0	3.5	120	70
565	Hyd2o Bore Wattle Grove 6	15/06/2023	WG6	AFR		7.49	17.85	18.70	1.614	5.40	39.2	3.40	0.690	2.700	0.005	2.700	0.005	0.05	0.007	0.0010	0.0001	0.0010	0.0012	0.0420	0.0001	0.0016	0.0015		7.8	33.0	9.0	200	150
566	Hyd2o Bore Wattle Grove 7 Shallow	15/06/2023	WG7S	AFR	Dry	3.68	19.82																									
567	Hyd2o Bore Wattle Grove 7 Deep	15/06/2023	WG7D	AFR		7.56	15.88	19.10	0.742	5.90	19.9	2.60	0.200	2.400	0.005	2.400	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0020	0.0010	0.0001	0.0021	0.0045		6.1	13.0	4.1	82	68
568	Hyd2o Bore Wattle Grove 8	15/06/2023	WG8	AFR		25.48	16.29	18.20	0.884	5.27	37.7	0.54	0.170	0.360	0.005	0.360	0.007	0.18	0.006	0.0010	0.0001	0.0010	0.0069	0.0010	0.0001	0.0056	0.0590		2.7	15.0	3.4	120	70
569	Hyd2o Bore Wattle Grove 9	15/06/2023	WG9	AFR		4.61	19.25	19.20	1.941	5.77	13.6	12.00	0.750	11.000	0.005	11.000	0.005	1.80	1.700	0.0011	0.0001	0.0012	0.0095	0.0010	0.0001	0.0040	0.0028		44.0	46.0	33.0	210	300
570	Hyd2o Bore Wattle Grove 10 Shallow	15/06/2023	WG10S	AFR		3.00	20.60																									
571	Hyd2o Bore Wattle Grove 10 Deep	15/06/2023	WG10D	AFR		7.07	16.55	18.10	0.428	6.01	42.1	5.80	0.700	5.100	0.005	5.100	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0010	0.0021		8.0	6.7	5.1	31	48
572	Unknown Origin Bore	15/06/2023	Mba	AFR	Blocked																											
573	Douglas Partners Bore 1	15/06/2023	MBb	AFR		14.97	16.93	18.10	0.847	6.12	15.2	1.10	1.000	0.019	0.005	0.023	0.730	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0029	0.0140		15.0	36.0	7.8	77	190
574	Urbaqua Bore 1	15/06/2023	GW1	AFR																												
575	Endemic Bore 3	15/06/2023	GW3	AFR		1.56	8.09																									
576	Endemic Bore 5	15/06/2023	GW5	AFR		1.05	18.36	16.20	0.430	7.33	53.7	0.73	0.710	0.016	0.005	0.020	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0030	0.0010	0.0001	0.0048	0.0021		60.0	4.3	5.1	18	170
577	Hyd2o Deep Bore next to Endemic 5	15/06/2023	GW5D	AFR		5.00	14.37	17.50	0.679	4.77	18.5	0.61	0.620	0.005	0.005	0.005	0.180	0.05	0.005	0.0011	0.0001	0.0011	0.0011	0.0024	0.0001	0.0120	0.0130		17.0	10.0	6.9	72	84
578	Endemic Bore 8	15/06/2023	GW8	AFR		3.70	20.91	16.90	0.192	6.04	53.0	2.50	0.630	1.900	0.005	1.900	0.013	0.36	0.093	0.0010	0.0001	0.0010	0.0059	0.0010	0.0001	0.0018	0.0180		5.0	3.7	3.1	14	28
579	Hyd2o Deep Bore next to Endemic 8	15/06/2023	GW8D	AFR		7.57	16.95	21.00	0.229	6.14	25.8	0.10	0.100	0.007	0.005	0.012	0.010	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0023	0.0190		1.3	3.1	1.1	33	16
580	Hyd2o Bore Wetlands 9 Shallow	15/06/2023	GW9S	AFR		2.47	19.34	17.70	0.363	6.67	32.2	7.00	0.530	6.500	0.005	6.500	0.005	1.40	0.085	0.0049	0.0001	0.0010	0.0029	0.0010	0.0001	0.0045	0.0110		32.0	4.4	5.5	21	98
581	Hyd2o Bore Wetlands 9 Deep	15/06/2023	GW9D	AFR		2.89	18.89	18.30	0.413	6.44	16.2	1.20	0.830	0.400	0.005	0.400	0.005	0.05	0.016	0.0012	0.0001	0.0010	0.0099	0.0010	0.0001	0.0140	0.0078		10.0	7.8	11.0	45	58
582	Endemic Bore 12	15/06/2023	GW12	AFR		1.26	8.13																									
583	DWER Bore 1	15/06/2023	SCC 05/08	AFR		19.21	22.57																									
584	DWER Bore 2	15/06/2023	SCC 06/08	AFR		1.68	6.30																									
585	DWER Bore 3	15/06/2023	SCC 09/08	AFR		3.87	9.34																									
586	Hyd2o Bore Wattle Grove 1	14/07/2023	WG1	AFR		15.78	16.32																									
587	Hyd2o Bore Wattle Grove 2 Shallow	14/07/2023	WG2S	AFR	Dry	3.51	22.50																									
588	Hyd2o Bore Wattle Grove 2 (Deep)	14/07/2023	WG2	AFR		8.88	17.24																									
589	Hyd2o Bore Wattle Grove 3	14/07/2023	WG3	AFR		6.24	16.73																									
590	Hyd2o Bore Wattle Grove 4 Shallow	14/07/2023	WG4S	AFR		1.23	24.43																									
591	Hyd2o Bore Wattle Grove 4 Deep	14/07/2023	WG4D	AFR		9.45	16.28																									
592	Hyd2o Bore Wattle Grove 5 Shallow	14/07/2023	WG5S	AFR	Dry	5.91	29.23																									
593	Hyd2o Bore Wattle Grove 5 Deep	14/07/2023	WG5D	AFR		18.82	16.31																									
594	Hyd2o Bore Wattle Grove 6	14/07/2023	WG6	AFR		7.39	17.95																									
595	Hyd2o Bore Wattle Grove 7 Shallow	14/07/2023	WG7S	AFR	Dry	3.68	19.82																									
596	Hyd2o Bore Wattle Grove 7 Deep	14/07/2023	WG7D	AFR		7.10	16.34																									
597	Hyd2o Bore Wattle Grove 8	14/07/2023	WG8	AFR		25.38	16.39																									
598	Hyd2o Bore Wattle Grove 9	14/07/2023	WG9	AFR		4.64	19.22																									
599	Hyd2o Bore Wattle Grove 10 Shallow	14/07/2023	WG10S	AFR		3.07	20.53																									
600	Hyd2o Bore Wattle Grove 10 Deep	14/07/2023	WG10D	AFR		7.55	16.07																									
601	Unknown Origin Bore	14/07/2023	Mba	AFR	Blocked																											
602	Douglas Partners Bore 1	14/07/2023	MBb	AFR		14.91	16.99																									
603	Urbaqua Bore 1	14/07/2023	GW1	AFR																												
604	Endemic Bore 3	14/07/2023	GW3	AFR		1.44	8.21																									
605	Endemic Bore 5	14/07/2023	GW5	AFR		1.16	18.25																									
606	Hyd2o Deep Bore next to Endemic 5	14/07/2023	GW5D	AFR		5.54	13.83																									
607	Endemic Bore 8	14/07/2023	GW8	AFR		3.85	20.76																									
608	Hyd2o Deep Bore next to Endemic 8	14/07/2023	GW8D	AFR		7.54	16.98																									
609	Hyd2o Bore Wetlands 9 Shallow	14/07/2023	GW9S	AFR		2.44	19.37																									
610	Hyd2o Bore Wetlands 9 Deep	14/07/2023	GW9D	AFR		2.72	19.06																									
611	Endemic Bore 12	14/07/2023	GW12	AFR		1.11	8.28																									
612	DWER Bore 1	14/07/2023	SCC 05/08	AFR		19.13	22.65																									
613	DWER Bore 2	14/07/2023	SCC 06/08	AFR		1.70	6.28																									

614	DWER Bore 3	14/07/2023	SCC 09/08	AFR		3.31	9.90																									
615	Hyd2o Bore Wattle Grove 1	16/08/2023	WG1	AFR		15.61	16.49																									
616	Hyd2o Bore Wattle Grove 2 Shallow	16/08/2023	WG2S	AFR	Dry	3.51	22.50																									
617	Hyd2o Bore Wattle Grove 2 (Deep)	16/08/2023	WG2	AFR		8.68	17.44																									
618	Hyd2o Bore Wattle Grove 3	16/08/2023	WG3	AFR		6.20	16.77																									
619	Hyd2o Bore Wattle Grove 4 Shallow	16/08/2023	WG4S	AFR		0.88	24.78																									
620	Hyd2o Bore Wattle Grove 4 Deep	16/08/2023	WG4D	AFR		8.88	16.85																									
621	Hyd2o Bore Wattle Grove 5 Shallow	16/08/2023	WG5S	AFR	Dry	5.91	29.23																									
622	Hyd2o Bore Wattle Grove 5 Deep	16/08/2023	WG5D	AFR		18.68	16.45																									
623	Hyd2o Bore Wattle Grove 6	16/08/2023	WG6	AFR		7.34	18.00																									
624	Hyd2o Bore Wattle Grove 7 Shallow	16/08/2023	WG7S	AFR	Dry	3.68	19.82																									
625	Hyd2o Bore Wattle Grove 7 Deep	16/08/2023	WG7D	AFR		6.66	16.78																									
626	Hyd2o Bore Wattle Grove 8	16/08/2023	WG8	AFR		25.25	16.52																									
627	Hyd2o Bore Wattle Grove 9	16/08/2023	WG9	AFR		4.64	19.22																									
628	Hyd2o Bore Wattle Grove 10 Shallow	16/08/2023	WG10S	AFR		3.08	20.52																									
629	Hyd2o Bore Wattle Grove 10 Deep	16/08/2023	WG10D	AFR		7.08	16.54																									
630	Unknown Origin Bore	16/08/2023	Mba	AFR	Blocked	2.60	18.01																									
631	Douglas Partners Bore 1	16/08/2023	MBb	AFR		14.68	17.22																									
632	Urbaqua Bore 1	16/08/2023	GW1	AFR																												
633	Endemic Bore 3	16/08/2023	GW3	AFR		1.06	8.59																									
634	Endemic Bore 5	16/08/2023	GW5	AFR		0.77	18.64																									
635	Hyd2o Deep Bore next to Endemic 5	16/08/2023	GW5D	AFR		4.03	15.34																									
636	Endemic Bore 8	16/08/2023	GW8	AFR		3.80	20.81																									
637	Hyd2o Deep Bore next to Endemic 8	16/08/2023	GW8D	AFR		7.07	17.45																									
638	Hyd2o Bore Wetlands 9 Shallow	16/08/2023	GW9S	AFR		2.12	19.69																									
639	Hyd2o Bore Wetlands 9 Deep	16/08/2023	GW9D	AFR		2.50	19.28																									
640	Endemic Bore 12	16/08/2023	GW12	AFR		0.58	8.81																									
641	DWER Bore 1	16/08/2023	SCC 05/08	AFR		18.99	22.79																									
642	DWER Bore 2	16/08/2023	SCC 06/08	AFR		1.27	6.71																									
643	DWER Bore 3	16/08/2023	SCC 09/08	AFR		2.35	10.86																									
644	Surface Water Site 10	16/08/2023	SW10	AFR	SW1 at H21003 COC18			17.70	0.125	7.19	64.7	0.29	0.290	0.005	0.005	0.005	0.005	0.05	0.021	0.0010	0.0001	0.0010	0.0011	0.0010	0.0001	0.0010	0.0025		8.2	0.9	1.7	2.1	24
645	Surface Water Site 3	16/08/2023	SW3	AFR	SW2 at H21003 COC18			15.20	0.149	6.65	53.7	1.80	0.550	1.200	0.012	1.200	0.051	0.27	0.260	0.0047	0.0001	0.0010	0.0110	0.0010	0.0001	0.0010	0.0290		14.0	1.9	2.8	5	43
646	Surface Water Site 2	16/08/2023	SW2	AFR	SW3 at H21003 COC18			15.50	1.113	7.49	72.0	3.50	1.300	2.100	0.017	2.100	0.110	0.13	0.065	0.0010	0.0001	0.0010	0.0049	0.0014	0.0001	0.0010	0.0120		59.0	25.0	9.1	120	250
647	Surface Water Site 6	16/08/2023	SW6	AFR	SW4 at H21003 COC18			16.10	0.293	6.76	68.1	1.10	1.100	0.005	0.005	0.005	0.021	0.05	0.005	0.0010	0.0001	0.0010	0.0027	0.0010	0.0001	0.0015	0.0100		13.0	6.1	3.9	28	58
648	Surface Water Site 7	16/08/2023	SW7	AFR	SW5 at H21003 COC18			15.50	0.280	7.17	54.4	1.50	1.500	0.005	0.005	0.005	0.005	0.08	0.061	0.0011	0.0001	0.0010	0.0025	0.0010	0.0001	0.0011	0.0088		18.0	4.8	4.7	25	65
649	Hyd2o Bore Wattle Grove 1	14/09/2023	WG1	AFR		15.50	16.60	19.60	0.325	5.52	37.8	3.80	0.540	3.200	0.005	3.200	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0030	0.0001	0.0010	0.0017		2.4	7.0	2.9	71	35
650	Hyd2o Bore Wattle Grove 2 Shallow	14/09/2023	WG2S	AFR	Dry	3.51	22.50																									
651	Hyd2o Bore Wattle Grove 2 (Deep)	14/09/2023	WG2	AFR		8.48	17.64	20.10	2.984	5.26	21.3	0.44	0.270	0.160	0.006	0.170	0.005	0.05	0.005	0.0051	0.0001	0.0010	0.0010	0.0010	0.0001	0.0045	0.0073		6.0	120.0	11.0	420	510
652	Hyd2o Bore Wattle Grove 3	14/09/2023	WG3	AFR		5.87	17.10	19.20	4.605	5.98	16.9	1.00	1.000	0.005	0.005	0.005	0.064	0.05	0.005	0.0027	0.0001	0.0013	0.0010	0.0010	0.0001	0.0010	0.0025		46.0	83.0	27.0	780	460
653	Hyd2o Bore Wattle Grove 4 Shallow	14/09/2023	WG4S	AFR		0.99	24.67	18.60	1.813	5.79	16.3	0.33	0.330	0.005	0.005	0.005	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0010	0.0013		38.0	56.0	9.8	280	330
654	Hyd2o Bore Wattle Grove 4 Deep	14/09/2023	WG4D	AFR		8.44	17.29	19.50	1.291	6.58	28.3	0.75	0.650	0.099	0.005	0.100	0.060	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0010	0.0010		86.0	29.0	8.0	150	330
655	Hyd2o Bore Wattle Grove 5 Shallow	14/09/2023	WG5S	AFR	Dry	5.91	29.23																									
656	Hyd2o Bore Wattle Grove 5 Deep	14/09/2023	WG5D	AFR		18.60	16.53	20.40	0.744	5.32	31.2	17.00	3.400	14.000	0.005	14.000	0.005	0.06	0.005	0.0010	0.0001	0.0010	0.0010	0.0045	0.0001	0.0016	0.0044		4.0	14.0	3.7	120	66
657	Hyd2o Bore Wattle Grove 6	14/09/2023	WG6	AFR		7.21	18.13	18.90	1.427	5.27	37.9	4.20	0.720	3.500	0.005	3.500	0.005	0.05	0.006	0.0010	0.0001	0.0010	0.0010	0.0280	0.0001	0.0014	0.0021		8.0	37.0	9.7	230	170
658	Hyd2o Bore Wattle Grove 7 Shallow	14/09/2023	WG7S	AFR	Dry	3.68	19.82																									
659	Hyd2o Bore Wattle Grove 7 Deep	14/09/2023	WG7D	AFR		6.33	17.11	20.90	0.437	6.47	21.1	4.90	0.680	4.200	0.005	4.200	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0032	0.0010	0.0001	0.0023	0.0019		20.0	16.0	5.9	58	120
660	Hyd2o Bore Wattle Grove 8	14/09/2023	WG8	AFR		25.18	16.59	18.70	0.679	5.30	16.2	0.48	0.400	0.075	0.005	0.076	0.005	0.21	0.006	0.0010	0.0001	0.0010	0.0017	0.0010	0.0001	0.0019	0.0056		1.7	13.0	3.3	110	57
661	Hyd2o Bore Wattle Grove 9	14/09/2023	WG9	AFR		4.62	19.24	19.30	1.715	5.99	32.1	15.00	4.500	11.000	0.005	11.000	0.006	2.00	1.600	0.0015	0.0001	0.0016	0.0110	0.0010	0.0001	0.0048	0.0034		48.0	41.0	39.0	230	290
662	Hyd2o Bore Wattle Grove 10 Shallow	14/09/2023	WG10S	AFR	Dry	3.21	20.39																									
663	Hyd2o Bore Wattle Grove 10 Deep	14/09/2023	WG10D	AFR		6.46	17.16	20.70	0.112	6.34	63.4	3.30	0.860	2.400	0.005	2.400	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0010	0.0010		5.4	3.3	4.0	22	27
664	Unknown Origin Bore	14/09/2023	Mba	AFR	Blocked	2.60	18.01																									
665	Douglas Partners Bore 1	14/09/2023	MBb	AFR		14.66	17.24	18.50	0.795	6.95	72.1	2.30	2.300	0.016	0.005	0.017	1.700	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0064	0.0150		25.0	47.0	9.2	80	260
666	Endemic Bore 3	14/09/2023	GW3	AFR		1.24	8.41																									
667	Endemic Bore 5	14/09/2023	GW5	AFR		1.10	18.31	17.80	0.541	7.33	40.7	1.30	1.300	0.024	0.005	0.024	0.031	0.06	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0056	0.0010		110.0	5.7	5.9	21	290
668	Hyd2o Deep Bore next to Endemic 5	14/09/2023	GW5D	AFR		3.19	16.18	19.10	0.715	5.13	13.6	0.70	0.710	0.005	0.005	0.005	0.140	0.05	0.005	0.0026	0.0001	0.0010	0.0010	0.0010	0.0001	0.0170	0.0044		29.0	15.0	8.6	91	130
669	Endemic Bore 8	14/09/2023	GW8	AFR		3.93	20.68																									
670	Hyd2o Deep Bore next to Endemic 8	14/09/2023	GW8D	AFR		6.73	17.79	20.30	0.169	5.50	23.4	0.23	0.220	0.010	0.005	0.011	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0011	0.0012		0.7	1.7	1.0	32	8.7
671	Hyd2o Bore Wetlands 9 Shallow	14/09/2023	GW9S	AFR		2.27	19.54	18.30	0.149	7.04	34.9	1.50	0.590	0.870	0.005	0.870	0.005	0.12	0.089	0.0071	0.0001	0.0010	0.0018	0.0010	0.0001	0.0019	0.0043		21.0	2.5	5.1	13	62
672	Hyd2o Bore Wetlands 9 Deep	14/09/2023	GW9D	AFR		2.56	19.22	18.30	0.325	6.56	14.4	0.76	0.620	0.140	0.005	0.140	0.005	0.05	0.009	0.0010	0.0001	0.0010	0.0034	0.0010	0.0001	0.0070	0.0023		11.0	9.7	8.4	41	67
673	Endemic Bore 12	14/09/2023	GW12	AFR		0.72	8.67																									
674	DWER Bore 1	14/09/2023	SCC 05/08	AFR		18.86	22.92																									
675	DWER Bore 2	14/09/2023	SCC 06/08	AFR		1.30	6.68																									
676	DWER Bore 3	14/09/2023	SCC 09/08	AFR		2.14	11.07																									
677	Surface Water Site 10	14/09/2023	SW10	AFR	SW1 at H21003 COC19C			20.20	0.137	6.84	31.5	0.92	0.930	0.005	0.005	0.005	0.005	0.37	0.320	0.0010	0.0001	0.0010	0.0025	0.0010	0.0001	0.0012	0.0080		12.0	6.0	7.8	20	54
678	Surface Water Site 2	14/09/2023	SW2	AFR	SW2 at H21003 COC19C			17.80	1.434	8.01	60.4	2.30	1.100	1.200	0.023	1.200	0.055	0.07	0.016	0.0010	0.0001	0.0010	0.0024	0.0011	0.0001	0.0011	0.0043		68.0	33.0	12.0	170	300
679	Surface Water Site 6	14/09/2023	SW6	AFR	SW3 at H21003 COC19C			17.40	0.450	6.74	37.2	0.96	0.940	0.015	0.005	0.015	0.008	0.05	0.005	0.0010	0.0001	0.0010	0.0025	0.0010	0.0001	0.0015	0.0061		27.0	12.0	6.9	53	110
680	Surface Water Site 7	14/09/2023	SW7	AFR	SW4 at H21003 COC19C			17.70	0.647	7.65	52.2	1.80	1.800	0.005	0.005	0.005	0.008	0.17	0.088	0.0015	0.0001	0.0010	0.0019	0.0010	0.0001	0.0017	0.0060		44.0	14.0	11.0	70	170
681	Surface Water Site 9	14/09/2023	SW9	AFR	SW5 at H21003 COC19C			18.60	0.708	7.85	61.3	1.90	1.800	0.033	0.005	0.031	0.005	0.18	0.099	0.0017	0.0001	0.0010	0.0019	0.0010	0.0001	0.0027	0.0036		65.0	15.0	12.0	64	220
682	Hyd2o Bore Wattle Grove 1	13/10/2023	WG1	AFR		15.42	16.68																									

683	Hyd2o Bore Wattle Grove 2 Shallow	13/10/2023	WG2S	AFR	Dry	3.51	22.50																											
684	Hyd2o Bore Wattle Grove 2 (Deep)	13/10/2023	WG2	AFR		8.45	17.67																											
685	Hyd2o Bore Wattle Grove 3	13/10/2023	WG3	AFR		5.87	17.10																											
686	Hyd2o Bore Wattle Grove 4 Shallow	13/10/2023	WG4S	AFR		1.43	24.23																											
687	Hyd2o Bore Wattle Grove 4 Deep	13/10/2023	WG4D	AFR		8.41	17.32																											
688	Hyd2o Bore Wattle Grove 5 Shallow	13/10/2023	WG5S	AFR	Dry	5.91	29.23																											
689	Hyd2o Bore Wattle Grove 5 Deep	13/10/2023	WG5D	AFR		18.54	16.59																											
690	Hyd2o Bore Wattle Grove 6	13/10/2023	WG6	AFR		7.38	17.96																											
691	Hyd2o Bore Wattle Grove 7 Shallow	13/10/2023	WG7S	AFR		3.68	19.82																											
692	Hyd2o Bore Wattle Grove 7 Deep	13/10/2023	WG7D	AFR		6.46	16.98																											
693	Hyd2o Bore Wattle Grove 8	13/10/2023	WG8	AFR		25.11	16.66																											
694	Hyd2o Bore Wattle Grove 9	13/10/2023	WG9	AFR		4.75	19.11																											
695	Hyd2o Bore Wattle Grove 10 Shallow	13/10/2023	WG10S	AFR	Dry	3.21	20.39																											
696	Hyd2o Bore Wattle Grove 10 Deep	13/10/2023	WG10D	AFR		6.25	17.37																											
697	Unknown Origin Bore	13/10/2023	Mba	AFR	Blocked	2.60	18.01																											
698	Douglas Partners Bore 1	13/10/2023	MBb	AFR		14.55	17.35																											
699	Endemic Bore 3	13/10/2023	GW3	AFR		1.53	8.12																											
700	Endemic Bore 5	13/10/2023	GW5	AFR		1.56	17.85																											
701	Hyd2o Deep Bore next to Endemic 5	13/10/2023	GW5D	AFR		3.34	16.03																											
702	Endemic Bore 8	13/10/2023	GW8	AFR		4.03	20.58																											
703	Hyd2o Deep Bore next to Endemic 8	13/10/2023	GW8D	AFR		6.84	17.68																											
704	Hyd2o Bore Wetlands 9 Shallow	13/10/2023	GW9S	AFR		2.58	19.23																											
705	Hyd2o Bore Wetlands 9 Deep	13/10/2023	GW9D	AFR		2.83	18.95																											
706	Endemic Bore 12	13/10/2023	GW12	AFR		1.22	8.17																											
707	DWER Bore 1	13/10/2023	SCC 05/08	AFR		18.78	23.00																											
708	DWER Bore 2	13/10/2023	SCC 06/08	AFR		1.90	6.08																											
709	DWER Bore 3	13/10/2023	SCC 09/08	AFR		2.41	10.80																											
710	Hyd2o Bore Wattle Grove 1	15/11/2023	WG1	AFR & TD		15.63	16.47																											
711	Hyd2o Bore Wattle Grove 2 Shallow	15/11/2023	WG2S	AFR & TD	Dry	3.51	22.50																											
712	Hyd2o Bore Wattle Grove 2 (Deep)	15/11/2023	WG2	AFR & TD		8.73	17.39																											
713	Hyd2o Bore Wattle Grove 3	15/11/2023	WG3	AFR & TD		6.18	16.79																											
714	Hyd2o Bore Wattle Grove 4 Shallow	15/11/2023	WG4S	AFR & TD		1.67	23.99																											
715	Hyd2o Bore Wattle Grove 4 Deep	15/11/2023	WG4D	AFR & TD		8.71	17.02																											
716	Hyd2o Bore Wattle Grove 5 Shallow	15/11/2023	WG5S	AFR & TD	Dry	5.91	29.23																											
717	Hyd2o Bore Wattle Grove 5 Deep	15/11/2023	WG5D	AFR & TD		18.72	16.41																											
718	Hyd2o Bore Wattle Grove 6	15/11/2023	WG6	AFR & TD		7.79	17.55																											
719	Hyd2o Bore Wattle Grove 7 Shallow	15/11/2023	WG7S	AFR & TD	Dry	3.68	19.82																											
720	Hyd2o Bore Wattle Grove 7 Deep	15/11/2023	WG7D	AFR & TD		6.86	16.58																											
721	Hyd2o Bore Wattle Grove 8	15/11/2023	WG8	AFR & TD		25.20	16.57																											
722	Hyd2o Bore Wattle Grove 9	15/11/2023	WG9	AFR & TD		4.93	18.93																											
723	Hyd2o Bore Wattle Grove 10 Shallow	15/11/2023	WG10S	AFR & TD	Dry	3.21	20.39																											
724	Hyd2o Bore Wattle Grove 10 Deep	15/11/2023	WG10D	AFR & TD		6.31	17.31																											
725	Unknown Origin Bore	15/11/2023	Mba	AFR & TD	Blocked	2.60	18.01																											
726	Douglas Partners Bore 1	15/11/2023	MBb	AFR & TD		14.58	17.32																											
727	Endemic Bore 3	15/11/2023	GW3	AFR & TD	Dry	1.57	8.08																											
728	Endemic Bore 5	15/11/2023	GW5	AFR & TD	Dry	1.75	17.66																											
729	Hyd2o Deep Bore next to Endemic 5	15/11/2023	GW5D	AFR & TD		3.96	15.41																											
730	Endemic Bore 8	15/11/2023	GW8	AFR & TD		4.04	20.57																											
731	Hyd2o Deep Bore next to Endemic 8	15/11/2023	GW8D	AFR & TD		7.31	17.21																											
732	Hyd2o Bore Wetlands 9 Shallow	15/11/2023	GW9S	AFR & TD		2.82	18.99																											
733	Hyd2o Bore Wetlands 9 Deep	15/11/2023	GW9D	AFR & TD		3.08	18.70																											
734	Endemic Bore 12	15/11/2023	GW12	AFR & TD		1.68	7.71																											
735	DWER Bore 1	15/11/2023	SCC 05/08	AFR & TD		18.85	22.93																											
736	DWER Bore 2	15/11/2023	SCC 06/08	AFR & TD		2.19	5.79																											
737	DWER Bore 3	15/11/2023	SCC 09/08	AFR & TD		3.64	9.57																											
738	Hyd2o Bore Wattle Grove 1	19/12/2023	WG1	AFR & TD		15.69	16.41	22.60	2.758	5.39	44.7	4.00	1.100	2.900	0.005	2.900	0.005	0.18	0.005	0.0010	0.0005	0.0010	0.0015	0.0043	0.0001	0.0010	0.0230		2.1	8.3	2.1	59	39
739	Hyd2o Bore Wattle Grove 2 Shallow	19/12/2023	WG2S	AFR & TD	Dry	3.51	22.50																											
740	Hyd2o Bore Wattle Grove 2 (Deep)	19/12/2023	WG2	AFR & TD		8.89	17.23	24.70	3.851	5.86	41.4	0.23	0.220	0.005	0.005	0.005	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0030	0.0073		4.3	120.0	9.7	470	520
741	Hyd2o Bore Wattle Grove 3	19/12/2023	WG3	AFR & TD		6.54	16.43	23.40	6.275	5.55	24.3	0.64	0.650	0.005	0.005	0.005	0.005	0.05	0.005	0.0022	0.0001	0.0018	0.0010	0.0010	0.0001	0.0050	0.0097		68.0	120.0	24.0	900	650
742	Hyd2o Bore Wattle Grove 4 Shallow	19/12/2023	WG4S	AFR & TD		1.76	23.90	27.50	2.513	5.93	31.7	0.29	0.160	0.120	0.005	0.120	0.005	0.05	0.005	0.0011	0.0008	0.0010	0.0010	0.0010	0.0001	0.0016	0.0470		36.0	55.0	8.3	270	320
743	Hyd2o Bore Wattle Grove 4 Deep	19/12/2023	WG4D	AFR & TD		8.97	16.76	24.50	2.340	6.10	23.5	0.83	0.780	0.047	0.005	0.050	0.063	0.08	0.005	0.0010	0.0002	0.0010	0.0010	0.0010	0.0001	0.0010	0.0110		88.0	45.0	10.0	260	410
744	Hyd2o Bore Wattle Grove 5 Shallow	19/12/2023	WG5S	AFR & TD	Dry	5.91	29.23																											
745	Hyd2o Bore Wattle Grove 5 Deep	19/12/2023	WG5D	AFR & TD		18.74	16.39	24.00	0.897	5.37	40.6	14.00	4.300	10.000	0.005	10.000	0.005	0.11	0.005	0.0010	0.0001	0.0010	0.0010	0.0036	0.0001	0.0021	0.0076		2.8	11.0	2.9	120	51
746	Hyd2o Bore Wattle Grove 6	19/12/2023	WG6	AFR & TD		8.02	17.32	23.10	1.846	5.39	52.4	4.80	0.630	4.200	0.005	4.200	0.005	0.05	0.007	0.0010	0.0001	0.0010	0.0010	0.0410	0.0001	0.0016	0.0100		7.0	42.0	7.5	240	190
747	Hyd2o Bore Wattle Grove 7 Shallow	19/12/2023	WG7S	AFR & TD	Dry	3.68	19.82																											
748	Hyd2o Bore Wattle Grove 7 Deep	19/12/2023	WG7D	AFR & TD		7.10	16.34	26.30	0.954	6.23	31.6	4.60	0.640	4.000	0.005	4.000	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0019	0.0010	0.0001	0.0023	0.0018		16.0	15.0	4.9	110	100
749	Hyd2o Bore Wattle Grove 8	19/12/2023	WG8	AFR & TD	Clogged at 25.45																													
750	Hyd2o Bore Wattle Grove 9	19/12/2023	WG9	AFR & TD		4.94	18.92	23.60	1.291	6.29	17.8	24.00	5.500	18.000	0.005	18.000	0.007	3.20	2.700	0.0011	0.0001	0.0010	0.0083	0.0010	0.0001	0.0042	0.0045		27.0	26.0	12.0	160	170
751	Hyd2o Bore Wattle Grove 10 Shallow	19/12/2023	WG10S	AFR & TD	Dry	3.21	20.39								0.005																			

752	Hyd2o Bore Wattle Grove 10 Deep	19/12/2023	WG10D	AFR & TD		7.13	16.49	27.20	0.325	6.30	50.6	2.80	0.720	2.100	0.005	2.100	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0010	0.0010		6.9	4.3	3.6	25	35
753	Unknown Origin Bore	19/12/2023	Mba	AFR & TD	Damaged/blocked	2.60	18.01								0.005																	
754	Douglas Partners Bore 1	19/12/2023	MBb	AFR & TD		14.57	17.33	24.60	1.128	6.33	23.5	3.90	3.900	0.005	0.005	0.008	1.700	0.19	0.005	0.0015	0.0001	0.0010	0.0010	0.0010	0.0001	0.0036	0.0110		20.0	47.0	8.8	100	240
755	Endemic Bore 3	19/12/2023	GW3	AFR & TD	Dry	1.57	8.08																									
756	Endemic Bore 5	19/12/2023	GW5	AFR & TD	Dry	1.75	17.66																									
757	Hyd2o Deep Bore next to Endemic 5	19/12/2023	GW5D	AFR & TD		4.28	15.09	25.30	0.833	4.51	18.2	0.62	0.630	0.005	0.005	0.005	0.110	0.05	0.005	0.0018	0.0001	0.0010	0.0010	0.0042	0.0001	0.0094	0.0022		17.0	12.0	6.6	82	93
758	Endemic Bore 8	19/12/2023	GW8	AFR & TD	Not enough water for sampling	3.90	20.71	29.00	0.309	6.97	37.0																					
759	Hyd2o Deep Bore next to Endemic 8	19/12/2023	GW8D	AFR & TD		7.64	16.88	26.50	0.253	5.48	19.4	0.10	0.100	0.005	0.005	0.005	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0014	0.0015		1.5	1.9	1.2	29	12
760	Hyd2o Bore Wetlands 9 Shallow	19/12/2023	GW9S	AFR & TD		2.91	18.90	27.70	1.005	6.64	13.0	6.00	1.400	4.500	0.089	4.600	0.007	0.42	0.310	0.0160	0.0001	0.0010	0.0050	0.0010	0.0001	0.0033	0.0100		44.0	6.3	14.0	99	140
761	Hyd2o Bore Wetlands 9 Deep	19/12/2023	GW9D	AFR & TD		3.23	18.55	25.40	0.598	6.60	25.7	0.71	0.550	0.150	0.005	0.160	0.005	0.05	0.010	0.0010	0.0001	0.0010	0.0029	0.0010	0.0001	0.0085	0.0093		15.0	13.0	8.2	51	90
762	Endemic Bore 12	19/12/2023	GW12	AFR & TD		1.94	7.45																									
763	DWER Bore 1	19/12/2023	SCC 05/08	AFR & TD		18.81	22.97																									
764	DWER Bore 2	19/12/2023	SCC 06/08	AFR & TD		2.36	5.62																									
765	DWER Bore 3	19/12/2023	SCC 09/08	AFR & TD		4.42	8.79																									
766	Hyd2o Bore Wattle Grove 1	19/01/2024	WG1	TD		16.03	16.07																									
767	Hyd2o Bore Wattle Grove 2 Shallow	19/01/2024	WG2S	TD	Dry	3.51	22.50																									
768	Hyd2o Bore Wattle Grove 2 (Deep)	19/01/2024	WG2	TD		9.34	16.78																									
769	Hyd2o Bore Wattle Grove 3	19/01/2024	WG3	TD		7.23	15.74																									
770	Hyd2o Bore Wattle Grove 4 Shallow	19/01/2024	WG4S	TD		2.03	23.63																									
771	Hyd2o Bore Wattle Grove 4 Deep	19/01/2024	WG4D	TD		9.48	16.25																									
772	Hyd2o Bore Wattle Grove 5 Shallow	19/01/2024	WG5S	TD	Dry	5.91	29.23																									
773	Hyd2o Bore Wattle Grove 5 Deep	19/01/2024	WG5D	TD		19.06	16.07																									
774	Hyd2o Bore Wattle Grove 6	19/01/2024	WG6	TD		8.49	16.85																									
775	Hyd2o Bore Wattle Grove 7 Shallow	19/01/2024	WG7S	TD	Dry	3.68	19.82																									
776	Hyd2o Bore Wattle Grove 7 Deep	19/01/2024	WG7D	TD		7.53	15.91																									
777	Hyd2o Bore Wattle Grove 8	19/01/2024	WG8	TD	Clogged at 25.45																											
778	Hyd2o Bore Wattle Grove 9	19/01/2024	WG9	TD		5.38	18.48																									
779	Hyd2o Bore Wattle Grove 10 Shallow	19/01/2024	WG10S	TD	Dry	3.21	20.39																									
780	Hyd2o Bore Wattle Grove 10 Deep	19/01/2024	WG10D	TD		9.02	14.60																									
781	Unknown Origin Bore	19/01/2024	Mba	TD	Damaged/blocked	2.60	18.01																									
782	Douglas Partners Bore 1	19/01/2024	MBb	TD		14.86	17.04																									
783	Endemic Bore 3	19/01/2024	GW3	TD	Dry	1.57	8.08																									
784	Endemic Bore 5	19/01/2024	GW5	TD	Dry	1.75	17.66																									
785	Hyd2o Deep Bore next to Endemic 5	19/01/2024	GW5D	TD		4.64	14.73																									
786	Endemic Bore 8	19/01/2024	GW8	TD	Dry	4.13	20.48																									
787	Hyd2o Deep Bore next to Endemic 8	19/01/2024	GW8D	TD		8.14	16.38																									
788	Hyd2o Bore Wetlands 9 Shallow	19/01/2024	GW9S	TD		3.26	18.55																									
789	Hyd2o Bore Wetlands 9 Deep	19/01/2024	GW9D	TD		3.58	18.20																									
790	Endemic Bore 12	19/01/2024	GW12	TD		2.51	6.88																									
791	DWER Bore 1	19/01/2024	SCC 05/08	TD		19.09	22.69																									
792	DWER Bore 2	19/01/2024	SCC 06/08	TD		2.75	5.23																									
793	DWER Bore 3	19/01/2024	SCC 09/08	TD		5.18	8.03																									
794	Hyd2o Bore Wattle Grove 1	19/02/2024	WG1	TD		16.23	15.87																									
795	Hyd2o Bore Wattle Grove 2 Shallow	19/02/2024	WG2S	TD	Dry	3.51	22.50																									
796	Hyd2o Bore Wattle Grove 2 (Deep)	19/02/2024	WG2	TD	Clogged at 8.72																											
797	Hyd2o Bore Wattle Grove 3	19/02/2024	WG3	TD		7.38	15.59																									
798	Hyd2o Bore Wattle Grove 4 Shallow	19/02/2024	WG4S	TD		2.10	23.56																									
799	Hyd2o Bore Wattle Grove 4 Deep	19/02/2024	WG4D	TD		9.89	15.84																									
800	Hyd2o Bore Wattle Grove 5 Shallow	19/02/2024	WG5S	TD	Dry	5.91	29.23																									
801	Hyd2o Bore Wattle Grove 5 Deep	19/02/2024	WG5D	TD		19.24	15.89																									
802	Hyd2o Bore Wattle Grove 6	19/02/2024	WG6	TD		8.71	16.63																									
803	Hyd2o Bore Wattle Grove 7 Shallow	19/02/2024	WG7S	TD	Dry	3.68	19.82																									
804	Hyd2o Bore Wattle Grove 7 Deep	19/02/2024	WG7D	TD		7.90	15.54																									
805	Hyd2o Bore Wattle Grove 8	19/02/2024	WG8	TD	Clogged/dry at 25.90																											
806	Hyd2o Bore Wattle Grove 9	19/02/2024	WG9	TD		5.65	18.21																									
807	Hyd2o Bore Wattle Grove 10 Shallow	19/02/2024	WG10S	TD	Dry	3.21	20.39																									
808	Hyd2o Bore Wattle Grove 10 Deep	19/02/2024	WG10D	TD	Wet soil	9.07	14.55																									
809	Unknown Origin Bore	19/02/2024	Mba	TD	Damaged/blocked	2.60	18.01																									
810	Douglas Partners Bore 1	19/02/2024	MBb	TD		14.94	16.96																									
811	Endemic Bore 3	19/02/2024	GW3	TD	Dry	1.57	8.08																									
812	Endemic Bore 5	19/02/2024	GW5	TD	Dry	1.75	17.66																									
813	Hyd2o Deep Bore next to Endemic 5	19/02/2024	GW5D	TD		4.93	14.44																									
814	Endemic Bore 8	19/02/2024	GW8	TD	Dry	4.13	20.48																									
815	Hyd2o Deep Bore next to Endemic 8	19/02/2024	GW8D	TD	Clogged at 1.45																											
816	Hyd2o Bore Wetlands 9 Shallow	19/02/2024	GW9S	TD		3.43	18.38																									
817	Hyd2o Bore Wetlands 9 Deep	19/02/2024	GW9D	TD		3.79	17.99																									
818	Endemic Bore 12	19/02/2024	GW12	TD		2.80	6.59																									
819	DWER Bore 1	19/02/2024	SCC 05/08	TD		19.25	22.53																									
820	DWER Bore 2	19/02/2024	SCC 06/08	TD		2.93	5.05																									

821	DWER Bore 3	19/02/2024	SCC 09/08	TD		5.57	7.64																									
822	Hyd2o Bore Wattle Grove 1	20/03/2024	WG1	AFR & TD		16.35	15.75	21.60	0.175	5.16		4.30	1.100	3.200	0.005	3.200	0.130	0.08	0.005	0.0010	0.0001	0.0010	0.0012	0.0055	0.0001	0.0010	0.0051		1.9	3.8	1.6	34	21
823	Hyd2o Bore Wattle Grove 2 Shallow	20/03/2024	WG2S	AFR & TD	Dry	3.51	22.50																									
824	Hyd2o Bore Wattle Grove 2 (Deep)	20/03/2024	WG2	AFR & TD	Clogged	9.42	16.70																									
825	Hyd2o Bore Wattle Grove 3	20/03/2024	WG3	AFR & TD		8.04	14.93	20.90	7.588	5.61		8.80	8.800	0.007	0.005	0.006	0.180	0.85	0.009	0.0039	0.0001	0.0010	0.0010	0.0011	0.0001	0.0070	0.0160		98.0	180.0	39.0	1300	990
826	Hyd2o Bore Wattle Grove 4 Shallow	20/03/2024	WG4S	AFR & TD		2.21	23.45	26.40	2.471	5.52		0.32	0.170	0.150	0.005	0.150	0.160	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0017	0.0051		54.0	61.0	13.0	290	390
827	Hyd2o Bore Wattle Grove 4 Deep	20/03/2024	WG4D	AFR & TD		10.56	15.17	23.40	2.266	5.28		0.34	0.340	0.005	0.005	0.005	0.160	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0011	0.0023		75.0	65.0	15.0	290	460
828	Hyd2o Bore Wattle Grove 5 Shallow	20/03/2024	WG5S	AFR & TD	Dry	5.91	29.23																									
829	Hyd2o Bore Wattle Grove 5 Deep	20/03/2024	WG5D	AFR & TD		19.37	15.76	21.50	0.756	5.10		14.00	0.820	14.000	0.005	14.000	0.130	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0057	0.0001	0.0017	0.0051		4.6	13.0	3.4	120	66
830	Hyd2o Bore Wattle Grove 6	20/03/2024	WG6	AFR & TD		8.99	16.35	20.60	1.583	5.32		3.50	0.570	2.900	0.005	2.900	0.160	0.05	0.009	0.0010	0.0001	0.0010	0.0013	0.0600	0.0001	0.0020	0.0043		11.0	45.0	8.9	240	210
831	Hyd2o Bore Wattle Grove 7 Shallow	20/03/2024	WG7S	AFR & TD	Dry	3.68	19.82																									
832	Hyd2o Bore Wattle Grove 7 Deep	20/03/2024	WG7D	AFR & TD		8.03	15.41	22.50	0.588	5.59		0.66	0.360	0.300	0.005	0.300	0.140	0.05	0.005	0.0010	0.0001	0.0010	0.0036	0.0010	0.0001	0.0027	0.0059		7.5	12.0	4.8	80	68
833	Hyd2o Bore Wattle Grove 8	20/03/2024	WG8	AFR & TD	Clogged at 26.20																											
834	Hyd2o Bore Wattle Grove 9	20/03/2024	WG9	AFR & TD	Not enough water for sampling	5.87	17.99																									
835	Hyd2o Bore Wattle Grove 10 Shallow	20/03/2024	WG10S	AFR & TD	Dry	3.21	20.39																									
836	Hyd2o Bore Wattle Grove 10 Deep	20/03/2024	WG10D	AFR & TD	Mud	9.07	14.55																									
837	Unknown Origin Bore	20/03/2024	Mba	AFR & TD	Damaged/blocked	2.60	18.01																									
838	Douglas Partners Bore 1	20/03/2024	MBb	AFR & TD		15.14	16.76	25.00	1.116	6.07		2.60	2.500	0.023	0.005	0.021	1.800	0.08	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0062	0.0280		29.0	55.0	11.0	97	300
839	Endemic Bore 3	20/03/2024	GW3	AFR & TD	Dry	1.57	8.08																									
840	Endemic Bore 5	20/03/2024	GW5	AFR & TD	Dry	1.75	17.66																									
841	Hyd2o Deep Bore next to Endemic 5	20/03/2024	GW5D	AFR & TD		5.12	14.25	23.90	0.702	3.99		0.53	0.530	0.005	0.005	0.005	0.270	0.05	0.005	0.0018	0.0001	0.0010	0.0010	0.0010	0.0001	0.0110	0.0140		22.0	14.0	7.6	85	110
842	Endemic Bore 8	20/03/2024	GW8	AFR & TD	Dry	4.13	20.48																									
843	Hyd2o Deep Bore next to Endemic 8	20/03/2024	GW8D	AFR & TD		8.57	15.95	23.80	0.189	5.31		0.50	0.380	0.009	0.005	0.009	0.140	0.05	0.005	0.0010	0.0001	0.0010	0.0026	0.0010	0.0001	0.0022	0.0030		2.9	2.4	2.1	34	17
844	Hyd2o Bore Wetlands 9 Shallow	20/03/2024	GW9S	AFR & TD	Not enough water for sampling	3.55	18.26																									
845	Hyd2o Bore Wetlands 9 Deep	20/03/2024	GW9D	AFR & TD		3.95	17.83	25.90	0.536	6.45		1.40	1.100	0.320	0.005	0.320	0.190	0.10	0.066	0.0035	0.0001	0.0012	0.0180	0.0010	0.0001	0.0150	0.0130		16.0	10.0	11.0	70	82
846	Endemic Bore 12	20/03/2024	GW12	AFR & TD	Dry	2.84	6.55																									
847	DWER Bore 1	20/03/2024	SCC 05/08	AFR & TD		19.38	22.40																									
848	DWER Bore 2	20/03/2024	SCC 06/08	AFR & TD		3.10	4.88																									
849	DWER Bore 3	20/03/2024	SCC 09/08	AFR & TD		5.84	7.37																									
850	Hyd2o Bore Wattle Grove 1	17/04/2024	WG1	TD		16.47	15.63																									
851	Hyd2o Bore Wattle Grove 2 Shallow	17/04/2024	WG2S	TD	Dry	3.51	22.50																									
852	Hyd2o Bore Wattle Grove 2 (Deep)	17/04/2024	WG2	TD	Clogged	9.42	16.70																									
853	Hyd2o Bore Wattle Grove 3	17/04/2024	WG3	TD		8.32	14.65																									
854	Hyd2o Bore Wattle Grove 4 Shallow	17/04/2024	WG4S	TD		2.28	23.38																									
855	Hyd2o Bore Wattle Grove 4 Deep	17/04/2024	WG4D	TD		10.82	14.91																									
856	Hyd2o Bore Wattle Grove 5 Shallow	17/04/2024	WG5S	TD	Dry	5.91	29.23																									
857	Hyd2o Bore Wattle Grove 5 Deep	17/04/2024	WG5D	TD		19.47	15.66																									
858	Hyd2o Bore Wattle Grove 6	17/04/2024	WG6	TD		9.19	16.15																									
859	Hyd2o Bore Wattle Grove 7 Shallow	17/04/2024	WG7S	TD	Dry	3.68	19.82																									
860	Hyd2o Bore Wattle Grove 7 Deep	17/04/2024	WG7D	TD		8.35	15.09																									
861	Hyd2o Bore Wattle Grove 8	17/04/2024	WG8	TD	Clogged - roots	25.20	16.57																									
862	Hyd2o Bore Wattle Grove 9	17/04/2024	WG9	TD	Dry - wet clay	6.13	17.73																									
863	Hyd2o Bore Wattle Grove 10 Shallow	17/04/2024	WG10S	TD	Dry	3.21	20.39																									
864	Hyd2o Bore Wattle Grove 10 Deep	17/04/2024	WG10D	TD	Dry - wet clay	9.03	14.59																									
865	Unknown Origin Bore	17/04/2024	Mba	TD	Damaged/blocked	2.60	18.01																									
866	Douglas Partners Bore 1	17/04/2024	MBb	TD		15.25	16.65																									
867	Endemic Bore 3	17/04/2024	GW3	TD	Dry	1.81	7.84																									
868	Endemic Bore 5	17/04/2024	GW5	TD	Dry	1.75	17.66																									
869	Hyd2o Deep Bore next to Endemic 5	17/04/2024	GW5D	TD		5.24	14.13																									
870	Endemic Bore 8	17/04/2024	GW8	TD	Dry - wet mud	4.14	20.47																									
871	Hyd2o Deep Bore next to Endemic 8	17/04/2024	GW8D	TD		8.72	15.80																									
872	Hyd2o Bore Wetlands 9 Shallow	17/04/2024	GW9S	TD		3.63	18.18																									
873	Hyd2o Bore Wetlands 9 Deep	17/04/2024	GW9D	TD		4.09	17.69																									
874	Endemic Bore 12	17/04/2024	GW12	TD	Dry - wet mud	2.84	6.55																									
875	DWER Bore 1	17/04/2024	SCC 05/08	TD		19.49	22.29																									
876	DWER Bore 2	17/04/2024	SCC 06/08	TD		3.21	4.77																									
877	DWER Bore 3	17/04/2024	SCC 09/08	TD		5.89	7.32																									
878	Hyd2o Bore Wattle Grove 1	23/05/2024	WG1	AFR		16.55	15.55																									
879	Hyd2o Bore Wattle Grove 2 Shallow	23/05/2024	WG2S	AFR	Dry	3.51	22.50																									
880	Hyd2o Bore Wattle Grove 2 (Deep)	23/05/2024	WG2	AFR		9.99	16.13																									
881	Hyd2o Bore Wattle Grove 3	23/05/2024	WG3	AFR		8.47	14.50																									
882	Hyd2o Bore Wattle Grove 4 Shallow	23/05/2024	WG4S	AFR		2.49	23.17																									
883	Hyd2o Bore Wattle Grove 4 Deep	23/05/2024	WG4D	AFR		11.09	14.64																									
884	Hyd2o Bore Wattle Grove 5 Shallow	23/05/2024	WG5S	AFR	Dry	5.91	29.23																									
885	Hyd2o Bore Wattle Grove 5 Deep	23/05/2024	WG5D	AFR		19.53	15.60																									
886	Hyd2o Bore Wattle Grove 6	23/05/2024	WG6	AFR		9.33	16.01																									
887	Hyd2o Bore Wattle Grove 7 Shallow	23/05/2024	WG7S	AFR	Dry	3.68	19.82																									
888	Hyd2o Bore Wattle Grove 7 Deep	23/05/2024	WG7D	AFR		8.77	14.67																									
889	Hyd2o Bore Wattle Grove 8	23/05/2024	WG8	AFR	Clogged	25.20	16.57																									

890	Hyd2o Bore Wattle Grove 9	23/05/2024	WG9	AFR	Dry - wet clay	6.13	17.73																									
891	Hyd2o Bore Wattle Grove 10 Shallow	23/05/2024	WG10S	AFR	Dry	3.21	20.39																									
892	Hyd2o Bore Wattle Grove 10 Deep	23/05/2024	WG10D	AFR	Dry - wet clay	9.03	14.59																									
893	Unknown Origin Bore	23/05/2024	Mba	AFR	Damaged/blocked	2.60	18.01																									
894	Douglas Partners Bore 1	23/05/2024	MBb	AFR		15.38	16.52																									
895	Endemic Bore 3	23/05/2024	GW3	AFR	Dry	1.57	8.08																									
896	Endemic Bore 5	23/05/2024	GW5	AFR	Dry	1.75	17.66																									
897	Hyd2o Deep Bore next to Endemic 5	23/05/2024	GW5D	AFR		5.39	13.98																									
898	Endemic Bore 8	23/05/2024	GW8	AFR	Dry	4.13	20.48																									
899	Hyd2o Deep Bore next to Endemic 8	23/05/2024	GW8D	AFR		8.81	15.71																									
900	Hyd2o Bore Wetlands 9 Shallow	23/05/2024	GW9S	AFR		3.68	18.13																									
901	Hyd2o Bore Wetlands 9 Deep	23/05/2024	GW9D	AFR		4.18	17.60																									
902	Endemic Bore 12	23/05/2024	GW12	AFR	Dry - wet mud	2.84	6.55																									
903	DWER Bore 1	23/05/2024	SCC 05/08	AFR		19.59	22.19																									
904	DWER Bore 2	23/05/2024	SCC 06/08	AFR		3.42	4.56																									
905	DWER Bore 3	23/05/2024	SCC 09/08	AFR		5.98	7.23																									
906	Hyd2o Bore Wattle Grove 1	20/06/2024	WG1	AFR		16.48	15.62	18.30	0.358	5.13	59.8	3.00	0.220	2.800	0.005	2.800	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0010	0.0065		0.5	3.0	1.3	33	13
907	Hyd2o Bore Wattle Grove 2 Shallow	20/06/2024	WG2S	AFR	Dry	3.51	22.50																									
908	Hyd2o Bore Wattle Grove 2 (Deep)	20/06/2024	WG2	AFR		9.74	16.38	15.30	2.309	5.58	70.8	11.00	11.000	0.210	0.005	0.210	0.180	2.20	0.073	0.0010	0.0001	0.0010	0.0017	0.0010	0.0001	0.0078	0.0370		3.7	68.0	19.0	280	290
909	Hyd2o Bore Wattle Grove 3	20/06/2024	WG3	AFR		7.75	15.22	18.80	12.939	5.05	42.6	1.90	1.900	0.005	0.005	0.005	0.005	0.09	0.005	0.0030	0.0001	0.0041	0.0018	0.0010	0.0001	0.0960	0.0330		190.0	330.0	56.0	2200	1800
910	Hyd2o Bore Wattle Grove 4 Shallow	20/06/2024	WG4S	AFR		1.68	23.98	20.80	2.115	5.20	35.4	0.19	0.170	0.016	0.005	0.016	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0038	0.0029		40.0	60.0	11.0	310	350
911	Hyd2o Bore Wattle Grove 4 Deep	20/06/2024	WG4D	AFR		10.42	15.31	21.80	2.645	5.30	18.2	6.00	0.160	5.900	0.005	5.900	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0036	0.0059		86.0	73.0	14.0	330	520
912	Hyd2o Bore Wattle Grove 5 Shallow	20/06/2024	WG5S	AFR	Dry	5.91	29.23																									
913	Hyd2o Bore Wattle Grove 5 Deep	20/06/2024	WG5D	AFR		19.42	15.71	19.80	0.764	4.85	60.6	15.00	1.000	14.000	0.005	14.000	0.005	0.08	0.005	0.0010	0.0001	0.0010	0.0042	0.0013	0.0001	0.0029	0.0240		3.0	14.0	3.2	120	67
914	Hyd2o Bore Wattle Grove 6	20/06/2024	WG6	AFR		9.00	16.34	16.70	2.067	4.94	38.2	3.40	1.500	1.900	0.005	1.900	0.014	0.60	0.007	0.0010	0.0001	0.0010	0.0010	0.0031	0.0001	0.0042	0.0130		9.0	60.0	8.0	290	270
915	Hyd2o Bore Wattle Grove 7 Shallow	20/06/2024	WG7S	AFR	Dry	3.68	19.82																									
916	Hyd2o Bore Wattle Grove 7 Deep	20/06/2024	WG7D	AFR		8.13	15.31	20.70	0.788	5.64	24.6	4.60	0.360	4.200	0.005	4.200	0.005	0.05	0.010	0.0010	0.0001	0.0010	0.0025	0.0010	0.0001	0.0017	0.0026		11.0	17.0	3.6	120	97
917	Hyd2o Bore Wattle Grove 8	20/06/2024	WG8	AFR	Clogged	25.63	16.14																									
918	Hyd2o Bore Wattle Grove 9	20/06/2024	WG9	AFR	Dry	6.13	17.73																									
919	Hyd2o Bore Wattle Grove 10 Shallow	20/06/2024	WG10S	AFR	Dry	3.21	20.39																									
920	Hyd2o Bore Wattle Grove 10 Deep	20/06/2024	WG10D	AFR		7.12	16.50	21.10	0.165	5.63	56.9	6.50	1.100	0.005	0.005	5.400	0.005	0.05	0.008	0.0010	0.0001	0.0010	0.0045	0.0010	0.0001	0.0010	0.0130		7.5	5.1	3.7	36	40
921	Unknown Origin Bore	20/06/2024	Mba	AFR	Damaged/blocked	2.60	18.01																									
922	Douglas Partners Bore 1	20/06/2024	MBb	AFR		15.45	16.45	18.20	1.154	5.85	55.0	3.10	3.100	0.005	0.005	0.005	2.200	0.50	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0040	0.0079		34.0	71.0	11.0	93	380
923	Endemic Bore 3	20/06/2024	GW3	AFR	Dry	1.57	8.08																									
924	Endemic Bore 5	20/06/2024	GW5	AFR	Not enough water for sampling	1.42	17.99																									
925	Hyd2o Deep Bore next to Endemic 5	20/06/2024	GW5D	AFR		5.23	14.14	21.90	0.724	4.36	30.6	0.52	0.520	0.005	0.005	0.005	0.120	0.05	0.005	0.0014	0.0001	0.0010	0.0043	0.0023	0.0001	0.0100	0.0210		21.0	15.0	6.9	82	110
926	Endemic Bore 8	20/06/2024	GW8	AFR	Not enough water for sampling	4.10	20.51																									
927	Hyd2o Deep Bore next to Endemic 8	20/06/2024	GW8D	AFR		8.06	16.46	21.00	0.174	5.45	39.1	0.19	0.190	0.005	0.005	0.006	0.005	0.05	0.005	0.0010	0.0001	0.0010	0.0010	0.0010	0.0001	0.0016	0.0049		1.6	1.6	1.6	26	10
928	Hyd2o Bore Wetlands 9 Shallow	20/06/2024	GW9S	AFR		3.11	18.70	19.90	0.245	6.20	29.4	5.30	0.710	4.600	0.005	4.600	0.005	1.30	0.200	0.0074	0.0001	0.0010	0.0043	0.0010	0.0001	0.0032	0.0055		16.0	4.6	5.5	14	59
929	Hyd2o Bore Wetlands 9 Deep	20/06/2024	GW9D	AFR		3.37	18.41	20.40	0.395	6.02	15.4	2.10	0.770	1.400	0.005	1.400	0.005	0.10	0.078	0.0022	0.0001	0.0010	0.0081	0.0010	0.0001	0.0069	0.0085		13.0	7.4	8.4	43	63
930	Endemic Bore 12	20/06/2024	GW12	AFR		2.08	7.31																									
931	DWER Bore 1	20/06/2024	SCC 05/08	AFR		19.62	22.16																									
932	DWER Bore 2	20/06/2024	SCC 06/08	AFR		2.29	5.69																									
933	DWER Bore 3	20/06/2024	SCC 09/08	AFR		5.60	7.61																									
934	Hyd2o Bore Wattle Grove 1	5/07/2024	WG1	AFR		16.43	15.67																									
935	Hyd2o Bore Wattle Grove 2 Shallow	5/07/2024	WG2S	AFR	Dry	3.51	22.50																									
936	Hyd2o Bore Wattle Grove 2 (Deep)	5/07/2024	WG2	AFR		9.67	16.45																									
937	Hyd2o Bore Wattle Grove 3	5/07/2024	WG3	AFR		7.56	15.41																									
938	Hyd2o Bore Wattle Grove 4 Shallow	5/07/2024	WG4S	AFR		1.66	24.00																									
939	Hyd2o Bore Wattle Grove 4 Deep	5/07/2024	WG4D	AFR		10.35	15.38																									
940	Hyd2o Bore Wattle Grove 5 Shallow	5/07/2024	WG5S	AFR	Dry	5.91	29.23																									
941	Hyd2o Bore Wattle Grove 5 Deep	5/07/2024	WG5D	AFR		19.36	15.77																									
942	Hyd2o Bore Wattle Grove 6	5/07/2024	WG6	AFR		8.87	16.47																									
943	Hyd2o Bore Wattle Grove 7 Shallow	5/07/2024	WG7S	AFR	Dry	3.68	19.82																									
944	Hyd2o Bore Wattle Grove 7 Deep	5/07/2024	WG7D	AFR		8.01	15.43																									
945	Hyd2o Bore Wattle Grove 8	5/07/2024	WG8	AFR		25.84	15.93																									
946	Hyd2o Bore Wattle Grove 9	5/07/2024	WG9	AFR	Mud	6.12	17.74																									
947	Hyd2o Bore Wattle Grove 10 Shallow	5/07/2024	WG10S	AFR	Dry	3.21	20.39																									
948	Hyd2o Bore Wattle Grove 10 Deep	5/07/2024	WG10D	AFR		7.66	15.96																									
949	Unknown Origin Bore	5/07/2024	Mba	AFR	Damaged/blocked	2.60	18.01																									
950	Douglas Partners Bore 1	5/07/2024	MBb	AFR		15.44	16.46																									
951	Endemic Bore 3	5/07/2024	GW3	AFR	Dry	1.57	8.08																									
952	Endemic Bore 5	5/07/2024	GW5	AFR		1.40	18.01																									
953	Hyd2o Deep Bore next to Endemic 5	5/07/2024	GW5D	AFR		5.15	14.22																									
954	Endemic Bore 8	5/07/2024	GW8	AFR		4.10	20.51																									
955	Hyd2o Deep Bore next to Endemic 8	5/07/2024	GW8D	AFR		8.37	16.15																									
956	Hyd2o Bore Wetlands 9 Shallow	5/07/2024	GW9S	AFR		3.05	18.76																									
957	Hyd2o Bore Wetlands 9 Deep	5/07/2024	GW9D	AFR		3.21	18.57																									
958	Endemic Bore 12	5/07/2024	GW12	AFR		2.68	6.71																									

959	DWER Bore 1	5/07/2024	SCC 05/08	AFR		19.58	22.20																										
960	DWER Bore 2	5/07/2024	SCC 06/08	AFR		2.22	5.76																										
961	DWER Bore 3	5/07/2024	SCC 09/08	AFR		5.42	7.79																										
962	Hyd2o Bore Wattle Grove 1	17/07/2024	WG1	AFR		16.39	15.71																										
963	Hyd2o Bore Wattle Grove 2 Shallow	17/07/2024	WG2S	AFR	Dry	3.51	22.50																										
964	Hyd2o Bore Wattle Grove 2 (Deep)	17/07/2024	WG2	AFR		9.61	16.51																										
965	Hyd2o Bore Wattle Grove 3	17/07/2024	WG3	AFR		7.41	15.56																										
966	Hyd2o Bore Wattle Grove 4 Shallow	17/07/2024	WG4S	AFR		1.44	24.22																										
967	Hyd2o Bore Wattle Grove 4 Deep	17/07/2024	WG4D	AFR		10.24	15.49																										
968	Hyd2o Bore Wattle Grove 5 Shallow	17/07/2024	WG5S	AFR	Dry	5.91	29.23																										
969	Hyd2o Bore Wattle Grove 5 Deep	17/07/2024	WG5D	AFR		19.33	15.80																										
970	Hyd2o Bore Wattle Grove 6	17/07/2024	WG6	AFR		8.85	16.49																										
971	Hyd2o Bore Wattle Grove 7 Shallow	17/07/2024	WG7S	AFR	Dry	3.68	19.82																										
972	Hyd2o Bore Wattle Grove 7 Deep	17/07/2024	WG7D	AFR		8.04	15.40																										
973	Hyd2o Bore Wattle Grove 8	17/07/2024	WG8	AFR		25.81	15.96																										
974	Hyd2o Bore Wattle Grove 9	17/07/2024	WG9	AFR	Mud	6.12	17.74																										
975	Hyd2o Bore Wattle Grove 10 Shallow	17/07/2024	WG10S	AFR	Dry	3.21	20.39																										
976	Hyd2o Bore Wattle Grove 10 Deep	17/07/2024	WG10D	AFR		7.62	16.00																										
977	Unknown Origin Bore	17/07/2024	Mba	AFR	Damaged/blocked	2.60	18.01																										
978	Douglas Partners Bore 1	17/07/2024	MBb	AFR		15.43	16.47																										
979	Endemic Bore 3	17/07/2024	GW3	AFR	Dry	1.57	8.08																										
980	Endemic Bore 5	17/07/2024	GW5	AFR		1.27	18.14																										
981	Hyd2o Deep Bore next to Endemic 5	17/07/2024	GW5D	AFR		5.10	14.27																										
982	Endemic Bore 8	17/07/2024	GW8	AFR		3.87	20.74																										
983	Hyd2o Deep Bore next to Endemic 8	17/07/2024	GW8D	AFR		8.23	16.29																										
984	Hyd2o Bore Wetlands 9 Shallow	17/07/2024	GW9S	AFR		2.88	18.93																										
985	Hyd2o Bore Wetlands 9 Deep	17/07/2024	GW9D	AFR		3.04	18.74																										
986	Endemic Bore 12	17/07/2024	GW12	AFR		1.54	7.85																										
987	DWER Bore 1	17/07/2024	SCC 05/08	AFR		19.55	22.23																										
988	DWER Bore 2	17/07/2024	SCC 06/08	AFR		1.98	6.00																										
989	DWER Bore 3	17/07/2024	SCC 09/08	AFR		3.86	9.35																										
990	Surface Water Site 2	17/07/2024	SW2	AFR	SW1 at H21003 CoC23			16.60	1.872	8.21	64.7																						
991	Surface Water Site 7	17/07/2024	SW7	AFR	SW2 at H21003 CoC23			16.40	0.755	7.06	8.3																						
992	Surface Water Site 9	17/07/2024	SW9	AFR	SW3 at H21003 CoC23			15.60	1.346	7.19	27.4																						

APPENDIX J
Monitoring Protocols
& Laboratory Reports

HYD2O FIELD SAMPLING METHODS

Water samples are collected consistent with AS/NZS 5667.1:1998.

While in the field collected samples are stored in an esky (with ice bricks) to maintain sample integrity. Collected samples are usually delivered to MPL Laboratory same day following field work. In cases where this is not possible, they are stored in a fridge overnight and delivered to the laboratory the following morning.

Relevant information is collected during the sampling event such as date of sampling, method of sampling, time of sampling, name of sampler and general environmental and climatic conditions.

Surface water sampling is conducted using a telescopic sampling arm and jar. For sampling within a stormwater drain this comprises of capturing a flowing sample or a sample captured shortly after a rainfall event. Stagnant or stationary water is not sampled.

For groundwater monitoring each borehole is sufficiently pumped prior to sampling to ensure that the water drawn is representative of a screened flow from the associated aquifer. Sample pumping occurs within the bore screen and off the base to ensure sediment sitting at the bottom of the bore is not pumped. When possible, sample pumping is taken approximately 1 m below the present groundwater level.

After every sample, the equipment is triple rinsed to avoid cross contamination prior to use.

Where sample filtering is required, this occurs via a Waterra FHT-45 High Turbidity 0.45-micron GW filter.

The following equipment is employed during the water quality monitoring:

- Geotech Interface Meter 60m
- YSI Pro Plus Water Quality Meter
- Geotech Geopump Series 2 Peristaltic Pump (used for bores with < 8m of depth)
- Geotech Geocontrol Low Flow Bladder Pump (used for bores with > 8m of depth)

SAMPLE ANALYSIS

Sample containers are provided from and delivered to MPL Laboratories (a NATA-accredited) consistent with the specifications of each respective water quality monitoring program.

Typical analytes and containers selected for the current monitoring program are:

<u>Analytes:</u>

- Nutrients: Total Nitrogen (TN), Total Kjeldahl Nitrogen (TKN), Total Phosphorus (TP), Filterable Reactive Phosphorus (FRP), Nitrate, Nitrite, and Ammonia.
- Dissolved Metals: Arsenic (As), Cadmium (Cd), Calcium (Ca), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Magnesium (Mg), Nickel (Ni), Potassium (K), Sodium (Na) and Zinc (Zn).
- pH and Electrical Conductivity (EC).

<u>Containers:</u>

- Nutrients, pH and EC: 500mL polythene bottle, green labelled, filled to exclude air.
- Dissolved Metals: 125mL polythene bottle, red labelled

pH and EC are tested in-situ, as well as other physical parameters such as Dissolved Oxygen % (DO), Total Dissolved Solids (TDS), Temperature, and Oxygen Reduction Potential (ORP).

For the purposes of stabilising certain chemical constituents (generally dissolved metals), red labelled 125 mL polythene containers provided from the laboratory contain residual nitric acid wash.

A method summary for MPL lab testing for various analytes is provided in the table below.

MPL ANALYSIS METHODOLOGY

Method ID	Methodology Summary
Calc	Calculation
Calc - TKN	TKN determined by calculation (Total Nitrogen - NOx).
INORG-001	pH - Measured using pH meter and electrode. Please note that the results for water analyses are indicative only, as analysis can be completed outside of the recommended holding times. Solids are reported from a 1:5 water extract unless otherwise specified. Alternatively, pH is determined in a 1:5 extract using 0.01M calcium chloride or a solid is extracted at a ratio of 1:2.5 (AS1289.4.3.1), pH is measured in the extract.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C. Soil results reported from a 1:5 Soil:Water extract unless otherwise specified. Please note Resistivity is estimated by calculation and may not correlate with results otherwise obtained using the Resistivity current method (based on AS 1289.4.4.1), depending on the nature of the soil being analysed.
INORG-055	Nitrate/Nitrite/NOx/TKN - determined colourimetrically. Waters samples are filtered on receipt prior to analysis. Soils/solids are analysed following a water extraction.
INORG-057	Ammonia - determined colourimetrically. Water samples are filtered on receipt prior to analysis. Soils and OHS media are analysed following a water extraction. Alternatively, Ammonia can be extracted from soil using 1M KCl.
INORG-060	Phosphate - determined colourimetrically using APHA latest edition 4500 P E. Water samples are filtered on receipt prior to analysis. Soils are analysed from a water extract.
INORG-127	Total Nitrogen by high temperature catalytic combustion with chemiluminescence detection. Organic Carbon forms (inorganic, organic, total) determined using a TOC/NDIR analyser via combustion. Dissolved forms require filtering prior to determination.
METALS-020	Determination of various metals by ICP-OES.
METALS-021	Determination of Mercury by Cold Vapour AAS.
METALS-022	Determination of various metals by ICP-MS.Please note for Bromine and Iodine, any forms of these elements that are present are included together in the one result reported for each of these two elements.Salt forms and/or anion/cation forms (e.g. FeO, PbO, ZnO, BO3) are determined stoichiometrically from the base metal concentration.

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CERTIFICATE OF ANALYSIS 261595

Client Details

Client	Hyd2O
Attention	Sean O'Sullivan
Address	Suite 6B, 103 Rokeby Rd, Subiaco, WA, 6008

Sample Details

Your Reference	**H21003**
Number of Samples	2 Water
Date samples received	07/05/2021
Date completed instructions received	10/05/2021
Location	Wattle Grove Predev Monitoring

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	17/05/2021
Date of Issue	17/05/2021

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Results Approved By
Michael Mowle, Metals/Inorganics Supervisor

Authorised By



Michael Kubiak, Laboratory Manager

Miscellaneous Inorganics				
Our Reference	UNITS	PQL	261595-1	261595-2
Your Reference			SW2	SW4
Date Sampled			06/05/2021	06/05/2021
Type of sample			Surface Water	Surface Water
Date prepared	-		10/05/2021	10/05/2021
Date analysed	-		10/05/2021	10/05/2021
pH	pH Units		6.8	6.4
Electrical Conductivity (EC)	µS/cm	1	240	33

Nutrients in Water				
Our Reference	UNITS	PQL	261595-1	261595-2
Your Reference			SW2	SW4
Date Sampled			06/05/2021	06/05/2021
Type of sample			Surface Water	Surface Water
Date prepared	-		10/05/2021	10/05/2021
Date analysed	-		10/05/2021	10/05/2021
Total Nitrogen	mg/L	0.1	1.2	1.2
Total Kjeldahl Nitrogen	mg/L	0.1	0.8	1.2
NOx as N	mg/L	0.005	0.32	0.014
Nitrate as N	mg/L	0.005	0.31	0.014
Nitrite as N	mg/L	0.005	0.013	<0.005
Ammonia as N	mg/L	0.005	0.042	0.012
Total Phosphorus	mg/L	0.05	<0.05	0.15
Phosphate as P	mg/L	0.005	0.022	0.078

Metals in Water - Low Level				
Our Reference	UNITS	PQL	261595-1	261595-2
Your Reference			SW2	SW4
Date Sampled			06/05/2021	06/05/2021
Type of sample			Surface Water	Surface Water
Date prepared	-		12/05/2021	12/05/2021
Date analysed	-		12/05/2021	12/05/2021
Arsenic-Dissolved	mg/L	0.001	<0.001	<0.001
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	0.006	0.10
Lead-Dissolved	mg/L	0.001	0.001	0.003
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005
Nickel-Dissolved	mg/L	0.001	0.001	0.006
Zinc-Dissolved	mg/L	0.001	0.047	0.078

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CERTIFICATE OF ANALYSIS 262773

Client Details

Client	Hyd2O
Attention	Sean O'Sullivan
Address	Suite 6B, 103 Rokeby Rd, Subiaco, WA, 6008

Sample Details

Your Reference	**H21003 - Wattle Grove Monitoring**
Number of Samples	3 Water
Date samples received	31/05/2021
Date completed instructions received	31/05/2021

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	04/06/2021
Date of Issue	04/06/2021

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Results Approved By
Heram Halim, Operations Manager

Authorised By



Michael Kubiak, Laboratory Manager

Nutrients in Water					
Our Reference	UNITS	PQL	262773-1	262773-2	262773-3
Your Reference			WG1	WG2	WG3
Date Sampled			28/05/2021	28/05/2021	28/05/2021
Type of sample			Groundwater	Groundwater	Groundwater
Date prepared	-		01/06/2021	01/06/2021	01/06/2021
Date analysed	-		01/06/2021	01/06/2021	01/06/2021
Total Nitrogen	mg/L	0.1	5.5	5.2	1.7
Total Kjeldahl Nitrogen	mg/L	0.1	0.7	0.9	1.5
NOx as N	mg/L	0.005	4.8	4.3	0.21
Ammonia as N	mg/L	0.005	<0.005	0.017	0.11
Nitrate as N	mg/L	0.005	4.7	4.3	0.21
Nitrite as N	mg/L	0.005	<0.005	0.005	<0.005
Total Phosphorus	mg/L	0.05	0.12	0.09	0.20
Phosphate as P	mg/L	0.005	<0.005	<0.005	0.047

Metals in Water - Low Level					
Our Reference	UNITS	PQL	262773-1	262773-2	262773-3
Your Reference			WG1	WG2	WG3
Date Sampled			28/05/2021	28/05/2021	28/05/2021
Type of sample			Groundwater	Groundwater	Groundwater
Date prepared	-		04/06/2021	04/06/2021	04/06/2021
Date analysed	-		04/06/2021	04/06/2021	04/06/2021
Arsenic-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	0.005	0.01	<0.001
Lead-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005	<0.00005
Nickel-Dissolved	mg/L	0.001	0.005	0.012	0.019
Zinc-Dissolved	mg/L	0.001	0.019	0.031	0.030

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CERTIFICATE OF ANALYSIS 264798

Client Details

Client	Hyd2O
Attention	Georgia Ross
Address	Suite 6B, 103 Rokeby Rd, Subiaco, WA, 6008

Sample Details

Your Reference	**H21003 - Wattle Grove Predev Monitoring**
Number of Samples	7 Water
Date samples received	05/07/2021
Date completed instructions received	05/07/2021

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	12/07/2021
Date of Issue	12/07/2021

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Results Approved By
Heram Halim, Operations Manager

Authorised By



Michael Kubiak, Laboratory Manager

Miscellaneous Inorganics							
Our Reference			264798-1	264798-2	264798-3	264798-4	264798-5
Your Reference	UNITS	PQL	SW1	SW2	SW4	SW6	SW7
Date Sampled			05/07/2021	05/07/2021	05/07/2021	05/07/2021	05/07/2021
Type of sample			Surface Water	Surface Water	Surface Water	Surface Water	Surface Water
Date prepared	-		06/07/2021	06/07/2021	06/07/2021	06/07/2021	06/07/2021
Date analysed	-		06/07/2021	06/07/2021	06/07/2021	06/07/2021	06/07/2021
pH	pH Units		5.9	6.3	6.2	6.2	6.2
Electrical Conductivity (EC)	µS/cm	1	94	810	110	190	230

Miscellaneous Inorganics				
Our Reference			264798-6	264798-7
Your Reference	UNITS	PQL	~~SW8~~ SW5	SW9
Date Sampled			05/07/2021	05/07/2021
Type of sample			Surface Water	Surface Water
Date prepared	-		06/07/2021	06/07/2021
Date analysed	-		06/07/2021	06/07/2021
pH	pH Units		5.9	6.2
Electrical Conductivity (EC)	µS/cm	1	160	410

Nutrients in Water							
Our Reference			264798-1	264798-2	264798-3	264798-4	264798-5
Your Reference	UNITS	PQL	SW1	SW2	SW4	SW6	SW7
Date Sampled			05/07/2021	05/07/2021	05/07/2021	05/07/2021	05/07/2021
Type of sample			Surface Water	Surface Water	Surface Water	Surface Water	Surface Water
Date prepared	-		06/07/2021	06/07/2021	06/07/2021	06/07/2021	06/07/2021
Date analysed	-		06/07/2021	06/07/2021	06/07/2021	06/07/2021	06/07/2021
Total Nitrogen	mg/L	0.1	0.3	5.4	0.6	1.3	1.6
Total Kjeldahl Nitrogen	mg/L	0.1	0.3	1.3	0.5	1.1	1.4
Nitrate as N	mg/L	0.005	0.012	4.1	0.022	0.24	0.20
Nitrite as N	mg/L	0.005	<0.005	0.010	<0.005	<0.005	<0.005
NOx as N	mg/L	0.005	0.017	4.1	0.025	0.24	0.20
Ammonia as N	mg/L	0.005	0.016	0.022	0.011	0.006	0.007
Total Phosphorus	mg/L	0.05	<0.05	0.17	0.06	<0.05	0.08
Phosphate as P	mg/L	0.005	0.005	0.14	0.026	<0.005	0.065

Nutrients in Water				
Our Reference			264798-6	264798-7
Your Reference	UNITS	PQL	~~SW8~~ SW5	SW9
Date Sampled			05/07/2021	05/07/2021
Type of sample			Surface Water	Surface Water
Date prepared	-		06/07/2021	06/07/2021
Date analysed	-		06/07/2021	06/07/2021
Total Nitrogen	mg/L	0.1	1.2	2.6
Total Kjeldahl Nitrogen	mg/L	0.1	1.2	1.6
Nitrate as N	mg/L	0.005	<0.005	1.1
Nitrite as N	mg/L	0.005	<0.005	0.011
NOx as N	mg/L	0.005	<0.005	1.1
Ammonia as N	mg/L	0.005	0.007	0.009
Total Phosphorus	mg/L	0.05	<0.05	0.32
Phosphate as P	mg/L	0.005	<0.005	0.32

Dissolved Metals in Water							
Our Reference	UNITS	PQL	264798-1	264798-2	264798-3	264798-4	264798-5
Your Reference			SW1	SW2	SW4	SW6	SW7
Date Sampled			05/07/2021	05/07/2021	05/07/2021	05/07/2021	05/07/2021
Type of sample			Surface Water	Surface Water	Surface Water	Surface Water	Surface Water
Date prepared	-		09/07/2021	09/07/2021	09/07/2021	09/07/2021	09/07/2021
Date analysed	-		09/07/2021	09/07/2021	09/07/2021	09/07/2021	09/07/2021
Arsenic-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	0.003	0.006	<0.001	0.002	0.002
Lead-Dissolved	mg/L	0.001	<0.001	0.001	<0.001	<0.001	<0.001
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Nickel-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc-Dissolved	mg/L	0.001	0.010	0.019	0.004	0.008	0.012

Dissolved Metals in Water				
Our Reference	UNITS	PQL	264798-6	264798-7
Your Reference			~~SW8~~ SW5	SW9
Date Sampled			05/07/2021	05/07/2021
Type of sample			Surface Water	Surface Water
Date prepared	-		09/07/2021	09/07/2021
Date analysed	-		09/07/2021	09/07/2021
Arsenic-Dissolved	mg/L	0.001	<0.001	0.003
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	0.002	0.004
Lead-Dissolved	mg/L	0.001	<0.001	<0.001
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005
Nickel-Dissolved	mg/L	0.001	<0.001	<0.001
Zinc-Dissolved	mg/L	0.001	0.008	0.013

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CERTIFICATE OF ANALYSIS 266006

Client Details

Client	Hyd2O
Attention	Georgia Ross
Address	Suite 6B, 103 Rokeby Rd, Subiaco, WA, 6008

Sample Details

Your Reference	**H21003**
Number of Samples	9 Water
Date samples received	28/07/2021
Date completed instructions received	28/07/2021
Location	Wattle Grove Predev Monitoring

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	03/08/2021
Date of Issue	03/08/2021

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Results Approved By
Heram Halim, Operations Manager

Authorised By



Michael Kubiak, Laboratory Manager

Miscellaneous Inorganics							
Our Reference	UNITS	PQL	266006-1	266006-2	266006-3	266006-4	266006-5
Your Reference			SW1	SW2	SW3	SW4	SW5
Date Sampled			27/07/2021	27/07/2021	27/07/2021	27/07/2021	27/07/2021
Type of sample			Surface Water	Surface Water	Surface Water	Surface Water	Surface Water
Date prepared	-		28/07/2021	28/07/2021	28/07/2021	28/07/2021	28/07/2021
Date analysed	-		28/07/2021	28/07/2021	28/07/2021	28/07/2021	28/07/2021
pH	pH Units		7.2	7.1	7.1	7.3	6.9
Electrical Conductivity (EC)	µS/cm	1	320	700	230	200	200

Miscellaneous Inorganics						
Our Reference	UNITS	PQL	266006-6	266006-7	266006-8	266006-9
Your Reference			SW6	SW7	SW8	SW9
Date Sampled			27/07/2021	27/07/2021	27/07/2021	27/07/2021
Type of sample			Surface Water	Surface Water	Surface Water	Surface Water
Date prepared	-		28/07/2021	28/07/2021	28/07/2021	28/07/2021
Date analysed	-		28/07/2021	28/07/2021	28/07/2021	28/07/2021
pH	pH Units		5.8	7.3	7.4	7.6
Electrical Conductivity (EC)	µS/cm	1	720	310	340	470

Nutrients in Water							
Our Reference	UNITS	PQL	266006-1	266006-2	266006-3	266006-4	266006-5
Your Reference			SW1	SW2	SW3	SW4	SW5
Date Sampled			27/07/2021	27/07/2021	27/07/2021	27/07/2021	27/07/2021
Type of sample			Surface Water	Surface Water	Surface Water	Surface Water	Surface Water
Date prepared	-		29/07/2021	29/07/2021	29/07/2021	29/07/2021	29/07/2021
Date analysed	-		29/07/2021	29/07/2021	29/07/2021	29/07/2021	29/07/2021
Total Nitrogen	mg/L	0.1	0.9	18	2.8	0.3	1.5
Total Kjeldahl Nitrogen	mg/L	0.1	0.8	13	2.1	0.3	1.5
NOx as N	mg/L	0.005	0.017	5.4	0.72	<0.005	<0.005
Ammonia as N	mg/L	0.005	0.011	0.032	0.77	<0.005	0.011
Nitrate as N	mg/L	0.005	0.017	5.4	0.64	<0.005	<0.005
Nitrite as N	mg/L	0.005	<0.005	0.007	0.076	<0.005	<0.005
Total Phosphorus	mg/L	0.05	<0.05	0.43	5.6	0.09	<0.05
Phosphate as P	mg/L	0.005	0.005	0.31	0.17	0.021	<0.005

Nutrients in Water						
Our Reference	UNITS	PQL	266006-6	266006-7	266006-8	266006-9
Your Reference			SW6	SW7	SW8	SW9
Date Sampled			27/07/2021	27/07/2021	27/07/2021	27/07/2021
Type of sample			Surface Water	Surface Water	Surface Water	Surface Water
Date prepared	-		29/07/2021	29/07/2021	29/07/2021	29/07/2021
Date analysed	-		29/07/2021	29/07/2021	29/07/2021	29/07/2021
Total Nitrogen	mg/L	0.1	1.2	1.8	2.0	2.0
Total Kjeldahl Nitrogen	mg/L	0.1	1.0	1.7	1.9	1.7
NOx as N	mg/L	0.005	0.21	0.051	0.12	0.33
Ammonia as N	mg/L	0.005	0.50	0.020	0.027	0.031
Nitrate as N	mg/L	0.005	0.21	0.050	0.12	0.32
Nitrite as N	mg/L	0.005	<0.005	<0.005	<0.005	0.010
Total Phosphorus	mg/L	0.05	<0.05	0.16	0.19	0.23
Phosphate as P	mg/L	0.005	<0.005	0.073	0.093	0.15

Metals in Water - Low Level							
Our Reference	UNITS	PQL	266006-1	266006-2	266006-3	266006-4	266006-5
Your Reference			SW1	SW2	SW3	SW4	SW5
Date Sampled			27/07/2021	27/07/2021	27/07/2021	27/07/2021	27/07/2021
Type of sample			Surface Water	Surface Water	Surface Water	Surface Water	Surface Water
Date prepared	-		30/07/2021	30/07/2021	30/07/2021	30/07/2021	30/07/2021
Date analysed	-		30/07/2021	30/07/2021	30/07/2021	30/07/2021	30/07/2021
Arsenic-Dissolved	mg/L	0.001	0.002	0.003	0.002	<0.001	<0.001
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	0.001
Copper-Dissolved	mg/L	0.001	0.004	0.006	0.005	0.001	0.001
Lead-Dissolved	mg/L	0.001	<0.001	0.001	<0.001	<0.001	<0.001
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Nickel-Dissolved	mg/L	0.001	<0.001	0.001	<0.001	<0.001	0.002
Zinc-Dissolved	mg/L	0.001	0.017	0.036	0.015	0.006	0.025

Metals in Water - Low Level						
Our Reference	UNITS	PQL	266006-6	266006-7	266006-8	266006-9
Your Reference			SW6	SW7	SW8	SW9
Date Sampled			27/07/2021	27/07/2021	27/07/2021	27/07/2021
Type of sample			Surface Water	Surface Water	Surface Water	Surface Water
Date prepared	-		30/07/2021	30/07/2021	30/07/2021	30/07/2021
Date analysed	-		30/07/2021	30/07/2021	30/07/2021	30/07/2021
Arsenic-Dissolved	mg/L	0.001	<0.001	0.002	0.002	0.002
Cadmium-Dissolved	mg/L	0.0001	0.0001	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	0.001	0.003	0.002	0.003
Lead-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Nickel-Dissolved	mg/L	0.001	0.006	0.002	0.002	0.002
Zinc-Dissolved	mg/L	0.001	0.041	0.019	0.015	0.017

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CERTIFICATE OF ANALYSIS 267547

Client Details

Client	Hyd2O
Attention	Georgia Ross
Address	Suite 6B, 103 Rokeby Rd, Subiaco, WA, 6008

Sample Details

Your Reference	**H21003 Wattle Grove Monitoring**
Number of Samples	7 Water
Date samples received	23/08/2021
Date completed instructions received	24/08/2021

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	30/08/2021
Date of Issue	30/08/2021

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Results Approved By
Michael Mowle, Metals/Inorganics Supervisor

Authorised By



Michael Kubiak, Laboratory Manager

Nutrients in Water							
Our Reference	UNITS	PQL	267547-1	267547-2	267547-3	267547-4	267547-5
Your Reference			WG1	WG2	WG3	MBb	GW1
Date Sampled			23/08/2021	23/08/2021	23/08/2021	23/08/2021	23/08/2021
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Date prepared	-		25/08/2021	25/08/2021	25/08/2021	25/08/2021	25/08/2021
Date analysed	-		25/08/2021	25/08/2021	25/08/2021	25/08/2021	25/08/2021
Total Nitrogen	mg/L	0.1	3.6	4.4	0.7	0.5	2.9
Total Kjeldahl Nitrogen	mg/L	0.1	0.8	0.5	0.7	0.5	0.3
Nitrate as N	mg/L	0.005	2.8	4.0	0.007	<0.005	2.5
Nitrite as N	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
NOx as N	mg/L	0.005	2.8	4.0	0.008	<0.005	2.5
Ammonia as N	mg/L	0.005	0.009	0.026	0.032	0.11	<0.005
Total Phosphorus	mg/L	0.05	0.40	0.10	0.36	0.06	0.06
Phosphate as P	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005

Nutrients in Water				
Our Reference	UNITS	PQL	267547-6	267547-7
Your Reference			GW5	GW6
Date Sampled			23/08/2021	23/08/2021
Type of sample			Groundwater	Groundwater
Date prepared	-		25/08/2021	25/08/2021
Date analysed	-		25/08/2021	25/08/2021
Total Nitrogen	mg/L	0.1	1.3	1.4
Total Kjeldahl Nitrogen	mg/L	0.1	1.3	1.4
Nitrate as N	mg/L	0.005	0.029	0.034
Nitrite as N	mg/L	0.005	<0.005	0.005
NOx as N	mg/L	0.005	0.029	0.039
Ammonia as N	mg/L	0.005	0.041	0.062
Total Phosphorus	mg/L	0.05	0.15	0.23
Phosphate as P	mg/L	0.005	0.007	0.042

Metals in Water - Low Level							
Our Reference	UNITS	PQL	267547-1	267547-2	267547-3	267547-4	267547-5
Your Reference			WG1	WG2	WG3	MBb	GW1
Date Sampled			23/08/2021	23/08/2021	23/08/2021	23/08/2021	23/08/2021
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Date prepared	-		26/08/2021	26/08/2021	26/08/2021	26/08/2021	26/08/2021
Date analysed	-		26/08/2021	26/08/2021	26/08/2021	26/08/2021	26/08/2021
Arsenic-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Nickel-Dissolved	mg/L	0.001	0.003	0.010	0.01	0.013	0.001
Zinc-Dissolved	mg/L	0.001	0.007	0.025	0.012	0.017	0.004

Metals in Water - Low Level				
Our Reference	UNITS	PQL	267547-6	267547-7
Your Reference			GW5	GW6
Date Sampled			23/08/2021	23/08/2021
Type of sample			Groundwater	Groundwater
Date prepared	-		26/08/2021	26/08/2021
Date analysed	-		26/08/2021	26/08/2021
Arsenic-Dissolved	mg/L	0.001	<0.001	<0.001
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	<0.001	0.002
Lead-Dissolved	mg/L	0.001	<0.001	<0.001
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005
Nickel-Dissolved	mg/L	0.001	0.011	0.002
Zinc-Dissolved	mg/L	0.001	0.003	0.017

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CERTIFICATE OF ANALYSIS 268352

Client Details

Client	Hyd2O
Attention	Sean O'Sullivan
Address	Suite 6B, 103 Rokeby Rd, Subiaco, WA, 6008

Sample Details

Your Reference	**H21003 - Wattle Grove Predev Monitoring**
Number of Samples	8 Water
Date samples received	06/09/2021
Date completed instructions received	07/09/2021

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	13/09/2021
Date of Issue	13/09/2021

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Results Approved By
Michael Mowle, Metals/Inorganics Supervisor

Authorised By



Michael Kubiak, Laboratory Manager

Miscellaneous Inorganics			
Our Reference	UNITS	PQL	268352-6
Your Reference			SW7
Date Sampled			01/09/2021
Type of sample			Surface Water
Date prepared	-		07/09/2021
Date analysed	-		07/09/2021
pH	pH Units		4.4
Electrical Conductivity (EC)	µS/cm	1	5,200

Nutrients in Water							
Our Reference			268352-1	268352-2	268352-3	268352-4	268352-5
Your Reference	UNITS	PQL	SW2	SW3	SW4	SW5	SW6
Date Sampled			01/09/2021	01/09/2021	01/09/2021	01/09/2021	01/09/2021
Type of sample			Surface Water	Surface Water	Surface Water	Surface Water	Surface Water
Date prepared	-		08/09/2021	08/09/2021	08/09/2021	08/09/2021	08/09/2021
Date analysed	-		08/09/2021	08/09/2021	08/09/2021	08/09/2021	08/09/2021
Total Nitrogen	mg/L	0.1	1.9	1.1	0.3	1.4	1.4
Total Kjeldahl Nitrogen	mg/L	0.1	1.1	1	0.3	1.4	1.4
NOx as N	mg/L	0.005	0.76	0.097	<0.005	<0.005	0.036
Ammonia as N	mg/L	0.005	0.089	0.20	<0.005	0.016	0.45
Nitrate as N	mg/L	0.005	0.75	0.073	<0.005	<0.005	0.035
Nitrite as N	mg/L	0.005	0.011	0.024	<0.005	<0.005	<0.005
Total Phosphorus	mg/L	0.05	0.26	2.9	0.05	0.13	<0.05
Phosphate as P	mg/L	0.005	0.048	0.10	0.025	0.007	<0.005

Nutrients in Water					
Our Reference			268352-6	268352-7	268352-8
Your Reference	UNITS	PQL	SW7	SW8	SW9
Date Sampled			01/09/2021	01/09/2021	01/09/2021
Type of sample			Surface Water	Surface Water	Surface Water
Date prepared	-		08/09/2021	08/09/2021	08/09/2021
Date analysed	-		08/09/2021	08/09/2021	08/09/2021
Total Nitrogen	mg/L	0.1	3.5	3.1	3.4
Total Kjeldahl Nitrogen	mg/L	0.1	3.5	3.1	3.4
NOx as N	mg/L	0.005	0.031	<0.005	<0.005
Ammonia as N	mg/L	0.005	2.7	0.015	0.015
Nitrate as N	mg/L	0.005	0.028	<0.005	<0.005
Nitrite as N	mg/L	0.005	<0.005	<0.005	<0.005
Total Phosphorus	mg/L	0.05	<0.05	0.27	0.31
Phosphate as P	mg/L	0.005	<0.005	0.18	0.20

Metals in Water - Low Level							
Our Reference	UNITS	PQL	268352-1	268352-2	268352-3	268352-4	268352-5
Your Reference			SW2	SW3	SW4	SW5	SW6
Date Sampled			01/09/2021	01/09/2021	01/09/2021	01/09/2021	01/09/2021
Type of sample			Surface Water	Surface Water	Surface Water	Surface Water	Surface Water
Date prepared	-		09/09/2021	09/09/2021	09/09/2021	09/09/2021	09/09/2021
Date analysed	-		09/09/2021	09/09/2021	09/09/2021	09/09/2021	09/09/2021
Arsenic-Dissolved	mg/L	0.001	<0.001	0.001	<0.001	<0.001	<0.001
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	0.004	0.005	0.002	0.002	0.003
Lead-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Nickel-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	0.002
Zinc-Dissolved	mg/L	0.001	0.017	0.011	0.011	0.005	0.032

Metals in Water - Low Level					
Our Reference	UNITS	PQL	268352-6	268352-7	268352-8
Your Reference			SW7	SW8	SW9
Date Sampled			01/09/2021	01/09/2021	01/09/2021
Type of sample			Surface Water	Surface Water	Surface Water
Date prepared	-		09/09/2021	09/09/2021	09/09/2021
Date analysed	-		09/09/2021	09/09/2021	09/09/2021
Arsenic-Dissolved	mg/L	0.001	<0.001	0.002	0.003
Cadmium-Dissolved	mg/L	0.0001	0.0003	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	0.002	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	0.004	0.003	0.002
Lead-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005	<0.00005
Nickel-Dissolved	mg/L	0.001	0.019	0.002	0.003
Zinc-Dissolved	mg/L	0.001	0.36	0.0099	0.011

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CERTIFICATE OF ANALYSIS 272540

Client Details

Client	Hyd2O
Attention	Sean O'Sullivan
Address	Suite 6B, 103 Rokeby Rd, Subiaco, WA, 6008

Sample Details

Your Reference	**H21003 - Wattle Grove Monitoring**
Number of Samples	7 Water
Date samples received	19/11/2021
Date completed instructions received	19/11/2021

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	25/11/2021
Date of Issue	25/11/2021

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Results Approved By
Michael Mowle, Metals/Inorganics Supervisor

Authorised By



Michael Kubiak, Laboratory Manager

Nutrients in Water							
Our Reference	UNITS	PQL	272540-1	272540-2	272540-3	272540-4	272540-5
Your Reference			WG1	WG2	WG3	MBb	GW1
Date Sampled			18/11/2021	18/11/2021	18/11/2021	18/11/2021	18/11/2021
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Date prepared	-		22/11/2021	22/11/2021	22/11/2021	22/11/2021	22/11/2021
Date analysed	-		22/11/2021	22/11/2021	22/11/2021	22/11/2021	22/11/2021
Total Nitrogen	mg/L	0.1	4.5	2.7	0.9	0.7	2.8
Total Kjeldahl Nitrogen	mg/L	0.1	0.5	0.7	0.9	0.7	0.8
NOx as N	mg/L	0.005	4.0	2.0	0.026	0.028	1.9
Ammonia as N	mg/L	0.005	0.018	0.079	0.011	0.20	0.012
Nitrate as N	mg/L	0.005	4.0	2.0	0.025	0.027	1.9
Nitrite as N	mg/L	0.005	<0.005	0.006	<0.005	<0.005	<0.005
Total Phosphorus	mg/L	0.05	0.30	0.15	<0.05	0.12	0.08
Phosphate as P	mg/L	0.005	<0.005	0.018	0.006	<0.005	0.013

Nutrients in Water				
Our Reference	UNITS	PQL	272540-6	272540-7
Your Reference			GW3	GW5
Date Sampled			18/11/2021	18/11/2021
Type of sample			Groundwater	Groundwater
Date prepared	-		22/11/2021	22/11/2021
Date analysed	-		22/11/2021	22/11/2021
Total Nitrogen	mg/L	0.1	1.4	1.8
Total Kjeldahl Nitrogen	mg/L	0.1	1.4	1.8
NOx as N	mg/L	0.005	0.027	<0.005
Ammonia as N	mg/L	0.005	0.089	0.075
Nitrate as N	mg/L	0.005	0.024	<0.005
Nitrite as N	mg/L	0.005	<0.005	<0.005
Total Phosphorus	mg/L	0.05	0.30	0.72
Phosphate as P	mg/L	0.005	0.062	<0.005

Dissolved Metals in Water							
Our Reference	UNITS	PQL	272540-1	272540-2	272540-3	272540-4	272540-5
Your Reference			WG1	WG2	WG3	MBb	GW1
Date Sampled			18/11/2021	18/11/2021	18/11/2021	18/11/2021	18/11/2021
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Date prepared	-		24/11/2021	24/11/2021	24/11/2021	24/11/2021	24/11/2021
Date analysed	-		24/11/2021	24/11/2021	24/11/2021	24/11/2021	24/11/2021
Arsenic-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	0.001	<0.001
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	0.006	0.002	0.004	<0.001	0.004
Lead-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Nickel-Dissolved	mg/L	0.001	0.002	0.005	0.008	0.005	<0.001
Zinc-Dissolved	mg/L	0.001	0.026	0.044	0.038	0.016	0.016

Dissolved Metals in Water				
Our Reference	UNITS	PQL	272540-6	272540-7
Your Reference			GW3	GW5
Date Sampled			18/11/2021	18/11/2021
Type of sample			Groundwater	Groundwater
Date prepared	-		24/11/2021	24/11/2021
Date analysed	-		24/11/2021	24/11/2021
Arsenic-Dissolved	mg/L	0.001	<0.001	<0.001
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	0.002	<0.001
Lead-Dissolved	mg/L	0.001	<0.001	<0.001
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005
Nickel-Dissolved	mg/L	0.001	0.002	0.006
Zinc-Dissolved	mg/L	0.001	0.019	0.004

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CERTIFICATE OF ANALYSIS 277742

Client Details

Client	Hyd2O
Attention	Georgia Ross
Address	Suite 1, 387 Hay St, PERTH, WA, 6008

Sample Details

Your Reference	**H21003 Wattle Grove Monitoring**
Number of Samples	3 Water
Date samples received	02/03/2022
Date completed instructions received	02/03/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	09/03/2022
Date of Issue	09/03/2022

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Results Approved By
Heram Halim, Operations Manager
Travis Carey, Organics - Team Leader

Authorised By

Michael Kubiak, Laboratory Manager

Miscellaneous Inorganics				
Our Reference	UNITS	PQL	277742-2	277742-3
Your Reference			WG3	MBb
Date Sampled			01/03/2022	01/03/2022
Type of sample			Groundwater	Groundwater
Date prepared	-		02/03/2022	02/03/2022
Date analysed	-		02/03/2022	02/03/2022
Free Chlorine	mg/L	0.1	0.2	<0.1

Nutrients in Water					
Our Reference	UNITS	PQL	277742-1	277742-2	277742-3
Your Reference			WG1	WG3	MBb
Date Sampled			01/03/2022	01/03/2022	01/03/2022
Type of sample			Groundwater	Groundwater	Groundwater
Date prepared	-		02/03/2022	02/03/2022	02/03/2022
Date analysed	-		02/03/2022	02/03/2022	02/03/2022
Total Nitrogen	mg/L	0.1	5.3	0.9	0.8
Total Kjeldahl Nitrogen	mg/L	0.1	1.6	0.9	0.8
NOx as N	mg/L	0.005	3.7	<0.05	0.027
Nitrate as N	mg/L	0.005	3.7	<0.05	0.026
Nitrite as N	mg/L	0.005	0.007	<0.05	<0.005
Ammonia as N	mg/L	0.005	0.025	0.031	0.38
Total Phosphorus	mg/L	0.05	0.36	0.18	<0.05
Phosphate as P	mg/L	0.005	0.018	<0.05	0.006

Dissolved Metals in Water					
Our Reference	UNITS	PQL	277742-1	277742-2	277742-3
Your Reference			WG1	WG3	MBb
Date Sampled			01/03/2022	01/03/2022	01/03/2022
Type of sample			Groundwater	Groundwater	Groundwater
Date prepared	-		08/03/2022	08/03/2022	08/03/2022
Date analysed	-		08/03/2022	08/03/2022	08/03/2022
Arsenic-Dissolved	mg/L	0.001	<0.001	0.002	<0.001
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	0.001	<0.001	0.002
Lead-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005	<0.00005
Nickel-Dissolved	mg/L	0.001	<0.001	0.010	0.004
Zinc-Dissolved	mg/L	0.001	0.002	0.016	0.010

Glyphosate in water				
Our Reference	UNITS	PQL	277742-2	277742-3
Your Reference			WG3	MBb
Date Sampled			01/03/2022	01/03/2022
Type of sample			Groundwater	Groundwater
Date Extracted	-		03/03/2022	03/03/2022
Date Analysed	-		04/03/2022	04/03/2022
Glyphosate	mg/L	0.01	<0.01	<0.01
Surrogate: L-Cysteic Acid	%		109	110

Acid Herbicides in Water				
Our Reference	UNITS	PQL	277742-2	277742-3
Your Reference			WG3	MBb
Date Sampled			01/03/2022	01/03/2022
Type of sample			Groundwater	Groundwater
Date extracted	-		03/03/2022	03/03/2022
Date analysed	-		08/03/2022	08/03/2022
Clopyralid	µg/L	0.5	<0.5	<0.5
3,5-Dichlorobenzoic acid	µg/L	0.5	<0.5	<0.5
o-chlorophenoxy acetic acid	µg/L	0.5	<0.5	<0.5
4-CPA	µg/L	0.5	<0.5	<0.5
Dicamba	µg/L	0.5	<0.5	<0.5
Mecoprop (MCPP)	µg/L	0.5	<0.5	<0.5
MCPA	µg/L	0.5	<0.5	<0.5
Dichlorprop (2,4-DP)	µg/L	0.5	<0.5	<0.5
2,4-D	µg/L	0.5	<0.5	<0.5
Bromoxynil	µg/L	0.5	<0.5	<0.5
Triclopyr	µg/L	0.5	<0.5	<0.5
2,4,5-TP (Silvex)	µg/L	0.5	<0.5	<0.5
2,4,5-T	µg/L	0.5	<0.5	<0.5
MCPB	µg/L	0.5	<0.5	<0.5
Dinoseb	µg/L	1	<1	<1
2,4-DB	µg/L	0.5	<0.5	<0.5
Ioxynil	µg/L	1	<1	<1
Picloram	µg/L	1	<1	<1
Acifluorfen	µg/L	2	<2	<2
2,4,6-T	µg/L	0.5	<0.5	<0.5
2,6-D	µg/L	0.5	<0.5	<0.5
Surrogate: 2,4-DCPA	%		82	84

Triazine Herbicides in water				
Our Reference	UNITS	PQL	277742-2	277742-3
Your Reference			WG3	MBb
Date Sampled			01/03/2022	01/03/2022
Type of sample			Groundwater	Groundwater
Date extracted	-		03/03/2022	03/03/2022
Date analysed	-		08/03/2022	08/03/2022
Ametryn	µg/L	2	<2	<2
Atrazine	µg/L	2	<2	<2
Cyanazine	µg/L	2	<2	<2
Hexazinone	µg/L	2	<2	<2
Prometryn	µg/L	2	<2	<2
Simazine	µg/L	2	<2	<2
Terbutryn	µg/L	2	<2	<2
Propazine	µg/L	2	<2	<2
Irgarol	µg/L	2	<2	<2
Metribuzin	µg/L	2	<2	<2
Terbuthylazine	µg/L	2	<2	<2
Surrogate p-Terphenyl-D_{14}	%		68	62

Carbamates in water				
Our Reference	UNITS	PQL	277742-2	277742-3
Your Reference			WG3	MBb
Date Sampled			01/03/2022	01/03/2022
Type of sample			Groundwater	Groundwater
Date extracted	-		03/03/2022	03/03/2022
Date analysed	-		08/03/2022	08/03/2022
Carbaryl	µg/L	0.5	<0.5	<0.5
Carbofuran	µg/L	0.5	<0.5	<0.5
Molinate	µg/L	0.5	<0.5	<0.5
Surrogate p-Terphenyl-D_{14}	%		68	62

OCP in water				
Our Reference	UNITS	PQL	277742-2	277742-3
Your Reference			WG3	MBb
Date Sampled			01/03/2022	01/03/2022
Type of sample			Groundwater	Groundwater
Date extracted	-		03/03/2022	03/03/2022
Date analysed	-		08/03/2022	08/03/2022
Hexachlorobenzene (HCB)	µg/L	0.2	<0.2	<0.2
a-BHC	µg/L	0.2	<0.2	<0.2
b-BHC	µg/L	0.2	<0.2	<0.2
Lindane (g-BHC)	µg/L	0.2	<0.2	<0.2
d-BHC	µg/L	0.2	<0.2	<0.2
Heptachlor	µg/L	0.2	<0.2	<0.2
Aldrin	µg/L	0.2	<0.2	<0.2
Heptachlor Epoxide	µg/L	0.2	<0.2	<0.2
g-Chlordane	µg/L	0.2	<0.2	<0.2
a-Chlordane	µg/L	0.2	<0.2	<0.2
a-Endosulphan	µg/L	0.2	<0.2	<0.2
p,p'-DDE	µg/L	0.2	<0.2	<0.2
Dieldrin	µg/L	0.2	<0.2	<0.2
Endrin	µg/L	0.2	<0.2	<0.2
p,p'-DDD	µg/L	0.2	<0.2	<0.2
b-Endosulphan	µg/L	0.2	<0.2	<0.2
Endrin Aldehyde	µg/L	0.2	<0.2	<0.2
Endosulfan Sulphate	µg/L	0.2	<0.2	<0.2
p,p'-DDT	µg/L	0.2	<0.2	<0.2
Endrin Ketone	µg/L	0.2	<0.2	<0.2
Methoxychlor	µg/L	0.2	<0.2	<0.2
Surrogate 2-chlorophenol-d4	%		102	105

OPP in water				
Our Reference	UNITS	PQL	277742-2	277742-3
Your Reference			WG3	MBb
Date Sampled			01/03/2022	01/03/2022
Type of sample			Groundwater	Groundwater
Date extracted	-		03/03/2022	03/03/2022
Date analysed	-		08/03/2022	08/03/2022
Diazinon (Dimpylate)	µg/L	0.2	<0.2	<0.2
Chlorpyrifos-methyl	µg/L	0.2	<0.2	<0.2
Ronnel	µg/L	0.2	<0.2	<0.2
Fenitrothion	µg/L	0.2	<0.2	<0.2
Malathion (Maldison)	µg/L	0.2	<0.2	<0.2
Chlorpyrifos (ethyl)	µg/L	0.2	<0.2	<0.2
Parathion (ethyl)	µg/L	0.2	<0.2	<0.2
Ethion	µg/L	0.2	<0.2	<0.2
Bromophos Ethyl	µg/L	0.2	<0.2	<0.2
Dimethoate	µg/L	0.2	<0.2	<0.2
Dichlorvos	µg/L	0.2	<0.2	<0.2
Azinphos methyl (Guthion)	µg/L	0.2	<0.2	<0.2
Surrogate 2-chlorophenol-d4	%		102	105

Miscellaneous Organics - Water				
Our Reference	UNITS	PQL	277742-2	277742-3
Your Reference			WG3	MBb
Date Sampled			01/03/2022	01/03/2022
Type of sample			Groundwater	Groundwater
Date Extracted	-		03/03/2022	03/03/2022
Date Analysed	-		08/03/2022	08/03/2022
Toxaphene	mg/L	0.002	<0.002	<0.002

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CERTIFICATE OF ANALYSIS 279395

Client Details

Client	Hyd2O
Attention	Sean O'Sillivan
Address	Suite 1, 387 Hay St, PERTH, WA, 6008

Sample Details

Your Reference	**H21003 - Wattle Grove Monitoring**
Number of Samples	1 Water
Date samples received	31/03/2022
Date completed instructions received	31/03/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	07/04/2022
Date of Issue	07/04/2022

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Results Approved By
Michael Mowle, Metals/Inorganics Supervisor
Travis Carey, Organics - Team Leader

Authorised By



Michael Kubiak, Laboratory Manager

Miscellaneous Inorganics			
Our Reference	UNITS	PQL	279395-1
Your Reference			WG2
Date Sampled			31/03/2022
Type of sample			Groundwater
Date prepared	-		31/03/2022
Date analysed	-		31/03/2022
Free Chlorine	mg/L	0.1	<0.1
pH	pH Units		5.4
Electrical Conductivity (EC)	µS/cm	1	2,500

Nutrients in Water			
Our Reference	UNITS	PQL	279395-1
Your Reference			WG2
Date Sampled			31/03/2022
Type of sample			Groundwater
Date prepared	-		01/04/2022
Date analysed	-		01/04/2022
Total Nitrogen	mg/L	0.1	4.1
Total Kjeldahl Nitrogen	mg/L	0.1	1.9
NOx as N	mg/L	0.005	2.2
Ammonia as N	mg/L	0.005	0.020
Nitrate as N	mg/L	0.005	2.2
Nitrite as N	mg/L	0.005	<0.005
Total Phosphorus	mg/L	0.05	0.35
Phosphate as P	mg/L	0.005	<0.005

Dissolved Metals in Water			
Our Reference	UNITS	PQL	279395-1
Your Reference			WG2
Date Sampled			31/03/2022
Type of sample			Groundwater
Date prepared	-		05/04/2022
Date analysed	-		05/04/2022
Arsenic-Dissolved	mg/L	0.001	<0.001
Cadmium-Dissolved	mg/L	0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001
Copper-Dissolved	mg/L	0.001	<0.001
Lead-Dissolved	mg/L	0.001	<0.001
Mercury-Dissolved	mg/L	0.00005	<0.00005
Nickel-Dissolved	mg/L	0.001	0.003
Zinc-Dissolved	mg/L	0.001	0.015

Glyphosate in water			
Our Reference	UNITS	PQL	279395-1
Your Reference			WG2
Date Sampled			31/03/2022
Type of sample			Groundwater
Date Extracted	-		05/04/2022
Date Analysed	-		06/04/2022
Glyphosate	mg/L	0.01	<0.01
Surrogate: L-Cysteic Acid	%		97

Acid Herbicides in Water			
Our Reference	UNITS	PQL	279395-1
Your Reference			WG2
Date Sampled			31/03/2022
Type of sample			Groundwater
Date extracted	-		05/04/2022
Date analysed	-		06/04/2022
Clopyralid	µg/L	0.5	<0.5
3,5-Dichlorobenzoic acid	µg/L	0.5	<0.5
o-chlorophenoxy acetic acid	µg/L	0.5	<0.5
4-CPA	µg/L	0.5	<0.5
Dicamba	µg/L	0.5	<0.5
Mecoprop (MCPP)	µg/L	0.5	<0.5
MCPA	µg/L	0.5	<0.5
Dichlorprop (2,4-DP)	µg/L	0.5	<0.5
2,4-D	µg/L	0.5	<0.5
Bromoxynil	µg/L	0.5	<0.5
Triclopyr	µg/L	0.5	<0.5
2,4,5-TP (Silvex)	µg/L	0.5	<0.5
2,4,5-T	µg/L	0.5	<0.5
MCPB	µg/L	0.5	<0.5
Dinoseb	µg/L	1	<1
2,4-DB	µg/L	0.5	<0.5
Ioxynil	µg/L	1	<1
Picloram	µg/L	1	<1
Acifluorfen	µg/L	2	<2
2,4,6-T	µg/L	0.5	<0.5
2,6-D	µg/L	0.5	<0.5
Surrogate: 2,4-DCPA	%		90

Triazine Herbicides in water			
Our Reference	UNITS	PQL	279395-1
Your Reference			WG2
Date Sampled			31/03/2022
Type of sample			Groundwater
Date extracted	-		05/04/2022
Date analysed	-		06/04/2022
Ametryn	µg/L	2	<2
Atrazine	µg/L	2	<2
Cyanazine	µg/L	2	<2
Hexazinone	µg/L	2	<2
Prometryn	µg/L	2	<2
Simazine	µg/L	2	<2
Terbutryn	µg/L	2	<2
Propazine	µg/L	2	<2
Irgarol	µg/L	2	<2
Metribuzin	µg/L	2	<2
Terbuthylazine	µg/L	2	<2
Surrogate p-Terphenyl-D_{14}	%		35

Carbamates in water			
Our Reference	UNITS	PQL	279395-1
Your Reference			WG2
Date Sampled			31/03/2022
Type of sample			Groundwater
Date extracted	-		05/04/2022
Date analysed	-		06/04/2022
Carbaryl	µg/L	0.5	<0.5
Carbofuran	µg/L	0.5	<0.5
Molinate	µg/L	0.5	<0.5
Surrogate p-Terphenyl-D_{14}	%		35

OCP in water			
Our Reference	UNITS	PQL	279395-1
Your Reference			WG2
Date Sampled			31/03/2022
Type of sample			Groundwater
Date extracted	-		05/04/2022
Date analysed	-		06/04/2022
Hexachlorobenzene (HCB)	µg/L	0.2	<0.2
a-BHC	µg/L	0.2	<0.2
b-BHC	µg/L	0.2	<0.2
Lindane (g-BHC)	µg/L	0.2	<0.2
d-BHC	µg/L	0.2	<0.2
Heptachlor	µg/L	0.2	<0.2
Aldrin	µg/L	0.2	<0.2
Heptachlor Epoxide	µg/L	0.2	<0.2
g-Chlordane	µg/L	0.2	<0.2
a-Chlordane	µg/L	0.2	<0.2
a-Endosulphan	µg/L	0.2	<0.2
p,p'-DDE	µg/L	0.2	<0.2
Dieldrin	µg/L	0.2	<0.2
Endrin	µg/L	0.2	<0.2
p,p'-DDD	µg/L	0.2	<0.2
b-Endosulphan	µg/L	0.2	<0.2
Endrin Aldehyde	µg/L	0.2	<0.2
Endosulfan Sulphate	µg/L	0.2	<0.2
p,p'-DDT	µg/L	0.2	<0.2
Endrin Ketone	µg/L	0.2	<0.2
Methoxychlor	µg/L	0.2	<0.2
Surrogate 2-chlorophenol-d4	%		85

OPP in water			
Our Reference	UNITS	PQL	279395-1
Your Reference			WG2
Date Sampled			31/03/2022
Type of sample			Groundwater
Date extracted	-		05/04/2022
Date analysed	-		06/04/2022
Diazinon (Dimpylate)	µg/L	0.2	<0.2
Chlorpyrifos-methyl	µg/L	0.2	<0.2
Ronnel	µg/L	0.2	<0.2
Fenitrothion	µg/L	0.2	<0.2
Malathion (Maldison)	µg/L	0.2	<0.2
Chlorpyrifos (ethyl)	µg/L	0.2	<0.2
Parathion (ethyl)	µg/L	0.2	<0.2
Ethion	µg/L	0.2	<0.2
Bromophos Ethyl	µg/L	0.2	<0.2
Dimethoate	µg/L	0.2	<0.2
Dichlorvos	µg/L	0.2	<0.2
Azinphos methyl (Guthion)	µg/L	0.2	<0.2
Surrogate 2-chlorophenol-d4	%		85

Miscellaneous Organics - Water			
Our Reference	UNITS	PQL	279395-1
Your Reference			WG2
Date Sampled			31/03/2022
Type of sample			Groundwater
Date Extracted	-		05/04/2022
Date Analysed	-		06/04/2022
Toxaphene	mg/L	0.001	<0.001

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CERTIFICATE OF ANALYSIS 282509

Client Details

Client	Hyd2O
Attention	Georgia Ross
Address	Suite 1, 387 Hay St, PERTH, WA, 6008

Sample Details

Your Reference	**H21003 Wattle Grove Monitoring**
Number of Samples	5 Water
Date samples received	30/05/2022
Date completed instructions received	30/05/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	08/06/2022
Date of Issue	08/06/2022

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Results Approved By
Lien Tang, Assistant Operations Manager
Michael Kubiak, Laboratory Manager
Travis Carey, Organics - Team Leader

Authorised By



Michael Kubiak, Laboratory Manager

Miscellaneous Inorganics						
Our Reference	UNITS	PQL	282509-2	282509-3	282509-4	282509-5
Your Reference			WG2	WG3	MBb	GW5
Date Sampled			30/05/2022	30/05/2022	30/05/2022	30/05/2022
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater
Date prepared	-		31/05/2022	31/05/2022	31/05/2022	31/05/2022
Date analysed	-		31/05/2022	31/05/2022	31/05/2022	31/05/2022
Free Chlorine	mg/L	0.1	<0.1	<0.1	<0.1	<0.1

Nutrients in Water							
Our Reference	UNITS	PQL	282509-1	282509-2	282509-3	282509-4	282509-5
Your Reference			WG1	WG2	WG3	MBb	GW5
Date Sampled			30/05/2022	30/05/2022	30/05/2022	30/05/2022	30/05/2022
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Date prepared	-		31/05/2022	31/05/2022	31/05/2022	31/05/2022	31/05/2022
Date analysed	-		31/05/2022	31/05/2022	31/05/2022	31/05/2022	31/05/2022
Total Nitrogen	mg/L	0.1	4.7	5.2	1.1	4.6	3.4
Total Kjeldahl Nitrogen	mg/L	0.1	0.7	3.0	0.9	4.6	2.5
NOx as N	mg/L	0.005	4.0	2.2	0.21	<0.005	0.93
Ammonia as N	mg/L	0.005	0.033	0.059	0.048	3.4	0.012
Nitrate as N	mg/L	0.005	4.0	2.2	0.21	<0.005	0.93
Nitrite as N	mg/L	0.005	<0.005	0.013	<0.005	<0.005	<0.005
Total Phosphorus	mg/L	0.05	<0.05	0.60	0.06	<0.05	<0.05
Phosphate as P	mg/L	0.005	<0.005	<0.005	0.020	<0.005	<0.005

Dissolved Metals in Water							
Our Reference	UNITS	PQL	282509-1	282509-2	282509-3	282509-4	282509-5
Your Reference			WG1	WG2	WG3	MBb	GW5
Date Sampled			30/05/2022	30/05/2022	30/05/2022	30/05/2022	30/05/2022
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Date prepared	-		02/06/2022	02/06/2022	02/06/2022	02/06/2022	02/06/2022
Date analysed	-		02/06/2022	02/06/2022	02/06/2022	02/06/2022	02/06/2022
Arsenic-Dissolved	mg/L	0.001	<0.001	<0.001	0.001	<0.001	<0.001
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	<0.001	0.002	<0.001	<0.001	0.004
Lead-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.0005	<0.00005	<0.00005	<0.00005
Nickel-Dissolved	mg/L	0.001	0.001	0.010	0.015	0.012	0.01
Zinc-Dissolved	mg/L	0.001	0.004	0.033	0.008	0.013	0.004

Glyphosate in water						
Our Reference	UNITS	PQL	282509-2	282509-3	282509-4	282509-5
Your Reference			WG2	WG3	MBb	GW5
Date Sampled			30/05/2022	30/05/2022	30/05/2022	30/05/2022
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater
Date Extracted	-		01/06/2022	01/06/2022	01/06/2022	01/06/2022
Date Analysed	-		02/06/2022	02/06/2022	02/06/2022	02/06/2022
Glyphosate	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Surrogate: L-Cysteic Acid	%		99	102	88	96

Acid Herbicides in Water						
Our Reference	UNITS	PQL	282509-2	282509-3	282509-4	282509-5
Your Reference			WG2	WG3	MBb	GW5
Date Sampled			30/05/2022	30/05/2022	30/05/2022	30/05/2022
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater
Date extracted	-		01/06/2022	01/06/2022	01/06/2022	01/06/2022
Date analysed	-		08/06/2022	08/06/2022	08/06/2022	08/06/2022
Clopyralid	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
3,5-Dichlorobenzoic acid	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
o-chlorophenoxy acetic acid	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
4-CPA	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Dicamba	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Mecoprop (MCPP)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
MCPA	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Dichlorprop (2,4-DP)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
2,4-D	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Bromoxynil	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Triclopyr	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
2,4,5-TP (Silvex)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
2,4,5-T	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
MCPB	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Dinoseb	µg/L	1	<1	<1	<1	<1
2,4-DB	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Ioxynil	µg/L	1	<1	<1	<1	<1
Picloram	µg/L	1	<1	<1	<1	<1
Acifluorfen	µg/L	2	<2	<2	<2	<2
2,4,6-T	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
2,6-D	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Surrogate: 2,4-DCPA	%		130	97	100	120

Triazine Herbicides in water						
Our Reference	UNITS	PQL	282509-2	282509-3	282509-4	282509-5
Your Reference			WG2	WG3	MBb	GW5
Date Sampled			30/05/2022	30/05/2022	30/05/2022	30/05/2022
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater
Date extracted	-		01/06/2022	01/06/2022	01/06/2022	01/06/2022
Date analysed	-		08/06/2022	08/06/2022	08/06/2022	08/06/2022
Ametryn	µg/L	2	<2	<2	<2	<2
Atrazine	µg/L	2	<2	<2	<2	<2
Cyanazine	µg/L	2	<2	<2	<2	<2
Hexazinone	µg/L	2	<2	<2	<2	<2
Prometryn	µg/L	2	<2	<2	<2	<2
Simazine	µg/L	2	<2	<2	<2	<2
Terbutryn	µg/L	2	<2	<2	<2	<2
Propazine	µg/L	2	<2	<2	<2	<2
Irgarol	µg/L	2	<2	<2	<2	<2
Metribuzin	µg/L	2	<2	<2	<2	<2
Terbuthylazine	µg/L	2	<2	<2	<2	<2
Surrogate p-Terphenyl-D_{14}	%		38	87	121	85

Carbamates in water						
Our Reference	UNITS	PQL	282509-2	282509-3	282509-4	282509-5
Your Reference			WG2	WG3	MBb	GW5
Date Sampled			30/05/2022	30/05/2022	30/05/2022	30/05/2022
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater
Date extracted	-		01/06/2022	01/06/2022	01/06/2022	01/06/2022
Date analysed	-		08/06/2022	08/06/2022	08/06/2022	08/06/2022
Carbaryl	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Carbofuran	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Molinate	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Surrogate p-Terphenyl-D_{14}	%		38	87	121	85

OCP in water						
Our Reference	UNITS	PQL	282509-2	282509-3	282509-4	282509-5
Your Reference			WG2	WG3	MBb	GW5
Date Sampled			30/05/2022	30/05/2022	30/05/2022	30/05/2022
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater
Date extracted	-		01/06/2022	01/06/2022	01/06/2022	01/06/2022
Date analysed	-		08/06/2022	08/06/2022	08/06/2022	08/06/2022
Hexachlorobenzene (HCB)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
a-BHC	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
b-BHC	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Lindane (g-BHC)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
d-BHC	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Heptachlor	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Aldrin	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Heptachlor Epoxide	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
g-Chlordane	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
a-Chlordane	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
a-Endosulphan	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDE	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Dieldrin	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Endrin	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDD	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
b-Endosulphan	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Endrin Aldehyde	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Endosulfan Sulphate	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDT	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Endrin Ketone	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Methoxychlor	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Surrogate 2-chlorophenol-d4	%		115	119	121	94

OPP in water						
Our Reference	UNITS	PQL	282509-2	282509-3	282509-4	282509-5
Your Reference			WG2	WG3	MBb	GW5
Date Sampled			30/05/2022	30/05/2022	30/05/2022	30/05/2022
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater
Date extracted	-		01/06/2022	01/06/2022	01/06/2022	01/06/2022
Date analysed	-		08/06/2022	08/06/2022	08/06/2022	08/06/2022
Diazinon (Dimpylate)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Chlorpyrifos-methyl	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Ronnel	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Fenitrothion	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Malathion (Maldison)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Chlorpyrifos (ethyl)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Parathion (ethyl)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Ethion	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Bromophos Ethyl	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Dimethoate	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Dichlorvos	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Azinphos methyl (Guthion)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Surrogate 2-chlorophenol-d4	%		115	119	121	94

Miscellaneous Organics - Water						
Our Reference	UNITS	PQL	282509-2	282509-3	282509-4	282509-5
Your Reference			WG2	WG3	MBb	GW5
Date Sampled			30/05/2022	30/05/2022	30/05/2022	30/05/2022
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater
Date Extracted	-		01/06/2022	01/06/2022	01/06/2022	01/06/2022
Date Analysed	-		08/06/2022	08/06/2022	08/06/2022	08/06/2022
Toxaphene*	µg/L	2	<2	<2	<2	<2

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Certificate of Analysis PDJ0379

Client Details

Client	Hyd2O
Contact	Sean O'Sullivan
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H21003 - Wattle Grove Monitoring
Number of Samples	14 Groundwater
Date Samples Received	07/10/2022
Date Samples Registered	07/10/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	17/10/2022
Date of Issue	17/10/2022

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Authorisation Details

Results Approved By	Heram Halim, Operations Manager Todd Lee, Group Operations Manager
Laboratory Manager	Michael Kubiak

Certificate of Analysis PDJ0379

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PDJ0379-01	WG2D	Groundwater	06/10/2022	07/10/2022
PDJ0379-02	WG3	Groundwater	06/10/2022	07/10/2022
PDJ0379-03	WG4S	Groundwater	06/10/2022	07/10/2022
PDJ0379-04	WG4D	Groundwater	06/10/2022	07/10/2022
PDJ0379-05	WG5D	Groundwater	06/10/2022	07/10/2022
PDJ0379-06	WG6	Groundwater	06/10/2022	07/10/2022
PDJ0379-07	WG7D	Groundwater	06/10/2022	07/10/2022
PDJ0379-08	MBb	Groundwater	06/10/2022	07/10/2022
PDJ0379-09	GW1	Groundwater	06/10/2022	07/10/2022
PDJ0379-10	GW3	Groundwater	06/10/2022	07/10/2022
PDJ0379-11	GW5S	Groundwater	06/10/2022	07/10/2022
PDJ0379-12	GW5D	Groundwater	06/10/2022	07/10/2022
PDJ0379-13	GW8D	Groundwater	06/10/2022	07/10/2022
PDJ0379-14	GW9S	Groundwater	06/10/2022	07/10/2022

Acid Extractable Metals (Groundwater)

Envirolab ID	Units	PQL	PDJ0379-01	PDJ0379-02	PDJ0379-03	PDJ0379-04	PDJ0379-05
Your Reference			WG2D	WG3	WG4S	WG4D	WG5D
Date Sampled			06/10/2022	06/10/2022	06/10/2022	06/10/2022	06/10/2022
Phosphorus	mg/L	0.050	0.057	<0.050	<0.050	<0.050	0.062

Envirolab ID	Units	PQL	PDJ0379-06	PDJ0379-07	PDJ0379-08	PDJ0379-09	PDJ0379-10
Your Reference			WG6	WG7D	MBb	GW1	GW3
Date Sampled			06/10/2022	06/10/2022	06/10/2022	06/10/2022	06/10/2022
Phosphorus	mg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050

Envirolab ID	Units	PQL	PDJ0379-11	PDJ0379-12	PDJ0379-13	PDJ0379-14
Your Reference			GW5S	GW5D	GW8D	GW9S
Date Sampled			06/10/2022	06/10/2022	06/10/2022	06/10/2022
Phosphorus	mg/L	0.050	<0.050	<0.050	<0.050	0.15

Dissolved Metals (Groundwater)

Envirolab ID	Units	PQL	PDJ0379-01	PDJ0379-02	PDJ0379-03	PDJ0379-04	PDJ0379-05
Your Reference			WG2D	WG3	WG4S	WG4D	WG5D
Date Sampled			06/10/2022	06/10/2022	06/10/2022	06/10/2022	06/10/2022
Calcium	mg/L	0.50	3.3	30	35	59	5.6
Magnesium	mg/L	0.50	80	54	54	21	17
Potassium	mg/L	0.50	9.0	20	10	7.8	4.4
Sodium	mg/L	0.50	310	520	260	64	120
Hardness as CaCO3	mg/L	3.0	340	300	310	230	83

Envirolab ID	Units	PQL	PDJ0379-06	PDJ0379-07	PDJ0379-08	PDJ0379-09	PDJ0379-10
Your Reference			WG6	WG7D	MBb	GW1	GW3
Date Sampled			06/10/2022	06/10/2022	06/10/2022	06/10/2022	06/10/2022
Calcium	mg/L	0.50	9.6	3.8	3.6	3.3	86
Magnesium	mg/L	0.50	42	6.7	22	4.2	3.8
Potassium	mg/L	0.50	9.2	3.8	7.4	8.0	6.9
Sodium	mg/L	0.50	240	29	76	15	26
Hardness as CaCO3	mg/L	3.0	200	37	100	26	230

Envirolab ID	Units	PQL	PDJ0379-11	PDJ0379-12	PDJ0379-13	PDJ0379-14
Your Reference			GW5S	GW5D	GW8D	GW9S
Date Sampled			06/10/2022	06/10/2022	06/10/2022	06/10/2022
Calcium	mg/L	0.50	97	18	1.7	51
Magnesium	mg/L	0.50	6.9	14	4.4	9.7
Potassium	mg/L	0.50	8.5	8.0	1.3	17
Sodium	mg/L	0.50	46	82	37	53
Hardness as CaCO3	mg/L	3.0	270	100	23	170

Dissolved Low Level Metals (Groundwater)

Envirolab ID	Units	PQL	PDJ0379-01	PDJ0379-02	PDJ0379-03	PDJ0379-04	PDJ0379-05
Your Reference			WG2D	WG3	WG4S	WG4D	WG5D
Date Sampled			06/10/2022	06/10/2022	06/10/2022	06/10/2022	06/10/2022
Arsenic	µg/L	1.0	<1.0	1.9	<1.0	<1.0	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	1.6	<1.0	<1.0	<1.0
Copper	µg/L	1.0	<1.0	<1.0	<1.0	1.7	1.6
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	4.4	6.1	1.5	1.8	5.3
Lead	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	4.1	5.3	2.4	8.9	30

Envirolab ID	Units	PQL	PDJ0379-06	PDJ0379-07	PDJ0379-08	PDJ0379-09	PDJ0379-10
Your Reference			WG6	WG7D	MBb	GW1	GW3
Date Sampled			06/10/2022	06/10/2022	06/10/2022	06/10/2022	06/10/2022
Arsenic	µg/L	1.0	<1.0	<1.0	1.2	<1.0	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	1.4	<1.0	<1.0	<1.0
Copper	µg/L	1.0	<1.0	2.1	<1.0	<1.0	2.7
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	2.0	3.5	5.5	<1.0	<1.0
Lead	µg/L	1.0	29	1.1	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	2.2	<1.0	61	1.1	3.8

Envirolab ID	Units	PQL	PDJ0379-11	PDJ0379-12	PDJ0379-13	PDJ0379-14
Your Reference			GW5S	GW5D	GW8D	GW9S
Date Sampled			06/10/2022	06/10/2022	06/10/2022	06/10/2022
Arsenic	µg/L	1.0	<1.0	2.0	<1.0	5.6
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0
Copper	µg/L	1.0	<1.0	<1.0	<1.0	6.0
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	9.5	19	2.2	9.1
Lead	µg/L	1.0	<1.0	1.3	<1.0	<1.0
Zinc	µg/L	1.0	<1.0	4.1	3.5	12

Inorganics (Groundwater)

Envirolab ID	Units	PQL	PDJ0379-01	PDJ0379-02	PDJ0379-03	PDJ0379-04	PDJ0379-05
Your Reference			WG2D	WG3	WG4S	WG4D	WG5D
Date Sampled			06/10/2022	06/10/2022	06/10/2022	06/10/2022	06/10/2022
Ammonia as N	mg/L	0.0050	<0.0050	<0.0050	0.014	<0.0050	<0.0050
Nitrate as N	mg/L	0.0050	0.62	<0.0050	0.96	1.2	13
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	0.0051	<0.0050
Total Nitrogen	mg/L	0.10	0.89	0.65	1.3	1.6	15
NOx as N	mg/L	0.0050	0.62	<0.0050	0.96	1.2	13
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Organic Nitrogen by calc.	mg/L	0.10	0.26	0.65	0.27	0.47	2.7
TKN as N by calculation	mg/L	0.10	0.26	0.65	0.29	0.48	2.7
Nitrate as NO3 by calculation	mg/L	0.020	2.7	<0.020	4.3	5.1	56
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020

Envirolab ID	Units	PQL	PDJ0379-06	PDJ0379-07	PDJ0379-08	PDJ0379-09	PDJ0379-10
Your Reference			WG6	WG7D	MBb	GW1	GW3
Date Sampled			06/10/2022	06/10/2022	06/10/2022	06/10/2022	06/10/2022
Ammonia as N	mg/L	0.0050	<0.0050	<0.0050	0.057	<0.0050	0.18
Nitrate as N	mg/L	0.0050	3.4	1.0	0.0089	2.6	4.0
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.25
Total Nitrogen	mg/L	0.10	4.5	1.7	0.30	3.2	5.8
NOx as N	mg/L	0.0050	3.4	1.0	0.011	2.6	4.3
Phosphate as P	mg/L	0.0050	<0.0050	0.034	<0.0050	<0.0050	0.013
Organic Nitrogen by calc.	mg/L	0.10	1.2	0.72	0.24	0.63	1.4
TKN as N by calculation	mg/L	0.10	1.2	0.72	0.29	0.63	1.6
Nitrate as NO3 by calculation	mg/L	0.020	15	4.5	0.040	11	18
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	0.81

Envirolab ID	Units	PQL	PDJ0379-11	PDJ0379-12	PDJ0379-13	PDJ0379-14
Your Reference			GW5S	GW5D	GW8D	GW9S
Date Sampled			06/10/2022	06/10/2022	06/10/2022	06/10/2022
Ammonia as N	mg/L	0.0050	0.015	0.13	<0.0050	<0.0050
Nitrate as N	mg/L	0.0050	0.0095	<0.0050	<0.0050	5.8
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	0.056
Total Nitrogen	mg/L	0.10	1.0	0.44	<0.10	8.2
NOx as N	mg/L	0.0050	0.011	<0.0050	<0.0050	5.9
Phosphate as P	mg/L	0.0050	0.0057	<0.0050	<0.0050	0.15
Organic Nitrogen by calc.	mg/L	0.10	0.99	0.31	<0.10	2.3
TKN as N by calculation	mg/L	0.10	1.0	0.44	<0.10	2.3

Inorganics (Groundwater)

Envirolab ID	Units	PQL	PDJ0379-11	PDJ0379-12	PDJ0379-13	PDJ0379-14
Your Reference			GW5S	GW5D	GW8D	GW9S
Date Sampled			06/10/2022	06/10/2022	06/10/2022	06/10/2022
Nitrate as NO3 by calculation	mg/L	0.020	0.042	<0.020	<0.020	26
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	0.18

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Certificate of Analysis PDJ0584

Client Details

Client	Hyd2O
Contact	Sean O'Sullivan
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H21003 Wattle Grove Monitoring
Number of Samples	2 Groundwater
Date Samples Received	11/10/2022
Date Samples Registered	11/10/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	19/10/2022
Date of Issue	19/10/2022

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Authorisation Details

Results Approved By	Heram Halim, Operations Manager Todd Lee, Group Operations Manager
Laboratory Manager	Michael Kubiak

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PDJ0584-01	WG1	Groundwater	10/10/2022	11/10/2022
PDJ0584-02	GW9D	Groundwater	10/10/2022	11/10/2022

Acid Extractable Metals (Groundwater)

Envirolab ID	Units	PQL	PDJ0584-01	PDJ0584-02
Your Reference			WG1	GW9D
Date Sampled			10/10/2022	10/10/2022
Phosphorus	mg/L	0.050	0.16	0.23

Dissolved Metals (Groundwater)

Envirolab ID	Units	PQL	PDJ0584-01	PDJ0584-02
Your Reference			WG1	GW9D
Date Sampled			10/10/2022	10/10/2022
Calcium	mg/L	0.50	1.0	32
Magnesium	mg/L	0.50	3.7	40
Potassium	mg/L	0.50	1.6	16
Sodium	mg/L	0.50	43	130
Hardness as CaCO3	mg/L	3.0	18	240

Dissolved Low Level Metals (Groundwater)

Envirolab ID	Units	PQL	PDJ0584-01	PDJ0584-02
Your Reference			WG1	GW9D
Date Sampled			10/10/2022	10/10/2022
Arsenic	µg/L	1.0	<1.0	1.3
Cadmium	µg/L	0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0
Copper	µg/L	1.0	1.0	6.4
Mercury	µg/L	0.050	<0.050	<0.050
Nickel	µg/L	1.0	<1.0	26
Lead	µg/L	1.0	<1.0	<1.0
Zinc	µg/L	1.0	5.8	23

Inorganics (Groundwater)

Envirolab ID	Units	PQL	PDJ0584-01	PDJ0584-02
Your Reference			WG1	GW9D
Date Sampled			10/10/2022	10/10/2022
Ammonia as N	mg/L	0.0050	0.0098	0.089
Electrical Conductivity	µS/cm	2.0	300	1300
Nitrate as N	mg/L	0.0050	3.3	<0.0050
Nitrite as N	mg/L	0.0050	<0.0050	0.0063
Total Nitrogen	mg/L	0.10	4.4	3.7
NOx as N	mg/L	0.0050	3.3	<0.0050
pH	pH units		5.9	6.5
Phosphate as P	mg/L	0.0050	<0.0050	0.0067
Organic Nitrogen by calc.	mg/L	0.10	1.0	3.6
TKN as N by calculation	mg/L	0.10	1.0	3.7
Nitrate as NO3 by calculation	mg/L	0.020	15	<0.020
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	0.021

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Certificate of Analysis PDK1523

Client Details

Client	Hyd2O
Contact	Sean O'Sullivan
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H21003 - Wattle Grove Monitoring
Number of Samples	5 Groundwater
Date Samples Received	24/11/2022
Date Samples Registered	24/11/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	01/12/2022
Date of Issue	03/12/2022

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Authorisation Details

Results Approved By	Heram Halim, Operations Manager Michael Mowle, Inorganics Supervisor
Laboratory Manager	Michael Kubiak

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PDK1523-01	GW5S	Groundwater	23/11/2022	24/11/2022
PDK1523-02	GW5D	Groundwater	23/11/2022	24/11/2022
PDK1523-03	GW8D	Groundwater	23/11/2022	24/11/2022
PDK1523-04	GW9S	Groundwater	23/11/2022	24/11/2022
PDK1523-05	GW9D	Groundwater	23/11/2022	24/11/2022

Acid Extractable Metals (Groundwater)

Envirolab ID	Units	PQL	PDK1523-01	PDK1523-02	PDK1523-03	PDK1523-04	PDK1523-05
Your Reference			GW5S	GW5D	GW8D	GW9S	GW9D
Date Sampled			23/11/2022	23/11/2022	23/11/2022	23/11/2022	23/11/2022
Phosphorus	mg/L	0.050	<0.050	<0.050	<0.050	0.16	<0.050

Dissolved Metals (Groundwater)

Envirolab ID	Units	PQL	PDK1523-01	PDK1523-02	PDK1523-03	PDK1523-04	PDK1523-05
Your Reference			GW5S	GW5D	GW8D	GW9S	GW9D
Date Sampled			23/11/2022	23/11/2022	23/11/2022	23/11/2022	23/11/2022
Calcium	mg/L	0.50	27	13	4.0	51	41
Magnesium	mg/L	0.50	7.0	11	4.0	14	34
Potassium	mg/L	0.50	6.0	6.8	2.8	18	21
Sodium	mg/L	0.50	79	74	37	52	130
Hardness as CaCO3	mg/L	3.0	95	78	27	190	240

Dissolved Low Level Metals (Groundwater)

Envirolab ID	Units	PQL	PDK1523-01	PDK1523-02	PDK1523-03	PDK1523-04	PDK1523-05
Your Reference			GW5S	GW5D	GW8D	GW9S	GW9D
Date Sampled			23/11/2022	23/11/2022	23/11/2022	23/11/2022	23/11/2022
Arsenic	µg/L	1.0	<1.0	1.6	<1.0	3.3	1.5
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	1.8	1.1
Copper	µg/L	1.0	<1.0	<1.0	<1.0	4.1	3.7
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	4.1	6.6	2.0	9.6	28
Lead	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	2.9	2.5	1.8	11	4.0

Certificate of Analysis PDK1523

Inorganics (Groundwater)

Envirolab ID	Units	PQL	PDK1523-01	PDK1523-02	PDK1523-03	PDK1523-04	PDK1523-05
Your Reference			GW5S	GW5D	GW8D	GW9S	GW9D
Date Sampled			23/11/2022	23/11/2022	23/11/2022	23/11/2022	23/11/2022
Ammonia as N	mg/L	0.0050	0.039	0.16	<0.0050	0.016	0.12
Electrical Conductivity	µS/cm	2.0	530	530	210	570	1100
Nitrate as N	mg/L	0.0050	0.020	<0.0050	0.0084	2.3	<0.0050
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	0.023	<0.0050
Total Nitrogen	mg/L	0.10	1.0	0.58	<0.10	3.8	2.9
NOx as N	mg/L	0.0050	0.020	<0.0050	0.0086	2.3	<0.0050
pH	pH units		7.4	4.3	6.5	7.0	6.7
Phosphate as P	mg/L	0.0050	0.0091	<0.0050	<0.0050	0.078	0.020
Organic Nitrogen by calc.	mg/L	0.10	0.94	0.42	<0.10	1.4	2.8
TKN as N by calculation	mg/L	0.10	0.98	0.58	<0.10	1.5	2.9
Nitrate as NO3 by calculation	mg/L	0.020	0.088	<0.020	0.037	10	<0.020
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	0.075	<0.020

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Certificate of Analysis PDK1525

Client Details

Client	Hyd2O
Contact	Sean O'Sullivan
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H21003 - Wattle Grove Monitoring
Number of Samples	12 Groundwater
Date Samples Received	24/11/2022
Date Samples Registered	24/11/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	01/12/2022
Date of Issue	03/12/2022

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Authorisation Details

Results Approved By	Heram Halim, Operations Manager Michael Mowle, Inorganics Supervisor
Laboratory Manager	Michael Kubiak

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PDK1525-01	WG1	Groundwater	23/11/2022	24/11/2022
PDK1525-02	WG2D	Groundwater	23/11/2022	24/11/2022
PDK1525-03	WG3	Groundwater	23/11/2022	24/11/2022
PDK1525-04	WG4S	Groundwater	23/11/2022	24/11/2022
PDK1525-05	WG4D	Groundwater	23/11/2022	24/11/2022
PDK1525-06	WG5D	Groundwater	23/11/2022	24/11/2022
PDK1525-07	WG6	Groundwater	23/11/2022	24/11/2022
PDK1525-08	WG7D	Groundwater	23/11/2022	24/11/2022
PDK1525-09	WG8	Groundwater	23/11/2022	24/11/2022
PDK1525-10	WG9	Groundwater	23/11/2022	24/11/2022
PDK1525-11	WG10D	Groundwater	23/11/2022	24/11/2022
PDK1525-12	MBb	Groundwater	23/11/2022	24/11/2022

Acid Extractable Metals (Groundwater)

Envirolab ID	Units	PQL	PDK1525-01	PDK1525-02	PDK1525-03	PDK1525-04	PDK1525-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			23/11/2022	23/11/2022	23/11/2022	23/11/2022	23/11/2022
Phosphorus	mg/L	0.050	0.11	0.089	<0.050	<0.050	0.15

Envirolab ID	Units	PQL	PDK1525-06	PDK1525-07	PDK1525-08	PDK1525-09	PDK1525-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			23/11/2022	23/11/2022	23/11/2022	23/11/2022	23/11/2022
Phosphorus	mg/L	0.050	0.22	<0.050	<0.050	1.6	2.4

Envirolab ID	Units	PQL	PDK1525-11	PDK1525-12
Your Reference			WG10D	MBb
Date Sampled			23/11/2022	23/11/2022
Phosphorus	mg/L	0.050	<0.050	0.063

Dissolved Metals (Groundwater)

Envirolab ID	Units	PQL	PDK1525-01	PDK1525-02	PDK1525-03	PDK1525-04	PDK1525-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			23/11/2022	23/11/2022	23/11/2022	23/11/2022	23/11/2022
Calcium	mg/L	0.50	2.0	9.6	79	35	70
Magnesium	mg/L	0.50	6.4	120	92	53	31
Potassium	mg/L	0.50	3.7	8.9	26	9.7	9.4
Sodium	mg/L	0.50	71	420	820	270	120
Hardness as CaCO3	mg/L	3.0	32	500	580	300	300

Envirolab ID	Units	PQL	PDK1525-06	PDK1525-07	PDK1525-08	PDK1525-09	PDK1525-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			23/11/2022	23/11/2022	23/11/2022	23/11/2022	23/11/2022
Calcium	mg/L	0.50	4.1	12	12	12	45
Magnesium	mg/L	0.50	11	32	13	14	44
Potassium	mg/L	0.50	3.5	10	6.3	4.6	24
Sodium	mg/L	0.50	100	220	39	120	200
Hardness as CaCO3	mg/L	3.0	56	160	82	85	290

Envirolab ID	Units	PQL	PDK1525-11	PDK1525-12
Your Reference			WG10D	MBb
Date Sampled			23/11/2022	23/11/2022
Calcium	mg/L	0.50	1.5	3.0
Magnesium	mg/L	0.50	1.5	29
Potassium	mg/L	0.50	2.9	6.9
Sodium	mg/L	0.50	22	100
Hardness as CaCO3	mg/L	3.0	10	130

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Dissolved Low Level Metals (Groundwater)

Envirolab ID	Units	PQL	PDK1525-01	PDK1525-02	PDK1525-03	PDK1525-04	PDK1525-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			23/11/2022	23/11/2022	23/11/2022	23/11/2022	23/11/2022
Arsenic	µg/L	1.0	<1.0	<1.0	1.8	<1.0	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	8.8
Copper	µg/L	1.0	2.7	2.6	<1.0	<1.0	2.3
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	<1.0	6.3	4.1	2.7	3.2
Lead	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	1.1
Zinc	µg/L	1.0	7.9	33	6.7	16	6.0

Envirolab ID	Units	PQL	PDK1525-06	PDK1525-07	PDK1525-08	PDK1525-09	PDK1525-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			23/11/2022	23/11/2022	23/11/2022	23/11/2022	23/11/2022
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	1.0	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	2.5	<1.0	<1.0	5.8	2.0
Copper	µg/L	1.0	2.2	1.3	1.9	7.5	8.6
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	0.31
Nickel	µg/L	1.0	1.7	<1.0	1.8	4.4	4.5
Lead	µg/L	1.0	<1.0	30	<1.0	5.6	5.2
Zinc	µg/L	1.0	11	1.3	1.9	18	7.8

Envirolab ID	Units	PQL	PDK1525-11	PDK1525-12
Your Reference			WG10D	MBb
Date Sampled			23/11/2022	23/11/2022
Arsenic	µg/L	1.0	<1.0	1.4
Cadmium	µg/L	0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	2.7
Copper	µg/L	1.0	<1.0	4.7
Mercury	µg/L	0.050	<0.050	<0.050
Nickel	µg/L	1.0	<1.0	3.2
Lead	µg/L	1.0	<1.0	1.4
Zinc	µg/L	1.0	<1.0	14

Certificate of Analysis PDK1525

Inorganics (Groundwater)

Envirolab ID	Units	PQL	PDK1525-01	PDK1525-02	PDK1525-03	PDK1525-04	PDK1525-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			23/11/2022	23/11/2022	23/11/2022	23/11/2022	23/11/2022
Ammonia as N	mg/L	0.0050	0.030	0.0079	<0.0050	<0.0050	0.034
Electrical Conductivity	µS/cm	2.0	330	2900	4700	1800	1100
Nitrate as N	mg/L	0.0050	3.0	0.46	0.0095	1.3	0.45
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Total Nitrogen	mg/L	0.10	4.1	1.5	0.61	1.5	3.8
NOx as N	mg/L	0.0050	3.0	0.46	0.011	1.3	0.45
pH	pH units		6.0	5.7	6.0	6.3	6.8
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	0.015	<0.0050	<0.0050
Organic Nitrogen by calc.	mg/L	0.10	1.1	1.0	0.60	0.24	3.3
TKN as N by calculation	mg/L	0.10	1.1	1.0	0.60	0.24	3.4
Nitrate as NO3 by calculation	mg/L	0.020	13	2.0	0.042	5.8	2.0
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020

Envirolab ID	Units	PQL	PDK1525-06	PDK1525-07	PDK1525-08	PDK1525-09	PDK1525-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			23/11/2022	23/11/2022	23/11/2022	23/11/2022	23/11/2022
Ammonia as N	mg/L	0.0050	0.011	<0.0050	<0.0050	0.022	0.0055
Electrical Conductivity	µS/cm	2.0	690	1300	340	750	1400
Nitrate as N	mg/L	0.0050	12	3.2	3.4	1.0	44
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	0.0062	<0.0050
Total Nitrogen	mg/L	0.10	14	3.7	4.0	3.9	52
NOx as N	mg/L	0.0050	12	3.2	3.4	1.1	44
pH	pH units		6.2	5.7	6.5	6.0	6.3
Phosphate as P	mg/L	0.0050	<0.0050	0.0068	<0.0050	0.0071	2.1
Organic Nitrogen by calc.	mg/L	0.10	1.3	0.46	0.59	2.8	8.1
TKN as N by calculation	mg/L	0.10	1.3	0.47	0.59	2.8	8.1
Nitrate as NO3 by calculation	mg/L	0.020	55	14	15	4.6	200
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	0.020	<0.020

Envirolab ID	Units	PQL	PDK1525-11	PDK1525-12
Your Reference			WG10D	MBb
Date Sampled			23/11/2022	23/11/2022
Ammonia as N	mg/L	0.0050	<0.0050	0.16
Electrical Conductivity	µS/cm	2.0	110	560
Nitrate as N	mg/L	0.0050	1.1	0.016
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050
Total Nitrogen	mg/L	0.10	1.4	1.2
NOx as N	mg/L	0.0050	1.1	0.018
pH	pH units		6.5	6.3
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050
Organic Nitrogen by calc.	mg/L	0.10	0.32	1.0
TKN as N by calculation	mg/L	0.10	0.32	1.2
Nitrate as NO3 by calculation	mg/L	0.020	4.9	0.072
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020

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Certificate of Analysis PEA1020

Client Details

Client	Hyd2O
Contact	Andre Righetti
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H21003 Wattle Grove Monitoring
Number of Samples	16 Groundwater
Date Samples Received	24/01/2023
Date Samples Registered	24/01/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	02/02/2023
Date of Issue	14/02/2023

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Authorisation Details

Results Approved By	Heram Halim, Operations Manager Todd Lee, Group Operations Manager
Laboratory Manager	Michael Kubiak

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PEA1020-01	WG1	Groundwater	23/01/2023	24/01/2023
PEA1020-02	WG2D	Groundwater	23/01/2023	24/01/2023
PEA1020-03	WG3	Groundwater	23/01/2023	24/01/2023
PEA1020-04	WG4S	Groundwater	23/01/2023	24/01/2023
PEA1020-05	WG4D	Groundwater	23/01/2023	24/01/2023
PEA1020-06	WG5D	Groundwater	23/01/2023	24/01/2023
PEA1020-07	WG6	Groundwater	23/01/2023	24/01/2023
PEA1020-08	WG7D	Groundwater	23/01/2023	24/01/2023
PEA1020-09	WG8	Groundwater	23/01/2023	24/01/2023
PEA1020-10	WG9	Groundwater	23/01/2023	24/01/2023
PEA1020-11	WG10D	Groundwater	23/01/2023	24/01/2023
PEA1020-12	MBb	Groundwater	23/01/2023	24/01/2023
PEA1020-13	GW5D	Groundwater	23/01/2023	24/01/2023
PEA1020-14	GW8D	Groundwater	23/01/2023	24/01/2023
PEA1020-15	GW9S	Groundwater	23/01/2023	24/01/2023
PEA1020-16	GW9D	Groundwater	23/01/2023	24/01/2023

Acid Extractable Metals (Groundwater)

Envirolab ID	Units	PQL	PEA1020-01	PEA1020-02	PEA1020-03	PEA1020-04	PEA1020-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			23/01/2023	23/01/2023	23/01/2023	23/01/2023	23/01/2023
Phosphorus	mg/L	0.050	<0.050	<0.050	<0.050	0.25	<0.050

Envirolab ID	Units	PQL	PEA1020-06	PEA1020-07	PEA1020-08	PEA1020-09	PEA1020-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			23/01/2023	23/01/2023	23/01/2023	23/01/2023	23/01/2023
Phosphorus	mg/L	0.050	<0.050	<0.050	<0.050	0.28	3.7

Envirolab ID	Units	PQL	PEA1020-11	PEA1020-12	PEA1020-13	PEA1020-14	PEA1020-15
Your Reference			WG10D	MBb	GW5D	GW8D	GW9S
Date Sampled			23/01/2023	23/01/2023	23/01/2023	23/01/2023	23/01/2023
Phosphorus	mg/L	0.050	<0.050	0.085	0.42	<0.050	0.46

Envirolab ID	Units	PQL	PEA1020-16
Your Reference			GW9D
Date Sampled			23/01/2023
Phosphorus	mg/L	0.050	<0.050

Dissolved Metals (Groundwater)

Envirolab ID	Units	PQL	PEA1020-01	PEA1020-02	PEA1020-03	PEA1020-04	PEA1020-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			23/01/2023	23/01/2023	23/01/2023	23/01/2023	23/01/2023
Calcium	mg/L	0.50	0.95	6.2	55	27	65
Magnesium	mg/L	0.50	4.1	140	88	53	39
Potassium	mg/L	0.50	1.6	11	25	7.5	12
Sodium	mg/L	0.50	39	500	770	300	250
Hardness as CaCO3	mg/L	3.0	19	580	500	280	320

Envirolab ID	Units	PQL	PEA1020-06	PEA1020-07	PEA1020-08	PEA1020-09	PEA1020-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			23/01/2023	23/01/2023	23/01/2023	23/01/2023	23/01/2023
Calcium	mg/L	0.50	4.5	14	6.6	4.9	26
Magnesium	mg/L	0.50	14	32	8.9	14	33
Potassium	mg/L	0.50	4.2	11	4.4	3.7	16
Sodium	mg/L	0.50	120	210	51	120	110
Hardness as CaCO3	mg/L	3.0	68	170	53	71	200

Envirolab ID	Units	PQL	PEA1020-11	PEA1020-12	PEA1020-13	PEA1020-14	PEA1020-15
Your Reference			WG10D	MBb	GW5D	GW8D	GW9S
Date Sampled			23/01/2023	23/01/2023	23/01/2023	23/01/2023	23/01/2023
Calcium	mg/L	0.50	3.2	9.1	11	1.7	35
Magnesium	mg/L	0.50	4.7	31	13	3.5	14
Potassium	mg/L	0.50	3.6	7.5	6.4	2.9	18
Sodium	mg/L	0.50	22	110	73	38	61
Hardness as CaCO3	mg/L	3.0	27	150	79	18	140

Envirolab ID	Units	PQL	PEA1020-16
Your Reference			GW9D
Date Sampled			23/01/2023
Calcium	mg/L	0.50	26
Magnesium	mg/L	0.50	21
Potassium	mg/L	0.50	23
Sodium	mg/L	0.50	79
Hardness as CaCO3	mg/L	3.0	150

Dissolved Low Level Metals (Groundwater)

Envirolab ID	Units	PQL	PEA1020-01	PEA1020-02	PEA1020-03	PEA1020-04	PEA1020-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			23/01/2023	23/01/2023	23/01/2023	23/01/2023	23/01/2023
Arsenic	µg/L	1.0	<1.0	<1.0	1.1	<1.0	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	0.11	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	1.1	<1.0	<1.0
Copper	µg/L	1.0	<1.0	<1.0	2.3	<1.0	1.4
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	1.2	5.3	5.3	2.1	2.6
Lead	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	3.6	14	13	3.8	8.7

Envirolab ID	Units	PQL	PEA1020-06	PEA1020-07	PEA1020-08	PEA1020-09	PEA1020-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			23/01/2023	23/01/2023	23/01/2023	23/01/2023	23/01/2023
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	2.1
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	µg/L	1.0	1.0	2.1	1.4	4.2	12
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	6.3	1.4	2.7	7.5	4.2
Lead	µg/L	1.0	<1.0	20	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	7.4	2.4	1.2	21	4.4

Envirolab ID	Units	PQL	PEA1020-11	PEA1020-12	PEA1020-13	PEA1020-14	PEA1020-15
Your Reference			WG10D	MBb	GW5D	GW8D	GW9S
Date Sampled			23/01/2023	23/01/2023	23/01/2023	23/01/2023	23/01/2023
Arsenic	µg/L	1.0	<1.0	<1.0	1.3	<1.0	5.7
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	3.8
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	1.3	7.7	5.4	3.3	23
Lead	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	1.3	10	3.6	3.1	12

Envirolab ID	Units	PQL	PEA1020-16
Your Reference			GW9D
Date Sampled			23/01/2023
Arsenic	µg/L	1.0	1.0
Cadmium	µg/L	0.10	<0.10
Chromium	µg/L	1.0	<1.0
Copper	µg/L	1.0	5.4
Mercury	µg/L	0.050	<0.050
Nickel	µg/L	1.0	27
Lead	µg/L	1.0	<1.0
Zinc	µg/L	1.0	3.9

Certificate of Analysis PEA1020

Inorganics (Groundwater)

Envirolab ID	Units	PQL	PEA1020-01	PEA1020-02	PEA1020-03	PEA1020-04	PEA1020-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			23/01/2023	23/01/2023	23/01/2023	23/01/2023	23/01/2023
Ammonia as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	0.32	0.021
Electrical Conductivity	µS/cm	2.0	190	3400	4700	2200	1700
Nitrate as N	mg/L	0.0050	3.5	0.73	<0.0050	<0.0050	<0.0050
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Total Nitrogen	mg/L	0.10	3.8	1.1	0.43	14	0.34
NOx as N	mg/L	0.0050	3.5	0.73	<0.0050	<0.0050	<0.0050
pH	pH units		5.7	5.4	5.3	6.9	6.3
Phosphate as P	mg/L	0.0050	0.0055	0.0054	0.0076	<0.0050	<0.0050
Organic Nitrogen by calc.	mg/L	0.10	0.32	0.41	0.42	13	0.31
TKN as N by calculation	mg/L	0.10	0.32	0.41	0.42	14	0.33
Nitrate as NO3 by calculation	mg/L	0.020	15	3.2	<0.020	<0.020	<0.020
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020

Envirolab ID	Units	PQL	PEA1020-06	PEA1020-07	PEA1020-08	PEA1020-09	PEA1020-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			23/01/2023	23/01/2023	23/01/2023	23/01/2023	23/01/2023
Ammonia as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	0.041	<0.0050
Electrical Conductivity	µS/cm	2.0	770	1400	390	800	930
Nitrate as N	mg/L	0.0050	13	3.4	1.1	0.84	38
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	0.0055	0.011
Total Nitrogen	mg/L	0.10	15	3.7	1.1	2.3	42
NOx as N	mg/L	0.0050	13	3.4	1.1	0.84	38
pH	pH units		5.8	5.5	6.2	5.9	6.3
Phosphate as P	mg/L	0.0050	<0.0050	0.014	<0.0050	0.0075	2.9
Organic Nitrogen by calc.	mg/L	0.10	1.7	0.28	<0.10	1.4	4.7
TKN as N by calculation	mg/L	0.10	1.7	0.28	<0.10	1.4	4.7
Nitrate as NO3 by calculation	mg/L	0.020	57	15	4.9	3.7	170
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	0.038

Envirolab ID	Units	PQL	PEA1020-11	PEA1020-12	PEA1020-13	PEA1020-14	PEA1020-15
Your Reference			WG10D	MBb	GW5D	GW8D	GW9S
Date Sampled			23/01/2023	23/01/2023	23/01/2023	23/01/2023	23/01/2023
Ammonia as N	mg/L	0.0050	<0.0050	0.48	0.18	0.0099	0.11
Electrical Conductivity	µS/cm	2.0	150	800	560	210	610
Nitrate as N	mg/L	0.0050	2.2	0.0098	<0.0050	<0.0050	2.3
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.014
Total Nitrogen	mg/L	0.10	2.5	0.45	5.5	0.12	3.9
NOx as N	mg/L	0.0050	2.2	0.010	<0.0050	<0.0050	2.3
pH	pH units		6.3	6.3	4.5	6.4	6.9
Phosphate as P	mg/L	0.0050	0.0064	<0.0050	0.0081	<0.0050	0.055
Organic Nitrogen by calc.	mg/L	0.10	0.33	<0.10	5.3	0.10	1.5
TKN as N by calculation	mg/L	0.10	0.34	0.44	5.5	0.11	1.6
Nitrate as NO3 by calculation	mg/L	0.020	9.6	0.043	<0.020	<0.020	10
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	0.047

Inorganics (Groundwater)

Envirolab ID	Units	PQL	PEA1020-16
Your Reference			GW9D
Date Sampled			23/01/2023
Ammonia as N	mg/L	0.0050	0.056
Electrical Conductivity	µS/cm	2.0	730
Nitrate as N	mg/L	0.0050	<0.0050
Nitrite as N	mg/L	0.0050	<0.0050
Total Nitrogen	mg/L	0.10	1.5
NOx as N	mg/L	0.0050	<0.0050
pH	pH units		6.7
Phosphate as P	mg/L	0.0050	0.014
Organic Nitrogen by calc.	mg/L	0.10	1.4
TKN as N by calculation	mg/L	0.10	1.5
Nitrate as NO3 by calculation	mg/L	0.020	<0.020
Nitrite as NO2 by calculation	mg/L	0.020	<0.020

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Certificate of Analysis PEB1634

Client Details

Client	Hyd2O
Contact	Sean O'Sullivan
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H21003 - Wattle Grove Monitoring
Number of Samples	15 Groundwater
Date Samples Received	24/02/2023
Date Samples Registered	24/02/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	27/02/2023
Date of Issue	01/03/2023

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Authorisation Details

Results Approved By	Heram Halim, Operations Manager Lien Tang, Assistant Operations Manager Michael Hall, Inorganics & Metals Supervisor Michael Mowle, Inorganics Supervisor
Laboratory Manager	Michael Kubiak

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PEB1634-01	WG1	Groundwater	23/02/2023	24/02/2023
PEB1634-02	WG2D	Groundwater	23/02/2023	24/02/2023
PEB1634-03	WG3	Groundwater	23/02/2023	24/02/2023
PEB1634-04	WG4S	Groundwater	23/02/2023	24/02/2023
PEB1634-05	WG4D	Groundwater	23/02/2023	24/02/2023
PEB1634-06	GW5D	Groundwater	23/02/2023	24/02/2023
PEB1634-07	WG6	Groundwater	23/02/2023	24/02/2023
PEB1634-08	WG7D	Groundwater	23/02/2023	24/02/2023
PEB1634-09	WG8	Groundwater	23/02/2023	24/02/2023
PEB1634-10	WG9	Groundwater	23/02/2023	24/02/2023
PEB1634-11	MBb	Groundwater	23/02/2023	24/02/2023
PEB1634-12	WG5D	Groundwater	23/02/2023	24/02/2023
PEB1634-13	GW8D	Groundwater	23/02/2023	24/02/2023
PEB1634-14	GW9S	Groundwater	23/02/2023	24/02/2023
PEB1634-15	GW9D	Groundwater	23/02/2023	24/02/2023

Dissolved Metals (Groundwater)

Envirolab ID	Units	PQL	PEB1634-01	PEB1634-02	PEB1634-03	PEB1634-04	PEB1634-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			23/02/2023	23/02/2023	23/02/2023	23/02/2023	23/02/2023
Calcium	mg/L	0.50	<0.50	4.2	110	39	43
Magnesium	mg/L	0.50	4.1	140	200	59	37
Potassium	mg/L	0.50	1.3	11	40	13	11
Sodium	mg/L	0.50	34	490	1500	310	220
Silica*	mg/L	0.20	15	28	60	9.9	5.2
Hardness as CaCO3	mg/L	3.0	18	570	1100	340	260

Envirolab ID	Units	PQL	PEB1634-06	PEB1634-07	PEB1634-08	PEB1634-09	PEB1634-10
Your Reference			GW5D	WG6	WG7D	WG8	WG9
Date Sampled			23/02/2023	23/02/2023	23/02/2023	23/02/2023	23/02/2023
Calcium	mg/L	0.50	11	8.5	17	4.2	31
Magnesium	mg/L	0.50	10	31	18	14	32
Potassium	mg/L	0.50	6.6	9.7	5.1	3.6	34
Sodium	mg/L	0.50	73	200	130	120	97
Silica*	mg/L	0.20	33	25	19	33	21
Hardness as CaCO3	mg/L	3.0	68	150	120	69	210

Envirolab ID	Units	PQL	PEB1634-11	PEB1634-12	PEB1634-13	PEB1634-14	PEB1634-15
Your Reference			MBb	WG5D	GW8D	GW9S	GW9D
Date Sampled			23/02/2023	23/02/2023	23/02/2023	23/02/2023	23/02/2023
Calcium	mg/L	0.50	8.9	3.7	3.2	31	20
Magnesium	mg/L	0.50	33	14	4.5	9.5	14
Potassium	mg/L	0.50	8.2	3.6	3.0	18	19
Sodium	mg/L	0.50	100	120	36	53	62
Silica*	mg/L	0.20	13	17	19	15	19
Hardness as CaCO3	mg/L	3.0	160	67	26	120	110

Dissolved Low Level Metals (Groundwater)

Envirolab ID	Units	PQL	PEB1634-01	PEB1634-02	PEB1634-03	PEB1634-04	PEB1634-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			23/02/2023	23/02/2023	23/02/2023	23/02/2023	23/02/2023
Aluminium	µg/L	10	<10	14	<10	<10	<10
Arsenic	µg/L	1.0	<1.0	<1.0	1.9	<1.0	<1.0
Iron	µg/L	10	13	250	9300	1100	39
Manganese	µg/L	1.0	5.9	100	220	34	19

Envirolab ID	Units	PQL	PEB1634-06	PEB1634-07	PEB1634-08	PEB1634-09	PEB1634-10
Your Reference			GW5D	WG6	WG7D	WG8	WG9
Date Sampled			23/02/2023	23/02/2023	23/02/2023	23/02/2023	23/02/2023
Aluminium	µg/L	10	870	10	15	<10	100
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	1.1
Iron	µg/L	10	6800	<10	47	<10	19
Manganese	µg/L	1.0	120	59	5.2	510	13

Envirolab ID	Units	PQL	PEB1634-11	PEB1634-12	PEB1634-13	PEB1634-14	PEB1634-15
Your Reference			MBb	WG5D	GW8D	GW9S	GW9D
Date Sampled			23/02/2023	23/02/2023	23/02/2023	23/02/2023	23/02/2023
Aluminium	µg/L	10	<10	<10	10	110	32
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	5.4	1.2
Iron	µg/L	10	6700	370	3400	1600	380
Manganese	µg/L	1.0	280	86	350	26	14

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Inorganics (Groundwater)

Envirolab ID	Units	PQL	PEB1634-01	PEB1634-02	PEB1634-03	PEB1634-04	PEB1634-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			23/02/2023	23/02/2023	23/02/2023	23/02/2023	23/02/2023
Anions as meq	meq/L	0.59	1.6	37	95	20	15
Cations as meq	meq/L	0.10	1.8	33	87	20	15
Total Anions	mg/L	7.0	66	1400	3500	780	630
Total Cations	mg/L	2.0	39	640	1800	420	310
Ammonia as N	mg/L	0.0050	<0.0050	<0.0050	0.0071	0.055	<0.0050
Bromide	mg/L	0.50	<0.50	2.0	6.7	1.6	1.2
Chloride	mg/L	1.0	40	1200	3100	480	320
Electrical Conductivity	µS/cm	2.0	230	3900	9700	2100	1600
Nitrate as N	mg/L	0.0050	3.5	0.81	<0.0050	<0.0050	0.40
pH	pH units		5.5	5.4	6.1	6.0	5.9
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	0.025	<0.0050	<0.0050
Sulfate	mg/L	1.0	15	120	310	270	280
Total Dissolved Solids	mg/L	5.0	160	2400	6100	1300	980
Nitrate as NO3 by calculation	mg/L	0.020	15	3.6	0.020	<0.020	1.8
Ionic Balance	%		-13 [1]	-6.3	-4.6	1.6	-2.2
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	11	11	43	30	24
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	11	11	43	30	24

Envirolab ID	Units	PQL	PEB1634-06	PEB1634-07	PEB1634-08	PEB1634-09	PEB1634-10
Your Reference			GW5D	WG6	WG7D	WG8	WG9
Date Sampled			23/02/2023	23/02/2023	23/02/2023	23/02/2023	23/02/2023
Anions as meq	meq/L	0.59	5.8	12	8.3	7.3	6.6
Cations as meq	meq/L	0.10	4.7	12	8.0	6.6	9.3
Total Anions	mg/L	7.0	250	460	330	270	260
Total Cations	mg/L	2.0	100	240	170	140	190
Ammonia as N	mg/L	0.0050	0.16	<0.0050	<0.0050	<0.0050	<0.0050
Bromide	mg/L	0.50	<0.50	1.0	<0.50	0.76	<0.50
Chloride	mg/L	1.0	66	390	190	230	180
Electrical Conductivity	µS/cm	2.0	650	1400	920	830	950
Nitrate as N	mg/L	0.0050	<0.0050	3.3	4.4	0.91	26
pH	pH units		3.7	5.4	6.3	5.6	6.1
Phosphate as P	mg/L	0.0050	<0.0050	0.034	<0.0050	0.0066	2.2
Sulfate	mg/L	1.0	190	63	110	29	60
Total Dissolved Solids	mg/L	5.0	390	860	550	470	680
Nitrate as NO3 by calculation	mg/L	0.020	<0.020	14	20	4.0	110
Ionic Balance	%		-10	-4.5	-5.9	-6.6	-5.7
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	5.2	28	18	26
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	5.2	28	18	26

Envirolab ID	Units	PQL	PEB1634-11	PEB1634-12	PEB1634-13	PEB1634-14	PEB1634-15
Your Reference			MBb	WG5D	GW8D	GW9S	GW9D
Date Sampled			23/02/2023	23/02/2023	23/02/2023	23/02/2023	23/02/2023
Anions as meq	meq/L	0.59	8.7	6.4	3.4	6.1	5.4

Inorganics (Groundwater)

Envirolab ID	Units	PQL	PEB1634-11	PEB1634-12	PEB1634-13	PEB1634-14	PEB1634-15
Your Reference			MBb	WG5D	GW8D	GW9S	GW9D
Date Sampled			23/02/2023	23/02/2023	23/02/2023	23/02/2023	23/02/2023
Cations as meq	meq/L	0.10	7.9	6.5	2.2	5.1	5.3
Total Anions	mg/L	7.0	400	240	150	280	240
Total Cations	mg/L	2.0	150	140	47	110	110
Ammonia as N	mg/L	0.0050	0.30	0.019	0.0095	0.11	0.046
Bromide	mg/L	0.50	<0.50	<0.50	0.90	<0.50	<0.50
Chloride	mg/L	1.0	130	200	59	110	100
Electrical Conductivity	µS/cm	2.0	890	820	240	660	560
Nitrate as N	mg/L	0.0050	<0.050 [3]	12	<0.0050	2.1	<0.050 [3]
pH	pH units		6.3	6.0	6.6	6.7	6.6
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	<0.0050	0.18	0.0085
Sulfate	mg/L	1.0	120	23	49	56	52
Total Dissolved Solids	mg/L	5.0	480	460	140	410	370
Nitrate as NO3 by calculation	mg/L	0.020	<0.20 [3]	53	<0.020	9.4	<0.20 [3]
Ionic Balance	%		-7.9	-12 [1]	-25 [1]	-14 [1]	-3.7
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	150	25	47	110	89
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	150	25	47	110	89

Result Comments

Identifier	Description
[1]	The mass inbalance may be caused by other ions that have not been measured.
[3]	PQL(s) has/have been raised due to matrix interference.

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Certificate of Analysis PEC1714

Client Details

Client	Hyd2O
Contact	Andre Righetti
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H21003 - Wattle Grove Monitoring
Number of Samples	4 Groundwater
Date Samples Received	23/03/2023
Date Samples Registered	23/03/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	03/04/2023
Date of Issue	11/04/2023

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Authorisation Details

Results Approved By	Heram Halim, Operations Manager Todd Lee, Group Operations Manager
Laboratory Manager	Michael Kubiak

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PEC1714-01	GW5D	Groundwater	22/03/2023	23/03/2023
PEC1714-02	GW8D	Groundwater	22/03/2023	23/03/2023
PEC1714-03	GW9S	Groundwater	22/03/2023	23/03/2023
PEC1714-04	GW9D	Groundwater	22/03/2023	23/03/2023

Acid Extractable Metals (Groundwater)

Envirolab ID	Units	PQL	PEC1714-01	PEC1714-02	PEC1714-03	PEC1714-04
Your Reference			GW5D	GW8D	GW9S	GW9D
Date Sampled			22/03/2023	22/03/2023	22/03/2023	22/03/2023
Phosphorus	mg/L	0.050	0.064	<0.050	0.27	0.067

Dissolved Low Level Metals (Groundwater)

Envirolab ID	Units	PQL	PEC1714-01	PEC1714-02	PEC1714-03	PEC1714-04
Your Reference			GW5D	GW8D	GW9S	GW9D
Date Sampled			22/03/2023	22/03/2023	22/03/2023	22/03/2023
Arsenic	µg/L	1.0	<1.0	<1.0	5.9	6.2
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	2.3
Copper	µg/L	1.0	<1.0	<1.0	3.0	1.7
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	10	4.2	14	35
Lead	µg/L	1.0	2.1	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	6.2	4.8	7.5	14

Inorganics - Physical Parameters (Groundwater)

Envirolab ID	Units	PQL	PEC1714-01	PEC1714-02	PEC1714-03	PEC1714-04
Your Reference			GW5D	GW8D	GW9S	GW9D
Date Sampled			22/03/2023	22/03/2023	22/03/2023	22/03/2023
pH	pH units		3.9	6.3	6.9	6.9
Electrical Conductivity	µS/cm	2.0	610	210	720	570

Inorganics - Ionic Balance and Indexes (Groundwater)

Envirolab ID	Units	PQL	PEC1714-01	PEC1714-02	PEC1714-03	PEC1714-04
Your Reference			GW5D	GW8D	GW9S	GW9D
Date Sampled			22/03/2023	22/03/2023	22/03/2023	22/03/2023
Calcium	mg/L	0.50	13	2.9	38	21
Magnesium	mg/L	0.50	12	3.9	12	15
Potassium	mg/L	0.50	7.0	2.8	19	19
Sodium	mg/L	0.50	82	37	71	64
Hardness as CaCO3	mg/L	3.0	83	23	140	120

Inorganics - Nutrients (Groundwater)

Envirolab ID	Units	PQL	PEC1714-01	PEC1714-02	PEC1714-03	PEC1714-04
Your Reference			GW5D	GW8D	GW9S	GW9D
Date Sampled			22/03/2023	22/03/2023	22/03/2023	22/03/2023
Ammonia as N	mg/L	0.0050	0.15	0.0075	0.084	0.082 [1]
Nitrate as N	mg/L	0.0050	<0.0050	0.0055	1.1	<0.050 [1]
Nitrate as NO3 by calculation	mg/L	0.020	<0.020	0.024	5.0	<0.20 [1]
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	0.080	<0.050 [1]
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	0.26	<0.20 [1]
NOx as N	mg/L	0.0050	<0.0050	0.0056	1.2	<0.050 [1]
TKN as N by calculation	mg/L	0.10	1.1	0.38	2.2	2.0
Organic Nitrogen by calc.	mg/L	0.10	0.93	0.37	2.2	1.9
Total Nitrogen	mg/L	0.10	1.1	0.38	3.4	2.0
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	0.20	0.056 [1]

Result Comments

Identifier	Description
[1]	Matrix interference - sample was highly coloured.

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Certificate of Analysis PEC1715

Client Details

Client	Hyd2O
Contact	Andre Righetti
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H21003 - Wattle Grove Monitoring
Number of Samples	10 Groundwater
Date Samples Received	23/03/2023
Date Samples Registered	23/03/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	03/04/2023
Date of Issue	11/04/2023

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Authorisation Details

Results Approved By	Heram Halim, Operations Manager Michael Hall, Inorganics & Metals Supervisor Todd Lee, Group Operations Manager
Laboratory Manager	Michael Kubiak

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PEC1715-01	WG1	Groundwater	22/03/2023	23/03/2023
PEC1715-02	WG2D	Groundwater	22/03/2023	23/03/2023
PEC1715-03	WG3	Groundwater	22/03/2023	23/03/2023
PEC1715-04	WG4D	Groundwater	22/03/2023	23/03/2023
PEC1715-05	WG5D	Groundwater	22/03/2023	23/03/2023
PEC1715-06	WG6	Groundwater	22/03/2023	23/03/2023
PEC1715-07	WG7D	Groundwater	22/03/2023	23/03/2023
PEC1715-08	WG8	Groundwater	22/03/2023	23/03/2023
PEC1715-09	WG9	Groundwater	22/03/2023	23/03/2023
PEC1715-10	MBb	Groundwater	22/03/2023	23/03/2023

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Acid Extractable Metals (Groundwater)

Envirolab ID	Units	PQL	PEC1715-01	PEC1715-02	PEC1715-03	PEC1715-04	PEC1715-05
Your Reference			WG1	WG2D	WG3	WG4D	WG5D
Date Sampled			22/03/2023	22/03/2023	22/03/2023	22/03/2023	22/03/2023
Phosphorus	mg/L	0.050	<0.050	<0.050	<0.050	0.057	<0.050

Envirolab ID	Units	PQL	PEC1715-06	PEC1715-07	PEC1715-08	PEC1715-09	PEC1715-10
Your Reference			WG6	WG7D	WG8	WG9	MBb
Date Sampled			22/03/2023	22/03/2023	22/03/2023	22/03/2023	22/03/2023
Phosphorus	mg/L	0.050	<0.050	<0.050	0.79	2.4	<0.050

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Dissolved Low Level Metals (Groundwater)

Envirolab ID	Units	PQL	PEC1715-01	PEC1715-02	PEC1715-03	PEC1715-04	PEC1715-05
Your Reference			WG1	WG2D	WG3	WG4D	WG5D
Date Sampled			22/03/2023	22/03/2023	22/03/2023	22/03/2023	22/03/2023
Arsenic	µg/L	1.0	<1.0	<1.0	1.2	<1.0	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	<1.0	3.7	8.2	1.5	2.4
Lead	µg/L	1.0	2.5	<1.0	1.3	<1.0	3.6
Zinc	µg/L	1.0	2.9	15	1.4	8.0	5.6

Envirolab ID	Units	PQL	PEC1715-06	PEC1715-07	PEC1715-08	PEC1715-09	PEC1715-10
Your Reference			WG6	WG7D	WG8	WG9	MBb
Date Sampled			22/03/2023	22/03/2023	22/03/2023	22/03/2023	22/03/2023
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	1.4	1.1
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	3.2	<1.0
Copper	µg/L	1.0	1.4	1.4	3.3	19	<1.0
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	0.075	<0.050
Nickel	µg/L	1.0	1.7	1.8	12	8.0	4.8
Lead	µg/L	1.0	20	<1.0	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	1.5	1.6	23	3.6	11

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Inorganics - Physical Parameters (Groundwater)

Envirolab ID	Units	PQL	PEC1715-01	PEC1715-02	PEC1715-03	PEC1715-04	PEC1715-05
Your Reference			WG1	WG2D	WG3	WG4D	WG5D
Date Sampled			22/03/2023	22/03/2023	22/03/2023	22/03/2023	22/03/2023
pH	pH units		5.8	5.4	6.2	6.1	5.9
Electrical Conductivity	µS/cm	2.0	200	4300	10000	1600	770

Envirolab ID	Units	PQL	PEC1715-06	PEC1715-07	PEC1715-08	PEC1715-09	PEC1715-10
Your Reference			WG6	WG7D	WG8	WG9	MBb
Date Sampled			22/03/2023	22/03/2023	22/03/2023	22/03/2023	22/03/2023
pH	pH units		5.6	8.4	8.4	7.5	7.2
Electrical Conductivity	µS/cm	2.0	1400	900	820	810	940

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Inorganics - Ionic Balance and Indexes (Groundwater)

Envirolab ID	Units	PQL	PEC1715-01	PEC1715-02	PEC1715-03	PEC1715-04	PEC1715-05
Your Reference			WG1	WG2D	WG3	WG4D	WG5D
Date Sampled			22/03/2023	22/03/2023	22/03/2023	22/03/2023	22/03/2023
Calcium	mg/L	0.50	0.90	6.2	130	46	2.5
Magnesium	mg/L	0.50	5.4	160	210	49	13
Potassium	mg/L	0.50	1.7	12	43	13	3.2
Sodium	mg/L	0.50	40	590	1600	280	110
Hardness as CaCO3	mg/L	3.0	24	680	1200	320	59

Envirolab ID	Units	PQL	PEC1715-06	PEC1715-07	PEC1715-08	PEC1715-09	PEC1715-10
Your Reference			WG6	WG7D	WG8	WG9	MBb
Date Sampled			22/03/2023	22/03/2023	22/03/2023	22/03/2023	22/03/2023
Calcium	mg/L	0.50	7.2	16	2.7	30	22
Magnesium	mg/L	0.50	31	21	16	26	42
Potassium	mg/L	0.50	9.3	4.8	3.6	35	9.2
Sodium	mg/L	0.50	190	130	120	81	85
Hardness as CaCO3	mg/L	3.0	150	130	74	180	230

Inorganics - Nutrients (Groundwater)

Envirolab ID	Units	PQL	PEC1715-01	PEC1715-02	PEC1715-03	PEC1715-04	PEC1715-05
Your Reference			WG1	WG2D	WG3	WG4D	WG5D
Date Sampled			22/03/2023	22/03/2023	22/03/2023	22/03/2023	22/03/2023
Ammonia as N	mg/L	0.0050	0.010	<0.0050	0.011	0.0076	<0.0050
Nitrate as N	mg/L	0.0050	3.1	0.40	0.015	0.30	14
Nitrate as NO3 by calculation	mg/L	0.020	14	1.8	0.068	1.3	61
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	3.1	0.40	0.012	0.30	14
TKN as N by calculation	mg/L	0.10	1.7	1.2	1.3	0.78	1.8
Organic Nitrogen by calc.	mg/L	0.10	1.7	1.2	1.3	0.77	1.8
Total Nitrogen	mg/L	0.10	4.9	1.6	1.3	1.1	16
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Envirolab ID	Units	PQL	PEC1715-06	PEC1715-07	PEC1715-08	PEC1715-09	PEC1715-10
Your Reference			WG6	WG7D	WG8	WG9	MBb
Date Sampled			22/03/2023	22/03/2023	22/03/2023	22/03/2023	22/03/2023
Ammonia as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.050 [1]	1.9
Nitrate as N	mg/L	0.0050	3.3	4.3	0.99	32 [1]	0.0076
Nitrate as NO3 by calculation	mg/L	0.020	15	19	4.4	140 [1]	0.034
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.050 [1]	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.20 [1]	<0.020
NOx as N	mg/L	0.0050	3.3	4.3	0.99	32 [1]	0.0091
TKN as N by calculation	mg/L	0.10	1.1	1.2	0.51	11	3.1
Organic Nitrogen by calc.	mg/L	0.10	1.1	1.2	0.51	11	1.2
Total Nitrogen	mg/L	0.10	4.4	5.5	1.5	43	3.1
Phosphate as P	mg/L	0.0050	0.028	<0.0050	0.0073	2.3 [1]	<0.0050

Result Comments

Identifier	Description
[1]	Matrix interference - sample was highly coloured.

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Certificate of Analysis PEF1145

Client Details

Client	Hyd2O
Contact	Andre Righetti
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H21003 - Wattle Grove Monitoring
Number of Samples	18 Groundwater
Date Samples Received	16/06/2023
Date Samples Registered	16/06/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	23/06/2023
Date of Issue	23/06/2023

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Authorisation Details

Results Approved By	Heram Halim, Operations Manager Michael Hall, Inorganics & Metals Supervisor Michael Mowle, Inorganics Supervisor
Laboratory Manager	Michael Kubiak

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Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PEF1145-01	WG1	Groundwater	15/06/2023	16/06/2023
PEF1145-02	WG2D	Groundwater	15/06/2023	16/06/2023
PEF1145-03	WG3	Groundwater	15/06/2023	16/06/2023
PEF1145-04	WG4S	Groundwater	15/06/2023	16/06/2023
PEF1145-05	WG4D	Groundwater	15/06/2023	16/06/2023
PEF1145-06	WG5D	Groundwater	15/06/2023	16/06/2023
PEF1145-07	WG6	Groundwater	15/06/2023	16/06/2023
PEF1145-08	WG7D	Groundwater	15/06/2023	16/06/2023
PEF1145-09	WG8	Groundwater	15/06/2023	16/06/2023
PEF1145-10	WG9	Groundwater	15/06/2023	16/06/2023
PEF1145-11	WG10D	Groundwater	15/06/2023	16/06/2023
PEF1145-12	MBb	Groundwater	15/06/2023	16/06/2023
PEF1145-13	GW5S	Groundwater	15/06/2023	16/06/2023
PEF1145-14	GW5D	Groundwater	15/06/2023	16/06/2023
PEF1145-15	GW8S	Groundwater	15/06/2023	16/06/2023
PEF1145-16	GW8D	Groundwater	15/06/2023	16/06/2023
PEF1145-17	GW9S	Groundwater	15/06/2023	16/06/2023
PEF1145-18	GW9D	Groundwater	15/06/2023	16/06/2023

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Acid Extractable Metals (Groundwater)

Envirolab ID	Units	PQL	PEF1145-01	PEF1145-02	PEF1145-03	PEF1145-04	PEF1145-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023	15/06/2023
Phosphorus	mg/L	0.050	<0.050	0.051	0.075	<0.050	<0.050

Envirolab ID	Units	PQL	PEF1145-06	PEF1145-07	PEF1145-08	PEF1145-09	PEF1145-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023	15/06/2023
Phosphorus	mg/L	0.050	0.054	<0.050	<0.050	0.18	1.8

Envirolab ID	Units	PQL	PEF1145-11	PEF1145-12	PEF1145-13	PEF1145-14	PEF1145-15
Your Reference			WG10D	MBb	GW5S	GW5D	GW8S
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023	15/06/2023
Phosphorus	mg/L	0.050	<0.050	<0.050	<0.050	<0.050	0.36

Envirolab ID	Units	PQL	PEF1145-16	PEF1145-17	PEF1145-18
Your Reference			GW8D	GW9S	GW9D
Date Sampled			15/06/2023	15/06/2023	15/06/2023
Phosphorus	mg/L	0.050	<0.050	1.4	<0.050

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Dissolved Low Level Metals (Groundwater)

Envirolab ID	Units	PQL	PEF1145-01	PEF1145-02	PEF1145-03	PEF1145-04	PEF1145-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023	15/06/2023
Arsenic	µg/L	1.0	<1.0	<1.0	1.6	<1.0	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	<1.0	2.5	1.2	1.2	1.0
Lead	µg/L	1.0	2.3	<1.0	2.1	<1.0	<1.0
Zinc	µg/L	1.0	5.8	2.4	2.6	3.0	5.5

Envirolab ID	Units	PQL	PEF1145-06	PEF1145-07	PEF1145-08	PEF1145-09	PEF1145-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023	15/06/2023
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	1.1
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	1.2
Copper	µg/L	1.0	<1.0	1.2	2.0	6.9	9.5
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	2.8	1.6	2.1	5.6	4.0
Lead	µg/L	1.0	2.6	42	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	13	1.5	4.5	59	2.8

Envirolab ID	Units	PQL	PEF1145-11	PEF1145-12	PEF1145-13	PEF1145-14	PEF1145-15
Your Reference			WG10D	MBb	GW5S	GW5D	GW8S
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023	15/06/2023
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	1.1	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	1.1	<1.0
Copper	µg/L	1.0	<1.0	<1.0	3.0	1.1	5.9
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	<1.0	2.9	4.8	12	1.8
Lead	µg/L	1.0	<1.0	<1.0	<1.0	2.4	<1.0
Zinc	µg/L	1.0	2.1	14	2.1	13	18

Envirolab ID	Units	PQL	PEF1145-16	PEF1145-17	PEF1145-18
Your Reference			GW8D	GW9S	GW9D
Date Sampled			15/06/2023	15/06/2023	15/06/2023
Arsenic	µg/L	1.0	<1.0	4.9	1.2
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0
Copper	µg/L	1.0	<1.0	2.9	9.9
Mercury	µg/L	0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	2.3	4.5	14
Lead	µg/L	1.0	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	19	11	7.8

Certificate of Analysis PEF1145

Inorganics - Physical Parameters (Groundwater)

Envirolab ID	Units	PQL	PEF1145-01	PEF1145-02	PEF1145-03	PEF1145-04	PEF1145-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023	15/06/2023
pH	pH units		5.7	5.3	6.2	5.8	6.1
Electrical Conductivity	µS/cm	2.0	290	2800	7800	1900	1700

Envirolab ID	Units	PQL	PEF1145-06	PEF1145-07	PEF1145-08	PEF1145-09	PEF1145-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023	15/06/2023
pH	pH units		5.5	5.4	6.1	5.6	6.1
Electrical Conductivity	µS/cm	2.0	790	1400	640	790	1700

Envirolab ID	Units	PQL	PEF1145-11	PEF1145-12	PEF1145-13	PEF1145-14	PEF1145-15
Your Reference			WG10D	MBb	GW5S	GW5D	GW8S
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023	15/06/2023
pH	pH units		6.2	6.4	7.6	3.8	6.1
Electrical Conductivity	µS/cm	2.0	150	750	380	650	120

Envirolab ID	Units	PQL	PEF1145-16	PEF1145-17	PEF1145-18
Your Reference			GW8D	GW9S	GW9D
Date Sampled			15/06/2023	15/06/2023	15/06/2023
pH	pH units		6.3	6.9	6.7
Electrical Conductivity	µS/cm	2.0	200	310	370

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Inorganics - Ionic Balance and Indexes (Groundwater)

Envirolab ID	Units	PQL	PEF1145-01	PEF1145-02	PEF1145-03	PEF1145-04	PEF1145-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023	15/06/2023
Calcium	mg/L	0.50	0.76	5.4	93	42	67
Magnesium	mg/L	0.50	4.5	100	150	62	47
Potassium	mg/L	0.50	1.6	10	33	11	11
Sodium	mg/L	0.50	52	340	1200	270	240
Hardness as CaCO3	mg/L	3.0	21	440	860	360	360

Envirolab ID	Units	PQL	PEF1145-06	PEF1145-07	PEF1145-08	PEF1145-09	PEF1145-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023	15/06/2023
Calcium	mg/L	0.50	3.6	7.8	6.1	2.7	44
Magnesium	mg/L	0.50	15	33	13	15	46
Potassium	mg/L	0.50	3.5	9.0	4.1	3.4	33
Sodium	mg/L	0.50	120	200	82	120	210
Hardness as CaCO3	mg/L	3.0	70	150	68	70	300

Envirolab ID	Units	PQL	PEF1145-11	PEF1145-12	PEF1145-13	PEF1145-14	PEF1145-15
Your Reference			WG10D	MBb	GW5S	GW5D	GW8S
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023	15/06/2023
Calcium	mg/L	0.50	8.0	15	60	17	5.0
Magnesium	mg/L	0.50	6.7	36	4.3	10	3.7
Potassium	mg/L	0.50	5.1	7.8	5.1	6.9	3.1
Sodium	mg/L	0.50	31	77	18	72	14
Hardness as CaCO3	mg/L	3.0	48	190	170	84	28

Envirolab ID	Units	PQL	PEF1145-16	PEF1145-17	PEF1145-18
Your Reference			GW8D	GW9S	GW9D
Date Sampled			15/06/2023	15/06/2023	15/06/2023
Calcium	mg/L	0.50	1.3	32	10
Magnesium	mg/L	0.50	3.1	4.4	7.8
Potassium	mg/L	0.50	1.1	5.5	11
Sodium	mg/L	0.50	33	21	45
Hardness as CaCO3	mg/L	3.0	16	98	58

Inorganics - Nutrients (Groundwater)

Envirolab ID	Units	PQL	PEF1145-01	PEF1145-02	PEF1145-03	PEF1145-04	PEF1145-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023	15/06/2023
Ammonia as N	mg/L	0.0050	<0.0050	0.013	0.20	<0.0050	<0.0050
Nitrate as N	mg/L	0.0050	3.4	2.0	<0.0050	0.20	8.1
Nitrate as NO3 by calculation	mg/L	0.020	15	9.0	<0.020	0.90	36
Nitrite as N	mg/L	0.0050	<0.0050	0.0064	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	0.021	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	3.4	2.1	<0.0050	0.21	8.1
TKN as N by calculation	mg/L	0.10	0.79	0.20	1.3	0.16	1.2
Organic Nitrogen by calc.	mg/L	0.10	0.79	0.18	1.1	0.16	1.2
Total Nitrogen	mg/L	0.10	4.2	2.2	1.3	0.37	9.2
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Envirolab ID	Units	PQL	PEF1145-06	PEF1145-07	PEF1145-08	PEF1145-09	PEF1145-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023	15/06/2023
Ammonia as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	0.0066	<0.0050
Nitrate as N	mg/L	0.0050	14	2.7	2.4	0.36	11
Nitrate as NO3 by calculation	mg/L	0.020	62	12	11	1.6	48
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	0.0054	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	14	2.7	2.4	0.36	11
TKN as N by calculation	mg/L	0.10	2.7	0.69	0.20	0.17	0.75
Organic Nitrogen by calc.	mg/L	0.10	2.7	0.69	0.20	0.16	0.75
Total Nitrogen	mg/L	0.10	17	3.4	2.6	0.54	12
Phosphate as P	mg/L	0.0050	<0.0050	0.0070	<0.0050	0.0058	1.7

Envirolab ID	Units	PQL	PEF1145-11	PEF1145-12	PEF1145-13	PEF1145-14	PEF1145-15
Your Reference			WG10D	MBb	GW5S	GW5D	GW8S
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023	15/06/2023
Ammonia as N	mg/L	0.0050	<0.0050	0.73	<0.0050	0.18	0.013
Nitrate as N	mg/L	0.0050	5.1	0.019	0.016	<0.0050	1.9
Nitrate as NO3 by calculation	mg/L	0.020	23	0.085	0.071	<0.020	8.4
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0052
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	5.1	0.023	0.020	<0.0050	1.9
TKN as N by calculation	mg/L	0.10	0.70	1.0	0.71	0.62	0.63
Organic Nitrogen by calc.	mg/L	0.10	0.70	0.31	0.71	0.44	0.61
Total Nitrogen	mg/L	0.10	5.8	1.1	0.73	0.61	2.5
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.093

Envirolab ID	Units	PQL	PEF1145-16	PEF1145-17	PEF1145-18
Your Reference			GW8D	GW9S	GW9D
Date Sampled			15/06/2023	15/06/2023	15/06/2023
Ammonia as N	mg/L	0.0050	0.0095	<0.0050	<0.0050
Nitrate as N	mg/L	0.0050	0.0072	6.5	0.40
Nitrate as NO3 by calculation	mg/L	0.020	0.032	29	1.8
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	0.012	6.5	0.40

Certificate of Analysis PEF1145

Inorganics - Nutrients (Groundwater)

Envirolab ID	Units	PQL	PEF1145-16	PEF1145-17	PEF1145-18
Your Reference			GW8D	GW9S	GW9D
Date Sampled			15/06/2023	15/06/2023	15/06/2023
TKN as N by calculation	mg/L	0.10	<0.10	0.53	0.83
Organic Nitrogen by calc.	mg/L	0.10	<0.10	0.53	0.83
Total Nitrogen	mg/L	0.10	<0.10	7.0	1.2
Phosphate as P	mg/L	0.0050	<0.0050	0.085	0.016

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Certificate of Analysis PEH1140

Client Details

Client	Hyd2O
Contact	Sean O'Sullivan
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H21003 Wattle Grove Monitoring
Number of Samples	5 Surface Water
Date Samples Received	17/08/2023
Date Samples Registered	17/08/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	24/08/2023
Date of Issue	24/08/2023

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Authorisation Details

Results Approved By	Heram Halim, Operations Manager Lien Tang, Assistant Operations Manager Michael Mowle, Inorganics Supervisor
Laboratory Manager	Michael Kubiak

Certificate of Analysis PEH1140

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PEH1140-01	SW1	Surface Water	16/08/2023	17/08/2023
PEH1140-02	SW2	Surface Water	16/08/2023	17/08/2023
PEH1140-03	SW3	Surface Water	16/08/2023	17/08/2023
PEH1140-04	SW4	Surface Water	16/08/2023	17/08/2023
PEH1140-05	SW5	Surface Water	16/08/2023	17/08/2023

Certificate of Analysis PEH1140

Acid Extractable Metals (Surface Water)

Envirolab ID	Units	PQL	PEH1140-01	PEH1140-02	PEH1140-03	PEH1140-04	PEH1140-05
Your Reference			SW1	SW2	SW3	SW4	SW5
Date Sampled			16/08/2023	16/08/2023	16/08/2023	16/08/2023	16/08/2023
Phosphorus	mg/L	0.050	<0.050	0.27	0.13	<0.050	0.076

Certificate of Analysis PEH1140

Dissolved Low Level Metals (Surface Water)

Envirolab ID	Units	PQL	PEH1140-01	PEH1140-02	PEH1140-03	PEH1140-04	PEH1140-05
Your Reference			SW1	SW2	SW3	SW4	SW5
Date Sampled			16/08/2023	16/08/2023	16/08/2023	16/08/2023	16/08/2023
Arsenic	µg/L	1.0	<1.0	4.7	<1.0	<1.0	1.1
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	µg/L	1.0	1.1	11	4.9	2.7	2.5
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	<1.0	<1.0	1.0	1.5	1.1
Lead	µg/L	1.0	<1.0	<1.0	1.4	<1.0	<1.0
Zinc	µg/L	1.0	2.5	29	12	10	8.8

Certificate of Analysis PEH1140

Inorganics - Physical Parameters (Surface Water)

Envirolab ID	Units	PQL	PEH1140-01	PEH1140-02	PEH1140-03	PEH1140-04	PEH1140-05
Your Reference			SW1	SW2	SW3	SW4	SW5
Date Sampled			16/08/2023	16/08/2023	16/08/2023	16/08/2023	16/08/2023
pH	pH units		7.4	7.2	7.8	7.0	7.4
Electrical Conductivity	µS/cm	2.0	67	130	1100	290	270

Inorganics - Ionic Balance and Indexes (Surface Water)

Envirolab ID	Units	PQL	PEH1140-01	PEH1140-02	PEH1140-03	PEH1140-04	PEH1140-05
Your Reference			SW1	SW2	SW3	SW4	SW5
Date Sampled			16/08/2023	16/08/2023	16/08/2023	16/08/2023	16/08/2023
Calcium	mg/L	0.50	8.2	14	59	13	18
Magnesium	mg/L	0.50	0.91	1.9	25	6.1	4.8
Potassium	mg/L	0.50	1.7	2.8	9.1	3.9	4.7
Sodium	mg/L	0.50	2.1	5.0	120	28	25
Hardness as CaCO3	mg/L	3.0	24	43	250	58	65

Inorganics - Nutrients (Surface Water)

Envirolab ID	Units	PQL	PEH1140-01	PEH1140-02	PEH1140-03	PEH1140-04	PEH1140-05
Your Reference			SW1	SW2	SW3	SW4	SW5
Date Sampled			16/08/2023	16/08/2023	16/08/2023	16/08/2023	16/08/2023
Ammonia as N	mg/L	0.0050	<0.0050	0.051	0.11	0.021	<0.0050
Nitrate as N	mg/L	0.0050	<0.0050	1.2	2.1	<0.0050	<0.0050
Nitrate as NO3 by calculation	mg/L	0.020	<0.020	5.4	9.3	<0.020	<0.020
Nitrite as N	mg/L	0.0050	<0.0050	0.012	0.017	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	0.038	0.054	<0.020	<0.020
NOx as N	mg/L	0.0050	<0.0050	1.2	2.1	<0.0050	<0.0050
TKN as N by calculation	mg/L	0.10	0.29	0.55	1.3	1.1	1.5
Organic Nitrogen by calc.	mg/L	0.10	0.29	0.50	1.2	1.1	1.5
Total Nitrogen	mg/L	0.10	0.29	1.8	3.5	1.1	1.5
Phosphate as P	mg/L	0.0050	0.021	0.26	0.065	<0.0050	0.061

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Certificate of Analysis PEI1127

Client Details

Client	Hyd2O
Contact	Sean O'Sullivan
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H21003 - Wattle Grove Monitoring
Number of Samples	17 Groundwater, 5 Surface Water
Date Samples Received	15/09/2023
Date Samples Registered	15/09/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	22/09/2023
Date of Issue	26/09/2023

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Authorisation Details

Results Approved By	Heram Halim, Operations Manager Lien Tang, Assistant Operations Manager Michael Hall, Inorganics & Metals Supervisor
Laboratory Manager	Michael Kubiak

Certificate of Analysis PEI1127

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PEI1127-01	WG1	Groundwater	14/09/2023	15/09/2023
PEI1127-02	WG2D	Groundwater	14/09/2023	15/09/2023
PEI1127-03	WG3	Groundwater	14/09/2023	15/09/2023
PEI1127-04	WG4S	Groundwater	14/09/2023	15/09/2023
PEI1127-05	WG4D	Groundwater	14/09/2023	15/09/2023
PEI1127-06	WG5D	Groundwater	14/09/2023	15/09/2023
PEI1127-07	WG6	Groundwater	14/09/2023	15/09/2023
PEI1127-08	WG7D	Groundwater	14/09/2023	15/09/2023
PEI1127-09	WG8	Groundwater	14/09/2023	15/09/2023
PEI1127-10	WG9	Groundwater	14/09/2023	15/09/2023
PEI1127-11	WG10D	Groundwater	14/09/2023	15/09/2023
PEI1127-12	MBb	Groundwater	14/09/2023	15/09/2023
PEI1127-13	GW5S	Groundwater	14/09/2023	15/09/2023
PEI1127-14	GW5D	Groundwater	14/09/2023	15/09/2023
PEI1127-15	GW8D	Groundwater	14/09/2023	15/09/2023
PEI1127-16	GW9S	Groundwater	14/09/2023	15/09/2023
PEI1127-17	GW9D	Groundwater	14/09/2023	15/09/2023
PEI1127-18	SW1	Surface Water	14/09/2023	15/09/2023
PEI1127-19	SW2	Surface Water	14/09/2023	15/09/2023
PEI1127-20	SW3	Surface Water	14/09/2023	15/09/2023
PEI1127-21	SW4	Surface Water	14/09/2023	15/09/2023
PEI1127-22	SW5	Surface Water	14/09/2023	15/09/2023

Certificate of Analysis PEI1127

Acid Extractable Metals (Groundwater)

Envirolab ID	Units	PQL	PEI1127-01	PEI1127-02	PEI1127-03	PEI1127-04	PEI1127-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
Phosphorus	mg/L	0.050	<0.050	<0.050	0.051	<0.050	<0.050

Envirolab ID	Units	PQL	PEI1127-06	PEI1127-07	PEI1127-08	PEI1127-09	PEI1127-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
Phosphorus	mg/L	0.050	0.059	<0.050	<0.050	0.21	2.0

Envirolab ID	Units	PQL	PEI1127-11	PEI1127-12	PEI1127-13	PEI1127-14	PEI1127-15
Your Reference			WG10D	MBb	GW5S	GW5D	GW8D
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
Phosphorus	mg/L	0.050	<0.050	<0.050	0.058	<0.050	<0.050

Envirolab ID	Units	PQL	PEI1127-16	PEI1127-17
Your Reference			GW9S	GW9D
Date Sampled			14/09/2023	14/09/2023
Phosphorus	mg/L	0.050	0.12	<0.050

Acid Extractable Metals (Surface Water)

Envirolab ID	Units	PQL	PEI1127-18	PEI1127-19	PEI1127-20	PEI1127-21	PEI1127-22
Your Reference			SW1	SW2	SW3	SW4	SW5
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
Phosphorus	mg/L	0.050	0.37	0.065	<0.050	0.17	0.18

Certificate of Analysis PEI1127

Dissolved Low Level Metals (Groundwater)

Envirolab ID	Units	PQL	PEI1127-01	PEI1127-02	PEI1127-03	PEI1127-04	PEI1127-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
Arsenic	µg/L	1.0	<1.0	5.1	2.7	<1.0	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	1.3	<1.0	<1.0
Copper	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	<1.0	4.5	<1.0	<1.0	<1.0
Lead	µg/L	1.0	3.0	<1.0	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	1.7	7.3	2.5	1.3	<1.0

Envirolab ID	Units	PQL	PEI1127-06	PEI1127-07	PEI1127-08	PEI1127-09	PEI1127-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	1.5
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	1.6
Copper	µg/L	1.0	<1.0	<1.0	3.2	1.7	11
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	1.6	1.4	2.3	1.9	4.8
Lead	µg/L	1.0	4.5	28	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	4.4	2.1	1.9	5.6	3.4

Envirolab ID	Units	PQL	PEI1127-11	PEI1127-12	PEI1127-13	PEI1127-14	PEI1127-15
Your Reference			WG10D	MBb	GW5S	GW5D	GW8D
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	2.6	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	µg/L	1.0	<1.0	<1.0	1.0	<1.0	<1.0
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	<1.0	6.4	5.6	17	1.1
Lead	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	<1.0	15	<1.0	4.4	1.2

Envirolab ID	Units	PQL	PEI1127-16	PEI1127-17
Your Reference			GW9S	GW9D
Date Sampled			14/09/2023	14/09/2023
Arsenic	µg/L	1.0	7.1	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0
Copper	µg/L	1.0	1.8	3.4
Mercury	µg/L	0.050	<0.050	<0.050
Nickel	µg/L	1.0	1.9	7.0
Lead	µg/L	1.0	<1.0	<1.0
Zinc	µg/L	1.0	4.3	2.3

Dissolved Low Level Metals (Surface Water)

Envirolab ID	Units	PQL	PEI1127-18	PEI1127-19	PEI1127-20	PEI1127-21	PEI1127-22
Your Reference			SW1	SW2	SW3	SW4	SW5
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	1.5	1.7
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	µg/L	1.0	2.5	2.4	2.5	1.9	1.9
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	1.2	1.1	1.5	1.7	2.7
Lead	µg/L	1.0	<1.0	1.1	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	8.0	4.3	6.1	6.0	3.6

Certificate of Analysis PEI1127

Inorganics - Physical Parameters (Groundwater)

Envirolab ID	Units	PQL	PEI1127-01	PEI1127-02	PEI1127-03	PEI1127-04	PEI1127-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
pH	pH units		5.8	5.4	6.2	6.0	6.8
Electrical Conductivity	µS/cm	2.0	350	3200	5000	2000	1400

Envirolab ID	Units	PQL	PEI1127-06	PEI1127-07	PEI1127-08	PEI1127-09	PEI1127-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
pH	pH units		5.7	5.4	6.6	5.7	6.2
Electrical Conductivity	µS/cm	2.0	810	1600	470	730	1900

Envirolab ID	Units	PQL	PEI1127-11	PEI1127-12	PEI1127-13	PEI1127-14	PEI1127-15
Your Reference			WG10D	MBb	GW5S	GW5D	GW8D
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
pH	pH units		6.5	7.1	7.5	5.0	5.7
Electrical Conductivity	µS/cm	2.0	120	880	600	760	180

Envirolab ID	Units	PQL	PEI1127-16	PEI1127-17
Your Reference			GW9S	GW9D
Date Sampled			14/09/2023	14/09/2023
pH	pH units		7.0	7.0
Electrical Conductivity	µS/cm	2.0	160	360

Certificate of Analysis PEI1127

Inorganics - Physical Parameters (Surface Water)

Envirolab ID	Units	PQL	PEI1127-18	PEI1127-19	PEI1127-20	PEI1127-21	PEI1127-22
Your Reference			SW1	SW2	SW3	SW4	SW5
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
pH	pH units		7.2	8.2	7.3	7.8	8.0
Electrical Conductivity	µS/cm	2.0	150	1600	500	720	790

Inorganics - Ionic Balance and Indexes (Groundwater)

Envirolab ID	Units	PQL	PEI1127-01	PEI1127-02	PEI1127-03	PEI1127-04	PEI1127-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
Calcium	mg/L	0.50	2.4	6.0	46	38	86
Magnesium	mg/L	0.50	7.0	120	83	56	29
Potassium	mg/L	0.50	2.9	11	27	9.8	8.0
Sodium	mg/L	0.50	71	420	780	280	150
Hardness as CaCO3	mg/L	3.0	35	510	460	330	330

Envirolab ID	Units	PQL	PEI1127-06	PEI1127-07	PEI1127-08	PEI1127-09	PEI1127-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
Calcium	mg/L	0.50	4.0	8.0	20	1.7	48
Magnesium	mg/L	0.50	14	37	16	13	41
Potassium	mg/L	0.50	3.7	9.7	5.9	3.3	39
Sodium	mg/L	0.50	120	230	58	110	230
Hardness as CaCO3	mg/L	3.0	66	170	120	57	290

Envirolab ID	Units	PQL	PEI1127-11	PEI1127-12	PEI1127-13	PEI1127-14	PEI1127-15
Your Reference			WG10D	MBb	GW5S	GW5D	GW8D
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
Calcium	mg/L	0.50	5.4	25	110	29	0.73
Magnesium	mg/L	0.50	3.3	47	5.7	15	1.7
Potassium	mg/L	0.50	4.0	9.2	5.9	8.6	0.95
Sodium	mg/L	0.50	22	80	21	91	32
Hardness as CaCO3	mg/L	3.0	27	260	290	130	8.7

Envirolab ID	Units	PQL	PEI1127-16	PEI1127-17
Your Reference			GW9S	GW9D
Date Sampled			14/09/2023	14/09/2023
Calcium	mg/L	0.50	21	11
Magnesium	mg/L	0.50	2.5	9.7
Potassium	mg/L	0.50	5.1	8.4
Sodium	mg/L	0.50	13	41
Hardness as CaCO3	mg/L	3.0	62	67

Inorganics - Ionic Balance and Indexes (Surface Water)

Envirolab ID	Units	PQL	PEI1127-18	PEI1127-19	PEI1127-20	PEI1127-21	PEI1127-22
Your Reference			SW1	SW2	SW3	SW4	SW5
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
Calcium	mg/L	0.50	12	68	27	44	65
Magnesium	mg/L	0.50	6.0	33	12	14	15
Potassium	mg/L	0.50	7.8	12	6.9	11	12
Sodium	mg/L	0.50	20	170	53	70	64
Hardness as CaCO3	mg/L	3.0	54	300	110	170	220

Inorganics - Nutrients (Groundwater)

Envirolab ID	Units	PQL	PEI1127-01	PEI1127-02	PEI1127-03	PEI1127-04	PEI1127-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
Ammonia as N	mg/L	0.0050	<0.0050	<0.0050	0.064	<0.0050	0.060
Nitrate as N	mg/L	0.0050	3.2	0.16	<0.0050	<0.0050	0.099
Nitrate as NO3 by calculation	mg/L	0.020	14	0.73	<0.020	<0.020	0.44
Nitrite as N	mg/L	0.0050	<0.0050	0.0060	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	3.2	0.17	<0.0050	<0.0050	0.10
TKN as N by calculation	mg/L	0.10	0.54	0.27	1.0	0.33	0.65
Organic Nitrogen by calc.	mg/L	0.10	0.54	0.27	0.95	0.33	0.59
Total Nitrogen	mg/L	0.10	3.8	0.44	1.0	0.33	0.75
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Envirolab ID	Units	PQL	PEI1127-06	PEI1127-07	PEI1127-08	PEI1127-09	PEI1127-10
Your Reference			WG5D	WG6	WG7D	WG8	WG9
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
Ammonia as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0055
Nitrate as N	mg/L	0.0050	14	3.5	4.2	0.075	11
Nitrate as NO3 by calculation	mg/L	0.020	60	15	19	0.33	47
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	14	3.5	4.2	0.076	11
TKN as N by calculation	mg/L	0.10	3.4	0.72	0.68	0.40	4.5
Organic Nitrogen by calc.	mg/L	0.10	3.4	0.72	0.68	0.40	4.5
Total Nitrogen	mg/L	0.10	17	4.2	4.9	0.48	15
Phosphate as P	mg/L	0.0050	<0.0050	0.0055	<0.0050	0.0061	1.6

Envirolab ID	Units	PQL	PEI1127-11	PEI1127-12	PEI1127-13	PEI1127-14	PEI1127-15
Your Reference			WG10D	MBb	GW5S	GW5D	GW8D
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
Ammonia as N	mg/L	0.0050	<0.0050	1.7	0.031	0.14	<0.0050
Nitrate as N	mg/L	0.0050	2.4	0.016	0.024	<0.0050	0.0096
Nitrate as NO3 by calculation	mg/L	0.020	11	0.070	0.10	<0.020	0.042
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	2.4	0.017	0.024	<0.0050	0.011
TKN as N by calculation	mg/L	0.10	0.86	2.3	1.3	0.71	0.22
Organic Nitrogen by calc.	mg/L	0.10	0.85	0.65	1.2	0.56	0.22
Total Nitrogen	mg/L	0.10	3.3	2.3	1.3	0.70	0.23
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Envirolab ID	Units	PQL	PEI1127-16	PEI1127-17
Your Reference			GW9S	GW9D
Date Sampled			14/09/2023	14/09/2023
Ammonia as N	mg/L	0.0050	<0.0050	<0.0050
Nitrate as N	mg/L	0.0050	0.87	0.14
Nitrate as NO3 by calculation	mg/L	0.020	3.9	0.62
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	0.87	0.14

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Inorganics - Nutrients (Groundwater)

Envirolab ID	Units	PQL	PEI1127-16	PEI1127-17
Your Reference			GW9S	GW9D
Date Sampled			14/09/2023	14/09/2023
TKN as N by calculation	mg/L	0.10	0.59	0.62
Organic Nitrogen by calc.	mg/L	0.10	0.59	0.62
Total Nitrogen	mg/L	0.10	1.5	0.76
Phosphate as P	mg/L	0.0050	0.089	0.0085

Certificate of Analysis PEI1127

Inorganics - Nutrients (Surface Water)

Envirolab ID	Units	PQL	PEI1127-18	PEI1127-19	PEI1127-20	PEI1127-21	PEI1127-22
Your Reference			SW1	SW2	SW3	SW4	SW5
Date Sampled			14/09/2023	14/09/2023	14/09/2023	14/09/2023	14/09/2023
Ammonia as N	mg/L	0.0050	<0.0050	0.055	0.0079	0.0084	0.0052
Nitrate as N	mg/L	0.0050	<0.0050	1.2	0.015	<0.0050	0.033
Nitrate as NO3 by calculation	mg/L	0.020	<0.020	5.3	0.068	<0.020	0.15
Nitrite as N	mg/L	0.0050	<0.0050	0.023	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	0.075	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	<0.0050	1.2	0.015	<0.0050	0.031
TKN as N by calculation	mg/L	0.10	0.93	1.1	0.94	1.8	1.8
Organic Nitrogen by calc.	mg/L	0.10	0.92	1.1	0.93	1.8	1.8
Total Nitrogen	mg/L	0.10	0.92	2.3	0.96	1.8	1.9
Phosphate as P	mg/L	0.0050	0.32	0.016	<0.0050	0.088	0.099

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Certificate of Analysis PEL1474

Client Details

Client	Hyd2O
Contact	Sean O'Sullivan
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H21003 - Wattle Grove Monitoring
Number of Samples	15 Groundwater
Date Samples Received	20/12/2023
Date Instructions Received	20/12/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	03/01/2024
Date of Issue	01/03/2024

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Authorisation Details

Results Approved By	Heram Halim, Operations Manager Michael Mowle, Inorganics Supervisor
Laboratory Manager	Michael Kubiak

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Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PEL1474-01	WG1	Groundwater	19/12/2023	20/12/2023
PEL1474-02	WG2D	Groundwater	19/12/2023	20/12/2023
PEL1474-03	WG3	Groundwater	19/12/2023	20/12/2023
PEL1474-04	WG4S	Groundwater	19/12/2023	20/12/2023
PEL1474-05	WG4D	Groundwater	19/12/2023	20/12/2023
PEL1474-06	WG5D	Groundwater	19/12/2023	20/12/2023
PEL1474-07	WG6	Groundwater	19/12/2023	20/12/2023
PEL1474-08	WG7D	Groundwater	19/12/2023	20/12/2023
PEL1474-09	WG9	Groundwater	19/12/2023	20/12/2023
PEL1474-10	WG10D	Groundwater	19/12/2023	20/12/2023
PEL1474-11	MBb	Groundwater	19/12/2023	20/12/2023
PEL1474-12	GW5D	Groundwater	19/12/2023	20/12/2023
PEL1474-13	GW8D	Groundwater	19/12/2023	20/12/2023
PEL1474-14	GW9S	Groundwater	19/12/2023	20/12/2023
PEL1474-15	GW9D	Groundwater	19/12/2023	20/12/2023

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Acid Extractable Metals (Groundwater)

Envirolab ID	Units	PQL	PEL1474-01	PEL1474-02	PEL1474-03	PEL1474-04	PEL1474-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			19/12/2023	19/12/2023	19/12/2023	19/12/2023	19/12/2023
Phosphorus	mg/L	0.050	0.18	<0.050	<0.050	<0.050	0.078

Envirolab ID	Units	PQL	PEL1474-06	PEL1474-07	PEL1474-08	PEL1474-09	PEL1474-10
Your Reference			WG5D	WG6	WG7D	WG9	WG10D
Date Sampled			19/12/2023	19/12/2023	19/12/2023	19/12/2023	19/12/2023
Phosphorus	mg/L	0.050	0.11	<0.050	<0.050	3.2	<0.050

Envirolab ID	Units	PQL	PEL1474-11	PEL1474-12	PEL1474-13	PEL1474-14	PEL1474-15
Your Reference			MBb	GW5D	GW8D	GW9S	GW9D
Date Sampled			19/12/2023	19/12/2023	19/12/2023	19/12/2023	19/12/2023
Phosphorus	mg/L	0.050	0.19	<0.050	<0.050	0.42	<0.050

Certificate of Analysis PEL1474

Dissolved Low Level Metals (Groundwater)

Envirolab ID	Units	PQL	PEL1474-01	PEL1474-02	PEL1474-03	PEL1474-04	PEL1474-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			19/12/2023	19/12/2023	19/12/2023	19/12/2023	19/12/2023
Arsenic	µg/L	1.0	<1.0	1.0	2.2	1.1	<1.0
Cadmium	µg/L	0.10	0.45	0.14	0.12	0.82	0.16
Chromium	µg/L	1.0	<1.0	<1.0	1.8	<1.0	<1.0
Copper	µg/L	1.0	1.5	<1.0	<1.0	<1.0	<1.0
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	<1.0	3.0	5.0	1.6	<1.0
Lead	µg/L	1.0	4.3	<1.0	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	23	7.3	9.7	47	11

Envirolab ID	Units	PQL	PEL1474-06	PEL1474-07	PEL1474-08	PEL1474-09	PEL1474-10
Your Reference			WG5D	WG6	WG7D	WG9	WG10D
Date Sampled			19/12/2023	19/12/2023	19/12/2023	19/12/2023	19/12/2023
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	1.1	<1.0
Cadmium	µg/L	0.10	<0.10	0.13	0.12	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	1.0	<1.0
Copper	µg/L	1.0	<1.0	<1.0	1.9	8.3	<1.0
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	2.1	1.6	2.3	4.2	<1.0
Lead	µg/L	1.0	3.6	41	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	7.6	10	1.8	4.5	<1.0

Envirolab ID	Units	PQL	PEL1474-11	PEL1474-12	PEL1474-13	PEL1474-14	PEL1474-15
Your Reference			MBb	GW5D	GW8D	GW9S	GW9D
Date Sampled			19/12/2023	19/12/2023	19/12/2023	19/12/2023	19/12/2023
Arsenic	µg/L	1.0	1.5	1.8	<1.0	16	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	µg/L	1.0	<1.0	<1.0	<1.0	5.0	2.9
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	3.6	9.4	1.4	3.3	8.5
Lead	µg/L	1.0	<1.0	4.2	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	11	2.2	1.5	10	9.3

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Inorganics - Physical Parameters (Groundwater)

Envirolab ID	Units	PQL	PEL1474-01	PEL1474-02	PEL1474-03	PEL1474-04	PEL1474-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			19/12/2023	19/12/2023	19/12/2023	19/12/2023	19/12/2023
pH	pH units		5.7	5.8	5.8	6.5	6.3
Electrical Conductivity	µS/cm	2.0	260	3300	5300	1800	2000

Envirolab ID	Units	PQL	PEL1474-06	PEL1474-07	PEL1474-08	PEL1474-09	PEL1474-10
Your Reference			WG5D	WG6	WG7D	WG9	WG10D
Date Sampled			19/12/2023	19/12/2023	19/12/2023	19/12/2023	19/12/2023
pH	pH units		5.7	5.6	6.5	6.5	6.6
Electrical Conductivity	µS/cm	2.0	750	1600	760	1100	120

Envirolab ID	Units	PQL	PEL1474-11	PEL1474-12	PEL1474-13	PEL1474-14	PEL1474-15
Your Reference			MBb	GW5D	GW8D	GW9S	GW9D
Date Sampled			19/12/2023	19/12/2023	19/12/2023	19/12/2023	19/12/2023
pH	pH units		6.5	4.5	5.9	7.0	6.9
Electrical Conductivity	µS/cm	2.0	920	650	170	770	480

Inorganics - Ionic Balance and Indexes (Groundwater)

Envirolab ID	Units	PQL	PEL1474-01	PEL1474-02	PEL1474-03	PEL1474-04	PEL1474-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			19/12/2023	19/12/2023	19/12/2023	19/12/2023	19/12/2023
Calcium	mg/L	0.50	2.1	4.3	68	36	88
Magnesium	mg/L	0.50	8.3	120	120	55	45
Potassium	mg/L	0.50	2.1	9.7	24	8.3	10
Sodium	mg/L	0.50	59	470	900	270	260
Hardness as CaCO3	mg/L	3.0	39	520	650	320	410

Envirolab ID	Units	PQL	PEL1474-06	PEL1474-07	PEL1474-08	PEL1474-09	PEL1474-10
Your Reference			WG5D	WG6	WG7D	WG9	WG10D
Date Sampled			19/12/2023	19/12/2023	19/12/2023	19/12/2023	19/12/2023
Calcium	mg/L	0.50	2.8	7.0	16	27	6.9
Magnesium	mg/L	0.50	11	42	15	26	4.3
Potassium	mg/L	0.50	2.9	7.5	4.9	12	3.6
Sodium	mg/L	0.50	120	240	110	160	25
Hardness as CaCO3	mg/L	3.0	51	190	100	170	35

Envirolab ID	Units	PQL	PEL1474-11	PEL1474-12	PEL1474-13	PEL1474-14	PEL1474-15
Your Reference			MBb	GW5D	GW8D	GW9S	GW9D
Date Sampled			19/12/2023	19/12/2023	19/12/2023	19/12/2023	19/12/2023
Calcium	mg/L	0.50	20	17	1.5	44	15
Magnesium	mg/L	0.50	47	12	1.9	6.3	13
Potassium	mg/L	0.50	8.8	6.6	1.2	14	8.2
Sodium	mg/L	0.50	100	82	29	99	51
Hardness as CaCO3	mg/L	3.0	240	93	12	140	90

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Inorganics - Nutrients (Groundwater)

Envirolab ID	Units	PQL	PEL1474-01	PEL1474-02	PEL1474-03	PEL1474-04	PEL1474-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			19/12/2023	19/12/2023	19/12/2023	19/12/2023	19/12/2023
Ammonia as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.063
Nitrate as N	mg/L	0.0050	2.9	<0.0050	<0.0050	0.12	0.047
Nitrate as NO3 by calculation	mg/L	0.020	13	<0.020	<0.020	0.52	0.21
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	2.9	0.0053	<0.0050	0.12	0.050
TKN as N by calculation	mg/L	0.10	1.1	0.22	0.65	0.16	0.78
Organic Nitrogen by calc.	mg/L	0.10	1.1	0.22	0.64	0.16	0.72
Total Nitrogen	mg/L	0.10	4.0	0.23	0.64	0.29	0.83
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Envirolab ID	Units	PQL	PEL1474-06	PEL1474-07	PEL1474-08	PEL1474-09	PEL1474-10
Your Reference			WG5D	WG6	WG7D	WG9	WG10D
Date Sampled			19/12/2023	19/12/2023	19/12/2023	19/12/2023	19/12/2023
Ammonia as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	0.0071	<0.0050
Nitrate as N	mg/L	0.0050	10	4.2	4.0	18	2.1
Nitrate as NO3 by calculation	mg/L	0.020	44	19	18	81	9.2
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	10	4.2	4.0	18	2.1
TKN as N by calculation	mg/L	0.10	4.3	0.63	0.64	5.5	0.72
Organic Nitrogen by calc.	mg/L	0.10	4.3	0.63	0.64	5.5	0.72
Total Nitrogen	mg/L	0.10	14	4.8	4.6	24	2.8
Phosphate as P	mg/L	0.0050	<0.0050	0.0065	<0.0050	2.7	<0.0050

Envirolab ID	Units	PQL	PEL1474-11	PEL1474-12	PEL1474-13	PEL1474-14	PEL1474-15
Your Reference			MBb	GW5D	GW8D	GW9S	GW9D
Date Sampled			19/12/2023	19/12/2023	19/12/2023	19/12/2023	19/12/2023
Ammonia as N	mg/L	0.0050	1.7	0.11	<0.0050	0.0074	<0.0050
Nitrate as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	4.5	0.15
Nitrate as NO3 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	20	0.68
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	0.089	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	0.29	<0.020
NOx as N	mg/L	0.0050	0.0080	<0.0050	<0.0050	4.6	0.16
TKN as N by calculation	mg/L	0.10	3.9	0.63	<0.10	1.4	0.55
Organic Nitrogen by calc.	mg/L	0.10	2.2	0.52	<0.10	1.4	0.55
Total Nitrogen	mg/L	0.10	3.9	0.62	<0.10	6.0	0.71
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	<0.0050	0.31	0.010

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Certificate of Analysis PFC1386

Client Details

Client	Hyd2O
Contact	Sean O'Sullivan
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H21003 - Wattle Grove Monitoring
Number of Samples	11 Groundwater
Date Samples Received	21/03/2024
Date Instructions Received	21/03/2024

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	28/03/2024
Date of Issue	28/03/2024

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Authorisation Details

Results Approved By	Ben Carpenter, Metals Technician Heram Halim, Operations Manager Lien Tang, Assistant Operations Manager
Laboratory Manager	Michael Kubiak

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Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PFC1386-01	WG1	Groundwater	20/03/2024	21/03/2024
PFC1386-02	WG3	Groundwater	20/03/2024	21/03/2024
PFC1386-03	WG4S	Groundwater	20/03/2024	21/03/2024
PFC1386-04	WG4D	Groundwater	20/03/2024	21/03/2024
PFC1386-05	WG5D	Groundwater	20/03/2024	21/03/2024
PFC1386-06	WG6	Groundwater	20/03/2024	21/03/2024
PFC1386-07	WG7D	Groundwater	20/03/2024	21/03/2024
PFC1386-08	MBb	Groundwater	20/03/2024	21/03/2024
PFC1386-09	GW5D	Groundwater	20/03/2024	21/03/2024
PFC1386-10	GW8D	Groundwater	20/03/2024	21/03/2024
PFC1386-11	GW9D	Groundwater	20/03/2024	21/03/2024

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Acid Extractable Metals (Groundwater)

Envirolab ID	Units	PQL	PFC1386-01	PFC1386-02	PFC1386-03	PFC1386-04	PFC1386-05
Your Reference			WG1	WG3	WG4S	WG4D	WG5D
Date Sampled			20/03/2024	20/03/2024	20/03/2024	20/03/2024	20/03/2024
Phosphorus	mg/L	0.050	0.082	0.85	<0.050	<0.050	<0.050

Envirolab ID	Units	PQL	PFC1386-06	PFC1386-07	PFC1386-08	PFC1386-09	PFC1386-10
Your Reference			WG6	WG7D	MBb	GW5D	GW8D
Date Sampled			20/03/2024	20/03/2024	20/03/2024	20/03/2024	20/03/2024
Phosphorus	mg/L	0.050	<0.050	<0.050	0.075	<0.050	0.054

Envirolab ID	Units	PQL	PFC1386-11
Your Reference			GW9D
Date Sampled			20/03/2024
Phosphorus	mg/L	0.050	0.10

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Dissolved Low Level Metals (Groundwater)

Envirolab ID	Units	PQL	PFC1386-01	PFC1386-02	PFC1386-03	PFC1386-04	PFC1386-05
Your Reference			WG1	WG3	WG4S	WG4D	WG5D
Date Sampled			20/03/2024	20/03/2024	20/03/2024	20/03/2024	20/03/2024
Arsenic	µg/L	1.0	<1.0	3.9	<1.0	<1.0	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	µg/L	1.0	1.2	<1.0	<1.0	<1.0	<1.0
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	<1.0	7.0	1.7	1.1	1.7
Lead	µg/L	1.0	5.5	1.1	<1.0	<1.0	5.7
Zinc	µg/L	1.0	5.1	16	5.1	2.3	5.1

Envirolab ID	Units	PQL	PFC1386-06	PFC1386-07	PFC1386-08	PFC1386-09	PFC1386-10
Your Reference			WG6	WG7D	MBb	GW5D	GW8D
Date Sampled			20/03/2024	20/03/2024	20/03/2024	20/03/2024	20/03/2024
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	1.8	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	µg/L	1.0	1.3	3.6	<1.0	<1.0	2.6
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	2.0	2.7	6.2	11	2.2
Lead	µg/L	1.0	60	<1.0	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	4.3	5.9	28	14	3.0

Envirolab ID	Units	PQL	PFC1386-11
Your Reference			GW9D
Date Sampled			20/03/2024
Arsenic	µg/L	1.0	3.5
Cadmium	µg/L	0.10	<0.10
Chromium	µg/L	1.0	1.2
Copper	µg/L	1.0	18
Mercury	µg/L	0.050	<0.050
Nickel	µg/L	1.0	15
Lead	µg/L	1.0	<1.0
Zinc	µg/L	1.0	13

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Inorganics - Physical Parameters (Groundwater)

Envirolab ID	Units	PQL	PFC1386-01	PFC1386-02	PFC1386-03	PFC1386-04	PFC1386-05
Your Reference			WG1	WG3	WG4S	WG4D	WG5D
Date Sampled			20/03/2024	20/03/2024	20/03/2024	20/03/2024	20/03/2024
pH	pH units		5.8	6.1	6.1	5.8	5.6
Electrical Conductivity	µS/cm	2.0	190	8700	2300	2400	830

Envirolab ID	Units	PQL	PFC1386-06	PFC1386-07	PFC1386-08	PFC1386-09	PFC1386-10
Your Reference			WG6	WG7D	MBb	GW5D	GW8D
Date Sampled			20/03/2024	20/03/2024	20/03/2024	20/03/2024	20/03/2024
pH	pH units		5.6	6.0	6.5	4.1	6.0
Electrical Conductivity	µS/cm	2.0	1800	510	1100	740	190

Envirolab ID	Units	PQL	PFC1386-11
Your Reference			GW9D
Date Sampled			20/03/2024
pH	pH units		6.8
Electrical Conductivity	µS/cm	2.0	540

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Inorganics - Ionic Balance and Indexes (Groundwater)

Envirolab ID	Units	PQL	PFC1386-01	PFC1386-02	PFC1386-03	PFC1386-04	PFC1386-05
Your Reference			WG1	WG3	WG4S	WG4D	WG5D
Date Sampled			20/03/2024	20/03/2024	20/03/2024	20/03/2024	20/03/2024
Calcium	mg/L	0.50	1.9	98	54	75	4.6
Magnesium	mg/L	0.50	3.8	180	61	65	13
Potassium	mg/L	0.50	1.6	39	13	15	3.4
Sodium	mg/L	0.50	34	1300	290	290	120
Hardness as CaCO3	mg/L	3.0	21	990	390	460	66

Envirolab ID	Units	PQL	PFC1386-06	PFC1386-07	PFC1386-08	PFC1386-09	PFC1386-10
Your Reference			WG6	WG7D	MBb	GW5D	GW8D
Date Sampled			20/03/2024	20/03/2024	20/03/2024	20/03/2024	20/03/2024
Calcium	mg/L	0.50	11	7.5	29	22	2.9
Magnesium	mg/L	0.50	45	12	55	14	2.4
Potassium	mg/L	0.50	8.9	4.8	11	7.6	2.1
Sodium	mg/L	0.50	240	80	97	85	34
Hardness as CaCO3	mg/L	3.0	210	68	300	110	17

Envirolab ID	Units	PQL	PFC1386-11
Your Reference			GW9D
Date Sampled			20/03/2024
Calcium	mg/L	0.50	16
Magnesium	mg/L	0.50	10
Potassium	mg/L	0.50	11
Sodium	mg/L	0.50	70
Hardness as CaCO3	mg/L	3.0	82

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Inorganics - Nutrients (Groundwater)

Envirolab ID	Units	PQL	PFC1386-01	PFC1386-02	PFC1386-03	PFC1386-04	PFC1386-05
Your Reference			WG1	WG3	WG4S	WG4D	WG5D
Date Sampled			20/03/2024	20/03/2024	20/03/2024	20/03/2024	20/03/2024
Ammonia as N	mg/L	0.0050	0.13	0.18	0.16	0.16	0.13
Nitrate as N	mg/L	0.0050	3.2	0.0065	0.15	<0.0050	14
Nitrate as NO3 by calculation	mg/L	0.020	14	0.029	0.67	<0.020	60
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	3.2	0.0060	0.15	<0.0050	14
TKN as N by calculation	mg/L	0.10	1.1	8.8	0.17	0.34	0.82
Organic Nitrogen by calc.	mg/L	0.10	0.95	8.6	<0.10	0.18	0.69
Total Nitrogen	mg/L	0.10	4.3	8.8	0.32	0.34	14
Phosphate as P	mg/L	0.0050	<0.0050	0.0090	<0.0050	<0.0050	<0.0050

Envirolab ID	Units	PQL	PFC1386-06	PFC1386-07	PFC1386-08	PFC1386-09	PFC1386-10
Your Reference			WG6	WG7D	MBb	GW5D	GW8D
Date Sampled			20/03/2024	20/03/2024	20/03/2024	20/03/2024	20/03/2024
Ammonia as N	mg/L	0.0050	0.16	0.14	1.8	0.27	0.14
Nitrate as N	mg/L	0.0050	2.9	0.30	0.023	<0.0050	0.0094
Nitrate as NO3 by calculation	mg/L	0.020	13	1.3	0.10	<0.020	0.042
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	2.9	0.30	0.021	<0.0050	0.0086
TKN as N by calculation	mg/L	0.10	0.57	0.36	2.5	0.53	0.38
Organic Nitrogen by calc.	mg/L	0.10	0.42	0.22	0.77	0.27	0.24
Total Nitrogen	mg/L	0.10	3.5	0.66	2.6	0.53	<0.50 [4]
Phosphate as P	mg/L	0.0050	0.0086	<0.0050	<0.0050	<0.0050	<0.0050

Envirolab ID	Units	PQL	PFC1386-11
Your Reference			GW9D
Date Sampled			20/03/2024
Ammonia as N	mg/L	0.0050	0.19
Nitrate as N	mg/L	0.0050	0.32
Nitrate as NO3 by calculation	mg/L	0.020	1.4
Nitrite as N	mg/L	0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020
NOx as N	mg/L	0.0050	0.32
TKN as N by calculation	mg/L	0.10	1.1
Organic Nitrogen by calc.	mg/L	0.10	0.94
Total Nitrogen	mg/L	0.10	1.4
Phosphate as P	mg/L	0.0050	0.066

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Client Details

Client	Hyd2O
Contact	Sean O'Sullivan
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H21003 - Wattle Grove Monitoring
Number of Samples	14 Groundwater
Date Samples Received	21/06/2024
Date Instructions Received	21/06/2024

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	28/06/2024
Date of Issue	28/06/2024

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Authorisation Details

Results Approved By	Ben Carpenter, Metals Technician Heram Halim, Operations Manager Michael Mowle, Inorganics Supervisor Varsha Ho Wing, Inorganics and Metals Supervisor
Laboratory Manager	Michael Kubiak

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Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PFF1338-01	WG1	Groundwater	20/06/2024	21/06/2024
PFF1338-02	WG2D	Groundwater	20/06/2024	21/06/2024
PFF1338-03	WG3	Groundwater	20/06/2024	21/06/2024
PFF1338-04	WG4S	Groundwater	20/06/2024	21/06/2024
PFF1338-05	WG4D	Groundwater	20/06/2024	21/06/2024
PFF1338-06	WG5D	Groundwater	20/06/2024	21/06/2024
PFF1338-07	WG6	Groundwater	20/06/2024	21/06/2024
PFF1338-08	WG7D	Groundwater	20/06/2024	21/06/2024
PFF1338-09	WG10D	Groundwater	20/06/2024	21/06/2024
PFF1338-10	MBb	Groundwater	20/06/2024	21/06/2024
PFF1338-11	GW5D	Groundwater	20/06/2024	21/06/2024
PFF1338-12	GW8D	Groundwater	20/06/2024	21/06/2024
PFF1338-13	GW9S	Groundwater	20/06/2024	21/06/2024
PFF1338-14	GW9D	Groundwater	20/06/2024	21/06/2024

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Acid Extractable Metals (Groundwater)

Envirolab ID	Units	PQL	PFF1338-01	PFF1338-02	PFF1338-03	PFF1338-04	PFF1338-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			20/06/2024	20/06/2024	20/06/2024	20/06/2024	20/06/2024
Phosphorus	mg/L	0.050	<0.050	2.2 [2]	0.090	<0.050	<0.050

Envirolab ID	Units	PQL	PFF1338-06	PFF1338-07	PFF1338-08	PFF1338-09	PFF1338-10
Your Reference			WG5D	WG6	WG7D	WG10D	MBb
Date Sampled			20/06/2024	20/06/2024	20/06/2024	20/06/2024	20/06/2024
Phosphorus	mg/L	0.050	0.084	0.60 [2]	<0.050	<0.050	<0.50 [2]

Envirolab ID	Units	PQL	PFF1338-11	PFF1338-12	PFF1338-13	PFF1338-14
Your Reference			GW5D	GW8D	GW9S	GW9D
Date Sampled			20/06/2024	20/06/2024	20/06/2024	20/06/2024
Phosphorus	mg/L	0.050	<0.050	<0.050	1.3	0.10

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Dissolved Low Level Metals (Groundwater)

Envirolab ID	Units	PQL	PFF1338-01	PFF1338-02	PFF1338-03	PFF1338-04	PFF1338-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			20/06/2024	20/06/2024	20/06/2024	20/06/2024	20/06/2024
Arsenic	µg/L	1.0	<1.0	1.0	3.0	<1.0	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	4.1	<1.0	<1.0
Copper	µg/L	1.0	<1.0	1.7	1.8	<1.0	<1.0
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	<1.0	7.6	96	3.8	3.6
Lead	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	6.5	37	33	2.9	5.9

Envirolab ID	Units	PQL	PFF1338-06	PFF1338-07	PFF1338-08	PFF1338-09	PFF1338-10
Your Reference			WG5D	WG6	WG7D	WG10D	MBb
Date Sampled			20/06/2024	20/06/2024	20/06/2024	20/06/2024	20/06/2024
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	µg/L	1.0	4.2	<1.0	2.5	4.5	<1.0
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	2.9	4.2	1.7	<1.0	4.0
Lead	µg/L	1.0	1.3	3.1	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	24	13	2.6	13	7.9

Envirolab ID	Units	PQL	PFF1338-11	PFF1338-12	PFF1338-13	PFF1338-14
Your Reference			GW5D	GW8D	GW9S	GW9D
Date Sampled			20/06/2024	20/06/2024	20/06/2024	20/06/2024
Arsenic	µg/L	1.0	1.4	<1.0	7.4	2.2
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0
Copper	µg/L	1.0	4.3	<1.0	4.3	8.1
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	10	1.6	3.2	6.9
Lead	µg/L	1.0	2.3	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	21	4.9	5.5	8.5

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Inorganics - Physical Parameters (Groundwater)

Envirolab ID	Units	PQL	PFF1338-01	PFF1338-02	PFF1338-03	PFF1338-04	PFF1338-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			20/06/2024	20/06/2024	20/06/2024	20/06/2024	20/06/2024
pH	pH units		5.8	5.8	5.8	5.8	6.0
Electrical Conductivity	µS/cm	2.0	220	2300	14000	2200	2700

Envirolab ID	Units	PQL	PFF1338-06	PFF1338-07	PFF1338-08	PFF1338-09	PFF1338-10
Your Reference			WG5D	WG6	WG7D	WG10D	MBb
Date Sampled			20/06/2024	20/06/2024	20/06/2024	20/06/2024	20/06/2024
pH	pH units		5.6	5.6	6.3	6.2	6.5
Electrical Conductivity	µS/cm	2.0	820	2200	800	160	1200

Envirolab ID	Units	PQL	PFF1338-11	PFF1338-12	PFF1338-13	PFF1338-14
Your Reference			GW5D	GW8D	GW9S	GW9D
Date Sampled			20/06/2024	20/06/2024	20/06/2024	20/06/2024
pH	pH units		4.1	6.1	6.9	6.7
Electrical Conductivity	µS/cm	2.0	750	160	230	400

Inorganics - Ionic Balance and Indexes (Groundwater)

Envirolab ID	Units	PQL	PFF1338-01	PFF1338-02	PFF1338-03	PFF1338-04	PFF1338-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			20/06/2024	20/06/2024	20/06/2024	20/06/2024	20/06/2024
Calcium	mg/L	0.50	<0.50	3.7	190	40	86
Magnesium	mg/L	0.50	3.0	68	330	60	73
Potassium	mg/L	0.50	1.3	19	56	11	14
Sodium	mg/L	0.50	33	280	2200	310	330
Hardness (calc) equivalent CaCO3	mg/L	3.0	13	290	1800	350	520

Envirolab ID	Units	PQL	PFF1338-06	PFF1338-07	PFF1338-08	PFF1338-09	PFF1338-10
Your Reference			WG5D	WG6	WG7D	WG10D	MBb
Date Sampled			20/06/2024	20/06/2024	20/06/2024	20/06/2024	20/06/2024
Calcium	mg/L	0.50	3.0	9.0	11	7.5	34
Magnesium	mg/L	0.50	14	60	17	5.1	71
Potassium	mg/L	0.50	3.2	8.0	3.6	3.7	11
Sodium	mg/L	0.50	120	290	120	36	93
Hardness (calc) equivalent CaCO3	mg/L	3.0	67	270	97	40	380

Envirolab ID	Units	PQL	PFF1338-11	PFF1338-12	PFF1338-13	PFF1338-14
Your Reference			GW5D	GW8D	GW9S	GW9D
Date Sampled			20/06/2024	20/06/2024	20/06/2024	20/06/2024
Calcium	mg/L	0.50	21	1.6	16	13
Magnesium	mg/L	0.50	15	1.6	4.6	7.4
Potassium	mg/L	0.50	6.9	1.6	5.5	8.4
Sodium	mg/L	0.50	82	26	14	43
Hardness (calc) equivalent CaCO3	mg/L	3.0	110	10	59	63

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Inorganics - Nutrients (Groundwater)

Envirolab ID	Units	PQL	PFF1338-01	PFF1338-02	PFF1338-03	PFF1338-04	PFF1338-05
Your Reference			WG1	WG2D	WG3	WG4S	WG4D
Date Sampled			20/06/2024	20/06/2024	20/06/2024	20/06/2024	20/06/2024
Ammonia as N	mg/L	0.0050	<0.0050	0.18	<0.0050	<0.0050	<0.0050
Nitrate as N	mg/L	0.0050	2.8	0.21	<0.0050	0.016	5.9
Nitrate as NO3 by calculation	mg/L	0.020	12	0.91	<0.020	0.071	26
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	2.8	0.21	<0.0050	0.016	5.9
TKN as N by calculation	mg/L	0.10	0.22	11	1.9	0.17	0.16
Organic Nitrogen by calc.	mg/L	0.10	0.22	11	1.9	0.17	0.16
Total Nitrogen	mg/L	0.10	3.0	11	1.9	0.19	6.0
Phosphate as P	mg/L	0.0050	<0.0050	0.073	<0.0050	<0.0050	<0.0050

Envirolab ID	Units	PQL	PFF1338-06	PFF1338-07	PFF1338-08	PFF1338-09	PFF1338-10
Your Reference			WG5D	WG6	WG7D	WG10D	MBb
Date Sampled			20/06/2024	20/06/2024	20/06/2024	20/06/2024	20/06/2024
Ammonia as N	mg/L	0.0050	<0.0050	0.014	<0.0050	<0.0050	2.2
Nitrate as N	mg/L	0.0050	14	1.9	4.2	<0.0050	<0.0050
Nitrate as NO3 by calculation	mg/L	0.020	62	8.4	19	<0.020	<0.020
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	14	1.9	4.2	5.4	<0.0050
TKN as N by calculation	mg/L	0.10	1.0	1.5	0.36	1.1	3.1
Organic Nitrogen by calc.	mg/L	0.10	1.0	1.5	0.36	1.1	0.93
Total Nitrogen	mg/L	0.10	15	3.4	4.6	6.5	3.1
Phosphate as P	mg/L	0.0050	<0.0050	0.0070	0.010	0.0081	<0.0050

Envirolab ID	Units	PQL	PFF1338-11	PFF1338-12	PFF1338-13	PFF1338-14
Your Reference			GW5D	GW8D	GW9S	GW9D
Date Sampled			20/06/2024	20/06/2024	20/06/2024	20/06/2024
Ammonia as N	mg/L	0.0050	0.12	<0.0050	<0.0050	<0.0050
Nitrate as N	mg/L	0.0050	<0.0050	<0.0050	4.6	1.4
Nitrate as NO3 by calculation	mg/L	0.020	<0.020	<0.020	20	6.0
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	<0.0050	0.0064	4.6	1.4
TKN as N by calculation	mg/L	0.10	0.52	0.19	0.71	0.77
Organic Nitrogen by calc.	mg/L	0.10	0.41	0.18	0.71	0.76
Total Nitrogen	mg/L	0.10	0.52	0.19	5.3	2.1
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	0.20	0.078

APPENDIX K
Groundwater Level Hydrographs

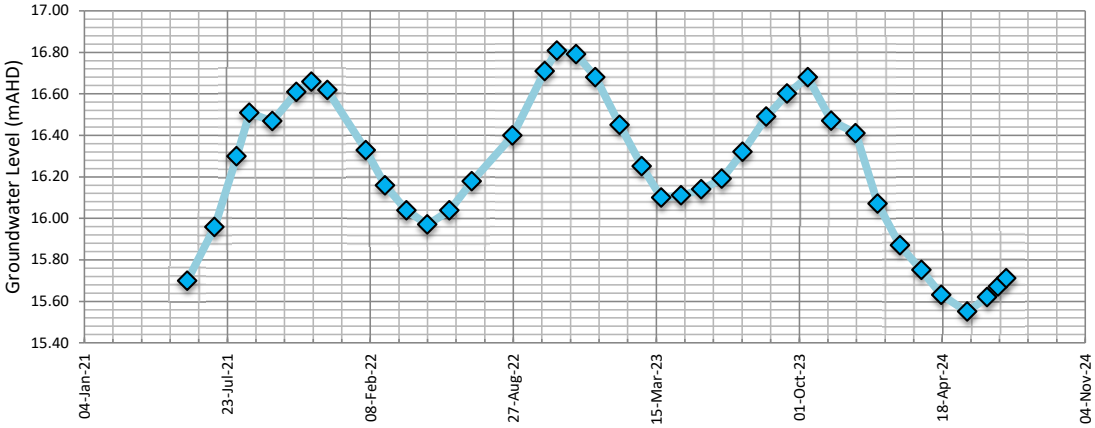
H21003 Wattle Grove South Monitoring

WG1 Hyd2o Bore Wattle Grove 1

Site Bore Victoria Rd North - Rear of Lot (Install : Nov 2020)

				Natural Surface (mAHD)	31.45
Data Analysis Period Start Date	1/01/2009	Easting	406115	Top of Casing (m AHD)	32.10
Data Analysis Period End Date	18/07/2024	Northing	6457800	End of Hole (mAHD)	13.95

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
28/05/2021	16.40	15.70	15.75
5/07/2021	16.14	15.96	15.49
5/08/2021	15.80	16.30	15.15
23/08/2021	15.59	16.51	14.94
24/09/2021	15.63	16.47	14.98
28/10/2021	15.49	16.61	14.84
18/11/2021	15.44	16.66	14.79
10/12/2021	15.48	16.62	14.83
2/02/2022	15.77	16.33	15.12
1/03/2022	15.94	16.16	15.29
31/03/2022	16.06	16.04	15.41
29/04/2022	16.13	15.97	15.48
30/05/2022	16.06	16.04	15.41
30/06/2022	15.92	16.18	15.27
26/08/2022	15.70	16.40	15.05
10/10/2022	15.39	16.71	14.74
27/10/2022	15.29	16.81	14.64
23/11/2022	15.31	16.79	14.66
20/12/2022	15.42	16.68	14.77
23/01/2023	15.65	16.45	15.00
23/02/2023	15.85	16.25	15.20
22/03/2023	16.00	16.10	15.35
19/04/2023	15.99	16.11	15.34
17/05/2023	15.96	16.14	15.31
15/06/2023	15.91	16.19	15.26
14/07/2023	15.78	16.32	15.13
16/08/2023	15.61	16.49	14.96
14/09/2023	15.50	16.60	14.85
13/10/2023	15.42	16.68	14.77
15/11/2023	15.63	16.47	14.98
19/12/2023	15.69	16.41	15.04
19/01/2024	16.03	16.07	15.38
19/02/2024	16.23	15.87	15.58
20/03/2024	16.35	15.75	15.70
17/04/2024	16.47	15.63	15.82
23/05/2024	16.55	15.55	15.90
20/06/2024	16.48	15.62	15.83
5/07/2024	16.43	15.67	15.78
17/07/2024	16.39	15.71	15.74

Minimum Recorded Level (mAHD)	15.55
Maximum Recorded Level (mAHD)	16.81

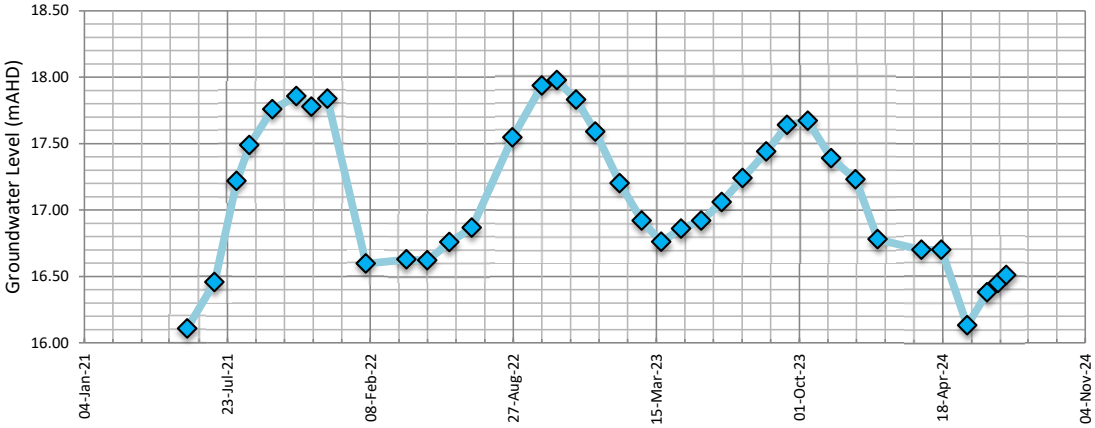
H21003 Wattle Grove South Monitoring

WG2 Hyd2o Bore Wattle Grove 2 (Deep)

Site Bore Victoria Rd South - Front of Lot (Install : Nov 2020)

				Natural Surface (mAHD)	25.47
Data Analysis Period Start Date	1/01/2009	Easting	405780	Top of Casing (m AHD)	26.12
Data Analysis Period End Date	18/07/2024	Northing	6457018	End of Hole (mAHD)	14.47

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
28/05/2021	10.01	16.11	9.36
5/07/2021	9.66	16.46	9.01
5/08/2021	8.90	17.22	8.25
23/08/2021	8.63	17.49	7.98
24/09/2021	8.36	17.76	7.71
28/10/2021	8.26	17.86	7.61
18/11/2021	8.34	17.78	7.69
10/12/2021	8.28	17.84	7.63
2/02/2022	9.52	16.60	8.87
31/03/2022	9.49	16.63	8.84
29/04/2022	9.50	16.62	8.85
30/05/2022	9.36	16.76	8.71
30/06/2022	9.25	16.87	8.60
26/08/2022	8.57	17.55	7.92
6/10/2022	8.18	17.94	7.53
27/10/2022	8.14	17.98	7.49
23/11/2022	8.29	17.83	7.64
20/12/2022	8.53	17.59	7.88
23/01/2023	8.92	17.20	8.27
23/02/2023	9.20	16.92	8.55
22/03/2023	9.36	16.76	8.71
19/04/2023	9.26	16.86	8.61
17/05/2023	9.20	16.92	8.55
15/06/2023	9.06	17.06	8.41
14/07/2023	8.88	17.24	8.23
16/08/2023	8.68	17.44	8.03
14/09/2023	8.48	17.64	7.83
13/10/2023	8.45	17.67	7.80
15/11/2023	8.73	17.39	8.08
19/12/2023	8.89	17.23	8.24
19/01/2024	9.34	16.78	8.69
20/03/2024	9.42	16.70	8.77
17/04/2024	9.42	16.70	8.77
23/05/2024	9.99	16.13	9.34
20/06/2024	9.74	16.38	9.09
5/07/2024	9.67	16.45	9.02
17/07/2024	9.61	16.51	8.96

Minimum Recorded Level (mAHD)	16.11
Maximum Recorded Level (mAHD)	17.98

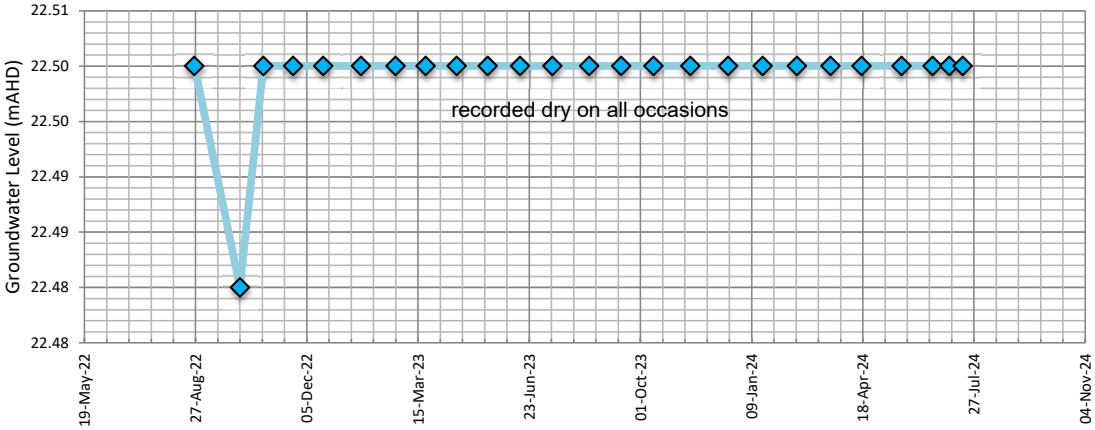
H21003 Wattle Grove South Monitoring

WG2S Hyd2o Bore Wattle Grove 2 Shallow

Site Bore Victoria Rd South - Front of Lot (Install : July 2022)

				Natural Surface (mAHD)	25.21
Data Analysis Period Start Date	1/01/2009	Easting	405781	Top of Casing (m AHD)	26.01
Data Analysis Period End Date	18/07/2024	Northing	6457018	End of Hole (mAHD)	22.21

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
26/08/2022	3.51	22.50	2.71
6/10/2022	3.53	22.48	2.73
27/10/2022	3.51	22.50	2.71
23/11/2022	3.51	22.50	2.71
20/12/2022	3.51	22.50	2.71
23/01/2023	3.51	22.50	2.71
23/02/2023	3.51	22.50	2.71
22/03/2023	3.51	22.50	2.71
19/04/2023	3.51	22.50	2.71
17/05/2023	3.51	22.50	2.71
15/06/2023	3.51	22.50	2.71
14/07/2023	3.51	22.50	2.71
16/08/2023	3.51	22.50	2.71
14/09/2023	3.51	22.50	2.71
13/10/2023	3.51	22.50	2.71
15/11/2023	3.51	22.50	2.71
19/12/2023	3.51	22.50	2.71
19/01/2024	3.51	22.50	2.71
19/02/2024	3.51	22.50	2.71
20/03/2024	3.51	22.50	2.71
17/04/2024	3.51	22.50	2.71
23/05/2024	3.51	22.50	2.71
20/06/2024	3.51	22.50	2.71
5/07/2024	3.51	22.50	2.71
17/07/2024	3.51	22.50	2.71

Minimum Recorded Level (mAHD)	22.48
Maximum Recorded Level (mAHD)	22.50

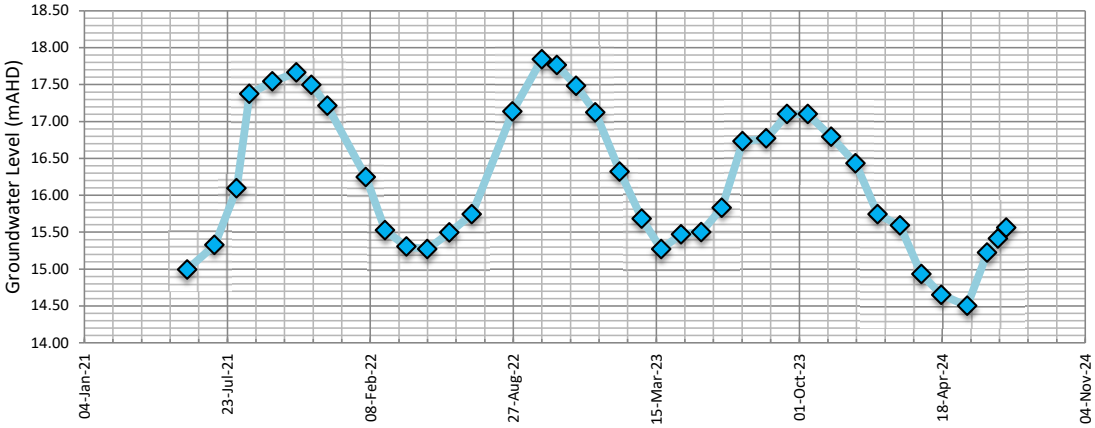
H21003 Wattle Grove South Monitoring

WG3 Hyd2o Bore Wattle Grove 3

Site Bore Brentwood Rd South - Front of Lot (Install : Nov 2020)

				Natural Surface (mAHD)	22.32
Data Analysis Period Start Date	1/01/2009	Easting	405419	Top of Casing (m AHD)	22.97
Data Analysis Period End Date	18/07/2024	Northing	6457710	End of Hole (mAHD)	14.32

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
28/05/2021	7.98	14.99	7.33
5/07/2021	7.65	15.32	7.00
5/08/2021	6.88	16.09	6.23
23/08/2021	5.60	17.37	4.95
24/09/2021	5.43	17.54	4.78
28/10/2021	5.31	17.66	4.66
18/11/2021	5.48	17.49	4.83
10/12/2021	5.76	17.21	5.11
2/02/2022	6.73	16.24	6.08
1/03/2022	7.45	15.52	6.80
31/03/2022	7.67	15.30	7.02
29/04/2022	7.70	15.27	7.05
30/05/2022	7.48	15.49	6.83
30/06/2022	7.23	15.74	6.58
26/08/2022	5.84	17.13	5.19
6/10/2022	5.13	17.84	4.48
27/10/2022	5.21	17.76	4.56
23/11/2022	5.49	17.48	4.84
20/12/2022	5.85	17.12	5.20
23/01/2023	6.65	16.32	6.00
23/02/2023	7.29	15.68	6.64
22/03/2023	7.70	15.27	7.05
19/04/2023	7.50	15.47	6.85
17/05/2023	7.47	15.50	6.82
15/06/2023	7.14	15.83	6.49
14/07/2023	6.24	16.73	5.59
16/08/2023	6.20	16.77	5.55
14/09/2023	5.87	17.10	5.22
13/10/2023	5.87	17.10	5.22
15/11/2023	6.18	16.79	5.53
19/12/2023	6.54	16.43	5.89
19/01/2024	7.23	15.74	6.58
19/02/2024	7.38	15.59	6.73
20/03/2024	8.04	14.93	7.39
17/04/2024	8.32	14.65	7.67
23/05/2024	8.47	14.50	7.82
20/06/2024	7.75	15.22	7.10
5/07/2024	7.56	15.41	6.91
17/07/2024	7.41	15.56	6.76

Minimum Recorded Level (mAHD)	14.50
Maximum Recorded Level (mAHD)	17.84

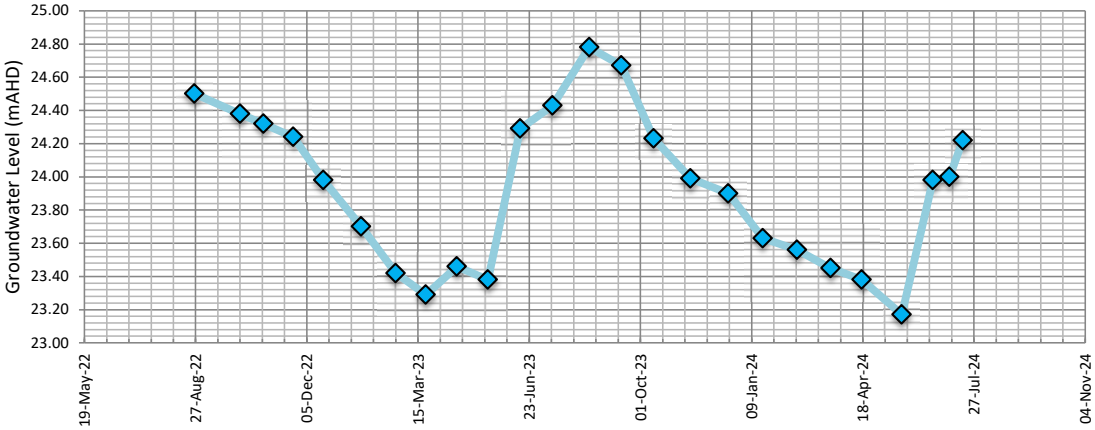
H21003 Wattle Grove South Monitoring

WG4S Hyd2o Bore Wattle Grove 4 Shallow

Site Bore Brentwood Rd North - Front of Lot (Install : Jul 2022)

				Natural Surface (mAHD)	25.11
Data Analysis Period Start Date	1/01/2009	Easting	405735	Top of Casing (m AHD)	25.66
Data Analysis Period End Date	18/07/2024	Northing	6458036	End of Hole (mAHD)	21.11

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
26/08/2022	1.16	24.50	0.61
6/10/2022	1.28	24.38	0.73
27/10/2022	1.34	24.32	0.79
23/11/2022	1.42	24.24	0.87
20/12/2022	1.68	23.98	1.13
23/01/2023	1.96	23.70	1.41
23/02/2023	2.24	23.42	1.69
22/03/2023	2.37	23.29	1.82
19/04/2023	2.20	23.46	1.65
17/05/2023	2.28	23.38	1.73
15/06/2023	1.37	24.29	0.82
14/07/2023	1.23	24.43	0.68
16/08/2023	0.88	24.78	0.33
14/09/2023	0.99	24.67	0.44
13/10/2023	1.43	24.23	0.88
15/11/2023	1.67	23.99	1.12
19/12/2023	1.76	23.90	1.21
19/01/2024	2.03	23.63	1.48
19/02/2024	2.10	23.56	1.55
20/03/2024	2.21	23.45	1.66
17/04/2024	2.28	23.38	1.73
23/05/2024	2.49	23.17	1.94
20/06/2024	1.68	23.98	1.13
5/07/2024	1.66	24.00	1.11
17/07/2024	1.44	24.22	0.89

Minimum Recorded Level (mAHD)	23.17
Maximum Recorded Level (mAHD)	24.78

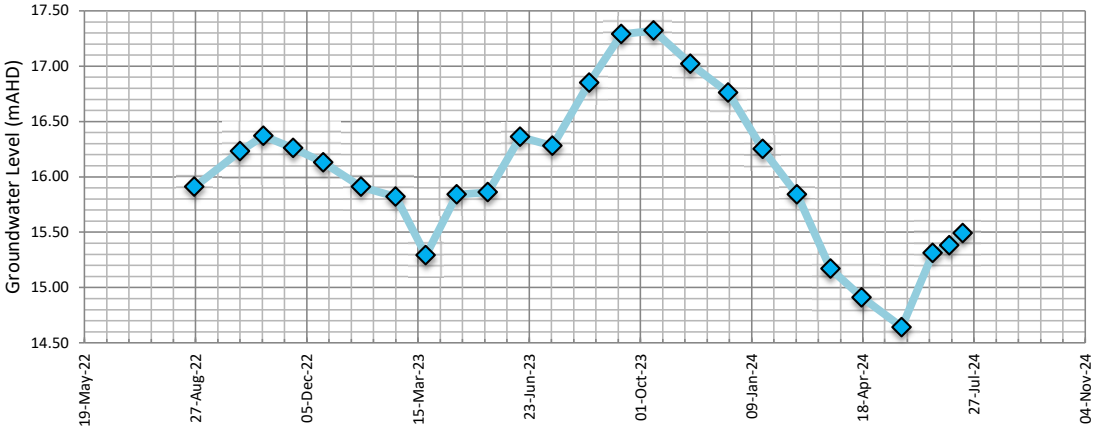
H21003 Wattle Grove South Monitoring

WG4D Hyd2o Bore Wattle Grove 4 Deep

Site Bore Brentwood Rd North - Front of Lot (Install : Jul 2022)

				Natural Surface (mAHD)	25.11
Data Analysis Period Start Date	1/01/2009	Easting	405736	Top of Casing (m AHD)	25.73
Data Analysis Period End Date	18/07/2024	Northing	6458037	End of Hole (mAHD)	13.11

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
26/08/2022	9.82	15.91	9.20
6/10/2022	9.50	16.23	8.88
27/10/2022	9.36	16.37	8.74
23/11/2022	9.47	16.26	8.85
20/12/2022	9.60	16.13	8.98
23/01/2023	9.82	15.91	9.20
23/02/2023	9.91	15.82	9.29
22/03/2023	10.44	15.29	9.82
19/04/2023	9.89	15.84	9.27
17/05/2023	9.87	15.86	9.25
15/06/2023	9.37	16.36	8.75
14/07/2023	9.45	16.28	8.83
16/08/2023	8.88	16.85	8.26
14/09/2023	8.44	17.29	7.82
13/10/2023	8.41	17.32	7.79
15/11/2023	8.71	17.02	8.09
19/12/2023	8.97	16.76	8.35
19/01/2024	9.48	16.25	8.86
19/02/2024	9.89	15.84	9.27
20/03/2024	10.56	15.17	9.94
17/04/2024	10.82	14.91	10.20
23/05/2024	11.09	14.64	10.47
20/06/2024	10.42	15.31	9.80
5/07/2024	10.35	15.38	9.73
17/07/2024	10.24	15.49	9.62

Minimum Recorded Level (mAHD)	14.64
Maximum Recorded Level (mAHD)	17.32

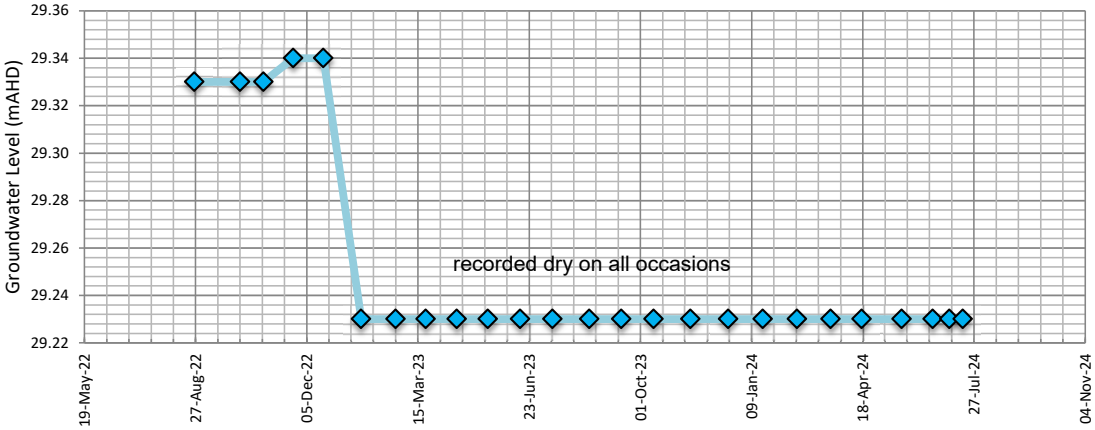
H21003 Wattle Grove South Monitoring

WG5S Hyd2o Bore Wattle Grove 5 Shallow

Site Bore Victoria Rd North - Front of Lot (Install : July 2022)

				Natural Surface (mAHD)	34.54
Data Analysis Period Start Date	1/01/2009	Easting	406304	Top of Casing (m AHD)	35.14
Data Analysis Period End Date	18/07/2024	Northing	6457567	End of Hole (mAHD)	29.24

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
26/08/2022	5.81	29.33	5.21
6/10/2022	5.81	29.33	5.21
27/10/2022	5.81	29.33	5.21
23/11/2022	5.80	29.34	5.20
20/12/2022	5.80	29.34	5.20
23/01/2023	5.91	29.23	5.31
23/02/2023	5.91	29.23	5.31
22/03/2023	5.91	29.23	5.31
19/04/2023	5.91	29.23	5.31
17/05/2023	5.91	29.23	5.31
15/06/2023	5.91	29.23	5.31
14/07/2023	5.91	29.23	5.31
16/08/2023	5.91	29.23	5.31
14/09/2023	5.91	29.23	5.31
13/10/2023	5.91	29.23	5.31
15/11/2023	5.91	29.23	5.31
19/12/2023	5.91	29.23	5.31
19/01/2024	5.91	29.23	5.31
19/02/2024	5.91	29.23	5.31
20/03/2024	5.91	29.23	5.31
17/04/2024	5.91	29.23	5.31
23/05/2024	5.91	29.23	5.31
20/06/2024	5.91	29.23	5.31
5/07/2024	5.91	29.23	5.31
17/07/2024	5.91	29.23	5.31

Minimum Recorded Level (mAHD)	29.23
Maximum Recorded Level (mAHD)	29.34

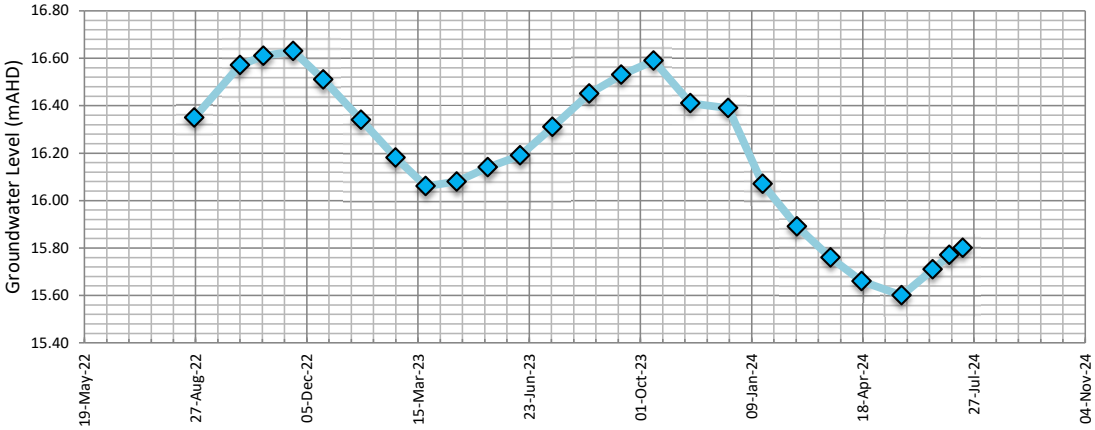
H21003 Wattle Grove South Monitoring

WG5D Hyd2o Bore Wattle Grove 5 Deep

Site Bore Victoria Rd North - Front of Lot (Install : Jul 2022)

				Natural Surface (mAHD)	34.55
Data Analysis Period Start Date	1/01/2009	Easting	406304	Top of Casing (m AHD)	35.13
Data Analysis Period End Date	18/07/2024	Northing	6457566	End of Hole (mAHD)	14.55

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
26/08/2022	18.78	16.35	18.20
6/10/2022	18.56	16.57	17.98
27/10/2022	18.52	16.61	17.94
23/11/2022	18.50	16.63	17.92
20/12/2022	18.62	16.51	18.04
23/01/2023	18.79	16.34	18.21
23/02/2023	18.95	16.18	18.37
22/03/2023	19.07	16.06	18.49
19/04/2023	19.05	16.08	18.47
17/05/2023	18.99	16.14	18.41
15/06/2023	18.94	16.19	18.36
14/07/2023	18.82	16.31	18.24
16/08/2023	18.68	16.45	18.10
14/09/2023	18.60	16.53	18.02
13/10/2023	18.54	16.59	17.96
15/11/2023	18.72	16.41	18.14
19/12/2023	18.74	16.39	18.16
19/01/2024	19.06	16.07	18.48
19/02/2024	19.24	15.89	18.66
20/03/2024	19.37	15.76	18.79
17/04/2024	19.47	15.66	18.89
23/05/2024	19.53	15.60	18.95
20/06/2024	19.42	15.71	18.84
5/07/2024	19.36	15.77	18.78
17/07/2024	19.33	15.80	18.75

Minimum Recorded Level (mAHD)	15.60
Maximum Recorded Level (mAHD)	16.63

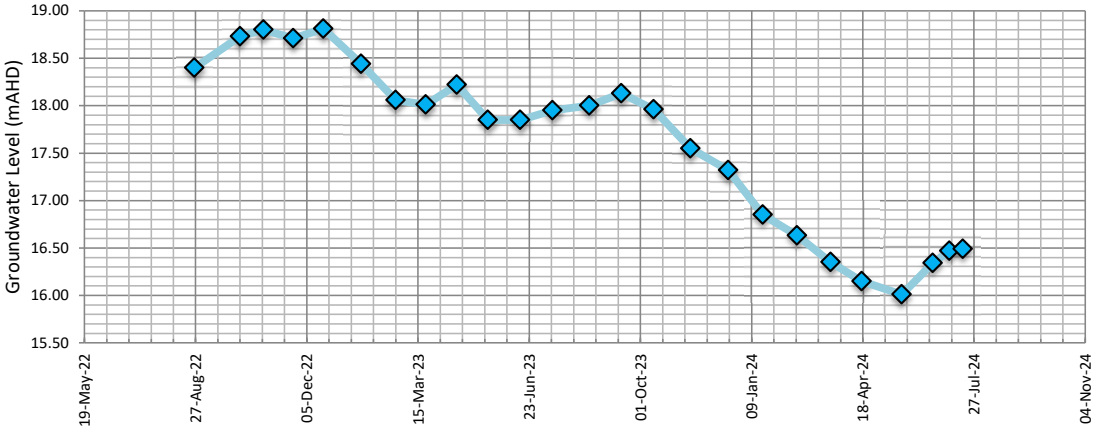
H21003 Wattle Grove South Monitoring

WG6 Hyd2o Bore Wattle Grove 6

Site Bore Victoria Rd Turf Farm North - Rear of Lot (Install : Jul 2022)

				Natural Surface (mAHD)	24.64
Data Analysis Period Start Date	1/01/2009	Easting	405790	Top of Casing (m AHD)	25.34
Data Analysis Period End Date	18/07/2024	Northing	6457474	End of Hole (mAHD)	13.64

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
26/08/2022	6.94	18.40	6.24
6/10/2022	6.61	18.73	5.91
27/10/2022	6.54	18.80	5.84
23/11/2022	6.63	18.71	5.93
20/12/2022	6.53	18.81	5.83
23/01/2023	6.90	18.44	6.20
23/02/2023	7.28	18.06	6.58
22/03/2023	7.33	18.01	6.63
19/04/2023	7.12	18.22	6.42
17/05/2023	7.49	17.85	6.79
15/06/2023	7.49	17.85	6.79
14/07/2023	7.39	17.95	6.69
16/08/2023	7.34	18.00	6.64
14/09/2023	7.21	18.13	6.51
13/10/2023	7.38	17.96	6.68
15/11/2023	7.79	17.55	7.09
19/12/2023	8.02	17.32	7.32
19/01/2024	8.49	16.85	7.79
19/02/2024	8.71	16.63	8.01
20/03/2024	8.99	16.35	8.29
17/04/2024	9.19	16.15	8.49
23/05/2024	9.33	16.01	8.63
20/06/2024	9.00	16.34	8.30
5/07/2024	8.87	16.47	8.17
17/07/2024	8.85	16.49	8.15

Minimum Recorded Level (mAHD)	16.01
Maximum Recorded Level (mAHD)	18.81

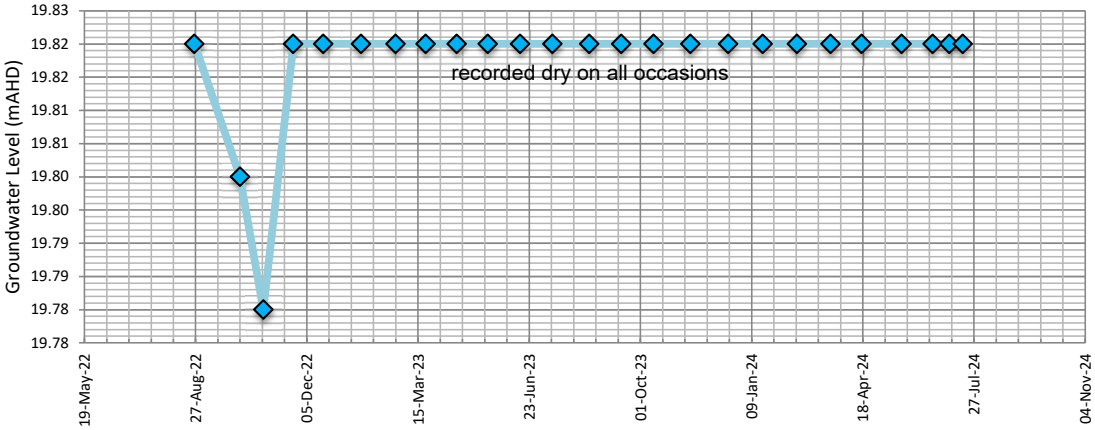
H21003 Wattle Grove South Monitoring

WG7S Hyd2o Bore Wattle Grove 7 Shallow

Site Bore Boundary Rd South - Rear of Lot (Install : Jul 2022)

				Natural Surface (mAHD)	22.85
Data Analysis Period Start Date	1/01/2009	Easting	405351	Top of Casing (m AHD)	23.50
Data Analysis Period End Date	18/07/2024	Northing	6457885	End of Hole (mAHD)	19.85

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
26/08/2022	3.68	19.82	3.03
6/10/2022	3.70	19.80	3.05
27/10/2022	3.72	19.78	3.07
23/11/2022	3.68	19.82	3.03
20/12/2022	3.68	19.82	3.03
23/01/2023	3.68	19.82	3.03
23/02/2023	3.68	19.82	3.03
22/03/2023	3.68	19.82	3.03
19/04/2023	3.68	19.82	3.03
17/05/2023	3.68	19.82	3.03
15/06/2023	3.68	19.82	3.03
14/07/2023	3.68	19.82	3.03
16/08/2023	3.68	19.82	3.03
14/09/2023	3.68	19.82	3.03
13/10/2023	3.68	19.82	3.03
15/11/2023	3.68	19.82	3.03
19/12/2023	3.68	19.82	3.03
19/01/2024	3.68	19.82	3.03
19/02/2024	3.68	19.82	3.03
20/03/2024	3.68	19.82	3.03
17/04/2024	3.68	19.82	3.03
23/05/2024	3.68	19.82	3.03
20/06/2024	3.68	19.82	3.03
5/07/2024	3.68	19.82	3.03
17/07/2024	3.68	19.82	3.03

Minimum Recorded Level (mAHD)	19.78
Maximum Recorded Level (mAHD)	19.82

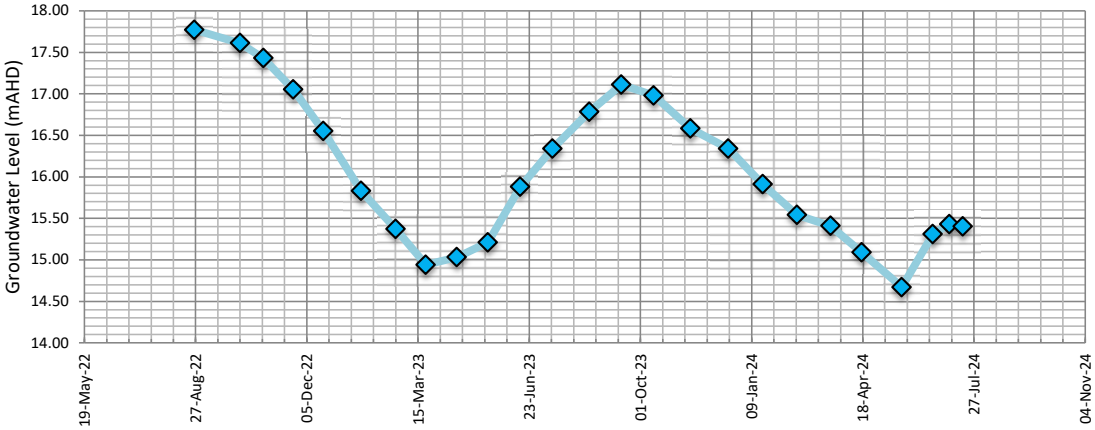
H21003 Wattle Grove South Monitoring

WG7D Hyd2o Bore Wattle Grove 7 Deep

Site Bore Boundary Rd South - Rear of Lot (Install : Jul 2022)

				Natural Surface (mAHD)	22.90
Data Analysis Period Start Date	1/01/2009	Easting	405352	Top of Casing (m AHD)	23.44
Data Analysis Period End Date	18/07/2024	Northing	6457884	End of Hole (mAHD)	11.90

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
26/08/2022	5.67	17.77	5.13
6/10/2022	5.83	17.61	5.29
27/10/2022	6.01	17.43	5.47
23/11/2022	6.39	17.05	5.85
20/12/2022	6.89	16.55	6.35
23/01/2023	7.61	15.83	7.07
23/02/2023	8.07	15.37	7.53
22/03/2023	8.50	14.94	7.96
19/04/2023	8.41	15.03	7.87
17/05/2023	8.23	15.21	7.69
15/06/2023	7.56	15.88	7.02
14/07/2023	7.10	16.34	6.56
16/08/2023	6.66	16.78	6.12
14/09/2023	6.33	17.11	5.79
13/10/2023	6.46	16.98	5.92
15/11/2023	6.86	16.58	6.32
19/12/2023	7.10	16.34	6.56
19/01/2024	7.53	15.91	6.99
19/02/2024	7.90	15.54	7.36
20/03/2024	8.03	15.41	7.49
17/04/2024	8.35	15.09	7.81
23/05/2024	8.77	14.67	8.23
20/06/2024	8.13	15.31	7.59
5/07/2024	8.01	15.43	7.47
17/07/2024	8.04	15.40	7.50

Minimum Recorded Level (mAHD)	14.67
Maximum Recorded Level (mAHD)	17.77

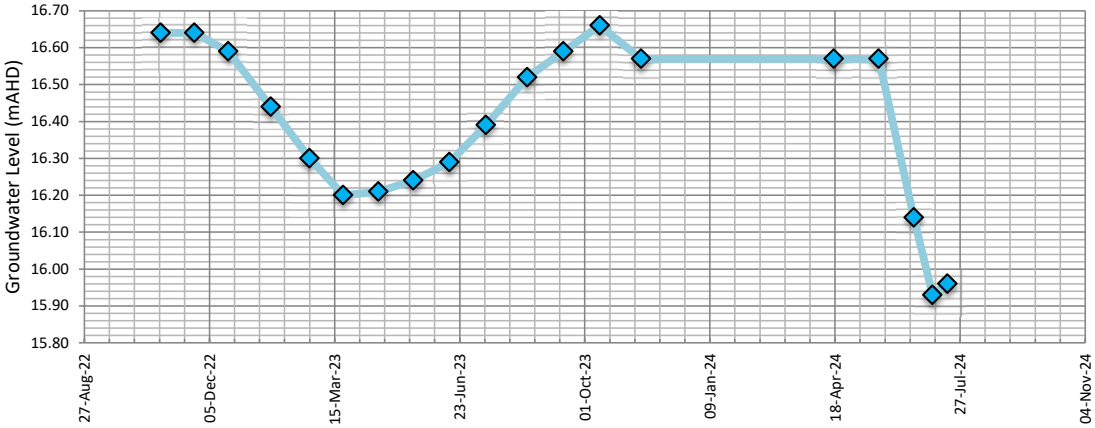
H21003 Wattle Grove South Monitoring

WG8 Hyd2o Bore Wattle Grove 8

Upstream Bore Emanuel Crt North - Verge (Install : Oct 2022)

				Natural Surface (mAHD)	41.08
Data Analysis Period Start Date	1/01/2009	Easting	406959	Top of Casing (m AHD)	41.77
Data Analysis Period End Date	18/07/2024	Northing	6457834	End of Hole (mAHD)	14.08

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
27/10/2022	25.13	16.64	24.44
23/11/2022	25.13	16.64	24.44
20/12/2022	25.18	16.59	24.49
23/01/2023	25.33	16.44	24.64
23/02/2023	25.47	16.30	24.78
22/03/2023	25.57	16.20	24.88
19/04/2023	25.56	16.21	24.87
17/05/2023	25.53	16.24	24.84
15/06/2023	25.48	16.29	24.79
14/07/2023	25.38	16.39	24.69
16/08/2023	25.25	16.52	24.56
14/09/2023	25.18	16.59	24.49
13/10/2023	25.11	16.66	24.42
15/11/2023	25.20	16.57	24.51
17/04/2024	25.20	16.57	24.51
23/05/2024	25.20	16.57	24.51
20/06/2024	25.63	16.14	24.94
5/07/2024	25.84	15.93	25.15
17/07/2024	25.81	15.96	25.12

Minimum Recorded Level (mAHD)	15.93
Maximum Recorded Level (mAHD)	16.66

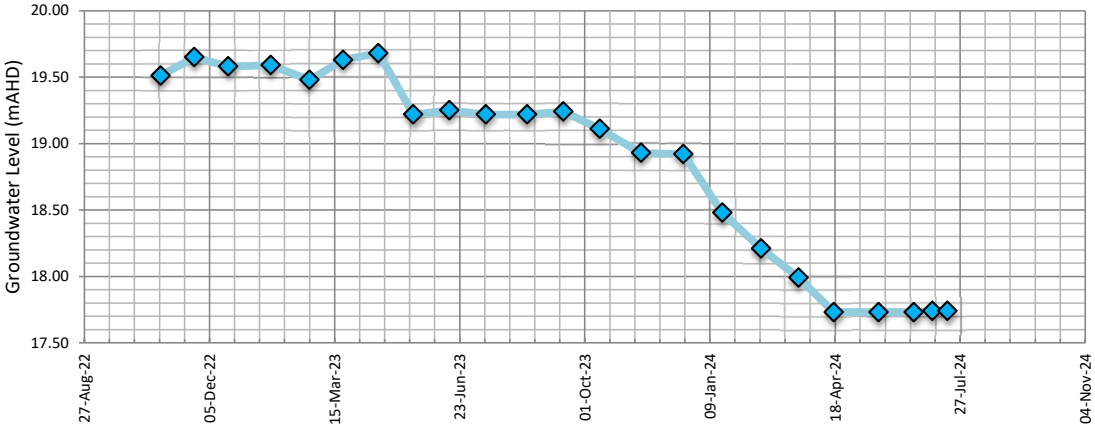
H21003 Wattle Grove South Monitoring

WG9 Hyd2o Bore Wattle Grove 9

Site Bore Victoria Rd Turf Farm South - Rear of Lot (Install : Oct 2022)

				Natural Surface (mAHD)	23.23
Data Analysis Period Start Date	1/01/2009	Easting	405651	Top of Casing (m AHD)	23.86
Data Analysis Period End Date	18/07/2024	Northing	6457338	End of Hole (mAHD)	17.23

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
27/10/2022	4.35	19.51	3.72
23/11/2022	4.21	19.65	3.58
20/12/2022	4.28	19.58	3.65
23/01/2023	4.27	19.59	3.64
23/02/2023	4.38	19.48	3.75
22/03/2023	4.23	19.63	3.60
19/04/2023	4.18	19.68	3.55
17/05/2023	4.64	19.22	4.01
15/06/2023	4.61	19.25	3.98
14/07/2023	4.64	19.22	4.01
16/08/2023	4.64	19.22	4.01
14/09/2023	4.62	19.24	3.99
13/10/2023	4.75	19.11	4.12
15/11/2023	4.93	18.93	4.30
19/12/2023	4.94	18.92	4.31
19/01/2024	5.38	18.48	4.75
19/02/2024	5.65	18.21	5.02
20/03/2024	5.87	17.99	5.24
17/04/2024	6.13	17.73	5.50
23/05/2024	6.13	17.73	5.50
20/06/2024	6.13	17.73	5.50
5/07/2024	6.12	17.74	5.49
17/07/2024	6.12	17.74	5.49

Minimum Recorded Level (mAHD)	17.73
Maximum Recorded Level (mAHD)	19.68

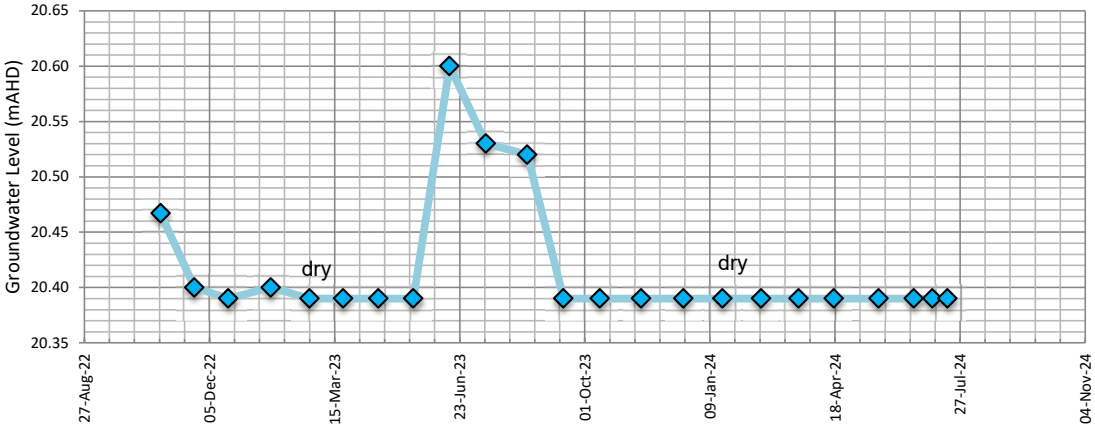
H21003 Wattle Grove South Monitoring

WG10S Hyd2o Bore Wattle Grove 10 Shallow

Site Bore Boundary Rd North - Verge (Install : Oct 2022)

				Natural Surface (mAHD)	22.80
Data Analysis Period Start Date	1/01/2009	Easting	405364	Top of Casing (m AHD)	23.60
Data Analysis Period End Date	18/07/2024	Northing	6458074	End of Hole (mAHD)	19.80

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
27/10/2022	3.13	20.47	2.33
23/11/2022	3.20	20.40	2.40
20/12/2022	3.21	20.39	2.41
23/01/2023	3.20	20.40	2.40
23/02/2023	3.21	20.39	2.41
22/03/2023	3.21	20.39	2.41
19/04/2023	3.21	20.39	2.41
17/05/2023	3.21	20.39	2.41
15/06/2023	3.00	20.60	2.20
14/07/2023	3.07	20.53	2.27
16/08/2023	3.08	20.52	2.28
14/09/2023	3.21	20.39	2.41
13/10/2023	3.21	20.39	2.41
15/11/2023	3.21	20.39	2.41
19/12/2023	3.21	20.39	2.41
19/01/2024	3.21	20.39	2.41
19/02/2024	3.21	20.39	2.41
20/03/2024	3.21	20.39	2.41
17/04/2024	3.21	20.39	2.41
23/05/2024	3.21	20.39	2.41
20/06/2024	3.21	20.39	2.41
5/07/2024	3.21	20.39	2.41
17/07/2024	3.21	20.39	2.41

Minimum Recorded Level (mAHD)	20.39
Maximum Recorded Level (mAHD)	20.60

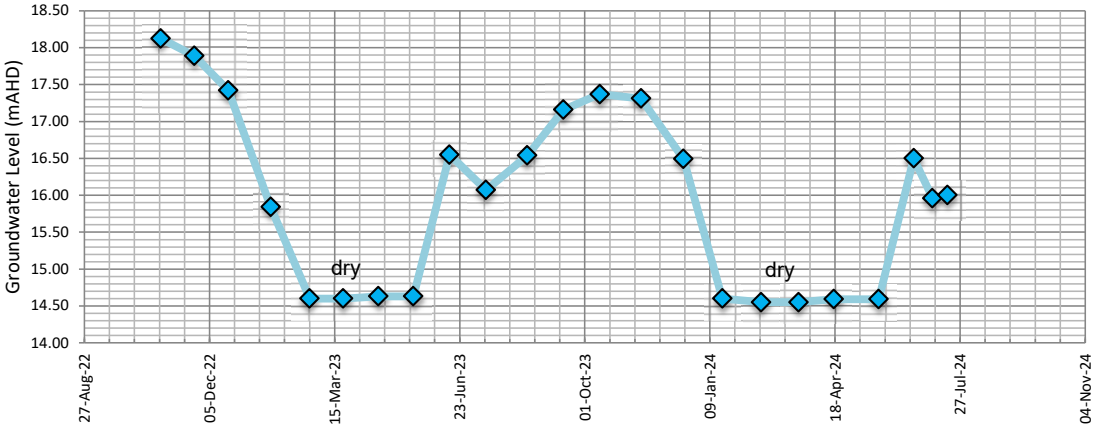
H21003 Wattle Grove South Monitoring

WG10D Hyd2o Bore Wattle Grove 10 Deep

Site Bore Boundary Rd North - Verge (Install : Oct 2022)

				Natural Surface (mAHD)	22.88
Data Analysis Period Start Date	1/01/2009	Easting	405365	Top of Casing (m AHD)	23.62
Data Analysis Period End Date	18/07/2024	Northing	6458075	End of Hole (mAHD)	13.88

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
27/10/2022	5.49	18.13	4.76
23/11/2022	5.73	17.89	4.99
20/12/2022	6.20	17.42	5.46
23/01/2023	7.78	15.84	7.04
23/02/2023	9.02	14.60	8.28
22/03/2023	9.02	14.60	8.28
19/04/2023	8.99	14.63	8.25
17/05/2023	8.99	14.63	8.25
15/06/2023	7.07	16.55	6.33
14/07/2023	7.55	16.07	6.81
16/08/2023	7.08	16.54	6.34
14/09/2023	6.46	17.16	5.72
13/10/2023	6.25	17.37	5.51
15/11/2023	6.31	17.31	5.57
19/12/2023	7.13	16.49	6.39
19/01/2024	9.02	14.60	8.28
19/02/2024	9.07	14.55	8.33
20/03/2024	9.07	14.55	8.33
17/04/2024	9.03	14.59	8.29
23/05/2024	9.03	14.59	8.29
20/06/2024	7.12	16.50	6.38
5/07/2024	7.66	15.96	6.92
17/07/2024	7.62	16.00	6.88

Minimum Recorded Level (mAHD)	14.55
Maximum Recorded Level (mAHD)	18.13

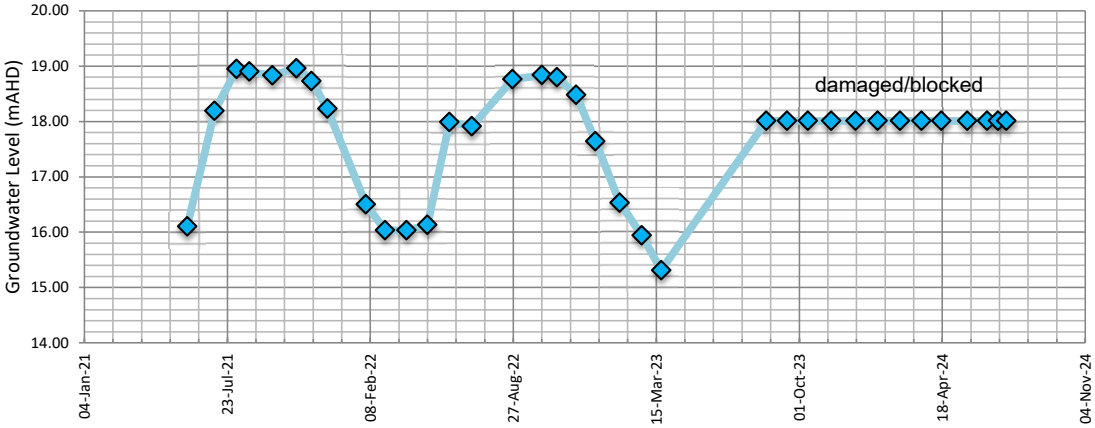
H21003 Wattle Grove South Monitoring

MBa Unknown Origin Bore

Downstream Bore Boundary Rd South - Verge (Install : Unknown)

				Natural Surface (mAHD)	20.03
Data Analysis Period Start Date	1/01/2009	Easting	405245	Top of Casing (m AHD)	20.61
Data Analysis Period End Date	18/07/2024	Northing	6457958	End of Hole (mAHD)	

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
28/05/2021	4.51	16.10	3.93
5/07/2021	2.42	18.19	1.84
5/08/2021	1.66	18.95	1.08
23/08/2021	1.71	18.90	1.13
24/09/2021	1.78	18.83	1.20
28/10/2021	1.65	18.96	1.07
18/11/2021	1.88	18.73	1.30
10/12/2021	2.38	18.23	1.80
2/02/2022	4.11	16.50	3.53
1/03/2022	4.58	16.03	4.00
31/03/2022	4.58	16.03	4.00
29/04/2022	4.48	16.13	3.90
30/05/2022	2.62	17.99	2.04
30/06/2022	2.70	17.91	2.12
26/08/2022	1.85	18.76	1.27
6/10/2022	1.77	18.84	1.19
27/10/2022	1.81	18.80	1.23
23/11/2022	2.13	18.48	1.55
20/12/2022	2.97	17.64	2.39
23/01/2023	4.08	16.53	3.50
23/02/2023	4.67	15.94	4.09
22/03/2023	5.30	15.31	4.72
16/08/2023	2.60	18.01	2.02
14/09/2023	2.60	18.01	2.02
13/10/2023	2.60	18.01	2.02
15/11/2023	2.60	18.01	2.02
19/12/2023	2.60	18.01	2.02
19/01/2024	2.60	18.01	2.02
19/02/2024	2.60	18.01	2.02
20/03/2024	2.60	18.01	2.02
17/04/2024	2.60	18.01	2.02
23/05/2024	2.60	18.01	2.02
20/06/2024	2.60	18.01	2.02
5/07/2024	2.60	18.01	2.02
17/07/2024	2.60	18.01	2.02

Minimum Recorded Level (mAHD)	15.31
Maximum Recorded Level (mAHD)	18.96

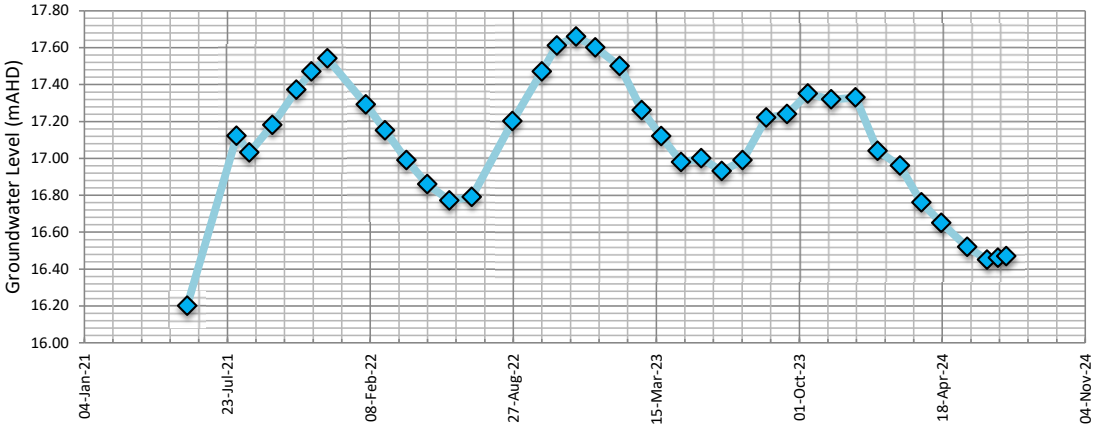
H21003 Wattle Grove South Monitoring

MBb Douglas Partners Bore 1

Site Bore Chicken Shed South - Rear of Lot (Install : Oct 2020)

				Natural Surface (mAHD)	31.25
Data Analysis Period Start Date	1/01/2009	Easting	406067	Top of Casing (m AHD)	31.90
Data Analysis Period End Date	18/07/2024	Northing	6456783	End of Hole (mAHD)	

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
28/05/2021	15.70	16.20	15.05
5/08/2021	14.78	17.12	14.13
23/08/2021	14.87	17.03	14.22
24/09/2021	14.72	17.18	14.07
28/10/2021	14.53	17.37	13.88
18/11/2021	14.43	17.47	13.78
10/12/2021	14.36	17.54	13.71
2/02/2022	14.61	17.29	13.96
1/03/2022	14.75	17.15	14.10
31/03/2022	14.91	16.99	14.26
29/04/2022	15.04	16.86	14.39
30/05/2022	15.13	16.77	14.48
30/06/2022	15.11	16.79	14.46
26/08/2022	14.70	17.20	14.05
6/10/2022	14.43	17.47	13.78
27/10/2022	14.29	17.61	13.64
23/11/2022	14.24	17.66	13.59
20/12/2022	14.30	17.60	13.65
23/01/2023	14.40	17.50	13.75
23/02/2023	14.64	17.26	13.99
22/03/2023	14.78	17.12	14.13
19/04/2023	14.92	16.98	14.27
17/05/2023	14.90	17.00	14.25
15/06/2023	14.97	16.93	14.32
14/07/2023	14.91	16.99	14.26
16/08/2023	14.68	17.22	14.03
14/09/2023	14.66	17.24	14.01
13/10/2023	14.55	17.35	13.90
15/11/2023	14.58	17.32	13.93
19/12/2023	14.57	17.33	13.92
19/01/2024	14.86	17.04	14.21
19/02/2024	14.94	16.96	14.29
20/03/2024	15.14	16.76	14.49
17/04/2024	15.25	16.65	14.60
23/05/2024	15.38	16.52	14.73
20/06/2024	15.45	16.45	14.80
5/07/2024	15.44	16.46	14.79
17/07/2024	15.43	16.47	14.78

Minimum Recorded Level (mAHD)	16.20
Maximum Recorded Level (mAHD)	17.66

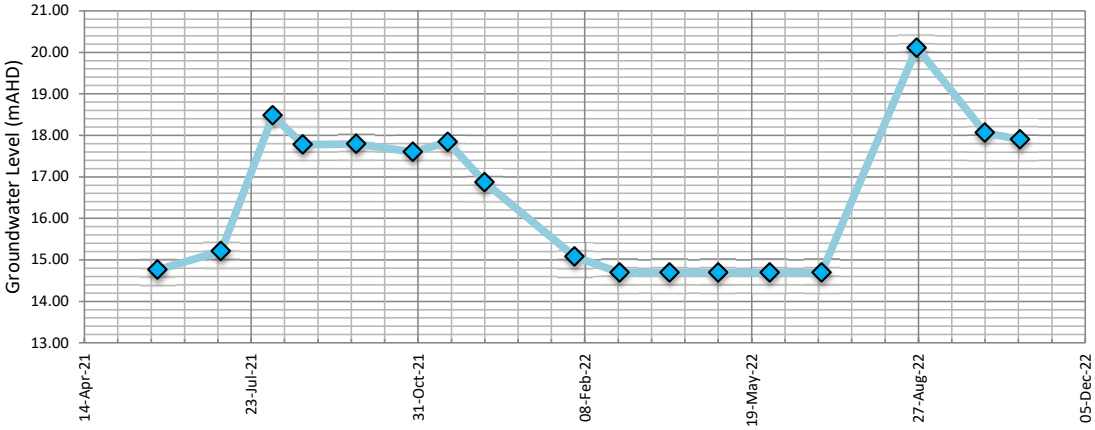
H21003 Wattle Grove South Monitoring

GW1 Urbaqua Bore 1

Site Bore Boundary Rd North - Verge (Install : Sep 2019)

				Natural Surface (mAHD)	22.99
Data Analysis Period Start Date	1/01/2009	Easting	405363	Top of Casing (m AHD)	23.49
Data Analysis Period End Date	18/07/2024	Northing	6458071	End of Hole (mAHD)	14.99

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
28/05/2021	8.73	14.76	8.23
5/07/2021	8.28	15.21	7.78
5/08/2021	5.01	18.48	4.51
23/08/2021	5.71	17.78	5.21
24/09/2021	5.70	17.79	5.20
28/10/2021	5.89	17.60	5.39
18/11/2021	5.65	17.84	5.15
10/12/2021	6.62	16.87	6.12
2/02/2022	8.41	15.08	7.91
1/03/2022	8.80	14.69	8.30
31/03/2022	8.80	14.69	8.30
29/04/2022	8.80	14.69	8.30
30/05/2022	8.80	14.69	8.30
30/06/2022	8.80	14.69	8.30
26/08/2022	3.38	20.11	2.88
6/10/2022	5.43	18.06	4.93
27/10/2022	5.59	17.90	5.09

Minimum Recorded Level (mAHD)	14.69
Maximum Recorded Level (mAHD)	20.11

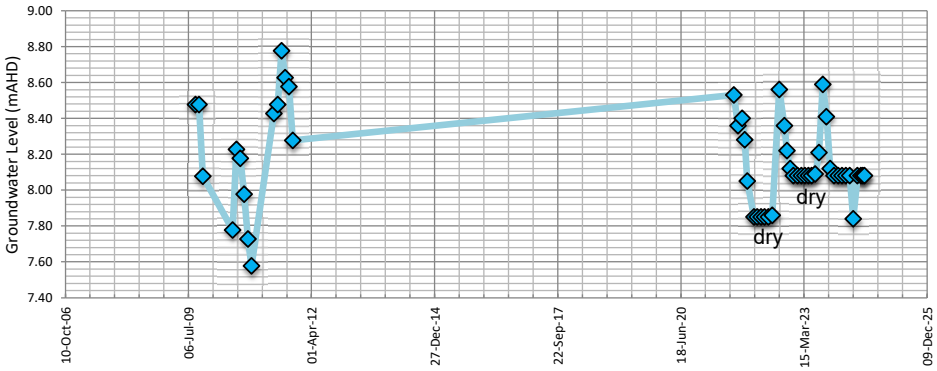
H21003 Wattle Grove South Monitoring

GW3 Endemic Bore 3

Downstream Bore Boundary Rd South - GBSWA (Install : Jun 2009)

				Natural Surface (mAHD)	8.97
Data Analysis Period Start Date	1/01/2009	Easting	403634	Top of Casing (m AHD)	9.65
Data Analysis Period End Date	18/07/2024	Northing	6456299	End of Hole (mAHD)	7.33

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
1/09/2009	1.17	8.48	0.49
1/10/2009	1.17	8.48	0.49
1/11/2009	1.57	8.08	0.89
1/07/2010	1.87	7.78	1.19
1/08/2010	1.42	8.23	0.74
1/09/2010	1.47	8.18	0.79
1/10/2010	1.67	7.98	0.99
1/11/2010	1.92	7.73	1.24
1/12/2010	2.07	7.58	1.39
1/06/2011	1.22	8.43	0.54
1/07/2011	1.17	8.48	0.49
1/08/2011	0.87	8.78	0.19
1/09/2011	1.02	8.63	0.34
1/10/2011	1.07	8.58	0.39
1/11/2011	1.37	8.28	0.69
23/08/2021	1.12	8.53	0.44
24/09/2021	1.29	8.36	0.61
28/10/2021	1.25	8.40	0.57
18/11/2021	1.37	8.28	0.69
10/12/2021	1.60	8.05	0.92
2/02/2022	1.80	7.85	1.12
1/03/2022	1.80	7.85	1.12
31/03/2022	1.80	7.85	1.12
29/04/2022	1.80	7.85	1.12
30/05/2022	1.80	7.85	1.12
30/06/2022	1.79	7.86	1.11
26/08/2022	1.09	8.56	0.41
6/10/2022	1.29	8.36	0.61
27/10/2022	1.43	8.22	0.75
23/11/2022	1.53	8.12	0.85
20/12/2022	1.57	8.08	0.89
23/01/2023	1.57	8.08	0.89
23/02/2023	1.57	8.08	0.89
22/03/2023	1.57	8.08	0.89
19/04/2023	1.57	8.08	0.89
17/05/2023	1.57	8.08	0.89
15/06/2023	1.56	8.09	0.88
14/07/2023	1.44	8.21	0.76
16/08/2023	1.06	8.59	0.38
14/09/2023	1.24	8.41	0.56
13/10/2023	1.53	8.12	0.85
15/11/2023	1.57	8.08	0.89
19/12/2023	1.57	8.08	0.89
19/01/2024	1.57	8.08	0.89
19/02/2024	1.57	8.08	0.89
20/03/2024	1.57	8.08	0.89
17/04/2024	1.81	7.84	1.13
23/05/2024	1.57	8.08	0.89
20/06/2024	1.57	8.08	0.89
5/07/2024	1.57	8.08	0.89
17/07/2024	1.57	8.08	0.89

Minimum Recorded Level (mAHD)	7.58
Maximum Recorded Level (mAHD)	8.78

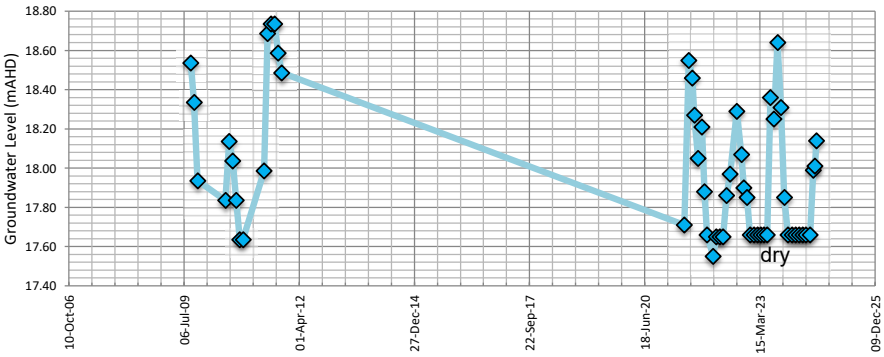
H21003 Wattle Grove South Monitoring

GW5 Endemic Bore 5

Downstream Bore Boundary Rd North - GBSWA (Install : Jun 2009)

				Natural Surface (mAHD)	18.84
Data Analysis Period Start Date	1/01/2009	Easting	405055	Top of Casing (m AHD)	19.41
Data Analysis Period End Date	18/07/2024	Northing	6457747	End of Hole (mAHD)	17.66

Report Date : 18/07/2024



Minimum Recorded Level (mAHD)	17.55
Maximum Recorded Level (mAHD)	18.74

Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
1/09/2009	0.87	18.54	0.30
1/10/2009	1.07	18.34	0.50
1/11/2009	1.47	17.94	0.90
1/07/2010	1.57	17.84	1.00
1/08/2010	1.27	18.14	0.70
1/09/2010	1.37	18.04	0.80
1/10/2010	1.57	17.84	1.00
1/11/2010	1.77	17.64	1.20
1/12/2010	1.77	17.64	1.20
1/06/2011	1.42	17.99	0.85
1/07/2011	0.72	18.69	0.15
1/08/2011	0.67	18.74	0.10
1/09/2011	0.67	18.74	0.10
1/10/2011	0.82	18.59	0.25
1/11/2011	0.92	18.49	0.35
28/05/2021	1.70	17.71	1.13
5/07/2021	0.86	18.55	0.29
5/08/2021	0.95	18.46	0.38
23/08/2021	1.14	18.27	0.57
24/09/2021	1.36	18.05	0.79
28/10/2021	1.20	18.21	0.63
18/11/2021	1.53	17.88	0.96
10/12/2021	1.75	17.66	1.18
2/02/2022	1.86	17.55	1.29
1/03/2022	1.76	17.65	1.19
31/03/2022	1.76	17.65	1.19
29/04/2022	1.76	17.65	1.19
30/05/2022	1.55	17.86	0.98
30/06/2022	1.44	17.97	0.87
26/08/2022	1.12	18.29	0.55
6/10/2022	1.34	18.07	0.77
27/10/2022	1.51	17.90	0.94
23/11/2022	1.56	17.85	0.99
20/12/2022	1.75	17.66	1.18
23/01/2023	1.75	17.66	1.18
23/02/2023	1.75	17.66	1.18
22/03/2023	1.75	17.66	1.18
19/04/2023	1.75	17.66	1.18
17/05/2023	1.75	17.66	1.18
15/06/2023	1.05	18.36	0.48
14/07/2023	1.16	18.25	0.59
16/08/2023	0.77	18.64	0.20
14/09/2023	1.10	18.31	0.53
13/10/2023	1.56	17.85	0.99
15/11/2023	1.75	17.66	1.18
19/12/2023	1.75	17.66	1.18
19/01/2024	1.75	17.66	1.18
19/02/2024	1.75	17.66	1.18
20/03/2024	1.75	17.66	1.18
17/04/2024	1.75	17.66	1.18
23/05/2024	1.75	17.66	1.18
20/06/2024	1.42	17.99	0.85
5/07/2024	1.40	18.01	0.83
17/07/2024	1.27	18.14	0.70

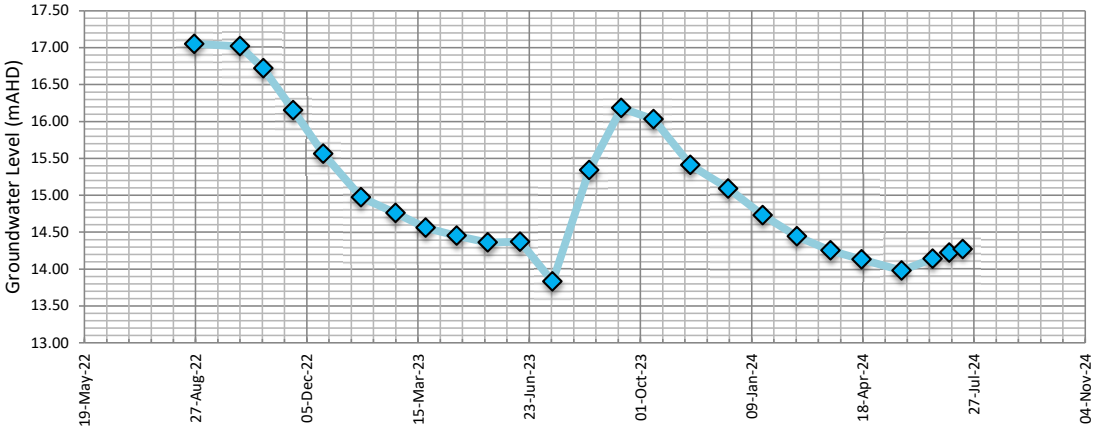
H21003 Wattle Grove South Monitoring

GW5D Hyd2o Deep Bore next to Endemic 5

Downstream Bore Boundary Rd North - GBSWA (Install : Jul 2022)

				Natural Surface (mAHD)	18.81
Data Analysis Period Start Date	1/01/2009	Easting	405053	Top of Casing (m AHD)	19.37
Data Analysis Period End Date	18/07/2024	Northing	6457750	End of Hole (mAHD)	11.81

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
26/08/2022	2.32	17.05	1.76
6/10/2022	2.35	17.02	1.79
27/10/2022	2.65	16.72	2.09
23/11/2022	3.22	16.15	2.66
20/12/2022	3.81	15.56	3.25
23/01/2023	4.40	14.97	3.84
23/02/2023	4.61	14.76	4.05
22/03/2023	4.81	14.56	4.25
19/04/2023	4.92	14.45	4.36
17/05/2023	5.01	14.36	4.45
15/06/2023	5.00	14.37	4.44
14/07/2023	5.54	13.83	4.98
16/08/2023	4.03	15.34	3.47
14/09/2023	3.19	16.18	2.63
13/10/2023	3.34	16.03	2.78
15/11/2023	3.96	15.41	3.40
19/12/2023	4.28	15.09	3.72
19/01/2024	4.64	14.73	4.08
19/02/2024	4.93	14.44	4.37
20/03/2024	5.12	14.25	4.56
17/04/2024	5.24	14.13	4.68
23/05/2024	5.39	13.98	4.83
20/06/2024	5.23	14.14	4.67
5/07/2024	5.15	14.22	4.59
17/07/2024	5.10	14.27	4.54

Minimum Recorded Level (mAHD)	13.83
Maximum Recorded Level (mAHD)	17.05

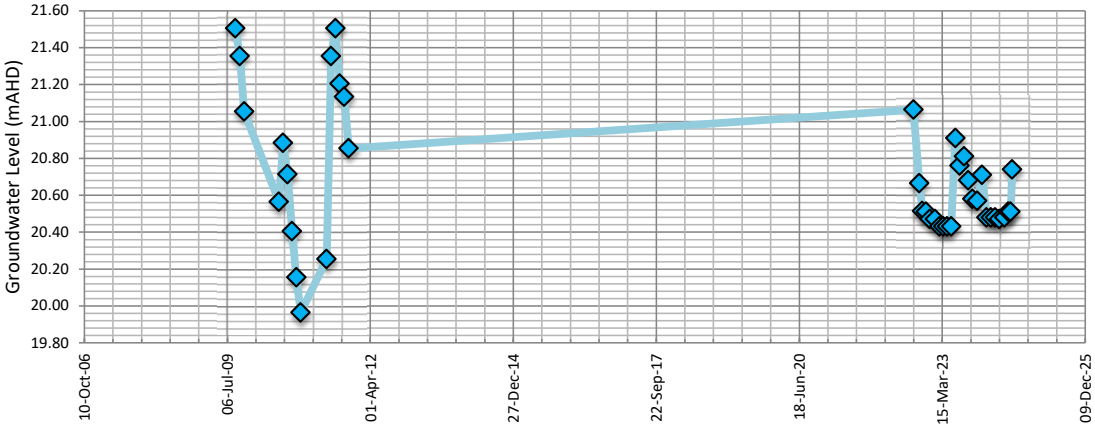
H21003 Wattle Grove South Monitoring

GW8 Endemic Bore 8

Downstream Bore Victoria Rd North - Verge (Install : Jun 2009)

				Natural Surface (mAHD)	24.00
Data Analysis Period Start Date	1/01/2009	Easting	405590	Top of Casing (m AHD)	24.61
Data Analysis Period End Date	18/07/2024	Northing	6456777	End of Hole (mAHD)	20.48

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
1/09/2009	3.11	21.50	2.50
1/10/2009	3.26	21.35	2.65
1/11/2009	3.56	21.05	2.95
1/07/2010	4.05	20.56	3.44
1/08/2010	3.73	20.88	3.12
1/09/2010	3.90	20.71	3.29
1/10/2010	4.21	20.40	3.60
1/11/2010	4.46	20.15	3.85
1/12/2010	4.65	19.96	4.04
1/06/2011	4.36	20.25	3.75
1/07/2011	3.26	21.35	2.65
1/08/2011	3.11	21.50	2.50
1/09/2011	3.41	21.20	2.80
1/10/2011	3.48	21.13	2.87
1/11/2011	3.76	20.85	3.15
26/08/2022	3.55	21.06	2.94
6/10/2022	3.95	20.66	3.34
27/10/2022	4.10	20.51	3.49
23/11/2022	4.10	20.51	3.49
20/12/2022	4.14	20.47	3.53
23/01/2023	4.14	20.47	3.53
23/02/2023	4.18	20.43	3.57
22/03/2023	4.18	20.43	3.57
19/04/2023	4.18	20.43	3.57
17/05/2023	4.18	20.43	3.57
15/06/2023	3.70	20.91	3.09
14/07/2023	3.85	20.76	3.24
16/08/2023	3.80	20.81	3.19
14/09/2023	3.93	20.68	3.32
13/10/2023	4.03	20.58	3.42
15/11/2023	4.04	20.57	3.43
19/12/2023	3.90	20.71	3.29
19/01/2024	4.13	20.48	3.52
19/02/2024	4.13	20.48	3.52
20/03/2024	4.13	20.48	3.52
17/04/2024	4.14	20.47	3.53
23/05/2024	4.13	20.48	3.52
20/06/2024	4.10	20.51	3.49
5/07/2024	4.10	20.51	3.49
17/07/2024	3.87	20.74	3.26

Minimum Recorded Level (mAHD)	19.96
Maximum Recorded Level (mAHD)	21.50

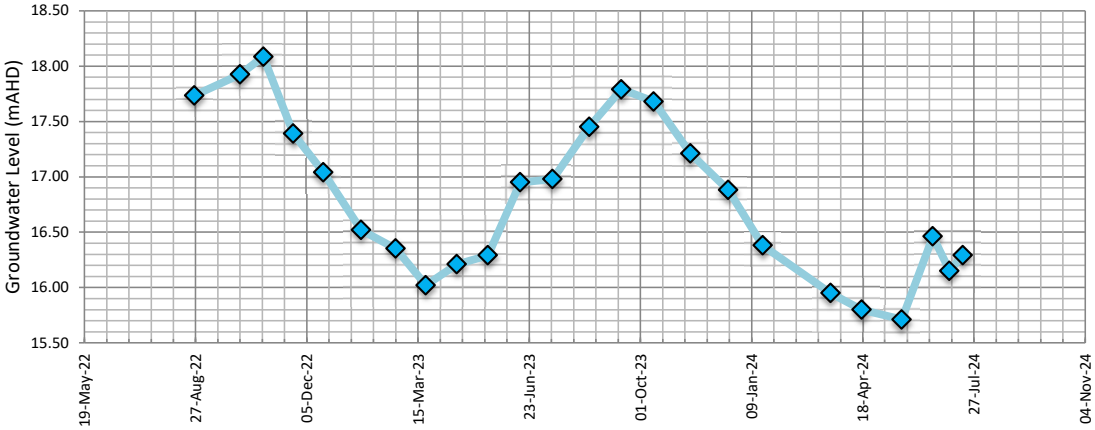
H21003 Wattle Grove South Monitoring

GW8D Hyd2o Deep Bore next to Endemic 8

Downstream Bore Victoria Rd North - Verge (Install Jul 2022)

				Natural Surface (mAHD)	24.00
Data Analysis Period Start Date	1/01/2009	Easting	405590	Top of Casing (m AHD)	24.52
Data Analysis Period End Date	18/07/2024	Northing	6456775	End of Hole (mAHD)	14.50

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
26/08/2022	6.78	17.74	6.27
6/10/2022	6.59	17.93	6.08
27/10/2022	6.43	18.09	5.92
23/11/2022	7.13	17.39	6.61
20/12/2022	7.48	17.04	6.96
23/01/2023	8.00	16.52	7.48
23/02/2023	8.17	16.35	7.65
22/03/2023	8.50	16.02	7.98
19/04/2023	8.31	16.21	7.79
17/05/2023	8.23	16.29	7.71
15/06/2023	7.57	16.95	7.05
14/07/2023	7.54	16.98	7.02
16/08/2023	7.07	17.45	6.55
14/09/2023	6.73	17.79	6.21
13/10/2023	6.84	17.68	6.32
15/11/2023	7.31	17.21	6.79
19/12/2023	7.64	16.88	7.12
19/01/2024	8.14	16.38	7.62
20/03/2024	8.57	15.95	8.05
17/04/2024	8.72	15.80	8.20
23/05/2024	8.81	15.71	8.29
20/06/2024	8.06	16.46	7.54
5/07/2024	8.37	16.15	7.85
17/07/2024	8.23	16.29	7.71

Minimum Recorded Level (mAHD)	15.71
Maximum Recorded Level (mAHD)	18.09

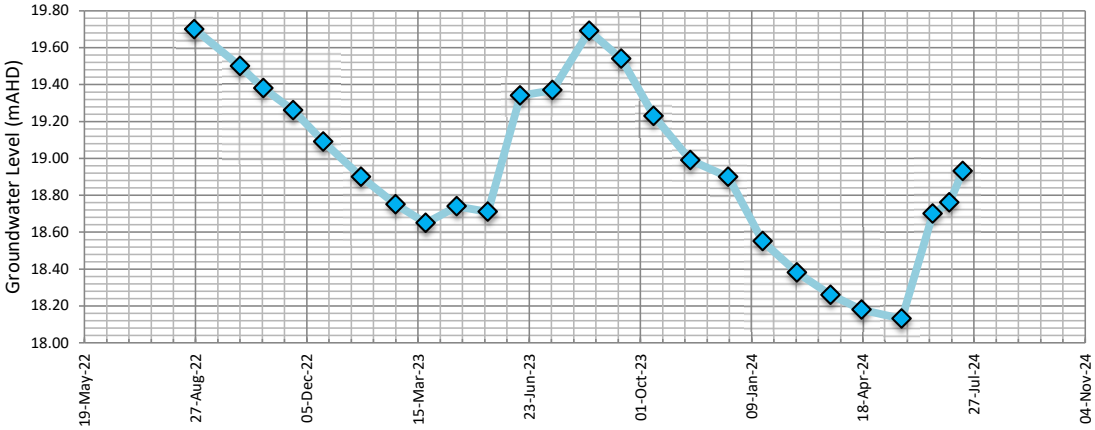
H21003 Wattle Grove South Monitoring

GW9S Hyd2o Bore Wetlands 9 Shallow

Downstream Bore Brentwood Rd North - Verge (Install Jul 2022)

				Natural Surface (mAHD)	21.19
Data Analysis Period Start Date	1/01/2009	Easting	405329	Top of Casing (m AHD)	21.81
Data Analysis Period End Date	18/07/2024	Northing	6457512	End of Hole (mAHD)	18.19

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
26/08/2022	2.11	19.70	1.49
6/10/2022	2.31	19.50	1.69
27/10/2022	2.43	19.38	1.81
23/11/2022	2.55	19.26	1.93
20/12/2022	2.72	19.09	2.10
23/01/2023	2.91	18.90	2.29
23/02/2023	3.06	18.75	2.44
22/03/2023	3.16	18.65	2.54
19/04/2023	3.07	18.74	2.45
17/05/2023	3.10	18.71	2.48
15/06/2023	2.47	19.34	1.85
14/07/2023	2.44	19.37	1.82
16/08/2023	2.12	19.69	1.50
14/09/2023	2.27	19.54	1.65
13/10/2023	2.58	19.23	1.96
15/11/2023	2.82	18.99	2.20
19/12/2023	2.91	18.90	2.29
19/01/2024	3.26	18.55	2.64
19/02/2024	3.43	18.38	2.81
20/03/2024	3.55	18.26	2.93
17/04/2024	3.63	18.18	3.01
23/05/2024	3.68	18.13	3.06
20/06/2024	3.11	18.70	2.49
5/07/2024	3.05	18.76	2.43
17/07/2024	2.88	18.93	2.26

Minimum Recorded Level (mAHD)	18.13
Maximum Recorded Level (mAHD)	19.70

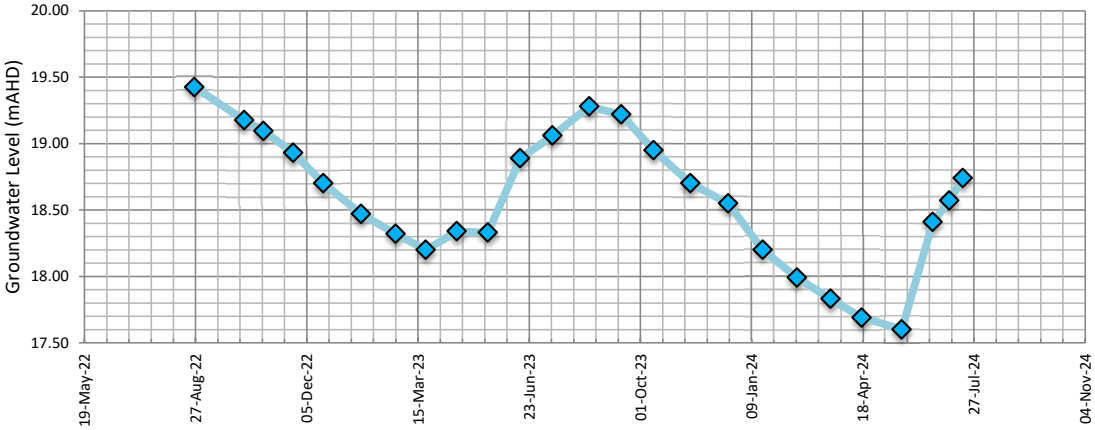
H21003 Wattle Grove South Monitoring

GW9D Hyd2o Bore Wetlands 9 Deep

Downstream Bore Brentwood Rd North - Verge (Install Jul 2022)

				Natural Surface (mAHD)	21.20
Data Analysis Period Start Date	1/01/2009	Easting	405329	Top of Casing (m AHD)	21.78
Data Analysis Period End Date	18/07/2024	Northing	6457513	End of Hole (mAHD)	13.20

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
26/08/2022	2.35	19.43	1.78
10/10/2022	2.60	19.18	2.03
27/10/2022	2.68	19.10	2.11
23/11/2022	2.85	18.93	2.27
20/12/2022	3.08	18.70	2.50
23/01/2023	3.31	18.47	2.73
23/02/2023	3.46	18.32	2.88
22/03/2023	3.58	18.20	3.00
19/04/2023	3.44	18.34	2.86
17/05/2023	3.45	18.33	2.87
15/06/2023	2.89	18.89	2.31
14/07/2023	2.72	19.06	2.14
16/08/2023	2.50	19.28	1.92
14/09/2023	2.56	19.22	1.98
13/10/2023	2.83	18.95	2.25
15/11/2023	3.08	18.70	2.50
19/12/2023	3.23	18.55	2.65
19/01/2024	3.58	18.20	3.00
19/02/2024	3.79	17.99	3.21
20/03/2024	3.95	17.83	3.37
17/04/2024	4.09	17.69	3.51
23/05/2024	4.18	17.60	3.60
20/06/2024	3.37	18.41	2.79
5/07/2024	3.21	18.57	2.63
17/07/2024	3.04	18.74	2.46

Minimum Recorded Level (mAHD)	17.60
Maximum Recorded Level (mAHD)	19.43

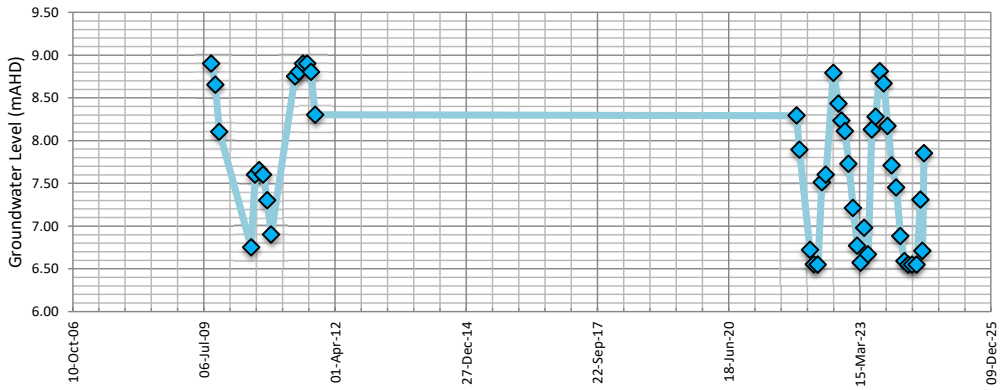
H21003 Wattle Grove South Monitoring

GW12 Endemic Bore 12

Downstream Bore Brook Rd South - GBSWA (Install : Jun 2009)

				Natural Surface (mAHD)	8.90
Data Analysis Period Start Date	1/01/2009	Easting	403440	Top of Casing (m AHD)	9.39
Data Analysis Period End Date	18/07/2024	Northing	6456803	End of Hole (mAHD)	6.57

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
1/09/2009	0.49	8.90	0.00
1/10/2009	0.74	8.65	0.25
1/11/2009	1.29	8.10	0.80
1/07/2010	2.64	6.75	2.15
1/08/2010	1.79	7.60	1.30
1/09/2010	1.74	7.65	1.25
1/10/2010	1.79	7.60	1.30
1/11/2010	2.09	7.30	1.60
1/12/2010	2.49	6.90	2.00
1/06/2011	0.64	8.75	0.15
1/07/2011	0.59	8.80	0.10
1/08/2011	0.49	8.90	0.00
1/09/2011	0.49	8.90	0.00
1/10/2011	0.59	8.80	0.10
1/11/2011	1.09	8.30	0.60
18/11/2021	1.10	8.29	0.61
10/12/2021	1.50	7.89	1.01
1/03/2022	2.67	6.72	2.18
31/03/2022	2.84	6.55	2.35
29/04/2022	2.84	6.55	2.35
30/05/2022	1.88	7.51	1.39
30/06/2022	1.79	7.60	1.30
26/08/2022	0.60	8.79	0.11
6/10/2022	0.96	8.43	0.47
27/10/2022	1.16	8.23	0.67
23/11/2022	1.28	8.11	0.79
20/12/2022	1.66	7.73	1.17
23/01/2023	2.18	7.21	1.69
23/02/2023	2.62	6.77	2.13
22/03/2023	2.82	6.57	2.33
19/04/2023	2.41	6.98	1.92
17/05/2023	2.72	6.67	2.23
15/06/2023	1.26	8.13	0.77
14/07/2023	1.11	8.28	0.62
16/08/2023	0.58	8.81	0.09
14/09/2023	0.72	8.67	0.23
13/10/2023	1.22	8.17	0.73
15/11/2023	1.68	7.71	1.19
19/12/2023	1.94	7.45	1.45
19/01/2024	2.51	6.88	2.02
19/02/2024	2.80	6.59	2.31
20/03/2024	2.84	6.55	2.35
17/04/2024	2.84	6.55	2.35
23/05/2024	2.84	6.55	2.35
20/06/2024	2.08	7.31	1.59
5/07/2024	2.68	6.71	2.19
17/07/2024	1.54	7.85	1.05

Minimum Recorded Level (mAHD)	6.55
Maximum Recorded Level (mAHD)	8.90

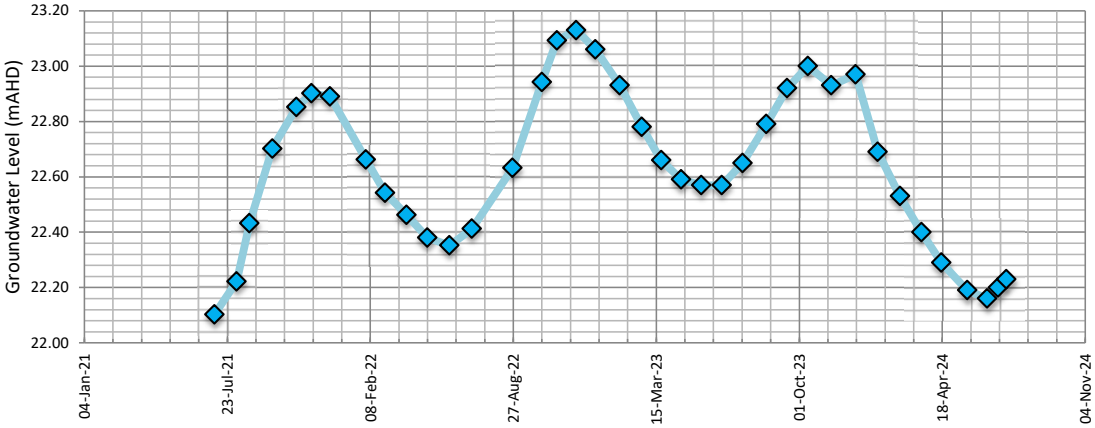
H21003 Wattle Grove South Monitoring

SCC 05/08 DWER Bore 1

Long Term DWER Bore - Ilex Way Forrestfield (Install : Feb 2008)

				Natural Surface (mAHD)	41.21
Data Analysis Period Start Date	1/01/2009	Easting	405767	Top of Casing (m AHD)	41.78
Data Analysis Period End Date	18/07/2024	Northing	6461821	End of Hole (mAHD)	12.21

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
5/07/2021	19.68	22.10	19.11
5/08/2021	19.56	22.22	18.99
23/08/2021	19.35	22.43	18.78
24/09/2021	19.08	22.70	18.51
28/10/2021	18.93	22.85	18.36
18/11/2021	18.88	22.90	18.31
14/12/2021	18.89	22.89	18.32
2/02/2022	19.12	22.66	18.55
1/03/2022	19.24	22.54	18.67
31/03/2022	19.32	22.46	18.75
29/04/2022	19.40	22.38	18.83
30/05/2022	19.43	22.35	18.86
30/06/2022	19.37	22.41	18.80
26/08/2022	19.15	22.63	18.58
6/10/2022	18.84	22.94	18.27
27/10/2022	18.69	23.09	18.12
23/11/2022	18.65	23.13	18.08
20/12/2022	18.72	23.06	18.15
23/01/2023	18.85	22.93	18.28
23/02/2023	19.00	22.78	18.43
22/03/2023	19.12	22.66	18.55
19/04/2023	19.19	22.59	18.62
17/05/2023	19.21	22.57	18.64
15/06/2023	19.21	22.57	18.64
14/07/2023	19.13	22.65	18.56
16/08/2023	18.99	22.79	18.42
14/09/2023	18.86	22.92	18.29
13/10/2023	18.78	23.00	18.21
15/11/2023	18.85	22.93	18.28
19/12/2023	18.81	22.97	18.24
19/01/2024	19.09	22.69	18.52
19/02/2024	19.25	22.53	18.68
20/03/2024	19.38	22.40	18.81
17/04/2024	19.49	22.29	18.92
23/05/2024	19.59	22.19	19.02
20/06/2024	19.62	22.16	19.05
5/07/2024	19.58	22.20	19.01
17/07/2024	19.55	22.23	18.98

Minimum Recorded Level (mAHD)	22.10
Maximum Recorded Level (mAHD)	23.13

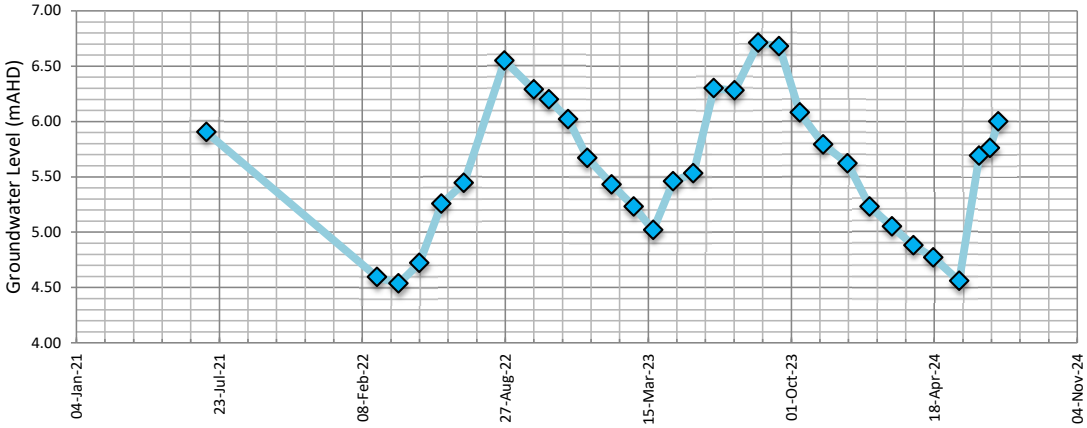
H21003 Wattle Grove South Monitoring

SCC 06/08 DWER Bore 2

Long Term DWER Bore - Crawford St, Cannington (Install : Jan 2008)

				Natural Surface (mAHD)	7.49
Data Analysis Period Start Date	1/01/2009	Easting	401381	Top of Casing (m AHD)	7.98
Data Analysis Period End Date	18/07/2024	Northing	6457518	End of Hole (mAHD)	-4.51

Report Date : 18/07/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
5/07/2021	1.56	5.91	1.58
1/03/2022	2.87	4.60	2.89
31/03/2022	2.93	4.54	2.95
29/04/2022	2.75	4.72	2.77
30/05/2022	2.21	5.26	2.23
30/06/2022	2.02	5.45	2.04
26/08/2022	1.43	6.55	0.94
6/10/2022	1.69	6.29	1.20
27/10/2022	1.78	6.20	1.29
23/11/2022	1.96	6.02	1.47
20/12/2022	2.31	5.67	1.82
23/01/2023	2.55	5.43	2.06
23/02/2023	2.75	5.23	2.26
22/03/2023	2.96	5.02	2.47
19/04/2023	2.52	5.46	2.03
17/05/2023	2.45	5.53	1.96
15/06/2023	1.68	6.30	1.19
14/07/2023	1.70	6.28	1.21
16/08/2023	1.27	6.71	0.78
14/09/2023	1.30	6.68	0.81
13/10/2023	1.90	6.08	1.41
15/11/2023	2.19	5.79	1.70
19/12/2023	2.36	5.62	1.87
19/01/2024	2.75	5.23	2.26
19/02/2024	2.93	5.05	2.44
20/03/2024	3.10	4.88	2.61
17/04/2024	3.21	4.77	2.72
23/05/2024	3.42	4.56	2.93
20/06/2024	2.29	5.69	1.80
5/07/2024	2.22	5.76	1.73
17/07/2024	1.98	6.00	1.49

Minimum Recorded Level (mAHD)	4.54
Maximum Recorded Level (mAHD)	6.71

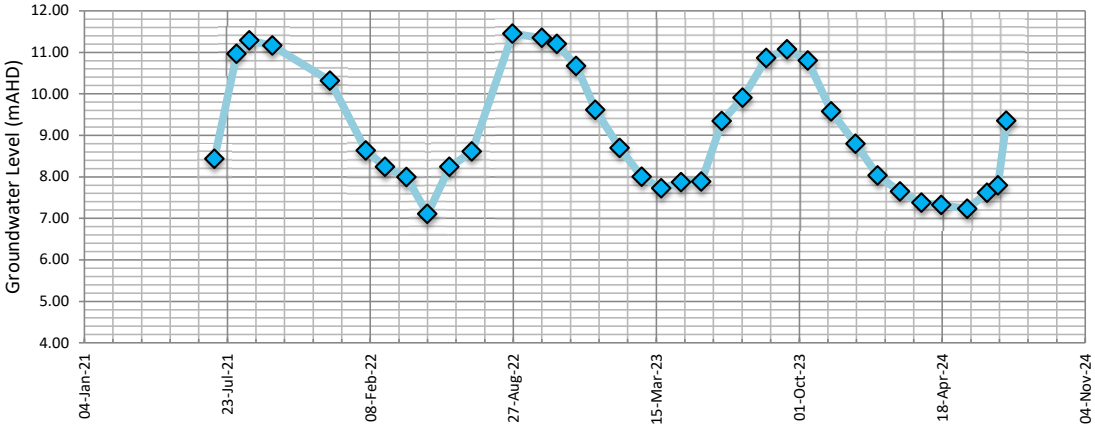
H21003 Wattle Grove South Monitoring

SCC 09/08 DWER Bore 3

Long Term DWER Bore - Banach St, Maddington (Install : Jan 2008)

				Natural Surface (mAHD)	12.62
Data Analysis Period Start Date	1/01/2009	Easting	405600	Top of Casing (m AHD)	13.21
Data Analysis Period End Date	18/07/2024	Northing	6452440	End of Hole (mAHD)	0.87

Report Date : 18/07/2024



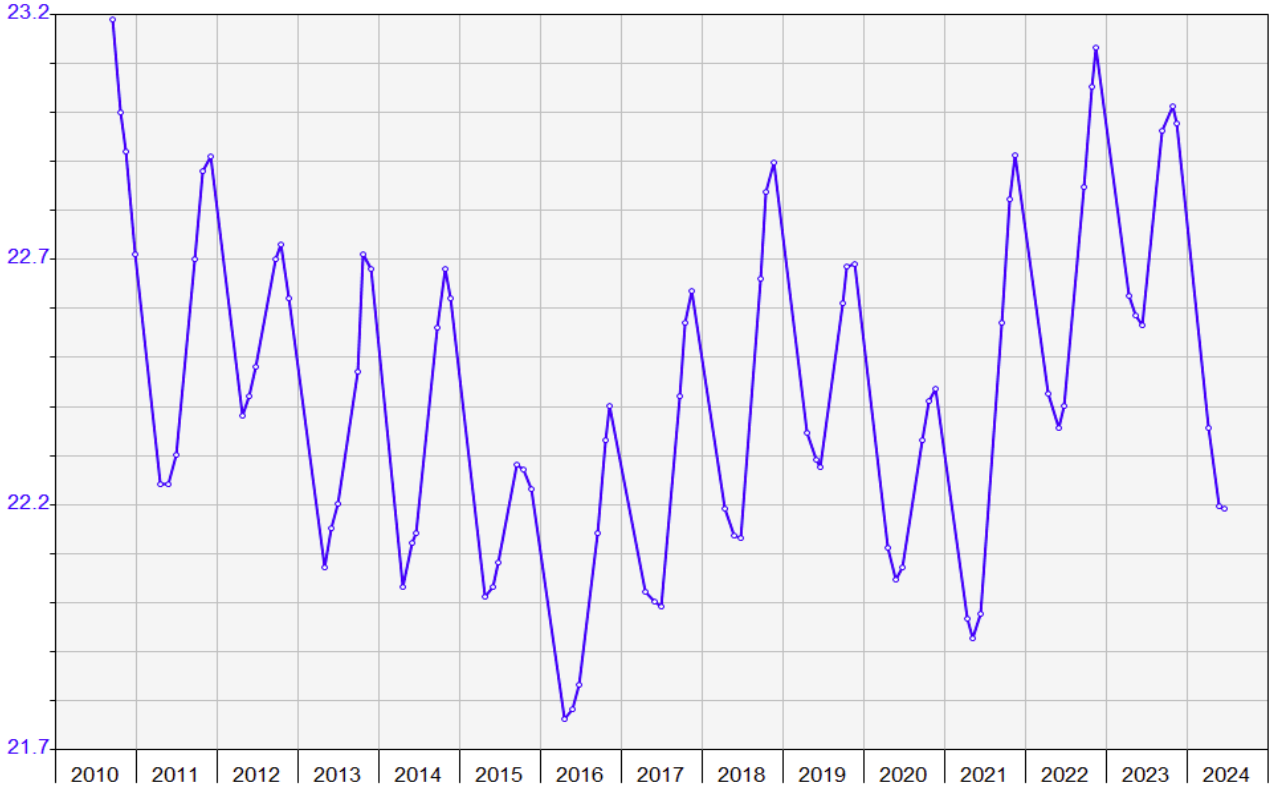
Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
5/07/2021	4.78	8.43	4.20
5/08/2021	2.25	10.96	1.67
23/08/2021	1.92	11.29	1.34
24/09/2021	2.05	11.16	1.47
14/12/2021	2.90	10.31	2.31
2/02/2022	4.58	8.63	4.00
1/03/2022	4.97	8.24	4.39
31/03/2022	5.22	7.99	4.64
29/04/2022	5.40	7.10	5.52
30/05/2022	4.97	8.24	4.39
30/06/2022	4.60	8.61	4.02
26/08/2022	1.76	11.45	1.18
6/10/2022	1.86	11.35	1.28
27/10/2022	2.01	11.20	1.43
23/11/2022	2.54	10.67	1.95
20/12/2022	3.60	9.61	3.01
23/01/2023	4.52	8.69	3.93
23/02/2023	5.21	8.00	4.62
22/03/2023	5.49	7.72	4.90
19/04/2023	5.34	7.87	4.75
17/05/2023	5.33	7.88	4.74
15/06/2023	3.87	9.34	3.28
14/07/2023	3.31	9.90	2.72
16/08/2023	2.35	10.86	1.76
14/09/2023	2.14	11.07	1.55
13/10/2023	2.41	10.80	1.82
15/11/2023	3.64	9.57	3.05
19/12/2023	4.42	8.79	3.83
19/01/2024	5.18	8.03	4.59
19/02/2024	5.57	7.64	4.98
20/03/2024	5.84	7.37	5.25
17/04/2024	5.89	7.32	5.30
23/05/2024	5.98	7.23	5.39
20/06/2024	5.60	7.61	5.01
5/07/2024	5.42	7.79	4.83
17/07/2024	3.86	9.35	3.27

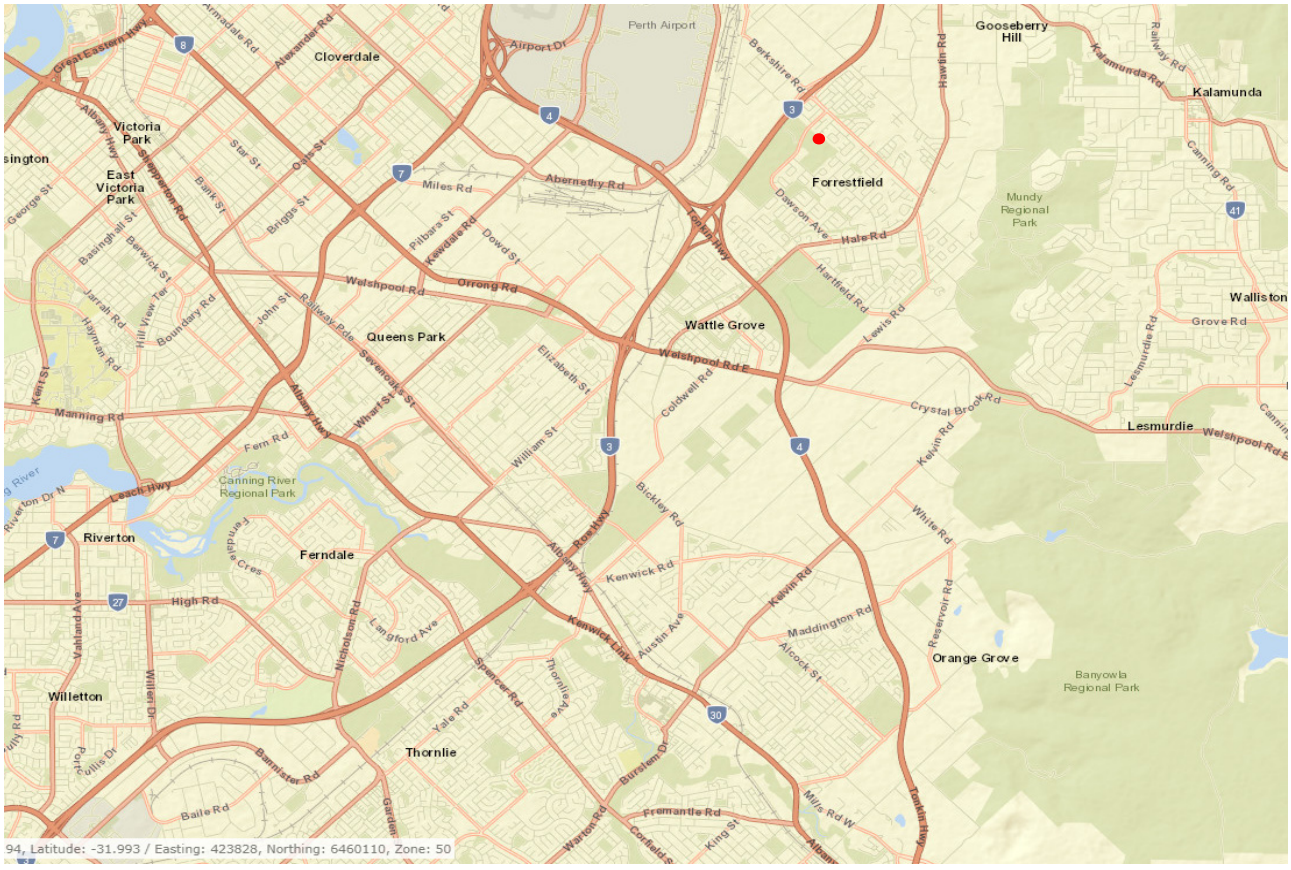
Minimum Recorded Level (mAHD)	7.10
Maximum Recorded Level (mAHD)	11.45

APPENDIX L

DWER Long Term Monitoring Bore Hydrographs

Date :18/07/2024 Job No. H22076





Source: Department of Water and Environmental Regulation (2024)

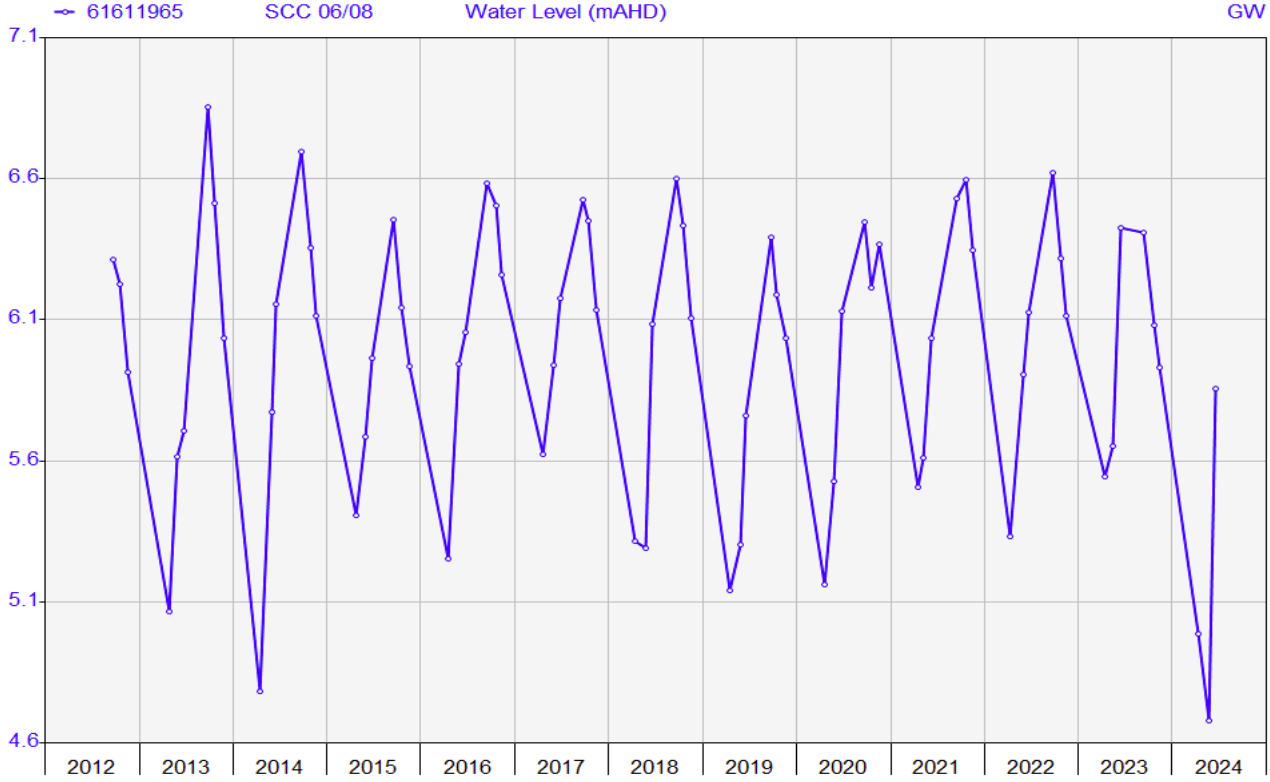
hyd2o

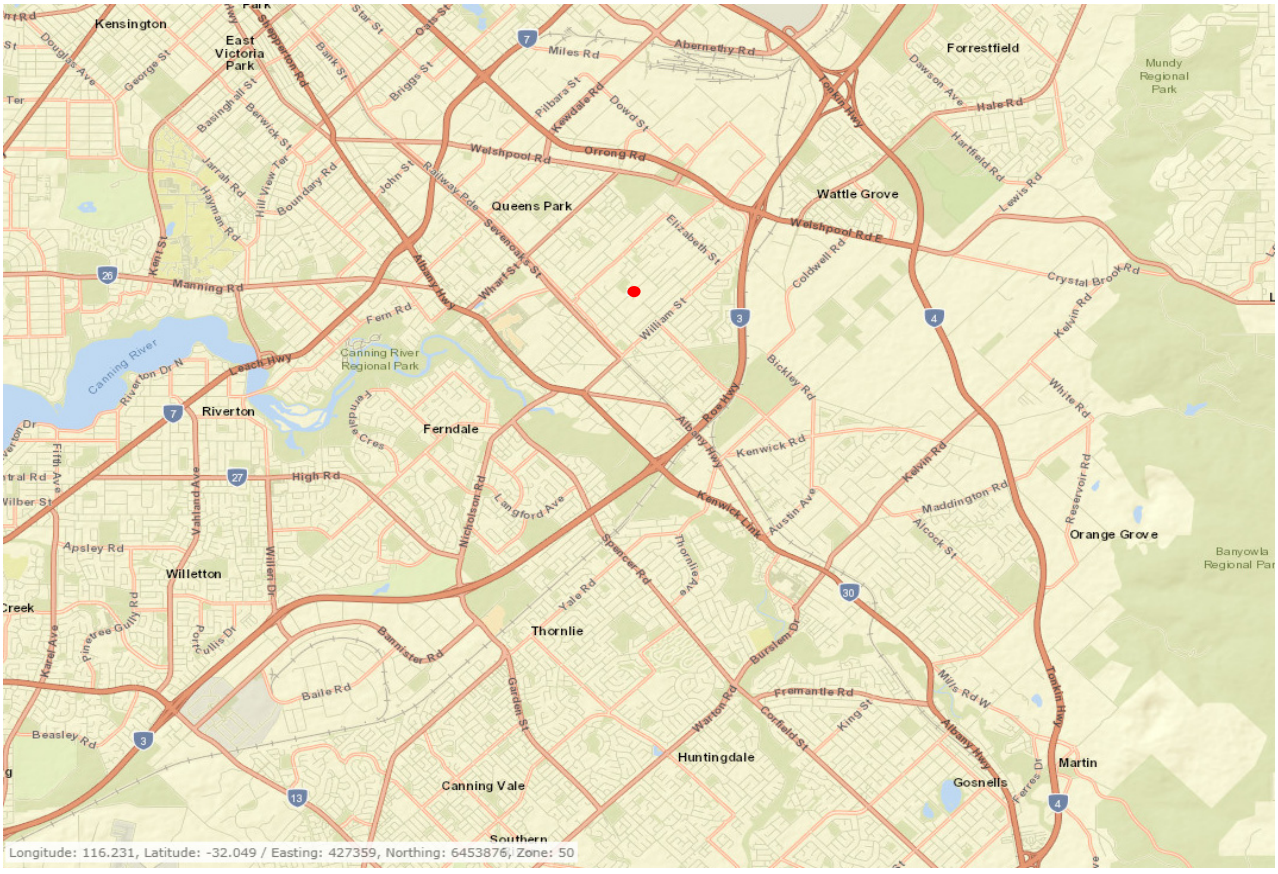
Wattle Grove South District Water Management Strategy

DWER Bore Hydrographs : SCC 05-08

Appendix L1

Date :18/07/2024 Job No. H22076





Source: Department of Water and Environmental Regulation (2024)

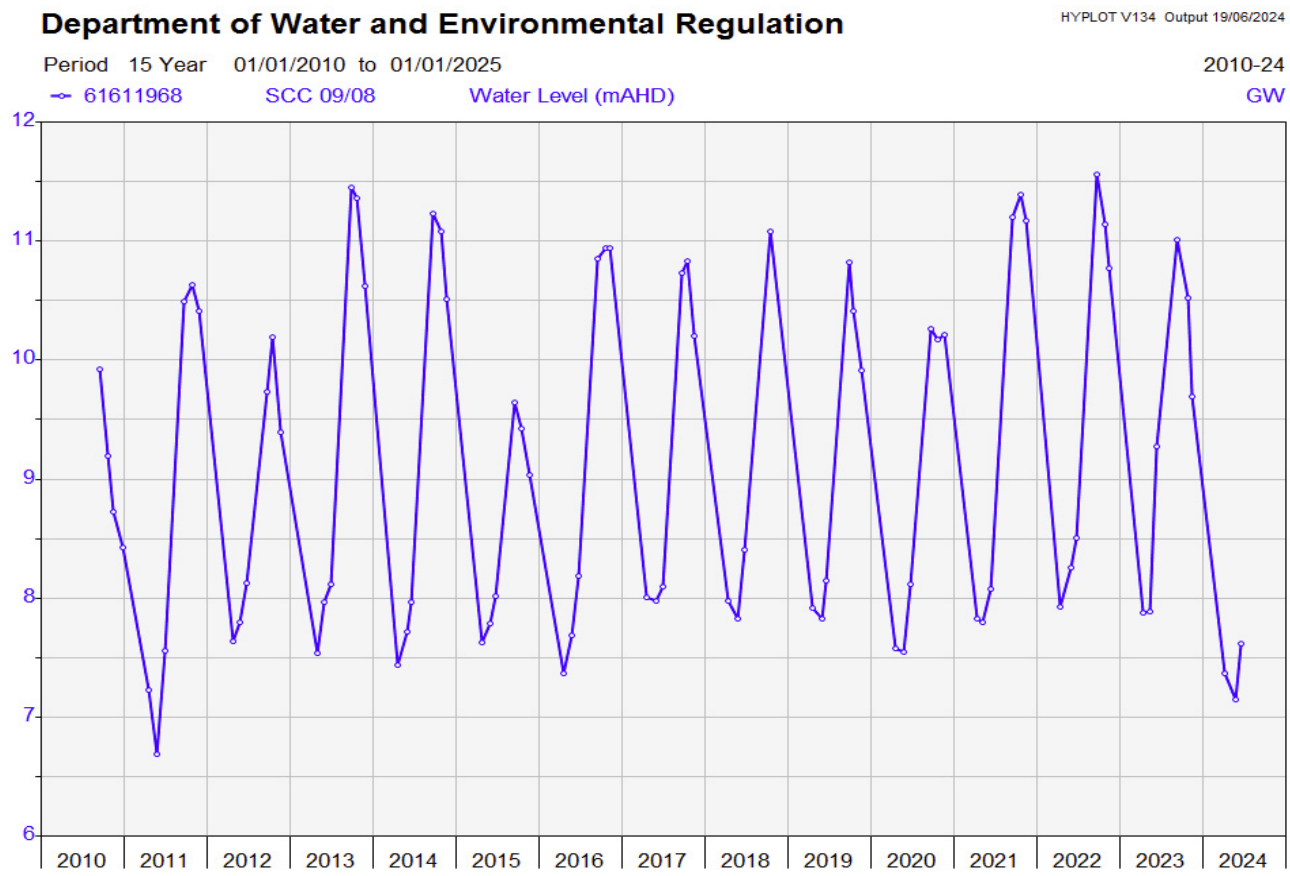
hyd2o

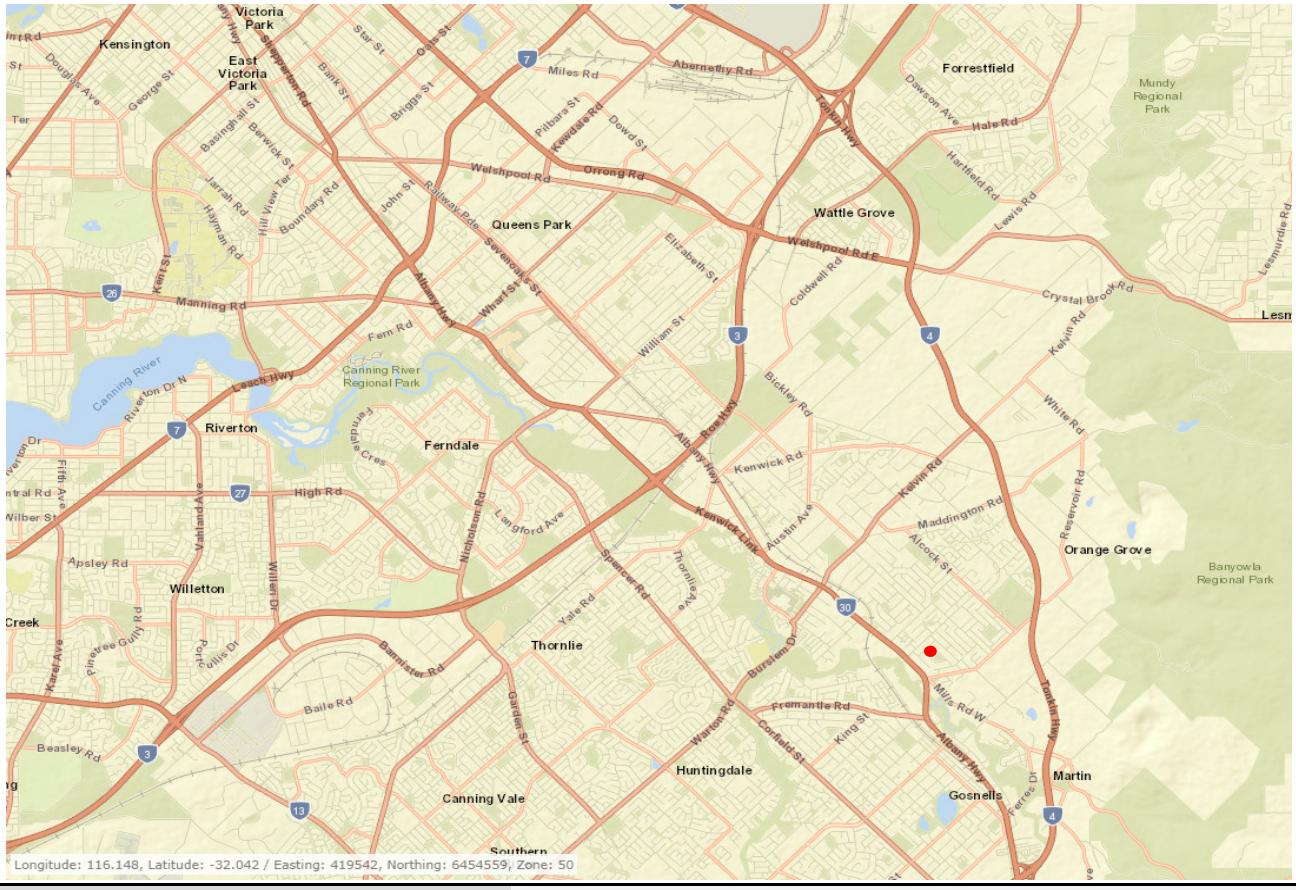
Wattle Grove South District Water Management Strategy

DWER Bore Hydrographs : SC 06-08

Appendix L2

Date : 18/07/2024 Job No. H22076





Source: Department of Water and Environmental Regulation (2024)

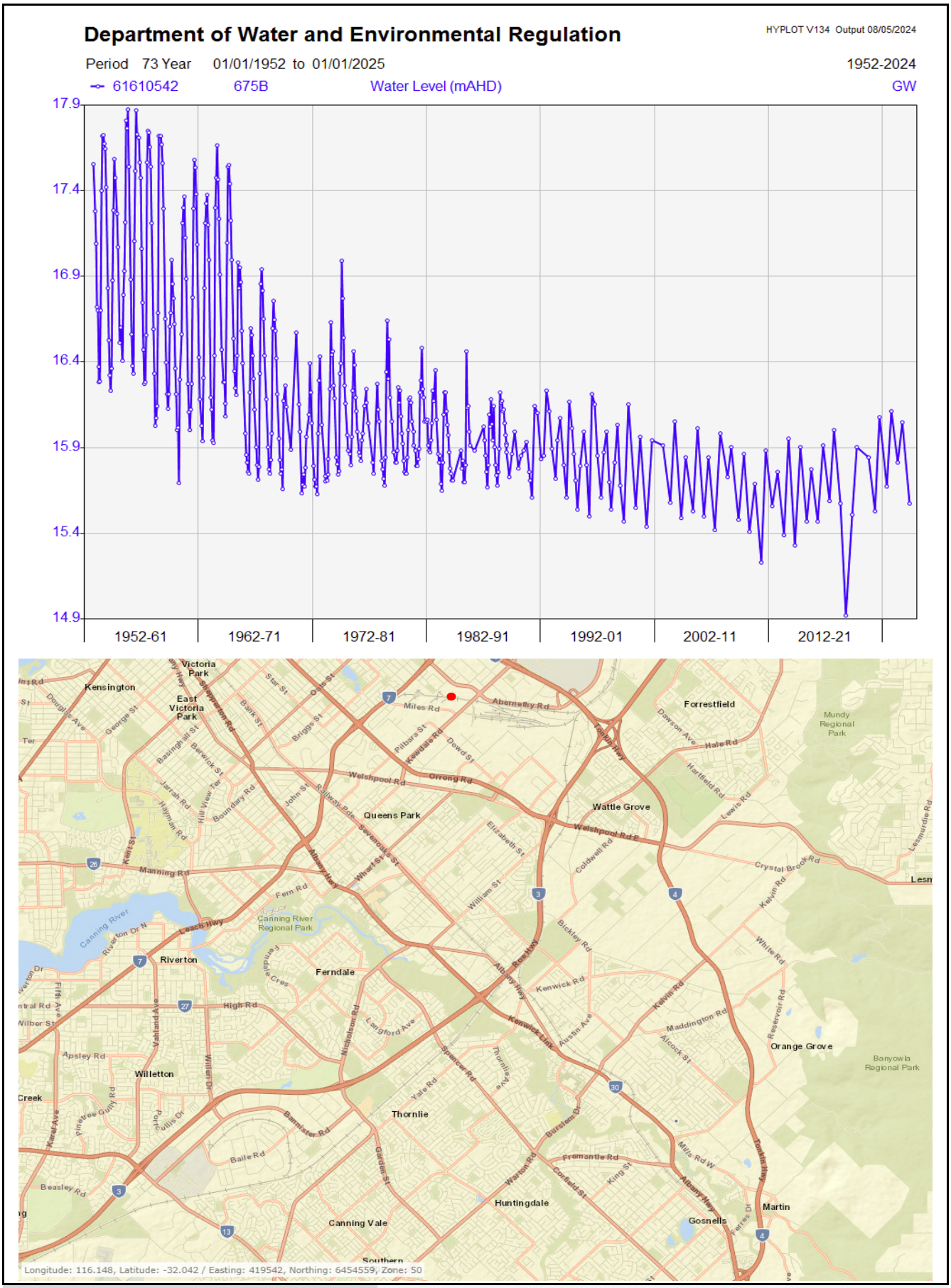
hyd2o

Wattle Grove South District Water Management Strategy

DWER Bore Hydrographs : SC 09-08

Appendix L3

Date :18/07/2024 Job No. H22076



Source: Department of Water and Environmental Regulation (2024)

hyd2o

Wattle Grove South District Water Management Strategy

DWER Bore Hydrographs : 675B

Appendix L4

APPENDIX M

Surface Water and Groundwater Quality Data Summary Sheets

H21003 Wattle Grove South Monitoring

WG1 Hyd2o Bore Wattle Grove 1

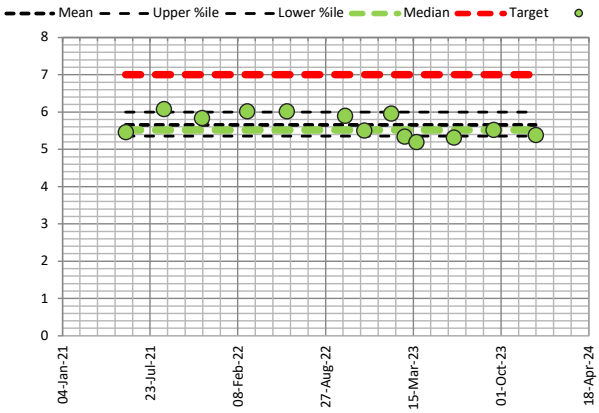
Site Bore Victoria Rd North - Rear of Lot (Install : Nov 2020)

Easting	406115	Data Analysis Period Start Date	1/01/2009
Northing	6457800	Data Analysis Period End Date	19/12/2023

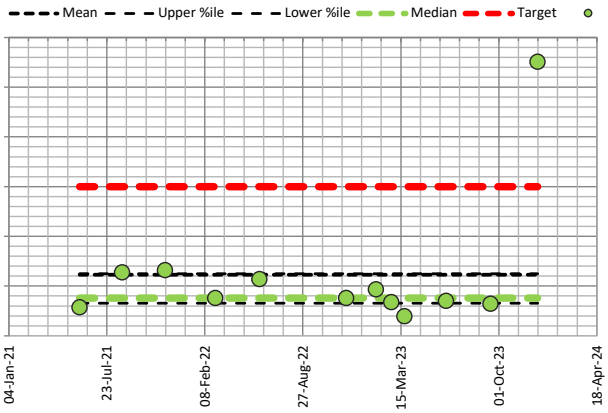
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	31	15.29	15.48	15.74	**15.70**	15.99	16.40		0
GWL mAHD	Groundwater Level	mAHD	31	15.70	16.11	16.36	**16.40**	16.62	16.81		0
T	Temperature	°C	12	18.30	19.200	22.067	**21.85**	25.400	25.800		0
EC	Electrical Conductivity	mS/cm	12	0.20	0.33	0.61	**0.38**	0.62	2.76	1.500	1
pH	pH	pH	13	5.20	5.36	5.66	**5.52**	6.00	6.08	7.00	0
DO	Dissolved Oxygen	%	12	35.00	39.50	53.04	**49.40**	60.91	89.50		0
TN	Total Nitrogen	mg/L	12	3.60	3.84	4.40	**4.30**	4.86	5.50	1.50	12
TKN	Total Kejdhal Nitrogen	mg/L	12	0.32	0.57	0.90	**0.80**	1.10	1.70		0
NO3	Nitrate	mg/L	13	2.80	3.04	3.47	**3.40**	3.88	4.70		0
NO2	Nitrite	mg/L	12	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	12	2.80	3.02	3.48	**3.35**	3.94	4.80	0.10	12
NH3	Ammonia	mg/L	13	0.01	0.01	0.01	**0.01**	0.02	0.03	0.90	0
TP	Total Phosphorous	mg/L	12	0.05	0.05	0.16	**0.12**	0.28	0.40	0.06	7
FRP	Filterable Reactive Phosphrous	mg/L	13	0.01	0.01	0.01	**0.01**	0.01	0.02	0.03	0
As	Arsenic	mg/L	13	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.02400	0
Cd	Cadmium	mg/L	12	0.00010	0.00010	0.00013	**0.00010**	0.00010	0.00045	0.00020	1
Cr	Chromium	mg/L	12	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00100	0
Cu	Copper	mg/L	12	0.00100	0.00100	0.00193	**0.00100**	0.00246	0.00600	0.00140	4
Pb	Lead	mg/L	12	0.00100	0.00100	0.00168	**0.00100**	0.00246	0.00430	0.00340	1
Hg	Mercury	mg/L	12	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	12	0.00100	0.00100	0.00160	**0.00100**	0.00184	0.00500	0.01100	0
Zn	Zinc	mg/L	12	0.00170	0.00304	0.00906	**0.00580**	0.01678	0.02600	0.00800	3
Cl	Chlorine	mg/L	1	40.00	40.00	40.00	**40.00**	40.00	40.00		0
Ca	Calcium	mg/L	8	0.50	0.82	1.33	**0.98**	2.06	2.40		0
Mg	Magnesium	mg/L	8	3.70	4.10	5.44	**4.95**	6.76	8.30		0
K	Potassium	mg/L	8	1.30	1.60	2.06	**1.65**	2.58	3.70		0
Na	Sodium	mg/L	8	34.00	39.40	51.13	**47.50**	66.20	71.00		0
H as CaCO3	Hardness as CaCO3	mg/L	8	18.00	18.40	25.75	**22.50**	33.80	39.00		0

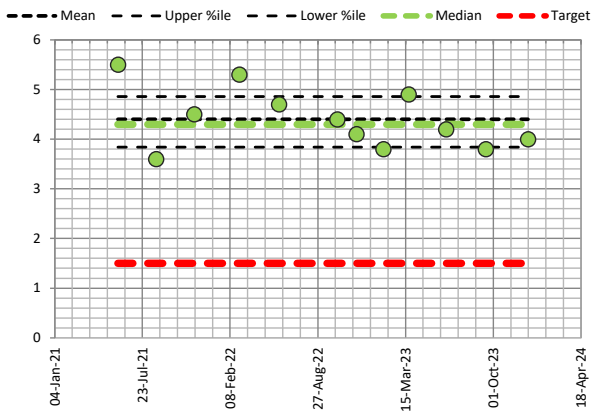
pH



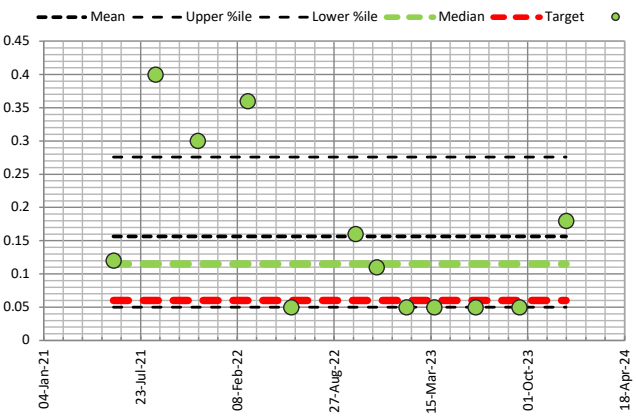
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

WG2 Hyd2o Bore Wattle Grove 2 (Deep)

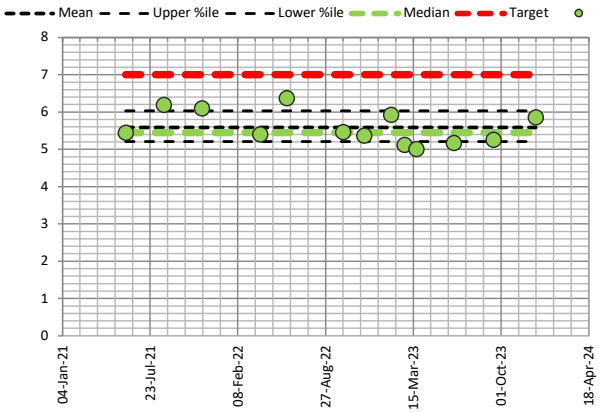
Site Bore Victoria Rd South - Front of Lot (Install : Nov 2020)

Easting	405780	Data Analysis Period Start Date	1/01/2009
Northing	6457018	Data Analysis Period End Date	19/12/2023

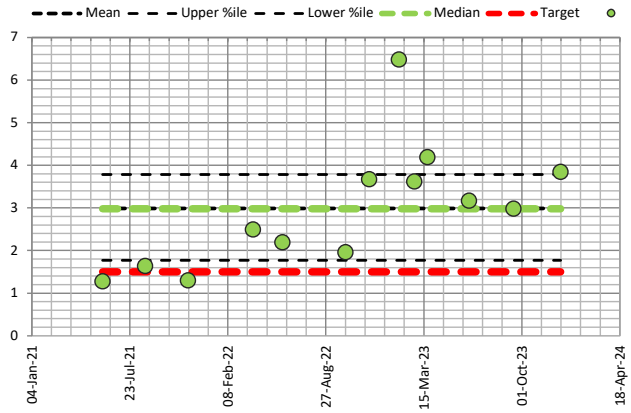
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	30	8.14	8.36	8.88	**8.89**	9.36	10.01		0
GWL mAHD	Groundwater Level	mAHD	30	16.11	16.76	17.24	**17.24**	17.76	17.98		0
T	Temperature	°C	12	16.30	19.540	21.917	**21.15**	24.540	29.800		0
EC	Electrical Conductivity	mS/cm	13	1.28	1.77	2.99	**2.98**	3.78	6.48	1.500	11
pH	pH	pH	13	5.01	5.21	5.59	**5.45**	6.03	6.37	7.00	0
DO	Dissolved Oxygen	%	12	15.40	23.00	37.88	**29.20**	57.24	83.80		0
TN	Total Nitrogen	mg/L	12	0.23	0.93	2.46	**1.90**	4.34	5.20	1.50	7
TKN	Total Kejdhal Nitrogen	mg/L	12	0.20	0.26	0.88	**0.60**	1.16	3.00		0
NO3	Nitrate	mg/L	13	0.01	0.42	1.53	**0.81**	2.20	4.30		0
NO2	Nitrite	mg/L	12	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	12	0.01	0.41	1.60	**1.37**	2.20	4.30	0.10	11
NH3	Ammonia	mg/L	13	0.01	0.01	0.02	**0.01**	0.02	0.08	0.90	0
TP	Total Phosphorous	mg/L	12	0.05	0.05	0.14	**0.07**	0.14	0.60	0.06	6
FRP	Filterable Reactive Phosphrous	mg/L	13	0.01	0.01	0.01	**0.01**	0.01	0.02	0.03	0
As	Arsenic	mg/L	13	0.00100	0.00100	0.00132	**0.00100**	0.00100	0.00510	0.02400	0
Cd	Cadmium	mg/L	12	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00014	0.00020	0
Cr	Chromium	mg/L	12	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00100	0
Cu	Copper	mg/L	12	0.00100	0.00100	0.00205	**0.00100**	0.00200	0.01000	0.00140	4
Pb	Lead	mg/L	12	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Hg	Mercury	mg/L	12	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	12	0.00250	0.00314	0.00581	**0.00475**	0.00926	0.01200	0.01100	1
Zn	Zinc	mg/L	12	0.00240	0.00730	0.01926	**0.01500**	0.03260	0.04400	0.00800	8
Cl	Chlorine	mg/L	3	0.10	0.10	400.07	**0.10**	720.04	1200.00		0
Ca	Calcium	mg/L	8	3.30	4.24	5.65	**5.70**	6.20	9.60		0
Mg	Magnesium	mg/L	8	80.00	108.00	122.50	**120.00**	140.00	160.00		0
K	Potassium	mg/L	8	8.90	9.28	10.33	**10.50**	11.00	12.00		0
Na	Sodium	mg/L	8	310.00	372.00	442.50	**445.00**	496.00	590.00		0
H as CaCO3	Hardness as CaCO3	mg/L	8	340.00	464.00	517.50	**515.00**	576.00	680.00		0

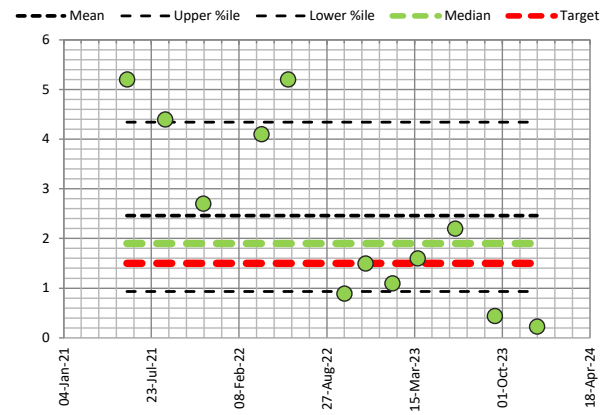
pH



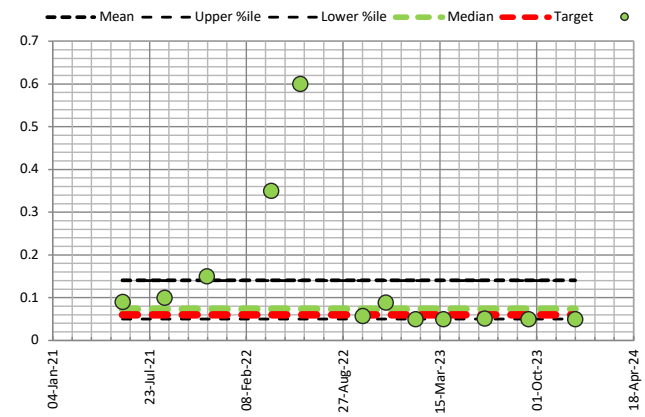
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

WG2S Hyd2o Bore Wattle Grove 2 Shallow

Site Bore Victoria Rd South - Front of Lot (Install : July 2022)

Easting	405781	Data Analysis Period Start Date	1/01/2009
Northing	6457018	Data Analysis Period End Date	19/12/2023

Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	17	3.51	3.51	3.51	**3.51**	3.51	3.53		0
GWL mAHD	Groundwater Level	mAHD	17	22.48	22.50	22.50	**22.50**	22.50	22.50		0
T	Temperature	°C	0	0.00	0.000	0.000	**0.00**	0.000	0.000		0
EC	Electrical Conductivity	mS/cm	0	0.00	0.00	0.00	**0.00**	0.00	0.00	1.500	0
pH	pH	pH	0	0.00	0.00	0.00	**0.00**	0.00	0.00	7.00	0
DO	Dissolved Oxygen	%	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TN	Total Nitrogen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	1.50	0
TKN	Total Kejdhal Nitrogen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NO3	Nitrate	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NO2	Nitrite	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox	Nox	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.10	0
NH3	Ammonia	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.90	0
TP	Total Phosphorous	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
FRP	Filterable Reactive Phosphrous	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.03	0
As	Arsenic	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.02400	0
Cd	Cadmium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00020	0
Cr	Chromium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00100	0
Cu	Copper	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00140	0
Pb	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Hg	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00800	0
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Mg	Magnesium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
K	Potassium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Na	Sodium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
H as CaCO3	Hardness as CaCO3	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

pH

No Data

Electrical Conductivity

No Data

Total Nitrogen

No Data

Total Phosphorous

No Data

H21003 Wattle Grove South Monitoring

WG3 Hyd2o Bore Wattle Grove 3

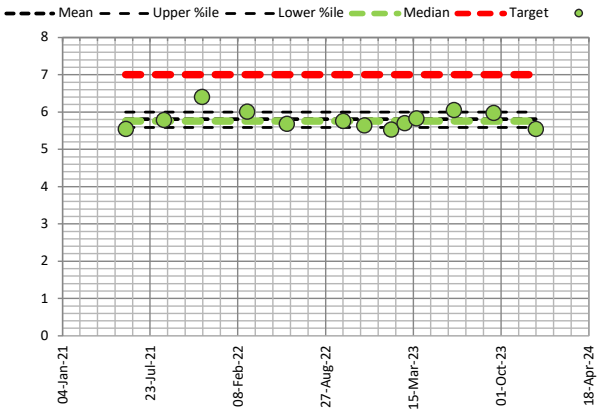
Site Bore Brentwood Rd South - Front of Lot (Install : Nov 2020)

Easting	405419
Northing	6457710
Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

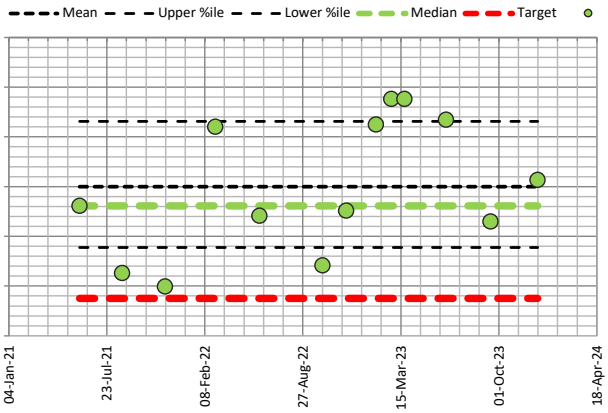
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	31	5.13	5.60	6.53	**6.54**	7.48	7.98		0
GWL mAHD	Groundwater Level	mAHD	31	14.99	15.49	16.44	**16.43**	17.37	17.84		0
T	Temperature	°C	13	18.10	18.880	21.923	**21.30**	25.020	28.300		0
EC	Electrical Conductivity	mS/cm	13	1.99	3.55	6.00	**5.23**	8.62	9.53	1.500	13
pH	pH	pH	13	5.53	5.59	5.81	**5.76**	6.00	6.41	7.00	0
DO	Dissolved Oxygen	%	13	11.80	17.18	28.61	**23.90**	39.29	61.80		0
TN	Total Nitrogen	mg/L	12	0.43	0.64	0.94	**0.90**	1.26	1.70	1.50	1
TKN	Total Kejdhal Nitrogen	mg/L	12	0.42	0.65	0.90	**0.90**	1.24	1.50		0
NO3	Nitrate	mg/L	13	0.01	0.01	0.04	**0.01**	0.02	0.21		0
NO2	Nitrite	mg/L	12	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	12	0.01	0.01	0.05	**0.01**	0.05	0.21	0.10	2
NH3	Ammonia	mg/L	13	0.01	0.01	0.04	**0.01**	0.06	0.20	0.90	0
TP	Total Phosphorous	mg/L	12	0.05	0.05	0.10	**0.05**	0.16	0.36	0.06	4
FRP	Filterable Reactive Phosphrous	mg/L	13	0.01	0.01	0.01	**0.01**	0.02	0.05	0.03	1
As	Arsenic	mg/L	13	0.00100	0.00100	0.00157	**0.00160**	0.00196	0.00270	0.02400	0
Cd	Cadmium	mg/L	12	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00012	0.00020	0
Cr	Chromium	mg/L	12	0.00100	0.00100	0.00115	**0.00100**	0.00126	0.00180	0.00100	4
Cu	Copper	mg/L	12	0.00100	0.00100	0.00136	**0.00100**	0.00100	0.00400	0.00140	2
Pb	Lead	mg/L	12	0.00100	0.00100	0.00112	**0.00100**	0.00100	0.00210	0.00340	0
Hg	Mercury	mg/L	12	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	12	0.00100	0.00428	0.00774	**0.00705**	0.01000	0.01900	0.01100	2
Zn	Zinc	mg/L	12	0.00140	0.00314	0.01210	**0.00885**	0.01540	0.03800	0.00800	6
Cl	Chlorine	mg/L	3	0.10	0.14	1033.43	**0.20**	1860.08	3100.00		0
Ca	Calcium	mg/L	8	30.00	49.60	76.38	**73.50**	103.20	130.00		0
Mg	Magnesium	mg/L	8	54.00	85.00	124.63	**106.00**	180.00	210.00		0
K	Potassium	mg/L	8	20.00	24.40	29.75	**26.50**	37.20	43.00		0
Na	Sodium	mg/L	8	520.00	774.00	1011.25	**860.00**	1380.00	1600.00		0
H as CaCO3	Hardness as CaCO3	mg/L	8	300.00	476.00	706.25	**615.00**	1004.00	1200.00		0

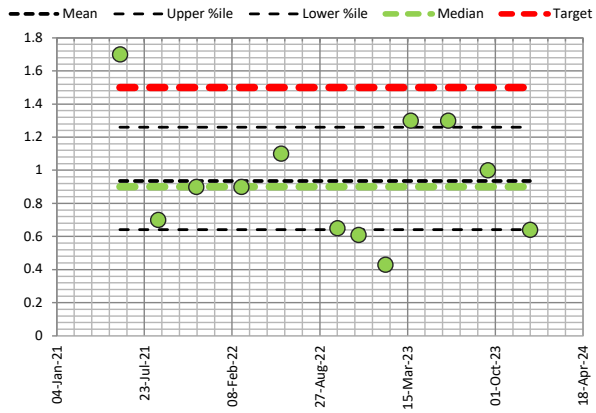
pH



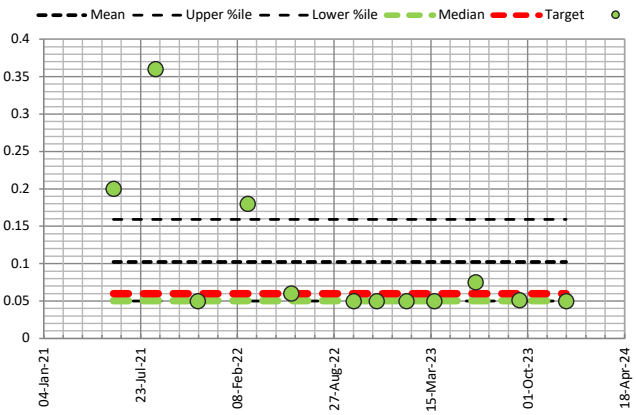
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

WG4D Hyd2o Bore Wattle Grove 4 Deep

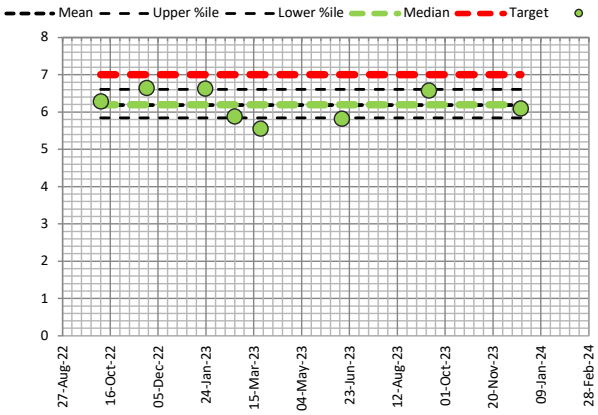
Site Bore Brentwood Rd North - Front of Lot (Install : Jul 2022)

Easting	405736
Northing	6458037
Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

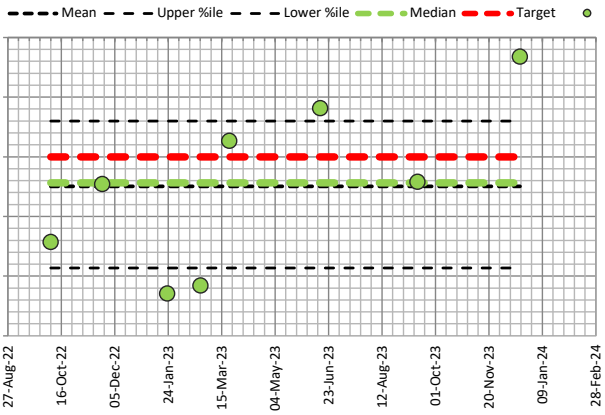
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	17	8.41	8.90	9.41	**9.47**	9.86	10.44		0
GWL mAHD	Groundwater Level	mAHD	17	15.29	15.87	16.32	**16.26**	16.83	17.32		0
T	Temperature	°C	8	18.40	19.380	22.988	**23.05**	24.740	31.200		0
EC	Electrical Conductivity	mS/cm	8	0.36	0.57	1.25	**1.28**	1.80	2.34	1.500	3
pH	pH	pH	8	5.56	5.84	6.19	**6.20**	6.61	6.65	7.00	0
DO	Dissolved Oxygen	%	8	23.10	25.42	38.53	**31.65**	47.32	79.40		0
TN	Total Nitrogen	mg/L	7	0.34	0.77	2.52	**1.10**	3.36	9.20	1.50	3
TKN	Total Kejdhal Nitrogen	mg/L	7	0.33	0.51	1.09	**0.78**	1.12	3.40		0
NO3	Nitrate	mg/L	8	0.01	0.07	1.33	**0.35**	0.90	8.10		0
NO2	Nitrite	mg/L	7	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	7	0.01	0.06	1.46	**0.30**	1.05	8.10	0.10	4
NH3	Ammonia	mg/L	8	0.01	0.01	0.03	**0.01**	0.05	0.06	0.90	0
TP	Total Phosphorous	mg/L	7	0.05	0.05	0.07	**0.05**	0.07	0.15	0.06	2
FRP	Filterable Reactive Phosphrous	mg/L	8	0.01	0.01	0.01	**0.01**	0.01	0.01	0.03	0
As	Arsenic	mg/L	8	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.02400	0
Cd	Cadmium	mg/L	7	0.00010	0.00010	0.00011	**0.00010**	0.00010	0.00016	0.00020	0
Cr	Chromium	mg/L	7	0.00100	0.00100	0.00211	**0.00100**	0.00100	0.00880	0.00100	1
Cu	Copper	mg/L	7	0.00100	0.00100	0.00134	**0.00100**	0.00164	0.00230	0.00140	2
Pb	Lead	mg/L	7	0.00100	0.00100	0.00101	**0.00100**	0.00100	0.00110	0.00340	0
Hg	Mercury	mg/L	7	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	7	0.00100	0.00110	0.00237	**0.00180**	0.00308	0.00550	0.01100	0
Zn	Zinc	mg/L	7	0.00100	0.00602	0.00710	**0.00800**	0.00886	0.01100	0.00800	3
Cl	Chlorine	mg/L	1	320.00	320.00	320.00	**320.00**	320.00	320.00		0
Ca	Calcium	mg/L	8	43.00	51.20	65.50	**66.00**	79.60	88.00		0
Mg	Magnesium	mg/L	8	21.00	29.80	37.25	**38.00**	46.20	49.00		0
K	Potassium	mg/L	8	7.80	8.56	10.28	**10.50**	11.60	13.00		0
Na	Sodium	mg/L	8	64.00	132.00	198.00	**230.00**	256.00	280.00		0
H as CaCO3	Hardness as CaCO3	mg/L	8	230.00	276.00	316.25	**320.00**	348.00	410.00		0

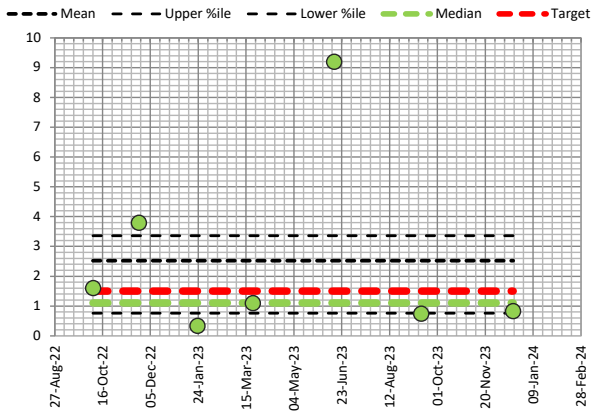
pH



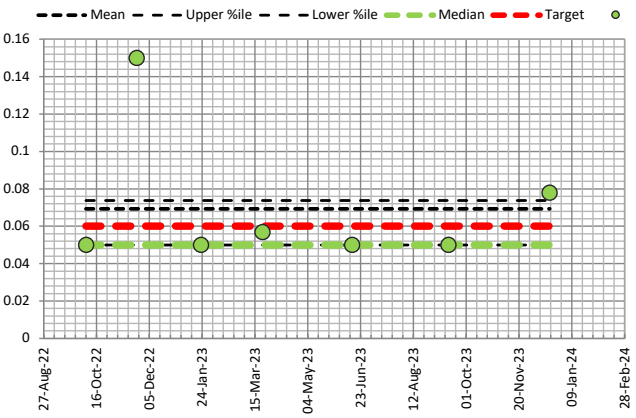
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

WG4S Hyd2o Bore Wattle Grove 4 Shallow

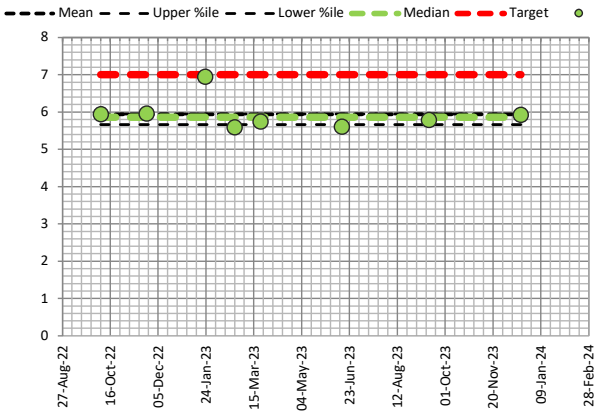
Site Bore Brentwood Rd North - Front of Lot (Install : Jul 2022)

Easting	405735
Northing	6458036
Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

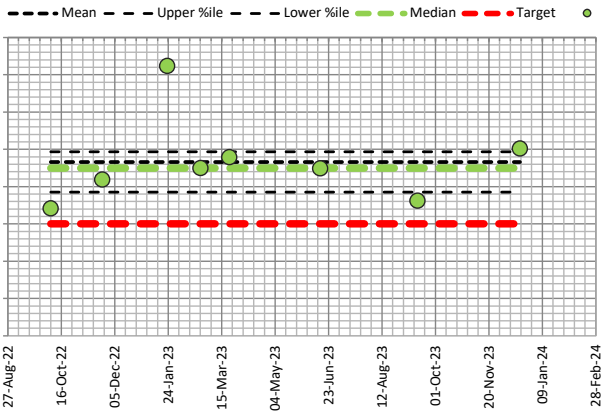
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	17	0.88	1.24	1.60	**1.43**	2.15	2.37		0
GWL mAHD	Groundwater Level	mAHD	17	23.29	23.51	24.06	**24.23**	24.42	24.78		0
T	Temperature	°C	8	18.20	18.760	25.563	**25.90**	30.560	36.300		0
EC	Electrical Conductivity	mS/cm	8	1.71	1.93	2.33	**2.25**	2.47	3.62	1.500	8
pH	pH	pH	8	5.59	5.67	5.94	**5.86**	5.95	6.95	7.00	0
DO	Dissolved Oxygen	%	8	-0.20	15.70	19.78	**20.05**	28.06	31.70		0
TN	Total Nitrogen	mg/L	6	0.29	0.33	2.97	**0.84**	1.50	14.00	1.50	1
TKN	Total Kejdhal Nitrogen	mg/L	6	0.16	0.16	2.53	**0.27**	0.33	14.00		0
NO3	Nitrate	mg/L	7	0.01	0.01	0.37	**0.12**	0.81	1.30		0
NO2	Nitrite	mg/L	6	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	6	0.01	0.01	0.43	**0.17**	0.96	1.30	0.10	4
NH3	Ammonia	mg/L	7	0.01	0.01	0.06	**0.01**	0.05	0.32	0.90	0
TP	Total Phosphorous	mg/L	6	0.05	0.05	0.08	**0.05**	0.05	0.25	0.06	1
FRP	Filterable Reactive Phosphrous	mg/L	7	0.01	0.01	0.01	**0.01**	0.01	0.01	0.03	0
As	Arsenic	mg/L	7	0.00100	0.00100	0.00101	**0.00100**	0.00100	0.00110	0.02400	0
Cd	Cadmium	mg/L	6	0.00010	0.00010	0.00022	**0.00010**	0.00010	0.00082	0.00020	1
Cr	Chromium	mg/L	6	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00100	0
Cu	Copper	mg/L	6	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00140	0
Pb	Lead	mg/L	6	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Hg	Mercury	mg/L	6	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	6	0.00100	0.00120	0.00168	**0.00155**	0.00210	0.00270	0.01100	0
Zn	Zinc	mg/L	6	0.00130	0.00240	0.01225	**0.00340**	0.01600	0.04700	0.00800	2
Cl	Chlorine	mg/L	1	480.00	480.00	480.00	**480.00**	480.00	480.00		0
Ca	Calcium	mg/L	7	27.00	35.00	36.00	**36.00**	38.80	42.00		0
Mg	Magnesium	mg/L	7	53.00	53.20	56.00	**55.00**	58.40	62.00		0
K	Potassium	mg/L	7	7.50	8.58	9.90	**9.80**	10.80	13.00		0
Na	Sodium	mg/L	7	260.00	270.00	280.00	**270.00**	296.00	310.00		0
H as CaCO3	Hardness as CaCO3	mg/L	7	280.00	302.00	320.00	**320.00**	338.00	360.00		0

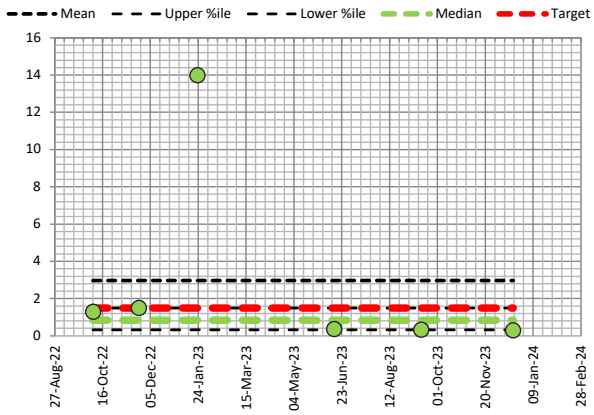
pH



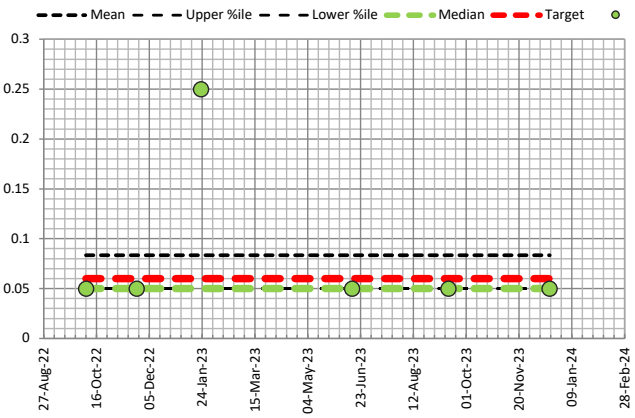
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

WG5D Hyd2o Bore Wattle Grove 5 Deep

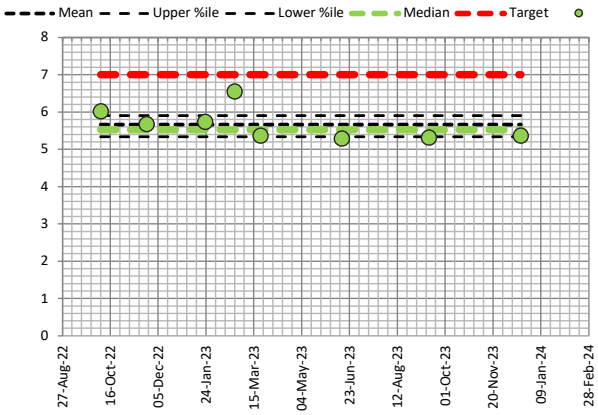
Site Bore Victoria Rd North - Front of Lot (Install : Jul 2022)

Easting	406304	Data Analysis Period Start Date	1/01/2009
Northing	6457566	Data Analysis Period End Date	19/12/2023

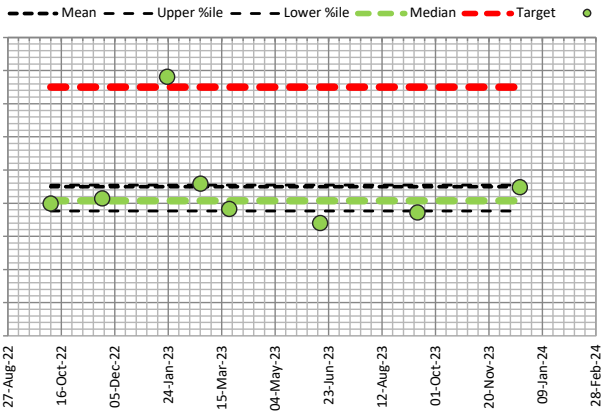
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	17	18.50	18.57	18.76	**18.74**	18.95	19.07		0
GWL mAHD	Groundwater Level	mAHD	17	16.06	16.18	16.37	**16.39**	16.56	16.63		0
T	Temperature	°C	8	18.60	19.860	22.550	**23.65**	24.320	26.000		0
EC	Electrical Conductivity	mS/cm	8	0.68	0.75	0.90	**0.81**	0.91	1.56	1.500	1
pH	pH	pH	8	5.29	5.34	5.67	**5.53**	5.91	6.55	7.00	0
DO	Dissolved Oxygen	%	8	31.20	37.30	54.85	**54.25**	72.78	78.50		0
TN	Total Nitrogen	mg/L	7	14.00	14.20	15.43	**15.00**	16.80	17.00	1.50	7
TKN	Total Kejdhal Nitrogen	mg/L	7	1.30	1.72	2.56	**2.70**	3.26	4.30		0
NO3	Nitrate	mg/L	8	10.00	12.00	12.75	**13.00**	14.00	14.00		0
NO2	Nitrite	mg/L	7	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	7	10.00	12.20	12.86	**13.00**	14.00	14.00	0.10	7
NH3	Ammonia	mg/L	8	0.01	0.01	0.01	**0.01**	0.01	0.02	0.90	0
TP	Total Phosphorous	mg/L	7	0.05	0.05	0.09	**0.06**	0.10	0.22	0.06	3
FRP	Filterable Reactive Phosphrous	mg/L	8	0.01	0.01	0.01	**0.01**	0.01	0.01	0.03	0
As	Arsenic	mg/L	8	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.02400	0
Cd	Cadmium	mg/L	7	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	7	0.00100	0.00100	0.00121	**0.00100**	0.00100	0.00250	0.00100	1
Cu	Copper	mg/L	7	0.00100	0.00100	0.00126	**0.00100**	0.00148	0.00220	0.00140	2
Pb	Lead	mg/L	7	0.00100	0.00100	0.00247	**0.00260**	0.00360	0.00450	0.00340	3
Hg	Mercury	mg/L	7	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	7	0.00160	0.00178	0.00317	**0.00240**	0.00480	0.00630	0.01100	0
Zn	Zinc	mg/L	7	0.00440	0.00596	0.01129	**0.00760**	0.01260	0.03000	0.00800	3
Cl	Chlorine	mg/L	1	200.00	200.00	200.00	**200.00**	200.00	200.00		0
Ca	Calcium	mg/L	8	2.50	3.12	3.85	**3.85**	4.34	5.60		0
Mg	Magnesium	mg/L	8	11.00	11.80	13.63	**14.00**	14.60	17.00		0
K	Potassium	mg/L	8	2.90	3.32	3.63	**3.55**	4.00	4.40		0
Na	Sodium	mg/L	8	100.00	114.00	116.25	**120.00**	120.00	120.00		0
H as CaCO3	Hardness as CaCO3	mg/L	8	51.00	57.20	65.00	**66.50**	69.20	83.00		0

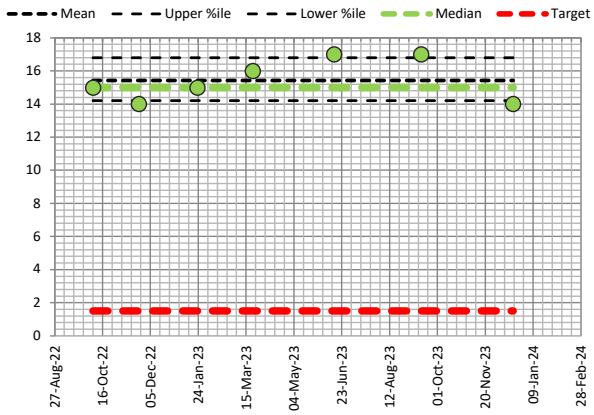
pH



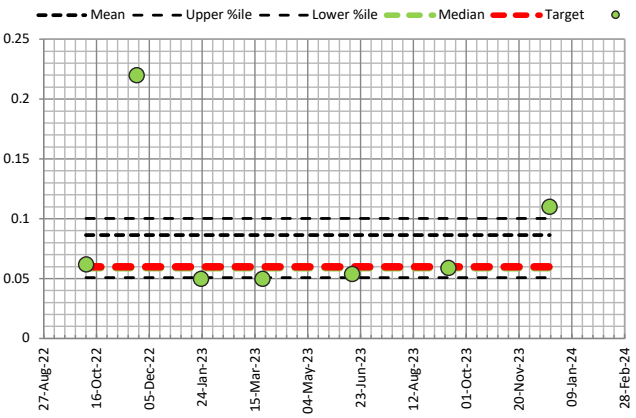
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

WG5S Hyd2o Bore Wattle Grove 5 Shallow

Site Bore Victoria Rd North - Front of Lot (Install : July 2022)

Easting	406304	Data Analysis Period Start Date	1/01/2009
Northing	6457567	Data Analysis Period End Date	19/12/2023

Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	17	5.80	5.81	5.88	**5.91**	5.91	5.91		0
GWL mAHD	Groundwater Level	mAHD	17	29.23	29.23	29.26	**29.23**	29.33	29.34		0
T	Temperature	°C	0	0.00	0.000	0.000	**0.00**	0.000	0.000		0
EC	Electrical Conductivity	mS/cm	0	0.00	0.00	0.00	**0.00**	0.00	0.00	1.500	0
pH	pH	pH	0	0.00	0.00	0.00	**0.00**	0.00	0.00	7.00	0
DO	Dissolved Oxygen	%	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TN	Total Nitrogen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	1.50	0
TKN	Total Kejdhal Nitrogen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NO3	Nitrate	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NO2	Nitrite	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox	Nox	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.10	0
NH3	Ammonia	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.90	0
TP	Total Phosphorous	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
FRP	Filterable Reactive Phosphrous	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.03	0
As	Arsenic	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.02400	0
Cd	Cadmium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00020	0
Cr	Chromium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00100	0
Cu	Copper	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00140	0
Pb	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Hg	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00800	0
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Mg	Magnesium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
K	Potassium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Na	Sodium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
H as CaCO3	Hardness as CaCO3	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

pH

No Data

Electrical Conductivity

No Data

Total Nitrogen

No Data

Total Phosphorous

No Data

H21003 Wattle Grove South Monitoring

WG6 Hyd2o Bore Wattle Grove 6

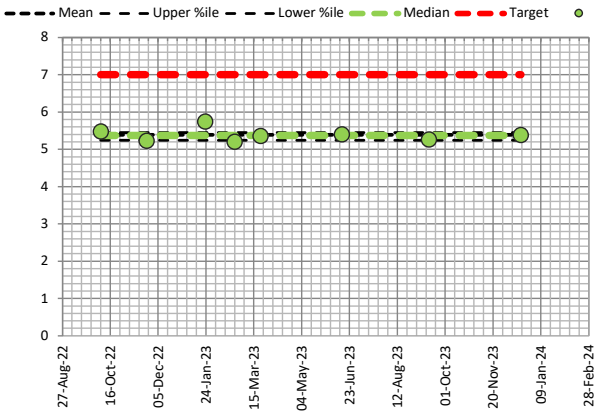
Site Bore Victoria Rd Turf Farm North - Rear of Lot (Install : Jul 2022)

Easting	405790	Data Analysis Period Start Date	1/01/2009
Northing	6457474	Data Analysis Period End Date	19/12/2023

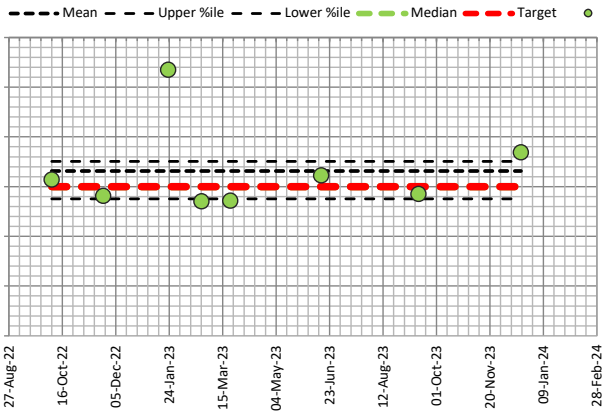
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	17	6.53	6.68	7.18	**7.28**	7.47	8.02		0
GWL mAHD	Groundwater Level	mAHD	17	17.32	17.87	18.16	**18.06**	18.66	18.81		0
T	Temperature	°C	8	18.70	18.980	22.138	**20.80**	25.320	28.900		0
EC	Electrical Conductivity	mS/cm	8	1.35	1.38	1.66	**1.50**	1.75	2.68	1.500	4
pH	pH	pH	8	5.21	5.25	5.39	**5.38**	5.45	5.75	7.00	0
DO	Dissolved Oxygen	%	8	37.90	40.60	47.69	**48.85**	53.24	57.60		0
TN	Total Nitrogen	mg/L	7	3.40	3.70	4.10	**4.20**	4.48	4.80	1.50	7
TKN	Total Kejdhal Nitrogen	mg/L	7	0.28	0.50	0.73	**0.69**	1.02	1.20		0
NO3	Nitrate	mg/L	8	2.70	3.24	3.38	**3.35**	3.46	4.20		0
NO2	Nitrite	mg/L	7	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	7	2.70	3.22	3.39	**3.40**	3.48	4.20	0.10	7
NH3	Ammonia	mg/L	8	0.01	0.01	0.01	**0.01**	0.01	0.01	0.90	0
TP	Total Phosphorous	mg/L	7	0.05	0.05	0.05	**0.05**	0.05	0.05	0.06	0
FRP	Filterable Reactive Phosphrous	mg/L	8	0.01	0.01	0.01	**0.01**	0.02	0.03	0.03	1
As	Arsenic	mg/L	8	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.02400	0
Cd	Cadmium	mg/L	7	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00013	0.00020	0
Cr	Chromium	mg/L	7	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00100	0
Cu	Copper	mg/L	7	0.00100	0.00100	0.00129	**0.00120**	0.00138	0.00210	0.00140	1
Pb	Lead	mg/L	7	0.02000	0.02160	0.03000	**0.02900**	0.03880	0.04200	0.00340	7
Hg	Mercury	mg/L	7	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	7	0.00100	0.00140	0.00153	**0.00160**	0.00168	0.00200	0.01100	0
Zn	Zinc	mg/L	7	0.00130	0.00150	0.00300	**0.00210**	0.00236	0.01000	0.00800	1
Cl	Chlorine	mg/L	1	390.00	390.00	390.00	**390.00**	390.00	390.00		0
Ca	Calcium	mg/L	8	7.00	7.44	9.26	**8.25**	11.04	14.00		0
Mg	Magnesium	mg/L	8	31.00	31.40	35.00	**32.50**	40.00	42.00		0
K	Potassium	mg/L	8	7.50	9.08	9.43	**9.50**	9.88	11.00		0
Na	Sodium	mg/L	8	190.00	200.00	216.25	**215.00**	236.00	240.00		0
H as CaCO3	Hardness as CaCO3	mg/L	8	150.00	150.00	167.50	**165.00**	182.00	200.00		0

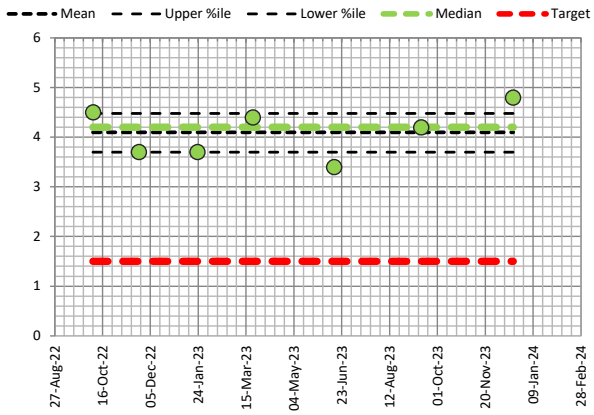
pH



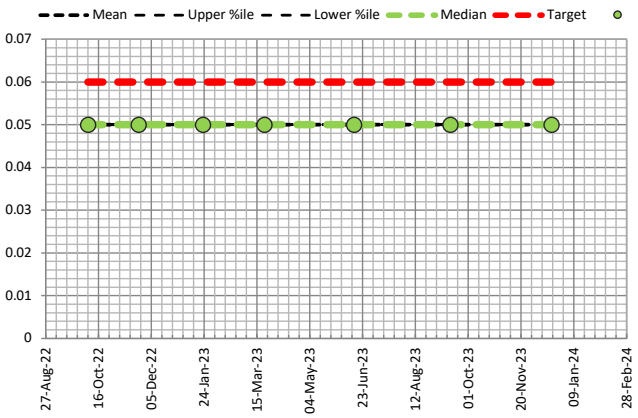
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

WG7D Hyd2o Bore Wattle Grove 7 Deep

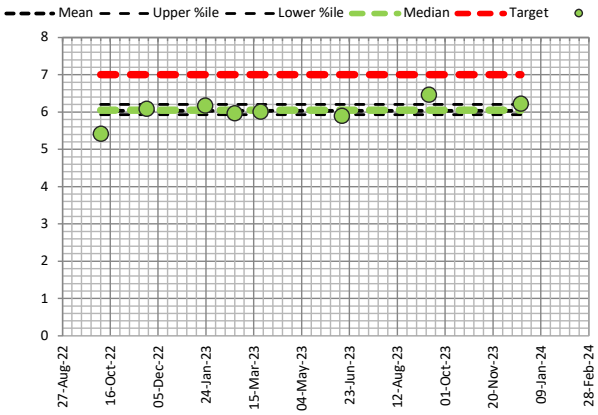
Site Bore Boundary Rd South - Rear of Lot (Install : Jul 2022)

Easting	405352
Northing	6457884
Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

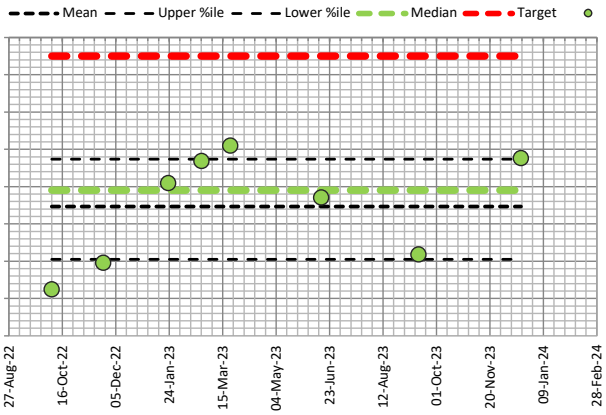
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	17	5.67	6.34	7.04	**6.89**	7.98	8.50		0
GWL mAHD	Groundwater Level	mAHD	17	14.94	15.46	16.40	**16.55**	17.10	17.77		0
T	Temperature	°C	8	19.10	21.140	24.313	**23.90**	27.380	30.800		0
EC	Electrical Conductivity	mS/cm	8	0.25	0.41	0.69	**0.78**	0.95	1.02	1.500	0
pH	pH	pH	8	5.42	5.93	6.03	**6.05**	6.21	6.47	7.00	0
DO	Dissolved Oxygen	%	8	13.30	16.90	22.29	**20.50**	27.68	36.60		0
TN	Total Nitrogen	mg/L	7	1.10	1.88	3.49	**4.00**	4.84	5.50	1.50	6
TKN	Total Kejdhal Nitrogen	mg/L	7	0.10	0.28	0.59	**0.64**	0.71	1.20		0
NO3	Nitrate	mg/L	8	1.00	1.62	3.10	**3.70**	4.26	4.40		0
NO2	Nitrite	mg/L	7	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	7	1.00	1.36	2.91	**3.40**	4.16	4.30	0.10	7
NH3	Ammonia	mg/L	8	0.01	0.01	0.01	**0.01**	0.01	0.01	0.90	0
TP	Total Phosphorous	mg/L	7	0.05	0.05	0.05	**0.05**	0.05	0.05	0.06	0
FRP	Filterable Reactive Phosphrous	mg/L	8	0.01	0.01	0.01	**0.01**	0.01	0.03	0.03	1
As	Arsenic	mg/L	8	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.02400	0
Cd	Cadmium	mg/L	7	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00012	0.00020	0
Cr	Chromium	mg/L	7	0.00100	0.00100	0.00106	**0.00100**	0.00100	0.00140	0.00100	1
Cu	Copper	mg/L	7	0.00140	0.00150	0.00199	**0.00190**	0.00208	0.00320	0.00140	5
Pb	Lead	mg/L	7	0.00100	0.00100	0.00101	**0.00100**	0.00100	0.00110	0.00340	0
Hg	Mercury	mg/L	7	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	7	0.00180	0.00186	0.00236	**0.00230**	0.00262	0.00350	0.01100	0
Zn	Zinc	mg/L	7	0.00100	0.00128	0.00199	**0.00180**	0.00190	0.00450	0.00800	0
Cl	Chlorine	mg/L	1	190.00	190.00	190.00	**190.00**	190.00	190.00		0
Ca	Calcium	mg/L	8	3.80	6.30	12.19	**14.00**	16.60	20.00		0
Mg	Magnesium	mg/L	8	6.70	10.54	13.95	**14.00**	17.20	21.00		0
K	Potassium	mg/L	8	3.80	4.22	4.91	**4.85**	5.58	6.30		0
Na	Sodium	mg/L	8	29.00	43.80	78.63	**70.00**	122.00	130.00		0
H as CaCO3	Hardness as CaCO3	mg/L	8	37.00	59.00	88.75	**91.00**	120.00	130.00		0

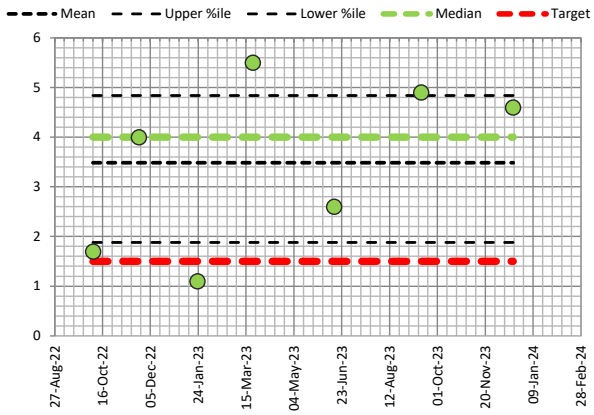
pH



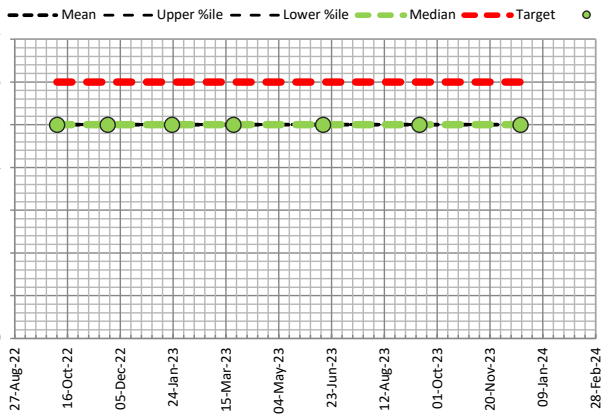
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

WG7S Hyd2o Bore Wattle Grove 7 Shallow

Site Bore Boundary Rd South - Rear of Lot (Install : Jul 2022)

Easting	405351	Data Analysis Period Start Date	1/01/2009
Northing	6457885	Data Analysis Period End Date	19/12/2023

Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	17	3.68	3.68	3.68	**3.68**	3.68	3.72		0
GWL mAHD	Groundwater Level	mAHD	17	19.78	19.82	19.82	**19.82**	19.82	19.82		0
T	Temperature	°C	0	0.00	0.000	0.000	**0.00**	0.000	0.000		0
EC	Electrical Conductivity	mS/cm	0	0.00	0.00	0.00	**0.00**	0.00	0.00	1.500	0
pH	pH	pH	0	0.00	0.00	0.00	**0.00**	0.00	0.00	7.00	0
DO	Dissolved Oxygen	%	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TN	Total Nitrogen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	1.50	0
TKN	Total Kejdhal Nitrogen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NO3	Nitrate	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NO2	Nitrite	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox	Nox	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.10	0
NH3	Ammonia	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.90	0
TP	Total Phosphorous	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
FRP	Filterable Reactive Phosphrous	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.03	0
As	Arsenic	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.02400	0
Cd	Cadmium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00020	0
Cr	Chromium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00100	0
Cu	Copper	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00140	0
Pb	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Hg	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00800	0
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Mg	Magnesium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
K	Potassium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Na	Sodium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
H as CaCO3	Hardness as CaCO3	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

pH

No Data

Electrical Conductivity

No Data

Total Nitrogen

No Data

Total Phosphorous

No Data

H21003 Wattle Grove South Monitoring

WG8 Hyd2o Bore Wattle Grove 8

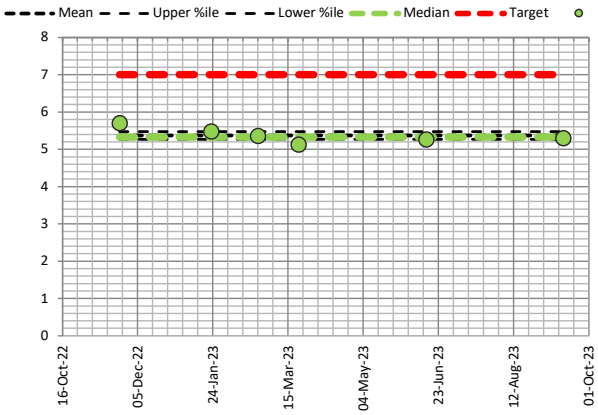
Upstream Bore Emanuel Crt North - Verge (Install : Oct 2022)

Easting	406959	Data Analysis Period Start Date	1/01/2009
Northing	6457834	Data Analysis Period End Date	19/12/2023

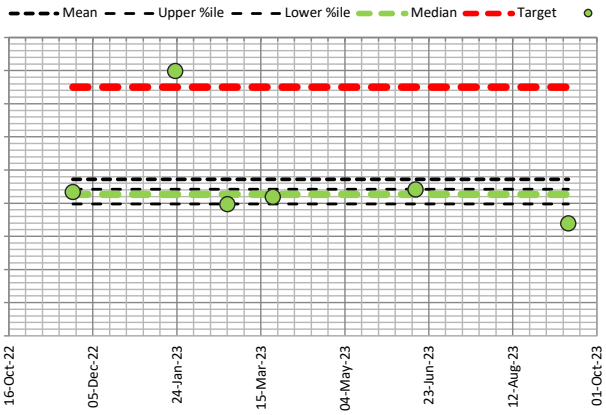
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	14	25.11	25.16	25.32	**25.29**	25.50	25.57		0
GWL mAHD	Groundwater Level	mAHD	14	16.20	16.27	16.45	**16.48**	16.61	16.66		0
T	Temperature	°C	6	18.20	18.700	21.300	**21.65**	22.700	24.900		0
EC	Electrical Conductivity	mS/cm	6	0.68	0.80	0.94	**0.85**	0.88	1.60	1.500	1
pH	pH	pH	6	5.13	5.27	5.37	**5.33**	5.48	5.70	7.00	0
DO	Dissolved Oxygen	%	6	16.20	22.80	34.08	**38.70**	41.50	46.60		0
TN	Total Nitrogen	mg/L	5	0.48	0.53	1.74	**1.50**	2.62	3.90	1.50	2
TKN	Total Kejdhal Nitrogen	mg/L	5	0.17	0.35	1.06	**0.51**	1.68	2.80		0
NO3	Nitrate	mg/L	6	0.08	0.36	0.70	**0.88**	0.99	1.00		0
NO2	Nitrite	mg/L	5	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	5	0.08	0.30	0.67	**0.84**	1.01	1.10	0.10	4
NH3	Ammonia	mg/L	6	0.01	0.01	0.01	**0.01**	0.02	0.04	0.90	0
TP	Total Phosphorous	mg/L	5	0.18	0.20	0.61	**0.28**	0.95	1.60	0.06	5
FRP	Filterable Reactive Phosphrous	mg/L	6	0.01	0.01	0.01	**0.01**	0.01	0.01	0.03	0
As	Arsenic	mg/L	6	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.02400	0
Cd	Cadmium	mg/L	5	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	5	0.00100	0.00100	0.00196	**0.00100**	0.00196	0.00580	0.00100	1
Cu	Copper	mg/L	5	0.00170	0.00298	0.00472	**0.00420**	0.00702	0.00750	0.00140	5
Pb	Lead	mg/L	5	0.00100	0.00100	0.00192	**0.00100**	0.00192	0.00560	0.00340	1
Hg	Mercury	mg/L	5	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	5	0.00190	0.00390	0.00628	**0.00560**	0.00840	0.01200	0.01100	1
Zn	Zinc	mg/L	5	0.00560	0.01552	0.02532	**0.02100**	0.03020	0.05900	0.00800	4
Cl	Chlorine	mg/L	1	230.00	230.00	230.00	**230.00**	230.00	230.00		0
Ca	Calcium	mg/L	6	1.70	2.70	4.70	**3.45**	4.90	12.00		0
Mg	Magnesium	mg/L	6	13.00	14.00	14.33	**14.00**	15.00	16.00		0
K	Potassium	mg/L	6	3.30	3.40	3.70	**3.60**	3.70	4.60		0
Na	Sodium	mg/L	6	110.00	120.00	118.33	**120.00**	120.00	120.00		0
H as CaCO3	Hardness as CaCO3	mg/L	6	57.00	69.00	71.00	**70.50**	74.00	85.00		0

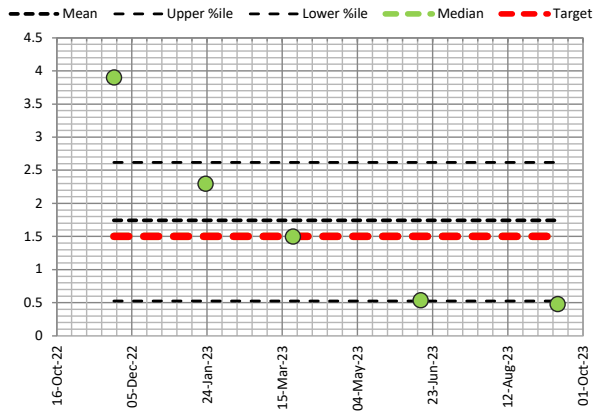
pH



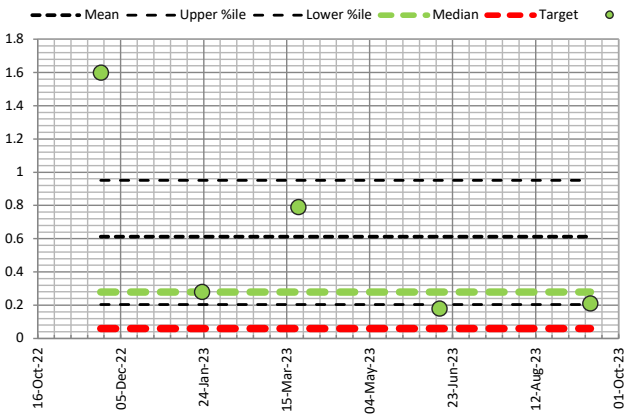
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

WG9 Hyd2o Bore Wattle Grove 9

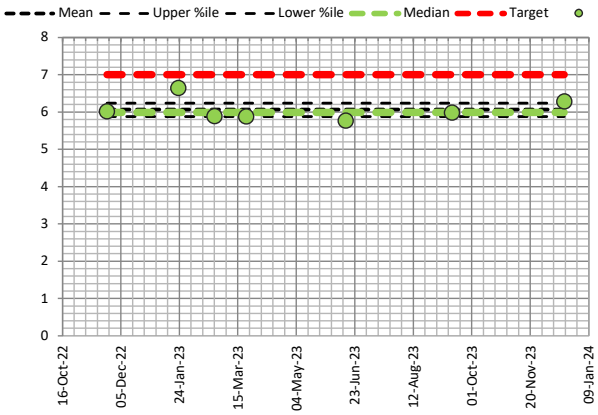
Site Bore Victoria Rd Turf Farm South - Rear of Lot (Install : Oct 2022)

Easting	405651	Data Analysis Period Start Date	1/01/2009
Northing	6457338	Data Analysis Period End Date	19/12/2023

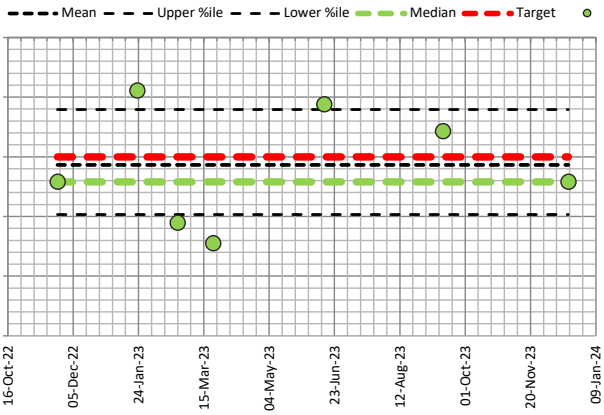
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	15	4.18	4.26	4.51	**4.61**	4.66	4.94		0
GWL mAHD	Groundwater Level	mAHD	15	18.92	19.20	19.35	**19.25**	19.60	19.68		0
T	Temperature	°C	7	19.20	19.940	23.343	**23.60**	26.160	27.500		0
EC	Electrical Conductivity	mS/cm	7	0.78	1.02	1.43	**1.29**	1.90	2.06	1.500	3
pH	pH	pH	7	5.77	5.88	6.07	**5.99**	6.24	6.65	7.00	0
DO	Dissolved Oxygen	%	7	13.60	15.56	19.39	**16.80**	22.60	32.10		0
TN	Total Nitrogen	mg/L	6	12.00	15.00	31.33	**33.00**	43.00	52.00	1.50	6
TKN	Total Kejdhal Nitrogen	mg/L	6	0.75	4.50	5.76	**5.10**	8.10	11.00		0
NO3	Nitrate	mg/L	7	11.00	12.40	25.71	**26.00**	36.80	44.00		0
NO2	Nitrite	mg/L	6	0.01	0.01	0.01	**0.01**	0.01	0.05		0
Nox	Nox	mg/L	6	11.00	11.00	25.67	**25.00**	38.00	44.00	0.10	6
NH3	Ammonia	mg/L	7	0.01	0.01	0.01	**0.01**	0.01	0.05	0.90	0
TP	Total Phosphorous	mg/L	6	1.80	2.00	2.58	**2.40**	3.20	3.70	0.06	6
FRP	Filterable Reactive Phosphrous	mg/L	7	1.60	1.78	2.21	**2.20**	2.62	2.90	0.03	7
As	Arsenic	mg/L	7	0.00100	0.00110	0.00133	**0.00110**	0.00148	0.00210	0.02400	0
Cd	Cadmium	mg/L	6	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	6	0.00100	0.00100	0.00167	**0.00140**	0.00200	0.00320	0.00100	4
Cu	Copper	mg/L	6	0.00830	0.00860	0.01140	**0.01025**	0.01200	0.01900	0.00140	6
Pb	Lead	mg/L	6	0.00100	0.00100	0.00170	**0.00100**	0.00100	0.00520	0.00340	1
Hg	Mercury	mg/L	6	0.00005	0.00005	0.00010	**0.00005**	0.00008	0.00031	0.00060	0
Ni	Nickel	mg/L	6	0.00400	0.00420	0.00495	**0.00435**	0.00480	0.00800	0.01100	0
Zn	Zinc	mg/L	6	0.00280	0.00340	0.00435	**0.00380**	0.00450	0.00780	0.00800	0
Cl	Chlorine	mg/L	1	180.00	180.00	180.00	**180.00**	180.00	180.00		0
Ca	Calcium	mg/L	7	26.00	27.60	35.86	**31.00**	44.80	48.00		0
Mg	Magnesium	mg/L	7	26.00	27.20	35.43	**33.00**	43.40	46.00		0
K	Potassium	mg/L	7	12.00	17.60	27.57	**33.00**	34.80	39.00		0
Na	Sodium	mg/L	7	81.00	99.60	155.43	**160.00**	208.00	230.00		0
H as CaCO3	Hardness as CaCO3	mg/L	7	170.00	184.00	234.29	**210.00**	290.00	300.00		0

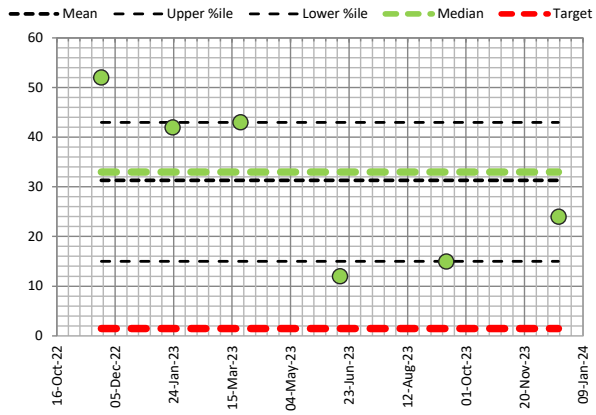
pH



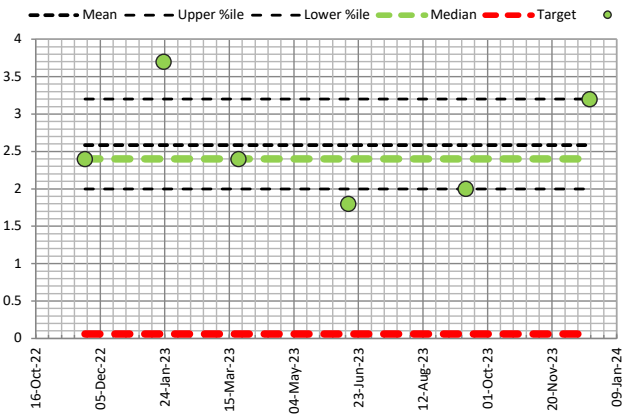
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

WG10D Hyd2o Bore Wattle Grove 10 Deep

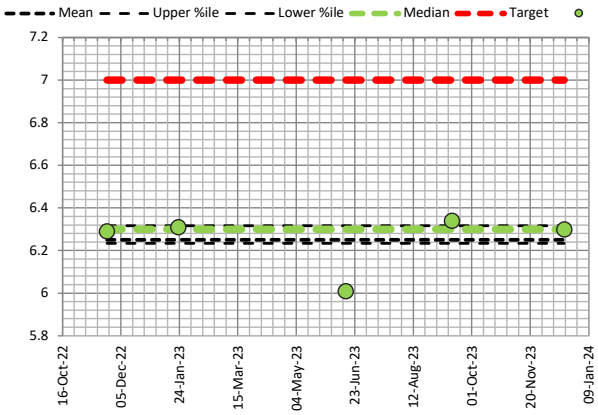
Site Bore Boundary Rd North - Verge (Install : Oct 2022)

Easting	405365	Data Analysis Period Start Date	1/01/2009
Northing	6458075	Data Analysis Period End Date	19/12/2023

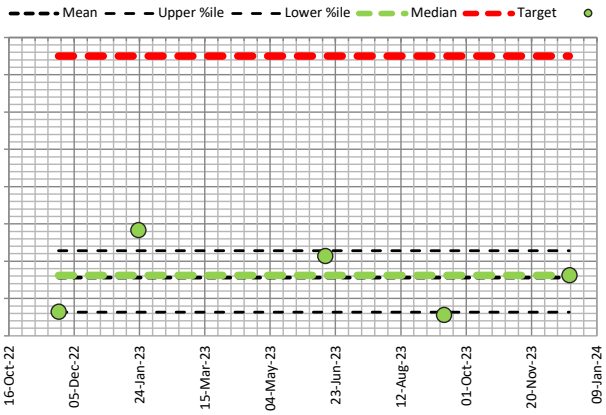
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	15	5.49	6.24	7.27	**7.08**	8.99	9.02		0
GWL mAHD	Groundwater Level	mAHD	15	14.60	14.63	16.35	**16.54**	17.38	18.13		0
T	Temperature	°C	5	18.10	20.180	23.640	**22.90**	27.620	29.300		0
EC	Electrical Conductivity	mS/cm	5	0.11	0.13	0.31	**0.33**	0.46	0.57	1.500	0
pH	pH	pH	5	6.01	6.23	6.25	**6.30**	6.32	6.34	7.00	0
DO	Dissolved Oxygen	%	5	42.10	48.90	52.68	**52.10**	56.84	63.40		0
TN	Total Nitrogen	mg/L	5	1.40	2.28	3.16	**2.80**	3.80	5.80	1.50	4
TKN	Total Kejdhal Nitrogen	mg/L	5	0.32	0.34	0.59	**0.70**	0.75	0.86		0
NO3	Nitrate	mg/L	5	1.10	1.90	2.58	**2.20**	2.94	5.10		0
NO2	Nitrite	mg/L	5	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	5	1.10	1.90	2.58	**2.20**	2.94	5.10	0.10	5
NH3	Ammonia	mg/L	5	0.01	0.01	0.01	**0.01**	0.01	0.01	0.90	0
TP	Total Phosphorous	mg/L	5	0.05	0.05	0.05	**0.05**	0.05	0.05	0.06	0
FRP	Filterable Reactive Phosphrous	mg/L	5	0.01	0.01	0.01	**0.01**	0.01	0.01	0.03	0
As	Arsenic	mg/L	5	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.02400	0
Cd	Cadmium	mg/L	5	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	5	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00100	0
Cu	Copper	mg/L	5	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00140	0
Pb	Lead	mg/L	5	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Hg	Mercury	mg/L	5	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	5	0.00100	0.00100	0.00106	**0.00100**	0.00106	0.00130	0.01100	0
Zn	Zinc	mg/L	5	0.00100	0.00100	0.00128	**0.00100**	0.00146	0.00210	0.00800	0
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	5	1.50	2.86	5.00	**5.40**	7.12	8.00		0
Mg	Magnesium	mg/L	5	1.50	2.94	4.10	**4.30**	5.10	6.70		0
K	Potassium	mg/L	5	2.90	3.46	3.84	**3.60**	4.22	5.10		0
Na	Sodium	mg/L	5	22.00	22.00	24.40	**22.00**	26.20	31.00		0
H as CaCO3	Hardness as CaCO3	mg/L	5	10.00	23.60	29.40	**27.00**	37.60	48.00		0

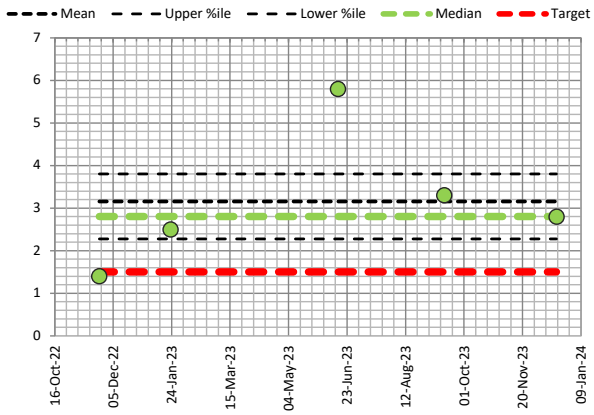
pH



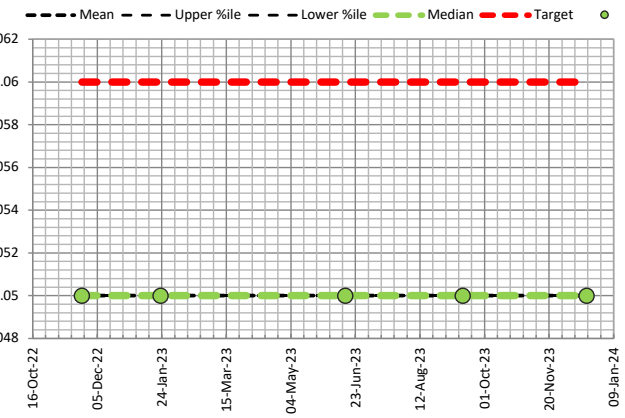
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

WG10S Hyd2o Bore Wattle Grove 10 Shallow

Site Bore Boundary Rd North - Verge (Install : Oct 2022)

Easting	405364	Data Analysis Period Start Date	1/01/2009
Northing	6458074	Data Analysis Period End Date	19/12/2023

Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	15	3.00	3.12	3.17	**3.21**	3.21	3.21		0
GWL mAHD	Groundwater Level	mAHD	15	20.39	20.39	20.43	**20.39**	20.48	20.60		0
T	Temperature	°C	0	0.00	0.000	0.000	**0.00**	0.000	0.000		0
EC	Electrical Conductivity	mS/cm	0	0.00	0.00	0.00	**0.00**	0.00	0.00	1.500	0
pH	pH	pH	0	0.00	0.00	0.00	**0.00**	0.00	0.00	7.00	0
DO	Dissolved Oxygen	%	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TN	Total Nitrogen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	1.50	0
TKN	Total Kejdhal Nitrogen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NO3	Nitrate	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NO2	Nitrite	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.10	0
NH3	Ammonia	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.90	0
TP	Total Phosphorous	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
FRP	Filterable Reactive Phosphrous	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.03	0
As	Arsenic	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.02400	0
Cd	Cadmium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00020	0
Cr	Chromium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00100	0
Cu	Copper	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00140	0
Pb	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Hg	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00800	0
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Mg	Magnesium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
K	Potassium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Na	Sodium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
H as CaCO3	Hardness as CaCO3	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

pH

No Data

Electrical Conductivity

No Data

Total Nitrogen

No Data

Total Phosphorous

No Data

H21003 Wattle Grove South Monitoring

MBa Unknown Origin Bore

Downstream Bore Boundary Rd South - Verge (Install : Unknown)

Easting	405245	Data Analysis Period Start Date	1/01/2009
Northing	6457958	Data Analysis Period End Date	19/12/2023

Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	27	1.65	1.82	2.91	**2.60**	4.41	5.30		0
GWL mAHD	Groundwater Level	mAHD	27	15.31	16.20	17.70	**18.01**	18.79	18.96		0
T	Temperature	°C	0	0.00	0.000	0.000	**0.00**	0.000	0.000		0
EC	Electrical Conductivity	mS/cm	0	0.00	0.00	0.00	**0.00**	0.00	0.00	1.500	0
pH	pH	pH	0	0.00	0.00	0.00	**0.00**	0.00	0.00	7.00	0
DO	Dissolved Oxygen	%	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TN	Total Nitrogen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	1.50	0
TKN	Total Kejdhal Nitrogen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NO3	Nitrate	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NO2	Nitrite	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.10	0
NH3	Ammonia	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.90	0
TP	Total Phosphorous	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
FRP	Filterable Reactive Phosphrous	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.03	0
As	Arsenic	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.02400	0
Cd	Cadmium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00020	0
Cr	Chromium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00100	0
Cu	Copper	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00140	0
Pb	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Hg	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00800	0
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Mg	Magnesium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
K	Potassium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Na	Sodium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
H as CaCO3	Hardness as CaCO3	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

pH

No Data

Electrical Conductivity

No Data

Total Nitrogen

No Data

Total Phosphorous

No Data

H21003 Wattle Grove South Monitoring

MBb Douglas Partners Bore 1

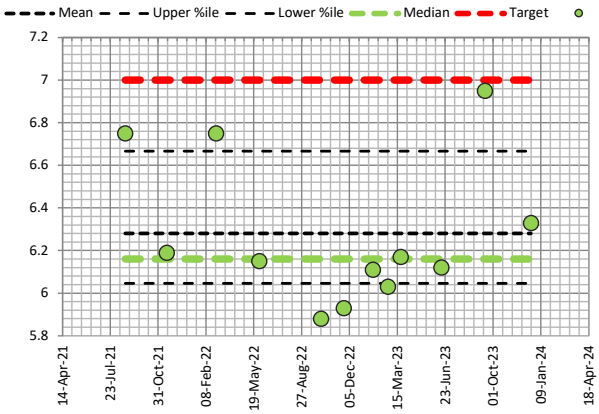
Site Bore Chicken Shed South - Rear of Lot (Install : Oct 2020)

Easting	406067
Northing	6456783
Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

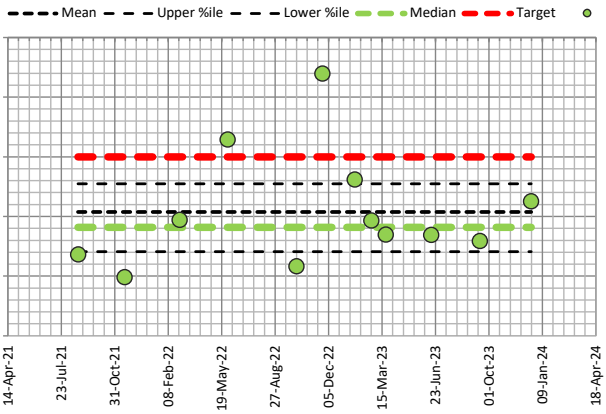
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	30	14.24	14.43	14.72	**14.69**	14.91	15.70		0
GWL mAHD	Groundwater Level	mAHD	30	16.20	16.99	17.19	**17.21**	17.47	17.66		0
T	Temperature	°C	12	18.10	18.620	23.008	**22.25**	26.520	31.800		0
EC	Electrical Conductivity	mS/cm	12	0.49	0.70	1.04	**0.91**	1.27	2.20	1.500	2
pH	pH	pH	12	5.88	6.05	6.28	**6.16**	6.67	6.95	7.00	0
DO	Dissolved Oxygen	%	12	8.80	11.68	33.68	**21.80**	68.56	75.24		0
TN	Total Nitrogen	mg/L	11	0.30	0.50	1.72	**1.10**	3.10	4.60	1.50	4
TKN	Total Kejdhal Nitrogen	mg/L	11	0.29	0.50	1.71	**1.00**	3.10	4.60		0
NO3	Nitrate	mg/L	12	0.01	0.01	0.02	**0.01**	0.02	0.05		0
NO2	Nitrite	mg/L	11	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	11	0.01	0.01	0.01	**0.01**	0.02	0.03	0.10	0
NH3	Ammonia	mg/L	12	0.06	0.17	0.93	**0.43**	1.70	3.40	0.90	4
TP	Total Phosphorous	mg/L	11	0.05	0.05	0.07	**0.05**	0.09	0.19	0.06	4
FRP	Filterable Reactive Phosphrous	mg/L	12	0.01	0.01	0.01	**0.01**	0.01	0.01	0.03	0
As	Arsenic	mg/L	12	0.00100	0.00100	0.00110	**0.00100**	0.00118	0.00150	0.02400	0
Cd	Cadmium	mg/L	11	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	11	0.00100	0.00100	0.00115	**0.00100**	0.00100	0.00270	0.00100	1
Cu	Copper	mg/L	11	0.00100	0.00100	0.00143	**0.00100**	0.00100	0.00470	0.00140	2
Pb	Lead	mg/L	11	0.00100	0.00100	0.00104	**0.00100**	0.00100	0.00140	0.00340	0
Hg	Mercury	mg/L	11	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	11	0.00290	0.00360	0.00619	**0.00500**	0.00770	0.01300	0.01100	2
Zn	Zinc	mg/L	11	0.01000	0.01100	0.01745	**0.01400**	0.01600	0.06100	0.00800	11
Cl	Chlorine	mg/L	3	0.10	0.10	43.40	**0.10**	78.04	130.00		0
Ca	Calcium	mg/L	8	3.00	5.72	13.33	**12.05**	21.20	25.00		0
Mg	Magnesium	mg/L	8	22.00	29.80	35.88	**34.50**	45.00	47.00		0
K	Potassium	mg/L	8	6.90	7.44	8.13	**8.00**	9.04	9.20		0
Na	Sodium	mg/L	8	76.00	78.20	91.00	**92.50**	100.00	110.00		0
H as CaCO3	Hardness as CaCO3	mg/L	8	100.00	138.00	182.50	**175.00**	236.00	260.00		0

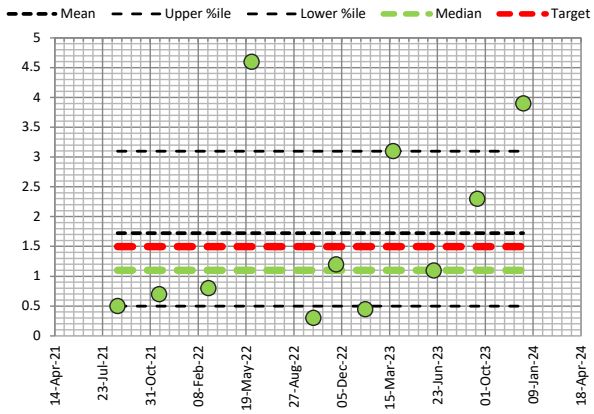
pH



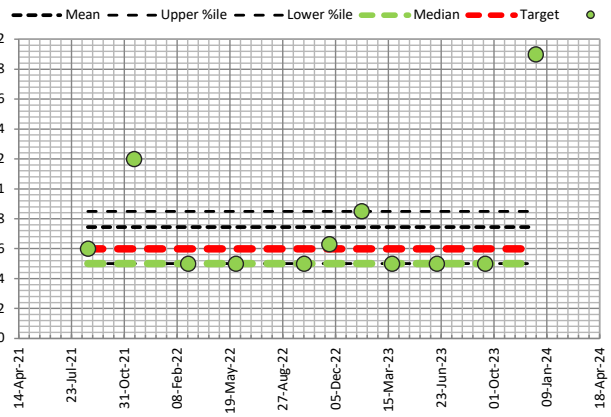
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

GW1 Urbaqua Bore 1

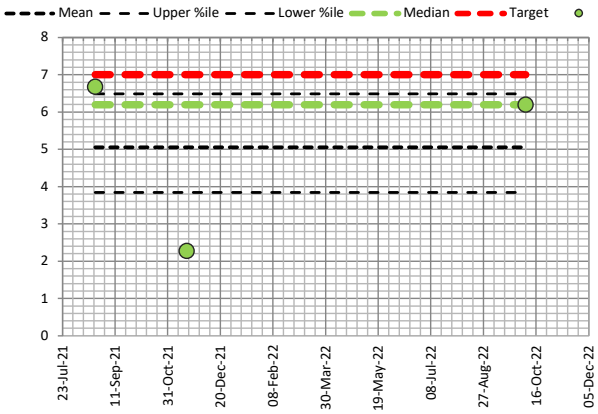
Site Bore Boundary Rd North - Verge (Install : Sep 2019)

Easting	405363
Northing	6458071
Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

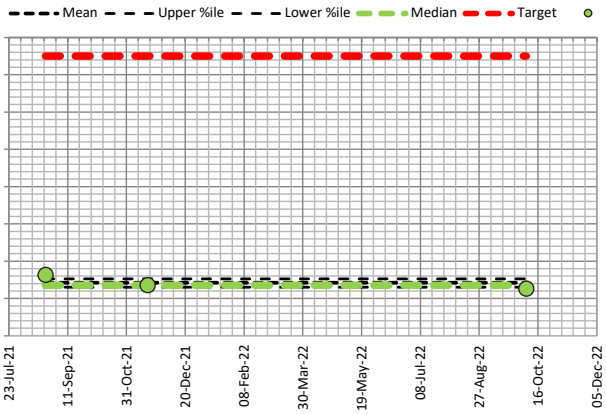
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	17	3.38	5.60	6.96	**6.62**	8.80	8.80		0
GWL mAHD	Groundwater Level	mAHD	17	14.69	14.69	16.52	**16.87**	17.89	20.11		0
T	Temperature	°C	3	19.50	19.860	20.433	**20.40**	21.000	21.400		0
EC	Electrical Conductivity	mS/cm	3	0.25	0.26	0.28	**0.27**	0.31	0.33	1.500	0
pH	pH	pH	3	2.28	3.85	5.05	**6.20**	6.49	6.68	7.00	0
DO	Dissolved Oxygen	%	3	27.20	40.68	54.70	**60.90**	69.96	76.00		0
TN	Total Nitrogen	mg/L	3	2.80	2.84	2.97	**2.90**	3.08	3.20	1.50	3
TKN	Total Kejdhal Nitrogen	mg/L	3	0.30	0.43	0.58	**0.63**	0.73	0.80		0
NO3	Nitrate	mg/L	3	1.90	2.14	2.33	**2.50**	2.56	2.60		0
NO2	Nitrite	mg/L	3	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	3	1.90	2.14	2.33	**2.50**	2.56	2.60	0.10	3
NH3	Ammonia	mg/L	3	0.01	0.01	0.01	**0.01**	0.01	0.01	0.90	0
TP	Total Phosphorous	mg/L	3	0.05	0.05	0.06	**0.06**	0.07	0.08	0.06	1
FRP	Filterable Reactive Phosphrous	mg/L	3	0.01	0.01	0.01	**0.01**	0.01	0.01	0.03	0
As	Arsenic	mg/L	3	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.02400	0
Cd	Cadmium	mg/L	3	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	3	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00100	0
Cu	Copper	mg/L	3	0.00100	0.00100	0.00200	**0.00100**	0.00280	0.00400	0.00140	1
Pb	Lead	mg/L	3	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Hg	Mercury	mg/L	3	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	3	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.01100	0
Zn	Zinc	mg/L	3	0.00110	0.00226	0.00703	**0.00400**	0.01120	0.01600	0.00800	1
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	1	3.30	3.30	3.30	**3.30**	3.30	3.30		0
Mg	Magnesium	mg/L	1	4.20	4.20	4.20	**4.20**	4.20	4.20		0
K	Potassium	mg/L	1	8.00	8.00	8.00	**8.00**	8.00	8.00		0
Na	Sodium	mg/L	1	15.00	15.00	15.00	**15.00**	15.00	15.00		0
H as CaCO3	Hardness as CaCO3	mg/L	1	26.00	26.00	26.00	**26.00**	26.00	26.00		0

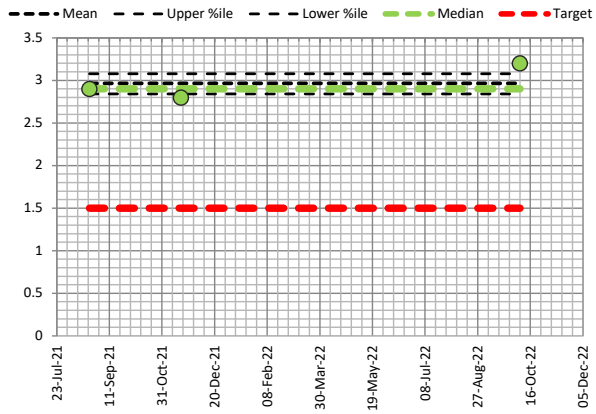
pH



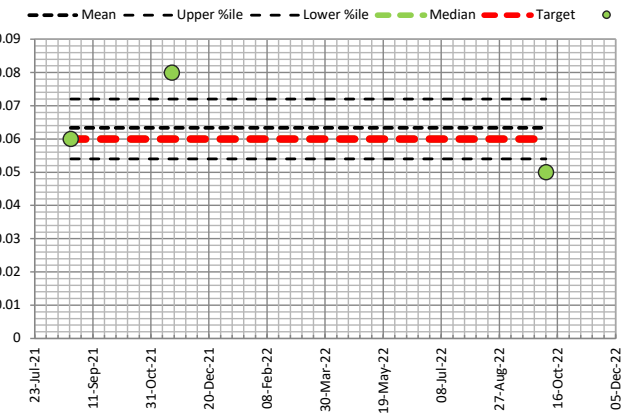
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

GW3 Endemic Bore 3

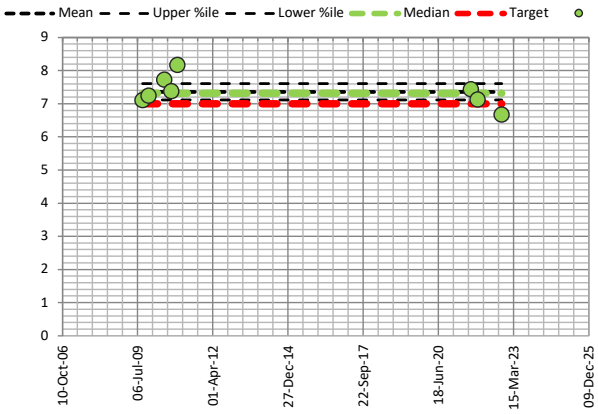
Downstream Bore Boundary Rd South - GBSWA (Install : Jun 2009)

Easting	403634	Data Analysis Period Start Date	1/01/2009
Northing	6456299	Data Analysis Period End Date	19/12/2023

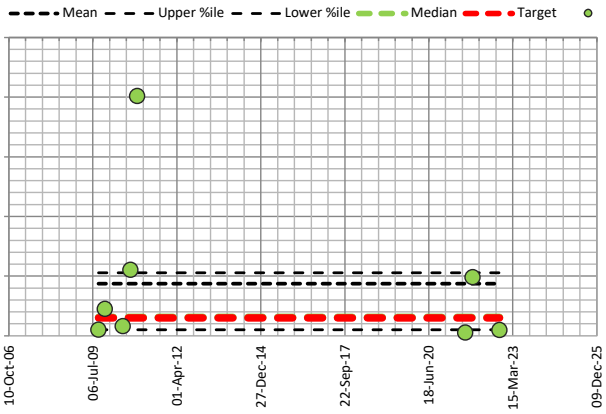
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	43	0.87	1.19	1.47	**1.53**	1.74	2.07		0
GWL mAHD	Groundwater Level	mAHD	43	7.58	7.91	8.18	**8.12**	8.46	8.78		0
T	Temperature	°C	8	15.90	16.980	19.388	**18.60**	20.900	26.000		0
EC	Electrical Conductivity	mS/cm	8	0.28	0.51	4.37	**1.54**	5.29	20.10	1.500	4
pH	pH	pH	8	6.68	7.12	7.36	**7.32**	7.61	8.17	7.00	7
DO	Dissolved Oxygen	%	3	21.40	22.28	30.60	**23.60**	37.52	46.80		0
TN	Total Nitrogen	mg/L	6	0.76	1.20	1.96	**1.30**	1.40	5.80	1.50	1
TKN	Total Kejdhal Nitrogen	mg/L	7	0.75	1.12	2.35	**1.40**	1.56	9.00		0
NO3	Nitrate	mg/L	7	0.01	0.03	1.67	**0.05**	3.21	7.55		0
NO2	Nitrite	mg/L	7	0.01	0.01	0.06	**0.01**	0.08	0.25		0
Nox	Nox	mg/L	6	0.02	0.03	2.00	**0.05**	4.30	7.55	0.10	2
NH3	Ammonia	mg/L	3	0.06	0.07	0.11	**0.09**	0.14	0.18	0.90	0
TP	Total Phosphorous	mg/L	7	0.05	0.05	0.14	**0.08**	0.22	0.30	0.06	5
FRP	Filterable Reactive Phosphrous	mg/L	7	0.01	0.01	0.03	**0.01**	0.06	0.08	0.03	3
As	Arsenic	mg/L	7	0.00020	0.00100	0.00789	**0.00100**	0.00100	0.05000	0.02400	1
Cd	Cadmium	mg/L	7	0.00005	0.00010	0.00022	**0.00010**	0.00010	0.00100	0.00020	1
Cr	Chromium	mg/L	7	0.00100	0.00100	0.00243	**0.00100**	0.00440	0.00600	0.00100	3
Cu	Copper	mg/L	7	0.00200	0.00200	0.00339	**0.00270**	0.00460	0.00700	0.00140	7
Pb	Lead	mg/L	7	0.00010	0.00100	0.00959	**0.00100**	0.01420	0.04400	0.00340	2
Hg	Mercury	mg/L	7	0.00005	0.00005	0.00011	**0.00010**	0.00010	0.00030	0.00060	0
Ni	Nickel	mg/L	7	0.00100	0.00200	0.00371	**0.00300**	0.00480	0.00900	0.01100	0
Zn	Zinc	mg/L	7	0.00100	0.00404	0.02354	**0.01700**	0.03100	0.08500	0.00800	4
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	1	86.00	86.00	86.00	**86.00**	86.00	86.00		0
Mg	Magnesium	mg/L	1	3.80	3.80	3.80	**3.80**	3.80	3.80		0
K	Potassium	mg/L	1	6.90	6.90	6.90	**6.90**	6.90	6.90		0
Na	Sodium	mg/L	1	26.00	26.00	26.00	**26.00**	26.00	26.00		0
H as CaCO3	Hardness as CaCO3	mg/L	1	230.00	230.00	230.00	**230.00**	230.00	230.00		0

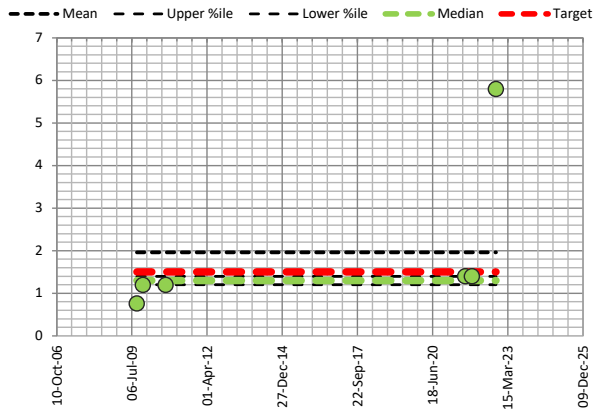
pH



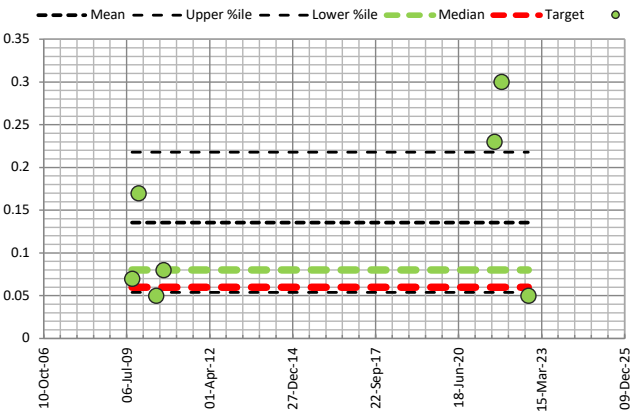
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

GW5 Endemic Bore 5

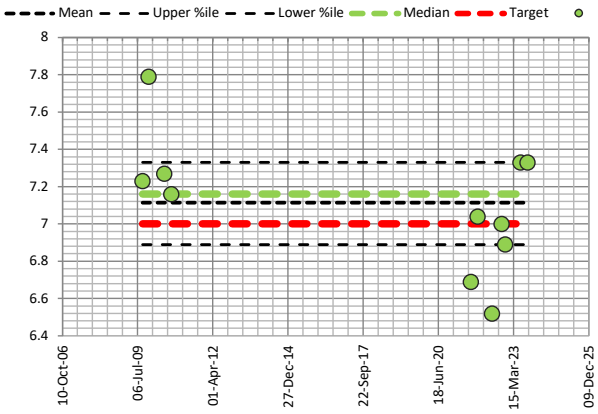
Downstream Bore Boundary Rd North - GBSWA (Install : Jun 2009)

Easting	405055	Data Analysis Period Start Date	1/01/2009
Northing	6457747	Data Analysis Period End Date	19/12/2023

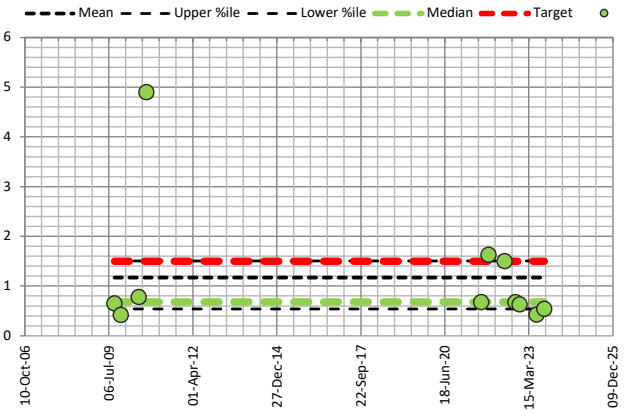
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	46	0.67	1.05	1.39	**1.49**	1.75	1.86		0
GWL mAHD	Groundwater Level	mAHD	46	17.55	17.66	18.02	**17.92**	18.36	18.74		0
T	Temperature	°C	11	15.50	16.400	18.764	**18.20**	20.600	23.200		0
EC	Electrical Conductivity	mS/cm	11	0.42	0.54	1.17	**0.68**	1.51	4.90	1.500	3
pH	pH	pH	11	6.52	6.89	7.11	**7.16**	7.33	7.79	7.00	7
DO	Dissolved Oxygen	%	7	12.80	22.52	37.06	**40.70**	51.94	55.30		0
TN	Total Nitrogen	mg/L	10	0.73	1.00	2.36	**1.55**	3.48	6.20	1.50	5
TKN	Total Kejdhal Nitrogen	mg/L	11	0.71	1.00	1.90	**1.70**	2.80	3.80		0
NO3	Nitrate	mg/L	11	0.01	0.01	0.56	**0.02**	0.58	4.50		0
NO2	Nitrite	mg/L	11	0.01	0.01	0.01	**0.01**	0.01	0.10		0
Nox	Nox	mg/L	10	0.01	0.01	0.61	**0.02**	0.65	4.50	0.10	3
NH3	Ammonia	mg/L	7	0.01	0.01	0.03	**0.03**	0.04	0.08	0.90	0
TP	Total Phosphorous	mg/L	11	0.05	0.05	0.13	**0.06**	0.12	0.72	0.06	5
FRP	Filterable Reactive Phosphrous	mg/L	11	0.01	0.01	0.01	**0.01**	0.01	0.01	0.03	0
As	Arsenic	mg/L	11	0.00100	0.00100	0.00664	**0.00100**	0.00200	0.05000	0.02400	1
Cd	Cadmium	mg/L	11	0.00005	0.00010	0.00022	**0.00010**	0.00010	0.00100	0.00020	2
Cr	Chromium	mg/L	11	0.00100	0.00100	0.11509	**0.00100**	0.01400	1.20000	0.00100	4
Cu	Copper	mg/L	11	0.00100	0.00100	0.04100	**0.00300**	0.00700	0.41000	0.00140	6
Pb	Lead	mg/L	11	0.00010	0.00100	0.02019	**0.00100**	0.00800	0.19000	0.00340	3
Hg	Mercury	mg/L	11	0.00005	0.00005	0.00010	**0.00005**	0.00010	0.00050	0.00060	0
Ni	Nickel	mg/L	11	0.00410	0.00500	0.04609	**0.00950**	0.01400	0.42000	0.01100	3
Zn	Zinc	mg/L	11	0.00100	0.00100	0.12936	**0.00300**	0.00500	1.10000	0.00800	2
Cl	Chlorine	mg/L	1	0.10	0.10	0.10	**0.10**	0.10	0.10		0
Ca	Calcium	mg/L	4	27.00	46.80	73.50	**78.50**	102.20	110.00		0
Mg	Magnesium	mg/L	4	4.30	5.14	5.98	**6.30**	6.94	7.00		0
K	Potassium	mg/L	4	5.10	5.58	6.38	**5.95**	7.00	8.50		0
Na	Sodium	mg/L	4	18.00	19.80	41.00	**33.50**	59.20	79.00		0
H as CaCO3	Hardness as CaCO3	mg/L	4	95.00	140.00	206.25	**220.00**	278.00	290.00		0

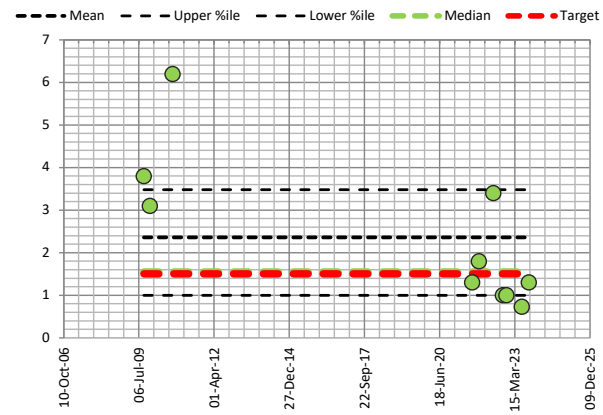
pH



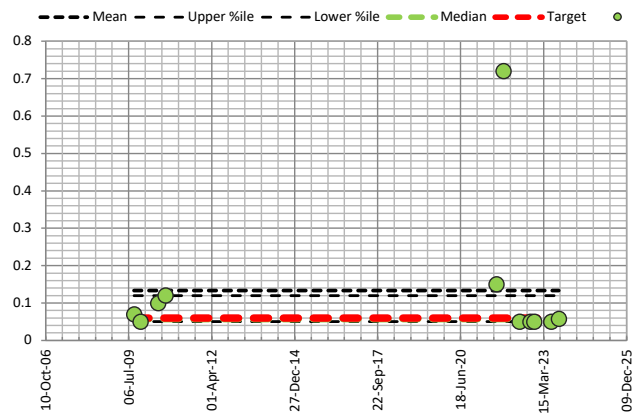
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

GW5D Hyd2o Deep Bore next to Endemic 5

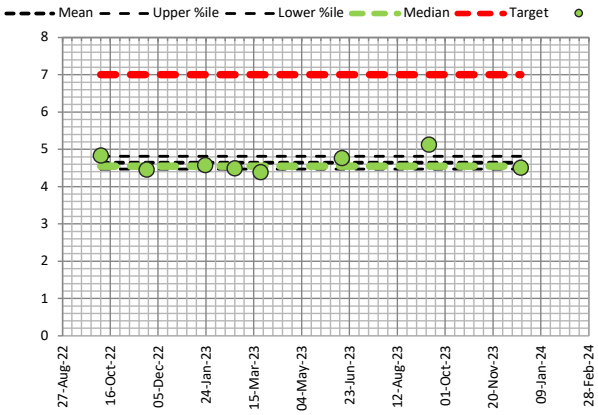
Downstream Bore Boundary Rd North - GBSWA (Install : Jul 2022)

Easting	405053	Data Analysis Period Start Date	1/01/2009
Northing	6457750	Data Analysis Period End Date	19/12/2023

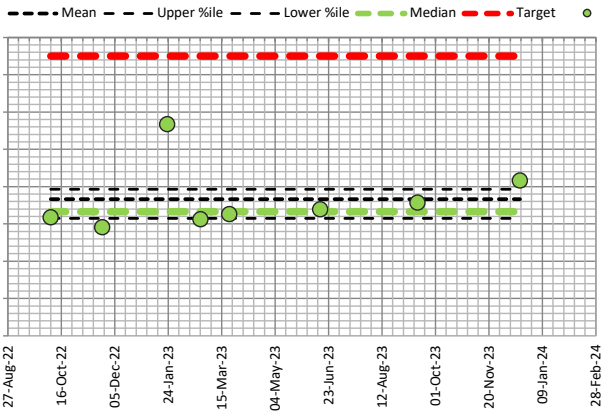
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	17	2.32	3.20	3.97	**4.03**	4.90	5.54		0
GWL mAHD	Groundwater Level	mAHD	17	13.83	14.47	15.40	**15.34**	16.17	17.05		0
T	Temperature	°C	8	17.50	18.980	23.338	**23.85**	26.920	30.200		0
EC	Electrical Conductivity	mS/cm	8	0.58	0.63	0.73	**0.67**	0.79	1.14	1.500	0
pH	pH	pH	8	4.39	4.47	4.65	**4.55**	4.81	5.13	7.00	0
DO	Dissolved Oxygen	%	8	11.00	12.34	15.01	**14.60**	18.26	18.50		0
TN	Total Nitrogen	mg/L	7	0.44	0.59	1.36	**0.62**	1.02	5.50	1.50	1
TKN	Total Kejdhal Nitrogen	mg/L	7	0.44	0.59	1.37	**0.63**	1.02	5.50		0
NO3	Nitrate	mg/L	8	0.01	0.01	0.01	**0.01**	0.01	0.01		0
NO2	Nitrite	mg/L	7	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	7	0.01	0.01	0.01	**0.01**	0.01	0.01	0.10	0
NH3	Ammonia	mg/L	8	0.11	0.13	0.15	**0.16**	0.17	0.18	0.90	0
TP	Total Phosphorous	mg/L	7	0.05	0.05	0.10	**0.05**	0.06	0.42	0.06	2
FRP	Filterable Reactive Phosphrous	mg/L	8	0.01	0.01	0.01	**0.01**	0.01	0.01	0.03	0
As	Arsenic	mg/L	8	0.00100	0.00104	0.00155	**0.00145**	0.00192	0.00260	0.02400	0
Cd	Cadmium	mg/L	7	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	7	0.00100	0.00100	0.00101	**0.00100**	0.00100	0.00110	0.00100	1
Cu	Copper	mg/L	7	0.00100	0.00100	0.00101	**0.00100**	0.00100	0.00110	0.00140	0
Pb	Lead	mg/L	7	0.00100	0.00100	0.00186	**0.00130**	0.00234	0.00420	0.00340	1
Hg	Mercury	mg/L	7	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	7	0.00540	0.00716	0.01134	**0.01000**	0.01600	0.01900	0.01100	3
Zn	Zinc	mg/L	7	0.00220	0.00272	0.00514	**0.00410**	0.00584	0.01300	0.00800	1
Cl	Chlorine	mg/L	1	66.00	66.00	66.00	**66.00**	66.00	66.00		0
Ca	Calcium	mg/L	8	11.00	11.80	16.13	**15.00**	17.60	29.00		0
Mg	Magnesium	mg/L	8	10.00	10.40	12.13	**12.00**	13.60	15.00		0
K	Potassium	mg/L	8	6.40	6.60	7.11	**6.85**	7.60	8.60		0
Na	Sodium	mg/L	8	72.00	73.00	78.63	**78.00**	82.00	91.00		0
H as CaCO3	Hardness as CaCO3	mg/L	8	68.00	78.40	89.38	**83.50**	97.20	130.00		0

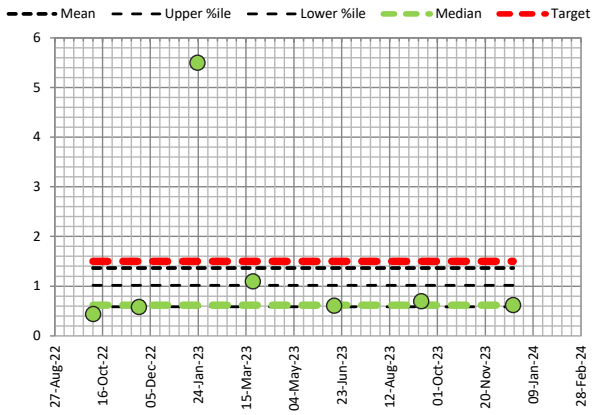
pH



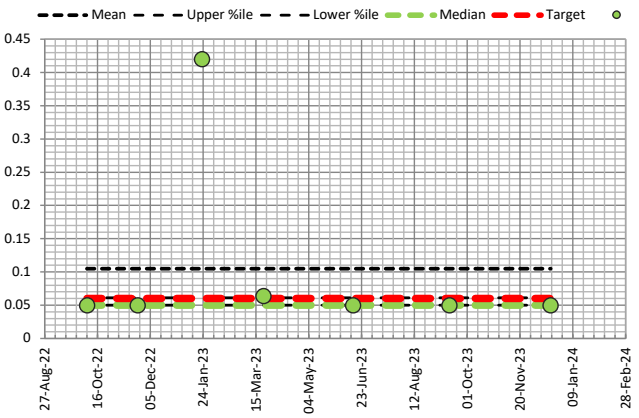
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

GW8 Endemic Bore 8

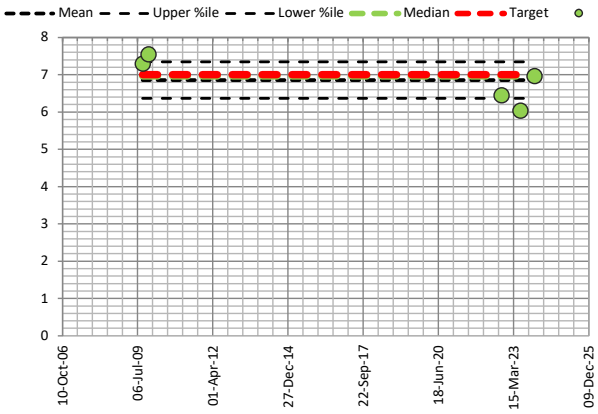
Downstream Bore Victoria Rd North - Verge (Install : Jun 2009)

Easting	405590	Data Analysis Period Start Date	1/01/2009
Northing	6456777	Data Analysis Period End Date	19/12/2023

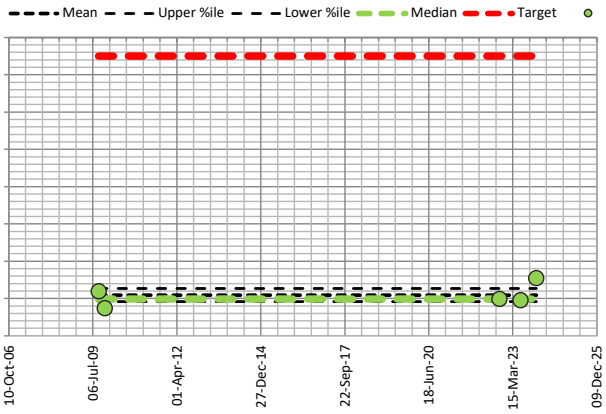
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	32	3.11	3.55	3.88	**3.94**	4.18	4.65		0
GWL mAHD	Groundwater Level	mAHD	32	19.96	20.43	20.73	**20.67**	21.06	21.50		0
T	Temperature	°C	5	16.90	18.020	21.040	**19.40**	23.080	29.000		0
EC	Electrical Conductivity	mS/cm	5	0.15	0.18	0.22	**0.20**	0.25	0.31	1.500	0
pH	pH	pH	5	6.04	6.37	6.86	**6.97**	7.35	7.55	7.00	2
DO	Dissolved Oxygen	%	3	19.80	26.68	36.60	**37.00**	46.60	53.00		0
TN	Total Nitrogen	mg/L	3	2.30	2.38	2.53	**2.50**	2.68	2.80	1.50	3
TKN	Total Kejdhal Nitrogen	mg/L	3	0.63	1.18	1.68	**2.00**	2.24	2.40		0
NO3	Nitrate	mg/L	3	0.25	0.29	0.84	**0.36**	1.28	1.90		0
NO2	Nitrite	mg/L	3	0.01	0.01	0.04	**0.02**	0.07	0.10		0
Nox	Nox	mg/L	2	0.38	0.68	1.14	**1.14**	1.60	1.90	0.10	2
NH3	Ammonia	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.90	0
TP	Total Phosphorous	mg/L	3	0.09	0.14	0.22	**0.22**	0.30	0.36	0.06	3
FRP	Filterable Reactive Phosphrous	mg/L	3	0.01	0.04	0.09	**0.09**	0.13	0.16	0.03	2
As	Arsenic	mg/L	3	0.00100	0.00260	0.01867	**0.00500**	0.03200	0.05000	0.02400	1
Cd	Cadmium	mg/L	3	0.00010	0.00010	0.00120	**0.00010**	0.00208	0.00340	0.00020	1
Cr	Chromium	mg/L	3	0.00100	0.29660	0.58033	**0.74000**	0.89600	1.00000	0.00100	2
Cu	Copper	mg/L	3	0.00590	0.07554	0.18863	**0.18000**	0.30000	0.38000	0.00140	3
Pb	Lead	mg/L	3	0.00100	0.01500	0.03500	**0.03600**	0.05520	0.06800	0.00340	2
Hg	Mercury	mg/L	3	0.00005	0.00007	0.00025	**0.00010**	0.00040	0.00060	0.00060	0
Ni	Nickel	mg/L	3	0.00180	0.03668	0.35693	**0.08900**	0.62360	0.98000	0.01100	2
Zn	Zinc	mg/L	3	0.01800	0.15480	0.32933	**0.36000**	0.51000	0.61000	0.00800	3
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	1	5.00	5.00	5.00	**5.00**	5.00	5.00		0
Mg	Magnesium	mg/L	1	3.70	3.70	3.70	**3.70**	3.70	3.70		0
K	Potassium	mg/L	1	3.10	3.10	3.10	**3.10**	3.10	3.10		0
Na	Sodium	mg/L	1	14.00	14.00	14.00	**14.00**	14.00	14.00		0
H as CaCO3	Hardness as CaCO3	mg/L	1	28.00	28.00	28.00	**28.00**	28.00	28.00		0

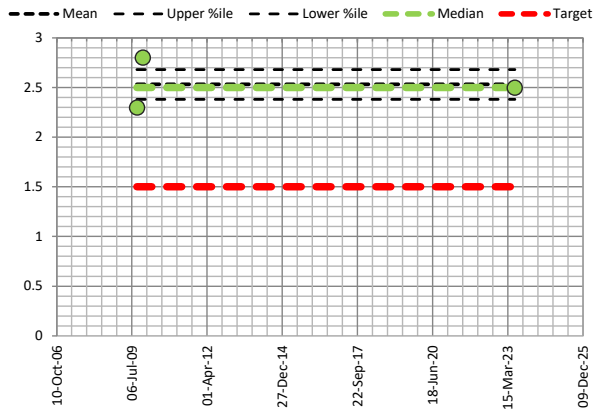
pH



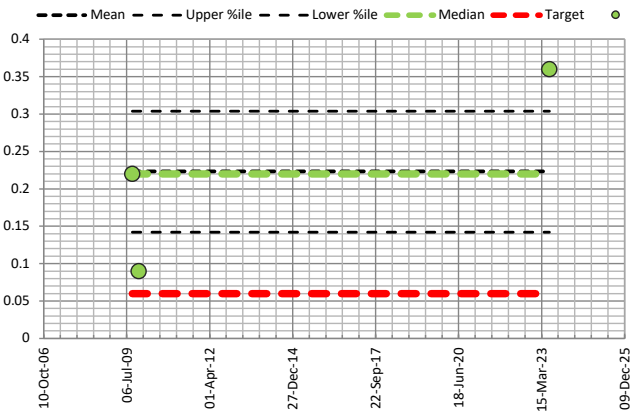
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

GW8D Hyd2o Deep Bore next to Endemic 8

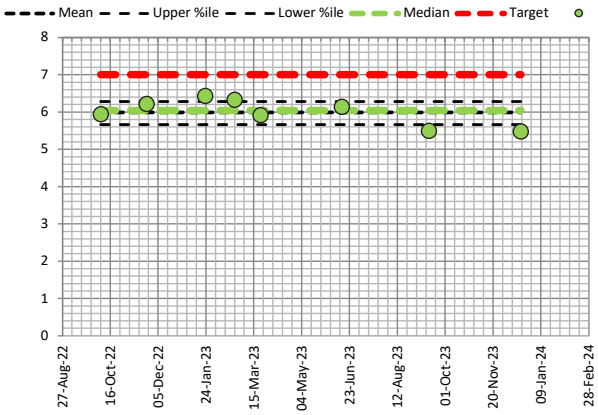
Downstream Bore Victoria Rd North - Verge (Install Jul 2022)

Easting	405590	Data Analysis Period Start Date	1/01/2009
Northing	6456775	Data Analysis Period End Date	19/12/2023

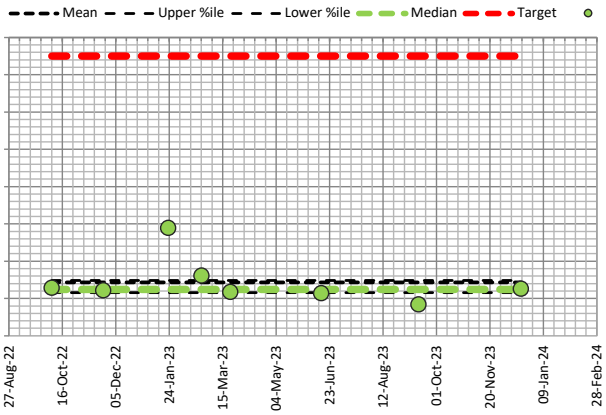
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	17	6.43	6.79	7.43	**7.48**	8.14	8.50		0
GWL mAHD	Groundwater Level	mAHD	17	16.02	16.38	17.09	**17.04**	17.72	18.09		0
T	Temperature	°C	8	20.30	21.040	24.263	**24.25**	27.460	28.600		0
EC	Electrical Conductivity	mS/cm	8	0.17	0.23	0.29	**0.25**	0.30	0.58	1.500	0
pH	pH	pH	8	5.48	5.67	6.00	**6.04**	6.29	6.43	7.00	0
DO	Dissolved Oxygen	%	8	19.40	21.42	24.66	**24.15**	26.10	34.30		0
TN	Total Nitrogen	mg/L	7	0.10	0.10	0.16	**0.10**	0.21	0.38	1.50	0
TKN	Total Kejdhal Nitrogen	mg/L	7	0.10	0.10	0.16	**0.10**	0.20	0.38		0
NO3	Nitrate	mg/L	8	0.01	0.01	0.01	**0.01**	0.01	0.01		0
NO2	Nitrite	mg/L	7	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	7	0.01	0.01	0.01	**0.01**	0.01	0.01	0.10	0
NH3	Ammonia	mg/L	8	0.01	0.01	0.01	**0.01**	0.01	0.01	0.90	0
TP	Total Phosphorous	mg/L	7	0.05	0.05	0.05	**0.05**	0.05	0.05	0.06	0
FRP	Filterable Reactive Phosphrous	mg/L	8	0.01	0.01	0.01	**0.01**	0.01	0.01	0.03	0
As	Arsenic	mg/L	8	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.02400	0
Cd	Cadmium	mg/L	7	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	7	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00100	0
Cu	Copper	mg/L	7	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00140	0
Pb	Lead	mg/L	7	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Hg	Mercury	mg/L	7	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	7	0.00110	0.00152	0.00236	**0.00220**	0.00310	0.00420	0.01100	0
Zn	Zinc	mg/L	7	0.00120	0.00156	0.00499	**0.00310**	0.00454	0.01900	0.00800	1
Cl	Chlorine	mg/L	1	59.00	59.00	59.00	**59.00**	59.00	59.00		0
Ca	Calcium	mg/L	8	0.73	1.38	2.13	**1.70**	3.08	4.00		0
Mg	Magnesium	mg/L	8	1.70	2.38	3.38	**3.70**	4.24	4.50		0
K	Potassium	mg/L	8	0.95	1.14	2.01	**2.05**	2.86	3.00		0
Na	Sodium	mg/L	8	29.00	32.40	34.88	**36.50**	37.00	38.00		0
H as CaCO3	Hardness as CaCO3	mg/L	8	8.70	13.60	19.21	**20.50**	24.80	27.00		0

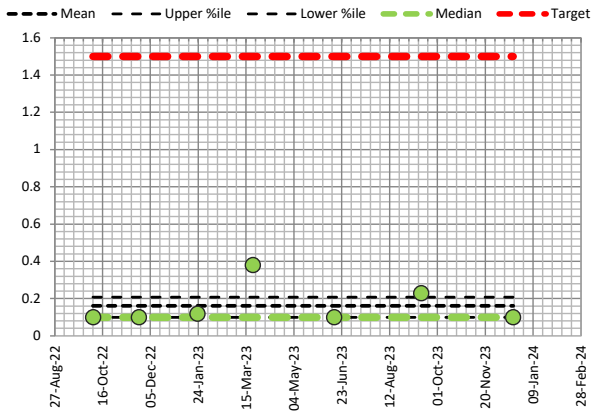
pH



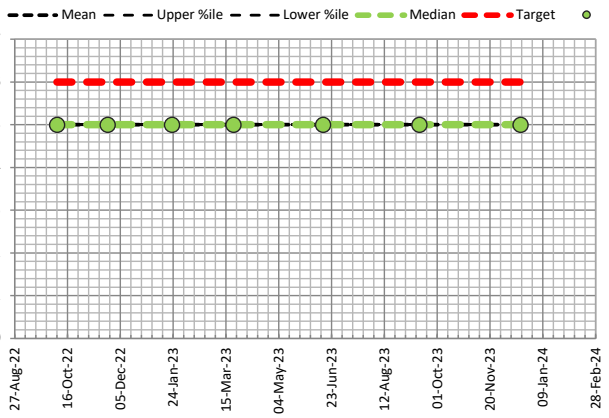
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

GW9D Hyd2o Bore Wetlands 9 Deep

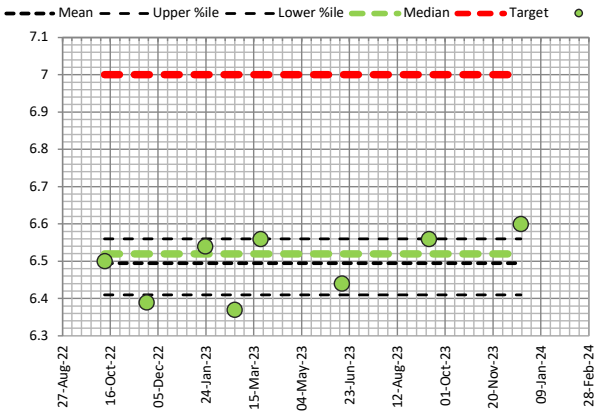
Downstream Bore Brentwood Rd North - Verge (Install Jul 2022)

Easting	405329	Data Analysis Period Start Date	1/01/2009
Northing	6457513	Data Analysis Period End Date	19/12/2023

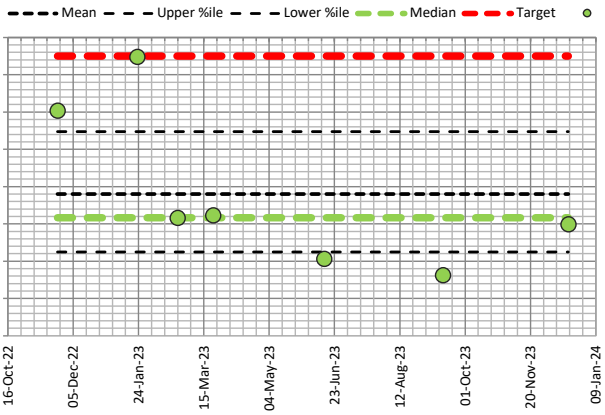
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	17	2.35	2.62	2.98	**2.89**	3.41	3.58		0
GWL mAHD	Groundwater Level	mAHD	17	18.20	18.37	18.80	**18.89**	19.16	19.43		0
T	Temperature	°C	7	18.30	19.420	24.214	**25.40**	27.180	29.300		0
EC	Electrical Conductivity	mS/cm	7	0.33	0.45	0.76	**0.63**	1.10	1.50	1.500	0
pH	pH	pH	8	6.37	6.41	6.50	**6.52**	6.56	6.60	7.00	0
DO	Dissolved Oxygen	%	7	10.70	11.36	15.40	**14.40**	17.32	25.70		0
TN	Total Nitrogen	mg/L	7	0.71	0.85	1.82	**1.50**	2.72	3.70	1.50	3
TKN	Total Kejdhal Nitrogen	mg/L	7	0.55	0.66	1.73	**1.50**	2.72	3.70		0
NO3	Nitrate	mg/L	8	0.01	0.01	0.10	**0.05**	0.15	0.40		0
NO2	Nitrite	mg/L	7	0.01	0.01	0.01	**0.01**	0.01	0.05		0
Nox	Nox	mg/L	7	0.01	0.01	0.11	**0.05**	0.16	0.40	0.10	3
NH3	Ammonia	mg/L	8	0.01	0.01	0.05	**0.05**	0.09	0.12	0.90	0
TP	Total Phosphorous	mg/L	7	0.05	0.05	0.08	**0.05**	0.06	0.23	0.06	2
FRP	Filterable Reactive Phosphrous	mg/L	8	0.01	0.01	0.02	**0.01**	0.02	0.06	0.03	1
As	Arsenic	mg/L	8	0.00100	0.00100	0.00180	**0.00120**	0.00142	0.00620	0.02400	0
Cd	Cadmium	mg/L	7	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	7	0.00100	0.00100	0.00120	**0.00100**	0.00108	0.00230	0.00100	2
Cu	Copper	mg/L	7	0.00170	0.00300	0.00477	**0.00370**	0.00620	0.00990	0.00140	7
Pb	Lead	mg/L	7	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Hg	Mercury	mg/L	7	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	7	0.00700	0.00960	0.02079	**0.02600**	0.02780	0.03500	0.01100	5
Zn	Zinc	mg/L	7	0.00230	0.00392	0.00919	**0.00780**	0.01306	0.02300	0.00800	3
Cl	Chlorine	mg/L	1	100.00	100.00	100.00	**100.00**	100.00	100.00		0
Ca	Calcium	mg/L	8	10.00	12.60	22.00	**20.50**	29.60	41.00		0
Mg	Magnesium	mg/L	8	7.80	11.02	19.31	**14.50**	28.80	40.00		0
K	Potassium	mg/L	8	8.20	9.44	15.70	**17.50**	20.20	23.00		0
Na	Sodium	mg/L	8	41.00	47.40	75.25	**63.00**	109.60	130.00		0
H as CaCO3	Hardness as CaCO3	mg/L	7	58.00	71.60	132.14	**110.00**	216.00	240.00		0

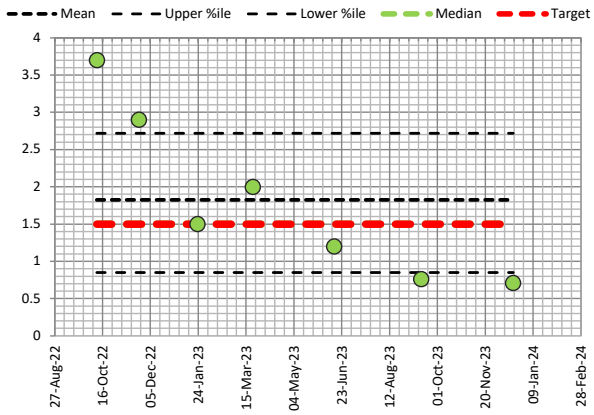
pH



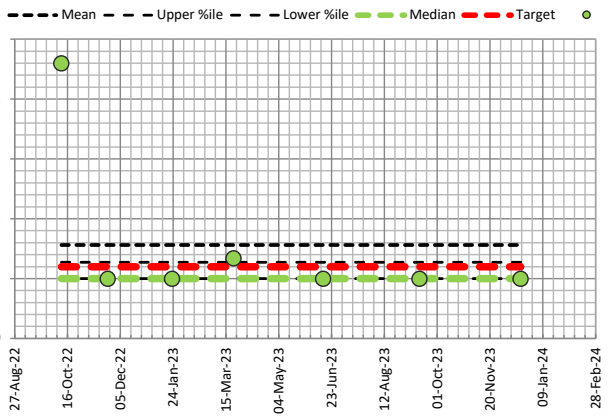
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

GW9S Hyd2o Bore Wetlands 9 Shallow

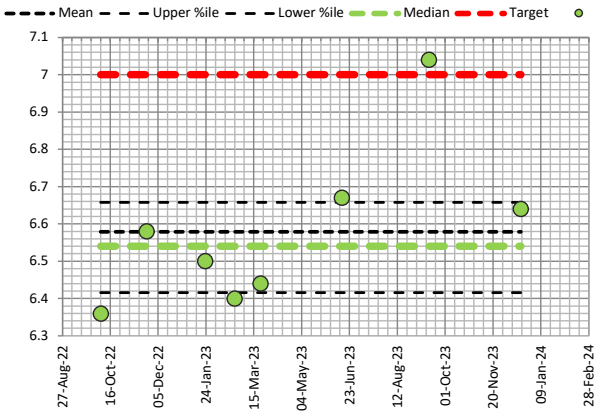
Downstream Bore Brentwood Rd North - Verge (Install Jul 2022)

Easting	405329	Data Analysis Period Start Date	1/01/2009
Northing	6457512	Data Analysis Period End Date	19/12/2023

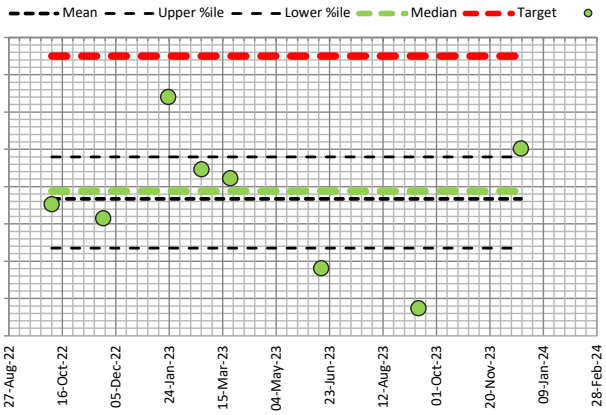
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	17	2.11	2.33	2.65	**2.58**	3.03	3.16		0
GWL mAHD	Groundwater Level	mAHD	17	18.65	18.78	19.16	**19.23**	19.48	19.70		0
T	Temperature	°C	8	17.70	18.940	24.413	**25.40**	28.800	31.300		0
EC	Electrical Conductivity	mS/cm	8	0.15	0.47	0.73	**0.78**	0.96	1.28	1.500	0
pH	pH	pH	8	6.36	6.42	6.58	**6.54**	6.66	7.04	7.00	1
DO	Dissolved Oxygen	%	8	13.00	15.24	23.18	**23.10**	30.32	34.90		0
TN	Total Nitrogen	mg/L	7	1.50	3.48	4.83	**3.90**	6.80	8.20	1.50	6
TKN	Total Kejdhal Nitrogen	mg/L	7	0.53	0.75	1.45	**1.50**	2.08	2.30		0
NO3	Nitrate	mg/L	8	0.87	1.50	3.18	**2.30**	5.28	6.50		0
NO2	Nitrite	mg/L	7	0.01	0.01	0.04	**0.02**	0.08	0.09		0
Nox	Nox	mg/L	7	0.87	1.42	3.38	**2.30**	5.64	6.50	0.10	7
NH3	Ammonia	mg/L	8	0.01	0.01	0.04	**0.01**	0.10	0.11	0.90	0
TP	Total Phosphorous	mg/L	7	0.12	0.15	0.43	**0.27**	0.45	1.40	0.06	7
FRP	Filterable Reactive Phosphrous	mg/L	8	0.06	0.08	0.14	**0.12**	0.19	0.31	0.03	8
As	Arsenic	mg/L	8	0.00330	0.00510	0.00674	**0.00565**	0.00662	0.01600	0.02400	0
Cd	Cadmium	mg/L	7	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	7	0.00100	0.00100	0.00111	**0.00100**	0.00100	0.00180	0.00100	1
Cu	Copper	mg/L	7	0.00180	0.00292	0.00380	**0.00380**	0.00482	0.00600	0.00140	7
Pb	Lead	mg/L	7	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Hg	Mercury	mg/L	7	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	7	0.00190	0.00354	0.00934	**0.00910**	0.01312	0.02300	0.01100	2
Zn	Zinc	mg/L	7	0.00430	0.00800	0.00969	**0.01100**	0.01180	0.01200	0.00800	5
Cl	Chlorine	mg/L	1	110.00	110.00	110.00	**110.00**	110.00	110.00		0
Ca	Calcium	mg/L	8	21.00	31.40	37.88	**36.50**	48.20	51.00		0
Mg	Magnesium	mg/L	8	2.50	5.16	9.05	**9.60**	13.20	14.00		0
K	Potassium	mg/L	8	5.10	8.90	14.33	**17.50**	18.00	19.00		0
Na	Sodium	mg/L	8	13.00	33.40	52.88	**53.00**	67.00	99.00		0
H as CaCO3	Hardness as CaCO3	mg/L	7	62.00	102.40	131.43	**140.00**	164.00	190.00		0

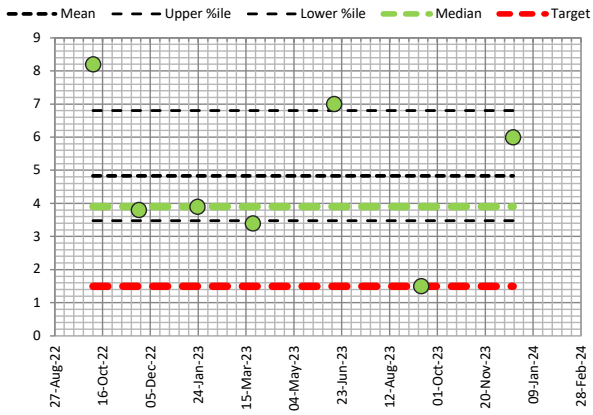
pH



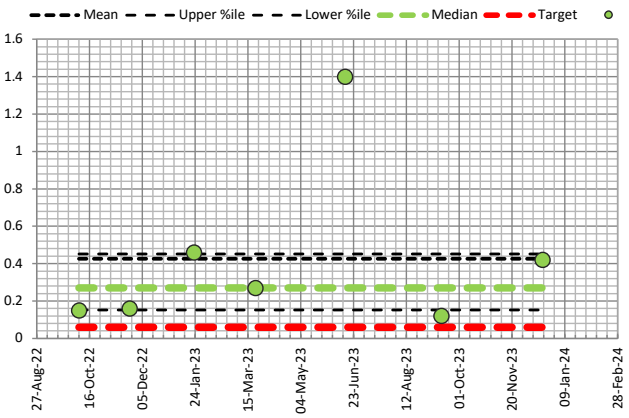
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

GW12 Endemic Bore 12

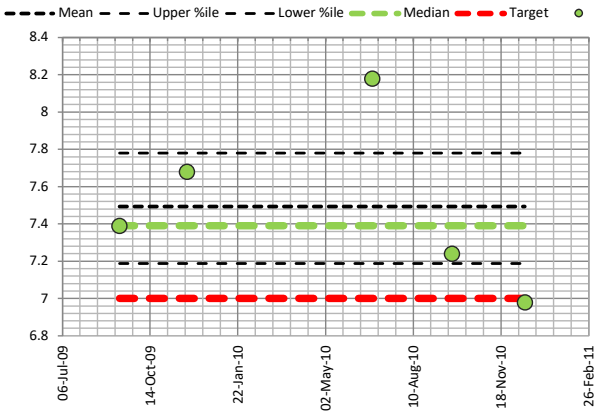
Downstream Bore Brook Rd South - GBSWA (Install : Jun 2009)

Easting	403440	Data Analysis Period Start Date	1/01/2009
Northing	6456803	Data Analysis Period End Date	19/12/2023

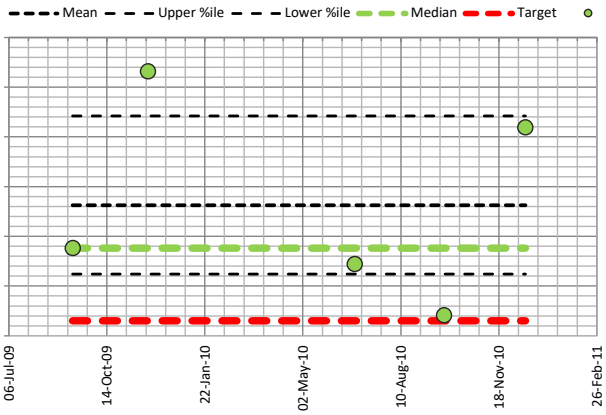
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Wetlands	Times Exceeded
GWL bToC	Groundwater Level	mBToC	39	0.49	0.69	1.55	**1.50**	2.44	2.84		0
GWL mAHD	Groundwater Level	mAHD	39	6.55	6.95	7.84	**7.89**	8.70	8.90		0
T	Temperature	°C	5	15.50	16.460	18.800	**16.90**	20.920	25.000		0
EC	Electrical Conductivity	mS/cm	5	2.08	6.20	13.14	**8.83**	22.10	26.60	1.500	5
pH	pH	pH	5	6.98	7.19	7.49	**7.39**	7.78	8.18	7.00	4
DO	Dissolved Oxygen	%	1	14.90	14.90	14.90	**14.90**	14.90	14.90		0
TN	Total Nitrogen	mg/L	4	1.10	2.06	4.03	**3.30**	5.70	8.40	1.50	3
TKN	Total Kejdhal Nitrogen	mg/L	5	0.90	2.26	3.66	**2.60**	4.78	8.30		0
NO3	Nitrate	mg/L	5	0.01	0.01	0.16	**0.05**	0.28	0.54		0
NO2	Nitrite	mg/L	5	0.01	0.01	0.03	**0.01**	0.04	0.10		0
Nox	Nox	mg/L	3	0.01	0.04	0.21	**0.08**	0.36	0.54	0.10	1
NH3	Ammonia	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.90	0
TP	Total Phosphorous	mg/L	4	0.52	0.80	1.10	**1.20**	1.44	1.50	0.06	4
FRP	Filterable Reactive Phosphrous	mg/L	4	0.01	0.04	0.21	**0.08**	0.33	0.68	0.03	3
As	Arsenic	mg/L	3	0.00500	0.01060	0.02467	**0.01900**	0.03760	0.05000	0.02400	1
Cd	Cadmium	mg/L	3	0.00005	0.00007	0.00038	**0.00010**	0.00064	0.00100	0.00020	1
Cr	Chromium	mg/L	3	0.00200	0.00720	0.57233	**0.01500**	1.02600	1.70000	0.00100	3
Cu	Copper	mg/L	3	0.01300	0.01500	0.17033	**0.01800**	0.29520	0.48000	0.00140	3
Pb	Lead	mg/L	3	0.00100	0.00460	0.03300	**0.01000**	0.05680	0.08800	0.00340	2
Hg	Mercury	mg/L	3	0.00010	0.00010	0.00020	**0.00010**	0.00028	0.00040	0.00060	0
Ni	Nickel	mg/L	3	0.00200	0.01160	0.07600	**0.02600**	0.13040	0.20000	0.01100	2
Zn	Zinc	mg/L	3	0.01000	0.06200	0.68333	**0.14000**	1.19600	1.90000	0.00800	3
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Mg	Magnesium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
K	Potassium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Na	Sodium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
H as CaCO3	Hardness as CaCO3	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

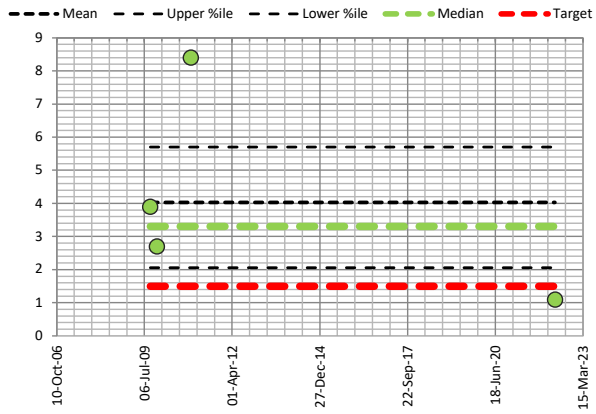
pH



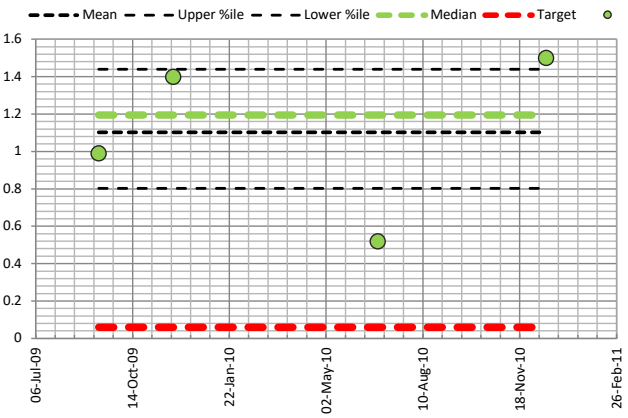
Electrical Conductivity



Total Nitrogen



Total Phosphorous



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SW1 Surface Water Site 1

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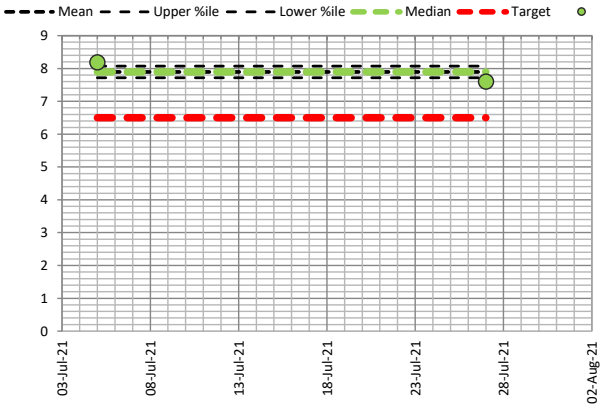
D□□□□□□□□□□□□□□r□□d□□□d□D□□□□ | □□□□□□□□□□

hyd2o HYDROLOGY

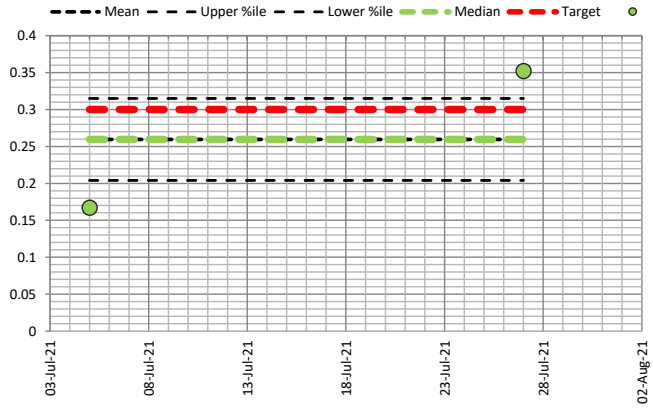
R□□□r□D□□□□□ □□□□□□□□□□

□□r□□ □□□r	D□□□r□□□□□	□ □□□□	□□□ □□□□	M□□□□ □□	□□□ □□ □□□	M□□□□	M□d□□□	□ □□□□□ □□□	M□□□□ □□	□□r□□□ ANZECC 95% & Lowland Rivers	□□□ □□ □□□□□d□d
GWL bToC	□r□□□d□ □□□r□□□□□□	□ □ □□□	□	□□□□	□□□□	□□□□	0.00	□□□□	□□□□		✓ □
GWL mAHD	□r□□□d□ □□□r□□□□□□	□ □□D	□	□□□□	□□□□	□□□□	0.00	□□□□	□□□□		✓ □
T	□□□□ □□r□□□r□	□□	□	□□□□□	□□□□□□	□□□□□□	13.70	□□□□□□	□□□□□□		✓ □
EC	□□□□r□□□□□ □□d□□□□□□□	□ □□□□	□	□□□□	□□□□	□□□□	0.26	□□□□	□□□□	□□□□	✗ □
pH	□□	□□	□	□□□□	□□□□	□□□□	7.90	□□□□	□□□□	□□□□	✗ □
DO	D□□□□□□d□□ □□□□□	□	□	□□□□	□□□□	□□□□	74.05	□□□□	□□□□		✓ □
TN	□□□□□□ □□r□□□□□	□ □□□	□	□□□□	□□□□	□□□□	0.60	□□□□	□□□□	□□□□	✓ □
TKN	□□□□□□□□d□□□□r□□□□	□ □□□	□	□□□□	□□□□	□□□□	0.55	□□□□	□□□□		✓ □
NO3	□□r□□□	□ □□□	□	□□□□	□□□□	□□□□	0.01	□□□□	□□□□		✓ □
NO2	□□r□□□	□ □□□	□	□□□□	□□□□	□□□□	0.01	□□□□	□□□□		✓ □
Nox	□□□	□ □□□	□	□□□□	□□□□	□□□□	0.02	□□□□	□□□□	□□□□	✓ □
NH3	□□ □ □□□□	□ □□□	□	□□□□	□□□□	□□□□	0.01	□□□□	□□□□	□□□□	✓ □
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FRP	□□□□r□□□□R□□□□□□□□□□□□r□□□	□ □□□	□	□□□□	□□□□	□□□□	0.01	□□□□	□□□□	□□□□	✓ □
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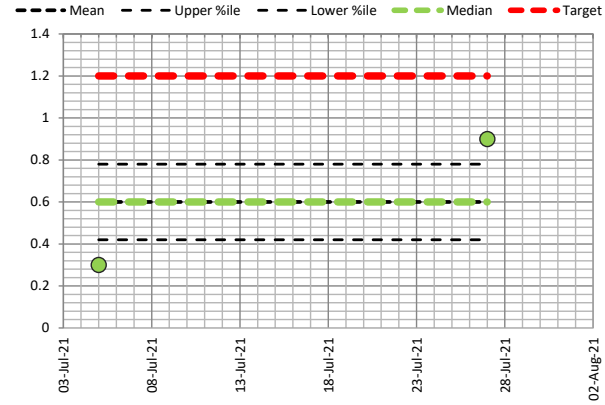
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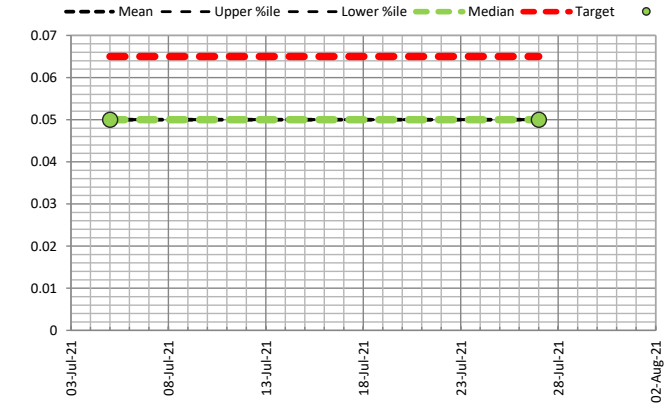
Electrical Conductivity



Total Nitrogen



Total Phosphorous



FieldDAE

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SW2 Surface Water Site 2

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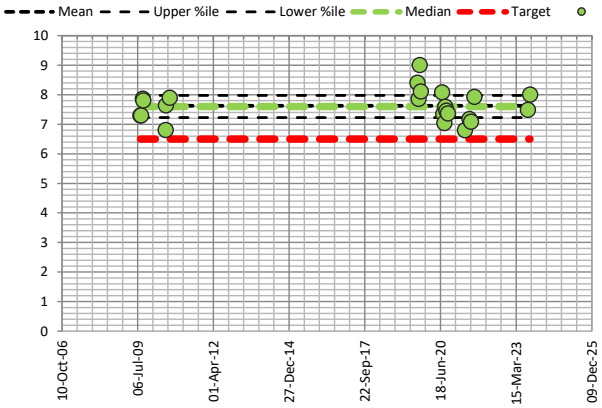
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hydrology

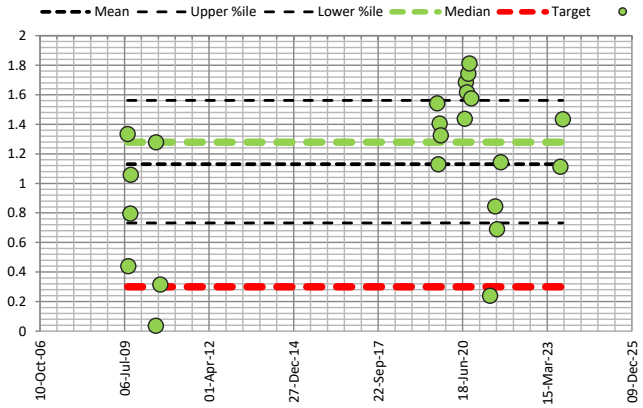
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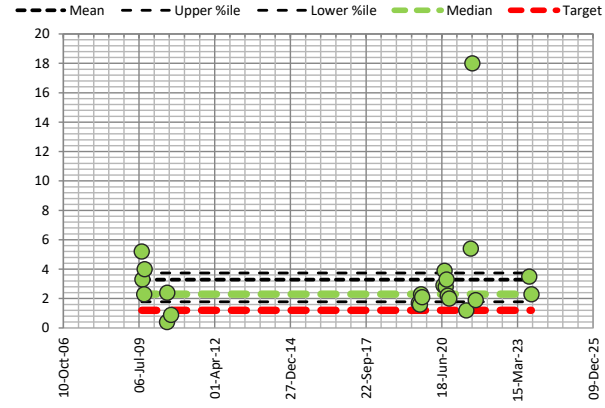
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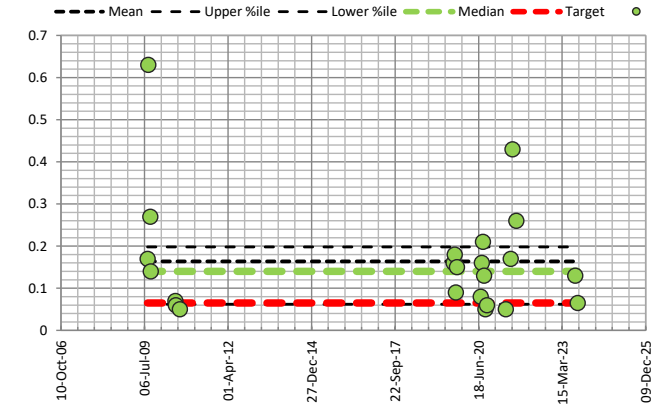
Electrical Conductivity



Total Nitrogen



Total Phosphorous



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SW3 Surface Water Site 3

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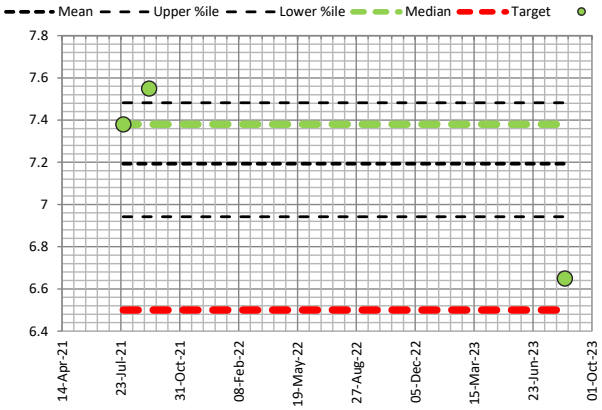
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hyd2o HYDROLOGY

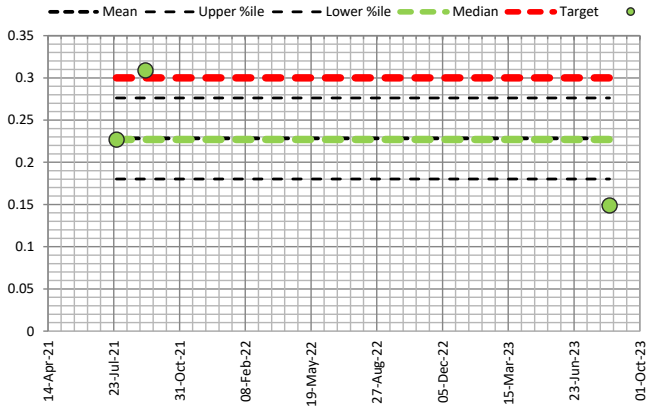
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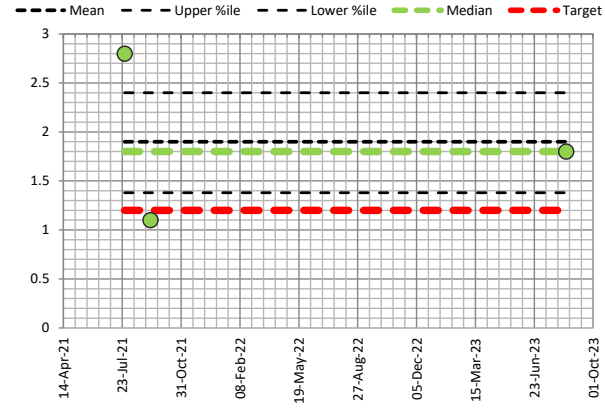
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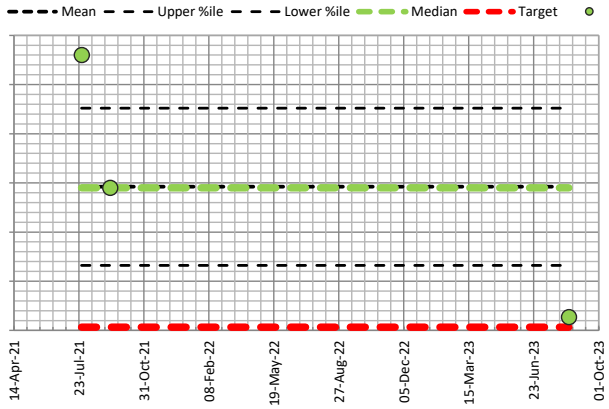
Electrical Conductivity



Total Nitrogen



Total Phosphorous



FieldDAE

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SW4 Surface Water Site 4

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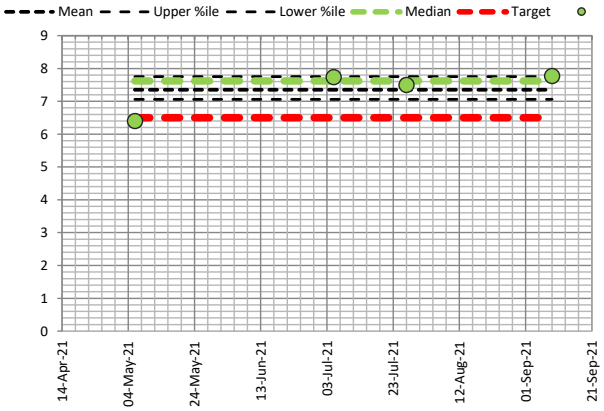
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hydro HYDROLOGY

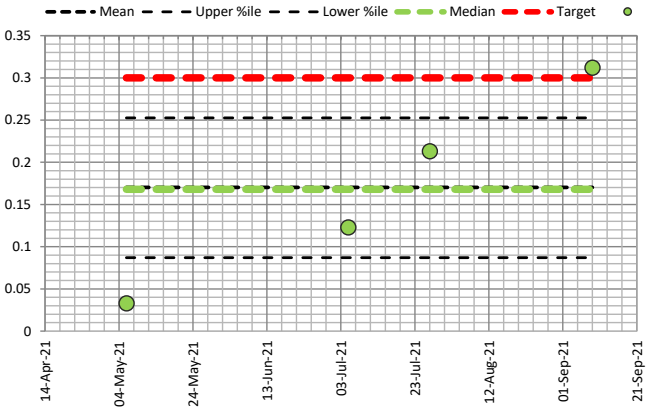
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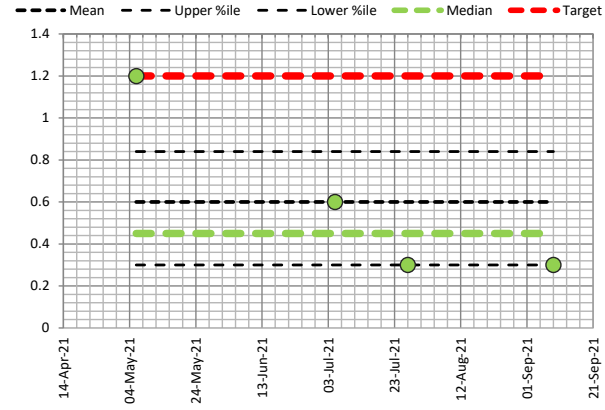
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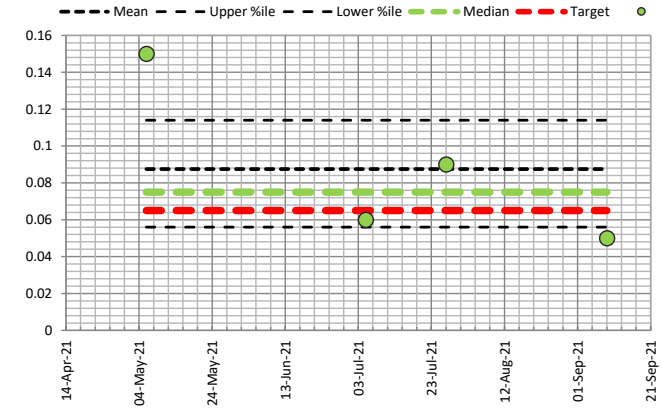
Electrical Conductivity



Total Nitrogen



Total Phosphorous



FieldDAE

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SW5 Surface Water Site 5

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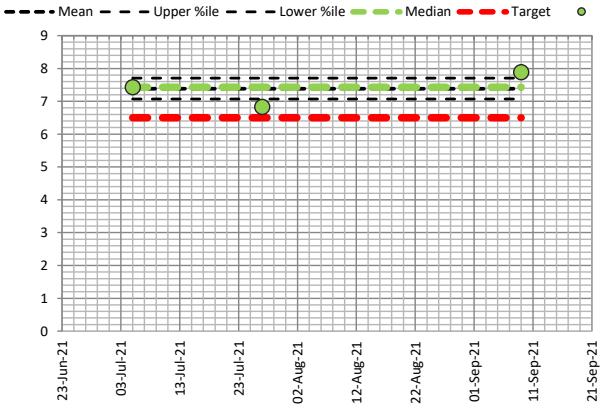
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hydrology

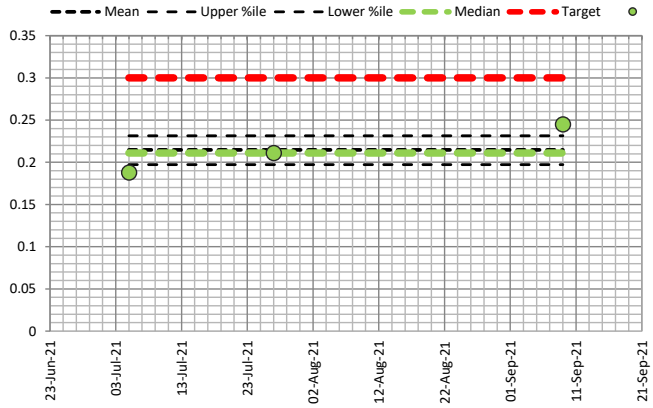
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GWL bToC	□r□□□d□□□□r□□□□□□	□ □ □□□	□	□□□□	□□□□	□□□□	0.00	□□□□	□□□□		✓	□
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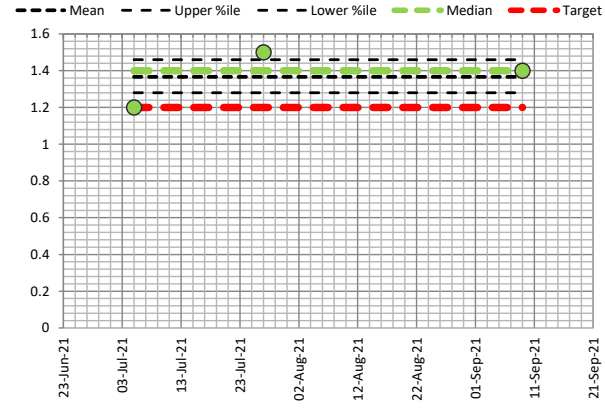
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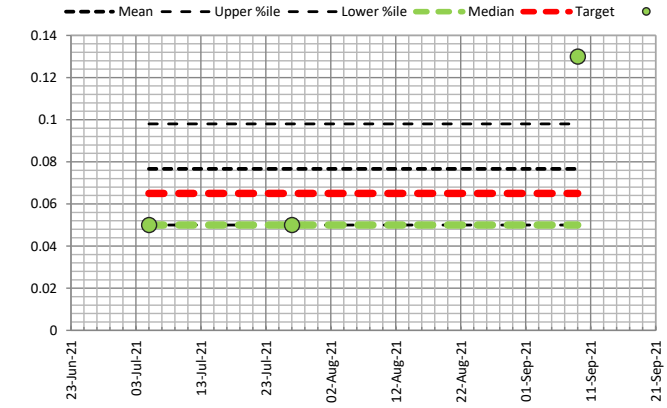
Electrical Conductivity



Total Nitrogen



Total Phosphorous



FieldDAE

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SW6 Surface Water Site 6

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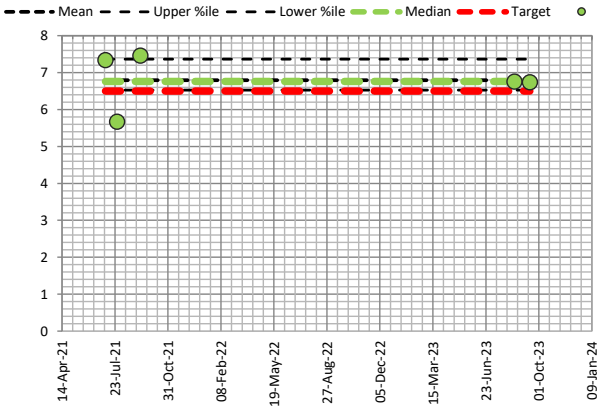
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hyd2o HYDROLOGY

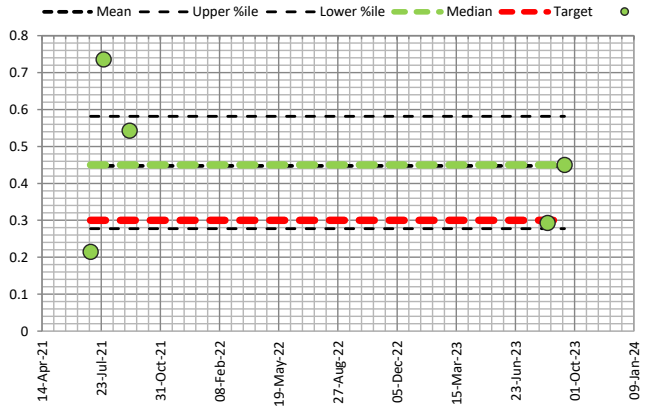
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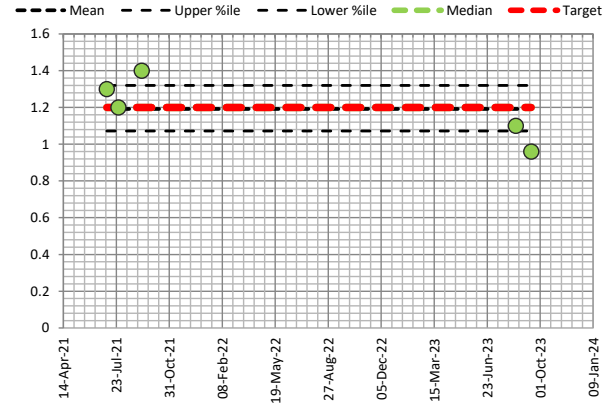
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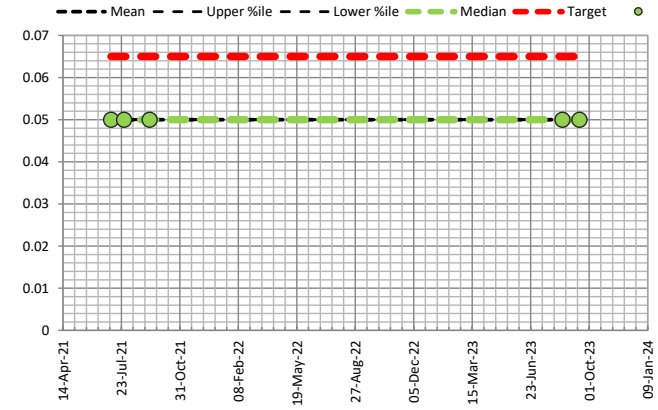
Electrical Conductivity



Total Nitrogen



Total Phosphorous



FieldDAE

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SW7 Surface Water Site 7

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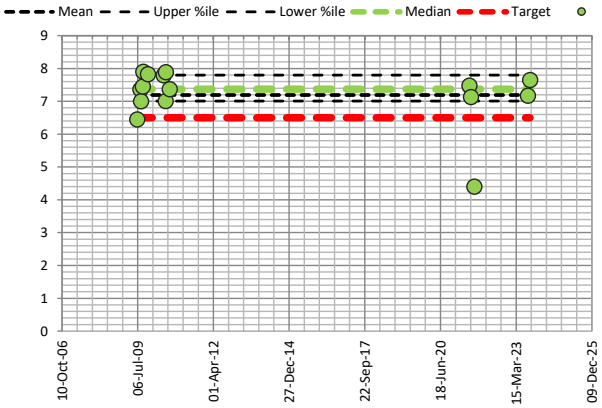
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hydzo HYDROLOGY

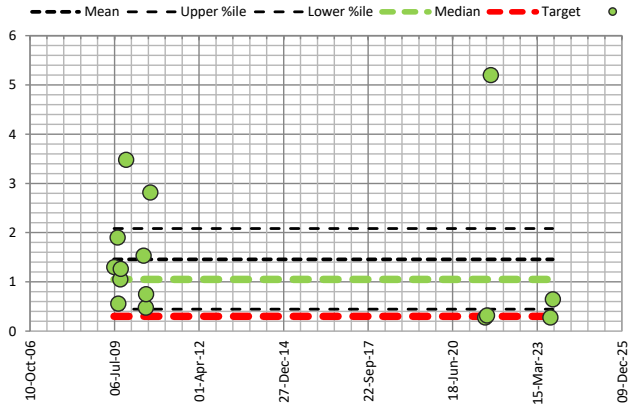
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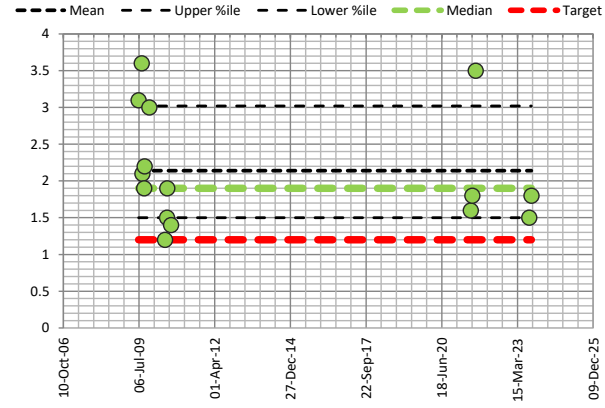
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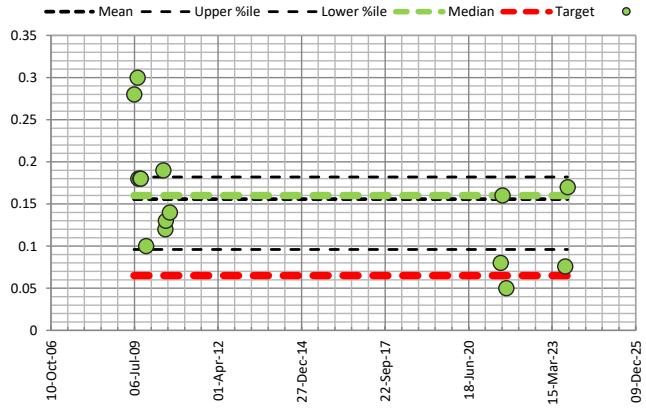
Electrical Conductivity



Total Nitrogen



Total Phosphorous



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SW8 Surface Water Site 8

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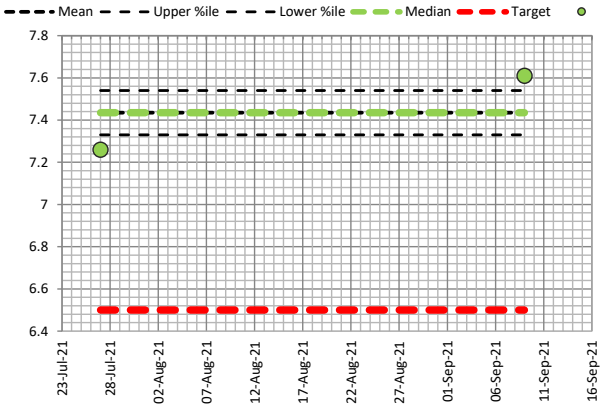
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hyd2o HYDROLOGY

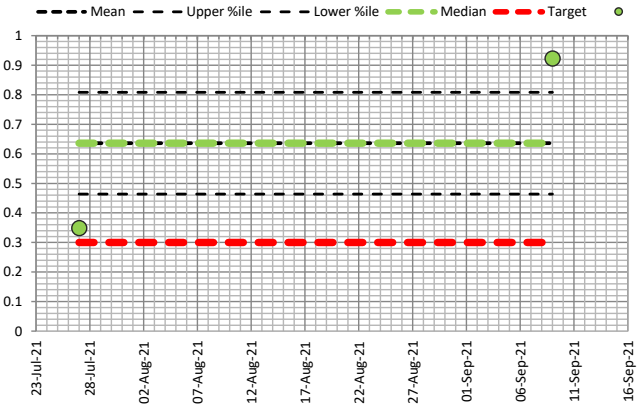
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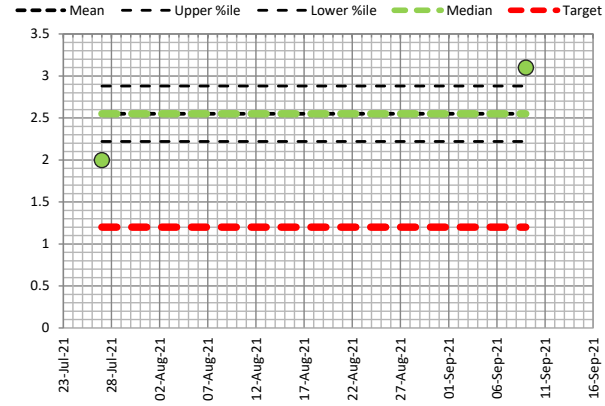
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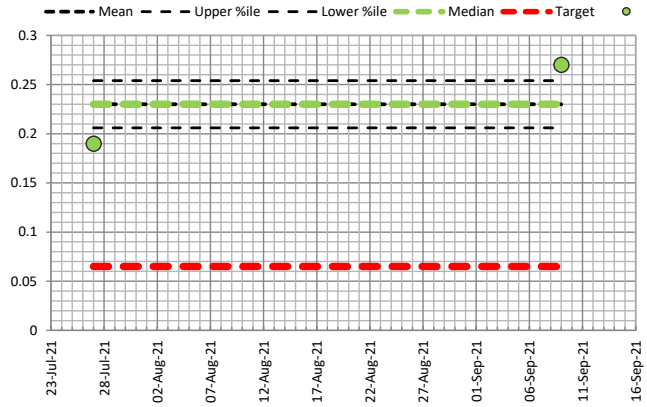
Electrical Conductivity



Total Nitrogen



Total Phosphorous



FieldDAE

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SW9 Surface Water Site 9

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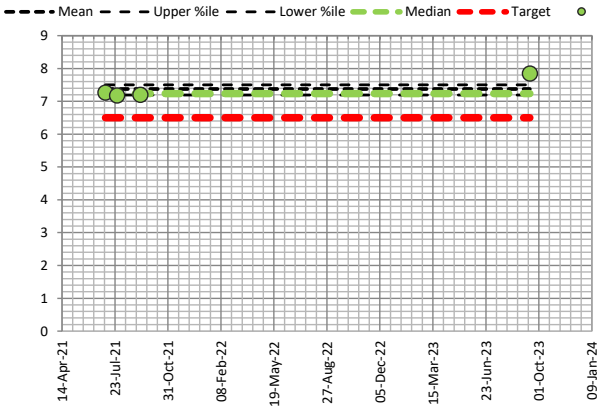
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hyd2o HYDROLOGY

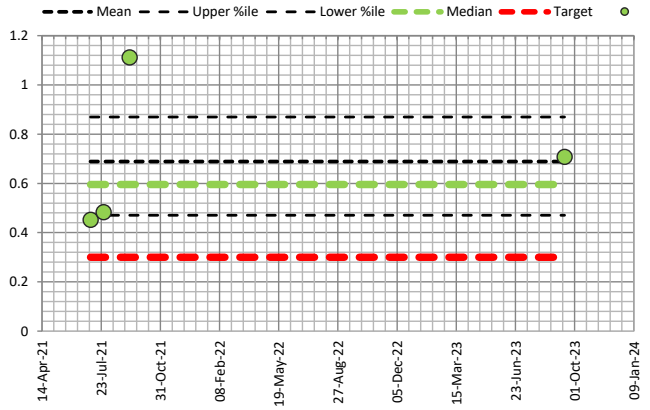
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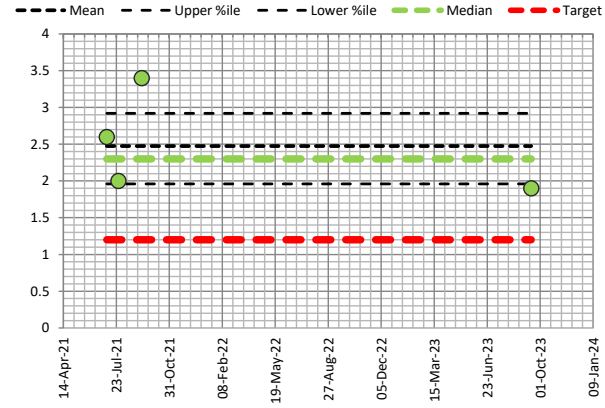
pH



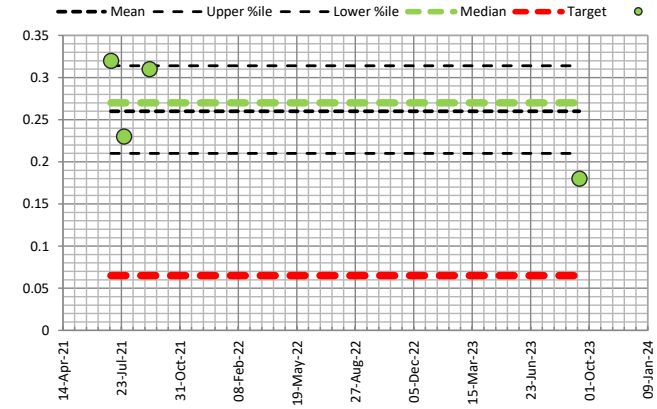
Electrical Conductivity



Total Nitrogen



Total Phosphorous



FieldDAE
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APPENDIX N

Aggregated Monitoring Data
Summary Sheets

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Aggregated Report: DWMS

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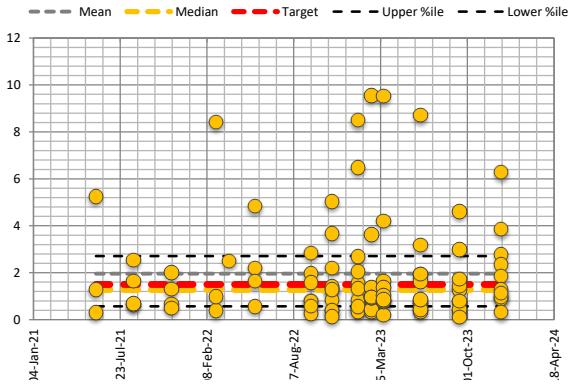
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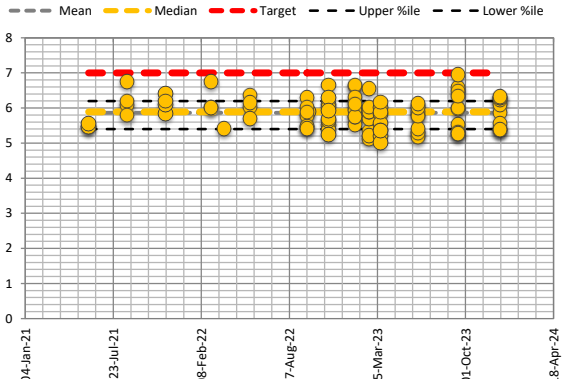
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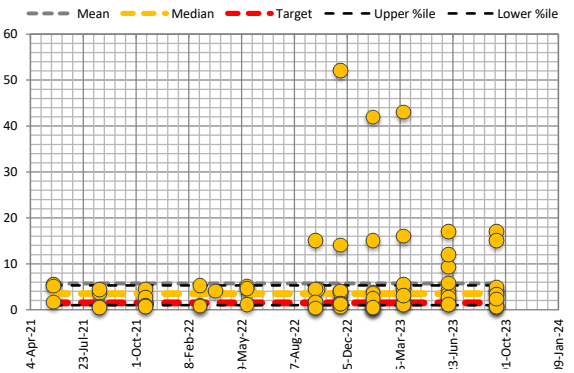
Electrical Conductivity



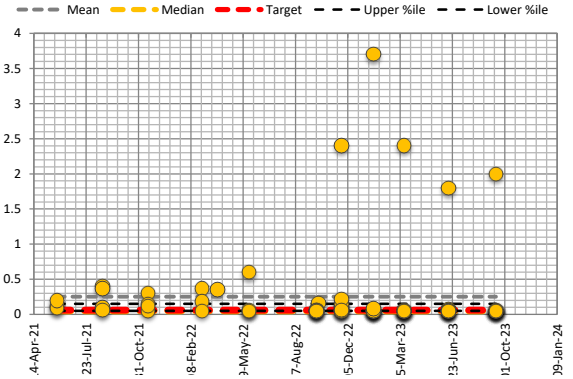
pH



Total Nitrogen



Total Phosphorous



FieldDAE

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Aggregated Report: DWMS

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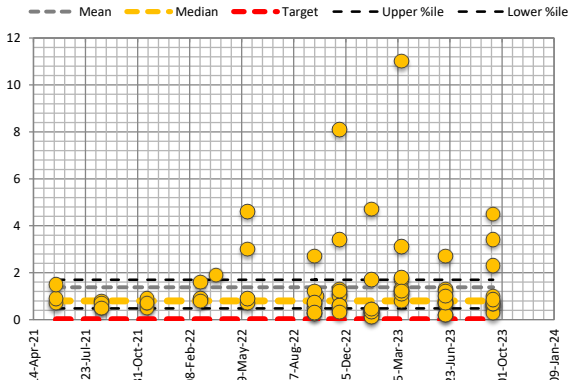
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hyd2o HYDROLOGY

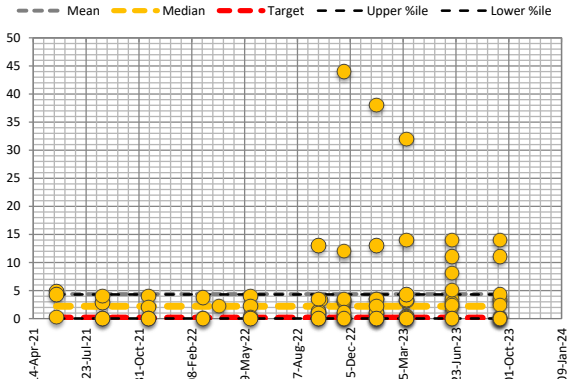
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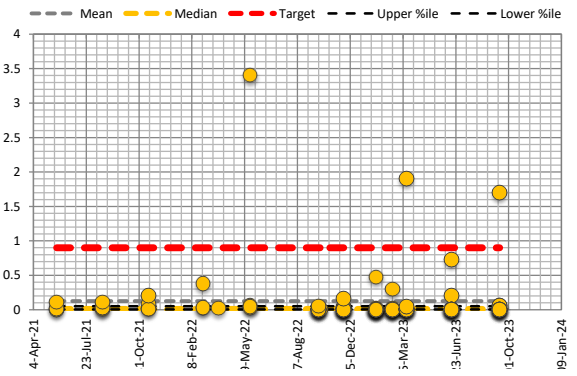
Total Kejdhal Nitrogen



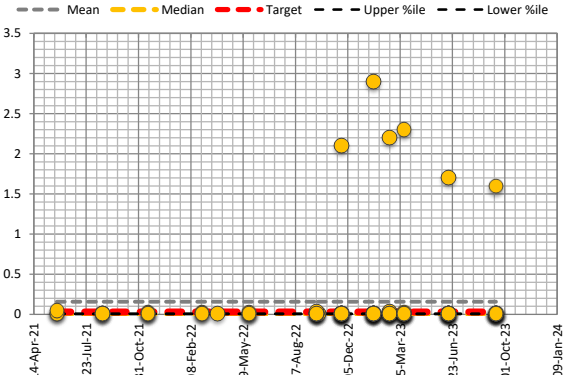
Nox



Ammonia



Filterable Reactive Phosphrous



FieldDAE

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Aggregated Report: DWMS

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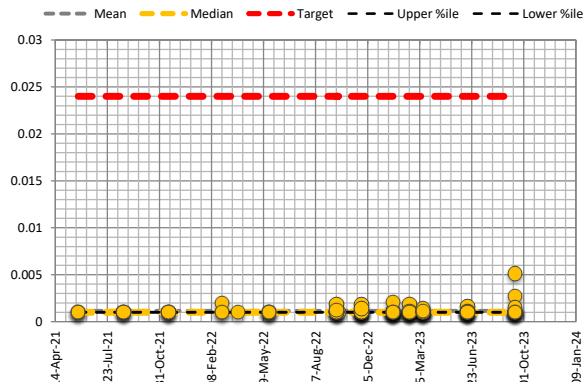
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hyd2o HYDROLOGY

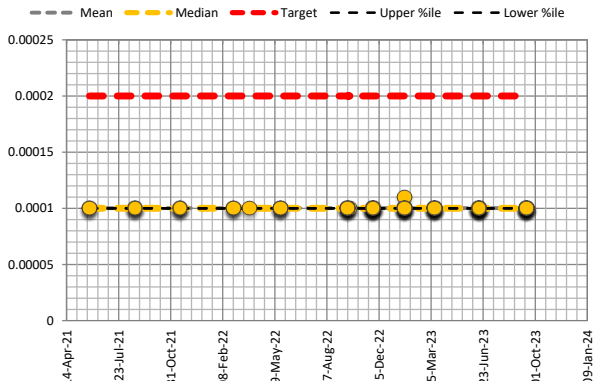
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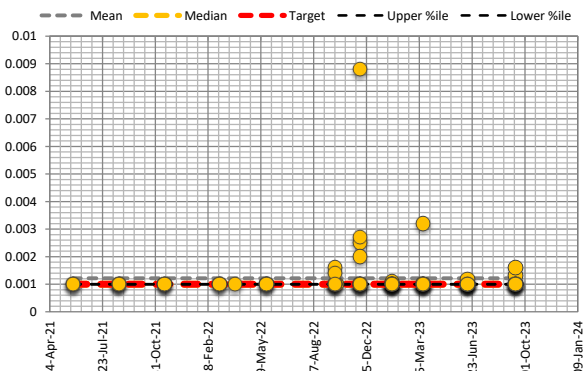
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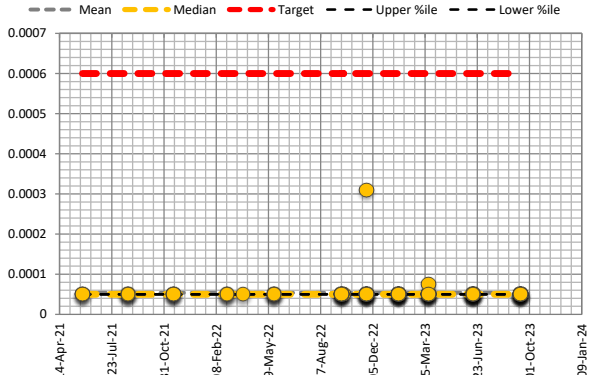
Cadmium



Chromium



Mercury



FieldDAE

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Aggregated Report: DWMS

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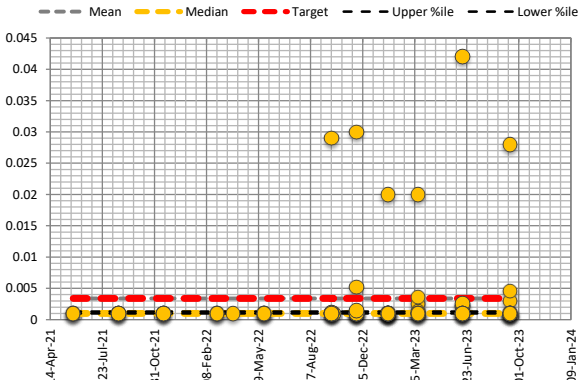
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hyd2o HYDROLOGY

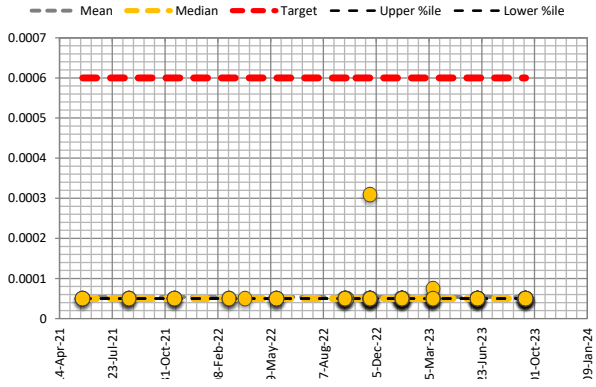
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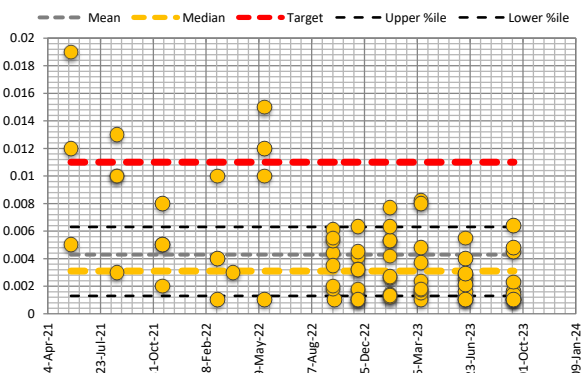
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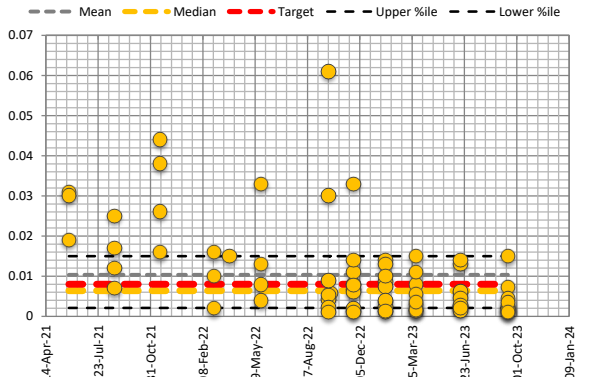
Mercury



Nickel



Zinc



FieldDAE

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Aggregated Report: DWMS

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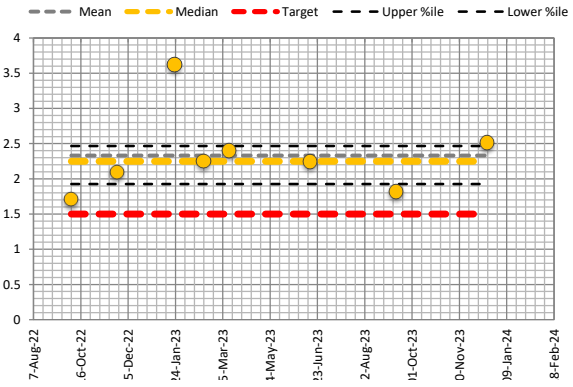
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hyd2o HYDROLOGY

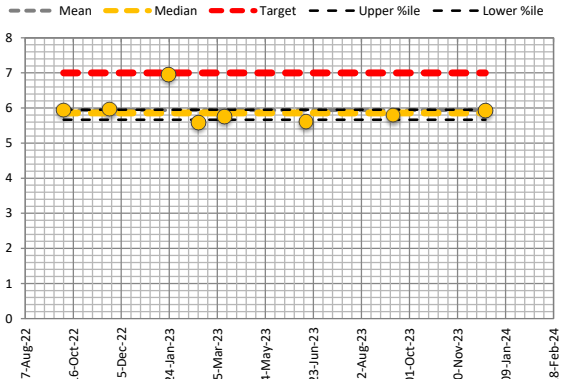
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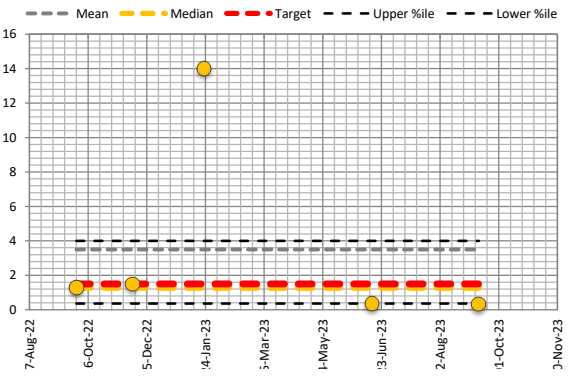
Electrical Conductivity



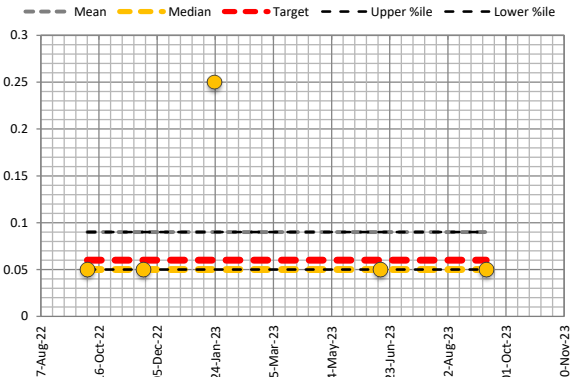
pH



Total Nitrogen



Total Phosphorous



FieldDAE

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Aggregated Report: DWMS

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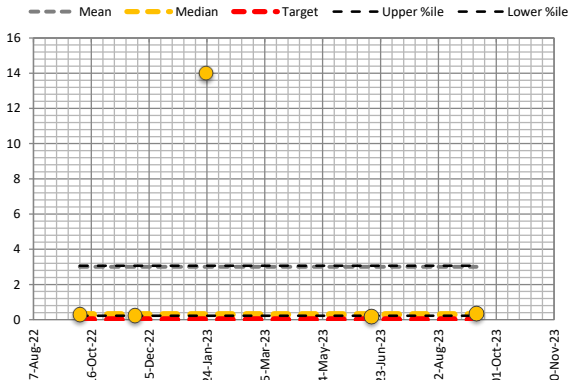
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hyd2o HYDROLOGY

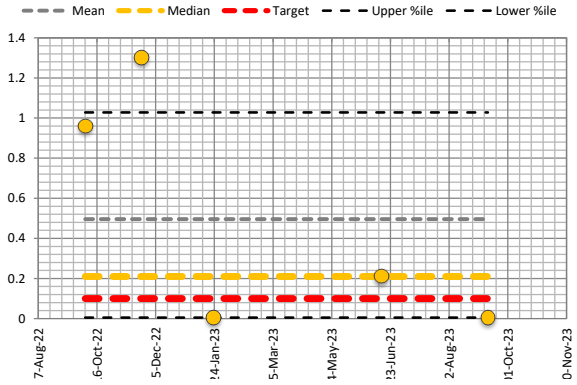
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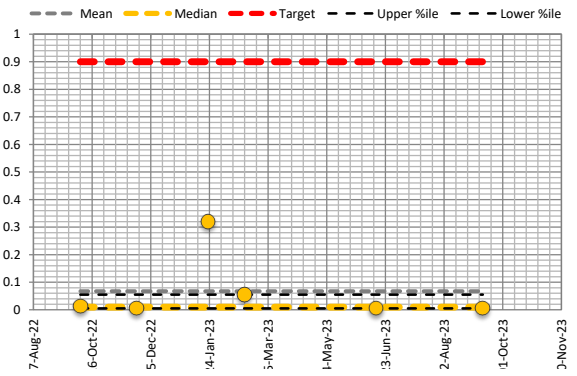
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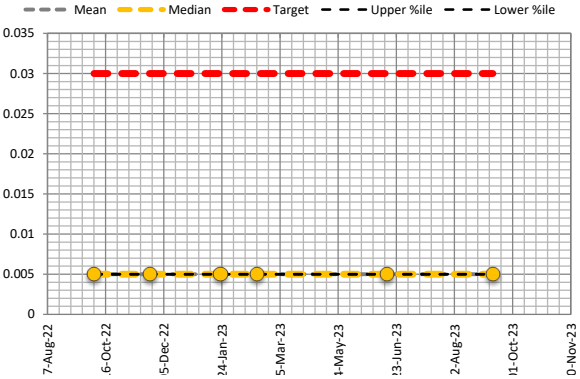
Nox



Ammonia



Filterable Reactive Phosphrous



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Aggregated Report: DWMS

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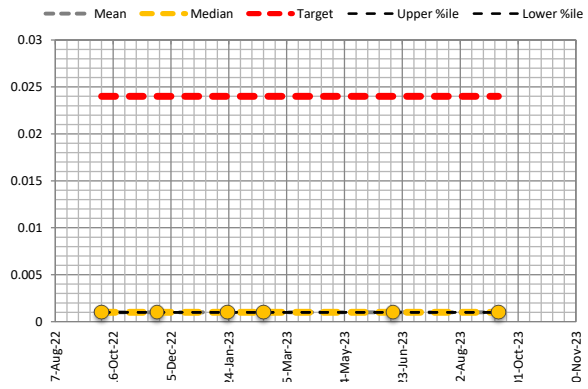
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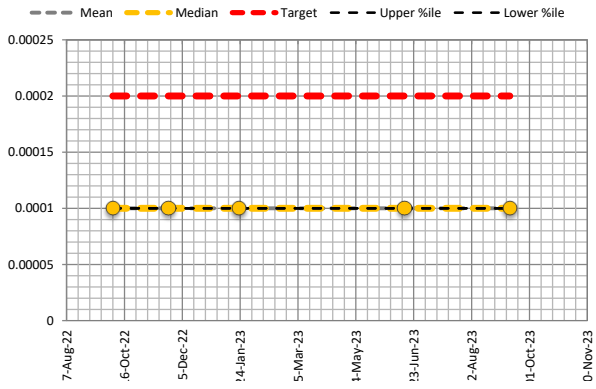
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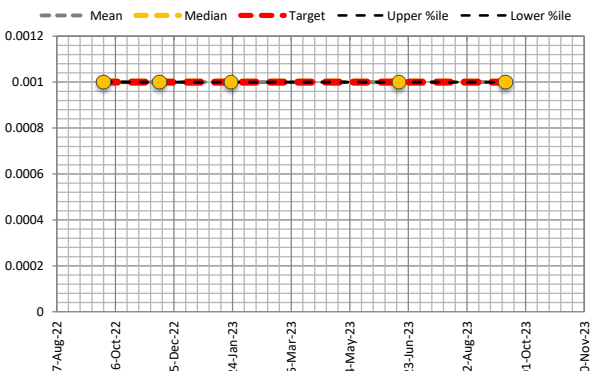
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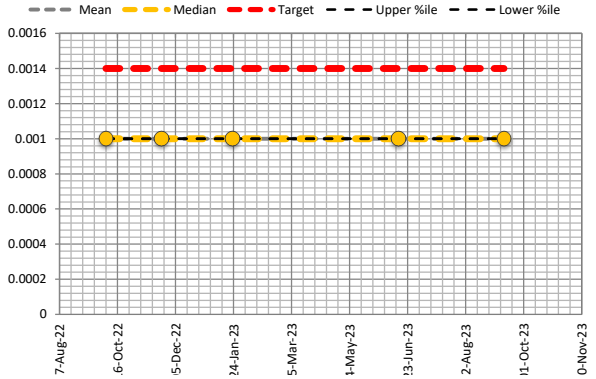
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Aggregated Report: DWMS

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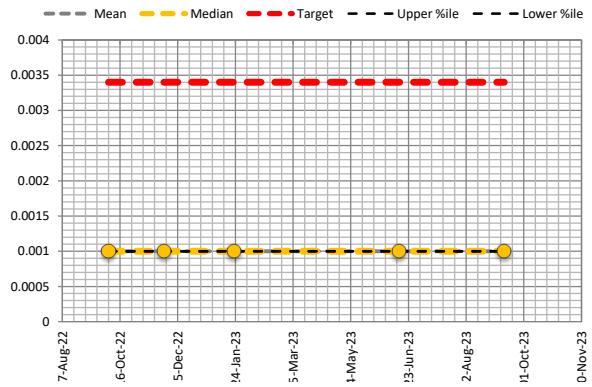
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hyd2o HYDROLOGY

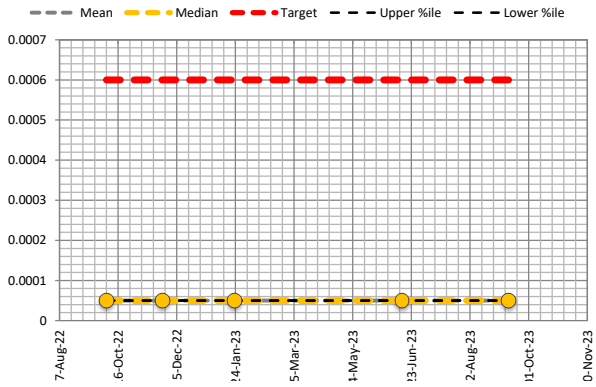
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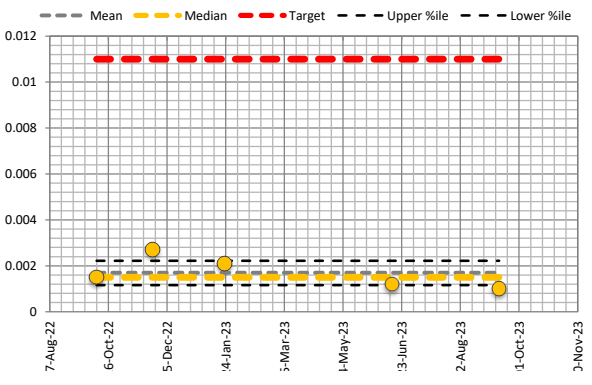
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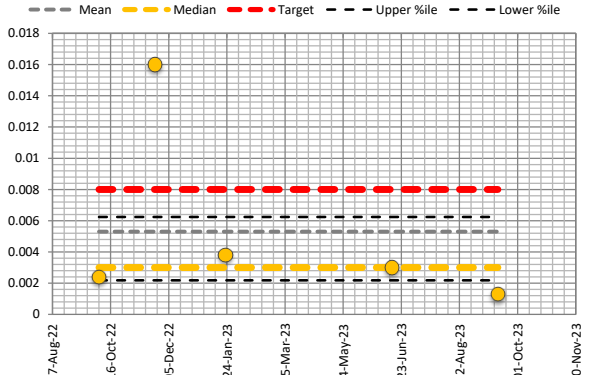
Mercury



Nickel



Zinc



FieldDAE

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Aggregated Report: DWMS

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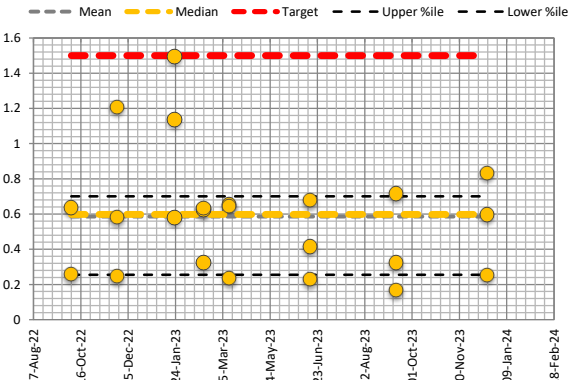
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hyd2o HYDROLOGY

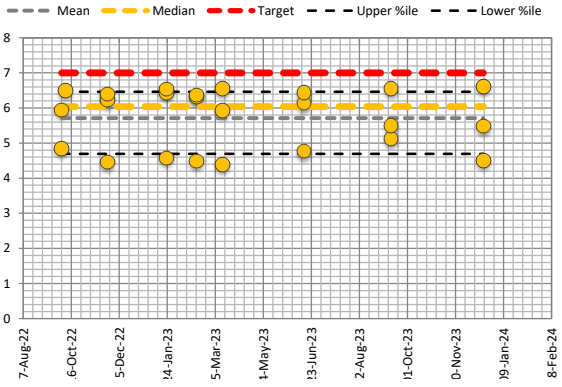
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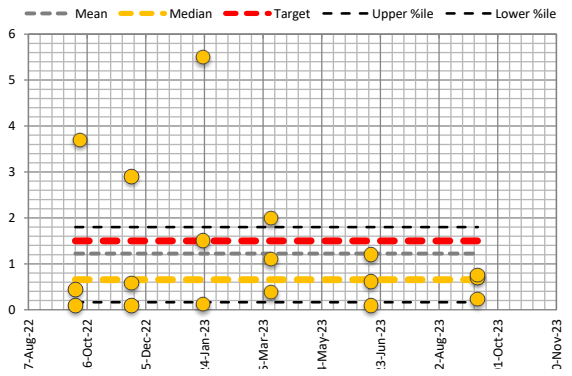
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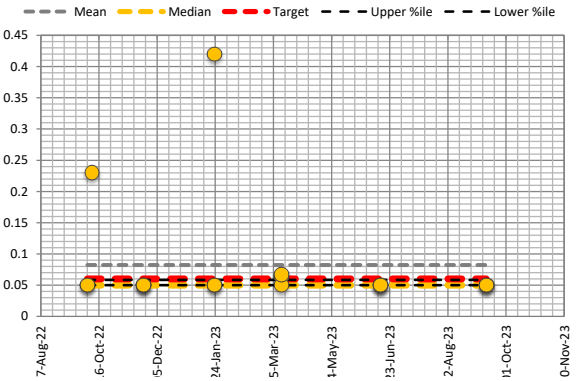
pH



Total Nitrogen



Total Phosphorous



FieldDAE

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Aggregated Report: DWMS

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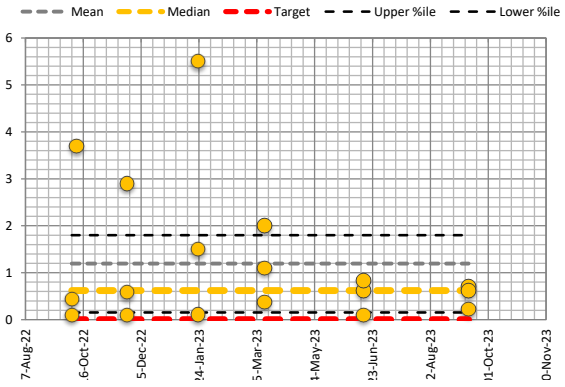
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hyd2o HYDROLOGY

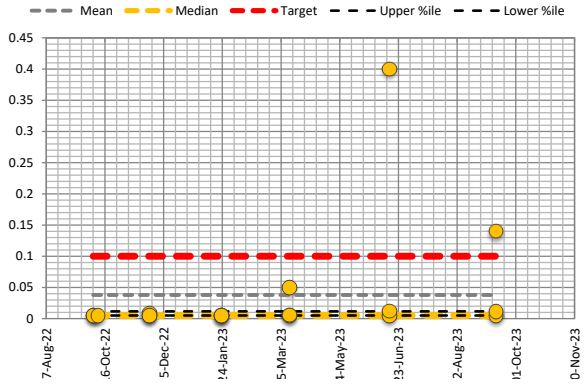
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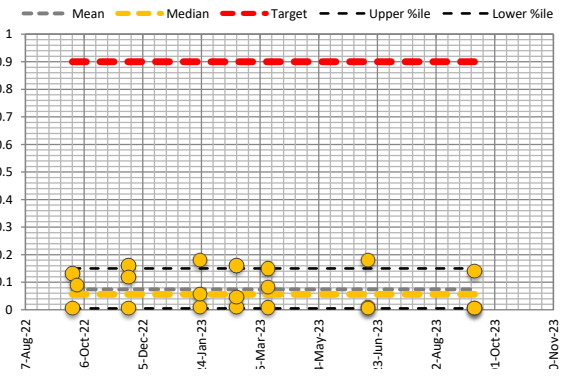
Total Kejdhal Nitrogen



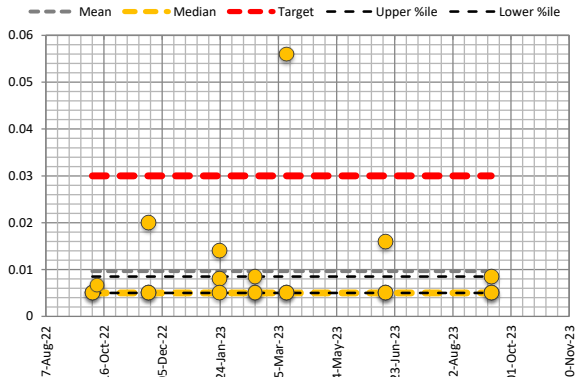
Nox



Ammonia



Filterable Reactive Phosphrous



FieldDAE

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Aggregated Report: DWMS

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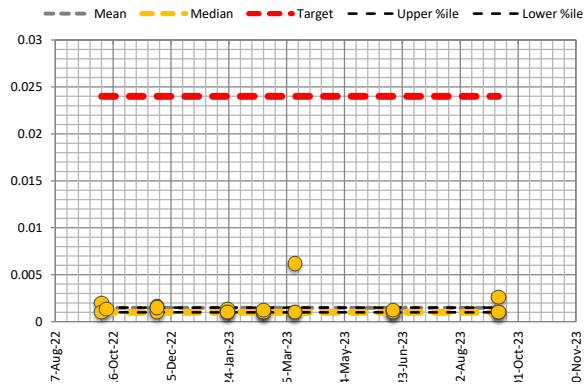
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hyd2o HYDROLOGY

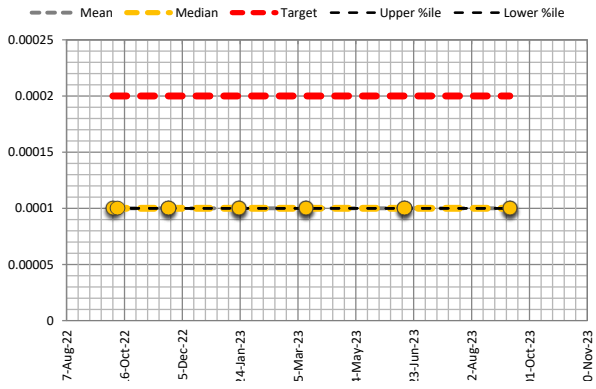
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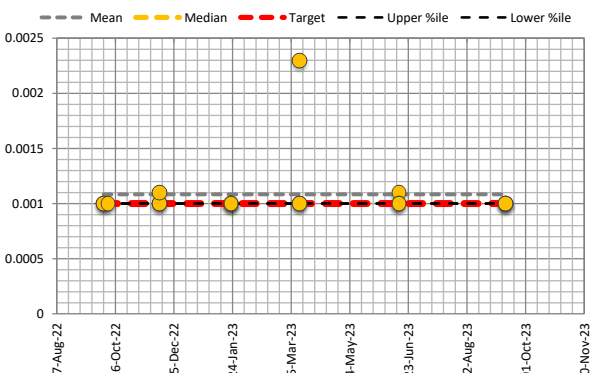
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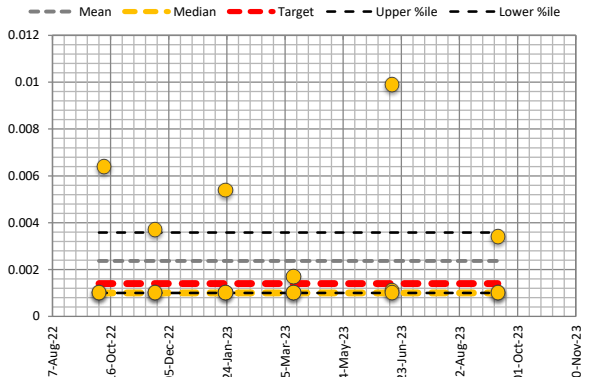
Cadmium



Chromium



Copper



FieldDAE

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Aggregated Report: DWMS

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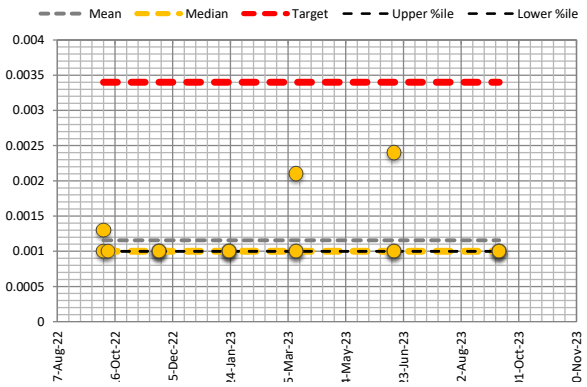
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hyd2o HYDROLOGY

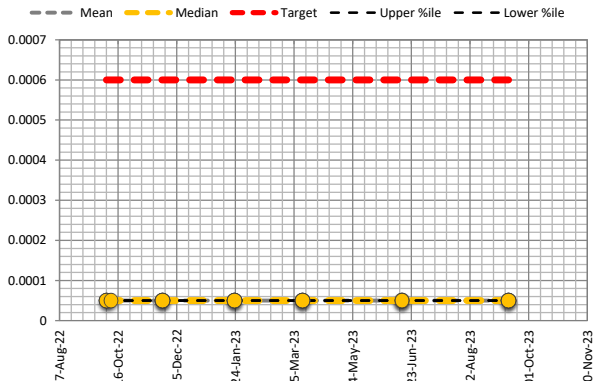
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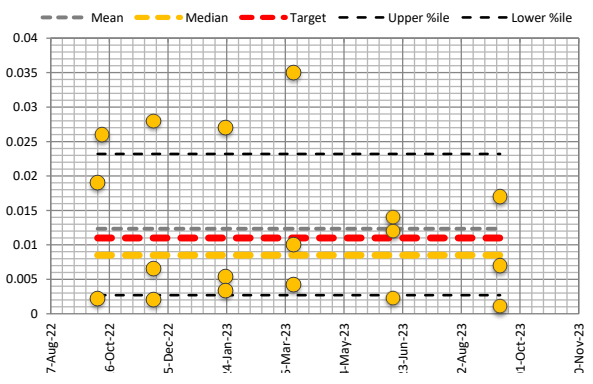
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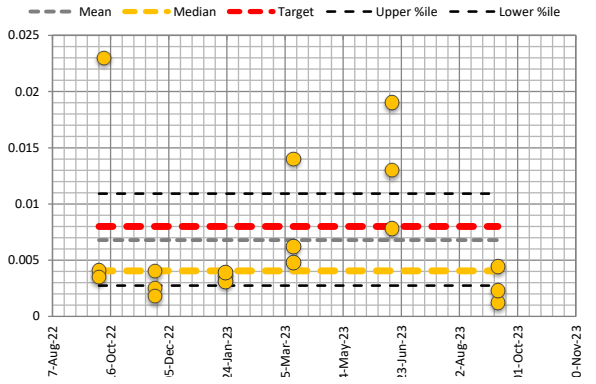
Mercury



Nickel



Zinc



FieldDAE

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Aggregated Report: DWMS

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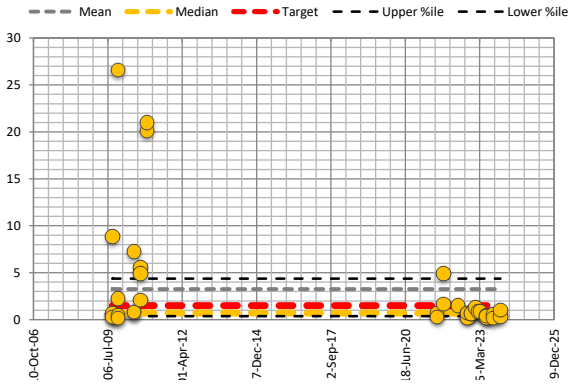
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hyd2o HYDROLOGY

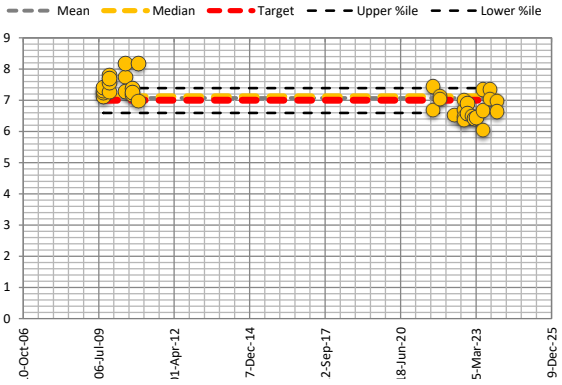
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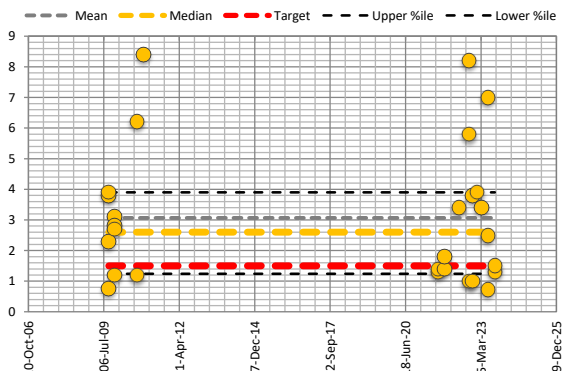
Electrical Conductivity



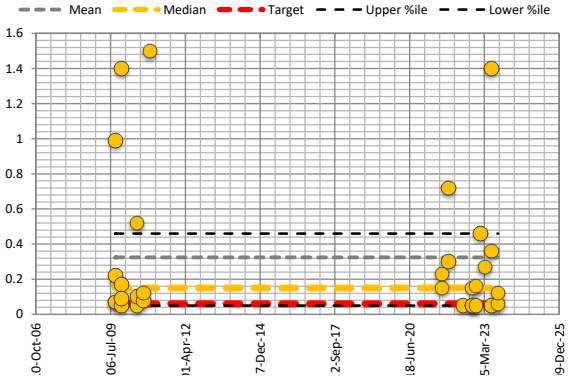
pH



Total Nitrogen



Total Phosphorous



FieldDAE

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Aggregated Report: DWMS

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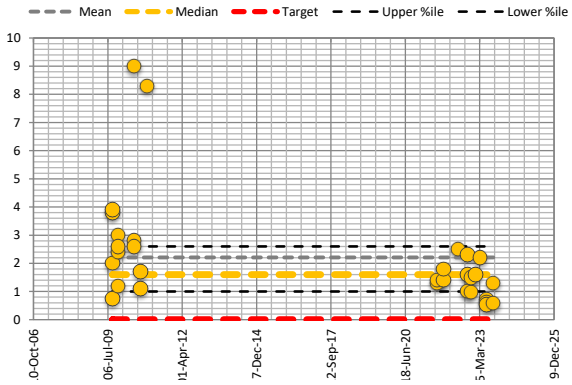
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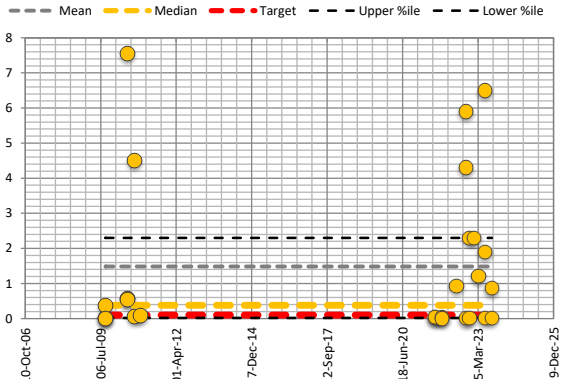
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pH	□□	□□	□□	□□□□	□□□□	□□□□	7.11	□□□□	□□□□	□□□□	□□
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TKN	□□□□□ □d□□□ □r□□□□	□ □□□	□□	□□□□	□□□□	□□□□	1.60	□□□□	□□□□		□
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NO2	□□r□□	□ □□□	□□	□□□□	□□□□	□□□□	0.01	□□□□	□□□□		□
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TP	□□□□□□ □□□□□r□□□	□ □□□	□□	□□□□	□□□□	□□□□	0.15	□□□□	□□□□	□□□□	□□
FRP	□□r□□□R□□□□□□□□ □□□□□r□□□	□ □□□	□□	□□□□	□□□□	□□□□	0.01	□□□□	□□□□	□□□□	□□
As	□r□□□□	□ □□□	□□	□□□□□□□	□□□□□□□	□□□□□□□	0.00200	□□□□□□□	□□□□□□□	□□□□□□□	□
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Hg	M□r□□r□	□ □□□	□□	□□□□□□□	□□□□□□□	□□□□□□□	0.00005	□□□□□□□	□□□□□□□	□□□□□□□	□
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H as CaCO3	□□rd□□□□□□□□ □□ □ □	□ □□□	□□	□□□□□	□□□□□	□□□□□	155.00	□□□□□	□□□□□		□

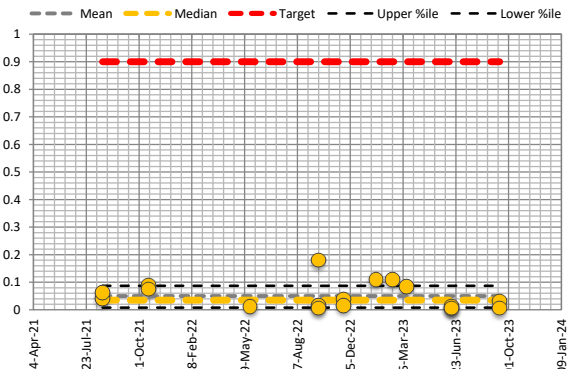
Total Kejdhal Nitrogen



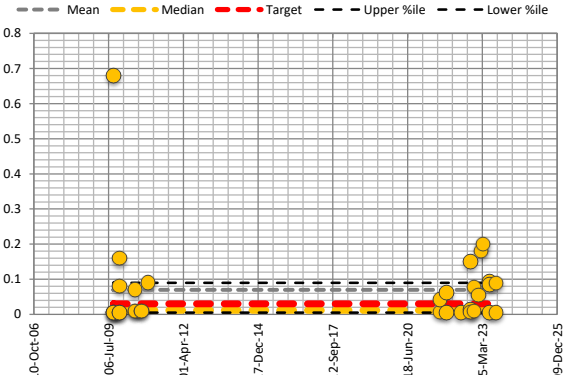
Nox



Ammonia



Filterable Reactive Phosphrous



FieldDAE

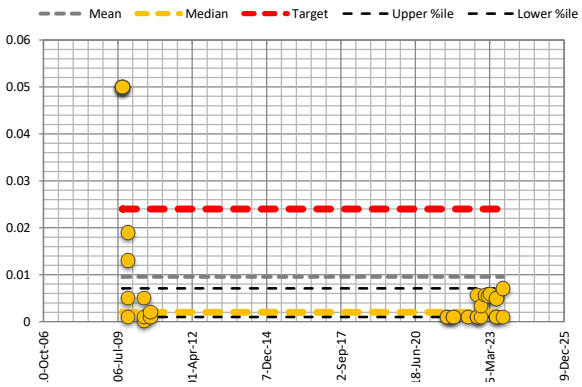
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Aggregated Report: DWMS

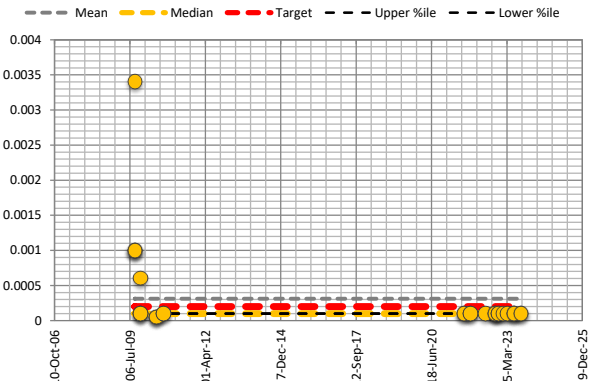
hydro HYDROLOGY

											Times
										ANZECC 95% & Wetlands	
GWL bToC							1.75				
GWL mAHD							17.66				
T							19.400				
EC							0.706				
pH							7.11				
DO							27.50				
TN							2.60				
TKN							1.60				
NO3							0.15				
NO2							0.01				
Nox							0.38				
NH3							0.04				
TP							0.15				
FRP							0.01				
As							0.00200				
Cd							0.00010				
Cr							0.00100				
Cu							0.00390				
Pb							0.00100				
Hg							0.00005				
Ni							0.00750				
Zn							0.01050				
Cl							55.05				
Ca							38.00				
Mg							6.90				
K							6.90				
Na							46.00				
H as CaCO3							155.00				

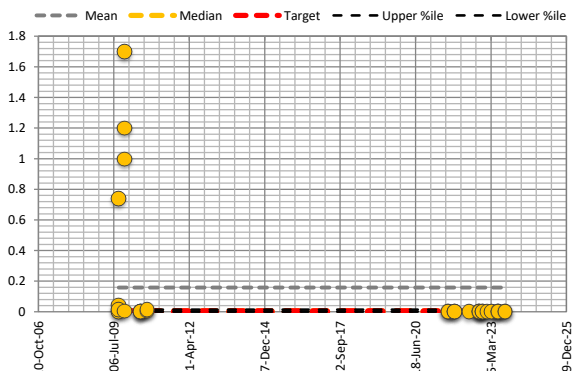
Arsenic



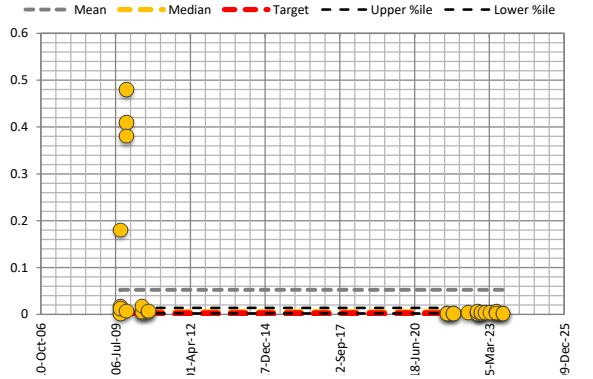
Cadmium



Chromium



Copper



FieldDAE

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Aggregated Report: DWMS

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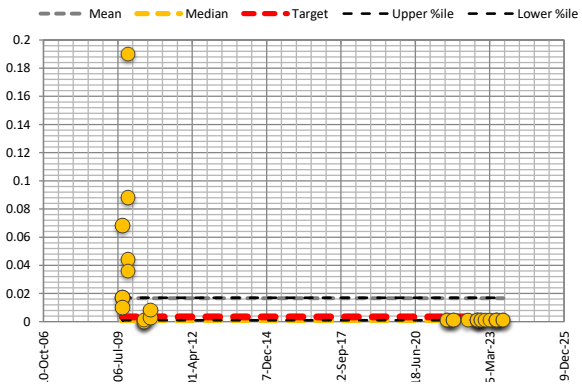
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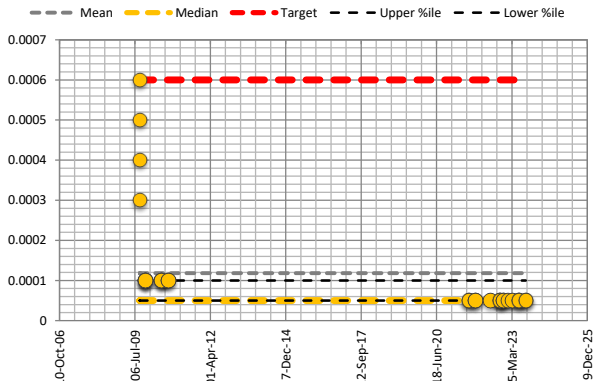
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GWL bToC	□r□□□d□□□□r□□□□□□	□ □□□□	□□□	□□□□	□□□□	□□□□	1.75	□□□□	□□□□		□
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pH	□□	□□	□□	□□□□	□□□□	□□□□	7.11	□□□□	□□□□	□□□□	□□
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FRP	□□r□□□R□□□□□□□□ □□□□r□□□	□ □□□	□□	□□□□	□□□□	□□□□	0.01	□□□□	□□□□	□□□□	□□
As	□r□□□□	□ □□□	□□	□□□□□□□	□□□□□□□	□□□□□□□	0.00200	□□□□□□□	□□□□□□□	□□□□□□□	□
Cd	□□d□ □□□ □	□ □□□	□□	□□□□□□□	□□□□□□□	□□□□□□□	0.00010	□□□□□□□	□□□□□□□	□□□□□□□	□
Cr	□□r□□ □□□	□ □□□	□□	□□□□□□□	□□□□□□□	□□□□□□□	0.00100	□□□□□□□	□□□□□□□	□□□□□□□	□□
Cu	□□□□□r	□ □□□	□□	□□□□□□□	□□□□□□□	□□□□□□□	0.00390	□□□□□□□	□□□□□□□	□□□□□□□	□□
Pb	□□□d	□ □□□	□□	□□□□□□□	□□□□□□□	□□□□□□□	0.00100	□□□□□□□	□□□□□□□	□□□□□□□	□
Hg	M□r□□r□	□ □□□	□□	□□□□□□□	□□□□□□□	□□□□□□□	0.00005	□□□□□□□	□□□□□□□	□□□□□□□	□
Ni	□□□□□□	□ □□□	□□	□□□□□□□	□□□□□□□	□□□□□□□	0.00750	□□□□□□□	□□□□□□□	□□□□□□□	□
Zn	□□□□	□ □□□	□□	□□□□□□□	□□□□□□□	□□□□□□□	0.01050	□□□□□□□	□□□□□□□	□□□□□□□	□□
Cl	□□□r□□□	□ □□□	□	□□□□	□□□□□	□□□□□	55.05	□□□□□	□□□□□□		□
Ca	□□□□□□	□ □□□	□□	□□□□	□□□□□	□□□□□	38.00	□□□□□	□□□□□□		□
Mg	M□□□□□□□□	□ □□□	□□	□□□□	□□□□	□□□□	6.90	□□□□□	□□□□□		□
K	□□□□□□□□	□ □□□	□□	□□□□	□□□□	□□□□	6.90	□□□□□	□□□□□		□
Na	□□d□□□	□ □□□	□□	□□□□□	□□□□□	□□□□□	46.00	□□□□□	□□□□□		□
H as CaCO3	□□rd□□□□□□□□ □□ □ □	□ □□□	□□	□□□□□	□□□□□	□□□□□	155.00	□□□□□	□□□□□		□

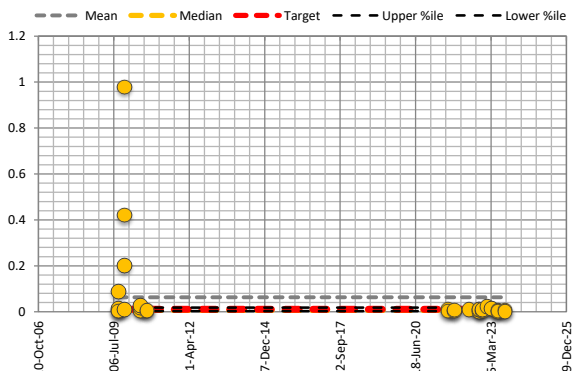
Lead



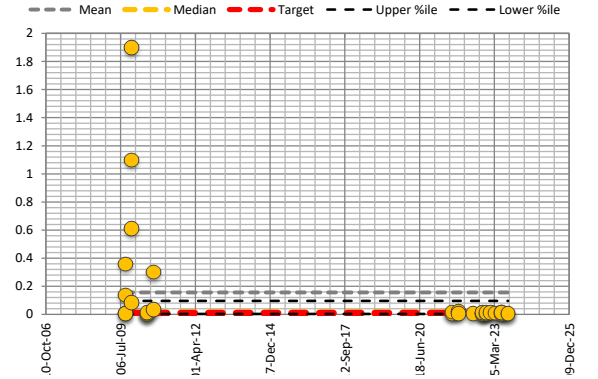
Mercury



Nickel



Zinc



FieldDAE

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H21003 Wattle Grove South Monitoring

Aggregated Report: DWMS

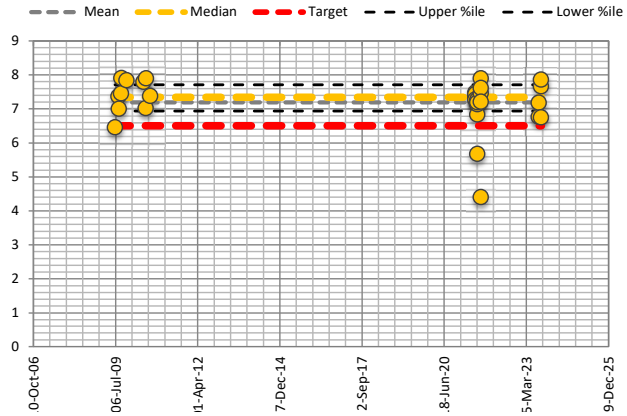
Aggregated Data : Surface Water Downstream

Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

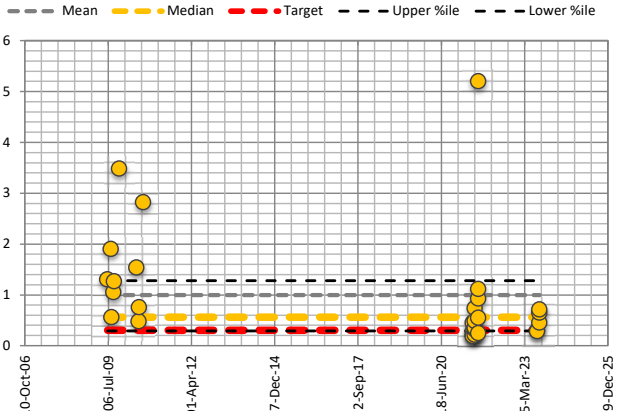
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Lowland Rivers	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
T	Temperature	°C	28	11.80	13.00	15.021	**13.950**	16.880	26.200		0
EC	Electrical Conductivity	mS/cm	29	0.19	0.29	0.992	**0.560**	1.278	5.200	0.300	22
pH	pH	pH	29	4.40	6.93	7.19	**7.34**	7.71	7.90	6.50	26
DO	Dissolved Oxygen	%	19	37.20	54.40	60.74	**57.50**	69.28	85.50		0
TN	Total Nitrogen	mg/L	29	0.96	1.36	1.97	**1.80**	2.76	3.60	1.20	24
TKN	Total Kejdhal Nitrogen	mg/L	29	0.94	1.26	1.78	**1.70**	1.90	3.50		0
NO3	Nitrate	mg/L	29	0.01	0.01	0.20	**0.05**	0.22	1.30		0
NO2	Nitrite	mg/L	29	0.01	0.01	0.01	**0.01**	0.01	0.05		0
Nox	Nox	mg/L	28	0.01	0.01	0.21	**0.04**	0.22	1.30	0.15	11
NH3	Ammonia	mg/L	19	0.01	0.01	0.20	**0.02**	0.03	2.70	0.90	1
TP	Total Phosphorous	mg/L	29	0.05	0.05	0.15	**0.14**	0.21	0.32	0.07	21
FRP	Filterable Reactive Phosphrous	mg/L	29	0.01	0.01	0.08	**0.07**	0.15	0.32	0.04	16
As	Arsenic	mg/L	22	0.00100	0.00100	0.00160	**0.00105**	0.00200	0.00400	0.02400	0
Cd	Cadmium	mg/L	22	0.00010	0.00010	0.00011	**0.00010**	0.00010	0.00030	0.00020	1
Cr	Chromium	mg/L	22	0.00100	0.00100	0.00127	**0.00100**	0.00100	0.00600	0.00100	2
Cu	Copper	mg/L	22	0.00100	0.00200	0.00289	**0.00225**	0.00300	0.01300	0.00140	20
Pb	Lead	mg/L	22	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Hg	Mercury	mg/L	22	0.00005	0.00005	0.00006	**0.00005**	0.00005	0.00010	0.00060	0
Ni	Nickel	mg/L	22	0.00100	0.00100	0.00334	**0.00200**	0.00294	0.01900	0.01100	2
Zn	Zinc	mg/L	22	0.00360	0.00800	0.03084	**0.01200**	0.02380	0.36000	0.00800	16
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	5	13.00	17.00	33.40	**27.00**	48.20	65.00		0
Mg	Magnesium	mg/L	5	4.80	5.84	10.38	**12.00**	14.20	15.00		0
K	Potassium	mg/L	5	3.90	4.54	7.70	**6.90**	11.20	12.00		0
Na	Sodium	mg/L	5	25.00	27.40	48.00	**53.00**	65.20	70.00		0
H as CaCO3	Hardness as CaCO3	mg/L	5	58.00	63.60	124.60	**110.00**	180.00	220.00		0

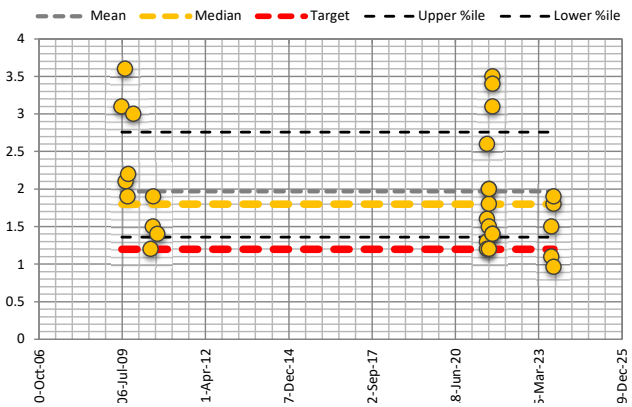
pH



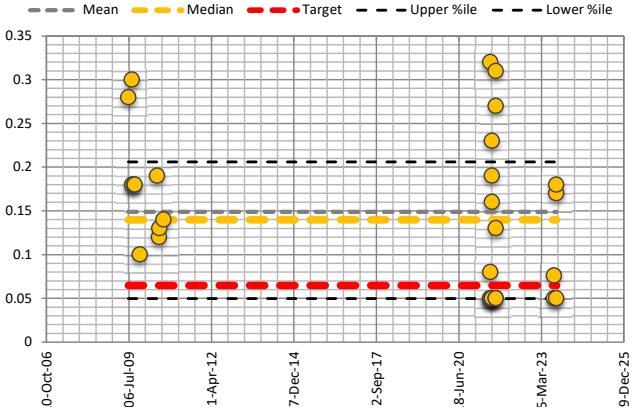
Electrical Conductivity



Total Nitrogen



Total Phosphorous



FieldDAE

Field Data Analysis & Evaluation System

H21003 Wattle Grove South Monitoring

Aggregated Report: DWMS

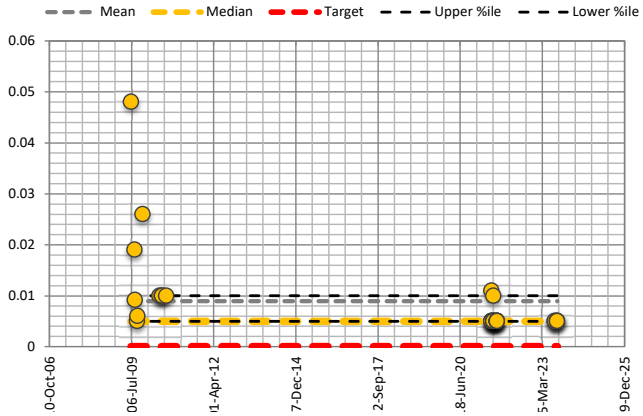
Aggregated Data : Surface Water Downstream

Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

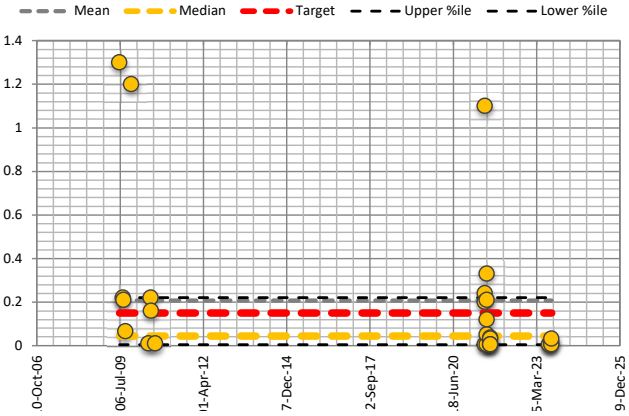
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Lowland Rivers	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
T	Temperature	°C	28	11.80	13.00	15.021	**13.950**	16.880	26.200		0
EC	Electrical Conductivity	mS/cm	29	0.19	0.29	0.992	**0.560**	1.278	5.200	0.300	22
pH	pH	pH	29	4.40	6.93	7.19	**7.34**	7.71	7.90	6.50	26
DO	Dissolved Oxygen	%	19	37.20	54.40	60.74	**57.50**	69.28	85.50		0
TN	Total Nitrogen	mg/L	29	0.96	1.36	1.97	**1.80**	2.76	3.60	1.20	24
TKN	Total Kejdhal Nitrogen	mg/L	29	0.94	1.26	1.78	**1.70**	1.90	3.50		0
NO3	Nitrate	mg/L	29	0.01	0.01	0.20	**0.05**	0.22	1.30		0
NO2	Nitrite	mg/L	29	0.01	0.01	0.01	**0.01**	0.01	0.05		0
Nox	Nox	mg/L	28	0.01	0.01	0.21	**0.04**	0.22	1.30	0.15	11
NH3	Ammonia	mg/L	19	0.01	0.01	0.20	**0.02**	0.03	2.70	0.90	1
TP	Total Phosphorous	mg/L	29	0.05	0.05	0.15	**0.14**	0.21	0.32	0.07	21
FRP	Filterable Reactive Phosphrous	mg/L	29	0.01	0.01	0.08	**0.07**	0.15	0.32	0.04	16
As	Arsenic	mg/L	22	0.00100	0.00100	0.00160	**0.00105**	0.00200	0.00400	0.02400	0
Cd	Cadmium	mg/L	22	0.00010	0.00010	0.00011	**0.00010**	0.00010	0.00030	0.00020	1
Cr	Chromium	mg/L	22	0.00100	0.00100	0.00127	**0.00100**	0.00100	0.00600	0.00100	2
Cu	Copper	mg/L	22	0.00100	0.00200	0.00289	**0.00225**	0.00300	0.01300	0.00140	20
Pb	Lead	mg/L	22	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Hg	Mercury	mg/L	22	0.00005	0.00005	0.00006	**0.00005**	0.00005	0.00010	0.00060	0
Ni	Nickel	mg/L	22	0.00100	0.00100	0.00334	**0.00200**	0.00294	0.01900	0.01100	2
Zn	Zinc	mg/L	22	0.00360	0.00800	0.03084	**0.01200**	0.02380	0.36000	0.00800	16
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	5	13.00	17.00	33.40	**27.00**	48.20	65.00		0
Mg	Magnesium	mg/L	5	4.80	5.84	10.38	**12.00**	14.20	15.00		0
K	Potassium	mg/L	5	3.90	4.54	7.70	**6.90**	11.20	12.00		0
Na	Sodium	mg/L	5	25.00	27.40	48.00	**53.00**	65.20	70.00		0
H as CaCO3	Hardness as CaCO3	mg/L	5	58.00	63.60	124.60	**110.00**	180.00	220.00		0

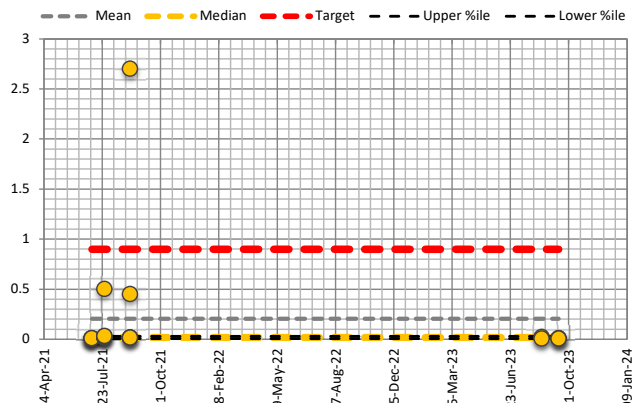
Nitrite



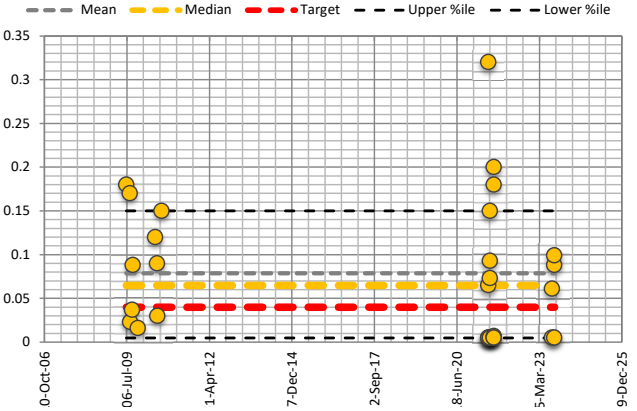
Nox



Ammonia



Filterable Reactive Phosphrous



H21003 Wattle Grove South Monitoring

Aggregated Report: DWMS

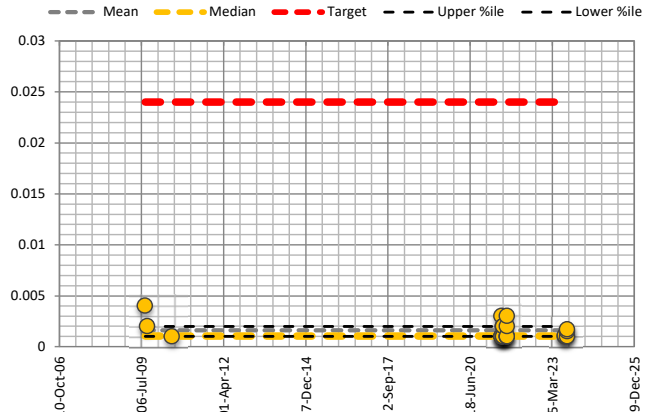
Aggregated Data : Surface Water Downstream

Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

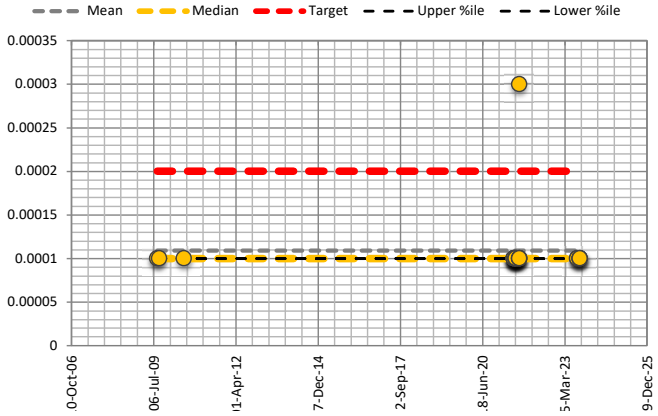
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Lowland Rivers	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
T	Temperature	°C	28	11.80	13.00	15.021	**13.950**	16.880	26.200		0
EC	Electrical Conductivity	mS/cm	29	0.19	0.29	0.992	**0.560**	1.278	5.200	0.300	22
pH	pH	pH	29	4.40	6.93	7.19	**7.34**	7.71	7.90	6.50	26
DO	Dissolved Oxygen	%	19	37.20	54.40	60.74	**57.50**	69.28	85.50		0
TN	Total Nitrogen	mg/L	29	0.96	1.36	1.97	**1.80**	2.76	3.60	1.20	24
TKN	Total Kejdhal Nitrogen	mg/L	29	0.94	1.26	1.78	**1.70**	1.90	3.50		0
NO3	Nitrate	mg/L	29	0.01	0.01	0.20	**0.05**	0.22	1.30		0
NO2	Nitrite	mg/L	29	0.01	0.01	0.01	**0.01**	0.01	0.05		0
Nox	Nox	mg/L	28	0.01	0.01	0.21	**0.04**	0.22	1.30	0.15	11
NH3	Ammonia	mg/L	19	0.01	0.01	0.20	**0.02**	0.03	2.70	0.90	1
TP	Total Phosphorous	mg/L	29	0.05	0.05	0.15	**0.14**	0.21	0.32	0.07	21
FRP	Filterable Reactive Phosphrous	mg/L	29	0.01	0.01	0.08	**0.07**	0.15	0.32	0.04	16
As	Arsenic	mg/L	22	0.00100	0.00100	0.00160	**0.00105**	0.00200	0.00400	0.02400	0
Cd	Cadmium	mg/L	22	0.00010	0.00010	0.00011	**0.00010**	0.00010	0.00030	0.00020	1
Cr	Chromium	mg/L	22	0.00100	0.00100	0.00127	**0.00100**	0.00100	0.00600	0.00100	2
Cu	Copper	mg/L	22	0.00100	0.00200	0.00289	**0.00225**	0.00300	0.01300	0.00140	20
Pb	Lead	mg/L	22	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Hg	Mercury	mg/L	22	0.00005	0.00005	0.00006	**0.00005**	0.00005	0.00010	0.00060	0
Ni	Nickel	mg/L	22	0.00100	0.00100	0.00334	**0.00200**	0.00294	0.01900	0.01100	2
Zn	Zinc	mg/L	22	0.00360	0.00800	0.03084	**0.01200**	0.02380	0.36000	0.00800	16
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	5	13.00	17.00	33.40	**27.00**	48.20	65.00		0
Mg	Magnesium	mg/L	5	4.80	5.84	10.38	**12.00**	14.20	15.00		0
K	Potassium	mg/L	5	3.90	4.54	7.70	**6.90**	11.20	12.00		0
Na	Sodium	mg/L	5	25.00	27.40	48.00	**53.00**	65.20	70.00		0
H as CaCO3	Hardness as CaCO3	mg/L	5	58.00	63.60	124.60	**110.00**	180.00	220.00		0

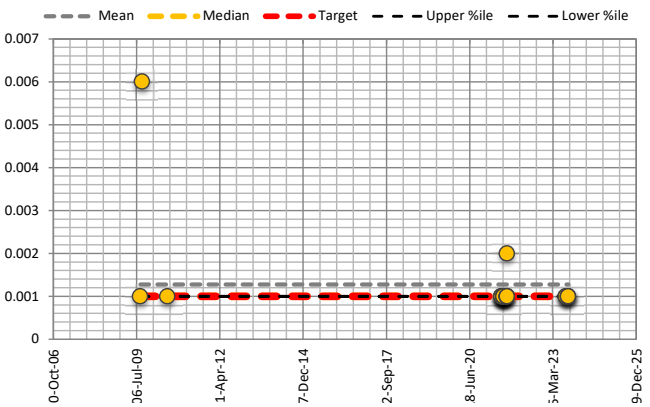
Arsenic



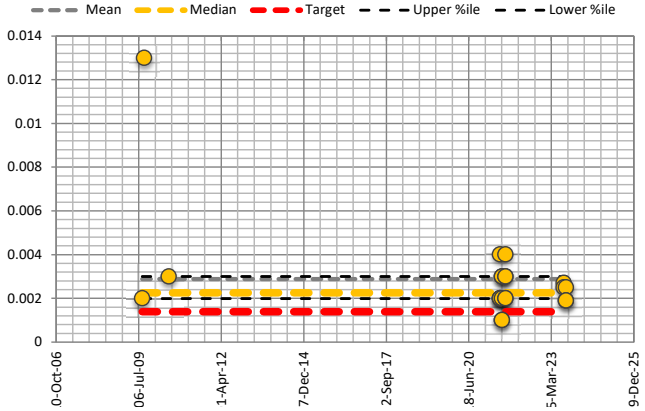
Cadmium



Chromium



Copper



H21003 Wattle Grove South Monitoring

Aggregated Report: DWMS

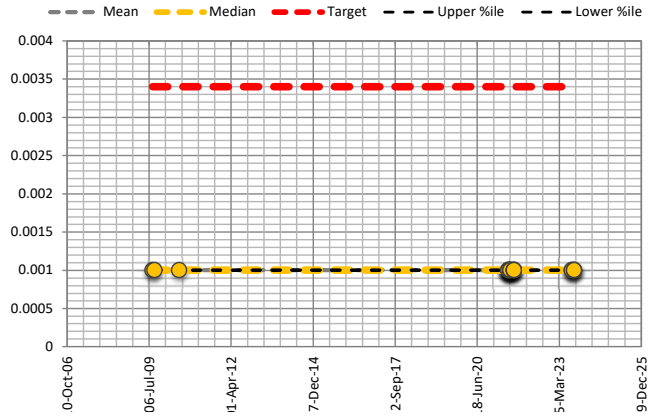
Aggregated Data : Surface Water Downstream

Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

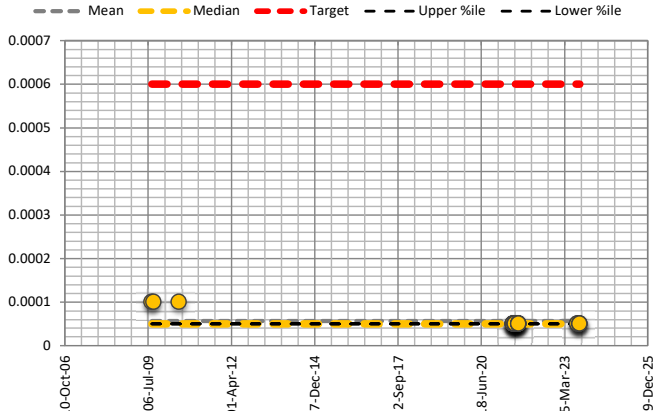
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Lowland Rivers	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
T	Temperature	°C	28	11.80	13.00	15.021	**13.950**	16.880	26.200		0
EC	Electrical Conductivity	mS/cm	29	0.19	0.29	0.992	**0.560**	1.278	5.200	0.300	22
pH	pH	pH	29	4.40	6.93	7.19	**7.34**	7.71	7.90	6.50	26
DO	Dissolved Oxygen	%	19	37.20	54.40	60.74	**57.50**	69.28	85.50		0
TN	Total Nitrogen	mg/L	29	0.96	1.36	1.97	**1.80**	2.76	3.60	1.20	24
TKN	Total Kejdhal Nitrogen	mg/L	29	0.94	1.26	1.78	**1.70**	1.90	3.50		0
NO3	Nitrate	mg/L	29	0.01	0.01	0.20	**0.05**	0.22	1.30		0
NO2	Nitrite	mg/L	29	0.01	0.01	0.01	**0.01**	0.01	0.05		0
Nox	Nox	mg/L	28	0.01	0.01	0.21	**0.04**	0.22	1.30	0.15	11
NH3	Ammonia	mg/L	19	0.01	0.01	0.20	**0.02**	0.03	2.70	0.90	1
TP	Total Phosphorous	mg/L	29	0.05	0.05	0.15	**0.14**	0.21	0.32	0.07	21
FRP	Filterable Reactive Phosphrous	mg/L	29	0.01	0.01	0.08	**0.07**	0.15	0.32	0.04	16
As	Arsenic	mg/L	22	0.00100	0.00100	0.00160	**0.00105**	0.00200	0.00400	0.02400	0
Cd	Cadmium	mg/L	22	0.00010	0.00010	0.00011	**0.00010**	0.00010	0.00030	0.00020	1
Cr	Chromium	mg/L	22	0.00100	0.00100	0.00127	**0.00100**	0.00100	0.00600	0.00100	2
Cu	Copper	mg/L	22	0.00100	0.00200	0.00289	**0.00225**	0.00300	0.01300	0.00140	20
Pb	Lead	mg/L	22	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Hg	Mercury	mg/L	22	0.00005	0.00005	0.00006	**0.00005**	0.00005	0.00010	0.00060	0
Ni	Nickel	mg/L	22	0.00100	0.00100	0.00334	**0.00200**	0.00294	0.01900	0.01100	2
Zn	Zinc	mg/L	22	0.00360	0.00800	0.03084	**0.01200**	0.02380	0.36000	0.00800	16
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	5	13.00	17.00	33.40	**27.00**	48.20	65.00		0
Mg	Magnesium	mg/L	5	4.80	5.84	10.38	**12.00**	14.20	15.00		0
K	Potassium	mg/L	5	3.90	4.54	7.70	**6.90**	11.20	12.00		0
Na	Sodium	mg/L	5	25.00	27.40	48.00	**53.00**	65.20	70.00		0
H as CaCO3	Hardness as CaCO3	mg/L	5	58.00	63.60	124.60	**110.00**	180.00	220.00		0

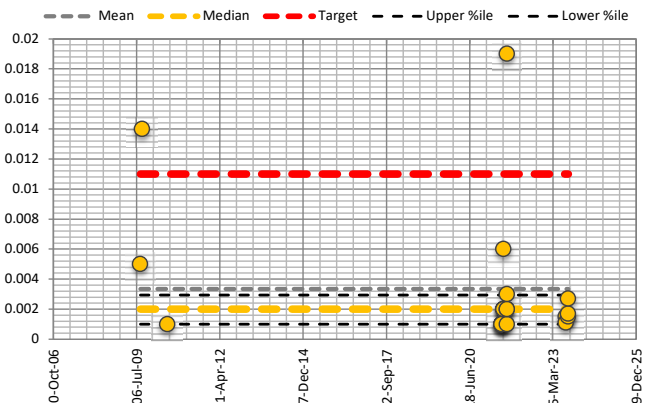
Lead



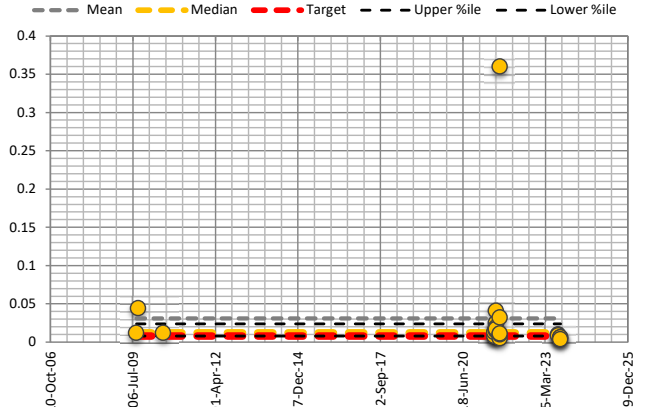
Mercury



Nickel



Zinc



FieldDAE

Field Data Analysis & Evaluation System

H21003 Wattle Grove South Monitoring

Aggregated Report: DWMS

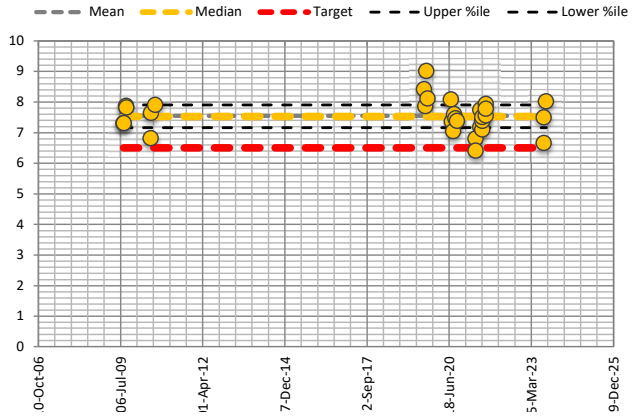
Aggregated Data : Surface Water Site Outlets

Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

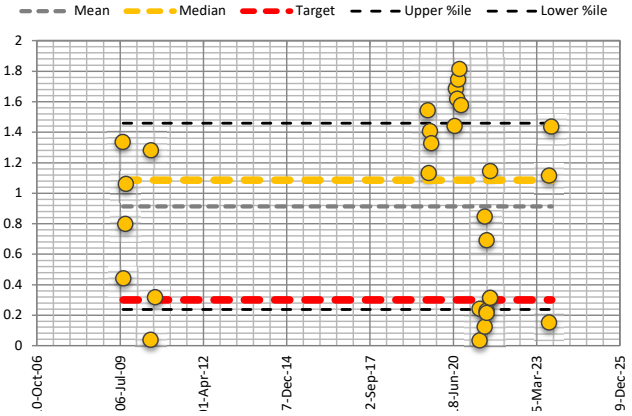
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Lowland Rivers	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
T	Temperature	°C	27	13.00	14.20	16.493	**16.200**	17.760	24.300		0
EC	Electrical Conductivity	mS/cm	30	0.03	0.24	0.912	**1.086**	1.459	1.812	0.300	23
pH	pH	pH	30	6.40	7.16	7.55	**7.53**	7.91	9.01	6.50	29
DO	Dissolved Oxygen	%	21	53.70	62.90	91.95	**82.00**	122.00	152.00		0
TN	Total Nitrogen	mg/L	30	0.30	1.18	2.79	**2.25**	3.34	18.00	1.20	22
TKN	Total Kejdhal Nitrogen	mg/L	30	0.30	0.54	1.49	**0.95**	1.44	13.00		0
NO3	Nitrate	mg/L	30	0.01	0.10	1.39	**0.96**	2.25	5.40		0
NO2	Nitrite	mg/L	30	0.01	0.01	0.02	**0.01**	0.02	0.08		0
Nox	Nox	mg/L	29	0.01	0.12	1.37	**0.97**	2.14	5.40	0.15	22
NH3	Ammonia	mg/L	13	0.01	0.01	0.11	**0.04**	0.10	0.77	0.90	0
TP	Total Phosphorous	mg/L	30	0.05	0.06	0.43	**0.15**	0.26	5.60	0.07	22
FRP	Filterable Reactive Phosphrous	mg/L	30	0.01	0.01	0.08	**0.02**	0.11	0.51	0.04	11
As	Arsenic	mg/L	16	0.00100	0.00100	0.00167	**0.00100**	0.00300	0.00470	0.02400	0
Cd	Cadmium	mg/L	16	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	16	0.00100	0.00100	0.00138	**0.00100**	0.00100	0.00600	0.00100	2
Cu	Copper	mg/L	16	0.00100	0.00200	0.01127	**0.00500**	0.00800	0.10000	0.00140	14
Pb	Lead	mg/L	16	0.00100	0.00100	0.00141	**0.00100**	0.00110	0.00500	0.00340	1
Hg	Mercury	mg/L	16	0.00005	0.00005	0.00006	**0.00005**	0.00005	0.00010	0.00060	0
Ni	Nickel	mg/L	16	0.00100	0.00100	0.00182	**0.00100**	0.00110	0.00600	0.01100	0
Zn	Zinc	mg/L	16	0.00400	0.01100	0.02527	**0.01800**	0.03600	0.07800	0.00800	13
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	3	14.00	32.00	47.00	**59.00**	64.40	68.00		0
Mg	Magnesium	mg/L	3	1.90	11.14	19.97	**25.00**	29.80	33.00		0
K	Potassium	mg/L	3	2.80	5.32	7.97	**9.10**	10.84	12.00		0
Na	Sodium	mg/L	3	5.00	51.00	98.33	**120.00**	150.00	170.00		0
H as CaCO3	Hardness as CaCO3	mg/L	3	43.00	125.80	197.67	**250.00**	280.00	300.00		0

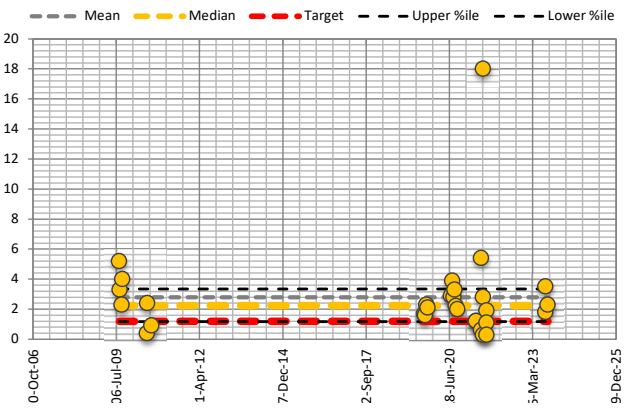
pH



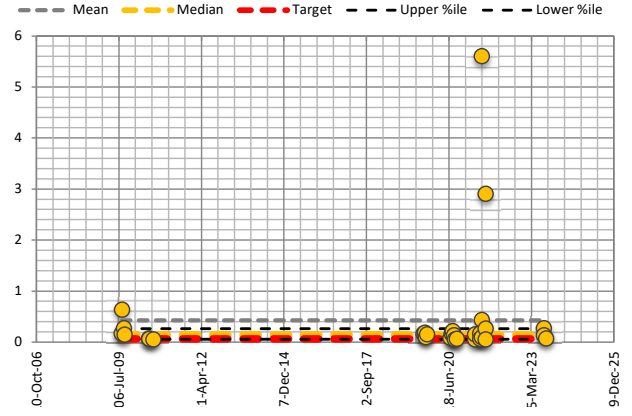
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H21003 Wattle Grove South Monitoring

Aggregated Report: DWMS

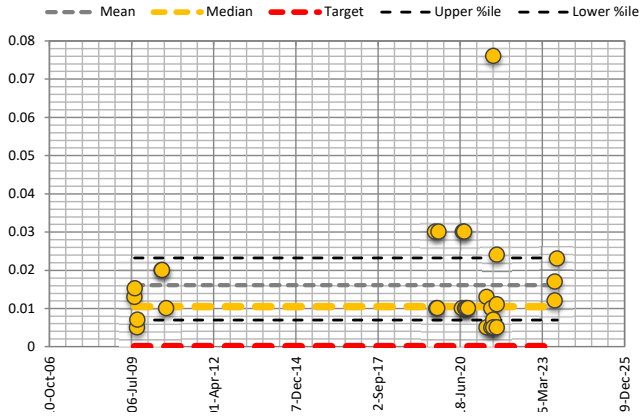
Aggregated Data : Surface Water Site Outlets

Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

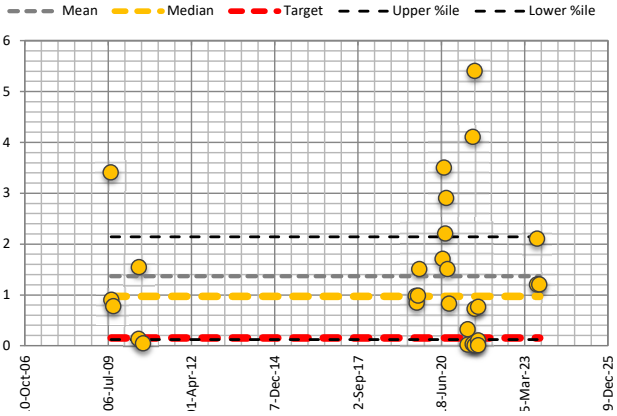
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Lowland Rivers	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
T	Temperature	°C	27	13.00	14.20	16.493	**16.200**	17.760	24.300		0
EC	Electrical Conductivity	mS/cm	30	0.03	0.24	0.912	**1.086**	1.459	1.812	0.300	23
pH	pH	pH	30	6.40	7.16	7.55	**7.53**	7.91	9.01	6.50	29
DO	Dissolved Oxygen	%	21	53.70	62.90	91.95	**82.00**	122.00	152.00		0
TN	Total Nitrogen	mg/L	30	0.30	1.18	2.79	**2.25**	3.34	18.00	1.20	22
TKN	Total Kejdhal Nitrogen	mg/L	30	0.30	0.54	1.49	**0.95**	1.44	13.00		0
NO3	Nitrate	mg/L	30	0.01	0.10	1.39	**0.96**	2.25	5.40		0
NO2	Nitrite	mg/L	30	0.01	0.01	0.02	**0.01**	0.02	0.08		0
Nox	Nox	mg/L	29	0.01	0.12	1.37	**0.97**	2.14	5.40	0.15	22
NH3	Ammonia	mg/L	13	0.01	0.01	0.11	**0.04**	0.10	0.77	0.90	0
TP	Total Phosphorous	mg/L	30	0.05	0.06	0.43	**0.15**	0.26	5.60	0.07	22
FRP	Filterable Reactive Phosphrous	mg/L	30	0.01	0.01	0.08	**0.02**	0.11	0.51	0.04	11
As	Arsenic	mg/L	16	0.00100	0.00100	0.00167	**0.00100**	0.00300	0.00470	0.02400	0
Cd	Cadmium	mg/L	16	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	16	0.00100	0.00100	0.00138	**0.00100**	0.00100	0.00600	0.00100	2
Cu	Copper	mg/L	16	0.00100	0.00200	0.01127	**0.00500**	0.00800	0.10000	0.00140	14
Pb	Lead	mg/L	16	0.00100	0.00100	0.00141	**0.00100**	0.00110	0.00500	0.00340	1
Hg	Mercury	mg/L	16	0.00005	0.00005	0.00006	**0.00005**	0.00005	0.00010	0.00060	0
Ni	Nickel	mg/L	16	0.00100	0.00100	0.00182	**0.00100**	0.00110	0.00600	0.01100	0
Zn	Zinc	mg/L	16	0.00400	0.01100	0.02527	**0.01800**	0.03600	0.07800	0.00800	13
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	3	14.00	32.00	47.00	**59.00**	64.40	68.00		0
Mg	Magnesium	mg/L	3	1.90	11.14	19.97	**25.00**	29.80	33.00		0
K	Potassium	mg/L	3	2.80	5.32	7.97	**9.10**	10.84	12.00		0
Na	Sodium	mg/L	3	5.00	51.00	98.33	**120.00**	150.00	170.00		0
H as CaCO3	Hardness as CaCO3	mg/L	3	43.00	125.80	197.67	**250.00**	280.00	300.00		0

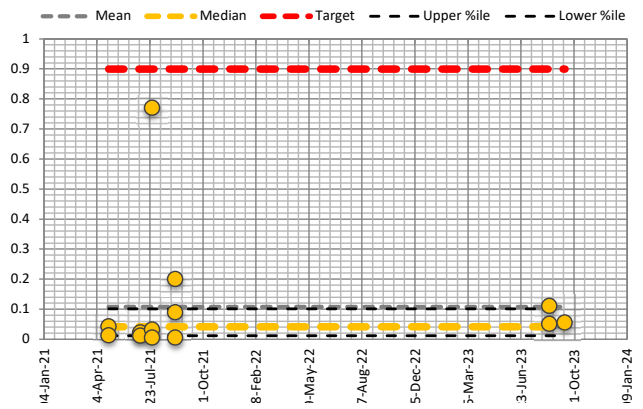
Nitrite



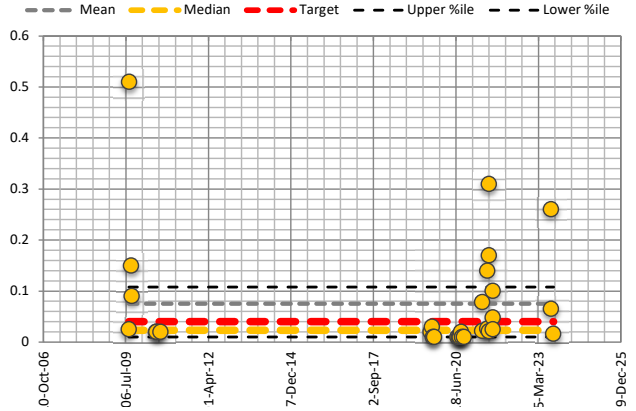
Nox



Ammonia



Filterable Reactive Phosphrous



H21003 Wattle Grove South Monitoring

Aggregated Report: DWMS

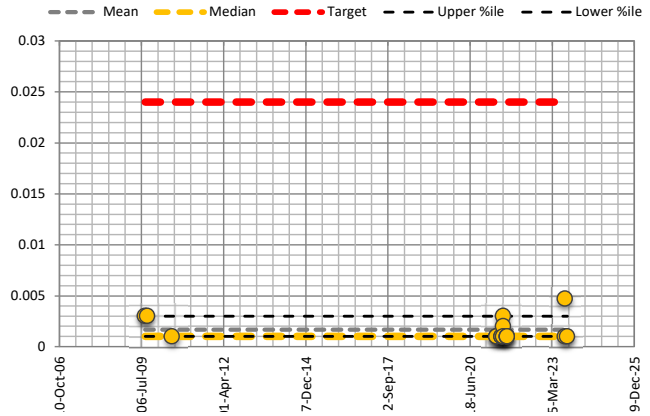
Aggregated Data : Surface Water Site Outlets

Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

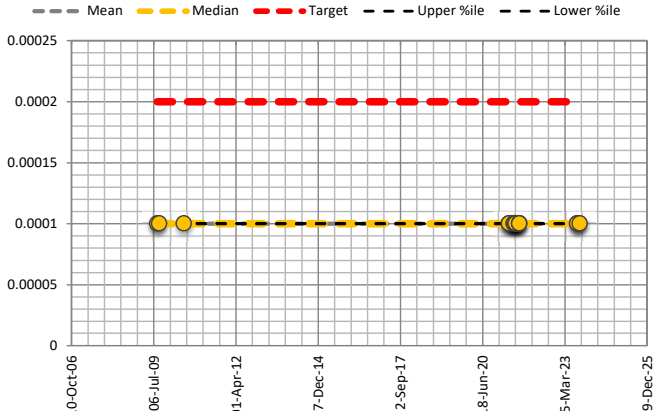
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Lowland Rivers	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
T	Temperature	°C	27	13.00	14.20	16.493	**16.200**	17.760	24.300		0
EC	Electrical Conductivity	mS/cm	30	0.03	0.24	0.912	**1.086**	1.459	1.812	0.300	23
pH	pH	pH	30	6.40	7.16	7.55	**7.53**	7.91	9.01	6.50	29
DO	Dissolved Oxygen	%	21	53.70	62.90	91.95	**82.00**	122.00	152.00		0
TN	Total Nitrogen	mg/L	30	0.30	1.18	2.79	**2.25**	3.34	18.00	1.20	22
TKN	Total Kejdhal Nitrogen	mg/L	30	0.30	0.54	1.49	**0.95**	1.44	13.00		0
NO3	Nitrate	mg/L	30	0.01	0.10	1.39	**0.96**	2.25	5.40		0
NO2	Nitrite	mg/L	30	0.01	0.01	0.02	**0.01**	0.02	0.08		0
Nox	Nox	mg/L	29	0.01	0.12	1.37	**0.97**	2.14	5.40	0.15	22
NH3	Ammonia	mg/L	13	0.01	0.01	0.11	**0.04**	0.10	0.77	0.90	0
TP	Total Phosphorous	mg/L	30	0.05	0.06	0.43	**0.15**	0.26	5.60	0.07	22
FRP	Filterable Reactive Phosphrous	mg/L	30	0.01	0.01	0.08	**0.02**	0.11	0.51	0.04	11
As	Arsenic	mg/L	16	0.00100	0.00100	0.00167	**0.00100**	0.00300	0.00470	0.02400	0
Cd	Cadmium	mg/L	16	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	16	0.00100	0.00100	0.00138	**0.00100**	0.00100	0.00600	0.00100	2
Cu	Copper	mg/L	16	0.00100	0.00200	0.01127	**0.00500**	0.00800	0.10000	0.00140	14
Pb	Lead	mg/L	16	0.00100	0.00100	0.00141	**0.00100**	0.00110	0.00500	0.00340	1
Hg	Mercury	mg/L	16	0.00005	0.00005	0.00006	**0.00005**	0.00005	0.00010	0.00060	0
Ni	Nickel	mg/L	16	0.00100	0.00100	0.00182	**0.00100**	0.00110	0.00600	0.01100	0
Zn	Zinc	mg/L	16	0.00400	0.01100	0.02527	**0.01800**	0.03600	0.07800	0.00800	13
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	3	14.00	32.00	47.00	**59.00**	64.40	68.00		0
Mg	Magnesium	mg/L	3	1.90	11.14	19.97	**25.00**	29.80	33.00		0
K	Potassium	mg/L	3	2.80	5.32	7.97	**9.10**	10.84	12.00		0
Na	Sodium	mg/L	3	5.00	51.00	98.33	**120.00**	150.00	170.00		0
H as CaCO3	Hardness as CaCO3	mg/L	3	43.00	125.80	197.67	**250.00**	280.00	300.00		0

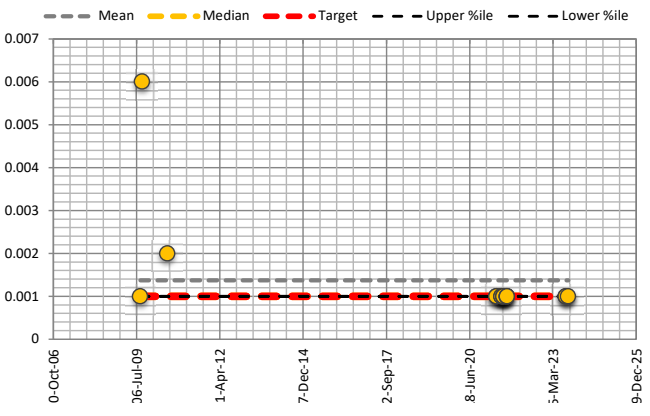
Arsenic



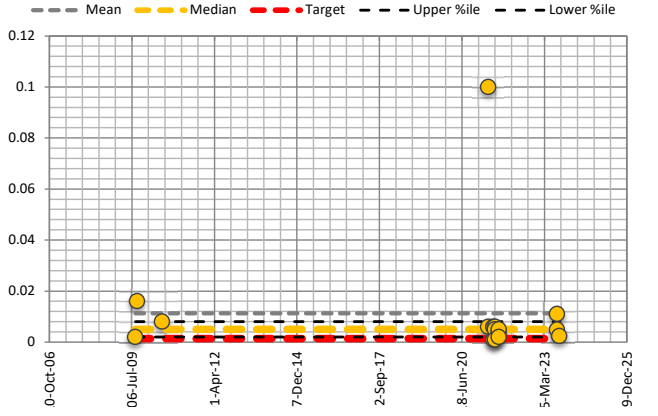
Cadmium



Chromium



Copper



H21003 Wattle Grove South Monitoring

Aggregated Report: DWMS

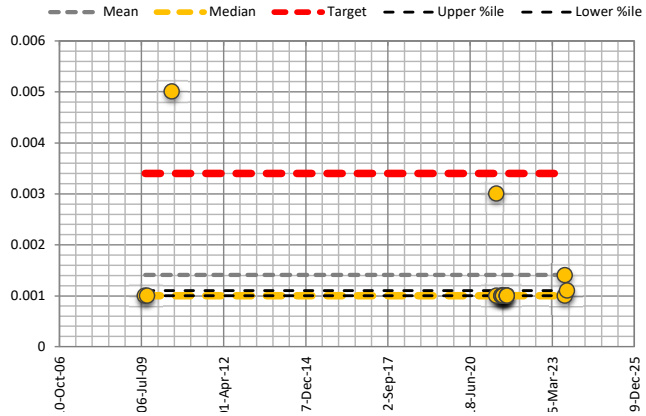
Aggregated Data : Surface Water Site Outlets

Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

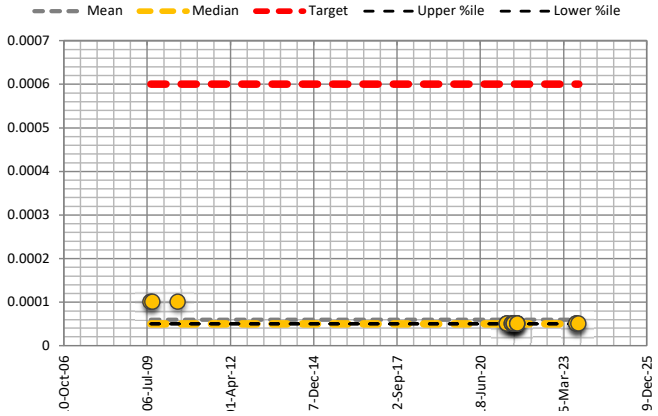
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Lowland Rivers	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
T	Temperature	°C	27	13.00	14.20	16.493	**16.200**	17.760	24.300		0
EC	Electrical Conductivity	mS/cm	30	0.03	0.24	0.912	**1.086**	1.459	1.812	0.300	23
pH	pH	pH	30	6.40	7.16	7.55	**7.53**	7.91	9.01	6.50	29
DO	Dissolved Oxygen	%	21	53.70	62.90	91.95	**82.00**	122.00	152.00		0
TN	Total Nitrogen	mg/L	30	0.30	1.18	2.79	**2.25**	3.34	18.00	1.20	22
TKN	Total Kejdhal Nitrogen	mg/L	30	0.30	0.54	1.49	**0.95**	1.44	13.00		0
NO3	Nitrate	mg/L	30	0.01	0.10	1.39	**0.96**	2.25	5.40		0
NO2	Nitrite	mg/L	30	0.01	0.01	0.02	**0.01**	0.02	0.08		0
Nox	Nox	mg/L	29	0.01	0.12	1.37	**0.97**	2.14	5.40	0.15	22
NH3	Ammonia	mg/L	13	0.01	0.01	0.11	**0.04**	0.10	0.77	0.90	0
TP	Total Phosphorous	mg/L	30	0.05	0.06	0.43	**0.15**	0.26	5.60	0.07	22
FRP	Filterable Reactive Phosphrous	mg/L	30	0.01	0.01	0.08	**0.02**	0.11	0.51	0.04	11
As	Arsenic	mg/L	16	0.00100	0.00100	0.00167	**0.00100**	0.00300	0.00470	0.02400	0
Cd	Cadmium	mg/L	16	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	16	0.00100	0.00100	0.00138	**0.00100**	0.00100	0.00600	0.00100	2
Cu	Copper	mg/L	16	0.00100	0.00200	0.01127	**0.00500**	0.00800	0.10000	0.00140	14
Pb	Lead	mg/L	16	0.00100	0.00100	0.00141	**0.00100**	0.00110	0.00500	0.00340	1
Hg	Mercury	mg/L	16	0.00005	0.00005	0.00006	**0.00005**	0.00005	0.00010	0.00060	0
Ni	Nickel	mg/L	16	0.00100	0.00100	0.00182	**0.00100**	0.00110	0.00600	0.01100	0
Zn	Zinc	mg/L	16	0.00400	0.01100	0.02527	**0.01800**	0.03600	0.07800	0.00800	13
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	3	14.00	32.00	47.00	**59.00**	64.40	68.00		0
Mg	Magnesium	mg/L	3	1.90	11.14	19.97	**25.00**	29.80	33.00		0
K	Potassium	mg/L	3	2.80	5.32	7.97	**9.10**	10.84	12.00		0
Na	Sodium	mg/L	3	5.00	51.00	98.33	**120.00**	150.00	170.00		0
H as CaCO3	Hardness as CaCO3	mg/L	3	43.00	125.80	197.67	**250.00**	280.00	300.00		0

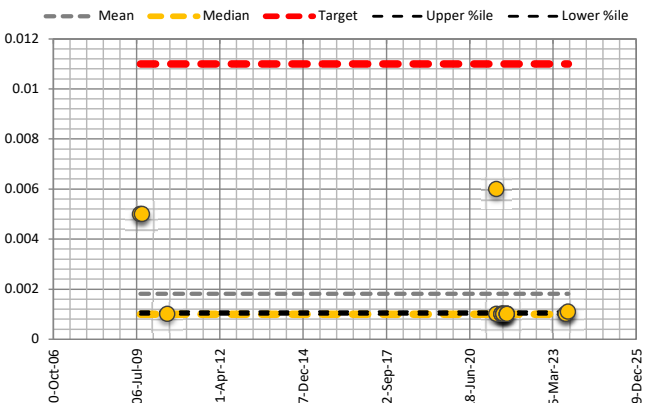
Lead



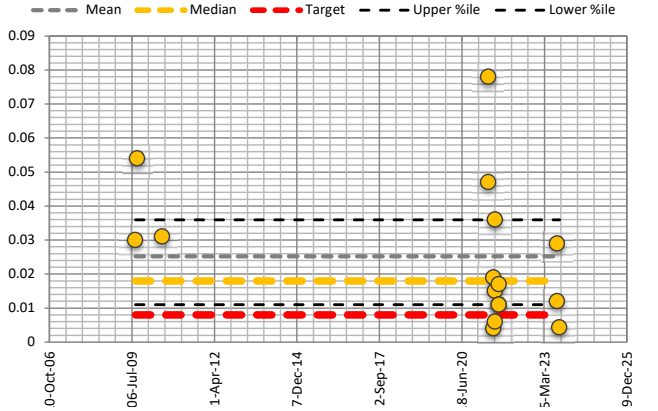
Mercury



Nickel



Zinc



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Aggregated Report: DWMS

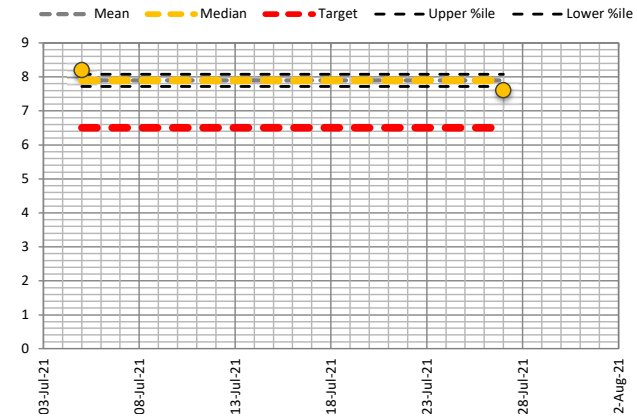
Aggregated Data : Surface Water Upstream

Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

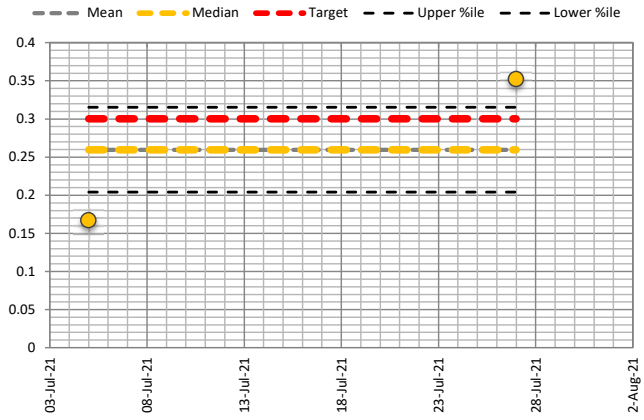
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Lowland Rivers	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
T	Temperature	°C	2	13.30	13.46	13.700	**13.700**	13.940	14.100		0
EC	Electrical Conductivity	mS/cm	2	0.17	0.20	0.260	**0.260**	0.315	0.352	0.300	1
pH	pH	pH	2	7.60	7.72	7.90	**7.90**	8.07	8.19	6.50	2
DO	Dissolved Oxygen	%	2	72.50	73.12	74.05	**74.05**	74.98	75.60		0
TN	Total Nitrogen	mg/L	2	0.30	0.42	0.60	**0.60**	0.78	0.90	1.20	0
TKN	Total Kejdhal Nitrogen	mg/L	2	0.30	0.40	0.55	**0.55**	0.70	0.80		0
NO3	Nitrate	mg/L	2	0.01	0.01	0.01	**0.01**	0.02	0.02		0
NO2	Nitrite	mg/L	2	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	2	0.02	0.02	0.02	**0.02**	0.02	0.02	0.15	0
NH3	Ammonia	mg/L	2	0.01	0.01	0.01	**0.01**	0.02	0.02	0.90	0
TP	Total Phosphorous	mg/L	2	0.05	0.05	0.05	**0.05**	0.05	0.05	0.07	0
FRP	Filterable Reactive Phosphrous	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	0.00120	0.00150	**0.00150**	0.00180	0.00200	0.02400	0
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00100	0
Cu	Copper	mg/L	2	0.00300	0.00320	0.00350	**0.00350**	0.00380	0.00400	0.00140	2
Pb	Lead	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.01100	0
Zn	Zinc	mg/L	2	0.01000	0.01140	0.01350	**0.01350**	0.01560	0.01700	0.00800	2
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Mg	Magnesium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
K	Potassium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Na	Sodium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
H as CaCO3	Hardness as CaCO3	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

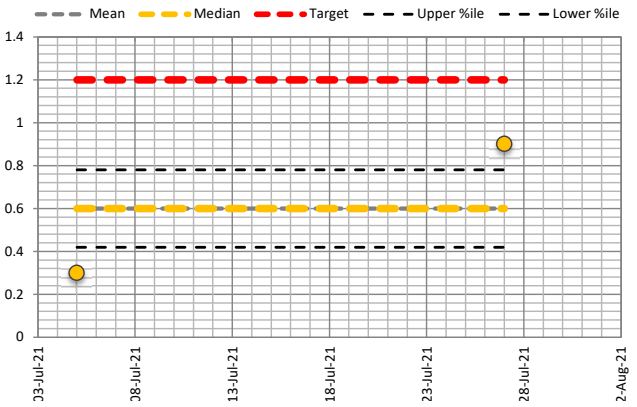
pH



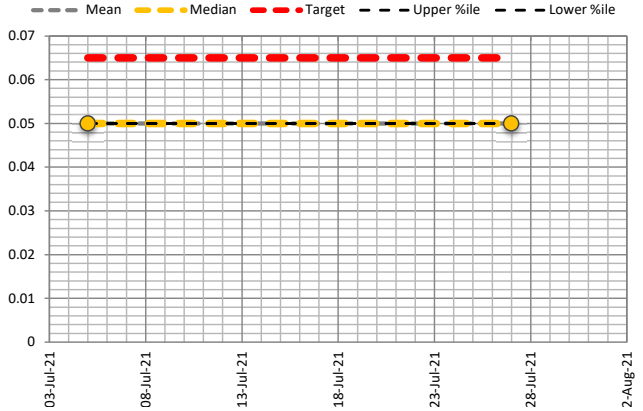
Electrical Conductivity



Total Nitrogen



Total Phosphorous



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Aggregated Report: DWMS

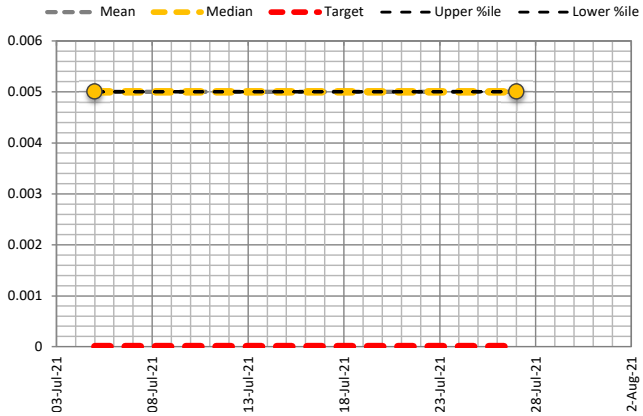
Aggregated Data : Surface Water Upstream

Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

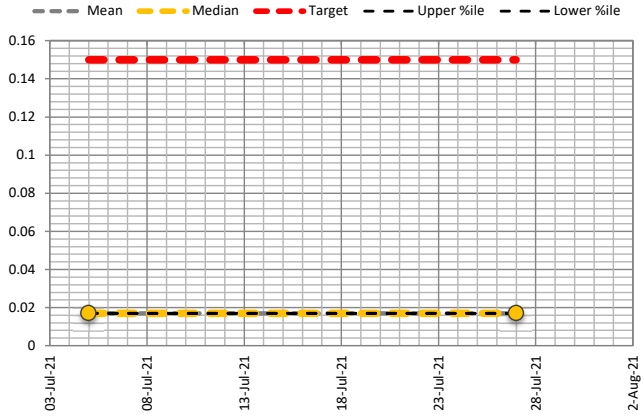
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Lowland Rivers	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
T	Temperature	°C	2	13.30	13.46	13.700	**13.700**	13.940	14.100		0
EC	Electrical Conductivity	mS/cm	2	0.17	0.20	0.260	**0.260**	0.315	0.352	0.300	1
pH	pH	pH	2	7.60	7.72	7.90	**7.90**	8.07	8.19	6.50	2
DO	Dissolved Oxygen	%	2	72.50	73.12	74.05	**74.05**	74.98	75.60		0
TN	Total Nitrogen	mg/L	2	0.30	0.42	0.60	**0.60**	0.78	0.90	1.20	0
TKN	Total Kejdhal Nitrogen	mg/L	2	0.30	0.40	0.55	**0.55**	0.70	0.80		0
NO3	Nitrate	mg/L	2	0.01	0.01	0.01	**0.01**	0.02	0.02		0
NO2	Nitrite	mg/L	2	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	2	0.02	0.02	0.02	**0.02**	0.02	0.02	0.15	0
NH3	Ammonia	mg/L	2	0.01	0.01	0.01	**0.01**	0.02	0.02	0.90	0
TP	Total Phosphorous	mg/L	2	0.05	0.05	0.05	**0.05**	0.05	0.05	0.07	0
FRP	Filterable Reactive Phosphrous	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	0.00120	0.00150	**0.00150**	0.00180	0.00200	0.02400	0
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00100	0
Cu	Copper	mg/L	2	0.00300	0.00320	0.00350	**0.00350**	0.00380	0.00400	0.00140	2
Pb	Lead	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.01100	0
Zn	Zinc	mg/L	2	0.01000	0.01140	0.01350	**0.01350**	0.01560	0.01700	0.00800	2
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Mg	Magnesium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
K	Potassium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Na	Sodium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
H as CaCO3	Hardness as CaCO3	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

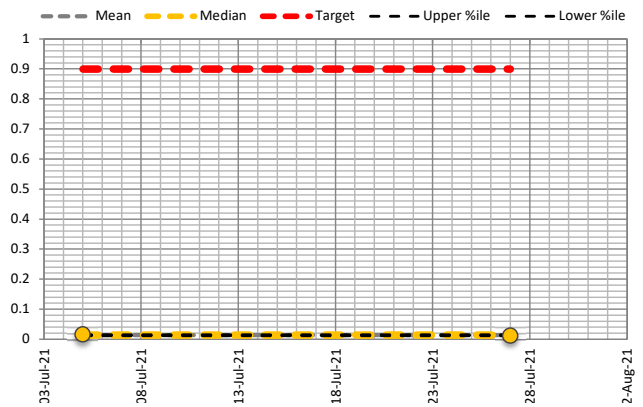
Nitrite



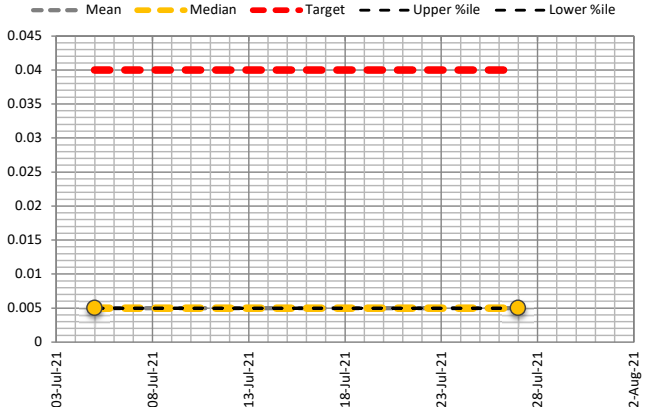
Nox



Ammonia



Filterable Reactive Phosphrous



H21003 Wattle Grove South Monitoring

Aggregated Report: DWMS

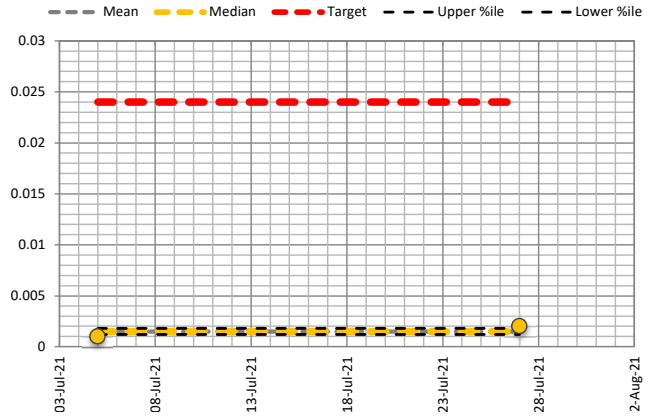
Aggregated Data : Surface Water Upstream

Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

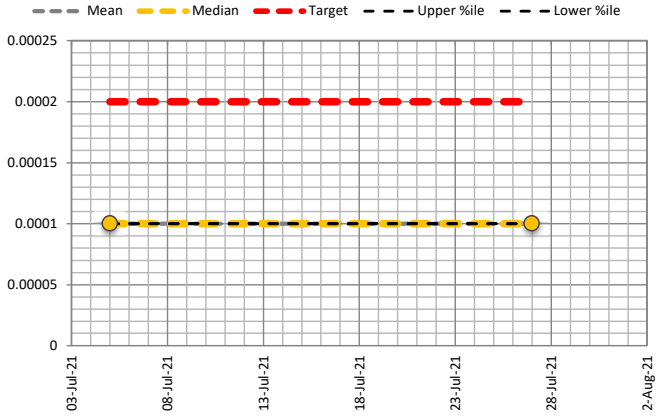
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Lowland Rivers	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
T	Temperature	°C	2	13.30	13.46	13.700	**13.700**	13.940	14.100		0
EC	Electrical Conductivity	mS/cm	2	0.17	0.20	0.260	**0.260**	0.315	0.352	0.300	1
pH	pH	pH	2	7.60	7.72	7.90	**7.90**	8.07	8.19	6.50	2
DO	Dissolved Oxygen	%	2	72.50	73.12	74.05	**74.05**	74.98	75.60		0
TN	Total Nitrogen	mg/L	2	0.30	0.42	0.60	**0.60**	0.78	0.90	1.20	0
TKN	Total Kejdhal Nitrogen	mg/L	2	0.30	0.40	0.55	**0.55**	0.70	0.80		0
NO3	Nitrate	mg/L	2	0.01	0.01	0.01	**0.01**	0.02	0.02		0
NO2	Nitrite	mg/L	2	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	2	0.02	0.02	0.02	**0.02**	0.02	0.02	0.15	0
NH3	Ammonia	mg/L	2	0.01	0.01	0.01	**0.01**	0.02	0.02	0.90	0
TP	Total Phosphorous	mg/L	2	0.05	0.05	0.05	**0.05**	0.05	0.05	0.07	0
FRP	Filterable Reactive Phosphrous	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	0.00120	0.00150	**0.00150**	0.00180	0.00200	0.02400	0
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00100	0
Cu	Copper	mg/L	2	0.00300	0.00320	0.00350	**0.00350**	0.00380	0.00400	0.00140	2
Pb	Lead	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.01100	0
Zn	Zinc	mg/L	2	0.01000	0.01140	0.01350	**0.01350**	0.01560	0.01700	0.00800	2
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Mg	Magnesium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
K	Potassium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Na	Sodium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
H as CaCO3	Hardness as CaCO3	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

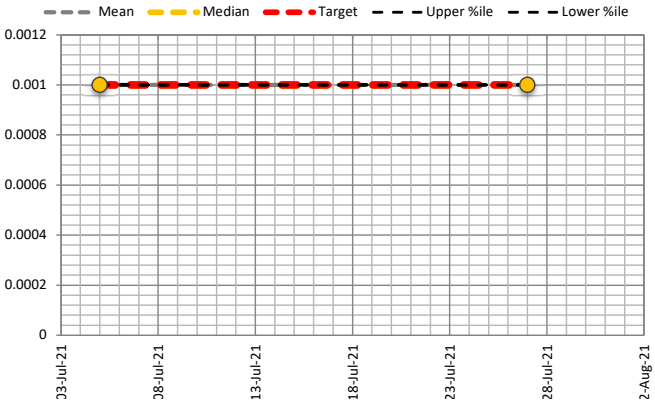
Arsenic



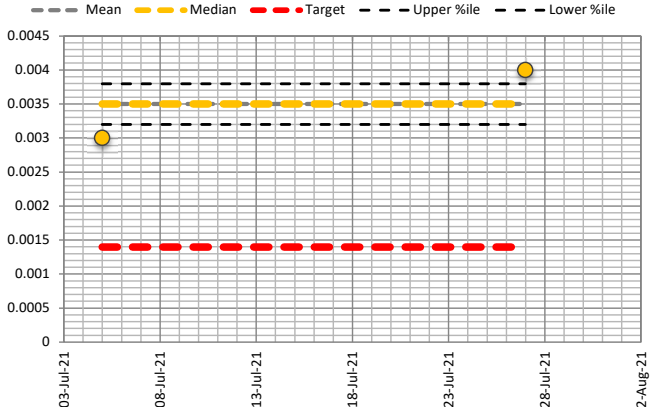
Cadmium



Chromium



Copper



H21003 Wattle Grove South Monitoring

Aggregated Report: DWMS

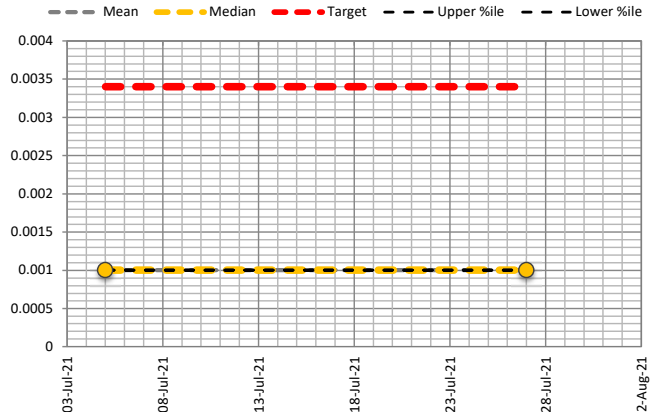
Aggregated Data : Surface Water Upstream

Data Analysis Period Start Date	1/01/2009
Data Analysis Period End Date	19/12/2023

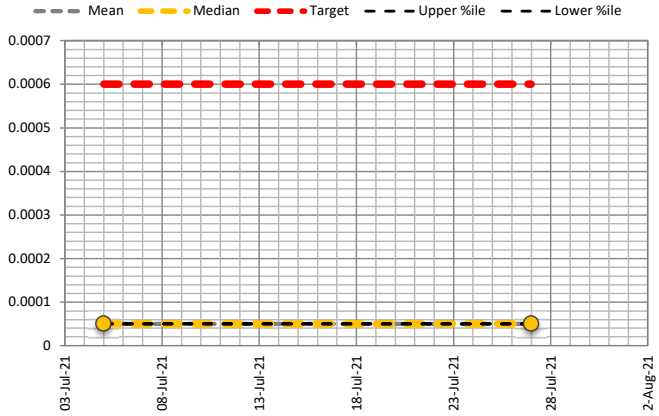
Report Date : 29/01/2024

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95% & Lowland Rivers	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
T	Temperature	°C	2	13.30	13.46	13.700	**13.700**	13.940	14.100		0
EC	Electrical Conductivity	mS/cm	2	0.17	0.20	0.260	**0.260**	0.315	0.352	0.300	1
pH	pH	pH	2	7.60	7.72	7.90	**7.90**	8.07	8.19	6.50	2
DO	Dissolved Oxygen	%	2	72.50	73.12	74.05	**74.05**	74.98	75.60		0
TN	Total Nitrogen	mg/L	2	0.30	0.42	0.60	**0.60**	0.78	0.90	1.20	0
TKN	Total Kejdhal Nitrogen	mg/L	2	0.30	0.40	0.55	**0.55**	0.70	0.80		0
NO3	Nitrate	mg/L	2	0.01	0.01	0.01	**0.01**	0.02	0.02		0
NO2	Nitrite	mg/L	2	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Nox	Nox	mg/L	2	0.02	0.02	0.02	**0.02**	0.02	0.02	0.15	0
NH3	Ammonia	mg/L	2	0.01	0.01	0.01	**0.01**	0.02	0.02	0.90	0
TP	Total Phosphorous	mg/L	2	0.05	0.05	0.05	**0.05**	0.05	0.05	0.07	0
FRP	Filterable Reactive Phosphrous	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	0.00120	0.00150	**0.00150**	0.00180	0.00200	0.02400	0
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00100	0
Cu	Copper	mg/L	2	0.00300	0.00320	0.00350	**0.00350**	0.00380	0.00400	0.00140	2
Pb	Lead	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ni	Nickel	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.01100	0
Zn	Zinc	mg/L	2	0.01000	0.01140	0.01350	**0.01350**	0.01560	0.01700	0.00800	2
Cl	Chlorine	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Ca	Calcium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Mg	Magnesium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
K	Potassium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Na	Sodium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
H as CaCO3	Hardness as CaCO3	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

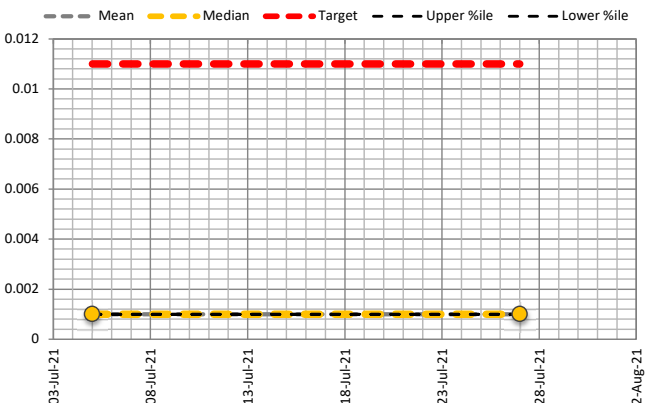
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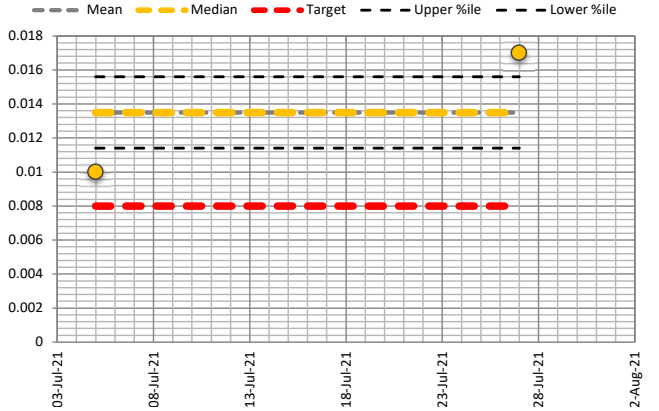
Mercury



Nickel



Zinc



APPENDIX O

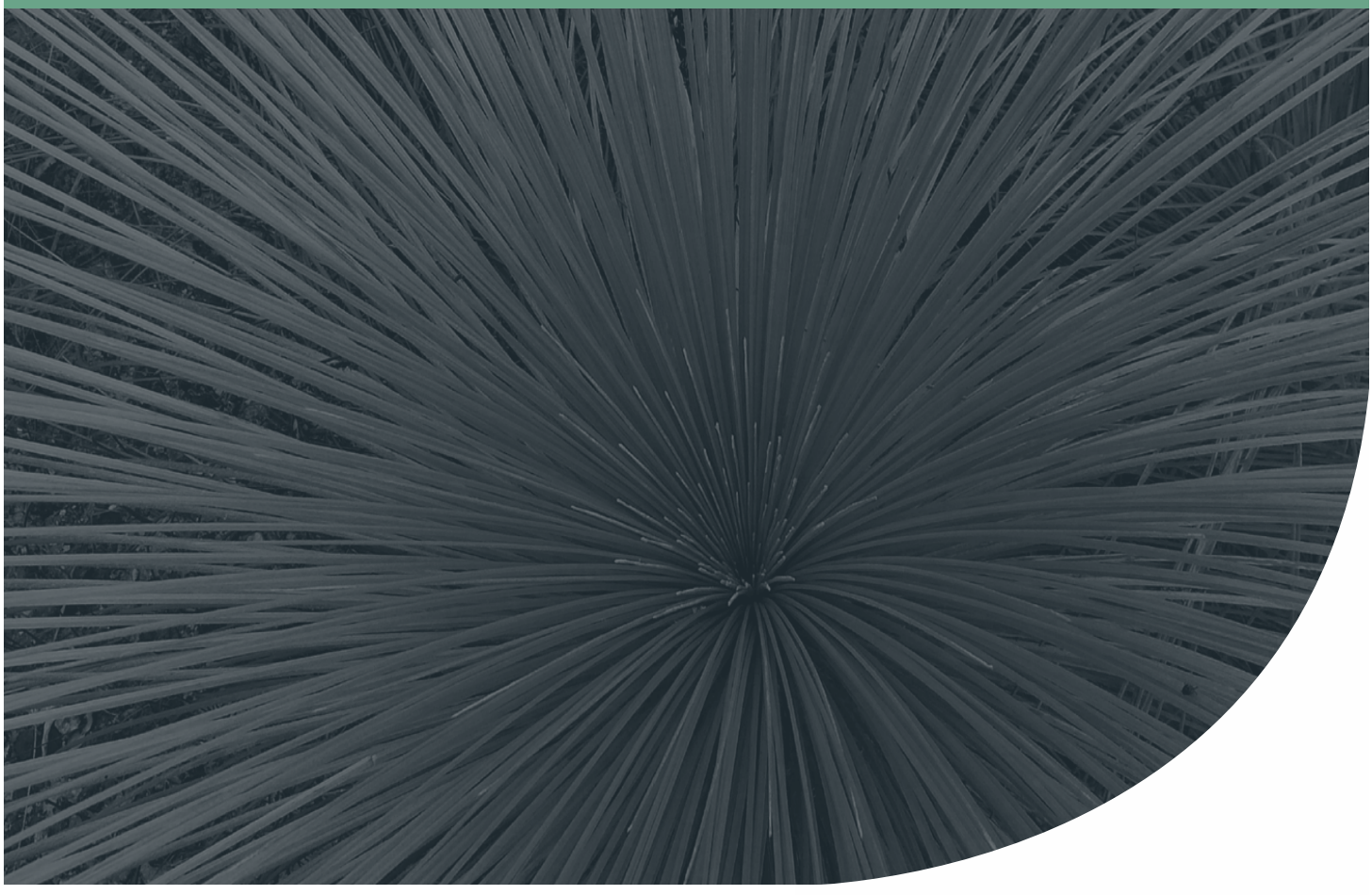
Water Balance Modelling Report
(Emerge Associates, 2024)

Water Balance Assessment

Wattle Grove South MRS Amendment

Project No: EP22-002(03)

Prepared for Hesperia Pty Ltd
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Executive Summary

This document outlines a water balance assessment (WBA) that has been prepared to support the environmental review document (ERD) prepared to support Metropolitan Region Scheme (MRS) Amendment 1388/57.

The overall WBA is outlined and described within the body of this report. A number of appendices (technical assessments) have also been prepared to detail the specifics of the individual components of the WBA and are intended to be read in conjunction with and supplementary to the WBA.

The hydrological regime of the WBA areas is complex in some regards, is interrelated and highly seasonal. The drivers and features of the hydrological cycle within the MRS amendment area are:

- Seasonally varied annual rainfall
- Rainfall interception due to vegetation, landform and soils
- Surface water runoff (including from upstream catchments)
- Majority of the MRS amendment area is underlain by permeable sand with significant depth to groundwater
- Horizontal groundwater throughflow within the superficial aquifer beneath the MRS amendment area
- Evapotranspiration which varies across different vegetation types and land uses
- Recharge to the underlying superficial aquifer
- Seasonal perched groundwater due to underlying soil profiles in minor parts of the MRS amendment area along the north west boundary.

A conceptual understanding of the water cycle within the MRS amendment area has been developed based on detailed investigations into the existing environment. The conceptual understanding is strongly influenced by the generally sandy and permeable nature of the majority of soils, underlain by irregular and interspersed sandy clay/clay of varying extent and depth. The site is located in an area of transition between the low permeability steeper slopes of the Darling Scarp, and the flatter landform beneath the Greater Brixton Street Wetland (GBSW) which is consistently underlain by thin layers of sand over clay/sandy clay. The MRS amendment area is also close to the top of catchment for groundwater, with modest amounts of aquifer recharge occurring upstream and entering the site via shallow groundwater throughflow. The higher permeability sands of the site facilitate infiltration at source, resulting in the majority of water inputs to the site either taken up by vegetation (i.e. via evapotranspiration) or recharged to groundwater.

A conceptual water balance has been developed which considers the pre-development and post-development environments of the MRS amendment area and of the Urban Expansion (UE) and Urban Investigation (UI) areas. The pre-development environment WBA has quantified each component of the assessment and has provided a basis for assessing the impacts of the proposed development. The key components of the water balance are:

- Rainfall
- Irrigation inputs from aquifers and domestic application of scheme water
- Rainfall and irrigation water interception
- Surface water runoff and drainage

- Upstream catchment inflows
- Groundwater throughflow
- Seasonal perched groundwater
- Evapotranspiration
- Recharge.

The WBA covers an annual time scale and provides a linked assessment of the key components listed above. The surface water and evapotranspiration processes represent the average of the 2010-2019 (inclusive) period. Use of an average for these components accounts for the annual variability of these values and provides for a more robust assessment. The groundwater throughflow components are based on measured (level) data from 2022. While the assessment period is a year and most of the data and results are presented as an annual figure (as summations or averages), each component is calculated with varying timesteps, typically daily but as small as hourly intervals (e.g. for the surface water runoff component).

The WBA takes a before/after comparison approach, in that it first assesses the water balance that currently exists for the pre-development environment and then applies the same assessment methodology to the post-development environment(s). Two scenarios are evaluated; one where the UE and UI are fully developed, and one where no development occurs in the UE and UI areas. The post-development water balance scenarios follow the same methodology as the pre-development water balance. It assumes that rainfall remains the same i.e. they assume that future rainfall and climate conditions are reflective of the period assessed in the WBA. The primary factors which influence changes in the post-development water balance are the increased impervious area resulting from the urban development proposed for the MRS amendment area and the development condition of the upstream catchments (i.e. whether it remains rural residential or becomes urbanised).

A key influence for the post-development scenarios is the reduction to evapotranspiration for the MRS amendment area (due to vegetation loss), infiltration within stormwater management infrastructure and increase in recharge. Surface water outflows for the MRS amendment area increase by approximately 11% to 24% (depending on the scenario). Of this, the increase in surface water outflows directed towards GBSW is up to 5,192 kL, and while this is a 16.4% increase in the volume of water, this only represents 0.4% of the overall water balance. Evapotranspiration reduces by approximately 26% (for rainfall) to 43% (for irrigation water). Both of these influences can be attributed to the increase in urbanisation, reduction of vegetation across the WBA area and reduction in irrigation water application.

Given the permeable sandy profile beneath most of the MRS amendment area and proposed adoption of infiltration-based water management, the increase in (or residual) water volume will result in an increase in groundwater recharge (to the superficial aquifer). The annual amount of water that will become recharge to the superficial aquifer in the pre-development scenario is 313,871 kL and this will increase in the post-development scenarios to 379,011 kL. In addition, a conservative assumption is that the UE and UI area (upstream catchments) will also see a similar increase to groundwater recharge attributed to urbanisation. Estimation of groundwater recharge for the upstream catchments has been based on the same proportions of recharge determined for the MRS amendment area. The estimated groundwater recharge generated by the upstream catchments is 198,981 kL.

Whilst the MRS amendment area will experience increased recharge to superficial groundwater from urban development groundwater flows are unlikely to change due to the stormwater management approach seeking to maintain the groundwater mound at this location (Hyd2O 2024). Given the radial direction of flows exiting the MRS amendment area there is the potential for impacts to occur to GBSW and the MKSEA area. However, as the superficial aquifer is several metres below the shallow perched conditions experienced along the western boundary of the site and the portion of GBSW near the site, the MRS amendment area will not affect localised perched conditions beneath GBSW.

While there will continue to be groundwater outflows from the MRS amendment area there are no drivers for change to the shallow/perched groundwater leaving the site towards the GBSW. The portion of the MRS amendment area underlain by shallow clay are upgradient of the GBSW and will not be developed. Further, the location of Tonkin Highway along the western boundary of the MRS amendment area is assumed act as an impermeable flow boundary for shallow/perched groundwater flows, as the construction of Tonkin Highway would have removed the shallow permeable soil profile beneath the highway to facilitate construction. Further, the perched groundwater conditions in this part of the site coincide with the Dampier to Bunbury Natural Gas Pipeline (DBNGP) corridor and the *Dampier to Bunbury Pipeline Act 1997* prohibits development within this corridor. The nature of construction of the DBNGP will also have disrupted the pre-development groundwater flow pathway and is expected to act as a preferential drainage pathway directing shallow/perched groundwater flows either downwards to the more permeable sands or away from GBSW and the MRS amendment area.

The WBA initially represents the recent average meteorological conditions and therefore inherently does not account for any potential future climate change impacts, which would likely amount to a warmer, drier climate with more intense rainfall events. The effect of climate change has therefore been incorporated into the water balance model as a separate process through assessment of climate change on the post-development scenario which assumes that the upstream UE and UI areas are developed as per the MRS amendment area.

To account for climate change factors, a future rainfall dataset was obtained from DWER to assess changes to key water balance inputs due to climate change (rainfall and evapotranspiration) (DWER 2021). The dataset from DWER is based on the climatic scenario projections from the World Climate Research Programme's (WCRP's) Coupled Model Intercomparison Project phase 3 (CMIP3) multimodel dataset (associated with the Intergovernmental Panel on Climate Change's (IPCC) 4th assessment report) (IPCC 2007). The DWER dataset uses the climate scenario projections to predict future climate data extrapolated from an observed climate baseline obtained from the Australian climate database named 'SILO' (Queensland Government 2021). The DWER climate prediction dataset provides predicted future rainfall data in daily intervals for three climate change scenarios (Wet, Median, Dry) at a time horizon of 2050 and 2100. The predictions are geographically based and as such the dataset obtained for this assessment has been calculated specifically for location of the assessment. The 2050 and 2100 'Dry' scenarios were selected for the climate change assessment as a conservative prediction.

Rainfall, associated runoff and evapotranspiration are the most significant components of the water balance by magnitude and future climate prediction data is available for rainfall, making assessment of climate response possible. While there will likely also be a direct effect on the other smaller-

magnitude water balance components, future climatic predictions (specifically relevant to the MRS amendment area) for these components are not readily available. However, these components are altered indirectly due to flow on effects from changes in other components due to changes in water availability, which has been considered as part of the climate change sensitivity analysis. The rainfall climate change factor was applied to the following water balance components:

- Rainfall
- Upstream catchment flows
- Rainfall interception
- Surface water runoff from the MRS amendment area
- Evapotranspiration.

The flow-on impacts of these changes also effect groundwater driven processes (throughflow and recharge).

The outcomes of the climate change sensitivity showed that in the Dry 2050 scenario the impact of the assessed climate changes was relatively small, being similar to the post-development (urbanised) water balance. Surface water flows reduced by approximately 10% when compared to the base case post-development scenario, but were still greater than the pre-development environment. Evapotranspiration and rainfall decreased further from the pre-development scenario as a direct result of the reduction in rainfall associated with climate change. Reduction to the other water balance components were also noted as a results of the reduction in rainfall.

The Dry 2100 scenario indicates more significant reductions in surface water runoff will occur with a reduction of approximately 63% when compared to the base case post-development scenario, or approximately 50% lower than pre-development levels. Evapotranspiration and interception also reduce significantly, being a portion of rainfall and irrigation. Increases to recharge to the superficial aquifer system beneath the MRS amendment area under this scenario are minimal with recharge to the superficial aquifer approximating the pre-development environment.

The impacts to surface water flows specifically to GBSW from climate change (not just overall from the MRS amendment area) have also been considered as part of this WBA. For the Dry 2050 scenario with fully urbanised upstream catchments the surface water runoff exported from the MRS amendment area to GBSW reduces from a 16.4% increase (in the post-development scenario without climate change factors) to a 5.1% increase in surface runoff towards GBSW, which represents 0.1% of the overall water balance. For the Dry 2100 scenario with fully urbanised upstream catchments the surface water runoff exported from the MRS amendment area reduces by 57.3% compared to the post-development scenario without climate change.

The key findings from the WBA are summarised below:

- The proposed development will change the water balance of the MRS amendment area by reducing evapotranspiration, increasing recharge and, to a lesser degree, surface runoff.
- The increase in surface water runoff can be managed through the logical placement of stormwater infrastructure within the site, to ensure any additional surface water generated due to the development is captured, treated and infiltrated on site. This in turn will ensure that changes to surface water runoff towards the GBSW can be mitigated.

- The predicted increase in recharge has the potential to increase groundwater depth, however this will not have a significant impact on any of the water balance components, as the superficial aquifer lies several metres below the natural surface level of the MRS amendment area. The (northerly) localised flow direction of superficial aquifer in this area does not grade towards GBSW. Further, GBSW is predominantly fed by direct rainfall. Therefore, the urbanisation of the MRS amendment area will not adversely impact the existing hydrological regime in the GBSW.
- Tonkin Highway (situation along the western boundary of the MRS amendment area) will act as an impermeable flow boundary, excluding shallow perched groundwater flows in a westerly direction (given likely removal of the shallow soil profile during construction). The presence of the DBNGP at this boundary is also expected to facilitate downward infiltration of shallow perched groundwater to the deeper sandy layer.
- There are no drivers that will trigger a change to the conditions supporting shallow perched groundwater levels and flow along the northern boundary of the MRS amendment area that is upstream of the GBSW.
- Assessment of climate change indicates a likely impact on the water balance due to reduced rainfall volumes. This will reduce the overall available water within the MRS amendment area in the future, with the likely outcome being a reduction in evapotranspiration but comparable recharge to the superficial aquifer and surface runoff as occurs in the pre-development scenario.

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Appendix A

Environmental Review Instructions (excerpt)

Appendix B

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Salinity and Sodicity

1 Introduction

1.1 Background

The Western Australian Planning Commission (WAPC) have initiated amendment 1388/57 to the Metropolitan Region Scheme (MRS). The amendment proposes to rezone approximately 126 ha of land within Wattle Grove from 'Rural' to 'Urban' situated within the Urban Expansion (UE) and Urban Investigation (UI) areas designated in the North-East Sub-Regional Planning Framework (DPLH 2018). The amendment is subject to environmental assessment by the Environmental Protection Authority (EPA) under the *Environmental Protection Act 1986* (the EP Act). Hesperia Pty Ltd (the proponent) is completing the Environmental Review (ER) required by the environmental assessment on behalf of WAPC.

For the purposes of this water balance assessment (WBA), 'the MRS amendment area' refers to the land bound by Tonkin Highway (west), Welshpool Road East (north), Crystal Brook Road (north), Victoria Road and Easterbrook Road (east) and the rear boundaries of lots fronting Victoria Road (south). The location of the MRS amendment area, UE and UI areas, and current aerial photography are shown in **Figure 1**. While the WBA has been prepared in support of rezoning of the MRS amendment area, the wider UE and UI areas in Wattle Grove have been considered in the WBA where relevant to the amendment. The location and extents of the MRS amendment area and wider UE and UI areas are shown on **Figure 1**.

The WBA is outlined and described within the body of this report. A number of detailed technical assessments have also been prepared to document the specifics of the individual components of the WBA and are intended to be read in conjunction with and supplementary to the WBA, and these are appended to this report.

1.2 Purpose of this report

As a part of the environmental assessment process for the proposed amendment, the EPA has requested an ER be undertaken and documented within an Environmental Review Document (ERD) to support the amendment in accordance with the instructions provided by the EPA. Specifically regarding the ER (see **Appendix A**), this WBA seeks to assist in addressing address points 6, 7, 8 and 12 from Table 3 (Inland Waters). A breakdown of how these are addressed by the WBA are summarised in **Table 1**. The instructions outline the key objectives, potential impacts and risks as well as the work required to ensure the objectives are achieved. Of greatest relevance to the WBA is the Inland Water environmental factors, however by association can directly or indirectly influence all the outlined environmental factors. The EPA objective for the Inland Water environmental factor is:

"*To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected*"

Table 1: Excerpt of ER document requirements

ER item number	ER required work summary	WBA section which addresses ER required work
6	Using a pre and post development water balance model, characterise the existing hydrology of the site and existing sub surface flow contribution to the GBSW; and assess the potential impacts (direct and indirect) of the proposed change in land use associated with the amendment, and urban expansion and investigation areas, on water quantity and quality of surface and ground waters and subsurface flow contribution in relation to nearby significant wetlands and waterways	Section 3, Section 4.1, Appendix B, Appendix C, Appendix D
7	Calculate the additional recharge from proposed change in land use associated with the amendment, and the resultant impact to the groundwater flow velocity and direction toward the GBSW. This should also include identification of the additional recharge from the urban expansion and investigation areas.	Section 4.1, Appendix B, Appendix C, Appendix D
8	Demonstrate that predevelopment surface water and groundwater flows to the Yule Brook and GBSW are maintained post development as a result of the proposed change in land use associated with this amendment, and urban expansion and investigation areas.	Section 4.1.3, Appendix B, C
12	Items 6, 8 and 11 should model existing conditions of, and potential changes to, groundwater and surface water chemistry, particularly in relation to salinity and soil sodicity, that will result from the proposed change in land use associated with this amendment, and urban expansion and investigation areas.	Appendix E

1.3 Previous and relevant studies

Previous studies of relevance to this water balance assessment have been undertaken within the MRS amendment area and surrounding land. These studies include nearby water balance investigations and water management reports which have been used to inform the WBA presented in this document. These include:

- *Wattle Grove District Water Management Strategy* (Hyd2O 2024)
- *Geophysical Subsurface Investigation for MRS Amendment 1388/57, Wattle Grove Western Australia* (GBG 2023)
- *Maddington Kenwick Strategic Employment Area Water Balance Assessment* (Emerge Associates 2022)
- *Wetland Water Balance – Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area* (Emerge Associates 2020)
- *Environmental values and pressures for the Greater Brixton Street Wetland on the Swan Coastal Plain* (EPA 2022)
- *Surface nuclear magnetic resonance sounding in the Greater Brixton Street Wetlands* (DBCA 2018)
- *A Jewel in the Crown of a Global Biodiversity Hotspot* (Lambers 2019)
- *Perth Regional Aquifer Modelling System (PRAMS) model development: Hydrogeology and groundwater modelling (Report HG20)* (DoW 2008)
- *Perth Regional Aquifer Modelling System (PRAMS) model development: A vertical flux model for the Perth groundwater region. Report HG33* (DoW 2009a)

- *Perth Regional Aquifer Modelling System (PRAMS) model development: Application of the Vertical Flux Model. Report HG27* (DoW 2009b)
- *Perth Regional Aquifer Modelling System (PRAMS) model development: Review of the Coupled Perth Regional Aquifer Modelling System. Report no. HG 30* (DoW 2009c)
- *Perth Regional Aquifer Modelling System (PRAMS) model development: Review of the Vertical Flux Component of the Perth Regional Aquifer Modelling System. Report no. HG 29* (DoW 2009d).

2 Existing Environment

2.1 Climate and rainfall

An annual median long-term average of 819.6 mm of rainfall has been recorded at the nearby Jandakot Aero weather station (number 9172) over a period of 10 years from 2010 to 2019 (inclusive / BoM 2020a). Rainfall gauging at the Gosnells station (number 9106) has been undertaken since 1961, with an average annual rainfall of 804.3 mm to date. The majority of this rainfall is received between the months of May and August. Further analysis of recent rainfall years indicates that the 30 year average rainfall at the Gosnells station (1991 to 2020) is 736.9 mm.

High resolution rainfall data from the Jandakot Aero station has been obtained for the purposes of this WBA (BoM 2020). This station was used as the greater temporal resolution (half hourly intervals) enables a detailed analysis of rainfall. Similar data was not available for the Gosnells station. The rainfall data covers a period of 10 years from 2010 – 2019 (inclusive) and consists of rainfall measurements in half hourly intervals. The average rainfall over this period is 734.9 mm. Both the Gosnells and Jandakot rainfall datasets indicate a downtrend in rainfall magnitude and as such the more recent (i.e. 10 year) observations are considered more relevant for application in the WBA. Rainfall is discussed further and in relation to the WBA inputs, in **Section 4.1.1**.

2.2 Topography

The MRS amendment area has a low relief with a gradual fall from east to west. Natural surface elevations vary from 37 m Australian height datum (AHD) at the east to 21 m AHD along the western boundary. The topographic contours of the MRS amendment area and immediate surrounds are shown on **Figure 2**.

2.3 Existing land use

Currently the MRS amendment area is comprised of a mix of commercial sites, rural residential land holdings and a turf farm with narrow un-kerbed local access roads. A decommissioned poultry farm is located along the southeastern boundary.

Pockets of vegetation are present across the MRS amendment area with increasing density from the western to eastern boundaries. The vegetation communities comprise a mixture of open woodlands which generally consist of a variety of *Corymbia* (Marri), *Eucalyptus*, *Melaleuca*, *Allocasuarina* (Sheoaks) and *Banksia* or equivalent species. Non-native vegetation is also expected to be found within the MRS amendment area. Current aerial imagery is shown in **Figure 1**.

2.4 Wetlands

The MRS amendment area contains two resource enhancement wetlands (REW / UFI 8037 and 15257) situated along the western boundary adjacent to Tonkin Highway. Additionally, two conservation category wetlands (CCW / UFI 8026 and 8027) are located at the north west corner of the proposed development adjacent to the intersection of Tonkin Hwy and Welshpool Road East.

Located to the west of Tonkin Hwy is the CCW recognised as the Greater Brixton Street Wetlands (GBSW). The condition of GBSW, from mapping performed by the Department of Biodiversity, Conservation and Attractions (DBCA), varies from excellent to completely degraded. For the area of GBSW closest to the MRS amendment area, the condition is listed as good to completely degraded.

The extent of mapped geomorphic wetlands within the vicinity of the MRS amendment area is shown on **Figure 3**.

2.5 Bush Forever

No Bush Forever (BF) sites are located within the MRS amendment area. Several BF sites are situated to the west and are associated with the GBSW and Maddington Kenwick Strategic Employment Area (MKSEA). Mapped BF locations are shown on **Figure 3**.

2.6 Soils and geology

Review of regional soil geology has identified that the MRS amendment area is situated within a transitional area between the Piedmont Zone of the Darling Scarp and the Pinjarra Plain. As such the soil profile of the MRS amendment area is expected to be complex and heterogeneous. Guildford and Yoganup formation soils are likely to be present along with greatly varying concentrations of Bassendean sands, increasing towards the east. Fine grained soils are indicated to occur predominantly to the west of the MRS amendment area increasing in frequency with depth but also to the north and, to a lesser extent, centrally (likely sporadically).

Regional soil information detailed in the *1:50,000 Geological Map Series – Armadale 2133 IV* (DMIRS 2018) for surface soils in the vicinity of the MRS amendment area are described in **Table 2.** Regional geology and the broader physiographic regions are shown on **Figure 4**.

Table 2: Summary of geological map units within the vicinity of the MRS amendment area

Map Unit	Description	Equivalent unit on geological maps
S_8	Sand – white to pale grey at surface, yellow at depth, fine to medium-grained, moderately sorted, subangular to subrounded, minor heavy minerals, of eolian origin.	Bassendean Sand (Qpb)
S_{10}	Sand – as S8 over sandy clay to clayey sand of the Guildford Formation, of eolian origin.	Thin Bassendean Sand over Guildford Formation (Qpb/Qpa)
S_{12}	Sand – structureless, yellow, fine-grained, subangular and medium to coarse-grained subrounded to rounded quartz, feldspar and heavy minerals common, minor silt and clay, of colluvial origin	Yoganup Formation (Qpr)
Mgs_2	Gravelly silt – strong brown, tough, common pebbles of fine to coarse-grained, sub-rounded granite, some dolerite and rare sandstone (SS), variable sand content	Colluvium (Qc)
Ms_4	Sandy silt – cream to pale brown, angular to rounded sand, low cohesion, of alluvial origin	Alluvium (Qha)
Cs	Sandy clay – white-grey to brown, fine to coarse-grained, subangular to rounded sand, clay of moderate plasticity gravel and silt layers near scarp	Guildford Formation (Qpa)

2.6.1 MRS amendment area investigations

A series of bores were installed during previous investigations in the vicinity of the MRS amendment area (GW1, GW5, WG1, WG3, Mba and Mbb). Recent information from these bores has assisted groundwater investigations within the WBA area. An initial on-site investigation was undertaken by Douglas Partners in October 2020. This investigation included 15 test pits (TP), Perth Sand Penetrometers (PSP) and the installation of two groundwater monitoring bores and infiltration tests (IT) (TP1 - TP15). The results of this investigation generally aligned with the regional mapping with no groundwater observed in any of the TP locations. Infiltration testing performed during this investigation (conducted 0.5 m to 1.0 m below ground level (BGL)) obtained values of 6 m/day to 34 m/day with higher infiltration rates associated with the S_8 and S_{12} soil units (see **Table 2**). An additional investigation was undertaken by Douglas Partner in November 2022. This investigation included 12 TP and three IT conducted in the southern region of the MRS amendment area (TP101 - 112). The results of this investigation generally aligned with the regional mapping with no groundwater observed in any of the TP locations.

Further investigations were conducted by Douglas Partners in October 2023 via two boreholes installed to a depth of 15 m BGL west of Tonkin Hwy adjacent to Boundary Road. Soil samples were logged as per AS1726 with specimens collected for Atterberg limit (AL), particle size distribution (PSD) and falling head (FH) permeability testing. These specimens were collected at approximately 9.5 m BGL, 12.0 m BGL and 14.0 m BGL. The results of this investigation indicated a layer of sandy clay soil up to 2.9 mBGL underlain by silty sands to depth. Atterberg and PSD test results aligned the deeper silty sands described in the borelogs. Results of the FH permeability testing are summarised in **Table 3**.

Table 3: Falling head permeability testing results

Depth (mBGL)	FH permeability result (m/day)	
	BH01	BH02
9.50 - 9.95	0.27	0.19
12.00 – 12.45	0.84*	0.35
14.00 – 14.45	0.14	0.23

** Result from BH01 (12.00 - 12.45 mBGL) elevated due to reduced silty soil found at this depth.*

The FH permeability tests indicated that the average vertical permeability of the deeper sandy soils (where the superficial aquifer was assumed to flow) was between 0.26 and 0.42 m/day. These results were converted to horizontal permeability values (using a conversion factor of 10) which determined the horizontal permeability at this location was 2.6 m/day and 4.2 m/day.

Additional groundwater monitoring bores were installed by Hyd2O in November 2020 (WG1, WG2, WG3), July 2022 (WG2S, WG4S/D, WG5S/D, WG6, WG7S/D, GW5D, GW8S/D, GW9S/D) and October 2022 (WG8, WG9, WG10S/D, MW202S/D). These bores were installed to assess the sub-soil and groundwater conditions (both shallow and deep) beneath the MRS amendment area. Assessment of the bore logs show that the local soils generally align with the regional soil mapping and support the previous soil investigation. In-situ permeability testing was performed through the use of borehole permeability tests to assess the conductivities of the soil profiles (HTS1 – bore WG1, HTS2 – bore

WG3, HTS3 – bore WG10) with conductivity values ranging from 12.3 to 28.8 m/day in the northern region of the proposed development area across the S_8, S_{10} and S_{12} soil units. These permeability ratings were used in preference to test pit rates for assessment of groundwater throughflow as they are considered to be a more accurate representation of horizontal permeability of the deeper underlying soil profile. The results of permeability testing are provided in **Table 4**. The location of the various MRS amendment area investigations is shown on **Figure 4** and **Figure 5**.

Table 4: Permeability testing results

Location	TP3	TP4	TP11	TP34	HTS1 (WG1)	HT2 (WG3)	HTS3 (WG10)
Permeability (m/day)	25	6	7	34	12.3	28.2	21.1

GBG Group undertook a geophysical investigations to assess the soil profile (to a depth of 50 m BGL) beneath the MRS amendment area in December 2022 and October of 2023 (GBG 2023). This investigation made use of Electrical Resistivity Tomography (ERT) to assess the deeper soil profile to interpret the porosity and permeability and to identify soils that could behave as an aquifer or aquitard. A total of 6,910 lineal metres across 16 transects was profiled as part of this investigation. The locations of these transects were guided by previous site soil and groundwater investigations with a view to providing additional information for the interpretation of groundwater flow direction and perching in the vicinity of GBSW.

The results of this investigation found that the soils beneath the MRS amendment area were generally non-uniform and complex. The soil profile obtained from this investigation was found to contain a mixture of soils which broadly aligns with previous geotechnical investigations.

Several regions of high resistivity soil were identified in the region of turf farm, Brentwood Road, Boundary Road and Victoria Rd (western boundary) starting at approximately 10 m AHD (15 m BGL) which extended to the depth of the geophysical investigation. Areas of lower resistivity soil were identified along Crystal Brook Road (northern boundary) and Johnson Place (outside of MRS amendment area to the north) extending from the natural surface to depth.

For soil below measured groundwater, low resistivity soils were interpreted to represent saturated, more permeable material. These low resistivity soils generally align with near surface geotechnical investigations and represent soils found along Crystal Brook Road and a portion of Johnson Road. Large masses of high resistivity soil below measured groundwater have been interpretated as very low permeability material. These high resistivity soils are found along Tonkin Highway, the southern end of Brentwood Road and Boundary Road.

2.6.2 Summary of soil profile and conditions

From a comparison between the regional soil mapping and the MRS amendment area investigations the soil conditions can be summarised as follows:

- Regional soil mapping found soil conditions beneath the MRS amendment area as highly variable consisting of a duplex soil along the western regions of the MRS amendment area with increasing sandy soils and greater depth of sand found in the central and eastern regions of the MRS amendment area.

- Soil in the western regions adjacent to Tonkin Highway consists of more fine grained soils (clay and silt) in the shallower soil profile which are interfingered with pockets of clayey sands/sandy clays to depth.
- Soils in the central and eastern regions of the MRS amendment area are generally found to have sand to the deeper soil profile with pockets of clay and silt found in both the shallow and deeper soil profiles.
- On-site soil investigations for the MRS amendment area are consistent with the regional soil mapping and previous investigations. indicated the presence of fine grained soils in the western region of the site which increases with depth. Increasing presence of sand with depth is noted towards the east.
- Geophysical investigation interprets the soils found across the MRS amendment area as being variable and complex. Lower permeability soils were found along the western boundary at approximately 15 mBGL with higher permeability soils located along the northern boundary close to the existing surface.
- Permeability for the MRS amendment area is variable with measured permeability rates ranging from 12.3 m/day up to 28.8 m/day in borehole tests and from 6 m/day to 34 m/day in test pits. Deeper soil profile adjacent to the western boundary at Boundary Road was found to have permeability rates ranging from 2.4 m/day to 4.2 m/day.

2.7 Groundwater

2.7.1 Aquifers

The *Water Register* (DWER 2024b) indicates that groundwater beneath the MRS amendment area is a multi-layered system comprised of the following:

- Perth – Superficial Swan unconfined aquifer
- Perth – Leederville confined aquifer
- Perth – Yarragadee North confined aquifer.

2.7.2 Groundwater levels

A review of the *Gnangara Jandakot Water Table Elevations* (DWER 2021a) provided the regional maximum groundwater contours for the MRS amendment area. These range from approximately 14.0 m AHD in the east to 12.0 m AHD along the western boundary adjacent to Tonkin Highway.

Additional groundwater level investigations have been undertake by Endemic (2012) for the purpose of gathering suitable data for baseline datasets (groundwater levels/quality, wetland water levels, surface water flow/quality) for the greater MKSEA and GBSW. This baseline data was collected over a period of 18 months during 2012 to 2013. While this investigation does not directly cover the MRS amendment area it does provide information for the lands to the west adjacent to Tonkin Highway.

Hyd2O have recently undertaken a groundwater investigation for the MRS amendment area to obtain as much data as reasonably possible to support the ERD. The measured depths in a number of groundwater monitoring bores within the MRS amendment area for both the regional superficial unconfined aquifer and a perched system have occurred on three occasions in the second half of 2022 (2022/08/26; 2022/10/10 and 2022/10/27).

Average annual maximum groundwater level (AAMGL) contours for the superficial aquifer have been derived from groundwater levels measured by Hyd2O and additional information obtained from DWER bores, Main Roads Western Australia (MRWA) bores located along Tonkin Highway, bores located to the west of the site within the MKSEA site, DBCA bores located within GBSW and Douglas Partners bores within the MRS amendment area. Additional data from the Canning River (located to the south west of the MRS amendment area) was incorporated to assist with the generation of the AAMGL contours. The complete extent of the groundwater monitoring bore dataset and the associated AAMGL contour dataset are presented in the District Water Management Strategy (DWMS). AAMGL contours for the MRS amendment area range from 16 m AHD at the north eastern region to 19 m AHD approximately at the western boundary. Groundwater contours and local bore locations for the MRS amendment area are shown on **Figure 5.** Groundwater flows were found to occur radially away from a mound evident along the western boundary adjacent to Tonkin Highway. Further discussion of seasonal variation within groundwater levels for the MRS amendment area and comparison to DWER regional mapping are presented in the DWMS (Hyd2O 2024).

Groundwater is highest beneath the existing turf farm adjacent to bore WG9 which is consistent the local low permeability geological conditions at this location and the application of groundwater extracted from the deeper aquifer at this location of the MRS amendment area.

Higher groundwater levels have been observed in bores GW5S, GW8S and GW9S, located to the west adjacent to Tonkin Highway, and in WG4S and WG10S to the north of the MRS amendment area, and these are concluded to represent localised perching. Measured depth within the shallow bores were used to derive maximum groundwater level (MGL) contours for the perched/shallow groundwater locations in the north western part of the MRS amendment area (WG4S, GW5S, GW9S and WG10S) as well as for the south western region of the MRS amendment area (GW8S) shown on **Figure 5**. The extent of perching beneath the MRS amendment area is relatively minor and limited to the fringes of the WBA area. The nature of construction of the DBNGP will also have disrupted the pre-development groundwater flow pathway and is expected to act as a preferential drainage pathway directing shallow/perched groundwater flows either downwards to the more permeable sands or away from GBSW to the south of the MRS amendment area.

2.8 Surface water

2.8.1 Existing hydrological features

Current drainage infrastructure found within the MRS amendment area is largely informal with a series of minor roadside swales installed alongside unkerbed roads. These informal structures are assumed to both convey and infiltrate the surface runoff generated by the local roads from rainfall events. Due to the existing soils found within the MRS amendment area (see **Section 2.6**) more formal drainage structures are likely not required given the current low density of development. Furthermore, the small portion of impervious areas present within the proposed development (roof, pavement and road asphalt) are not connected impervious areas given the absence of formal road drainage (i.e. pit and pipe network) and minimal extent of kerbed roads. Based on this, it is expected that runoff contributions from the MRS amendment area and upstream catchments are likely to be relatively minor, including runoff from impervious areas.

There are however some surface water features outside of the MRS amendment area or at the boundaries which are of relevance. An incised road-side swale to the north of Crystal Brook Road along the length of the MRS amendment area and upstream catchments acts a flow barrier for frequent and minor flows (which are of most consequence to a continuous annual water balance assessment – i.e. non-event based assessments). Runoff within this swale is conveyed to a drain that is located within open space adjacent to the north-western most corner of the proposed development area, which flows through a culvert under Tonkin Highway ('Discharge 1'). Flows from this culvert continue westward into GBSW through a degraded but natural streamline. The streamline is intercepted by access tracks however is well defined for approximately 450 m, at which point a portion of the streamline has been historically cleared for pasture and local track access, and recently (2017) filled which has effectively resulted in the removal of the natural streamline function. Infiltration and ponding of flows within the natural streamline due to the access track crossings and the imported fill/cleared section is expected to occur at this location. Connection to the downstream Yule Brook may be established during significantly larger rainfall events however this would require significant yet broad and shallow sheet flow across the MRS amendment area.

During an MRS amendment area inspection by Emerge Hydrologists in September 2022 to the culvert at Discharge 1 (located beneath Tonkin Highway, see **Plate 1**) no flow was observed and some ponding below the downstream invert elevation was noted. Based on the observed lack of baseflow during MRS amendment area visits and comparison of nearby groundwater level observations with topography, it is expected that the culvert at Discharge 1 flows predominantly in response to local rainfall events as opposed to interception of perched or superficial groundwater.

The runoff from north of Crystal Brook Road has not been considered in this WBA as a roadside swale located along Crystal Brook Road (northern boundary of the MRS amendment area) inhibits surface runoff from entering the MRS amendment area i.e. it is outside the WBA. Surface runoff from the UE and UI areas has been considered in the WBA (i.e. that which occurs as sheet flow from upstream areas into the WBA area). Runoff from the northern portion from the MRS amendment area and the northern upstream catchment is however also directed to the drain to the north-west and eventually discharged to the GBSW via the same pathway (which is external to the WBA area).

Runoff from the majority of the MRS amendment area and upstream catchments are expected to sheet flow (during sufficiently large rainfall events) generally towards Tonkin Highway, where a number of culverts are located which allow discharge under the highway into the adjacent MKSEA site. The main outlet locations discharge to Brentwood Road and Victoria Street. Ultimately runoff discharged to the MKSEA will be conveyed by the system of roadsides swales to Yule Brook.

A small portion of the MRS amendment area located to the south discharges southward towards a roadside swale on the eastern side of Tonkin Highway.

Hydrological features including the catchments, culverts and flowpaths are shown on **Figure 6**.



Plate 1: Discharge 1 culvert (Sept 12, 2022)

2.9 Conceptual understanding of the site

Based on the detailed investigations undertaken, information presented in this section of the report, and the information provided in the DWMS, the MRS amendment area is a superficial aquifer recharge area. It is located at or close to the top of a groundwater catchment area; groundwater inflows to the site are anticipated to follow existing surface channels/streamlines which act as a natural outlets for groundwater flows, resulting in overall flow directions towards Yule Brook to the North and Bickley Brook to the South. Shallow groundwater inflow to the site is therefore only a minor portion of the overall water balance.

The MRS amendment area is underlain by generally sandy soils with moderate to high permeability which results in rainfall/applied water being able to infiltrate downwards to the superficial aquifer. Shallow/perched groundwater (caused by localised fine grained/clayey soils near the surface) potentially occurs in the north western region of the MRS amendment area. These shallow/perched groundwater systems have the potential to direct shallow groundwater flows towards the west of the site (towards Tonkin Highway) which historically could have interacted with the GBSW (located to the west of Tonkin Highway). However, these flows are assumed to be intercepted by the DBNGP or unable to flow in this direction due to the impermeable boundary caused by the construction of Tonkin Highway. This results in shallow/perched groundwater to either become localised rechange to the deeper soil profile or leave the site in a northerly direction (via existing sandy soil pathways).

Deeper groundwater flows are found to be influenced by the existing groundwater mound that is found beneath the MRS amendment area (in the vicinity of the existing turf farm). The effects of this mound cause the deeper groundwater to flow radially away from the MRS amendment area. Reduced groundwater flows are noted in the north western regions of the MRS amendment area due to the presence of deep, low permeability soils at this location.

Based on the above, the majority of the water entering the site (surface water, groundwater inflow, rainfall etc.) is noted to either become recharge for the MRS amendment area which will result in higher groundwater outflows, or to be taken up by vegetation via evapotranspiration.

3 Conceptual Water Balance

The hydrological regime of the MRS amendment area along with the methodology used to quantify the key components is described conceptually within the following section of this document. It is complex in some regards due to the observed subsurface conditions in a western portion of the MRS amendment area where soils transition heterogeneously from near surface Bassendean sands to Guildford and Yonganup formation finer grained soils. The key features of the hydrological cycle identified within the MRS amendment area are:

- Rainfall
- Irrigation by various sources (superficial and confined groundwater).
- Rainfall and irrigation water interception
- Surface water runoff and drainage
- Upstream catchment inflows
- Groundwater throughflow
- Seasonal perched groundwater
- Evapotranspiration
- Recharge.

The individual components of the WBA have been outlined and discussed conceptually. Each element is quantified and discussed in greater detail in this section of the document and within the technical assessments provided in **Appendices B**, **C**, **D** and **E**. In order to conceptualise the overall water balance, the major fluxes attributable to the MRS amendment area are illustrated in a visual context in **Plate 2**.

As the MRS amendment area boundary is somewhat irregular with regards to lateral throughflow, for the purposes of the throughflow assessment the boundary has been slightly simplified to more succinctly account for throughflow fluxes.

3.1 Water balance key components

This section describes the key components of the WBA, and **Section 3.2** describes the methodology that has been used to quantify the key components of the WBA. The assessment of the final water balance is provided in **Section 4** under both pre-development and post-development scenarios.

The WBA covers an annual time scale. The surface water and evapotranspiration processes represent the average of the 2010-2019 (inclusive) period. Use of an average for these components accounts for the annual variability of these values and provides for a more robust assessment. The groundwater throughflow components are based on measured (level) data from 2022. Data from 2022 was selected as it was considered to represent the best spatial coverage for the MRS amendment area. While the assessment period is a year and most of the data and results are presented as an annual figure (as summations or averages), each component is calculated with varying timesteps, typically daily but as small as hourly intervals (e.g. for the surface water runoff component). The details of adopted timesteps are provided in the technical assessment covering each component (see **Appendices B**, **C** and **D**).

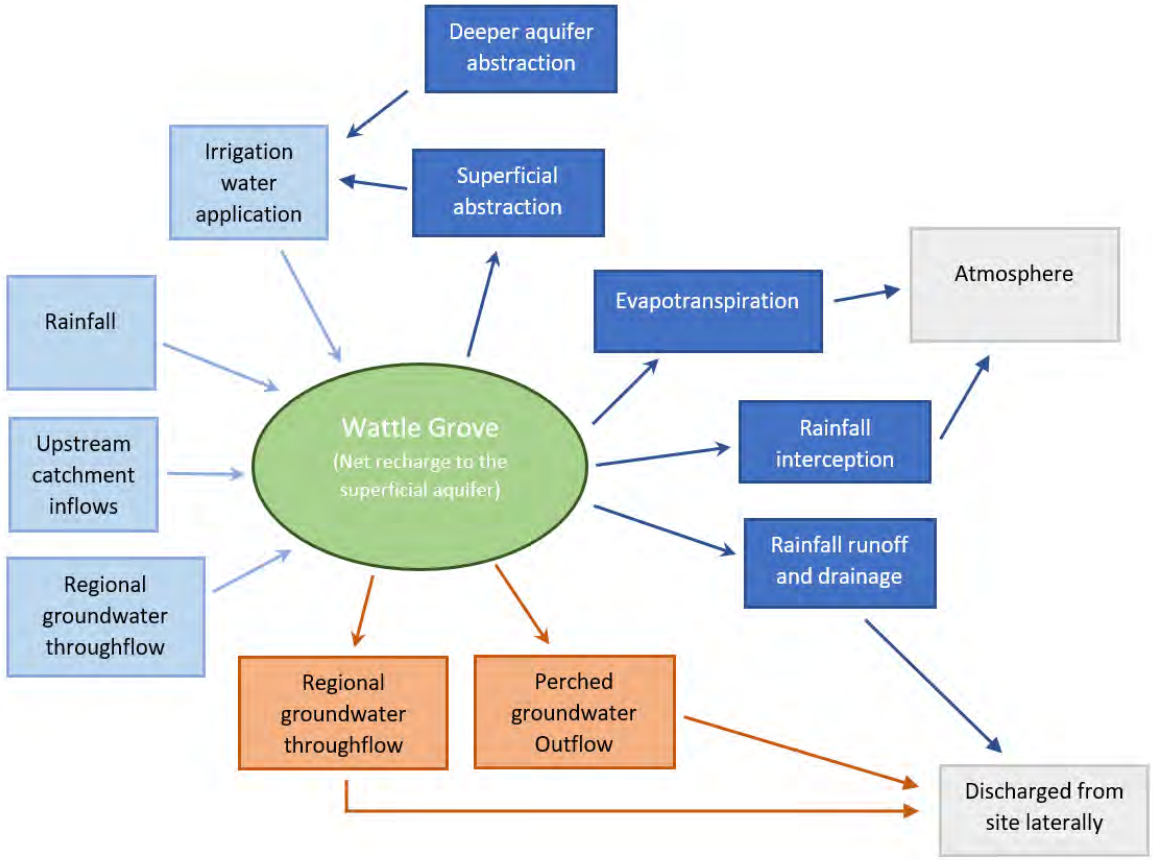


Plate 2: Conceptual water balance showing major water balance assessment factors (Pre-development)

3.1.1 Rainfall

Rainfall is a significant component of the hydrological regime and a key component of the water balance. Rainfall patterns are recorded for Australia by BoM at various weather stations located through the country. For the WBA an assessment of the weather stations in the vicinity of the MRS amendment area has been undertaken to determine the closest station to the MRS amendment area with the most robust rainfall dataset available. This may result in a weather station that is not the closest to the MRS amendment area being chosen for the WBA due to the quality of rainfall data available.

For this WBA rainfall data with a high temporal resolution is required to quantify several components, such as surface runoff and evapotranspiration. The time period for the data was over a 10 year period with rainfall data recorded in half hourly intervals. This allows for components that are sensitive to rapid rainfall generation to be adequately assessed while also minimising the effects of highly variable rainfall temporal patterns. This resulted in the use of rainfall from the Jandakot Aero station (ID: 009172) and not the Gosnells station (ID: 009106) which is located closer to the MRS amendment area.

3.1.2 Irrigation (abstracted groundwater application)

Within the MRS amendment area there are 14 groundwater licences issued by DWER for abstraction of groundwater from the superficial aquifer. For the purposes of this WBA it is assumed that the full

allocation of each of these licences is being extracted from groundwater resources beneath the MRS amendment area. This abstracted groundwater is then assumed to be fully utilised for the irrigation of vegetation within the MRS amendment area. This is assumed for both the pre and post-development scenarios. In the post-development scenario use of groundwater will be specifically for the irrigation of public open spaces (POS) within the proposed development.

The MRS amendment area will be connected to the Water Corporation (WC) Integrated Water Supply System (IWSS) to supply potable water to the proposed development. Use of this potable water will be for internal house use and it is anticipated that there will be some minor irrigation of private lots, assumed to be applied to 10% of the residential lot area.

3.1.3 Rainfall interception and irrigation interception

A portion of incidental rainfall will be physically intercepted and stored on the leaves and branches of vegetation and litter. The water that is retained within the vegetation and/or litter which does not eventually reach the ground surface (i.e. via stemflow) will eventually evaporate and hence constitutes a loss of water from the MRS amendment area (i.e. rainfall interception). The extent of rainfall interception is one of the factors determined from the vertical flux model (VFM) component of the PRAMS assessment for various representative recharge units (RRUs). The VFM represents the vertical movement (or flux) of water with the soil profile, which determines recharge to the underlying aquifer system. The RRU represents an area of land which shares similar characteristics (for the application of a VFM), such as watertable depth, soil type or landuse. This assessment is linked to the calculation of evapotranspiration losses, which utilises the same approach and is discussed further in **Section 3.2.5**, as well as other vertical water balance components. The interception of rainfall has been based on published values within the *PRAMS model development: Application of vertical flux model (Report No. HG27)* (DoW 2009b) for various corresponding and analogous land uses within the MRS amendment area. These same principles and methodology have been applied with respect to the interception of irrigation water.

A detailed description of the methodology used to determine interception is provided in **Appendix D**.

3.1.4 Surface runoff and drainage

The surface water runoff is generated from rain falling on the MRS amendment area in the same way as the runoff that is generated from upstream catchments. The surface water runoff assessment for the MRS amendment area has been largely based on the assessment previously undertaken in the DWMS, but also expands on this to consider the urbanisation of the UE and UI areas that surround the MRS amendment area. With respect to land use characterisations, the surface water runoff assessment has been based on a typical urban subdivision outcome that is representative of the north-east corridor of Perth. The assumptions that have informed this outcome are discussed further in **Appendix B**. This assessment also comprised of a catchment and land use analysis which included assigning loss rates to various land uses within the MRS amendment area and upstream catchment for both the pre-development and post-development environments. The loss rates from the DWMS were adopted for this assessment, with some additional consideration to represent infiltration within stormwater management structures.

Using the above approach (which is detailed further in **Appendix B**), an annual mean runoff coefficient from each land use (in both the pre and post-development scenarios) was calculated. The runoff coefficient is then applied to the land use areas to determine annual runoff volumes.

3.1.5 Upstream catchment inflow

Surface water runoff from upstream catchment areas is accounted for as an inflow to the MRS amendment area. The method for calculating the upstream runoff values is the same as that for runoff from rain falling directly onto the MRS amendment area (which is covered in **Section 3.1.3**).

The surface water runoff assessment for upstream catchments is based on the existing land uses (for pre-development) and a typical urban subdivision outcome (for post development scenarios) and as per the method described above and **Appendix B**. The UE and UI areas upstream of the proposed development may or may not be developed for urban uses, and therefore two post-development scenarios have been considered: one which assumes the upstream UE and UI areas are urbanised and one which assumes that the upstream UE and UI areas are not urbanised.

3.1.6 Groundwater throughflow

Groundwater throughflow is the lateral flow of water through a soil profile. Groundwater throughflow occurs where there is a groundwater gradient, a permeable soil profile and a pathway for groundwater to travel through.

On-site soil investigations and review of regional soil geology has identified that the underlying soil profile of the MRS amendment area is complex and heterogeneous with shallow clayey soils occurring in minor portions to the west and north of the MRS amendment area near to the surface (but not consistently) and increasingly with depth (see **Section 2.6**). While noting the heterogeneity of the soil, the observations to date indicate that near-surface groundwater (i.e. above the underlying Leederville Aquifer) within the MRS amendment area can be delineated into a regional superficial unconfined aquifer beneath the entire MRS amendment area and small areas of a perched system located along Tonkin Highway. The variability of soils and the locations of their perched systems have been taken into account in the WBA.

3.1.7 Perched groundwater flow

From previous investigations undertaken by Hyd2O (see **Section 2.7.2**) for the MRS amendment area a seasonal perched groundwater system has been identified. The perched groundwater flow is driven by rainfall and is assumed to be seasonal, only occurring during the five months of higher rainfall (May – September) with flow assumed to be occurring at maximum measured depth of groundwater obtained by Hyd2O.

The seasonal perched system is at shallower depths in comparison to the permanent superficial groundwater system also found beneath the MRS amendment area (by several metres) while also being limited to a small area in the north western region of the site.

3.1.8 Evapotranspiration

Evapotranspiration for the MRS amendment area has been determined through the quantification of all other components of the water balance. This has considered the RRUs delineated for the MRS

amendment area (see **Section 3.4**), regional soil mapping, land uses and groundwater levels. Documentation published for the development of PRAMS (DoW 2008, 2009a, b, c, d) details the associated range of values that have been shown to be suitable for the estimation of these components which allow for the determination of:

- Percentage of rainfall which has the potential of becoming recharge to groundwater, often simply referred to as recharge (and sometimes referred to in PRAMS documentation as 'drainage') and
- Likely amount of interception, of both rainfall and irrigation, before it reaches the ground.

Estimation of evapotranspiration has been achieved through the quantification of recharge, interception and taking the difference between all inputs and outputs for the WBA area, and then verified by calibrating the outcome to evapotranspiration rates adopted in other studies contained in the suite of PRAMS documentation listed above.

3.1.9 Recharge

An assessment of the degree of connectivity between the Superficial Swan and Leederville aquifers systems beneath the MRS amendment area has been undertaken to determine the degree of vertical groundwater movement from the Superficial Swan aquifer to the Leederville aquifer. The aquifer systems for the greater Perth region as presented in *Studying Perth's deep aquifers to improve groundwater management* (DWER 2021b) indicate that there is no connection between the Superficial Swan aquifer and the deeper Leederville aquifer in the vicinity of the MRS amendment area. The difference in total dissolved solids (TDS) values between the rainfall occurring on MRS amendment area (< 500mg/L) and the TDS values for the Leederville aquifer beneath the MRS amendment area ('> 2000 mg/l') suggests that rainfall does not reach the Leederville aquifer. This is likely due to the presence of an aquitard, which effectively reduces the TDS value within the superficial aquifer without having a similar effect on the Leederville aquifer, confirming the assumption of no/limited connectivity between the superficial and Leederville aquifers.

The lack of connection between the aquifer systems beneath the MRS amendment area means that there is likely to be minimal recharge to the deep Leederville aquifer that is presumed to also be located beneath the MRS amendment area (see **Section 2.7.1**). Therefore, this WBA assumes that no recharge to this deep aquifer system occurs. However, based on the MRS amendment area investigations undertaken, it can be assumed that there is a degree of connectivity between the shallow soil profiles/perched groundwater system and the superficial aquifer system beneath the MRS amendment area. For the purposes of this WBA the recharge volume that remains after all other components of the WBA are quantified and removed from rainfall represents the vertical movement ('recharge') of water downwards into the superficial aquifer. The groundwater inflow and outflow from the MRS amendment area predominantly occurs within the superficial aquifer, with the method as to how this is quantified discussed in **Section 3.2.4**.

3.2 Quantification of key components

3.2.1 Rainfall

Rainfall magnitude at the Gosnells station has a recent 30-year average (1991-2021) of 736.9 mm, which corresponds closely to the 2010-2019 average from the Jandakot Aero station (735 mm). Based on this, the data from the two nearby but separate stations are approximately analogous for the quantification of rainfall in the WBA. Jandakot Aero station data (BoM 2020) was used for the surface water runoff component as it provided the nearest station with high temporal resolution rainfall data that enabled detailed (hourly) surface runoff calculations to be determined. For consistency the same rainfall period was considered for the evapotranspiration component. Jandakot Aero rainfall for the years 2010-2019 (inclusive) at half hourly intervals was sourced for analysis, these were consolidated to provide hourly intervals. The 10 year interval was used for the surface water runoff component as runoff is generated as a rapid response to rainfall events and is sensitive to the rainfall event temporal patterns, which are highly variable. This becomes less significant when averaged over a longer time period, hence a 10 year period was chosen.

For consideration of climate change on the WBA (see **Section 4.2**) rainfall from the closest geological location found within the Australian climate database named 'SILO' (Queensland Government 2021) is required. This location is the suburb of Gosnells where rainfall data is available from the BoM is from Gosnells station. A separate consideration for rainfall and the effects of climate change on the WBA is presented in **Section 4.2**.

3.2.2 Surface water runoff

Surface water runoff is dependent largely on the land cover type and superficial soil profile (as well as rainfall), which effects how readily rainfall is converted into runoff. The surface water runoff land uses have been based on a typical urban subdivision outcome that is characteristic of the north-east corridor of Perth. This land use composition is considered to be highly representative of the likely future development of the MRS amendment area. The other surface water assumptions, including loss rates and catchment boundaries have been largely derived from the surface water assessment undertaken to support the DWMS by (Hyd2O 2024).

The calculation of the surface water runoff is based on the initial loss (IL) and continuing loss (CL) loss rate method which is routinely used in runoff magnitude calculations and modelling. The IL (in mm) and CL (in mm/hr) loss method is applied to the rainfall (in mm) on an hourly timestep basis for a period of 10 years (2010-2019 inclusive) and then averaged to provide an average annual runoff value. For runoff to occur both the IL and CL values must be exceeded in any given time step. This assessment was undertaken separately for each land use (i.e. once for every IL and CL combination) and in each development scenario. By multiplying the average annual runoff for each land use (IL, CL combination) by the area of each respective land use within each catchment, and then summing throughout, the total annual runoff volume is determined.

The upstream catchments and their land types/uses (pre-development and post-development) are shown on **Figure 6** and **Figure 7**. The catchment areas, land type areas and the IL and CL for each land type are detailed in Tables B1, B2, B3 and B4 of **Appendix B** for both the pre-development and the post-development scenarios.

3.2.2.1 Pre-development

As discussed in **Section 2.8**, there are no defined natural or man-made surface water conveyance features within the MRS amendment area. Any runoff that is generated is conveyed as overland flows to either MKSEA, to Crystal Brook Road and then to GBSW, or southward along the east of Tonkin Highway. Runoff is expected to follow topography and be conveyed as sheet flow generally to the west towards Tonkin Highway. Catchments within and upstream of the MRS amendment area have been digitised based on the publicly available 1 m topographical contours, aerial photography and informed by MRS amendment area visits from Emerge hydrologists.

Runoff from Catchments 1 and 1US is conveyed to Discharge 1 (the culvert crossing under Tonkin Highway for the drain to the north of the MRS amendment area). Flows from Discharge 1 will be conveyed within the natural (but degraded) streamline through the GBSW where flows will pond and infiltrate due to the interception of the streamline by access tracks, cleared land and imported fill. This degradation of the streamline will likely mean that the majority of Discharge 1 surface water flows are not expected to reach the downstream Yule Brook (as surface water).

Runoff from Catchments 2 and 3 (i.e. the majority of the MRS amendment area) and an upstream catchment 2US is expected to sheet flow (during sufficiently large rainfall events) generally towards Tonkin Highway, where a number of culverts are located to allow discharge under the highway into the adjacent MKSEA site. The main outlet locations discharge to Brentwood Road and Victoria Road. Runoff is currently discharged to the MKSEA located on the western side of Tonkin Highway. This is expected to continue to occur in the future prior to the development of the site. A small amount of runoff from Catchment 4, located to the south of the proposed development area, is conveyed to Discharge 4 which is conveyed southward towards a roadside swale on the eastern side of Tonkin Highway.

3.2.2.2 Post-development

The surface water regime is expected to change slightly in some regards in the post-development scenario. The overall flow regime and contributing catchment areas are generally consistent with the existing environment and the key discharge locations are maintained. The proposed future land use (see **Figure 7**) are anticipated to incorporate greater impervious areas which, unlike the existing impervious areas, are likely to be connected via kerbed roads and pit and pipe networks. The change in land use (from rural vegetation/pasture to urban) has the potential to increase flow volumes and flow rates leaving the MRS amendment area. This is however expected to be offset by the use of formalised drainage and infiltration infrastructure within the proposed development. These are designed to retain runoff from the first 15 mm of rainfall and maintain pre-development discharge rates. The stormwater management approach for the MRS amendment area is discussed in the DWMS (Hyd2O 2024).

It is noted that the DWMS does not account for ongoing infiltration within drainage structures (such as BRAs, soakwells and detention basins) which is very conservative however typical for assessments at the re-zoning stage. Infiltration has however been accounted for in the WBA by increasing the IL values to better represent the behavior of infiltration based drainage structures in the urbanised environment as all water quality treatment and flood detention structures will be logically placed

into permeable areas. The infiltration achieved within the MRS amendment area by this approach will inform the future design approach for water management infrastructure.

3.2.3 Groundwater abstraction and irrigation

There are 14 groundwater licences issued by DWER for abstraction of groundwater from the superficial aquifer beneath the MRS amendment area. The groundwater allocations range from 2,400 kL/year up to 176,000 kL/year (which is associated with the existing turf farm). Combined, there is a total abstraction allocation of 260,655 kL of water from beneath the MRS amendment area each year.

The abstraction and irrigation of 176,000 kL is expected to result in a considerable net extraction from the relevant aquifer due to the additional exposure to evapotranspiration and interception losses. There is however a groundwater mound observed within the vicinity of the turf farm (as shown on **Figure 5**), which warrants additional consideration.

The site report for Swan Coastal Catchment Bore 616 (site reference 61601079) located within and presumably owned by the turf farm details drilling, screening, pump testing and production supply recommendations for the abstraction of groundwater from the bore (DWER 2022a). The report states the bore was drilled to 63 m BGL (approximately -41 m AHD) and screened from 52 m BGL to 62 m BGL (-30 m AHD to -40 m AHD). The recommended supply rate was 10 L/s. The presence of headworks on the bore was confirmed by Hyd2O during groundwater monitoring. While the *Water Register* (DWER 2024b) indicates that there are other bores located within the same groundwater management area and (superficial) aquifer no details are available as to whether these bores are drilled to the deeper soil profile.

The abstraction of superficial groundwater and subsequent losses to evapotranspiration would be expected to result in a depression in local groundwater levels. However, the observed mounding of groundwater beneath the turf farm suggests an additional source of water is being applied to the superficial aquifer that exceeds the additional losses to evapotranspiration from irrigation (which is expected to be around 80% of irrigated water). Based on the observed groundwater mounding, the available information regarding bore screened depth, and the ability for the identified production bore to abstract groundwater at sufficient rate to fulfill the requirements of the allocation (through pumping at the recommended 10 L/s for approximately 13.5 hours per day), it is assumed that the 176,000 kL/year allocation is being abstracted from the underlying Leederville aquifer.

The remainder of the superficial groundwater allocations within the MRS amendment area, which are mostly associated with rural residences, total 84,655 kL and are assumed to be utilised for irrigation of garden areas and to be abstracted from the superficial aquifer as licensed.

Irrigated water (which includes the 84,655 kL of superficial abstraction and 176,000 kL of assumed Leederville abstraction and 32,500 kL of domestic supply from current IWSS connections) is subject to the following interactions which have been based on previous research provided in PRAMS documentation (DoW 2009b):

- Irrigation water lost to interception: 10%
- Amount of irrigation water becoming recharge: 20%
- The remainder of irrigated water is assumed to be taken up by evapotranspiration: 70%

3.2.4 Groundwater throughflow

The groundwater throughflow assessment has been based on investigations undertaken within and around the MRS amendment area as described in **Section 2**. These include geotechnical investigations (test pits, borehole logs and permeability testing) and groundwater level investigations (metered groundwater datalogger data and manual measurements). The specific inputs and how they are utilised for the groundwater throughflow assessment are detailed further in the *Groundwater Throughflow Technical Assessment* provided in **Appendix C**.

In summary, the rate of flow has been calculated using Darcy's law which calculates flow through a porous medium based on the bulk cross-sectional flow area, the hydraulic gradient and the permeability of the medium (Equation 1).

(1) $$Q = -kA\frac{dh}{dl}$$

where *Q*, the flow rate, is related to the hydraulic conductivity (*k*), bulk cross-sectional area (*A*) and the hydraulic gradient ($\frac{dh}{dl}$).

The bulk cross sectional flow areas at the boundaries of the MRS amendment area are the cross sectional areas between the base of the aquifer and the MGL determined from the groundwater contours.

The location of the groundwater throughflow boundaries and flow directions are shown on **Figure 8**, and **Figure 9** with a summary of the groundwater throughflow results and calculations (both inflow and outflow) are provided in Table C1 and C2 of **Appendix C** with the results used in **Section 4**.

Groundwater throughflow leaving the MRS amendment area is determined in the same manner as groundwater throughflow entering the MRS amendment area, which uses measured soil permeability, groundwater flow direction and gradient, and depth of permeable soil. Depending on the location of the outflow boundary, some of the throughflow leaving the MRS amendment area will become groundwater inflow to the downstream area, and this is quantified and accounted for in the WBA. The extent of groundwater throughflow boundaries are shown on **Figure 8** and **Figure 9**, and a detailed description of the analysis of groundwater throughflow (both inflow and outflow) is provided in **Appendix C**.

3.2.4.1 Superficial (regional/deep) groundwater throughflow

Groundwater throughflow is the lateral flow of groundwater which occurs through the deeper sandy or clayey sand profile and occurs at two levels beneath the MRS amendment area; within thin sand overlying a seasonal perched system and within the deeper superficial formation. Throughflow is driven by the groundwater gradient and direction where it occurs across the MRS amendment area boundary and the cross-sectional area of the soil profile through which water can flow. Lithology for deeper DWER bores (61601079, 61607580 and 61671956) (DWER 2020) indicate that the MRS amendment area is underlain by a lower permeability clay layer at approximately 27 m BGL. The lower boundary for groundwater throughflow is the base of the regional (superficial) aquifer based on DWER groundwater mapping (DWER 2024a). This is located approximately 27 m BGL (0 m AHD) and aligns with the clay layer noted previously.

Both the gradient and direction of groundwater flow across the MRS amendment area is influenced by the groundwater mound underlying the turf farm, however the effect is lessened as spatial separation from this groundwater mound increases. From pre-development groundwater investigations it was found that groundwater flows are influenced by the groundwater mound which is presumed to be caused by irrigation via deeper aquifers beneath the MRS amendment area and the highly variable subsurface geological conditions with a concentration of low permeability soils adjacent to Tonkin Highway (Hyd2O 2024). The effect of this mound causes the groundwater to flow radially away from the mound (see **Figure 8**). As discussed in **Section 2.6.1**, the borehole permeability values were adopted as the horizontal permeability for the majority of the MRS amendment area (except for a small portion of the site which has been identified by geophysical mapping with the presence of deep, lower permeability soils) where a 50% reduction factor has been applied to the permeability values.

In the post-development environment the turf farm irrigation ceases and it is acknowledged that in absence of other factors this lack of irrigation water may affect groundwater levels locally. A key principle adopted within the DWMS is to locate stormwater management areas in the vicinity of the existing groundwater mound to maintain the annual pre-development groundwater recharge and flow directions at that location (Hyd2O 2024). This approach utilises the recharge estimates presented within the WBA and considers the recharge to groundwater under three scenarios:

- Across the entire MRS amendment area
- Within a 29 ha area that encompassed the groundwater mound
- Localised 14 ha area associated with the existing turf farm.

Results of this are presented within the DWMS and indicate that there will be an overall minor increase in annual recharge across the site post-development. The implementation of a targeted stormwater management approach applied to the area of the existing mound results in a similar annual recharge to the pre-development environment. It is likely that localised changes in seasonal distribution of rainfall may impact the recharge at this location. However, given the existing geological conditions and groundwater gradients this is considered unlikely to impact the groundwater flow directions in this area. Based on the above the groundwater mound is expected to be maintained in the post-development environment through the implementation of a target stormwater management approach applied to the area of the existing mound. Therefore, for the purposes of this water balance assessment, groundwater throughflow will continue to occur radially from the MRS amendment area due to the continued presence of the groundwater mound. Note that this is within the deeper superficial aquifer (i.e. not shallow perched groundwater).

It is not anticipated that coordinated major earthworks that would modify the deeper soil profile will be implemented across the MRS amendment area and therefore, the pre-development and post-development soil profiles are expected to be consistent due to the general site characteristics requiring minimal interference during development. Also of note is measured groundwater levels in the superficial aquifer being several metres lower than the measured perched (shallow) groundwater levels (see **Section 3.2.4.2**) observed along the western boundary, and therefore changes in magnitude or flow direction within the MRS amendment area is unlikely to affect shallow groundwater throughflow that is expected to occur along the western boundary and beneath the GBSW in proximity to the MRS amendment area

3.2.4.2 Perched (shallow) groundwater throughflow

Seasonal perched groundwater (which exists in the thin layer of sand above a lower permeability clay layer) has been observed in groundwater bores located adjacent to Tonkin Highway (GW5S, GW8S and GW9S) as well as within two bores to the north of the MRS amendment area (WG4S and WG10S).

Based on measured groundwater levels, bores GW4S and GW10S appear to be hydraulically upstream of the shallow Tonkin Highway bores (e.g. GW5, GW9) (discussed in **Section 2.7.2**). However, the perched systems at these locations are unlikely to be connected given the deep sandy profile and lack of shallow clays in bores WG3 and WG7S/D situated between these two locations. Based on this it is expected that localised perched groundwater will generally disperse into immediately adjacent areas to infiltrate through to the superficial aquifer (at WG3/7) and along the clay layer towards bore WG10. The base and location of the localised perched areas is based on available bore logs and ranges between 15.14 m AHD and 20.11 m AHD.

While shallow clay conditions have been observed to the west of the MRS amendment area (approximately aligning with Tonkin Highway) perched shallow groundwater would flow towards this boundary and leave the MRS amendment area. However, due to the presence of Tonkin Highway, it is expected that the shallow soil profile would be intersected by an impermeable road base layer. It is therefore expected that Tonkin Highway would create an impermeable flow boundary which effectively inhibits the flow of perched shallow groundwater towards the west, resulting in a no flow boundary condition. This is reflected in the results of the WBA presented in **Section 4**.

Based on the above, flow of perched groundwater is expected to discharge from the MRS amendment area to the north only (via the WG4 to WG10 pathway). No flow is expected to the west due to the presence of Tonkin Highway (via the sections of identified and indicated as perched systems along the western boundary). As any perched system flow is driven by rainfall it is expected that perched flow would be seasonal, and likely only occurring in months of higher rainfall (i.e. May – September).

The shallow soil profile found within this portion of the MRS amendment area is not expected to be modified from the proposed development, and infiltration is likely to be dispersed through the MRS amendment area. Therefore, there are no drivers for change to there being no shallow/perched groundwater leaving the site towards the GBSW from this portion of the MRS amendment area. This also aligns with the DBNGP which will not be developed as the *Dampier to Bunbury Pipeline Act 1997* prohibits development within this corridor. It is expected that any shallow/perched groundwater which does flow towards the western boundary of the MRS amendment area would be intercepted by the DBNGP (which is assumed to be constructed using highly permeable sands and aggregates) which would promote the downward percolation of groundwater.

Therefore, the only perched groundwater expected to leave the site (horizontally) is from the higher permeability soil pathway located along the northern boundary. No westerly flows of perched shallow groundwater are expected towards the GBSW (found across Tonkin Highway to the west of the development) due to the presence of the DBNGP and Tonkin Highway found along the western boundary of the MRS amendment area.

The seasonal peak perched groundwater level contours and throughflow pathways are shown on **Figure 9**.

3.2.5 Evapotranspiration

The rate of evapotranspiration is dependent primarily on the land use and associated soils found beneath these land uses (as well as independent climatic factors). Developed areas that are predominately roof/road/hardstand have minimal rates of evapotranspiration while heavily vegetated areas have relatively higher evapotranspiration rates. The depth of the groundwater relative to the surface can have an effect on the rate of evapotranspiration where the capillary fringe is close to the surface of the soil profile (this can increase the amount of evapotranspiration). For the MRS amendment area this is not a significant consideration due to the large depth to groundwater beneath the majority of the WBA area and the poorly defined spatial extent of shallow perched groundwater conditions (and which only occurs in minor areas along the boundaries).

Previous research undertaken during the development of the PRAMS (DoW 2008, 2009a, b, c, d) has demonstrated that the estimation of evapotranspiration can be performed through the use of a VFM for regional scale investigations of evapotranspiration. However, the losses to evapotranspiration can also be determined by quantifying all other components of the assessment as a percentage of rainfall, such as groundwater recharge, surface runoff and interception. This method is useful for smaller scale evapotranspiration assessments as published data for similar land uses can provide sufficient levels of detail for the estimation of evapotranspiration (W. Dawes [CSIRO] 2022, pers. comm., 10 October). With all components quantified from these published PRAMS values they are removed from the indicative rainfall for the MRS amendment area (and irrigation water if applied) to estimate evapotranspiration.

The methodology that has been prescribed by for the estimation of evapotranspiration has been followed within the MRS amendment area and delineated into several RRUs which are based on soil type, vegetation type and land use. This has been done for the pre-development and post-development environments. Each land use has been spatially categorised and parameterised based on the generally observed soil profile, groundwater depth and vegetation cover. For the purposes of the WBA it is assumed that the soil profile and groundwater regime do not change as a result of future development, therefore changes to vegetation cover is the key component in determination of evapotranspiration.

As detailed in **Appendix D**, for the pre-development environment, 37.3% of rainfall is determined to become recharge to groundwater, 10.3% is intercepted by vegetation/leaf litter, 7.1% becomes surface runoff and 45.3% of rainfall is estimated to be taken up by evapotranspiration. For the post-development environment the land uses change to become more urbanised (i.e. less vegetation and more impervious surfaces) which influence the evapotranspiration estimation. In the post development scenarios 51.2% of rainfall is determined to become recharge to groundwater, 6.8% is intercepted by vegetation/leaf litter, 8.3% becomes surface runoff and 33.6% of rainfall becomes evapotranspiration.

For the purposes of determining evapotranspiration, irrigation water (abstracted from groundwater beneath the MRS amendment area and from the IWSS) has been considered separately, but in the same manner as rainfall. Assumptions for the amount of evapotranspiration from this source of

water are consistent between the pre-development and post-development environment and as per PRAMS methodology (see **Section 3.2**). Evapotranspiration of irrigation water applied to the site is then combined with the evapotranspiration estimated from rainfall to provide the total estimated evapotranspiration.

4 Water Balance

4.1 Water balance assessment

A conceptual water balance has been developed for the WBA area which considers the pre-development and post-development environments of the MRS amendment area and surrounding UE and UI areas. For the post-development environment, two scenarios have been considered: one where the UE and UI areas are not developed, and one where these areas are developed for urban uses as per the MRS amendment area. This approach allows analysis of the potential impacts to the WBA from the development of the upstream catchments. This section presents the quantification and summation of the water balance elements discussed in **Section 3**.

The pre-development environment WBA has quantified each component of the assessment and has provided a basis for assessing the impacts of the proposed development. The water balance assessment calculates the magnitude and direction of the movement of water attributable to each of the elements described in **Section 3**. Each element is detailed further within the respective technical summaries (see **Appendices B**, **C**, **D** and **E**).

Two post-development water balance scenarios have been considered for the WBA, one which assumes the upstream UE and UI areas are urbanised and one which assumes that the upstream UE and UI areas are not urbanised. These scenarios both follow the same methodology as the pre-development water balance. It assumes that rainfall remains the same i.e. it assumes that future rainfall and climate conditions are reflective of the period assessed in the WBA. The primary factors which influence the post-development water balances are the amount of impervious area resulting from the urban development proposed for the MRS amendment area and the development condition of the upstream catchments (i.e. whether it becomes urbanised or not urbanised).

The pre-development and post-development water balances are presented in **Table 5**.

4.1.1 Superficial aquifer recharge

The post-development WBA has determined that in both post-development scenarios there will be an increase in available water for the MRS amendment area. This water will likely become recharge to the superficial aquifer system located beneath the MRS amendment area. The annual amount of rainfall that will become recharge to the superficial aquifer in the pre-development scenario is 313,871 kL and in the two post-development scenarios is 379,011 kL.

4.1.2 Urban expansion and investigation area recharge

Recharge generated by the UE and UI areas (the upstream catchments) adjacent to the MRS amendment area are considered as these areas could potentially be urbanised in the post-development scenario. It is assumed that all previous WB components for the post-development scenario will be applicable to these areas. A conservative approach for estimating groundwater recharge is to proportion the recharge determined for the MRS amendment area to the upstream catchments area (Ct 1US and 2US). Using this approach the areas of the upstream catchments are approximately 52.5% of the MRS amendment area. Therefore, the groundwater recharge generated by the upstream catchments is 198,981 kL for the urbanised post-development scenario.

4.1.3 Interpretation of water balance and impacts

The water balance shows that, as a result of urbanisation, the following responses can be inferred for post-development environments as compared to pre-development conditions:

- Increased (slightly) groundwater abstraction from the superficial aquifer beneath the MRS amendment area (due to irrigation of POS and School areas)
- Decreased groundwater abstraction from the deeper Leederville aquifer beneath the MRS amendment area (due to cessation of irrigation from the deeper aquifer)
- Reduction in rainfall and irrigation water interception (due to less vegetation and overall less irrigation)
- Increase in surface water runoff and drainage (due to more impervious surfaces)
- Increase in groundwater recharge and through flow within the superficial aquifer beneath the MRS amendment area and UE and UI areas (due to increased recharge resulting from less vegetation and more impermeable surfaces).

Overall, in the post-development scenarios evapotranspiration within the WBA area is reduced, and while this is offset by a minor increase in surface water runoff, there is a net increase in water within the WBA areas. Given the permeable sandy profile beneath most of the MRS amendment area and proposed stormwater management approach, the increase in (or residual) water volume will result in an increase in groundwater recharge to the superficial aquifer. Surface water outflows for the MRS amendment area increase by approximately 11% to 24%. Evapotranspiration decreases by approximately 26% for rainfall and 43% for irrigation water (both groundwater and IWSS) from pre-development levels. Both of these influences can be attributed to the increase in urbanisation, reduction of vegetation across the MRS amendment area and reduction in irrigation water application from the proposed development.

Groundwater throughflow has not been calculated for the UE/UI areas in the pre and post-development environment due to the conceptual understanding of the site (see **Section 2.9**) which indicates the UE/UI areas are located at the top of the catchment to the east of the MRS amendment area which will direct GW throughflow away from the MRS amendment area.

Whilst the MRS amendment area will experience increased recharge to groundwater from urban development groundwater flows are expected to approximate pre-development flows due to the post-development stormwater management approach discussed in **Section 3.2.4.1** and in the DWMS (Hyd2O 2024). Given the radial direction of flows exiting the MRS amendment area there is the potential for impacts to occur to GBSW and the MKSEA area. However, given the post-development groundwater flows are expected to approximate pre-development flows and that the superficial aquifer is several metres below the shallow perched conditions experienced along the western boundary of the site and the portion of GBSW near the site, the development of the MRS amendment area will not affect localised perched conditions beneath GBSW.

Table 5: Wattle Grove water balance

Water balance component	Pre-development (kL)	Post-development (kL) – UE, UI areas undeveloped	Post-development (kL) – UE, UI areas fully developed
Inflows			
Rainfall	928,888	928,888	928,888
Upstream catchment inflows	34,536	34,536	48,210
Irrigation water application (of superficial aquifer origin)	84,655	123,694	123,694
Irrigation water application (of Leederville aquifer origin)	176,000	0	0
Irrigation water application (from IWSS)	32,500	46,000	46,000
Groundwater throughflow (superficial aquifer)	32,212	32,212	32,212
Total inflows	1,288,791	1,165,330	1,179,004
Outflows			
Rainfall interception	95,346	63,529	63,529
Irrigation water interception	29,316	18,206	18,206
Groundwater abstraction (of superficial aquifer origin)	84,655	123,694	123,694
Surface water runoff and drainage outflow (inclusive of upstream flows)	100,337	111,422	125,096
Groundwater throughflow (superficial aquifer)	346,081	411,223	411,223
Groundwater throughflow (perched groundwater)	7,280	7,280	7,280
Evapotranspiration (of rainfall)	420,566	312,427	312,427
Evapotranspiration (of irrigation water and IWSS)	205,209	117,549	117,549
Total outflow	1,288,791	1,165,330	1,179,004

4.1.4 Water balance changes to GBSW

The MRS amendment area is immediately bound by Tonkin Highway to the west, with GBSW in proximity to the west of Tonkin Highway. Post-development surface water runoff flows from the MRS amendment area will have a contribution to the export of water to the GBSW. The post development scenario with both the MRS amendment area and the upstream catchments being fully developed have been considered in the context of impacts to GBSW. **Table 6** presents the changes in surface water runoff between the pre-development and post development scenarios and the potential impacts this has to GBSW.

Table 6: Wattle Grove water balance post-development percentage change

Water balance component	Pre-development (kL)	Post-development change (%) to overall water balance – UE, UI areas fully developed	Post-development change (%) to the west of site
Inflows			
Rainfall	928,888	0%	0%
Upstream catchment inflows	34,536	+39.6%	0%
Irrigation water application (of superficial aquifer origin)	84,655	+46.1%	0%
Irrigation water application (of Leederville aquifer origin)	176,000	-100%	0%
Irrigation water application (from IWSS)	32,500	+41.5%	0%
Groundwater throughflow (superficial aquifer)	32,212	0%	0%
Outflows			
Rainfall interception	95,346	-33.4%	0%
Irrigation water interception	29,316	-37.9%	0%
Groundwater abstraction (of superficial aquifer origin)	84,655	+46.1%	0%
Surface water runoff and drainage outflow (inclusive of upstream flows)	100,337	+24.7%	+16.4%
Groundwater throughflow (superficial aquifer)	346,081	+18.8%	0%
Groundwater throughflow (perched groundwater)	7,280	0%	0%
Evapotranspiration (of rainfall)	420,566	-25.7%	0%
Evapotranspiration (of irrigation water and IWSS)	205,209	-42.7%	0%

The impacts to GBSW from the development of the MRS amendment area and upstream catchments are minimal with the only noted change being an increase in surface runoff exported from the MRS amendment area. The volume of surface water runoff exported from the MRS amendment area toward the GBSW is noted as increasing by 16.4%, however it is noted that this only represents 0.4% of the overall water balance.

Whilst groundwater throughflow is noted as increasing in the post-development environment this can be attributed to the increase in available water (from recharge) to the superficial aquifer. This increase recharge will assist in maintaining the groundwater mound, alongside the proposed stormwater management approach detailed in the DWMS, and so changes to groundwater flow towards GBSW are unlikely to occur. This increased recharge (65,142 kL) represents 5.5% of the overall water balance (1,179,004 kL).

4.2 Climate change sensitivity

The WBA has been developed to be a representation of the recent average hydrological system and therefore does not initially consider the impacts of climate. To provide a more robust WBA which considers any potential future climate change impacts relevant inputs should be included which account for a warmer, drier climate.

To account for climate change factors, a future climate prediction dataset was obtained from DWER to assess changes to key water balance inputs due to climate change (rainfall and evapotranspiration) (DWER 2021). The dataset from DWER is based on the climatic scenario projections from the World Climate Research Programme's (WCRP's) Coupled Model Intercomparison Project phase 3 (CMIP3) multimodel dataset (associated with the Intergovernmental Panel on Climate Change's (IPCC) 4th assessment report) (IPCC 2007). The DWER dataset uses the climate scenario projections to predict future climate data extrapolated from an observed climate baseline obtained from the Australian climate database named 'SILO' (Queensland Government 2021). The DWER climate prediction dataset provides predicted future climatic data in daily intervals for three climate change scenarios (wet, med, dry) at a time horizon of 2050 and 2100. The predictions are geographically based and as such the dataset obtained for this assessment has been calculated specifically for location of the assessment. The 2050 and 2100 'Dry' scenarios were selected for the climate change assessment as a pessimistic/conservative prediction.

Rainfall, associated runoff and evapotranspiration are the most significant components of the water balance by magnitude and future climate prediction data is available for rainfall, making assessment of climate response possible. While there will likely also be a direct effect on the other smaller-magnitude water balance components, future climatic predictions (specifically relevant to the MRS amendment area) for these components are not readily available. However, these components are altered indirectly due to flow on effects from changes in other components due to changes in water availability, which has been considered as part of this sensitivity analysis.

Future climate change predictions from DWER (2021) are summarised in **Table 7** with comparison made to the latest 11 years (2010-2020) of climate observations (from the SILO data provided by DWER). The rainfall reduction is applied as a modification to the annual runoff model such that these cumulatively approximate the predicted annual rainfall. The relative change of rainfall (-4.4% and -34.5%) from the 2010-2020 baseline has been applied to the associated water balances process to estimate the impact of climate change. The rainfall reduction resulting from climate change affects the following water balance components:

- Rainfall
- Upstream catchment flows
- Rainfall interception
- Surface water runoff from the MRS amendment area
- Evapotranspiration.

Table 7: Climate change factors

Climate Change Factor	Baseline average (2010-2020) (DWER, SILO 2021)	Future climate prediction (DWER 2021) percentage change from 2010-2020 baseline	
		Dry 2050	Dry 2100
Annual rainfall (mm) (Gosnells)	656	627 (-4.4%)	430 (-34.5%)
Annual rainfall used in the surface water balance (mm) (Jandakot hourly dataset)	735	702 (-4.4%)	481 (-34.5%)

The water balance was revised based on the predicted rainfall with the same methodology described in **Section 3**. For the assessment of climate change factors two post-development environments have been considered, one where the upstream catchments are undeveloped (remain rural residential) and one where they are fully developed (urbanised) for the two climate change scenarios considered. The resulting water balance incorporating climate change factors is summarised in **Table 8** and **Table 9**.

For the undeveloped upstream catchment recharge decreases to the superficial aquifer beneath the MRS amendment area to 358,334 kL in the Dry 2050 scenario, which is a reduction of 5.5% in comparison to the post-development environment without climate change factors. The Dry 2100 scenario shows recharge further decreasing to 214,939 kL, which is a reduction of 43.3% to the post-development scenario and effectively indicating that there will be minimal net additional recharge to the superficial aquifer (when compared to the pre-development environment).

For the fully developed upstream catchment recharge decreases to the superficial aquifer beneath the MRS amendment area to 358,370 kL in the Dry 2050 scenario, which is a reduction of 5.4% in comparison to the post-development environment without climate change factors. The Dry 2100 scenario shows recharge further reducing to 214,931 kL, which is a reduction of 43.3% to the post-development scenario and effectively indicating that there will be minimal net additional recharge to the superficial aquifer (when compared to the pre-development environment).

As is the case in the post-development water balance without climate change, the key influences of urbanisation are shown to be a decrease in evapotranspiration resulting in an increase in groundwater recharge. With the inclusion of climate change, rainfall reduces which significantly reduces surface water runoff leaving the MRS amendment area.

Overall, the impact of climate change on the water balance is relatively small in the Dry 2050 scenario but more significant for the Dry 2100 scenario. The most significant impact is seen in the surface water inflows and outflows for the MRS amendment area, which reduce by approximately 8% to 10% in the Dry 2050 scenario and 59% to 60% in the Dry 2100 scenario when compared to the post-development environment.

It is noted that changes to storm intensity are also expected to occur due to climate change, however are generally poorly understood at this stage, as described in ARR (Ball J *et al.* 2019). Longer term average rainfall influences are represented in the water balance through inclusion of the climate

change rainfall predictions provided by DWER. This has been used to account for the change of annual rainfall magnitude within the water balance, which is assessed over an annual time period.

The effects of the two climate change scenarios for impacts on GBSW have been considered during this WBA. These have been undertaken using the same methodology as presented in **Section 4.1.4**. For the Dry 2050 scenario with fully urbanised upstream catchments the surface water runoff exported from the MRS amendment area to GBSW reduces from 16.4% (in the post-development scenario without climate change factors) to 5.1% which represents 0.1% of the overall water balance. For the Dry 2100 scenario with fully urbanised upstream catchments the surface water runoff exported from the MRS amendment area reduces by 60.4%.

Table 8: Wattle Grove water balance with climate change factors with upstream catchments undeveloped

Water balance component	Post-development (kL)	Post-development (kL) Dry 2050	Post-development (kL) Dry 2100
Inflows			
Rainfall	928,888	887,963	608,350
Upstream catchment inflows	34,536	33,214	17,700
Irrigation water application (of superficial aquifer origin)	123,694	123,694	123,694
Irrigation water application (of Leederville aquifer origin)	0	0	0
Irrigation water application (from IWSS)	46,000	46,000	46,000
Groundwater throughflow (superficial aquifer)	32,212	32,212	32,212
Total inflows	1,165,330	1,123,083	827,956
Outflows			
Rainfall interception	63,529	60,684	41,580
Irrigation water interception	18,206	18,206	18,206
Groundwater abstraction (of superficial aquifer origin)	123,694	123,694	123,694
Surface water runoff and drainage outflow (inclusive of upstream flows)	111,422	102,641	45,979
Groundwater throughflow (superficial aquifer)	411,223	390,546	247,151
Groundwater throughflow (perched groundwater)	7,280	7,280	7,280
Evapotranspiration (of rainfall)	312,427	302,483	226,517
Evapotranspiration (of irrigation water)	117,549	117,549	117,549
Total outflow	1,165,330	1,123,083	827,956

Table 9: Wattle Grove water balance with climate change factors with upstream catchments fully developed

Water balance component	Post-development (kL)	Post-development (kL) Dry 2050	Post-development (kL) Dry 2100
Inflows			
Rainfall	928,888	887,963	608,350
Upstream catchment inflows	48,210	43,523	21,269
Irrigation water application (of superficial aquifer origin)	123,694	123,694	123,694
Irrigation water application (of Leederville aquifer origin)	0	0	0
Irrigation water application (from IWSS)	46,000	46,000	46,000
Groundwater throughflow (superficial aquifer)	32,212	32,212	32,212
Total inflows	1,179,004	1,133,392	831,5258
Outflows			
Rainfall interception	63,529	60,684	41,580
Irrigation water interception	18,206	18,206	18,206
Groundwater abstraction (of superficial aquifer origin)	123,694	123,694	123,694
Surface water runoff and drainage outflow (inclusive of upstream flows)	125,096	112,950	49,549
Groundwater throughflow (superficial aquifer)	411,223	390,582	247,143
Groundwater throughflow (perched groundwater)	7,280	7,280	7,280
Evapotranspiration (of rainfall)	312,427	302,447	226,524
Evapotranspiration (of irrigation water)	117,549	117,549	117,549
Total outflow	1,179,004	1,133,392	831,525

5 Conclusions

The MRS Amendment area is characterised as a groundwater recharge area given the sandy soils, minimal surface outflows and high groundwater throughflow leaving the site. Groundwater within the superficial aquifer that does flow in a westerly direction is a modest component of the water balance, and given that the superficial aquifer is several metres below the shallow perched conditions experienced along the western site boundary and beneath the portion of GBSW near the site, the changes to recharge beneath the MRS amendment area will not affect localised perched conditions beneath GBSW.

A conceptual water balance has been developed which considers the pre-development and post-development environments of the MRS amendment area and the UE and UI areas. The pre-development environment WBA has quantified each component of the assessment and has provided a basis for assessing the impacts of the proposed development.

The result of this WBA shows that there is a net increase in available water and this is attributable to the increased areas of impermeable surface and removal of pasture and vegetated areas that will likely occur as a result of urbanisation within the proposed development and UE and UI areas. These land use changes affect evapotranspiration, surface runoff and drainage which in turn result in an overall increase in available water of 65,141 kL within the MRS amendment area. Given the permeability of soils within the MRS amendment area, and the ability for stormwater management infrastructure to be located within permeable areas, this increase in available water will result in increased recharge to the superficial aquifer. This increase in recharge will assist, alongside the proposed stormwater management approach for the development, in maintaining the existing groundwater mound beneath the MRS amendment area. Groundwater flows are expected to be maintained and will continue to flow radially away from the mound. It is noted that groundwater which flows to the west towards Tonkin Highway is the same direction as GBSW but due to the lower elevation at which that this flow occurs, it is not expected to impact GBSW.

The WBA has identified that the key drivers of the hydrological regime within the WBA areas as surface water runoff and evapotranspiration. The proposed development will result in significantly increased hardstand area, reducing the evapotranspiration (and rainfall interception) for the MRS amendment area. The increased area of impermeable surfaces (such as roads, roofs, etc.) will also impact the other identified key driver of the WBA, which is surface water runoff. The overall volume of rainfall which becomes surface water runoff has been found to increase slightly as a result of urbanisation. This increase in surface water runoff can be managed through the logical placement of stormwater management infrastructure to ensure any additional surface water generated as a result of development is captured, treated and infiltrated on site. This will ensure that no additional surface water runoff enters GBSW.

The available water volume recharging the superficial aquifer could potentially increase groundwater depth beneath the MRS amendment area, as well as any surrounding areas that are directly connected to the superficial aquifer. However, none of the water balance components are significantly influenced by groundwater elevation due to the pre-existing depth of the superficial aquifer found beneath the MRS amendment area. It is therefore concluded that the urbanisation of the MRS amendment area will not adversely impact the existing hydrological regime in GBSW.

The effect of climate change has been incorporated into the water balance model as a separate scenario that adopts reduced rainfall patterns. The assessment for climate change has been based on the 'Dry' climate scenario at a time horizon of 2050 and 2100 and assumes that rainfall is expected to decrease by 4.4% and 34.5% respectively as per DWER estimates.

The predicted rainfall has influenced the following components of the water balance:

- Rainfall
- Upstream catchment flows
- Rainfall interception
- Surface water runoff and drainage
- Evapotranspiration.

The flow-on impacts of these changes also effect groundwater driven processes (throughflow and recharge).

The outcomes of the climate change sensitivity showed that in the Dry 2050 scenario the impact of the assessed climate changes was relatively small, being similar to the post-development (urbanised) water balance. Surface water flows reduced by approximately 10%, when compared to the base case post-development scenario, but were still greater than the pre-development environment. This results in a reductions of surface water runoff exported towards GBSW from 16.4% to 5.1% in the Dry 2050 scenario, which represents 0.1% of the total water balance. Evapotranspiration and rainfall decreased further from the pre-development scenario as a direct result of the reduction in rainfall associated with climate change. Reduction to the other water balance components were also noted as a result of the reduction in rainfall.

The Dry 2100 scenario indicates more significant reductions in surface water runoff from the site overall will occur with a reduction of approximately 60% when compared to the base case post-development scenario, or approximately 50% lower than pre-development levels. Surface water runoff exported towards GBSW also reduces by approximately 57% when compared to the base case post-development scenario. Evapotranspiration and interception also reduce significantly, being a portion of rainfall and irrigation. Increases to recharge to the superficial aquifer system beneath the MRS amendment area under this scenario are minimal with recharge to the superficial aquifer approximating the pre-development environment.

6 References

6.1 General references

The references listed below have been considered as part of preparing this document.

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Hyd2O 2024, *Wattle Grove South District Water Management Strategy*, H22076Bv6.

Intergovernmental Panel on Climate Change (IPCC) 2007, *Fourth Assessment Report*.

Lambers 2019, *A Jewel in the Crown of a Global Biodiversity Hotspot* Kwongon Foundation and the Western Australian Naturalists Club,.

6.2 Online references

The online resources that have been utilised in the preparation of this report are referenced in **Section 7.1**, with access date information provided in **Table R1**.

Table R 1 Access dates for online references

Reference	Date accessed	Website or dataset name
(BoM 2020)	November 2020	Climate Data Online
(DWER 2024a)	January 2024	Perth Groundwater Map
(DWER 2022b)	October 2022	Water Information Reporting
(DWER 2024b)	January 2024	Water Register
(Queensland Government 2020)	May 2020	SILO Climate Database
(Queensland Government 2021)	May 2021	SILO Climate Database

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Figure 5: Groundwater Investigations

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Figure 8: Superficial Groundwater Throughflow

Figure 9: Perched Groundwater Throughflow

Figure 10: Pre-development Evapotranspiration

Figure 11: Post-development Evapotranspiration

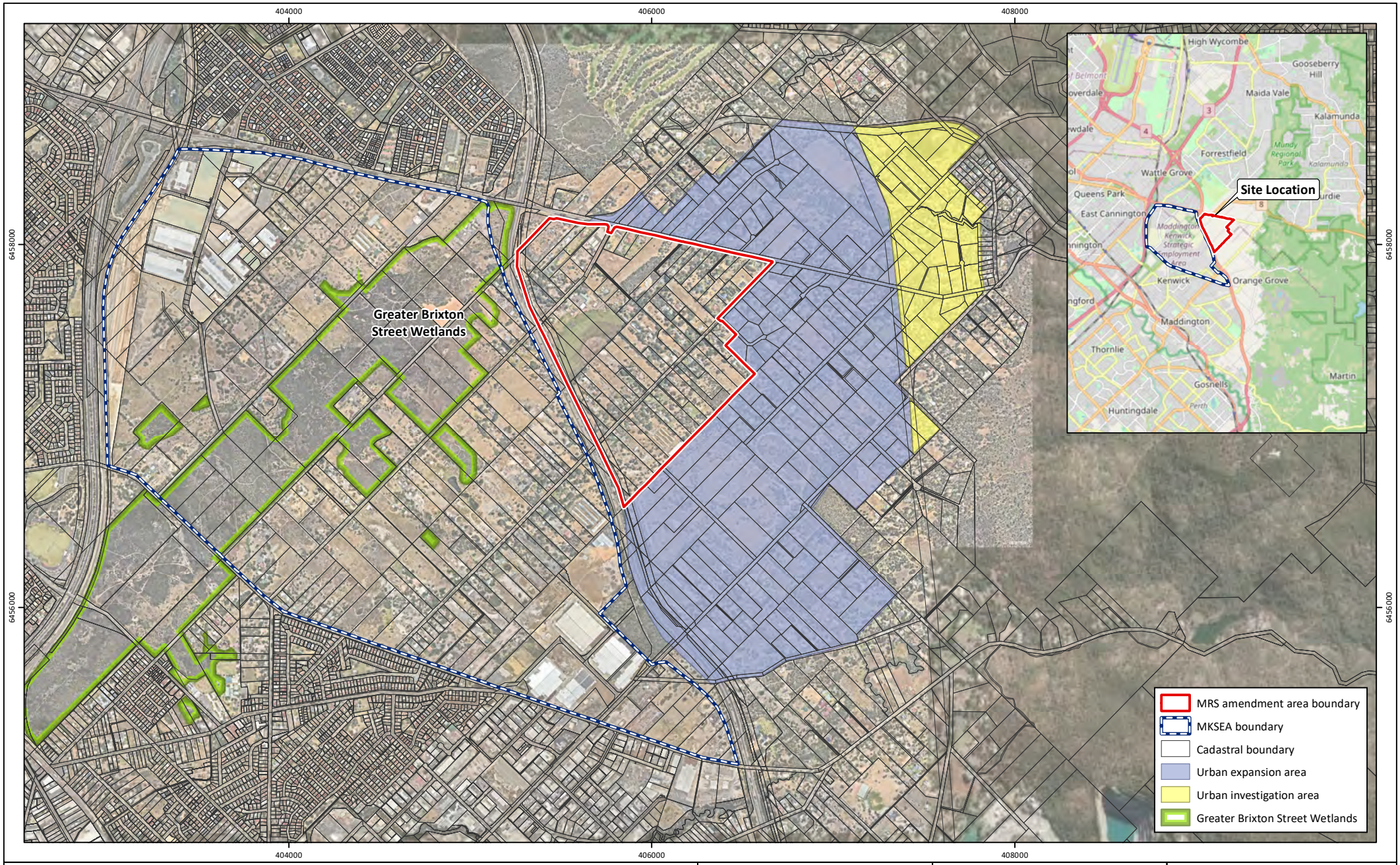


Figure 1: MRS Amendment Area Location

Project:	Water Balance Assessment Wattle Grove South
Client:	Hesperia Pty Ltd

Plan Number:
EP22-002(03)--F01a

Drawn:	GAR
Date:	06/01/2023
Checked:	BPB
Approved:	DPC
Date:	12/05/2023

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Scale: 1:27,500@A4

GDA 1994 MGA Zone 50

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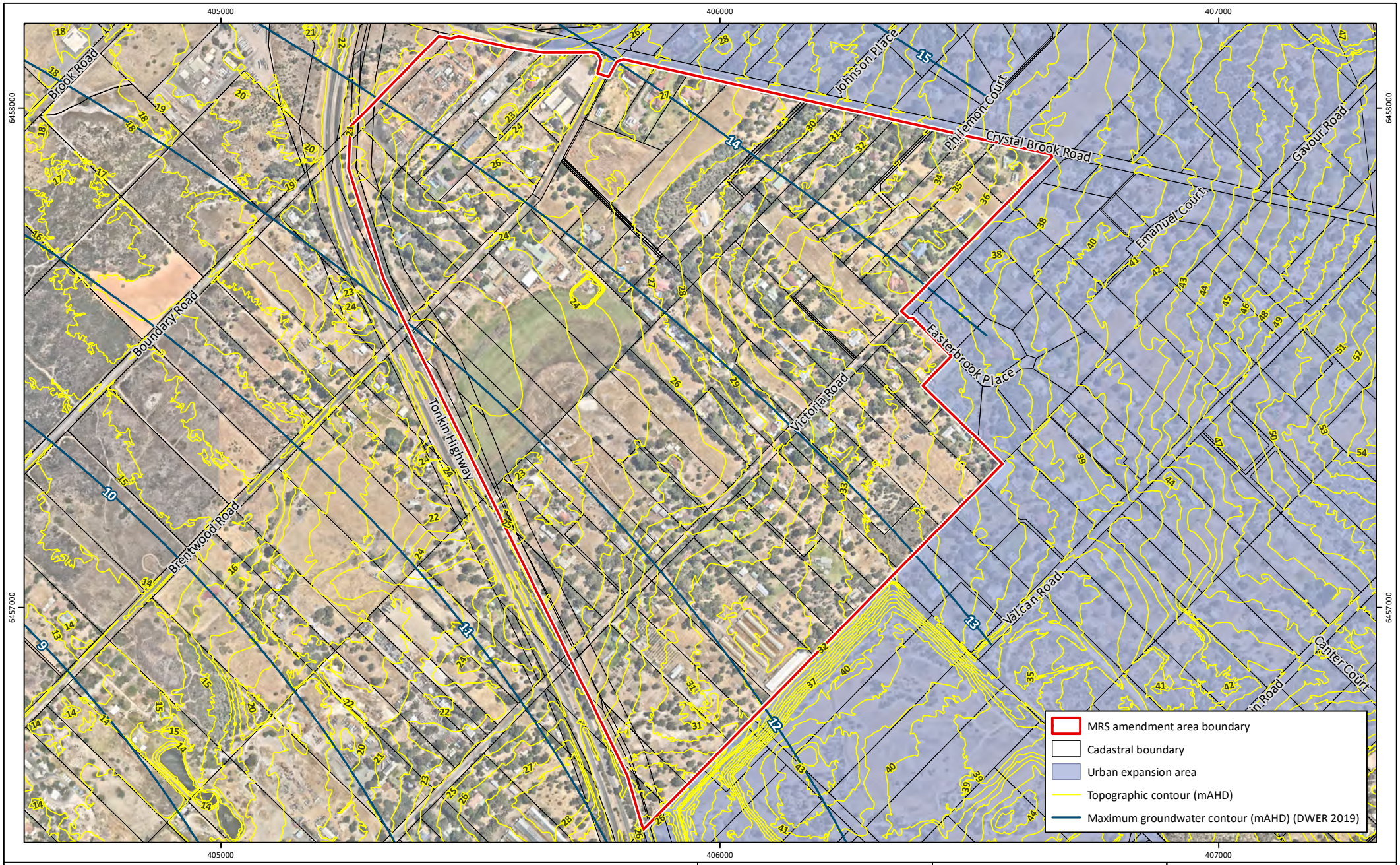


Figure 2: Topography and Regional Groundwater Contours

Project: Water Balance Assessment
Wattle Grove South
Client: Hesperia Pty Ltd

Plan Number:
EP22-002(03)--F02b

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Checked:	BPB
Approved:	DPC
Date:	23/01/2024

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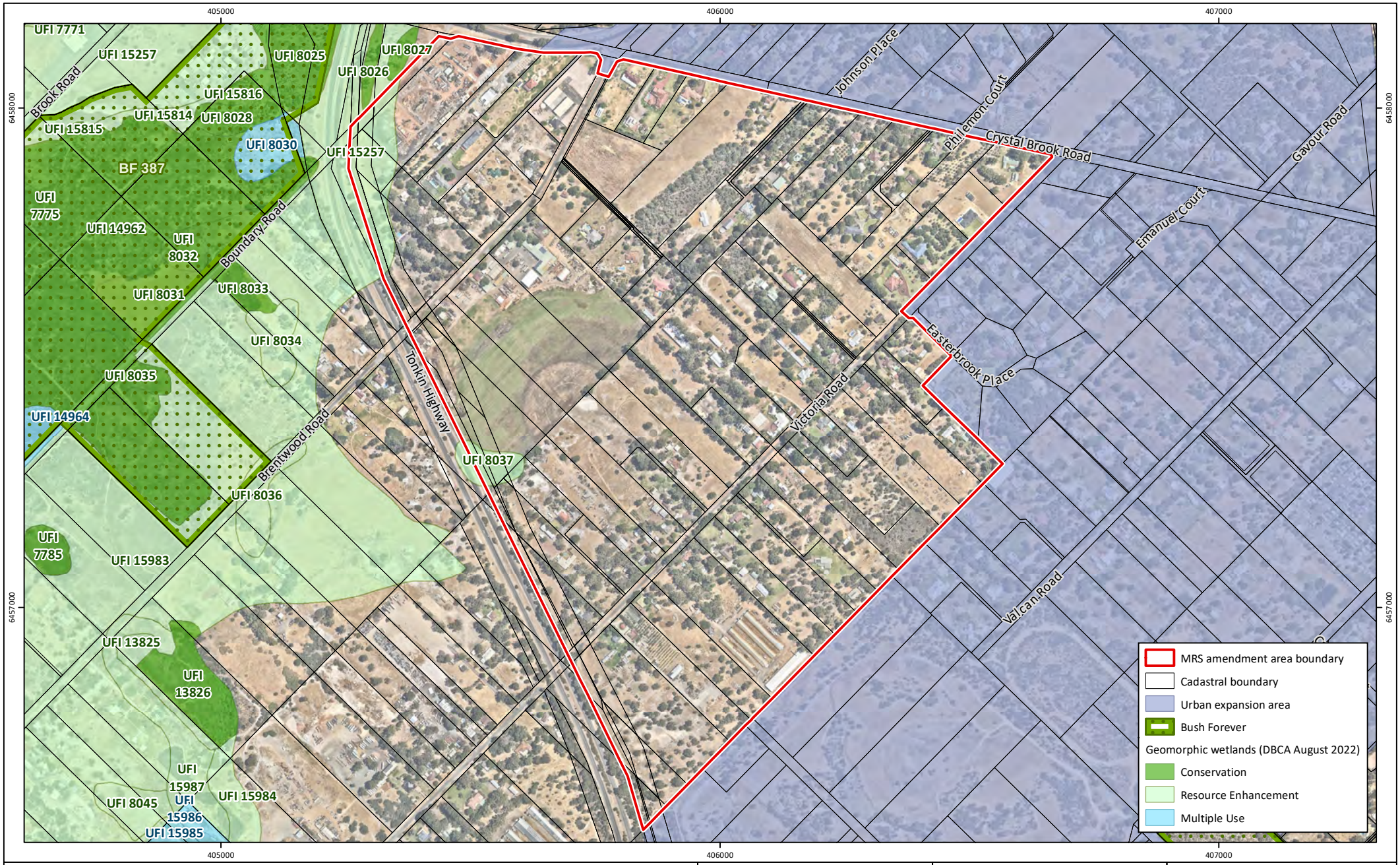


Figure 3: Geomorphic Wetlands and Bush Forever

Project:	Water Balance Assessment Wattle Grove South
Client:	Hesperia Pty Ltd

Plan Number:
EP22-002(03)--F03a

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Date:	06/01/2023
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Approved:	DPC
Date:	19/01/2023

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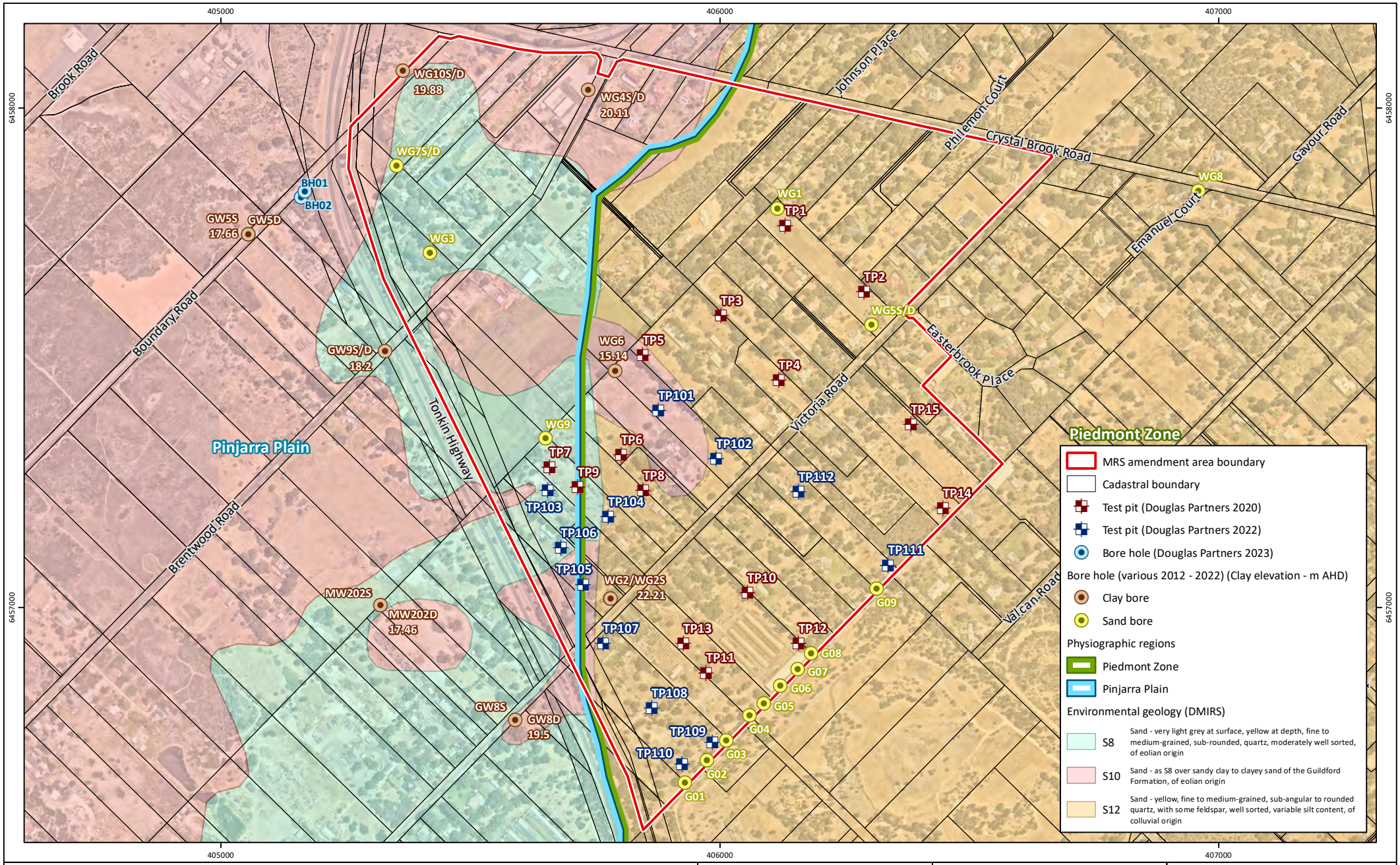


Figure 4: Regional Geology and Investigations

Project: Water Balance Assessment
Wattle Grove South
Client: Hesperia Pty Ltd

Plan Number:
EP22-002(03)--F04d

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Date:	23/01/2024

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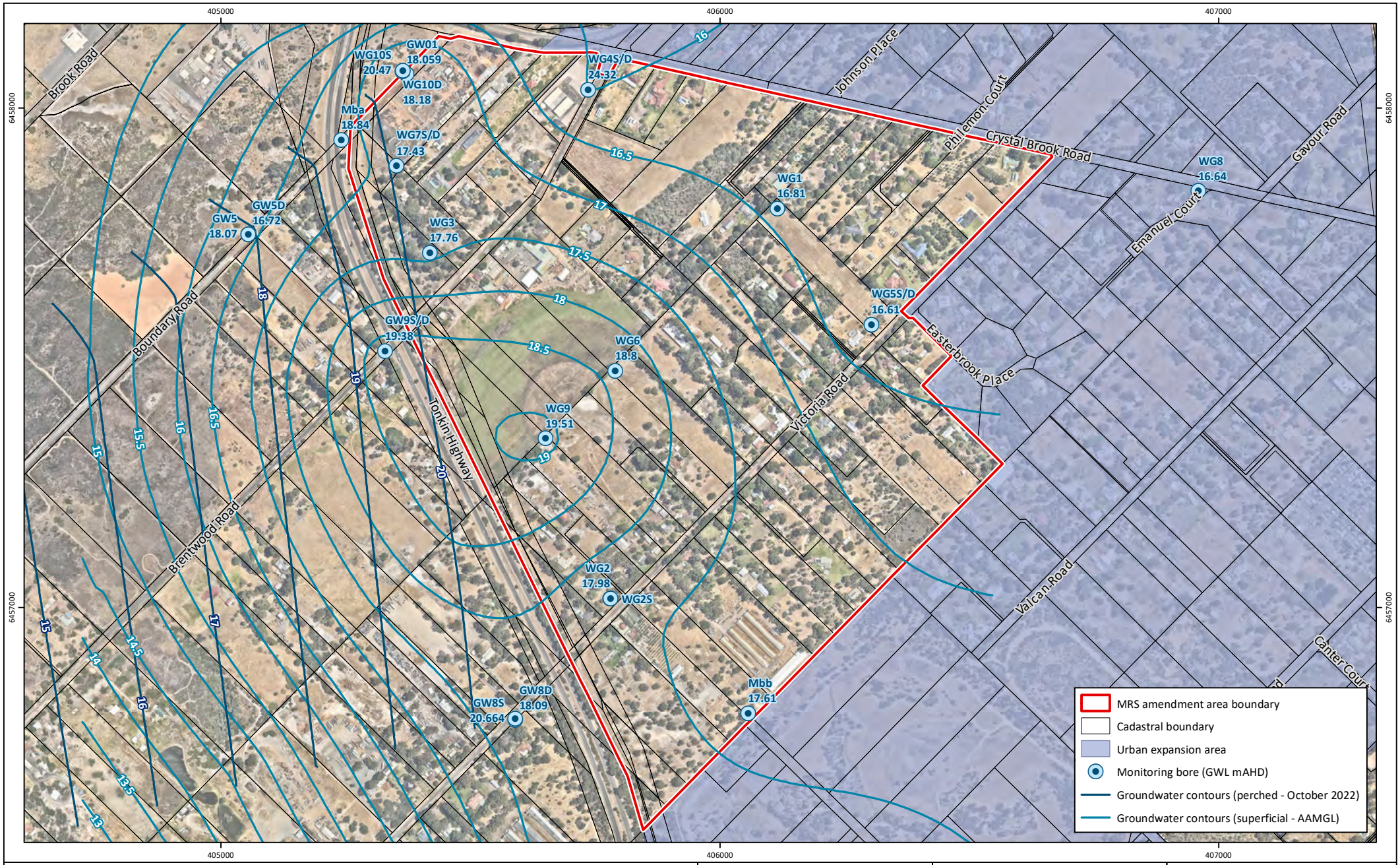


Figure 5: Groundwater Investigations

Project:	Water Balance Assessment Wattle Grove South
Client:	Hesperia Pty Ltd

Plan Number:
EP22-002(03)--F05b

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Date:	06/01/2023
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Date:	11/05/2023

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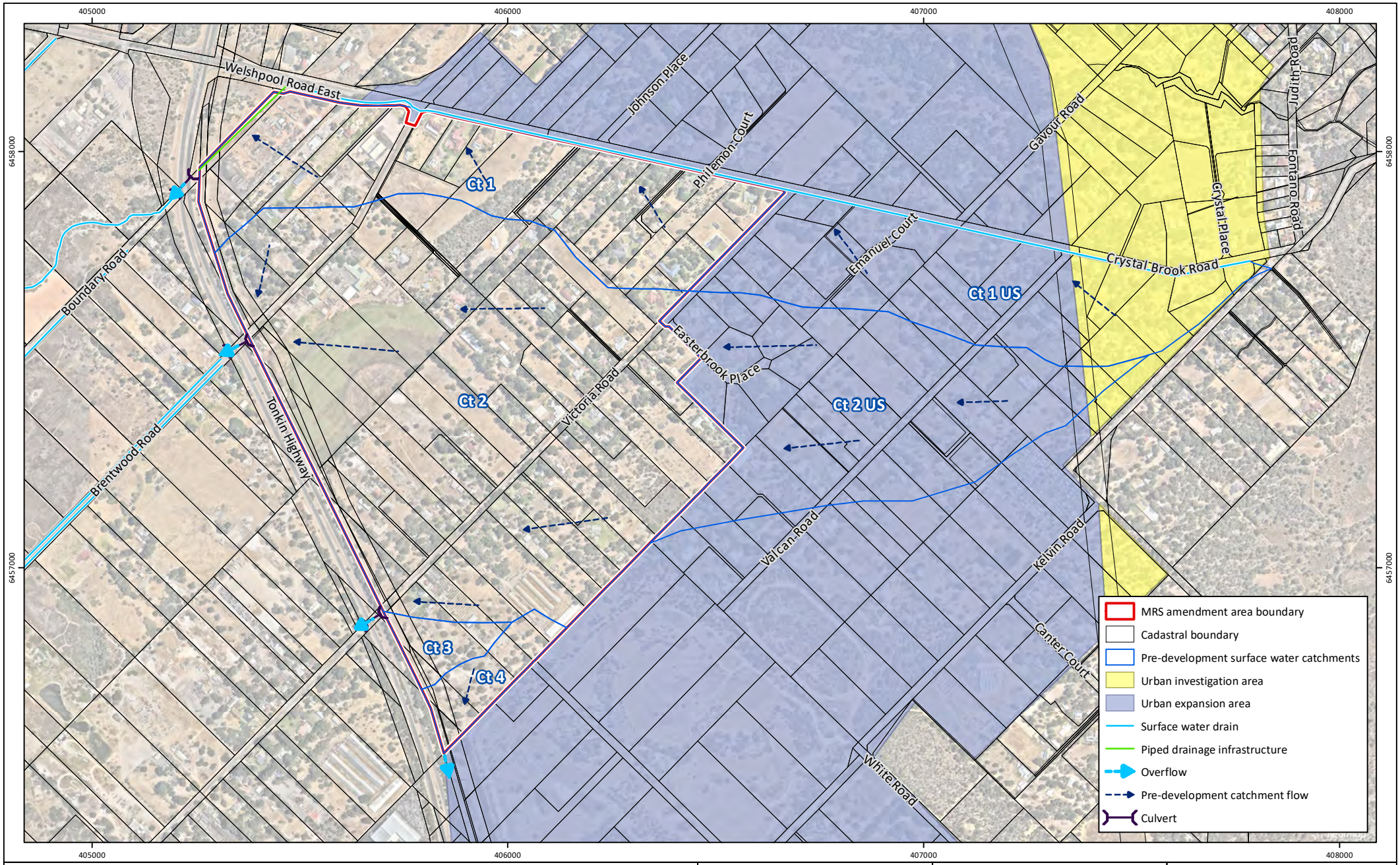


Figure 6: Hydrological Features

Project: Water Balance Assessment
Wattle Grove South
Client: Hesperia Pty Ltd

Plan Number:
EP22-002(03)--F06a

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Date:	19/01/2023

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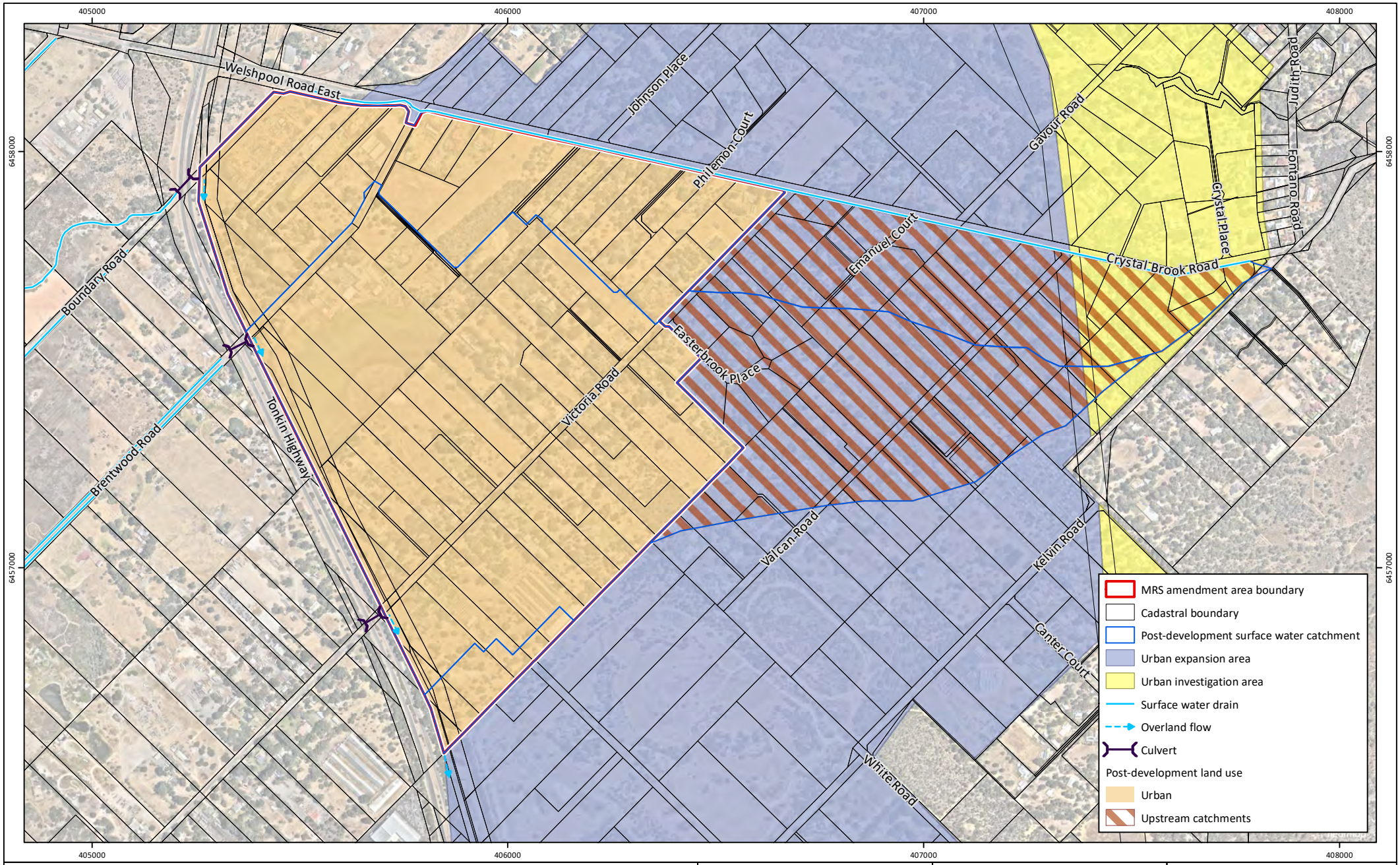


Figure 7: Post-Development Surface Water Runoff

Project: Water Balance Assessment
Wattle Grove South
Client: Hesperia Pty Ltd

Plan Number:
EP22-002(03)--F07a

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Date:	19/01/2023

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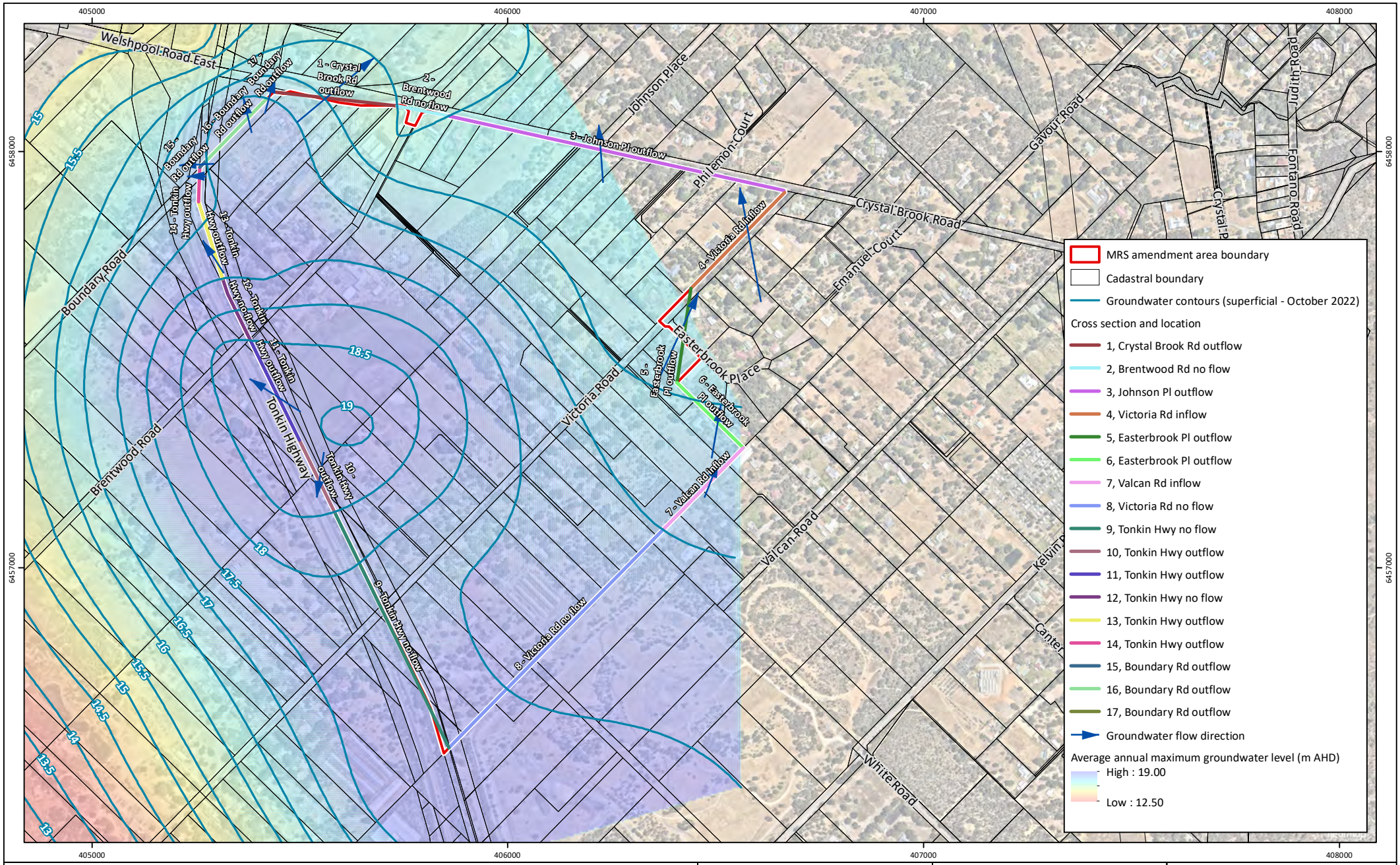


Figure 8: Superficial Groundwater Throughflow

Project:	Water Balance Assessment Wattle Grove South
Client:	Hesperia Pty Ltd

Plan Number:
EP22-002(03)--F08e

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Approved:	DPC
Date:	23/01/2024

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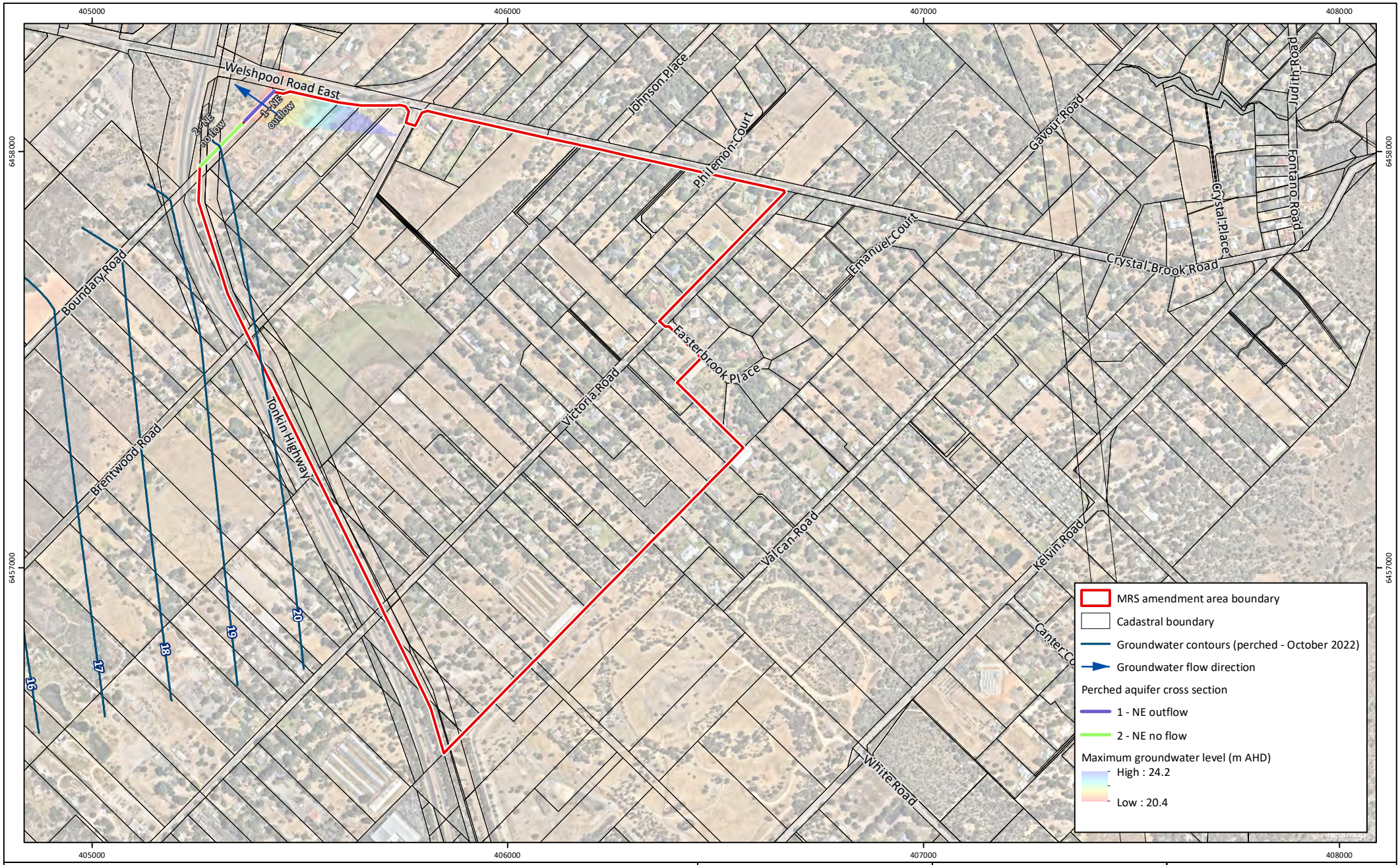


Figure 9: Perched Groundwater Throughflow

Project: Water Balance Assessment
Wattle Grove South
Client: Hesperia Pty Ltd

Plan Number:
EP22-002(03)--F10d
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Date: 18/01/2024
Checked: BPB
Approved: DPC
Date: 23/01/2024

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GDA 1994 MGA Zone 50

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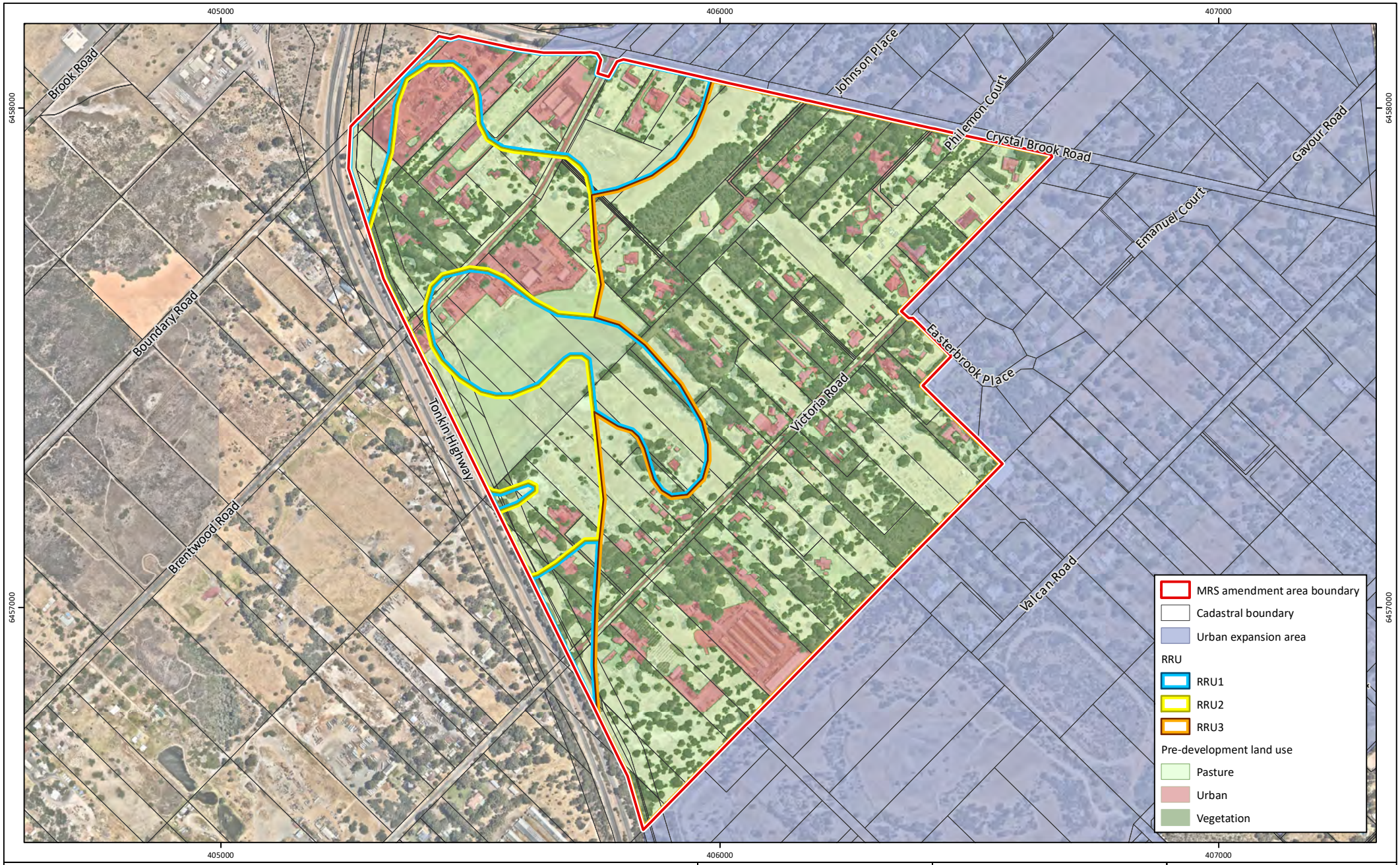


Figure 10: Pre-Development Evapotranspiration

Project: Water Balance Assessment
Wattle Grove South
Client: Hesperia Pty Ltd

Plan Number:
EP22-002(03)--F11b
Drawn: GAR
Date: 18/01/2024
Checked: BPB
Approved: DPC
Date: 18/01/2024

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Meters
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GDA 1994 MGA Zone 50

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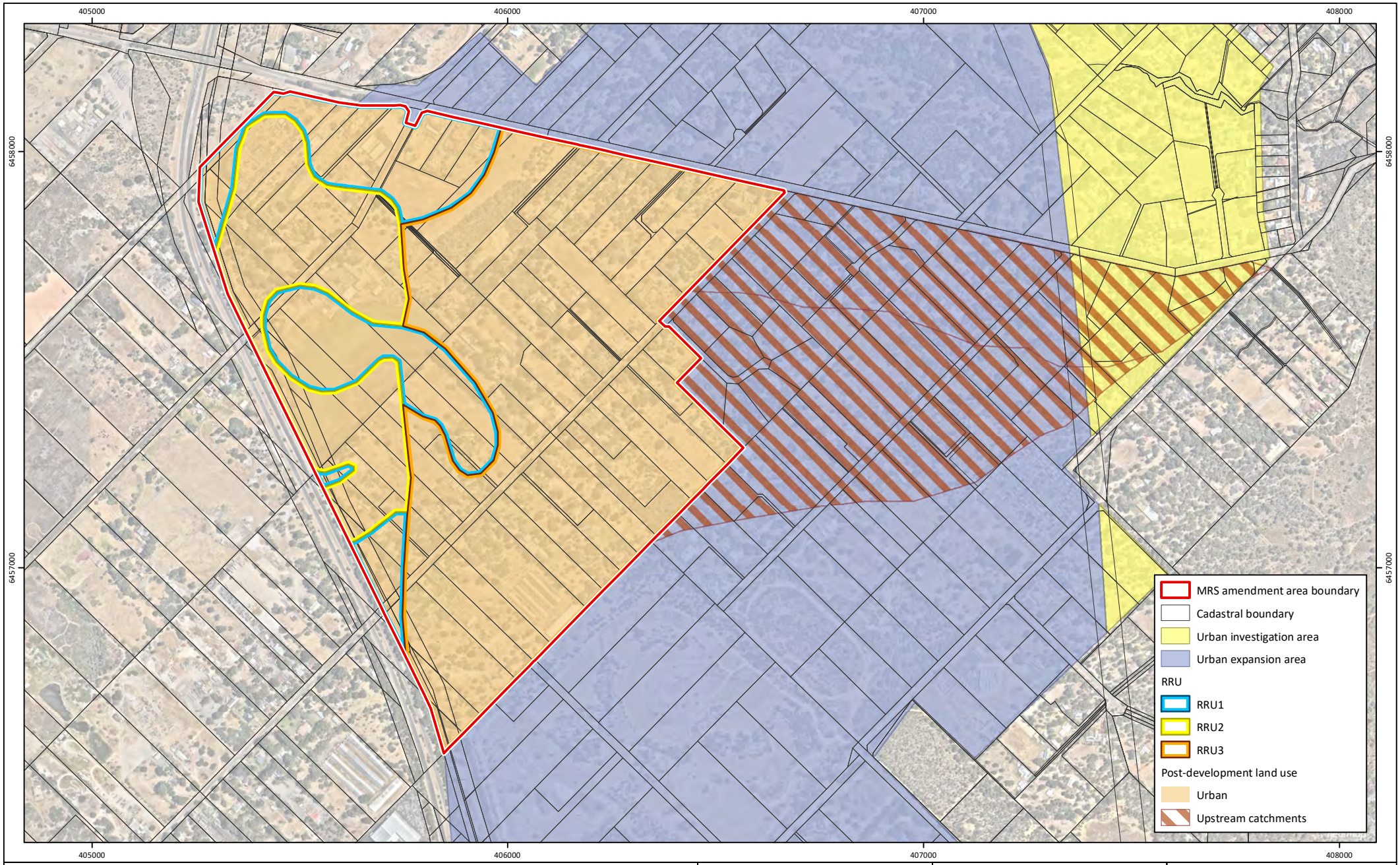


Figure 11: Post-Development Evapotranspiration

Project:	Water Balance Assessment Wattle Grove South
Client:	Hesperia Pty Ltd

Plan Number:
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Appendix A

Environmental Review Instructions (excerpt)

Prepared by EPA (2022)

3. Preliminary key environmental factors and required work

The preliminary key environmental factors for the environmental review are:

1. Inland Waters;
2. Flora and Vegetation;
3. Terrestrial Fauna;
4. Social Surroundings, and
5. Greenhouse Gas.

Table 3 outlines the work required for each preliminary key environmental factor and contains the following elements for each factor:

- **EPA factor** and **EPA objective** for that factor.
- **Relevant activities** – the development activities that may have a significant impact on that factor.
- **Potential impacts and risks** to that factor.
- **Required work** for that factor.
- **Relevant policy and guidance** – EPA (and other) guidance and policy relevant to the assessment.

Table 3 Preliminary key environmental factors and required work

Inland Waters	
EPA objective	To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.
Relevant activities	• Clearing of vegetation and alteration of natural drainage regimes for future development and associated infrastructure.
Potential impacts and risks	• Impacts to current surface and ground water cycles (alteration of hydrological regimes) resulting in impacts to significant wetlands and waterways within and nearby to the amendment area, including the Yule Brook and Greater Brixton Street Wetlands (GBSW). • Impacts to water quantity and quality of significant wetlands and waterways within and nearby to the amendment area. • Impact to the hydrology and biodiversity of the GBSW. • Loss of foreshore functions and groundwater and/or surface water dependent vegetation and impacts to other water dependent ecosystems.
Required Work	1. Identify and assess the values and significance of hydrological and geological characteristics within the amendment area and surrounding area including for the broader Wattle Grove Urban Expansion and

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	Urban Investigation area, particularly in relation to the GBSW, and describe these values in a local and regional context. 2. □Identify and map wetlands and watercourses within and adjacent to the amendment area including urban expansion and urban investigation areas and through work from the instructions below identify any areas proposed to be impacted. 3. □Map groundwater contours for the regional and perched groundwater tables over the amendment area using site specific monitoring data and monitoring data from other nearby bores including the Department of Water and Environmental Regulation (DWER) and Department of Biodiversity Conservation and Attractions (DBCA) sites to establish the groundwater flow direction. Assess results in comparison to previous regional mapping completed within the local area (amendment area, urban expansion and investigation areas). Liaise with DWER to obtain any monitoring data further to the publicly available data base. Additional long-term and extensive groundwater flow direction investigations (such as additional monitoring bores and an extended period of data collection) may be required to support groundwater flow mapping that is not consistent with the DWER mapping. Ensure that all superficial bores used in creating the regional groundwater contours are not perched, and represent the groundwater in superficial aquifer. 4. □Map the surface water catchment for the amendment, urban expansion and urban investigation areas, and map the contribution of pre development surface water flows to the surrounding wetlands and water courses. 5. □Describe the total water cycle for the amendment area in the context of it being within the Yule Brook Catchment and with consideration of the surrounding urban expansion and urban investigation area. Discuss the hydrology and hydrogeology, particularly as it relates to wetland and ecological diversity within and nearby to the amendment area. Include information and discussion on the water budget for the area, the existing drainage management practices and any known impacts on the wetlands and waterways in, and nearby to the amendment area. 6. □Using a pre and post development water balance model, characterise the existing hydrology of the site and existing sub surface flow contribution to the GBSW; and assess the potential impacts (direct and indirect) of the proposed change in land use associated with the amendment, and urban expansion and investigation areas, on water quantity and quality of surface and ground waters and subsurface flow contribution in relation to nearby significant wetlands and waterways The following should be considered in the development of any model: • □ The model should be developed in consultation with DWER and DBCA and consider inputs of the PRAMS groundwater flow model inputs.

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	• Provide details of the existing geological and hydrogeological conditions used in conceptualising any modelling undertaken. • The groundwater water balance and groundwater resources in the Superficial aquifer should consider PRAMS input parameters using the flow-net analysis with the Darcy equation. Groundwater throughflow from the site toward the GBSW should be calculated with consideration of the Darcy equation. • Demonstrate the water balance is based on an understanding of both the groundwater minimum and maximum for the amendment area and the GBSW. The assessment of soil/sediment gravimetric and volumetric water contents, where perched aquifers are suspected, is also required to adequately inform the water balance. • Minimum data and information required to support an appropriate water balance is listed below with accompanying published data. – Minimum groundwater levels (collected April-May) – as shown in the published data logger data presented in WA wetlands conference poster (Bourke et. al. 2018). – Groundwater levels (minimum and maximum) presented in metres below ground level – required to assess wetland flora and fauna and terrestrial vegetation groundwater dependency and threats (e.g. waterlogging, acidification and salinisation). Lambers (2019). – Volumetric water content, water retention and hydraulic conductivity – see Davis and Cahill (2018) for horizontal hydraulic conductivity calculations using surface nuclear magnetic resonance (SNMR). – Water quality within GBSW is known to be spatially varying (Davis and Cahill 2018, and Lambers 2019). A spatial, temporal and lithological interpretation of water quality data is therefore required against water balance modelling outcomes to assess threats to wetland flora and fauna and terrestrial vegetation. 7. Calculate the additional recharge from the proposed change in land use associated with the amendment, and the resultant impact to the groundwater flow velocity and direction toward the GBSW. This should also include identification of the additional recharge from the urban expansion and investigation areas. 8. Demonstrate that predevelopment surface water and groundwater flows to the Yule Brook and GBSW are maintained post development as a result of the proposed change in land use associated with this amendment, and urban expansion and investigation areas.

	9. Estimate post development nutrient input and export rates resulting from the proposed change in land use, including through the use of DWER's Urban Nutrient Decision Outcomes (UNDO) model. 10. Predict the extent, severity and duration of potential impacts further to items 5 to 9, including changes to local and regional groundwater flows and levels, drawdown, local water quality and impacts to other groundwater users as a result of the proposed change in land use associated with the Amendment, and urban expansion and investigation areas, and provide measures to mitigate these impacts. 11. Determine the boundaries of wetlands and/or buffer requirements to wetlands within and adjacent to the amendment area proposed to be retained. Boundary and buffer studies should consider the characteristics of hydrology, hydric soils and wetland vegetation, and the water balance of the wetland/wetland dependent vegetation. 12. In the context of the below, items 6, 8 and 11 should model existing conditions of, and potential changes to, groundwater and surface water chemistry, particularly in relation to salinity and soil sodicity, that will result from the proposed change in land use associated with this amendment, and urban expansion and investigation areas. Research in the southern area of the GBSW has shown the area is characterised by aquifers with locally elevated salinities and a water table that fluctuates from at or above the surface, to below ground level and there may be a risk from the provision of more groundwater or surface water to the GBSW, as this may persist into summer months and concentrate solutes in the root zone as it evaporates. 13. Describe how the principles of water sensitive urban design will be incorporated and implemented in the amendment area, consistent with the *Better Urban Water Management* framework (WAPC, 2008) and the Stormwater Management Manual for Western Australia (DWER 2004-2007) and other relevant guidelines. 14. Detail and discuss how future drainage practices within the site, is to be managed, considering the broader catchment. This management should ensure the hydrological balance and water quality of significant wetlands and watercourses within and nearby to the amendment area (such as the GBSW and Yule Brook) will be maintained. 15. Describe how drainage management practices could be adapted in the future to mitigate impacts of climate change on significant wetlands and waterways, within and adjacent to the amendment areas. 16. Using the mitigation hierarchy, detail and discuss how development activities will avoid and manage mobilisation of potentially poor-quality groundwater resulting from past agricultural land uses.

	17. Describe the planning or other mechanisms that will ensure drainage management will protect significant wetlands and watercourses within and adjacent to the amendment area. 18. Describe the ongoing management requirements for the amendment area to ensure the hydrology of significant wetlands and watercourses within and nearby to the amendment area is maintained. 19. Prepare a district water management strategy in accordance with the Guidelines for district water management strategies (DoW, 2013). 20. Prepare a monitoring program including management objectives, baseline conditions, public reporting and measures to be implemented in the event of non-compliance to management objectives. 21. Based on the outcomes of the above and taking into consideration the principles of avoidance and minimisation, identify an environmentally acceptable area for development. 22. Provide a summary of residual impacts of future development and associated infrastructure within and adjacent to the amendment areas. 23. Describe any proposed avoidance, mitigation and management measures that demonstrate the EPA's objectives can be met. 24. Describe the planning mechanisms that are to be applied to ensure impacts are managed to meet the EPA's objectives.
Relevant policy and guidance	***EPA Policy and Guidance*** *Statement of Environmental Principles, Factors, Objectives and Aims of EIA*, EPA, 2021. *Environmental Factor Guideline – Inland Waters*, EPA, June 2018. **Other policy and guidance** *Better Urban Water Management*, Western Australian Planning Commission, October 2008. Bourke L, Brown K, Paczkowska G. Characterising the condition and function of the Greater Brixton Street Wetlands, Kenwick, Western Australia, to inform conservation management. Poster presented at the 14th Annual WA Wetland Management Conference 2018, 2nd February, Bibra Lake, WA. Davis, Aaron; Cahill, Kevin. Surface nuclear magnetic resonance soundings in the Greater Brixton Street Wetlands. Perth, WA: CSIRO; 2018. Davis, Aaron; Cahill, Kevin. Ground-based time-domain electromagnetic soundings in Greater Brixton Street Wetlands. Perth, WA: CSIRO; 2018. Department of Biodiversity, Conservation and Attractions, A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia, 2017.

	Guideline for the determination of wetland buffer requirement, Draft, Department of Planning and Infrastructure, 2005. *Stormwater Management Manual for Western Australia* (DWER 2004-2007). *Guidelines for district water management strategies* DoW, 2013. *Identification and investigation of acid sulphate soils and acidic landscapes*, Department of Environment Regulation, June 2015. Lambers . Introduction and overview. In: Lambers H ed. A jewel in the crown of a global biodiversity hotspot. Perth: Kwongan Foundation and the Western Australian Naturalists' Club In, 2019 *Operational policy 4.3: Identifying and establishing waterways foreshore areas,* Department of Water, September 2012. *Treatment and management of soil and water in acid sulphate soil landscapes*, Department of Environment Regulation, June 2015 *Environment Protection and Biodiversity Conservation Act 1999 and approved conservation advices on relevant MNES.*

Flora and Vegetation	
EPA objective	To protect flora and vegetation so that biological diversity and ecological integrity are maintained.
Relevant activities	Clearing of vegetation, addition of fill, and alteration of natural drainage regimes for future development and associated infrastructure.
Potential impacts and risks	Direct and indirect loss of significant flora and vegetation, including threatened and priority ecological communities, threatened and priority flora, and vegetation complexes poorly represented in existing conservation reserves (Guildford Complex and Forrestfield and Southern River Complex). Potential impacts include: • Direct loss through clearing, • Loss of fauna habitat (vegetation loss) short and long term, • Impacts to wetland and riparian vegetation and ground water dependant ecosystems within and nearby to the amendment area (including GBSW) through changes to hydrology, • Spread or intensification of weeds and *Phytophthora* dieback, • Fragmentation.
Required work	25. Identify and characterise the flora and vegetation present and likely to be present within the amendment area, in accordance with EPA Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment, December 2016. For existing flora and vegetation

Appendix B

Surface Water Runoff

TECHNICAL ASSESSMENT

Project Name	**Wattle Grove South MRS Amendment 1388/57 Water Balance Assessment**
Project Number	**EP22-002**
Assessment Component	**Surface Water Runoff**

Introduction

This document is a technical summary and is intended to be read in conjunction with the *Wattle Grove South Amendment 1388/57 Water Balance Assessment* (the WBA), which covers the Wattle Grove South amendment area (the MRS amendment area).

One of the key components of the WBA is the quantification of the annual volume of surface water runoff conveyed into and discharging from the MRS amendment area. Surface water runoff is rainfall that is not retained/infiltrated at source resulting in rainfall becoming runoff. This occurs when rainfall intensity which exceeds the infiltration and storage capacity of soils and surfaces. Consideration is also given to the flow direction of runoff into the MRS amendment area from upstream catchments and discharges from the MRS amendment area.

The surface water runoff assessment is based on a detailed catchment assessment and preparation of surface water runoff assessments previously undertaken within and around the MRS amendment area by Hyd2O (2022) and Emerge Associates (Emerge Associates 2017, 2021). Surface water runoff investigations have included assessment of catchments, runoff routing, land use assessment and determination of the associated infiltration/storage 'loss' rates for each land use. Surface water assessments have been undertaken for both the pre-development and post-development environments and accounts for upstream catchments. The relevant assessment details are summarised in this document which are largely based on the work undertaken as part of the DWMS for the MRS amendment area prepared by Hyd2O (2022).

Data and inputs

The data and inputs used to determine the annual runoff volumes are summarised below.

- **Rainfall**

Rainfall data was obtained from the Bureau of Meteorology (BoM) (BoM 2020). The data comprises of gauged rainfall (in mm) at Jandakot Aero (Station 9172) in half hourly increments between 1/1/2010 00:00 and 31/12/2019 24:00. The data was condensed into one hour

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intervals to be compatible with the hourly loss rate units adopted in the modelling methodology (discussed below). The Jandakot dataset is used for the surface water balance calculations as it is the closest station with continuous rainfall observations available in a frequency of one hour or less.

- **Catchment extent and inflow locations**

The extent of both internal and upstream catchments in both the pre-development and post-development environments have been digitised based on topography and a preliminary structure plan layout provided by the client. The resulting catchments are generally consistent with those detailed in the DWMS for the MRS amendment area, with exception of a portion of the northernmost catchment which does not enter the MRS amendment area and therefore does not feature in water balance calculations, and some minor changes in flow direction owing to an updated preliminary land use plan. The catchments have been derived from the publicly available 1 m topographic LiDAR contours and inflow/discharge locations and directions have been taken from data provided by Main Roads WA, City of Gosnells Intramaps, site inspection and culvert surveys. These catchments only incorporate the land that contributes to the catchments of the MRS amendment area and so do not include the entire Urban Expansion/Investigation (UE and UI) areas. A summarised breakdown of catchment areas, flow directions and the discharge types are provided in **Table B1** and **Table B2** for the pre-development and post-development environments respectively. The catchments are shown for the pre-development and post-development environments in **Figure 7** of the WBA report respectively.

Table B1: Pre-development catchment summary

Catchment	Area (ha)	Runoff discharge direction	Runoff discharge type
Ct 1	32.56	Boundary Road streamline (GBSW)	Culvert crossing
Ct 2	86.80	Brentwood Road (MKSEA)	Culvert crossing
Ct 3	2.83	Victoria Street (MKSEA)	Culvert crossing
Ct 4	4.21	South (Tonkin Hwy)	Overland flow
Ct 1 US	28.28	Ct 1	Overland flow
Ct 2 US	38.06	Ct 2	Overland flow

Table B2: Post-development catchment summary

Catchment	Area (ha)	Runoff discharge direction	Runoff discharge type
Ct 1	40.83	Boundary Road streamline (GBSW)	Culvert crossing
Ct 2	81.55	Brentwood Road and Victoria Street (MKSEA)	Culvert crossings
Ct 3	3.91	South (Tonkin Hwy)	Overland flow
Ct 1 US	28.28	Ct 1	Overland flow
Ct 2 US	38.06	Ct 2	Overland flow

Table B1 and **Table B2** shown that the catchment areas are only slightly modified from pre to post development based on the preliminary land use plan which is subject to change. All discharge methods and locations remain unchanged.

- **Land use areas and loss rates**

Pre-development and post-development land use categorisations and loss rates for the MRS amendment area have been adopted from the DWMS and based on the preliminary structure plan layout. The land use details and loss rates are summarised in **Table B3** and **Table B4** and the extent of land uses are shown in **Figures 10** and **11** of the WBA for the pre-development and the post-development environments respectively. The 'runoff coefficient' presented is determined by converting an event based initial loss (IL in mm) and continuing loss (CL in mm/hr) rate to an annual coefficient by analysing annual rainfall and runoff at an hourly timestep. This approach is further described in following pages.

Land use types and infiltration losses are largely influenced by the underlying near-surface soil types and surface coverage/landuse (i.e. vegetation, asphalt etc.). It is common for vegetation/litter interception losses to influence landuse categorisation (e.g. pasture, native vegetation delineation), however interception losses are accounted for in the evapotranspiration component of this water balance and so are not included in land use delineation and loss rates for the surface water component to avoid minor double counting.

For the purposes of runoff assessment, the pre-development land use has been categorised as a single land use due to generally consistent near-surface soils and land use. The effective impervious area of this land use has been assumed to be zero due to the small portion of impervious areas and the lack of any connected impervious areas, un-kerbed roads and lack of local natural or formal drainage within the MRS amendment area.

A 45 mm initial loss (IL) was added to the catchment losses for post-development lot and road impervious areas to account for on-lot soakage and downstream infiltration structures (such as bio-retention areas (BRAs) designed to retain runoff from the first 15mm of rainfall, and flood detention basins, designed to manage up to a 1% AEP event.

Table B3: Pre-development land use summary

Land use	Contributing area (ha)	Initial loss (mm)	Continuing loss (mm/hr)	Percentage impervious (effective)	Runoff coefficient
MRS amendment area					
Rural residential (Existing)	126.39	20	4	0%	7.1%
Upstream					
Rural residential (Existing)	66.34	20	4	0%	7.1%

Table B4: Post-development land use summary

Land use	Contributing area (ha)	Initial loss (mm)	Continuing loss (mm/hr)	Percentage impervious	Runoff coefficient
MRS amendment area					
Commercial	14.07	Fully retained			0%
POS	14.06	45	4	0%	2.6%
Residential	68.03	45 (pervious and (impervious)	4 (pervious) 0.1 (impervious)	80%	11.0%
Road	25.86	45 (pervious and (impervious)	4 (pervious) 0.1 (impervious)	70%	11.0%
School	4.25	Fully retained			0%
Upstream					
Urban Expansion	66.34	Mixed – see ***Table B5*** below			9.9%

The upstream catchments have been considered to be developed for the purposes of the post-development surface water balance. The preliminary land use of these areas are proposed to be urban, however the final layout and composition is unknown and will likely not be determined for some time. The land use composition for the UE and UI areas has then been based on the preliminary land use plan for the MRS amendment area, with the exception of school and commercial areas, which have been redesignated to residential. A summary of the preliminary land use composition for the MRS amendment area and that assumed for the upstream Urban Expansion area is provided in **Table B5.**

Table B5: Land use proportional summary

Land use proportion	Commercial	POS	Residential	Road	School
MRS amendment area	11.1%	11.1%	53.9%	20.5%	3.4%
Urban Expansion	0%	11.1%	68.3%	20.5%	0%

Methodology

Runoff volumes

Runoff is calculated via the subtraction of loss rates from the rainfall values. This accounts for localised retention (e.g. due to topography or storages) and infiltration into the soil profile. Runoff is not subject to any further infiltration or transmission loss; the loss rates are purely rainfall abstraction and any runoff is then assumed to be discharged from the assessment area or upstream catchment at the identified locations.

The IL and CL was applied to the rainfall (in mm) on an hourly timestep basis and this was undertaken separately for each land use. where both the IL and CL amounts are exceeded by the rainfall amount for a given hourly timestep, runoff occurs; otherwise, no runoff occurs. The available IL value is tracked throughout the time series and resets (i.e., the IL value becomes fully available again for rainfall abstraction) after a full day where rainfall does not exceed 1 mm, representing the infiltration and evaporation of rainfall.

This calculation was completed for each hourly timestep over the rainfall data period (i.e. 2010-2019), for each land use type (i.e. for each unique IL and CL combination). This resulted in a total runoff value (in mm) over 2010-2019 for each land use, which was then averaged over that 10 year period to produce the final runoff coefficient adopted for each land use.

The IL and CL rates and resulting average runoff coefficient for land use is provided in **Table B3** and **Table B4**.

Runoff and flow routing

Runoff that is discharged from the MRS amendment area is an outflow from the water balance assessment. Upstream runoff is accounted for as an inflow to the MRS amendment area. Any runoff from upstream areas is assumed to be conveyed through the MRS amendment area without any transmission losses as the soils are likely fully saturated during rainfall events sufficiently large enough to produce upstream runoff.

Climate Change Sensitivity

The baseline pre-development and post-development water balance assessment has been developed to be a representation of the recent average hydrological system based on

observed data and therefore inherently does not account for any potential future impacts of a warmer, drier climate. The effect of climate change has been incorporated into the water balance model as a separate process through assessment of climate change on the post-development scenario. It is noted that predicting changes to rainfall patterns and magnitude and soil absorption (of which runoff is a dynamic outcome) due to warming is difficult and the consideration of climate change sensitivity should be considered as a rough estimate.

To account for climate change factors, Emerge Associates obtained a future climate prediction dataset from DWER which includes rainfall predictions (DWER 2021). The data is based on the climatic scenario projections from the World Climate Research Programme (WCRP) Coupled Model Intercomparison Project phase 3 (CMIP3) multimodel dataset (associated with the Intergovernmental Panel on Climate Change's (IPCC) 4th assessment report) (IPCC 2007). The DWER dataset uses the climate scenario projections to predict future climate data extrapolated from an observed climate baseline obtained from the Australian climate database named 'SILO' (Queensland Government 2021).

The DWER climate prediction dataset provides predicted future climatic data in daily intervals for three climate change scenarios (wet, med, dry) at a time horizon of 2050 and 2100. The predictions are geographically based and as such the dataset obtained for this assessment has been calculated specifically for location of the assessment (i.e. Wattle Grove). The 2050 and 2100 Dry scenarios were selected for the climate change assessment as a conservative/pessimistic prediction.

A summary of the future climate change factors predictions from DWER (2021) are summarised in **Table B6** with comparison made to the latest 11 years (2010-2020) of climate observations (from the SILO data provided by DWER).

Table B6: Rainfall climate change factors

Climate Change Factor	**Baseline average (2010-2020) (DWER, SILO 2021)**	**Future climate prediction (DWER 2021) percentage change from 2010-2020 baseline**	
		Dry 2050	**Dry 2100**
Annual rainfall (mm) (Gosnells)	656	627 (-4.4%)	430 (-34.5%)
Rainfall reduction (mm/hr)	0	-0.056	-0.597
Annual rainfall used in the surface water balance (mm) (Jandakot hourly dataset)	735	702 (-4.4%)	481 (-34.5%)

To account for the predicted changes to annual rainfall, the rainfall magnitude of each hourly timestep in the surface water balance was reduced by a fixed amount. The amount of rainfall reduction was calculated such that the reduction would result in the average annual runoff decreasing proportionally to the corresponding predicted future change. For example, the Dry 2050 scenario shows a decrease of 4.4% from the baseline average. The same percentage is taken from the baseline average of the Jandakot dataset. The Jandakot dataset is used for the

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surface water balance calculations as it is the closest station with continuous rainfall observations available in a frequency of one hour or less. This adjusted rainfall is applied to both the MRS amendment area and the UE and UI areas (i.e. upstream catchments). Other than the adjusted rainfall the climate change surface water balance calculations follow the same procedure as the baseline scenarios.

Results and summary

The surface water components of the overall water balance are summarised in **Table B7** for the pre-development and post-development environments. The post-development environment for the undeveloped (not urbanised) and developed (urbanised) UE and UI areas are presented for impacts to discharge from the MRS amendment area. Post-development climate change estimates for the Dry 2050 and Dry 2100 DWER future climate change predictions consider the developed UE and UI areas only.

Note that the surface water balance components are the quantification of the various surface water/runoff elements and are not intended to comprise a wholistic water balance. The main WBA report details consideration of the other water balance components such as evapotranspiration, groundwater throughflow, recharge, etc.

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Table B7: Surface water balance summary

Surface water balance components (m^3/year)	Pre-development	Post-development UE & UI areas undeveloped	Post-development UE & UI areas developed	Post-development (Dry 2050) UE & UI areas developed	Post-development (Dry 2100) UE & UI areas developed
Direct rainfall (falling on the MRS amendment area)	928,888	928,888	928,888	887,963	608,350
Runoff generated from rainfall on the MRS amendment area	65,889	76,886	76,886	69,427	28,279
Upstream catchment inflows	34,536	34,536	48,210	43,523	21,269
Total water infiltrated on the MRS amendment area	863,088	852,002	852,002	818,536	580,071
Total runoff discharging from the MRS amendment area (inclusive of upstream inflows)	100,337	111,422	125,096	112,950	49,549
Runoff to MKSEA (total)	66,472	77,960	85,804	77,474	33,586
Runoff to GBSW (total)	31,674	31,036	36,866	33,283	15,058
Runoff to south (total)	2,191	2,426	2,426	2,194	904

References

Bureau of Meteorology (BoM) 2020, *Rainfall data, Jandakot Aero 2010-2020*.

Emerge Associates 2017, *Maddington Kenwick Strategic Employment Area - Precinct 3A Local Water Management Strategy*, EP14-056(09)--009F RLE, F.

Emerge Associates 2021, *Local Water Management Strategy - Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area*, EP17-055(01)--005I ASC, Version I.

Hyd2O 2022, *Wattle Grove South District Water Management Strategy*.

Intergovernmental Panel on Climate Change (IPCC) 2007, *Fourth Assessment Report*.

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Appendix C

Groundwater Throughflow

TECHNICAL ASSESSMENT

Project Name	**Wattle Grove South MRS Amendment 1388/57 Water Balance Assessment**
Project Number	**EP22-002**
Assessment Component	**Groundwater Throughflow**

Introduction

This document is a technical summary and is intended to be read in conjunction with the *Water Balance Assessment Wattle Grove South* (the WBA), which covers the amendment 1388/57 area which is bound by Tonkin Highway (west), Welshpool Road East (north), Crystal Brook Road, Victoria Road and Easterbrook Road (east) and the rear boundaries of lots fronting Victoria Road (south) and referred to as the 'MRS amendment area'.

This document summarises the calculation of the groundwater throughflow component of the WBA. Groundwater throughflow is the lateral flow of water through the soil profile. As part of the WBA, the annual groundwater throughflow volumes flowing through the assessment area boundaries have been calculated, the methodology and results are summarised below.

Data and input

The groundwater throughflow assessment is based on investigations undertaken within and around the assessment areas. These include geotechnical investigations (test pits, infiltration testing) and groundwater level investigations (manual measurements). These are summarised below.

Sand profile depth, spatial distribution and permeability

The MRS amendment area is situated within a transitional area between the Piedmont Zone of the Darling Scarp and the Pinjarra Plain, resulting in a complex and heterogeneous soil profile. Bassendean sands and Guildford formation clays have been observed. Clay soils vary greatly in concentrations and locations but generally are limited to the west of the MRS amendment area near to the surface, and also to the north of the MRS amendment area and sporadically in the centre of the MRS amendment area. The majority of the MRS amendment area did not display an underlying shallow clay layer. The observations to date indicate that near-surface groundwater within the MRS amendment area can be delineated into a regional superficial unconfined aquifer and to a lesser (western and northern) extent a perched system within the layer of sand above a lower permeability clay layer.

Bore logs and lithology for deeper DWER bores (61601079, 61607580 and 61671956) (DWER 2022b) indicate that the MRS amendment area is underlain by a lower permeability clay layer at approximately 27 m BGL. The base of the regional aquifer was assumed as 0 m AHD based on DWER groundwater mapping (DWER 2022a), while the base of the perching which occurs at the top of the shallow clay layer is based on available bore logs and ranges between 15.14 m AHD and 20.11 m AHD.

A geophysical investigation assessed the soil profile beneath the MRS amendment area to a depth of 50 m BGL and found that the soils were generally non-uniform and complex. A large area of interpreted lower permeability soil was identified along Tonkin Highway (western boundary) and areas of higher permeability soil were identified along Crystal Brook Road (northern boundary) and Johnson Place (outside of the MRS amendment area to the north) (GBG 2023).

Permeability testing was performed using a borehole permeameter constant head test. Test pit locations and permeability rates are summarised in **Table 2**, **Table 3** and **Figure 4** of the WBA. Permeability across the MRS amendment area varied between 6 m/day and 34 m/day. Based on the locations of test sites it is assumed that the majority of the rates were measuring permeability of the upper sandy soils. The underlying clayey sand/sandy clay and clay layer will likely result in soil permeability decreasing with depth to some extent. Falling head permeability tests undertaken on the deeper, fine grained silty sand soil profile (9 to 15 m BGL) adjacent to Tonkin Hwy to the west of the site determined permeability rates varied from 1.62 $x10^{-5}$ m/s to 9.75 x 10^{-5} m/s. A permeability of 2.4 $x10^{-4}$ m/s was adopted for the majority of the deeper soil profile beneath the site except for specific areas along the western boundary where 1.2 x 10^{-5} m/day was used. A permeability of 2.89 $x10^{-4}$ m/s has been adopted for the shallow soil profile.

Maximum groundwater elevations

Groundwater depths were measured on three occasions (2022/08/26; 2022/10/10 and 2022/10/27) in a number of groundwater monitoring bores within the MRS amendment area for both the regional superficial unconfined aquifer and a perched system.

Pre-development scenario

Average Annual Maximum groundwater level (AAMGL) contours for the superficial aquifer have been derived from the measured ground water levels (supplied by the proponent). The complete extent of the groundwater monitoring bore dataset and the associated AAMGL contour dataset are shown in **Figure 5** of the WBA. The extent of the mapping has been expanded to cover the MRS amendment area. Groundwater generally moves radially away the highest groundwater elevation around existing turf farm located centrally within the MRS amendment area.

Post-development scenario

The high groundwater elevations centrally within the MRS amendment area can be attributed to localised geological conditions and groundwater abstraction from the deeper aquifer at this location. Expected post-development AAMGL contours for the superficial aquifer have been

assumed to remain unchanged from the pre-development environment due increase recharge to the superficial aquifer and proposed stormwater management approach which are expected to maintain the groundwater mound. Based on the above, groundwater flows beneath the site are unlikely to change post-development with the continued presence of the groundwater mound.

Perched system

Higher groundwater levels have been observed in bores GW5S, GW9S and GW8S, located to the west of Tonkin Highway, and in WG4S and WG10S to the north of the MRS amendment area, and these are concluded to represent localised perching. Based on measured groundwater levels, bores GW4S and GW10S appear to be hydraulically upstream of the shallow Tonkin Highway bores. However, these perched systems are unlikely to be connected given the deep sandy profile and lack of perched system in bores WG7S/D and WG3 which are situated between these two locations. Measured depth within the shallow bores were used to derive the maximum groundwater level (MGL) contours for the assumed perched groundwater locations in the northern part of the MRS amendment area (WG4S and WG12S). Long term AAMGL for the perched system is not available, therefore the derived maximum groundwater levels (MGL) was used. The perched system in the north western and south western part of the MRS amendment area, east of Tonkin Highway is likely not hydraulically connected to the perched system to the west of Tonkin Highway due to shallow clay layer. It is assumed that there is no flow from the perched system from the MRS amendment area to the west and south west of the area. Perched groundwater is expected to be present during months with higher rainfall. Based on historical rainfall it is assumed that perched groundwater will be present for five months annually (May to September). **Figure 9** of the WBA shows the MGL contours used for the perched system.

Methodology

Groundwater throughflow rate within the soil profile has been calculated using Darcy's law (*1*):

(1) $$Q = -kA\frac{dh}{dl}$$

where the flow rate (*Q*), is related to the hydraulic conductivity (*k*), bulk cross sectional area (*A*) and the hydraulic gradient ($\frac{dh}{dl}$).

Hydraulic conductivity

The average of the measured permeability between HTS1 - HTS3 (i.e. 20.73 m/d) was used as the hydraulic conductivity for the regional aquifer since these test pits are considered representative of the soils beneath the area based on location and depth of the test pits. A reduction factor of 0.5 was applied to the permeability used for throughflow from the western boundary (towards Tonkin Highway) based on the large area of lower permeability soil identified as part of the geophysical investigation (GBG 2023) and the lower permeability rates determined within the deeper soil profile along Tonkin Highway. This reduction factor has been applied to groundwater cross-sections 11, 13, 14, 15 and 16 (see **Table C1**).

The average of the measured permeability between the bores HTS3 and HTS2, closest to the throughflow locations (i.e. 24.95 m/d) was used as the hydraulic conductivity for the perched system.

Bulk cross sectional flow area

Pre- and post-development scenarios

The bulk cross sectional flow areas at the boundaries of the MRS amendment area are the areas between the base of the aquifer (0 m AHD) and the AAMGL determined from the groundwater contours.

Cross sections were derived from the AAMGL dataset at the boundaries of the MRS amendment area. The locations of the cross sections are shown in **Figure 8** of the WBA. The derived bulk cross sectional flow areas for each cross section are detailed in **Table C1**.

Some locations where the WBA boundary orientation is perpendicular to the groundwater contours (and therefore parallel to groundwater flow) were excluded as the resulting incident groundwater flow would be zero.

Perched system

The bulk cross sectional flow areas at the boundaries of the MRS amendment area, for the perched system, are the areas between base of the perched aquifer (top of the clay layer) and MGL determined from the groundwater contours.

Cross sections for the perched system at the north, west and south western boundaries of the MRS amendment area (corresponding with the clay layer) were derived from the MGL dataset. The locations of the cross sections are shown in **Figure 9** of the WBA. The derived bulk cross sectional flow areas for each cross section are detailed in **Table C2**.

Groundwater gradient and direction

The hydraulic gradient has been derived from the AAMGL contour dataset. The gradient has been taken at locations representative of the weighted groundwater gradient for each cross section, these are shown as groundwater flow direction arrows in **Figure 8** of the WBA for the pre-development and post development scenarios and **Figure 9** for the perched system.

Gradients were calculated from the change in groundwater elevation along the length of these vectors. The hydraulic groundwater gradients are provided in **Table C1** for the pre- and post-development scenario and **Table C2** for the perched system.

The direction of the groundwater flow relative to the orientation of the cross sections have also been noted. These angles of incidence have been accounted for in the respective flow calculations and are provided in the Tables.

Results and summary

Pre-development scenario

The horizontal groundwater flow rate has been calculated using Darcy's law (*1*) from the components summarised in **Table C1** and the permeability for each cross-section location. Flow has been assumed to occur across the saturated part of the cross-sectional area. The final yearly flow across each cross section is provided in **Table C1**.

A visual example of the cross sectional data is provided in **Plate C1** and **Plate C2**, which displays Cross Sections 3 (outflow to the north east) and 10 (outflow to the west of the MRS amendment area).

Table C1: Pre-development and post-development groundwater throughflow summary

Cross section/ location		Cross sectional area (m^2)	Groundwater gradient	Angle of incidence (degrees)	Flow (m^3/yr)	Flow direction
1 -	Crystal Brook Rd outflow	4,918	0.41%	46.57	111,774	Out from MRS amendment area
2 -	Brentwood Rd no flow	-	-	-	-	No flow
3 -	Johnson Pl outflow	13,386	0.07%	73.26	69,527	Out from MRS amendment area
4 -	Victoria Rd inflow	5,273	0.04%	54.91	11,652	Into MRS amendment area
5 -	Easterbrook Pl outflow	3,767	0.04%	16.39	3,240	Out from MRS amendment area
6 -	Easterbrook Pl outflow	3,705	0.15%	55.28	35,207	Out from MRS amendment area
7 -	Valcan Rd inflow	4,634	0.15%	23.50	20,560	Into MRS amendment area
8 -	Victoria Rd no flow	-	-	-	-	No flow
9 -	Tonkin Hwy no flow	-	-	-	-	No flow
10 -	Tonkin Hwy outflow	3,587	0.27%	34.51	41,473	Out from MRS amendment area
11 -	Tonkin Hwy outflow	4,971	0.20%	30.84	19,760	Out from MRS amendment area
12 -	Tonkin Hwy no flow	-	-	-	-	No flow
13 -	Tonkin Hwy outflow	3,319	0.37%	15.56	12,513	Out from MRS amendment area
14 -	Tonkin Hwy outflow	1,417	0.43%	87.23	23,054	Out from MRS amendment area
15 -	Boundary Rd outflow	389	0.51%	42.21	5,094	Out from MRS amendment area
16 -	Boundary Rd outflow	3,529	0.10%	58.13	11,662	Out from MRS amendment area
17 -	Boundary Rd outflow	383	0.90%	29.28	12,779	Out from MRS amendment area

Plate C1: Indicative Cross Section 1

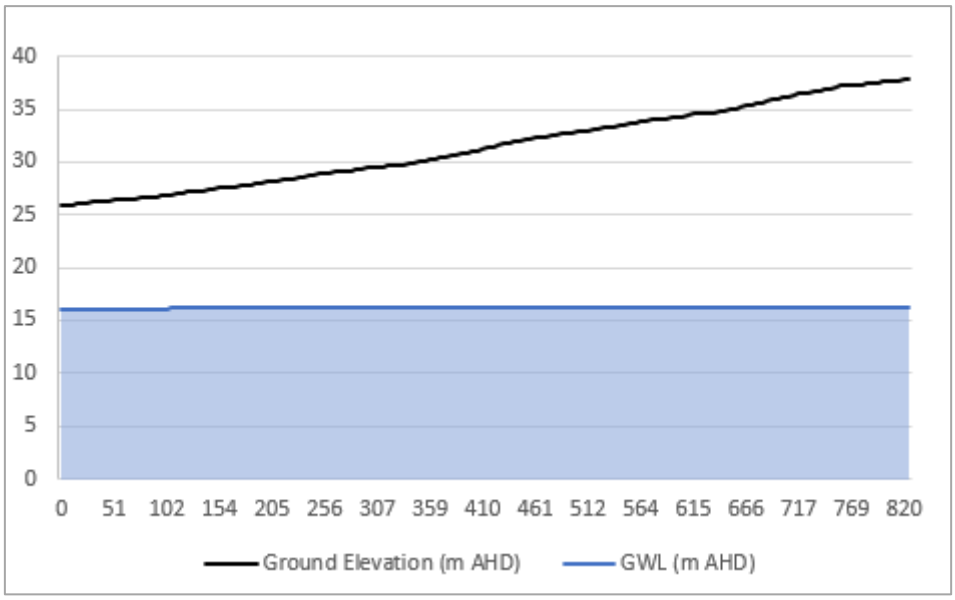
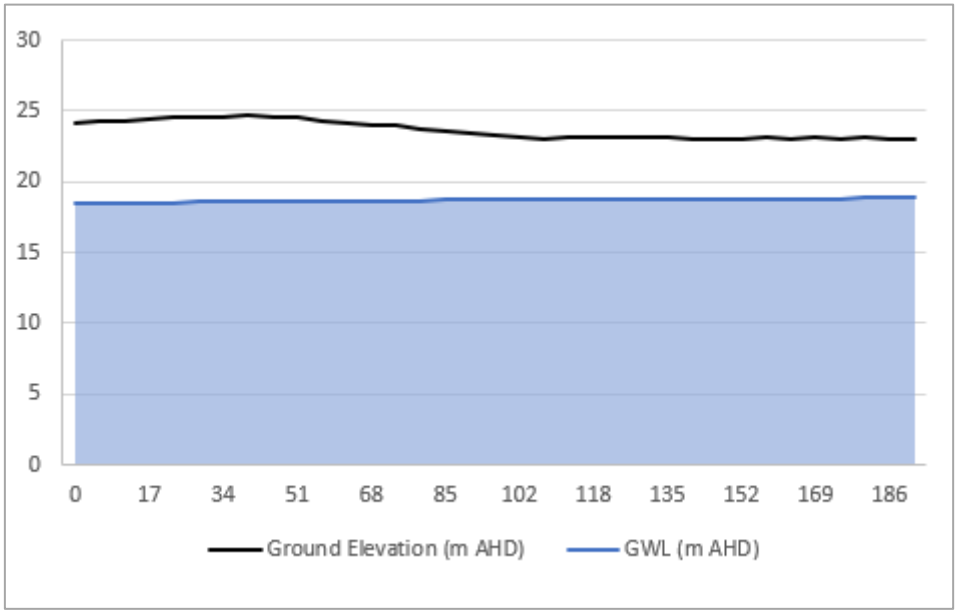


Plate C2: Indicative Cross Section 10



Post-development scenario

As the presence of the groundwater mound is expected to remain unchanged in the post-development scenario (see Section 3.2.4.1 of the WBA) the groundwater assumptions and summary presented in **Table C1** is expected to apply to the post-development scenario.

Perched system

The horizontal groundwater flow rate has been calculated using Darcy's law (*1*) from the components summarised in **Table C2** and the permeability for each cross-section location. Flow has been assumed to occur across the saturated part of the cross-sectional area. The final

yearly flow across each cross section is provided in **Table C2**. It is assumed that groundwater flow from the perched system will not change post development.

A visual example of the cross-sectional data is provided in **Plate C3**, which displays Cross Sections 1 (outflow to the north).

Table C2: Perched system groundwater throughflow summary

Cross section/ location	Cross sectional area (m^2)	Groundwater gradient	Angle of incidence (degrees)	Flow (m^3/yr)	Flow direction
1 - Boundary Rd outflow	68	1.19%	80.22	7,280	Out from MRS amendment area
2 – Boundary Rd outflow	-	-	-	-	No flow

Plate C3: Perched system indicative Cross Section 1

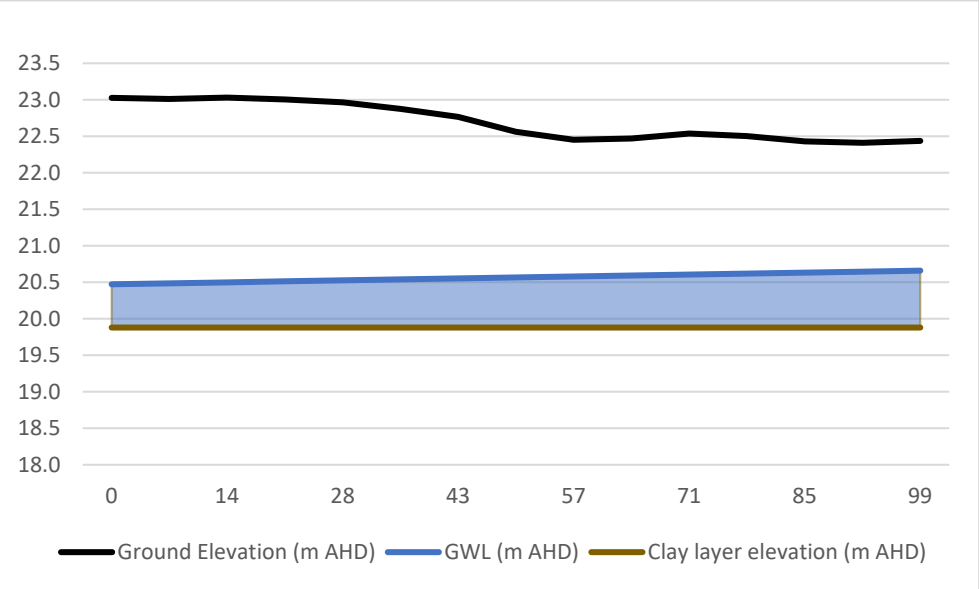


Table C3 summarises the total groundwater inflow and outflow from MRS amendment area as used in the water balance.

Note that the groundwater throughflow is not intended to comprise a wholistic water balance. The main WBA report details consideration of the other water balance components such as evapotranspiration, recharge, surface water, etc.

Table C3: Summary table

Scenario	Superficial Aquifer		Perched
	Pre-development	Post Development	Pre- and post-development
Inflow	32,212	32,212	-
Outflow	346,081	346,081	7,280

References

Department of Water and Environmental Regulation (DWER) 2022a, *Perth Groundwater Map*, <https://maps.water.wa.gov.au/Groundwater/>.

Department of Water and Environmental Regulation (DWER) 2022b, *Water Information Reporting*, <http://wir.water.wa.gov.au/Pages/Water-Information-Reporting.aspx>.

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Appendix D

Evapotranspiration

TECHNICAL ASSESSMENT

Project Name	**Wattle Grove South MRS Amendment 1388/57 Water Balance Assessment**
Project Number	**EP22-002**
Assessment Component	**Evapotranspiration**

Introduction

This document is a technical summary and is intended to be read in conjunction with the *Wattle Grove South Amendment 1388/57 Water Balance Assessment* (the WBA), which covers the Wattle Grove South amendment area (the MRS amendment area).

This document summarises the evapotranspiration components of the WBA. Evapotranspiration is determined indirectly through the quantification of other components in the water balance which are deducted from available water within the WBA area. Quantification of these components is based on published values presented in *Perth Regional Aquifer Modelling System* (PRAMS) documentation published by the Department of Water and Environmental Regulation (DWER formerly Department of Water/ DoW), and alignment with other components of the water balance (e.g. groundwater throughflow, rainfall, runoff, etc.).

Data and inputs

The data and inputs used to determine the annual evapotranspiration volumes are summarised below.

- Annual rainfall
- Groundwater abstraction / irrigation water (when applicable)
- Soil types (from regional soil mapping and MRS amendment area investigations)
- Land uses
- Vegetation type.

Delineation of MRS amendment area into representative recharge units

Several soil types and land use categories were distinguished in the pre-development and the post-development environments. For this assessment three distinct representative recharge units (RRU) areas (RRU1, RRU2, RRU3) have been determined based off the regional soil mapping, which are consistent with MRS amendment area investigations (soil bore logs) undertaken by Hyd2O (2022). The categorisation of land uses/types for the pre-development environment was based on MRS amendment area inspections and aerial photography/satellite imagery and the land uses can be broadly categorised as either ‘Pasture’ (i.e. areas which

predominately cleared with a low ground cover of grasses or similar) or 'Vegetation' (i.e. areas which are more densely vegetated and/or native trees, shrubs or similar) or 'Urban' (i.e. areas where pre-existing commercial development/hardstand, residential development and/or roads).

Land uses/types for the post-development environment were informed by a similar process as the pre-development environment. Land uses/types change to 'Commercial' (i.e. areas which are intended to generate profit and associated roads), 'Residential' (i.e. areas intended for human habitation, made up of suburban and associated roads), 'School' (i.e. educational facilities with associated sporting oval) or 'Public Open Space' (i.e. areas intended for public enjoyment and protection of existing vegetation).

The spatial extent of the RRUs and land types are shown on **Figures 10** and **11** of the WBA report for the pre-development and post-development environments respectively. The areas of each land type within each WBA area are summarised in **Table D1** and **Table D2**.

Table D1: Evapotranspiration land type area summary – pre-development

Land type	**Area (m^2)**		
	RRU1	**RRU2**	**RRU3**
Pasture	169,621	136,391	388,793
Vegetation	27,819	49,049	304,502
Urban	48,356	54,328	83,878

Table D2: Evapotranspiration land type area summary – post development

Land type	**Area (m^2)**		
	RRU1	**RRU2**	**RRU3**
Commercial	63,414	115,429	-
Residential	161,445	98,462	641,943
School	-	-	42,532
Public Open Space	22,394	25,648	92,676

Evapotranspiration by difference method

The losses to evapotranspiration for the WBA area have been determined by quantifying all other components of the assessment as a percentage of rainfall, such as groundwater recharge, surface runoff and interception. This method is useful for smaller scale evapotranspiration assessments as published data for similar land uses can provide sufficient levels of detail for the estimation of evapotranspiration (W. Dawes [CSIRO] 2022, pers. comm., 10 October). Published data that has been used for the determination of evapotranspiration has been obtained from research undertaken during the generation of the PRAMS modelling and is presented in this document.

PRAMS has been jointly developed by DWER and Water Corporation to assist with groundwater resource management. As part of the PRAMS development a Vertical Flux Model (VFM) was developed, with assistance from the Commonwealth Scientific and Industrial Research Organisation (CSIRO), to assess the temporal and spatial recharge to the aquifers beneath the Swan Coastal Plain. From these developments several studies have been published which make used of PRAMS (DoW 2008, 2009a, b, c, d) to estimate the recharge values for various types of soil, landuse and vegetation across the Swan Coastal Plain and a percentage of rainfall which becomes groundwater recharge.

As indicated the method adopted to estimate the evapotranspiration for the WBA area is through the quantification of the recharge, runoff and interception. A calibration of the outcome is achieved by taking the difference between all inputs and outputs of the water balance for the WBA area, and then calibrating the outcome to evapotranspiration rates adopted in other studies.

The background information and data from MRS amendment area investigations is presented in Section 2 of the WBA report.

Groundwater abstraction

Within the WBA area there are 14 licences to abstract groundwater from the superficial aquifer beneath the MRS amendment area that are registered with DWER. The groundwater allocation for these licences ranges from 2,400 kL/year up to 176,000 kL/year. Combined these bores abstract a total of 260,655 kL of water from beneath the MRS amendment area each year and assumed to be used predominantly for irrigation. It is noted that while all licenses are from the superficial aquifer, the logged depth of bores (based on information from the WIN database) may indicate that the extraction is occurring from a deeper confined aquifer. This is particularly the case for the turf farm located centrally within the amendment area, which has a reported screened depth of -30 m AHD to -40 m AHD (52m below ground level (BGL) to 62m BGL), and this would likely place the extraction into a deeper and presumably confined aquifer. For this assessment it is assumed that the full allocation is extracted every year and applied to the WBA area.

In the pre-development environment the total volume of this abstraction was determined for all bores within the MRS amendment area. This abstracted water is assumed to be irrigated across the MRS amendment area with the following assumptions being applied to this water:

- Irrigation water intercepted by MRS amendment area vegetation: 10%
- Amount of irrigation water becoming recharge: 20%

These assumptions are based on previous research presented in PRAMS documentation (DoW 2009b). The remaining volume of abstracted groundwater is then assumed to become evapotranspiration for the MRS amendment area with these values applied to the assessment after the evapotranspiration generated by rainfall is determined.

In the post-development environment it has been assumed that the existing private bores will be removed from the MRS amendment area and that all residential lots (including homestead lots) and commercial lots will be connected to the Water Corporation Integrated Water Supply Scheme (IWSS). This will cause a reduction in the amount of groundwater abstracted from the WBA area for the post-development environment. The only areas of land that will utilise groundwater will be 'Public Open Space' and 'School' land uses and are based on a prescribed irrigation rate (6,750 kL/ha/year) to determine the amount of groundwater abstracted from the superficial aquifer.

Vegetation - Pasture

The existing environment within the WBA areas is predominantly pasture, with some woody trees that are sparsely interspersed in the western regions of the MRS amendment area with increasing density towards the eastern portion of the WBA area.

Research undertaken by during PRAMS development (DoW 2009b) has found that approximately 30% to 45% of the rainfall becomes recharge to groundwater over areas of pasture. However, the soil type found beneath these areas of pasture also has an impact on the recharge estimate whereby increased amounts of fine grained soil, such as silts and clays, reduces the amount of rainfall that becomes recharge, and in some cases (such as Guildford Clays) this recharge value can be as low as 5% (Farrington *et al.* 1989; DoW 2009a, b).

Previous research into the aquifer systems found beneath the Perth region have defined a range of recharge assumptions that have been assessed for the various soil units, these recharge values assume that rainfall that falls over a given unit of soil will have a ratio of rainfall to runoff which has been robustly assessed in the creation of the PRAMS model.

Based on subsurface investigations within the WBA area the following recharge assumptions have been made for pasture land use for each soil unit which define the RRU areas:

- RRU1: 33 %
- RRU2: 38 %
- RRU3: 45 %.

Vegetation

The 'vegetation' in the WBA area (i.e. vegetation that is not pasture/grasses) is made up of pockets of remnant native and non-native vegetation which is associated with the commercial and residential developments within the MRS amendment area.

During the development of PRAMS (DoW 2008, 2009a, b, c, d) it was found that recharge is moderately impacted by vegetation with vegetation density having the biggest impact on estimation of the percentage of rainfall that becomes recharge. Vegetation density is a consideration of the amount of leaf coverage (or canopy) over a defined area. This assessment was carried out mostly on Banksia woodlands located north of Perth but the estimated recharge values can be applied to the majority of vegetation found on the Swan Coastal Plain.

Assessment of vegetation density for the WBA area has been undertaken through the use of aerial imagery/satellite imagery and MRS amendment area inspections. The delineation of the vegetation for the MRS amendment area has determined the areas of vegetation found in the pre-development environment. For the assessment of evapotranspiration the vegetation landuse has been considered in isolation (i.e. only the extent of the leaf canopy for individual stands of vegetation) across the MRS amendment area. Due to this the assumed density of the majority of vegetation was determined to be of 'low' with an assumed recharge value of 38% being used for the estimation of vegetation evapotranspiration. For the vegetation in the eastern region of the MRS amendment area (associated with RRU3) the density was determined to be 'medium' with an assumed recharge value of 18% for the estimation of evapotranspiration.

Urban, Commercial and Residential

Urban environments, which are defined as being made up of residential and commercial landuses, consist of large amount of impermeable surfaces (i.e. roofs, paved areas, roads, etc). These environments also have minimal areas of vegetation associated with their landuse. As such urban environments are considered to have increased recharge values due to the point sources of recharge/discharge, recharge sources that bypass the soil column through subsurface retention structures (such as soakwells/infiltration basins) and direct evaporation from surfaces with no vegetation (DoW 2009b).

For the pre-development environment the urban areas (both commercial and residential) were mapped from aerial imagery to determine an approximate area of the impermeable surface. Based on this mapping the following recharge assumptions have been made for urban land use for each soil unit which define the RRU areas:

- RRU1 (S_{10} soil unit): 59 %
- RRU2 (S_8 soil unit): 63 %
- RRU3 (S_{12} soil unit): 50 %.

For the post-development environment the estimation of recharge is done through the application of the linear equation as recommended by PRAMS (DoW 2009b). This is due to these post-development landuses being made up of a mixture of impermeable surfaces (such as roads, roofs and paving) and vegetation (from garden beds and streetscapes). The linear equation to determine the recharge for urban environments is as follows:

$$R = \alpha \times P - \beta \times PE \qquad (1)$$

Where *R* is net recharge, *P* is rainfall, *PE* is pan evaporation and coefficients α and β are constants based on the urban environment. These constants are noted as ranging from 0.4 to 0.75 depending on the urban environment (DoW 2009b).

The following values, which are based on the parameters presented in PRAMS documentation (DoW 2009b), have been used in the linear equation for the assessment of evapotranspiration:

- α = 0.75 for 'Commercial', 0.48 for 'Residential', 0.4 for 'POS' and 'School' land uses
- β = 0 for 'Residential' and 'Commercial'
- *PE* = 1800 mm/year.

It is also noted that post-development 'Commercial' lots (excluding associated roads) has no surface runoff as these are proposed to be fully retained lots that will not be discharging surface runoff from the WBA area. How surface runoff is estimated is presented later in this documents.

Public Open Space areas

No 'Public Open Space' land use is found within the WBA area for the pre-development environment and so is not considered for this scenario.

For the post-development environment a portion of the MRS amendment area is proposed to be established as 'Public Open Space' land use for the associated residential development. For this component of the evapotranspiration assessment the amount of rainfall that falls onto these areas and the irrigation water applied to them must be considered. For rainfall, the linear equation that has been recommended by PRAMS can be applied for quantifying recharge. For this the same rainfall amount that has been previously used is applied here with an α = 0.40 used for 'Parklands/Market Gardens'. Irrigation, water is assumed to be abstracted from superficial groundwater beneath the MRS amendment area at a prescribed irrigation rate (6,750 kL/ha/year) and this is applied to the proposed areas of 'Public Open Space'. As per PRAMS documentation (DoW 2008) it is assumed that 20% of this abstracted groundwater will return to the aquifer beneath the MRS amendment area as recharge. The same interception value (10%) is also used to account for turfed and planted areas found with these land uses.

School area

No 'School' land use is found within the WBA area for the pre-development environment and so is not considered for this scenario.

For the post-development environment a portion of the MRS amendment area is proposed to be established as 'School' land use. This landuse is considered as a mixture of the post-development 'Commercial' and 'POS' land uses as the runoff from the school MRS amendment area is proposed to be fully retained, and the sporting ovals associated with the school will be irrigated in a similar manner to the 'Public Open Space' areas. For this assessment 50% of the 'School' land use is quantified in the same method as the 'Commercial' land use and 50% is quantified using the same methodology as the 'Public Open Space' areas.

Surface Runoff

A surface water runoff assessment has been undertaken to quantify the annual volume of runoff conveyed into and discharging from the MRS amendment area (see Appendix A of the WBA). This assessment is based on the detailed catchment assessment and surface water runoff assessments previously undertaken by Hyd2O (2022) and Emerge Associates (Emerge Associates 2017, 2021). This surface runoff assessment has considered both the pre-development and post-development environments and accounts for upstream catchments.

From the surface water runoff assessment the following runoff recharge assumptions have been made:

- Pre-development environment:
  - 'Pasture' and 'Vegetation' land use: 7.1% of rainfall becomes surface runoff
  - 'Urban' land use: 7.0% of rainfall becomes surface runoff.
- Post-development environment:
  - 'Commercial' land use: 7.0% of rainfall becomes surface runoff from associated roads, commercial lots are fully retained and are assumed to produce no runoff
  - 'Residential' land use: 9.1% of rainfall becomes surface runoff
  - 'Public Open Space': 7.1% of rainfall becomes runoff while irrigation water is assumed to generate no surface runoff due to the nature of water application to these surfaces.

Rainfall interception

A portion of rainfall will be physically intercepted and stored on the leaves and branches of vegetation and litter found on the surface prior to it reaching the ground surface. This will eventually evaporate and hence constitutes a loss of water from the WBA area. It was observed during PRAMS development (DoW 2009b) that the values can vary from 7% (low density vegetation) to 12% (high density vegetation) of rainfall occurring over vegetated areas.

For the pre-development environment, based on the assumed recharge value for 'Vegetation' land use previously presented in this document being generally 'low' there will be an associated with lower interception due to reduced leaf mass and litter density. For the purposes of this assessment the following rainfall interception values have been assumed:

- 'Pasture' land use: 11%
- 'Vegetation' land use: varies from 7% to 9% dependant on vegetation density
- 'Urban' land use: 11%

For the post-development environment the land uses become increasingly urbanised so there is a general reduction in the amount of rainfall being intercepted. Rainfall that is intercepted is likely from the ponding and trapped lows that can occur from this land use (i.e. gaps in paving, porosity of roads, ponding of rainfall in road reserves, etc). For the purposes of this assessment the following interception values have been assumed:

- 'Commercial' and 'School' buildings land use: 5%
- 'Residential' land use: 7%
- 'Public Open Space' and 'School' oval land use: 11%

Evapotranspiration for WBA area

The recharge values discussed in this document were applied to each RRU and land use to quantify the amount of recharge, surface runoff and interception generated. The summation of these values was then removed from the rainfall amount to estimate the evapotranspiration for the WBA area. The abstracted groundwater, which has been considered as irrigation water for the MRS amendment area, was then assessed separately using the same method for rainfall evapotranspiration. These two evapotranspiration values were then combined to provide the total evapotranspiration for the WBA area.

In addition, two scenarios where the effects of climate change have been considered on the proposed development. These scenarios are based on future climate predictions by DWER which are presented in **Appendix B**. A summary of these climate change scenarios is a follows:

- Dry 2050 indicates an approximate reduction of rainfall in the vicinity of the WBA area of 4.4%, this represents and average annual rainfall of 702 mm.
- Dry 2100 indicates an approximate reduction of rainfall in the vicinity of the WBA area of 34.5%, this represents an average annual rainfall of 481 mm.

Results and Summary

The quantified components of the assessment of evapotranspiration is summarised in **Table D3** for the pre-development and post-development environments, including estimates for the Dry 2050 and Dry 2100 DWER future climate predictions.

Note that the evapotranspiration components are the quantification of the various components and are not intended to comprise a wholistic water balance. The main WBA report details consideration of the other water balance components such as groundwater throughflow, recharge, surface water, etc.

Table D3: Evapotranspiration summary

Evapotranspiration component (m^3/year)	**Pre-development**	**Post-development**	**Post-development (Dry 2050)**	**Post-development (Dry 2100)**
Direct rainfall (falling on MRS amendment area)	928,888	928,888	887,963	608,350
Irrigation water (abstracted from groundwater resources)	260,655	123,694	123,694	123,694
Irrigation water (from domestic supply)	32,500	46,000	46,000	46,000
Interception (rainfall)	95,346	63,529	60,684	41,580
Interception (irrigation)	29,316	18,206	18,206	18,206
Surface Runoff (rainfall)	65,752	76,886	69,427	28,279
Recharge (rainfall)	346,347	476,054	454,730	311,547
Net recharge (irrigation)	-26,024	-89,755	-89,755	-89,755
Evapotranspiration (rainfall)	**420,566**	**312,427**	**302,447**	**226,524**
Evapotranspiration (irrigation)	**205,209**	**117,549**	**117,549**	**117,549**
Total Evapotranspiration	**625,775**	**429,976**	**419,996**	**344,073**

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Appendix E

Salinity and Sodicity

TECHNICAL ASSESSMENT

Project Name	**Wattle Grove South MRS Amendment 1388/57 Water Balance Assessment**
Project Number	**EP22-002**
Assessment Component	**Salinity and Sodicity**

Introduction

This technical summary is intended to be read in conjunction with the *Wattle Grove South Amendment 1388/57 Water Balance Assessment* (the WBA), which covers the Wattle Grove South amendment area (the MRS amendment area). This document assesses the potential impacts of salinity and soil sodicity to the surface water and groundwater of the MRS amendment area and upstream catchments (urban expansion (UE) and urban investigation (UI) areas) presented in the WBA. Changes in water chemistry to these water sources present a risk to the water quality of the surrounding environment, particularly the nearby Greater Brixton Street Wetlands (GBSW) and where groundwater is close to the surface.

Soil salinity is the result of soluble salts (often associated with near surface groundwater interactions), concentrating within the shallow soil profile. The ions in salt that are responsible for causing salinity in soils are sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}) and chlorine (Cl^-).

Soil salinity occurs due to the soluble salts binding to clay particles found in soil due to their large surface area and inherent surface reactivity (ionic charge being positive or negative). These salts can be naturally occurring due to redistribution by water or caused by human activity (such as irrigation). Soluble salts may be transported through the soil profile by the movement of water, this can be through the groundwater; both vertically and horizontally. Seasonal variations in groundwater movement have the potential to transport increasing amounts of salt to the shallow soil profile. During dry periods the groundwater elevations can recede to the deeper soil profile due to lack of recharge from rainfall and increased evaporation. In areas where groundwater has receded the dissolved salts can bind to clay particles as it dries and remain in the shallow profile. During periods of increased rainfall groundwater level can rise and bound salts become re-saturated and are released back into solution, becoming part of the groundwater. As this process is repeated due to climatic cycles this can have the effect of increasing the concentration of salt within the shallow soil profile, resulting in soil salinity.

Soil sodicity is where the proportion of sodium ions resulting from soil salinity is excessive, leading to a loss of soil structure.

If the salts that are deposited in the shallow soil profile contain elevated amounts of Na^+ ions these can displace other ions (such as K^+, Ca^{2+}), leading to a change in the proportion Na^+ in the soil and an impact to soil structure. Once the Na^+ within the soil concentrates to an amount that it begins to affect the soil structure then this soil is considered to be sodic. Sodicity degrades the properties of soil by weakening the bonds between the soil particles. These structural problems commonly present as (DPIRD 2021):

- Soil become waterlogged when wet
- Reduced water infiltration capacity
- Dispersive soils (standing water becomes cloudy)
- Excessive shrinking/swelling behaviour when dry/wet
- Susceptibility to erosion
- Form hard setting crust when dry
- Abnormal/poor vegetation growth.

Given the development of soil salinity/sodic soil conditions requires groundwater to be at or have the potential to be at the surface, this will only be relevant to the parts of the site which display these conditions.

Existing conditions of the MRS amendment area

Previous research into the GBSW undertaken by the Environmental Protection Authority (EPA) has identified the presence of soil salinity within the shallow soil profile and the presence of salt tolerance vegetation (EPA 2022); this is most relevant to the areas southwest of Brixton Street (Wanaping Block) which are well removed from the MRS amendment area. A summary of concerns raised from this investigation are presented below:

- Changes in the water balance could lead to groundwater level rise close to the natural surface for capillary action to draw up salt, which create sodic soil conditions.
- Groundwater salinity is possibly driven by upward discharge of the saline Leederville aquifer beneath GBSW.
- Evaporation is a driving factor for concentrating salts in clayey sediments within GBSW.
- Increases in shallow groundwater levels can lead to waterlogging of soils.

Due to the proximity of the GBSW to the MRS amendment area (GBSW is west of Tonkin Highway) it is understood that there are concerns that the elevation of groundwater beneath GBSW may be altered due to the change in landuse from the proposed development. An increase in groundwater levels could potentially impact soil chemistry. Increases to groundwater levels could transport additional dissolved salts (solutes) from the shallow soil profile to the surface in areas where groundwater may not have previously intersected the surface (i.e. within GBSW). These solutes may persist and concentrate within the soils over the drier summer months (due to evaporation) may potentially impact the condition and health of vegetation within GBSW.

Groundwater level

Groundwater levels have been measured from a series of bores in the vicinity, and within, the MRS amendment area (see Section 2.7.2 of WBA). These indicate that the groundwater levels

across the MRS amendment area are significantly lower than the natural surface (> 10 m below ground level (BGL)) for the majority of the site, and this is highly unlikely to change as a result of development within the MRS amendment area due to the permeable sandy soils beneath the site.

Assessment of recharge to groundwater has been considered (see Section 4.1.1 of WBA) which indicates that the MRS amendment area will experience an increase in groundwater recharge due to the proposed development. However, the overall increase to recharge will be vertically towards the deeper and permanent superficial aquifer, and not to the margins which display shallow perched conditions. Groundwater levels are several metres below the natural surface and therefore not expected to rise enough to deposit salts to the surface.

There is a relatively minor westerly margin of the site where thin sand over clay conditions exist, however the drivers for groundwater levels in this area will not change as a result of development of the MRS amendment area.

The risk of salt being draw up to the surface, which create saline/sodic soil conditions, is not considered to be a concern for the MRS amendment area. Further, given that there will be no changes to shallow (perched) groundwater conditions as a result of development of the MRS amendment area (either within the site or adjacent), there are no drivers to change the shallow groundwater levels beneath GBSW, and therefore, no potential impacts to soil chemistry of GBSW are expected.

Upward discharge from Leederville aquifer

The investigation of groundwater conditions (see Section 2.7 of WBA) indicates a multi-layered aquifer system beneath the MRS amendment area. This system includes the Leederville aquifer which underlies the Superficial Swan aquifer. An assessment of the degree of connectivity between these aquifer systems has been undertaken to understand the degree of vertical groundwater movement. This assessment suggests that there is limited to no connectivity between the Superficial Swan and Leederville aquifer beneath the MRS amendment area.

Therefore, the risk of saline groundwater upwardly discharging from the Leederville aquifer beneath the MRS amendment area, and thereby contributing to soil salinity, is considered to be minimal and will not impact the MRS amendment area or GBSW.

Evaporation concentrating salt within clayey sediments in shallow soil profile

Investigations into the soil conditions of the MRS amendment have been undertaken (see Section 2.6 of WBA). Soils found within the MRS amendment area are generally considered to be sand with finer grained soils (such as clays and silts) being located along the western boundary and northern boundary. Due to the majority of the MRS amendment area being classified as sandy material the risk of salt being concentrated within shallow soil profile is considered to be minimal.

The finer grained soil located along the western and northern boundaries of the MRS amendment area present some potential that salt could be concentrated at these locations from evaporation. However, there are no drivers present (resulting from future development

□□□

in the MRS amendment area) to change the shallow groundwater levels. Therefore the following conclusions are made for these areas:

- Rainfall deposited onto these locations, which is considered to have a low salt content, will not be contribute to soil salinity.
- The soil that surrounds these locations within the MRS amendment area are classified as sandy, and will promote the draining of water into the deeper soil profile and away from these locations, as currently occurs. These areas will therefore have a low potential for loss of groundwater from the soil profile due to evaporation.

Based on these conclusions the risk of evaporation concentrating salt within the shallow soil profile in the MRS amendment area and immediate surrounds as a result of development within the MRS amendment area is minimal to non-existent. As the potential for evaporation concentrating salt within the shallow soil profile is considered to be minimal it is also concluded that there will be no potential for increased salt concentrations within GBSW due to evaporation (as a result of changes resulting from development within the MRS amendment area).

Waterlogged soils

The waterlogging of soils is evidence of a possible sodic soil, as water is unable to infiltrate into the deeper soil profile (potentially due to the structureless soil caused by sodicity). For the majority of the MRS amendment area this is not of concern as the measured water table is of significant depth below the natural surface (up to 10 m BGL). The permeable nature of the soils found across the majority of the MRS amendment area (sands) also promotes the free draining of surface water into the deeper soil profile, thereby mitigating the risk of waterlogging occurring.

For the minor areas of finer grained soil, found along the western and northern boundary of the MRS amendment area, whilst there is some potential for waterlogging of these soils to occur, the groundwater levels in these areas will not rise as a result of development in the MRS amendment area. Further, due to the likely fresh nature of the perched groundwater system associated with these locations waterlogging in these locations is of minimal concern.

Summary

Soil salinity and sodicity have been identified as of concern for GBSW due to proposed development of the MRS amendment area changing existing landuses, and therefore changing hydrological conditions which affect GBSW. If groundwater within the shallow soil profile beneath GBSW were to rise this could potentially increase soil salinity within the shallow soil profile of GBSW. Such increased salinity can induce soil sodicity which has been identified as a concern for GBSW.

While salinity has been noted within the adjacent GBSW the soils within the MRS amendment areas are geologically distinct, generally consisting of sandy soils to depth with areas of finer grained clay/silt soil generally found along the western and northern boundaries. In comparison, GBSW consists of majority fine grained soils with smaller deposits of sandy soil. The depth to groundwater is also different with GBSW consisting of shallow depths to the

water table while the MRS amendment area has a significant depth to groundwater (10 m BGL). This is of importance as salt can be transported to the surface via capillary force if the water table is close to the surface. While it has been noted in the WBA that there will be an increase to recharge from the proposed development this will generally infiltrate towards the deeper and permanent superficial aquifer, and not to the margins which display shallow perched conditions. Groundwater levels are several metres below the natural surface and therefore not expected to change enough to cause a rise in groundwater which would deposit salts to the surface.

The more saline Leederville aquifer, while being located beneath the MRS amendment area, likely has no/minimal connection to the Superficial Swan aquifer. With minimal connection noted between these aquifer systems (and the depth to groundwater) it is unlikely that the Leederville aquifer will contribute to soil salinity for GBSW and the MRS amendment area.

The results of this investigation into the impacts of soil salinity and sodicity indicate that there is minimal concern from the proposed development increasing soil salinity with GBSW due to the permeable nature of soils and significant depth to groundwater found within the MRS amendment area. For the minor portions of the site which exhibit some potential for shallow groundwater to be close to the surface, there are no drivers to change the existing groundwater conditions and therefore it is concluded that the risk of soil salinity and sodicity changing as a result of the proposed change in land use in the MRS amendment area and the urbanisation of the UE and UI areas is negligible. When considering impact from the proposed development it is considered that there is no potential risk for an increase to soil salinity and sodicity to GBSW.

References

Department of Primary Industries and Regional Development (DPIRD) 2021, *Identifying dispersive (sodic) soils*, <https://www.agric.wa.gov.au/dispersive-and-sodic-soils/identifying-dispersive-sodic-soils#:~:text=severely%20dispersive%20topsoils.-,Measure%20the%20exchangeable%20sodium%20percentage,than%2015%20(Table%201).&text=No%20dispersion%20evident%20after%2024%20hours.>.

Environment Protection Authority (EPA) 2022, *Environmental values and pressures for the Greater Brixton Street Wetlands on the Swan Coastal Plain*, Western Australia.

APPENDIX P
Stormwater Modelling
of Indicative Concept Plan

CURRV

Calculator for Urban Runoff Rates & Volumes
30/01/2024

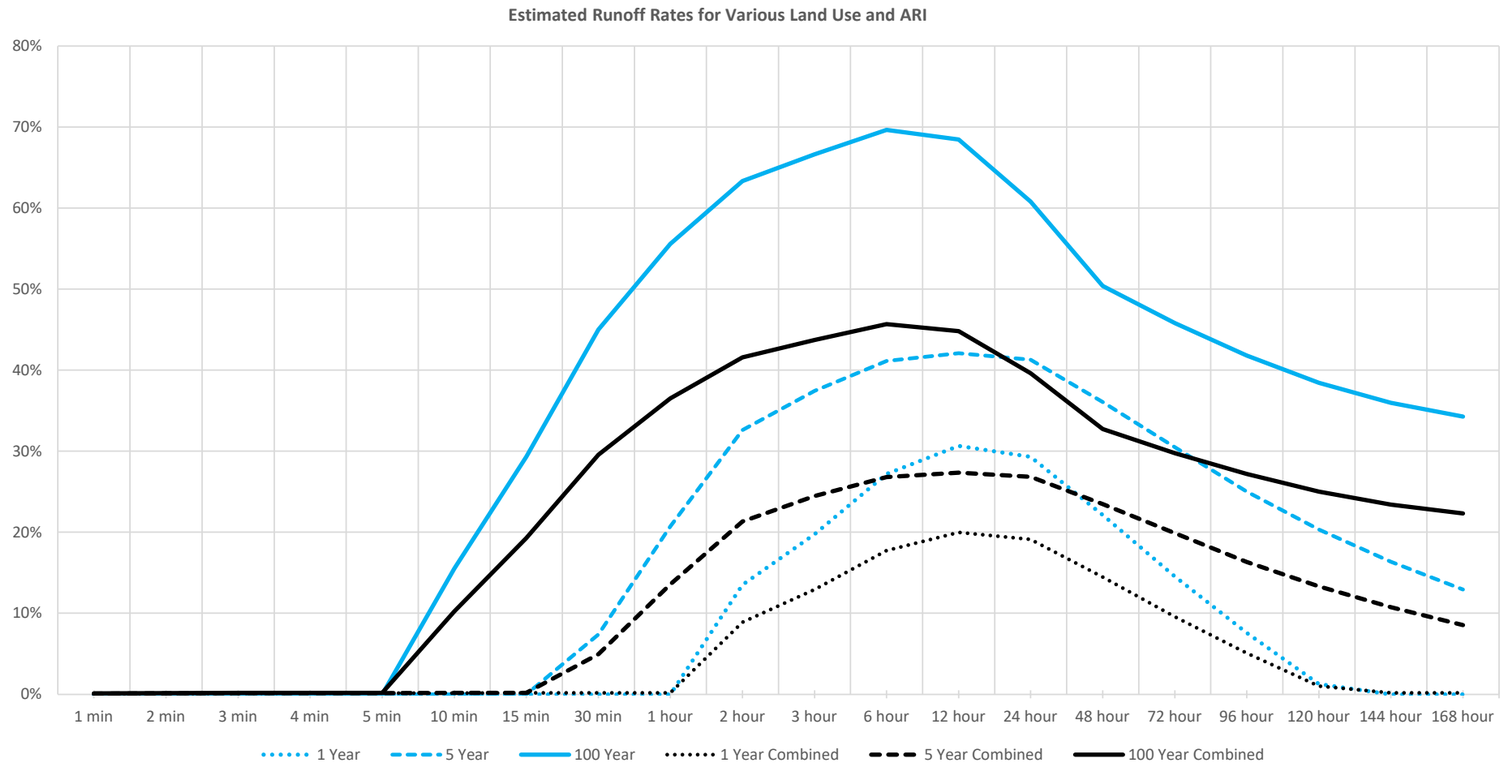
	Land Use Description	Area (ha)	Use in Calc	Imperv Initial Loss mm	Perv Initial Loss mm	Perv Continue Loss mm/hr	On Site Soak (mm)	Empty (days)	AR&R EIA/TIA System Connect Ratio	Roof %	Ext Imp %	Ext Perv %	Comment
1	Urban Lots	68	Yes	1.5	20.0	4.0	15.0	1.00	60%	60	15	25	soakwells assumed
2	Local Roads	26	Yes	1.5	20.0	4.0	15.0	1.00	100%	0	70	30	15mm on site assumed as biofilters modelled separately
3	POS	14	Yes	1.5	20.0	4.0	0.0	1.00	30%	0	5	95	including conservation areas
4	School	4	No	1.5	20.0	4.0		1.00					runoff management on site
5	Commercial	14	No	1.5	20.0	4.0		1.00					runoff management on site
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				1.5	20.0	4.0		1.00					

EIA : Effective Impervious Area, TIA : Total Impervious Area

Land Use Graph Selector **2**

(11 - combined total)

Local Roads



Project **Wattle Grove DWMS : Stormwater Modelling**

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	1.7	1.9	2.5	2.9	3.4	4.0	4.4
2	2 min	3.0	3.3	4.3	4.9	5.6	6.6	7.4
3	3 min	4.0	4.4	5.7	6.7	7.6	9.0	10.1
4	4 min	4.9	5.4	7.0	8.2	9.4	11.0	12.4
5	5 min	5.6	6.2	8.1	9.4	10.8	12.8	14.4
6	10 min	8.1	9.0	11.8	13.9	15.9	18.8	21.1
7	15 min	9.8	10.8	14.3	16.7	19.2	22.7	25.4
8	30 min	13.0	14.4	18.8	22.0	25.3	29.8	33.4
9	1 hour	15.0	18.6	24.2	28.2	32.4	38.4	43.2
10	2 hour	22.0	24.0	30.9	36.2	41.8	49.9	56.8
11	3 hour	25.6	27.9	35.9	42.1	48.8	58.7	67.3
12	6 hour	33.1	36.0	46.5	54.8	64.0	78.0	90.2
13	12 hour	42.7	46.5	60.2	71.1	83.2	102.0	118.0
14	24 hour	54.2	59.3	76.8	90.2	105.0	126.0	145.0
15	48 hour	68.0	74.6	95.9	111.0	126.0	148.0	166.0
16	72 hour	77.6	85.2	109.0	124.0	139.0	161.0	178.0
17	96 hour	85.8	94.1	119.0	136.0	151.0	173.0	190.0
18	120 hour	93.2	102.0	129.0	147.0	163.0	186.0	203.0
19	144 hour	100.0	110.0	139.0	158.0	176.0	200.0	219.0
20	168 hour	108.0	118.0	149.0	170.0	189.0	217.0	238.0

Estimated Runoff Rates
Annual Exceedence Probability

	63.2%	50%	20%	10%	5%	2%	1%
Maximum of All Events	1.00	1.44	4.48	10	20	50	100
Urban Lots	**20%**	22%	**27%**	**31%**	35%	40%	**43%**
Local Roads	**31%**	34%	**42%**	**50%**	57%	65%	**70%**
POS (excluding DBNGP Corridor)	**1%**	1%	**5%**	**8%**	11%	14%	**16%**
School	**0%**	0%	**0%**	**0%**	0%	0%	**0%**
Commercial	**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	**20%**	22%	**27%**	**33%**	37%	43%	**46%**

Event Selector	**1**	**1 min**					
Urban Lots	**0%**	0%	**0%**	**0%**	0%	0%	**0%**
Local Roads	**0%**	0%	**0%**	**0%**	0%	0%	**0%**
POS (excluding DBNGP Corridor)	**0%**	0%	**1%**	**1%**	1%	1%	**1%**
School	**0%**	0%	**0%**	**0%**	0%	0%	**0%**
Commercial	**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	**0%**	0%	**0%**	**0%**	0%	0%	**0%**

Date: 11/2/2024 Job No. H22076



Amendment Area
Catchments
Stormwater Flow
Existing Outlet

20% AEP Storage Area
1% AEP Storage Area
15mm Biofiltration Area

Indicative Land Use Applied for Modelling Purposes
Urban Area
Commercial Area
Conservation/POS Area

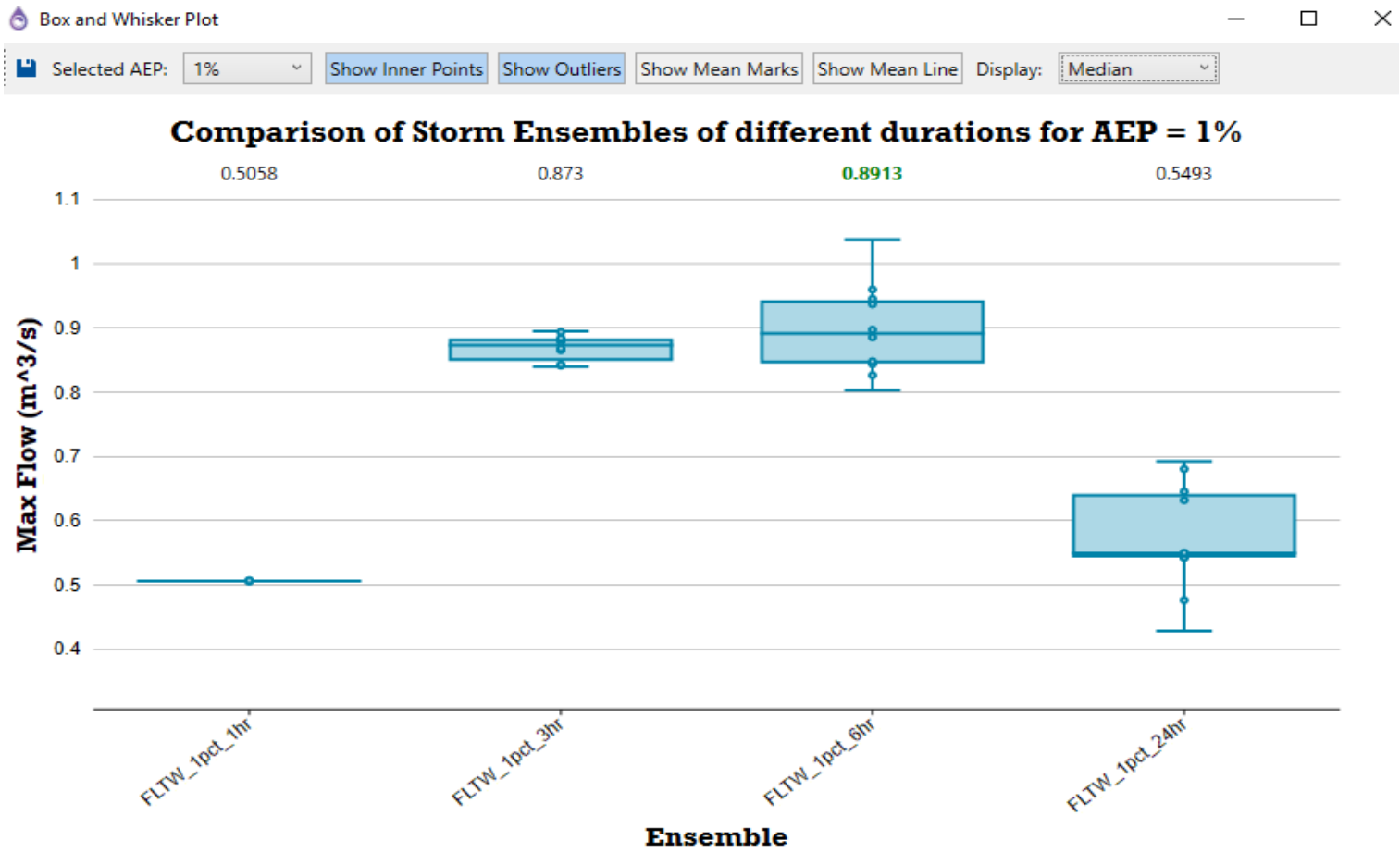
hyd2o

Wattle Grove South District Water Management Strategy

Stormwater Modelling : Indicative Concept

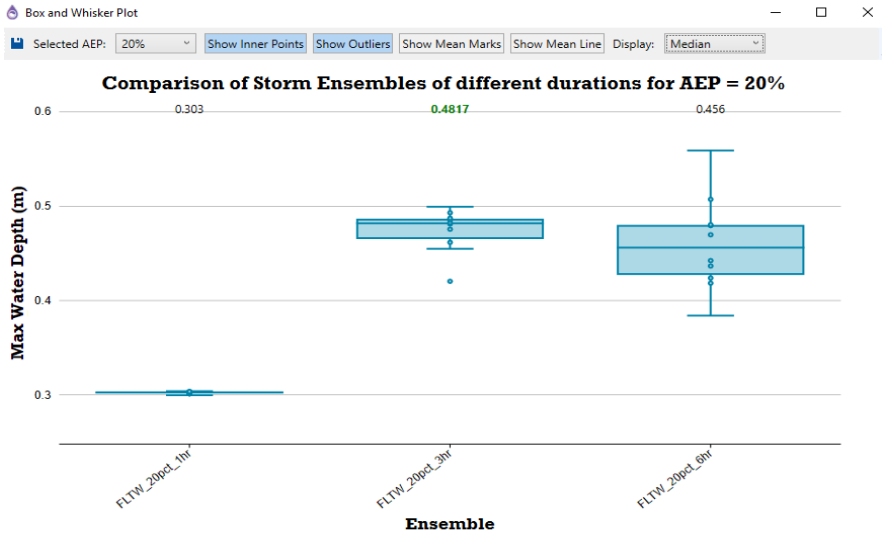
Appendix P

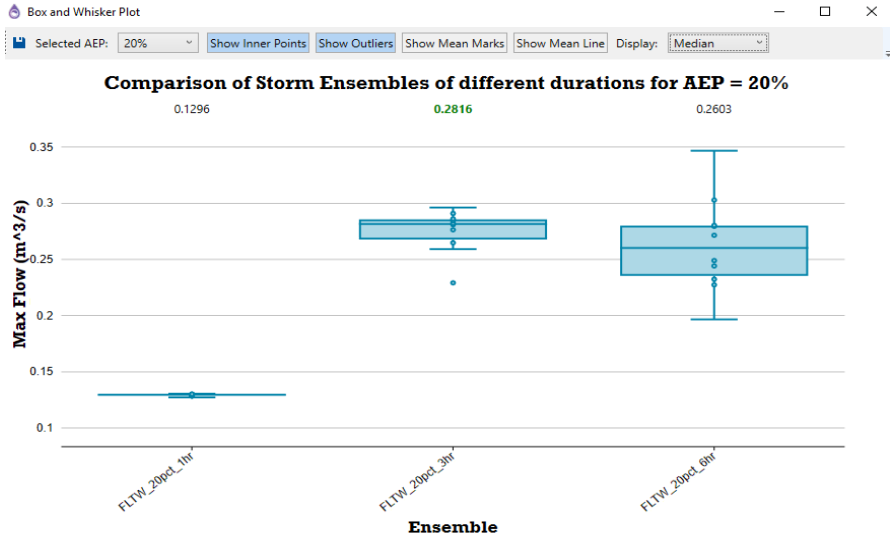
Date : 29/1/2024 Job No: H22076

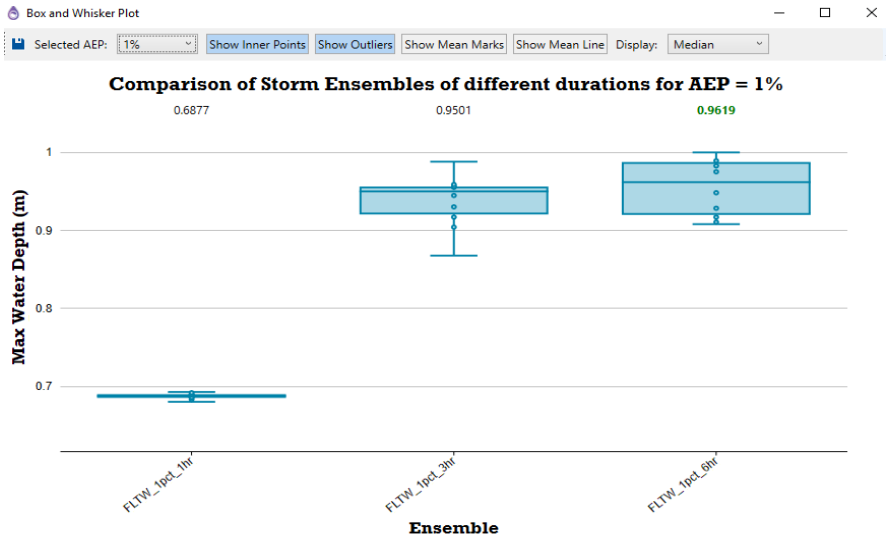


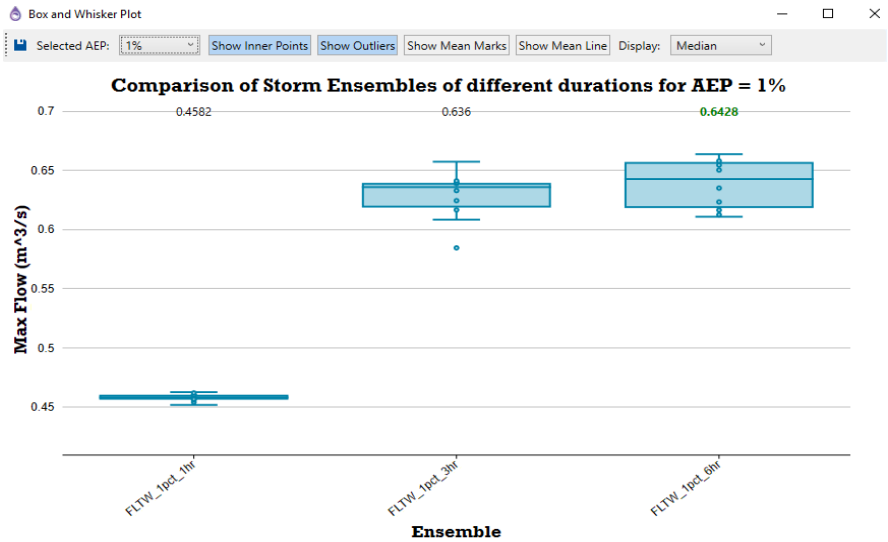
Based on XP-Storm Modelling, 126 ha Rural Catchment

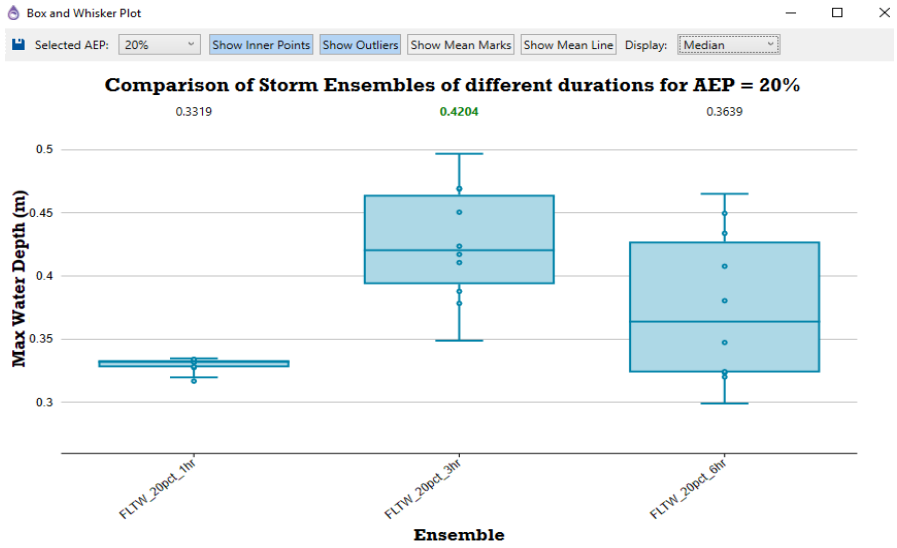
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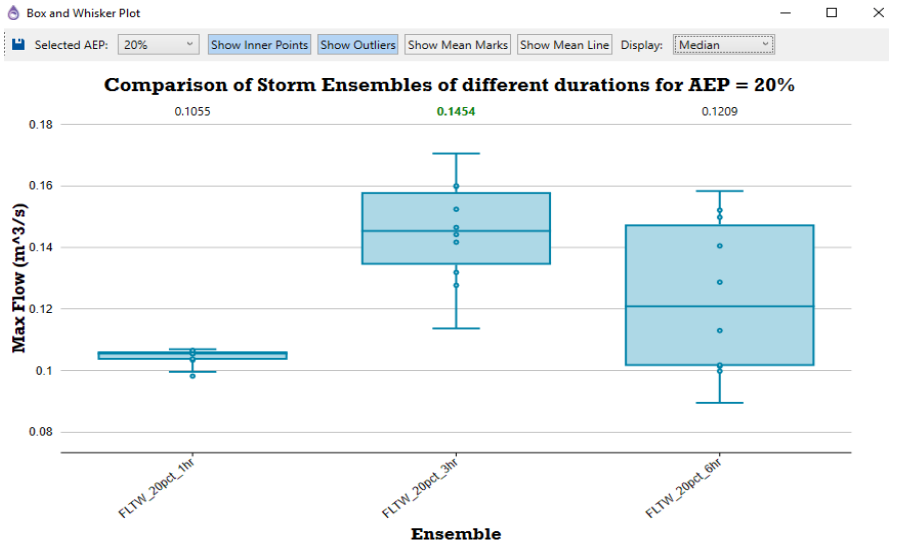


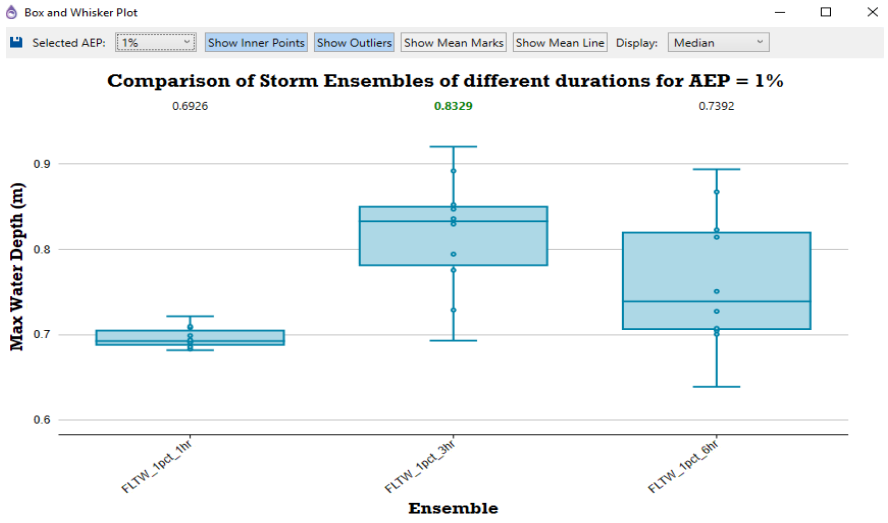


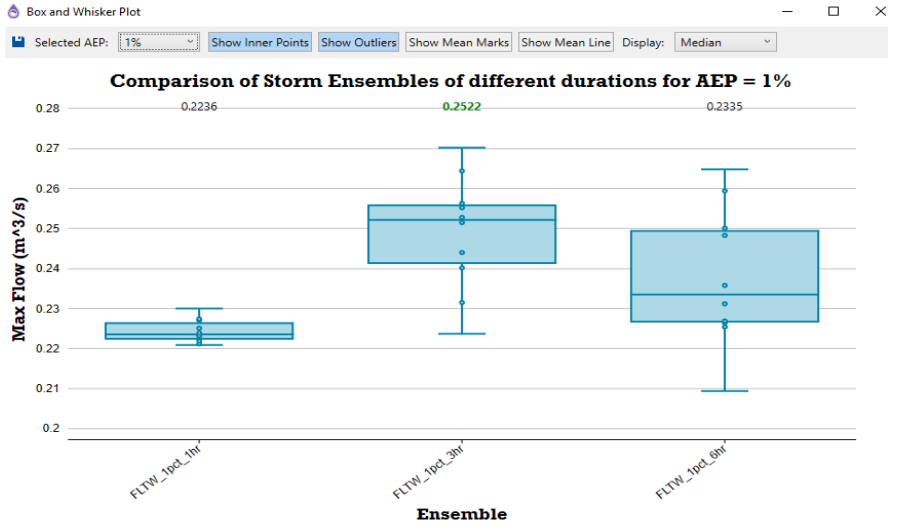





Box and Whisker Plot
Selected AEP: 20%
Show Inner Points
Show Outliers
Show Mean Marks
Show Mean Line
Display: Median
Comparison of Storm Ensembles of different durations for AEP = 20%
0.3319
0.4204
0.3639
Max Water Depth (m)
0.5
0.45
0.4
0.35
0.3
FLTW_20pct_1hr
FLTW_20pct_3hr
FLTW_20pct_6hr
Ensemble


Box and Whisker Plot
Selected AEP: 20%
Show Inner Points
Show Outliers
Show Mean Marks
Show Mean Line
Display: Median
Comparison of Storm Ensembles of different durations for AEP = 20%
0.1055
0.1454
0.1209
Max Flow (m^3/s)
0.18
0.16
0.14
0.12
0.1
0.08
FLTW_20pct_1hr
FLTW_20pct_3hr
FLTW_20pct_6hr
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%
0.6926
0.8329
0.7392
Max Water Depth (m)
0.9
0.8
0.7
0.6
FLTW_1pct_1hr
FLTW_1pct_3hr
FLTW_1pct_6hr
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%
0.2236
0.2522
0.2335
Max Flow (m^3/s)
0.28
0.27
0.26
0.25
0.24
0.23
0.22
0.21
0.2
FLTW_1pct_1hr
FLTW_1pct_3hr
FLTW_1pct_6hr
Ensemble

APPENDIX Q

Amendment Area Pre and Post Development
Superficial Aquifer Recharge Assessment

Pre Development & Post Development Recharge Comparison

Assessment Scale : Amendment Area (126 ha)

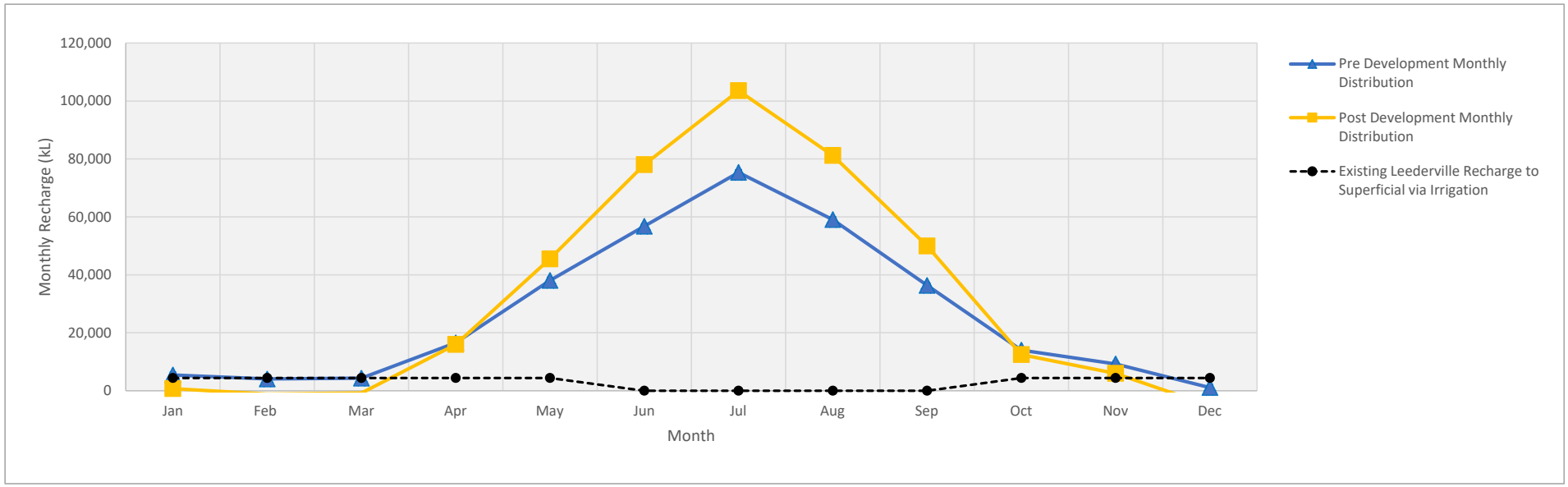
		Pre Dev		Post Dev
Irrigation via Groundwater Leederville (kL/yr)		176,000		0
RECHARGE	20%	35,200	20%	0
Irrigation via Domestic Supply (IWS) (kL/yr)		32,500		46,000
RECHARGE	20%	6,500	20%	9,200
Irrigation via Groundwater Superficial (kL/yr)		84,655		123,694
RECHARGE	20%	16,931	20%	24,739
Recharge Total Above (kL/yr)		58,631		33,939
Including Local Superficial Use (kL/yr)		-26,024		-89,755
Rainfall Recharge (kL/yr) - via Emerge (2024)		346,347		476,054
Total Recharge Within Amendment Area (kL/yr)		**320,323**		**386,299**

Pre Development Monthly Distribution

	Rainfall	Leederville	IWSS	Superficial	TOTAL
Jan	8,420	4,400	1,083	-8,466	5,438
Feb	7,054	4,400	1,083	-8,466	4,071
Mar	7,328	4,400	1,083	-8,466	4,346
Apr	19,511	4,400	1,083	-8,466	16,529
May	42,116	4,400	0	-8,466	38,050
Jun	56,764	0	0	0	56,764
Jul	75,337	0	0	0	75,337
Aug	59,066	0	0	0	59,066
Sep	36,359	0	0	0	36,359
Oct	18,080	4,400	0	-8,466	14,015
Nov	12,242	4,400	1,083	-8,466	9,260
Dec	4,069	4,400	1,083	-8,466	1,087
	346,347	35,200	6,500	-67,724	**320,323**

Post Development Monthly Distribution

Rainfall	Leederville	IWSS	Superficial	TOTAL
11,574	0	1,533	-12,369	738
9,695	0	1,533	-12,369	-1,141
10,073	0	1,533	-12,369	-763
26,818	0	1,533	-12,369	15,981
57,888	0	0	-12,369	45,519
78,022	0	0	0	78,022
103,551	0	0	0	103,551
81,187	0	0	0	81,187
49,976	0	0	0	49,976
24,851	0	0	-12,369	12,482
16,827	0	1,533	-12,369	5,991
5,592	0	1,533	-12,369	-5,244
476,054	0	9,200	-98,955	**386,299**



Pre Development & Post Development Recharge Comparison

Assessment Scale : Turf Farm Area and Surrounds (29 ha)

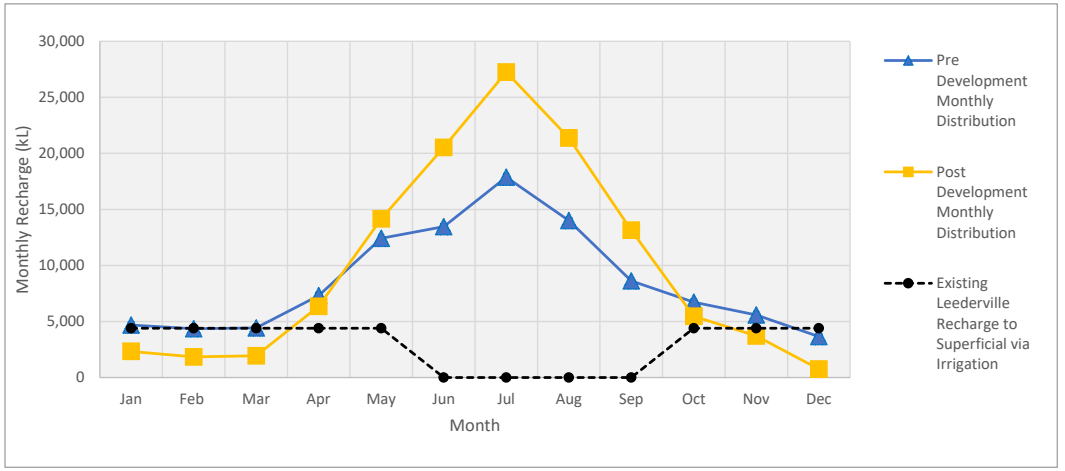
	Pre Dev	Post Dev
Area Considered for Analysis (ha)	29.3	29.3
Extenal Stormwater Catchment to be Managed in Area (ha)	0.0	21.2
Annual Rainfall (mm)	758	
Rainfall Recharge (via Emerge 2024) (%)	37%	51%
Volume of Rainfall Recharge (kL/yr)	82,175	113,268
Irrigation via Leederville Aquifer (kL/yr)	176,000	0
Irrigation Recharge (via Emerge 2024) (%)	20%	20%
Volume of Recharge via Leederville Irrigation (kL/yr)	35,200	0
Superficial Area Abstraction in Area (kL/yr) (via Water Register, & post dev pro rata)	19,700	10,697
Net Abstraction Following Recharge Consideration (%)	80%	80%
Volume Abstracted from Superficial (kL/yr)	15,760	8,557
Irrigation via IWSS		
Total for Amendment Area (via Emerge, 2024) (kL/yr)	32,500	46,000
Local Mound Area as % of total Amendment Area	23%	23%
Irrigation Recharge (via Emerge 2024) (%)	20%	20%
Volume of Recharge via IWSS Irrigation (kL/yr)	1,512	2,139
Post Development Infiltration in Area of Current Mound via External Catchment		
Road Area providing minor event runoff (25% of area assumed) (ha)		5.3
% Rainfall managed/retained in 15mm Areas, via Emerge (2024) 8% annual runoff		92%
% Runoff via road reserves in minor events (via stormwater modelling, Appendix P)		64%
Recharge (via Emerge 2024) (%)		51%
Volume of Stormwater Recharge (kL/yr)		12,064
Total Recharge Within Amendment Area (kL/yr)	**103,126**	**118,914**

Pre Development Monthly Distribution

	Rainfall	Leederville	IWSS	Superficial	TOTAL
Jan	1,998	4,400	252	-1,970	4,680
Feb	1,674	4,400	252	-1,970	4,355
Mar	1,739	4,400	252	-1,970	4,421
Apr	4,629	4,400	252	-1,970	7,311
May	9,992	4,400	0	-1,970	12,422
Jun	13,468	0	0	0	13,468
Jul	17,875	0	0	0	17,875
Aug	14,014	0	0	0	14,014
Sep	8,627	0	0	0	8,627
Oct	4,290	4,400	0	-1,970	6,720
Nov	2,905	4,400	252	-1,970	5,586
Dec	965	4,400	252	-1,970	3,647
	82,175	35,200	1,512	-15,760	**103,126**

Post Development Monthly Distribution

	Rainfall	Leederville	IWSS	Superficial	Stormwater	TOTAL
Jan	2,754	0	357	-1,070	293	2,334
Feb	2,307	0	357	-1,070	246	1,839
Mar	2,397	0	357	-1,070	255	1,939
Apr	6,381	0	357	-1,070	680	6,347
May	13,773	0	0	-1,070	1,467	14,171
Jun	18,564	0	0	0	1,977	20,541
Jul	24,638	0	0	0	2,624	27,262
Aug	19,317	0	0	0	2,057	21,374
Sep	11,891	0	0	0	1,266	13,157
Oct	5,913	0	0	-1,070	630	5,473
Nov	4,004	0	357	-1,070	426	3,717
Dec	1,331	0	357	-1,070	142	759
	113,268	0	2,139	-8,557	12,064	**118,914**



Pre Development & Post Development Recharge Comparison

Assessment Scale : Turf Farm Area (14 ha)

	Pre Dev	Post Dev
Area Considered for Analysis (ha)	13.7	13.7
Extenal Stormwater Catchment to be Managed in Area (ha)	0.0	36.8
Annual Rainfall (mm)	758	
Rainfall Recharge (via Emerge 2024) (%)	37%	51%
Volume of Rainfall Recharge (kL/yr)	38,423	52,961
Irrigation via Leederville Aquifer (kL/yr)	176,000	0
Irrigation Recharge (via Emerge 2024) (%)	20%	20%
Volume of Recharge via Leederville Irrigation (kL/yr)	35,200	0
Superficial Area Abstraction in Area (kL/yr) (via Water Register, & post dev pro rata)	0	5,002
Net Abstraction Following Recharge Consideration (%)	80%	80%
Volume Abstracted from Superficial (kL/yr)	0	4,002
Irrigation via IWSS		
Total for Amendment Area (via Emerge, 2024) (kL/yr)	32,500	46,000
Local Mound Area as % of total Amendment Area	11%	11%
Irrigation Recharge (via Emerge 2024) (%)	20%	20%
Volume of Recharge via IWSS Irrigation (kL/yr)	707	1,000
Post Development Infiltration in Area of Current Mound via External Catchment		
Road Area providing minor event runoff (25% of area assumed) (ha)		9.2
% Rainfall managed/retained in 15mm Areas, via Emerge (2024) 8% annual runoff		92%
% Runoff via road reserves in minor events (via stormwater modelling, Appendix P)		64%
Recharge (via Emerge 2024) (%)		51%
Volume of Stormwater Recharge (kL/yr)		20,941
Total Recharge Within Amendment Area (kL/yr)	**74,330**	**70,901**

Area of Lot Connections Required to Provide Annual Recharge Balance

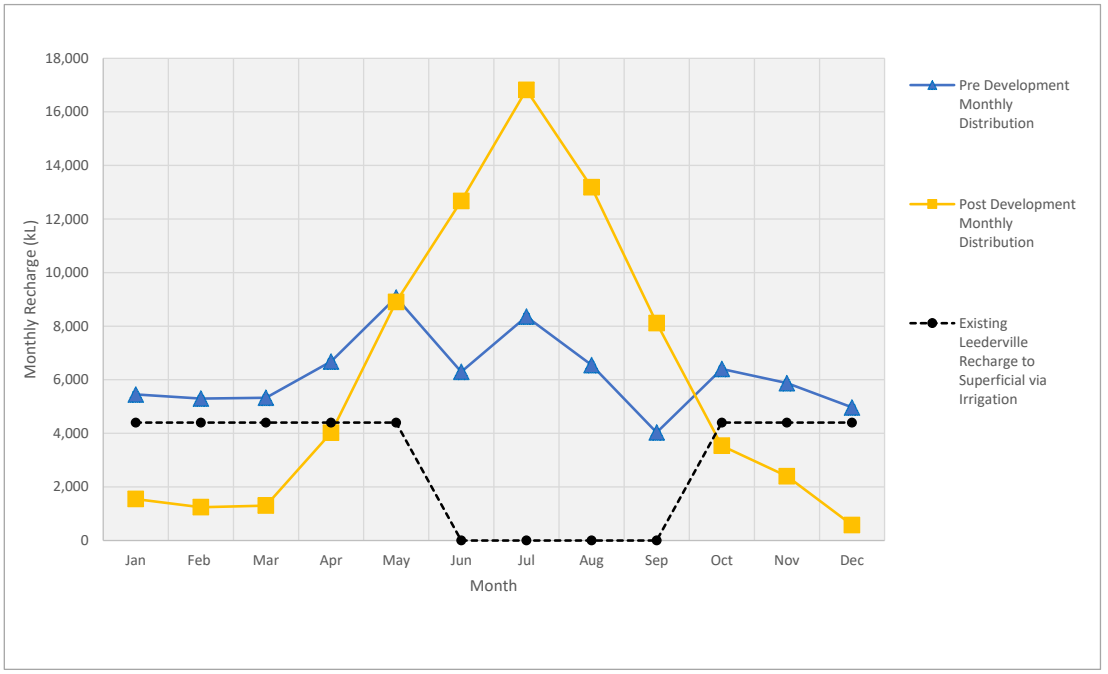
Overall Recharge Change Pre to Post Dev Above (kL/yr)	-3429
External Stormwater Catchment Area (ha)	50.5
Lot Area in Stormwater Catchment (25% roads, 10% POS) (ha)	65%
Lot Connection Runoff (assumed via impervious area of lot)	75%
Total Additional Stormwater Runoff Volume from all lots (kL/yr)	186610
Recharge (via Emerge 2024) (%)	51%
Volume of Recharge for Lot Connections Across Whole Catchment	95171
% of Lots Required to have Lot Connections to Balance Recharge	4%
Area of Lot Connection (ha)	1.8
Total Recharge Within Amendment Area (kL/yr)	**74,330**	**74,330**

Pre Development Monthly Distribution

	Rainfall	Leederville	IWSS	Superficial	TOTAL
Jan	934	4,400	118	0	5,452
Feb	783	4,400	118	0	5,300
Mar	813	4,400	118	0	5,331
Apr	2,164	4,400	118	0	6,682
May	4,672	4,400		0	9,072
Jun	6,297				6,297
Jul	8,358				8,358
Aug	6,553				6,553
Sep	4,034				4,034
Oct	2,006	4,400		0	6,406
Nov	1,358	4,400	118	0	5,876
Dec	451	4,400	118	0	4,969
	38,423	35,200	707	0	**74,330**

Post Development Monthly Distribution

	Rainfall	Leederville	IWSS	Superficial	Stormwater	TOTAL	Lot X	TOTAL
Jan	1,288	0	167	-500	509	1,463	83	1,547
Feb	1,079	0	167	-500	426	1,172	70	1,241
Mar	1,121	0	167	-500	443	1,230	73	1,303
Apr	2,983	0	167	-500	1,180	3,830	193	4,023
May	6,440	0		-500	2,546	8,486	417	8,903
Jun	8,680				3,432	12,112	562	12,674
Jul	11,520				4,555	16,075	746	16,821
Aug	9,032				3,571	12,603	585	13,188
Sep	5,560				2,198	7,758	360	8,118
Oct	2,765	0		-500	1,093	3,358	179	3,537
Nov	1,872	0	167	-500	740	2,279	121	2,400
Dec	622	0	167	-500	246	535	40	575
	52,961	0	1,000	-4,002	20,941	**70,901**	3,429	**74,330**



APPENDIX R
Nutrient Input Assessment
Post Development

UNDO Modelling Wattle Grove South

Results Summary

Existing Land Use Modelling

	Area ha	INPUT TN kg/yr	INPUT TP kg/yr	EXPORT TN kg/yr	EXPORT TP kg/yr
Total	**126**	**13772**	**1405**	**329.2**	**18.8**

Post Urban Development - Before WSUD Applied

	Area ha	INPUT TN kg/yr	INPUT TP kg/yr	EXPORT TN kg/yr	EXPORT TP kg/yr
Total	**126**	**5148**	**891**	**151.4**	**9.4**
% reduction to existing		**63%**	**37%**	**54%**	**50%**

Post Urban Development - with Biofilters and Storages Applied

	EXPORT TN kg/yr	EXPORT TP kg/yr
Total	**130.0**	**7.5**
% reduction to existing	**61%**	**60%**

Government of **Western Australia**
Department of **Water and Environmental Regulation**

Project: UNDO Post Dev 2

Date: 17/11/2021

Version: Version 1.2.0.19289

Subregion name: Infiltration Areas

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	47	46.86	1100.85	322.50
Industrial, commercial & schools	17	16.95	763.54	166.52
Rural living	22	21.93	1537.54	289.52
Public open space	14	13.96	456.42	13.54
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
99.70	79

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
4379.77	807.04

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
111.37	5.39

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	100	46.86	1100.85	322.50
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
46.85806	47

Nitrogen input (kg)	Phosphorus input (kg)
1100.85	322.50

Commercial, Industry and Schools

Landuse	Percent (%)	Area (ha)
Light industrial	0	0.00
Heavy industrial	0	0.00
Commercial / Offices	75	12.71
Schools	25	4.24
Public buildings	0	0.00

Total area (ha)	Total percent (%)
16.95	17

Nitrogen input (kg)	Phosphorus input (kg)
763.54	166.52

Rural living

Landuse	Percent (%)	Area (ha)
Unrestricted	100	21.93
No livestock	0	0.00
No clearing apart from the housing pad	0	0.00

Total area (ha)	Total percent (%)
21.93	22

Nitrogen input (kg)	Phosphorus input (kg)
1537.54	289.52

Note: Commercial horticultre is not permitted in the rural living zone, due to spray drift buffers.

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	30	4.19
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	30	4.19
Sport	0	0.00
Recreation	35	4.89
Golf course	0	0.00
Bowling green	0	0.00
Impervious	5	0.70
Water body	0	0.00

Total area (ha)	Total percent (%)
13.96	14

Nitrogen input (kg)	Phosphorus input (kg)
456.42	13.54

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**No**
Soil type	**Pinjarra**	**Does subregion contain onsite sewage diposal system?**	**No**
Depth to groundwater (m)	**10**		
Groundwater slope (%)	**0.1**		
Soil PRI	**19.3**		

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Connected Areas

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	0	0.00	0.00	0.00
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	26.50	630.75	80.70

Total area (ha)	Total percent (%)
26.50	**21**

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
769.35	**84.67**

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
39.99	**3.96**

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	40	10.60
Road reserve - impervious	30	7.95
Road reserve - native garden	5	1.33
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	5.30
Road reserve - not fertilised	5	1.33

Total area (ha)	Total percent (%)
26.502	**100**

Nitrogen input (kg)	Phosphorus input (kg)
630.75	**630.75**

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**No**
Soil type	**Pinjarra**	**Does subregion contain onsite sewage diposal system?**	**No**
Depth to groundwater (m)	**10**		
Groundwater slope (%)	**0.1**		
Soil PRI	**19.3**		

Note: Please attach the results of soil tests to this report when submitting.

Summary: Nutrient stripping devices

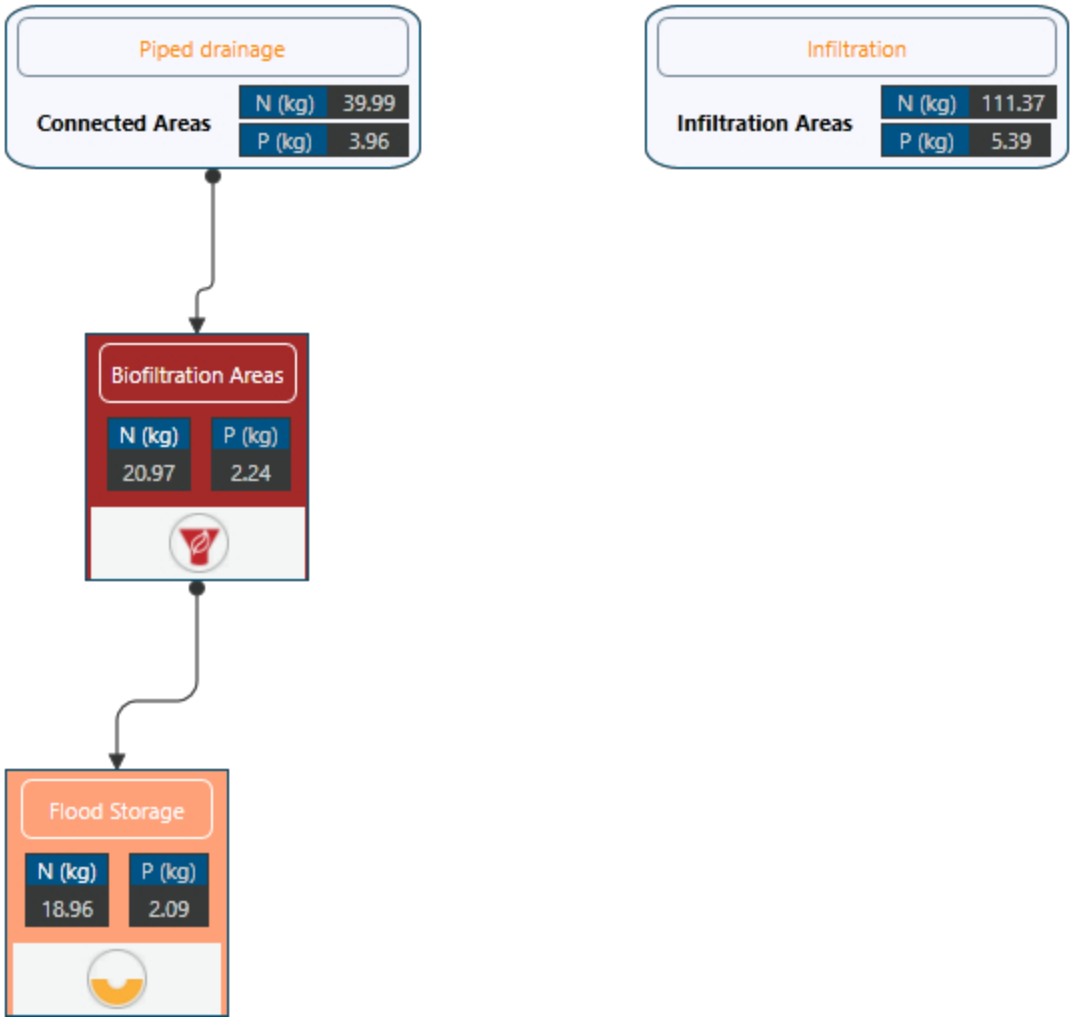
Treatment	Name	Size (m²)	Treated area (ha)	Treating	N removed (kg/yr)	P removed (kg/yr)
Biofilter	Biofiltration Areas	7500.00	26.50	Sandy soils – Runoff only (full lot connection)	19.02	1.72
Detention / infiltration basin	Flood Storage	20000.00	26.50	Sandy soils – Runoff only (full lot connection)	2.01	0.16
Load removed					**21.03**	**1.88**
Net export					**130.33**	**7.48**

Summary: Nutrient load exports

Region	Area (ha)	P export (kg/yr)	N export (kg/yr)
Infiltration Areas	99.70	5.39	111.37
Connected Areas	26.50	3.96	39.99

PRE-TREATMENT LOAD (kg/yr)		LOAD REMOVED (kg/yr)		NET LOAD EXPORT (kg/yr)	
NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS
151.36	**9.35**	**21.03**	**1.88**	**130.33**	**7.48**

Treatment diagram



APPENDIX S

Sodicity Assessment
(MBS Environmental, 2024)

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MEMORANDUM

Attention:	Grant Shepherd	From:	Greg Lekmine and Karl Zwickl
Company:	Hesperia	Date:	21 February 2024
Subject:	Potential Salinity and Sodicity Impacts of the Wattle Grove Urban Development on the Greater Brixton St Wetlands	Project:	Wattle Grove Metropolitan Region Scheme Amendment 1388/55

1. PROJECT BACKGROUND

In October 2021, the Western Australian Planning Commission (WAPC) initiated the Wattle Grove Metropolitan Region Scheme (MRS) Amendment 1388/57 for the 'rural to urban' rezoning of a 126-ha parcel nearby to the Greater Brixton Street Wetlands (GBSW). The Environmental Protection Authority (EPA) recognised the GBSW as being of environmental significance and determined that the amendment was to be assessed under Part IV of the EP Act with the submission of an Environmental Review Document (ERD) in order to support the MRS scheme amendment.

The GBSW is located approximately 1 km to the west of the Darling Scarp in the eastern area of the Perth Basin. It receives surface water from Crystal Brook and Yule Brook, along with groundwater inputs. The EPA raised an issue related to the rezoning include for groundwater related to the potential rise in local groundwater levels and associated increases in salinity or sodicity resulting from alterations to the hydrological regimes of the GBSW and its connected waterways.

To address the identified issues the EPA's Instructions (EPA 2022a) for the ERD included 'Inland Waters' work item 12: *"In the context of items 6, 8 and 11 should model existing conditions of and potential changes to groundwater and surface water chemistry, particularly in relation to salinity and sodicity, that will result from the proposed change in land use associated with this amendment and urban expansion and investigation areas."* Item 6 relates to a pre- and post-development water balance model. Item 8 relates to maintaining pre-development flows into Yule Brook and the GBSW, and Item 11 relates to wetland buffer zone requirements.

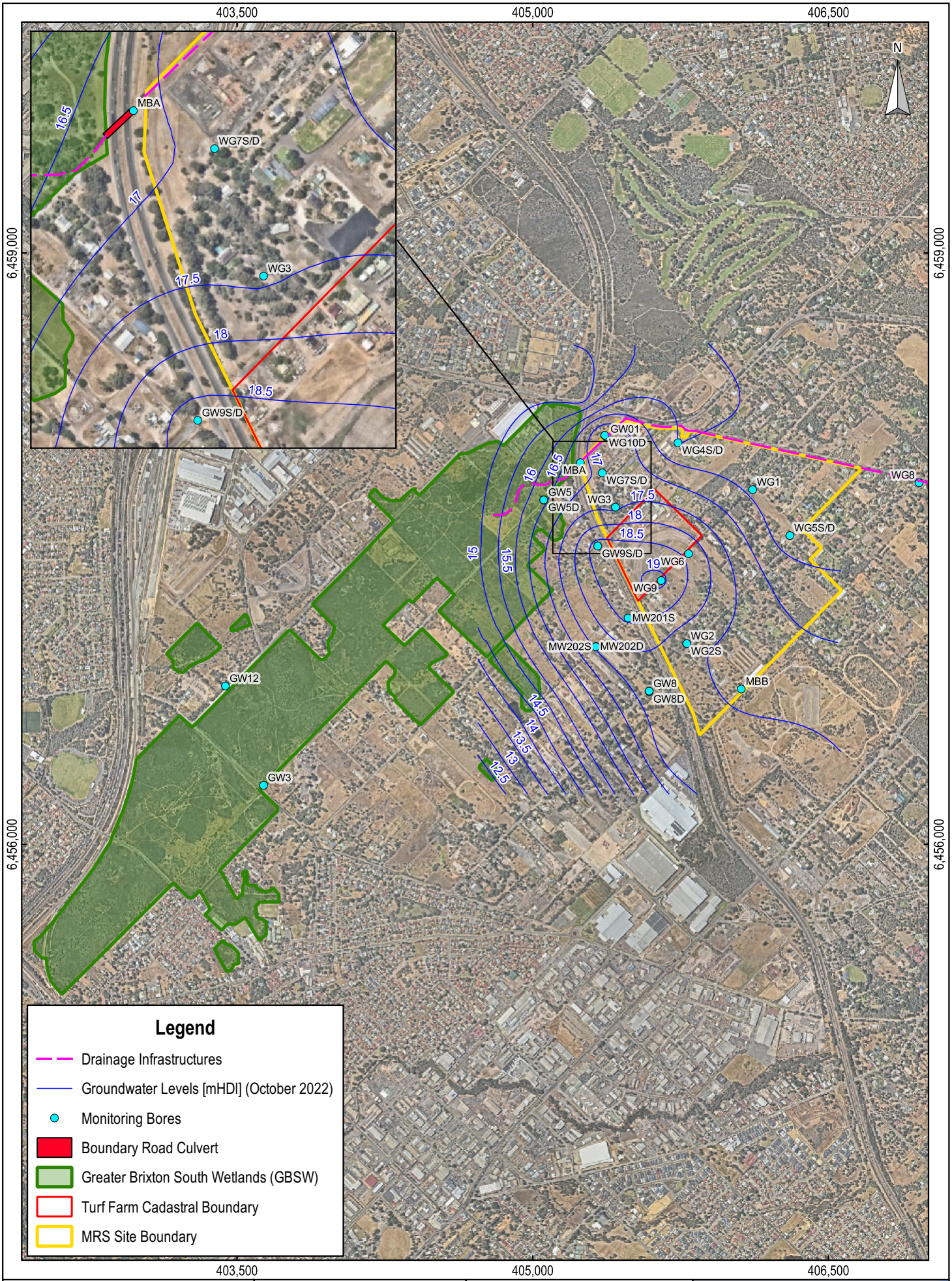
Previous concurrent studies to address the EPA's instructions include a water balance assessment (WBA) produced by Emerge Associates (Emerge 2024 — unpublished at time of writing). Emerge's WBA determined an increase to groundwater recharge into Superficial Aquifer. Groundwater levels are not expected to rise enough to deposit salts to the surface.

A turf farm in the west of the project area, which utilises the slightly higher salinity Leederville Aquifer for irrigation is altering local superficial groundwater levels and quality.

Excess of irrigation water infiltrates into the Superficial Aquifer and the presence of the Kardinya Shale at the base of the aquifer impedes long-term downward movement (Hyd2o, 2024). This has caused mounding centred at the turf farm, with groundwater flowing radially from this mound from the northeast to the southeast with some of these flows towards the GBSW. Groundwater mounding can be seen in Figure 1.

Other considerations include the connection between the GBSW and the MRS via the culvert underneath the Tonkin Highway at Boundary Road (Figure 1) and the Dampier Bunbury Natural Gas Pipeline (DBNGP) trench which runs along the western side of the Wattle Grove proposed MRS. The DBNGP trench (backfilled with coarse aggregate) is a significant hydraulic barrier for much of the near surface flow across to the GBSW from the project area in all but the northernmost area (around the Boundary Rd culvert).

The WBA data supplied to MBS from Emerge has been expanded to consider the potential post-development chemistry (with associated aquifer volume changes), resulting from the development associated removal of the turf farm and presence of the Tonkin Highway infrastructure (hydraulic barrier).



Scale: 1: 25,000
Original Size: A4
Aerial Date: Dec 2023
Grid: GDA94 / MGA zone 50
0 250 500 m

Hesperia - Wattle Grove

Figure 1

Site Layout and Groundwater Contours

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MBS ENVIRONMENTAL

W:\Hesperia\Wattle Grove\GIS\Wattle_Grove.qgz 19/02/2024 F1 Site Layout

2. SCOPE OF WORK

MBS Environmental (MBS) was engaged by Hesperia to address Item 12 of the ER through the provision of the following:

- Description and background of the project, GBSW system, local hydrogeology and potential changes associated with the development.
- Discussion of salinity and sodicity and how these may relate to potential for impacts on the GBSW.
- Collate and average source water quality data as available and hydrogeological settings to assign source terms against the water balance model terms.
- Populate the final Emerge mass water balance with chemistry for major ions and salinity for each source term as per their conceptual model. The Emerge WBA generally consisted of four scenarios (pre-development, post-development, post-development including climate change conditions to 2050 and 2100).
- Predict the post-development change in salinity and sodicity (conservative mixing/evaporation) using current assumptions for the three scenarios. Compare results to current conditions and guidelines for the assessment of risk.

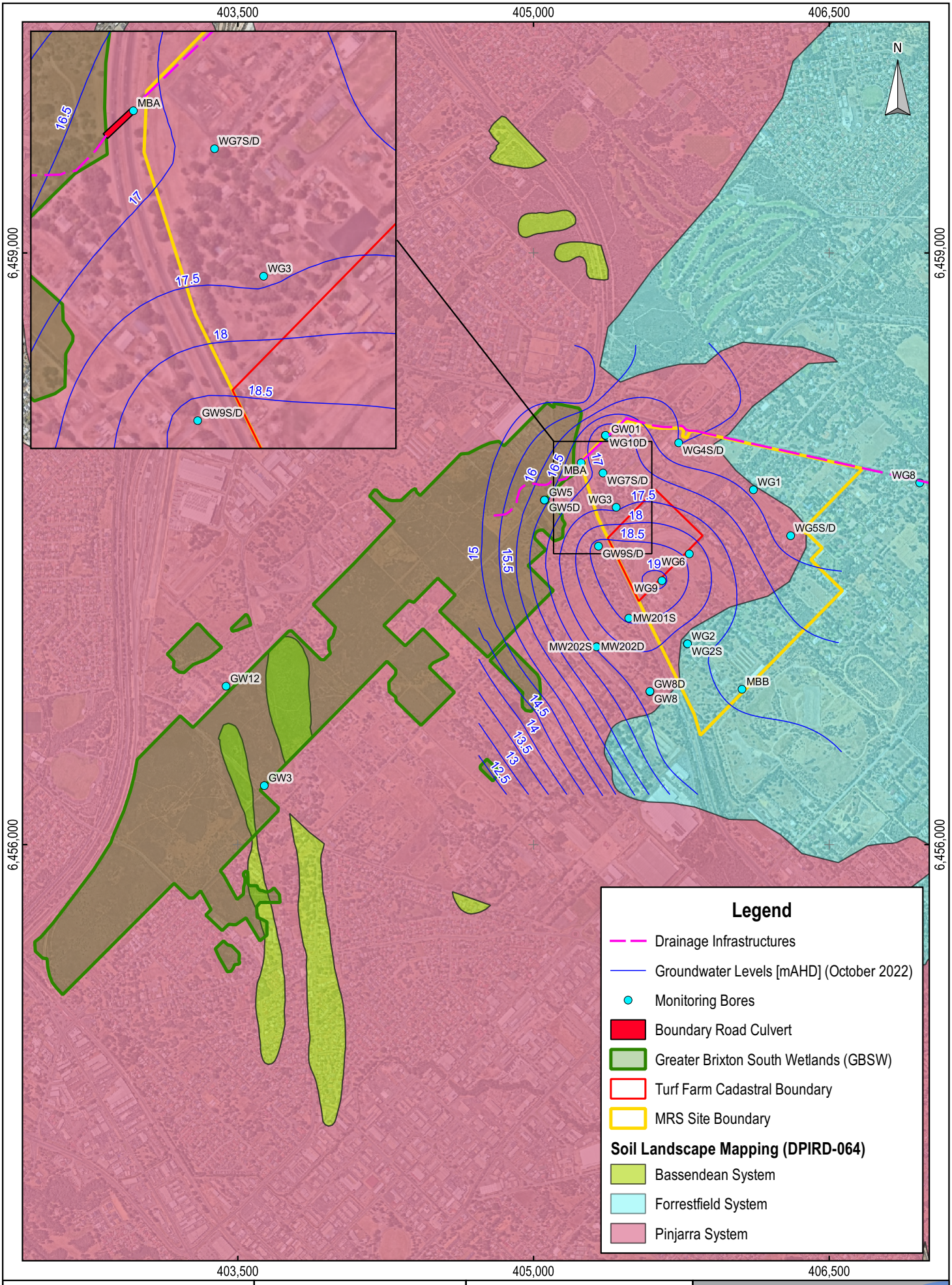
3. HYDROGEOLOGY

3.1 HYDROSTRATIGRAPHY

The superficial formations of the GBSW are comprised of thin Bassendean Sand over Guildford Formation or clayey sand of the Guildford Formation. The western extent of the Wattle Grove MRS site (east of the GBSW) is underlain by superficial formations comprised of thin Bassendean Sand over sandy clay to clayey sand of the Guildford Formation. The Yoganup Formation makes up the eastern area of the MRS Amendment Area (Hyd2o, 2024).

The base of the superficial formations is at approximately sea water level AHD, sloping downwards to the west (Davidson and Yu, 2008). Based on ground surface elevations, this equates to the superficial formations being about 20 to 35 m thick. The superficial formations in this area are underlain by Kardinya Shale and/or the Henley Sandstone. This is supported by the lithological log for the turf farm irrigation bore (WIN ID 20019551) which is screened from 48 to 62 m in fine sand, which lies beneath 21 m of black clay namely Kardinia Shale (Rockwater 2023).

Investigations of the GBSW hydrogeology identified localised connections between the wetlands and underlying aquifers, in the southwest of Brixton Street (Wanaping Block), including slow leakage from clay-based wetland areas (EPA 2022). A figure showing the soil mapping units underlying the site is provided in Figure 2.



Scale: 1: 25,000
Original Size: A4
Aerial Date: Dec 2023
Grid: GDA94 / MGA zone 50
0 250 500 m

Hesperia - Wattle Grove

Figure 2

Site Layout and Soil Landscape Mapping

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W:\Hesperia\Wattle Grove\GIS\Wattle_Grove.qgz 19/02/2024 F2 Site Layout and Soil Landscape Mapping

3.2 GROUNDWATER LEVELS

Contours derived from interpolation of the groundwater levels in the Superficial Aquifer (October 2022) at the scale of the site are presented in Figure 1. Groundwater in the Superficial Aquifer flows west-southwest, with levels ranging between approximately 16 and 19 mAHD around the MRS (Hyd2O 2024). Groundwater levels of the MRS area are characterised by mounding centred around bore WG9 (19 mAHD) on the turf farm (Figure 1). This groundwater mounding is likely the consequence of:

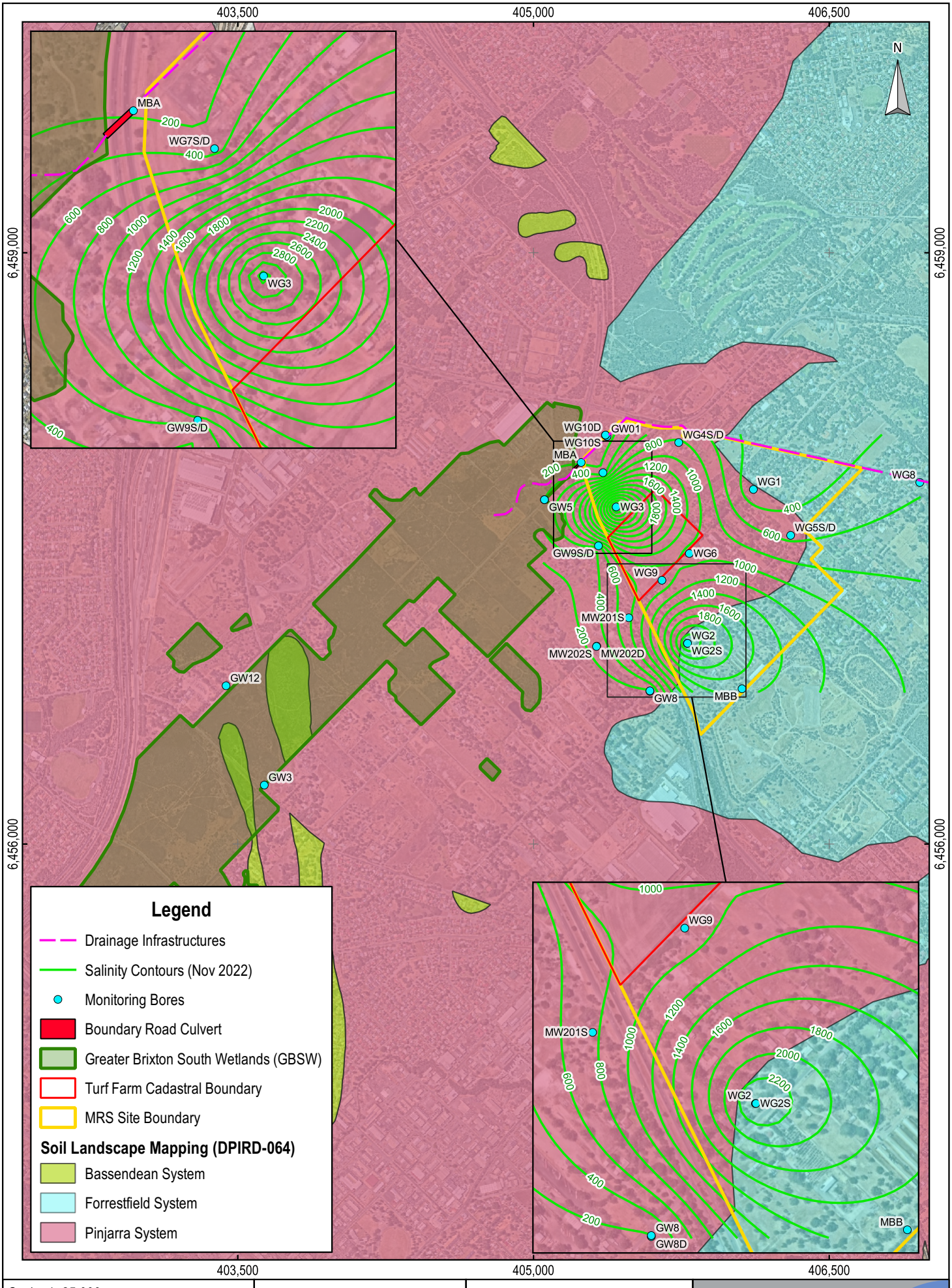
- Irrigation at the turf farm, where groundwater was drawn from the Henley Sandstone member of the Leederville Aquifer and is then used to irrigate the turf, with the excess infiltrating into the Superficial Aquifer.
- High rainfall recharge into the higher-permeability Yoganup Formation, as suggested by the seasonal variations. The shape of the mound is broader to the east over the higher-permeability Yoganup Formation. To the west, the aquifer is predominantly the Guildford Formation which has a lower permeability — resulting in a steeper hydraulic gradient on this side.
- Due to the irrigation of the turf farm and subsequent evapoconcentration of salts into the soil profile followed by flushing during winter rains, salinity contours in the MRS area were primarily determined by this process and the groundwater flow direction. Figure 3 shows the salinity contours interpolated from November 2022 monitoring data as total dissolved solids (TDS, mg/L). Salinity is higher at WG3 and WG2, corresponding to groundwater flow north and south away from the turf farm, which is just north of WG09 (where the highest groundwater level was recorded).

Water level records on site for the period April 2021 – February 2023 are presented in Hyd2O DWMS report (Hyd2O 2024) and are summarised below:

- Despite a general trend of increase due to the mounding, seasonal variations were noted at bores WG1 (15.7 – 16.8 mAHD), WG2 (16.1 – 18.0 mAHD), WG3 (15.0 – 18.0 mAHD), MBa localised downstream of the western drain (16 – 19 mAHD), MBb (16.2 – 17.6 mAHD), GW1 (14.7 – 20.11 mAHD).
- No seasonal fluctuations were reported for the other onsite bores. These include bores WG2S/D, WG4S/D, WG6, WG7S/D and WG9. Due to their proximity to the turf farm these bores were mostly impacted by irrigation and mounding.

Previous hydrogeological assessments in the area of the GBSW identified a temporary perched aquifer associated with the presence of a hard pan (Endemic 2012). Despite some potential perched groundwater conditions occurring in the northwest corner of the site, no evidence of perching was found at the onsite bores (Emerge 2024). A roadside drain is located along Boundary Road, on the western boundary of the Wattle Grove MRS. This drain intersects the shallow groundwater, which locally varies seasonally between 16 and 19 mAHD (bore MBa, Hyd2O 2024). This alters the surface water discharge and hydrology of the GBSW, which is mainly fed by rainfall runoff and ponding (DPW 2017).

The hard pan extends through most of the area covered by the GBSW and therefore vertical connections between the surface and underlying groundwater of the Superficial Aquifer are limited (Emerge 2024). Water levels in the centre/southern part of the GBSW (bores GW12 and GW3) vary seasonally between 6.5 and 9 mAHD (Hyd2O 2024).



Scale: 1: 25,000
Original Size: A4
Aerial Date: Dec 2023
Grid: GDA94 / MGA zone 50
0 250 500 m

Hesperia - Wattle Grove

Figure 3

Site Layout and Salinity Contours

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MBS ENVIRONMENTAL

W:\Hesperia\Wattle Grove\GIS\Wattle_Grove.qgz 19/02/2024 F3 Site Layout and Salinity Contours

3.3 WATER BALANCE SUMMARY

Emerge developed a yearly averaged surface and groundwater balance within the MRS amendment area. The key annual flow rates derived by the water balance (Appendix A1) include the following key components:

- Rainfall and surface water runoff. Surface water runoff comprises runoff from onsite direct rainfall, runoff from the upstream catchment area via sheet flow and roadside drainage, runoff outflow via the drain systems in the west and southwest of the site to the GBSW, MKSEA and South. Surface water runoff discharges offsite into the GBSW via the Boundary Road – Tonkin Highway culvert.
- Rainwater evaporation and infiltration into the Superficial Aquifer.
- Evaporation and infiltration of irrigation water on the MRS amendment area into the Superficial Aquifer. This comprises water from the Superficial Aquifer, the Leederville Aquifer and domestic water from the Integrated Water Supply Scheme (IWSS, Water Corporation).
- Infiltration from the perched aquifer into the Superficial Aquifer.
- Outflow from the Superficial Aquifer including groundwater flowing west towards the GBSW.

The model includes pre-development, post-development and predicted climate change (years 2050 and 2150) conditions affecting the inflows and outflows in the surface and groundwater water balance.

It should be noted that as the water balance model is based on yearly averages, it does not include seasonal variations potentially affecting salinity and sodicity in the soil profile, despite overall elevated drainage conditions to the water table were identified on site.

4. POTENTIAL IMPACTS OF SALINITY AND SODICITY

In order to describe potential impacts on the GBSW from salinity or sodicity changes, some background on these terms and general potential influences from them are described below.

4.1 SALINITY

Salinity in general refers to the concentration of soluble or dissolved salts in a soil or water. Salinity, expressed as total dissolved solid (TDS) is the content of minerals dissolved in water. Water with TDS less than 1,000 mg/L classify as fresh, water ranging from 1,000 – 3,000 mg/L TDS are brackish and classify as saline for the range 3,000 – 35,000 mg/L TDS.

Soil salinity is in general attributed to the soluble salts binding to clay particles found in soil due to their large surface area and inherent surface reactivity (ionic charge being positive or negative), while groundwater influenced salinity may also occur due to interactions with the porous matrix of the aquifer. Infiltration of surface water and seasonal variations (rise and fall and associated capillary rise) of the groundwater table have the potential to transport increasing amounts of salt from groundwater to the vadose zone (unsaturated zone) of a shallow soil profile. In summer, evaporation (including from irrigation water as above) and the decrease of groundwater levels can trigger salt precipitation in the soil profile. During periods of increased rainfall (winter), percolation of rainwater through the profile and rising groundwater levels can trigger re-dissolution and drainage of salts from the soil profile. Therefore, seasonal variations of rainfall/evaporation and the water table can contribute to salinisation of the soil profile, surface and groundwater bodies. The nett accumulation of salts in a soil profile depends on the balance of these contributions.

Previous assessment of the GBSW, undertaken by EPA and reported by Emerge Associates (Emerge 2024), identified the presence of soil salinity within the shallow soil profile and the presence of salt tolerant vegetation (EPA 2022). This is most relevant to the locations southwest of Brixton Street (Wanaping Block) which are well removed from the MRS amendment area.

4.2 SODICITY

Sodicity is a term which refers specifically to the relative balance of salt cations comprising the salinity. Specifically it refers to the amount of sodium present in irrigation/surface water relative to amounts of divalent cations (Ca^{2+} and Mg^{2+}). Exposure of soils to water with excessive amounts of sodium relative to calcium and magnesium can favour its accumulation on adsorption sites (versus calcium and magnesium) in soil and may deteriorate the soil structure. This in turn has potentially negative impacts on plant and native vegetation growth. Sodium concentration can also produce an adverse impact on the soil's physical properties in the form of clay dispersion, leading to deterioration of aggregate stability; decreased soil hydraulic conductivity/permeability; increased susceptibility to surface sealing and soil erosion problems; soil compaction; and decreased soil aeration. Clay rich soils (compared to sandy soils) are more impacted in structure by changes in sodicity (as sandy soils have very low clay content and hence exchangeable ionic sites for binding).

The risk of sodicity is reduced with increasing concentrations of multivalent cations (primarily calcium and magnesium) also present in the irrigation water. The sodium adsorption ratio (SAR) is a quantitative unitless indicator calculated from the concentrations (expressed with units of milliequivalents per litre, me/L) of sodium, calcium and magnesium in water:

$$SAR = \frac{[Na^+]}{\sqrt{([Ca^{2+}] + [Mg^{2+}])/2}}$$

Long-term discharge/irrigation use of water with high SAR can lead to a decrease in infiltration and permeability of the soil to water. Sandy soils will have fewer problems as noted above, but fine-textured soils are likely to have severe problems if SAR is greater than 9. Sodicity is considered low when the SAR value is less than 10.

A reduction of soil permeability can lead to soil water logging; however, water logging of the soils profile across the MRS is unlikely due to the depth of the water table and the very permeable nature of the local sandy soils, which promotes free drainage of surface water (DPIRD 2018). Small areas along the western and northern boundary of the MRS have localised finer grained soils. There is potential for waterlogging where these soils occur, however the groundwater levels in these areas are still not expected to rise as a result of development in the MRS amendment area (Emerge 2024).

5. WATER QUALITY — SOURCE TERM COMPOSITIONS FOR CALCULATIONS

5.1 RAINWATER

The salinity and sodicity values for rainwater were derived from the rainfall composition database established by CSIRO (Crosbie et al. 2012). The data were collected over 27 monitoring events between May 2007 and December 2011. Weighted average concentrations of solutes were typically used to define the source term. Alkalinity (as bicarbonate, HCO_3^-) was adjusted (reduced) to achieve charge neutrality (ionic balance). The adopted source term definition is presented in Table 1. As expected for rainfall, salinity and SAR values calculated from the derived composition were very low.

Table 1: Rainwater Composition

Parameter	Unit	Concentration
Ca	mg/L	0.73
Cl		4.10
K		0.31
Mg		0.56
Na		1.78
SO4		1.61
Total Alkalinity	**mg $CaCO_3$/L**	**2.00**
Salinity (TDS)	**mg/L TDS**	**11.09**
Sodicity (SAR)	**-**	**0.16**

5.2 GROUNDWATER COMPOSITION

5.2.1 Leederville Aquifer

The primary reason for the onsite groundwater mounding is attributed to the highly variable subsurface geology, concentration of low permeability soils in the vicinity of the mound and the long-term impeded infiltration through the Kardinya Shale of the irrigation water at the base of the Superficial Aquifer. Irrigation water is locally abstracted on the turf farm from the upper part of the Leederville Aquifer below the Kardinya Shale confining unit . Groundwater composition at the abstractions bore/s within the Leederville Aquifer onsite of the turf farm was not available. To date the only composition available was reported in 1991 by the WIR database (WIN ID 20019551) at Bore AM41B (Table 2) located approximately 3,000 m north of the site. Salinity of the Leederville Aquifer at this bore is fresh (657 mg/L TDS) but higher than reference bores from the Superficial Aquifer. Salinity is dominated by moderate concentrations of sodium (156 mg/L) and chloride (276 mg/L in Table 2 mg/L) and sodicity (7.0) is low.

Table 2: Leederville Aquifer Composition — DWER Bore AM41B (1991)

Parameter	Unit	Concentration
Ca	mg/L	6.0
Cl		276
K		4.0
Mg		19
Na		156
SO_4		21
NO_3		1.0
SiO_2		26
Total Alkalinity	**mg $CaCO_3$/L**	**18**
Salinity (TDS)	**mg/L TDS**	**657**
Sodicity (SAR)	**-**	**7.0**

5.2.2 Superficial Aquifer

Composition of the Superficial Aquifer (including salinity and sodicity) within the MRS area is affected by the combination of watering on the turf farm with water extracted from the Leederville Aquifer and seasonal variations of the groundwater table. Fluctuations of the water table contribute to increase of salinity by cycles of precipitation,

re-dissolution and drainage. The average onsite composition of the aquifer (measured across eight bores on 23/11/2022) and average inflow composition measured on 06/10/2022 and 23/11/2022 at bore WG5D are presented in Table 3. Average salinity across the MRS was fresh to slightly brackish in 2022. The average SAR of 7.45 was similar to the SAR calculated for the Leederville Aquifer (Table 2) and indicative of low sodicity.

Table 3: Superficial Aquifer Average Onsite and Inflow Compositions

Parameter	Unit	Average Onsite	WG5D (Inflow)
pH	pH Units	5.77	5.85
Ca	mg/L	36	4.9
Cl		581	218
K		13	4.0
Mg		54	14
Na		303	110
NO_3		7.5	12.5
SO_4		150	10
Total Alkalinity	**mg $CaCO_3$/L**	**309**	**69.5**
Salinity (TDS)	**mg/L TDS**	**1,445**	**537**
Sodicity (SAR)	**-**	**7.45**	**5.73**

5.2.3 Perched Aquifer

As discussed in Section 3, localised perched aquifer conditions were identified in the northwest of the site. The water balance model assumed that the perched aquifer is recharged by rainwater infiltration and seasonally drains down to the Superficial Aquifer. Therefore, in a first approximation, the rainwater composition (Table 1) was attributed to the perched aquifer composition discharging into the Superficial Aquifer. This is supported by similar groundwater quality being found in bore GW01 during winter.

5.3 DOMESTIC WATER USAGE (IWSS WATER SUPPLY)

As described in Section 3.3, the water balance model includes a portion of domestic water used for irrigation used during the pre- and post-development periods by residents/council. The composition of the domestic water was obtained from the Water Corporation annual drinking water quality report 2023 (Water Corp. 2023). The composition presented in Table 4 was obtained from the median value of the closest records to the Wattle Grove project in Perth Metropolitan Area (South Perth/Kewdale). The water is fresh (528 mg/L TDS) and hard (107 mg/L $CaCO_3$). The calculated SAR value of 5.0 was between those for the Superficial and Leederville Aquifer but higher than the value of SAR = 1.0 calculated from the single water composition available at bore GW3 (within the GBSW, 329 mg/L TDS).

Table 4: Domestic Water Quality in South Perth/Kewdale

Parameter	Unit	IWSS (Water Corporation 2021–2022)
pH	pH Units	7.61
Ca	mg/L	29
Cl	mg/L	173
K	mg/L	7.6
Mg	mg/L	8.2
Na	mg/L	119
SO_4	mg/L	26
Total Alkalinity	**mg $CaCO_3$/L**	**121**
Salinity (TDS)	**mg/L TDS**	**528**
Sodicity (SAR)	**-**	**5.0**

5.4 GREATER BRIXTON STREET WETLANDS

No connections have been included in the water balance model between the surface water and the Superficial Aquifer beneath the GBSW, with limited recharge via slow leakage, due to the presence of a low-permeability hard pan. Groundwater composition at the GBSW was predicted to be mostly controlled by upgradient inflow from the MRS amendment area in the northeast although it is noted that composition is expected to change with dissolution of calcium in particular from the limestone within the GBSW. Compositions at bores GW12 and GW3 are expected to be the most representative of the groundwater under the wetland; however, very limited pre-development records and data were available for these bores. Between 2009 and 2022 the salinity ranged from 183 – 13,266 mg/L TDS (average of 2,882 mg/L) at GW3 and from 1,370 – 17,556 mg/L TDS (average of 8,675 mg/L TDS) at GW12. Samples were analysed for major ion composition on only one occasion (06/10/2022) at bore GW3 (Table 5) and reported a very low calculated sodicity of 1.0 (the higher calcium content of 86 mg/L resulting in lower calculated SAR compared to MRS bores).

Table 5: Groundwater Composition in the GBSW Area — Bore GW3

Parameter	Unit	GW3 (06/10/2022)
pH	pH Units	6.68
Ca	mg/L	86
Cl	mg/L	N/A
K	mg/L	6.9
Mg	mg/L	3.8
Na	mg/L	26
SO_4	mg/L	N/A
NO_3	mg/L	4
Total Alkalinity	**mg $CaCO_3$/L**	**230**
Salinity (TDS)	**mg/L TDS**	**329**
Sodicity (SAR)	**-**	**1.05**

6. MODELLING APPROACH AND ASSUMPTIONS

A simple solute mass balance of the groundwater in the area covered by the MRS was undertaken with the geochemical speciation code PHREEQC 3.7.3 (USGS 2021). The derived mixing ratios of the solute mass balance are shown in Appendix A1 for the three scenarios, the main characteristics of the approach with its limitations and assumptions were as follows:

- Compositions of the water quality source terms described in Section 5 were mixed in proportions to their annual volumes derived from the groundwater and surface water balance developed by Emerge (Emerge 2024).
- Source term compositions were based on available major ion (and nitrate) concentrations. All other dissolved species, including metals and metalloids (generally low to negligible) were not included.
- Three scenarios were adopted including:
  - A pre-development scenario covering the period 2024 – 2150. For this scenario annual inflows and outflows were derived from conditions prior to onsite development.
  - A post-development scenario; current post-development annual volumes were applied for a 75-year period (2024 – 2150).
  - A scenario including post-development climate change conditions from year 2050 – 2100 and year 2100 – 2150 (Emerge 2024).
- A separate surface water solute mass balance (versus groundwater) was undertaken including the portions of the MRS rainfall runoff and groundwater discharging at the Boundary Road culvert and evaporation. Surface water discharging from the MRS into the GBSW was assumed to only occur through the culvert at Boundary Road.
- The surface water model does not account for potential leaching of the soil material on the MRS from rainfall runoff since the land system locally presents a low salinity risk (<3% of the mapped area, DPIRD 2018).
- Predicted salinity/sodicity prediction for both surface and groundwater were based on an initial Superficial Aquifer volume of 21.63 GL derived from the groundwater contours presented in Figure 1 and overlapping the MRS amendment area.
- The modelling approach does not include any dispersion and transport components which may potentially dilute and attenuate the estimated salinity and SAR values.
- Both solute mass balances (i.e. surface and groundwater) were conservative and no potential sorption, precipitation/dissolution, redox, acid/base or biogeochemical reactions were included other than evapo-concentration. Evaporation was applied to rainfall and domestic irrigation source terms (Section 3.3) in proportion to their respective annual evapotranspiration volumes (Emerge 2024).
- All data provided to MBS such as water chemistry records, monitoring bore details and groundwater/surface volumes derived from the water balance were accepted as accurate and representative.

7. RESULTS

This section presents the results of the solute mass balance assessments resulting from application of the source terms to the Emerge water balance assessment. These were undertaken separately on the surface water and groundwater discharging and/or flowing to the wetland for the three selected scenarios (pre-development, post-development, and post-development with climate change). The salinity is expressed as TDS (mg/L) and the sodicity as SAR.

7.1 SURFACE WATER DISCHARGE

Results for predicted surface water discharge from the culvert at Boundary Road in the north of the GBSW are presented in Chart 1 and Chart 2 for selected time steps of the projection period 2024 – 2150. The key results are summarised as follows:

- Predicted salinity and sodicity of the pre and post-development scenarios were overall stable for the entire 2024 – 2150 projection period.
- Salinity was brackish for both scenarios with a predicted value of 2,230 mg/L TDS for pre-development and 1,590 mg/L TDS for post-development. Sodicity was low with SAR values of 8.5 and 7.12 respectively. The difference between both scenarios was attributed to higher evapotranspiration and lower rainfall runoff rates to the GBSW in the pre-development scenario.
- Results for the post-development climate change scenario were identical to the post-development for the period 2024 – 2050. After year 2050 salinity was predicted to become fresh by dropping significantly to 1,184 – 761 mg/L TDS for the period 2050 – 2100. Sodicity followed the same trend and decreased to SAR values of 6.26 – 5.20 over the same period.
- After year 2100 surface water salinity and sodicity were anticipated to slightly increase to 788 mg/L TDS and a SAR of 5.36 due to a decrease of the rainfall runoff contribution.

No surface water composition data were reported for the GBSW; however, post-development salinity (TDS) and salinity (SAR) of the surface water discharging from the Boundary Road culvert (inflow to GBSW) were predicted to be lower than pre-development. Salinity for both post-development scenarios were predicted to be fresh to marginally brackish, however this was based on the conservative approach assuming all the groundwater outflow from the MRS at Boundary Road discharges into the culvert. Therefore, based on the assumptions that soil on the MRS has a negligible impact on the surface water runoff composition, salinity and sodicity of surface water discharging in the MRS are expected to be lower than the predicted values shown in Chart 1 and Chart 2.

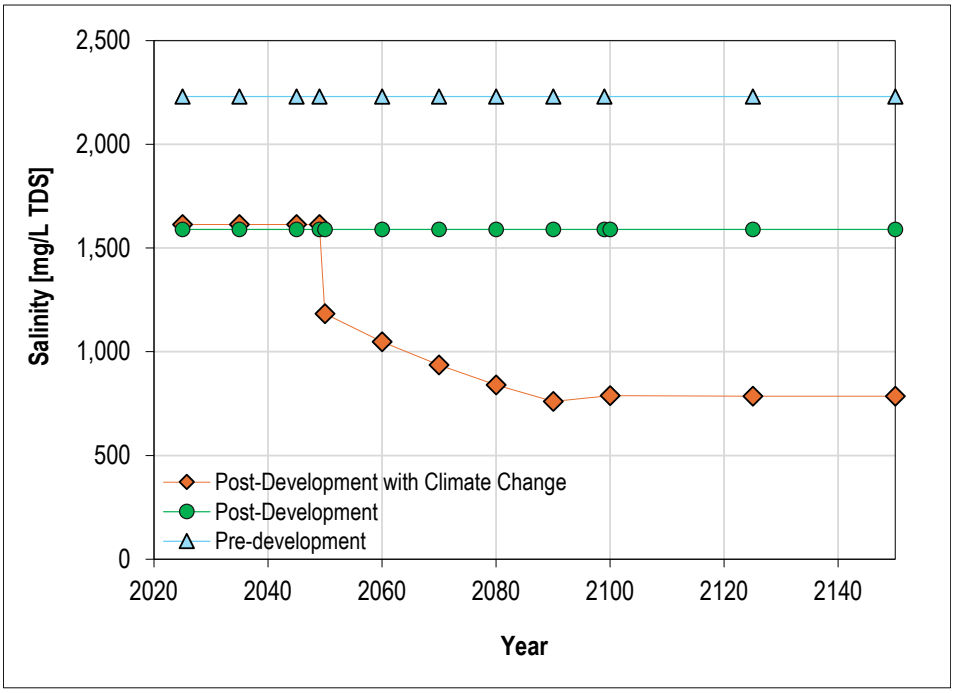


Chart 1: Predicted Surface Water Salinity Discharging to the GBSW

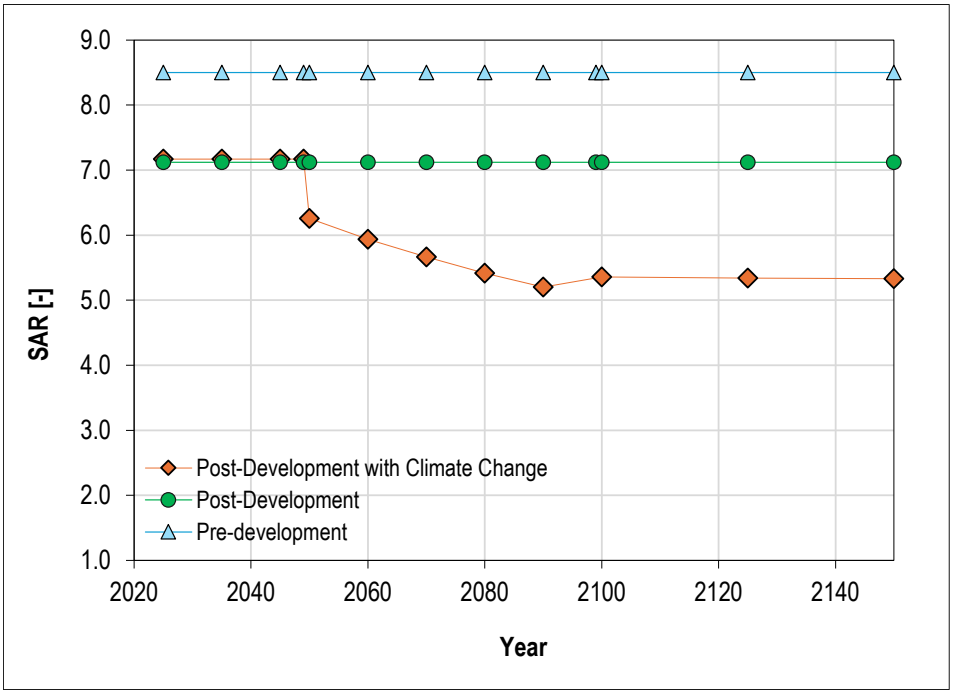


Chart 2: Predicted Surface Water SAR (Sodicity) Discharging to the GBSW

7.2 GROUNDWATER

Predicted salinity and sodicity in groundwater flowing to the GBSW are presented in Chart 3 and Chart 4 for selected time steps over the period projection 2024 – 2150. The key results are summarised as follows:

- Similar to surface water, salinity and sodicity of the pre and post-development scenarios were predicted to remain steady for the total duration of the projection. Both scenarios showed very close results with marginally fresh groundwater salinities of 1,775 and 1,714 mg/L TDS, and SAR values of 7.50 and 7.38, respectively.
- Salinity decreased significantly after 2050 for the post-development scenario with climate change conditions. Values were anticipated to drop to 1,170 mg/L TDS in 2050 and steadily decrease to 575 mg/L TDS in 2100. Between years 2100 and 2150 values are predicted to slightly drop to 492 mg/L TDS.
- Sodicity followed the same trend and decreased slightly from a SAR value of 6.21 in 2050 to reach 4.55 in 2150 and 4.46 in 2150. These depletions of salinity and SAR are attributed to a reduction of rainfall infiltration during the projection period.

Results indicated that the groundwater salinities in the Superficial Aquifer flowing from the MRS towards the GBSW were expected to be very similar between the pre and post-development scenarios and remained marginally brackish. These values are within the lower end of the range recorded at downgradient bore GW3 (183 – 13,266 mg/L TDS) for the period 2009 – 2022. The SAR was low to moderate but slightly higher than the calculated value of the single available record reported at GW3 in October 2022 (SAR = 1.05). Although the sandy soil profile across the MRS favours free drainage, the model did not account for potential seasonal groundwater loading of higher salinity/sodicity attributed to soil sorption and variation of the water table. However, the hardpan extending from the MRS across most of the GBSW (EPA 2022) limits the vertical connections between the wetland and the underlying Superficial Aquifer. Therefore, any potentially elevated salinity or sodicity in the groundwater flowing from the MRS is unlikely to have a significant impact on the wetland.

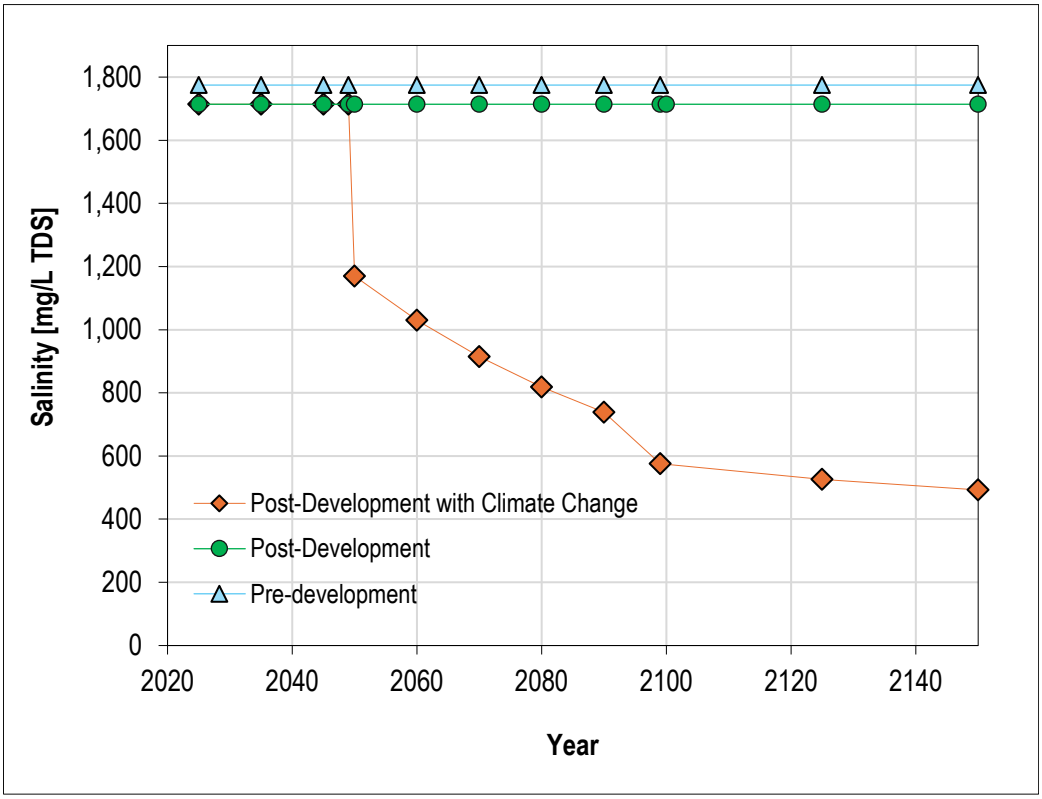


Chart 3: Predicted Salinity — Superficial Aquifer

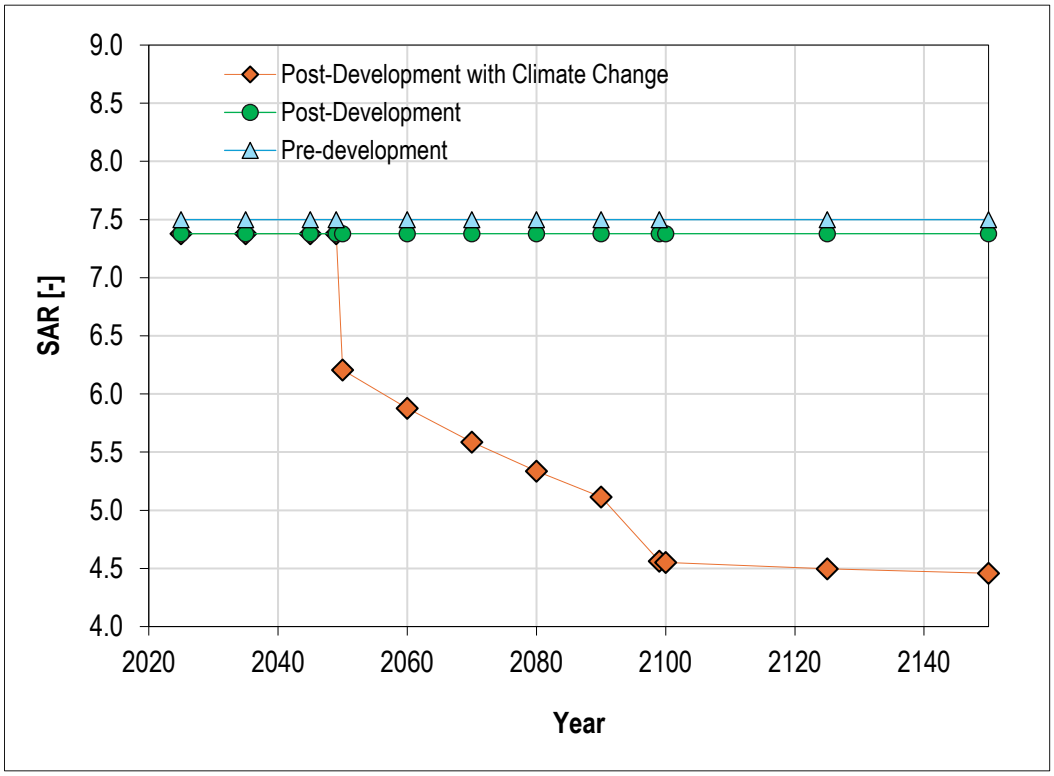


Chart 4: Predicted SAR — Superficial Aquifer

7.3 IDENTIFICATION OF POTENTIAL RISKS

The GBSW comprises a complex series of seasonally inundated or seasonally waterlogged areas classified as basins, palusplains, floodplains, sumplands and channels shaped from direct rainfall/evaporation and rainfall runoff.

The primary receptors in the wetland include seasonally dependant flora, terrestrial and aquatic fauna (DBCA 2017), which require seasonal flooding to maintain the local ecosystem. Increases of salinity and sodicity attributed to water discharged through the culvert from the MRS could potentially affect the root zone of non-saline and/or non-sodium tolerant vegetation species, life and reproduction cycles of aquatic invertebrates, or reduce palatability of ponding water palatability for terrestrial fauna.

Connections have been identified between the GBSW and the Superficial Aquifer. Shallow groundwater in these areas may seasonally impact the wetlands and the root zone by upgradient loading of salinity/sodicity (e.g. from the MRS) and local variations of the water table. Salts can accumulate due to slow rates of recharge in winter and evaporation due to capillary action when the water table is close to the surface in summer (EPA 2022). When the water table is high, waterlogging may also be a threat to some vegetation in the GBSW. Some species of samphire (e.g. *Tecticornia* spp. Observed in the wetland) have a low tolerance to prolonged inundation from low salinity surface water (Konnerup et al. 2014). However, these connections between the GBSW and the Superficial Aquifer are very localised and limited to the south of the GBSW, due to the presence of a hardpan underlying most of the wetland. Therefore, interactions between surface water and groundwater from the Superficial Aquifer potentially impacted by salinity/sodicity changes from the MRS amendment area are unlikely.

The following guidelines summarised in Table 6 were used to characterise the risk associated with the potential discharge to the GBSW with respect to accepted environmental criteria:

- ANZECC (2000) long term irrigation guideline values — used to assess saline tolerances to potential plant receptors in the GBSW.
- DAFWA salinity tolerances for native vegetation (DPRID, 2022).

Table 6: Default Environmental Trigger Values for Salinity (mg/L TDS) Vegetation

Guideline	Low	Moderate	Moderate/High	High	Very High
ANZECC LTI	<416	<1,856	<3,328	<5,184	>5,184
DAFWA Native Veg	<1,280	<2,560	<5,120	<10,240	>10,240

Maximum predicted post-development salinity (i.e. conservative approach, <1,590 mg/L TDS) of the surface water discharge at Boundary Road is lower than the conservative salinity range predicted for the pre-development period (2,230 mg/L TDS), which represents a net environmental benefit outcome with a 'moderate risk' range for the vegetation of the GBSW (Table 6). These values are the higher predicted range of annual loads at the discharge point in the wetland (i.e. assuming full groundwater discharge in the drain) and therefore represent a risk limited to the wetland drainage lines located in the immediate surrounding of Boundary Road (i.e. north of GBSW). This also does not consider potential mixing and dilution with water ponding from direct rainfall on the wetland.

No salinity/sodicity guideline values were available for comparison for aquatic and terrestrial fauna. However, all the predicted salinities for the three scenarios remained well below the livestock drinking water guideline trigger value of 4,000 mg/L TDS (ANZECC 2000/ANZG 2018) and were predicted to fall with development. Although the livestock drinking water guideline values do not explicitly account for sensitivity of other terrestrial species to potential toxicants, they present the most relevant generic health-based screening values for drinking water to be consumed by terrestrial fauna.

The surface water discharging from the MRS and potentially ponding in GBSW, as well as the groundwater in the Superficial Aquifer underneath the wetland were predicted to be fresh to brackish with low sodicity. The decrease in both salinity and sodicity (based on the model) indicate better/low risk profile to the GBSW than pre-development situation. However, this was based on an annual water balance and did not account for seasonal variations of the water table (at the MRS and GBSW) which may increase the levels of salinity/sodicity of the water expressing in the wetland from the MRS (EPA 2022).

8. SUMMARY/CONCLUSIONS

The GBSW is located approximately 1 km to the west of the Darling Scarp in the eastern area of the Perth Basin. The EPA has identified issues related to the proposed rezoning of Wattle Grove, including the potential rise in local groundwater levels and associated increases in salinity and sodicity resulting from alteration to the hydrological regimes of the GBSW and its connected waterways.

Based on the water balance model produced by Emerge for the MRS, solute compositions were derived for the individual source terms. These source terms were combined to generate groundwater (i.e. Superficial Aquifer) and surface water (i.e. water discharging from the MRS amendment area via the culvert at Boundary Road) solute mass balances for three water balance scenarios (pre-development, post-development and post-development with climate change). The predicted groundwater quality upgradient to the GBSW and discharging at the surface through the Boundary Road culvert indicated that:

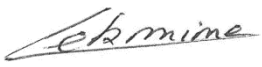
- Maximum salinity and sodicity (i.e. conservative approach) of the post-development scenarios for surface water discharge were both predicted to be less than the pre-development scenario for the entire 2024 – 2150 projection period. This represents a nett reduction in risk to the GBSW based on modelling conducted.
- Conservative post-development salinity of the surface water discharging to the north of the GBSW was predicted to be slightly brackish, and values decreasing to fresh after 2050 under the climate change scenario. Surface water sodicity followed the same trend and was always low.
- The general trend of both salinity and sodicity in the Superficial Aquifer flowing to the GBSW was constant and very close to the pre-development scenario for the entire projection period 2024-2150. Salinity was marginally brackish at all times and within the lower end of the range recorded in groundwater overlain by the wetland for the period 2009 – 2022. Predicted salinity and sodicity of post-development climate change scenario in groundwater decreased steadily between 2050 and 2100 from marginally brackish to fresh with low SAR values. After 2150 predicted values started to stabilise.
- The predicted groundwater salinities were at all times within the lowest range of the records reported at downgradient bore GW3 in the GBSW. Values of SAR were slightly higher than the calculated value of the single available record reported at GW3 in October 2022 (SAR = 1.0). No records for surface water composition at the GBSW were available to assess the impact of the predicted groundwater salinity/sodicity on the wetland.
- The primary receptors in the wetland were identified to be seasonally dependant flora, terrestrial and aquatic fauna (DBCA 2017), which require seasonal flooding to maintain the local ecosystem. Connection between the GBSW and the Superficial Aquifer is limited due to the presence of a hardpan beneath the wetland.
- There is a low to moderate risk for the GBSW vegetation in regard to surface water discharge at Boundary Road. The potential risk from the MRS remains limited to the wetland drainage lines located in the immediate surrounding of Boundary Road (i.e. north of GBSW). This did not account for potential runoff, ponding, evaporation and mixing with direct rainfall in the wetland.
- No salinity/sodicity guideline values were available for comparison for aquatic and terrestrial fauna. However, all the predicted salinities for all scenarios remained well below the livestock drinking water guideline trigger value of 4,000 mg/L TDS (ANZECC 2000/ANZG 2018) and were predicted to fall with development.

Overall, this assessment indicated that there is a low risk of increasing salinity and sodicity in the GBSW from the MRS surface and groundwater discharge and modelling predicted the opposite — a decrease in both. It is noted that an irrigated golf course and playing fields to the north of the MRS (and evapoconcentration from the

irrigation) likely has much larger influence on salinity/sodicity within the GBSW than the proposed MRS however this was outside the scope of assessment.

Although the sandy soil profile across the MRS favours free drainage, the model did not account for potential seasonal groundwater loading of higher salinity/sodicity attributed to soil sorption and variation of the water table. Similarly, in areas of the GBSW where groundwater is potentially connected to the surface water (Wanaping Block in the south not impacted by development of the MRS), seasonal variations may favour upgradient loading of salinity/sodicity from the MRS into the wetlands and the root zone. At the time of writing records of surface water and groundwater compositions were limited. It is therefore recommended that additional testing be undertaken during the structure planning phases to refine the water balance and salinity/sodicity predictions of this assessment as planning progresses. Ideally surface water and groundwater should be sampled seasonally within the GBSW and analysed for physical parameters, major ions, nutrients and key metals/metalloids to establish seasonal baseline concentrations. This would help to monitor changes in salinity and sodicity in the wetland in relation to the MRS and other nearby sources.

Yours sincerely
MBS Environmental



Greg Lekmine
Geochemist/Modeller



Karl Zwickl
Environmental Scientist

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Appendix A1: Solute Mass Balance Summaries

Appendix A1-1: Solute Mass Balance Summary - Pre-development Scenario

Year		2024	2025	2035	2045	2049	2050	2060	2070	2080	2090	2099	2100	2125	2150
Cumulated Years		1.0	1.0	10	20	24	25	35	45	55	65	74	75	100	125
Years Per Time Step		0	1.0	9	10	4.0	1.0	10	10	10	10	9.0	1.0	25	25
GROUNDWATER	Individual Filling volume (KL)	128,533	128,533	1,156,797	1,285,330	514,132	128,533	1,285,330	1,285,330	1,285,330	1,285,330	1,156,797	128,533	3,213,325	3,213,325
	Perched Aquifer	7,280	7,280	65,520	72,800	29,120	7,280	72,800	72,800	72,800	72,800	65,520	7,280	182,000	182,000
	Rainfall	767,742	767,742	6,909,678	7,677,420	3,070,968	767,742	7,677,420	7,677,420	7,677,420	7,677,420	6,909,678	767,742	19,193,550	19,193,550
	Superficial Aquifer Inflow	32,212	32,212	289,908	322,120	128,848	32,212	322,120	322,120	322,120	322,120	289,908	32,212	805,300	805,300
	Superficial Aquifer Irrigation	84,655	84,655	761,895	846,550	338,620	84,655	846,550	846,550	846,550	846,550	761,895	84,655	2,116,375	2,116,375
	Leederville Aquifer Irrigation	176,000	176,000	1,584,000	1,760,000	704,000	176,000	1,760,000	1,760,000	1,760,000	1,760,000	1,584,000	176,000	4,400,000	4,400,000
	IWSS Aquifer Irrigation	32,500	32,500	292,500	325,000	130,000	32,500	325,000	325,000	325,000	325,000	292,500	32,500	812,500	812,500
	Rainfall EVT	420,566	420,566	3,785,094	4,205,660	1,682,264	420,566	4,205,660	4,205,660	4,205,660	4,205,660	3,785,094	420,566	10,514,150	10,514,150
	Leederville Aq. Irrigation EVT	123,200	123,200	1,108,803	1,232,003	492,801	123,200	1,232,003	1,232,003	1,232,003	1,232,003	1,108,803	123,200	3,080,008	3,080,008
	Superficial Aq. Irrigation EVT	59,259	59,259	533,328	592,587	237,035	59,259	592,587	592,587	592,587	592,587	533,328	59,259	1,481,467	1,481,467
	IWSS Irrigation EVT	22,750	22,750	204,750	227,500	91,000	22,750	227,500	227,500	227,500	227,500	204,750	22,750	568,750	568,750
	Superficial Aquifer Volume	21,625,929	21,754,462	21,882,995	23,039,792	24,325,122	24,839,254	24,967,787	26,253,117	27,538,447	28,823,777	30,109,107	31,265,904	31,394,437	34,607,762
	Superficial Aquifer Outflow	346,081	346,081	3,114,729	3,460,810	1,384,324	346,081	3,460,810	3,460,810	3,460,810	3,460,810	3,114,729	346,081	8,652,025	8,652,025
	Sum EVTs	625,775	625,775	5,631,975	6,257,750	2,503,100	625,775	6,257,750	6,257,750	6,257,750	6,257,750	5,631,975	625,775	15,644,375	15,644,375
SURFACE WATER	Surface runoff to GBSW	31,674	31,674	285,066	316,740	126,696	31,674	316,740	316,740	316,740	316,740	285,066	31,674	791,850	791,850
	Superficial Aquifer to BD Road Culvert	5,904	5,904	53,137	59,041	23,617	5,904	59,041	59,041	59,041	59,041	53,137	5,904	147,604	147,604
	EVT	20,585	20,585	185,266	205,852	82,341	20,585	205,852	205,852	205,852	205,852	185,266	20,585	514,629	514,629
GROUNDWATER Mixing Factors	Combined Influx m3	1,100,389	1,100,389	9,903,501	11,003,890	4,401,556	1,100,389	11,003,890	11,003,890	11,003,890	11,003,890	9,903,501	1,100,389	27,509,725	27,509,725
	Cumulative Influx Prior to Evap. m3	22,597,785	22,726,318	30,629,699	32,758,352	28,212,546	25,811,110	34,686,347	35,971,677	37,257,007	38,542,337	38,855,811	32,237,760	55,690,837	58,904,162
	Perched Aquifer	0.000	0.000	0.002	0.002	0.001	0.000	0.002	0.002	0.002	0.002	0.002	0.000	0.003	0.003
	Rainfall	0.034	0.034	0.226	0.234	0.109	0.030	0.221	0.213	0.206	0.199	0.178	0.024	0.345	0.326
	Superficial Aquifer Inflow	0.001	0.001	0.009	0.010	0.005	0.001	0.009	0.009	0.009	0.008	0.007	0.001	0.014	0.014
	Superficial Aquifer Irrigation	0.004	0.004	0.025	0.026	0.012	0.003	0.024	0.024	0.023	0.022	0.020	0.003	0.038	0.036
	Leederville Aquifer Irrigation	0.008	0.008	0.052	0.054	0.025	0.007	0.051	0.049	0.047	0.046	0.041	0.005	0.079	0.075
	IWSS Aquifer Irrigation	0.001	0.001	0.010	0.010	0.005	0.001	0.009	0.009	0.009	0.008	0.008	0.001	0.015	0.014
	Superficial Aquifer Volume	0.957	0.957	0.714	0.703	0.862	0.962	0.720	0.730	0.739	0.748	0.775	0.970	0.564	0.588
	Aquifer Outflow	-0.006	-0.006	-0.038	-0.039	-0.018	-0.005	-0.037	-0.036	-0.034	-0.033	-0.030	-0.004	-0.058	-0.055
	Evaporation Loss	-0.028	-0.028	-0.184	-0.191	-0.089	-0.024	-0.180	-0.174	-0.168	-0.162	-0.145	-0.019	-0.281	-0.266
	Solution Volumn Correction Factor	1.03	1.03	1.28	1.30	1.12	1.03	1.28	1.27	1.25	1.24	1.21	1.02	1.51	1.47
SURFACE WATER Mixing Factors	Cumulative Influx Prior to Evap. m3	37578	37578	338203	375781	150313	37578	375781	375781	375781	375781	338203	37578	939454	939454
	Surface runoff to GBSW	0.843	0.843	0.843	0.843	0.843	0.843	0.843	0.843	0.843	0.843	0.843	0.843	0.843	0.843
	Superficial Aquifer to BD Road Culvert	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157
	Evaporation loss	-0.548	-0.548	-0.548	-0.548	-0.548	-0.548	-0.548	-0.548	-0.548	-0.548	-0.548	-0.548	-0.548	-0.548
	Solution Volumn Correction Factor	2.211	2.211	2.211	2.211	2.211	2.211	2.211	2.211	2.211	2.211	2.211	2.211	2.211	2.211

Appendix A1-2: Solute Mass Balance Summary - Post-development Scenario

Year		2025	2035	2045	2049	2050	2060	2070	2080	2090	2099	2100	2125	2150
Cumulated Years		1.0	10	20	24	25	35	45	55	65	74	75	100	125
Years Per Time Step		1.0	9	10	4.0	1.0	10	10	10	10	9.0	1.0	25	25
GROUNDWATER	Individual Filling volume (KL)	157,460	543,150	603,500	241,400	60,350	603,500	603,500	603,500	603,500	543,150	60,350	1,508,750	1,508,750
	Perched Aquifer	7,280	65,520	72,800	29,120	7,280	72,800	72,800	72,800	72,800	65,520	7,280	182,000	182,000
	Rainfall	789,473	7,105,257	7,894,730	3,157,892	789,473	7,894,730	7,894,730	7,894,730	7,894,730	7,105,257	789,473	19,736,825	19,736,825
	Superficial Aquifer Inflow	32,212	289,908	322,120	128,848	32,212	322,120	322,120	322,120	322,120	289,908	32,212	805,300	805,300
	Superficial Aquifer Irrigation	123,694	1,113,246	1,236,940	494,776	123,694	1,236,940	1,236,940	1,236,940	1,236,940	1,113,246	123,694	3,092,350	3,092,350
	Leederville Aquifer Irrigation													
	IWSS Aquifer Irrigation	46,000	414,000	460,000	184,000	46,000	460,000	460,000	460,000	460,000	414,000	46,000	1,150,000	1,150,000
	Rainfall EVT	312,427	2,811,843	3,124,270	1,249,708	312,427	3,124,270	3,124,270	3,124,270	3,124,270	2,811,843	312,427	7,810,675	7,810,675
	Leederville Aq. Irrigation EVT													
	Superficial Aq. Irrigation EVT	85,349	1,642,131	1,824,590	729,836	182,459	1,824,590	1,824,590	1,824,590	1,824,590	1,642,131	182,459	4,561,475	4,561,475
	IWSS Irrigation EVT	32,200	289,800	322,000	128,800	32,200	322,000	322,000	322,000	322,000	289,800	32,200	805,000	805,000
	Superficial Aquifer Volume	21,625,929	21,783,389	22,326,539	22,930,039	23,171,439	23,231,789	23,835,289	24,438,789	25,042,289	25,645,789	26,188,939	26,249,289	27,758,039
	Superficial Aquifer Outflow	411,223	3,701,007	4,112,230	1,644,892	411,223	4,112,230	4,112,230	4,112,230	4,112,230	3,701,007	411,223	10,280,575	10,280,575
	Sum EVTs	429,976	4,743,774	5,270,860	2,108,344	527,086	5,270,860	5,270,860	5,270,860	5,270,860	4,743,774	527,086	13,177,150	13,177,150
SURFACE WATER	Surface runoff to GBSW	36,866	331,794	368,660	147,464	36,866	368,660	368,660	368,660	368,660	331,794	36,866	921,650	921,650
	Superficial Aquifer to BD Road Culvert	7,015	63,139	70,155	28,062	7,015	70,155	70,155	70,155	70,155	63,139	7,015	175,387	175,387
	EVT	17,366	156,291	173,657	69,463	17,366	173,657	173,657	173,657	173,657	156,291	17,366	434,143	434,143
GROUNDWATER Mixing Factors	Combined Influx m3	998,659	8,987,931	9,986,590	3,994,636	998,659	9,986,590	9,986,590	9,986,590	9,986,590	8,987,931	998,659	24,966,475	24,966,475
	Cumulative Influx Prior to Evap. m3	22,467,128	30,228,170	31,709,629	26,683,275	24,109,748	32,614,879	33,218,379	33,821,879	34,425,379	34,090,570	27,127,248	49,707,014	51,215,764
	Perched Aquifer	0.000	0.002	0.002	0.001	0.000	0.002	0.002	0.002	0.002	0.002	0.000	0.004	0.004
	Rainfall	0.035	0.235	0.249	0.118	0.033	0.242	0.238	0.233	0.229	0.208	0.029	0.397	0.385
	Superficial Aquifer Inflow	0.001	0.010	0.010	0.005	0.001	0.010	0.010	0.010	0.009	0.009	0.001	0.016	0.016
	Superficial Aquifer Irrigation	0.006	0.037	0.039	0.019	0.005	0.038	0.037	0.037	0.036	0.033	0.005	0.062	0.060
	Leederville Aquifer Irrigation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	IWSS Aquifer Irrigation	0.002	0.014	0.015	0.007	0.002	0.014	0.014	0.014	0.013	0.012	0.002	0.023	0.022
	Superficial Aquifer Volume	0.963	0.721	0.704	0.859	0.961	0.712	0.718	0.723	0.727	0.752	0.965	0.528	0.542
	Aquifer Outflow	-0.007	-0.018	-0.019	-0.009	-0.003	-0.019	-0.018	-0.018	-0.018	-0.016	-0.002	-0.030	-0.029
	Evaporation Loss	-0.0191	-0.1569	-0.1662	-0.0790	-0.0219	-0.1616	-0.1587	-0.1558	-0.1531	-0.1392	-0.0194	-0.2651	-0.2573
	Solution Volumn Correction Factor	1.03	1.21	1.23	1.10	1.02	1.22	1.21	1.21	1.21	1.18	1.02	1.42	1.40
SURFACE WATER Mixing Factors	Cumulative Influx Prior to Evap. m3	43881	394933	438815	175526	43881	438815	438815	438815	438815	394933	43881	1097037	1097037
	Surface runoff to GBSW	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840
	Superficial Aquifer to BD Road Culvert	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160
	Evaporation loss	-0.396	-0.396	-0.396	-0.396	-0.396	-0.396	-0.396	-0.396	-0.396	-0.396	-0.396	-0.396	-0.396
	Solution Volumn Correction Factor	1.655	1.655	1.655	1.655	1.655	1.655	1.655	1.655	1.655	1.655	1.655	1.655	1.655

Appendix A1-3: Solute Mass Balance Summary - Post-development with Climate Change Scenario

Year		2025	2035	2045	2049	2050	2060	2070	2080	2090	2099	2100	2125	2150
Cumulated Years		1.0	10	20	24	25	35	45	55	65	74	75	100	125
Years Per Time Step		1.0	9	10	4.0	1.0	10	10	10	10	9.0	1.0	25	25
GROUNDWATER	Individual Filling volume (KL)	157,460	543,150	603,500	241,400	147,717	506,070	506,070	506,070	506,070	455,463	156,458	1,483,700	1,483,700
	Perched Aquifer	7,280	65,520	72,800	29,120	7,280	72,800	72,800	72,800	72,800	65,520	7,280	182,000	182,000
	Rainfall	789,473	7,105,257	7,894,730	3,157,892	749,109	7,491,090	7,491,090	7,491,090	7,491,090	6,741,981	538,491	13,462,275	13,462,275
	Superficial Aquifer Inflow	32,212	289,908	322,120	128,848	32,212	322,120	322,120	322,120	322,120	289,908	32,212	805,300	805,300
	Superficial Aquifer Irrigation	123,694	1,113,246	1,236,940	494,776	123,694	1,236,940	1,236,940	1,236,940	1,236,940	1,113,246	123,694	3,092,350	3,092,350
	Leederville Aquifer Irrigation													
	IWSS Aquifer Irrigation	46,000	414,000	460,000	184,000	46,000	460,000	460,000	460,000	460,000	414,000	46,000	1,150,000	1,150,000
	Rainfall EVT	312,427	2,811,843	3,124,270	1,249,708	302,447	3,024,470	3,024,470	3,024,470	3,024,470	2,722,023	226,527	5,663,175	5,663,175
	Leederville Aq. Irrigation EVT													
	Superficial Aq. Irrigation EVT	85,349	1,642,131	1,824,590	729,836	85,349	1,824,590	1,824,590	1,824,590	1,824,590	1,642,131	85,349	4,561,475	4,561,475
	IWSS Irrigation EVT	32,200	289,800	322,000	128,800	32,200	322,000	322,000	322,000	322,000	289,800	32,200	805,000	805,000
	Superficial Aquifer Volume	21,625,929	21,783,389	22,326,539	22,930,039	23,171,439	23,319,156	23,825,226	24,331,296	24,837,366	25,343,436	25,798,899	25,955,357	27,439,057
	Superficial Aquifer Outflow	411,223	3,701,007	4,112,230	1,644,892	390,582	3,905,820	3,905,820	3,905,820	3,905,820	3,515,238	247,143	6,178,575	6,178,575
	Sum EVTs	429,976	4,743,774	5,270,860	2,108,344	419,996	5,171,060	5,171,060	5,171,060	5,171,060	4,653,954	344,076	11,029,650	11,029,650
SURFACE WATER	Surface runoff to GBSW	36,866	331,794	368,660	147,464	33,283	332,830	332,830	332,830	332,830	299,547	15,058	376,450	376,450
	Superficial Aquifer to BD Road Culvert	7,015	63,139	70,155	28,062	6,663	66,633	66,633	66,633	66,633	59,970	4,216	105,406	105,406
	EVT	17,366	156,291	173,657	69,463	16,128	161,280	161,280	161,280	161,280	145,152	8,108	202,703	202,703
GROUNDWATER Mixing Factors	Combined Influx m3	998,659	8,987,931	9,986,590	3,994,636	958,295	9,582,950	9,582,950	9,582,950	9,582,950	8,624,655	747,677	18,691,925	18,691,925
	Cumulative Influx Prior to Evap. m3	22,467,128	30,228,170	31,709,629	26,683,275	23,982,017	32,396,036	32,902,106	33,408,176	33,914,246	33,512,628	26,390,118	43,163,582	44,647,282
	Perched Aquifer	0.000	0.002	0.002	0.001	0.000	0.002	0.002	0.002	0.002	0.002	0.000	0.004	0.004
	Rainfall	0.035	0.235	0.249	0.118	0.031	0.231	0.228	0.224	0.221	0.201	0.020	0.312	0.302
	Superficial Aquifer Inflow	0.001	0.010	0.010	0.005	0.001	0.010	0.010	0.010	0.009	0.009	0.001	0.019	0.018
	Superficial Aquifer Irrigation	0.006	0.037	0.039	0.019	0.005	0.038	0.038	0.037	0.036	0.033	0.005	0.072	0.069
	Leederville Aquifer Irrigation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	IWSS Aquifer Irrigation	0.002	0.014	0.015	0.007	0.002	0.014	0.014	0.014	0.014	0.012	0.002	0.027	0.026
	Superficial Aquifer Volume	0.963	0.721	0.704	0.859	0.966	0.720	0.724	0.728	0.732	0.756	0.978	0.601	0.615
	Aquifer Outflow	-0.007	-0.018	-0.019	-0.009	-0.006	-0.016	-0.015	-0.015	-0.015	-0.014	-0.006	-0.034	-0.033
	Evaporation Loss	-0.019	-0.157	-0.166	-0.079	-0.018	-0.160	-0.157	-0.155	-0.152	-0.139	-0.013	-0.256	-0.247
	Solution Volumn Correction Factor	1.03	1.21	1.23	1.10	1.02	1.21	1.21	1.20	1.20	1.18	1.02	1.41	1.39
SURFACE WATER Mixing Factors	Cumulative Influx Prior to Evap. m3	43881	394933	438815	175526	39946	399463	399463	399463	399463	359517	19274	481856	481856
	Surface runoff to GBSW	0.840	0.840	0.840	0.840	0.833	0.833	0.833	0.833	0.833	0.833	0.781	0.781	0.781
	Superficial Aquifer to BD Road Culvert	0.160	0.160	0.160	0.160	0.167	0.167	0.167	0.167	0.167	0.167	0.219	0.219	0.219
	Evaporation loss	-0.396	-0.396	-0.396	-0.396	-0.404	-0.404	-0.404	-0.404	-0.404	-0.404	-0.421	-0.421	-0.421
	Solution Volumn Correction Factor	1.655	1.655	1.655	1.655	1.677	1.677	1.677	1.677	1.677	1.677	1.726	1.726	1.726