Albany Woolstores, Albany

Local Water Management Strategy

April 2023

Client: Rowe Group

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Executive Summary

Hyd2o was commissioned by Rowe Group to prepare this Local Water Management Strategy (LWMS) to support the proposed local structure plan (LSP) for land extending over the former Albany Woolstores (herein referred to as the site).

The LSP area is approximately 16.4 ha in size and located approximately 2 km west of the Albany City Centre in the suburb of Mount Elphinstone. The proposed coastal development consists of tourism, residential and commercial areas along with roads and public open space adjacent to Princess Royal Harbour.

This document provides a comprehensive overall assessment of the existing water management system of the area and how it will be modified and integrated with the new development to improve water sensitive urban design outcomes as a result of the proposed land use change. Understanding key hydrological considerations has informed the development of this LWMS for the site. Key findings based on assessment of the site and subsequent water planning outcomes are as follows:

- Historically the southern half of the site has housed the historical Albany Woolstores with the balance to the north made up general rural lots. Site topography ranges from approximately 7 mAHD in the north down to 1 mAHD in the south.
- Western Australia Environmental Geology Series Sheets classifies the site as predominantly Alluvium Sand formation. A geotechnical investigation is set to take place to inform future planning.
- According to DWER Acid Sulphate Soil (ASS) Mapping the site contains areas classified as moderate to high risk of ASS occurring less than 3m from surface. As such, further assessment will be required and management measures put in place as necessary consistent with agency guidelines. The site is not registered as a contaminated site on DWER's Contaminated Sites Database.
- There are no conservation category wetlands, resource enhancement wetlands, multiple use wetlands or natural waterways within the site. An environmental assessment review has been conducted to inform this LWMS, with outcomes leading to a further ecological survey being conducted which will inform future planning.
- Given proximity of the development to the coast a Coastal Hazard Assessment Risk (CHARs) Report has been prepared to project inundation levels associated with sea level rise. Design for the LSP area will be required to account for a projected 100 year storm surge inundation level of approximately 2.2 mAHD.
- Surface flow runoff is able to be discharged readily from site to Princess Royal Harbour either directly or via existing drainage infrastructure. A remnant drainage network exists on site as part of the historic Woolstores while a large open drain dissects the site to service the northern rural lots and a large upstream catchment. This drain provides drainage connection for the Main Roads Albany Ring Rd upgrades and discharges into the reworked Frenchman Bay Rd intersection. The sites drainage network will be required to account for upstream catchments and the Main Roads Albany Ring Road drainage design. Surface water quality sampling conducted in June 2022 reported no major guidelines exceedances either upstream or downstream of the site.

- Maximum groundwater level mapping based on correlated site monitoring data shows that the site generally has a low clearance to groundwater. Groundwater across the site has a notable gradient as it was found to generally follow site topography with the rise to the north. Groundwater across the site is also expected to rise to some extent given projected rising levels. Groundwater sampling conducted in June 2022 reported high levels of nutrients consistent with historic land use and logged soil types. In general, concentrations of heavy metals suggested no levels of concern.
- The site is located across two groundwater areas; Albany's proclaimed groundwater area and Albany's unproclaimed hinterland management area. While this would suggest that options are available, abstracting groundwater for use in future is expected to be dictated by license availability and groundwater quality.
- Water use post-development will be predominantly sourced via the Water Corporation's Lower Great Southern Town Water Supply Scheme with initiatives in place to encourage the reduction of water use consistent with Water Corporation's "Waterwise" land development criteria. The Water Corporation will also provide wastewater management.
- Management of stormwater quality on site for the protection of coastal ecosystems will be achieved via the treatment of the first 15mm of runoff from both road reserves and hardstand areas. A gross pollutant trap will be fitted at the piped discharge point to the coast.
- From an amenity stand point piped road drainage infrastructure will be sized to maintain service for up to the 20% AEP event. The existing Woolstores drain will be replaced by a pipe for better LSP outcomes with this pipe to be sized to maintain the 10% AEP event below road level and configured to redirect this flow directly to coast given the magnitude of upstream flows.
- From a flood management perspective it is proposed that no attenuation of flows occur (apart from 15mm treatment storage) given the proximity of the coast and size of the receiving water. Road reserves are to provide the nearest available flood routes to the coast to minimise the convergence of major flows. The redirection of major flows directly to the coast will also benefit the capacity of the downstream Main Roads drainage network.
- Design levels and fill requirements will be driven by the requirement to provide suitable clearance to groundwater and free outfall to the coast during major rainfall events. Both these aspects are subject to projected sea level rise.
- Monitoring conducted as part of this LWMS is considered sufficient to satisfy predevelopment monitoring requirements. Post development monitoring in the interest of water quality discharge and system performance will be conducted for a period of up to 3 years consistent with agency requirements.
- Consistent with the integrated planning and urban water management process, the refinement of information included as part of this LWMS will be refined as necessary at the UWMP stage. Ongoing consultation with main stakeholders including the City of Albany and the Department of Water and Environmental

Regulation will be required in the interest of approving this LWMS and implementing its strategies beyond this stage.

This document has been prepared in accordance with the principles and objectives of Better Urban Water Management (Western Australian Planning Commission, 2008). Implementation of the strategy will be undertaken in accordance with Better Urban Water Management through the development and implementation of an Urban Water Management Plan (or Plans).

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

Local Water Management Strategy Summary

Water Use Sustainability	
Water Efficiency	• Promotion of 6 star building standards (water efficient fixtures and fittings). • Use of water-wise plantings in POS and landscape areas. • Water efficient measures to be adopted during the construction phase.
Water Supply	• Lots: Water Corporation LGSTWSS and rainwater tanks (encouraged). • POS: Groundwater via DWER licence optional if required. • Construction: Groundwater via DWER licence optional if required.
Wastewater	• Water Corporation reticulated sewerage.
Stormwater	
Design & Management Principles	• Water quality to be managed through biofiltration treatment of hardstand runoff generated by first 15mm of rainfall. • Stormwater management for larger events to be safely conveyed via road drainage flow paths to Princess Royal Harbour without attenuation • Development pad levels to have suitable clearance above groundwater, minimum 0.3m above road drainage flood routes and 0.5m above projected coastal surge risk levels. Projected 100 year storm surge level estimated at ~2.2 mAHD.
Lot Scale Measures	• First 15mm hardstand runoff to be treated in biofiltration areas at lot scale • Roof runoff permitted to be directly discharged to the road drainage network • Rainwater tanks (optional). • Water-wise landscaping to retain stormwater and minimise runoff
Street Scale Measures	• Biofiltration areas within road reserves to provide at-source treatment of the first 15mm of road runoff. Total storage volume of distributed areas estimated to be 330 m^3. • Events managed in piped drainage network with excess directed by controlled overland flow paths • Woolstores Pl drain replacing pipe sized for the 10% AEP event and remaining road piped drainage sized for the 20% AEP event. • GPT's / trash rack placed at main pipe costal discharge point.
Estate Scale Measures	• Distributed points of discharge to minimise convergence of major flows. Peak site discharge for 1% AEP event estimated as ~4 m^3/s. • Upstream catchment predevelopment flow paths to Princess Royal Harbour maintained • Post development groundwater, surface water, and system performance monitoring and annual reporting.
Groundwater	
Fill & Subsoil	• Import fill and establish levels to meet design criteria of clearance above groundwater and coastal risk mapping. • Subsoil drainage in road reserves potentially used at detailed design stage.
Acid Sulphate Soils	▪ Site has moderate to high risk of ASS. Acid sulphate soils to be investigated as a separate process and a management plan implemented if required.
Implementation	
Process	• Future stages of planning consistent with BUWM including preparation of UWMP. • Staging of stormwater to be detailed in the relevant UWMP's and implemented to ensure key hydrological performance criteria are maintained during transition. • Monitoring requirement for 3 years following development for water quality and system performance.

1. Introduction

Hyd2o was commissioned by Rowe Group to prepare this Local Water Management Strategy (LWMS) to support the proposed local structure plan (LSP) for land extending over the former Albany Woolstores (herein referred to as the site).

The LSP area is approximately 16.4 ha in size and located approximately 2 km west of the Albany City Centre in the suburb of Mount Elphinstone (Figure 1). The proposed coastal development consists of high density residential lots, roads, public open space, and commercial areas adjacent to Princess Royal Harbour (PRH).

This LWMS addresses stormwater management of the site while accounting for catchment external to the LSP area which currently discharges stormwater through the site via the Woolstores Pl drain with eventual connection to the new Main Roads (MR) Albany Ring Rd. This document provides a comprehensive overall assessment of the existing water management system of the area and how it will be modified and integrated with the new development to improve water sensitive urban design outcomes as a result of the proposed land use change.

This LWMS provides a total water cycle management approach to development and has been prepared in accordance with the principles and objectives of Better Urban Water Management (Western Australian Planning Commission, 2008). It provides the outcomes of detailed site specific analysis relating to groundwater and stormwater and provides a clear vision in terms of adopting best management practices to achieve water sensitive design.

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

Key stakeholders involved with its implementation of this strategy including the City of Albany and Department of Water and Environmental Regulation (DWER), have been consulted during this process. Given the size of the site and its likely development timeframe, ongoing consultation with these stakeholders will continue as planning progresses for the site.

1.1 Planning Background

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 site is currently predominantly zoned as 'General Industry' and 'Rural Small Lot Holdings' under the City of Albany's current Local Planning Scheme 1 (2022). It is understood a Local Planning Scheme 2 is being drafted with proposed plans for the development area being made with ongoing consultation with the City. This LWMS supports the preparation of a local structure plan for the site for residential and commercial. The urban water management planning process for the site is shown in Table 1.

Table 1: Integrated Planning and Urban Water Management Process

Planning Phase	Planning Document	Urban Water Management Documents
Local Structure Plan	Local Structure Plan	Albany Woolstores Local Water Management Strategy **THIS DOCUMENT**
Subdivision	Subdivision Application	Urban Water Management Plan **FUTURE PREPARATION**

1.2 Key Documents and Previous Studies

The requirements for water protection and urban water management for the site are established in a range of publications including the Water Corporations Water Forever: Lower Great Southern (2010), the Great Southern Regional Water Supply Strategy (Department of Water, 2014) and the City of Albany's Stormwater Management Strategy (2017).

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

- Decision Process for Stormwater Management in WA (DWER, 2017)
- Better Urban Water Management (WAPC, 2008)
- Stormwater Management Manual for WA (DWER, 2023)
- Stormwater Drainage Specification (City of Albany, 2017)

2. Proposed Development

The local structure plan (LSP) for the site is shown in Figure 2, providing a unique opportunity for the redevelopment of unused and degraded industrial land located on the picturesque coast near the City Centre.

The LSP area covers 16.4 ha, with the proposed development consists of tourism and residential areas overlooking the coast, new and upgraded roads, and POS and Public Access Ways (PAW) adjacent to the foreshore. The area also includes a commercial area slightly further inland.

The development will provide tourism and a vibrant residential community providing an alternative housing option to the predominantly lower density living in Albany and surrounds. The structure plan design aims to integrate with the ongoing MR Albany Ring Road upgrades and provide better usability of disused coastal space for the public and a tourism destination for the region.

From a stormwater management perspective, the development will seek to provide improvements in management for existing and new systems, both from a water quality and public amenity viewpoint.

3. Existing Environment

3.1 Site Conditions

The site is located in the suburb of Mount Elphinstone in the City of Albany.

A large portion of the site is the former Albany Woolstores and with the balance made up of rural lots. The site is bounded by PRH to the south with a combination of rural lots, industrial land and woodland in all other directions. The MR Albany Ring Road upgrades run adjacent to the western and northern boundaries of the site with connection to Woolstores Pl running west to east through the site.

Figure 3 shows an aerial photograph with existing land use, topography and extent of the MR works around the site. Based on survey carried out by Harley Dykstra in July 2022 site topography ranges from approximately 7 mAHD in the northern most area to below 1m on the southern coastal border. The site survey is included in Appendix B and is generally consistent with 1m Landgate topography available over the area.

3.2 Geotechnical

According to the Albany 1:50 000 Environmental Geology Series Sheets 2427 I, 2428 II, 2527 IV & 2528 III (Gozzard 1989), the site is predominantly characterised as Alluvium Sand (S14), described as white to pale grey, fine to medium, occasionally coarse, angular to sub-angular quartz (Figure 4).

A geotechnical investigation is expected to take place as part of the next stage of planning with findings reported in the subsequent UWMP (or UWMP's).

3.2.1 Acid Sulphate Soils

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

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

DWER's ASS soil risk mapping over the Albany region indicates that the site is predominantly classified as having a high to moderate risk of ASS across the site less than 3 m from the surface. This classification aligns with the low-lying coastal location where the risk is more prone. As such it is expected an ASS investigation separate to this LWMS will take place to make an ultimate assessment of the land and provide recommendations in development consistent with WAPC (2008) planning guidelines.

3.2.2 Contaminated Sites

The site is not registered as a contaminated site on DWER's Contaminated Sites Database mapping (2023). The database does report registered sites to the north which are hydrologically upstream of the site (Figure 4) however it should be noted these have been classified as remediated.

Strategen JBS&G (2022) conducted a preliminary site investigation at the site and identified areas of concern for potential contamination given historical industrial landuse and structure materials such as asbestos and part of the site overlaying uncontrolled fill associated with the reclaimed land on which the Woolstores are built. Recommendations to provide a more in depth contaminated site investigation have been provided as part of the Environmental Assessment Review (Strategen JBS&G, 2022).

3.3 Environment

There are no conservation category wetlands, resource enhancement wetlands, multiple use wetlands, or natural waterways within the site.

Strategen JBS&G's Environmental Assessment Review (2022) identified the Subtropical and Temperate Coastal Saltmarsh Threatened Ecological Community (TEC) to be associated with remnant vegetation within and coastal habitat in proximity to the site. Three threatened fauna species have been known to previously exist within the site and as such an ecological survey has been undertaken inform future planning. Any further environmental assessment outcomes will inform the UWMP planning stage.

3.4 Coastal Risk

Given the proximity of the development to the coast a Coastal Hazard Assessment Risk (CHARs) Report has been prepared to inform potential inundation risk of the site with sea level rise. Storm surge inundation levels with projected sea level rise in the next 100 years are provided in Figure 5. Modelling indicates the potential for an inundation storm surge level of approximately 2.2 mAHD in 2122. This modelling corresponds to a projected 100 year sea level rise of 0.94m (Water Technology, 2022).

Albany tidal data has been collected from a tidal gauge located within Princess Royal Harbour (station # 62120) for the period from 1966 to the end of 2020. During that time the Bureau of Meteorology (2022) reported mean readings for each month, with a maximum mean of 0.32 mAHD recorded in 1999 across all months.

Other notable sea levels recorded by the Department of Transport (2021) based on 5 to 15 minute increment data includes a mean sea level (MSL) of 0.08 mAHD and a highest recorded level of 1.14 mAHD in 2007.

3.5 Surface Water

There is no overarching DWER regional or district stormwater strategy which covers the site. While some infiltration may occur on site, stormwater is able to be readily discharged to PRH via drainage infrastructure connected directly to the coast or to Albany's road drainage network. The site also conveys flows from an upstream catchment via a drain which runs adjacent to Woolstores Pl and ultimately discharges to the road drainage network at the corner with Frenchman Bay Rd. Flows produced in drainage networks both upstream and downstream of the site will also be influenced by the ongoing construction of the MR Albany Ring Road which introduces its own road drainage design.

Following a preliminary desktop assessment to determine expected stormwater behaviour on-site, Hyd2o conducted a site investigation on 27 and 28 June 2022 to identify stormwater infrastructure and flow paths. The investigation was limited by the stage of deconstruction of the Woolstores site and overgrowth however sufficient elements of infrastructure were located to estimate flow paths and produce the drainage network

map as shown in Figure 6. A notable finding was the existence of culverts east of the site which directs runoff underneath the rail tracks and into the sites drainage network. These culverts are shown in Figure 6.

Catchments associated with the site were mapped using investigation findings, available Landgate topography and historical aerial imagery, City of Albany Stormwater Infrastructure mapping and MR drainage design drawings. Mapped catchments are shown in Figure 6. For analysis purposes predevelopment catchments have been delineated into site catchments within the bounds of the LSP area and catchments external. Main Roads upgrades have also been considered as constructed with external catchments allocated accordingly. It is estimated that the Woolstores Pl drain receives flow from a total upstream catchment approximately 117 ha in size and the upstream coastal catchment that also drains through the site is approximately 3 ha in size.

Hyd2o conducted modelling using XP-Storm to provide an estimate of flows produced from each catchment for 20% Annual Exceedance Probability (AEP) and 1% AEP events. Modelled durations ranged from 30 minutes to 72 hours. Runoff rates used in modelling were derived using Hyd2o CURRV runoff calculator which integrates Australian Rainfall and Runoff (2016) methodology with to up to date Intensity Frequent Durations (IFD) design rainfalls (Appendix C). The relatively steep nature of the upstream environment was also factored in to the model.

Values displayed in Table 2 for critical event durations show site and external catchment flows separately for analysis and comparison purposes in relation to their relative contributions to PRH. Where applicable individual contributing catchments (as shown on Figure 6) are also provided in Table 2. External flows shown also account for inflow to and subsequent discharge from individual Main Roads attenuation basins, with these storage areas incorporated into the model based on detail provided by Main Roads.

The majority of site flows would be expected to be readily conveyed to PRH directly via the existing piped network or by overland flow paths. The largest concentration of flow would be expected to take place at the downstream end of the Woolstores Pl drain where a 600mm diameter pipe with an invert level of 0.92 mAHD connects in to the network at the Main Roads Frenchman Bay Rd intersection. Based on survey and field observations, the existing Woolstore Pl drain would be expected to have the capacity to attenuate flows with additional shallow storage provided by the rural land on the north side of the drain if required. It is estimated that approximately 7300 m^3 of storage would be available as a combination of drain and land storage and this was input into the model accordingly. As expected modelling showed that attenuation would occur for minor and major events given the capacity of the 600mm diameter outlet to the downstream network. The 20% AEP event was managed within the drain while the 1% AEP would overtop into the rural land on the northern side.

Three outfalls to Princess Royal Harbour in regards to site and external flows were identified as part of the predevelopment environment. Consistent with site catchments two of these comprised of discharge to the coast either directly via infrastructure associated with the old Woolstores site or indirectly via the western creek. The third outfall is the ultimate outlet from the Main Roads Frenchman Bay Rd intersection out to the sea which is a 675mm diameter pipe at an invert of 0.29 mAHD. All three critical outfall flows for 1% AEP events are shown on Figure 6 and have considered a sea level at 0.6 mAHD as a tail water condition, being a nominal value between the mean sea level and highest sea level recorded discussed in Section 3.4. Notably in the model this condition results in breaches of

the Frenchman Bay Rd intersection drainage network which would subsequently lead to overland flow. Based on MR drawings it is inconclusive whether the road layout would direct this flow if breaching was to occur however there appears the potential for it to sheet across the southern rural lots. Considering all flows and durations it is estimated that a combined peak discharge to PRH of 2.68 m^3/s would occur based on site related catchments during the critical 30 minute 1% AEP event.

Table 2: Predevelopment Surface Water Flow

	Site			External		
Location **Contributing Catchments** *as shown on Figure 6*	**Woolstores Pl Drain**	**Coast**	**Creek**	**Woolstores Pl Upstream** MR Basin 3Q MR Basin 3R WSPlDrainUp	**Coast Upstream** UpCoast	**Woolstores Pl Downstream** MR Basin 3S MR Basin 3T DownCatch
Rural Res (ha)	-	-	0.19	44.59	-	9.12
Industrial (ha)	-	5.65	3.42	-	1.74	4.53
Forested (ha)	-	-	-	53.15	-	7.26
Range (ha)	5.51	0.34	-	0.12	0.14	-
Rail Reserve (ha)	-	-	-	0.97	0.77	1.66
Road Reserve (ha)	1.85	0.54	0.02	18.36	0.17	6.89
Total Area (ha)	7.36	6.53	3.64	117.21	2.82	29.46
Equiv Imp Area (20% AEP) (ha)	1.46	4.43	2.47	24.90	1.51	10.69
Equiv Imp Area (1% AEP) (ha)	2.87	4.72	2.61	44.85	1.86	14.94
20% AEP Event						
Peak Flow (m^3/s)	0.164	0.272	0.167	0.600	0.116	0.490
Critical Duration	10 min	30 min	30 min	10 min	30 min	30 min
1% AEP Event						
Peak Flow (m^3/s)	0.484	0.727	0.428	1.760	0.355	0.915
Critical Duration (hr)	10 min	30 min	30 min	10 min	30 min	1 hr

3.5.1 Surface Water Quality

Hyd2o took a set of pre development surface water quality monitoring during the June 2022 site investigation. Samples were taken at sites identified to be flowing and reflective of quality either entering or leaving the site. Sampling locations are shown in Figure 6.

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

Surface water quality results are summarised in Table 3 compared to ANZECC (2000) guideline trigger values for lowland river ecosystems. Given ultimate discharge to the ocean consideration was also made with trigger values for marine ecosystems, particularly for metals. Full monitoring results are summarised in Appendix D along with the lab report.

Key results are summarised as follows:

- pH at all sites were below the ANZECC guideline value of 8.2 for marine ecosystems however all fell within the guideline range for lowland river ecosystems (6.5 – 8).
- Values for Electric Conductivity (EC) for each site ranged from 0.856 mS/cm to 44.67 mS/cm. The highest reading was recorded at SW1, consistent with the tidal creek location.
- Total nitrogen (TN) for all sites ranged from 1.1 to 2.6 mg/L, outside the ANZECC guideline limit for lowland river ecosystems (1.2 mg/L).
- Total phosphorus (TP) ranged from 0.06 to 0.14 mg/L with values ranging from below the ANZECC guideline limit for lowland rivers (0.065 mg/L) entering the site at SW2 to exceeding the limit leaving the site at SW1 and SW3.

With respect to metals, results were as follows relative to ANZECC guideline values for marine ecosystems:

- Arsenic, Cadmium, Mercury, Chromium, Copper, Lead, and Nickel were all within the 99% protection limit across all sites.
- Zinc was within the 95% protection limit at SW1 while within the 90% protection limit at SW2 and SW3.

In general sampled surface water quality across all sites was relatively good with no major guideline exceedances in either nutrients or metals. Notably in regards to the Woolstores Pl drain, levels of organic nutrients (TN and TP) were higher at the downstream end while higher in inorganic forms at the receiving upstream end (Ammonia, NOx and FRP).

Table 3:Predevelopment Surface Water Quality

Surface Water Sample	Sampled Parameters						
	EC (mS/cm)	pH	TN (mg/L)	Ammonia (mg/L)	NOx (mg/L)	TP (mg/L)	FRP (mg/L)
ANZECC (Lowland Rivers)	0.120 - 0.3	6.5-8.0	1.2	2.49 – 5.07 (95% protect. for sampled pH range)	0.15	0.065	0.04
SW1 (Creek outfall to sea)	44.67	7.40	1.1	0.11	0.028	0.14	0.09
SW2 (Woolstores Pl drain upstream)	0.856	6.56	2.1	0.16	1.30	0.06	0.039
SW3 (Woolstores Pl drain downstream)	1.94	7.04	2.6	0.015	0.041	0.11	0.058

3.6 Groundwater

3.6.1 Groundwater Levels

Mount Barker – Albany 1:250 000 Hydrogeology mapping over the site area indicates an underlying sedimentary aquifer with intergranular porosity. Given proximity to the coast a shallow clearance to the superficial aquifer is expected. This is supported by visible expressions of groundwater as shown by Landgate historical aerial imagery (2022).

To enable groundwater mapping over the site Hyd2o installed three groundwater monitoring bores via hand auger during the site investigation in June 2022. Given the loamy soils excavated during construction, water level readings were allowed to settle and were recorded later the same day. During the investigation two additional bores within the site area were found with levels also taken. All bore locations are shown in Figure 7. Clearance from natural surface to readings taken ranged from approximately 0.1m to 1.2m. All bores were surveyed during the detailed site survey.

To estimate maximum groundwater levels (MGL) for the site, readings taken were correlated to behaviour at a nearby DWER bore with a longer term record. DWER bore C3 11 (shallow) is located approximately 5.5 km southwest of site has been monitored continuously via logger since 2012 with the bore's hydrograph contained in Appendix E. The MGL based on the past 10 years of data is shown in Table 4 along with the calculated correction to the level at the bore 27 June 2022. Calculated MGL's at the site bores based on the applied correction factor to site readings are shown in Table 5.

MGL levels at some bore locations were corrected to natural surface and these levels were used for the mapping of groundwater over the site. Surveyed water levels from the

Woolstores Pl drain taken August 2022 were also used in the mapping as seasonally these would represent a drain level controlled by the outlet. Similarly an inferred creek level and the maximum monthly mean sea level (0.32 mAHD) were used to provide control points in analysis. Contour mapping based on the calculated MGL's and the additional sites is shown in Figure 7.

MGL's across the site range from 7 mAHD at the northern end to less than 0.5 mAHD at the southern coastal interface. The clearance from natural surface to MGL exceeds 1m in the southern region of the site where the historic wool store warehouses existed however the site predominantly has a clearance of less than 1m. As mentioned earlier groundwater would express at surface at some locations in an MGL condition and groundwater contours tend to be dictated by topography at the site as shown in Figure 7. This aligns with observations of ponding water in areas of the site during the June 2022 site investigation.

It is important to note that while average annual maximum groundwater levels (AAMGL) tend to represent a better reflection of long term average seasonal behaviour, MGL's have been mapped for the purposes of this LWMS based on the availability of data and observations made on site.

It should be noted that mapping of groundwater reflects a current sea level condition. As discussed in Section 3.4 there is a projected sea level rise of 0.94m adjacent to the development area. An extent of groundwater rise would therefore also be expected within the site with the greatest effect over the lower half of the site nearest the coast. For indicative purposes groundwater contouring (in Figure 7) also includes associated values with the approximate 0.9m projected rise.

Table 4: MGL for DWER Bore

Bore	Period of Record Used	Groundwater Level (mAHD) 27/06/2022	MGL 2012-2022 (mAHD)	Correction Factor (m)
C3 11	2012 – 2022	1.21	1.67	0.46

Table 5: MGL for Site Bores

Bore	Natural Surface (mAHD)	Groundwater Level (mAHD) 27/06/2022	MGL (mAHD)	Depth to MGL Below Natural Surface (m)	Corrected MGL (mAHD)
WS1	2.53	2.41	2.87	-0.34	2.53
WS2	2.03	1.76	2.22	-0.19	2.03
WS3	6.75	6.15	6.61	0.13	6.61
UK1	4.42	3.26	3.72	0.70	3.72
UK2	2.48	1.73	2.19	0.29	2.19

3.6.2 Groundwater Quality

Sampling for groundwater quality was also carried at the 5 bore locations during the June 2022 site investigation.

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

Groundwater quality results are summarised in Table 6 compared to ANZECC (2000) guideline trigger values for lowland river ecosystems. Given tidal interaction and proximity to the ocean consideration was also made with trigger values for marine ecosystems, particularly for metals. Full monitoring results are summarised in Appendix D along with the lab report.

Results are summarised as follows:

- pH across the groundwater bores ranged between 4.70 and 7.24 with all sites falling within the ANZECC guideline range (6.5 – 8.0) with the exception of WS2.
- EC across the groundwater bores ranged between 0.303 mS/cm and 1.915 mS/cm. All groundwater sites exceeded the upper limit of the ANZECC guideline range (0.12 – 0.30 mS/cm). Notably the exceedance at WS3 was marginal and greater at WS1 and WS2.
- TN values ranged from 0.9 mg/L at to 49 mg/L at mg/L, with all bores exceeding the ANZECC guideline limit (1.2 mg/L) with the exception of UK1. Exceedances at the bores were notably high, particularly at WS1 and WS2.
- NOx readings ranged from <0.005 mg/L to 0.036 mg/L, with all bores within the ANZECC guideline limit for lowland river ecosystems (0.15 mg/L) with the exception of UK2. WS1, WS2 and WS3 also fell within the ANZECC guideline limit for estuary ecosystems (0.045 mg/L) and WS2 even that for marine ecosystems (0.005 mg/L).
- TP was exceeded the ANZECC guideline limit of 0.065 mg/L across all sites ranging from 0.27 mg/L at UK1 to 0.66 mg/L at WS1.
- FRP readings ranged from <0.005 mg/L to 0.21 mg/L, with only WS3 and UK2 falling within the AZECC guideline limit for lowland ecosystems (0.04 mg/L). UK2 also fell within the ANZECC guideline limit for marine ecosystems (0.005 mg/L).

With respect to metals, results were as follows relative to ANZECC guideline values for marine ecosystems:

- Arsenic, Cadmium, Chromium, Lead, Mercury and Nickel were within the 99% protection limit at all bores.
- Copper was within the 95% protection limit at WS1 and UK1 while within the 90% protection limit at all remaining bores.
- Zinc fell within the 95% protection limit at all bores with the exception of WS2, where the reading fell outside the 80% protection limit.

Findings of the sampling were that the groundwater quality at the site is generally high in nutrients. Notably this is predominantly in organic form (TN and TP) rather than inorganic with each bore reporting below ANZECC guideline limits for either NOx or FRP. This is consistent with the loamy organic soils observed when excavating during monitoring bore

installation. It is expected that the high levels of organics is the result of accumulation over time given unfavourable conditions for decomposition which is typical in waterlogged areas or areas with low pH (DPI, 2023). This is consistent with organic nutrient levels being highest at WS1 and WS2 which exist in depressed areas of the site where groundwater is expected to intersect the surface in a high water table condition and pond.

In general, concentrations of heavy metals across the bore samples suggested no levels for concern. Notably readings at the bores located within the historic Woolstores site, WS1 and UK2, were within at least the 90% protection limit for marine ecosystems across all metal parameters.

Table 6: Existing Groundwater Quality

Groundwater Bore	Sampled Parameters						
	EC (mS/cm)	pH	TN (mg/L)	Ammonia (mg/L)	NOx (mg/L)	TP (mg/L)	FRP (mg/L)
ANZECC (Lowland Rivers)	0.12-0.30	6.5-8.0	1.2	2.84 – 5.96 (95% protect. for sampled pH range)	0.15	0.065	0.04
WS1	1.925	6.58	33	0.67	0.034	0.66	0.021
WS2	1.689	4.70	49	0.10	<0.005	0.64	0.21
WS3	0.303	6.81	9.8	0.11	0.036	0.30	0.008
UK1	0.713	7.24	0.9	0.029	0.11	0.27	0.056
UK2	0.556	7.13	9.7	0.045	0.2	0.34	<0.005

3.6.3 Groundwater Resource Area

Groundwater across Albany is recognised to be part of either Albany's proclaimed groundwater area or Albany's unproclaimed hinterland management area. Based off DWER's most recent 2017 Prospective Groundwater Resource mapping (Appendix F) the site straddles the boundary between the two management areas. As shown in Figure 7 the area within the site generally north of Woolstores Pl is proclaimed while the southern area, historically the Woolstores site area, is unproclaimed.

Abstracting groundwater within the proclaimed management area requires a licence and currently no license exists over the site. The underlying Bremer West Superficial aquifer is currently fully allocated in the associated Level 1 Albany Racecourse subarea at the resource classification with limited information available on Level 2. Notably a groundwater licence for 90,000 kL/yr exists just north of the site within the same subarea allocated to Decmil for the Albany Ring Road construction project. This license is currently

ending in 2023 and it is expected this allocation will be relinquished back to DWER following construction. A DWER Water Register (2023) extract is contained in Appendix F.

Groundwater within the unproclaimed management area requires no groundwater licence should the source be non-artesian.

3.7 Constraints and Opportunities

Based on the sites existing environment, the following key constraints and opportunities are identified to guide the development of the water management strategy and proactive management practices detailed in later sections of this report:

- The site has generally low winter clearance to groundwater with the major event runoff expected to discharge off site either directly via coast outfalls or the Woolstores Pl drain. Levels across the development will be required to account for the clearance to groundwater and flood management based on storm surge inundation levels with projected sea level rise.
- The site provides a flow path for a total of approximately 120 ha of upstream catchment. This is done via the Woolstores Pl drain and a drainage network associated with the historic Albany Woolstores site. Development of the site will be required to continue to provide a means of conveyance for external catchments post development.
- Opportunities exist to improve the existing stormwater management in terms of water quality treatment as currently none exist prior to discharge to coastal ecosystems. Generally clean runoff from roof areas would reduce nutrient runoff from existing rural land following land development.
- There is an opportunity to better manage the conveyance of flow to the PRH with sea levels projected to rise. Based on current drainage configuration the downstream Main Roads network becomes breached with a current high sea level condition. Modification of local drainage through the site could mitigate this even with a high sea level condition consistent with the 100 year projected sea level rise.
- Configuration of stormwater management systems to be consistent with the capacity of the post development site to infiltrate and/or potential site contamination as per EAR comments (Strategen JBS&G, 2022).
- There are no conservation category wetlands, resource enhancement wetlands, multiple use wetlands, or natural waterways within the site. Management of potential TEC areas will be required following further flora investigations consistent with the EAR.

4. Design Criteria & Objectives

Key design principles and criteria for the site are shown in Table 7 and have been established consistent with the key reference documents previously detailed in Section 1.2, and reflect the site constraints and opportunities identified in Section 3.

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

Table 7: Design Principles & Criteria

Strategy Elements	Method & Approach
Water Use Sustainability	
Water Efficiency	• Water efficiency implementation to be consistent with Building Codes of Australia requirements • Aim for less than 100 kL/person/year water use • Establish "Waterwise" Public Open Space
Water Supply	• Minimise overall use of scheme water for non-drinking purposes • Water Corporation LGSTWSS for lots plus use of rainwater tanks (non-mandated) • Irrigation of POS via groundwater resource
Wastewater	• Water Corporation reticulated sewerage
Stormwater	
Ecological Protection	• Biofiltration areas on lots for treatment of hardstand runoff (15mm event on site) • Establishment of distributed biofiltration areas within road reserves for treatment of first 15mm road runoff
Serviceability	• Piped drainage system (where required) sized to convey 20% AEP event • Woolstores PI drainage infrastructure sized to convey 10% AEP event
Flood Protection	• Overland flow paths within road reserves for safe conveyance of flows exceeding pipe drainage system capacity • Provide flood paths directly to coastal outlet areas where possible • Establish minimum habitable floor levels at 0.5m above the projected 100 year storm surge level and 0.3m above road drainage systems • Provide gross pollutant traps (GPT) for coastal discharge where appropriate
Groundwater	
Fill Requirement & Subsoil Drainage	• Development levels to establish an acceptable clearance to groundwater • Subsoil configurations used in road drainage design where required
Acid Sulphate Soils & Contamination	• Management of Acid Sulphate Soils and any contamination to be handled as a separate process if required consistent with DER (2015) and WAPC (2008) requirements

5. Water Use Sustainability

5.1 Water Efficiency Measures

The development of the site will lead to an overall increased demand for potable water and for landscaped areas. Water conservation measures will be implemented to reduce scheme water consumption within the development will be consistent with Water Corporation's "Waterwise" land development criteria including:

- Promotion of use of waterwise practices including water efficient fixtures and fittings (taps, showerheads, toilets, rainwater tanks, waterwise landscaping).
- All buildings to be built to 6 star building standards (water efficient fixtures and fittings).
- Fit-for-purpose use of water based on land use need.
- Mandatory use of water wise plantings in landscapes areas.
- Use of high density residential zoning to remove use of water for individual gardens and minimise fertiliser nutrient inputs.

5.2 Water Supply

The Water Corporation's Lower Great Southern Town Water Supply Scheme (LGSTWSS) will supply potable water to residential and commercial buildings on the site.

Rainwater tanks will not be mandated to supplement the domestic water supply scheme however incorporation in design will be encouraged given the availability of large roof areas across residential and commercial buildings for stormwater harvesting.

As mentioned in Section 3.6.3 the northern region of the site is located in a fully allocated subarea of the West Bremer superficial aquifer however there may be opportunities with Level 2 licensing or available allocation in future based on relinquishment of existing licenses. Otherwise the southern region of the site is located in an unproclaimed management area and a license would not be required to draw from aquifers that are not artesian. It is expected that groundwater quality at potential abstraction bore locations will play a role in determining whether drawing from the proclaimed or unproclaimed would be ideal. As shown in Section 3.6.2 groundwater quality is variable across the site.

Consistent with DWER (2014) and Water Corporation (2010) strategies for water supply in the Great Southern region fit-for-purpose use for both landscape irrigation and commercial activities could be supplemented by groundwater on site. Notably the Great Southern also utilises a great amount of recycled wastewater for fit-for-purpose initiatives with treated wastewater from the Albany wastewater treatment plant currently being used to irrigate tree plantations.

A landscape masterplan for the site prepared by Plan E is contained as Appendix G.

5.3 Wastewater Management

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

6. Stormwater Management Strategy

This LWMS proposes a stormwater strategy considering the proximity of the LSP area to the coast with the implementation of an at-source stormwater treatment approach to improve water quality management while introducing drainage infrastructure to safely manage major event flows in a rising sea level environment for both the site and its upstream catchment.

Improving water quality in minor event discharge to coastal ecosystems will be achieved the through the adoption of both non-structural and structural control measures while safe conveyance in major events will be managed via direct flood routes elevated above projected sea level rise.

The site will continue to service the upstream catchment via Woolstores Pl however it is proposed to replace the current open steep sided trapezoidal drain with an integrated pipe network to allow for improved LSP outcomes and local area amenity.

Stormwater management at the site has been designed in accordance with Better Urban Water Management (WAPC, 2008), City of Albany Stormwater Management Strategy (2017), DWER requirements, and Stormwater Management Manual for Western Australia (DoW, 2007).

The key elements of the stormwater management strategy are as follows:

- Management of the first 15mm of hardstand runoff on lots
- Treatment of first 15mm of road runoff at-source in road reserve swales
- Provide Gross Pollutant Traps (GPT) at piped coastal discharge points
- No attenuation of flow rates, apart from 15mm management, given proximity and capacity of receiving water
- Road drainage network with capacity for up to the 20% Annual Exceedance Probability (AEP) event
- Conveyance of upstream catchment via Woolstores Pl maintained, with infrastructure sized with capacity to maintain flows for up to the 10% AEP event below road level to harbour outlet
- Reduce flows to downstream MR drainage network to improve capacity in a rising sea level environment
- Maintain a drainage flow path to the coast for industrial land to the east of site
- Road reserves provide safe flood route conveyance for up to the 1% AEP event to harbour and set above the 100 year coastal storm surge projected level (2.18 mAHD)
- Residential and commercial floor levels set a minimum 0.5m above the 100 year coastal storm surge projected level

Catchments have been determined in consideration of water quality management, infrastructure limitations demonstrated in predevelopment modelling and providing the safest drainage route for discharge to the harbour. As such catchments based on points of discharge for minor events, are shown in Figure 8 and 9, and catchments for major events,

shown in Figure 10, differ. Differing catchments and discharge locations based on the magnitude of rainfall events is consistent with engineering concepts shown in Appendix H.

6.1 Stormwater Event Modelling

Stormwater modelling was conducted to provide indicative flows and infrastructure capacity requirements consistent with the proposed stormwater management strategy and catchments.

Stormwater modelling was done using XP-Storm. XP-Storm is an industry standard program that performs detailed hydraulic and hydrological calculations to simulate the performance of stormwater systems for a range of design storm events. The design storms modelled by XP-Storms were based on methodology in Australian Rainfall & Runoff (Ball, et al, 2016) and the Bureau of Meteorology Computerised Design Intensity Frequency Duration (IFD) Rainfall System. Storms modelled for the 20%, 10% and 1% AEP events ranged from the 10 minutes to 24 hours duration.

Various runoff coefficients applied to different land uses for each of the AEP's modelled were again determined using Hyd2o's CURRV runoff rate calculator as shown in Appendix C. Note road reserves and hardstand were modelled with an initial loss of 15mm consistent with the stormwater strategy.

All post development modelling incorporated a tailwater sea level condition of 1.6 mAHD. This reflects the nominal value based on historic sea levels used in predevelopment modelling with the addition of the projected 0.94m of sea level rise.

Constructed models incorporated drainage detail upstream and downstream of the site from survey information, MR design drawings and drainage network information available from the City of Albany's online mapping tools (2022).

6.2 Ecological Protection (15 mm)

Storm volumes for ecological protection based on the first 15 mm event are provided in Table 8 to provide a guide for storage requirements consistent with the stormwater strategy.

Biofiltration areas for the at-source treatment of road runoff are shown distributed in Figure 8 and represent a combination of both median and verge swales. Configuration in terms of the capacity to infiltrate either via permeable soils or underlain subsoil will be determined following geotechnical investigations undertaken in conjunction with the UWMP.

Appendix I provides typical storage cross sections showing biofilters in relation to road reserve arrangements. Biofilters will be designed at UWMP stage consistent with the Adoption Guidelines for Stormwater Biofiltration Systems (CRC for Water Sensitive Cities, 2015) however indicative sections are provided in the landscape masterplans in Appendix G.

Table 9 details a summary from the Stormwater Management Manual for Western Australia (DoW, 2007) of expected pollutant removal efficiencies for various WSUD measures in relation to water quality design criteria contained in WAPC (2008).

While DoW (2007) does not provide expected pollutant removal efficiencies for all best management practices (BMPs), application of a treatment train approach using a

combination of the non-structural and structural measures will therefore clearly achieve the design objectives for water quality for the site.

Table 8: Stormwater Management – Minor Events

Catchment	PRH Outlet (& WS Pl Upstream input flow)	Ring Rd	PAW
Residential (ha) Assumed breakdown: Hardstand – 25% Roof – 60% Landscape/Drainage – 15%	7.29	-	-
Commercial (ha) Assumed breakdown: Hardstand – 35% Roof – 55% Landscape/Drainage – 10%	4.53	-	-
Road Reserve (ha)	2.81	0.28	-
Public Open Space (ha)	0.43	0.42	-
External MR (ha)	-	1.13	-
PAW (ha)	-	-	0.61
Total Area (ha)	15.06	1.84	-
Equiv Imp Area (15mm event) (ha)*	5.03	0.20	-
Equiv Imp Area (20% AEP) (ha)	12.22	1.13	0.09
Water Quality: 15mm Biofiltration			
Road Swale Vol. (m^3)	300	30	-
Lot Management Vol. (m^3)	455	-	-
20% AEP Event			
Peak Flow (m^3/s)	1.175	0.093*	0.003
Critical Duration	30 min	30 min	1 hour

*Flow influenced by 1.6 mAHD sea level tailwater condition

Table 9: BMP Water Quality Performance in Relation to Design Criteria

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

1. Typical Performance Efficiencies via DoW (2007)

6.3 Serviceability (20% & 10% AEP)

The site's road drainage network will maintain up to the 20% AEP event below road level. Modelled discharge flows for the 20% AEP from the site's minor catchments are shown in Table 8 and Figure 8.

The pipe to replace the Woolstores Pl drain will be sized to maintain up to the 10% AEP event below road surface to which the pipe travels. The configuration of the pipe is limited by the 600mm sized outlet pipe at the western end of the drain consistent with Main Roads drainage design.

Stromwater modelling revealed that under these constraints a 600mm replacement pipe via the existing route would not have the capacity maintain the 10% AEP event below road level. Instead it is proposed that the pipe be redirected south at the main site intersection to an alternative discharge point a shown in Figure 9 to enable further capacity. It is proposed that the remainder of the pipe west of the intersection continues to drain west to the Ring Rd intersection with a significantly reduced catchment. This proposed configuration has informed the minor event catchments shown in Figure 8.

Minor event catchments shown in Figure 8 were further lineated in to sub-catchments shown in Figure 9 in order to model indicative 10% AEP event pipe flow requirements. Critical pipe flows are also shown on Figure 9 and in Table 10. XP-Storm modelling extracts are provided in Appendix J.

Pipe sizes and grades in the proposed design of the pipe were derived based on a collaborative process with project engineers Stantec in consideration of additional development level constraints to achieve consistency with the stormwater strategy. A nominal 600mm cover from pipe to road level was assumed in the analysis based on general Stantec advice. Pipe sizes and grades to enable management of the 10% AEP event below road level based on the modelled sub-catchments are also shown in Table 10 and are consistent with conceptual engineering drainage design in Appendix H. It should be noted that pipe design provided should be considered as indicative only with further detailed modelling to inform pipe design to be undertaken at the UWMP stage in conjunction with detailed engineering design.

For completeness the remaining section of Woolstores Pl pipe that remains heading west to the Albany Ring Rd intersection is also included in Table10. The catchment flow shown in Table 10 is easily conveyed by a 600mm diameter pipe however the capacity of the pipe is impacted by the modelled sea level condition of 1.6 mAHD acting against an outlet invert of 0.29 mAHD. Critically, flows are still maintained below road level.

Installation of a GPT is proposed at the main minor event discharge point which conveys the majority of pipe flow across the site. Doing so should effectively provide a means of screening stromwater prior to direct outfall to the coastal environment. The location is indicated on Figure 8 and on engineering concepts in Appendix H.

Table 10: Woolstores Pl Pipe Design Analysis

Catchment	WS Pl Upstream to WS Pl Pipe A	WS Pl Pipe A to WS Pl Pipe B	WS Pl Pipe B to WS Pl Pipe C	WS Pl Pipe C to PRH Outfall	WS Pl Pipe D to MR Ring Rd

Additional EIA (10% AEP) (ha)	30.08	0.61	4.70	0.20	0.23
10% AEP Event					
Peak Flow (m^3/s)	0.788	0.785	1.073	1.067	0.016*
Critical Duration	15 min	15 min	15 min	15 min	1 hr
Indicative Pipe Dimensions					
Diameter (mm)	750	750	900	900	600
Nominal Grade	1:50	1:250	1:333	1:333	1:133

*Value reflects catchment flow

6.4 Flood Protection (1% AEP)

Major catchments shown in Figure 10 provide the shortest (and safest) conveyance route out to the coast where possible once the piped drainage network capacity is exceeded. These are achieved via worked road levels which effectively provide drainage flood routes through the site. Critical 1% AEP discharge flows from these catchments are shown in Table 11. Road levels in all discharge locations sit above the 100 year projected storm surge level as shown in conceptual engineering design in Appendix H to effectively allow for free outfall.

Catchments PRHOutA and PRHOutB discharge 1.33 m^3/s and 2.39 m^3/s respectively from their points of discharge. These flows should be treated as indicative only give the variation between minor and major event catchments with the distribution of total flow between the two points likely to be influenced by the nature of the rainfall event and sea level at the time. Erosion control measures at both outlet locations with consideration of this will be required in detailed design at the UWMP stage.

In regards to the minor catchment that discharges to the Ring Rd drainage network, the peak discharge of 0.27 m^3/s from the 600mm outlet reflects a flow that is still managed below road level and as such no nominated overland flow path for the 1% AEP event is considered necessary. However, in events greater than the 1% AEP event a safeguard overland flow path to the west does exist given road levels and a low point side entry pit where Woolstores Place and the intersection integrate as part of MR design. Notably modelled pits and basins within the intersection demonstrated better management of flow in comparison to the predevelopment model given the reduction of contributing catchment flow even with a higher sea level condition (1.6 mAHD).

Note that while peak discharge to PRH has risen as result of landuse change and new drainage routes via the site, management of flow for the integrated area with coastal considerations has improved, particularly in relation to water quality management. As mentioned above, erosion controls will mitigate any potential impacts of increased flow on the coastal environment.

As shown in Figure 10, the flow path to the coast for the industrial land to the east of the site will be maintained with the 1% AEP event flow from this catchment of 0.36 m^3/s (Section 3.5) to be conveyed along the eastern boundary of the site. The design of the conveyance structure, likely an open drain, will be included in drainage drawings submitted with UWMP.

Finished slab levels have been designed with a minimum separation of 0.5m to the projected 100 year storm surge inundation level as shown in Appendix H.

Table 11: Stormwater Management – Major Events

	PRH Outlet A	PRH Outlet B (& WS Pl Upstream input flow)	Ring Rd	PAW
Residential (ha) Assumed breakdown: Hardstand – 25% Roof – 60% Landscaped/Drainage – 15%	3.50	3.79	-	-
Commercial (ha) Assumed breakdown: Hardstand – 35% Roof – 55% Landscape/Drainage – 10%	4.52	-	-	-
Road Reserve (ha)	1.53	1.28	0.28	-
Public Open Space (ha)	0.15	0.29	0.42	-
External MR (ha)	-	-	1.13	-
PAW (ha)	-	-	-	0.61
Total Area (ha)	9.70	5.36	1.83	0.61
Equiv Imp Area (1% AEP) (ha)	8.45	4.44	1.30	0.19
1% AEP Event				
Peak Flow (m^3/s)	1.332	2.386	0.270*	0.018
Critical Duration	30 min	30 min	30 min	1 hr

*Flow influenced by 1.6 mAHD sea level tailwater condition

7. Groundwater Management Strategy

7.1 Earthworks, Fill and Subsoil Drainage

With groundwater near surface over the majority of the site development levels will be dictated by mapped groundwater levels. Fill requirements will need to account for the nature of groundwater rise from south to north as well as any potential further rise in groundwater levels in the local coastal area as a result of projected sea level rise. Conceptual finished floor and road levels have been prepared by Stantec based on groundwater mapping completed as part of this LWMS and with these additional considerations.

These conceptual levels are shown in the engineering drawings Appendix H and have been derived to enable flood routes to PRH consistent with the stormwater strategy discussed in Section 6 while also providing a minimum clearance to groundwater (plus sea level rise) of 1m for lot levels and 0.5m for roadways.

It is understood that these levels should be considered as indicative only with final detailed engineering design lot levels and fill specification to be subject to the subdivision plan and incorporated into the UWMP. As such this will include any potential road design with subsoil drainage as part of a groundwater management over the site.

7.2 Acid Sulphate Soils

Acid sulphate soil mapping has been previously discussed in Section 3.2.1 as having a high to moderate risk of ASS across the site less than 3 m from the surface. As such it is expected an ASS investigation separate to this LWMS will take place to make an ultimate assessment of the land and provide recommendations in development consistent with WAPC (2008) planning guidelines.

If required, management of ASS will be addressed by a separate study by a suitably qualified environmental consultant, and any ASS management plan required will detail the actions to minimise and mitigate potential adverse environmental effects during the works. Any management strategies are to follow Department of Environment (2015) guidelines.

8. Urban Water Management Plans

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

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

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

Further detail of the integration of stormwater within lots to the road drainage network will be provided during the development of the relevant UWMP's covering those specific areas. This will include the refinement of stormwater modelling, preparation of detailed landscape plans (species selection and treatments), and detailed engineering design drawings.

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

9. Monitoring

9.1 Pre Development

Surface and groundwater monitoring of existing conditions conducted in June 2022 is considered suitable for establishing a predevelopment baseline condition for future monitoring and reporting. As such, no further predevelopment monitoring is considered necessary from a water management planning perspective. However, should any more monitoring take place to inform any further environment reporting this will also be utilised during the UWMP process.

9.2 Post Development

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

The post development monitoring program is summarised in Table 12 with proposed sites in Figure 11. Post development groundwater monitoring is proposed at 5 groundwater monitoring bores to provide suitable coverage of the site and surface water sampling is proposed at 3 locations to capture upstream and downstream water quality (where possible) relative the development area. Some locations have been able to be maintained from predevelopment to post.

The following frequency of monitoring is proposed:

- Quarterly groundwater level and quality measurements.
- Four surface water sampling occasions opportunistically across winter (when available).

It proposed that groundwater levels are also be simultaneously measured at a nearby DWER bore for historical referencing.

Groundwater quality will be monitored quarterly (typically January, April, July, October) for physical parameters (pH, electrical conductivity), nutrients (total nitrogen, total Kjeldahl nitrogen, ammonia, nitrate, nitrite, total phosphorus, and filterable reactive phosphorus) and heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, aluminium, manganese, arsenic and lead). All water quality samples will be analysed at a NATA approved laboratory.

Stormwater quality sampling of key inflow and outflow locations will also be undertaken opportunistically via grab sampling during groundwater monitoring occasions. Sampling parameters will be the same as groundwater monitoring. Samples may also be supplemented by biofiltration areas within road reserves as necessary. Visual assessment of each of these areas will also be undertaken on a quarterly basis via a standardised proforma, to assess performance in relation to design.

The monitoring schedule will be undertaken for a three year period consistent with usual DWER requirements. An annual report will be prepared summarising the results of the program, with results compared to predevelopment monitoring data.

The program may need to be modified as data is collected to increase or decrease the monitoring effort in a particular area, or to alter the scope of the program itself. This will require agreement of all parties.

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

A contingency plan is presented in Table 13, which will be refined at UWMP stage should any further environmental monitoring take place. Post development monitoring results will be compared to both pre-development monitoring outcomes and ANZECC guideline data. This approach is required as the local baseline condition may naturally be outside the recommended ANZECC range for some parameters.

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

Table 12: Post Development Monitoring Program

Monitoring	Parameter	Location	Method	Frequency and Timing
Groundwater level	Water level (m AHD)	5 bores within site area and 1 DWER bores	Electrical depth probe or similar	Quarterly (4 occasions annually)
Groundwater quality	Physical, nutrients and heavy metals	5 bores within site area	Pumped bore sample	Quarterly (4 occasions annually)
Stormwater quality	Physical, nutrients and heavy metals	2 inflow and 1 outflow locations	Collected grab samples of outflow	Simultaneous to groundwater (when available)
Stormwater System performance	Profroma	Biofilters	Visual Assessment	Simultaneous to groundwater (when available)

Table 13: Contingency Planning

Type	Criteria for Assessment	Frequency	Process & Possible Actions
Water Quality	Surface and groundwater quality significantly worse than: a) predevelopment water quality; and/or b) with reference to ANZECC guidelines [1]	Ongoing assessment following monitoring with annual review	**Process** 1. Assess spatial extent of occurrence. 2. Determine if due to development or other 3. Perform appropriate action as required 4. Record and report any breach and action 5. If necessary inform residents of any works 6. Inform and provide data to DWER/ CoA **Possible Actions** 1. Resample to determine if a true reading 2. Identify & remove point sources of pollution 3. Review operation & maintenance practices 4. Consider alterations to POS areas including landscape regimes and soil amendment. 5. Consider stormwater system modifications 6. Consider community based projects.

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

10. Implementation

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

Monitoring outcomes will be used in a continual improvement capacity to review the implemented WSUD within the site and inform the planning and design approaches for subsequent stages of development.

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

Monitoring outcomes will also be used to inform continual design and planning improvements as the development proceeds.

Table 14: Implementation, Roles and Responsibilities

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

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hyd2o HYDROLOGY

abn 93 697 380 883
suite 1b hay st subiaco wa 6008
PO Box 1055 subiaco wa 6904
p 08 9382 8683 f 08 9382 8712
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FIGURES

Date: 24/02/2023 Job No. H21128

LSP Area/Site

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Albany Woolstores Local Water Management Strategy

Location Plan

Figure 1

Date: 06/04/2023 Job No H21128

STRUCTURE PLAN MAP
VARIOUS LOTS, WOOLSTORES PLACE
MOUNT ELPHINSTONE, ALBANY

DRAFT

SCALE @ A3: 1:2500
9116-LSP-01-F

ROWE GROUP DESIGN

Source: Rowe Group (2023)

hyd2o

Albany Woolstores Local Water Management Strategy

Proposed Local Structure Plan

Figure 2

Date: 24/02/2023 Job No. H21128

Site

Topography (mAHD) - Survey (Harley Dykstra, 2022)

Main Roads Ring Rd Upgrade Extent

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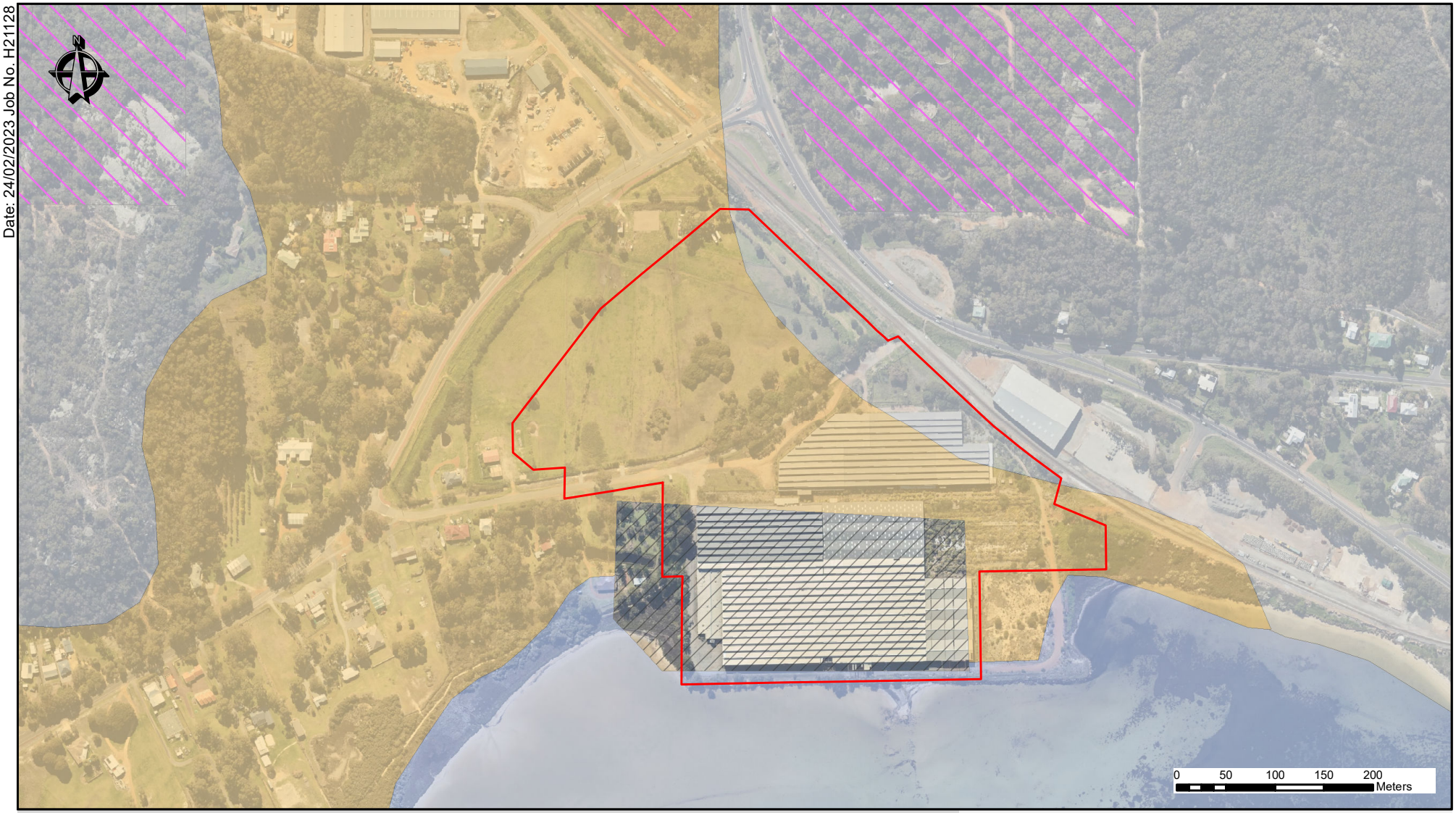
Albany Woolstores Local Water Management Strategy

Site Conditions Plan

Figure 3

Date: 24/02/2023 Job No. H21128



Site

Gozzard (1989) Geology Series

S14 - Sand - white to pale grey, fine to medium, occasionally coarse, angular to sub-angular quartz, little fines, moderately sorted (Alluvium)

GR - Granite - fine to coarse, even-grained and porphyritic granitic rocks

Ocean

Made Ground

Contaminated Sites - Remediated (DWER, 2022)

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Albany Woolstores Local Water Management Strategy

Geotechnical Plan

Figure 4

Date: 24/02/2023 Job No. H21128

Site

Storm Surge Level

- PRH 2122 Inundation Extent - 2.18 mAHD
- PRH 2072 Inundation Extent - 1.59 mAHD
- PRH 2047 Inundation Extent - 1.39 mAHD
- PRH 2022 Inundation Extent - 1.24 mAHD

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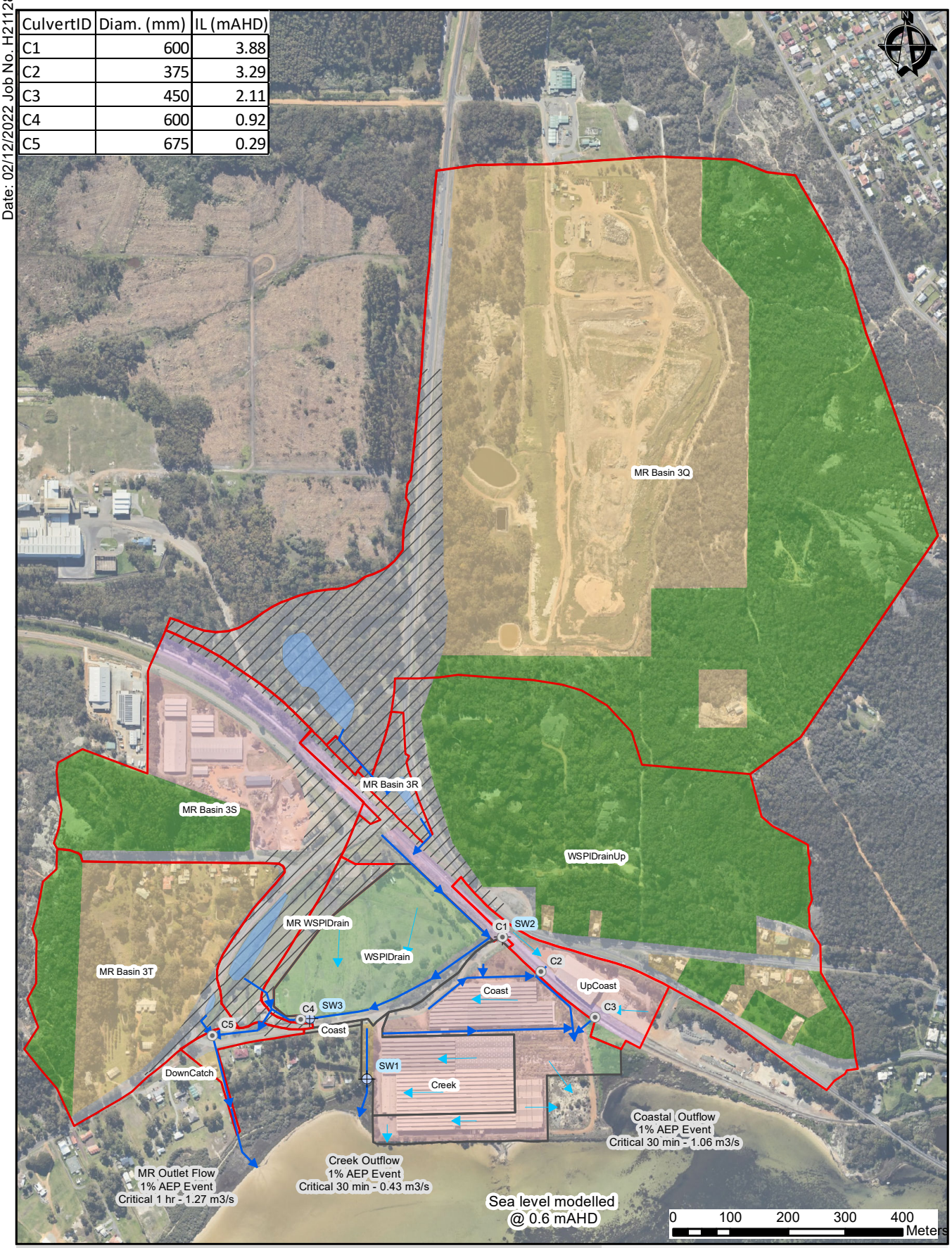
Albany Woolstores Local Water Management Strategy

Coastal Risk Plan

Figure 5

Date: 02/12/2022 Job No. H21128

CulvertID	Diam. (mm)	IL (mAHD)
C1	600	3.88
C2	375	3.29
C3	450	2.11
C4	600	0.92
C5	675	0.29



Site Catchments
External Catchments
Drains/Pipes
Surface Flow Path
Culvert/Headwall
Indus
Rail
Range
Road Res
Rural
Forested
MR Upgrades
MR Basins
SW Sampling

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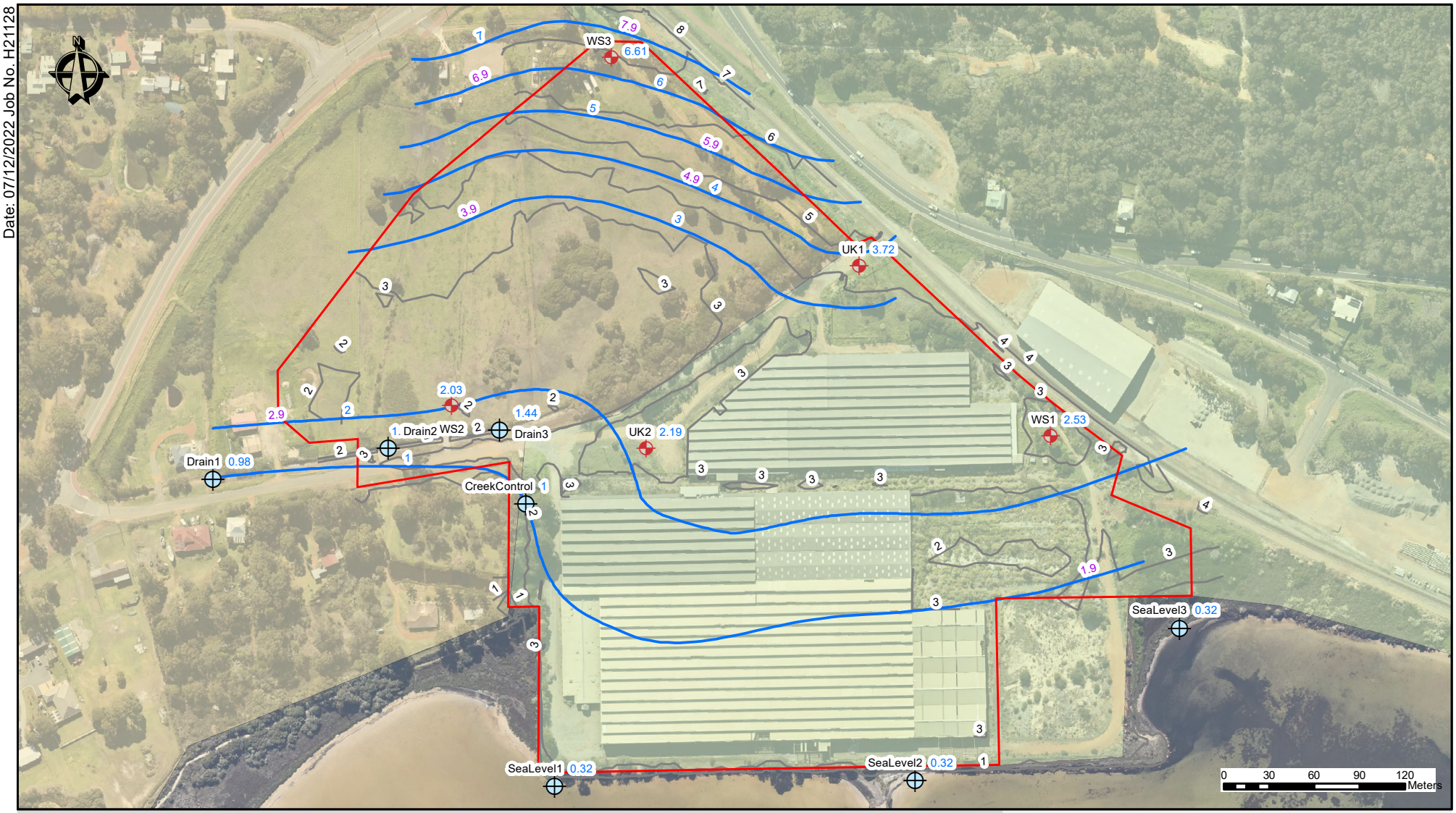
Albany Woolstores LWMS

Surface Water Plan

Figure 6

Date: 07/12/2022 Job No. H21128



Site

GW Monitoring Bores MGL (mAHD)

Mapping Control Points MGL (mAHD)

MGL Contours (mAHD) Values with Projected Sea Level Rise (mAHD)

Survey Topo (mAHD)

Albany GW Management

Proclaimed

Unproclaimed

hyd2o

Albany Woolstores LWMS

Groundwater Plan

Figure 7

Date: 22/03/2023 Job No. H21128

Catchments
Catchment Flow
Road Level High Points
15mm Road Biofiltration (m3)
Catchment Discharge Point
Piped Network Flow
External Flow
Maintained Flow Path
MR Upgrades
MR Basins
Residential
Commercial
POS
Road
External Main Roads

hyd2o

Albany Woolstores LWMS

Stormwater Management Plan - Minor Events

Figure 8

Date: 22/03/2023 Job No. H21128

Sub-catchments
External Catchments
Woolstores Pl Pipe
ExternalFlow
Maintained Flow Path

Residential
Commercial
POS
Road
External Main Roads

hyd2o

Albany Woolstores LWMS

Stormwater Management Plan - Woolstores Pl Pipe

Figure 9

Date: 22/02/2023 Job No. H21128

Catchments
External Catchments
Catchment Discharge Point
Catchment Flow
External Flow
Maintained Flow Path
MR Upgrades
MR Basins
Residential
Commercial
POS
Road
External Main Roads

hyd2o

Albany Woolstores LWMS

Stormwater Management Plan - Major Events

Figure 10

Date: 22/02/2023 Job No. H21128

Site
Proposed GW Locations
Proposed SW Locations

Residential
Commercial
POS
Road
External Main Roads

hyd2o

Albany Woolstores LWMS

Post Development Monitoring

Figure 11

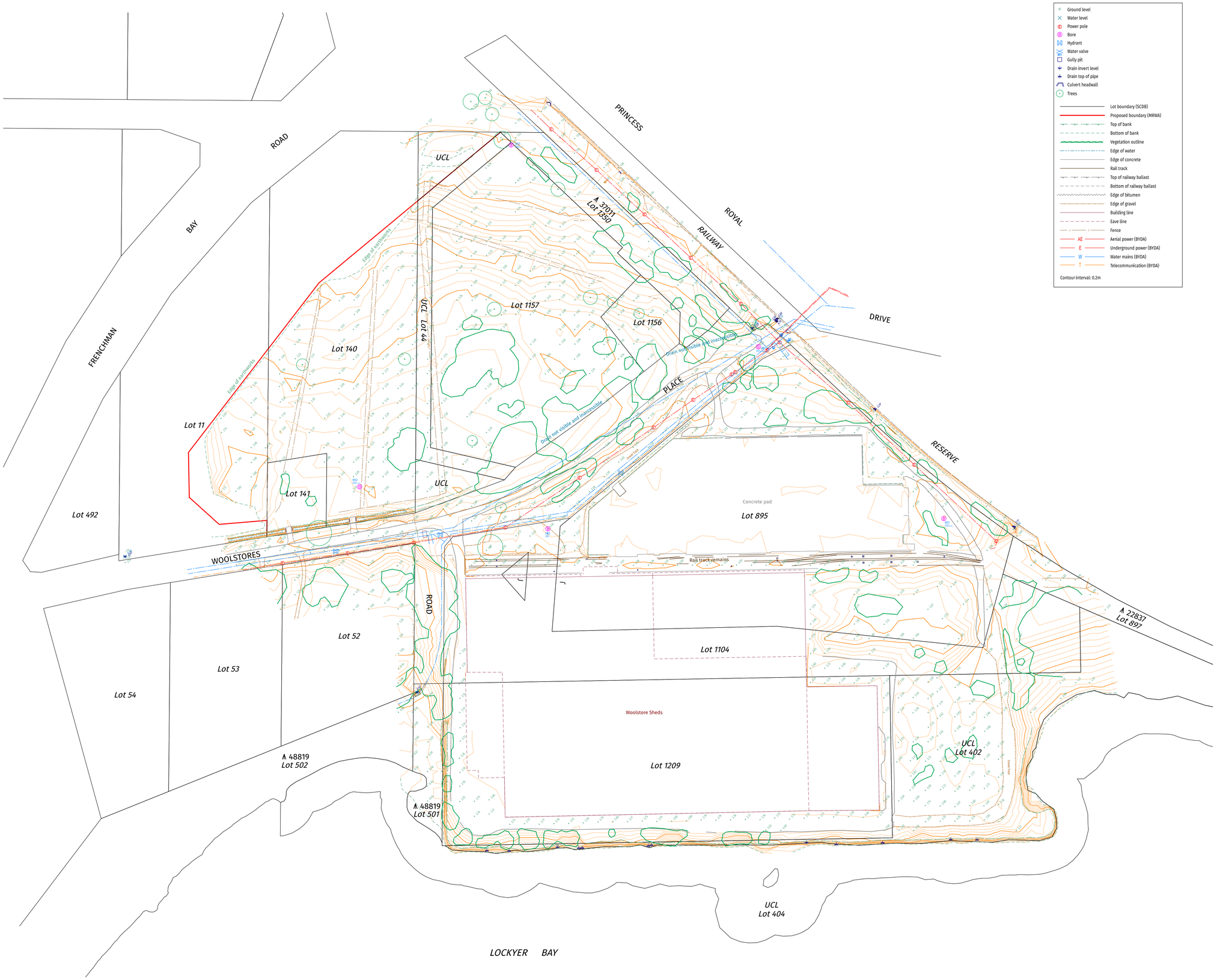
APPENDIX A
BUWM Checklist

Better Urban Water Management LWMS Checklist

Local Water Management Strategy Item	Deliverable	✓	Comments
Executive summary			
Summary of the development design strategy, outlining how the design objectives are proposed to be met	Table 1: design elements and requirements for BMP's and critical control points	☑	Executive Summary
Introduction			
Total water cycle management - principles and objectives Planning background Previous studies		☑	Chapter 1, Figure 1
Proposed development			
Structure plan, zoning and land use Key landscape features Previous land use	Site Context Plan Structure Plan	☑	Section 1.1, Section 2, Figure 2
Landscape - proposed POS areas, POS credits, water source, bore(s), lake details (if applicable), irrigation areas	Landscape plan	☑	Section 5.2, Appendix G
Design criteria			
Agreed design objective and source of objective		☑	Section 4, Table 7
Pre-development environment			
Existing information and more detailed assessments (monitoring). How do the site characteristics affect the design?		☑	Section 3, Figures 3-7
Site conditions- existing topography/ contours, aerial photo underlay, major physical features	Site Condition plan	☑	Section 3.1, Figure 3
Geotechnical - topography, soils including acid sulfate soils and infiltration capacity, test pit locations	Geotechnical plan	☑	Section 3.2, Figure 4
Environmental- areas of significant flora and fauna, wetlands and buffers, waterways and buffers, contaminated sites	Environmental plan plus supporting data where appropriate	☑	Sections 3.3
Surface water- topography, 100 year floodways and flood fringe areas, water quality of flows entering and leaving (if applicable)	Surface water plan	☑	Section 3.4 & 3.5, Figure 5 & 6, Appendix D & J
Groundwater - topography, pre development groundwater levels and water quality, test bore locations	Groundwater plan plus details of groundwater monitoring and testing	☑	Section 3.6, Figure 7, Appendices D-F, J
Water use sustainability initiatives			
Water efficiency measures- private and public open spaces including method of enforcement		☑	Section 5.1
Water supply (fit- for-purpose strategy), agreed actions and implementation. If non-potable supply, support with water balance		☑	Section 5.2, Appendix F
Wastewater management		☑	Section 5.3
Stormwater management strategy			
Flood protection - peak flow rates, volumes and top water levels at control points, 100 year flow paths and 100 year detentions storage areas	100yr event plan Long section of critical points	☑	Section 6.4 Table 11, Figures 10, Appendix H & J
Manage serviceability - storage and retention required for the critical 5 year ARI storm events Minor roads should be passable in the 5 year ARI event	5yr event plan	☑	Section 6.3 , Table 8 & 9, Figures 8 & 9, Appendix H & J
Protect ecology - detention areas for the 1 yr 1 hr ARI event, areas for water quality treatment and types of (including indicative locations for) agreed structural and non-structural best management practices and treatment trains. Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages	1 yr event plan Typical cross sections	☑	Section 6.2 Table 8, Figure 8, Appendix I

Local Water Management Strategy Item	Deliverable	✓	Comments
Groundwater management strategy			
Post development groundwater levels, fill requirements (including existing and likely final surface levels), outlet controls, and subsoil areas/exclusion zones	Groundwater/subsoil plan	☑	Section 7.1 Appendix H
Actions to address acid sulphate soils or contamination		☑	Section 7.2
The next stage - subdivision and urban water management plans			
Content and coverage of future urban water management plans to be completed at subdivision. Include areas where further investigations are required prior to detailed design		☑	Section 8
Monitoring			
Recommended future monitoring plan including timing, frequency, locations and parameters, together with arrangements for ongoing actions		☑	Section 9, Figure 11 Table 12 & 13
Implementation			
Developer commitments		☑	Section 10, Table 14
Roles, responsibilities, funding for implementation		☑	Section 10, Table 14
Review		☑	Section 10, Table 14

APPENDIX B
Site Survey (Harley Dykstra, 2022)



LEGEND

- Ground level
- Water level
- Power pole
- Bore
- Hydrant
- Water valve
- Gully pit
- Drain invert level
- Drain top of pipe
- Culvert headwall
- Trees
- Lot boundary (SCDB)
- Proposed boundary (MRWA)
- Top of bank
- Bottom of bank
- Vegetation outline
- Edge of water
- Edge of concrete
- Rail track
- Top of railway ballast
- Bottom of railway ballast
- Edge of bitumen
- Edge of gravel
- Building line
- Eave line
- Fence
- AE Aerial power (BYDA)
- E Underground power (BYDA)
- W Water mains (BYDA)
- T Telecommunication (BYDA)

Contour interval: 0.2m

n

Harley Dykstra

PLANNING & SURVEY SOLUTIONS

DISCLAIMER

This plan has been prepared for RURAL LOGISTICS PTY LTD from a combination of field survey and existing records for the purpose of showing the physical features of the land to assist in designing future development. It should not be used for any other purpose.

The title boundaries shown hereon were not verified or marked at the time of survey but are derived from the SCDB 08 2022. They are estimated to be accurate only to +/- 0.1m. This plan should not be used for building to boundary, or to prescribed set-backs, without further boundary survey.

Underground services shown on this drawing have been plotted from service authority records obtained from 'Before You Dig Australia' or a similar source. Unless indicated otherwise only surface features have been located by survey .

Before starting any demolition, excavation or construction on the site, the relevant person should make an independent and updated enquiry of 'Before You Dig Australia' and any relevant service providers to ascertain the existence of further services (if any) and the accurate location of those not surveyed at the time of preparing this plan (or data).

No responsibility can be accepted by Harley Dykstra for any damage caused to any underground service or any loss or injury so suffered if enquiry and verification have not been completed in accordance with this note.

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rev	details	approved	date
A	Original drawing	DPJ	26/08/22

survey: PDH 27/07/22	cad file: 23304-01A.dgn
drawn: BdR 26/08/22	checked: DPJ 29/08/22
horiz datum: MGA94 Zone 50	level datum: AHD

scale at A1: 1 : 1250 — all distances are in metres (0 10 20 30 40 50)

plan type: FEATURE & CONTOUR SURVEY

client: RURAL LOGISTICS PTY LTD

description: WOOLSTORES PLACE
MOUNT ELPHINSTONE & MOUNT MELVILLE

drawing no: 23304-01A

ALBANY OFFICE:
HARLEY DYKSTRA PTY LTD
31 Albany Highway, ALBANY WA 6330
T: 08 9844 5100
E: albany@harleydykstra.com.au
W: www.harleydykstra.com.au

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APPENDIX C
Hyd2o CURRV Runoff Calculator

CURRV

Calculator for Urban Runoff Rates & Volumes

06-04-23

Project: **Albany Woolstores**

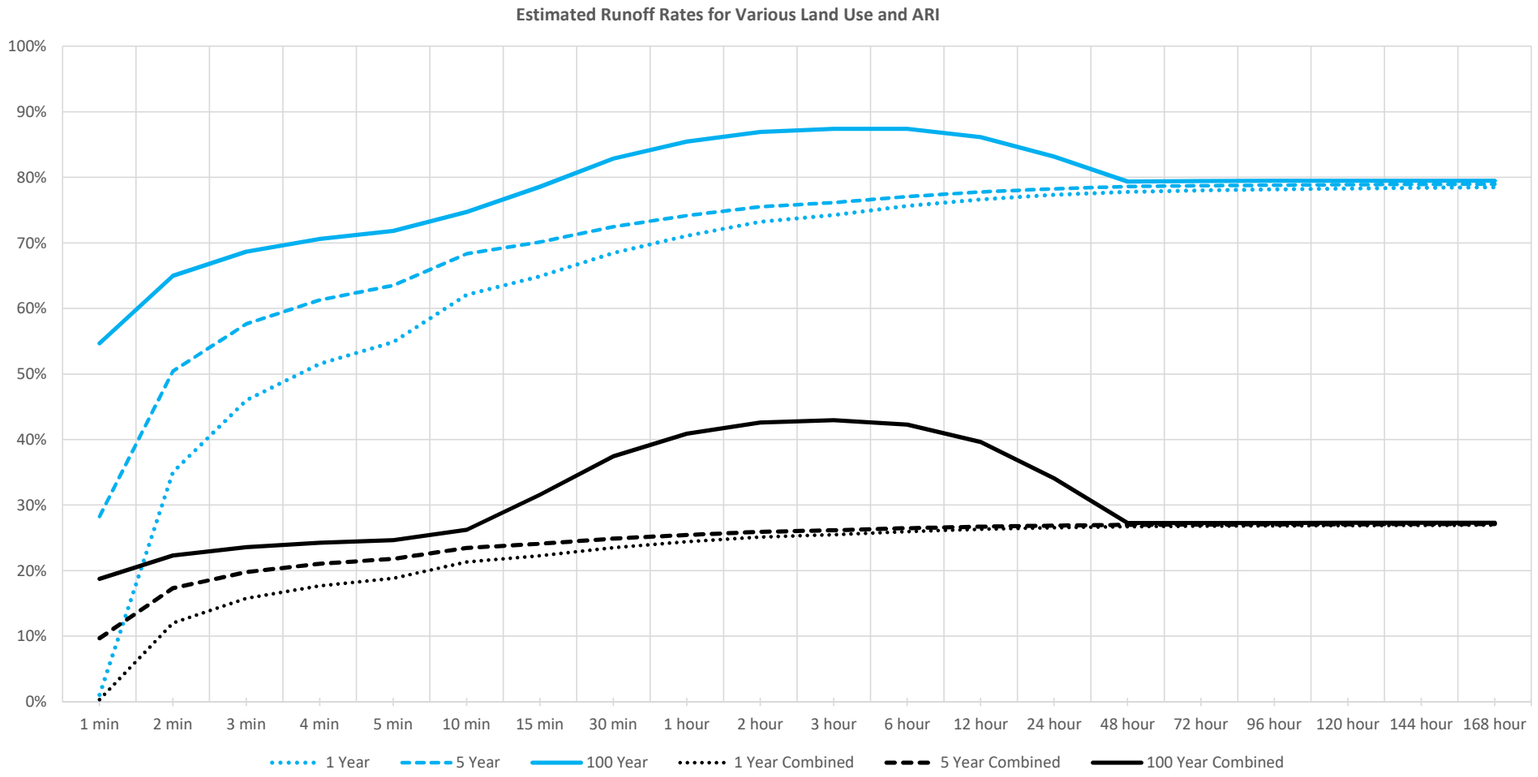
	Land Use Description	Area (ha)	Use in Calc	Imperv Initial Loss mm	Perv Initial Loss mm	Perv Continue Loss mm/hr	On Site Soak (mm)	Empty (days)	AR&R EIA/TIA System Connect Ratio	Roof %	Ext Imp %	Ext Perv %	Comment
1	Rural residential	53.90	Yes	1.5	20.0	4.0	0.0	1.00	50%	14	8	78	
2	Industrial	15.34	Yes	1.5	20.0	4.0	0.0	1.00	80%	60	30	10	
3	Roads	27.83	Yes	1.5	20.0	4.0	0.0	1.00	100%	0	80	20	
4	Range	6.11	Yes	1.5	20.0	4.0	0.0	1.00	50%	0	0	100	
5	Forested	60.41	Yes	1.5	20.0	4.0	0.0	1.00	50%	0	20	80	
6	Rail	3.40	Yes	1.5	20.0	4.0	0.0	1.00	90%	0	20	80	
7			Yes					1.00					
8			Yes					1.00					
9			Yes					1.00					
10			Yes					1.00					

EIA : Effective Impervious Area, TIA : Total Impervious Area

Land Use Graph Selector: **3**

(11 - combined total)

Roads



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	1.5	1.7	2.3	2.8	3.3	4.1	4.7
2	2 min	2.7	3.0	4.1	4.9	5.8	7.0	8.0
3	3 min	3.5	3.9	5.4	6.5	7.7	9.3	10.6
4	4 min	4.2	4.7	6.4	7.7	9.2	11.2	12.8
5	5 min	4.8	5.3	7.3	8.8	10.4	12.7	14.7
6	10 min	6.7	7.5	10.3	12.4	14.7	18.1	21.1
7	15 min	8.0	8.9	12.2	14.7	17.5	21.6	25.2
8	30 min	10.4	11.7	16.0	19.3	22.9	28.2	32.7
9	1 hour	13.5	15.1	20.6	24.8	29.3	35.8	41.3
10	2 hour	17.7	19.8	26.8	32.0	37.6	45.6	52.1
11	3 hour	20.9	23.3	31.3	37.4	43.7	52.8	60.3
12	6 hour	27.6	30.7	41.2	49.0	57.2	69.2	79.4
13	12 hour	35.9	40.0	54.0	64.5	75.7	92.6	107.0
14	24 hour	45.1	50.5	69.3	83.9	99.8	124.0	145.0
15	48 hour	54.7	61.6	86.1	106.0	128.0	161.0	190.0
16	72 hour	60.9	68.5	96.1	119.0	144.0	182.0	215.0
17	96 hour	66.0	74.1	103.0	127.0	154.0	194.0	229.0
18	120 hour	70.9	79.2	109.0	133.0	160.0	201.0	237.0
19	144 hour	75.7	84.3	114.0	138.0	163.0	204.0	241.0
20	168 hour	80.8	89.4	119.0	141.0	165.0	204.0	241.0

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
Rural residential	**11%**	11%	**11%**	**16%**	21%	26%	**29%**
Industrial	**71%**	71%	**71%**	**71%**	72%	73%	**74%**
Roads	**79%**	79%	**79%**	**80%**	83%	86%	**87%**
Range	**0%**	0%	**0%**	**7%**	13%	20%	**23%**
Forested	**10%**	10%	**10%**	**15%**	20%	25%	**29%**
Rail	**18%**	18%	**18%**	**28%**	37%	46%	**51%**
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	**27%**	27%	**27%**	**31%**	36%	40%	**43%**

Event Selector	**9**	**1 hour**					
Rural residential	**10%**	10%	**10%**	**12%**	17%	23%	**27%**
Industrial	**64%**	65%	**67%**	**68%**	70%	72%	**73%**
Roads	**71%**	72%	**74%**	**76%**	80%	83%	**85%**
Range	**0%**	0%	**0%**	**2%**	9%	16%	**21%**
Forested	**9%**	9%	**9%**	**11%**	17%	23%	**26%**
Rail	**16%**	16%	**17%**	**19%**	30%	41%	**48%**
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	**24%**	25%	**25%**	**27%**	32%	38%	**41%**

CURRV

Calculator for Urban Runoff Rates & Volumes

06-04-23

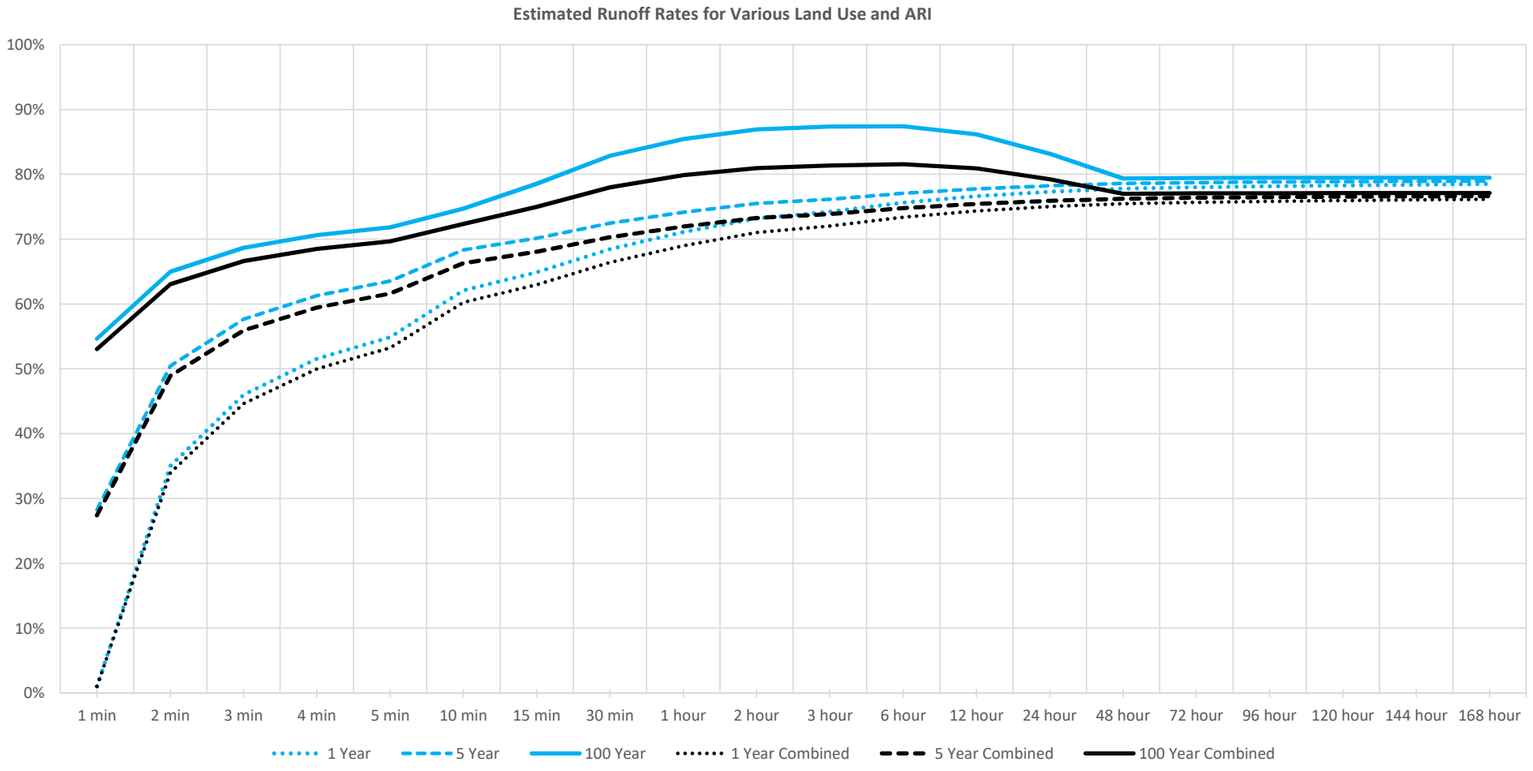
	Land Use Description	Area (ha)	Use in Calc	Imperv Initial Loss mm	Perv Initial Loss mm	Perv Continue Loss mm/hr	On Site Soak (mm)	Empty (days)	AR&R EIA/TIA System Connect Ratio	Roof %	Ext Imp %	Ext Perv %	Comment
1	High Res / Commercial Roof	6.87	Yes	1.5	20.0	4.0	0.0	1.00	96%	100	0	0	
2	High Res / Commercial Hardstand	3.41	Yes	1.5	20.0	4.0	0.0	1.00	100%	0	100	0	
3	High Res / Commercial Landscaped/Drainage	1.55	Yes	1.5	20.0	4.0	0.0	1.00	60%	0	10	90	
4	Road Reserve	4.22	Yes	1.5	20.0	4.0	0.0	1.00	100%	0	80	20	
5	POS	0.85	Yes	1.5	20.0	4.0	0.0	1.00	30%	0	10	90	
6	PAW	0.61	Yes	1.5	20.0	4.0	0.0	1.00	50%	0	30	70	
7		1.00						1.00					
8		1.00						1.00					
9		1.00						1.00					
10		1.00						1.00					

EIA : Effective Impervious Area, TIA : Total Impervious Area

Land Use Graph Selector	4

(11 - combined total)

Road Reserve



Project: Albany Woolstores

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	1.5	1.7	2.3	2.8	3.3	4.1	4.7
2	2 min	2.7	3.0	4.1	4.9	5.8	7.0	8.0
3	3 min	3.5	3.9	5.4	6.5	7.7	9.3	10.6
4	4 min	4.2	4.7	6.4	7.7	9.2	11.2	12.8
5	5 min	4.8	5.3	7.3	8.8	10.4	12.7	14.7
6	10 min	6.7	7.5	10.3	12.4	14.7	18.1	21.1
7	15 min	8.0	8.9	12.2	14.7	17.5	21.6	25.2
8	30 min	10.4	11.7	16.0	19.3	22.9	28.2	32.7
9	1 hour	13.5	15.1	20.6	24.8	29.3	35.8	41.3
10	2 hour	17.7	19.8	26.8	32.0	37.6	45.6	52.1
11	3 hour	20.9	23.3	31.3	37.4	43.7	52.8	60.3
12	6 hour	27.6	30.7	41.2	49.0	57.2	69.2	79.4
13	12 hour	35.9	40.0	54.0	64.5	75.7	92.6	107.0
14	24 hour	45.1	50.5	69.3	83.9	99.8	124.0	145.0
15	48 hour	54.7	61.6	86.1	106.0	128.0	161.0	190.0
16	72 hour	60.9	68.5	96.1	119.0	144.0	182.0	215.0
17	96 hour	66.0	74.1	103.0	127.0	154.0	194.0	229.0
18	120 hour	70.9	79.2	109.0	133.0	160.0	201.0	237.0
19	144 hour	75.7	84.3	114.0	138.0	163.0	204.0	241.0
20	168 hour	80.8	89.4	119.0	141.0	165.0	204.0	241.0

Estimated Runoff Rates

Annual Exceedence Probability

	63.2% 1.00	50% 1.44	20% 4.48	10% 10	5% 20	2% 50	1% 100
Maximum of All Events	1.00	1.44	4.48	10	20	50	100
High Res / Commercial Roof	94%	94%	95%	95%	95%	95%	95%
High Res / Commercial Hardstand	98%	98%	99%	99%	99%	99%	99%
h Res / Commercial Landscaped/Drainage	6%	6%	6%	14%	20%	27%	31%
Road Reserve	79%	79%	79%	80%	83%	86%	87%
POS	3%	3%	3%	7%	10%	14%	16%
PAW	15%	15%	15%	19%	24%	28%	31%
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	**76%**	76%	**77%**	**77%**	78%	80%	**82%**

Event Selector	9	1 hour					
High Res / Commercial Roof	85%	86%	89%	90%	91%	92%	93%
High Res / Commercial Hardstand	89%	90%	93%	94%	95%	96%	96%
h Res / Commercial Landscaped/Drainage	5%	5%	6%	7%	15%	24%	28%
Road Reserve	71%	72%	74%	76%	80%	83%	85%
POS	3%	3%	3%	4%	8%	12%	14%
PAW	13%	14%	14%	15%	21%	26%	29%
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	**69%**	70%	**72%**	**73%**	76%	78%	**80%**

APPENDIX D
Predevelopment Monitoring

H21128
Albany Woolstores
Surface Water Quality Summary

Physical Parameters

27-06-22		
	EC (mS/cm)	pH
SW1	44.67	7.40
SW2	0.856	6.56
SW3	1.94	7.04
ANZECC (2000)- Lowland Rivers	-	*6.5 - 8.0*
ANZECC (2000)- Estuaries	-	*7.5 - 8.5*
*ANZECC (2000)- Marine offshore**	*0.12 - 0.3*	*8.2 (upper & lower limit)*

Nutrients (mg/L)

27-06-22						
	TN	TKN	NOx	Ammonia	TP	FRP
SW1	1.1	1.0	0.028	0.11	0.14	0.09
SW2	2.1	0.8	1.30	0.16	0.06	0.039
SW3	2.6	2.5	0.041	0.015	0.11	0.058
ANZECC (2000)- Lowland Rivers	*1.2*	-	*0.15*	-	*0.065*	*0.04*
ANZECC (2000)- Estuaries	*0.75*	-	*0.045*	-	*0.03*	*0.005*
*ANZECC (2000) - Marine offshore**	*0.23*	-	*0.005*	-	*0.02*	*0.005*
ANZECC (2000)- 95% marine protection	-	-	-	*2.49 (pH 7.4) - 5.07 (pH 6.6)*	-	-

Metals (mg/L)

27-06-22								
	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
SW1	0.001	0.0001	0.001	0.001	0.001	0.00005	0.001	0.014
SW2	0.001	0.0001	0.001	0.001	0.001	0.00005	0.001	0.016
SW3	0.001	0.0001	0.001	0.001	0.001	0.00005	0.001	0.02
ANZECC (2000)- 80% marine protection	*0.0023***	*0.036*	*0.0906*	*0.008*	*0.012*	*0.0014*	*0.56*	*0.043*
ANZECC (2000)- 90% marine protection		*0.014*	*0.0486*	0.003	*0.0066*	*0.0007*	*0.2*	*0.023*
ANZECC (2000)- 95% marine protection		*0.0055*	*0.0274*	0.0013	*0.0044*	*0.0004*	*0.07*	*0.015*
ANZECC (2000)- 99% marine protection		*0.0007*	*0.0077*	0.0003	*0.0022*	*0.0001*	*0.007*	*0.007*

**Marine offshore values reconemnded more appropriate for unprotected coastlines such as Albany*
***low reliability trigger value*
Below laboratory detectable limit

H21128
Albany Woolstores
Groundwater Quality Summary

Physical Parameters

27-06-22		
	EC (mS/cm)	pH
WS1	1.925	6.58
WS2	1.689	4.70
WS3	0.303	6.81
UK1	0.713	7.24
UK2	0.556	7.13
ANZECC (2000)- Lowland Rivers	-	*6.5 - 8.0*
ANZECC (2000)- Estuaries	-	*7.5 - 8.5*
*ANZECC (2000)- Marine offshore**	*0.12 - 0.3*	*8.2 (upper & lower limit)*

Nutrients (mg/L)

27-06-22						
	TN	TKN	NOx	Ammonia	TP	FRP
WS1	33	33.0	0.034	0.67	0.66	0.021
WS2	49	49.0	0.005	0.10	0.64	0.21
WS3	9.8	9.8	0.036	0.11	0.30	0.008
UK1	0.9	0.8	0.11	0.029	0.27	0.056
UK2	9.7	9.5	0.2	0.045	0.34	0.005
ANZECC (2000)- Lowland Rivers	*1.2*	-	*0.15*	-	*0.065*	*0.04*
ANZECC (2000)- Estuaries	*0.75*	-	*0.045*	-	*0.03*	*0.005*
*ANZECC (2000) - Marine offshore**	*0.23*	-	*0.005*	-	*0.02*	*0.005*
ANZECC (2000)- 95% marine protection	-	-	-	*2.84 (pH 7.3) - 5.96 (pH 6.0)*	-	-

Metals (mg/L)

27-06-22								
	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
WS1	0.002	0.0001	0.001	0.001	0.001	0.00005	0.002	0.008
WS2	0.002	0.0001	0.005	0.003	0.001	0.00005	0.002	0.064
WS3	0.002	0.0001	0.002	0.001	0.001	0.00005	0.002	0.015
UK1	0.002	0.0001	0.001	0.001	0.001	0.00005	0.001	0.015
UK2	0.001	0.0001	0.001	0.003	0.001	0.00005	0.001	0.014
ANZECC (2000)- 80% marine protection	*0.0023***	*0.036*	*0.0906*	*0.008*	*0.012*	*0.0014*	*0.56*	*0.043*
ANZECC (2000)- 90% marine protection		*0.014*	*0.0486*	0.003	*0.0066*	*0.0007*	*0.2*	*0.023*
ANZECC (2000)- 95% marine protection		*0.0055*	*0.0274*	0.0013	*0.0044*	*0.0004*	*0.07*	*0.015*
ANZECC (2000)- 99% marine protection		*0.0007*	*0.0077*	0.0003	*0.0022*	*0.0001*	*0.007*	*0.007*

**Marine offshore values reconemnded more appropriate for unprotected coastlines such as Albany*
***low reliability trigger value*
Below laboratory detectable limit

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph 08 9317 2505 fax 08 9317 4163
lab@mpl.com.au
www.mpl.com.au

CERTIFICATE OF ANALYSIS 284299

Client Details

Client	Hyd2O
Attention	Sean O'Sullivan
Address	Suite 1, 387 Hay St, PERTH, WA, 6008

Sample Details

Your Reference	**H21128 - Albany Woolstores**
Number of Samples	8 Water
Date samples received	29/06/2022
Date completed instructions received	29/06/2022

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	06/07/2022
Date of Issue	06/07/2022

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Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Heram Halim, Operations Manager

Authorised By

Michael Kubiak, Laboratory Manager

Nutrients in Water							
Our Reference			284299-1	284299-2	284299-3	284299-4	284299-5
Your Reference	UNITS	PQL	SW1	SW2	SW3	WS1	WS2
Date Sampled			27/06/2022	27/06/2022	27/06/2022	27/06/2022	28/06/2022
Type of sample			Surface Water	Surface Water	Surface Water	Groundwater	Groundwater
Date prepared	-		30/06/2022	30/06/2022	30/06/2022	30/06/2022	30/06/2022
Date analysed	-		30/06/2022	30/06/2022	30/06/2022	30/06/2022	30/06/2022
Total Nitrogen	mg/L	0.1	1.1	2.1	2.6	33	49
Total Kjeldahl Nitrogen	mg/L	0.1	1.0	0.8	2.5	33	49
NOx as N	mg/L	0.005	0.028	1.3	0.041	0.034	<0.005
Ammonia as N	mg/L	0.005	0.11	0.16	0.015	0.67	0.10
Nitrate as N	mg/L	0.005	0.021	1.3	0.041	0.015	<0.005
Nitrite as N	mg/L	0.005	0.007	0.019	<0.005	0.019	0.009
Total Phosphorus	mg/L	0.05	0.14	0.06	0.11	0.66	0.64
Phosphate as P	mg/L	0.005	0.090	0.039	0.058	0.021	0.21

Nutrients in Water					
Our Reference			284299-6	284299-7	284299-8
Your Reference	UNITS	PQL	WS3	UK1	UK2
Date Sampled			28/06/2022	27/06/2022	28/06/2022
Type of sample			Groundwater	Groundwater	Groundwater
Date prepared	-		30/06/2022	30/06/2022	30/06/2022
Date analysed	-		30/06/2022	30/06/2022	30/06/2022
Total Nitrogen	mg/L	0.1	9.8	0.9	9.7
Total Kjeldahl Nitrogen	mg/L	0.1	9.8	0.8	9.5
NOx as N	mg/L	0.005	0.036	0.11	0.20
Ammonia as N	mg/L	0.005	0.11	0.029	0.045
Nitrate as N	mg/L	0.005	0.036	0.11	0.19
Nitrite as N	mg/L	0.005	<0.005	<0.005	<0.005
Total Phosphorus	mg/L	0.05	0.30	0.27	0.34
Phosphate as P	mg/L	0.005	0.008	0.056	<0.005

Metals in Water - Low Level							
Our Reference	UNITS	PQL	284299-1	284299-2	284299-3	284299-4	284299-5
Your Reference			SW1	SW2	SW3	WS1	WS2
Date Sampled			27/06/2022	27/06/2022	27/06/2022	27/06/2022	28/06/2022
Type of sample			Surface Water	Surface Water	Surface Water	Groundwater	Groundwater
Date prepared	-		04/07/2022	04/07/2022	04/07/2022	04/07/2022	04/07/2022
Date analysed	-		04/07/2022	04/07/2022	04/07/2022	04/07/2022	04/07/2022
Arsenic-Dissolved	mg/L	0.001	0.001	0.001	0.001	0.002	0.002
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	0.005
Copper-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	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	0.002	0.002
Zinc-Dissolved	mg/L	0.001	0.014	0.016	0.020	0.008	0.064

Metals in Water - Low Level					
Our Reference	UNITS	PQL	284299-6	284299-7	284299-8
Your Reference			WS3	UK1	UK2
Date Sampled			28/06/2022	27/06/2022	28/06/2022
Type of sample			Groundwater	Groundwater	Groundwater
Date prepared	-		04/07/2022	04/07/2022	04/07/2022
Date analysed	-		04/07/2022	04/07/2022	04/07/2022
Arsenic-Dissolved	mg/L	0.001	0.002	0.002	<0.001
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	0.002	0.001	<0.001
Copper-Dissolved	mg/L	0.001	0.001	<0.001	0.003
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	0.002	0.001	<0.001
Zinc-Dissolved	mg/L	0.001	0.015	0.015	0.014

Method ID	Methodology Summary
INORG-055	Nitrite - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	Nitrate - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	NOx - determined colourimetrically. Soils are analysed from a water extract.
INORG-057	Ammonia by colourimetric analysis based on APHA latest edition 4500-NH3 F.
INORG-060	Phosphate- determined colourimetrically. Soils are analysed from a water extract.
INORG-062	TKN by calculation from Total Nitrogen and NOx using APHA methodology.
INORG-110	Total Nitrogen by high temperature catalytic combustion with chemiluminescence detection. Dissolved/Total Carbon and Dissolved/Total Organic and Inorganic Carbon by high temperature catalytic combustion with NDIR
METALS-020	Determination of various metals by ICP-AES.
METALS-021	Determination of Mercury by Cold Vapour AAS. For urine samples total Mercury is determined, however, mercury in urine is almost entirely in the inorganic form (CDC).
METALS-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: Nutrients in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			30/06/2022	[NT]	[NT]	[NT]	[NT]	30/06/2022	[NT]
Date analysed	-			30/06/2022	[NT]	[NT]	[NT]	[NT]	30/06/2022	[NT]
Total Nitrogen	mg/L	0.1	INORG-110	<0.1	[NT]	[NT]	[NT]	[NT]	108	[NT]
Total Kjeldahl Nitrogen	mg/L	0.1	INORG-062	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
NOx as N	mg/L	0.005	INORG-055	<0.005	[NT]	[NT]	[NT]	[NT]	94	[NT]
Ammonia as N	mg/L	0.005	INORG-057	<0.005	[NT]	[NT]	[NT]	[NT]	95	[NT]
Nitrate as N	mg/L	0.005	INORG-055	<0.005	[NT]	[NT]	[NT]	[NT]	100	[NT]
Nitrite as N	mg/L	0.005	INORG-055	<0.005	[NT]	[NT]	[NT]	[NT]	106	[NT]
Total Phosphorus	mg/L	0.05	METALS-020	<0.05	[NT]	[NT]	[NT]	[NT]	102	[NT]
Phosphate as P	mg/L	0.005	INORG-060	<0.005	[NT]	[NT]	[NT]	[NT]	112	[NT]

QUALITY CONTROL: Metals in Water - Low Level						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	284299-1
Date prepared	-			04/07/2022	4	04/07/2022	04/07/2022		04/07/2022	04/07/2022
Date analysed	-			04/07/2022	4	04/07/2022	04/07/2022		04/07/2022	04/07/2022
Arsenic-Dissolved	mg/L	0.001	METALS-022	<0.001	4	0.002	[NT]		98	114
Cadmium-Dissolved	mg/L	0.0001	METALS-022	<0.0001	4	<0.0001	[NT]		94	107
Chromium-Dissolved	mg/L	0.001	METALS-022	<0.001	4	0.001	[NT]		99	108
Copper-Dissolved	mg/L	0.001	METALS-022	<0.001	4	<0.001	[NT]		97	96
Lead-Dissolved	mg/L	0.001	METALS-022	<0.001	4	<0.001	[NT]		97	90
Mercury-Dissolved	mg/L	0.00005	METALS-021	<0.00005	4	<0.00005	<0.00005	0	99	[NT]
Nickel-Dissolved	mg/L	0.001	METALS-022	<0.001	4	0.002	[NT]		98	98
Zinc-Dissolved	mg/L	0.001	METALS-022	<0.001	4	0.008	[NT]		98	95

QUALITY CONTROL: Metals in Water - Low Level						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	284299-5
Date prepared	-			[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	04/07/2022
Date analysed	-			[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	04/07/2022
Mercury-Dissolved	mg/L	0.00005	METALS-021	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	87

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.

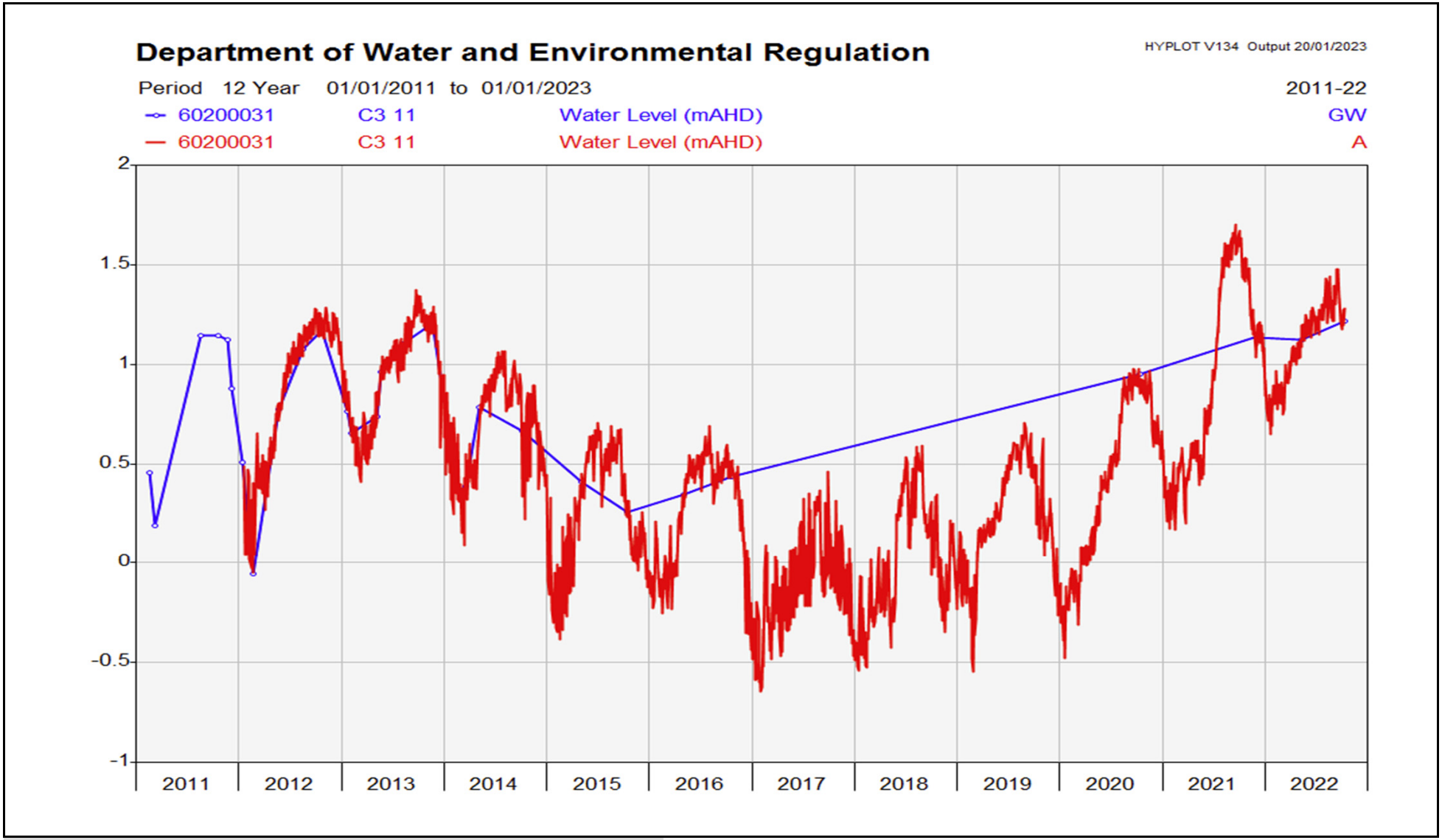
Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

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
DWER Bore Hydrograph
(Water Register, 2023)

Date : 06/04/2023 Job No: H21128



APPENDIX F
Groundwater Resource Avaliability

Department of **Water**
Department of **Regional Development**

GOVERNMENT OF WESTERN AUSTRALIA

ROYALTIES FOR REGIONS

ALBANY HINTERLAND

PROSPECTIVE GROUNDWATER RESOURCES

SHM Hydrogeological Map Series 12

This map shows the location and salinity of prospective groundwater resources within the King River, Kalgan River, Manypeaks and Nanarup areas in the Albany hinterland. The water resources are stored within infilled palaeochannels and overlying sediments.

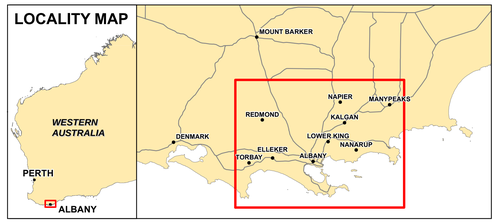
The map shows the potential for fit-for-purpose groundwater supplies across the Albany hinterland area. To access groundwater at a local scale, proponents will need to collect site specific information to confirm that groundwater volumes and quality are suitable for their needs, and that groundwater can be taken sustainably.

MAP DEVELOPMENT
This map is a product of the South Coast groundwater investigation project, made possible by the Government of Western Australia's Royalties for Regions program.

To develop the map, the project gathered new data from an airborne electromagnetic survey and from exploratory drilling at 16 new sites. A depth to basement layer was developed from the new data and synthesised with regional scale digital elevation models, drilling reports, expert knowledge and various other sources.

All information used to compile the map is available from the Water Information Reporting portal on the department's website at www.wir.water.wa.gov.au. Spatial datasets including the depth to basement layer can be accessed here: spatial.data@water.wa.gov.au.

The method used to produce this map is described in the explanatory notes (Ryan et al. 2017).



HINTERLAND MAP AREA

WATER RESOURCE MANAGEMENT
The Department of Water is responsible for managing the state's water resources. Under the *Rights in Water and Irrigation Act 1914*, the department protects the state's water resources and promotes their sustainable and efficient use using mechanisms including science, policy, planning, licensing and monitoring. A licence to construct wells or take water may be required to access groundwater resources in the Albany hinterland. For more information contact our regional office or visit our website at:

South Coast regional office
Street: 5 Bevan Street, Albany, Western Australia, 6330
Postal: PO Box 525, Albany, Western Australia, 6331
Phone: 08 98410100; **Fax:** 08 98421204
Email: southcoast@water.wa.gov.au
Website: www.water.wa.gov.au

RECOMMENDED REFERENCE FOR THIS MAP
Ryan, SA, Yesertener, C, Maughan, A and Thornton, H 2017, *Albany hinterland prospective groundwater resources map*, Department of Water, Hydrogeological map series, map no. SHM12, Western Australia.

REFERENCES

Ryan, SA, Yesertener, C, and Maughan, A, 2017, *Albany hinterland prospective groundwater resources map – explanatory notes*, Department of Water, Hydrogeological map series HM 12, Western Australia.

UNITS OF MEASUREMENT

Salinity
mg/L milligrams per litre
TDS total dissolved solids

Volumes of water

1 litre	(L)	1 litre
1 kilolitre	(kL)	1000 litres
1 megalitre	(ML)	1 000 000 litres
1 gigalitre	(GL)	1 000 000 000 litres

Depth
m bgl metres below ground level
m AHD metres Australian Height Datum

Conversion of kilolitres per day to litres per second

10 kL/d	0.1 L/s
100 kL/d	1.2 L/s
500 kL/d	5.8 L/s
1000 kL/d	11.6 L/s

GUIDE TO MAIN FEATURES AND USE OF THE MAP

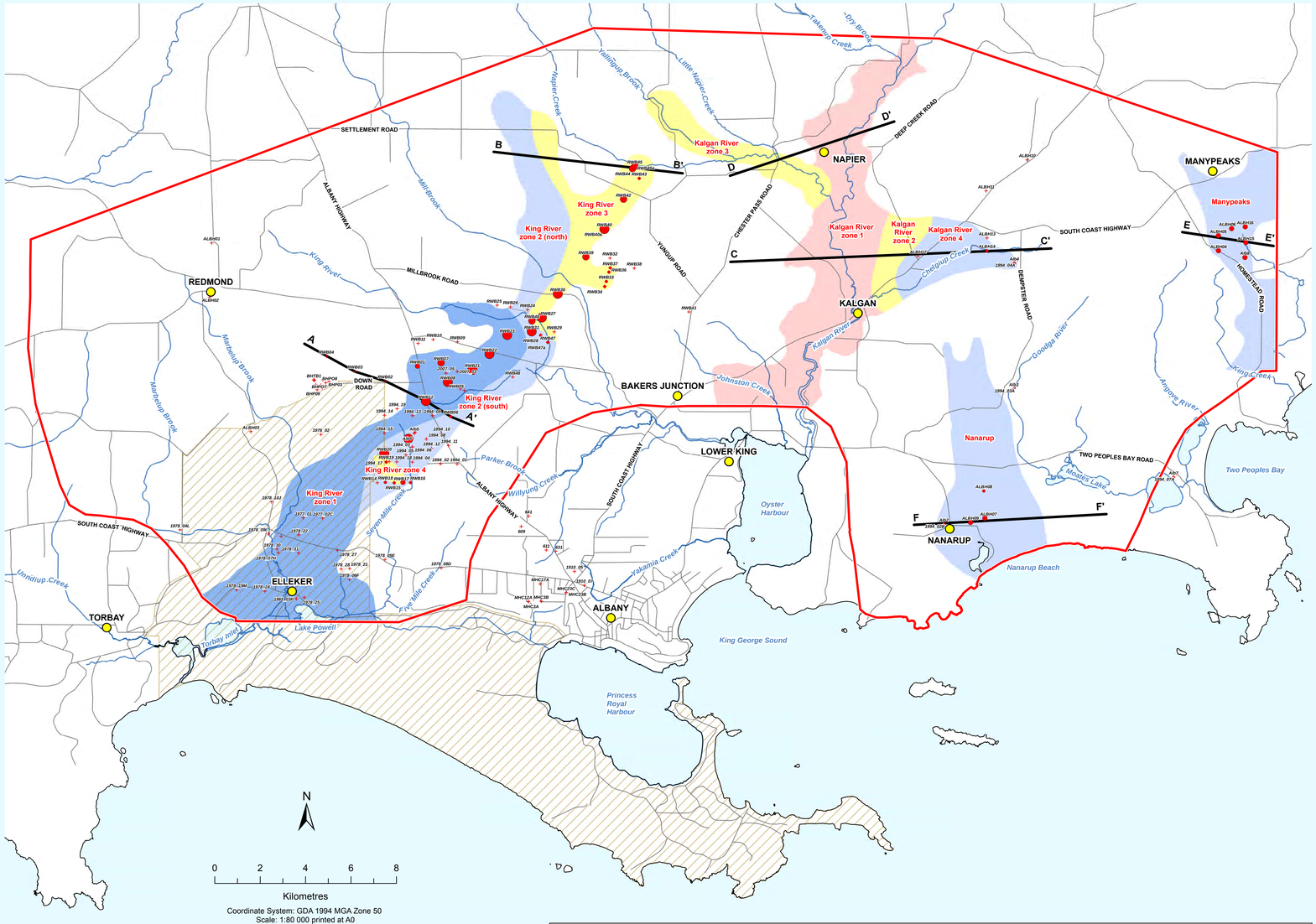
- On the map below prospective groundwater resources in the King River, Kalgan River, Manypeaks and Nanarup areas are colour coded into salinity zones. The salinity zone will help determine the suitability of each resource as described in the salinity categories table.
- The red dots on the map show estimated airlift yields calculated during bore drilling. Estimates can be a guide to potential yield for production bores.
- The hydrogeological information table summarises information for each resource zone, including broad estimates of annual recharge. This can be used to guide assessment of sustainable abstraction volumes.
- The cross section diagrams show the distribution of palaeochannels, minor sedimentary aquifers, groundwater elevations, salinity and airlift rates, and can be used to guide drilling depths.

SALINITY CATEGORIES

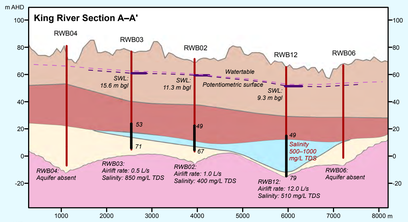
The department categorises salinity into five broad ranges, shown below, that indicate the suitable fit–for–purpose use. Higher salinity water can often be utilised if appropriate technologies, crop selection and farming techniques are applied. The salinity categories are explained in more detail in the Department of Water's *Water resource inventory 2014*, available from: www.water.wa.gov.au

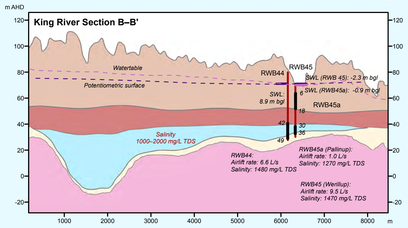
The salinities shown in this map are based on groundwater samples from bores and surface water samples from rivers. Salinity is measured in milligrams per litre of total dissolved solids (mg/L TDS). Salinity varies across a groundwater resource depending on location within the aquifer and the time of year.

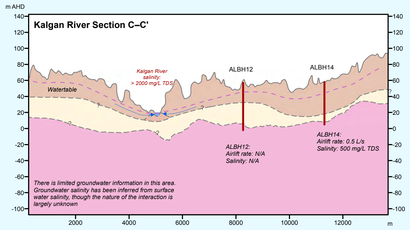
	Fresh 0—500 mg/L TDS	Marginal 500—1000 mg/L TDS	Brackish 1000—3000 mg/L TDS	Saline 3000—35 000 mg/L TDS	Hypersaline >35 000 mg/L TDS
Potable water - desirable					
Potable water - acceptable					
Irrigation					
Industry					

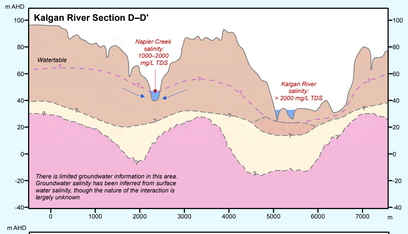


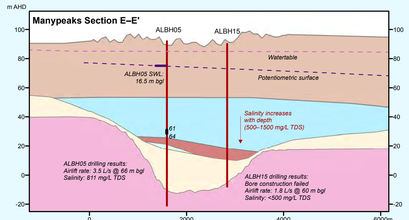
CROSS SECTIONS

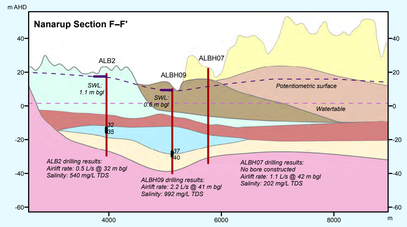












Map legend
- Bore or well
- Town
- River
- Road
- Cross section location
- Investigation area
- Albany groundwater area (proclaimed)

Airlift yield
- <100 kL/d (<1 L/s)
- 100—500 kL/d (1—5 L/s)
- 500—1000 kL/d (5—11 L/s)
- >1000 kL/d (>11 L/s)

Salinity zones
King River Zone name
- 0—500 mg/L TDS
- 500—1000 mg/L TDS
- 1000—3000 mg/L TDS
- 3000—35000 mg/L TDS

HYDROGEOLOGICAL INFORMATION

Resource zone and area name	Cross section	Aquifer	Lithology	Area (km²)	Saturated thickness (m)	Storage (GL)	Recharge range (GL/year)*	Salinity (mg/L TDS)
King River zone 1	A–A'	Werillup	sand	50	19	190	1.5–5.6	<500
King River zone 2 (north)	A–A'	Werillup	sand, minor clay	15	20	60	0.1–1.2	500–1000
King River zone 2 (south)	B–B'	Werillup	sand	12	7	16.8	0.1–1.0	500–1000
King River zone 3	B–B'	Werillup	sand, clay, lignite	16	11	35.2	0.1–0.4	1000–3000
King River zone 4	B–B'	Werillup	sand, minor clay	1	15	3	0.0–0.02	1000–3000
King River area total	**A–A'; B–B'**	**Werillup**		**94**		**305**	**1.8–8.2**	
Kalgan River zone 1	C–C'	Pallinup	sand, silt	48	15	72	0.1–0.7	>3000
Kalgan River zone 2	C–C'	Pallinup	sand, silt	6	15	9	0.0–0.1	1000–3000
Kalgan River zone 3	D–D'	Pallinup	sand, silt	11	15	16.5	0.0–0.2	1000–3000
Kalgan River zone 4	C–C'	Pallinup	sand, silt	10	15	15	0.1–0.4	500–1000
Kalgan River area total	**C–C'; D–D'**	**Pallinup**		**75**		**112.5**	**0.2–1.3**	
Manypeaks area total	**E–E'**	**Werillup**	**sandstone; minor sand and silt**	**20**	**35**	**105**	**0.7–1.3**	**500–1000**
Nanarup area total	**F–F'**	**Werillup**	**silty sand**	**30**	**8**	**48**	**1.2–1.7**	**500–1000**

* recharge is presented as a range in gigalitres per year and shows broad estimates of the minimum and maximum recharge volumes.

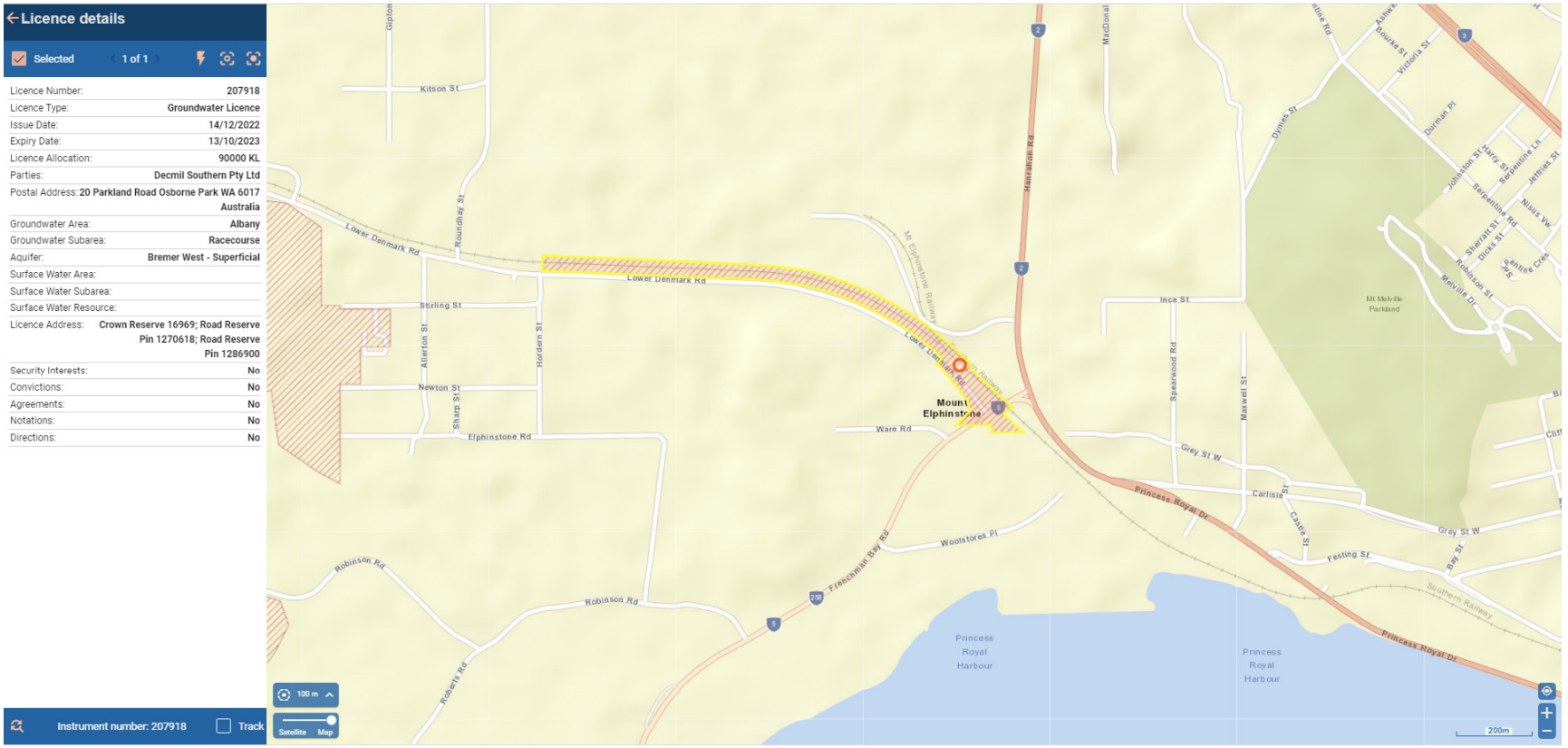
Cross section legend

Hydrostratigraphy
- **Surficial aquifer**
  - potential unknown
- **Pallinup aquifer**
  - minor, fresh
  - minor, saline
- **Pallinup aquitard**
  - confining layer
- **Werillup aquitard**
  - confining layer
- **Werillup aquifer**
  - palaeochannel, fresh to marginal
  - minor local, potential unknown
- **Basement**
  - weathered clay
  - fresh granite

- Screen interval
- Bore or well
- Surface water
- Watertable
- Potentiometric surface
- Static water level – Pallinup
- Static water level – Werillup
- Uncertain

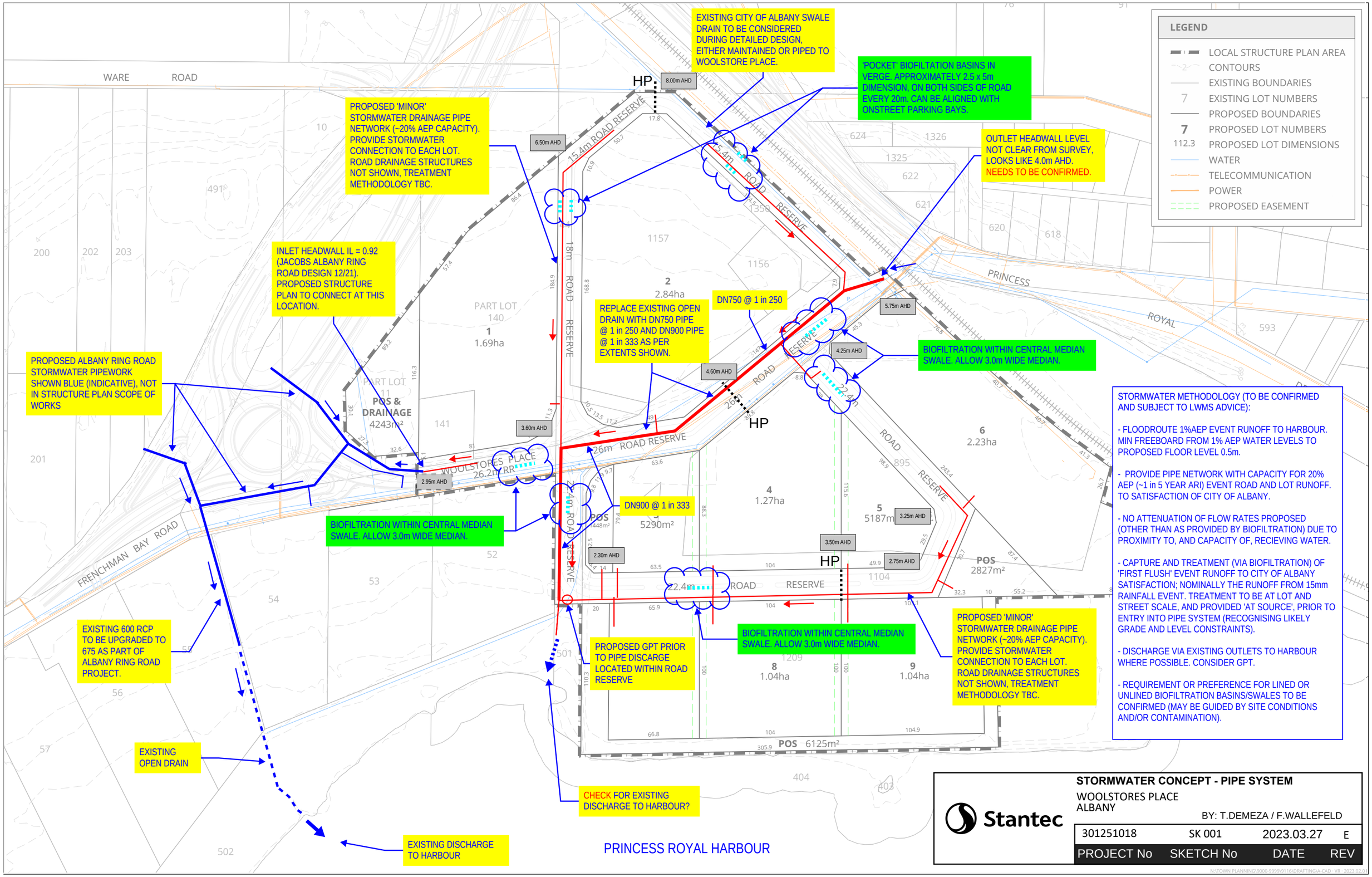
APPENDIX F

Accessed online at Water Register (DWER, 2023)



APPENDIX G
Landscape Masterplan (Plan E, 2023)

APPENDIX H
Engineering Concept Drawings (Stantec, 2023)



STORMWATER CONCEPT - PIPE SYSTEM

WOOLSTORES PLACE
ALBANY

BY: T.DEMEZA / F.WALLEFELD

PROJECT No	SKETCH No	DATE	REV
301251018	SK 001	2023.03.27	E

N:\TOWN PLANNING\9000-9999\9116\DRAFTING\A-CAD - VR - 2023.02.01

DEVELOPMENT CONCEPT

VARIOUS LOTS, WOOLSTORES PLACE
MOUNT ELPHINSTONE, ALBANY

DRAFT

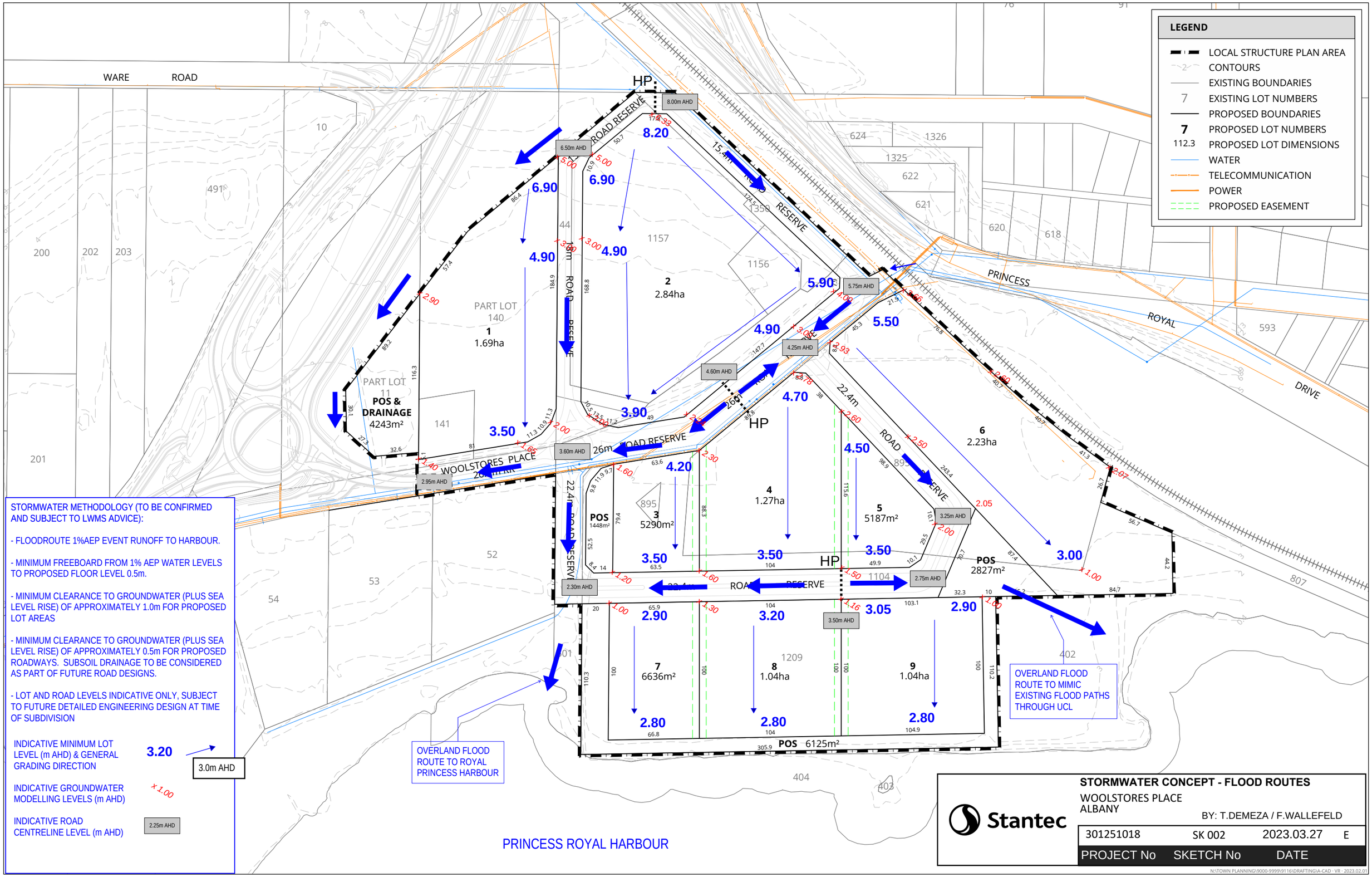
N

0 62.5 m
SCALE @ A3: 1:2500

9116-CON-02-A

DRAWN: VR
DATE CREATED: 2023.02.01
PROJECTION: MGA50 GDA94
CADASTRE: LANDGATE
SURVEY: HARLEY DYKSTRA 23304-01A

ROWE GROUP DESIGN



Stantec

STORMWATER CONCEPT - FLOOD ROUTES

WOOLSTORES PLACE
ALBANY

BY: T.DEMEZA / F.WALLEFELD

PROJECT No	SKETCH No	DATE	
301251018	SK 002	2023.03.27	E

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DEVELOPMENT CONCEPT

VARIOUS LOTS, WOOLSTORES PLACE
MOUNT ELPHINSTONE, ALBANY

DRAFT

N

0 62.5 m

SCALE @ A3: 1:2500

9116-CON-02-A

DRAWN: VR
DATE CREATED: 2023.02.01
PROJECTION: MGA50 GDA94
CADASTRE: LANDGATE
SURVEY: HARLEY DYKSTRA 23304-01A

ROWE GROUP DESIGN

APPENDIX I
Biofilter Design Guidance

Government of Western Australia
Department of Water

Looking after all our water needs

Water sensitive urban design

Biofilters

Summary

Biofilters (also known as biofiltration systems, bioretention systems and rain gardens) are excavated basins or trenches that are filled with porous filter media and planted with vegetation to remove pollutants from stormwater runoff. They use natural and physical processes to treat stormwater.

This brochure is part of a series that explain various aspects of water sensitive urban design. Please see *Water sensitive urban design in Western Australia* for background information on water sensitive urban design.

Main benefits

- They will work in a variety of climate, soil and groundwater conditions.
- Their flexible design (linear, basins, tree pits, planter boxes) allows them to fit into many different locations.
- Soil and sand filters provide good removal of sediment and heavy metals.
- Specially selected soil filter media and appropriate vegetation selection improves nutrient removal rates.
- They require less space than other infiltration systems due to their higher infiltration rate.

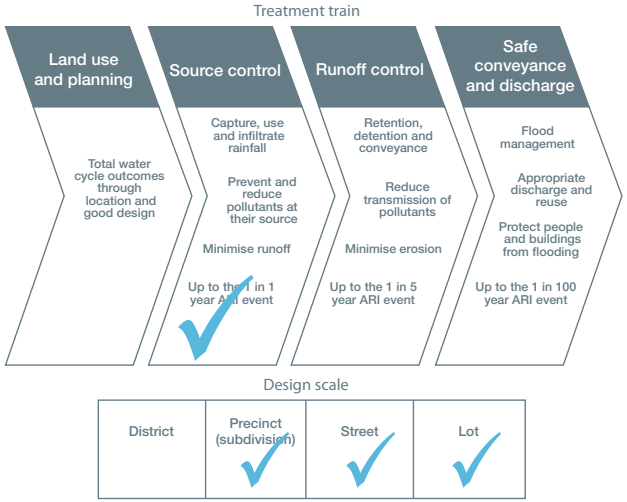
Design factors

- Ensure they are integrated into landscape design.
- Consider location as part of planning and design of roads and lots.
- Design to infiltrate or connect to the larger stormwater system where appropriate.
- Make the surface area at least 2% of the constructed, directly connected impervious catchment for water quality treatment.
- Size the storage volume to suit system hydraulics – ideally a 1-year critical average recurrence interval event.
- Use vegetation appropriate to the climate and desired pollutant removal.
- Incorporate a submerged zone and carbon source to promote vegetation health and resilience during dry periods and aid nitrogen removal.
- Consider the impact of potential acid sulfate soils on filter media and/or structures where relevant.

Target pollutants

- coarse sediment
- suspended solids
- phosphorus
- nitrogen
- heavy metals

Where they can be used in the water sensitive urban design process



Public open space biofilter, Meadow Springs, Mandurah

Roadside biofilter retrofit, Busselton CBD

On-lot biofilter, Evermore Heights, Baldivis

Water sensitive urban design

Biofilters

Design function

Note: Transition and drainage layers may not be required if direct infiltration of treated stormwater to surrounding soils is possible. See FAWB guidelines for diagrams demonstrating submerged zones, outlets, etc.

Aid aesthetics, assist in pollutant removal and maintain hydraulic conductivity of filter media

Sedimentation of primary sediments and metals

Suppress weeds and retain moisture in underlying filter media

Soil filters fine sediments and colloidal particles

Soil layer for plants to grow in

Sorption of metals and nutrients by filter particles

Side liner required if in clay sites to prevent contamination of filter, and in coarse sandy sites if the native soil has a higher hydraulic conductivity than the filter media

Include a carbon source to improve chemical processes in soil and promote vegetation health

Nutrient sorption and pollutant decomposition by soil and bacteria

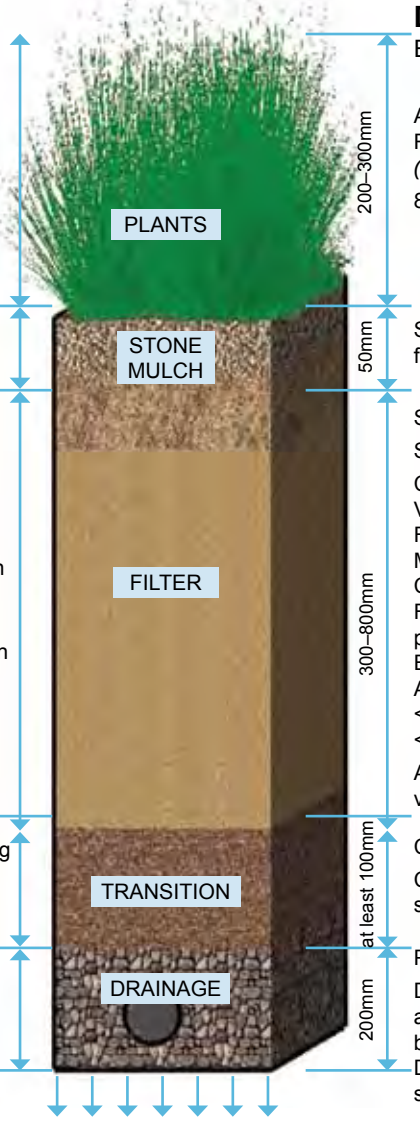
Separates filter layer from drainage layer to avoid clogging and stop transition of the filter media into the drainage layer

Free draining layer containing pipe (if required)

Subsoil pipe can aid in watertable control and is also required in impervious systems to collect and convey water

Infiltration from base if applicable

Biofilter elements



Design guidelines

Extended detention depth

At least 50% of the plants to be effective at nutrient removal. Remainder to be local, native, ephemeral plants e.g. *Ficinia nodosa (*formerly *Isolepis nodosa)*

8–12 plants per m^2, depending on species

Stone 100% 4–13mm in size. No fines. Note that wood mulch will float under flooded conditions

Sandy loam

Saturated hydraulic conductivity in range 100–300mm/hr

Clay and silt	<3%	(<0.05mm)
Very fine sand	5–30%	(0.05–0.15mm)
Fine sand	10–30%	(0.15–0.25mm)
Medium to coarse sand	40–60%	(0.25–1.0mm)
Coarse sand	7–10%	(1.0–2.0mm)
Fine gravel	<3%	(2.0–3.4mm)
pH	5.5–7.5	
Electrical conductivity	<1.2dS/m	

At least 3% low nutrient-content organic matter
<80mg/kg orthophosphate
<1000mg/kg total nitrogen content

Amend soil with 5% mulch and 5% hardwood chips (6mm) by volume

Clean, well-graded sand <2% fines

Clean, fine gravel or crushed rock 2–5mm and carbon source, if submerged

Perforated PVC subsoil pipe (if required)

Drainage layer (if there are no subsoil pipes) - should be at least as deep as the extended detention depth, however this should be based on individual site characteristics
Drainage layer (if subsoil pipes are used) - completely surround the subsoil pipe and at least 50mm over pipe

(Adapted from: Thompson McRobert Edgeloe Group 2008)

Required reading

Adoption guidelines for stormwater biofiltration systems, 2009, Facility for Advancing Water Biofiltration, Monash University, available at <www.monash.edu.au/fawb/products/index.html> for the most recent advice.

Australian runoff quality: a guide to water sensitive urban design, 2006, Engineers Australia, available at <www.arq.org.au>.

Construction and establishment guidelines: swales, bioretention systems and wetlands, 2009, Water by Design, South East Queensland Healthy Waterways Partnership, Brisbane, available at <www.waterbydesign.com.au/ceguide>.

Guideline specifications for soil media in bioretention systems, 2008, Monash University Facility for Advancing Water Biofiltration.

In situ monitoring of hydraulic conductivity, 2009, Monash University Facility for Advancing Water Biofiltration.

Stormwater management manual for Western Australia, 2004–07, Department of Water, available at <www.water.wa.gov.au>. See Section 4.2 of Chapter 9 – Structural controls. Suitable plant species for use in biofilters in Western Australia are being researched. Section 4.2 will be updated to reflect the findings from this research and the Monash University FAWB research.

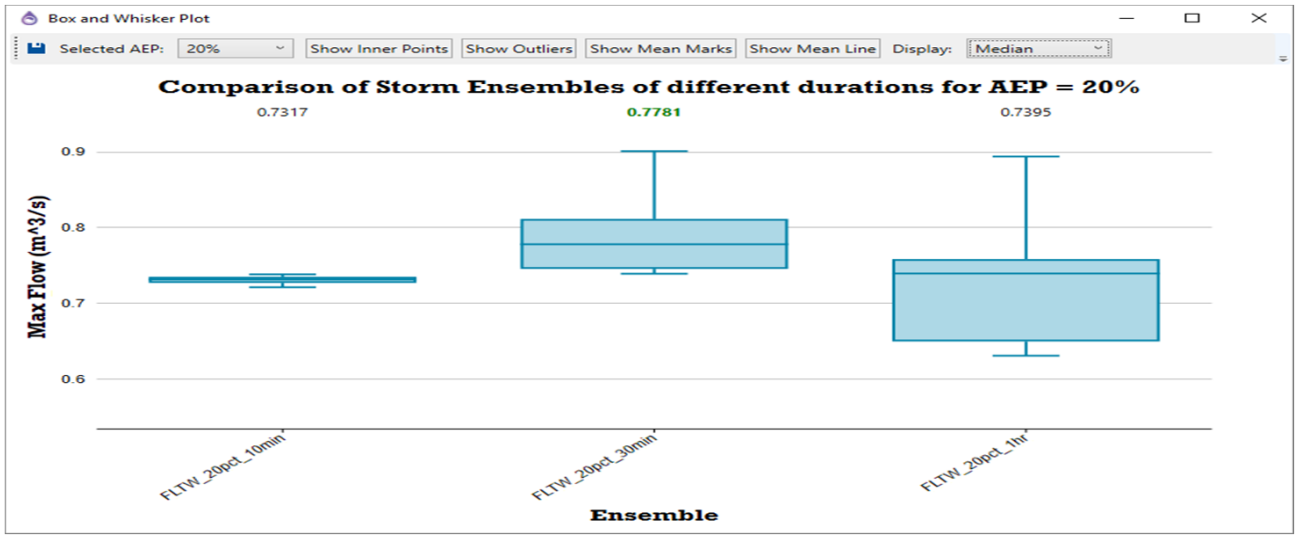
The department acknowledges the past project contributions of the Leschenault Catchment Council.

Department of **Water**
168 St Georges Terrace
Perth Western Australia
PO Box K822 Perth
Western Australia 6842
Ph: 08 6364 7600 • Fax: 08 6364 7601
www.water.wa.gov.au

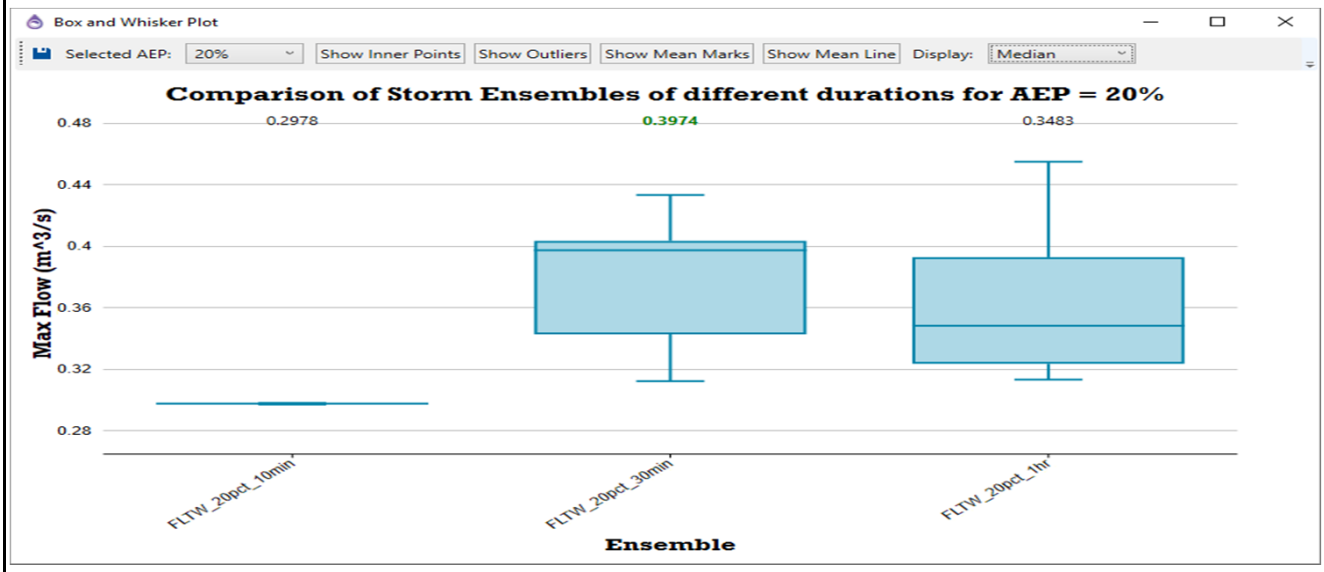
June 2011
21592_100_06/11

APPENDIX J
XP-Storm Modelling Outputs

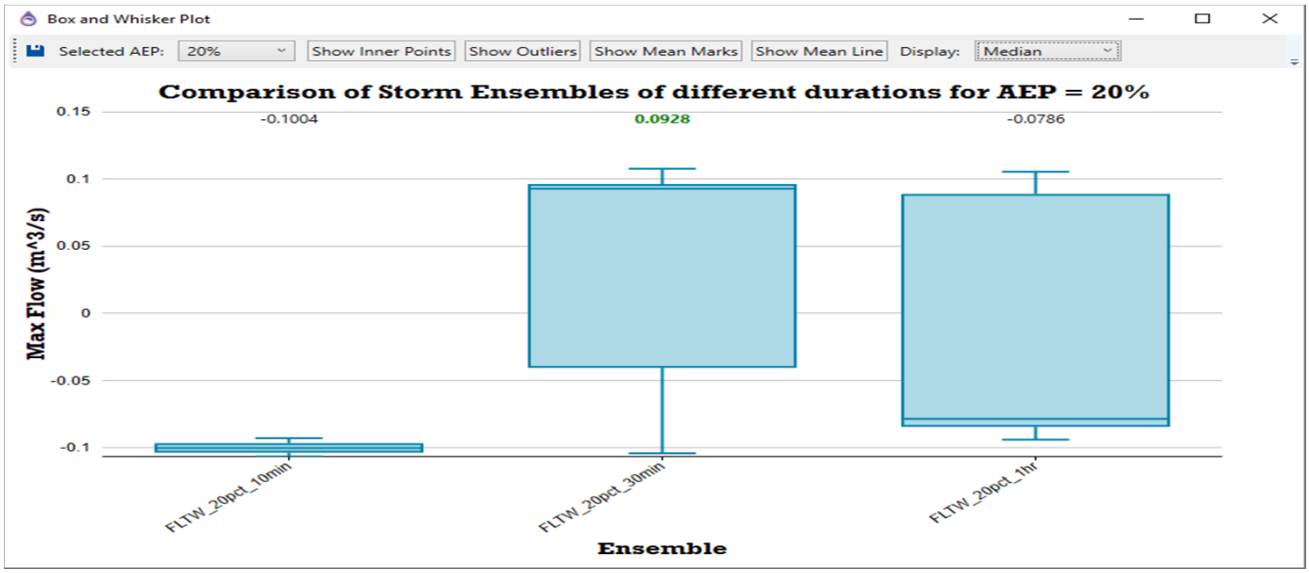
PRH Outlet Pipe Network Main Section



PRH Outlet Pipe Network Minor Section



Ring Rd Outlet



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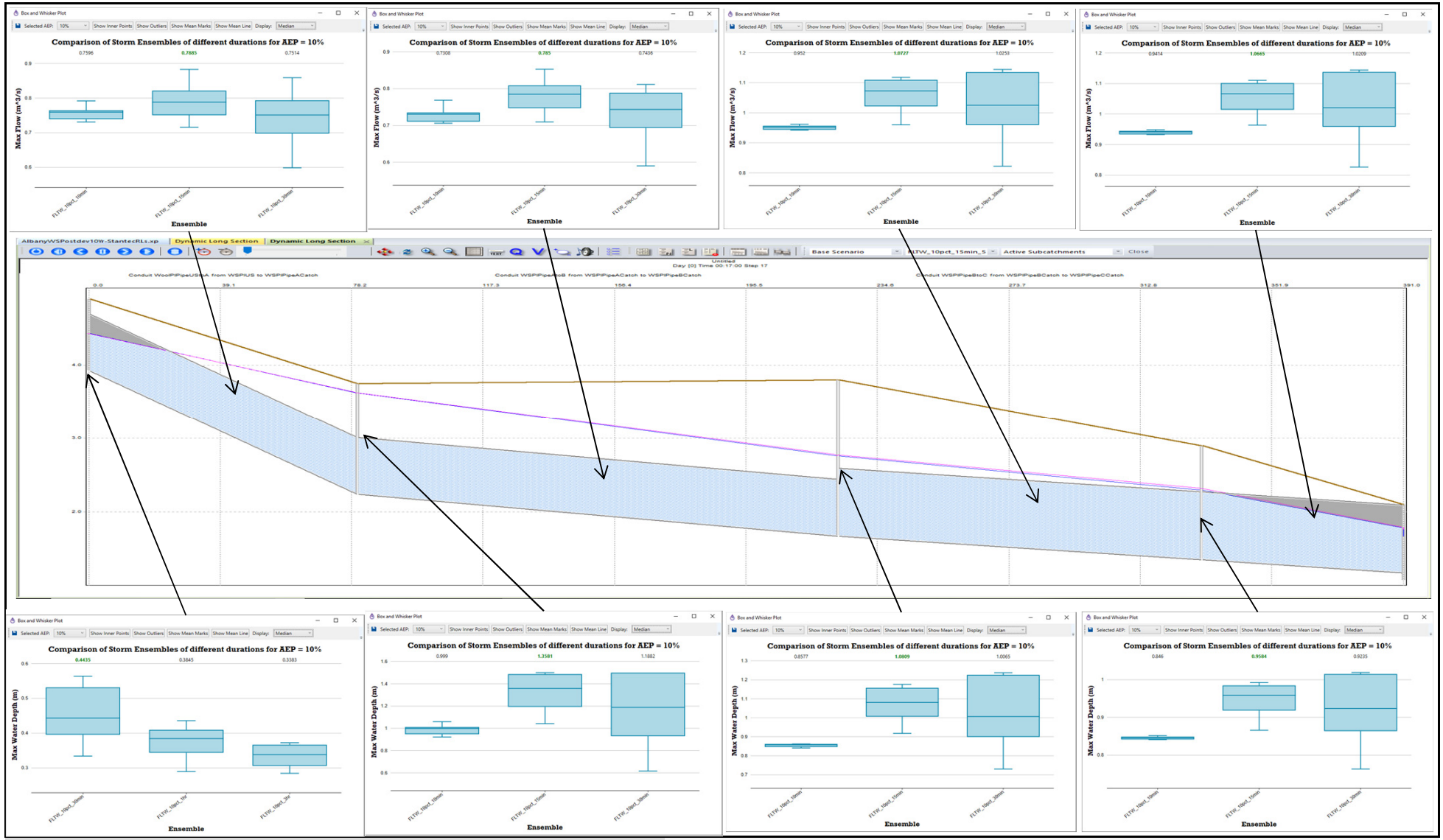


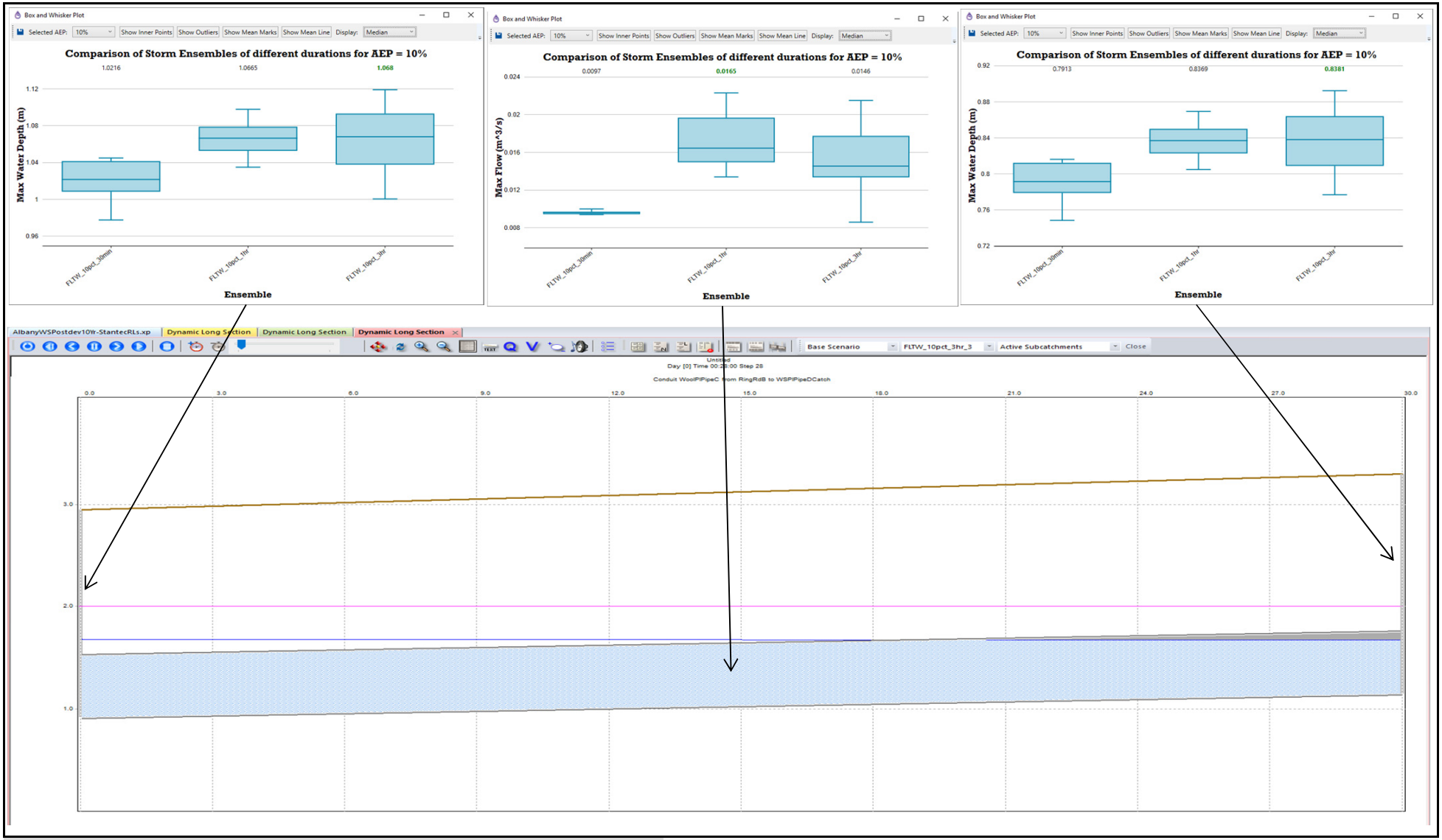
hyd2o

Albany Woolstores Local Water Management Strategy

XP-Storm Woolstore PI Pipe Main Section: 10% AEP Critical Event

Appendix J2

Date : 06/04/2023 Job No: H21128



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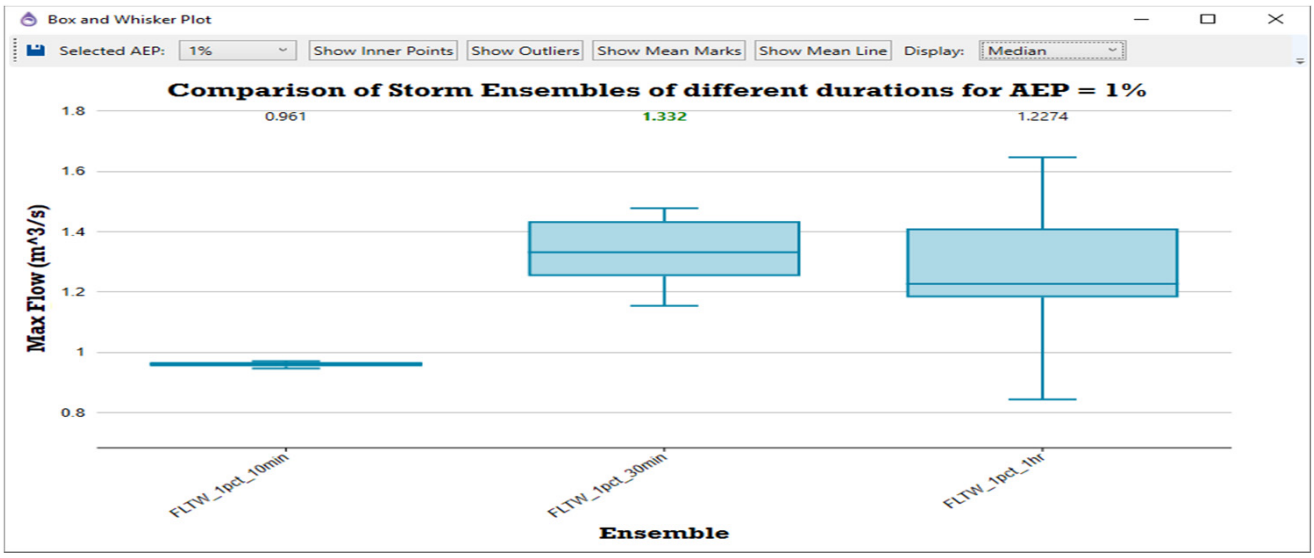
Albany Woolstores Local Water Management Strategy

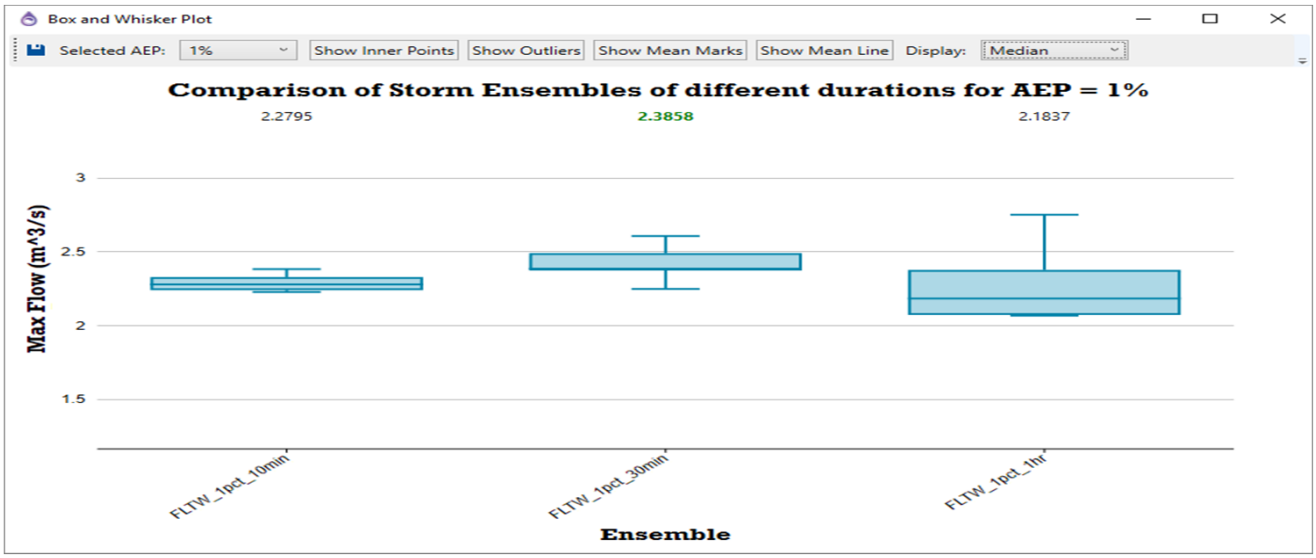
XP -Storm Woolstore PI Pipe Minor Section: 10% AEP Critical Event

Appendix J3

PRHOutA Outfall Discharge to Coast



PRHOutB Outfall Discharge to Coast



RingRd Outflow to MR Drainage Network