Ajax Rd, Altona

Stormwater Management Report

CG130309

Prepared for
Axxcel Management Services Pty Ltd

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Cardno
Shaping the Future

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Table of Contents

Appendices

Tables

Figures

1 Introduction

Cardno was engaged by Axxcel Management Services Pty Ltd to undertake a Stormwater Management Plan for a proposed 55.4ha industrial development on Ajax Rd, Altona. The subject site is located 15km south west of Melbourne's CBD and is the continuation of an existing industrial subdivision.

The site is bounded by Kayes Drain to the west, the Geelong-Werribee railway line to the south and the existing subdivision to the east.

This report demonstrates how the proposed development will manage stormwater runoff to meet Best Practice stormwater environmental performance targets and manage minor and major overland flow events.

Water sensitive urban design is a key issue to be managed on this site to demonstrate that release of runoff from the proposed subdivision is of a high quality as the downstream wetland and flora offset area contains threatened species.

To address the issues of stormwater quality, precinct scale stormwater detention and treatment systems using bioretention technology will be incorporated and managed by a body corporate.

Two detention systems have been incorporated to attenuate peak flows from Ajax Rd development. The detention basin discharging directly into Kayes Drain will reduce the peak discharge to the existing flow rate, while the detention basin discharging to the south, under the existing rail line will reduce peak flows to the hydraulic capacity of the existing drainage infrastructure.

A balance of floodplain storage has been undertaken to ensure that the development does not impact on existing flood levels in Kayes Drain or surrounds.

The modelling undertaken by Cardno and innovative technology recommended will ensure that the environmental performance of the development is robust and provides the highest level of environmental performance available.

This report outlines the hydraulics and water quality treatment technical details for the proposed development.

2 Site Characteristics

2.1 Location and Land Use

The proposed development, located on Ajax Rd, Altona, is approximately 15km south-west of Melbourne City CBD. It is bounded by the Geelong/Werribee railway line, existing industrial development and Ajax Rd to the north, Kayes Drain to the west, and the Altona Loop railway line and existing detention basin to the south, as shown in Figure 1.

The development is approximately 55.35ha.

Figure 1: Subject Site Aerial View

2.2 Existing site

As illustrated in Figure 2, stormwater from the existing site flows from north-to-south to Laverton Wetland (located south of the railway line) and eventually into Laverton Creek.

The site is relatively flat with a slope ranging from 0.3 - 0.5%. Several culverts under the southern railway line allow water to drain southwards towards Laverton Creek.

Four subcatchments currently exist on site, each draining to an existing culvert under the Altona Loop Railway Line to the south of the site.

Table 1: Existing Drainage Infrastructure

Catchment	Size (ha)	Outlet
1	18.44	5 x 2.4m x 1.8m culverts
2	15.55	1.7 x 0.8m culvert
3	3.73	1.7 x 0.8m culvert
4	29.76	1.5m dia culvert

Figure 2: Existing catchment, flow directions and culverts

2.3 External Catchments

Two external catchments adjacent to the subject site have been identified. These areas drain through the proposed Ajax Rd development, however they have existing stormwater outlet infrastructure, as shown in Figure 3.

External Catchment 1 is approximately 6 ha and drains towards Laverton Creek though a twin 1050mm diameter underground drainage network, while External Catchment 2 is approximately 59.4ha with a 1200mm diameter outlet pipe located south-west of its catchment boundary.

Stormwater from areas further north of these external catchments are assumed to be conveyed to Laverton Creek via Kayes Drain (west of the subject site).

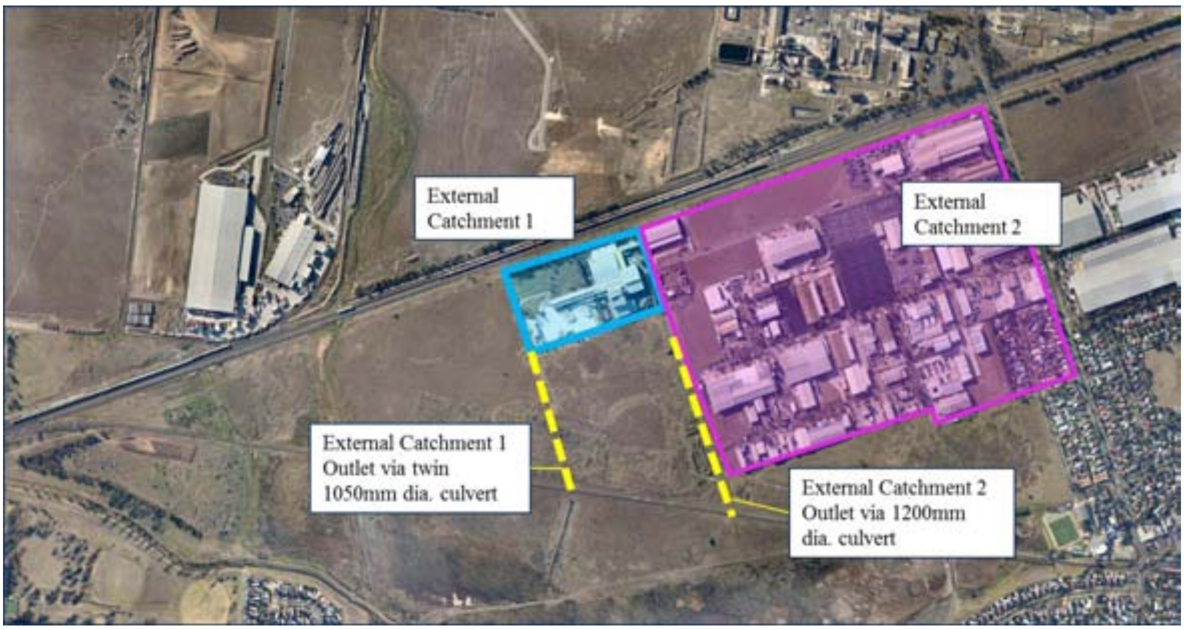


Figure 3: External catchments and their outlet properties

Kayes drain carries stormwater runoff from a large catchment to the north of the site. Melbourne Water was consulted and provided the output files for the RORB model used in the calculation of flows for the existing drainage system in the area. The hydrograph for the 1 in 100 year ARI storm event at the location of the existing culverts is shown below in Figure 4.

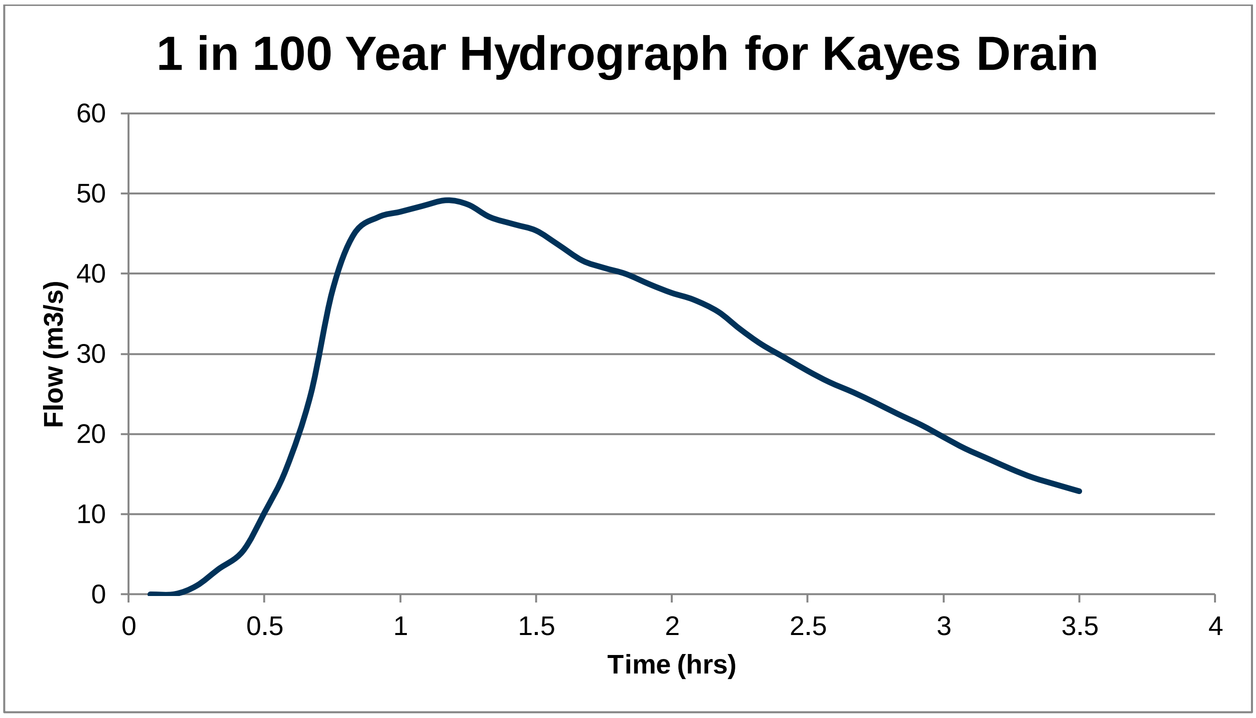


Figure 4: Kayes Drain 1 in 100 year ARI Hydrograph

2.4 Proposed site characteristics

The proposed site is to be developed for industrial uses. The site is proposed to have three stormwater catchments based on existing outlets to be utilised. An imperviousness of 80% was adopted for modelling purposes for all catchments.

Stormwater runoff from Catchment A will be detained to pre-developed flow rates from Catchment 1 (Figure 2) and released to Kayes Drain.

Low flows, in the order of 1 in 3mth ARI from Catchment A will be diverted to the proposed stormwater treatment device located at the outlet of Catchment B. The colocation of the treatment device for both catchments will be more economical for construction and maintenance.

Stormwater flowing from Catchment B will drain to the existing twin 1050mm dia outlet, via a proposed detention basin. This detention basin will detain flows to the capacity of the existing drainage infrastructure.

Stormwater from Catchment C will drain to the existing detention basin located south-east of the site.

It is expected that the developed site will be graded to drain stormwater to the proposed outlets for each area.

Table 2: Catchment Information

	Area (ha)	Imperviousness	Outlet
Catchment A	8.00	80%	Kayes Drain
Catchment B (Including Up Stream Catchment)	36.83	80%	Existing 1050mm dia. culvert
Catchment C (Including Up Stream Catchment)	49.97	80%	Outflow to existing detention basin

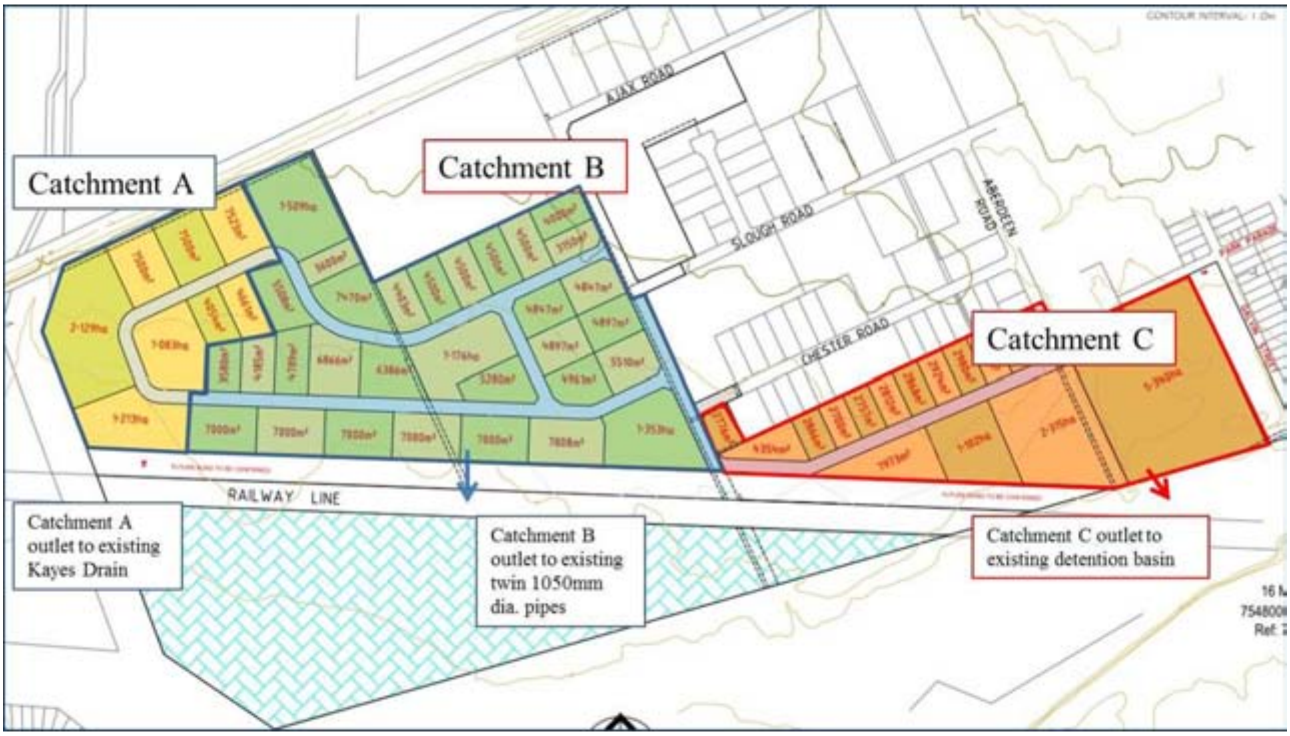


Figure 5: Catchment delineation

3 Hydraulic modelling

Hydraulic modelling was used to calculate the volume needed to ensure that the 1 in 100 year ARI flow from the site did not exceed the existing peak discharge rate for Catchment A and the outlet culvert's capacity for Catchment B and C.

The XP Software program, XP SWMM 2012 (Stormwater & Wastewater Management Model) was selected to analyse the site hydraulic activities for the Ajax Rd development.

XP SWMM is a highly sophisticated hydrologic and hydraulic modelling software package which has the ability to generate hydrographs then model open channels, pressure flow networks, back water affects, stage storage relationships utilizing a complex routing package.

The Laurenson method was adopted to calculate flows and is the same as methods used in RORB and Tuflow.

Key parameters used to construct the model are outlined below.

3.1 Evaporation

Evaporation was not taken into account for the hydraulic analysis as the duration of events modelled are not long enough for evaporation to play a significant part.

Water quality models using MUSIC do take into account evaporation as they are based on long term simulations.

3.2 Loss Model

The model for pervious runoff assumes a 20mm initial loss and a continuing loss of 2mm/hr.

For impervious developed catchments, an initial loss of 2mm depth and zero continuing loss were assumed.

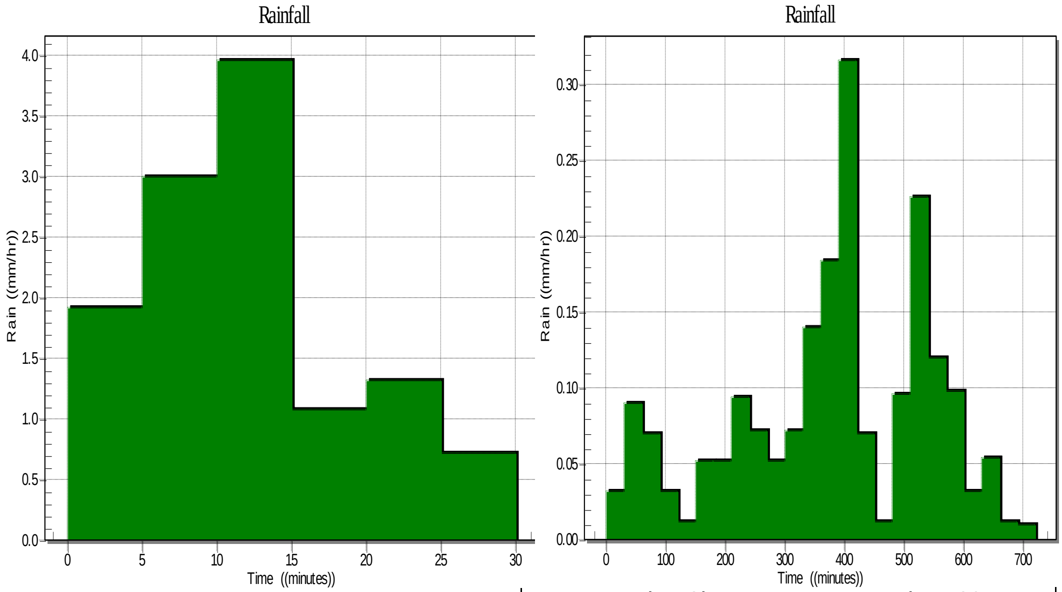
The loss models are considered to be within industry standard practice.

3.3 Rainfall Parameters

Rainfall flow and volumes were generated within the SWMM runoff module for the 100 year events.

The range of storm events modelled were based on the Australian Rainfall and Runoff (AR&R) standard unit hyetographs and give more accurate flow results than the Rational Method as the actual shape of the storm event is used rather than an assumed constant rainfall intensity for a given time of concentration.

The actual site hyetographs were computed by SWMM by selecting the appropriate standard unit hyetographs and scaling the storm to suit the site via multipliers obtained from Intensity-Frequency-Duration curves.



Hyetograph_30mins storm, less than 30years ARI	Hyetograph_12hrs storm, greater than 30years ARI

Figure 6: Standard Unit Hyetographs used in XP SWMM

The Laurenson Method was selected as the preferred means of calculating peak flows and runoff routing.

Intensities were taken from the Bureau of Meteorology website for the site location and are shown below in Figure 7.

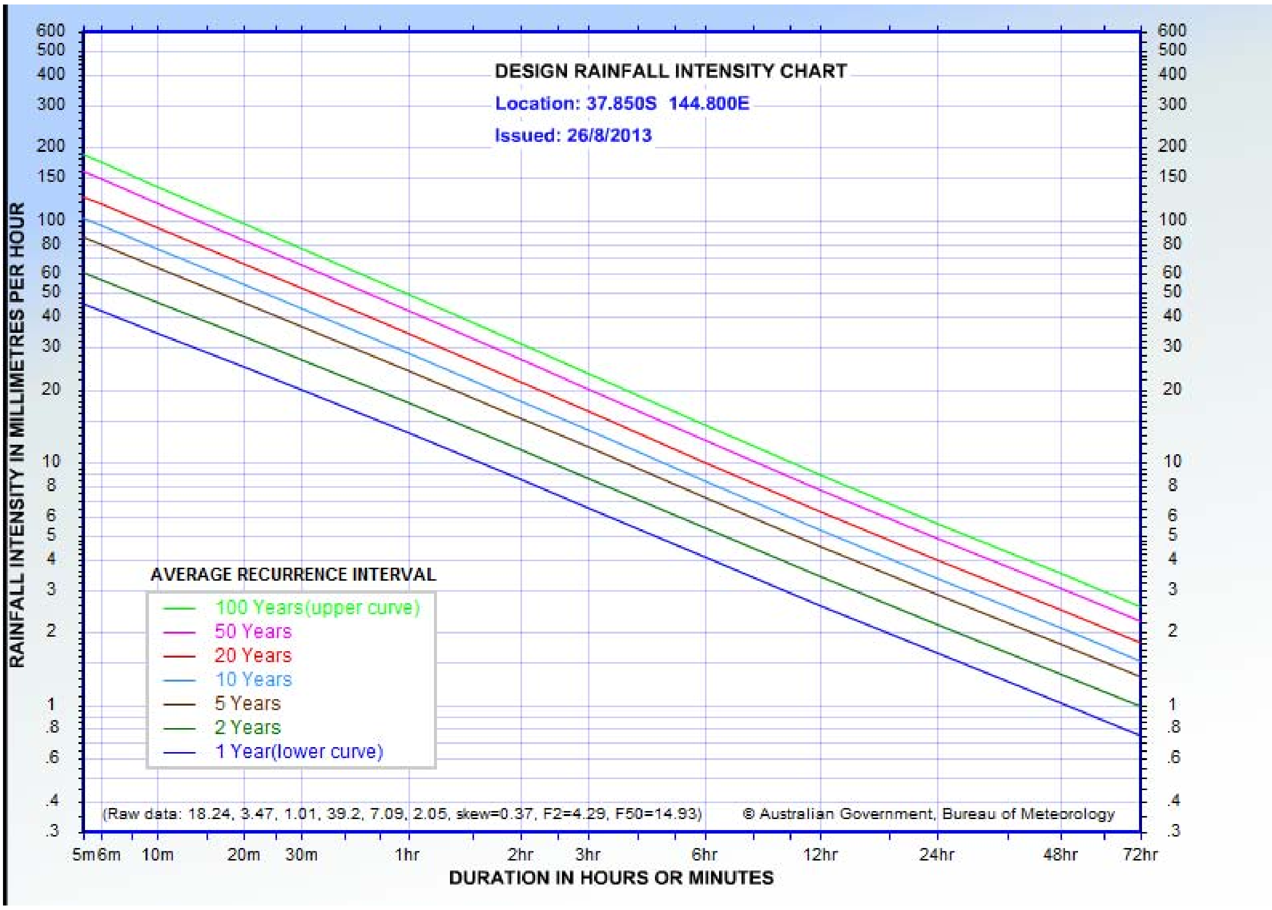


Figure 7: IFD Chart

3.4 Existing Conditions

The existing site is currently open grass land with industrial development to the north east of the site. The site generally falls to the south towards the Altona Loop railway line. Kayes Drain runs along the western boundary of the site.

Existing stormwater runoff rates were calculated in XP SWMM using the Laurenson Method. For the purposes of ascertaining an existing peak runoff rate, it was assumed the total site was undeveloped with a percentage impervious of 0%.

The runoff from the developed Catchment A only is to be detained to pre-developed levels. All other catchments are to be detained such that the capacity if existing drainage infrastructure is not exceeded. Therefore, the existing outflow rate from existing Catchment 1 is of concern to the proposed development.

The outflow hydrograph for the existing Catchment 1 into Kayes Drain is shown below in Figure 8 and indicates a peak discharge rate of 1.0m^3/s

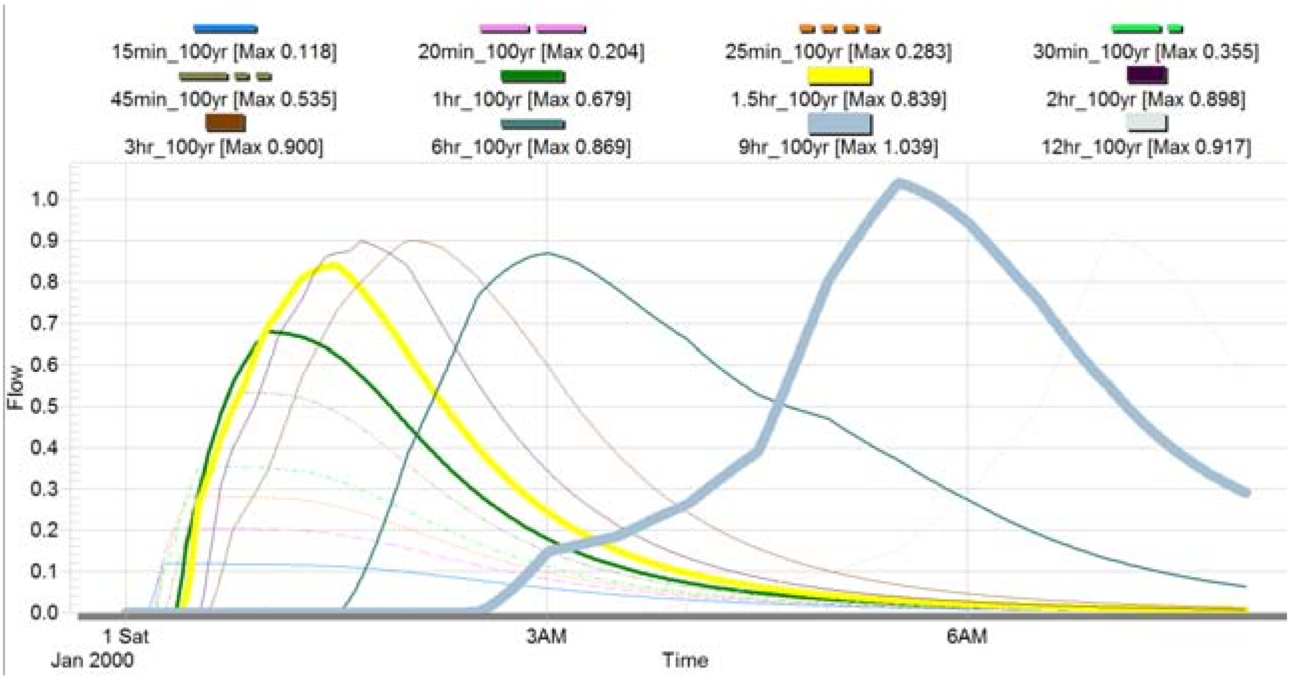


Figure 8: Outflow Hydrograph from Existing Catchment 1

The 1 in 100 year ARI flow regime down Kayes Drain has been provided by Melbourne Water and indicates a peak flow rate of 49.2m^3/s. the entire flow down Kayes Drain passes through an existing 5 x 1.8m x 2.4m box culverts. These culverts have been surveyed and the invert level was found to be 1.1m AHD. The maximum ponding depth for the peak flow to pass through the existing culverts is 1.8m. Therefore the flood depth at the upstream end of the culverts is 2.9m AHD.

A portion of the site lies beneath 2.9m AHD and therefore forms part of the flood plain storage. Some of this area is proposed to be filled as a part of the development. Therefore additional flood plain storage will need to be provided within the site in order to not create a worsening effect on surrounding areas. The volume of additional flood plain storage to be provided is to be determined during the functional design phase.

All properties and buildings will need to ensure that adequate freeboard has been maintained to the expected flood level of 2.9m AHD. This will form part of the functional design phase.

The existing 2 x 1050mm dia pipes under the railway line to the south of the site have also been surveyed to determine the precise invert level and location. These drains currently carry stormwater flow from External Catchment 1, and have capacity for additional flow.

3.5 Proposed Conditions

The proposed development will largely consist of impervious roof and hard stand area. For the purposes of the hydraulic modelling, it is assumed that the development will be 80% impervious.

Two detention basins are proposed to be constructed as a part of the development. It was found that the existing wetland and retarding basin to the south east of the development, to the north of the railway line, has sufficient capacity to accommodate the additional flows from the proposed development.

The XP SWMM model for the proposed conditions is shown below in Figure 9

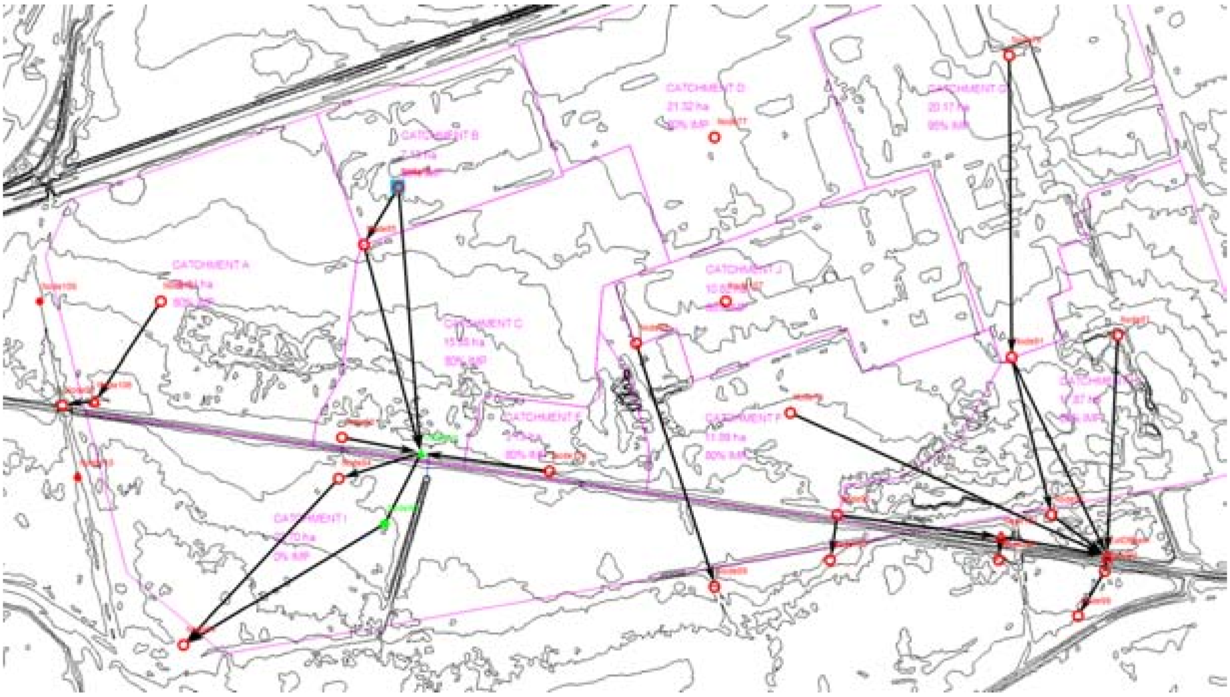


Figure 9: XPSWMM setup for Proposed Conditions

3.5.1 Western Retarding Basin

The proposed retarding basin at the west of the site has been sized such that the outflow rate is no more than the existing discharge rate from existing Catchment 1.

The outflow from this retarding basin is affected by the flood waters within Kayes Drain. Therefore the hydraulic modelling has been carried out using the provided hydrograph acting as a back water effect to this retarding basin.

It is proposed to construct the retarding basin at a lower level than the peak 1 in 100 year flood level within the drain. It is proposed to install 'duck bill valves' or other back flow prevention devices to prevent back flow from the Kayes Drain into the retarding basin.

Due to the high downstream water level at times compared to the retarding basin levels, the proposed retarding basin does not act as efficiently as it would with a free outflow. In order to reduce the physical size of the retarding basin, it is proposed to regrade the site such that a large portion of existing Catchment 1 is directed to the central retarding basin rather than the western retarding basin.

Cardno has carried out preliminary site grading and have reduced the catchment area flowing directly into Kayes Drain from 18.44ha to 8.00ha. The remaining catchment area will be directed to the central retarding basin.

The retarding basin is proposed to be 2,700m^3 with the outlet controlled by 4 x 600mm dia culverts with a back flow prevention device installed.

The proposed 1 in 100 year ARI outflow hydrograph is shown below in Figure 10. The pause in the flow rate is due to the peak flow within Kayes Drain preventing outflow from the basin. During this time, the basin continues to fill due to the inflow from the proposed Catchment A.

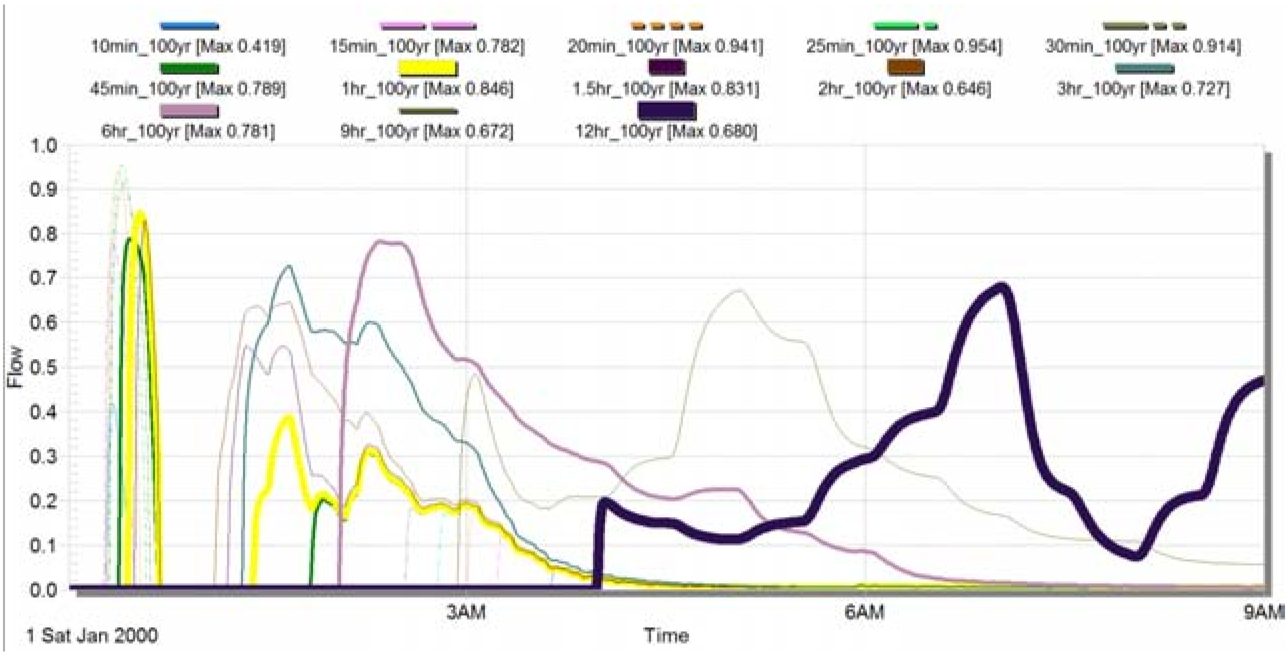


Figure 10: Eastern Retarding Basin Outflow Hydrograph

The basin storage hydrograph is shown below in Figure 11. The maximum water level during a 1 in 100 year ARI event is expected to be 2.9m AHD. This is the same flood level as within Kayes Drain and will not increase the freeboard level of the surrounding properties.

The retarding basin does not completely drain in the below graph due to a static boundary condition downstream of the existing culverts under the railway line of 2.0m AHD. In reality this downstream boundary condition will be dynamic and the basin will be dry for the majority of the time.

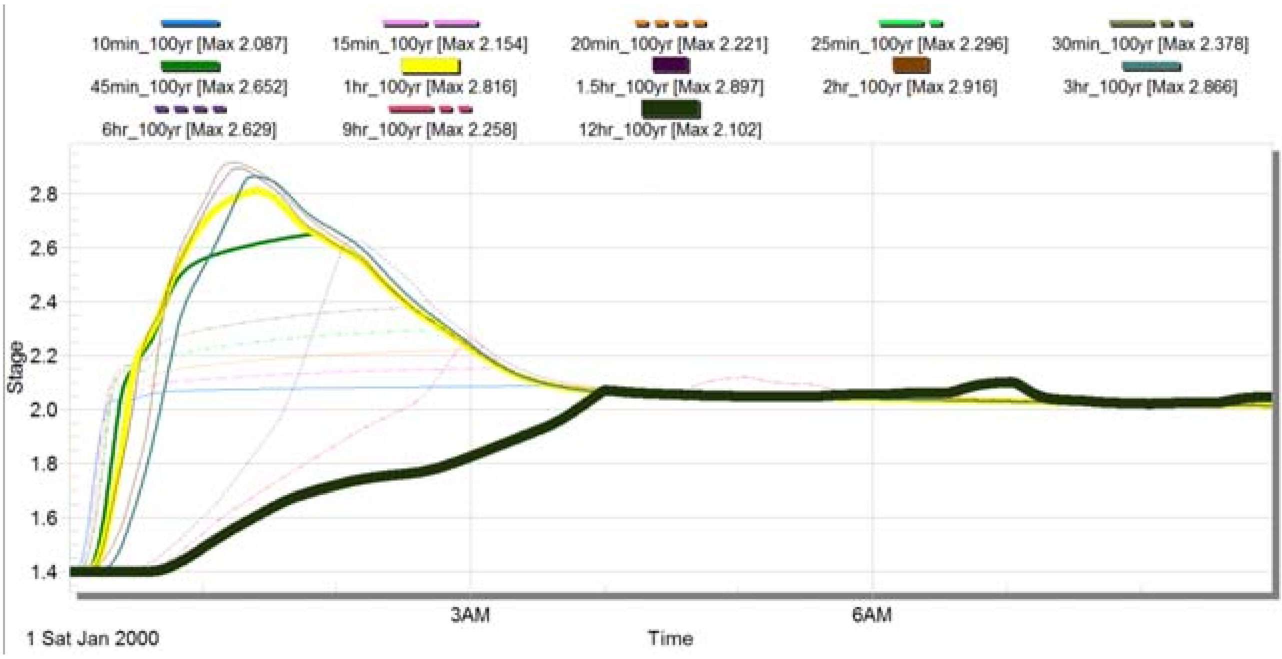


Figure 11: Eastern Retarding Basin Stage Hydrograph

3.5.2 <u>Central Retarding Basin</u>

The outflow from the site via the existing culverts beneath the railway line is not restricted to the existing peak outflow rate. Instead, the allowable outflow rate is determined by the capacity of the existing infrastructure.

The central retarding basin has been designed to utilise the existing twin 1050mm dia pipes currently draining External Catchment 1 as well as the 1.7m x 0.8m box culvert currently draining existing Catchment 2.

A survey has been carried out on the existing infrastructure and it was found that the invert level of the twin 1050mm dia pipes is 1.4m AHD and for the box culvert it is 2.45m AHD.

The construction of the proposed retarding basin will include the demolition of a portion of the 1050mm dia pipes and the instillation of headwalls at the point in which they are exposed.

Figure 12 below illustrates the configuration of the proposed retarding basin. Full scale Concept design drawings are included in Appendix A.

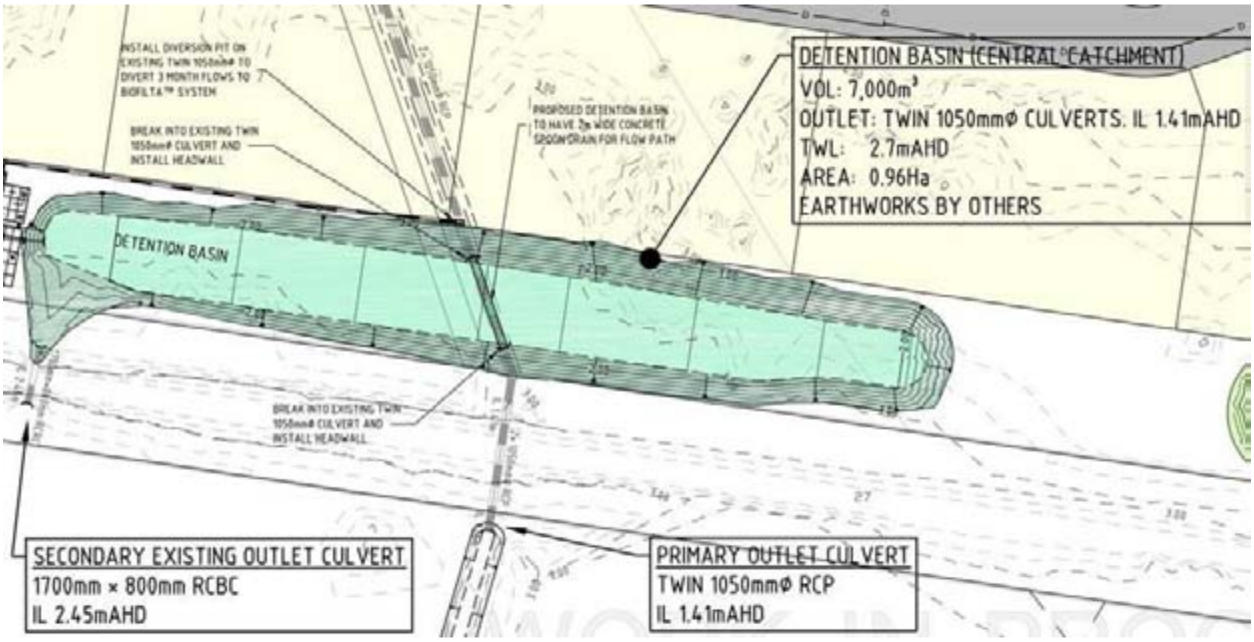


Figure 12: Proposed Central Retarding Basin

The hydraulic modelling has indicated that the retarding basin is to be 7,000m^3 with a top water level of 2.6m AHD.

This top water level provides a hydraulic head of 0.7m above the centroid of the twin 1050mm dia culverts. The peak discharge rate through culverts is 4.3m^3/s. The outflow hydrograph for these culverts is shown below in Figure 13.

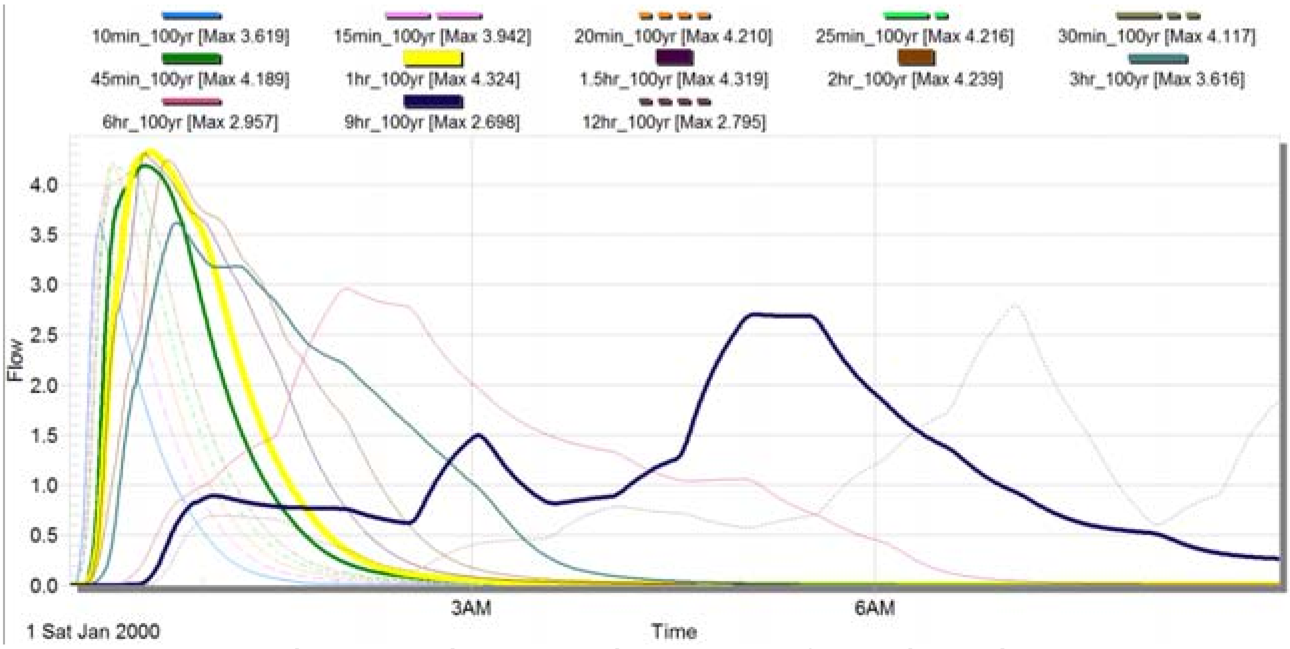


Figure 13: Twin 1050mm Dia Culverts Outflow Hydrograph

The peak 1 in 100 year ARI outflow through the existing box culvert is 0.16m^3/s. Although this connection is not necessary in the modelled scenario, it will act as an emergency overflow in the event of a rarer storm than a 1 in 100 year ARI or the failure of the twin 1050mm dia culverts.

The basin storage hydrograph is shown below in Figure 14. The maximum water level during a 1 in 100 year ARI event is expected to be 2.6m AHD.

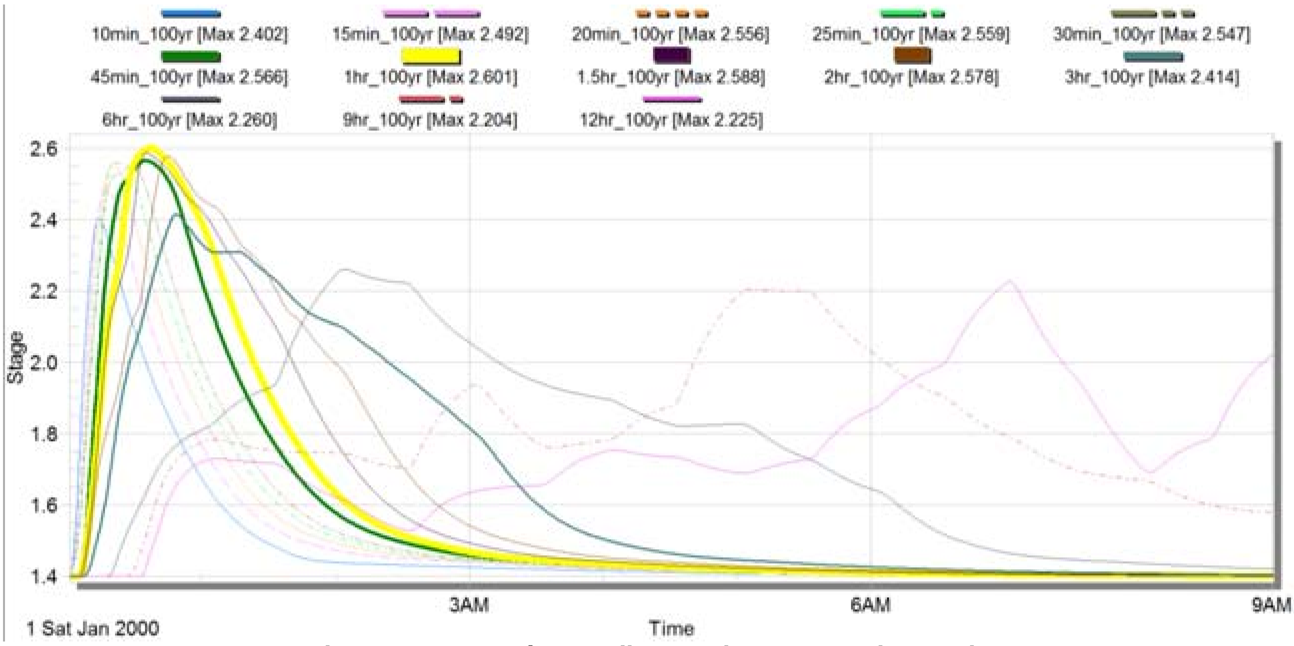


Figure 14: Central Retarding Basin Stage Hydrograph

3.5.3 Existing Eastern Retarding Basin

It is proposed to utilise the existing retarding basin and outlet to the east of the site for the drainage of Catchment C. The hydraulic modelling, including the upstream catchment, has indicated that the basin and outlet have sufficient capacity to accommodate the increased flow from the development of the site.

The existing primary outlet is a single 1500mm dia culvert under the railway line. The invert of the culvert is at approximately 1.5m AHD, the normal top water level of the existing wetland.

A secondary outlet of 525mm dia exists to the west of the primary outlet. From visual inspection, it was determined that this outlet drains low flows from a separate wetland to the east. During high flow events however, these two wetlands act as a single retarding basin. The secondary outlet pipe has an invert level of approximately 1.8m AHD.

Both outlets have been utilised for the purposes of this investigation.

Hydraulic modelling for the existing retarding basin has indicated that the maximum water level expected under developed conditions is 2.5m AHD or 1.0m detention depth.

The maximum discharge rate through the primary outlet is 2.15m^3/s.

The maximum discharge rate through the secondary outlet is 0.67m^3/s.

The basin storage hydrograph is shown below in Figure 15.

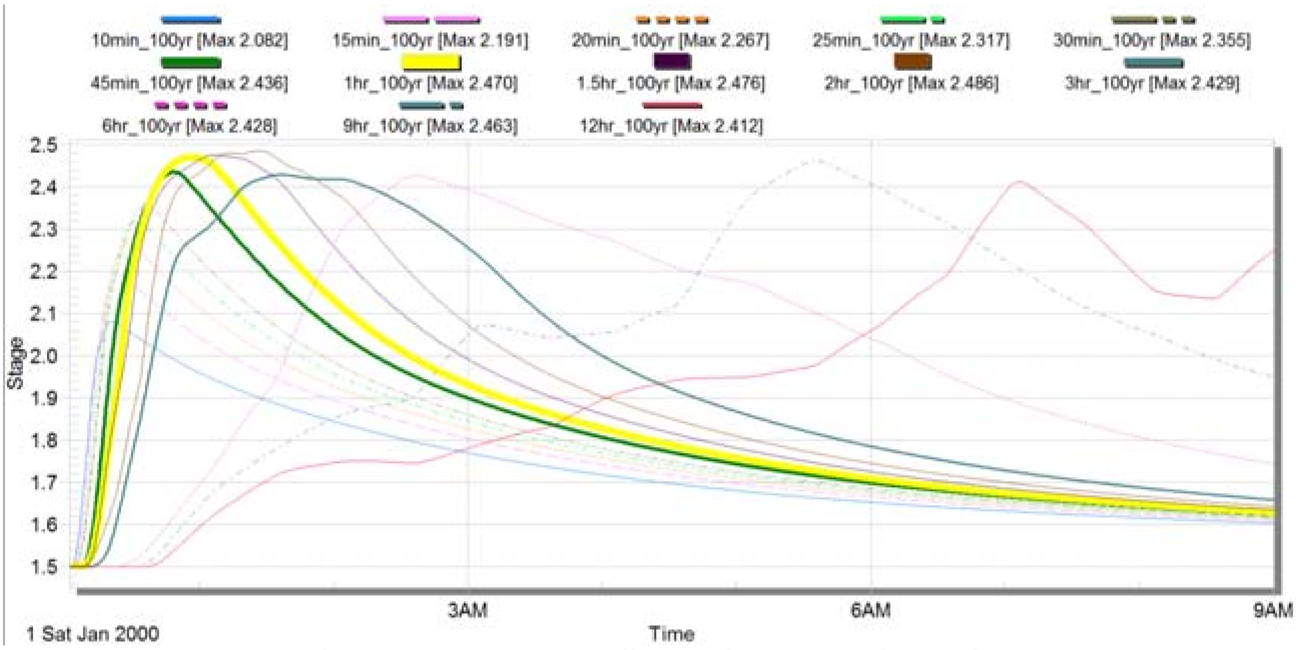


Figure 15: Eastern Retarding Basin Stage Hydrograph

4 Stormwater Quality modelling

Stormwater runoff from the site is proposed to be treated to best practice environmental standards using the patented Biofilta system.

All low flows from the site will be treated by one of two proposed Biofilta systems prior to being discharged to the existing Laverton Wetlands to the south of the Altona Loop railway line.

Two separate Biofilta systems including a sediment chamber, primary tank and a planter bed are proposed to be installed at the southern and eastern boundary of the site. The sediment chamber and primary tank will be beneath the ground level while the planter bed will be installed within open space shown below.

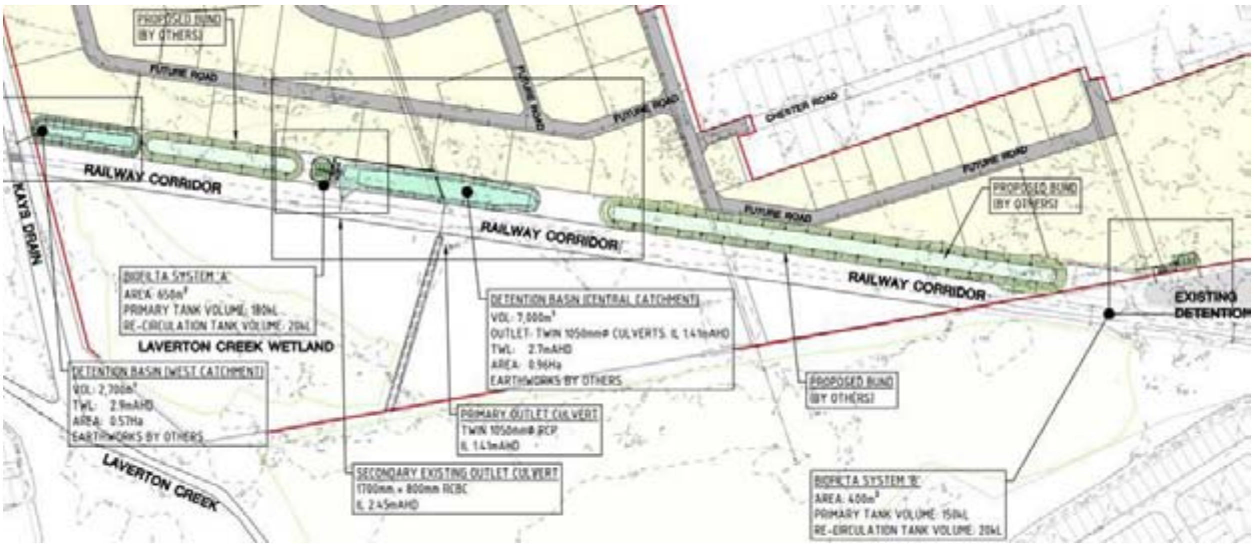


Figure 16: Stormwater Treatment Layout

4.1 MUSIC Modelling

Stormwater quality modelling was undertaken using the software package Model for Urban Stormwater Improvement Conceptualisation (MUSIC).

The parameters used for the MUSIC modelling were taken from Melbourne Water's Guidelines for the use of MUSIC.

The rainfall data used for the MUSIC modelling was the 1996 record for Melbourne Airport, as per Melbourne Water's guidelines.

The MUSIC model was run which includes two separate Biofilta Systems. The total low flow from Catchments A and B will be directed to Biofilta System A while the low flow from Catchment C will be directed to Biofilta System B. The physical size of the individual components of each Biofilta system are detailed in Table 3.

Table 3: Biofilta System Details

	Primary Tank Volume (m^3)	Planter Bed Area (m^2)	Pump Rate (l/s)
Biofilta A	180	650	120
Biofilta B	150	400	88

Each Biofilta system also includes a GPT to remove coarse sediment prior to entering the primary tank. Also, a recirculation tank has been included in the design of each system for the purposes of sustainability.

A reuse of 11,000 and 7,600kl/day has been applied to the proposed primary tanks for Biofilta system A and B respectively. However, this reuse has been directed to the proposed planter bed to simulate the pumping regime from the primary tank to the planter bed. 11,000kl/day equates to a pump rate of approximately 120l/s. All stormwater overflow from the primary tank will bypass the planter bed treatment.

The Biofilta planter bed utilises nonstandard filter media to obtain a higher quality treatment within the planter beds.

MUSIC Model parameters for the Biofilta planter bed used are detailed below in Table 4 below.

Table 4: MUSIC Model Parameters for Bioretention Node

Parameter		Default Value	Adopted Value
Saturated Hydraulic Conductivity (mm/hr)		100	360
TN Content of Filter Media (mg/kg)		800	400
Orthophosphate Content of Filter Media (mg/kg)		80	5
Total Suspended Solids K	K (m/yr)	8000	8000
	C* (mg/L)	20	20
Total Phosphorus	K (m/yr)	6000	6000
	C* (mg/L)	0.13	0.13
Total Nitrogen	K (m/yr)	500	500
	C* (mg/L)	1.4	1.4
Filter Media Soil Type		Loamy Sand	Sand
Number of CSTR Cells		3	3
Porosity of Filter Media		0.35	0.35

The bioretention node default of 80mg/kg orthophosphate content associated with a sandy loam filter media, results in phosphorus being the limiting pollutant and drives the size of the bioretention basin needed to meet Best Practice standards. The media and plants will be supplied by Biofilta Pty Ltd. Due to their low phosphorous sand, confirmed through independent testing, demonstrating a phosphorous content of 5ppm or 5mg/kg, this default has been substantially reduced.

A screen shot of the MUSIC model used in the analysis of the proposed development is included below in Figure 17.

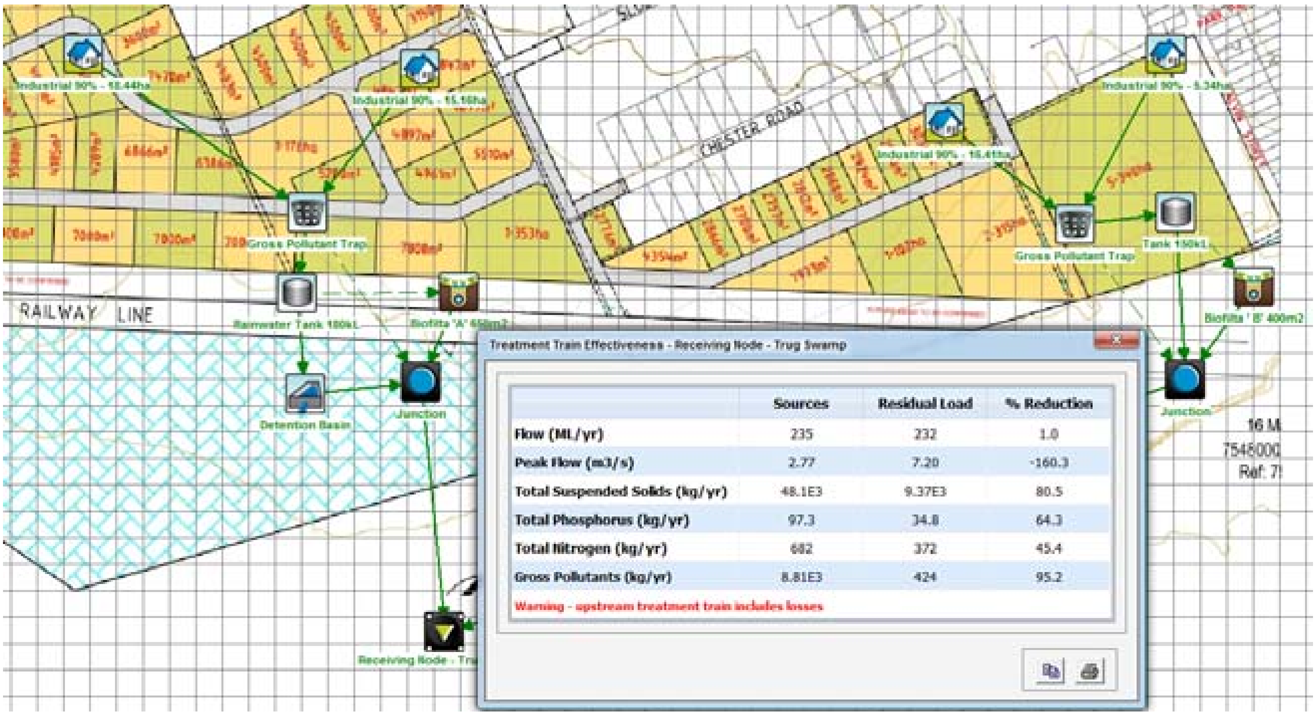


Figure 17: MUSIC Model Setup

MUSIC modelling confirms that a combination of rainwater reuse and a Biofilta system will result in a WSUD treatment outcome for the site that meets best practice environmental guidelines.

4.2 Biofilta System

The proposed Biofilta system will capture and process the bulk of all stormwater generated on site and discharge treated stormwater into the Laverton Wetlands.

The Biofilta system is an innovative and spatially compact vegetated sand filter (rain garden or bioretention) process that incorporates all the elements of water sensitive urban design:

1. Gross pollutant removal
2. Free oils and grease separation
3. Sand filtration
4. Biological nutrient uptake
5. Sustainability

A schematic layout of the proposed Biofilta System A is shown below in Figure 18.

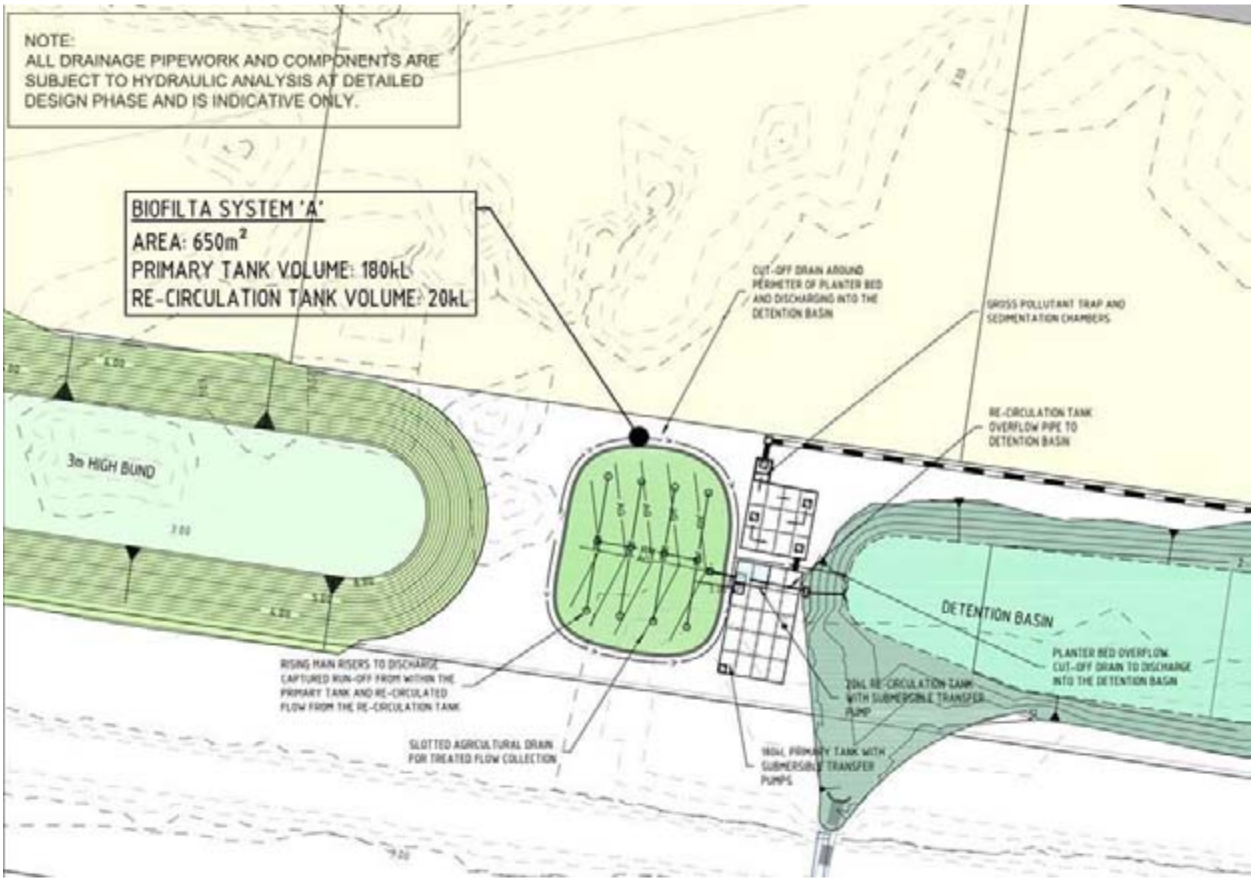


Figure 18: Biofilta Schematic

Stormwater will enter the sediment trap carrying all pollutants where inlet screens will remove large debris. Oils and grease are caught upstream of the baffled chamber and coarse sands are deposited within the chamber.

The primary tank is proposed to be constructed as a single unit with the sediment trap. The sediment trap and primary tank is proposed to be located under the finished surface level and will receive stormwater runoff from the site via a low flow diversion from the proposed underground drainage network.

Stormwater captured within the primary tank is pumped at a controlled rate to the proposed surface planter. The planter bed contains the Biofilta sand media and pre-grown vegetation of native Juncus.

Stormwater is biologically filtered through the filter media where soluble pollutants are removed by plants and beneficial bacteria.

Filtered stormwater drains via gravity to the proposed detention basin and ultimately through the outlet under the rail line and to the existing Laverton Wetlands.

Typical installations can be found at Biofilta's website: www.biofilta.com.au

A typical long section of the proposed Biofilta system is included below in Figure 19.

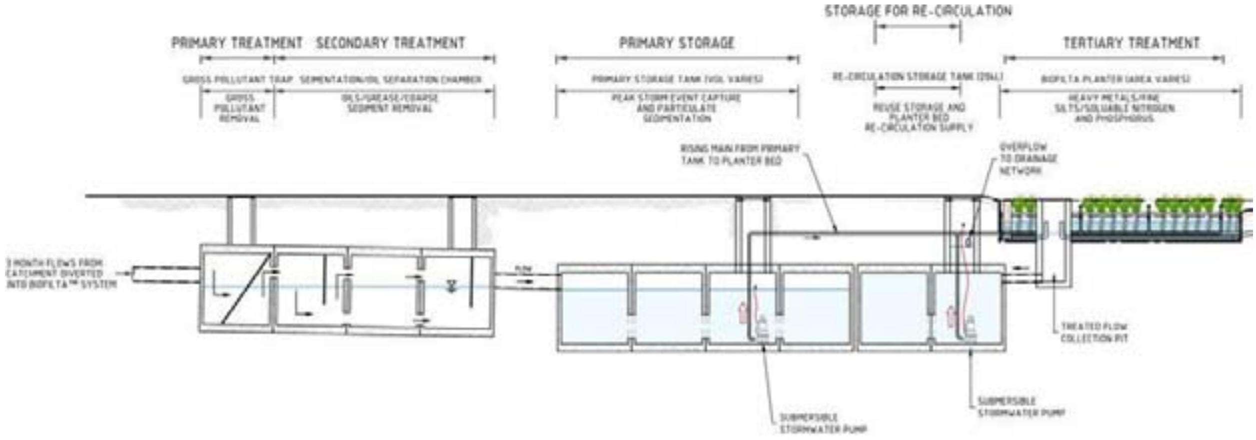


Figure 19: Biofilta Long Section

5 Recommendations

Cardno was engaged by Axxcel Management Services Pty Ltd to undertake a Stormwater Management Plan for a proposed development on Ajax Rd, Altona. This report demonstrates how the proposed development will manage stormwater runoff.

Two detention systems have been incorporated to attenuate peak flows from Ajax Rd development.

The detention basin discharging directly into Kayes Drain will reduce the peak discharge to the existing flow rate of 1.0m^3/s. The outlet control from this retarding basin it to be 4 x 600mm dia culverts with back flow prevention devices installed to prevent flow from Kayes Drain entering the basin. The total volume of the retarding basin is to be 2,700m^3.

The central retarding basin discharging to the south, under the existing rail line will reduce peak flows to the hydraulic capacity of the existing 2 x 1050mm dia pipes. A secondary outlet, the existing 1.7 x 0.8m box culvert will carry a small amount of flow during a 1 in 100 year ARI event but will also act as an emergency overflow outlet. The total volume of this retarding basin is to be 7,000m^3.

The existing retarding basin to the east of the site was found to have sufficient capacity to contain the increased stormwater flow from the developed site. The top water level of this retarding basin is expected to be 2.5m AHD.

Two Biofilta stormwater treatment systems will be provided on site to treat the stormwater runoff to meet best practice environmental guidelines. In addition to meeting the best practice objectives for stormwater treatment, the water sensitive design features will provide a visual and environmental amenity will be a lasting and sustainable community asset.

Cardno recommends:

- Approval in principle be granted for the proposed stormwater management plan as the issues of flow conveyance and treatment will be treated to meet all relevant guidelines.
- To meet Best Practice water quality targets:
    - A single Biofilta system will treat low flows from Catchments A and B. The primary tank is proposed to be 180m^3 while the planter bed is to be 650m^2.
    - A second Biofilta system will treat low flows from Catchments C. The primary tank is proposed to be 150m^3 while the planter bed is to be 400m^2.
- Management of the above systems to be undertaken by Biofilta as per manufacturers recommendations and funded through a Body Corporate.

APPENDIX

A

CONCEPT DESIGN DRAWINGS