



145 Rossiter Road, Koo Wee Rup
Stormwater Management Strategy

14 February 2022

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1 Introduction

This report concerns the potential drainage infrastructure required to enable development of 145 Rossiter Road, Koo Wee Rup (the **Site**).

Stormy Water Solutions (**SWS**) was commissioned by KLM Spatial Pty Ltd (**KLM**) in May 2021 to prepare a stormwater Management Strategy (**SWMS**) for the Site.

It should be noted development of this property is proposed as a result of the approval of the rezoning allowed under Planning Scheme Amendment C235card. This amendment was gazetted in July 2020. The Melbourne Water Corporation (**MWC**) did not object to the rezoning proposal, subject to various conditions.

The Site location is shown in Figure 1 and the proposed development layout (as of February 2022) is shown in Appendix E.



Figure 1 Site Location
Source: <https://mapshare.vic.gov.au/vicplan/>

This report details the proposed SWMS for the Site. This work confirms that development of the Site is feasible, from a drainage perspective (as agreed to by the C235 panel). However, the work is based on the understanding that a SWMS is the first step in a design process. As such the design presented are a “strategy development” and “Concept Design” level.

Notwithstanding the above, SWS consider that, although design development tasks are still required going forward (see Section 5), enough analysis and design has been completed at this time to provide confidence that the Site can be developed in line with the current KLM proposals.

2 Background Considerations

2.1 Amendment C235card

Planning Scheme Amendment 235card proposed to rezone 145 Rossiter Road, Koo Wee Rup, from Farming Zone to Neighbourhood Residential Zone – Schedule 1.

A Stormwater Management Plan entitled “Rossiter Road Stormwater Management Plan, 25 July 2017” by Biofilta Pty Ltd (the **2017 Biofilta SWMP**) was the drainage strategy submitted as part of the land owners submission to the C235card Panel.

The C235card Panel conclusions regarding drainage are documented in the Panel Report Dated 30 December 2019. These are reiterated below.

The Biofilta Stormwater Management Plan (July 2017) provides the level of detail consistent with the requirement for a Stormwater Management Plan including a Fill Plan. However, this plan requires updating to reflect Melbourne Water’s current requirements and revisions in the layout of the proposed development.

The 2017 Biofilta plan therefore does not provide all the detailed analysis that would be required to be approved by Melbourne Water in the future, but the Amendment clearly establishes the need for an updated Stormwater Management Plan. The 2017 plan does provide confidence that it will be possible to update and redraft the plan and meet all drainage, flooding and water quality issues.

C235card was gazetted in July 2020.

Given the above, this SWMS concentrates on meeting any conditions subsequently provided by Melbourne Water Corporation (**MWC**) in relation to development of the Site, with the underlying context that resident development of the Site is achievable as determined by the panel.

2.2 Land subject to Inundation Overlay

As stated in the 235card Panel Report, the Site is affected by a Land Subject to Inundation Overlay (**LSIO**).

The LSIO triggers a requirement for permits for subdivision. Consideration of any permit will be considered within Melbourne Water’s “Guidelines for Development within the Koo Wee Rup and Longwarry Flood Protection District, July 2019” (**KWRFPD Guidelines**). The KWRFPD Guidelines will determine conditions applied to any planning permit. The KWRFPD Guidelines provide a consistent approach to subdivisions and development occurring within Koo Wee Rup flood protection district.

2.3 Koo Wee Rup Flood Protection Guidelines

As defined in the KWRFPD Guidelines, the Site is located in a Zone 2 flood zone.

- Provision of an appropriate flow path is provided along the western boundary of the Site to convey the 1% AEP Southern Boundary Drain flow.

2.4 Melbourne Water Advice

Melbourne Water has provided advice in relation to development of the Site in four documents being:

1. Melbourne Water - Letter to Cardinia Shire Council "Amendment: Cardinia Planning Scheme Amendment C235 – Rezoning of 145 Rossiter Road, Koo Wee Rup, Property: 145 Rossiter Road, Koo Wee Rup, Melbourne Water Reference: MWA-1139355" dated 19 July 2019.
2. Melbourne Water Letter to SWS "Proposal: Pre-development advice - General Site Advice, Site location: Lot No 2, 135 Rossiter Road Koo Wee Rup 3981, Melbourne Water reference: MWA-1221167" 28 September 2021.
3. Melbourne Water Letter to SWS "Proposal: Pre-development advice - General Site Advice (Updated from Response dated 28 September 2021 - Updated Flood Level Information), Site location: Lot No 2, Rossiter Road Koo Wee Rup 3981, Melbourne Water reference: MWA-1221167" 4 October 2021.
4. Melbourne Water email to SWS "MWA-1221167 - Lot No 2 135 Rossiter Road Koo Wee Rup 3981" 4 October 2021.

In line with the discussion in Section 2.3, all of the above documents stated that the 1% AEP flood level graded from 4.0 m AHD at the southern boundary (the year 2100 tidal surge level) to 4.6 m AHD at the northern boundary. The exception to this was Document 2 above where defined levels varies from the those detailed in all other correspondence. However, Documents 3 and 4 confirmed the 4.0 – 4.6 m 1% AEP flood level variation as the correct flood levels.

As the most recent advice, the development requirements of Document 3 above are taken as the requirements for development in this SWMS. These are reiterated below.

- *A stormwater management and drainage strategy must be submitted and approved by Melbourne Water. This strategy must provide details of the outfall/s for the development and calculate the appropriate flow volumes and flood levels for the 100-year ARI storm event and demonstrates how stormwater runoff from the subdivision will achieve State Environment Protection Policy (Waters of Victoria) objectives for environmental management of stormwater.*
- *Stormwater runoff from the subdivision must achieve State Environment Protection Policy (Waters of Victoria) objectives for environmental management of stormwater as set out in the 'Urban Stormwater Best Practice Environmental Management Guidelines (CSIRO) 1999'.*

- *Any subdivision must retard stormwater back to pre-development levels before entering the downstream drainage system and/or retard stormwater back to the sufficient capacity of the downstream drainage system, whichever is appropriate. Any road or access way intended to act as a stormwater overland flow path must be designed and constructed to comply with the floodway safety criteria as specified by Melbourne Water.*
- *If new lots are to be created, all new lots are to be filled to a minimum of 600mm above the graded 1 in 100 year flood level.*
- *Flood levels on adjacent properties must not be increased as a result of any future development on the site. Evidence that the overall capacity of the floodplain will not be reduced through the development of the site and a cut/fill balance or appropriate analysis will need to be provided to the satisfaction of Melbourne Water.*
- *Any new stormwater connection proposed to Melbourne Water's Southern Boundary Drain must be constructed in accordance with our stormwater connection guidelines. Any new connections will have to go through applications to Melbourne Water's Asset Services Team. Fees and bonds are applicable for these type of application.*
- *Additional requirements may be applicable upon receipt of site development plans and any proposed subdivision layout.*
- *Future development of the site must not compromise Melbourne Water's ability to conduct future works on the adjacent drains and must provide sufficient space for this purpose.*
- *Southern Brown Bandicoot (EPBC Listed), recorded along the drain corridor to the west of the site. Growling Grass Frog, 30 observations within 5 kilometres of the site, and confirmed records within the main vegetated dam within the site. Future development of this site must ensure that these values are managed appropriately in accordance with the relevant legislation.*

This SWMS details how these conditions can be met (Section 4.2).

3 Design Constraints and Considerations

As well as the considerations detailed in Section 2, the following general design constraints have been considered in the formulation of this SWMS.

3.1 Ecological Constraints

Although straight and manmade, Southern Boundary Drain is a significant waterway with a mature treed riparian zone. As such, although not required by MWC, a buffer to development of at least 65 metres (to the centre line of the Southern Boundary Drain) has been assumed in the formulation of this SWMS. This is accommodated via inclusion of a 45 m wide reserve along western boundary of the Site.

As such, this offset is in line with MWC requirements to ensure that future:

- Development of the site does not compromise Melbourne Water's ability to conduct future works on the adjacent drains and must provide sufficient space for this purpose; and
- To protect the Southern Brown Bandicoot recorded along the drain corridor to the west of the Site.

Future development of this Site must ensure that these values are managed appropriately in accordance with the relevant legislation.

Design development must ensure appropriate ecological surveys are undertaken going forward onto the design process, particularly in regard to the impact on the Growling Grass Frog site observations. It is understood that the KLM design team are currently working through these issues with DELWP.

3.2 Electricity Assets and Other Services

There is an electricity line located running parallel to the southern boundary of the Site. This asset contains a set of existing poles and lines. At this stage, the pole locations have been determined by aerial photography and should be confirmed with Site survey.

It is SWS's understanding that KLM are currently proposing that the electricity line be relocated underground in areas designated for residential development. However, this SWMS proposes to retain the existing above ground assets in the vicinity of the proposed wetland/retarding basin asset. As this stage it is assumed that, in line with previous projects:

- A 4-metre access track will be required along the southern boundary of the wetland/retarding basin site to ensure access to each pole;
- A 10-metre offset from the poles to any cut line is required; and
- A 20-metre offset from the poles to any sediment pond or wetland normal water level (NWL) is required.

These assumptions are required to be confirmed by the relevant asset managers going forward into the design process but have been incorporated in the formulation of this SWMP.

In addition, all Site services are required to be accurately proven in the functional design stage of the project.

If the powerlines are ultimately undergrounded through the site, the wetland/retarding basin asset could be enlarged (at the functional design stage) and all the associated benefits details in would then be exceeded.

3.3 Groundwater and Soils

The Site is generally no more than 2 to 3 metres above historic high tide levels in the Westernport Bay. As such, groundwater quality and level are key design considerations for any proposed wetland development and are required to be investigated going forward.

Notwithstanding the above, saline groundwater conditions at shallow depth should be expected. As such, the proposed wetland will likely have to be clay lined to mitigate saline intrusion.

The likelihood of acid sulphate soils being present should be further investigated with geotechnical studies at the proposed wetland location. If found, construction activities can be planned and managed in a manner that mitigates the formation of acid sulphate soils. However, given significant wetlands have been constructed in this area of Koo Wee Rup, although a design (and potentially cost) consideration going forward, acid sulphate soils should not impede the final adoption of the wetland systems proposed in this SWMS.

3.4 Flooding and Tidal influences including Climate Change

There are two potential impacts due to tidal surges in Westernport Bay. These are:

- Regular high tide levels on a day to day and week to week basis; and
- The 1% AEP tidal surge expected in the bay.

3.4.1 Regular downstream Influences

The Victorian Tide Tables 2021 show a Mean Higher High Water (**MHHW**) tide level at the Tooradin Pier (which is assumed to be relevant for the Bunyip River/South East Catch Drain at Koo Wee Rup) of 1.10 m AHD currently. To account for the 800 mm of sea level rise by 2100 expected (Melbourne Water, 2017b), the outlets from the proposed retarding basin into the South East Catch Drain have been specified at an invert level of 1.90 m AHD into the South East Catch Drain (with a flood gate).

This level is also 400 mm above the invert level of the outfall to South East Catch Drain. Thus incorporating a wetland normal water level of 2.2 m AHD, with a pipe outfall at the outfall drain of 1.9 m AHD will allow for significant baseflow in the South East Catch Drain system, while still ensuring outflow from the Site. These levels have been adopted in the wetland/retarding basin design presented in this strategy.

3.4.2 1% AEP Flood Conditions

As detailed in Section 4.2, the 1% AEP flood level grades from 4.0 m AHD at the southern boundary (the year 2100 tidal surge level) to 4.6 m AHD at the northern boundary. Hydraulic modelling (Appendix D) has confirmed this.

In line with previous MWC advice, it is assumed that any development must:

- Maintain the existing 1% AEP active flood storage volume in the flood plain;
- Not increase 1% AEP flood levels upstream of the Site at any of the flow input points to the Site.

These requirements have been shown to be met via the analysis presented in Appendix D.

Although not undertaken in this report, going forward a climate change flood analysis is required to be undertaken given the expected (probable) increase in rainfall intensities in the year 2100. Given the 65 metre offset to the centreline of the Southern Boundary Drain, and the proposed excavation in the 45 metre western reserve (adjacent to this drain), at this stage it is expected that any impact on 1% AEP flood levels will be minimal.

3.5 Downstream Flow Impact Considerations

Appendix B details a comprehensive hydrological modelling analysis which shows that the retarding basin provision proposed as part of this SWMS will ensure no increase in flows discharging to the Southern Boundary Drain (including the 90 minute 1% AEP flow as required by MWC in their C253card panel response).

3.6 Additional Fill Considerations

Appendix D details the approximate area of the Site required to be filled. At this stage it is assumed all development must be filled to 600 mm above the final 1% AEP flood levels as detailed above.

In addition however, fill is required to drain the Site towards the wetland/retarding basin drainage system, while incorporating adequate fill over development pipe systems. To minimise fill requirements in regard to this design consideration, SWS has formulated this SWMS in collaboration with KLM to incorporate (at a high level) pipe designs which:

- Utilise short pipe runs and small catchment delineations to minimise pipe sizes,
- Utilise 20% AEP pipe capacities,
- Possibly incorporate slightly drowned pipe inverts at the entry to wetland systems (1/3 pipe drowned at the upstream end of a wetland) to allow for a slightly increased pipe slope,
- Discharge to the upstream end of wetland systems to gain the advantage of a wetland having no drainage line slope over its length,
- Possibly consider duplicate pipes to (minimise pipe sizes),
- Utilise minimal pipe grades, and
- Design pipes to incorporate 600 mm cover to the design finished surface level (typically).

At this stage fill requirements have been formulated by KLM with pipe cover requirements in mind. This has resulted in fill requirements in the northern portion of the Site being greater than required to achieve 1% AEP flood protection from the external catchments.

3.7 MWC's Healthy Waterways Strategy

The proposals detailed in this SWMS are completely consistent with MWC's current Healthy Waterways Strategy, particularly in regard to maintaining bird habitat, local ecology and fish passage within Southern Boundary Drain via the 65 metre offset from the drain centre line to the development line advocated in this SWMS.

4 Stormwater Management Strategy

4.1 General Description

Appendix E details SWS Drawing Set 2154/SWMS/1 and 2. This drawing set details the proposed SWMS. The major drainage elements are described in Table 1 below.

The following design methodologies are required to be adhered to going forward into the design process to ensure all design considerations detailed in Sections 2 and 3 are met going forward.

- General catchment delineations as per drawing 2154/SWMS/1,
- General pipe alignments as per drawing 2154/SWMS/1,
- Pipe design requirements (see Section 3.6) to minimise slope and obvert levels to ensure that fill within the Site is minimised as per drawing 2154/SWMS/1,
- Ensuring provision of defined overland flow paths in roads shown as containing pipelines in drawing 2154/SWMS/1,
- All sediment pond and wetland design proposals detailed in 2154/SWMS/2 should be maintained going forward (e.g. design NWL's, TED, upstream and downstream inlet and outlet points, element areas etc),
- The retarding basin stage/storage/discharge relationship detailed in 2154/SWMS/2 should be maintained going forward, and
- Filling of the flood plain as shown in Drawing 2154/SWMS/1 (which are at least 600 mm above the defined 1% AEP flood level and provide adequate cover to all defined subdivisional pipelines).

Table 1 SWMS Elements

SWMS Element	Description	Primary Purpose(s)
Wetland Retarding Basin in the South Western portion of the Site	A sediment pond/ wetland placed within a retarding basin (cut construction) as per detailed in 2154/SWMS/2. See Appendix B for Retarding Basin assumptions/details. See Appendix C for Sediment Pond and Wetland parameters. Connected to the South East Catch Drain via a flood gated outlet, the invert level of which has been determined given existing base flow presence in winter and increased in the expected MHHW by 2100.	Provide current best practice WSUD stormwater treatment. Ensure 1% AEP flood flow is retarded to predevelopment flow rate. Ensure flood storage and capacity gains within the Southern Boundary Drain flood plain.
Tanks for Toilet Flushing and Laundry on all lots	Provided through a future 173 agreement on the development	Ensure stormwater reuse on site. Help meet current best practice WSUD stormwater treatment via supplementing the treatment of the proposed sediment pond/wetland.
Provision of a 45 m wide reserve along the western site boundary	Reserve incorporates a cut construction (and small swale in the valley being formed) - see 2154/SWMS/1 and 2 for design contours.	Allow flow conveyance of the 40 m³/s external Southern Boundary Drain through the western portion of the Site. Ensure flood storage and capacity gains within the Southern Boundary Drain flood plain. Ensure no increase in upstream 1% AEP flood levels.
Accounting for small external catchment inputs	Provision of 1% AEP pipes and/or overland flow path provisions for the minor flows generated from the existing hospital site (2 small external input locations)	Ensure no adverse flood impacts in the adjacent hospital site.
Site filling	Filling from 4.6 m AHD (minimum fill level on southern boundary) to 5.6 m AHD (maximum fill level on the northern boundary).	Provide at least 600 mm freeboard to the defined flood levels of 3.9 m AHD on the southern boundary to 4.6 m AHD on the northern boundary. Provide adequate fill over subdivisional pipelines.

4.2 SWMS Outcomes

Regarding upstream and downstream impacts:

- Appendix B shows that the proposed SWMS should ensure no increase in the design 1% AEP flood flow entering the South East Catch Drain at the Site outfall,
- Appendix C shows that the SWMS WSUD elements can ensure best practice stormwater quality treatment is obtained at the Site outfall,
- Appendix D shows that, the SWMS can be formulated to ensure no increase in 1% AEP flood levels at the northern boundary of the Site.

Table 2 details how/where the specific requirements of MWC are met in this SWMS report. MWC requirements as per their letter to SWS “Proposal: Pre-development advice - General Site Advice (Updated from Response dated 28 September 2021 - Updated Flood Level Information) dated 4 October 2021.

Table 2 MWC Requirement Outcomes

MWC Requirement	Where/How Requirement is met
A stormwater management and drainage strategy must be submitted and approved by Melbourne Water. This strategy must provide details of the outfall/s for the development and calculate the appropriate flow volumes and flood levels for the 100-year ARI storm event and demonstrates how stormwater runoff from the subdivision will achieve State Environment Protection Policy (Waters of Victoria) objectives for environmental management of stormwater.	This report details the SWMS. Outfall as per 2139/SWMS/2 (Appendix E). Flood Levels and Volumes as per Appendix D. Stormwater treatment to requirements as per Appendix C.
Stormwater runoff from the subdivision must achieve State Environment Protection Policy (Waters of Victoria) objectives for environmental management of stormwater as set out in the 'Urban Stormwater Best Practice Environmental Management Guidelines (CSIRO) 1999'.	Stormwater treatment to requirements as per Appendix C.
Any subdivision must retard stormwater back to pre-development levels before entering the downstream drainage system and/or retard stormwater back to the sufficient capacity of the downstream drainage system, whichever is appropriate. Any road or access way intended to act as a stormwater overland flow path must be designed and constructed to comply with the floodway safety criteria as specified by Melbourne Water.	Retardation to requirements as per Appendix B. Overland flow provisions to align with roads/pipelines specified in 2154/SWMS/1 (App E). KLM to formulate on MWC provisional agreement of this SWMS.
If new lots are to be created, all new lots are to be filled to a minimum of 600mm above the graded 1 in 100 year flood level.	All Fill levels detailed in 2154/SWMS/1 (Appendix E) are at least 600 mm above the defined 1% AEP flood level
Flood levels on adjacent properties must not be increased as a result of any future development on the site. Evidence that the overall capacity of the floodplain will not be reduced through the development of the site and a cut/fill balance or appropriate analysis will need to be provided to the satisfaction of Melbourne Water.	Reduction in the upstream 1% AEP flood level and retention of active flood storage in demonstrated in the hydraulic calculations detailed in Appendix D.
Any new stormwater connection proposed to Melbourne Water's Southern Boundary Drain must be constructed in accordance with our stormwater connection guidelines. Any new connections will have to go through applications to Melbourne Water's Asset Services Team. Fees and bonds are applicable for these type of application.	Understood. To be addressed at detailed design stage, nothing that the outfall detailed in 2154/SWMS/2 (Appendix E) accounts for baseflow in the South East Catch Drain and the expected increase in the MHHW in 2100.
Any new stormwater connection proposed to Melbourne Water's Southern Boundary Drain must be constructed in accordance with our stormwater connection guidelines. Any new connections will have to go through applications to Melbourne Water's Asset Services Team. Fees and bonds are applicable for these type of application.	Understood. To be addressed at detailed and functional design stages.
Additional requirements may be applicable upon receipt of site development plans and any proposed subdivision layout.	Understood. To be addressed at detailed and functional design stages.
Future development of the site must not compromise Melbourne Water's ability to conduct future works on the adjacent drains and must provide sufficient space for this purpose.	2154/SWMS/2 (Appendix E) allows enough space for a 4 m access track around the wetland/sediment pond assets and an adequate dewatering area etc.
Southern Brown Bandicoot (EPBC Listed), recorded along the drain corridor to the west of the site. Growling Grass Frog, 30 observations within 5 kilometres of the site, and confirmed records within the main vegetated dam within the site. Future development of this site must ensure that these values are managed appropriately in accordance with the relevant legislation.	Design development will ensure appropriate ecological surveys are undertaken. KLM Spatial will work through these issues with DELWP. The 65 m offset to the Southern Boundary Drain to development will ensure the existing habitat corridor is maintained.

5 Conclusions and Further Work Required

As concluded by the C235card Panel, this SWMS shows that development of the Site is feasible from a drainage perspective. The work presented at a “strategy development” and “Concept Design” level. Although additional design development tasks are required going forward, enough analysis and design has been completed at this time to provide confidence that the Site can be developed in line with the proposals detailed in Appendix E going forward.

Further work required going forward includes (but may not be limited to):

- Service proving.
- Confirmation of all ecological and archaeological constraints, especially in regard to the specific WSUD and drainage element sites detailed in Appendix E.
- Geotechnical studies including identifying any Acid Sulphate soil issues.
- Appropriate design development to a functional design standard (i.e. confirmation of sizes using the MUSIC model, details of connection structures, outlet structures etc) of all drainage elements detailed in Appendix E.
- Functional design of the pipes and overland flow provisions in each sub catchment. That is definition of individual pipe sizes, alignments, slopes, fill/cover requirements and overland flow path provisions within road reserves.
- Development, via an appropriate digital terrain model of the:
 - Flood plain Sediment Pond and Wetland proposals,
 - Flood plain shaping and fill requirements (given flood protection and fill over pipe requirements). The digital terrain model may be required to be modified in an iterative process to ensure all drainage requirements are met going forward (including the requirements of the functional design requirements of the MWC Wetlands Design Manual).
- Using the developed digital terrain model to confirm (via an appropriate two dimensional hydrological (such as TuFlow) to confirm that:
 - The 1% AEP flood levels at the upstream end of all drainage paths entering the Site will not increase from existing levels,
 - The 1% AEP active flood volume in the flood plain is increased or maintained.
- Development of a staging plan (if required), including any temporary interim works.

SWS considers that future design development (as detailed above) will ensure that development of the Site can occur provided the general catchment delineations, pipe alignments, pipe design requirements, sediment pond and wetland configurations are as presented in Appendix E.

As noted in Appendix D, SWS has used the one dimensional HECRAS model to assist in developing the concept designs at this phase of this project. HECRAS has been used as it is a quick and easy design tool, where designs can be changed simply, and outputs examined without requiring lengthy rerun and post processing times etc.

ARR19 (Book 9, Chapter 6.3.2) recognises that an experienced modeler can use a 1D model to replicate (and understand) 2D implications. This is the way HECRAS has been used at this stage of the project. The analysis presented is considered has been formulated in a prudent and diligent manner and is considered sufficient at this stage to give MWC enough confidence that the proposed SWMS is sound.

It is anticipated that MWC will require the more expensive and complex 2D modelling as a condition on the approval of the future civil Functional Layout Plan (**FLP**) and Functional Design of the western drainage reserve and wetland/retarding basin.

It is requested that MWC and Cardinia Shire Council agree in principle to the SWMS detailed in this report, subject to conditions generally in line with the “further work” dot points presented above.

6 References

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Melbourne Water Letter to Cardinia Shire Council "Amendment: Cardinia Planning Scheme Amendment C235 – Rezoning of 145 Rossiter Road, Koo Wee Rup, Property: 145 Rossiter Road, Koo Wee Rup, Melbourne Water Reference: MWA-1139355" dated 19 July 2019

Melbourne Water Letter to SWS "Proposal: Pre-development advice - General Site Advice, Site location: Lot No 2, 135 Rossiter Road Koo Wee Rup 3981, Melbourne Water reference: MWA-1221167" 28 September 2021

Melbourne Water Letter to SWS "Proposal: Pre-development advice - General Site Advice (Updated from Response dated 28 September 2021 - Updated Flood Level Information), Site location: Lot No 2, Rossiter Road Koo Wee Rup 3981, Melbourne Water reference: MWA-1221167" 4 October 2021.

Melbourne Water email to SWS "MWA-1221167 - Lot No 2 135 Rossiter Road Koo Wee Rup 3981" 4 October 2021

Nearmap 2022. *Areal imagery for locations of vegetated areas etc.*

Victorian Tide Tables 2021.

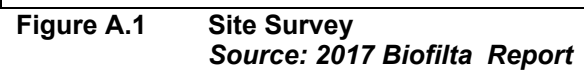
7 Abbreviations, Descriptions and Definitions

The following table lists some common abbreviations and drainage system descriptions and their definitions which are referred to in this report.

Abbreviation / Descriptions	Definition
AHD - Australian Height Datum	Common base for all survey levels in Australia. Height in metres above mean sea level.
ARI - Average Recurrence Interval.	The average length of time in years between two floods of a given size or larger. A 100 Year ARI event has a 1 in 100 chances of occurring in any one year.
AEP – Annual Exceedance Probability	The chance of a storm (flow) of that magnitude (or larger) occurring in a given year. $AEP = 1 - e^{\left(\frac{-1}{ARI}\right)}$. i.e. 18.13% AEP = 5 Year ARI
BPEMG	Best Practice Environmental Management Guidelines. See CSIRO (1999)
DSS or DS	Development Services Scheme (DSS) or Drainage Scheme (DS) is a master plan developed by MWC for drainage within a catchment area.
EY – Exceedances per year	The amount of times a storm (flow) of that magnitude is expected to be exceeded per year. i.e. 4 EY = 3 Month ARI
Hectare (ha)	10,000 square metres
HECRAS	A hydraulic software package that enables the calculations of flood levels and velocities along a waterway given a specified flow.
Kilometre (km)	1000 metres
m ³ /s -cubic metre/second	Unit of discharge usually referring to a design flood flow along a stormwater conveyance system
Megalitre (ML) (1000 cubic metres)	1,000,000 litres = 1000 cubic metres. Often a unit of water body (e.g. pond) size
MUSIC	Hydrologic computer program used to calculate stormwater pollutant generation in a catchment and the amount of treatment which can be attributed to the WSUD elements placed in that catchment
MWC / MW	Melbourne Water Corporation
Retarding basin	A flood storage dam which is normally empty. May contain a lake or wetland in its base
NWL - Normal Water Level	Water level of a wetland or pond defined by the lowest invert level of the outlet structure
NSL – Natural Surface Level	The surface level of the natural (existing) surface before works.
RORB	Hydrologic computer program used to calculate the design flood flow (in m ³ /s) along a stormwater conveyance system (e.g. waterway)
Sedimentation basin (Sediment pond)	A pond that is used to remove coarse sediments from inflowing water mainly by settlement processes.
Swale	A small shallow drainage line designed to convey stormwater discharge. A complementary function to the flood conveyance task is its WSUD role (where the vegetation in the base acts as a treatment swale).
TED	The top level of water stored for treatment within a wetland before bypass occurs
TSS	Total Suspended Solids – a term for a particular stormwater pollutant parameter
TP	Total Phosphorus – a term for a particular stormwater pollutant parameter
TN	Total Nitrogen – a term for a particular stormwater pollutant parameter
WSUD - Water Sensitive Urban Design	Term used to describe the design of drainage systems used to: ○ Convey stormwater safely ○ Retain stormwater pollutants ○ Enhance local ecology ○ Enhance the local landscape and social amenity of built areas
Wetland	WSUD element which is used to collect TSS, TP and TN. Usually incorporated at normal water level (NWL) below which the system is designed as shallow marsh, marsh, deep marsh and open water areas.

Appendix A – Site Survey

Appendix A Site Survey



Appendix B Hydrological Modelling

Hydrological modelling has been completed using the RORB model (v6.45) to obtain estimates of the current and future development flood flows exiting the Site into the South East Catch Drain.

B.1 Pre-development Conditions

The pre-development conditions model is generally reflective of the current catchment configuration as of August 2021.

B.1.1 Model Description

Catchment delineations have been based on the following sources:

- LiDAR information captured in November 2017; and
- A site visit performed by SWS on the 18th of August 2021.

Figure B.1 details the RORB model for the pre-development conditions towards the South East Catch Drain and Tables B.1 and B.2 detail the tabulation of the RORB model setup (i.e. catchment area, fraction imperviousness, reach lengths, etc).

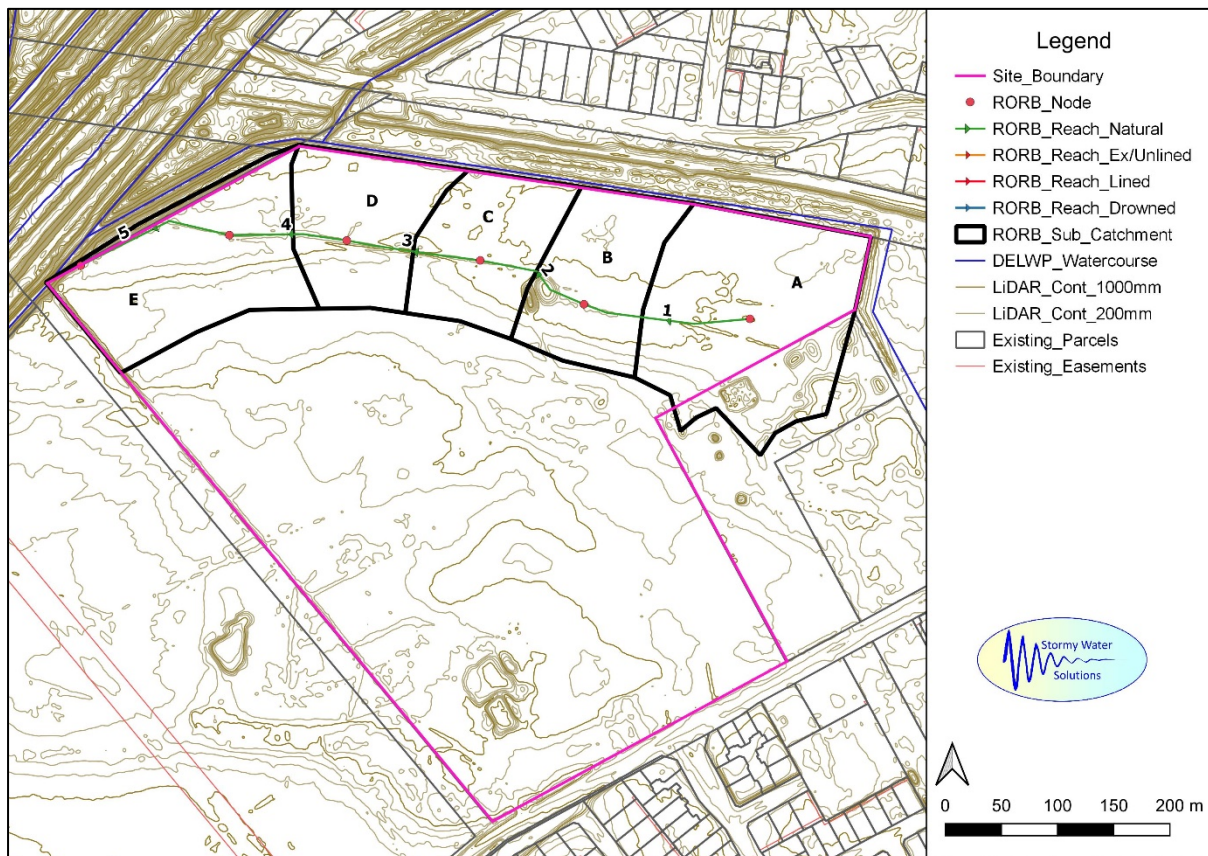


Figure B.1 Pre-development RORB model layout

Appendix B – Hydrological Modelling

Table B.1 Pre-development RORB Sub-Catchment Details

Sub Area	Area (ha)	Area (km ²)	Fraction Impervious
A	3.2	0.032	0.15
B	1.6	0.016	0.10
C	1.5	0.015	0.10
D	1.6	0.016	0.10
E	2.3	0.023	0.10
Total	10.2	0.102	0.12

Table B.2 Pre-development RORB Reach Details

Reach	Reach Type	Length (km)	Slope (%)
1	1	0.150	
2	1	0.104	
3	1	0.120	
4	1	0.105	
5	1	0.143	

B.1.2 Model Parameters, Inputs and Preliminary Validation

Australian Rainfall and Runoff (ARR) 2019 Data hub (Lat: 38.199 S, Lon: 145.482 E, accessed: 13th August 2021) was used to extract rainfall depths, rainfall temporal patterns (for 24 durations ranging from 10-minutes to 168-hours) and areal reduction factors which have been used in the modelling.

No pre-burst from the ARR 2019 datahub has been utilised in the modelling.

Further, the effective impervious area (**EIA**) and indirectly connected area (**ICA**) surface type splitting's recommended in ARR 2019 have not been used in the Loss Model. The EIA and ICA concepts introduce an additional complexity into the modelling, which given the many uncertainties with these estimates, may not produce better final design outcomes. Modelling without EIA and ICA will likely produce conservative results (i.e. higher flows and volumes) (Chapter 5.3.4.1.2, Book 5, ARR 2019).

The following parameter set has been adopted for this modelling exercise:

$$K_c = 0.43 \quad K_c/d_{av} = 1.11 \quad m = 0.8 \quad IL = 10 \text{ mm} \quad CL = 2.5 \text{ mm/hr}$$

The above parameters have been derived from the following sources:

K_c = Melbourne Water equation for the Port Phillip and Westernport regions ($K_c = 1.53A^{0.55}$).

m = standard 0.8.

IL = Melbourne Water dataset for the Port Phillip and Westernport regions.

CL = Melbourne Water Flood Mapping and Technical Specifications (2020).

Appendix B – Hydrological Modelling

A preliminary validation on the above parameters has been completed as shown in Table B.3 for the flows entering the South East Catch Drain from the Site.

Table B.3 RORB Model preliminary validation for 1% AEP Flow Events

Estimation Method:	RORB	Regression Curve ² .	Rational Method ³ .
1% AEP Flow Estimate (m ³ /s) ¹ .	1.10	0.80	0.95
20% AEP Flow Estimate (m ³ /s) ¹ .	0.40	N/A	0.30

Notes: ¹. All flow estimates rounded to the nearest 0.05 m³/s.

². Regression Curve = Rural Nikoloau/Vont Steen Equation ($Q = 4.67A^{0.763}$). This model does not account for variations in development and reach types within a catchment and should be utilised with caution.

³. Rational Method assumptions:

- No partial area effects simulated with the rational method.
- $C_{1\%AEP} = 0.30$, $C_{20\%AEP} = 0.20$
- $t_c =$ determined utilising a L/V method to give a 1% AEP t_c of 15 min.
 IFD 2016 IFD at (38.1875 S, 145.4875 E) which is consistent with RORB model.

Overall, Table B.3 is showing that the RORB model, with a continuing loss (CL) model is providing reasonable flow estimates from the catchment.

B.1.3 Model Results

The model has been simulated for a range of AEP storm events using the full ensembles of 240 temporal patterns as required in ARR 2019 with the results provided in Table B.4.

Table B.4 Pre-development flow estimates into the South East Catch Drain from the Site.

AEP	Pre-development Flow Estimate	
	Q (m ³ /s)	Duration
50%	0.25	1.5-hour
1%	1.10	45-min

Note: * Flows estimates reported are the peak average flow for the 10 temporal patterns analysed for the critical duration, rounded to the nearest 0.05 m³/s.

B.2 Post-Development Conditions

The post-development conditions model is generally reflective of the expected catchment configurations post development. This includes filling across the Site to grade additional catchment towards the South East Catch Drain, rather than to towards the southern boundary as currently occurs.

B.2.1 Model Description

KLM Spatial have provided preliminary development layouts and surface contours which have formed the basis of the post-development model.

Figure B.2 details the RORB model for the post-development conditions towards the South East Catch Drain and Tables B.5 and B.6 detail the tabulation of the RORB model setup.

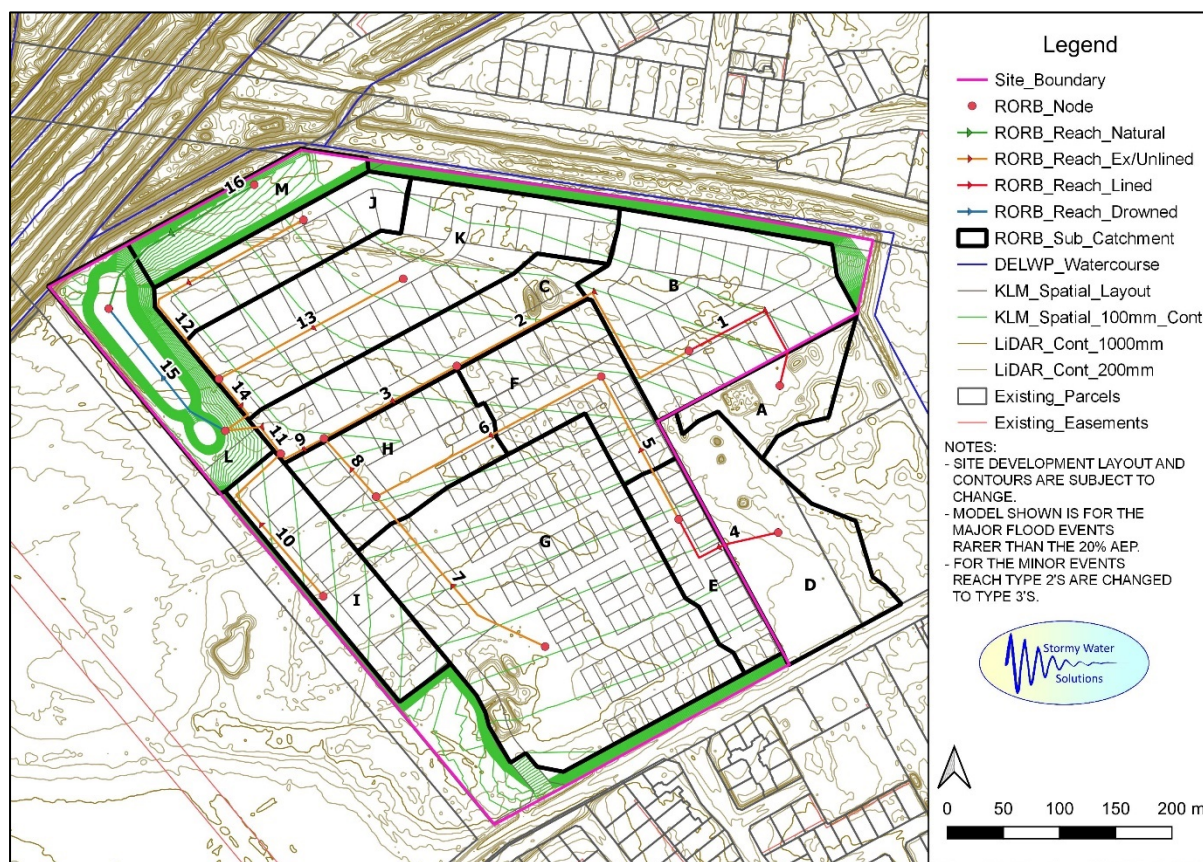


Figure B.2 Post-development RORB model layout

Appendix B – Hydrological Modelling

Table B.5 Post-development RORB Sub-Catchment Details

Sub Area	Area (ha)	Area (km ²)	Fraction Impervious
A	0.8	0.008	0.20
B	2.8	0.028	0.60
C	1.6	0.016	0.60
D	2.0	0.020	0.20
E	1.0	0.010	0.75
F	1.6	0.016	0.70
G	5.8	0.058	0.75
H	1.5	0.015	0.70
I	1.4	0.014	0.60
J	1.2	0.012	0.60
K	3.2	0.032	0.60
L	1.5	0.015	0.10
M	0.9	0.009	0.10
Total	25.4	0.254	0.56

Table B.6 Post-development RORB Reach Details

Reach	Reach Type (Major)	Reach Type (Minor)	Length (km)	Slope (%)
1	3	3	0.149	0.33%
2	2	3	0.274	0.33%
3	2	3	0.135	0.33%
4	3	3	0.113	0.33%
5	2	3	0.145	0.33%
6	2	3	0.227	0.33%
7	2	3	0.205	0.33%
8	2	3	0.070	0.33%
9	2	3	0.045	0.33%
10	2	3	0.173	0.33%
11	2	3	0.061	0.33%
12	2	3	0.237	0.33%
13	2	3	0.187	0.33%
14	2	3	0.066	0.33%
15	4	4	0.152	
16	1	1	0.176	

B.2.2 Model Parameters, Inputs and Preliminary Validation

Generally the same model inputs as utilised within the pre-development modelling have been adopted.

The model parameters utilised for the post-development modelling are as follows:

$$K_c = 0.72 \quad K_c/d_{av} = 1.44 \quad m = 0.8 \quad IL = 10 \text{ mm} \quad CL = 2.5 \text{ mm/hr}$$

The above parameters have been derived from the following sources:

K_c = Melbourne Water equation for the Port Phillip and Westernport regions ($K_c = 1.53A^{0.55}$).

m = standard 0.8.

IL = Melbourne Water dataset for the Port Phillip and Westernport regions.

CL = Melbourne Water Flood Mapping and Technical Specifications (2020).

A preliminary validation on the above parameters has been completed as shown in Table B.7 for the flows entering the South East Catch Drain from the Site without the effects of the proposed retarding basin.

Appendix B – Hydrological Modelling

Table B.7 RORB Model preliminary validation for 1% AEP Flow Events

Estimation Method:	RORB	Regression Curve ² .	Rational Method ³ .
1% AEP Flow Estimate (m ³ /s) ¹ .	4.75	3.90	4.70
20% AEP Flow Estimate (m ³ /s) ¹ .	2.95	N/A	2.10

Notes: ¹. All flow estimates rounded to the nearest 0.05 m³/s.

². Regression Curve = Urban Nikolau/Vont Steen Equation ($Q = 10.29A^{0.71}$). This model does not account for variations in development and reach types within a catchment and should be utilised with caution.

³. Rational Method assumptions:

- No partial area effects simulated with the rational method.
 - $C_{1\%AEP} = 0.60$, $C_{20\%AEP} = 0.50$
 - $t_c =$ determined utilising a L/V method to give a 1% AEP t_c of 15 min, noting the longer travel length from the pre-development model.
- IFD 2016 IFD at (38.1875 S, 145.4875 E) which is consistent with RORB model.

Overall, Table B.3 is showing that the RORB model, with a continuing loss (CL) model is providing reasonable flow estimates from the under the potential post-development catchment scenario.

B.2.3 Retarding Basin Model

The Victorian Tide Tables 2021 have that the Mean Higher High Water (MHHW) tide level at the Tooradin Pier (which is assumed to be relevant for the Bunyip River at Koo Wee Rup) of 1.10 m AHD currently. To account for the 800 mm of sea level rise by 2100 expected (Melbourne Water, 2017b), the outlets from the proposed retarding basin into the South East Catch Drain have been specified at an invert level of 1.90 m AHD into the South East Catch Drain (with a flood gate)

This allows for the retarding basin to be proposed within the void space above the wetland normal water level (NWL) of 2.20 m AHD. The NWL of 2.20 m AHD has been specified to ensure operational independence from tidal (and a level of low flow) influences within the South East Catch Drain now and under a potential year 2100 scenario.

The NWL of 2.20 m AHD allows for the retarding basin to be proposed almost entirely in cut below the existing natural surface levels which vary between 3.80 m AHD to 4.10 m AHD (approx.) across the retarding basin site.

At this concept stage, the expected outlet arrangement of the combined wetland retarding basin is proposed to be generally as per Melbourne Water standard drawing 7251/12/4003 with the following outlets:

Outlet 1: Wetland ED Control

A twin chamber outfall pit generally as per Melbourne Water standard drawing 7251/12/006 with the pit sill at 3.80 m AHD.

Outlet 2: Lower retarding basin outlet

Appendix B – Hydrological Modelling

A 1.2 x 1.2 m drop pit with a sill at 2.55 m AHD which connects into a 300 mmØ at an invert of 2.00 m AHD.

Outlet 3: Upper retarding basin outlet

A 1.2 x 1.5 m drop pit with a sill at 3.20 m AHD which connects into a 600 mmØ at an invert of 2.00 m AHD.

Outlet 4: A informal spillway above 3.80 m AHD towards both the South East Catch Drain and the land to the south.

Table B.8 details the proposed stage vs storage vs discharge (**SSD**) relationship for the retarding basin developed at this concept stage from the above outlet arrangement (noting that a higher exit loss has been applied on the outlet control equations to account for the flood gate influences).

The storage values above 2.20 m AHD within Table B.8 have been derived approximately utilising the layout shown in the drawing 2154/SWMS/2, including allowing a 10 m offset from the existing poles to any earthworks cut line.

Table B.8 Concept Level SSD for the proposed retarding basin

Stage (m AHD)	Storage (m ³)	Discharge (m ³ /s)
2.20	0	0.00
2.55	1179	0.005
2.60	1370	0.08
2.80	2185	0.12
3.00	3110	0.13
3.20	4155	0.15
3.40	5305	0.83
3.60	6560	0.94
3.80	7925	1.00
4.00	9345	1.95

B.2.4 Model Results – Flow Estimates

The model has been simulated for a range of AEP storm events using the full ensembles of 240 temporal patterns as required in ARR 2019. Table B.9 compares the pre and post-development flow estimates entering the South East Catch Drain and shows that the proposal is able to retard the 50% and 1% AEP flows to pre-development rates.

Appendix B – Hydrological Modelling

Table B.9 Flow estimates into the South East Catch Drain

AEP	Pre-development Flow Estimate		Post-development Flow Estimate	
	Q (m ³ /s)	Duration	Q (m ³ /s)	Duration
50%	0.25	1.5-hour	0.15	6-hour
1%	1.10	45-min	1.10	2-hour

*Note: * Flows estimates reported are the peak average flow for the 10 temporal patterns analysed for the critical duration, rounded to the nearest 0.05 m³/s.*

It is noted that in MWC's response to the C253card panel, they required retardation of the 90 minute storm. In retarding the 2 hour storm (the critical storm for the ARR19 temporal patterns and intensities) the retarding basin volume will also be able to retard the 90 minute storm, as longer duration storms contain more flood volume.

B.2.5 Model Results – Retarding Basin Function

Table B.10 details the predicted function of the retarding basin for a range of AEP's which can be utilised going forward in regard to wetland inlet and outlet and/or subdivisional pipe design.

Table B.10 Conceptual function of the retarding basin

AEP		63%	50%	20%	10%	1%
RB Inflow	Flow (m ³ /s)	1.50	1.75	2.95	2.50	4.75
	Duration	1-hour	1-hour	20-min	30-min	2-hour
RB Outflow	Flow (m ³ /s)	0.15	0.15	0.60	0.80	1.10
	Duration	4.5-hour	6-hour	2-hour	2-hour	2-hour
	Flood Storage Estimate (m ³)	3,600	4,200	4,900	5,250	8,100
	Flood Level Estimate (m AHD)	3.10	3.25	3.35	3.40	3.85

Note: All flow estimates are rounded to the nearest 0.05 m³/s and are taken as the peak average for the critical duration. Flood storage estimates are rounded up to the nearest 50 m³ and flood level estimates are rounded up to the nearest 50 mm.

B.2.6 Local Potential Year 2100 Climate Influences

It is expected that by the year 2100, under an RCP 8.5 climate scenario that the IFD's will increase by 18.4 %.

To check that the local retarding basin flood under this potential climate scenario is less than the regional 1% AEP flood level of 4.00 m AHD, the model has been simulated with the increase in IFD's.

Under this scenario, the 2100 1% AEP local flood level is expected to be 3.95 m AHD (100 mm rise) and as such is not the critical level when setting the minimum fill levels across the Site.

Appendix B – Hydrological Modelling

B.2.7 Blockage Analysis

At this concept design stage, no blockage analysis has been performed. However, given the surrounding fill levels are set to a minimum level of 4.60 m AHD (due to the regional flood influences), and that there is a downstream overflow spillway set at 3.8 m AHD, it is anticipated that the blockage effected flood levels will sit well within the 750 mm of freeboard provision. This assumption should be confirmed at the functional design stage of the project.

Appendix C WSUD Design and Modelling

C.1 Primary/Sediment Treatment Proposals

Two forms of primary/sediment treatment are proposed.

Firstly, a gross pollutant trap (**GPT**) is proposed on the primary inlet into the wetland system. At this stage a Rocla Cleans all 750 GPT has been modelled, but any equivalent GPT could be utilised moving forward.

The second type of primary/sediment treatment proposed is a formal sediment basin at the inlet to the wetland system. Tables C.1 and C.2 detail the sizing of the sediment basin proposed.

Table C.1 Sediment Basin Minimum Width, 1% AEP Velocity Check

Step	Description	Label	Value
1a	1% AEP Flow through Sediment Basin ¹ .	Q	4.75 m ³ /s
2 (i)	NWL	NWL	2.20 m
2 (ii)	10% AEP Level Estimation ¹ .	FL	3.40 m
3 (i)	Narrowest Width at NWL	W _{NWL}	15.0 m
3 (ii)	Narrowest Width at 10% AEP Level	W _{10%AEP}	29.4 m
4	Flow Area = $\frac{W_{10\%AEP} - W_{NWL}}{2} \times (FL - NWL) =$	A	26.64 m ²
5	Flow Velocity = $\frac{Q}{A} =$	V	0.18 m/s
Check	SP3 Requirement, V <		0.50 m/s
	Requirement Met?		YES

Notes: ¹. See RORB modelling of RB.

It is noted that Melbourne Water standard drawing 7251/12/001 specifies that the sediment basin should have a NWL 100 mm above the downstream wetland. In this instance, this is not appropriate. Much of the fill requirements for the site are not due to regional flooding, rather they are due to providing appropriate cover to the minor pipe system. If the NWL was raised 100 mm in the sediment basin to 2.30 m AHD this would result in approximately 15,000 to 20,000 m³ of additional fill being required for the development of the Site.

Appendix C – WSUD Design and Modelling

Table C.2 Sediment Basin Sizing Calculations

Asset Properties	
Normal Water Level = NWL =	2.20 m AHD
NWL Area = (A_{asset}) =	600 m ²
Pond Depth = (d_p) =	1.20 m
Extended Detention Depth = (d_e) =	0.30 m
Volume = (Vol_{TOT}) =	404 m ³
Sump Volume ¹ = ($Vols$) =	236 m ³
4EY Inflow ² = (Q_{4EY}) =	0.60 m ³ /s
Assumed Hydraulic efficiency ³ = λ =	0.26
Upstream Catchment Area = (A_{Catch}) =	27.3 ha
Target Particle Settling Velocity ⁴ = (V_s) =	0.011 m/s
Removal Efficiency	
$d^* = \max(d_p, 1) =$	1.2
$\frac{d_e + d_p}{d_e + d^*} =$	1.6
$\frac{V_s \times A_{asset}}{Q_{4EY}} =$	11.0
$n = \frac{1}{1 - \lambda} =$	1.35
$Removal\ efficiency^5 = R = 1 - \left[1 + \frac{1}{n} \times \frac{V_s \times A_{asset}}{Q_{4EY}} \times \frac{d_e + d_p}{d_e + d^*} \right]^{-n} =$	95.0%
Cleanout Frequency	
Sediment Load ⁶ = (L_s) =	1.60 m ³ /ha/year
$Cleanout\ Frequency = \frac{R \times (L_s + L_{GP}) \times A_{Catch}}{Vol_s} =$	5.7 years
Dewatering Area Required ((assuming 500 mm deep layout & 5-year cleanout frequency) =	415 m ²

Notes: ¹ Sump volume taken as the volume below 350mm deep (i.e. below the safety bench).

² 4 EY inflow taken as 40% of the RBQ 63% AEP inflow from RORB modelling.

³ Hydraulic efficiency estimated from Figure 4.3 of Melbourne Water 2005.

⁴ Target particle size taken as 125 μ m (as per criteria SP3 of Melbourne Water 2018c) with a settling velocity sourced from Table 4.1 of Melbourne Water 2005.

⁵ Methodology taken from Chapter 4.3.2 of Melbourne Water 2005.

⁶ Load estimate sourced from Willing and Partners 1992.

C.2 Stormwater Re-use Proposals

2 kL rainwater tanks have been assumed on all lots within the development. At this concept stage, there are assumed to be 350 lots (including the retirement village).

As per the national stormwater harvesting and reuse guidelines (Natural Resource Management Ministerial Council et al. 2009), stormwater harvested from roofs can be used within the house for toilet flushing and laundry use without routine monitoring (p15). As such, these uses are proposed within this strategy. The estimated demands for each use have been calculated below:

Appendix C – WSUD Design and Modelling

Toilet Flushing Demand:

Assumed People per dwelling =	2.7 people/dwelling (Census 2016)
Assumed daily usage =	4 flush/person/day (DoISER 2020)
Litres used per flush =	3.5 L/flush (DoISER 2020)
Thus, total toilet demand =	13.8 kL/year/dwelling

Laundry Demand:

Assumed People per dwelling =	2.7 people/dwelling (Census 2016)
Assumed annual usage =	11.9 kL/person/year (Melbourne Water 2005)
Thus, total laundry demand =	32.1 kL/year/dwelling

The above demands have been modelled in MUSIC as a constant year-round demand.

C.3 Tertiary Treatment Proposals

At this concept design stage, the wetland has been designed with properties as per Table C.3, which is reflective of the proposals shown in the drawing 2154/SWMS/2.

Table C.3 Wetland Design Properties

Asset Property	Value	Unit
Normal Water Level (NWL)	2.20	m AHD
Extended Detention Depth (ED)	350	mm
Top of Extended Detention (TED)	2.55	m AHD
Wetland Area at NWL	2,375	m ²
Permanent Pool Volume below NWL	715	m ³
Approximate Detention Time ¹ .	62	hrs
Infiltration Rate ² .	0	mm/hr

Notes: ¹. approx. 60-hours is required to meet Wetland Design Manual criteria for plant health at later design stages, the MUSIC modelling is simulated with the custom outflow relationship.

². conservatively assumed to be 0 mm/hr. However, if it is found that the in-situ soil is suitable for infiltration this is encouraged and will improve the treatment performance.

It is noted that the wetland has been split into two cells. The two cells are the result of providing earthworks offset from the existing power poles within the Site. The two cells are connected by 3 x 450 mm (high) x 900 mm (wide) box culverts. These culverts have been sized to act under minimal (200 mm) head loss in the 63% AEP event (which is assumed to result in the two wetland cells acting as one cell during treatment events).

Though not required at the concept design stage, the wetland 4 EY velocity has also been checked and found to be 0.06 m/s for the 25 m wide wetland width. This is deemed acceptable in this instance, as future 2D hydraulic modelling (which will consider the form of the wetland under its NWL) should ensure the requirement of 0.05 m/s is met.

Appendix C – WSUD Design and Modelling

C.4 Continuous Simulation Modelling

The Model for Urban Stormwater Improvement Conceptualisation (**MUSIC**), Version 6.3.0, has been used to assess the stormwater pollutant retention benefits of the proposed stormwater treatment systems.

C.4.1 Model Development

Figure C.1 details the model developed and Tables C.4 summarise the source nodes simulated.

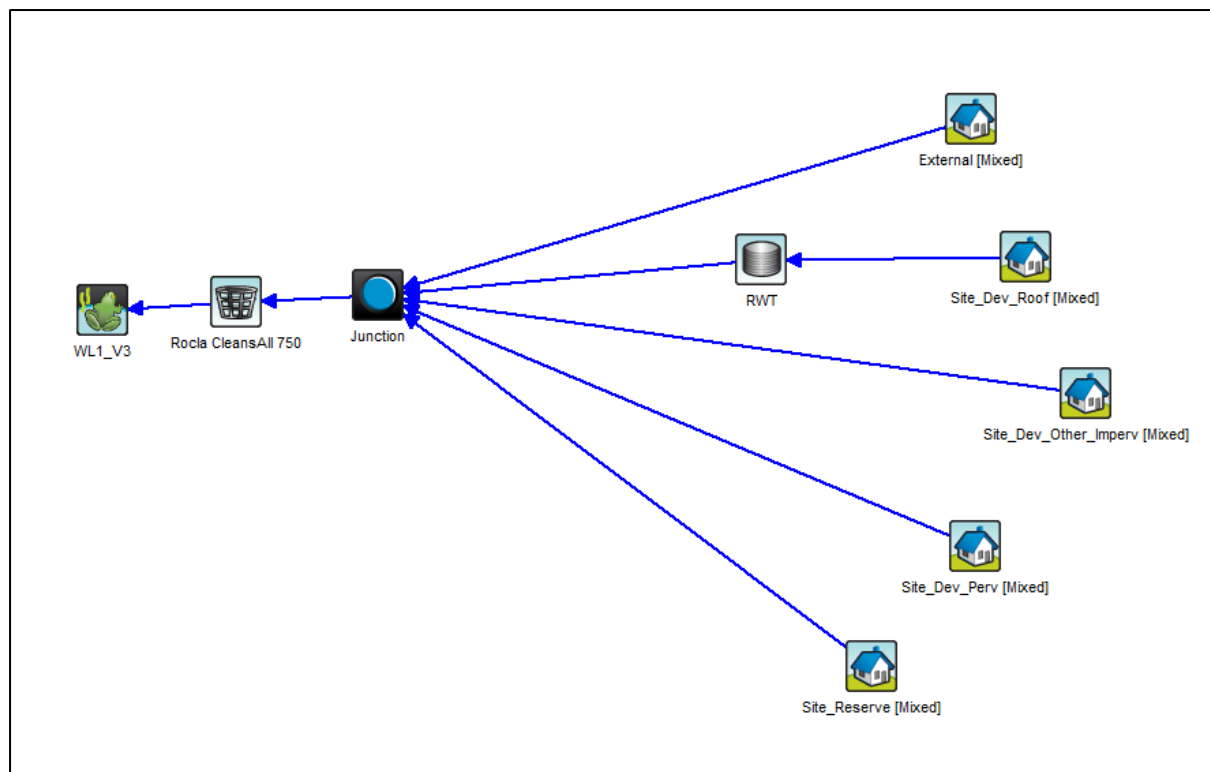


Figure C.1 MUSIC Model Schematic

Table C.4 MUSIC Source Nodes

Node ID	RORB Catch	Area (ha)	F _{imp}
External	A, D	2.8	0.20
Site_Dev_Roof	B, C, E - K (Parts)	8.8	1.00
Site_Dev_Other_Imperv	B, C, E - K (Parts)	4.8	1.00
Site_Dev_Perv	B, C, E - K (Parts)	6.7	0.00
Site_Reserve	L, M	2.5	0.10
Total:		25.5	0.56

Treatment nodes simulated are as per the above appendices, noting that the sediment basin has been simulated as the 'inlet pond' within the wetland treatment node.

Koo Wee Rup climate data as per the MUSIC Tool Guidelines has been adopted.

No hydrologic routing has been simulated.

Appendix C – WSUD Design and Modelling

C.4.2 Model Results – Stormwater Treatment

Table C.5 details the equivalent treatment train effectiveness of the system for the Site (as there are external Hospital catchment serviced within the treatment system).

Table C.5 Equivalent Treatment train effectiveness for the Site

Pollutant:		Total Suspended Solids	Total Phosphorus	Total Nitrogen	Gross Pollutants
Site Pollutants Generated (kg/yr)		18,034	39	283	3,453
Pollutants Removed By:	RWT (kg/yr)	6,224	11	50	2,188
	GPT (kg/yr)	8,127	7	0	1,374
	Wetland (kg/yr)	2,360	10	83	76
Total Pollutants Removed (kg/yr)		16,712	28	133	3,638
Equivalent Treatment Train Effectiveness (%)		93%	73%	47%	105%

C.4.3 Model Results – Mean Annual Runoff Volumes

The EPA 'urban stormwater management guidance' specifies that new developments in Koo Wee Rup (rainfall band 700-800 mm/yr) should aim to reduce the mean annual runoff volume (**MARV**) generated from post-development impervious areas by:

- 26% using harvesting (i.e. re-use) and evapotranspiration; and
- 11% using infiltration.

Table C.5 shows that the proposed system performs well against the harvesting and evapotranspiration target.

Table C.5 MARV Calculations

Total MARV generated from impervious areas (ML/yr)		85.2
MARV removed by:	RWT reuse (ML/yr)	14.9
	Wetland Evapotranspiration (ML/yr)	2.7
Percentage of impervious MARV reduced by re-use and evap (%)		20.6%

No infiltration has been assumed from the wetland at this stage as the Melbourne water wetland design manual specifies clay liners within the base of the wetland.

It is noted that the 'urban stormwater management guidance' is clear that it does not impose compliance obligations. Rather, the 'urban stormwater management guidance' provides quantitative performance objectives for urban stormwater which set an objective that should be aimed to be met as far as 'reasonably practicable'. It is deemed that the levels and type of treatments proposed are what is reasonably practicable for the Site in this instance.

Appendix D – Hydraulic Modelling

Appendix D Hydraulic Modelling

SWS has used the one dimensional HECRAS Model (v5.0.7) to assist in developing the concept designs at this phase of this project. HECRAS has been used as it is a quick and easy design tool, where designs can be changed simply, and outputs examined without requiring lengthy rerun and post processing times etc.

ARR19 (Book 9, Chapter 6.3.2) recognises that an experienced modeller can use a 1D model to replicate (and understand) 2D implications. This is the way HECRAS has been used below. This has been undertaken at this stage of the project to give MWC enough confidence that the proposed SWMS is sound.

It is anticipated that MWC will require the more expensive and complex 2D modelling as a condition on the approval of the future civil Functional Layout Plan (**FLP**) and Functional Design of the western drainage reserve and wetland/retarding basin.

The HECRAS hydraulic modelling methodology was as detailed below.

D.1 Existing 1% AEP Flood Modelling

As detailed in Section 4.2, MWC have advised that the 1% AEP flood level grades from 4.0 m AHD at the southern boundary (3.9 m AHD without the 2100 tidal surge) to 4.6 m AHD at the northern boundary. Existing HECRAS models were developed to replicate (as far as possible) these 1% AEP flood levels.

To help SWS understand the nature of how flood water moves through (and around) the site a 1% AEP flood map in the area of interest (south of Koo Wee Rup) was requested from MWC. The indicative flood map detailed in Figure D.1 was provided to SWS in September 2021.

As detailed, the flood map provided is very confusing and appears to be a combination of many flood mapping projects (and possibly other GIS layers) overlaid on the LSIO (which covers the whole of the property and most of the Koo Wee Rup flood protection district). No legend was provided. When SWS requested clarification of flood depths etc over the property the MWC advised that *“The current 1% AEP flood extent covers whole property, so this flood extent shape does not help you to determine floodwater movement. So we use surface contour/LIDAR information for flow movement purposes”* (MWC email to SWS 6/10/2021).

Verbally SWS was also informed that TUFLOW output files could not be provided to SWS as these were confidential and related to the design of the downstream Koo Wee Rup Bypass.

Given the above, SWS has used first principals, local knowledge and the HECRAS analysis below to assess the flood impact on site.

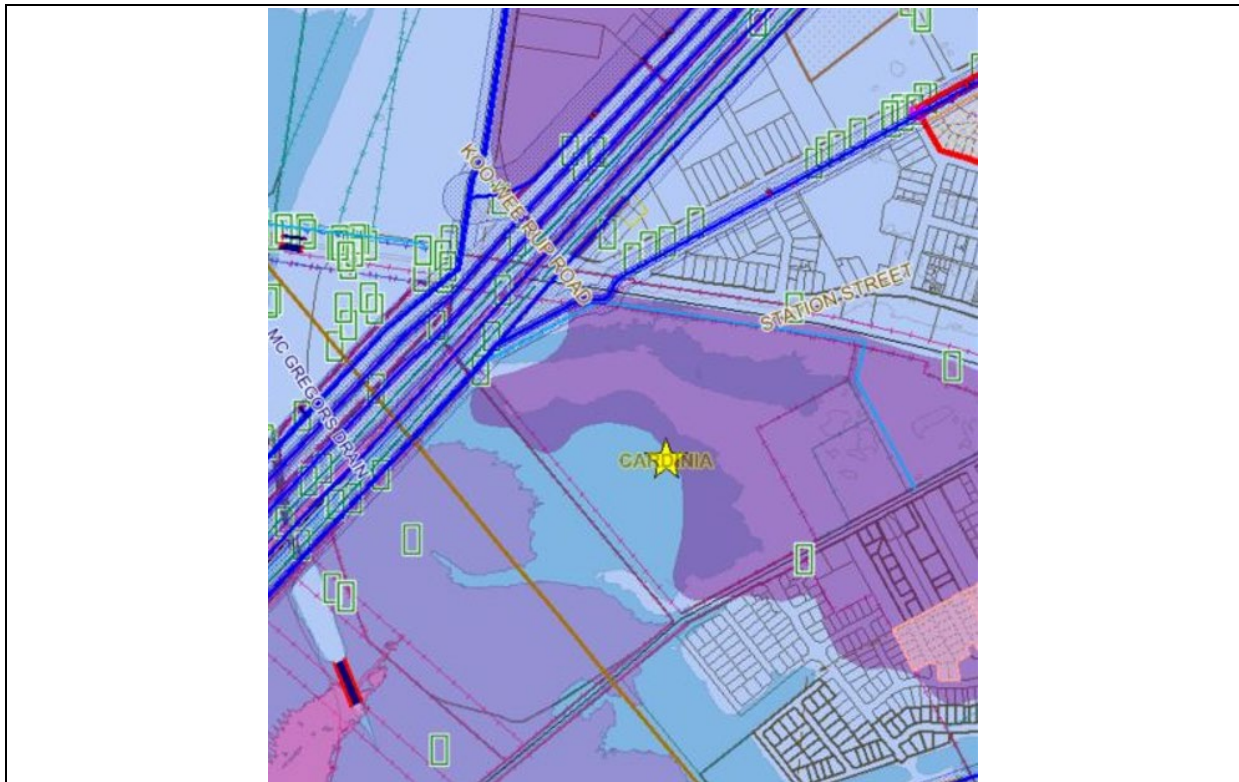


Figure D.1 Indicative Flood Map provided to SWS by MWC in September 2021

The existing conditions HECRAS model developed is detailed in Figure D.2 below.

Cross sections were obtained via extraction of detailed surface levels from the LiDAR information available. The starting water elevation at Chainage 0 is taken at normal depth at a longitudinal slope of 1/1000.

Mannings Roughness coefficients were :

- 0.09 for the southern boundary drain and the Eastern Catch Drain (and treed riparian zone), and
- 0.05 – 0.07 for flat grassed flood plains (the higher Manning n was used where the flood depth was relatively shallow).

It should be noted that the total flow of 40 m³/s (MWC advice) affecting the site from the north west is a combination of:

- Flow in the Bunyip South East Catch Drain (in the order of 25% of the catchment upstream of the railway), and
- Flow in the Southern Boundary Drain (in the order of 75% of the catchment upstream of the railway).

Given a major levee separates these two drains from the railway until just upstream of CH500, the South East Catch Drain has been excluded from the analysis (upstream of CH 500) and the design flows in the Southern Boundary Drain and it's flood plain have been specified as 30 m³/s upstream of CH500 and 40 m³/s downstream of CH500.

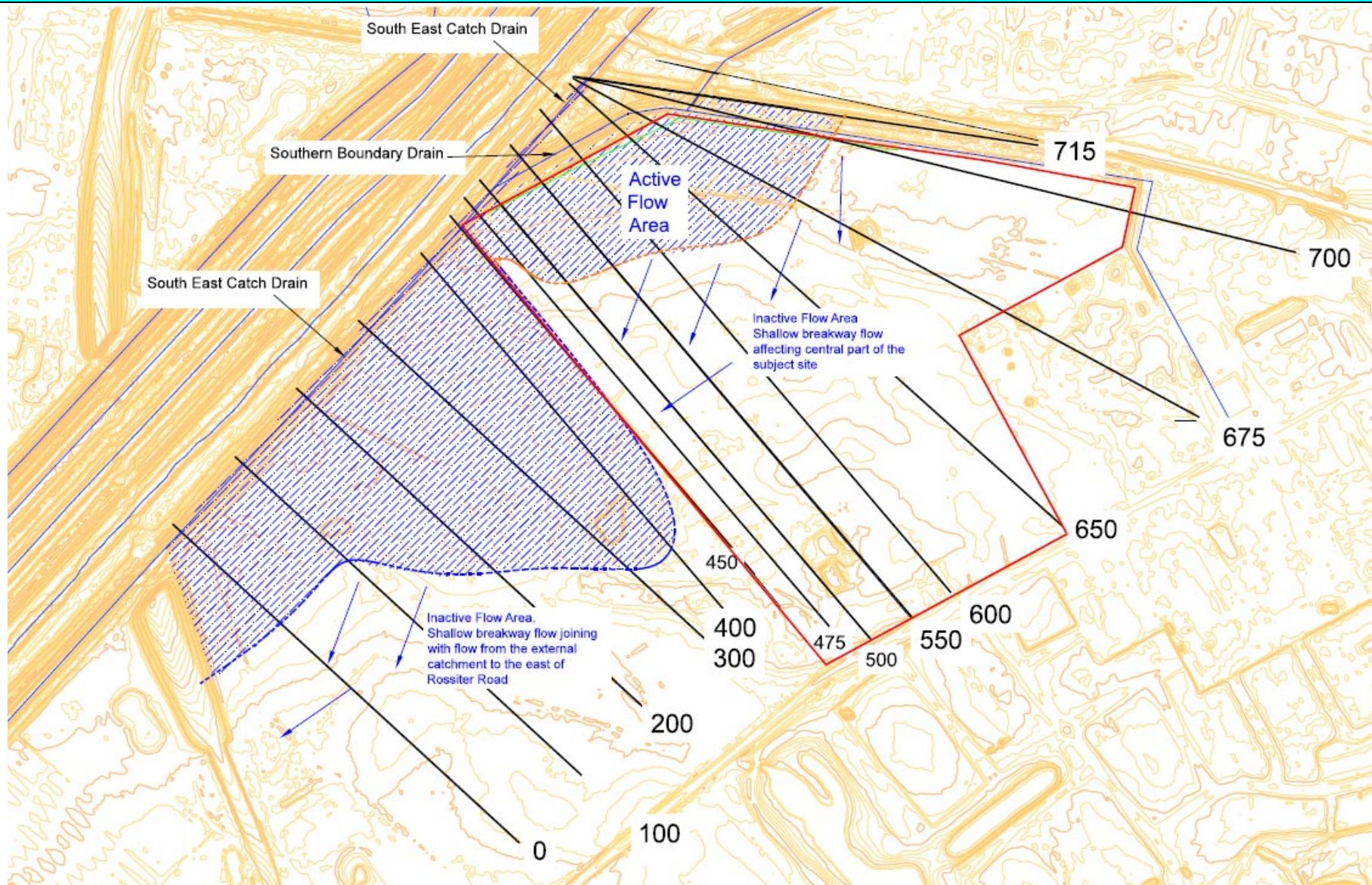


Figure D.2

Existing 1% AEP HECRAS Cross Section Locations (RossiterEx_Feb22.prj)

Appendix D – Hydraulic Modelling

The model above was used to replicate the defined MWC flood levels over the site.

The first iteration considered uniform flood levels over all cross sections. This analysis showed that:

- A 1% AEP flood level of 3.9 m AHD could be replicated at the southern boundary of the site, but
- Utilising a design flow of 30-40 m³/s over the whole of the flood plain in the property, the upstream flood level was calculated at 4.25 m AHD.

To achieve 4.6 m AHD at the northern boundary (assuming active flood storage across the entire Site), a design flow of 100 m³/s was required. Clearly this cannot occur, as the design flow rate is only 40 m³/s.

On examination of the HECRAS analysis, site observations, and the detailed LiDAR information, SWS has determined that two hydraulic effects are dominating to achieve the MWC defined flood level of 4.6 m AHD at the northern boundary of the property being:

- Flow being concentrated to within 150 – 250 metres of the Southern boundary drain in the vicinity of Chainages 650 – 715 due to concentration of flow as it exists the railway bridge, and
- “Active flow” being concentrated to the western side of the small ridge line which runs through the property to the east of the Southern Boundary Drain. This ridge line concentrates the “active flow” to within 125 – 150 from the Southern Boundary Drain in the vicinity of Chainages 450 – 600. In fact, the ridge line is producing a “pinch point” at about Chainage 475 which raises the flood level from 3.9 m AHD (just downstream of the southern boundary of the site) to 4.4 m AHD in the vicinity of CH 500.

Flood flow does affect the site east of the small ridge line. However, this is breakaway flow from the “active flow” area immediately east of the Southern Boundary Drain. Future 2D modelling is expected to show very shallow, inactive flood affects in the majority of the site located to the east of the active flow areas defined above.

Given the above, “ineffective flow areas” were defined in HECRAS, generally defining the small ridge line (“orange line” in Figure D.2). With this definition, the existing HECRAS results are as detailed in Table D.1 below.

Appendix D – Hydraulic Modelling

Table D.1 Existing HECRAS Results

River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude # Chl
715	PF 1	30.00	2.22	4.60		4.60	0.000616	0.29	126.32	370.05	0.09
700	PF 1	30.00	2.07	4.59		4.60	0.000079	0.10	190.35	647.07	0.03
675	PF 1	30.00	2.08	4.59		4.59	0.000240	0.20	139.00	504.69	0.06
650	PF 1	30.00	2.01	4.58		4.58	0.000326	0.24	123.71	605.45	0.07
600	PF 1	30.00	1.97	4.56		4.56	0.000468	0.30	101.43	604.15	0.08
550	PF 1	30.00	2.21	4.52		4.53	0.000947	0.43	75.01	621.57	0.11
500	PF 1	40.00	1.48	4.45		4.46	0.001714	0.65	76.52	642.65	0.16
475	PF 1	40.00	1.52	4.37		4.40	0.003553	0.81	60.60	603.10	0.22
450	PF 1	40.00	1.48	4.10	3.15	4.23	0.014298	1.63	24.51	496.01	0.43
400	PF 1	40.00	1.62	3.90		3.92	0.002955	0.67	113.43	451.67	0.19
300	PF 1	40.00	1.54	3.82		3.83	0.000493	0.44	167.51	452.68	0.14
200	PF 1	40.00	1.30	3.80		3.80	0.000190	0.18	231.67	511.19	0.05
100	PF 1	40.00	1.29	3.76		3.76	0.000863	0.43	118.65	509.25	0.11
0	PF 1	40.00	1.37	3.66	3.22	3.67	0.001001	0.37	114.15	508.71	0.11

As detailed in Table D.1, the existing HECRAS analysis is duplicating the MWC defined flood levels of 3.9 m AHD just downstream of the southern site boundary and 4.6 m AHD at the northern site boundary.

Figure D.3 below details the longitudinal flood profile, and clearly shows the “jump” in the 1% AEP flood level upstream of the “pinch point” in the vicinity of CH 475.

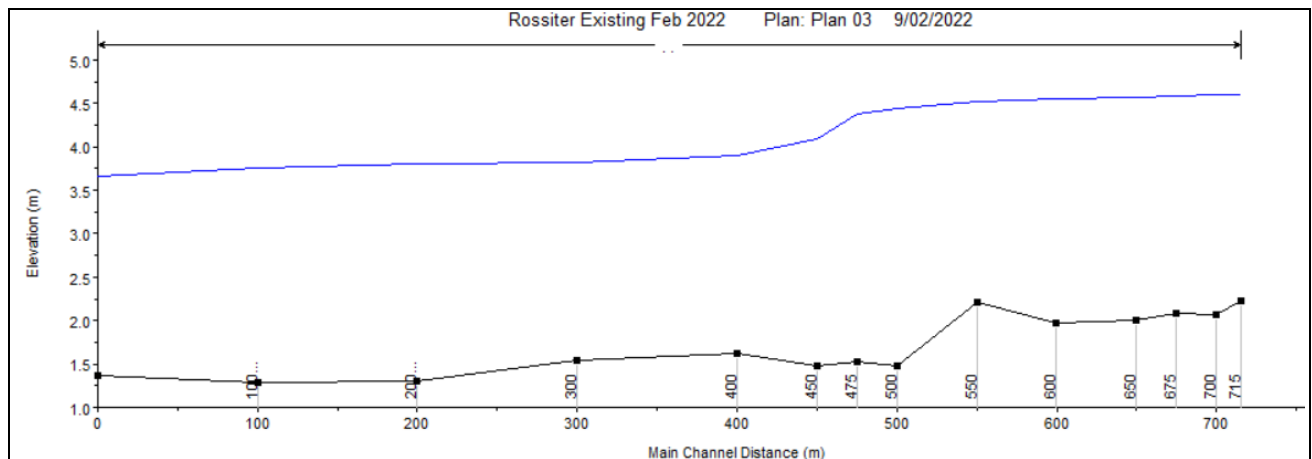


Figure D.3 Existing 1% AEP HECRAS Flood Longitudinal Profile

The HECRAS output has been extracted to an excel spreadsheet to determine the 1% AEP flood volume associated with the active flow area. As detailed in Table D.2 below, the 1% AEP active flood volume over the Site is estimated at in the order of 26,000 m³.

Appendix D – Hydraulic Modelling

Table D.2 Existing 1% AEP Active/Effective Flood Volume Affecting the Site

Flood Level - 3.9 - 4.6 m AHD (as extracted from Hec Ras)				
Chainage (m)	Effective Flow Area (m ²)	Average Flow Area (m ²)	delta CH (m)	Effective Volume (m ³)
450	25			
475	59	42	25	1049
500	66	63	25	1568
550	75	71	50	3526
600	102	88	50	4418
650	124	113	50	5645
675	139	132	25	3293
700	189	164	25	4108
715	127	158	15	2370
Total Effective Food area =				25978 m ²

D.2 Future 1% AEP Flood Modelling

Future scenario HECRAS models were developed by modifying cross sections above to:

- Incorporate “obstructions” at reserve boundaries (as detailed in the Appendix E),
- Add some additional cross sections to ensure replication all proposed wetland/retarding basin and the “cut” within the western reserve (as advocated in this SWMS) via incorporating design contours as per Appendix E, and
- Replicate the proposed sediment pond and wetland in the proposed reserves (active flood storage was taken as the volume above NWL (as previously required by MWC (Melbourne Water Letter to Cardinia Shire Council “Amendment: Cardinia Planning Scheme Amendment C235 – Rezoning of 145 Rossiter Road, Koo Wee Rup, 19 July 2019)).

The model developed is detailed in Figure D.4 below.

Starting water elevations at Chainage 0, Mannings n values and design flows are as per the existing HECRAS Model, except for incorporating a Mannings Roughness coefficients of 0.05 for the wetland and sediment pond areas and where “cut” is proposed in the western reserve.

Appendix D – Hydraulic Modelling

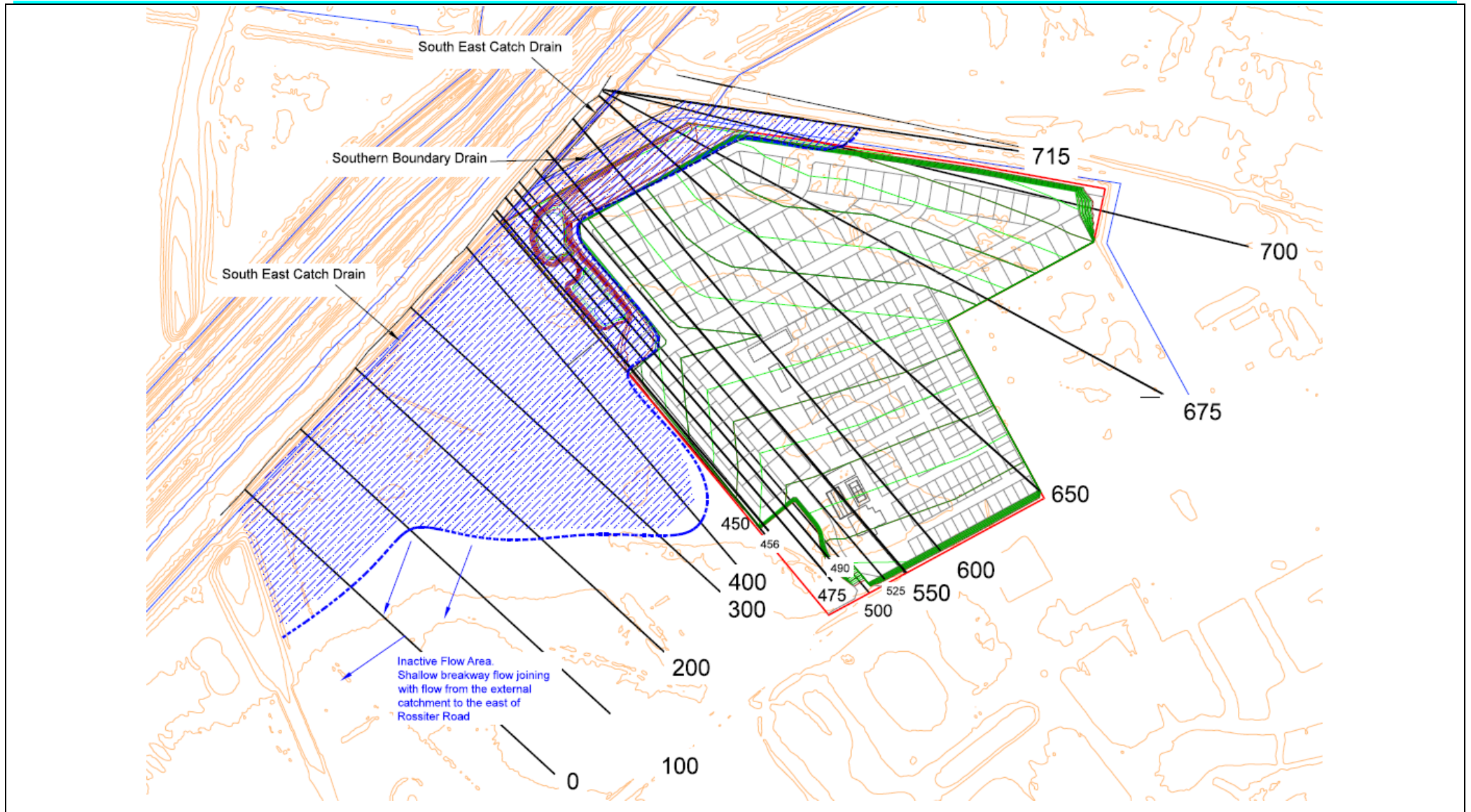


Figure D.3 Future 1% AEP HECRAS Cross Sections

Appendix D – Hydraulic Modelling

D.3.1 1% AEP Future Flood Levels

Table D.3 details the 1% AEP future (with Development) HECRAS results and Figure D.4 details the future 1% AEP flood longitudinal profile.

Table D.3 1% AEP Future HECRAS Results

River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude # Chl
715	PF 1	30.00	2.22	4.46		4.46	0.001173	0.36	103.09	324.54	0.12
700	PF 1	30.00	2.07	4.45		4.45	0.000129	0.12	164.27	632.07	0.04
675	PF 1	30.00	2.08	4.43		4.44	0.001509	0.47	58.00	73.75	0.14
650	PF 1	30.00	2.01	4.37		4.38	0.001735	0.52	49.94	59.53	0.15
600	PF 1	30.00	1.97	4.29		4.31	0.001265	0.45	55.15	60.37	0.13
550	PF 1	30.00	2.21	4.23		4.25	0.001230	0.42	52.63	57.57	0.12
525	PF 1	40.00	2.21	4.18		4.21	0.002039	0.56	55.12	62.59	0.16
500	PF 1	40.00	1.48	4.18		4.19	0.000236	0.22	164.93	212.45	0.06
490	PF 1	40.00	1.48	4.18		4.18	0.000023	0.07	354.04	262.22	0.02
475	PF 1	40.00	1.52	4.18		4.18	0.000041	0.08	291.05	245.49	0.02
456	PF 1	40.00	1.48	4.17	3.15	4.18	0.001824	0.59	94.65	208.21	0.15
450	PF 1	40.00	1.48	4.10	3.15	4.16	0.007764	1.20	44.74	496.18	0.32
400	PF 1	40.00	1.62	3.90		3.92	0.002955	0.67	113.43	451.67	0.19
300	PF 1	40.00	1.54	3.82		3.83	0.000493	0.44	167.51	452.68	0.14
200	PF 1	40.00	1.30	3.80		3.80	0.000190	0.18	231.67	511.19	0.05
100	PF 1	40.00	1.29	3.76		3.76	0.000863	0.43	118.65	509.25	0.11
0	PF 1	40.00	1.37	3.66	3.22	3.67	0.001001	0.37	114.15	508.71	0.11

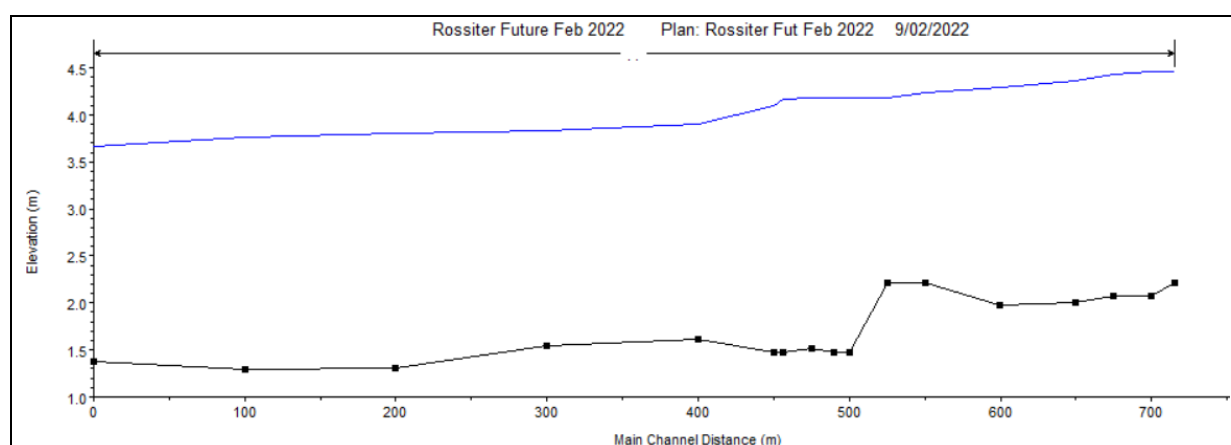


Figure D.5 Future 1% AEP Flood Longitudinal Profile

As detailed, construction of the wetland/retarding basin in the south western corner of the site and providing “cut” within the western drainage reserve removes the “Pinch Point” in the south western flood plain (described in D.1 above) which,

- Allows better distribution of upstream flood flows into the flood plain to the south (as shallow engagement of the flood plain), and
- Reduces 1% AEP flood levels adjacent to (and in) the Southern Boundary Drain along the western boundary of the site.

Importantly, the 1% AEP flood level at the northern boundary of the site decreases from 4.6 m AHD to 4.46 m AHD.

Appendix D – Hydraulic Modelling

D.3.2 Flood Volume Analysis

The flow areas detailed in Table D.3 have been extracted to an excel spreadsheet to determine the 1% AEP flood volume once development of the site occurs. As detailed in Table D.4 below, the 1% AEP flood volume provided within the site in the developed situation is in the order of 27,000 m³.

Table D.4 Existing 1% AEP Flood Volume Affecting the Site

Flood Level - 3.9 - 4.5 m AHD (as extracted from Hec Ras)				
Chainage (m)	Flow Area (m ²)	Average Flow Area (m ²)	delta CH (m)	Flood Volume (m ³)
450	25			
456	95	60	6	359
475	291	193	19	3664
490	354	323	15	4838
500	165	259	10	2595
525	55	110	25	2751
550	53	54	25	1347
600	55	54	50	2695
650	50	53	50	2627
675	58	54	25	1349
700	164	111	25	2775
715	103	134	15	2003
Total Effective Flood Volume =				27002 m³

The above analysis shows that the provision of the wetland/retarding basin and cut within the western reserve will ensure that the 1% AEP flood volume provided within the site is greater than the existing active flood storage on site.

D.3.3 Wetland Velocity Issues

The current MWC wetland design manual required the design flows over the constructed wetlands to be:

- 0.5 m/s in the 1% AEP event, and
- 0.05 m/s in the 4EY event.

These velocities are assumed to be required to be met both for:

1. Flow generated in the local catchments (i.e. subdivision flow through the wetlands), and
2. Flow generated when the wider flood plain is in flood (i.e. larger flows from the regional drain system inundating the wetlands in the flood plain).

At this stage it is assumed that the functional design stage of the project will confirm that the 4EY and 1% AEP velocity requirements can be met (see Appendix C.3) for flows generated within the local

Appendix D – Hydraulic Modelling

catchment (these checks are not specifically required at this stage of the project, but high level calculations indicate they can be met going forward).

With regard to flow regimes under the second point above, examination of the 1% AEP HECRAS output for the overbank areas incorporating wetlands indicates that the 1% AEP flow velocity over the wetlands generally vary between 0.12 – 0.25 m/s. This is much less than the 0.5 m/s required under the current MWC wetlands manual.

At this stage, as the 1% AEP flow velocities are so slow, it is also assumed that the 4EY overbank flow velocities will meet the 0.05 m/s requirement as above. This is required to be confirmed as the design development of the project proceeds.

Appendix E – Drainage Strategy Concept Drawings

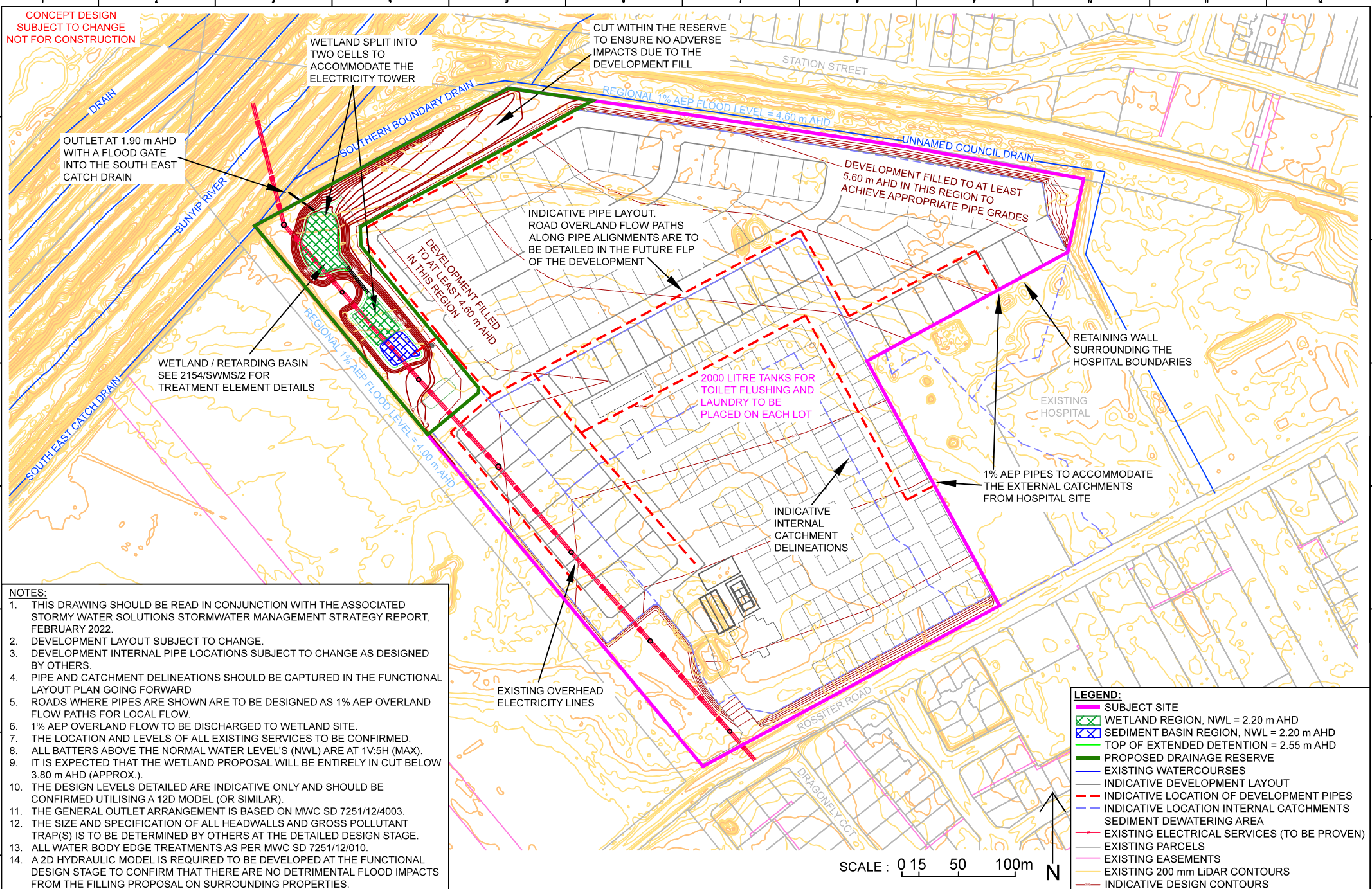
Appendix E Drainage Strategy Concept Drawings

The drawings below replicate SWS Drawings 2154/SWMS/1 and 2.

The drawings are to concept design standard at this stage of the project.

The following design methodologies are required to be adhered to going forward into the design process:

- General catchment delineations as per 2154/SWMS/1,
- General pipe alignments as per 2154/SWMS/1,
- Pipe design requirements (see Section 3.6) to minimise slope and obvert levels to ensure that fill within the Site is minimised as per drawing 2154/SWMS/1,
- Provision of 1% AEP overland flow provisions in all subdivision roads containing defined pipelines as defined in 2154/SWMS/1,
- All sediment pond and wetland design proposals detailed in 2154/SWMS/2 should be maintained going forward (e.g. design NWL's, TED, upstream and downstream inlet and outlet points, element areas etc),
- The Stage/Storage/Discharge retarding basin relationship detailed in 2154/SWMS/2 should be maintained going forward, and
- Filling of the flood plain as shown in Drawing 2154/SWMS/1. These fill levels are at least 600 mm above the defined 1% AEP flood level and provide adequate cover to all defined subdivisional pipelines.



- NOTES:
- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE ASSOCIATED STORMY WATER SOLUTIONS STORMWATER MANAGEMENT STRATEGY REPORT, FEBRUARY 2022.
 - DEVELOPMENT LAYOUT SUBJECT TO CHANGE.
 - DEVELOPMENT INTERNAL PIPE LOCATIONS SUBJECT TO CHANGE AS DESIGNED BY OTHERS.
 - PIPE AND CATCHMENT DELINEATIONS SHOULD BE CAPTURED IN THE FUNCTIONAL LAYOUT PLAN GOING FORWARD
 - ROADS WHERE PIPES ARE SHOWN ARE TO BE DESIGNED AS 1% AEP OVERLAND FLOW PATHS FOR LOCAL FLOW.
 - 1% AEP OVERLAND FLOW TO BE DISCHARGED TO WETLAND SITE.
 - THE LOCATION AND LEVELS OF ALL EXISTING SERVICES TO BE CONFIRMED.
 - ALL BATTERS ABOVE THE NORMAL WATER LEVEL'S (NWL) ARE AT 1V:5H (MAX).
 - IT IS EXPECTED THAT THE WETLAND PROPOSAL WILL BE ENTIRELY IN CUT BELOW 3.80 m AHD (APPROX.).
 - THE DESIGN LEVELS DETAILED ARE INDICATIVE ONLY AND SHOULD BE CONFIRMED UTILISING A 12D MODEL (OR SIMILAR).
 - THE GENERAL OUTLET ARRANGEMENT IS BASED ON MWC SD 7251/12/4003.
 - THE SIZE AND SPECIFICATION OF ALL HEADWALLS AND GROSS POLLUTANT TRAP(S) IS TO BE DETERMINED BY OTHERS AT THE DETAILED DESIGN STAGE.
 - ALL WATER BODY EDGE TREATMENTS AS PER MWC SD 7251/12/010.
 - A 2D HYDRAULIC MODEL IS REQUIRED TO BE DEVELOPED AT THE FUNCTIONAL DESIGN STAGE TO CONFIRM THAT THERE ARE NO DETRIMENTAL FLOOD IMPACTS FROM THE FILLING PROPOSAL ON SURROUNDING PROPERTIES.

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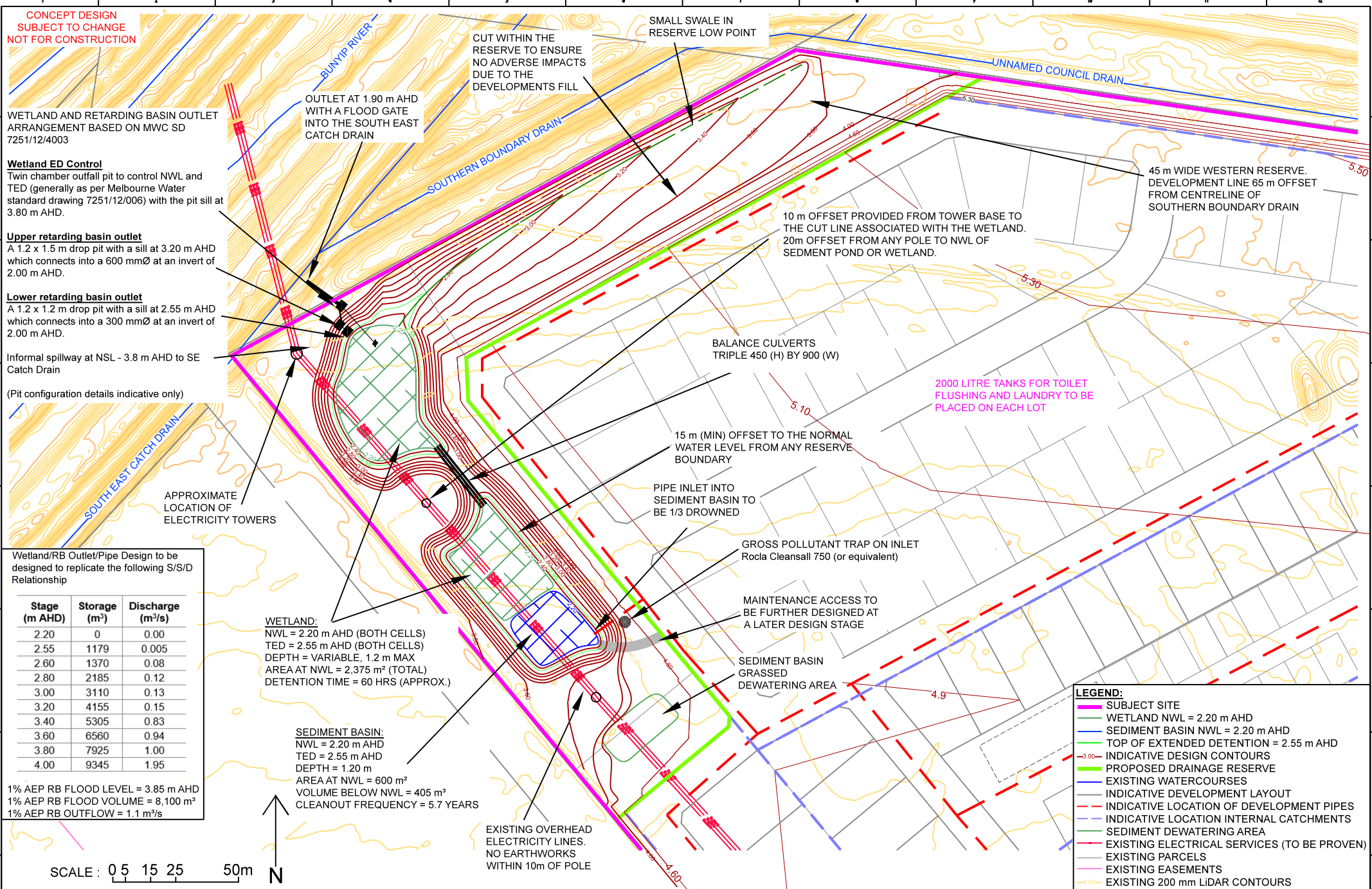


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CHECKED	Michael Mag		
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54 ROSSITER ROAD
KOO WEE RUP
STORMWATER MANAGEMENT STRATEGY
OVERVIEW

SCALE: AS SHOWN
SHEET 1 OF 2
DRAWING No.
2154/SWMS/1



CONCEPT DESIGN
SUBJECT TO CHANGE
NOT FOR CONSTRUCTION

WETLAND AND RETARDING BASIN OUTLET
ARRANGEMENT BASED ON MWC SD
7251/12/4003

Wetland ED Control
Twin chamber outfall pit to control NWL and
TED (generally as per Melbourne Water
standard drawing 7251/12/006) with the pit sill at
3.80 m AHD.

Upper retarding basin outlet
A 1.2 x 1.5 m drop pit with a sill at 3.20 m AHD
which connects into a 600 mmØ at an invert of
2.00 m AHD.

Lower retarding basin outlet
A 1.2 x 1.2 m drop pit with a sill at 2.55 m AHD
which connects into a 300 mmØ at an invert of
2.00 m AHD.

Informal spillway at NSL - 3.8 m AHD to SE
Catch Drain

(Pit configuration details indicative only)

Wetland/RB Outlet/Pipe Design to be
designed to replicate the following S/S/D
Relationship

Stage (m AHD)	Storage (m³)	Discharge (m³/s)
2.20	0	0.00
2.55	1179	0.005
2.60	1370	0.08
2.80	2185	0.12
3.00	3110	0.13
3.20	4155	0.15
3.40	5305	0.83
3.60	6560	0.94
3.80	7925	1.00
4.00	9345	1.95

1% AEP RB FLOOD LEVEL = 3.85 m AHD
1% AEP RB FLOOD VOLUME = 8,100 m³
1% AEP RB OUTFLOW = 1.1 m³/s

WETLAND:
NWL = 2.20 m AHD (BOTH CELLS)
TED = 2.55 m AHD (BOTH CELLS)
DEPTH = VARIABLE, 1.2 m MAX
AREA AT NWL = 2,375 m² (TOTAL)
DETENTION TIME = 60 HRS (APPROX.)

SEDIMENT BASIN:
NWL = 2.20 m AHD
TED = 2.55 m AHD
DEPTH = 1.20 m
AREA AT NWL = 600 m²
VOLUME BELOW NWL = 405 m³
CLEANOUT FREQUENCY = 5.7 YEARS

EXISTING OVERHEAD
ELECTRICITY LINES.
NO EARTHWORKS
WITHIN 10m OF POLE

BALANCE CULVERTS
TRIPLE 450 (H) BY 900 (W)

15 m (MIN) OFFSET TO THE NORMAL
WATER LEVEL FROM ANY RESERVE
BOUNDARY

PIPE INLET INTO
SEDIMENT BASIN TO
BE 1/3 DROWNED

GROSS POLLUTANT TRAP ON INLET
Rocla Cleansall 750 (or equivalent)

MAINTENANCE ACCESS TO
BE FURTHER DESIGNED AT
A LATER DESIGN STAGE

SEDIMENT BASIN
GRASSED
DEWATERING AREA

2000 LITRE TANKS FOR TOILET
FLUSHING AND LAUNDRY TO BE
PLACED ON EACH LOT

- LEGEND:**
- SUBJECT SITE
 - WETLAND NWL = 2.20 m AHD
 - SEDIMENT BASIN NWL = 2.20 m AHD
 - TOP OF EXTENDED DETENTION = 2.55 m AHD
 - INDICATIVE DESIGN CONTOURS
 - PROPOSED DRAINAGE RESERVE
 - EXISTING WATERCOURSES
 - INDICATIVE DEVELOPMENT LAYOUT
 - INDICATIVE LOCATION OF DEVELOPMENT PIPES
 - INDICATIVE LOCATION INTERNAL CATCHMENTS
 - SEDIMENT DEWATERING AREA
 - EXISTING ELECTRICAL SERVICES (TO BE PROVEN)
 - EXISTING PARCELS
 - EXISTING EASEMENTS
 - EXISTING 200 mm LiDAR CONTOURS

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54 ROSSITER ROAD
KOO WEE RUP
STORMWATER MANAGEMENT STRATEGY
RETARDING BASIN/ WETLAND CONCEPT

SCALE: AS SHOWN
SHEET 2 OF 2
DRAWING No.
2154/SWMS/2