Moira Shire Council Cobram East

Stormwater Drainage Strategy Report

AS ADOPTED BY MOIRA SHIRE COUNCIL

25/03/2026

ACKNOWLEDGEMENTS

This report has been prepared by Engeny Australia Pty Ltd for Moira Shire Council. The report authors would like to give special acknowledgements to the Shire's Administrators.

The report is intended for strategic planning of future storm water infrastructure in the Cobram East rainfall catchment and should not be considered as final approved engineering design. Moira Shire Council and Engeny accepts no liability or responsibility for it in respect of any use of or reliance upon this Report by any third party who should make necessary due diligence checks on accuracy of content prior to development and submission of Engineering plans to Council for approval.

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1. BACKGROUND

1.1 Introduction

Moira Shire Council (Council) engaged Engeny Australia (Engeny) to prepare a revised stormwater drainage strategy for the Cobram East Development Area (the site). This work was undertaken following Engeny's review of the previous Cobram East Stormwater Drainage Strategy (DS) originally prepared by Alluvium (March 2021).

Engeny's review of the previous Alluvium report recommended changes to the modelling inputs and assumptions to ensure the proposed Central Wetland Retarding Basin (WLRB) asset is adequately sized to manage flooding and stormwater quality treatment within the spatial constraints of the approved Development Plan (2019). A summary of findings and recommendations are outlined in the Cobram East Drainage Strategy Review Report (Engeny, 7 September 2023). These recommendations have been used to inform and update this current revised drainage strategy report. The revised strategy also focuses on the ultimate future developed conditions as Council has indicated that the investigation of interim developed scenarios would be addressed separately through Council's planning permit approvals process.

The outcomes of Engeny's revised drainage strategy will inform the subsequent Central WLRB's design phases and future developer stormwater management plans.

1.2 Site Locality & Description

The Cobram Development Plan (approved by Council on the 19th December 2019 and included as **Appendix A**) covers a majority of the Cobram East catchment. The Cobram East catchment has an area of approximately 66 ha and is bound by Bisogni Drive to the north, River Road to the east, Murray Valley Road to the south and Campbell Road to the west. The existing catchment contains localised depressions with no formal outlet.

The Cobram Development Plan and previous Alluvium Drainage Strategy incorporates the following key elements:

- Central Wetland Retarding (WLRB) asset which receives stormwater runoff from the Cobram development plan growth area and provides attenuation and treatment. The Cobram Development Plan has allocated a drainage reserve of approximately 3 hectares for this asset.
- A pump outlet structure and rising main which conveys flows from the Central WLRB into Scotts Creek and ultimately into the Murray River.
- South-eastern WLRB asset which receives stormwater runoff from the future south-eastern development area located outside of the 2019 Cobram Development Plan and provides attenuation and treatment. Council indicated that while this asset has no drainage reserve allocation at this stage, the revised drainage strategy should still make an allowance for runoff generated and entering the Central WLRB.
- A pipe which conveys flows from the South-eastern WLRB asset into the Central WLRB asset.

The revised Cobram East DS and associated catchment area has also been aligned with the Cobram South DS catchment boundary to ensure a consistent approach to the catchment delineation. The property at 52 Campbell Road was also included within the Cobram South DS following a review of the existing topography and discussions with Council. Engeny issued the Cobram South DS report on the 3rd December 2024 which documents the existing drainage improvements and upgrade works required to enable future development within the Cobram South area.

Figure 1.1 displays the extent of the 2019 Cobram Development Plan and the Cobram East and South DS catchment boundaries.

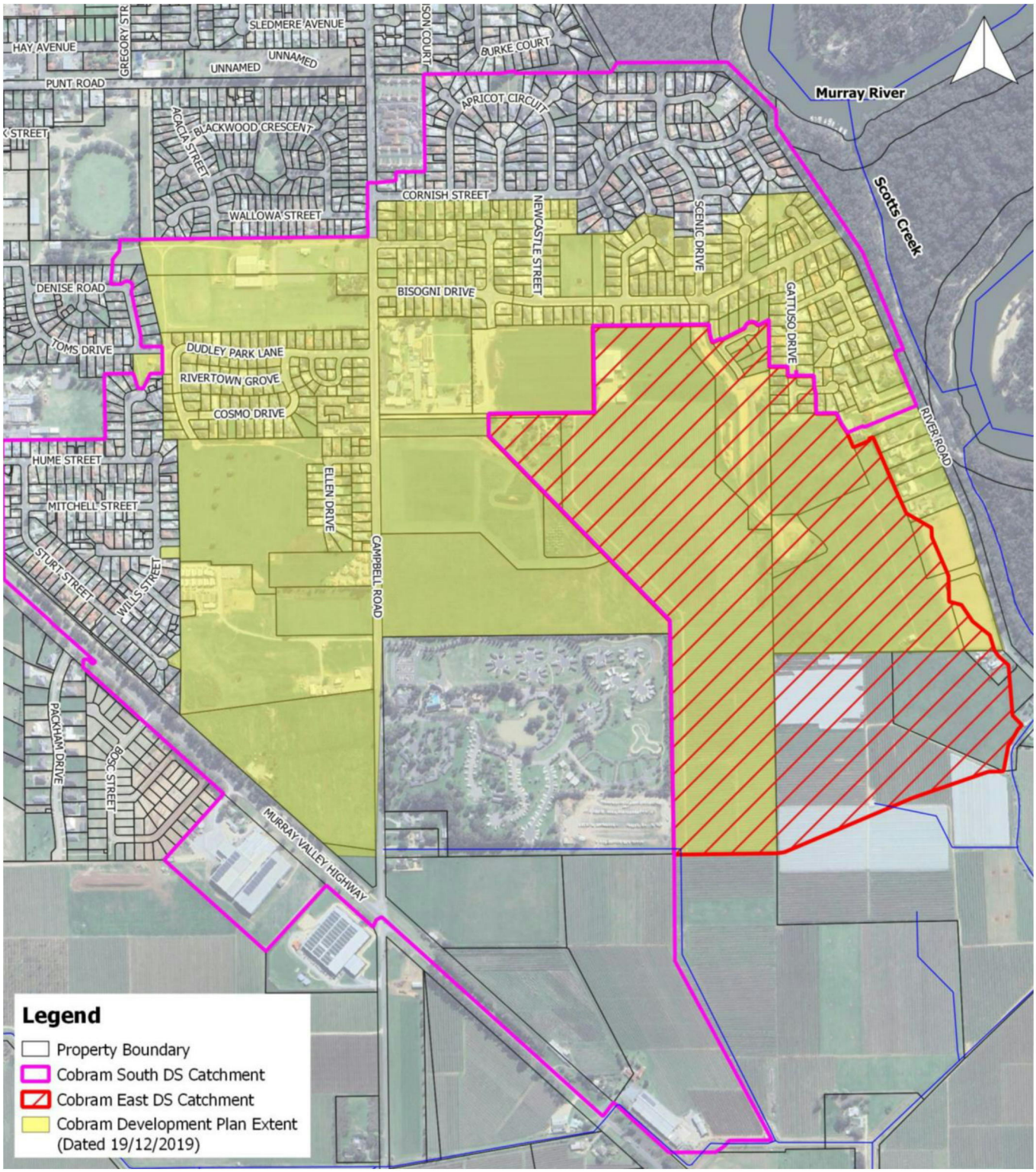

FIGURE 1.1: STUDY AREA

1.3 Drainage Strategy Objectives

The proposed Central WLRB asset within the Cobram East DS aims to achieve the following key objectives:

- Best Practice Environmental Management (BPEM) stormwater quality targets for the contributing Cobram East DS catchment (assuming that the south-eastern WLRB will manage water quality separately for the south-eastern catchment areas currently outside of the Cobram Development Plan).
- Sufficient flood storage capacity to fully contain the 1% AEP flood event with allowance for:
  - The conveyance of stormwater runoff generated from the contributing upstream catchment areas (with consideration to existing site levels and potential site re-grading).
  - The future lots to be located above the target 1% AEP flood level with an appropriate freeboard allowance (may require some areas of lot filling).
  - An appropriate pumped outfall rate for the Central WLRB with consideration to the existing site levels and Development Plan (2019) spatial constraints.
    - Note that Council has not yet allocated a drainage reserve for the south-eastern WLRB asset which is proposed to pump flows into the Central WLRB. Therefore, the Central WLRB pump rate is based on high level assumptions that the future South-eastern WLRB will be designed to contain the southeastern catchment flows (external to the Cobram East Development Plan) with pumped outflows designed to match the existing 1% AEP pre-developed peak flow rate.

To achieve these objectives, Council has indicated that the Central WLRB asset should be contained within the allocated drainage reserve area of approximately 2.9 hectares to avoid additional land take acquisitions and updates to the development plan (2019) layout.

1.4 Scope

The following key tasks were undertaken as part of the revised Cobram East DS to achieve the objectives:

- Development of a pre-developed conditions hydrologic (RORB) model generally in line with the Australian Rainfall & Runoff (ARR) 2019 guidelines and other industry recommendations such as the Melbourne Water Flood Mapping Project Specifications (August 2023).
- Development of a post-developed conditions hydrologic RORB model, to reflect the proposed land use once the Cobram East catchment is fully developed.
- Development of a post-developed conditions hydraulic TUFLOW model with the inclusion of both the Central WLRB and indicative South-eastern WLRB and associated pumped outfall structures and rising mains.
- Assessment and iterations of the hydraulic TUFLOW model to determine the Central WLRB's storage requirements and pump outflow rate that is required to wholly contain the 1% AEP flood event.
- Sizing of the Central WLRB asset (including sediment ponds and wetlands) to achieve the BPEM stormwater quality requirements for the contributing Cobram development plan catchment area.
- Preparation of the revised Cobram East Drainage Strategy report which summarises the modelling and proposed high-level Central WLRB arrangement, including assumptions regarding inflows received from the future South-eastern WLRB asset.

2. DATA REVIEW

The following provides a summary of the data used in the preparation of the revised Cobram East DS.

2.1 Topography Data

Council provided Engeny with a copy of the latest LiDAR data which was captured on 29 March 2022. Engeny notes that this LiDAR data captures the entire Cobram East study area, excluding the south-eastern catchment area. To inform the levels within the south-eastern catchment, a previous LiDAR data set provided by Council and dated 2001 was used.

The topography data was used to delineate the hydrological RORB subareas and the alignment of the RORB reaches. The levels were also utilised to inform a target 1% AEP flood level within the Central WLRB asset as discussed further in Section 5.2.

2.2 Cobram Development Plan

The Cobram Development Plan layout included as **Appendix A** defines the proposed areas of standard, low density and medium density residential in addition to the drainage open space, local park and road reserve areas. This Development Plan was approved by Council on 19 December 2019. Since its approval, some development has progressed within the Cobram East DS catchment largely within the north-eastern portion referred to as the River Road Development.

As part of the proposed River Road Development and registered property boundaries, changes to the Central WLRB's drainage reserve footprint were identified along the eastern and southern boundary as shown within Figure 2.1. Council confirmed that the revised Central WLRB asset should be adjusted to align with the registered property boundary on the eastern and southern side of the drainage reserve. Future design stages will also ensure that the pump outlet structure and rising mains are located within the revised adjacent road reserves.

FIGURE 2.1: CENTRAL WLRB DRAINAGE RESERVE ADJUSTMENT

2.3 Previous Alluvium Drainage Strategy

Alluvium prepared the previous Cobram East Drainage Strategy in March 2021 where Engeny completed a review of the Drainage Strategy and Central WLRB functional design in September 2023. Refer to the Cobram East Drainage Review Report (Engeny, 7 September 2023) for a summary of the review comments and identified recommendations. The recommendations outlined have informed the updates included within this revised drainage strategy report.

In addition to the previous recommendations (Engeny, 7 September 2023), Engeny identified the need to further consider the existing topography to identify a suitable target 1% AEP flood level within the Central WLRB. This was required to ensure the stormwater runoff generated from the upstream contributing development areas could be drained into the Central WLRB asset without extensive and unnecessary filling and earthwork requirements to elevate lots above the 1% AEP flood level to achieve freeboard requirements (refer Section 5.2 for further discussion).

Figure 2.2 displays the original Central WLRB functional design which has been revised as part of this updated drainage strategy.

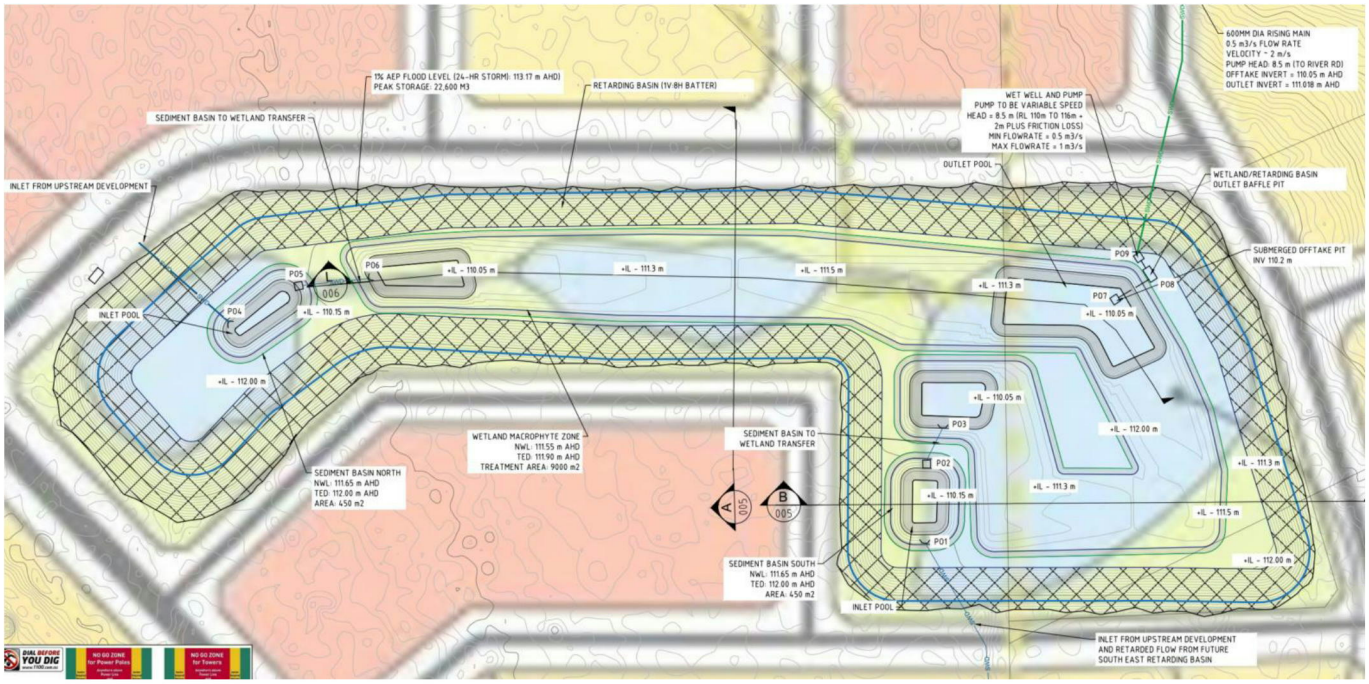

FIGURE 2.2: ORIGINAL CENTRAL WLRB FUNCTIONAL DESIGN LAYOUT (ALLUVIUM, 2021)

3. HYDROLOGICAL MODELLING

3.1 Model Overview

Engeny has developed a RORB hydrological model for Cobram East. Figure 3.1 provides a layout plan of the RORB model showing the catchment and sub area boundaries.

RORB modelling was undertaken for the following scenarios:

- Pre-developed conditions: to estimate the 1% AEP pre-developed conditions peak flow generated from the south-eastern catchment and used to set the target 1% AEP post-developed conditions peak flow discharging from the South-eastern WLRB asset.
- Post-developed conditions: to represent the stormwater runoff generated from the future development of the catchment. The RORB model was used to generate the Central and South-eastern WLRB's routed inflow hydrographs which were applied to the hydraulic TUFLOW modelling discussed within Section 5. The peak inflows to the WLRB assets were also extracted from the RORB outputs and used in the sizing of sediment ponds discussed within Section 4.3.

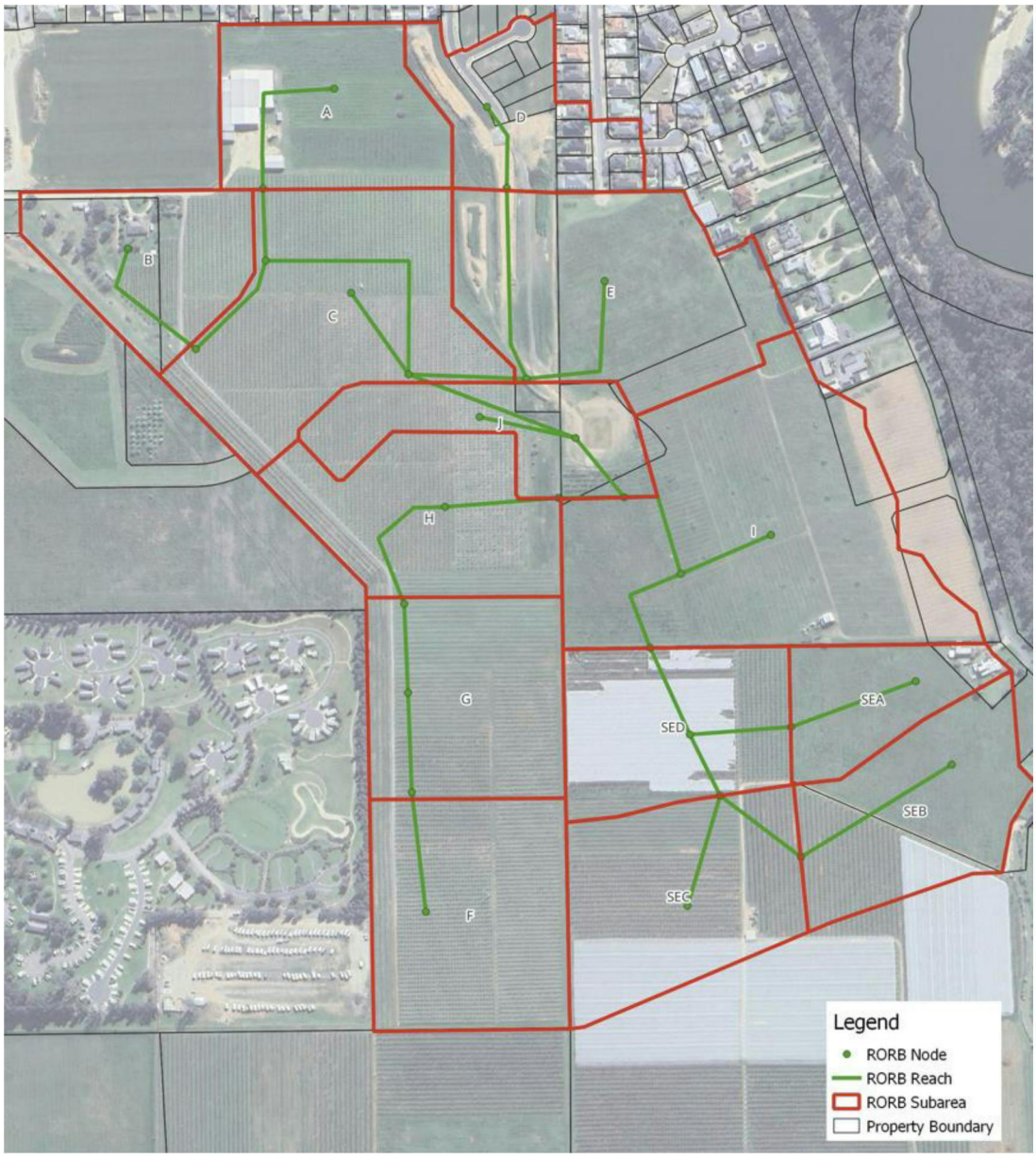

FIGURE 3.1: RORB MODEL LAYOUT PLAN

3.2 Model Setup

3.2.1 Pre-developed Conditions

The subareas delineated for the pre-developed conditions RORB model were informed by the Council provided LiDAR data in addition to the existing property boundaries and development plan (2019). The pervious/ rural catchment was represented with a fraction impervious value of zero and the reach types were represented as type 1 natural reaches.

3.2.2 Developed Conditions

The developed conditions RORB model used the same subarea delineation and reach alignments as the pre-developed conditions RORB model. The catchments reach types were however set to type 2 excavated and unlined reaches. Each subarea's fraction impervious value was also split into Effective Impervious Areas (EIA) and Indirectly Connected Areas (ICA).

The EIA/ICA modelling approach is in accordance with the recommendations within the latest ARR Version 4.2 guidelines and general industry guidance (such as Melbourne Water's Technical Specification dated August 2023). Table 3.1 presents the fraction impervious values that were assigned based on expected future lot sizes shown within the Cobram development plan.

TABLE 3.1: POST-DEVELOPED CONDITIONS FRACTION IMPERVIOUSNESS BY LAND TYPE

Land Type	Fraction Impervious Value
Standard Density Residential (600-800 m^2 lots)	0.70
Medium Density Residential (300-500 m^2 lots)	0.80
Local Parks	0.05 – 0.10

3.3 Model Validation and Parameters

3.3.1 Initial and Continuous Loss Values

Table 3.2 indicates the initial and continuous loss values that have been adopted in the pre-developed and post-developed conditions RORB modelling.

TABLE 3.2: RORB MODEL INITIAL AND CONTINUOUS LOSS VALUES

RORB Surface Type	Initial Loss (mm)	Continuous Loss (mm/h)	Source
Pervious / Rural Areas	23	2.5	ARR Data Hub
Effective Impervious Areas	1.5	0	ARR 2019 Book 5 Guidance
Indirectly Connected Impervious Areas	16.1	1.75	ARR 2019 Book 5 Guidance (applied as 70% of the pervious area loss values)

3.3.2 RORB Routing Parameter Kc

The RORB model routing parameter – Kc, was selected by identifying the relevant regional Kc equation that produced the closest match between the RORB generated peak flows at key catchment locations and the flow estimates using validation equations and rule of thumb. Table 3.3 provides a summary of the relevant Kc values considered in this validation assessment.

Based on the comparison of flow estimates, the RORB equation Kc (Kc = 1.79) produced the closest match to the 1% AEP peak flow estimates. This was hence adopted for both the existing and developed conditions RORB modelling.

TABLE 3.3: APPLICABLE REGIONAL EQUATIONS FOR RORB ROUTIN PARAMETER KC

No	Regional Equation	Application	Source
1	$Kc = 2.2 \times A^{0.5}$	General	RORB V6 User Manual Equation 2.5
2	Kc = 1.25 x dav	Victoria	Pearse et al. (2002)

3.3.3 Pre-Burst Rainfall

Pre-burst rainfall has been incorporated into the RORB model by prepending the pre-burst storm depths to the burst storm, thereby modelling the complete storm, in accordance with the latest ARR guidance. As the subject site is located within ARR Loss Region 3, the 75th percentile pre-burst rainfall depths were modelled. The default (GSAM and Jordan et al) RORB pre-burst temporal patterns were modelled in RORB.

3.3.4 Aerial Reduction Factors

The Areal Reduction Factors (ARFs) modelled in RORB use the ARFs from the ARR Data Hub text file.

3.4 RORB Outputs

The RORB model was simulated for the 1% AEP and 20% AEP storm events. The following provides a summary of the key outputs and how they informed / were used in the preparation of the revised Cobram East DS:

- 1% AEP routed hydrographs at the Central and South-eastern WLRB assets to enable the application of these flows into the hydraulic TUFLOW modelling discussed within Section 4. Given the South-eastern WLRB asset proposes to pump outflows to the Central WLRB, the RORB model was set up to ensure print locations did not double count the application of inflows into the hydraulic TUFLOW model.
- 1% AEP and 20% AEP peak flows entering the Central and South-eastern WLRB assets to inform the sizing of the sediment pond (based on the 3-month flow estimated by proportioning the 20% AEP peak flow by 20% and high-level velocity checks for the Central wetland.

4. STORMWATER QUALITY MODELLING

4.1 Policy and Reduction Targets

The State Environment Protection Policy (SEPP) defines the required water quality conditions for urban waterways. Clause 56.07-4 of the Victorian Planning Provisions (and the clause 53.18 extension of these requirements to non-residential development) sets the stormwater treatment targets required for development in Victoria to comply with SEPP and the Planning Scheme. The Urban Stormwater – Best Practice Environmental Management (BPEM) Guidelines (Victorian Stormwater Committee, 1999) water quality targets are specified by the Victorian Planning Provisions as achieving compliance with the SEPP. The BPEM targets are presented in Table 4.1.

TABLE 4.1: BEST PRACTICE REDUCTION TARGETS

Pollutant	Performance Objective
Total Suspended Solids (TSS)	80% reduction from typical urban load
Total Phosphorus (TP)	45% reduction from typical urban load
Total Nitrogen (TN)	45% reduction from typical urban load
Gross Pollutants (GP)	70% reduction from typical urban load

4.2 Model Setup

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software was used to represent the developed Cobram East DS catchment and confirm the Central and South-eastern wetland sizes required to achieve the BPEM pollutant removal targets.

The following summarises the general MUSIC model inputs and assumptions:

- 10-year rainfall data set from the Goulburn Murray Rainfall Station (ID 080109) capturing data between 1 January 1990 to 31 December 1999 and in 6-minute time step increments. This corresponds to the closest data set to Cobram.
- Monthly aerial potential evapotranspiration (PET)
- Soil store capacity: 120 mm
- Field capacity: 50 mm
- Catchment subareas represented with urban mixed source nodes and reflecting the same area and fraction impervious values determined as part of the RORB hydrologic modelling.
- Wetland and sediment pond treatment nodes representing the Central and assumed South-eastern assets based on the details provided within Sections 4.3 and 4.4 below.

Figure 4.1 displays the WSUD layout plan, showing the treatment assets and contributing catchments to each asset.

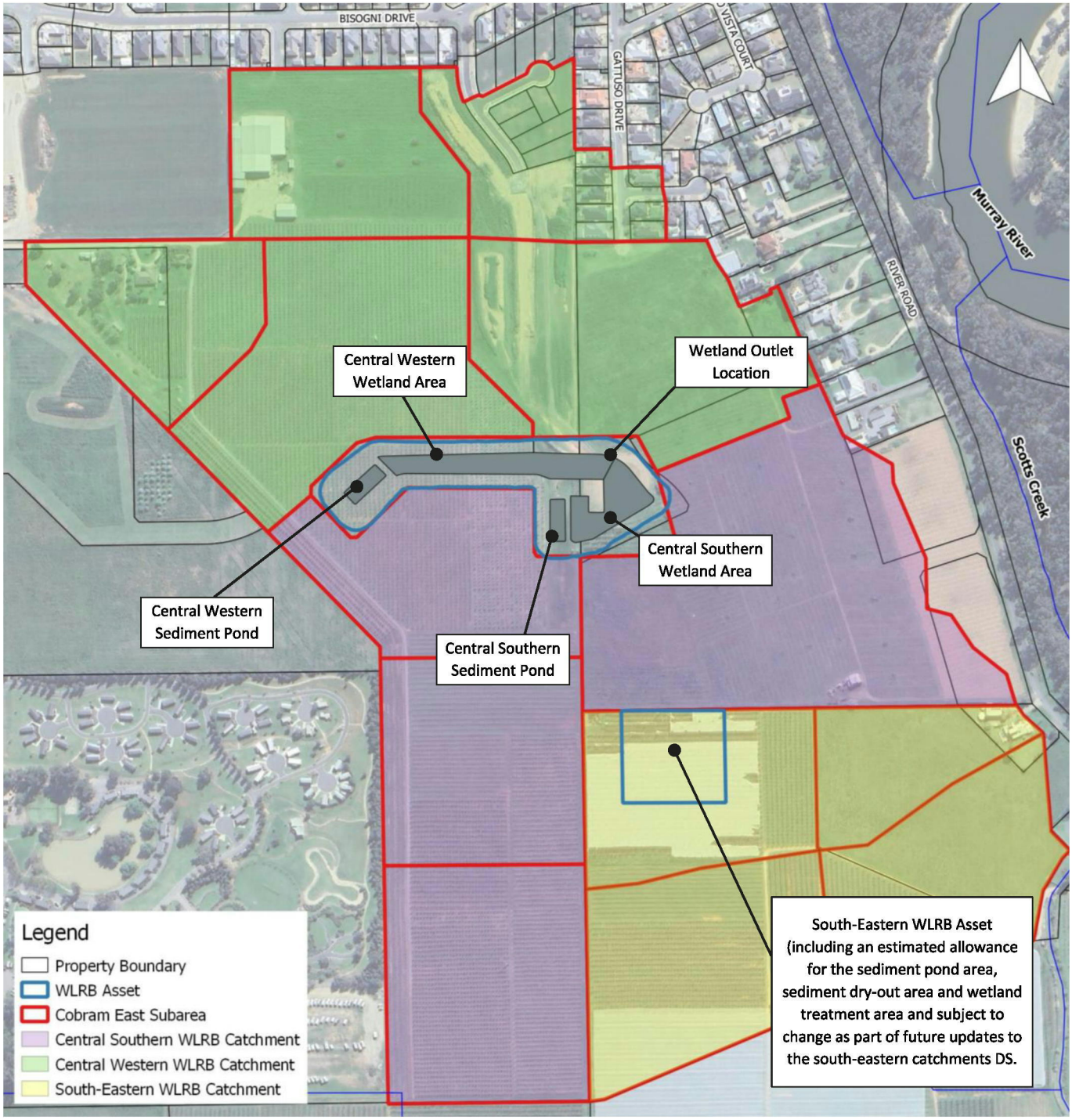

FIGURE 4.1: WSUD LAYOUT PLAN

4.3 Sediment Pond Sizing

Sediment ponds are required at the inlet of the Central and South-eastern wetland assets. Due to the Central wetland's two inflow locations from the north-western and southern catchments, two sediment ponds are proposed similar to Alluvium's original Cobram East DS (referred to as the Central Southern Sediment Pond and Central Western Sediment Pond and shown on Figure 4.1 above).

The sediment ponds were sized using the Fair & Geyer calculations, in accordance with the Melbourne Water's Deemed to Comply requirements. The key objectives of the proposed sediment ponds include:

- Capture 95% of coarse particles ≥ 125 µm diameter for the peak three-month ARI. The sizing of the Central Southern Sediment Pond has excluded inflows from the South-eastern catchment given these already treated pumped inflows are proposed to discharge directly into the Central Southern Wetland.

- Provide adequate sediment storage volume to store five years of sediment, with the top of the sediment accumulation zone being 500mm below the normal water level (NWL).
- An area at NWL and batters which provide a flat base to enable future maintenance and sediment removal.

Table 4.2 summarises the adopted sediment pond sizing parameters. Due to the spatial constraints of the Central WLRB's drainage reserve included in the development plan (2019), the Central WLRB sediment dry-out areas (shown as red within the table below) cannot be accommodated within the existing drainage reserve area. Therefore, an off-site sediment dry-out location would be required to facilitate sediment clean out of the Central WLRB sediment ponds.

The south-eastern WLRB parameters shown in Table 4.2 are indicative only and will require further investigation and confirmation once a development plan and associated drainage strategy is prepared for the southeast catchment area (currently outside of the Cobram development plan (2019) extent). It is recommended that provision for a sediment dry-out area be included within the south-eastern WLRB footprint early during the planning phases.

TABLE 4.2: SEDIMENT POND SIZING PARAMETERS

Parameter	Central WLRB – Southern Asset	Central WLRB – Western Asset	South-Eastern WLRB
Untreated Development Catchment Area (ha)	23.9	23.5	16
$Q_{3\text{-month}}$ (4 EY) Treatment Inflow (m^3/s)	0.31	0.30	0.24
Treatment Area @ NWL (m^2)	600	600	500
Extended Detention Depth (EDD) (m)	0.35	0.35	0.35
Permanent Pool Volume (PPV) (m^3)	350	344	229
Total PPV Depth (m)	1.5	1.5	1.5
Cleanout Frequency	5	5	5
Sediment Dry-out Area (m^2)	*466*	*459*	305

4.4 Wetland Sizing

The Cobram East DS MUSIC model was used to confirm the wetland treatment areas required to achieve the BPEM pollutant removal targets. Due to the Central Southern and Central Western sediment ponds and corresponding two inflow locations, the wetland asset was represented with two wetland treatment nodes in the MUSIC model (referred to as the Central Southern Wetland and Central Western Wetland as annotated on Figure 4.1 above).

The Central Southern and Central Western wetland areas would be controlled by the same outlet and as such Engeny conducted a sensitivity test to compare the MUSIC treatment performance results if the central basin was modelled as one combined wetland treatment node (with a total area of 9,000 m^2) in contrast to the two split wetland treatment nodes. The differences in the overall treatment effectiveness were marginal with the separate wetland treatment nodes being selected as it resulted in slightly lower and more conservative treatment effectiveness outputs. A combined treatment node may be adopted as part of future design stages when assessing the wetland's inundation frequency.

The total Central wetland treatment area of 9,000 m^2 matches Alluvium's original functional design, however the sediment pond sizes were increased to achieve the objectives noted within Section 4.3. Additionally, a high-level review of the wetland's arrangement was undertaken which considered:

- The revisions to the earthworks and design levels to achieve the flood storage objectives discussed within Section 5.2 resulting in a reduced area available at NWL.
- Velocity checks to confirm the minimum recommended Central Wetland width which identified the 4EY (3 month) velocity resulted in the narrowest minimum width of 18 metres. This wasn't considered a concern given the minimum available wetland width at NWL is expected to be approximately 27 metres.

Figure 4.1 displays the high-level arrangement of the asset noting that further refinements and terrain modelling will be undertaken as part of the next stage to confirm wetland widths, zones, internal batters/bunds and general arrangement. The indicative layout prepared does however confirm that the Central Wetland can be accommodated within the existing drainage reserve.

Table 4.3 provides a summary of the wetland treatment areas at NWL, the inlet sediment pond treatment area, allowable sediment dry-out area and the estimated total available base area at NWL.

The indicative South-eastern WLRB's base area at NWL has been informed by the sum of the treatment area at NWL, the sediment pond area at NWL and the sediment dry-out area multiplied by a factor of 1.3. The factor aims to make an allowance for internal batters and bunds required between EDD, NWL and the sediment dry-out area which should be set above the 10% AEP flood level. These indicative south-eastern wetland parameters will require further investigation and confirmation once a development plan and associated drainage strategy is prepared for the southeast catchment area (currently outside of the Cobram development plan (2019) extent).

TABLE 4.3: WETLAND TREATMENT AREAS

Parameter	Central WLRB		South-Eastern Wetland
	Central Southern Wetland Asset	Central Western Wetland Asset	
Wetland Treatment Area @ NWL (m^2)	5,000	4,000	2,350
Sediment Pond Area @ NWL (m^2)	600	600	500
Sediment Dry-out Area (m^2)	Not able to be accommodated within assets available base area	Not able to be accommodated within available base area	305
Total Available Base Area @ NWL (m^2)	16,650 (noting the additional base area not assigned as the wetland or sediment pond areas, will be utilised for battering and earthworks and refined as part of future design stages)		4,100 (allows for 30% increase to sum of wetland and sediment pond areas for battering and earthworks)

4.5 Treatment Results

Table 4.4 provides a summary of the resultant MUSIC modelling which shows that Best Practice water quality targets are achieved for the future development areas.

TABLE 4.4: MUSIC MODEL RESULTS

Parameter	Source Volume (kg/yr)	Volume Removed (kg/yr)	MUSIC Model % Reduction	BPEMG Target (%)
Total Suspended Solids (TSS)	33,600	27,130	81	80
Total Phosphorus	68.2	46.8	69	45
Total Nitrogen (TN)	475	212	45	45
Gross Pollutants	7,120	7,064	99	70

5. HYDRAULIC MODELLING

5.1 Model Overview

Hydraulic modelling was undertaken using TUFLOW HPC (Build: 2023-03-AC-iSP-w64). The 1% AEP storm event was simulated for the front, base and mid-loaded temporal patterns for the standard storm durations up to the 12-hour duration. The resultant maximum of the median temporal pattern for each duration produced the key outputs and maximum flood level results within each basin.

The following provides a summary of the model's key inputs:

- A model extent which covers a wider catchment area, but the key areas modelled and contain wet cells are the Central and South-eastern WLRB assets in addition to the representation of pumped outfalls and rising mains.
- A three-metre cell size was adopted to provide suitable resolution of the Central and South-eastern WLRB design levels, batters and overall flood storage.
- Routed inflow hydrographs from RORB were applied directly into the Central and Southern Basin.
- A static water level vs time (HT) downstream boundary condition was applied at the pipe outlet which crosses River Road and discharges into Scotts Creek. The boundary condition assumes no tailwater interaction with the potential flood levels of Scotts Creek, given the differing times of concentration between the local Cobram East catchment and the waterway. The proposed pipe outfall's invert level will also likely be located over five metres above the existing creek invert level, further reducing the likelihood of backwater effects within the area of interest.
- A Manning's roughness value of 0.065 was applied to each of the WLRB assets representing the wetlands emergent vegetation.
- High-level terrain modifications were undertaken within the TUFLOW model to represent the South-eastern WLRB asset. The Central WLRB asset was largely informed by an updated version of the design surface originally prepared by Alluvium (discussed within Section 5.2).
- An Initial water level polygon was set to 111.4 m AHD to represent the Central WLRB's EDD ensuring no flood storage is accounted for between the wetland's base and EDD elevations. The terrain modifications undertake to represent the South-eastern WLRB asset did not extend beyond the EDD elevation and as such no initial water level polygon was required for this asset.
- Pumps were modelled at the Central and South-eastern WLRB outlet structures including:
  - A static pump rate of 1 m^3/s adopted as the Central WLRB asset's outlet.
  - A static pump rate of 0.84 m^3/s adopted for the South-eastern WLRB asset and corresponding to the catchment's 1% AEP pre-developed conditions peak discharge.
- The rising mains from the Central and South-eastern WLRB outlet structures were assumed to have a diameter of 600 mm where invert levels were informed by the WLRB asset's EDD, base level and considering sufficient cover between the rising main obvert and existing ground elevations. Following discussions with Council, the Central WLRB's outfall alignment was also updated to direct flows east along the alignment of future road reserves within the Cobram Development Plan and towards River Road (rather than north towards Bisogni Drive as per the previous Alluvium drainage strategy).

Figure 5.1 displays the TUFLOW model's key inputs and results which represent the overall Cobram East DS. Section 5.2 provides details related to the assumptions and approach undertaken.

5.2 Central & South-Eastern WLRB Representation

A key revision to the original Central and South-Eastern WLRB design assumptions is the target 1% AEP peak flood level. Engeny determined the revised target flood level based on the existing elevation of the furthest / lowest-lying contributing catchment point, graded at a minimum longitudinal slope toward the WLRB asset inlets, with a 300 mm freeboard allowance subtracted. Table 5.1 presents the resultant target 1% AEP peak flood levels and input assumptions.

TABLE 5.1: SUMMARY OF REVISED WLRB 1% AEP TARGET FLOOD LEVELS

Parameter	Central WLRB Asset	South-Eastern WLRB Asset
Lowest-lying Upstream Contributing Catchment Elevation (m AHD)	114.84	115.53
Approximate distance to WLRB Asset (m)	650	580
Minimum Longitudinal Grade Assumed	1 in 300	1 in 200
Resultant Top of Embankment Elevation (m AHD)	112.67	112.63
Target 1% AEP Peak Flood Level (allowing for 300 mm freeboard) (m AHD)	112.37	112.33

The revised Central WLRB's target 1% AEP peak flood level is 800 mm lower than the original design's 1% AEP flood level of 113.17 m AHD. The adoption of the lowered target 1% AEP flood level was considered critical in ensuring future development could effectively drain into the WLRB assets while also minimising the need for fill earthworks and enabling lots to be located above the flood level.

The lowered 1% AEP flood level does however result in only 370 mm of flood storage if the same Central WLRB EDD is maintained and would not be sufficient to contain the contributing catchment's runoff without overtopping. This would still be the case even when an increased pump outflow rate of 1 m^3/s is incorporated. As such Engeny incorporated updates to the original Central WLRB design surface including:

- Deepening the Central WLRB's NWL to 111.05 m AHD resulting in an EDD elevation of 111.4 m AHD
- Adopting 1 in 4 batter slopes rather than the previous 1 in 5 batter slopes to maximise the area at EDD and overall flood storage.

Incorporating steeper slopes above NWL is not an ideal design outcome as it limits the landscaping and usability of open space areas adjacent to the wetland. However, due to the development plan (2019) spatial constraints and Council's preference to contain the WLRB asset within the designated drainage reserve, there were no alternative design options. An increase to the pump outfall rate to 1 m^3/s from the originally proposed 0.5 m^3/s was also required although there may be an opportunity to review and further refine the specific pump rate as part of future design stages.

The indicative South-eastern WLRB's design levels adopted 1 in 5 batters from the NWL to inform the overall high-level footprint area. As part of future design stages including terrain modelling there may be an opportunity to refine the South-eastern WLRB's design to reduce the overall footprint area. The excavation depth of the asset could also be reduced by reducing the flood storage depth and raising the wetland and sediment pond NWL.

TABLE 5.2: SUMMARY OF WLRB DESIGN LEVELS

Parameter	Central WLRB Asset	South-Eastern WLRB Asset
Existing Topography Level within Asset Area (m AHD)	113.3	114.3
Top of Embankment Level (m AHD)	112.67	112.63
Target 1% AEP Peak Flood Level (allowing for 300 mm freeboard) (m AHD)	112.37	112.33
EDD Level (m AHD)	111.4	110.83 (allowing for 1.5 metres of flood storage depth)
NWL (m AHD)	111.05	110.48
Approximate Base Level of the Wetland / Sediment Pond (assuming a 1.5 metre PPV depth) (m AHD)	109.55	108.98

5.3 Results

Figure 5.1 provides a summary of the overall updated Cobram East DS and includes annotations summarising the inputs and flood level results from the hydraulic TUFLOW modelling.

In summary the resultant 1% AEP flood levels within the Central WLRB was below the target 1% AEP flood levels. This serves as a proof-of-concept design that will be refined in future design stages. Potential refinements include:

- 12D terrain modelling of the Central sediment pond and wetland assets including bunds and batters above NWL.
- Sizing of the Central WLRB's pump outlet infrastructure to account for pump head and operational logic. This may present an opportunity to reduce the pump rate while still maintaining the peak 1% AEP flood level at or below the target.

The South-eastern WLRB asset also resulted in 1% AEP flood levels below the target flood level. However, as the South-eastern WLRB footprint area is indicative only, further investigation is recommended to confirm and optimise the asset's area and design level assumptions.

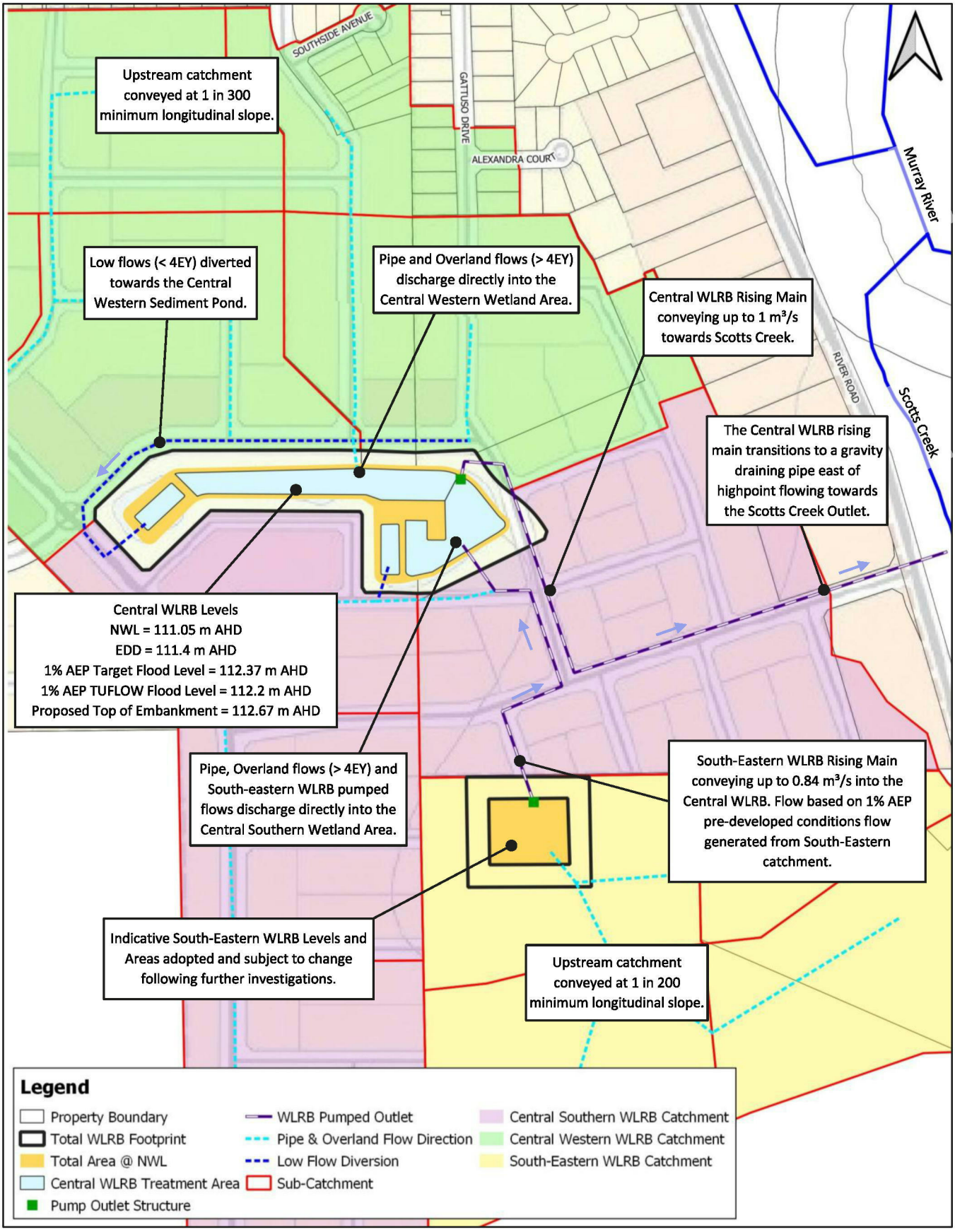

FIGURE 5.1: OVERALL SWMS LAYOUT

6. CONCLUSIONS & RECOMMENDATIONS

6.1 Conclusion

Engeny has prepared the revised Cobram East DS based on a review of the previous strategy, updated modelling and consideration of the catchment's constraints particularly in relation to topography and likely future development longitudinal grades.

The Cobram East DS has confirmed:

- The sediment pond and wetland asset treatment and overall footprint areas including a revised Central WLRB conceptual level design surface which incorporates steeper batters (1 in 4) above the NWL to achieve sufficient flood storage and contain the asset wholly within Council's allocated drainage reserve area.
- The indicative pump outlet rates from the Central and South-eastern WLRB assets required to maintain the 1% AEP peak flood levels at or below the target 1% AEP flood level.

The outcomes of this strategy will inform the next stage of the project which includes the detailed design of the Central WLRB asset. The drainage strategy is also expected to guide future stormwater management for the Cobram Development Plan area and also the south-eastern catchment.

6.2 Recommendations

Based on the revised Cobram East DS, the following provides a summary of recommendations which should be considered as part of the next stages:

- Preparation of the functional / detailed design for the Central WLRB, ensuring alignment with the revised strategy and considering the following refinements:
  - 12D terrain modelling of the Central sediment pond and wetland assets including bunds and batters above NWL.
  - Sizing and optimisation of the Central WLRB's pump outlet infrastructure to account for pump head and operational logic. This may allow for reducing the pump rate while still maintaining the peak 1% AEP flood level at or below the target.
- Confirmation of the South-eastern WLRB's footprint area and design assumptions as part of the preparation of a development plan and drainage strategy for the South-eastern catchment (currently outside of the Cobram development plan). The drainage strategy would ensure outflows pumped from the South-eastern WLRB towards the Central WLRB are equal to or less than the 1% AEP pre-developed conditions flow rate of 0.84 m^3/s. As part of this strategy, consideration should be given to maximising the flood storage within the South-eastern WLRB asset if possible to reduce the Central WLRB's 1% AEP flood level for additional freeboard allowance.
- Planning controls for future residential areas, particularly those located near the Central and South-eastern WLRB areas should consider the impact of pump failures and whether floor levels could be set to a higher level representing the peak 1% AEP flood levels under a pump failure scenario.

APPENDIX A:
COBRAM DEVELOPMENT PLAN

DEVELOPMENT PLAN

Cobram

Moira Shire Council

LEGEND:

- SITE BOUNDARY
- COLLECTOR ROADS
- LOCAL ACCESS STREETS
- TITLE/OWNERSHIP BOUNDARY
- STANDARD RESIDENTIAL (500 - 1000 SQM)
- LOW DENSITY RESIDENTIAL (1000 - 2000 SQM)
- MEDIUM DENSITY RESIDENTIAL (300 - 500 SQM)
- OPEN SPACE ASSOCIATED WITH DRAINAGE FUNCTION
- LOCAL PARKS
- PROPOSED RETENTION AND WETLANDS
- EXISTING TREES
- ROAD WIDENING CAMPBELL RD (5MTS)
- EXISTING IRRIGATION CHANNEL

SPORTS CENTRE

BISOGNI DRIVE

TOMS DVE

CHRIST THE KING SCHOOL

Provide links to existing east-west streets in adjoining development.

Two key east - west roads link River Rd and Campbell Rd to provide good permeability.

RIVER RD

WILLIS ST

LAWSON DRIVE

STURT PL

RESERVE NO 1 FOR DRAINAGE PURPOSES

CAMPBELL

Potential links to future development

Provide opportunity for local neighbourhood centre on intersection of Campbell Rd and new collector road to service local community.

Local open spaces of a larger size to provide suitable areas for kicking a football and playground facilities within walking distance of all residents.

Drainage retardation & water quality treatment for southern part of DP area

Provide links to existing open spaces to the west

Proposed collector road to provide optional future link to Murray Valley Hwy to the south.

MURRAY VALLEY HWY

Existing retarding basin expanded to provide for water quality treatment and open space needs west of Campbell Road

RACV SITE

0 25 50 75m

Scale: 1:2500 @ A1
Ref.: M6534
Date: December 2019
Rev.: G

PLANNING AND ENVIRONMENT ACT 1987
MOIRA PLANNING SCHEME

This Development Plan is pursuant to the Development Plan Overlay Number 8

Council approved this plan at its meeting on 18/12/2019

Delegate

Date 19 / 12 / 2019