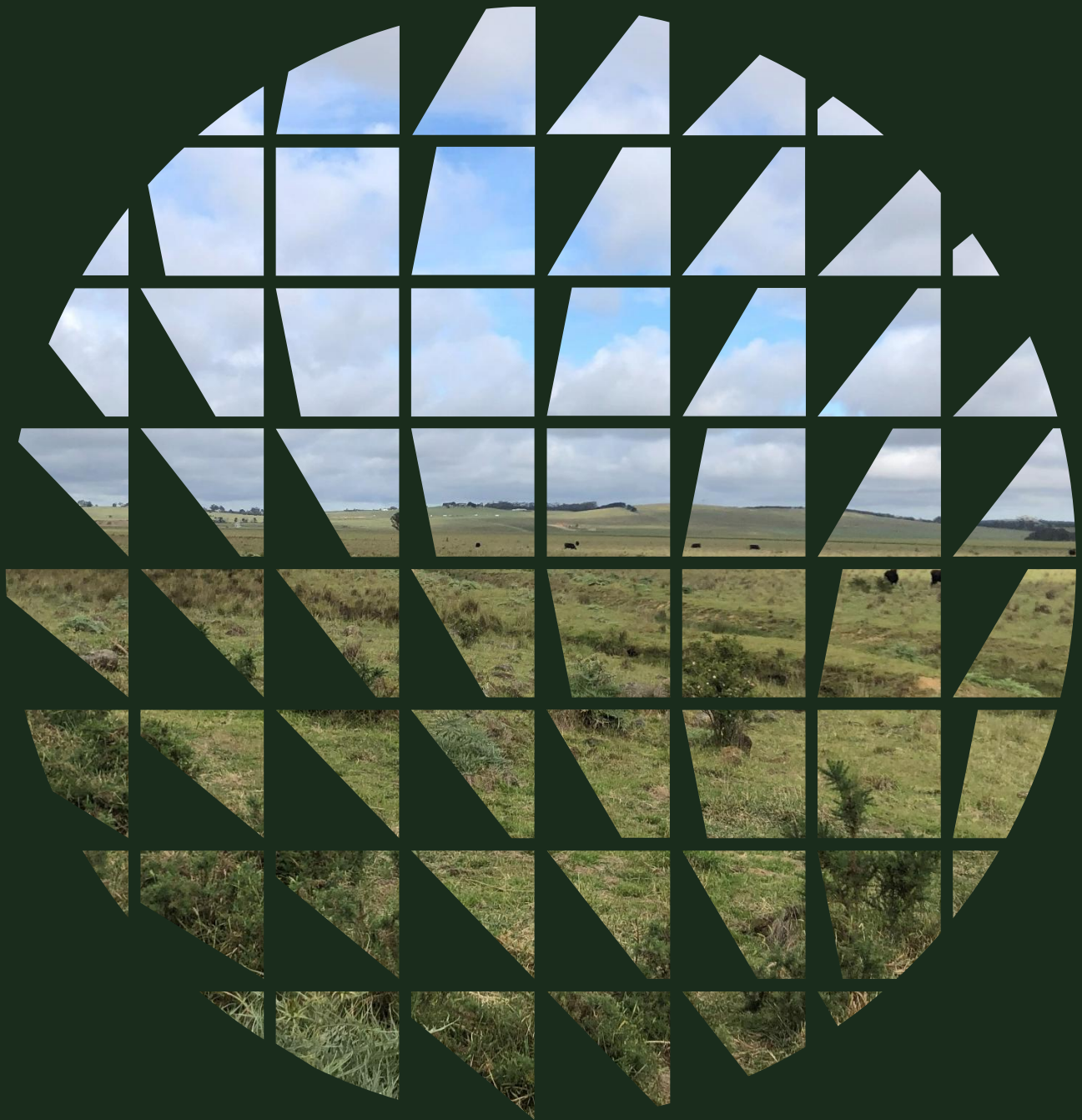




Concept Design Report

Concept Waterway and Drainage Design – Merrifield North PSP

Prepared for
Melbourne Water
July 2026





Alluvium Consulting recognises and acknowledges the unique relationship and deep connection to Country shared by Aboriginal and Torres Strait Islander people, as First Peoples and Traditional Owners of Australia. We pay our respects to their Cultures, Country and Elders past and present.

Artwork by Melissa Barton. This piece was commissioned by the Alluvium Group, and tells our story of caring for Country, through different forms of waterbodies, from creeklines to coastlines. The artwork depicts people linked by journey lines, sharing stories, understanding and learning to care for country and the waterways within.

This report has been prepared by Alluvium Consulting Australia Pty Ltd for Melbourne Water under the contract titled Re-engineering of Kalkallo Creek DSS in Merrifield North PSP

Date issued:	17 July 2026
Issued to:	Melbourne Water
Authors:	Angelina Newton, Stuart Cleven.
Citation:	Alluvium, 2026, Concept Design Report Concept Waterway and Drainage Design - Merrifield North PSP, report prepared by Alluvium Consulting Australia for Melbourne Water, Melbourne.

Version	Date	Review	Approval	Description
1.	17/07/26	Stuart Cleven	Stuart Cleven	First Draft

Contents

1 Introduction	1
1.1 Background	1
1.2 Project objectives	3
2 Background review	5
2.1 Previous background investigations	5
2.1.1 Flora and fauna	5
2.1.2 Geomorphology	6
2.1.3 Geotechnical conditions	10
2.1.4 Cultural heritage	10
2.1.5 Previous hydraulic modelling	10
2.2 Stormy Water Solutions functional design reports	11
2.3 Engeny 2017 Kalkallo Basin Study	12
2.4 Jacobs 2022 Kalkallo Basin Study	14
2.5 OMRR and Aitken Boulevard	15
2.6 PSP land use	16
3 Constraints, values and gaps analysis	17
3.1 Predevelopment modelling assumptions and constraints	17
3.1.1 Hydrologic model build	17
3.1.2 Hydrologic model parameters	19
3.2 Post development modelling assumptions and constraints.....	19
3.2.1 Hydrologic model build	19
3.2.2 Beveridge North West retardation basins.....	20
3.2.3 OMRR and Aitken Boulevard alignments.....	20
3.2.4 RB4 and RB5 storages	20
3.2.5 Kalkallo RB design	22
3.3 Concept design assumptions and constraints	22
3.3.1 Further background investigations.....	22
4 Predevelopment modelling.....	23
4.1 Hydrologic modelling.....	23
4.1.1 Model build	23

4.1.2 Modelling results	25
4.2 Hydraulic modelling.....	26
4.2.1 Boundary conditions	28
4.2.2 Hydraulic roughness.....	28
4.2.3 Hydraulic structures	29
4.2.4 Modelling results	29
5 Post development modelling	31
5.1 Hydrologic modelling	31
5.1.1 Model build	31
5.1.2 Modelling results	35
6 Concept design options	37
6.1 Constructed waterway sizing	37
7 Next steps	40
8 References	41

Tables

Table 1. Key flora and fauna considerations for waterway design.	6
Table 2. Geomorphic recommendations for each reach.	7
Table 3. Alluvium 2023 RORB parameters.....	10
Table 4. Alluvium 2023 TUFLOW parameters.	10
Table 5. Kalkallo RB outlet details for Engeny (2017) options.	13
Table 6. Jacobs 2022 RORB model parameters.	15
Table 7. Comparison of model parameters for key RORB models and adopted parameters.	19
Table 8. RB4 height storage relationship comparison.	21
Table 9. RB5 height storage relationship comparison.	21
Table 10. Climate scenarios.	23
Table 11. Key routing parameters.	23
Table 12. Key rainfall loss parameters.	23
Table 13. Predevelopment 1% AEP SSP1 RORB modelling results at key locations.....	25
Table 14. Predevelopment TUFLOW model parameters.....	26
Table 15. TUFLOW boundary conditions.....	28

Table 16. Mannings n values for each land use.....	28
Table 17. Post development fraction imperviousness.....	34
Table 18. Key routing parameters.	34
Table 19. Post development hydrologic modelling results for 1%AEP SSP1 event.	35
Table 20. Post development hydrologic modelling results for 1%AEP SSP3 event.	35
Table 21. Key channel design parameters.....	37
Table 22. Constructed Waterway Design Parameters	39

Figures

Figure 1. Merrifield North PSP and the adjacent Beveridge South West PSP.....	1
Figure 2. Site overview.	2
Figure 3. Section of Kalkallo DSS (2017) showing the Merrifield North PSP.	3
Figure 4. Key vegetation within the Merrifield North PSP.	5
Figure 5. Summary of geomorphic assessment (Alluvium, 2023)	7
Figure 6. Geology of the study area.	9
Figure 7. Stormy Water Solutions (2014) post development RORB model.	12
Figure 8. Peak flow results for Kalkallo RB outflow (Engeny, 2017).	14
Figure 10. OMRR reserve and potential Aitken Boulevard alignments (Melbourne Water, 2025).....	16
Figure 11. Source of predevelopment RORB model subarea delineation.....	18
Figure 12. Predevelopment RORB model layout.	24
Figure 13. Predevelopment TUFLOW model layout.	27
Figure 14. Predevelopment 1% AEP SSP1 peak depth results.....	30
Figure 15. Post development RORB model layout.	32
Figure 16. Post development land use categories.	33
Figure 17. Preliminary constructed waterway corridor widths for Merrifield North.	38

1 Introduction

1.1 Background

Alluvium Consulting Australia Pty Ltd (Alluvium) has been engaged by Melbourne Water (MW) to undertake a review and develop concept designs for the Merrifield North Precinct Structure Plan (PSP). The flood study accounted for the broader catchment, including Merrifield North and the adjacent Beveridge South West PSP shown in Figure 1.

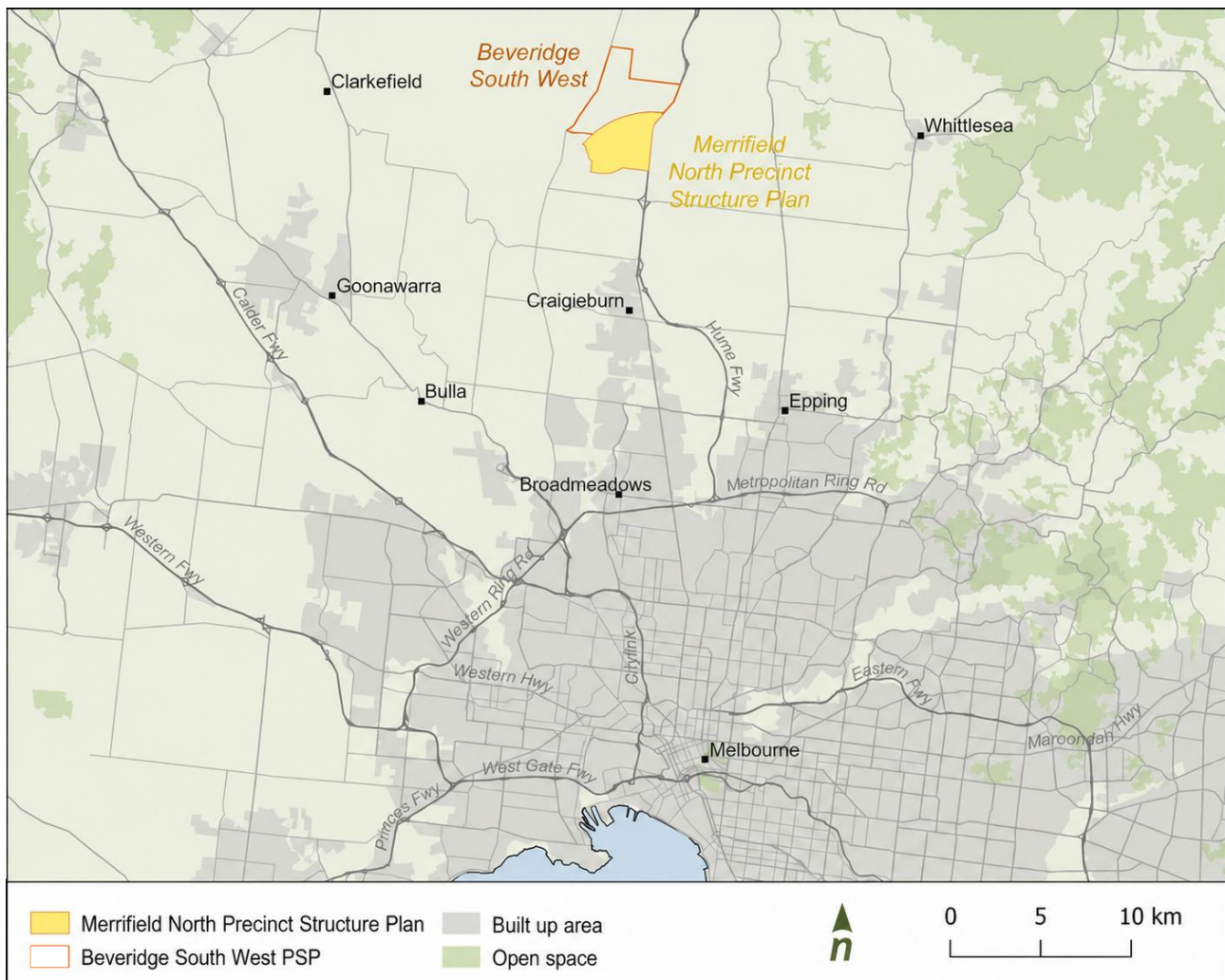


Figure 1. Merrifield North PSP and the adjacent Beveridge South West PSP.

The Victorian Planning Authority (VPA), in consultation with Hume City Council and Mitchell Shire Council, is preparing the Merrifield North Employment Precinct Structure Plan (PSP), which sits within the Kalkallo Creek Development Services Scheme (DSS) and covers an area of 991 ha. The Kalkallo Retarding Basin (RB) is located within the Merrifield North Employment PSP and is a key piece of stormwater management infrastructure for the broader DSS. These features are shown in Figure 2, where the Kalkallo RB is located within the MW owned land boundary.

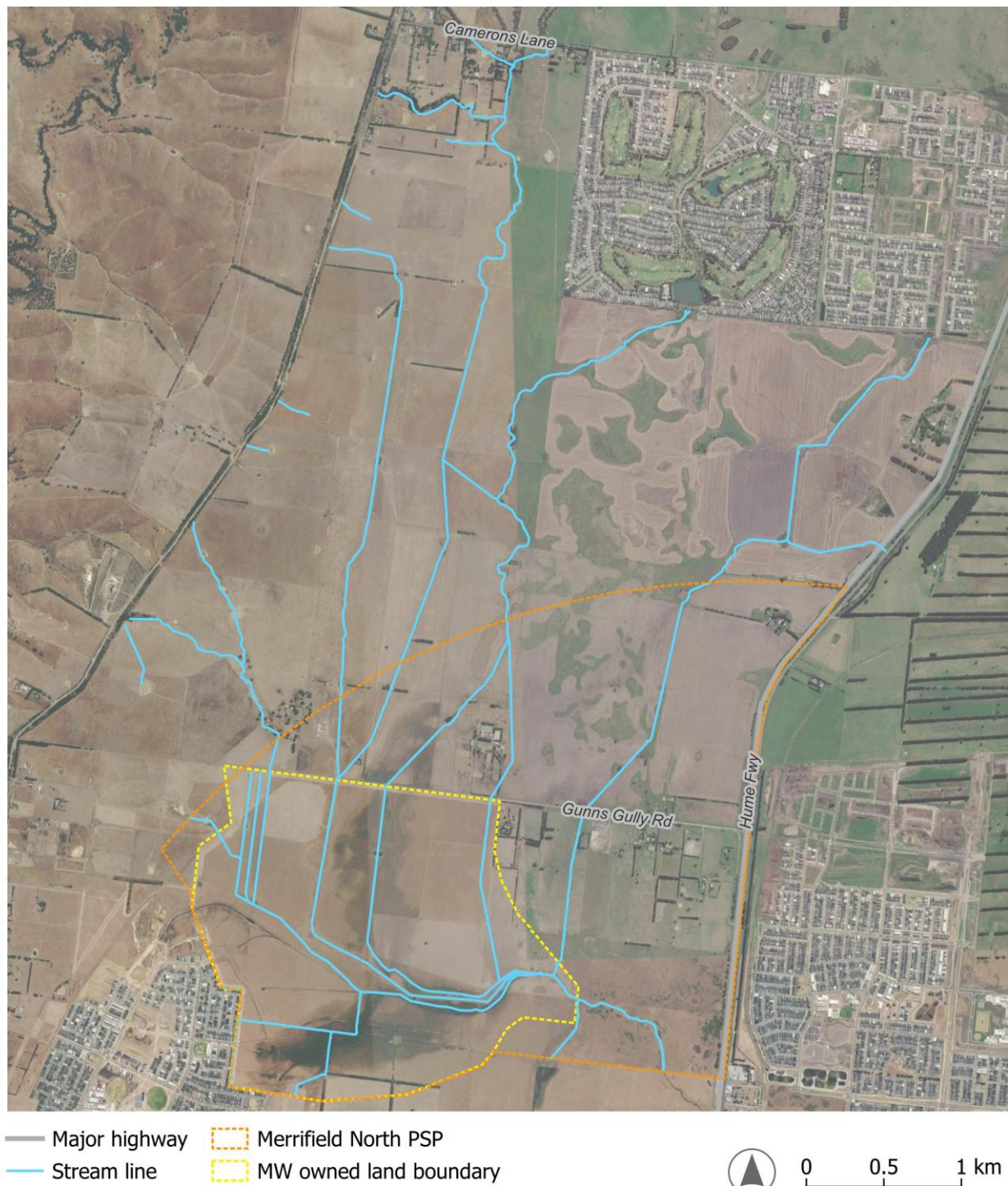


Figure 2. Site overview.

Melbourne Water, MAB, Australand and Evolve jointly commissioned detailed drainage assessments for the Kalkallo Creek catchment before the scheme was finalised in 2017. The scheme design was largely based on concept designs prepared by Neil Craigie in 2010. The strategy proposed that the future Outer

Metropolitan Ring Road (OMRR) could act as a catchment barrier, consolidating upstream catchments to a single outfall point for Kalkallo Creek. The DSS (2017) is shown in Figure 3.

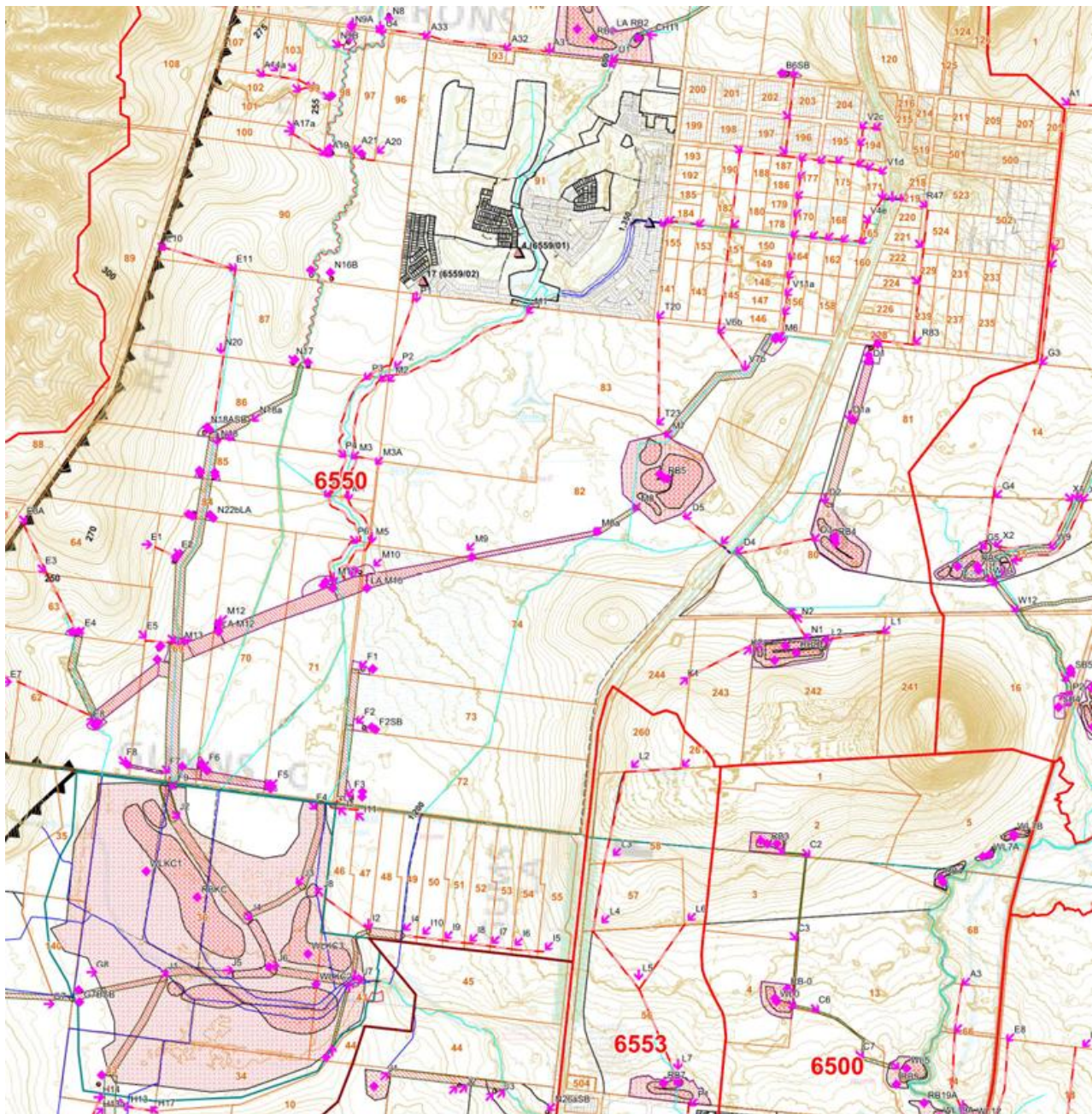


Figure 3. Section of Kalkallo DSS (2017) showing the Merrifield North PSP.

The combined study area is a wide, flat, low-gradient valley floor where shallow groundwater, sodic soils and significant wetlands combine to create challenges for stormwater management and the design and maintenance of future DSS assets.

1.2 Project objectives

The key objectives of this project are to:

- Review and confirm whether the existing drainage scheme concept and layout remain fit for purpose and aligned with current industry best practice.
- Develop a concept option for Outer Metropolitan Ring Road (OMRR) crossing locations.
- Develop a concept design for constructed waterways in the northern portion of the scheme within the Merrifield North PSP, with a focus on waterway sizing, conveyance and corridor establishment north of the proposed Kalkallo Retarding Basin.

The scope of this project is limited to the areas within the Merrifield North PSP, north of the proposed Kalkallo RB.

At this stage, the concept design for the constructed waterways is limited to preliminary waterway corridors and sediment basins for the Merrifield North PSP. Further detail on constructed waterway sizing for the Merrifield North PSP will be provided in subsequent stages.

2 Background review

2.1 Previous background investigations

In 2022, Alluvium commenced background investigations into flora and fauna and geomorphology for the Merrifield North PSP. The key findings are outlined below. Further detail is provided in the report *Merrifield North Employment and Beveridge South West Precinct Structure Plans – Geomorphology and Vegetation Assessments* (Alluvium, 2024).

2.1.1 Flora and fauna

In 2023, Alluvium undertook a desktop review and vegetation field assessment to provide a high-level overview of the ecological values likely to be affected by future development. Figure 4 shows the key vegetation within the Merrifield North PSP.

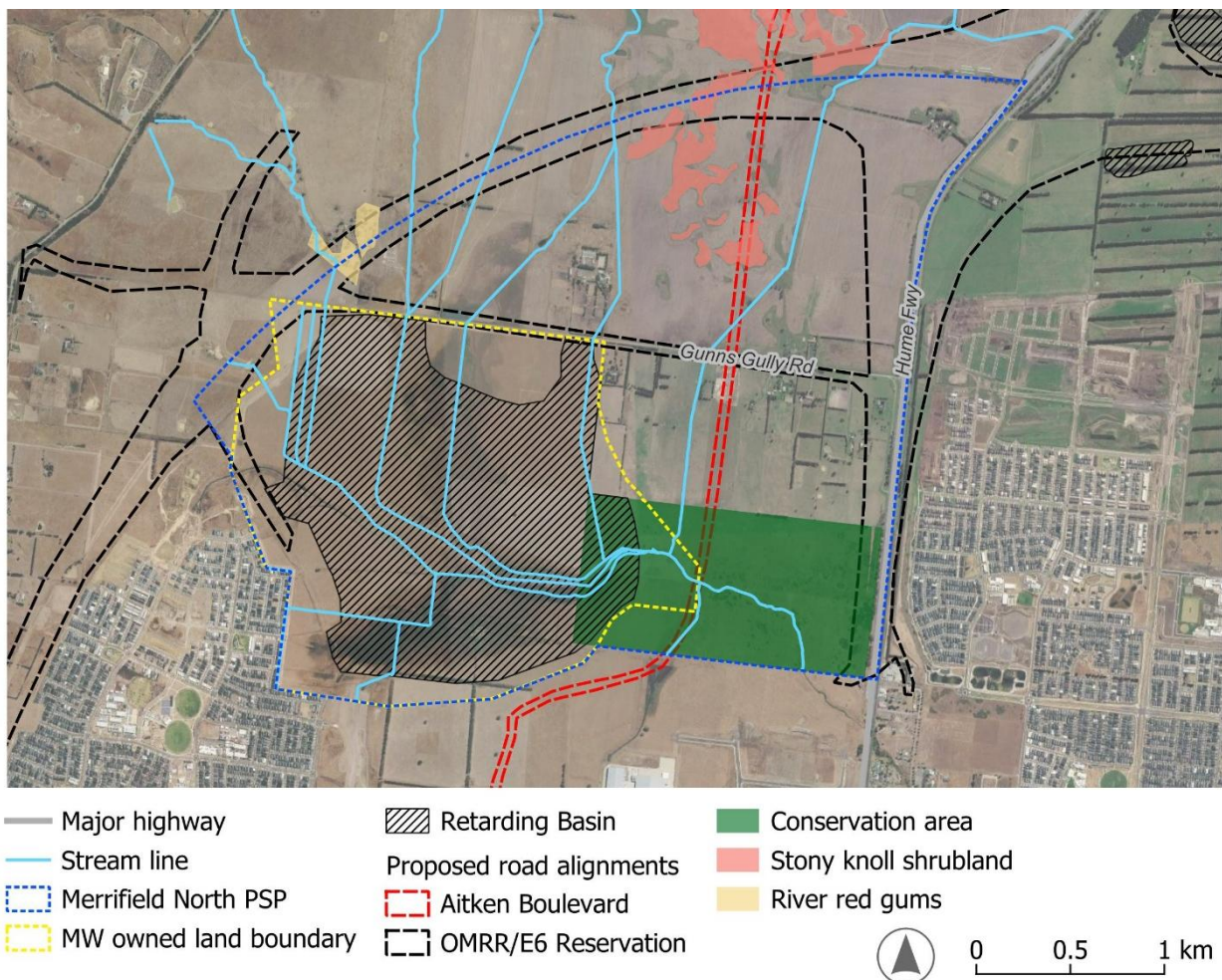


Figure 4. Key vegetation within the Merrifield North PSP.

Most remnant vegetation occurs within the conservation area to the south-east of the Merrifield North PSP, shown in Figure 4. This conservation area is also known habitat for the golden sun moth and potential habitat for the growling grass frog, both of which are listed as threatened (vulnerable) species. It is recommended that all stormwater be diverted through treatment ponds before entering Kalkallo Creek via the conservation reserve.

Little native vegetation has persisted north of the Kalkallo RB because of the legacy of channelisation and grazing within this sensitive environment. For the remnant vegetation shown in Figure 4, the key considerations for waterway and crossing design are outlined in Table 1.

Table 1. Key flora and fauna considerations for waterway design.

Remnant Vegetation	Relevance to Study Area
River Red Gum	Considered high value and located in potential constructed waterway location. However, most of the trees lie in the OMRR boundary and are therefore unlikely to be maintained.
Stony Knoll Shrubland	Recommended for detailed assessment. Mostly modified or converted to pasture/crops therefore unlikely to be of high value. Intersects with potential constructed waterway locations.

The field assessment was restricted to waterways and wetlands where access was available. Ground truthing is required for areas that rely solely on the desktop review. Additional recommendations included a detailed habitat assessment and on-ground assessment of fauna by specialist zoologists.

2.1.2 Geomorphology

Alluvium completed a geomorphic assessment of each reach within the study area to classify waterway type and document channel form, bed and bank composition, and the presence of riparian and instream vegetation, as summarised in Figure 5.

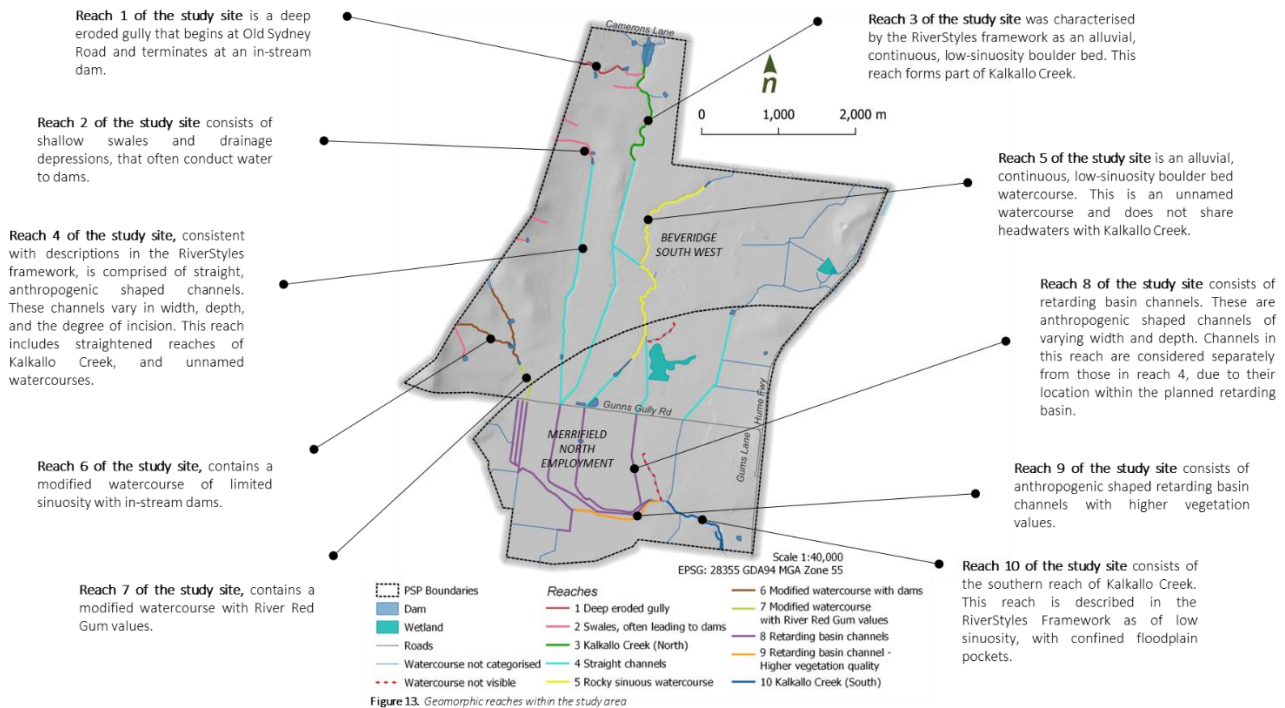


Figure 5. Summary of geomorphic assessment (Alluvium, 2023)

The reach sensitivity and geomorphic recommendations for all reaches north of the Kalkallo RB are provided in Table 2.

Table 2. Geomorphic recommendations for each reach.

Reach	Reach type	Geomorphic Value	Sensitivity to hydrologic alteration	Management recommendation
1	Confined, incised gully with a bed of silt and sand.	Low	High	Halt incision cycle by stabilising bed, establish/maintain riparian vegetation buffer.
2	Unconfined, shallow swales and drainage depressions.	Low	Moderate to low	No intervention recommended, suitable for constructed waterway.
3	Incised, low sinuosity, mixed boulder and fine-grained bed.	Moderate	High	Use tributary/catchment stormwater management to limit future incision, accelerate channel recovery by treating weeds, and investigate possible native instream vegetation that can tolerate drying. Establish riparian buffer.

Reach	Reach type	Geomorphic Value	Sensitivity to hydrologic alteration	Management recommendation
4	<u>Central and western channels:</u> Straight, anthropogenic shaped channels with fine grained bed.	Low	High	Use tributary/catchment stormwater management to limit future incision, suitable for replacement with constructed waterway.
4	<u>Eastern channels:</u> Straight, anthropogenic shaped channels, bed alternates between fine grained and exposed basalt boulders.	Low	High	Use tributary/catchment stormwater management to limit future incision in sections where basalt not yet exposed. Consider incorporating basalt sections, which emulate locally rare waterways type, into a constructed waterway.
5	Unconfined, continuous, low-sinuosity boulder bed, intermittent fine-grained deposits.	Low-Moderate	Moderate	Central and western: Use tributary/catchment stormwater management to limit future incision. Retain waterway and focus on accelerating recovery by treating weeds, and investigate possible native instream vegetation that can tolerate drying. Establish riparian buffer.
6	<u>Upstream of dam</u> Incised, low sinuosity waterway with fine grained bed.	Low	High	Upstream: Halt incision cycle by stabilising bed, establish/maintain riparian vegetation buffer to protect Old Sydney Road. No intervention recommended in open swale section upstream of dam.
6	<u>Downstream of dam</u> Unconfined, low sinuosity, discontinuous channel.	Low	Moderate	No intervention recommended, suitable for replacement with constructed waterway.
7	Unconfined, low sinuosity, discontinuous channel		Moderate	No intervention recommended, suitable for replacement with constructed waterway – focus on reinstatement/preservation of gum remnant vegetation (see ecology section).

All the key waterways are ephemeral streams which will have their hydrology altered post development to more continually receive flows. The presence of sodic, dispersive soils along waterways and most likely the entire PSP area is responsible for the high sensitivity rating to hydrologic alteration applied in Table 2.

Sodic soils are erosion prone and are highly sensitive to even subtle increases in flow energy or exposure during construction. Fine sediment liberated by the formation of new gullies or expansion of existing sodic waterways will threaten downstream waterways. Standard construction methods are insufficient to adequately manage this risk. Previous studies therefore recommend a sodic soil management plan for all works within the PSP areas. Key measures include minimising disturbance of sodic topsoil and subsoil,

applying soil treatments such as gypsum, and using stormwater controls to reduce erosion in retained natural waterways and reaches.

Basalt rocks and basalt boulder beds also appear in sections of the channel that intersect with the stony rise geomorphological management unit shown in Figure 6. Little weathering or soil development is associated with this unit.

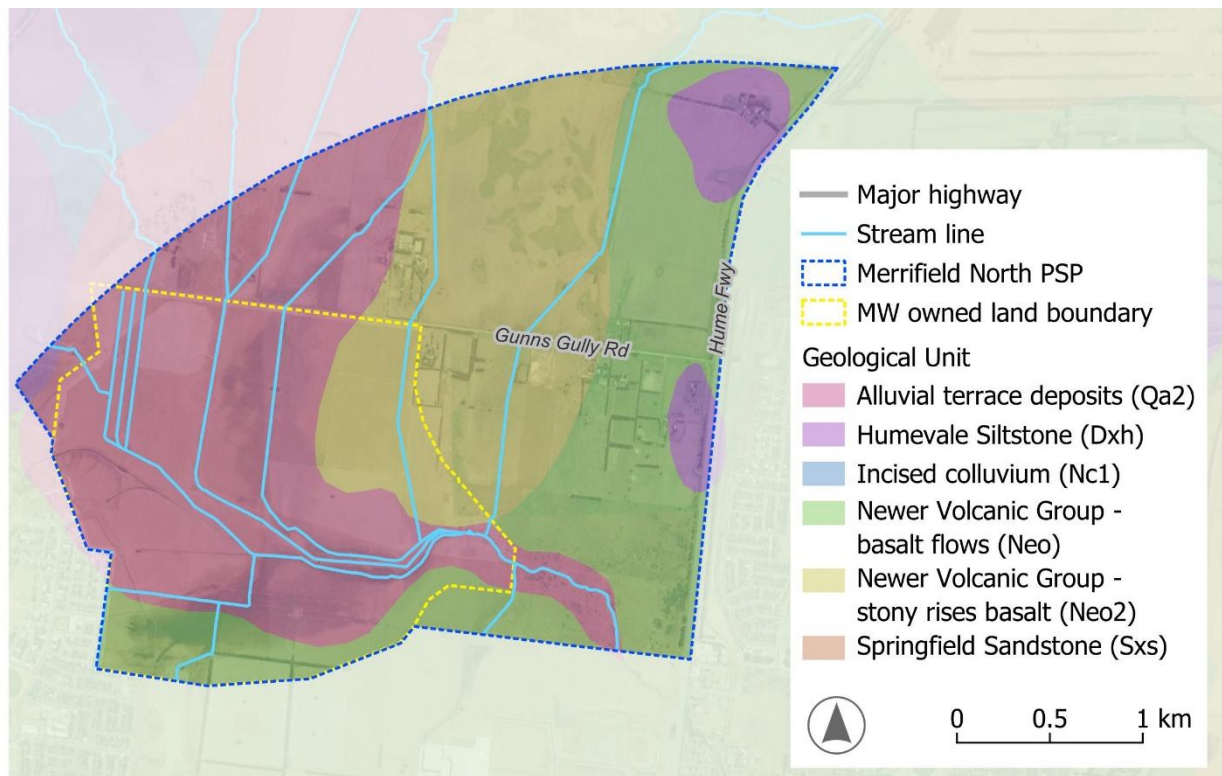


Figure 6. Geology of the study area.

2.1.3 Geotechnical conditions

No detailed geotechnical study is available for the Merrifield North PSP north of Gunns Gully Road. In later stages of constructed waterway design, targeted geotechnical investigations are expected to be undertaken to confirm key ground conditions, including soil composition and depth to rock.

2.1.4 Cultural heritage

No detailed cultural heritage assessment has been undertaken to date for the Merrifield North PSP north of Gunns Gully Road. This work will be important to identify any potential artefacts, better understand the likely extent of wetlands prior to European settlement, recognise the cultural values associated with those wetlands, and inform future discussions with Traditional Owners about aspirations for the landscape.

2.1.5 Previous hydraulic modelling

In 2023, Alluvium conducted flood modelling of the predevelopment scenario and pre-European scenario for the Merrifield North and Beveridge South West PSPs. The results of this study were used to recommend earthworks bench levels and freeboard, based on sensitivity of flood levels. Further detail is provided in the report titled 'Merrifield North and Beveridge South West PSP Flood Assessment Modelling Report' (Alluvium, 2023).

Hydrologic analysis of the study area was undertaken using RORB to determine the predevelopment and pre-European peak flow runoff flow rates for various flood events. The RORB model was based off the existing catchment delineation GIS layer provided by Melbourne Water and built to follow ARR2019 guidance. The key RORB model parameters are provided in Table 3. The hydrographs and excess rainfall produced by the hydrologic modelling was used as inputs into the hydraulic modelling.

Table 3. Alluvium 2023 RORB parameters.

Parameter	Value
Model type	Initial loss/Continuing loss model
kc	13.25 ($k_c = 1.19 \times A^{0.56}$)
M	0.80
Initial loss (IL)	23 mm (ARR 2019 data hub)
Continuing loss (CL)	3.5 mm/h (ARR 2019 data hub)

Hydraulic modelling was undertaken using TUFLOW, with key parameters provided in Table 4. The model covers the extent of the Beveridge South West and Merrifield North PSPs and are available for use in this study.

Table 4. Alluvium 2023 TUFLOW parameters.

Parameter	Value	Notes
Inflow boundaries	9 x 2d_bc inflow hydrographs 26 x 2d_sa regions	RORB sub catchments within the PSP area were used as 2d_sa regions

Parameter	Value	Notes
Outflow boundaries	HQ slope outfall: 0.015 m/m (1 in 67)	Located at Kalkallo Creek near southeast corner of the Beveridge South West PSP
Model Topography	LiDAR from Melbourne Water (2017)	1m resolution for input data
Grid Size	2 m	Sufficient resolution to capture instream detail and consistent with Melbourne Water Technical Specification

2.2 Stormy Water Solutions functional design reports

In 2014, Melbourne Water engaged Stormy Water Solutions to undertake functional designs for the following assets in the Kalkallo DSS:

- Retarding Basin/Wetland RB4/WL4,
- Retarding Basin/Wetland RB5/WL5,
- The design of vegetated waterway D1 – D2,
- The design of vegetated waterway M6 – M8, and
- The increase in pipe sizing of Pipeline B6 – M6 related to the proposed removal of the RB3 from the DSS.

Further detail is provided in the report titled “Kalkallo Development Services Scheme – East Catchment DSS Element Functional Design” (Stormy Water Solutions, 2014). The post development RORB model, including RB4 and RB5 stage-discharge relationships, and functional design drawings for each asset were also made available for the current study. The catchment delineation for the post development RORB model is shown in Figure 7.

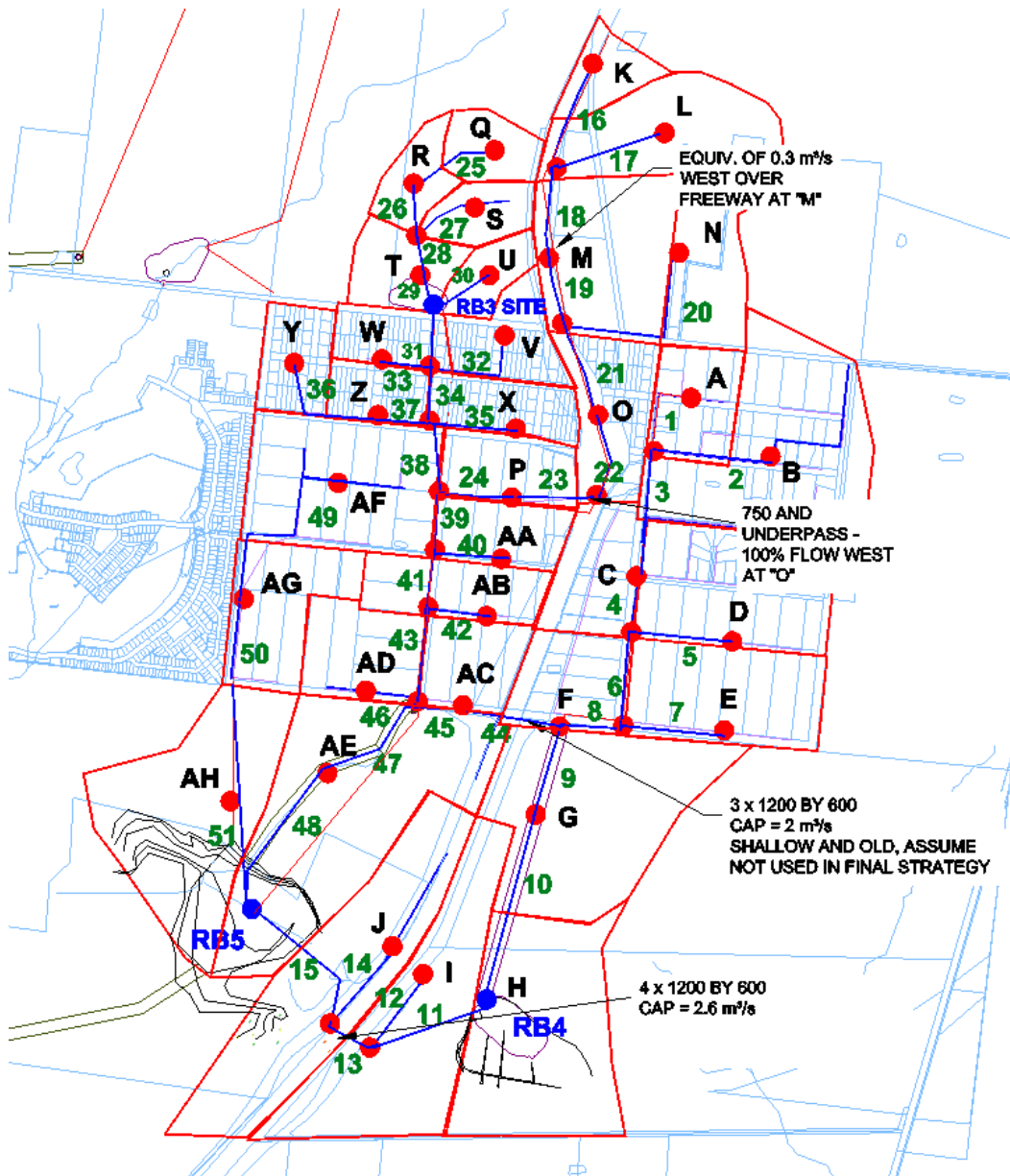


Figure 7. Stormy Water Solutions (2014) post development RORB model.

2.3 Engeny 2017 Kalkallo Basin Study

In 2017, Melbourne Water engaged Engeny to modify the design of the proposed Kalkallo RB. Further details are provided in the report titled 'Kalkallo Retarding Basin Hydrology and Concept Design' (Engeny 2017).

The design objectives for the Kalkallo RB are:

- Achieve a target 1% AEP flood flow in Merri Creek at the Yarra River confluence of no more than five per cent above the predicted existing conditions 1% AEP flow of 337 m³/s.
- No increase in excavation beyond that proposed on the Stormy Water Solutions design.

The three concept designs are outlined in Table 5. The preferred concept design that was progressed in future studies was the 600mm freeboard to development option, based on the outcomes of the RORB hydrologic analysis. The critical 1% AEP Kalkallo RB outflow for this option was 36.4 m³/s for the 72-hour duration.

Table 5. Kalkallo RB outlet details for Engeny (2017) options.

Parameter	Design with 400mm freeboard for 1% AEP event	Design with 500mm freeboard for 1% AEP event	Design with 600mm freeboard for 1% AEP event
RORB file reference	Engeny 81	Engeny 91	Engeny 95
Pipe Outlet diameter (mm)	1,050	1,050	1,050
Pipe outlet length (m)	40	40	40
Pipe u/s IL (m AHD)	226.65	226.65	226.65
Pipe grade (%)	0.375	0.375	0.375
Spillway 1 level (m AHD)	231.05	230.95	230.85
Spillway 1 length (m)	40	45	45
Spillway 2 level (m AHD)	231.6	231.5	231.4
Spillway 2 length (m)	160	155	155

The adjustments to the Kalkallo RB from the existing conditions were based on the following rationale:

- The pipe diameter was reduced to delay the peak outflow from the Kalkallo RB so that it doesn't coincide with the peak flow for the lower reaches of Merri Creek, which lies in the 30 – 40hr range, shown in Figure 8.
- The lower spillway level and length was set to achieve the desired freeboard in the 1% AEP event. For the preferred concept design with 600mm, the water levels in the RB need to be less than 231.4 mAHd, as in Table 5.
- The higher spillway was set at the 1% AEP top water level to allow for conveyance of peak flows for events in excess of the 1% AEP event.

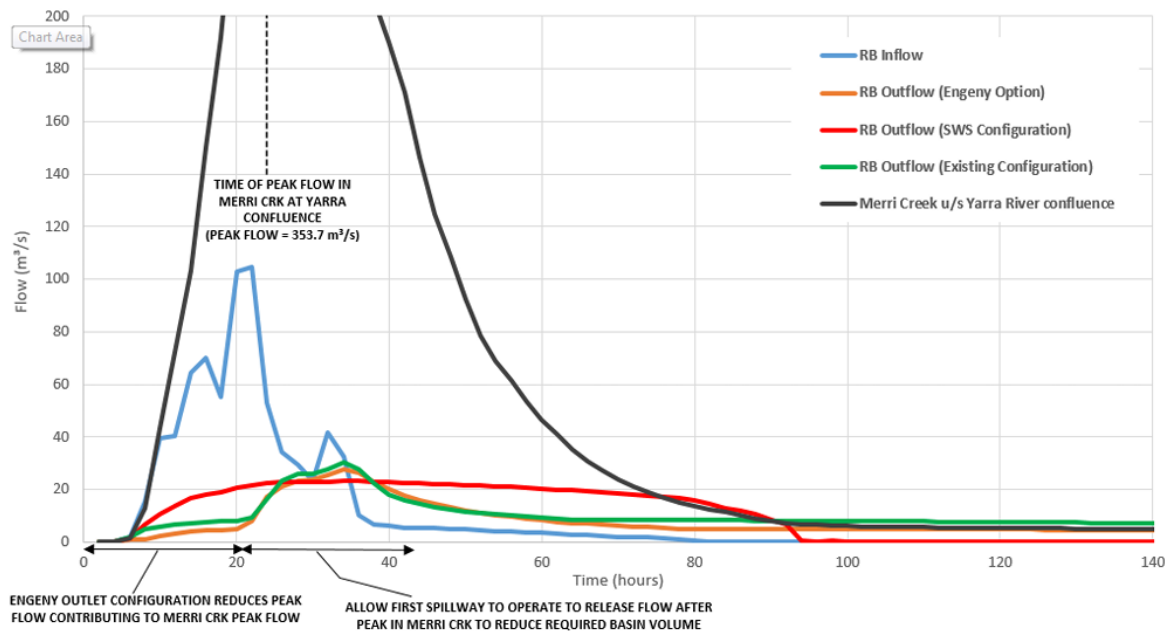


Figure 8. Peak flow results for Kalkallo RB outflow (Engeny, 2017).

2.4 Jacobs 2022 Kalkallo Basin Study

In 2022, Melbourne Water engaged Jacobs to assess their preferred concept option for the Kalkallo RB and demonstrate the preferred asset configuration within the Kalkallo RB. This included hydrologic, hydraulic and water quality design analysis. Further information can be found in the report titled 'Kalkallo Basin - Concept Design Analysis' (Jacobs, 2022). While this study was undertaken in 2022, further investigations and review of the Kalkallo Retarding Basin design are ongoing, therefore it should not be regarded as the final or definitive study.

The 600mm freeboard concept design option has been progressed to incorporate the following:

- Splitting each of the large wetlands within the DSS (MW, 2017) into multiple cells
- Providing densely planted waterways to bypass stormwater
- Employing targeted excavation to provide retardation storage
- Utilisation of currently proposed retarding basin outlet infrastructure (Engeny, 2017)

The RORB model for the hydrological analysis was based on the Engeny (2017) model and has been updated to ARR2019 standards. Both an IL/C and IL/RoC model were developed, with the IL/RoC model being used for the Kalkallo RB assessment. The stage storage parameters for the Kalkallo RB were updated based on the concept design and associated terrain modelling. The key RORB model parameters are provided in Table 6.

Table 6. Jacobs 2022 RORB model parameters.

Parameter	Value
Model type	Initial loss/Runoff Coefficient model
kc	11.86
m	0.80
Initial Loss (IL)	16 mm
Runoff Coefficient (RoC)	See Table 4 in Jacobs (2022).
Continuing Loss (CL)	2.6 mm/hr

The critical peak discharge for the Kalkallo RB was 35.9 m³/s for the 48-hr duration, with an expected peak flood elevation of 231.4 mAHD. According to the Jacobs (2022) report, this level is the RL required to ensure freeboard levels to adjacent properties need to be maintained and is reflected in the TUFLOW modelling for the 1% AEP event.

A TUFLOW model was developed to determine flood depths and shear stresses within the Kalkallo RB. The post development RORB model and TUFLOW model for the Kalkallo RB were provided by Melbourne Water for this study.

2.5 OMRR and Aitken Boulevard

The latest OMRR and Aitken Boulevard alignment information was provided by Melbourne Water on 4/12/25. Melbourne Water advised that Alignment 1 for Aitken Boulevard, shown in Figure 10, is the preferred assumption because the road is unlikely to pass through the Kalkallo RB. Note that the final OMRR and Aitken Boulevard alignments are not yet finalised and are subject to change. The current study is subject to and reliant upon the finalisation of these alignments, therefore any changes will have an impact on the proposed constructed waterways and road crossings.

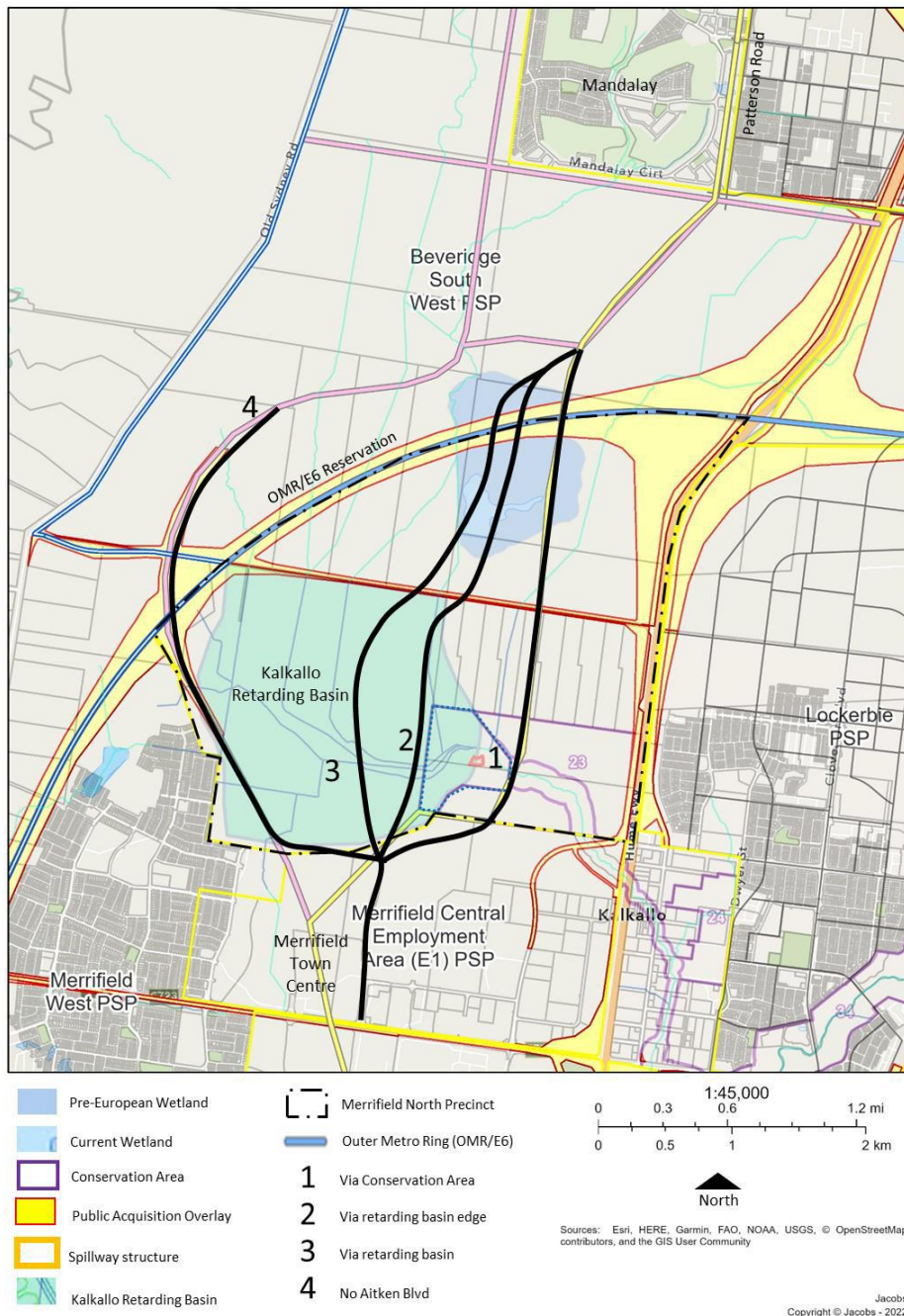


Figure 9. OMR/E6 reserve and potential Aitken Boulevard alignments (Melbourne Water, 2025).

2.6 PSP land use

Draft PSP land use information for Merrifield North was provided by Melbourne Water on 29/1/26 to support land use assumptions for the post development modelling. The land use assumptions based on this draft PSP are further detailed in Section 5.1.1.

3 Constraints, values and gaps analysis

3.1 Predevelopment modelling assumptions and constraints

3.1.1 Hydrologic model build

Two predevelopment RORB models were available to Alluvium for this study:

- Alluvium 2025 RORB model – Beveridge North West PSP (referred to as BNW 2025 RORB model)
- Alluvium 2023 RORB model – whole study area

To develop a fit-for-purpose predevelopment RORB model and maintain consistency with the work currently being undertaken for the Beveridge North West PSP, the BNW 2025 RORB model subareas were adopted north of Cameron’s Lane. South of Cameron’s Lane, the predevelopment subarea delineation provided by Melbourne Water for the Alluvium 2023 RORB model was adopted. The subarea split is shown in Figure 11.

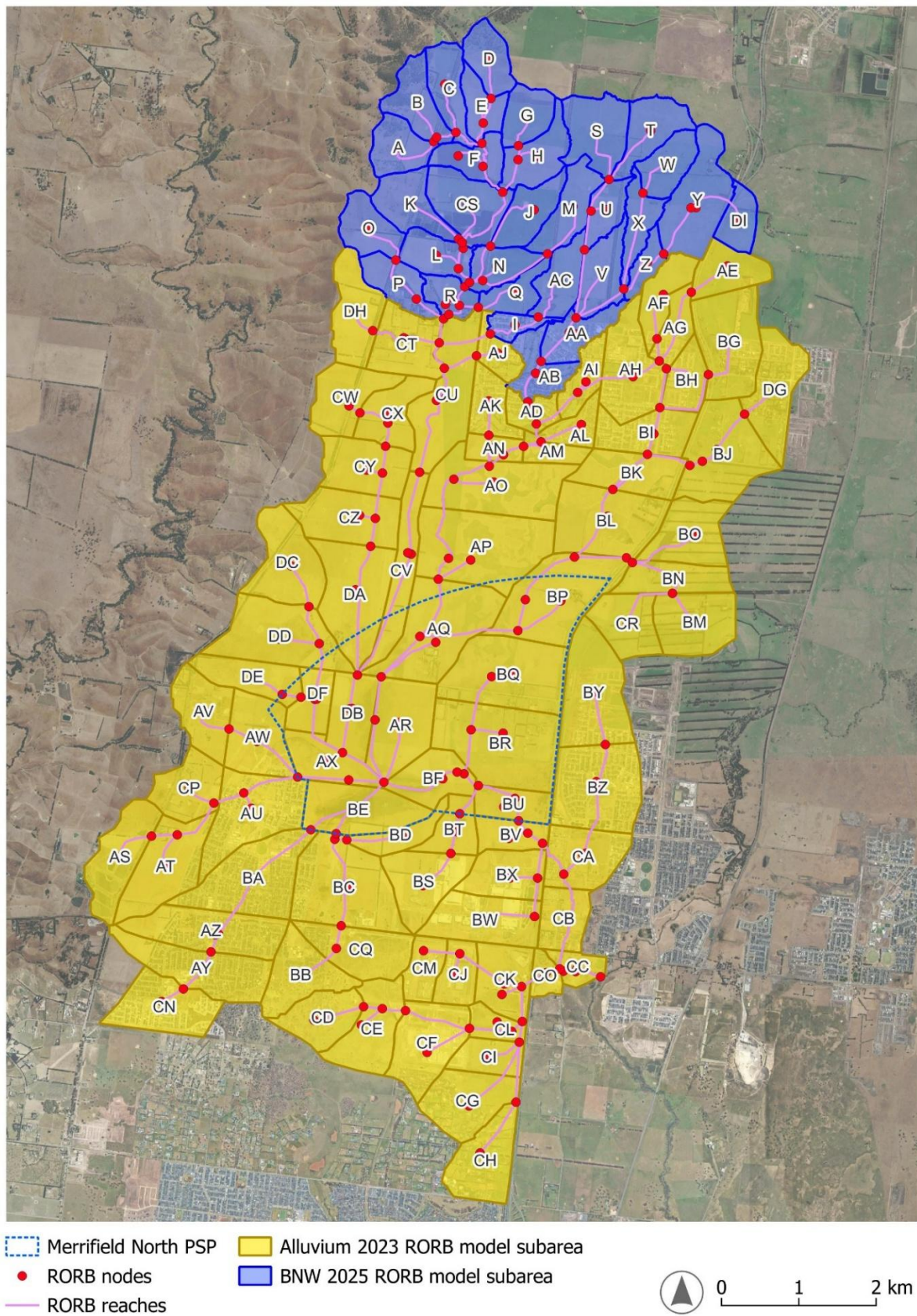


Figure 10. Source of predevelopment RORB model subarea delineation.

3.1.2 Hydrologic model parameters

In addition to the two predevelopment models, a Jacobs 2022 post development RORB model was provided for use in this study. Table 7 provides a comparison between key model parameters for the Jacobs 2022 RORB model, Alluvium 2023 RORB model and Beveridge North West (BNW) 2025 RORB model. The model built for this study is referred to as the Merrifield North (MN) 2025 RORB model. It should be noted that the Jacobs 2022 RORB model results were based on the runoff coefficient method (RoC), whereas the modelling for this project will use the IL/CL method with a sensitivity check for the Kalkallo Retarding Basin using the IL/RoC method once the initial modelling has been completed, as agreed upon by MW.

Table 7. Comparison of model parameters for key RORB models and adopted parameters.

Parameter	Jacobs 2022	Alluvium 2023	BNW 2025	MN 2025
Preburst	No preburst mentioned in report or batch.out	75 th percentile preburst (Victoria jurisdiction specific advice)	Median preburst (based on MW guidance)	Median preburst (based on MW guidance), using the ratio method
Initial Loss (IL)	16mm	23mm (from ARR datahub)	20mm (approved by MW, based on previous assessments in the area)	20mm (approved by MW, based on previous assessments in the area)
Continuing Loss (CL)	2.6mm/hr	3.0mm/hr	3.0mm/hr	3.0mm/hr (approved by MW)

Minimal variation was found between the IFDs for the northern, central and southern sections of the model, therefore the IFD at the model centroid has been adopted.

3.2 Post development modelling assumptions and constraints

3.2.1 Hydrologic model build

Four post development RORB models were available to Alluvium for this study:

- Alluvium 2025 RORB model -Beveridge North West PSP (referred to as BNW 2025 RORB model)
- Jacobs 2022 RORB model - whole study area
- Engeny 2017 RORB model - whole study area
- Stormy Water Solutions (SWS) 2014 RORB model - north-east section of Beveridge South West PSP

For the post development RORB model build north of Camerons Lane, the BNW 2025 post development subareas were used to maintain consistency with the works being undertaken in the Beveridge North West PSP area. For inflows to RB4 and RB5, the SWS 2014 RORB model subarea delineation was followed.

South of Camerons Lane, the MN 2025 predevelopment RORB model was used as the base model and updated accordingly as detailed in Section 5.1. This was due to the Jacobs 2022 RORB model and Engeny 2017 RORB model GIS layers being unavailable during model development.

3.2.2 Beveridge North West retardation basins

The Beveridge North West PSP is currently undergoing concept designs for different retardation options in Kalkallo Creek north of Cameron's Lane. The options under consideration are:

- Option 1: No retardation, sediment basins only
- Option 2: Offline retardation, wetland retarding basins with sediment basins incorporated
- Option 3: Online retarding basins within Kalkallo Creek
- Option 4: Integrated water management with stormwater harvesting basins (under development)

To minimise flood impacts downstream of Cameron's lane, it is highly likely that retardation will be included in the Beveridge North West PSP to return post development peak flows to predevelopment levels. As such, the Option 2 retarding basins have been incorporated into the post development RORB modelling for this study.

3.2.3 OMRR and Aitken Boulevard alignments

The OMRR and option 1 Aitken Boulevard alignments shown in Figure 9 have been assumed for this study. As there is potential for these alignments to change, sizing of any road crossings will not be conducted in this study. It is assumed that the option 1 Aitken Boulevard alignment is the most likely due to it not crossing through the Kalkallo RB. Any changes to the road alignments will impact the locations of the waterway corridors. As no levels are provided for the road alignments, it is assumed that the OMRR alignment will be at grade, with waterways to tie into surface level, including freeboard.

3.2.4 RB4 and RB5 storages

A comparison of storage relationships for RB4 and RB5 from the SWS 2014 RORB model and Jacobs 2022 RORB model are shown in Table 8 and Table 9 respectively. While the S-Q relationships for the outlets have mostly remained the same, the storage volumes have increased.

Table 8. RB4 height storage relationship comparison.

Height (mAHD)	SWS 2014 Storage (m ³)	Engeny 2017 Storage (m ³)
254.7	0	0
255	11085	12090
255.1	-	16421
256	53285	59040
257	111335	114340
258	187285	178590
259	-	250540
260	-	344000

Table 9. RB5 height storage relationship comparison.

Height (mAHD)	SWS 2014 Storage (m ³)	Engeny 2017 Storage (m ³)
246	0	0
246.5	5125	64625
246.55	-	71515
247.5	36575	210400
248.5	205207	371360
249.5	398207	548860
250	502207	642980
251	-	872700

Based on the previous reports, the progressions made to the RB4 and RB5 design are as follows:

1. 2014 - Stormy Water Solutions RORB model was created, for which RB5 takes flows from its northern subareas and RB4 only. RB5 was not included in this model. Recommendations were made to update the storages if a more detailed survey of the terrain was done.
2. 2016 - Dalton Consulting Engineers created a digital terrain model of the Stormy Water Solutions design surface. While the report mentions that this was done for the Kalkallo RB, it is possible that this was also completed for RB4 and RB5, explaining the slight increase in RB4 storage.
3. 2017 - Melbourne Water provided Engeny with a Kalkallo Creek Catchment RORB Model (Kalkallo Creek DSS - Ultimate Conditions.catg). Assuming this model was based on the 2017 DSS in which RB8 is now connected to RB5, it is possible that this is when the RB5 storage was increased significantly to account for these additional inflows from RB8 to the southeast.
4. 2017 - A cut down version of the Merri Creek model was created to model larger magnitude flood events (Kalkallo Creek DSS - Ultimate Conditions Nov 2016.catg). For this model to be run for the 0.50% AEP event, it was necessary to extend the stage - storage and stage - discharge relationships for the other nine special storages in the model.

It is assumed that the Jacobs 2022 RORB model is based off Engeny's further updates to the Kalkallo Creek DSS – Ultimate Conditions Nov 2016.catg. As such, the storage relationships in the Jacobs 2022 RORB model will be used as these include the most recent and updated versions of RB4 and RB5. It is flagged that these storages are different from the original SWS 2014 functional designs.

3.2.5 Kalkallo RB design

The Jacobs (2022) design for the Kalkallo RB has been assumed for the post development hydrologic. It is likely that this design may be subject to change due to updated treatment modelling, potential waterway corridor requirements requiring additional inflow channels, additional excavation to meet freeboard requirements for SSP3 climate change conditions and the proposed wetland to the south being in a protected grassland. This study does not explore updates to the Kalkallo RB and therefore the Jacobs (2022) design has been assumed for this study.

3.3 Concept design assumptions and constraints

3.3.1 Further background investigations

No detailed cultural heritage studies have been undertaken for the study area. The results of this study may affect the location of the proposed waterways and could require protection of the main Kalkallo Creek Line, which would take away the option to divert flows further upstream according to the 2017 DSS.

Further detailed vegetation assessments have been recommended for the study area, and currently there is no confirmed high value vegetation layer. While the river red gum habitat shown in Figure 4 is considered to be high value, the current OMRR reserve removes this habitat. Therefore, it assumed that any proposed waterway corridor in the vicinity of this habitat is acceptable.

No contaminated land layers or geotechnical studies are available for the Merrifield North PSP and may influence constructed waterway designs in later stages.

4 Predevelopment modelling

4.1 Hydrologic modelling

The predevelopment hydrologic modelling was undertaken in RORB to determine the critical peak flows, durations and temporal patterns associated with 1% AEP SSP1 event.

4.1.1 Model build

The layout of the predevelopment RORB model is shown in Figure 11, comprising a total 74.2 km² catchment. All reaches were modelled as 'natural' reach types and subareas were given a 0.05 fraction imperviousness (FI) to mimic predevelopment land use.

The predevelopment RORB model was run for the noSSP and SSP1 scenarios. A summary of the climate scenarios used across the predevelopment and post development models is provided in Table 10.

Table 10. Climate scenarios.

Scenario	Description
noSSP	Historic climate conditions from which ARR datahub values are derived.
SSP1	SSP1 – 2.6 (current and near term, 2021-2024) climate projection, representing the present-day climate.
SSP3	SSP3 – 7.0 (long term, 2081-2100) climate projection, representing future climate change.

The routing parameters for the existing conditions model are provided in Table 11 and loss parameters provided in Table 12. A whole of catchment k_c , IL and CL value was used, maintaining the k_c/d_{av} recommended by MW.

Table 11. Key routing parameters.

Model	k_c	K_c/d_{av}	m
Predevelopment	12.285	1.35	0.8

Table 12. Key rainfall loss parameters.

Scenario	IL (mm)	CL (mm/hr)	Preburst
noSSP	20.0	3.0	Median
SSP1	20.9	3.3	Median
SSP3	23.0	4.0	Median

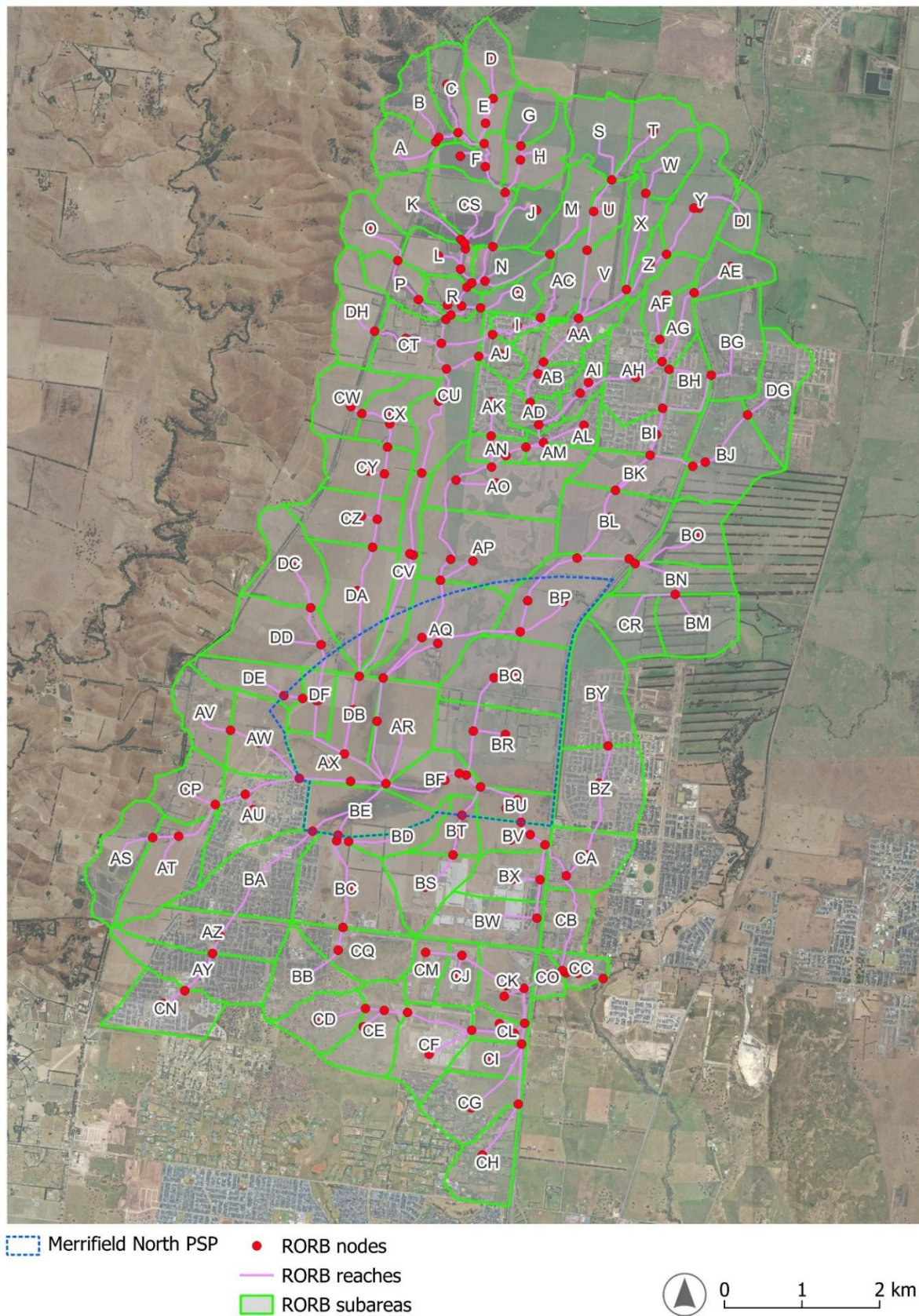


Figure 11. Predevelopment RORB model layout.

ARR datahub IFDs were derived from the centroid of the model and point temporal patterns applied with filter embedded burst. Areal reduction factors (ARF) are applied based on a total catchment area (74.2 km²), consistent with a lumped rainfall approach. While this simplifies spatial variability of rainfall, it is considered appropriate for the scale and purpose of the modelling. Preburst ratios were derived based on the median preburst values from ARR datahub and 20mm IL.

The Kalkallo RB has been modelled in RORB as a storage node, with key parameters summarised below. The parameters were based on drawings of the Kalkallo RB culvert from the 5/4/84, Melbourne Board of Works Drainage Division.

- Discharge Relation: Weir and Pipe Formulas
- Spillway:
 - 3 x spillways
 - Spillway 1: 231.30 mAHD crest elevation at 50m effective length
 - Spillway 2: 231.73 mAHD crest elevation at 40m effective length
 - Spillway 3 (embankment): 232.30 mAHD at 370m effective length
- Outlet pipe:
 - 1 x outlet pipe
 - 1350mm pipe diameter
 - 28m length
 - 0.8% slope
 - 227.05 mAHD entrance invert

The stage-storage relationship for the Kalkallo RB was derived from the 1m 2017 LiDAR from MW being used in the predevelopment TUFLOW model to represent the predevelopment terrain.

4.1.2 Modelling results

The critical flows, temporal patterns and durations for the key locations are provided in Table 13. The flows from the critical storms at TUFLOW model inflow locations were used as inputs to the predevelopment hydraulic modelling.

Table 13. Predevelopment 1% AEP SSP1 RORB modelling results at key locations.

Location	Peak flow (m ³ /s)	Duration	Temporal pattern
Kalkallo Creek at Cameron's Lane	39.3	2 hour	28
Kalkallo RB Inflow	139.0	9 hour	27
Kalkallo RB Outflow	20.9	12 hour	27
End of PSP	25.6	4.5 hour	22
Confluence with Merri Creek	63.3	4.5 hour	28

From Table 13, the existing Kalkallo RB attenuates peak flows at the outlet to 20.9 m³/s for a 12 hour critical duration. For the existing Kalkallo RB, the first spillway is at 231.3 mAHD, second spillway is at

231.73 mAHD and third spillway is at 232.3 mAHD. The predevelopment 1% AEP SSP1 peak depths suggest that peak water level reaches 231.57 mAHD, meaning that only the first spillway is engaged.

4.2 Hydraulic modelling

A TUFLOW model has been developed to determine the predevelopment flows and peak flood levels for the Merrifield North PSP during the 1% AEP SSP1 event, with key parameters summarised in Table 14. The model setup is shown in Figure 12.

Table 14. Predevelopment TUFLOW model parameters.

Parameter	Merrifield TUFLOW Model
AEPs assessed	1% AEP SSP1 (current climate)
Storm durations assessed	45 min (TP24), 1.5 hour (TP26), 3 hour (TP25), 4.5 hour (TP27), 9 hour (TP27), 12 hour (TP27)
Hydraulic model software	TUFLOW HPC 2025.1.2
Grid size	3m with sub-grid sampling at 1m
DEM	1m LiDAR (2017) from MW, +/-10cm vertical accuracy
Roughness	Refer to Table 16
Model Boundaries	Refer to Table 15
Timesteps	1D timestep = 0.5s, 2D timestep = 1s for the first calculation timestep and adaptive timestep for the rest of the simulation as HPC has been used.
Cell Wet/Dry Depth	0.0002m
Initial water levels	Flat-water level from 1m LiDAR (2017) for all farm dams within the study area.

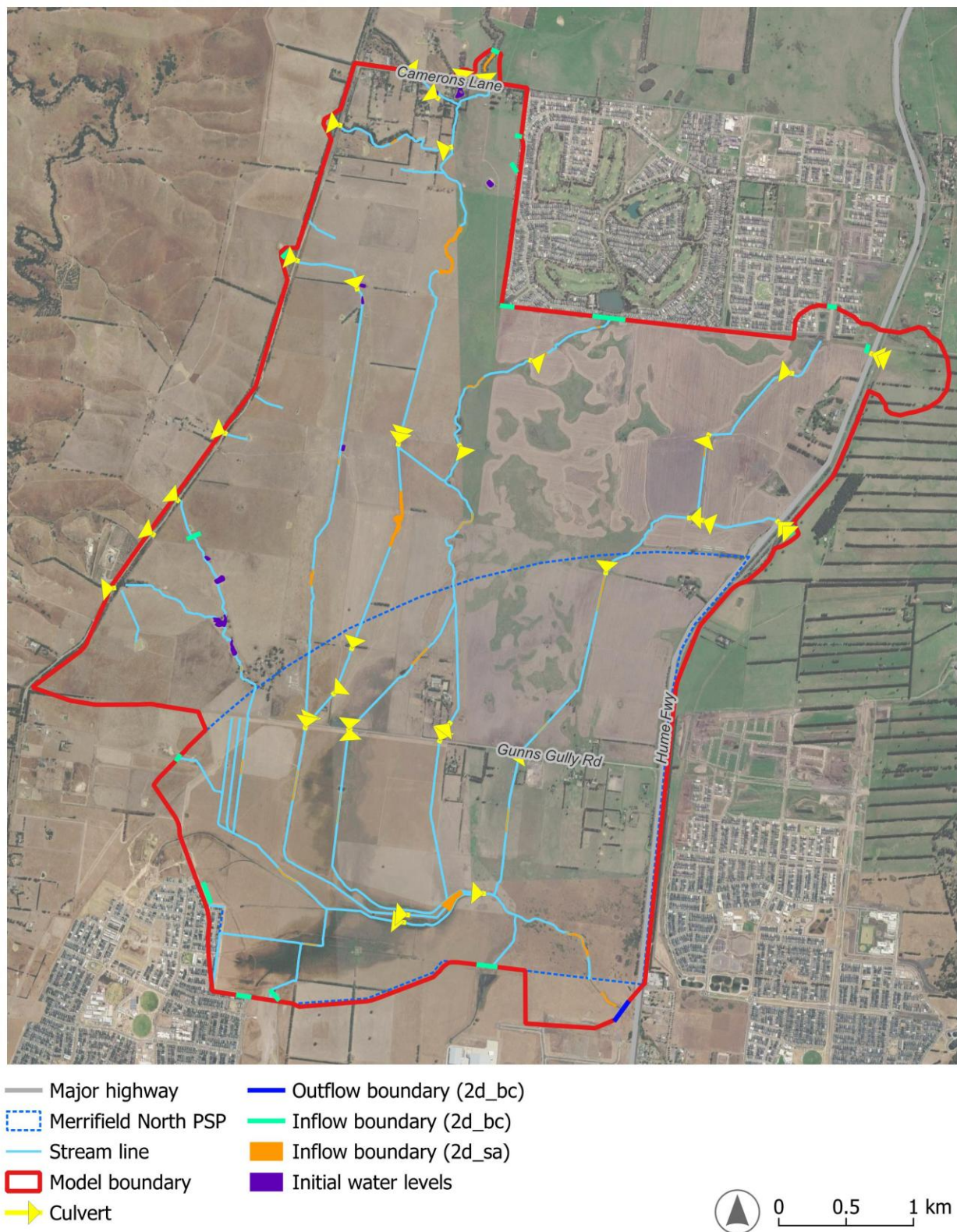


Figure 12. Predevelopment TUFLOW model layout.

4.2.1 Boundary conditions

To apply flows into the model, the boundary conditions in Table 15 were used and are shown in Figure 12.

Table 15. TUFLOW boundary conditions.

Type	Boundary Condition	Description
Inflow boundary condition	2d_bc QT line	To apply flows from external subareas at the model boundary.
	2d_sa polygon	To apply flows from the internal subareas into the waterway.
1D-2D boundary condition	2d_bc SX and CN line	To transfer flow into and out of the culverts that have been included in the model as shown in Figure 12.
Downstream boundary condition	2d_bc HQ line	To allow overland flow to leave the model. Assumed slope of 0.005 m/m based on MW advice.

4.2.2 Hydraulic roughness

Hydraulic roughness parameters were assigned according to land use categories delineated from aerial imagery. The Manning's n roughness parameters for each land use category are listed in Table 16 and based on AMSTAA 6200 guidance.

Table 16. Mannings n values for each land use.

Material ID	Manning's n	Description/Use
1	0.3	Residential High Density Urban Combined Parcel and Building
2	0.1	Residential Lower Density Rural Combined Parcel and Building
3	0.1	Residential High Density Urban Separate Parcel and Building
4	0.05	Residential Lower Density Rural Separate Parcel and Building
5	0.5	Building
6	0.3	Industrial
7	0.3	Commercial
8	0.05	Open Pervious Areas Minimal Grassed Vegetation
9	0.06	Open Pervious Areas Moderate Shrubbed Vegetation
10	0.1	Open Pervious Areas Thick Tree Vegetation
11	0.03	Waterways / Channels Minimal Vegetation
12	0.06	Waterways / Channels Moderate Vegetation
13	0.09	Waterways / Channels Heavy Vegetation
14	0.02	Concrete Lined Channels
15	0.025	Carparks / Driveways

Material ID	Manning's n	Description/Use
16	0.02	Lakes No Emergent Vegetation
17	0.06	Wetlands Emergent Vegetation
18	0.03	Estuaries / Oceans
19	0.1	Railway Lines
20	0.05	Significant Drainage Easement
21	0.05	Gravelled Surface Rural Road
22	0.015	Artificial Turf / Handstand Sporting Surface
23	0.015	Culvert
24	0.05	Agriculture / Farmland
25	0.02	Paved Roads

4.2.3 Hydraulic structures

The hydraulic structure parameters for the culverts shown in Figure 12 were based on the data sources below, listed in order of precedence:

- Drawings of the Kalkallo RB culvert from the 5/4/84, Melbourne Board of Works Drainage Division providing culvert dimensions, inverts, length and slope.
- Drawings of the culverts upstream of Gunns Gully Road from the 28/6/2006, Earth Tech, providing culvert dimensions and inverts.
- Site visit measurements of culvert dimensions from the 9/12/25.
- Annotated image of existing culverts with dimensions from 17/1/2023.
- Nearmap aerial imagery and 1m LiDAR (2017) for culvert lengths and invert levels.

4.2.4 Modelling results

The predevelopment 1% AEP SSP1 peak depths are shown in Figure 14, with shallow sheet flow into the Merrifield North PSP due to the poorly defined channels. Five distinct waterway inflow points are observed along the proposed OMRR reservation. Not all of these inflows converge in the Kalkallo RB as shown in Figure 14, with flows from the eastern waterway bypassing and spilling into the Kalkallo RB.

For the existing Kalkallo RB, the first spillway is at 231.3 mAHD, second spillway is at 231.73 mAHD and third spillway is at 232.3 mAHD. The predevelopment 1% AEP SSP1 peak depths suggest that peak water level reaches 231.62 mAHD, meaning that only the first spillway is engaged as shown.



Figure 13. Predevelopment 1% AEP SSP1 peak depth results.

5 Post development modelling

5.1 Hydrologic modelling

A post development hydrologic model was developed in RORB for the concept design option with 5 crossing locations of the OMRR. This concept design was based on maintaining the existing waterways within the Merrifield North PSP and is further detailed in Section 6. See Section 4.1.1 for key assumptions surrounding the hydrologic modelling parameters.

The post development RORB model was run for the 1% AEP SSP1 (current climate conditions) and SSP3 (2100 climate change conditions) as input for the hydraulic modelling. The SSP3 was run for both the 1% AEP and 63.20% AEP to size the constructed waterways.

5.1.1 Model build

The post development RORB model is shown in Figure 14. Subareas were delineated according to the OMRR and Aitkens Boulevard alignments, preferred waterway alignments, 2017 DSS (see Figure 3) and RB5 footprint. The post development BNW 2025 RORB model subareas were used in section of the model north of Cameron's Lane. The Stormy Water Solutions (2014) subarea delineation shown in Figure 7 were used for the area flowing into RB4 and RB5.

All reaches within the PSP were modelled as 'excavated but unlined' reach types to reflect waterways and overland flow paths in urban areas. For areas where the land use is unchanged in the post development scenario, reach types were maintained as 'natural'.

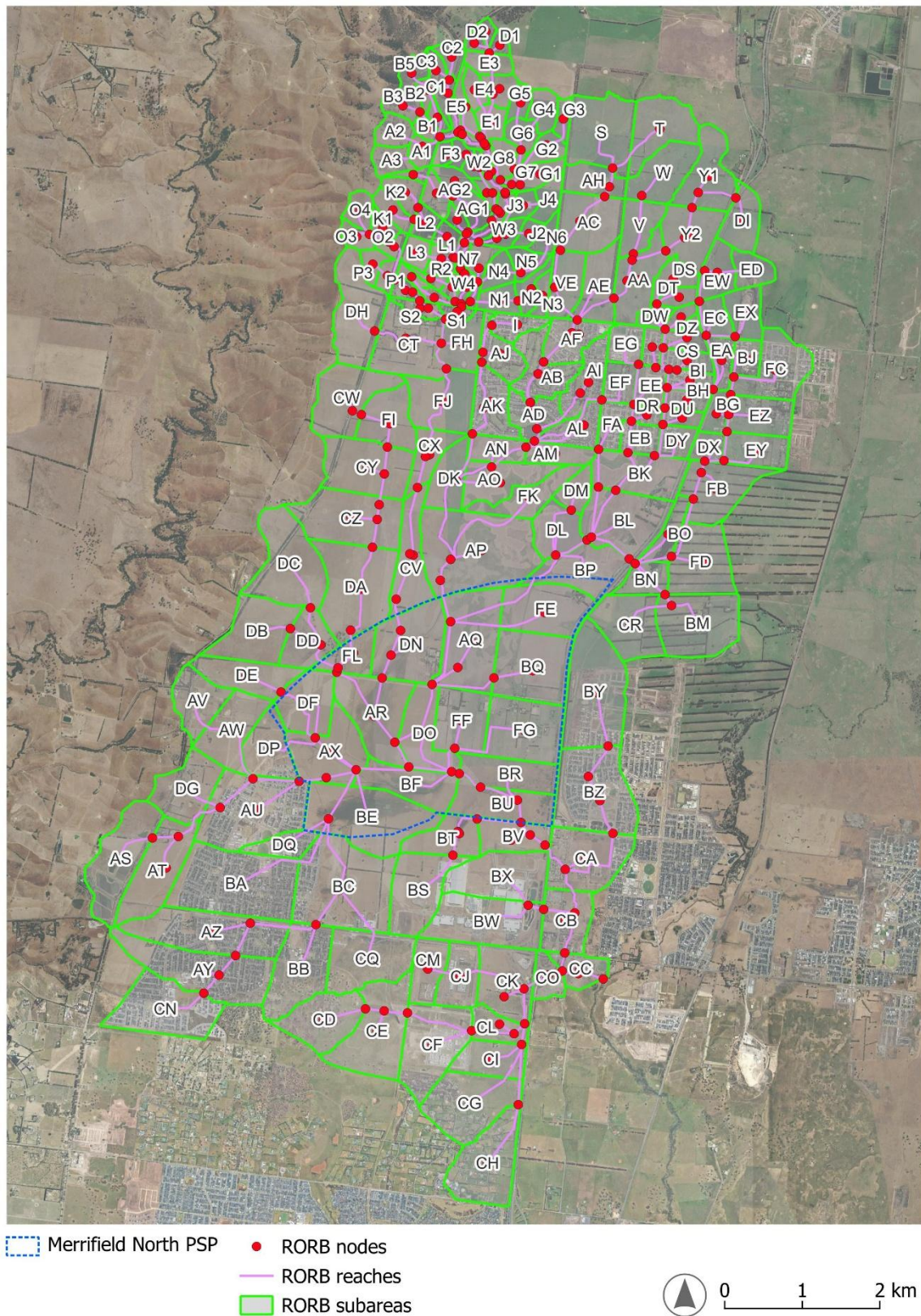


Figure 14. Post development RORB model layout.

The post development land use is shown in Figure 15 and was based on the draft PSP land use. FI values were assigned to each land use according to Table 17.

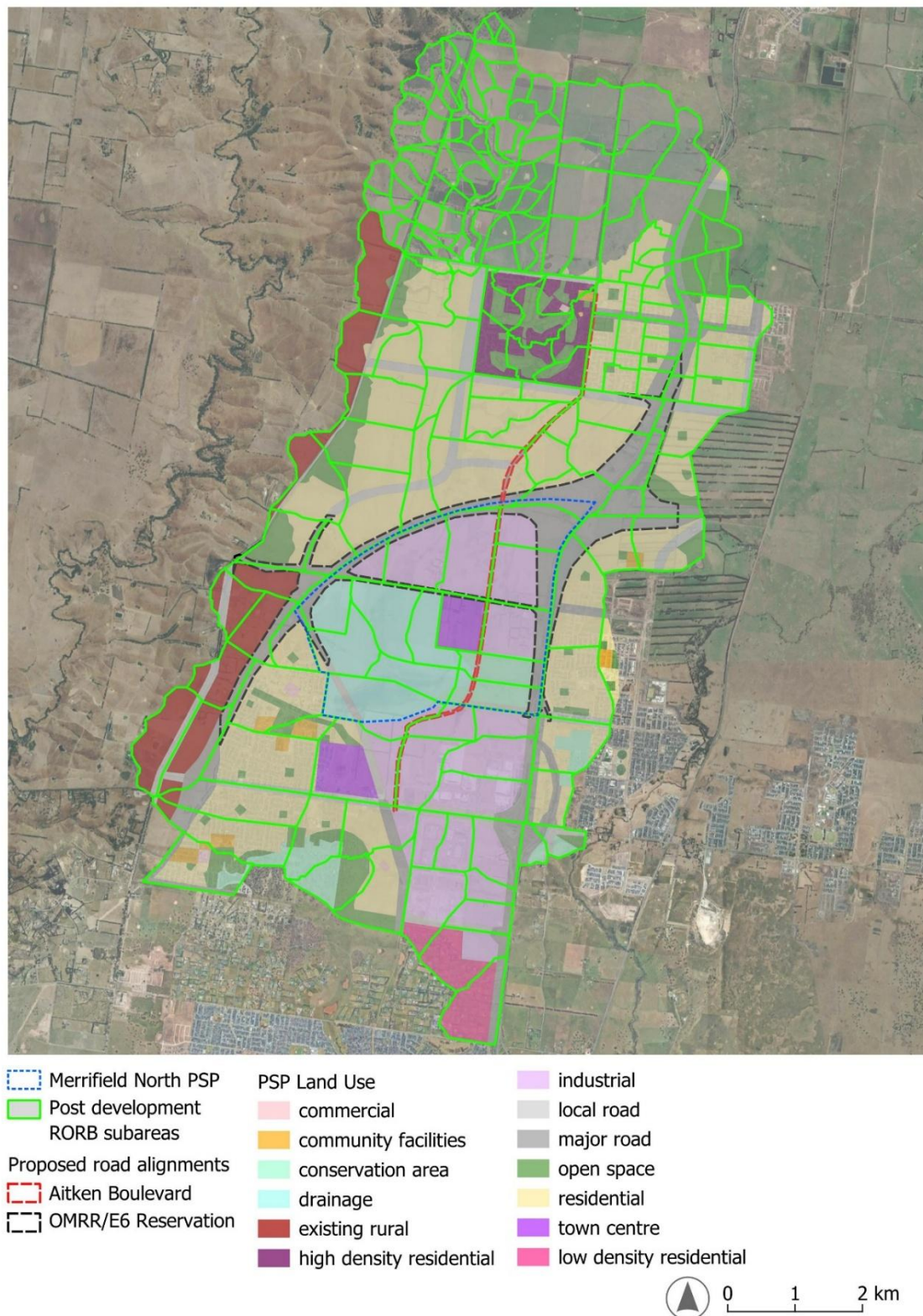


Figure 15. Post development land use categories.

Table 17. Post development fraction imperviousness.

Land Use Category	PSP Land Use	FI
Residential	Residential	0.8
High density residential	High density residential from aerial imagery (25 lots/ha density)	0.85
Low density residential	Low density residential from aerial imagery (lots > 0.4 ha)	0.2
Local open space	Uncredited open space, credited open space, public park and recreation zone	0.1
Industrial	Industry - heavy, extractive industries	0.9
Local road	Existing roads, secondary and local roads	0.6
Existing rural	Existing rural areas outside of PSP scope	0.05
Town centre	Local town centre	0.9
Drainage	Retarding basin / wetland, waterways	0.1
Major road	Major roads and freeways, arterial roads, railways and tramways	0.7
Community facilities	Government and non-government schools, local community facilities	0.7
Conservation area	Conservation area	0.05
Commercial	Business	0.9

The routing parameters for the post development model are provided in Table 18. The loss parameters are the same as the predevelopment model and are shown in Table 12.

Table 18. Key routing parameters.

Model	k_c	K_c/d_{av}	m
Concept design	11.69	1.35	0.8

The parameters and stage storage relationship for the Kalkallo RB were updated to match the Jacobs (2022) post development model for the preferred Kalkallo RB concept design, as below:

- Discharge Relation: Weir and Pipe Formulas
- Spillway:
 - 2 x spillways
 - Spillway 1: 230.85 mAHD crest elevation, 45m effective length
 - Spillway 2: 231.40 mAHD crest elevation, 155m effective length
- Outlet pipe:
 - 1 x outlet pipe / 1050mm pipe diameter
 - 40m length
 - 0.375% slope
 - 226.65 mAHD entrance invert

All other retarding basins in the Jacobs (2022) post development RORB model were included. This included RB4 and RB5, as the H-S and S-Q relationships has been updated since the SWS (2014) functional designs. The Option 2 retarding basins from the Beveridge North West scheme have also been included in the model to represent the with retardation option north of Cameron's Lane.

5.1.2 Modelling results

The critical flows, temporal patterns and durations for the key locations for the 1% AEP SSP1 and SSP3 events are provided in Table 19 and Table 20 respectively. The flows from the critical storms at TUFLOW model inflow locations were used as inputs to the predevelopment hydraulic modelling.

Table 19. Post development hydrologic modelling results for 1%AEP SSP1 event.

Location	Peak flow (m ³ /s)	Duration	Temporal pattern
Kalkallo Creek at Cameron's Lane	31.5	4.5 hour	22
Kalkallo RB Inflow	239.3	2 hour	22
Kalkallo RB Outflow	38.6	24 hour	21
End of PSP	38.5	24 hour	21
Confluence with Merri Creek	54.0	4.5 hour	26

Table 20. Post development hydrologic modelling results for 1%AEP SSP3 event.

Location	Peak flow (m ³ /s)	Duration	Temporal pattern
Kalkallo Creek at Cameron's Lane	49.4	2 hour	28
Kalkallo RB Inflow	353.9	1.5 hour	27
Kalkallo RB Outflow	86.1	24 hour	21
End of PSP	86.6	24 hour	21
Confluence with Merri Creek	99.2	24 hour	21

The post development Kalkallo RB has its first spillway at 230.85 mAHD and second spillway at 231.4 mAHD. The peak water level within the Kalkallo RB must not be greater than 231.4 mAHD to maintain 600mm freeboard to development (Jacobs, 2022).

From Table 19, the peak outflow from the Kalkallo RB for the 1% AEP SSP1 event is 38.6 m³/s with a critical duration of 24 hours and peak water level of 231.4mAHD within the basin. Therefore the post development RORB modelling suggests that the Kalkallo RB meets the 600mm freeboard requirements under the 1% AEP SSP1 event.

The existing Kalkallo RB attenuates peak flows to 20.9 m³/s for a 12 hour critical duration. Therefore the preferred concept design for the Kalkallo RB does not mitigate the post development flood peak back down to predevelopment flood levels. However, the post development results for the 1% AEP SSP1 event

are in agreement with the Engeny 2017 and Jacobs 2022 RORB modelling. The Engeny 2017 Kalkallo RB peak outflow was 36.4 m³/s at a 72 hour critical duration, and Jacobs 2022 Kalkallo RB peak outflow was 35.9 m³/s for a 48 hour critical duration with a peak water level of 231.4 mAHD. It is worth noting that part of the Kalkallo RB design was to delay peak flows from Kalkallo Creek to ensure that it does not coincide with the peak flow at Merri Creek. As the hydrologic model extent does not include Merri Creek, this has not been analysed in detail as part of this study. As shown in Figure 8, the timing of the peak flow in Merri Creek at the Yarra confluence is close to 20 hours, whereas the timing of the Kalkallo RB peak outflows is 24 hours. Since the Kalkallo RB design is not yet finalised and expected to be subject to change, further analysis of the peak flow timing can be explored in the next iterations of the Kalkallo RB design.

From Table 20, the peak outflow from the Kalkallo RB for the 1% AEP SSP3 event is 86.1 m³/s for a 24 hour critical duration and peak water level of 231.62 mAHD within the Kalkallo RB. The second spillway is engaged due to the much higher inflows expected with 2100 climate change conditions. Under the 1% AEP SSP3 event, the preferred Kalkallo RB design would provide 380mm freeboard to development. Further iterations of the Kalkallo RB design may need to be undertaken to meet the 600mm freeboard requirement under 1% AEP SSP3 2100 climate change conditions.

6 Concept design options

6.1 Constructed waterway sizing

Preliminary sizing of the waterway corridors has been undertaken for the 5 main waterways in the Merrifield North PSP. It was ensured that every 60ha of developable catchment is serviced by a waterway.

The 1% AEP and 63.20% AEP SSP3 (2100 climate change conditions) peak flows were used as a conservative estimate for constructed waterway sizing. The key channel design parameters used to calculate the waterway corridors are provided in Table 21. The 1m LiDAR (2017) was used to calculate approximate waterway slopes along each section of the constructed waterways. Where the calculated slope was steeper than 1 in 200, it was assumed that the channel will have rock chutes with a 1 in 200 slope in between. The constructed waterway sizing was based on a conservative estimate of a shallow and wide channel, to be refined in future iterations. Once the waterway corridor was estimated, a 7.5m sodic soil buffer was added to each side.

Table 21. Key channel design parameters.

Parameter	Value
Channel slope	1 in 500 (0.2%) to 1 in 200 (0.5%)
Side slopes	1 in 3 (channel) - 1 in 5 (upper batters)
Freeboard allowance	300mm (min above 1% AEP SSP3 flood level)

The preliminary concept waterway corridors and preliminary sediment basin locations for the Merrifield North PSP are shown in Figure 16. This includes 5 road crossings of the OMRR to maintain the existing waterway alignments. Note that the concept waterway corridors in Merrifield North are not yet finalised and will be provided in future stages.

The constructed waterway corridors shown in Figure 16 are comprised of a core riparian zone, vegetated buffer and additional sodic soil buffer, based on the 1% AEP SSP3 flows. A summary of the constructed waterway design parameters to determine these zones are provided in Table 22.

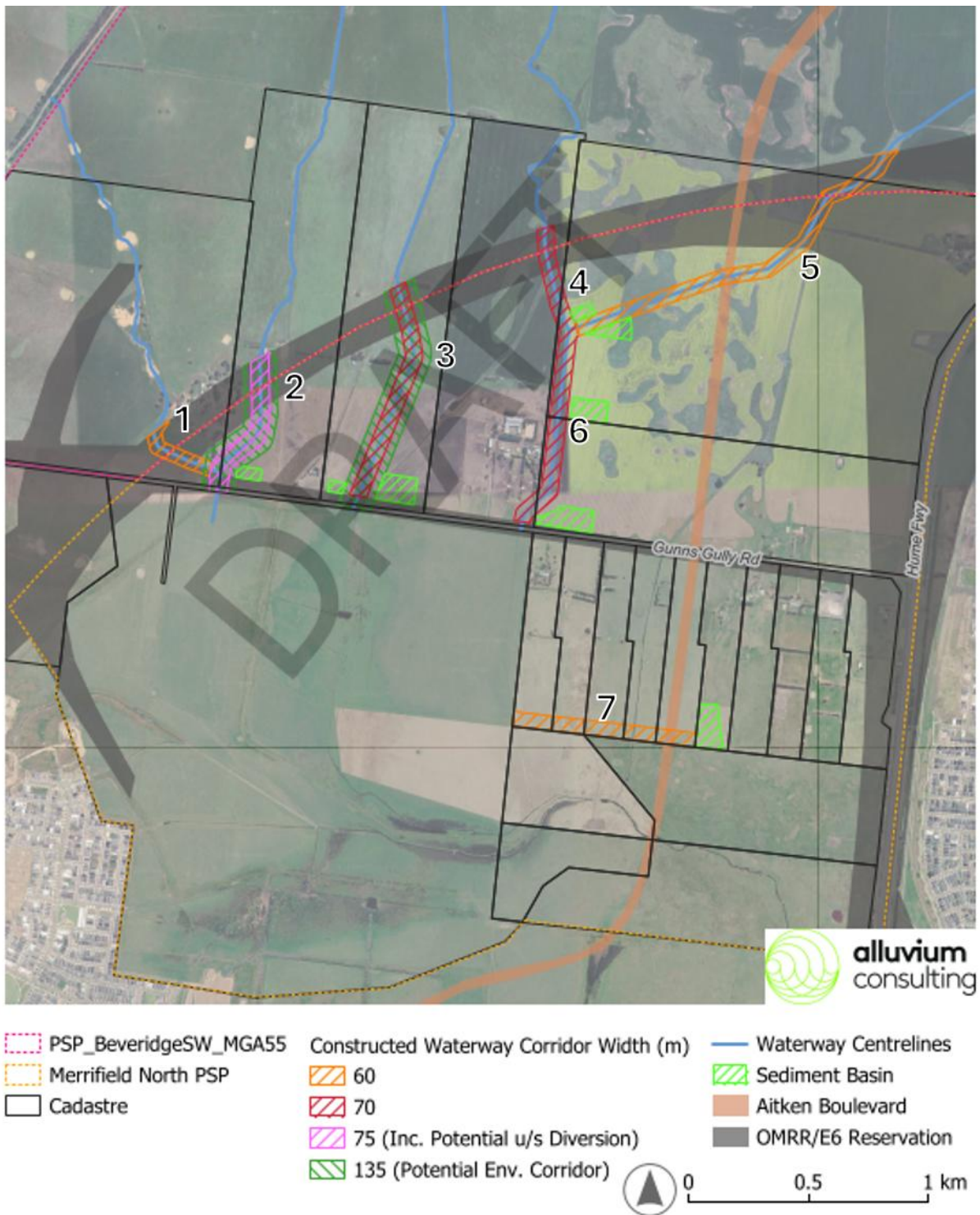


Figure 16. Preliminary constructed waterway corridor widths for Merrifield North.

A summary of the constructed waterway design parameters is provided in Table 22.

Table 22. Constructed Waterway Design Parameters

Waterway No.	1 EAY (reach max m ³ /s)	1% AEP (reach max m ³ /s)	Core riparian zone	Vegetated buffer	Calculated corridor width	Corridor width with +15m SS buffer
1	9.23	42.23	30	15	45	60
2	21.5	114.72	40	20	60	75
3	7.07	63.55	35	20	55	70
4	15.95	75.96	35	20	55	70
5	7.83	31.15	30	15	45	60
6	20.93	105.06	35	20	55	70
7	7.65	28.83	30	15	45	60

A key point to address, which affects the sizing of the constructed waterway corridors is whether Kalkallo Creek will be diverted upstream of the Merrifield North PSP within the Beveridge South West PSP. If Kalkallo Creek is not diverted, the central constructed waterway corridor representing the original Kalkallo Creek line will need to be maintained (Waterway No. 3), with a constructed waterway width of 70m.

If Kalkallo Creek is to be diverted according to the 2017 DSS, constructed waterway corridor (Waterway No. 2) in Figure 16 will receive higher flows and therefore has been sized for this diversion scenario (waterway corridor width of 75m). In the diversion scenario, the central constructed waterway corridor (Waterway No. 3) would no longer be required.

Additionally, a 135m environmental buffer for the main Kalkallo Creek line has been added to both the western Waterway No. 2 and central Waterway No. 3 corridors to account for both diversion and no diversion scenarios. This 135m environmental buffer was applied to the main Kalkallo Creek line for the Beveridge North West PSP and included here for consistency.

A high-level preliminary estimate of sediment basin sizing shown in Figure 16 was based on 3% of the developable catchment area, excluding road reserves. The sediment basins were aligned to the parcel boundaries in the 2017 DSS (see Figure 3) to prevent staging issues.

7 Next steps

Following the review of the proposed concept waterway corridors and sediment basin locations in the Merrifield North PSP, the next steps include:

- Refinement of the sediment basins and constructed waterway calculations for the Merrifield North waterway corridors based on stakeholder feedback.
- Concept/functional design layout plans including waterway alignments, earthworks, setbacks, stabilisation (rock chutes) for Merrifield North
- Undertake a safety in design assessment and cost estimates

8 References

Alluvium (2023). Merrifield North and Beveridge South West PSP Flood Assessment Modelling Report. Prepared for Melbourne Water.

Alluvium (2024). Merrifield North Employment and Beveridge South West Precinct Structure Plans – Geomorphology and Vegetation Assessments. Prepared for Melbourne Water.

Engeny (2017). Kalkallo Retarding Basin Hydrology and Concept Design. Prepared for Melbourne Water.

Jacobs (2022). Kalkallo Basin Concept Design Analysis. Prepared for Melbourne Water.

Stormy Water Solutions (2014). Kalkallo Development Services Scheme – East Catchment DSS Element Functional Design. Prepared for Melbourne Water.

