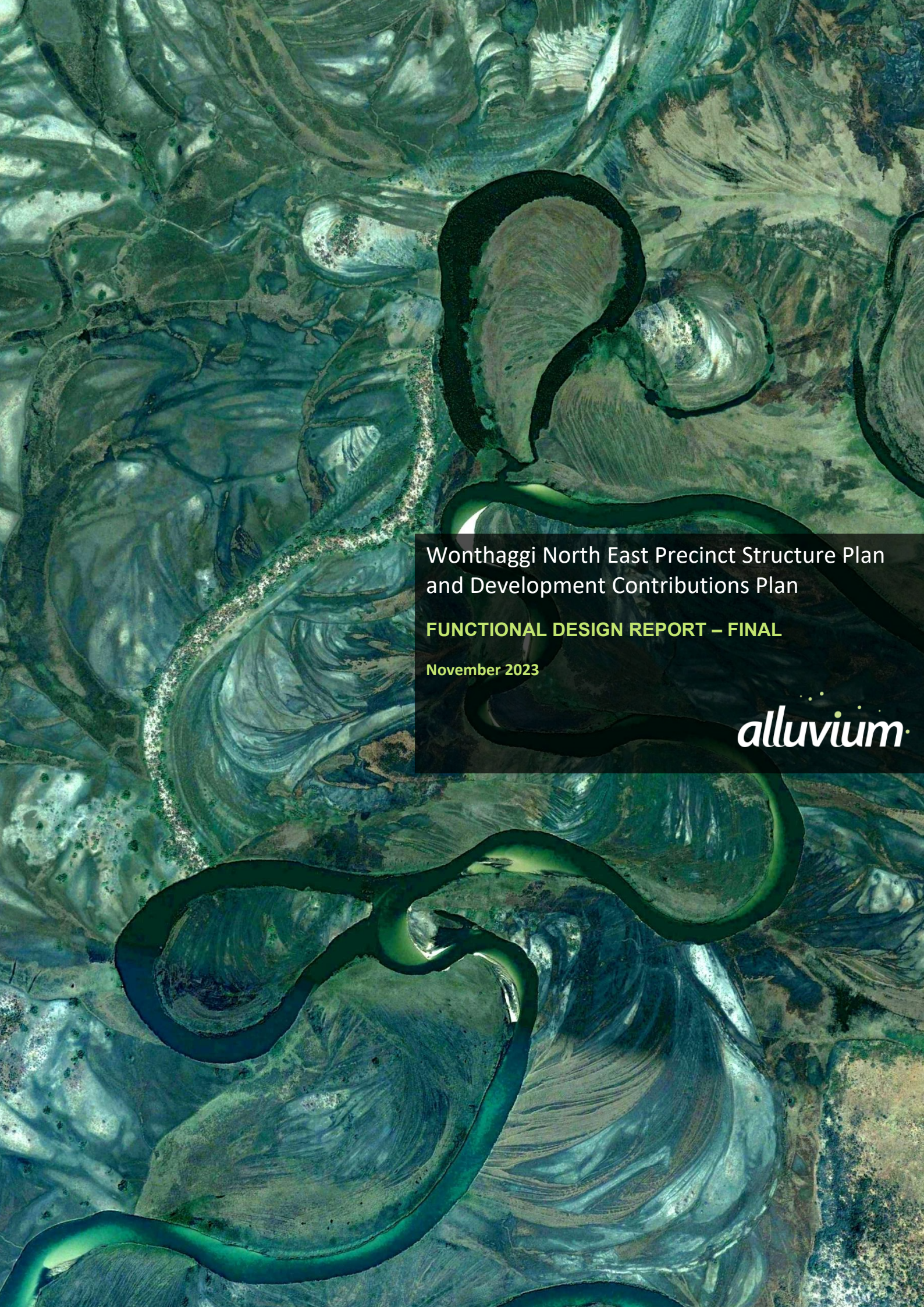


# Wonthaggi North East Precinct Structure Plan and Development Contributions Plan

## FUNCTIONAL DESIGN REPORT – FINAL

**November 2023**

alluvium



Alluvium 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 Vicki Golding. This piece was commissioned by Alluvium and has told our story of water across Country, from catchment to coast, with people from all cultures learning, understanding, sharing stories, walking to, and talking at the meeting places as one nation.*

This report has been prepared by Alluvium Consulting Australia Pty Ltd for the Victorian Planning Authority under the contract titled 'D/21/3212 – WONTHAGGI NORTH EAST PRECINCT STRUCTURE PLAN AND DEVELOPMENT CONTRIBUTIONS PLAN – STORMWATER DRAINAGE FUNCTIONAL DESIGNS AND COSTINGS'.

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## Abbreviations

| | |
|---|---|
| Alluvium | Alluvium Consulting Australia Pty Ltd |
| BCSC | Bass Coast Shire Council |
| BPEMG | Urban Stormwater - Best Practice Environmental Management Guidelines (CSIRO, 1999) |
| CMA | Catchment Management Authority |
| CU | Culvert |
| CRZ | Core Riparian Zone (waterway corridor component) |
| DCP | Development Contributions Plan |
| DETV | Department of Education and Training, Victoria |
| Engeny | Engeny Water Management Pty Ltd |
| GPT | Gross Pollutant Trap |
| PoC | Proof of Concept Report (Alluvium) |
| PSP | Precinct Structure Plan |
| SB | Sediment Basin |
| TSS | Total Suspended Solids |
| TP | Total Phosphorus |
| TN | Total Nitrogen |
| VB | Vegetated Buffer (waterway corridor component) |
| VPA | Victorian Planning Authority |
| WGCMA | West Gippsland Catchment Management Authority |
| WLRB | Wetland and Retarding Basin (integrated asset). DCP Referencing uses WL generically (see notes below) |
| WNEP | Wonthaggi North East Precinct |
| WW | Constructed Waterway (E-WW is east alignment; W-WW is west alignment) |

### Notes – Reading this report:

1. **WLRB** – the flood retarding function and wetland treatment requirements for the PSP have been resolved with integrated systems (multi-functional / multi-beneficial assets) to reduce overall land take across the precinct. Both water quality treatment function and quantity retarding function are performed by the one asset as denoted by WLRB in this Report.

2. **DCP Referencing** – currently, asset referencing does not identify asset functionality in the nomenclature (naming format) for PSPs and DCPs. The nomenclature does not demonstrate differences between an asset that performs multi-functionality (e.g. treatment and retardation) versus an asset that is singular in function (e.g. treatment only or retardation only). All such assets (singular or multi-functional) are generically referenced as WLs under the DCP process. This annotation is not technically representative of the asset's function and is not reflective of overall cost, nor its functional importance to the precinct.

   Similarly, constructed waterways are represented as DRs (drain nomenclature). This naming is inconsistent with current thinking / best practice of water resources / State Framework for IWM, where this language has moved away from "drainage" to stormwater management, recognising the resource value stormwater plays in urban landscapes and liveability outcomes.

3. **Cross Referencing –** where Alluvium has applied asset function naming (e.g. WLRB or WW for waterways) this naming is followed with the DCP reference naming for that asset (captured in brackets). Sediment Basins have Alluvium (DCP ref) numbering formats. All Culvert numbering has adopted the new (2023) DCP reference numbers. This is true for this Report and the functional design set (drawings) for the PSP. TABLE 2 in this report provides further clarity on asset IDs / DCP referencing and corresponding report sections.

# 1 Introduction

Alluvium Consulting Australia Pty Ltd (Alluvium) was engaged by the Victorian Planning Authority (VPA) in July 2021, in partnership with Bass Coast Shire Council (BCSC), to undertake a suite of stormwater drainage functional designs and associated cost estimates for the Wonthaggi North East Precinct Structure Plan (PSP) and Development Contributions Plan (DCP). This work was based on the original Stormwater Management Plan (October 2019) by Engeny Water Management, with associated concept design layouts for the precinct.

Following the planning panels and amendments processes (2022), Alluvium was re-engaged by the VPA (November 2022) to undertake a review of the Functional Design Report, functional asset designs and cost estimates in line with the Standing Advisory Committee's (SAC) findings. Engeny was also re-engaged by the VPA to work in parallel with Alluvium and refine and update the original Stormwater Management Plan (2019) and associated concept layouts, to the now *Revised Drainage Strategy* (September 2023).

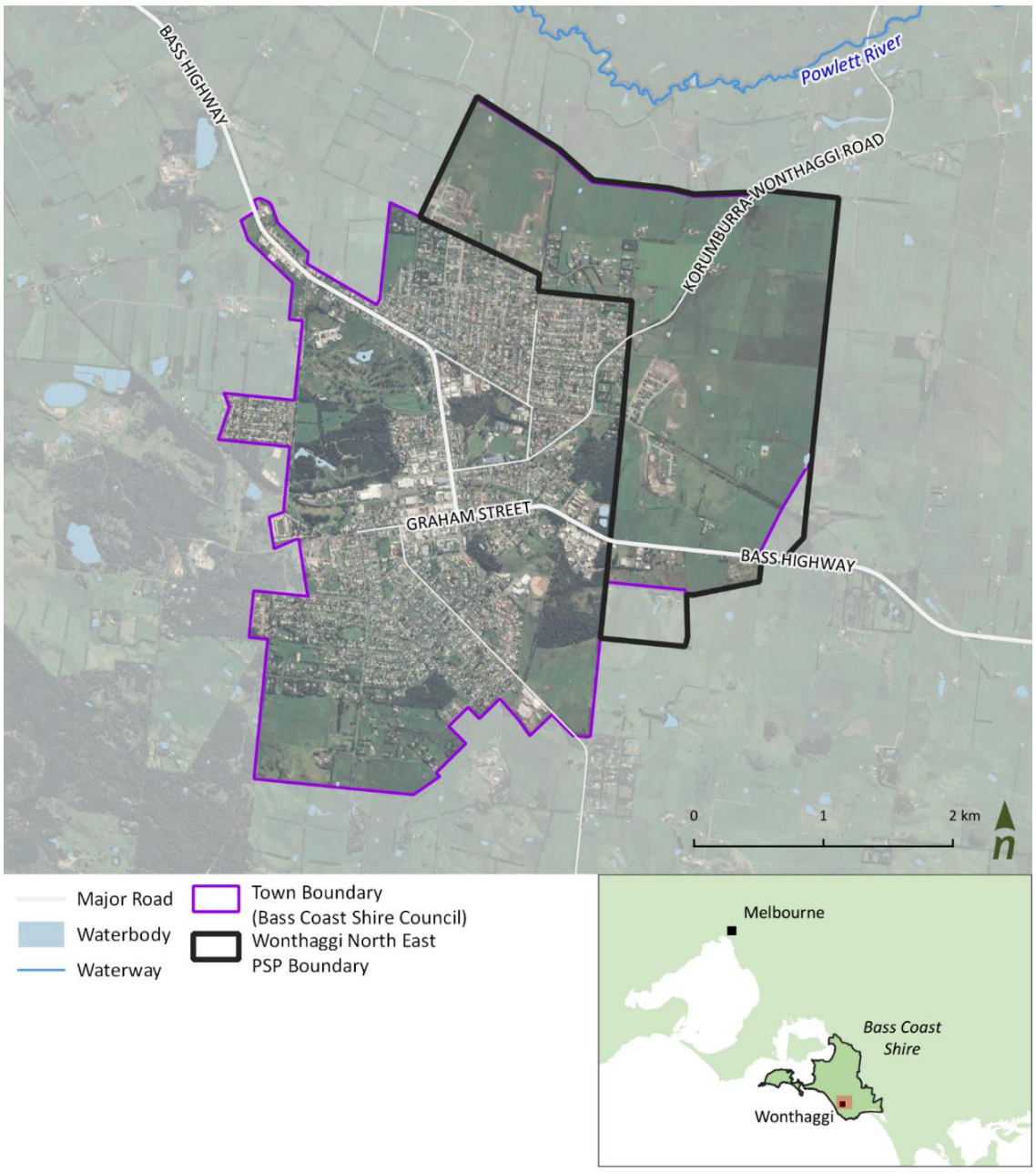



**Figure 1.** *Site location*

A summary of the proposed PSP land use is provided below.

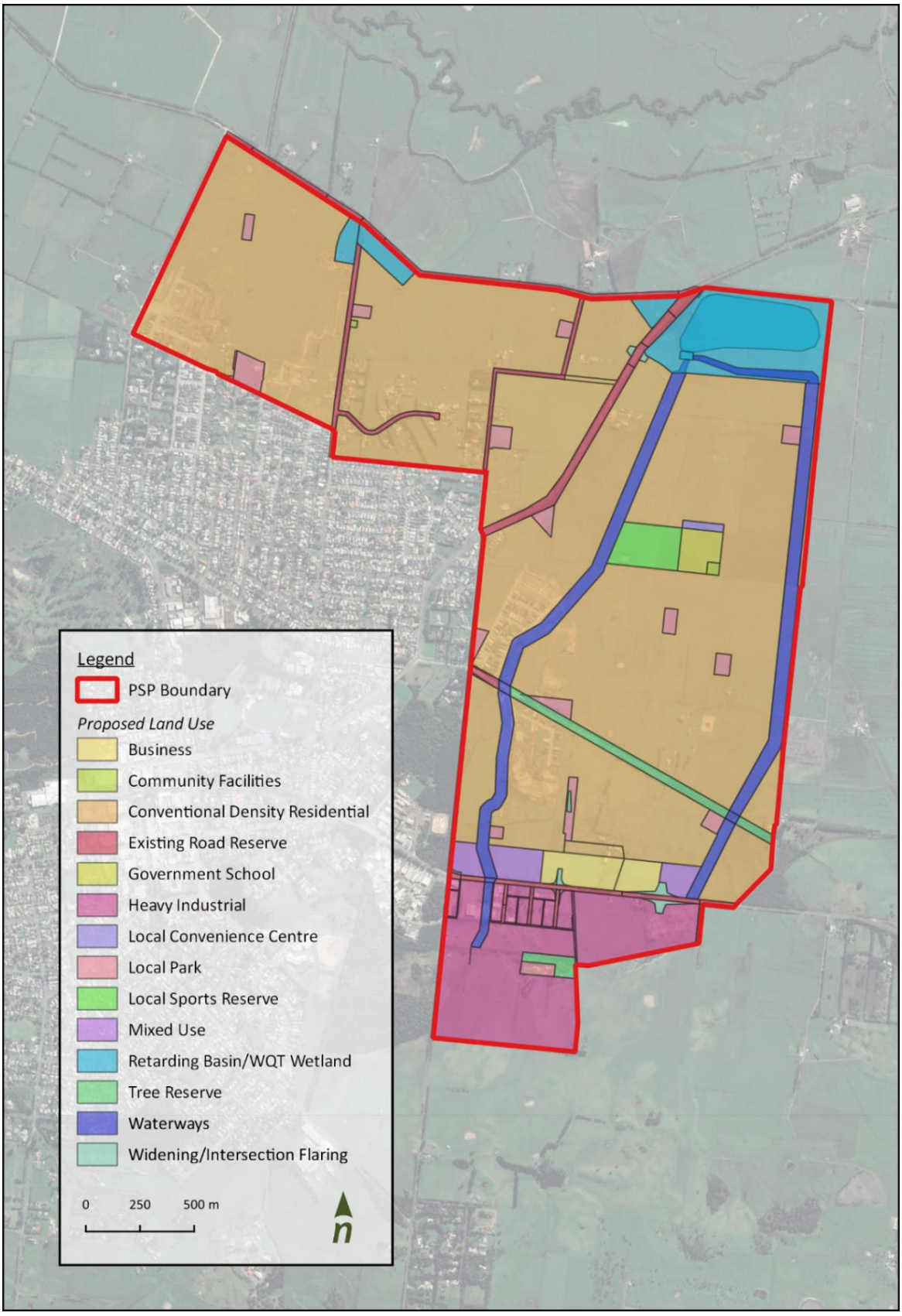



**Figure 2.** *Site Overview - project PSP area and proposed land use (source: modified from GIS proposed land use data, VPA).*

# 2 Background – Context, Submissions & Revisions

## 2.1 Stormwater Strategy & PSP Concepts (Engeny, October 2019 – September 2021)

2016 – Engeny consultants were engaged by the Bass Coast Shire Council to undertake flood modelling, stormwater drainage investigations, and development of a stormwater management strategy for the Wonthaggi North East growth area. This work underwent multiple minor revisions between 2017 and 2019 and was finalised in October 2019 – *Stormwater Management Plan (2019)*, herein, the Strategy.

October 2019 – The Engeny Stormwater Management Plan developed the proposed assets to a conceptual level with associated high-level cost estimates. The adopted Strategy for the PSP identified 29 functional water assets (plus additional main outfall) for capture, conveyance and management of stormwater quantity and quality across the precinct, which included:

- Two (2) 'internal' constructed waterways (a west and east alignment)
- Four (4) treatment wetlands, two (2) of which to be integrated with retarding function (RBs)
- 11 sediment basins (SBs)
- 12 culverts (CUs)
- and potential for additional (e.g. main outfall to Powlett River - MOP).

June 2020 – Following the Scheme Amendment C152 process for the PSP, Engeny was re-engaged by Council to prove the proposed PSP concepts further, specifically in relation to the proposed wetland-retarding basin 1 (WLRB1; DCP ref WL-01) and the ultimate outfall from the precinct to the downstream at Powlett River. This work resulted in the *Impact and Proposed Mitigation Works Strategies* (Engeny, March 2021).

April 2021 – Tranche 1 of the Standing Advisory Committee (SAC) Hearing was held with further community consultation undertaken later (Nov-Dec 2021).

July 2021 – Alluvium was engaged by the VPA for a PSP "fast track" process to develop the functional designs for the stormwater related PSP assets, as proposed in the Council-approved *Stormwater Management Plan* (Engeny, 2019).

However, following the SAC (Tranche 1), Engeny was re-engaged by the VPA (on behalf of Bass Coast Shire Council) to update the 2019 Strategy in accordance with the SAC recommendations. During the time of Alluvium's engagement, three revisions (iterations) of the Strategy and Concept Layouts were produced, with further revised modelling work and changes to the number / footprints of proposed stormwater assets.

Alluvium produced / submitted / revised outputs to accommodate changes, as follows:

- Preliminary Proof of Concept Report (23 July 2021)
- Revised Proof of Concept Report (20 August 2021) to accommodate new flood modelling data
- Revised Proof of Concept Report (31 August 2021) to accommodate updates to the Strategy
- Final (4$^{th}$) Proof of Concept Report (22 September 2021) to accommodate further changes to the final Stormwater (drainage) Strategy and modelling confirmations.

The Proof of Concept Report(s) identified issues of concern and opportunities for the PSP relating to:

- no main outfall for the PSP to the Powlett River (noted by stakeholders)
- all treatment wetlands need to function as integrated treatment and retarding systems (accepted by stakeholders)
- all wetlands must include an integrated sediment basin as per standard wetland design (accepted by stakeholders)

- potential opportunities to consolidate the number of sediment basins proposed to free up developable land areas, without compromising CMA requirements for sediment controls (accepted by stakeholders)
- potential to decentralise stormwater assets (for development staging efficiencies) by retaining interim solutions (at Parklands Estate, north of McGibbonys Road) into the ultimate design solution for the sub-catchment (recommendation not accepted by Council)
- potential to create naturalised (sinuous) constructed waterways to enhance landscape amenity (not accepted by VPA due to requirements to remain within designated PSP boundaries as per planning regulations/process)
- potential walkability links from the PSP to existing surrounds (Wonthaggi Central, bushland reserves, rail corridor, historic precincts and walking trails).

The main changes by Engeny to the Strategy, concept designs and PSP layouts included:

- Updating the hydrology to be compliant with Australian Rainfall and Runoff 2019
- Undertaking flood modelling of the Powlett River system
- An adjusted waterway alignment for the E-WW or eastern waterway (DR-02)
- Changes to the flood extents, WLRB asset locations, footprints and alignments
- Changes to subdivisional development activities (council-approved) impacting the proposed PSP assets
- Changes to footprint / alignment of WLRB4 (DCP ref WL-04) to accommodate the council-approved Design Development Plan (2011) for residential area east of Fuller / west of Wentworth roads
- 4 treatment wetlands – now confirmed all require an integrated wetland-retarding basin approach
- 11 sediment basins – increased to a total of 16 proposed SBs
- 12 culverts – reduced in total as some found to be existing / installed as per subdivisional works at play
- PSP outfall asset – additional asset to be designed to provide an ultimate outfall* to the Powlett River and reduce flooding to private land to the north of the PSP (Figure 3).

Engeny's work was summarised in the Revised Drainage Strategy for Wonthaggi North East PSP (November 2021).

*It should be noted that the Engeny final concept for the PSP outfall to the Powlett River was conceptualised from the PSP boundary to *within* a private land parcel to the north, at 465 Heslop Road (the subject property), where an existing open farm channel is located.

Planned mitigation works to reduce flooding on the subject property (Engeny, March 2021) included a widening of the farm channel(s) to increase capacity in the 50% AEP to meet WGCMA requirements for downstream protection. The existing farm channel(s) then run adjacent to the river towards the north-west and ultimately outfalls to an existing discharge point on the Powlett River, downstream of Pinkerton Rd.

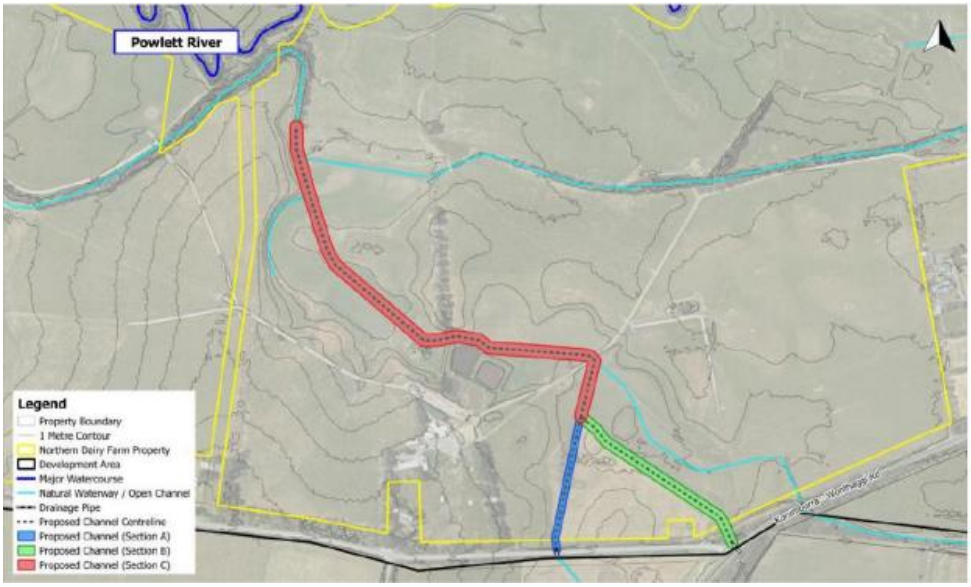



Figure 3. *Planned mitigation works to reduce flooding on subject property (Engeny, March 2021)*

Comparative changes in assets / concept layouts between the original council-approved Engeny Strategy (Oct 2019) and Revised Strategy (Sept 2023) are below.

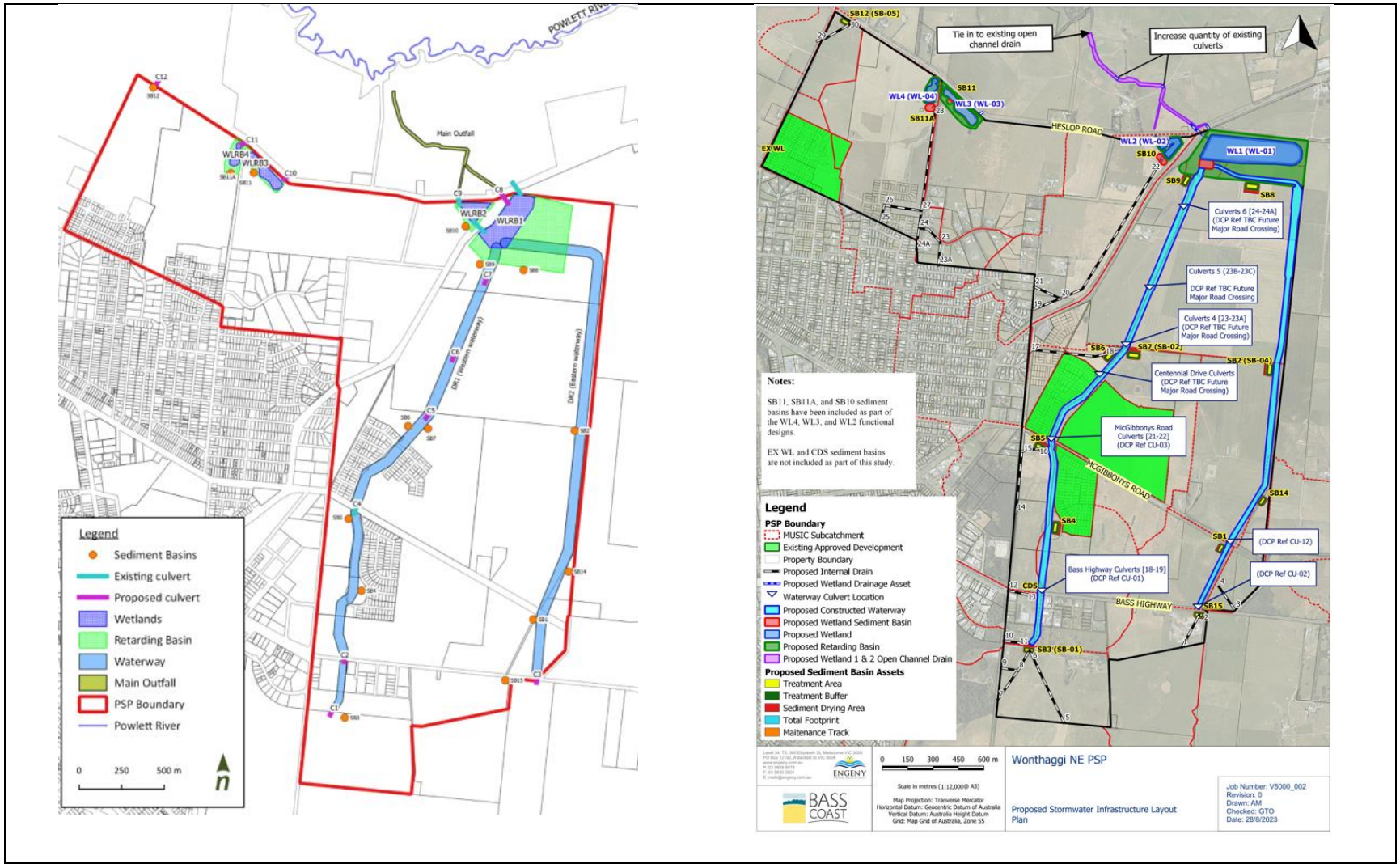



**Figure 4.** *Comparative changes in proposed asset concept design layout - Oct 2019 (left) to Sept 2023 (right) (as per Engeny, 2023)*

## 2.2 Functional Designs & Costings (Alluvium, October 2021 – November 2022)

October 2021 – Following submission and adoption of the Final *Proof of Concept Report* (Alluvium, Sept 2021), Alluvium developed the Functional Design Report, functional design drawings package and cost estimates for the PSP stormwater related assets – *Wonthaggi North East Precinct Structure Plan and Development Contributions Plan Functional Design Report* (Alluvium, November 2021).

Alluvium identified concerns with regard to:

- Incomplete survey data and lack of a main outfall for the PSP
- Potential erosion risk / vegetation losses along existing farm channels if widened as per Engeny (March 2021)
- Subdivisional works undertaken south of McGibbonys Road on the constructed section of the western waterway (DR-01) and associated bank stability issues, sediment basins, and drainage discharge points (connections to waterway)
- Discharge quality from the proposed industrial estate on Carneys Road and the impacts of this on the constructed waterway / wetland assets (ecological impacts over time).

VPA later engaged Alluvium to undertake the MOP investigations to determine if a suitable main outfall for the PSP to the Powlett River could be resolved. The scope of this work is shown below.

The proposed MOP design extends from the northern extent of the PSP boundary, to upstream point of the Pinkerton Rd (existing) culverts. No design changes were made or suggested in relation to the Powlett River in this study.

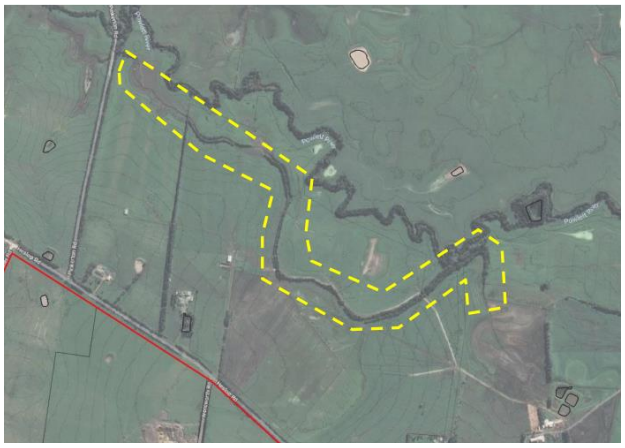


Figure 5. *Extent of study area (yellow) up to Pinkerton Rd culverts / farm channel shown (outfall to Powlett)*

This work – ***Addendum:*** *Main Outfall Functional Design Report* (Alluvium, December 2021) was limited by:

- the lack of survey information to assess suitability / function of the downstream channels
- the likely risk of increasing flooding to the north-west (downstream of Pinkerton Road)
- and/or cause erosive potential to bed and banks or longer term headward erosion of the farm channels without better informed survey data.

The Addendum later formed part of Alluvium's final Functional Design Report, with recommendations to inform future detailed design stages to resolve survey data issues and the ultimate downstream outfall design considerations. It was found that modest design changes resulted in increased flooding downstream.

December 2021 – The PSP / DCP and supporting technical work was released for public consultation. During this time, VPA engaged Craigie & Daff to undertake an independent preliminary assessment (peer review) of

the Alluvium functional designs and cost estimates going back to first principles and determine if there is scope for significant cost savings through re-design of the proposed stormwater infrastructure.

April 2022 – Alluvium was re-engaged by VPA in January 2022 to consider the *Preliminary Drainage Assessment Report* (independent peer review by Craigie and Daff) and provide a response to recommendations.

For those recommendations considered feasible, in accord with best practice, and beneficial to overall PSP/DCP costs and intended outcomes, Alluvium updated relevant asset designs to ensure clearance requirements for other authority assets could be achieved, and ultimately, cost savings may be realised for the overall DCP, particularly regarding the WLRB1 (DCP ref WL-01) design.

Engeny was re-engaged by VPA to test Alluvium's design changes (as per recommendations of the independent peer review) to determine if:

- PSP asset functionality can be maintained (retardation/treatment)
- flood conditions are not made worse
- retarding basin storages are sufficient to meet flood protection requirements.

Following model confirmations, the Final Functional Design Report and design drawings package were refined, and cost estimates updated, and the package of works resubmitted to VPA (end April 2022).

May 2022 – Alluvium and Engeny were re-engaged to participate / contribute to a *Drainage Engineering & Costings Experts Conclave* to discuss concerns and clarify modelling influences, design approaches, results and outputs, and cost estimations with regard to the proposed stormwater Strategy and Functional Designs for the precinct.

The Conclave points of agreement, non-agreement, resolutions and recommendations were prepared for submission to the pending Tranche 2 SAC Hearing – *Final Statement of Facts Wonthaggi North East PSP and DCP – Drainage Conclave (May 2022).*

June 2022 – Tranche 2 of the SAC Panel Hearing commenced in June 2022 and led to the *SAC Recommendations Report* (August 2022).

November 2022 –The VPA re-engaged Alluvium and Engeny to undertake an update of the Strategy (Engeny) and the Functional Design Report (Alluvium) in response to the SAC Recommendations Report. This included designing the main (trunk) drainage system to support future subdivisional connections to the proposed stormwater assets for the PSP, as per Panel discussions (refer to Section 8.3).

Further, as identified through the panel process, a number of subdivisional approvals have occurred during the PSP/DCP development process that no longer accord with the strategic intent or proposed concepts for the PSP, as determined by the approved Stormwater (Drainage) Strategy for Wonthaggi North East Precinct Structure Plan (Engeny, September 2021). As a result, the post hearings revision seeks to account for development changes that have occurred over time within the precinct, approved development plans, S173 agreements, and reviews of alternate design strategies and submissions to date.

This Report accounts for the above and responds to the SAC Recommendations Report (August 2022) as detailed in Section 3.3.

# 3 Design Approach

Wonthaggi NE PSP was a VPA 'fast track' PSP process in response to demand for growth areas. The scope of this study was to develop feasible and cost-effective functional designs (30+) based on the adopted concepts and flood modelling works undertaken previously by others. This study is to provide the VPA and key stakeholders confidence that the proposed concepts for the PSP can adequately function as intended; and provide a more accurate understanding of the required infrastructure, land take (footprints), capital investment costs, and maintenance requirements and associated costs for the DCP.

Ultimately, this project allows for the finalisation of the Precinct Structure Plan (PSP) and further informs the Development Contributions Plan (DCP) assets and costings for the Wonthaggi North East Precinct.

The intent of this study is to:

- review previous strategies and background information and reports (Phase 1)
- analyse previous modelling and concepts, and undertake refined modelling (Phase 1/2)
- confirm the required stormwater management assets (location, type, footprints) in an integrated manner (Phase 2, Proof of Concept Report)
- develop the concepts into a functional set for the PSP including functional designs, refined costing estimates, and Functional Design Report (Phase 3).

## 3.1 Phase 2 - Proof of Concept Report (September 2021)

Building on existing work and reports (by others) Alluvium recommended an alternative concept / modified design approach for the precinct for consideration of VPA and Council, as part of the Proof of Concept (PoC) phase. The PoC recommendations were based on potential efficiencies in land take, asset performance and long term protection, capital costs and lifecycle management costs, asset locations and practical delivery potential – all particularly important to allow development to proceed viably, sustainably and efficiently.

Recommendations included a consolidation of proposed (assets) concepts from 30+ to a total of 25 functional designs, including the precinct's Main Outfall to the Powlett (MOP) River design, with a number of independent assets integrated into others. For instance, of the 16 independent sediment basins, 4 were integrated into the 4 wetland designs (as per best practice); while others were made redundant due to small contributing catchments that could be accommodated by downstream assets (removing doubling up); or removed due to existing assets and/or recently approved (installed) assets as per subdivisional approvals underway (as per Council advice).

Therefore, the total number of individual assets for functional design are as follows:

- 2 proposed constructed waterways (east and west alignments) – remains same as per PSP/DCP and Engeny concepts
- 2 treatment wetlands + 2 integrated wetland-retarding basins proposed – Proof of Concept confirmed all 4 wetlands required to provide flood protection, therefore all now integrated WLRB assets.
- 16 sediment basins proposed – these were reconciled with further modelling and analysis:
    - 7 SBs were proposed as independent structures and have been reduced to 5 SBs overall.
    - 5 SBs have been removed/integrated into the four WLRB designs as per design standards. Note: WLRB1 (DCP ref WL-01) has been split into 2 systems (1A & 1B) to account for the large catchments.
    - 4 SBs were deemed redundant / of limited contribution to the PSP as catchments were too small to warrant; or were removed from Engeny's final strategy; or were delivered under recently approved development plans / other works.

- Stakeholders requested a revisit of the merit of two sediment basins to the PSP (DCP SB4 & DCP SB6) given late alterations to their ultimate location and relative catchments.

- 12 culverts recommended – these were reconciled with further modelling and analysis:
  - 5 were removed following further analyses – either found to be existing; removed from final Engeny Strategy; or not a PSP / DCP item (e.g. Centennial Dve).
  - 7 remain – where these were deemed critical to the PSP during Alluvium's Proof of Concept phase, either servicing the two constructed waterways or WLRB (independent) outfalls (e.g. between WL-03 and WL-04), with some refinements.
  - Plus 3 additional – as proposed for the Main Outfall (DCP ref DR-03) to Powlett River.

  This is a total of 10 proposed PSP culverts (CU-01 to CU-10). Following the redesign process, two further culverts have been designed:
  - CU-11 provides High Flow Outfall from WLRB1 (WL-01) to DR-03 as a separate item (previously incorporated with WL-01 design / costs. Now consistently separated as per other culverts).
  - CU-12 is located along the McGibbonys Road reservation (future extension) for crossing the East-Waterway (DR-02). The design was undertaken as the road reservation is existing (as per existing conditions design approach). Culvert allows waterway to pass unimpeded.
- 1 main outfall (MOP and associated infrastructure) – the MOP asset (DR-03) was additional to scope.

Following Alluvium's submission of the PoC Report, stakeholder reviews and comments (VPA, BCSC and CMA) were addressed and informed the next stage of the project – the functional designs of the 25 approved stormwater management assets for the Wonthaggi North East PSP (refer to summary in Table 2 for further details on the agreed / approved PSP assets).

Note: Following Tranche 2 of the SAC and recommendations report, the trunk drainage to service the subdivisional stormwater pipe network and connections to the PSP treatment/retarding assets, has since been undertaken and included in the functional design package in accordance with the Tranche 2 SAC recommendations (as outlined in Section 3.3).

## 3.2 Phase 3 – Functional Designs & Report

The Functional Design Report (this report) accompanies the functional designs (CAD drawings) and cost estimates and provides the agreed design layout for the precinct. The agreed functional designs are based on achieving potential efficiencies in land take, accounting for size of contributing catchments, asset performance and long-term protection, capital costs and lifecycle management costs. All are particularly important to allow development to proceed viably and sustainably, without compromising site values or impacts to downstream, or creating subsequent implications for Bass Coast Shire Council - the ultimate asset owner.

This report documents the site context for the proposed development precinct; previous drainage investigations and modelling reviews; background and site investigations undertaken which have influenced the proposed stormwater drainage system for the study area; and the subsequent functional design package proposed (agreed) for the precinct. Ultimately, this project will allow for the finalisation of the Precinct Structure Plan (PSP) and the Development Contributions Plan (DCP) for the Wonthaggi North East Precinct.

This Functional Design Report sets out:

- The agreed strategy and approach following the Proof of Concept (Alluvium) document
- Functional design documentation of the stormwater management assets as required for the PSP
- Construction estimates and costings for each of the functional design assets included within the PSP

- Accounts for all work undertaken to date (pre and post the SAC Tranche 1 and Tranche 2 hearings).

Underlying our approach is the desire to provide robust, sustainable assets which adequately:

- capture, retard, detain, treat, and convey stormwater safely through the precinct and beyond
- protect and further enhance receiving environments and local biodiversity
- deliver improved landscape / neighbourhood amenity outcomes (multi-benefits, not only function)
- provide future community services related to community connectivity, comfort, health and wellbeing and broader liveability outcomes.

Any proposed land use changes should provide for multiple benefits and multiple community-based outcomes, beyond stormwater function alone. This consideration, amongst others, are foundational principles that have been applied to the development of the functional design package for the Wonthaggi North East PSP and DCP.

## 3.3 SAC Recommendations Report (August 2022)

In accordance with Section 10.2, Recommendation 1, Appendix H and Table 7 of the *VPA Projects SAC Final Recommendations Report* (August 2022), Alluvium has updated the Alluvium 2022 Functional Design package (Report and drawings) to:

- Provide further clarity of purpose, outcomes, assumptions adopted and other relevant details of the stormwater design solution for the PSP
- Provide consistency between the PSP Stormwater Strategy by Engeny and the PSP Functional Design Report by Alluvium to enable other professionals to:
    - Understand and reproduce the PSP results, as well as making future amendments if needed
    - Assess and approve, with confidence, proposals from developers without needing to contact the original authors.

Specifically, amendments included:

- Re-alignment (straightening) of waterway DR-01 through parcels 65 and 66-R, to reflect the March 2022 Council-approved development plans, and evidence submission (Barich, June 2022)
- Update all proposed stormwater asset numbers to be consistent with the final PSP documentation and updated Stormwater Strategy (Engeny, 2023).
- Review all stormwater pipe layouts and locations from the Engeny updated Strategy to ensure general consistency
- Undertake new functional level designs of the main (trunk) stormwater network relative to the proposed PSP stormwater assets (confirming levels and asset alignments)
- Update main (trunk) stormwater pipes (serving external catchments) to clearly create a masterplan of all main (trunk) stormwater pipes passing through the PSP region, including:
    - Trunk stormwater pipe alignments
    - Expected points of discharge into the trunk infrastructure
    - Outfall locations for all trunk stormwater pipes.
- For each trunk outfall location, provide:
    - Primary treatment mechanism (i.e., either sediment basin or gross pollutant trap)
    - Proposed trunk stormwater pipe invert levels
    - Relevant waterway flood level estimates (Note: these are shown in waterway long- / cross-sections and HEC-RAS modelling).

- Provide (show) 1% AEP, 10% AEP, and 50% AEP peak flows and water depths in the waterway(s) at the trunk infrastructure outfall locations.

- Include the design solution for the main outfall for the PSP (DR-03) including the status of designs and approvals of its relationship with the Powlett River, with respect to ARR2019 Guidelines .
- Redesign of WL-03 as per Alluvium's recommendations to be a separated asset from the Northern Views (S173) WL-04 arrangement, including a new culvert design for WL-03 across Heslop Road to account for any changes.
- On all plans and section (for all asset types) include:
    - proposed stormwater (drainage) reserves
    - 1% AEP flood level estimates
    - potential for earth fill.
- Ensure sediment basins proposed are consistently shown in the final Alluvium package (including the report, drawings, cross sections, and associated models)
- Provide clarity regarding decommissioning of any existing assets proposed across the PSP region
- Review and update all cost estimates to reflect:
    - Revised designs/associated costs as a result of any design changes, including cost sheets for the 'new' infrastructure - DCP ref CU-04, CU-06 and CU-07 to include allowances for crossing of servicing infrastructure
    - "General consistency" for stormwater pipe costings, with the Engeny Stormwater Strategy costs, subject to adjustment to current industry rates as appropriate, based on available price guides (i.e. Rawlings Construction Handbook 2022)
    - Clear justification or basis of the costs, including applicable date of adopted rates
    - A line item for landscape maintenance costs (period 24 months) to allow for site establishment for all relevant stormwater assets
    - Apply a nominal $50,000 allowance for Environmental Management and Reporting, and an additional 0.5% of construction value, specifically for erosion control management, for each proposed WL asset
    - Maintenance tracks and shared paths costings to be itemised per square metre
    - Inclusion of rubber ring joints for all stormwater pipes.
- Update all functional design cost sheets with the following delivery allowances (refer Section 24):
    - Council fees to remain at 3.25% (includes supervision)
    - Vic Roads fees to remain at 1% for WL-01, given works under Korumburra Rd (apply 0% for all other assets)
    - Traffic management rate to change from 5% to 2% (as site is greenfield)
    - Survey and design to remain at 5%
    - Supervision and project management to change from 9% to 4% (as council supervision is now included in (as above)
    - Site establishment to remain at 2.5%
    - Contingency rate of 35%, to be applied to all cost estimates
    - Include additional items in cost sheets for each proposed wetland-retarding basin (WL) asset as follows:
        - Geotechnical Investigation ($50K)

- Cultural Heritage Assessment ($50K)
- Flora and Fauna Study ($30K)
- Safety Assessment ($20K).

In accordance with the SAC recommendations Alluvium has updated this Report to ensure that it:

- is based on the updated 2023 revised version *Wonthaggi North-East PSP Stormwater Strategy* by Engeny (as per SAC Recommendation 2)
- provides **more detailed discussion / explanation** regarding internal and external catchments, treatment targets, and offsets to meet PSP pollutant load reduction targets
- provides **fully supportable information** and clearly outlines the data, assumptions, models with sufficient details to enable Bass Coast Shire Council (BCSC), developers and the community to confidently progress the future development of the PSP area
- provides **commentary on the practical delivery** of the agreed/revised stormwater design solution for the PSP
- provides **commentary on development staging** of the PSP, and potential alternate solutions to accommodate the distributed system of assets, subject to achieving compliance with State policy objectives
- provides an adequate **knowledge and capacity to allow flexibility** to address future challenges to the practical delivery of the PSP, that may emerge in response to local conditions
- provides **confidence to all parties** in using the information to further progress the stormwater asset designs for the PSP.

**This Report** and development of the functional design drawings and cost estimates has considered:

- Existing conditions – existing, proposed, constraints, values, and opportunities
- Background analyses – reports, data, GIS, topography, flood / MUSIC models, concepts, and strategic changes/updates
- Development changes – planning decisions / approvals by others
- Project's core objectives – including stakeholders, liveability (added value), future opportunities.
- **Recommendations and agreements** as presented in the Proof of Concept Report (Alluvium, Sept 2021) which focused on the most cost-effective approach to ensure –
    - asset intended functionality and constructability (noting the centralised nature of the precinct's asset layout as per the Strategy)
    - best practice integrated management of stormwater is achieved for the precinct / district
    - capital cost and ongoing maintenance implications are minimised through asset integration and consolidation
    - development viability and land availability without compromising stormwater function, environmental, social, cultural heritage, or landscape amenity values
    - broader outcomes of liveability for the current and future communities.
- **Recommendations agreed and confirmed**
    - as per Conclave/Panel process and submissions in the Functional Design Report by Alluvium (April 2022)
    - Final Statement of Facts Wonthaggi North East PSP and DCP – Drainage Conclave (May 2022).
- **Recommendations of Standing Advisory Committee** (SAC) Recommendations Report (August 2022).
- **Revised Strategy –** Wonthaggi North East PSP Revised Drainage Strategy by Engeny (September 2023).

# 4 Strategic Context

Wonthaggi North East PSP covers approximately 632 hectares of land located to the north-east of the existing Wonthaggi township, just south of the Powlett River, and intersected with most of the land north of Bass Highway and west of Kirrak Road. The proposed precinct boundary is shown in Figure 2 (above). The precinct is potentially to provide up to 5,000 new homes, to respond to population growth predictions for the town from 8,000 to 20,000 residents over the next 30 to 50 years. The Wonthaggi North East PSP represents 40% of the Wonthaggi township.

The PSP is divided into three distinct catchments (North West Catchment, South West Catchment and East Catchment – see Figure 16) and has three major outfalls, two of which outfall north into the Powlett River, and one that outfalls towards the west and away from the PSP assets. The topography of the PSP area is generally flat and ranges in elevation from 13m AHD on the northern Heslop Road boundary to 32m AHD at a central highpoint in the precinct at the southern boundary.

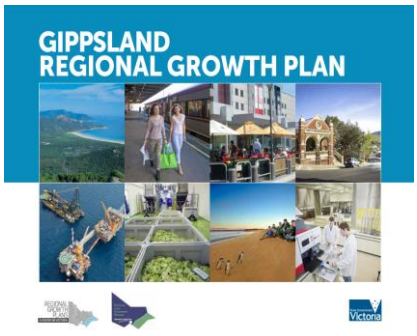
Bass Coast Shire Council is the local drainage authority for all urban land in the region, while West Gippsland Catchment Management Authority (WGCMA) is the rural drainage and floodplains manager. Together, with Traditional Owners, local landowners, and the broader community, they represent the key stakeholders to this project.

## 4.1 Strategic drivers

Planning for growth in Wonthaggi has been driven by the VPA's work in regional city growth plans. The sustainable management and use of surface waters (runoff) in the landscape, and the appropriate guidance for urban development adjacent to riverine floodplains, are vital to the continued growth and water resilience of the region.

Similarly, the IWM Forum vision for the West Gippsland Strategic Directions Statement has a focus on *Working together through sustainable water management to enhance urban landscapes and maximise amenity, environment, and economic outcomes for our communities.* In our experience with other IWM plans, stormwater drainage strategies, PSPs and DCPs, a clear and shared vision is critical in setting the focus and achieving intended outcomes.

The following summarises key strategic documents that are directly relevant to, will influence, and/or align with key outcomes of this project and the vision for the Wonthaggi North East PSP and DCP.

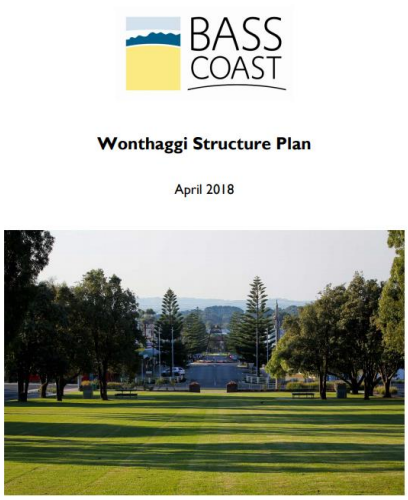



**Gippsland Regional Growth Plan (VPA, 2014)**

This plan addresses a wide range of challenges by recognising Gippsland's assets of regional significance and putting an integrated planning framework in place to direct and manage sustainable growth across the region.

It establishes regional policy to guide the use and preservation of these assets and provides a higher level of certainty and direction for investors, infrastructure and service providers, the community and decision makers.

Gippsland is forecast to become a fast-growing part of Victoria as more people relocate to the region from Melbourne. This plan considers the implications of growing the region to a population of 386,000 by 2041, an increase of 116,000 people.




### Wonthaggi Structure Plan (BCSC, 2018)

The Plan recognises and responds to the significant growth and change in the Wonthaggi area which is emerging as a major centre in the West Gippsland region. Emerging issues to be addressed by the plan include:

- potential economic and social impacts on local townships
- population growth
- role of Wonthaggi as a regional centre
- opportunities for the preservation of remnant vegetation and environmental areas.

The 2018 Wonthaggi Structure Plan has incorporated key recommendations identified by the Future Wonthaggi Focus Group. The group produced a report (Future Wonthaggi Focus Group Workshop – Community Representative Report, 2016) which identified six key themes to enhance liveability in Wonthaggi:

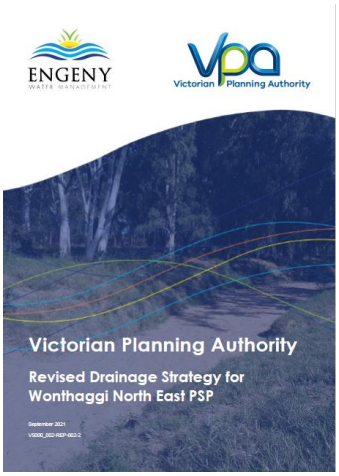
- A safe town to walk and move around
- Create an interest and understanding of the community
- Focus on our infrastructure
- Deliver strong tourism services
- Wonthaggi a model town
- Stimulate job growth.




### IWM Forum – Gippsland Strategic Directions Statement (DELWP, 2018)

The Strategic Directions Statement (SDS) has a region-specific vision, outcomes, objectives, and priority actions. Collaboration between Traditional Owners, Councils, Water Corps, CMAs, and DEWLP, with representatives from a cross section of these institutions has led to shared ideas, buy-in, and momentum. Opportunities identified through this project will demonstrably align with the following outcomes and their associated objectives:

1. Safe secure and affordable supplies
2. Effective and affordable wastewater systems
3. Reduced flood risks
4. Healthy and valued waterways, and Gippsland Lakes
5. Healthy and valued urban landscapes
6. Community values are reflected in place-based planning
7. Jobs, economic bene fits and innovation.




### Revised Drainage Strategy for Wonthaggi North East PSP (Engeny, 2023)

The WNEPSP Stormwater Strategy was initially undertaken by Engeny on behalf of Bass Coast Shire Council and later revised (updated) on behalf of the VPA.

Key objectives were to:

1. Update an original 2016 drainage strategy to current best practice standards and guidelines, including Australian Rainfall & Runoff 2019.
2. Develop a concept design of stormwater management assets that meets best practice requirements and current industry standards.
3. Minimise the risk of flooding of new dwellings.
4. Maximise developable land available within the precinct by locating assets in land with the highest risk of flooding where possible.
5. Centralise infrastructure to minimise the number of total assets Council is required to maintain.

# 5 Existing Conditions

## 5.1 Site visit

A site visit was conducted on the 14 July 2021 by the Alluvium project team with representatives from Bass Coast Shire Council and the Victorian Planning Authority in attendance. The site visit commenced at McGibbonys Road, near the developing Powlett Ridge subdivision to the south and Parklands residential estate to the north and progressed around the precinct (see Figure 6) identifying key sites that have since informed the functional design package.

Proposed locations for key stormwater assets as identified in the Engeny stormwater strategy concepts were visited to better understand the landscape, surrounding features and connections, challenges, issues, and constraints, as well as opportunities. Sites included the Powlett Ridge subdivision (currently under construction), existing Parklands Estate and the proposed industrial area on Carneys Road.

It is noted that the land area southwest of the McGibbonys Road and Connection Road intersection has recently been sold to the Department of Education and Training Victoria for the provision of a local school.

A summary of our key findings from the site visit was presented in the Proof of Concept Report. It has been reproduced below with updated information received through stakeholder feedback and more recent review of land development plans and drawings received from council.

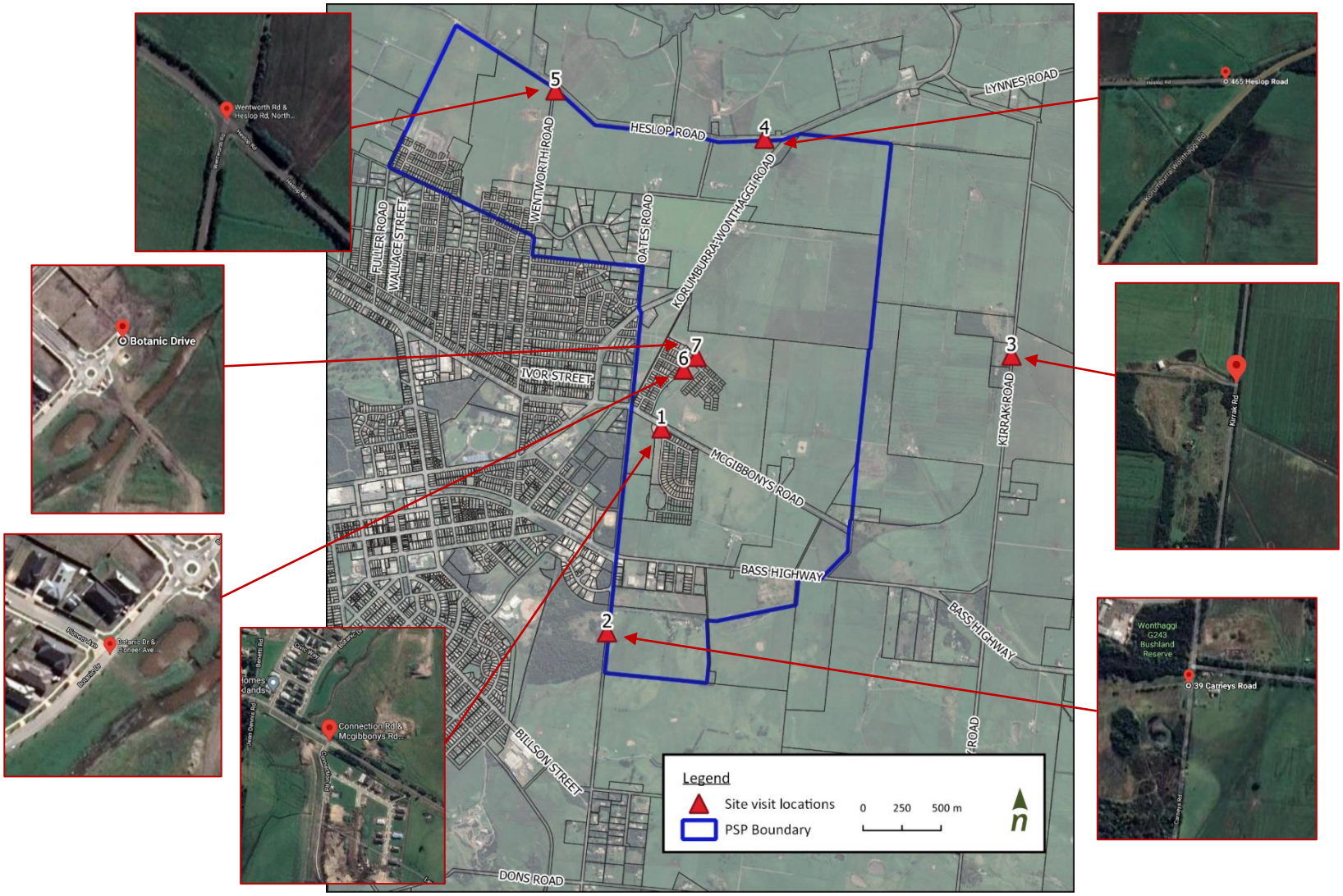



***Figure 6**. Site visit locations with georeferenced site photos (July 2021)*

### Site 1 – McGibbonys Road and Connection Road – Powlett Ridge Estate

The Powlett Ridge estate is located south of McGibbonys Road and is currently under development, with several houses and internal roads already constructed. The estate is adjacent and east of the proposed constructed waterway 'west' alignment. West of the constructed waterway corridor (and south of McGibbonys Road) land has been purchased by the Department of Education and Training Victoria (DETV) for a proposed local school.

DETV has undertaken some site drainage works with pipe outfalls into the newly constructed western waterway. It was noted on site, that these pipe outfalls have been poorly constructed, placed and finished and is already resulting in headward and rill erosion to embankments, with no end wall treatments, or rock armouring to dissipate erosive impacts of stormwater discharges. It was evident that the combined sediment loading to the newly constructed waterway (from both the DETV land and Powlett Ridge subdivision under construction) will require removal of this build up and re-shaping/reinstatement of the waterway floor/banks.

The section of waterway adjacent to the Powlett Ridge Estate is generally in poor condition. Vegetation along the waterway bed (floor) has not established, and only a sparse non-indigenous grassed/weed layer exists along the banks, resulting in erosional scour of banks where stormwater outfalls, and is resulting in sediment deposition to the waterway floor. This low flow channel (western waterway/DCP ref DR-01) lacks natural sinuosity along its length, a lack of rock armouring at critical locations (pipe outfalls) with ongoing erosion impacts highly likely. This is important to address as this area and waterway ultimately discharge into PSP assets (WLRB-1B/DCP ref WL-01) and will affect asset integrity and add to maintenance implications.

It is noted through the Tranche 2 panel process, this section (north of Bass Hwy) of the W-WW (DR-01) alignment was straightened from the original strategy alignment (Engeny, 2019) as part of a council-approved Development Plan.



Powlett Ridge Estate temporary sediment basin, looking upstream of constructed waterway 'west' alignment.



Existing headward and gully erosion along the newly constructed waterway banks from DETV land



Existing outfall drain from Powlett Ridge estate into constructed waterway 'west' alignment.



Constructed waterway 'west' alignment, looking upstream

**Figure 7.** *Site investigation photos of constructed waterway 'west' straightened alignment (as per council approved development plan)*

### Site 2 - Proposed Industrial Area (Carneys Road)

The proposed industrial area (Figure 8) is located at the southern boundary of the Wonthaggi North East precinct (WNEP). An undeveloped greenfield, external catchment falls through the industrial area from the south. The external catchment sheet flows across this relatively flat landscape. To the west of this industrial zone is the Wonthaggi Bushland Reserve and Wetlands (ID - G244).

It is noted that the existing industrial buildings / warehouses at this location, currently do not have any stormwater treatment infrastructure installed, prior to the area out-falling into one of the two proposed 'internal' constructed waterways (the west alignment in this instance), therefore exposing these assets to potentially hazardous pollutants. Ideally, Council should negotiate some form of proprietary intervention to protect the PSP waterways and downstream retarding basin/wetland systems. While this study is not to resolve this land use issue or design and cost a solution to this area of the PSP, it is provided as guidance to council to ensure this is not an ongoing concern and risk to the PSP water assets.

As advised by Council, permit conditions for the industrial area did make allowance for a 40m wide waterway reserve (the western waterway) which is critical in the ability to design and construct this waterway with reasonable space allowed for waterway stability and urban buffering. The reach of the waterway will therefore be narrowest at this location but widens to a 60m wide waterway corridor further downstream.

The urban pollutant loads of this area have been considered in the MUSIC modelling (i.e. industrial node selection) to inform the water quality treatment requirements for the design of the precinct assets.




Upstream of the proposed industrial area of Wonthaggi NE PSP, looking south at the future extension of Carneys Road.



Kirrak coal mine site (ruins) has been derelict for 100+ years and likely to be heritage protected. The land is owned by the State (Council).

Undulations and 'hills' are representative of coal mine spoil piles, otherwise the area is relatively flat.




West side of Carneys Rd (looking west) across the Wonthaggi Bushland Reserve and Wetlands (ID - G244). The site is outside the PSP area and opposite the proposed industrial zone (within the precinct/PSP area).

The developed catchment upstream outfalls to this wetland (refer Figure 17 in this report).

**Figure 8.** *Proposed industrial precinct at southern extent (Carneys Rd) of PSP and surrounding landscape features.*

### Site 3 – Kirrak Road

Kirrak Road runs north-south on the eastern side of the PSP area just outside the official PSP boundary. The landscape to the east of Kirrak Rd is relatively flat and surface runoff falls gently to an existing swale. Kirrak Road is proposed to be a future 40m wide bypass road (advice from BCSC during site visit). Flows from this external catchment are not entering the precinct / study area.

### Site 4 – Proposed Wetlands 1 & 2

#### Wetland-Retarding Basin 1 (WLRB 1A & 1B / DCP ref WL-01)

The Engeny stormwater strategy proposed an integrated wetland and retarding basin (DCP WL-01) at the downstream extent of the precinct, off the Korumburra-Wonthaggi Road. The site was inaccessible at the time of the site visit due to constrained timelines, where access to private property was not able to be arranged. As a result, the analysis of WLRB1 was completed, based on a desktop analysis, using NearMap and Google maps.

WLRB1 is located within the natural depression of the property, close to the Korumburra-Wonthaggi Road property boundary. The location selected is based on existing flood overlays and the Engeny flood modelling undertaken to date, indicating that this location is subject to flooding. Engeny's subsequent re-modelling of this wetland changed the concept layout considerably and identified this system would be performing significant retardation function.

Alluvium's analysis of the concept and our own modelling work during Proof of Concept determined that the size of this WLRB needed to be increased based on the contributing catchment size, the increased retarding function expected, and land use nature upstream (that is 720ha of agricultural and proposed urban catchments external to the PSP boundary draining to this point). Therefore, this asset is now a split system - WLRB1A and WLRB1B (DCP ref WL-01) to account for these issues.



*Figure 9. Looking east along Heslop Rd to site for WLRB1A & WLRB1B* (DCP ref WL-01) *(beyond tree line) on Korumburra-Wonthaggi Rd*

### Wetland 2 (WLRB2 / DCP ref WL-02)

This asset was previously identified to be a treatment-only wetland, located at the corner of Korumburra-Wonthaggi Road and Heslop Road. However, subsequent Engeny modelling and Alluvium's own for the Proof of Concept Report (September 2021) identified that this wetland is performing a retarding function and therefore should be an integrated system. This is the case found for all precinct wetlands – all systems will be required to perform treatment and retardation function.

The site has a natural depression near the downstream corner of the site with an open cut drainage channel through the proposed WLRB2 location, which then outfalls through existing culverts under Heslop Road (image left) and flows northwards across a private farm referred to as the 'subject property' hereon (image right) to its ultimate outfall to the Powlett River (downstream of Pinkerton Road).

BCSC's negotiations with the property owner of the subject property relates to addressing drainage issues and provision of an ultimate outfall alignment from the WNEP to the River. This main precinct outfall forms part of this functional design package by Alluvium.



Existing outfall from proposed WLRB2(WL-02) site to culvert on Heslop Road (looking west).



Existing open channel outfall to Powlett River (looking north from Heslop Road) across subject property (private farm).

**Figure 10.** *Site investigation photos of the proposed WLRB2 (DCP ref WL-02) landscape and ultimate outfall to Powlett River (tree line in the north of image right).*

### Site 5 – Wetlands 3 & 4

As demonstrated in the Engeny Stormwater Strategy and Alluvium's Proof of Concept Report, all wetlands for the PSP will be integrated WLRBs as all are performing a retarding and treatment function.

### Wetland 3 (WLRB3; DCP ref WL-03)

The asset is located at the northern extent of the precinct, south of Heslop Road and on the east side of Wentworth Road, at their intersection. The landscape at this location generally falls to the east, towards the location of the WLRB3 area. Based on all modelling undertaken to date, the functional design for this asset is for an integrated wetland-retarding system.

It is noted, based on Council advice under the proposed development, the Wentworth Road extension will not be progressing (discontinued) for the PSP.

### Wetland & Retarding Basin 4 (WLRB4; DCP ref WL-04)

This wetland is located at the north-western extent of the precinct, just south of Heslop Road and on the west side of the 'discontinued' Wentworth Road alignment. The system is 'perched' within the landscape (sits significantly higher than WL-03) and found to perform a retarding function. It is the smallest of all 4 retarding/treatment systems in the precinct. During the site visit, discussion was had around potential for merging WLRBs 3 and 4 into one consolidated asset.

However, as advised by Council, this (WL-04) system has been approved as part of a Development Plan (2011) and planning permit process to allow for the construction of the residential subdivision, east of Fuller Road and to the west side of the Wentworth Road alignments. These approvals were completed prior to investigations into the Wonthaggi North East PSP process (this study). WLRB4 is being delivered as per the S173 Agreement in place for Northern Views Estate (AT823177H, Parcel ID6).

The approved / allowable area set aside for WLRB4 (DCP ref WL-04) through the planning approvals process has since been accommodated (updated since the PoC Report and council feedback) in the functional design stage. However, cost estimate tables are not provided for the WLRB as it is now outside this study's project scope.

Alluvium discussed the possibility with stakeholders to merge these WLRBs (3 & 4) as part of a future asset renewal program (some 30-50yrs) if found to be value-adding (e.g. to overall landscape amenity, community use, or contributes positively to Council's future maintenance program). For the purposes of this study and as agreed at Proof of Concept, these assets have been functionally designed as two separate structures.



WLRB 3 (WL-03) site, looking east along Heslop Road



Intersection of Wentworth Road alignment and Heslop Road, looking west across site of WLRB3 (WL-03) and WLRB4 (WL-04, foreground)

**Figure 11.** *Site investigation photos for WLRB3 and WLRB4 (DCP ref WL-03 and 04) proposed locations.*

### Site 6 – Pipe Track at Pioneer Ave & Botanic Drive

An existing pipe track at this location offers an ideal opportunity to connect its alignment in both directions to better connect the PSP and future community with existing blue-green corridors and the existing community. Trail links could extend northwards from this point through to the functional water assets along the northern extent of the PSP. This northern extent provides a significant blue-green passive recreation corridor for the area. This trail link could then be connected to a future trail concept along the Powlett River where accessible to public (outside private land areas).

The existing pipe track at Pioneer Ave/Botanic Dve could also be enhanced by extending it southwards along the Carneys Road section of the PSP and/or through existing walks and trail links to the south of the precinct, thereby connecting current and future trails and communities along/to/from the PSP via a series of "living links".

As can be seen in Figure 12 below, Wonthaggi township is well serviced with extensive walkable routes and key sites of ecological, historical, and social recreational value. There is an unusually high number of 'destinations and trail links that could successfully be connected to the WNE PSP and further enhance community experiences, landscape values, and passive recreation opportunities.

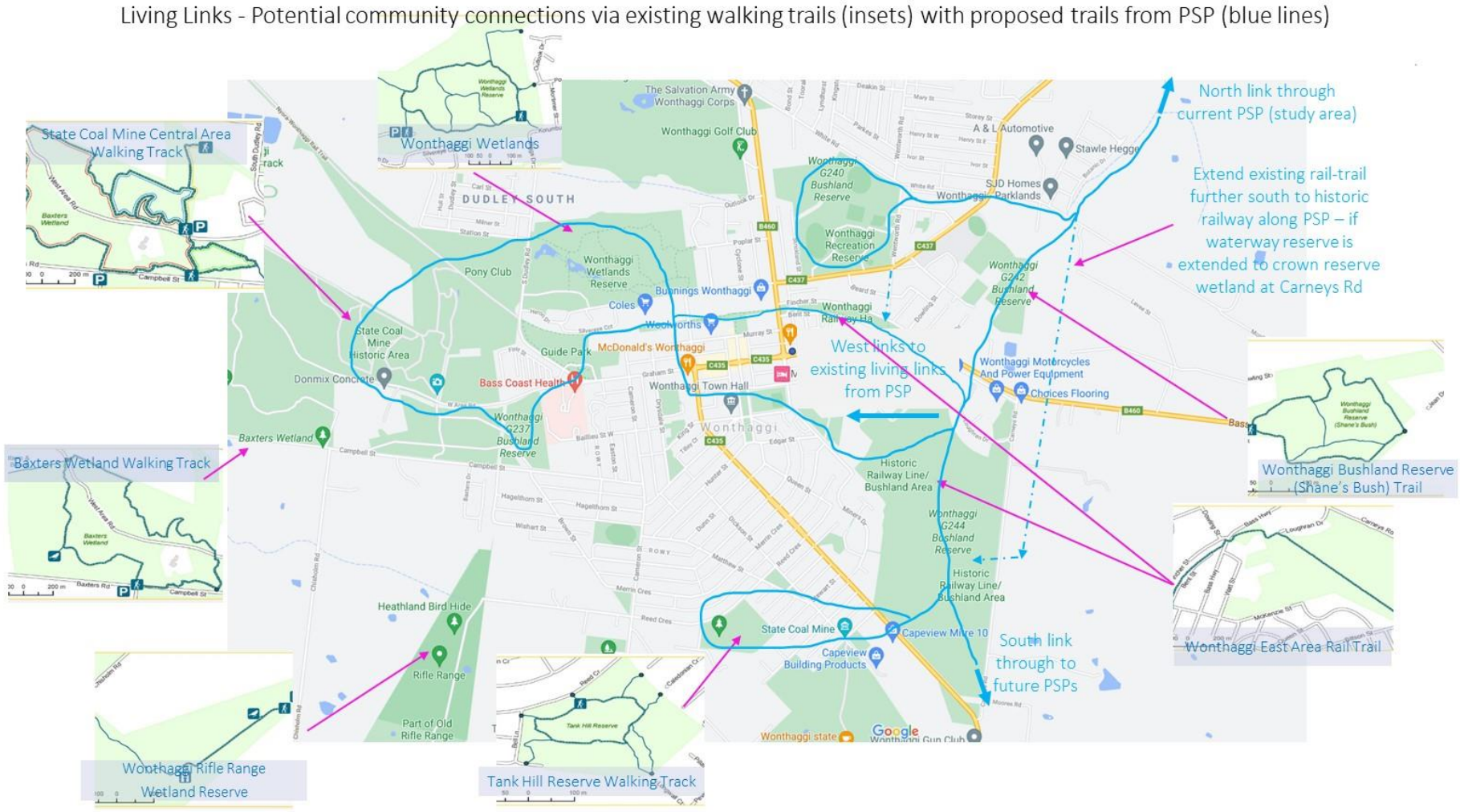



**Figure 12.** *Map of proposed trails from the Wonthaggi North East PSP to existing mapped trails as potential community connections along 'living links' (Oct 2021).*

### Site 7 - Parklands Estate Constructed Waterway (west alignment / DCP ref DR-01)

The Parklands Estate is located north of McGibbonys Road and has been developed with all necessary stormwater drainage infrastructure completed within the road layouts of the estate. Adjacent to the estate is a section of the temporary open channels that align with the precinct's western waterway corridor (W-WW or DCP ref DR-01). This section of open channels could be further enhanced as part of the W-WW works as they have stabilised well, and then connect to the upstream section, recently constructed as part of the Powlett Ridge Estate (refer Site 1 details above).

The Parklands estate outfalls into two interim / temporary sediment basins located adjacent to the open channel. The channel is generally in good condition with meanders present in the upstream section of this reach and has healthy, established aquatic vegetation. The channel appears to back up just upstream of the culvert / road crossing likely due to a restricted outlet at the downstream section of the estate. This appears to have been retained as an interim stormwater *quantity* control so as not to impact downstream landowners during these temporary / interim drainage conditions in place.

Alluvium notes the potential to retain and further enhance this open channel section as part of the ultimate design for the W-WW (DCP ref DR-01).

It was noted through the Tranche 2 panel process that council's preference does not support interim solutions, however this may be necessary to allow development staging efficiencies (refer Section 26).



Existing interim / temporary sediment basin



Existing waterway profile, looking upstream with good vegetation establishment



Existing temporary waterway outfall control for flood/drainage protection of downstream properties



Existing waterway profile, looking downstream

**Figure 13.** *Site investigation of temporary open channel / pond works adjacent to Parklands estate, along west waterway alignment (W-WW; DCP DR-01)) north of McGibbonys Road and east of Carneys/Korumburra-Wonthaggi roads.*

## 5.2 Topography

The precinct has a mostly flat topography ranging from 13m AHD on the northern Heslop Rd boundary to 32m AHD at a central highpoint at the southern boundary. The PSP is divided into three distinct catchments (North West Catchment, South West Catchment and East Catchment). The average slope (topography) of the precinct area means the site falls steadily towards the north, directing most of the flow to the Powlett River.

An overview of the topography is presented in Figure 14 below.

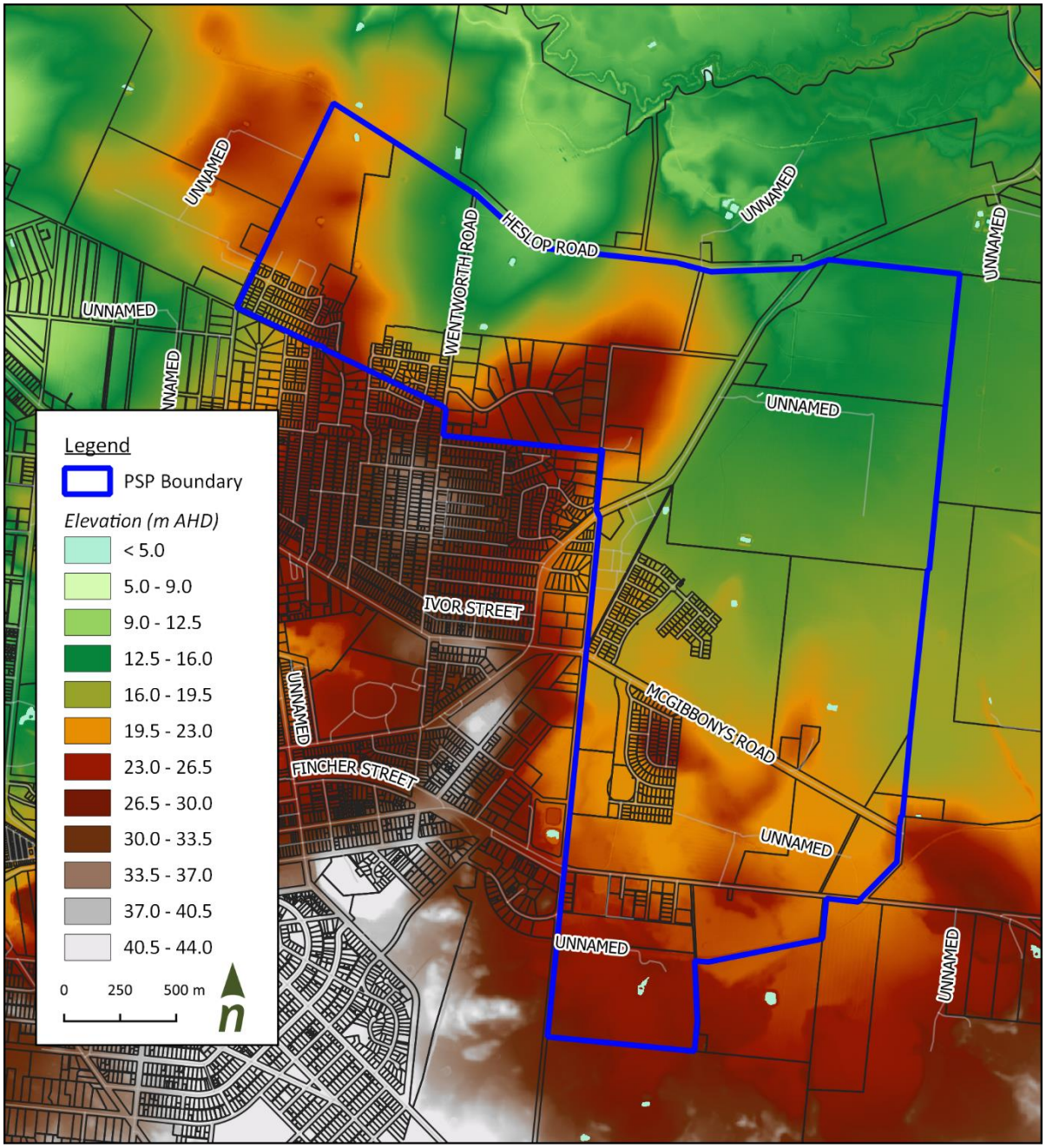



**Figure 14.** *Topography of PSP and surrounding area*

## 5.3 Existing services and infrastructure

The PSP area is intersected by major roads including the Korumburra-Wonthaggi Rd which runs north-east from Wonthaggi CBD, and the Bass Highway which runs east of the CBD. There are multiple existing culverts on the site (see Figure 15). Three culverts are used to convey the partially constructed west waterway (W-WW; DCP ref DR-01) flows from McGibbonys Rd, under Korumburra-Wonthaggi Rd and out falling to the proposed wetland systems along Heslop Road at the northern extent of the PSP. One culvert conveys eastern catchment flows under the Korumburra-Wonthaggi Rd at Heslop Rd. Of the six culverts in the southern region of the PSP, four pass under Bass Highway and one was used to convey flows under a former railway line.

Although efforts were made to utilise the existing culverts, only the former railway line culvert, western McGibbonys Rd culvert and western Heslop Rd culvert were able to be incorporated into the Alluvium design solution (Figure 15). The remaining culverts were either not in functional locations or insufficiently sized to convey the 1% AEP flow. In these instances, the functional design set (and cost estimates) includes a redesign/upgrade of existing culverts to convey the 1% AEP flow.

Another major infrastructure consideration is the water supply pipeline from the Victorian Desalination Plant. The pipeline runs from the plant (located west of Wonthaggi) along the north west edge of the PSP boundary, then runs east, parallel along Heslop Road and northwards towards the Powlett River. The pipeline location has particular significance in planning the main outfall for the PSP, as the outfall alignment is proposed to pass over the desal pipeline.

A transmission pressure gas pipeline runs along the north-eastern boundary of the PSP, immediately outside the precinct. The impact of this transmission pressure gas pipeline was investigated through a Safety Management Study undertaken by the VPA in 2021. WLRB 1A and 1B (DCP ref WL-01) have been designed to be co-located within the pipeline offset area, in accordance with the pipeline licensee's requirements.

Dial Before You Dig (DBYD) assessments undertaken at the concepts stage, confirmed the water supply main and a gas transmission main alignments. These alignments have been added to the map below using digitised information provided for the water main by South Gippsland Water; and images provided of the gas main alignment by Multinet Gas (data provided 27/08/2021). This has informed the asset layouts for the PSP, and the functional design package.

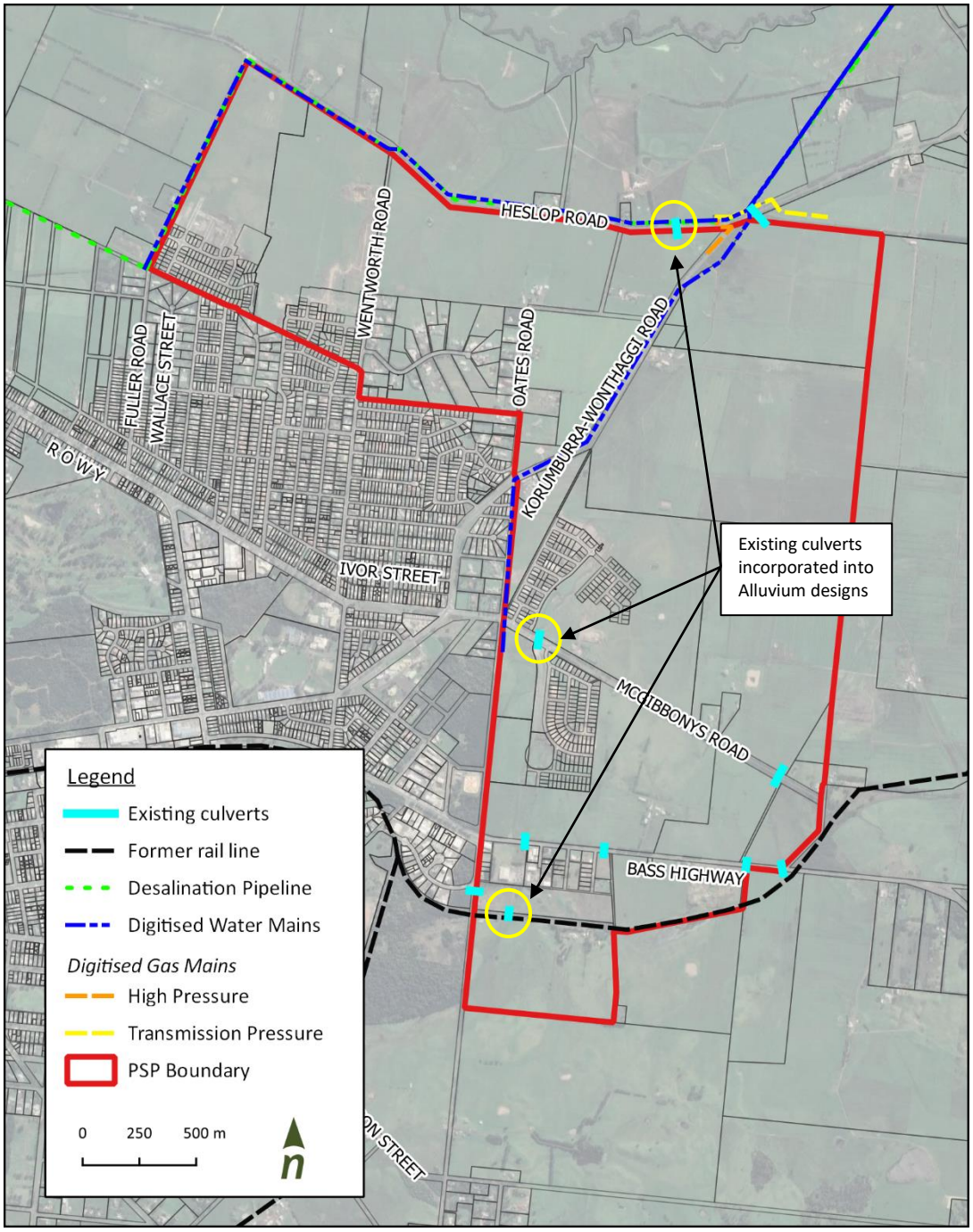



**Figure 15.** *Existing services and infrastructure in PSP area (digitised water and gas mains from data provided)*

## 5.4 Catchments & Sub-Catchments

There are three distinct catchments that cross the PSP study area (Figure 16). All stem from the local highpoint in the south-west extent of the precinct. The north-west catchment (green) is approx. 300 ha, and the eastern catchment (yellow) is approx. 1540 ha – together they cover most of the PSP area. These two catchments fall predominantly towards the north and ultimately outfall to the Powlett River via two outfall points across private land.

The eastern catchment extends south past the PSP area and further east until it intersects with Kirrak Rd. This large section of the eastern catchment (external to the PSP) has been accounted for in the functional design solutions. A grassy swale which runs along Kirrak Road captures and conveys flows from the undeveloped landscape further east and drains away from the PSP.

The south-west catchment (blue) falls south-westerly away from the PSP area and outfalls to the Powlett River. Due to the current development activity in this catchment, it is assumed that a drainage strategy for this area has already been established as part of the approved Development Plan (Council communication at site visit).

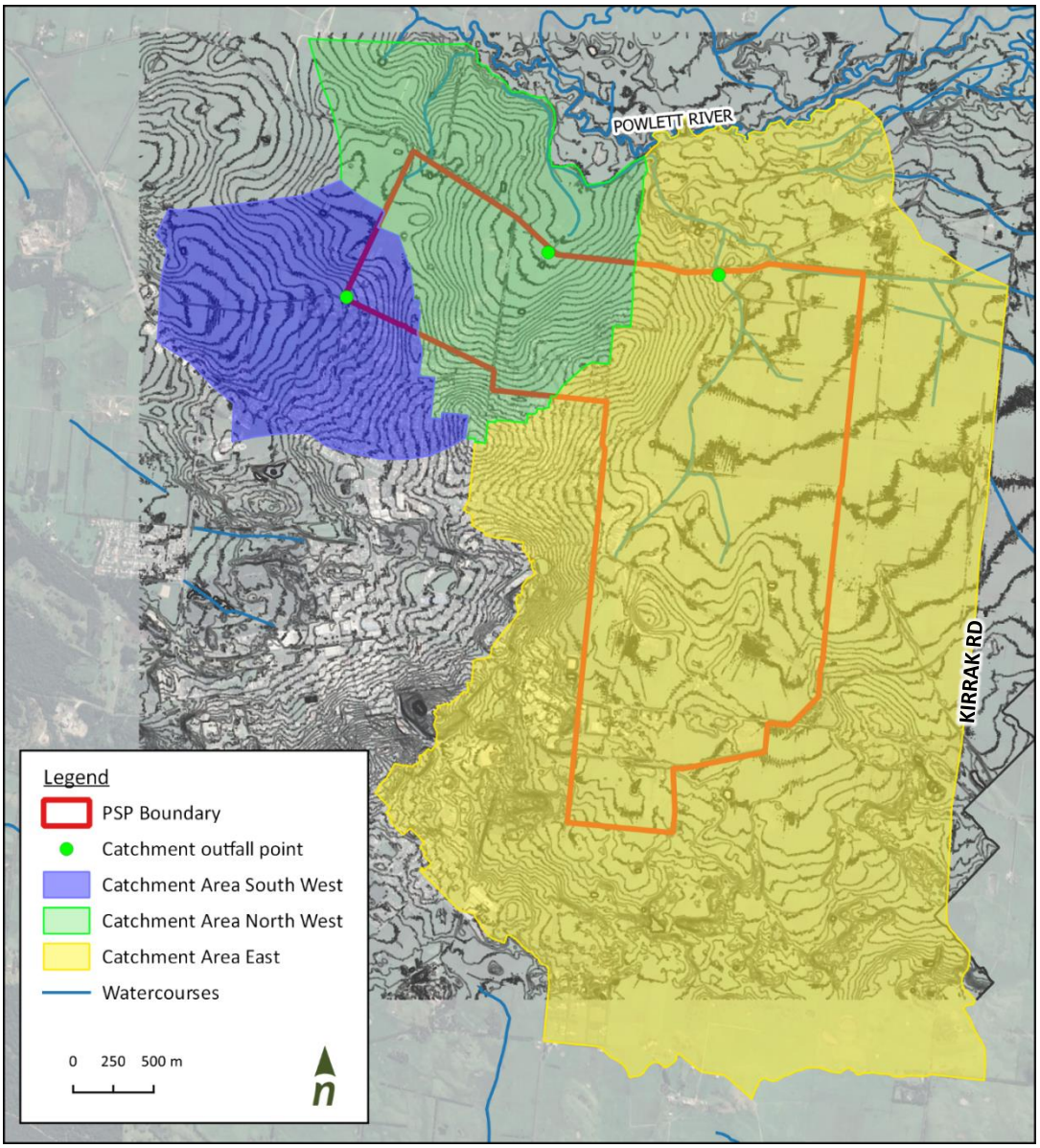



**Figure 16.** *Catchments across the PSP and broader area*

The proof of concept approach undertaken by Alluvium sought to better understand the impacts of these catchment areas (outside the PSP boundary) on the proposed waterways and WLRBs for the precinct. Figure 17 below highlights key locations across the sub-catchments that would be ideal locations for future stormwater management infrastructure (retardation and/or treatment) to meet best practice and ensure assets within the PSP are able to function as intended and for duration of their asset life (approx. industry standard for wetlands is 30-50yrs subject to design, catchment condition and maintenance regimes).

**Note:** Legend key below shows Alluvium asset numbering, which translate to the revised (2023) DCP numbers as follows: SB1 (SB-01), SB4 (SB-02), SB5 (SB-03), SB6 (SB-04), SB7 (SB-05).

**Note:** SB4 (SB-02) has been located north of the property boundary, whereas SB6 (SB-04) has been located south of the property boundary, which will assist in development staging (refer Section 26).

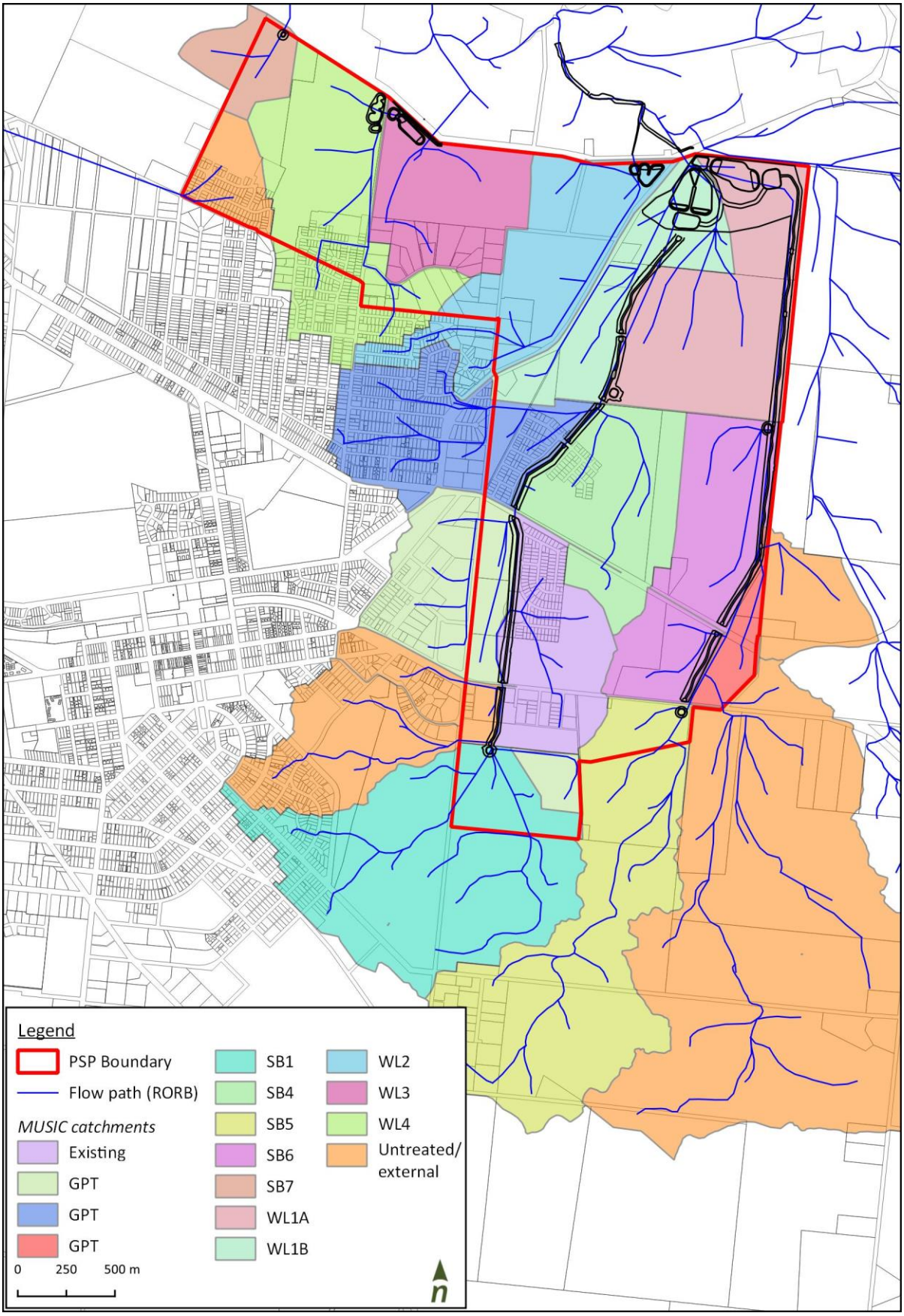



Figure 17. *Map of drainage catchments/respective outfalls indicating ideal treatment asset locations within/beyond PSP.*

As per the figure above, a breakdown of the contributing catchments with respect to the external agricultural land, the external urban land (i.e. the Wonthaggi township); and the future proposed developable area contributing to each outfall location within the PSP area, is provided below.

Table 1. Catchment breakdowns within the PSP and external area

| Asset | Area type | Area (ha) | % Area of each sub catchment | % Area of total catchment |
|---|---|---|---|---|
| WLRB 1A (DCP ref WL-01) | Existing External Agricultural | 442 | 71% | 32% |
| | PSP | 186 | 29% | 14% |
| | **Total** | **628** | **100%** | - |
| WLRB 1B (DCP ref WL-01) | Existing External Agricultural | 119 | 23% | 9% |
| | Existing External Urban | 156 | 31% | 11% |
| | PSP | 236 | 46% | 17% |
| | **Total** | **511** | **100%** | - |
| WLRB2 (DCP ref WL-02) | Existing External Urban | 14 | 19% | 1% |
| | PSP | 59 | 81% | 4% |
| | **Total** | **73** | **100%** | - |
| WLRB3 (DCP ref WL-03) | PSP | 52 | 100% | 4% |
| | **Total** | **52** | **100%** | - |
| WLRB4 (DCP ref WL-04) | Existing External Urban | 23 | 25% | 2% |
| | PSP | 68 | 75% | 5% |
| | **Total** | **91** | **100%** | - |
| SB7 (DCP ref SB-05) | Existing External | 9 | 45% | 1% |
| | PSP | 11 | 55% | 1% |
| | **Total** | **20** | **100%** | - |
| **Total catchment area** | | **1375** | - | **100%** |
| **Total external catchment area (mix)** | | **763** | | |
| **Existing Agricultural total** | | **570** | | |
| **Existing Urban total** | | **193** | | |
| **Total internal PSP catchment area** | | **612** | | |

A map of the contributing external catchments and 1% AEP flows to each of the WLRB assets is shown in Figure 18.

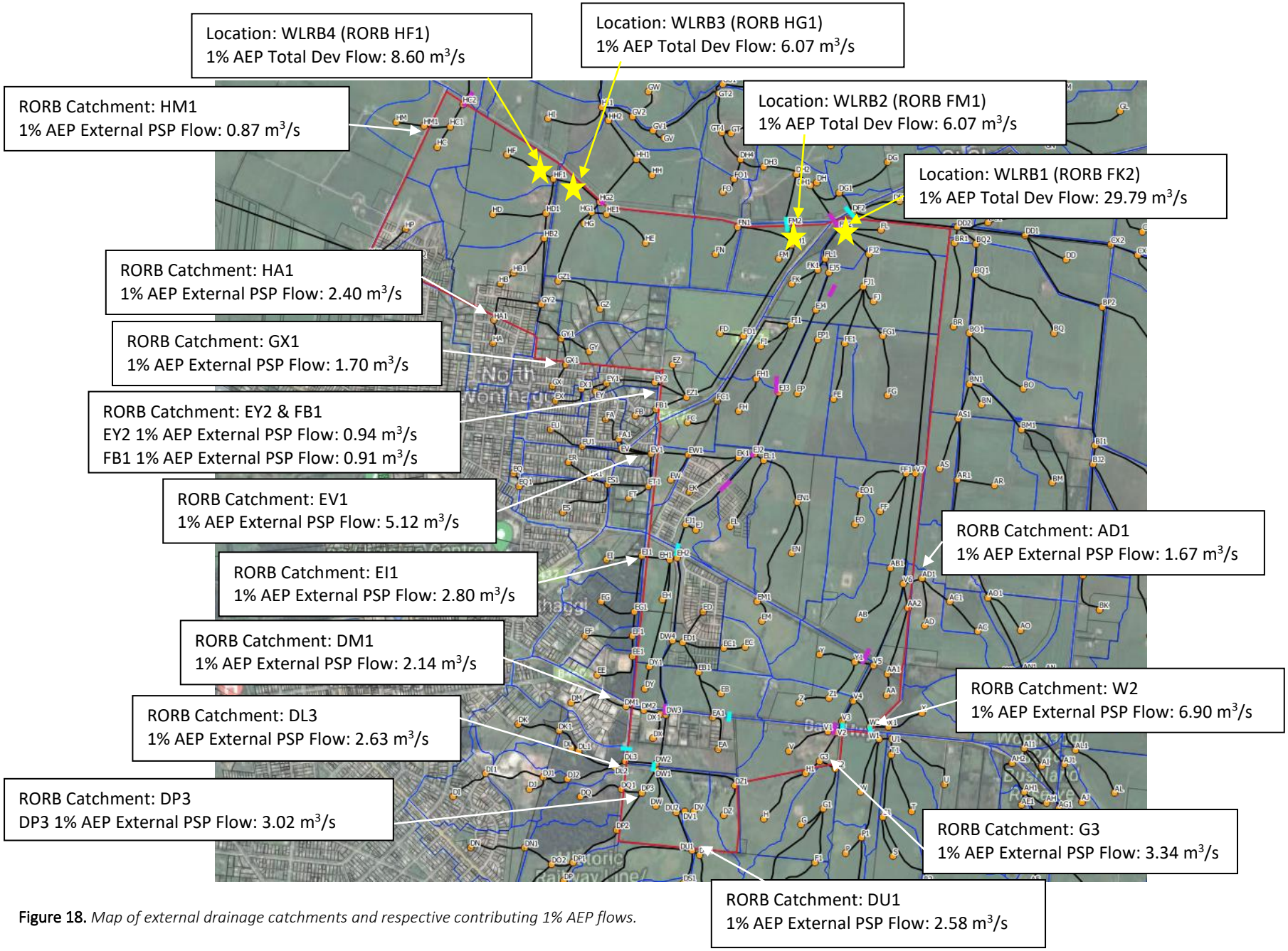



**Figure 18.** *Map of external drainage catchments and respective contributing 1% AEP flows.*

The three catchments that cross the PSP may be further broken down into smaller stormwater drainage sub-catchments (Figure 19). There are 3 large sub-catchments south of the WNE PSP that are currently agricultural land use which drain through the precinct. These external catchment inflows have been accounted for in the functional designs. These areas have been factored into the WLRB1A and 1B (DCP ref WL-01) functional design footprints.

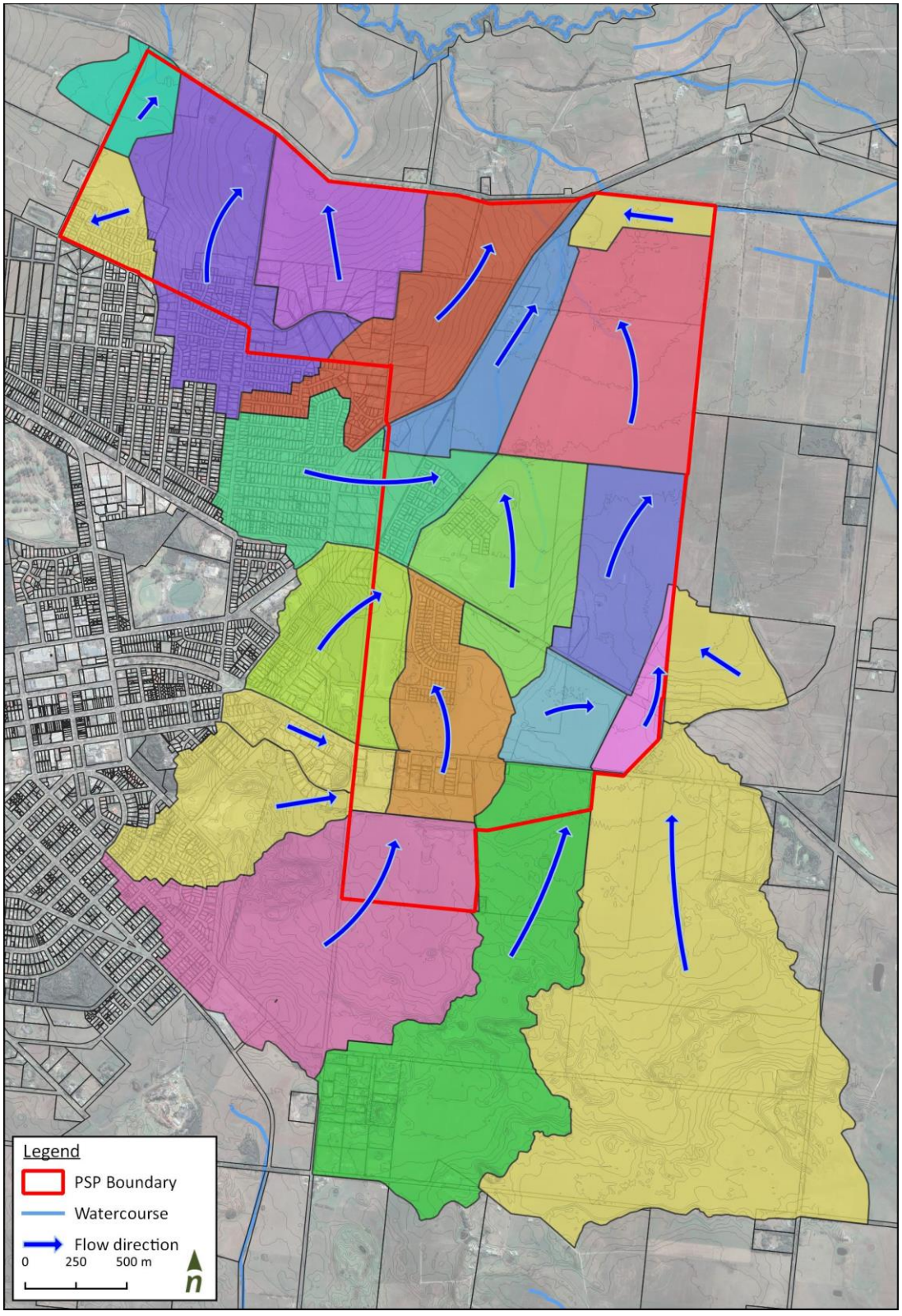



**Figure 19.** *Stormwater drainage sub-catchments across the PSP area (Engeny delineations, 2021)*

## 5.5 Flora and Fauna values

As part of the precinct planning process, Nature Advisory were engaged by Council in 2020 to conduct a biodiversity assessment of the PSP area. The investigation provided information on the extent and conditions of native vegetation in the area according to *Victoria's Guidelines for the removal, destruction or lopping of native vegetation* to be used as input into the Native Vegetation Precinct Plan for the area. The study was conducted by a review of existing information on the region and two independent site visits.

- The site primarily comprised of agricultural lots which supported introduced pastures and/or used for cattle grazing
- The predominant native vegetation recorded throughout the PSP area includes:
    - Swamp Scrub (EVC 53), mainly around roadsides
    - Damp Sands Herb-rich Woodland (EVC 3)
    - Lowland Forest (EVC 16)
    - Grassy Woodland (EVC 175)
    - Tall Marsh (EVC 821)
    - Swampy Woodland (EVC 937)
- A total of 14 large native trees were recorded across the area. Nature Advisory noted under the DEWLP Native Vegetation Removal Report (May 2020), any approval for removal of native vegetation would have these offset requirements:
- 1.744 general habitat units with a minimum strategic biodiversity value score (SBV) of 0.338
- The protection of the 14 large trees.
- A large wetland exists near the intersection of Bass Hwy and Carneys Road, providing an aquatic habitat, and is heavily vegetated with Narrow-leaf Cumbungi (*Typha domingensis*)
- Based on the current development plan at the time of the Flora and Fauna study, no threatened ecological communities, flora, or fauna species were likely to be impacted
- A map of identified native vegetation is provided in Figure 20.

Additional to the general biodiversity assessment, Nature Advisory was also engaged by Council in 2020 to conduct targeted Growling Grass Frog, Swamp Skink and Latham's Snipe Surveys. The surveys consisted of three separate field trips to the PSP area including active searches for the target species and placement of cameras.

The surveys concluded that the PSP development posed a low threat to the target species due to:

- the current considerations and PSP retain the main fauna habitat linkages
- a lack of presence of the target species in the PSP area
- the proposed PSP poses a low risk to the target species.

Based on the ecological studies undertaken for the PSP, Alluvium has considered the recommendations from the Flora and Fauna studies and considered:

- the presence of roadside native flora
- pre-existing wetland ecosystems that we have demonstrated could provide direct links and enhanced outcomes through connection with the PSP blue-green asset corridors
- existing flora values and how these may be enhanced to improve ecological outcomes through PSP waterways and wetland systems.

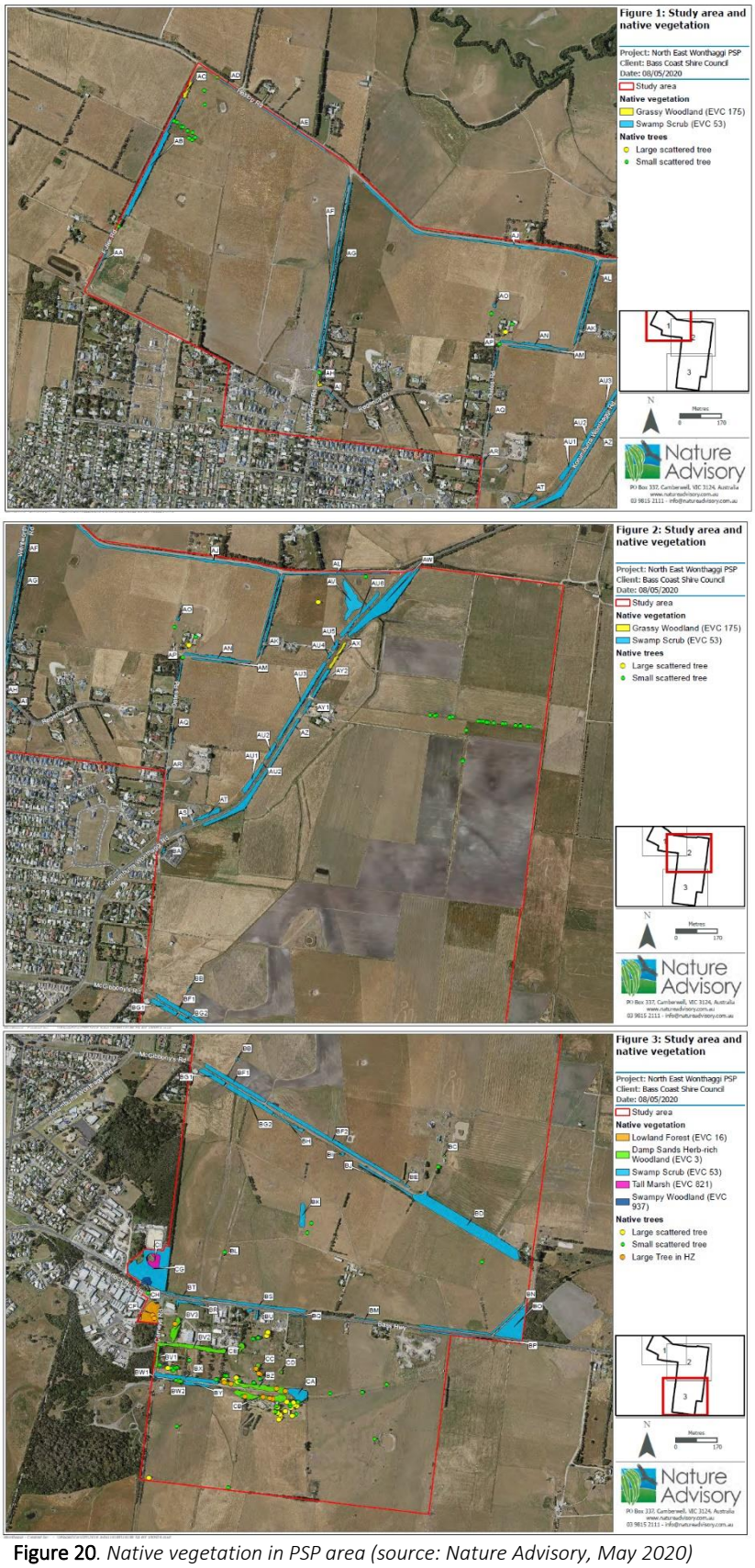



**Figure 20**. *Native vegetation in PSP area (source: Nature Advisory, May 2020)*

## 5.6 Cultural heritage

The Yallock Bulluk clan (one of the largest clans of the Bunurong People) are the traditional owners of the region. The traditional land of Bunurong People (Figure 21) extends from the Werribee River in the north-west, down to Wilson's Promontory in the south east which includes the Powlett River catchment. The Bunurong people have a continuing connection to country, including the lands and water for which the precinct falls within.

Like many other Indigenous Peoples, the Yallock Bulluk People changed with the seasons. Their culture and lifestyle explored all elements of the diverse land around them - from hunting in the ocean for seals and mutton bird, to trading with other Bunurong clans or Koolin People in the Dandenong, Bass Valley and Upper Powlett River. The Boon Wurrung Foundation and Bunurong Land Council Aboriginal Corporation (BLCAC) are the current Traditional Owner Groups for the PSP area, with BLCAC being appointed as a registered Aboriginal Party in 2017. Their feedback and input to the development of this PSP is critical for inclusion of Traditional Owner values in the management of water and development of land in the region.

An Aboriginal Cultural Heritage Survey was completed by Triskel Heritage Consultants in 2017 as part of the Wonthaggi North East Growth Area (WNEGA) Precinct Structure Plan. This survey was contained within the PSP boundary and did not include areas external to the precinct. The study involved a desktop-based assessment of the PSP conducted in 2016 by Andrew Orr (Triskel) and a fieldwork component conducted in March 2017.

The following provides a summary of the Aboriginal Cultural Heritage Survey:

- The survey comprised of visual (surface level only) inspection over most of the WNEGA
- Identified no new artifacts or archaeological features
- There are six approved Cultural Heritage Management Plans (CHMPs) within the current WNEGA boundaries
- Assessment of the CHMPs identified seven Aboriginal places all assessed as having low to moderate significance - no areas of high significance were found
- Dan Turnbull (Manager, Bunurong) emphasized the traditional cultural value of elevated land, while also expressing the importance of the whole area, especially considering the Yowengerra Clan (a relevant clan to the area) potentially having no living descendants.




Figure 21. *Bunurong Land Council Aboriginal Corporation (BLCAC) registered Aboriginal party (source: BLCAC website)*

While waterways (rivers and creeks) were typically travelling routes for Aboriginal peoples, there were often numerous landforms other than waterways, and elevated land areas that can pose a high potential to yield Aboriginal material culture. Any high impact activity (such as the proposed land development for the PSP) within defined areas of Aboriginal cultural sensitivity, requires a mandatory Cultural Heritage Management Plan (CHMP).

Key recommendations from the Triskel Heritage study were to produce voluntary CHMPs, especially in the high potential locations as shown in Figure 22, and continue to consult and engage relevant Traditional Owners through the current PSP process, in this instance, the BLCAC. It is noted that to date, while CHMPs have been undertaken for the PSP, none have been commissioned for areas of *high potential sensitivity.*

**Key definitions of note for the protection of Aboriginal cultural values** (*source*: Triskel Heritage study)

| | |
|---|---|
| **High Impact Activity** | Examples include the subdivision of land into three or more parcels/lots. (*Victorian Aboriginal Heritage Act 2006*, Regulation 46) |
| **Areas of Cultural Sensitivity** | Are determined using several spatial parameters intended to reflect where Aboriginal cultural heritage places are most commonly found; and land within 50m of these (R.25) and land within 200m of a waterway (R.26) |
| **High Sensitivity (Most Likely potential)** | As much as possible, these areas should be retained in their current form and, where applicable, be rehabilitated to further stabilise them (e.g. from erosion). This should be in the form of passive open space or other non-developable reserved land.<br>Where lower impact works are proposed in these areas, such as pedestrian and/or bike paths, these works should be designed to minimise impacts and be placed largely on top of the surface, to avoid impacting below the ground surface where material culture is most likely. |
| **Significant ground disturbance** | Under the Aboriginal Heritage Regulations these areas are no longer areas of cultural heritage sensitivity as disturbance of the topsoil layer by machine excavation or grading (excluding ploughing) is defined as significant disturbance (R.5) |
| **Registered Aboriginal Parties (RAP)** | In this case, Bunurong Land Council Aboriginal Corporation (BLCAC) are given the responsibility for most Aboriginal heritage matters within their registered area, including being responsible for the evaluation of CHMPs (as per *Aboriginal Heritage Act 2006*). |

The map below shows the predicted likelihood of Aboriginal cultural heritage occurring within the PSP area based on topographical conditions. Of note, is that the proposed locations for the functional stormwater assets to the north of the precinct do not conflict with areas of *High Potential* for Aboriginal cultural value (Figure 22).

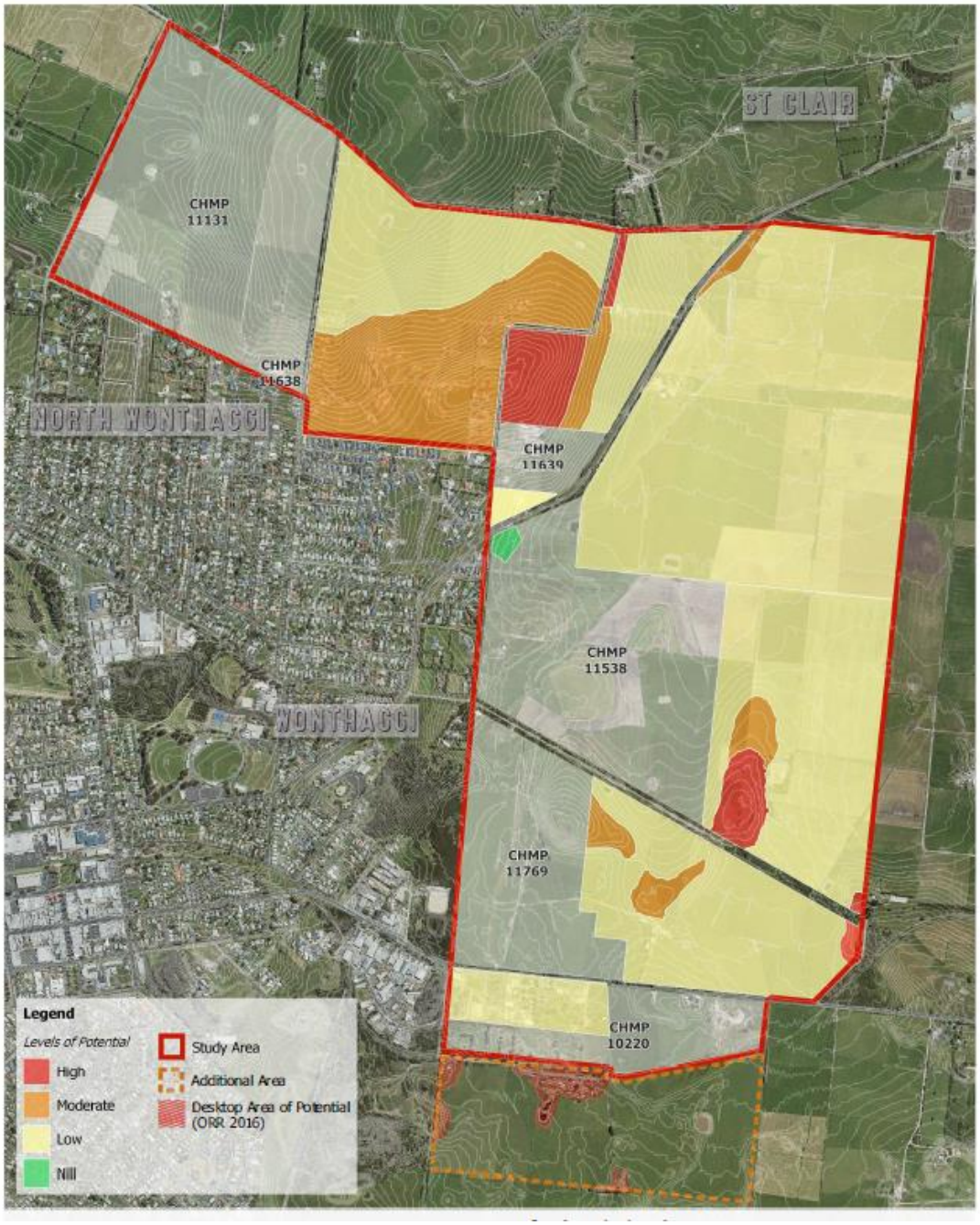



**Figure 22.** *Areas of potential Aboriginal cultural heritage values (source: Triskel, May 2017)*

In accordance with current regulations for the protection of Aboriginal culture, during the functional design stage we have ensured the alignment of E-WW (DCP ref DR2) does not conflict with the adjacent high value location at McGibbonys Road intersect and has ensured avoidance and preservation of existing.

## 5.7 Geology

A desktop survey was conducted to understand the geological conditions present in the PSP area. Based on publicly available State data, the predominant geological types in the PSP boundary are gravel/sand-silt layers and lithic volcanic sandstone.

No geotechnical assessments have been completed as part of the PSP process, it is assumed that further geotechnical investigations will be undertaken prior to the development of the Precinct, and ultimate implementation of the functionally designed assets for the PSP.

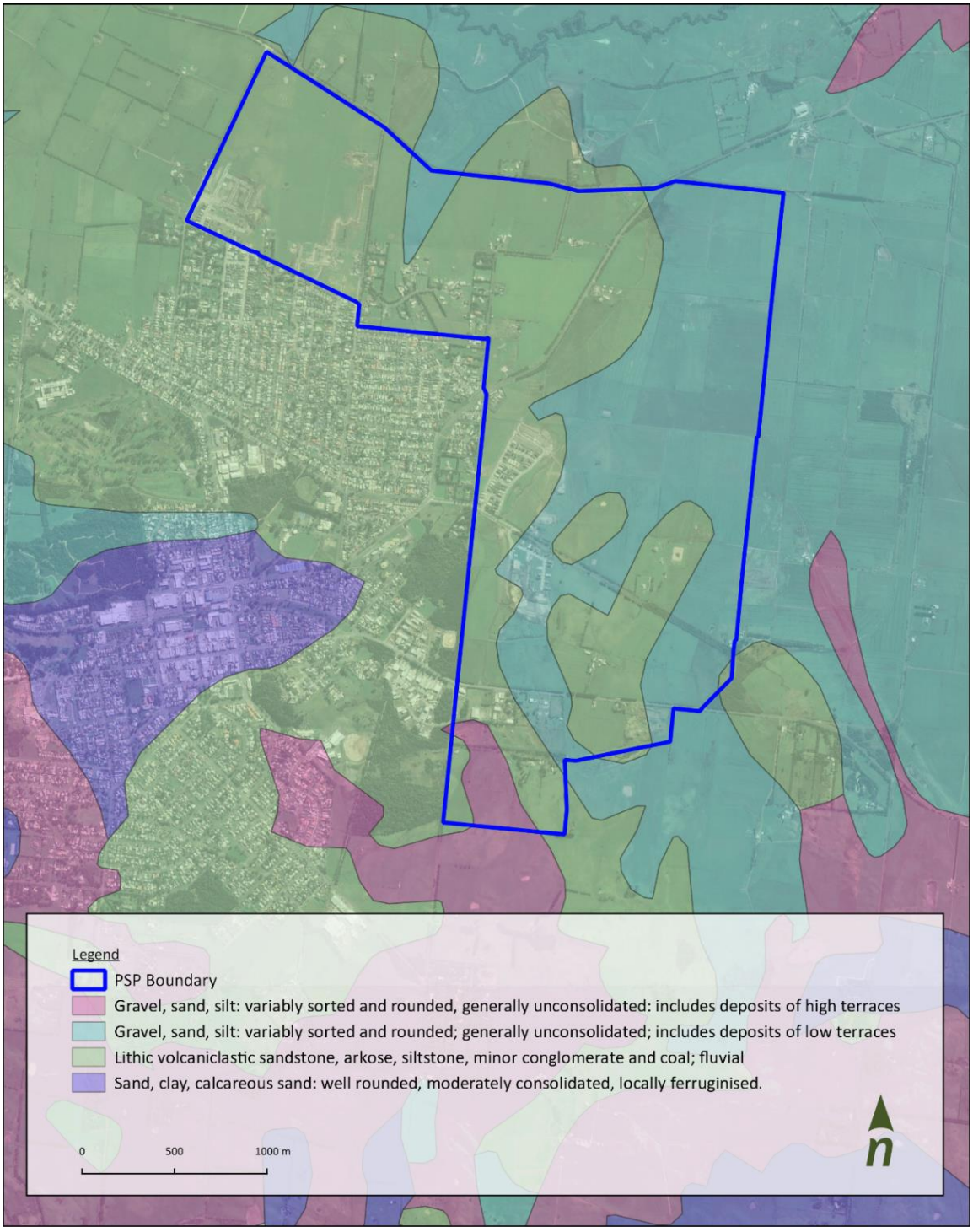



**Figure 23.** *Geological features of PSP and surrounding areas*

# 6 Proof of Concept Assessments

Alluvium has undertaken a thorough review and analysis of the work undertaken to date for the WNE PSP. In assessing concepts and modelling (undertaken by others) for the PSP assets. Below is a summary of Alluvium's assessment of the DCP / Engeny concepts that led to the recommended final concept layout (Figure 26) and the suite of functional designs approved by stakeholders. We have not reiterated all PSP assets only those that vary from what has been previously proposed. This variation in Alluvium's recommendations is to ensure all requirements, including best practice standards are being met, and that the design solutions lead to functionally sound assets.

## 6.1 Constructed wetland design principles

Constructed wetlands are man-made surface water management structures that aim to mimic natural wetland systems by filtering surface water flows through:

- Physical processes – a combination of wetland form and aquatic plant selection and placement
- Biological / chemical processes – nutrient cycling, chemical uptake, and contaminant removal (including heavy metals)
- Transformation processes – stabilising and 'fixing' contaminants like phosphorus and metals; converting pollutants such as ammonium and nitrogen into inert (non-reactive) gases (denitrification) released safely to the atmosphere; and providing some disinfection through ultraviolet (UV) exposure across open water areas.

Wetlands are a tertiary treatment component typically part of a 'treatment train' with an upstream primary treatment component such as a sediment basin or gross pollutant trap (GPT). Wetlands are shallow waterbodies with extensive vegetation coverage and long flow paths to reduce flow velocities and allow treatment action.

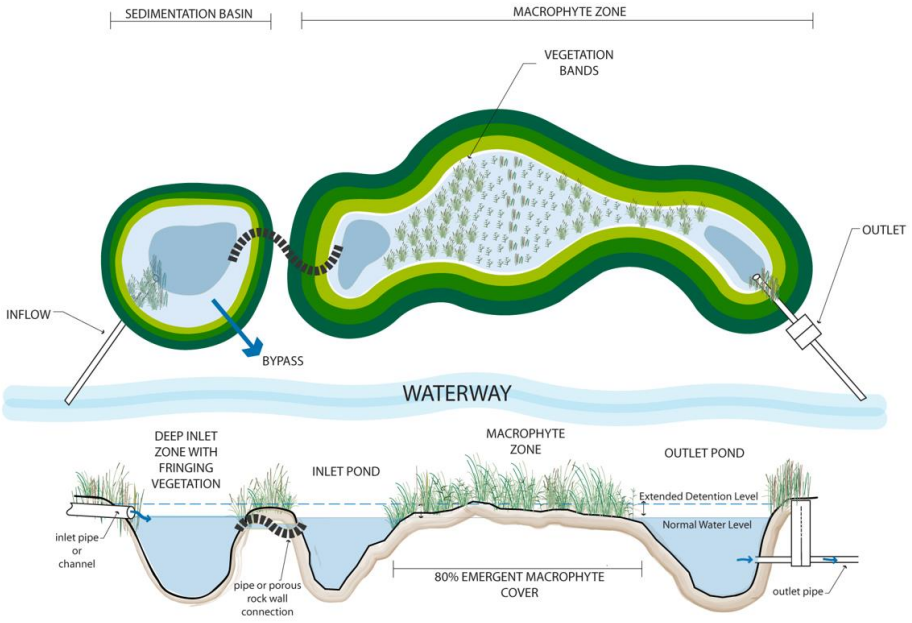



**Figure 24.** Typical concept layout of treatment wetlands *(source: Constructed Wetlands Design Manual, Melbourne Water)*

Constructed wetlands are comprised of three (3) main parts:

- **Inlet zone** – a sediment forebay or sediment basin that allows coarse sediment (> 125 micron) deposition (and litter) to protect the main body (integrity and lifespan) of the wetland. The sediment basin performs the primary treatment function in the treatment train and passes pre-treated flows into the inlet zone (first deep pool) of the wetland.

- Macrophyte zone (bounded by with inlet and outlet pools) – Pre-treated flows then move from the inlet zone (first wetland deep pool) and pass slowly over a 48-72hr period through a combination of shallow marsh and deep marsh zones (macrophyte zone) before entering the final deep pool (or outlet zone). A controlled outlet helps detain flows within the wetland for the treatment duration. The macrophyte zones are densely planted with specifically selected aquatic vegetation that filter flows and remove the pollutants from the water column.
    - Fine sediments and heavy metals which adhere to fines (e.g. clays) are trapped by the vegetation and 'locked' to the wetland floor (preventing their re-suspension).
    - Nutrient cycling of dissolved organics in the water column (e.g. phosphorus and nitrogen) is undertaken by the aquatic plants (for their growth and survival).
    - Micro-organisms (biofilms) growing on the surface of aquatic plants absorb pollutants and trap fine suspended particles through adhesion.
    - Stabilisation and 'fixing' of contaminants (e.g. phosphorus and metals) in the wetland soils through regular wetting and drying cycles of the designed wetland.
    - UV treatment in open water sections of the wetland provides a level of disinfection.
- High-flow bypass channel – allows excess flows to pass around (and not through) the wetland to protect wetland stability and plant survival (from bank, floor and vegetation scouring); and ensures further flows are bypassed when maximum extended detention depth (EDD) is reached within the wetland, allowing the system to effectively treat flows and achieve pollutant reduction targets as generated from the source catchment.

  Note: pollutant reduction targets are not about reducing by target percentages from the volume of water that enters the wetland, but a reduction in pollutants generated from the land area. Excess volume within the wetland reduces its design intent function in pollutant reductions.

During our Proof of Concept and background analysis stages we identified the following considerations.

Consideration of WLRB 3 (DCP WL-03) & WLRB 4 (DCP WL-04)
These two assets are located at the north-west corner of the PSP at the intersection of the discontinued Wentworth Road and Heslop Road.

The wetland concepts included:

- Inlet pond / sediment basin for each wetland
- Maintenance access ramps to the base of each sediment basin
- Sediment dry-out areas provided for each sediment basin
- Balance pipes between open water zones within the macrophyte zone
- Wetland vegetation zones provided in a banded manner
- Sediment basin transfer pits / pipes to outfall from the sediment basin to macrophyte zone
- Outlet provided from wetlands through the downstream adjacent property to the north.

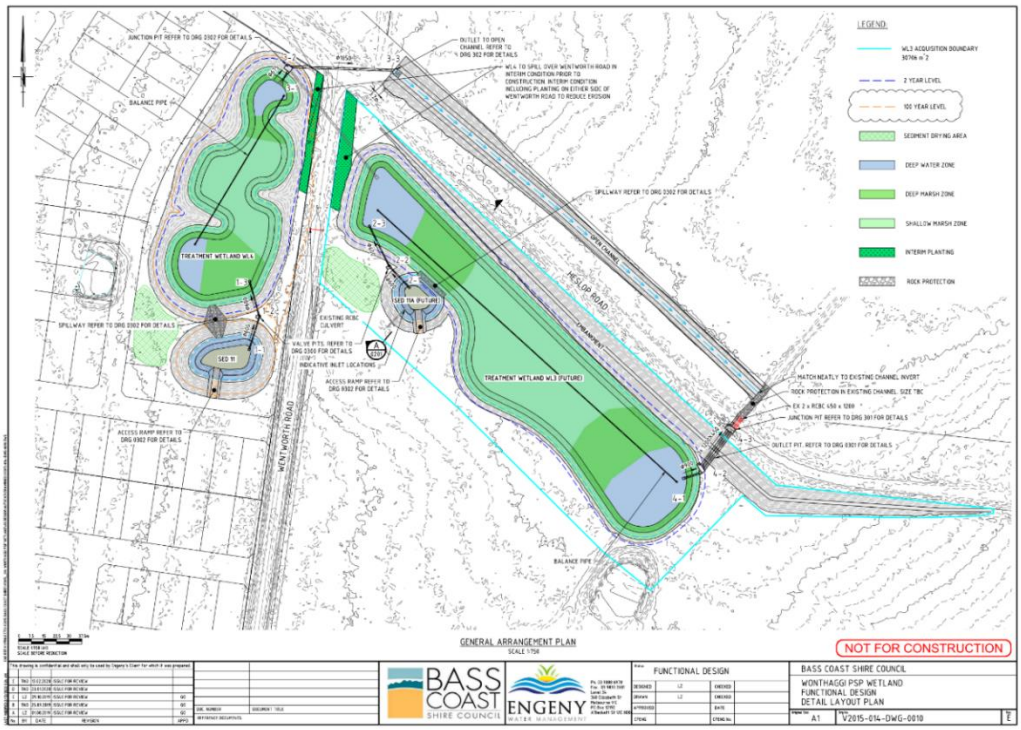



**Figure 25.** *Layout plans for WLRB3 (WL-03) & WLRB4 (WL-04) at Wentworth and Heslop roads (Engeny, 2020)*

### Summary of assessment - *Wetlands*

- No indicative inlet location was provided for WLRB4 (DCP ref WL-04) sediment basin.
- Connection between WLRB4 (DCP ref WL-04) sediment basin and the macrophyte zone of WLRB4 (DCP ref WL-04) should be made into the open water zone, not the macrophyte zone. The concept designs show these flows out-falling from the SB into the deep marsh vegetated zone and will likely result in higher shear stresses and stripping vegetation. This also results in a 'short circuit' of the wetland where flows are bypassing the first deep pool or wetland inlet zone where velocities are mitigated, and first line of the treatment process begins.
- The width at NWL along the wetland macrophyte zone (WLRB4; DCP WL-04) is very constricted near the outlet pool, but within the deep marsh zone. Constricting the width at NWL too much at this point will likely result in increased velocities through this vegetated section of the wetland, and likely strip vegetation and resuspend sediments and trapped pollutants from the wetland floor.
- The wide meanders along WLRB4 (DCP ref WL-04) will likely result in areas of stagnation at the widest points or ineffective flow areas and reduce the overall treatment efficiency of the wetland.
- Sediment basins and wetland macrophyte zones have been set at the same NWL. For maintenance purposes it is best to have the sediment basin NWL set at least 100mm above the wetland macrophyte zone NWL, to allow for draining of the sediment basin for sediment clean outs.
- To protect the integrity of the wetland and vegetation drowning out from an increased inundation duration, it is recommended that a high flow bypass of the wetland asset be incorporated, for events greater than the 20% AEP. Further, if these high flows are not diverted around the wetland, the pollutant reduction performance of the wetland will drop significantly as it is unable to manage these high volumes and reduced pollutant concentrations (dilution is not an acceptable pollutant reduction approach to waterway protection).
- The 1% AEP gap flows (i.e. 1% AEP minus the 20% AEP flow) can be managed via overland flow paths and along road reserves.

### Consideration of Bushfire Management

It should be noted that plant selections proposed for the treatment wetlands, constructed waterways and sediment basins are necessary for the function of each specific stormwater management (drainage) assets and note proposed as part of landscaping finishes for the PSP. Plants recommended for key water assets in the precinct meet the criteria for 'excluded vegetation under AS 3959-2018' as identified in the *Addendum* to the *Bushfire Development Report for the Wonthaggi North East Precinct Structure Plan* (VPA, 2021). Further, waterway corridor widths within the PSP have ensured a minimum bushfire protection buffer width of 19m to the proposed developed interface.

Plant recommendations are predominantly aquatic species requiring submersion or wet/dry conditions and are necessary for the design function of the wetland systems (i.e. stabilisation and pollutant filtration function). Species proposed for the sediment basins and constructed waterways are those requiring wet/moist conditions for bank stabilisation. No shrubs or trees have been specified, nor terrestrial plantings. All the plants are either related to the water asset function and/or bank stabilisation.

### Consideration of Flood management at 465 Heslop Road (subject property)

In response to concerns raised in the C152 amendment of the PSP, Council engaged Engeny to produce an *Impact and Proposed Mitigation Works Report* (March 2021) to reduce flooding conditions to a dairy farm at 465 Heslop Road (directly north, and downstream, of the PSP boundary, hereafter referred to as the subject property). Concerns that increased runoff from the developed area would exacerbate flood conditions already existing on the property were raised by the landowner.

Engeny produced an impact assessment using a more complex and detailed software (TUFLOW), allowing for considerations to be made for the inflows (riverine flooding) from the Powlett River. The results indicated that although there is an increase in flows from the precinct to the subject property in the 1% AEP event, inundation within the property was dominated by inflows from rural catchments to the east of the property and outfalling into the Powlett River upstream, and not directly attributable to the PSP discharge.

The summary findings (below) were applied to the functional design process (for the subject property / main outfall to the river):

- An increase in flooding in the 50% AEP event of up to 60 mm (up to 100mm at some locations)
- An increase in flooding in the 20% AEP event of generally less than 40 mm
- An increase in flooding in the 1% AEP event of less than 30 mm with the PSP flows only. When the Powlett River flows are included, there is no increase in the peak flooding experienced on the subject property.

A series of non-structural (non-designed) levees exist along the Powlett River on the subject property side which is providing protection to the property from river flows during the smaller more frequent events, however, they may also prevent the large events from discharging to the river from the PSP and should be considered further in the main outfall design.

### Consideration of Powlett Ridge Estate – Endorsed Plans (Sept 2021)

Powlett Ridge Estate is one of two main developments proposed for the Wonthaggi North East PSP. A review of endorsed plans (June 2019 – Sept 2021) was completed and found to be in line with Alluvium's prior understanding of the site. As such, no changes were required in our modelling and functional design approach in relation to this area.

### Summary of assessment – *Powlett Ridge*

- Land take for proposed W-WW (DCP ref DR-01) is accounted for as 'future reserve space' with provision for approx. 45m wide waterway corridor within the Powlett Ridge estate.

- Development location aligns with original DCP layout. Detailed designs in development plan set did not specify construction of an SB however, negotiations between council and the developer have resulted in a GPT being installed at this location (council update Oct 2021).

- North-western lot at McGibbonys Rd purchased by DETV proposed to include sediment basin - Alluvium recommends this SB be made redundant as the catchment's treatment is catered for by downstream WLRBs. Engeny's final strategy concurs with this redundancy.
- Changes to the W-WW (DCP ref DR-01) alignment at the upstream extent of works (north of Bass Hwy and south of parcels 65 and 65R) has resulted in a widening and straightening of this section. No functional design is required for this section as the location is under an S173 agreement as per Council's development approvals. However performance of this upstream section has been considered in the functional design of the downstream system.
- Whalebone Boulevard is currently planned to pass over the waterway entrance to the future reserve (Council advice Sep 2021), subsequent culverts should be sized appropriately to convey 1% AEP flows. As this section of W-WW (DCP ref DR-01) is existing along Connection Road, and the waterway it has no direct impact on the functional design set.
- Council update (Oct 2021): School site - flow from Jean Dennis Rd to discharge into waterway via GPT to be approved by the landowner and constructed by Powlett Ridge. Town drainage from the south to be redirected to a GPT in the drainage reserve in Powlett Ridge stage 6 (as per Council advice).

## 6.2 Revised Drainage Strategy (Engeny, September 2023)

Engeny was originally engaged by Bass Coast Shire Council in 2016 to investigate the stormwater quantity and stormwater quality treatment requirements of the proposed Wonthaggi North East growth area / development precinct. A number of minor adjustments were made to the strategy between 2017 and 2019 when a finalised version was resolved (October 2019). The stormwater drainage strategy has since undergone various reviews and updates in response to submissions through the planning process, to the current version (Engeny, 2023).

Alluvium's review and analysis of the proposed approach for the PSP's surface water management is based on a considered understanding of existing values, conditions and constraints, background investigations, modelling updates and reports (Engeny, February 2020 and March 2021), stakeholder inputs, development activity (agreements), endorsed recommendations, and the core PSP objectives (project intent).

The revised *Strategy for the Wonthaggi North East PSP* (Engeny, 2023) has been undertaken in parallel with this study - *Wonthaggi North East PSP Functional Designs* (Alluvium, 2023). The functional design response has accounted for all the above, and the more recent SAC recommendations accordingly. Alluvium and Engeny have revisited the strategic and functional design work in line with the agreed changes and recommendations, to ensure steps going forward are consistent and direction is clear for all other users.

Note: Appendix A (Table 66) provides an asset tracking summary of changes that occurred during the PSP functional design process (Oct 2019 – April 2022), and prior to the SAC Tranche 2 (June 2022) process. It is provided for future background reference.

### High level cost estimates (Engeny)

The Engeny Strategy high level conceptual estimated landscape and civil costs (based on 2019 rates) for the Wonthaggi North East Precinct Structure Plan is as follows:

- $25,284,000 for conveyance related drainage infrastructure:
    - $16,389,000 is estimated for constructed waterways
    - $4,438,000 is estimated for culvert structures
    - $4,457,000 is estimated for drainage pipelines.
- $10,070,000 for stormwater treatment infrastructure:
    - $3,439,000 is estimated for WL1 (DCP WL-01)
    - $1,017,000 is estimated for WL2 (DCP WL-02)
    - $1,935,000 Is estimated for WL3 (DCP WL-03)
    - $1,400,000 is estimated for WL4 (DCP WL-04)
    - $2,279,000 is estimated for stand-alone sediment basins (x11).

- $4,328,000 for the retarding basin infrastructure at WL1 (DCP WL-01) (see note).

Note: The intention of retardation in each of the wetlands was to retard flows for the 63% and 39% AEP events. This could be achieved within the wetland areas for wetlands 2, 3 and 4. At WL1 additional storage, and hence excavation, was required to achieve this retardation goal, therefore this WL was costed separately to show a line item for associated retardation costs for this wetland asset only (as per Engeny advice).

The total cost of the Engeny strategy is equal to $39,682,000. However, it should be noted that this total infrastructure excludes costs associated with land acquisition, litter traps / GPTs, and/or high flow bypass pipes for sediment basins.

A 35% contingency was applied to the overall conceptual cost estimates. This is consistent with advice through the Wonthaggi Engineering Conclave (costings experts) and the SAC Panel.

It should be noted that cost estimates provided in the original Stormwater Strategy (2019) were based on high-level, concept only estimations. These costings have not since been updated in the revised Strategy (Engeny, 2023). Given this, it is expected that conceptual cost estimations for the PSP will vary significantly from 2019 rates to those represented in this Functional Design Report, which are based on 2022 rates at the functional design detail level. Further, costings now include the trunk (main) drainage design as per the SAC recommendations, with some redesign of assets to accommodate stakeholder submissions (as per Panel) and development approvals (changes) over time.

## Summary

The following is based on all information provided for the Wonthaggi North East PSP, up to and including the Revised Drainage Strategy (Engeny, 2023) as follows:

- Development density of 13 dwellings / or lots per hectare
- Fraction impervious for the residential development area of 0.65
- The development precinct is required to meet best practice treatment of stormwater prior to outfall into the Powlett River, which includes:
    - 70% removal of the Total Gross Pollutant load
    - 80% removal of the Total Suspended Solids (TSS)
    - 45% removal of the Total Phosphorus (TP)
    - 45% removal of the Total Nitrogen (TN).
- All drains outfalling into an existing or constructed waterway will receive primary sediment removal (treatment) through sediment basins
- Confirmed with the WGCMA there is no requirement to control peak flows to predevelopment peak flow rates for major storm events in the 1% AEP, understanding the significant cost burden likely.
- However, increased runoff due to development in more frequent storm events means downstream land owners are likely to be subject to more frequent inundation, as a result more frequent events are to be controlled back to predevelopment peak flow rates up to the 50% AEP (as per WGCMA).

## Review of Revised Drainage Strategy (Engeny, 2023)

A cross-referencing review of the Revised Strategy (2023) and the Alluvium Functional Design Report and drawings (2023) has been undertaken to ensure:

- consistency between the Revised Strategy (by Engeny) and the PSP Functional Design Report (by Alluvium) to enable other professionals to:
    - Understand and reproduce the PSP results, as well as making future amendments if needed

- Assess and approve, with confidence, proposals from developers without needing to contact the original authors.

The Revised Drainage Strategy (2023) considerations include:

### *Sediment Basins*

- Includes 11 sediment basins, 8 of which outfall directly into the proposed waterway corridors. [Alluvium Note: opportunity to reduce overall Development Contributions Plan (DCP) costs and land take – consolidation of some sediment basins has been provided].
- Each sediment basin will require safe batters, hardstand areas for maintenance access and dedicated area for sediment drying prior to disposal – all of which will impact overall asset footprints / land take / asset costs. These will be addressed as part of the future functional design to ensure stormwater quality treatment to best practice reduction targets are achieved.
- The proposed sediment basins are to be sized using the Fair and Geyer equation, where sediment basins must meet the following criteria:
    - Capture 95% of coarse particles ≥ 125 µm diameter for the peak 4EY event.
    - It should be noted that several of the sediment basins have been significantly undersized and are currently not meeting the capture efficiency target highlighted above. This is likely to result in a high amount of sediment transferring from the sediment basins into the proposed waterway corridors, and subsequently, the proposed wetland assets.
    - Sediment basins have been designed to include a clean out frequency of 3 years. A 5 year cleanout frequency may be more desirable (and is standard industry practice and recommendation) to reduce ongoing maintenance costs.

### *Wetlands*

- WLRB1 (DCP ref WL-01) was designed as online to the constructed waterways, as it is expected to receive flows from the external rural catchment.
- Wetlands that are located online to a waterway generally experience increased durations of inundation and high velocities through the system, as a large volume of flow generated from the catchment is required to pass through the online system. This is likely to result in stripping of vegetation due to higher velocities and vegetation 'drowning' due to increased periods, and depths, of inundation.
- Due to a large contributing catchment to WLRB1, a large regular flow is expected to enter the system via the waterways. Currently, the proposed wetland designs do not meet velocity threshold limits of 0.05 m/s in the 4EY event, and 0.5 m/s in the 20% AEP event, whilst maintaining an appropriate length to width ratio of 4:1. Wetland velocity calculations / performance (based on the revised Engeny strategy) were completed as part of the previous proof of concept reporting. If wetland velocity thresholds are exceeded vegetation within the system is likely.
- It is noted WLRB1 is also carrying 319mm of excess volume, above NWL and needs to be addressed through increasing the wetland size and macrophyte zone to safely distribute this volume and ensure wetland function. WLRB's 2, 3 & 4 also have increased water level exceedance, and are to be addressed as part of the functional design.
- Based on the revised strategy, it is assumed any future development that occurs upstream of the PSP area is controlled back to predevelopment conditions, and stormwater treated to BPEM guidelines prior to outfalling into the PSP area.

### *Waterway Corridors*

- The overall waterway corridor widths provided within the strategy appear adequate (range 40-60m). However, the lack of sinuosity (meandering) of the waterway layout is likely to lead to higher velocities, erosive capabilities, and in time compromise bed, bank, and associated vegetation.

- The proposed industrial area at the southern extent of the precinct on Carneys Road should require installation of a triple interceptor or similarly suitable product to manage quality of flows from this area discharging into the precinct's constructed waterway.
- The E-WW (DCP ref DR-02) located along the eastern boundary of the PSP includes a 90-degree bend prior to outfall into the proposed WLRB1 (DCP ref WL-01) asset. This is likely to result in localised high velocities / shear stresses, which will result in erosion along the banks and incision of the waterway over time, and potential short circuiting of the system. If a 90-degree bend along the waterway is to remain, substantial rock armouring / beaching will be required to ensure the waterway can be retained in this form (without short circuit/bank collapse).
- W-WW (DCP ref DR-01) alignment has been adjusted to reflect an approved Development Plan for the subdivisional works north of Bass Hwy and south of McGibbonys Road (as per SAC recommendations).
- Combined with areas of deeper pools and rock riffle zones with meanders, will not only better stabilise and protect the system, but will encourage a biodiverse creek environment allowing macroinvertebrates to move in and breed, providing a reliable food supply for higher order species (birds, frogs, etc).
- Further, the landscape amenity, community enjoyment and appreciation of these constructed waterways will be further improved, increasing their value to the community and therefore their passive surveillance (through use / visitation) and protection.

### *Culverts*

- Multiple outfall culverts from the PSP are proposed across Heslop Road, more specifically, two are proposed at the WLRB1 (WL-01) and WLRB2 (WL-02) locations, and two are proposed at the WLRB3 (WL-03) and WLRB4 (WL-04) locations. It may be more desirable to consolidate these culvert assets with an appropriate design that reduces the number of assets for long term maintenance / asset renewal costs, and initial capital investment.

### *Retarding Basins*

- Due to the complex hydraulics of the strategy and tailwater effects of the downstream Powlett River floodplain, retarding basins have been sized using TUFLOW. As such storage sizes of each retarding basin, and their respective outlets have been sized to reduce flows, and the downstream afflux flood depth (i.e. the difference between developed conditions flood depth minus the existing conditions flood depth).
- Each retarding basin has been designed to include a wetland located within the base of the system, which provides stormwater quality treatment for the Precinct.
- The TUFLOW model is required to be updated to include any changes to the retarding basin/wetland systems, as well as any changes to the constructed waterway systems.

# 7 Functional Design Approach

Following review of all previous studies, modelling and data, strategies, and stakeholder feedback, we have built on this knowledge and established a thorough understanding of the PSP landscape. We have considered future plans, current conditions and intended outcomes for the PSP; as well as stakeholder preferences, development approvals (changes) at play, and developed a **revised** stormwater management **concept layout for the PSP** (refer Figure 26).

The focus of the revised Alluvium Concept Layout was to build on work done to date, to focus on asset function and protection of downstream environs, while also seeking a more cost-effective outcome through asset integration, and optimised functionality, including asset relocation, co-location and/or asset redundance to minimise developable land take (improve lot yield). Overall, to reduce development contribution cost for the precinct, without compromising strategic intent, values and outcomes.

Underlying this approach is the objective to design multi-outcome/multi-functional assets which not only manage flows and treat urban stormwater runoff, but provide for broader community benefits such as amenity, recreation, cooling, connectivity, health and wellbeing, biodiversity and cultural heritage preservation and potential enhancement. In considering all these objectives and outcomes, our functional design considerations are also mindful of a changing climate and the potential impacts this may have on asset performance, integrity, robustness, and endurance.

### Climate change considerations

Victoria's climate is changing and will continue to change into the future. We understand that with continued increases in greenhouse gas concentrations, most climate models predict Victoria's climate will become hotter and drier. The latest research from the Victorian Climate Initiative (DELWP, 2016) has identified clear reductions in cool season (April to October) rainfall over recent decades. Compared to current conditions, median climate projections for 2065, expect that Victoria will experience a temperature increase of between 1.9 - 2.6°C and an increased rate of potential evapotranspiration of 6% - 8%. The greatest impacts from climate change are projected to occur in western Victoria.

Climate change is having an impact on Wonthaggi's water cycle – while overall annual rainfall and runoff will decrease, the intensity of storms is expected to increase and has bearing on how we build (design in) resilience into the PSP water infrastructure. A key component of treatment asset function and optimal performance is directly related to the selection, placement, densities, and survival of aquatic vegetation within these assets. Understanding the impacts of inundation frequencies, depths, and equally times of low rainfall and/or high evapotranspiration rates, all contributed to the functional design outcomes.

Further, well-designed assets should ensure these systems integrate seamlessly with the surrounding urban landscape, respond to the opportunities the 'location landscape' offers in the design outcomes, and considers how people may use the space in future.

### Functional design considerations

Alluvium's Proof of Concept recommendations for the PSP have been incorporated (along with stakeholder feedback) into the functional design phase.

The following key considerations were addressed:

- all wetlands have a retarding function, subsequently adopting the naming convention WLRB.
- considered flow volumes modelled to pass through WLRB1 (DCP ref WL-01) which is 'split' into WLRB-1A and WLRB-1B with corresponding inlet zones (sediment basins integrated). This will improve overall treatment performance and asset integrity (given the size of the contributing catchments in play),

while ensuring overall land take (footprint) is confined to existing areas prone to inundation (currently encumbered / non-developable land areas).

- increase sinuosity of W-WW (DCP ref DR-01) and E-WW (DCP ref DR-02) to reduce instream flow velocities to protect waterway bed/banks and promote ecological health of waterways and associated riparian zones (i.e. vegetation buffer for bank protection/stabilisation, habitat creation and wildlife protection, landscape amenity, shade, and cooling).
- alignment of E-WW (DR-02) and the waterway reserve is to remain within PSP boundary as defined (VPA advice) and to avoid isolating areas of developable land, therefore velocity management through this waterway to be sought in other ways.
- reduce the number of independent sediment basins overall by integrating them into WLRB assets or remove redundant / unnecessary assets (e.g., GPT installed or small catchments).

Of the proposed 30+ assets for the PSP, these have been consolidated to 25 functional designs as follows:

- 3 constructed waterways
- 4 wetland-retarding systems (includes integrated sediment basins)
- 5 independent sediment basins
- 12 culverts
- Plus the trunk stormwater network for the PSP (as per SAC recommendations).

The confirmed Concept Layout of proposed PSP's stormwater assets is shown in Figure 26. The proposed culverts (crossings) for the PSP are detailed in Section 9.4 and shown in Figure 37.

Breakdown of retarding basin areas vs wetland treatment areas:

Wetland / Retarding Basin 1 (A&B) – 22.97 hectares

- Wetland 1A treatment area: 3.5 ha
- Wetland 1B treatment area: 4.5 ha
- Retarding Basin 1: 14.97 ha

Wetland / Retarding Basin 2 – 2.04 hectares

- Wetland 2 treatment area: 1.0 ha
- Retarding Basin 2: 1.04 ha

Wetland / Retarding Basin 3 – 2.94 hectares

- Wetland 3 treatment area: 1.0 ha
- Retarding Basin 3: 1.94 ha

Wetland / Retarding Basin 4 – 1.70 hectares

- Wetland 4 treatment area: 1.7 ha

Table 2 (below) provides a summary of the functional asset designs contained in this report, including naming (ID), DCP reference, footprints, location and hyperlinks to relevant sections in this report.

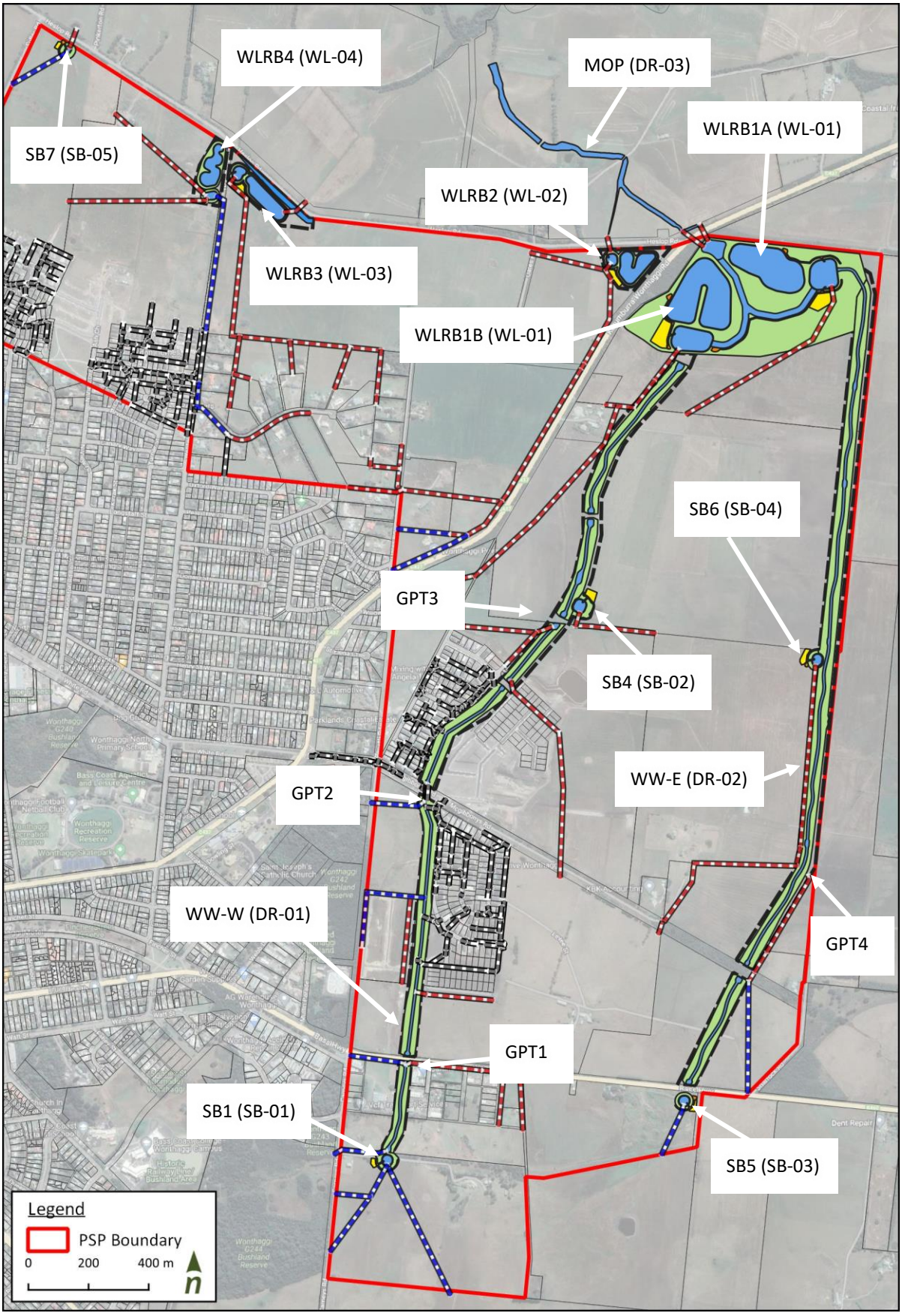



**Figure 26.** *Overall stormwater asset layouts for the PSP (Alluvium 2023)*

Table 2. Assets considered for functional design – naming, footprints, and location links within this report

| DESIGNS | ALLUVIUM ASSET ID | DCP REFERENCE | | ASSET FOOTPRINT (REQUIRED) | REFER TO REPORT SECTION |
|---|---|---|---|---|---|
| | 2022 | 2022 | 2023 | | |
| 1 | W-WW | DR-01 | DR-01 | 60m corridor | Section 10 |
| 2 | E-WW | DR-02 | DR-02 | 60m corridor | Section 11 |
| 3 | MOP | DR-03 | DR-03 | - | Section 12 |
| 4A | WLRB1A (east) | WL-01 | WL-01 | 22.97 ha^ | Section 14 |
| 4B | WLRB1B (west) | WL-01 | WL-01 | (included above)* | Section 15 |
| 5 | WLRB2 | WL-02 | WL-02 | 2.04 ha^ | Section 16 |
| 6 | WLRB3 | WL-03 | WL-03 | 2.94 ha^ | Section 17 |
| 7 | WLRB4 | WL-04 | WL-04 | 1.70 ha^ | Section 18 |
| 8 | SB1 | SB-01 | SB-01 | 0.51 ha^ | Section 19 |
| 9 | SB4 | SB-02 | SB-02 | 0.49 ha^ | Section 20 |
| 10 | SB5 | SB-03 | SB-03 | 0.48 ha^ | Section 21 |
| 11 | SB6 | SB-04 | SB-04 | 0.37 ha^ | Section 22 |
| 12 | SB7 | SB-05 | SB-05 | 0.33 ha^ | Section 23 |
| 13 | CU-02 | CU-02 | CU-01 | - | Section 10.3 |
| 14 | CU-03 | CU-03 | CU-02 | - | Section 11.3 |
| 15 | CU-05 | CU-04 | CU-03 | - | Section 10.3 |
| 16 | CU-08 | CU-08 | CU-04 | - | Section 14 to Section 15 |
| 17 | CU-09 | CU-09 | CU-05 | - | Section 16 |
| 19 | CU-10 | CU-10 | CU-06 | - | Section 17 |
| 20 | CU-12 | CU-12 | CU-07 | - | Section 22 |
| 21 | CU-14 | CU-14 | CU-08 | new | MOP (DR-03) crossing Section 0 |
| 22 | CU-15 | CU-15 | CU-09 | new | MOP (DR-03) crossing Section 0 |
| 23 | CU-16 | CU-16 | CU-10 | new | MOP (DR-03) crossing Section 0 |
| 24 | - | - | CU-11 | new | Section 14 to Section 15 |
| 25 | CU-13 | CU-13 | CU-12 | | Section 11.3 |
| + | - | - | Trunk drainage network | new | As per SAC recommendations Section 8.3 |

* Total footprint of WLRB1A & WLRB1B (DCP ref WL-01) system is combined.
^ Total asset footprint includes treatment plus retarding areas but does not include the required sediment dry out area.

# 8 Stormwater Quantity Management

## 8.1 Hydrologic modelling

The hydrologic analysis of the Wonthaggi North East PSP was undertaken to determine the pre and post-development peak runoff flow rates ($m^3/s$) for various flood events throughout the catchment. The hydrologic analysis is used to determine the storage capacities of proposed retarding basins required to retard the fully developed peak stormwater runoff rates back to pre-developed conditions, and to determine the flows entering the stormwater quality treatment wetlands for the PSP. The hydrology results are also used as inputs for the flood modelling.

The aim of the RORB modelling is to establish critical peak flows and the storage requirements within the Wonthaggi North East PSP. As identified by the WGCMA, development conditions peak runoff from the PSP area is to be controlled back to the equivalent 50% AEP predeveloped conditions peak flow. The supplied Engeny RORB models were reviewed as part of the functional design process.

The hydrologic analysis was undertaken using RORB (v6.31), which is a runoff-routing software designed to simulate attenuation and time of concentrations to produce flood estimates at specified catchment locations to determine:

- Existing peak flows
- Impact of development on peak flows
- Reduction in peak flows that is possible using retarding basin storage etc.
- Impact of climate change on peak flows.

The RORB model was built by delineating the major catchments into sub-areas based on topography and potential road alignments. A layout of the RORB model is provided in Figure 27.

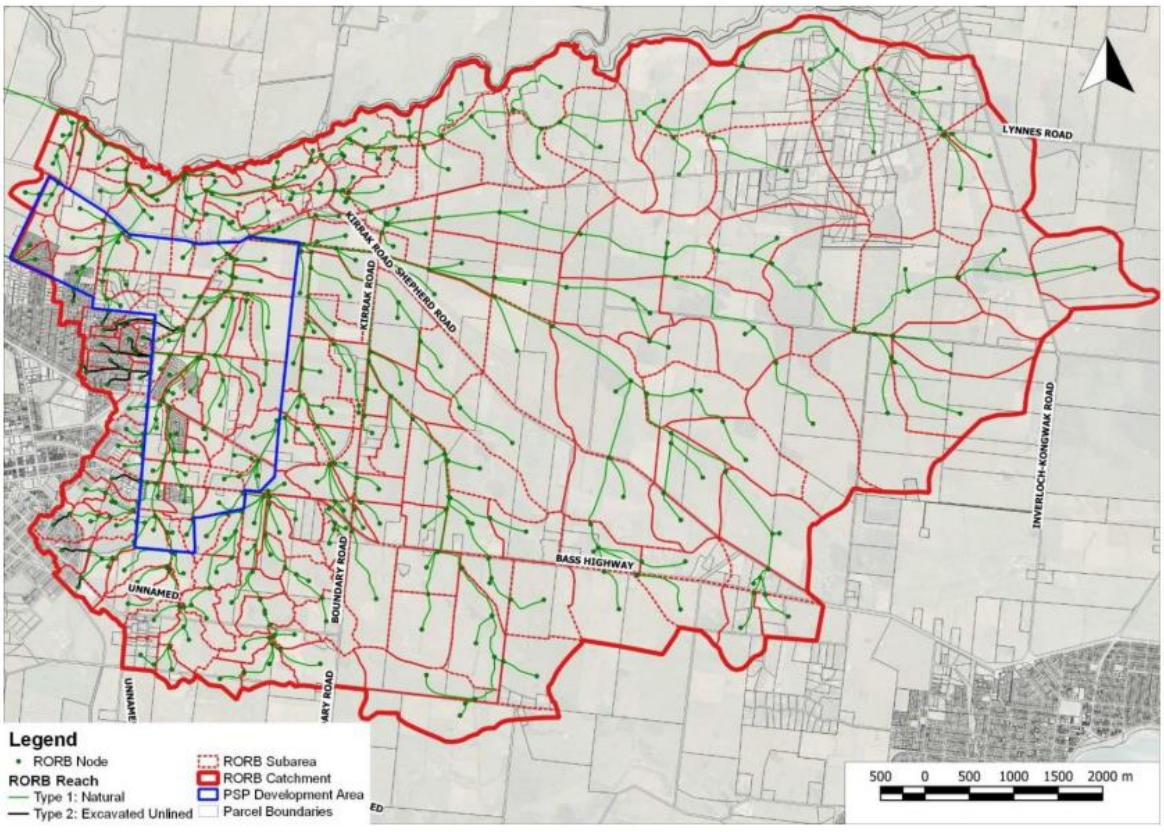



**Figure 27**. *RORB model layout for the Wonthaggi North East PSP (source: Engeny, 2023)*

## Catchment calibration

In line with previous studies of the area, no gauge data exists within the local catchment of the PSP area, and no calibration data is available from past flood events that can be used for the calibration of the RORB model. As a result, the Engeny RORB model has adopted utilising the RFFE tool to calculate flows for rural/natural catchment conditions as the calibration method.

Given some development has occurred, a RORB model assuming 'no development' was created. The model removed any significant hydraulic controls, such as Korumburra-Wonthaggi Road. Reaches were assumed to be natural (or Type-1) and subareas assumed a fraction impervious of 0. The model was run for a range of input parameters in order to determine the set of parameters which provide the best trend with the RFFE results. The model was run for the 1% AEP and 50% AEP flood events, and was compared against the DNRE flood regression analysis, which provides a secondary 'sanity' check on the magnitude of flows.

The initial RORB model runs were computed using initial and continuing loss values form the data hub, and a kc value derived using the Pearse equation (a Victorian wide kc estimation). All models were run with an aerial reduction factor (ARF) matching the total catchment size of 67.3km$^2$. in line with the updated Victorian specific guidance for pre-bursts, 75% pre-burst depths were adopted.

The following routing scenarios have been modelled:

1. Pearse et al. kc (kc = 10.48) and losses adopted from ARR Datahub (IL = 21mm, CL = 4.6mm/hr)
2. Pearse et al. kc (kc = 10.48) and reduction in losses (IL = 20mm, CL = 3.8mm/hr)
3. Lower kc (kc = 10) and reduction in losses (IL = 20mm, CL = 3.8mm/hr)
4. Higher kc (kc = 15) and reduction in losses (IL = 20mm, CL = 3.8mm/hr)
5. Median kc (kc = 13) and reduction in losses (IL = 20mm, CL = 3.8mm/hr)
6. Median kc (kc = 13) and further reduction in losses (IL = 10mm, CL = 3.8mm/hr)

Five validation points within the greater catchment were considered, the flow rates determined for each of these catchments using RORB have been compared against the RFFE flow outputs and the DNRE flood regression analysis. A description of the five catchments analysed are listed below:

- Sub catchment A: External catchment draining to a culvert crossing at Korumburra-Wonthaggi Road north of Lynnes Road
- Sub catchment B: PSP catchment area draining to the future WLRB1 location (part of this study)
- Sub catchment C: External catchment draining to a culvert crossing at Korumburra-Wonthaggi Road south of Lynnes Road
- Sub catchment D: Remaining catchment area within the PSP draining to the Powlett River north of Wonthaggi
- Sub catchment E: External catchment draining to a culvert crossing at Korumburra-Wonthaggi Road south of Lynnes Road.
- Sub catchment F: total contributing area of Sub catchments A to E.

An overview of the catchments mapped for the calibration of the RORB model is depicted in Figure 28 below.

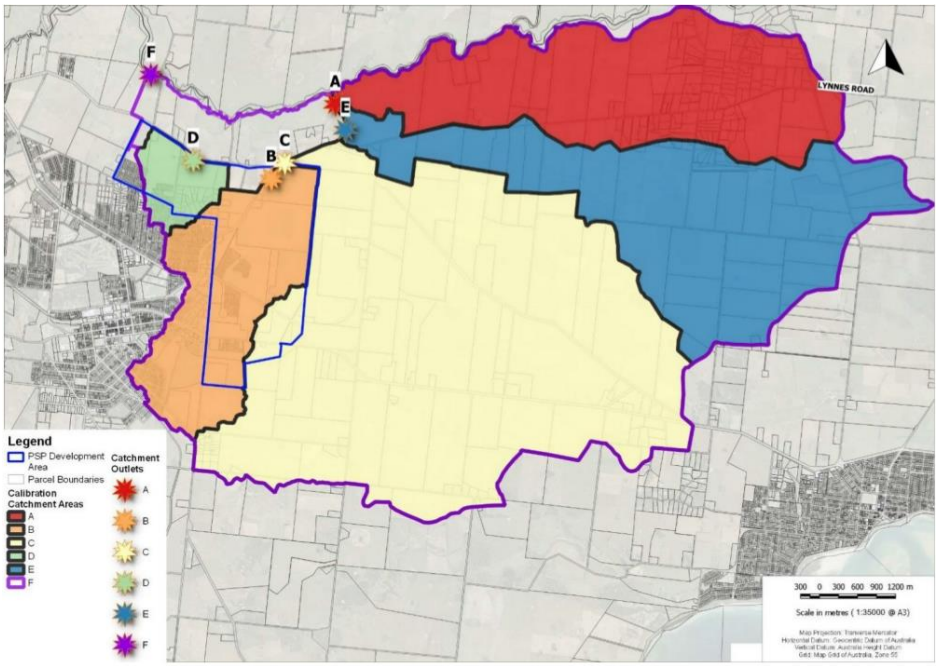



**Figure 28.** *Validation sub-catchments (source: Engeny, 2023)*

A summary of the RORB outputs, RFFE results and DNRE calculations are provided below.

**Table 3. Predevelopment conditions RORB modelling results for the Wonthaggi North East PSP (1% AEP)**

| Calibration | Catchment A | Catchment B | Catchment C | Catchment D | Catchment E | Catchment F |
|---|---|---|---|---|---|---|
| Catchment Area ($km^2$) | 12.17 | 6.80 | 29.78 | 1.45 | 14.07 | 67.34 |
| RFFE | 35.2 | 31.2 | 74.9 | 20.0 | 35.9 | 108.0 |
| RFFE 5% Limit | 15.3 | 13.6 | 32.6 | 8.7 | 15.6 | 47.0 |
| RFFE 95% Limit | 80.2 | 71.1 | 171.0 | 45.7 | 81.7 | 248.0 |
| DNRE | 31.4 | 20.2 | 62.2 | 6.2 | 35.1 | 116.0 |
| kc 10.48 (Pearse), IL 21mm, CL 4.6mm/hr | 18.4 | 14.9 | 55.4 | 7.1 | 23.9 | 104.6 |
| kc 10.48, IL 20mm, CL 3.8mm/hr | 21.2 | 16.6 | 62.0 | 7.5 | 26.6 | 115.9 |
| kc 10, IL 20mm, CL 3.8mm/hr | 21.9 | 17.1 | 64.3 | 7.8 | 27.4 | 119.9 |
| kc 15, IL 20mm, CL 3.8mm/hr | 15.9 | 12.4 | 46.9 | 5.4 | 20.2 | 90.1 |
| kc 13, IL 20mm, CL 3.8mm/hr | 18.1 | 14.0 | 51.7 | 6.2 | 23.1 | 100.7 |
| kc 13, IL 10mm, CL 3.8mm/hr | 20.6 | 15.7 | 59.6 | 7.9 | 25.9 | 116.1 |

Table 4. Predevelopment conditions RORB modelling results for the Wonthaggi North East PSP (50% AEP)

| Calibration | Catchment A | Catchment B | Catchment C | Catchment D | Catchment E | Catchment F |
|---|---|---|---|---|---|---|
| Catchment Area ($km^2$) | 12.17 | 6.80 | 29.78 | 1.45 | 14.07 | 67.34 |
| RFFE | 6.9 | 6.1 | 14.6 | 3.9 | 7.0 | 21.3 |
| RFFE 5% Limit | 3.4 | 3.1 | 7.4 | 2.0 | 3.5 | 10.8 |
| RFFE 95% Limit | 13.7 | 12.1 | 29.1 | 7.8 | 13.9 | 42.1 |
| kc 10.48 (Pearse), IL 21mm, CL 4.6mm/hr | 2.2 | 2.1 | 7.6 | 1.2 | 2.8 | 13.1 |
| kc 10.48, IL 20mm, CL 3.8mm/hr | 1.2 | 1.3 | 4.5 | 0.9 | 1.6 | 7.7 |
| kc 10, IL 20mm, CL 3.8mm/hr | 2.3 | 2.3 | 8.0 | 1.3 | 3.0 | 13.8 |
| kc 15, IL 20mm, CL 3.8mm/hr | 1.4 | 1.4 | 5.0 | 0.8 | 1.8 | 8.6 |
| kc 13, IL 20mm, CL 3.8mm/hr | 1.7 | 1.6 | 5.9 | 1.0 | 2.2 | 10.2 |
| kc 13, IL 10mm, CL 3.8mm/hr | 3.6 | 3.3 | 12.1 | 2.1 | 4.7 | 21.0 |

The RORB model has adopted the routing scenario which utilises the following routing parameters:

- Kc value of 13
- Initial loss value of 10mm
- Continuing loss value of 3.8mm/hr.

## Powlett River RORB model

A RORB model was developed (GHD, 2008) in accordance with ARR 1987, as part of the Victorian Desalination Project Environmental Effects Statement (EES). The GHD model provided flows for the Powlett River, which were required in order to determine the impact of the Powlett River on the development area. The EES RORB model was required in order to determine hydrograph inputs for the TUFLOW model.

Engeny previously obtained a copy of the EES document and recreated the RORB model based on the report. Engeny made minor adjustments to the recreated RORB model parameters to achieve a close match in the peak flows at the gauging stations used to calibrate the EES RORB model. Engeny calibrated the EES RORB model to a flood frequency analysis (FFA) undertaken at the Powlett River, downstream of Foster Creek Junction (gauge station 227236) for seven storm events between 1980 and 2001. These events did not include the August 2022 rainfall events.

Engeny expects that the EES RORB model "is slightly underestimating peak flows on the Powlett River". Despite these concerns, Engeny deemed the model was suitable to use only for a sensitivity test of the impact of flooding on properties downstream of the development area, when the Powlett River flows are considered. Given this potential underestimation of flows on the Powlett River, Engeny's Strategy suggests "utilising these

flows represents a conservative position, as higher flows would reduce the relative impact of flows from the development area compared to the Powlett River".

An overview of the gauging stations checked, and the sensitivity results are provided in Figure 29 below.

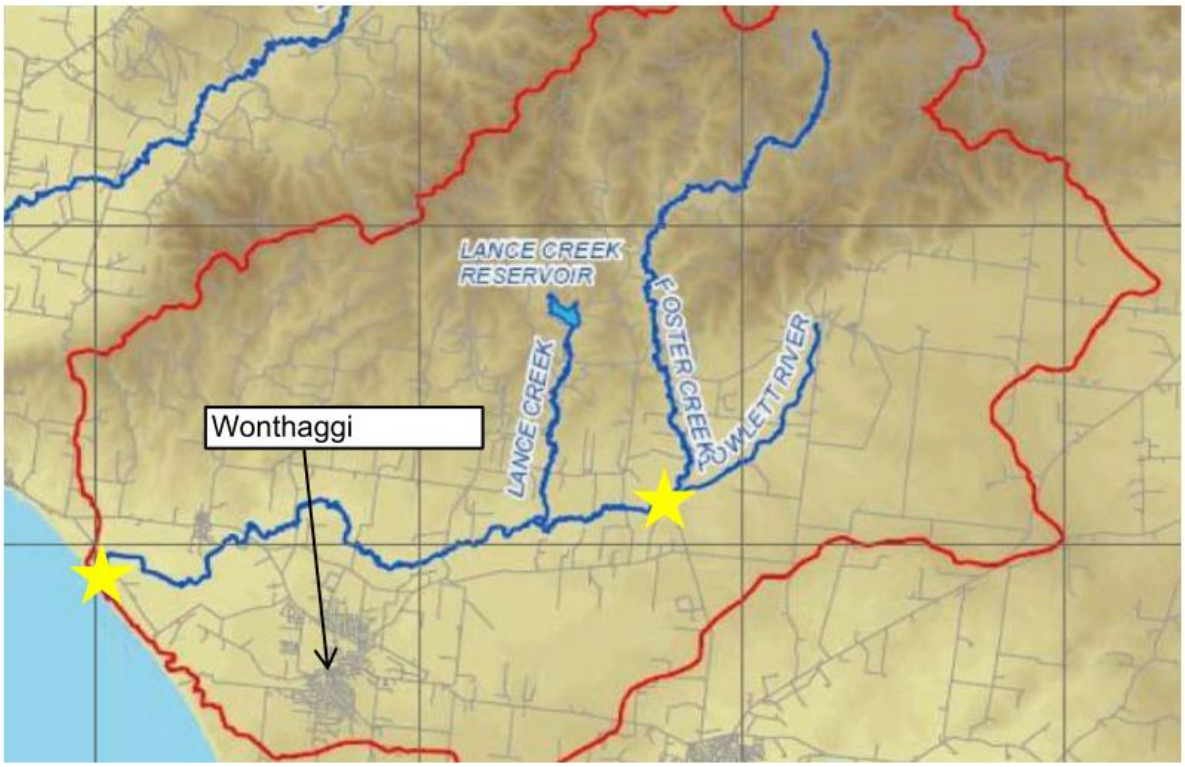



Figure 29. *Location of documented flows within the EES (source: Engeny, 2023)*

Table 5. Summary of results at gauging station 227236 (confluence Powlett River & Foster Creek)

| AEP | Peak flow ($m^3/s$) | Upper estimate ($m^3/s$) | Lower estimate ($m^3/s$) |
|---|---|---|---|
| 1 in 50 (2%) | 82 | 108 | 64 |
| 1 in 100 (1%) | 104 | 133 | 80 |

Table 6. Summary of results at outlet of Powlett River

| AEP | Peak flow ($m^3/s$) | Upper estimate ($m^3/s$) | Lower estimate ($m^3/s$) |
|---|---|---|---|
| 1 in 50 (2%) | 97 | 124 | 74 |
| 1 in 100 (1%) | 127 | 158 | 92 |

Flows were matched to the above flow rates, and the Powlett River RORB model run for the 1% AEP and 50% AEP events. These output hydrographs were used within the TUFLOW model.

## Climate change sensitivity

A climate change sensitivity analysis was completed for the Wonthaggi North East PSP, the influence of climate change on a hydrologic model is determined by increasing the rainfall intensities that are used as input to the model. In line with the ARR guidelines, the rainfall intensity was increased for the year 2100 RCP 8.5 scenario, which represented a rainfall intensity increase of 18.4%. The climate change scenario was run for the 1% AEP event.

## Wetland design flows

The developed conditions RORB model determined for the Wonthaggi NE PSP has been run for the 1% AEP, 10% AEP, 20% AEP, 50% AEP, 1EY and 4EY events. Incoming flows to each wetland asset were derived from the RORB model, the following flow rates were determined.

**Table 7. Wetland design inflows based on the Wonthaggi North East RORB model**

| Functional Design Report ref. | WLRB1A | WLRB1B | WLRB2 | WLRB3 | WLRB4 |
|---|---|---|---|---|---|
| DCP reference | (WL-01) | (WL-01) | (WL-02) | (WL-03) | (WL-04) |
| Catchment area (ha) | 628 | 511 | 73 | 52 | 91 |
| 1% AEP Developed flow rate ($m^3/s$) | 13.14 | 19.65 | 6.07 | 6.07 | 8.60 |
| 10% AEP Developed flow rate ($m^3/s$) | 6.56 | 11.39 | 3.62 | 3.64 | 4.99 |
| 20% AEP Developed flow rate ($m^3/s$) | 4.74 | 8.61 | 2.80 | 3.17 | 4.02 |
| 50% AEP Developed flow rate ($m^3/s$) | 2.66 | 5.31 | 1.65 | 2.04 | 2.50 |
| 1EY Developed flow rate ($m^3/s$) | 2.17 | 4.10 | 1.37 | 1.62 | 1.91 |
| 4EY developed flow rate ($m^3/s$) | 0.73 | 1.40 | 0.62 | 0.74 | 0.73 |

Subsequently, flow rates were derived from the RORB model for each of the sediment basins proposed along the waterways. The following flow rates were determined for the design of the SBs.

**Table 8. Sediment basin design inflows based on the Wonthaggi North East RORB model**

| Functional Design Report ref. | SB1 | SB4 | SB5 | SB6 | SB7 |
|---|---|---|---|---|---|
| DCP reference | (SB-01) | (SB-02) | (SB-03) | (SB-04) | (SB-05) |
| 20% AEP Developed flow rate (m3/S) | 2.59 | 2.71 | 1.35 | 2.02 | 0.59 |
| 1EY Developed flow rate (m3/s) | 0.99 | 1.33 | 0.56 | 0.99 | 0.27 |
| 4EY developed flow rate (m3/s) | 0.48 | 0.52 | 0.27 | 0.40 | 0.09 |

The above derived flow rates have formed the basis for the design of the wetland and sediment basin sizing. Flow rates have been used to determine the minimum widths with respect to velocity thresholds. This is further discussed in Sections 14 to 23 below.

## 8.2 Hydraulic modelling (Engeny)

As per the Engeny Strategy, retarding basins have been modelled using TUFLOW as the assets are proposed within the Powlett River floodplain, and significant inundation occurs across the downstream adjacent (subject) property to the north of the PSP.

A summary of the extent of the Engeny TUFLOW model is shown below.

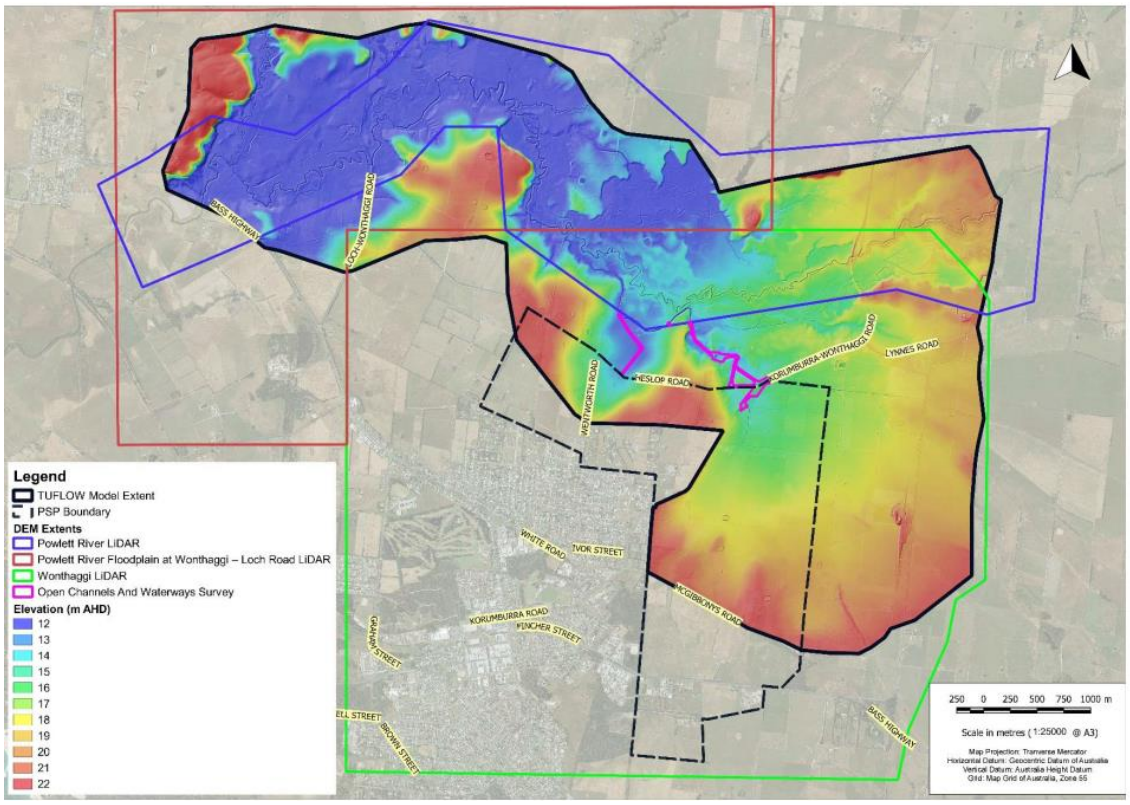



Figure 30. *TUFLOW model extent, DEM, and Topography data (Engeny, 2023)*

As per the WGCMA requirements, retarding basin storages are required to control the 50% AEP event back to predeveloped conditions. Based on the TUFLOW modelling for the retarding basin assets, outfall culverts and pipes form each of the assets were adjusted in an iterative process until outflows from the retarding basins were less than the predeveloped conditions flows and the flood levels through the downstream property were equal to or less than the predeveloped flood levels.

The TUFLOW model was computed for pre and post development scenarios, and the outflow culvert size / retarding basin storage areas adjusted to ensure the post development flood depths were no greater than the existing conditions flood depths (i.e., the afflux).

The Engeny TUFLOW model was updated to include the Alluvium functional design retarding basin/wetlands.

### Culverts and bridge structures

The outlet properties modelled in the system included a combination of pipe structures, culvert structures and bridge structures. The TUFLOW model has included these systems by inputting the culvert and pipe structures in the 1-D domain, and the bridges and pedestrian crossings modelled as layered flow constrictions in the 2-D domain. Culvert sizes were informed by Council GIS data, site measurement or survey data.

Figure 31 below provides the location of key drainage assets.

**Note:** The concept designs of wetland/retarding basin assets were conceptual at the time of the Engeny Strategy and have changed slightly as part of the functional design process.

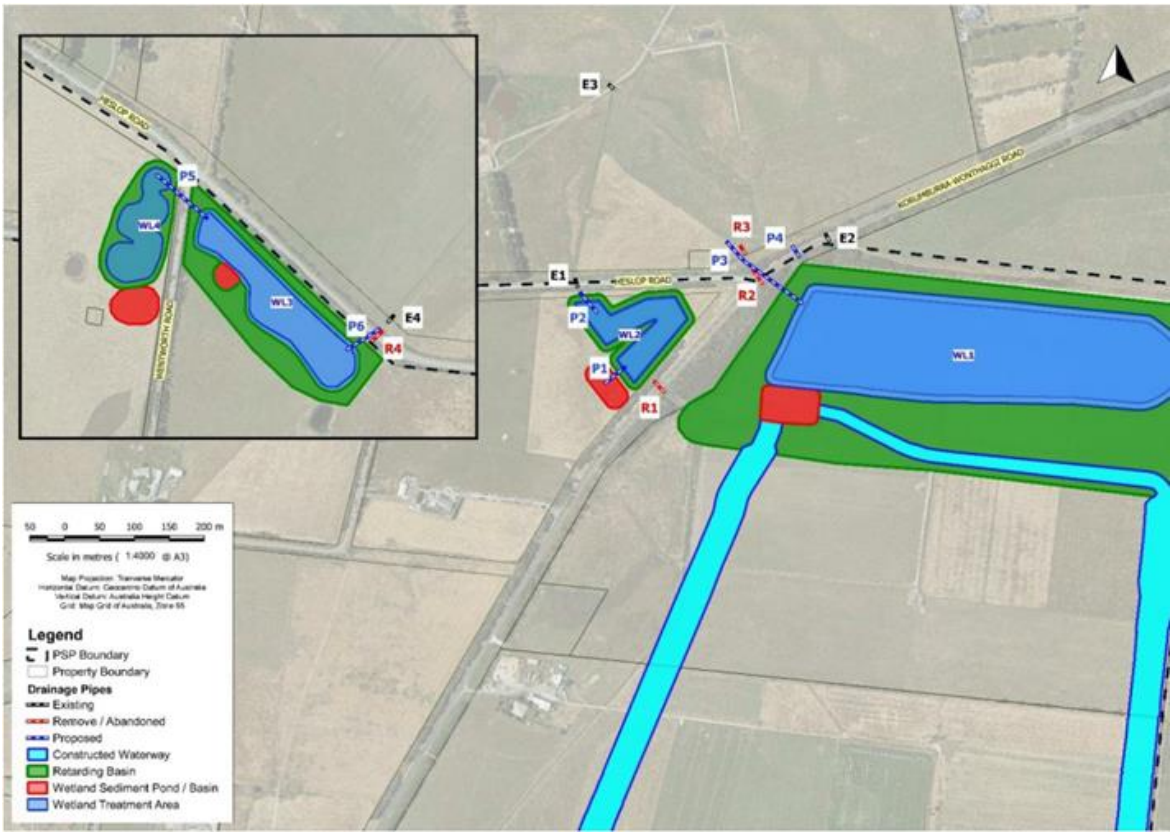



Figure 31. *Location of key drainage assets or waterway crossings (source: Engeny, 2023)*

A summary of the outfall properties from each of the WLRB assets is provided below.

**Table 9. Summary of key outfall culverts and pipelines from the proposed WLRB**

| Engeny ID (DCP ref) | WLRB1 (DCP ref WL-01) | |
|---|---|---|
| E2 | Existing | 3 x 1200mm(W) x 1200mm(H) Box culverts under Korumburra-Wonthaggi Road. |
| P3 (CU-04) | Proposed | 2 x 900mm(W) x 300mm(H) transitioning to 1 x 1200mm(W) x 600mm(H) WLRB1 low flow outfall culverts under Korumburra-Wonthaggi Road. |
| P4 (CU-11) | Proposed | 3 x 1200mm(W) x 900mm(H) WLRB1 high flow outlet culverts under Korumburra-Wonthaggi Road. |
| | WLRB2 (DCP ref WL-02) | |
| E1 (CU-05) | Existing | 3 x 1650mm dia. pipe culverts under Heslop Road. |
| P1 | Proposed | 1 x 1200mm dia. sediment basin to wetland transfer pipe. |
| P2 | Proposed | 1 x 1200mm dia. pipe outfall from WL2 via CU-05 |

| Engeny ID (DCP ref) | WLRB3 (DCP ref WL-03) | |
|---|---|---|
| P6 (CU-06) | Proposed | 3 x 1200mm(W) x 450mm(H) box culverts under Heslop Road. |
| | WLRB4 (DCP ref WL-04) | |
| P5 | Proposed | 1 x 1050mm dia. WL-04 transfer pipe under Heslop Road. |
| | Others | |
| E3 (CU-10) | Existing | 1 x 1500mm dia. Circular pipe in existing channel within 465 Heslop Rd property under farm access track. |
| E4 | Existing | 1 x 600mm dia. Circular pipe in existing channel downstream of Heslop Road at proposed WL-03 culverts. |
| R1 | Redundant | 4 x 1200mm (W) x 1200mm(H) existing box culverts under Korumburra-Wonthaggi Road south of intersection with Heslop Road, **to be removed**. |
| R2 | Redundant | 1 x 600mm dia. circular culvert under Korumburra-Wonthaggi Road east of intersection with Heslop Road, **to be removed**. |
| R3 | Redundant | 1 x 600mm dia. circular pipe in existing channel in 465 Heslop Road property just downstream of Korumburra-Wonthaggi Road, **to be removed**. |
| R4 | Existing | 2 x 1200mm(W) x 450mm(H) existing box culverts under Heslop Road, north of proposed WL-03 to be retained, with **culverts to be added** (DCP CU-06)). |

The location, size, number and orientation of some of the existing culverts has changed under the proposed developed conditions model. This was completed to achieve the required retardation storages, and minimise the overall afflux of the hydraulic model, whilst minimising the overall footprint required for the drainage reserve. The area east of Korumburra-Wonthaggi Road is the natural low point of the catchment and has been identified as the most practical location for future retarding basin assets to manage the majority of the PSP draining catchment.

Given the area west of Korumburra-Wonthaggi Road only contains a portion of land subject to regular inundation, the culverts transferring the majority of the WNEPSP catchment into this area from the east, are recommended to be removed/abandoned. This will provide the highest development yield, whilst minimising the extent of fill required within the entire PSP area. This remains consistent with the previous Engeny Strategy for the Wonthaggi NE PSP.

## Surface roughness

The hydraulic model included a land use layer reflecting the surface roughness (or Manning's n) value for the whole model extent. Surface roughness defines the resistance to overland flow. The manning's roughness coefficients adopted in the Engeny TUFLOW model are provided below.

Table 10. Manning's 'n' roughness values adopted in the Engeny TUFLOW model

| Land use type | Manning's roughness |
|---|---|
| Open paddock with minimal vegetation | 0.03 |
| Open paddock with moderate vegetation | 0.06 |
| Open paddock with thick vegetation | 0.09 |
| Commercial and residential building footprints | 0.50 |
| Paved road / carparks / driveways | 0.025 |
| Remainder of parcel (residential high density) | 0.01 |
| Waterway – main channel, with some vegetation, weeds / stone | 0.045 |
| Waterway – vegetated, sluggish reaches / wetlands / deep pools | 0.06 |
| Waterway – proposed open channel(s) with moderate to thick vegetation | 0.07 |
| Waterbody – Open waterbodies with submerged vegetation (ponds / dams) | 0.02 |

## Results

The TUFLOW model was computed by Engeny based on the above inputs. A summary of key flow locations are shown in Figure 32 below. These flow locations have been used to determine the impact that the retarding basins have on the overall flow rate for the 50% AEP and the 1% AEP events.

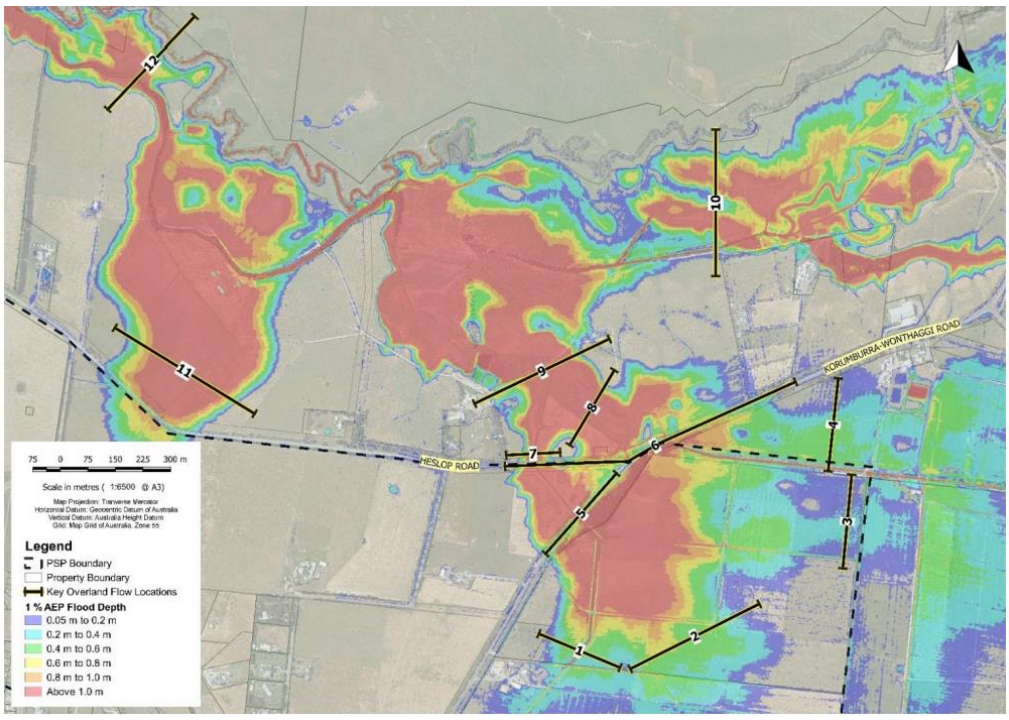



Figure 32. *Key locations subject to overland flooding, 1% AEP baseline conditions depicted (source: Engeny, Sept 2023)*

A comparison of the baseline vs developed conditions peak flows at the locations depicted above is provided in the table below.

Table 11. Comparison of Baseline vs Developed conditions peak flow rates

| Location | Baseline (50% AEP) | Developed (50% AEP) | Baseline (1% AEP) | Developed (1% AEP) |
|---|---|---|---|---|
| 1 | 2.9 | 8.2 | 11.7 | 21.9 |
| 2 | 2.5 | 0 | 17.4 | 0 |
| 3 | 3.0 | 5.1 | 16.1 | 28.8 |
| 4 | 7.5 | 3.9 | 35.4 | 29.7 |
| 5 | 0 | 0 | 33.0 | 35.5 |
| 6 | 0 | 0 | 44.3 | 40.6 |
| 7 | 6.4 | 0.9 | 15.6 | 14.4 |
| 8 | 5.1 | 10.3 | 52.6 | 63.5 |
| 9 | 11.3 | 10.3 | 64.7 | 73.5 |
| 10 | 7.4 | 7.4 | 41.5 | 41.4 |
| 11 | 2.4 | 0.8 | 4.9 | 4.6 |
| 12 | 14.9 | 14.2 | 82.4 | 87.8 |

Subsequent to the above, a climate change sensitivity run was completed using the TUFLOW model, and the maximum storage within the retarding basins determined. A summary of the TUFLOW outputs is provided in Appendix E.

Based on the above output, Table 12 to

Table 15 show the required capacity of the retarding basins (WLRBs), based on the TUFLOW modelling completed by Engeny.

Table 12. WLRB1 (DCP ref WL-01) retarding basin requirements

| Parameter | Retarding Basin WLRB1 (DCP ref WL-01) |
|---|---|
| Peak RB storage required (m3) (50% AEP) | 212,100 (212.1 ML) |
| Peak RB storage required (m3) (1% AEP) | 447,700 (447.7 ML) |
| Peak RB storage required (m3) (1% AEP with climate change) | 471,300 (471.3 ML) |
| 1% AEP peak water level (m AHD) | 16.52 |
| 1% AEP with climate change peak water level (m AHD) | 16.62 |
| Surface Area (ha) | 23 |

Table 13. WLRB2 (DCP ref WL-02) retarding basin requirements

| Parameter | Retarding Basin WLRB2 (DCP ref WL-02) |
|---|---|
| Peak RB storage required ($m^3$) (50% AEP) | 10,600 (10.6 ML) |
| Peak RB storage required ($m^3$) (1% AEP) | 31,400 (31.4 ML) |
| 1% AEP peak water level (m AHD) | 15.90 |
| Surface Area (ha) | 2.1 ha |

Table 14. WLRB3 (DCP ref WL-03) retarding basin requirements

| Parameter | Retarding Basin WLRB3 (DCP ref WL-03) |
|---|---|
| Peak RB storage required ($m^3$) (50% AEP) | 34,100 (34.1 ML) |
| Peak RB storage required ($m^3$) (1% AEP) | 42,400 (42.4 ML) |
| 1% AEP peak water level (m AHD) | 14.69 |
| Surface Area (ha) | 3.94 |

Table 15. WLRB4 (DCP ref WL-04) retarding basin requirements

| Parameter | Retarding Basin WLRB4 (DCP ref WL-04) |
|---|---|
| Peak RB storage required (m3) (50% AEP) | 12,000 (12.0 ML) |
| Peak RB storage required (m3) (1% AEP) | 17,600 (17.6 ML) |
| 1% AEP peak water level (m AHD) | 14.52 |
| Surface Area (ha) | 3.94 |

Table 16. Outflows from WLRB 1 to WLRB 4 (based on Engeny TUFLOW modelling)

| Asset | Description | 50% AEP | | 1% AEP | |
|---|---|---|---|---|---|
| | | Pre-Developed ($m^3/s$) | Developed ($m^3/s$) | Pre-Developed ($m^3/s$) | Developed ($m^3/s$) |
| WLRB1 (DCP ref WL-01) | Existing box culverts under Korumburra-Wonthaggi Road – to be removed / abandoned (4 x 1260 mm) | 0.46 | - | 0.9 | - |
| | WLRB1 low flow outlet (2 x 300 x 900 RCB into 1 x 600 x 1200 RCB) | n/a | 1.1 | - | 1.42 |
| | WLRB1 high flow outlet (3 x 1200 mm box culverts) | n/a | 4.2 | - | 13.60 |
| | Overland flow d/s of WLRB1 | 5.1 | 10.3 | 52.6 | 63.5 |
| WLRB2 (DCP ref WL-02) | Outfall Pipes from WLRB2 - Circular culverts under Heslop Road (3 x 1650 mm) | 6.4 | 0.9 | 15.72 | 14.70 |
| | Overland flow d/s of WLRB2 | 6.4 | 0.9 | 15.6 | 14.50 |
| WLRB 1&2 | Overland flow overtopping Korumburra-Wonthaggi and Heslop Road d/s of WLRBs 1 & 2 | 0 | 0 | 44.3 | 40.70 |
| WLRB 3 (DCP ref WL-03) & WLRB 4 (DCP ref WL-04) | Proposed WL4 to WL3 circular transfer pipe (1 x 1050 mm) | - | -0.8 | - | -1.60 |
| | Proposed WL3 low level outlet pipe 1 new culvert and extension to 2 existing culverts (3 x 1200 x 450) | - | 0.7 | - | 4.50 |
| | Overland flow d/s of WLRBs 3&4 | 2.4 | 0.8 | 4.9 | 4.60 |

## 8.3 Proposed trunk drainage network

A masterplan for the proposed trunk stormwater drainage network has been developed to ensure the future sub-divisional (local) pipe networks can adequately discharge to each proposed treatment/retarding system within the PSP, and shows the existing pipe network, proposed external connections and proposed internal pipe network. The proposed trunk drainage network has been designed to ensure outfall connection from development pad(s) to the proposed stormwater-related PSP assets is achievable with sufficient pipe fall, pipe cover and minimal fill requirements, as per the SAC recommendations.

The trunk drainage network has followed the Infrastructure Design Manual's (IDM) major/minor drainage network design principles. The minor stormwater drainage network system would consist essentially of an underground piped network and should be designed to accommodate the 20% AEP flow rate for residential areas, and the 10% AEP flow rate for industrial/commercial areas.

The pipe size, pipe grade, and the indicative layout of the internal and external pipe alignments have been determined for the Wonthaggi North East PSP. Table 17 below provides pipeline details, including pipe size, pipe capacity, pipe grade and upstream & downstream invert levels. The trunk drainage system has been designed at a conceptual level to inform waterway and wetland invert levels.

Figure 33 below provides the proposed alignment of each pipeline and the reference nodes for each.

**Table 17. Trunk drainage network details**

| Reference node | Connection type | Design flow | Pipe size | Pipe Grade | IL (US) | IL (DS) |
|---|---|---|---|---|---|---|
| 0 – 4 | Internal | 0.32 $m^3/s$ | 600mm | 1 in 350 | 23.90m AHD | 23.40m AHD |
| 1 – 3 | Internal | 0.41 $m^3/s$ | 750mm | 1 in 411 | 24.00m AHD | 23.55m AHD |
| 2 – 3 | Internal | 0.62 $m^3/s$ | 825mm | 1 in 200 | 23.60m AHD | 23.55m AHD |
| 3 – 4 | Internal | 1.04 $m^3/s$ | 1050mm | 1 in 333 | 23.55m AHD | 23.40m AHD |
| 4 – EA1 | Internal | 1.25 $m^3/s$ | 1200mm | 1 in 280 | 23.40m AHD | 23.15m AHD |
| EA1 – GPT3 | Internal | 1.78 $m^3/s$ | 1350mm | 1 in 377 | 23.15m AHD | 22.50m AHD |
| 5 – 6 | Internal | 0.74 $m^3/s$ | 900mm | 1 in 367 | 22.00m AHD | 21.40m AHD |
| DY1 – 7 | Internal | 0.35 $m^3/s$ | 675mm | 1 in 290 | 21.60m AHD | 20.60m AHD |
| EI1 – EH1 | External | 1.13 $m^3/s$ | 900mm | 1 in 400 | 19.00m AHD | 18.60m AHD |
| EH1 – GPT1 | External | 1.62 $m^3/s$ | 1050mm | 1 in 200 | 18.60m AHD | 18.50m AHD |
| EM1 – 8 | Internal | 0.77 $m^3/s$ | 900mm | 1 in 396 | 19.50m AHD | 18.20m AHD |
| 8 – 10 | Internal | 1.02 $m^3/s$ | 1050mm | 1 in 396 | 18.20m AHD | 17.90m AHD |
| 11 – EL1 | Internal | 1.04 $m^3/s$ | 1050mm | 1 in 408 | 16.05m AHD | 15.40m AHD |
| EL1 – SB4 (SB-02) | Internal | 2.71 $m^3/s$ | 1350mm | 1 in 333 | 15.40m AHD | 15.25m AHD |
| 10 – EK1 | Internal | 1.19 $m^3/s$ | 1050mm | 1 in 375 | 15.60m AHD | 15.20m AHD |
| EK1 – GPT2 | Internal | 2.69 $m^3/s$ | 1500mm | 1 in 250 | 15.20m AHD | 15.00m AHD |
| EV1 – EW1 | External | 2.57 $m^3/s$ | 1350mm | 1 in 370 | 16.70m AHD | 16.20m AHD |
| EW1 – EK1 | Internal | 2.58 $m^3/s$ | 1350mm | 1 in 290 | 16.20m AHD | 15.20m AHD |
| DU1 – DW1 | External | 1.29 $m^3/s$ | 1200mm | 1 in 281 | 26.20m AHD | 24.65m AHD |
| DP2 – DP3 | External | 1.41 $m^3/s$ | 1200mm | 1 in 307 | 25.80m AHD | 25.05m AHD |
| DQ1 – DP3 | External | 0.38 $m^3/s$ | 675mm | 1 in 329 | 25.40m AHD | 25.05m AHD |
| DP3 – DW1 | External | 1.62 $m^3/s$ | 1200mm | 1 in 317 | 25.05m AHD | 24.75m AHD |

| Reference node | Connection type | Design flow | Pipe size | Pipe Grade | IL (US) | IL (DS) |
|---|---|---|---|---|---|---|
| DW1 – SB1 (SB-01) | External | 3.46 $m^3/s$ | 1500mm | 1 in 200 | 24.75m AHD | 24.65m AHD |
| DL3 – DW2 | External | 1.40 $m^3/s$ | 1050mm | 1 in 330 | 23.00m AHD | 22.50m AHD |
| DM1 – DX1 | External | 1.33 $m^3/s$ | 1050mm | 1 in 486 | 22.70m AHD | 22.35m AHD |
| 12 – FC1 | Internal | 0.16 $m^3/s$ | 525mm | 1 in 388 | 16.90m AHD | 16.50m AHD |
| FC1 – FH1 | Internal | 0.49 $m^3/s$ | 750mm | 1 in 443 | 16.50m AHD | 15.10m AHD |
| FH1 – FI1 | Internal | 0.63 $m^3/s$ | 825mm | 1 in 443 | 15.1m AHD | 14.80m AHD |
| 21 – FI1 | Internal | 0.13 $m^3/s$ | 450mm | 1 in 400 | 14.95m AHD | 14.80m AHD |
| FI1 – FK1 | Internal | 1.13 $m^3/s$ | 1050mm | 1 in 429 | 14.80m AHD | 14.10m AHD |
| FK1 – WLRB-1B (WL-01) | Internal | 1.30 $m^3/s$ | 1050mm | 1 in 350 | 14.10m AHD | 14.00m AHD |
| G3 – V2 | External | 1.58 $m^3/s$ | 1200mm | 1 in 457 | 22.50m AHD | 22.15m AHD |
| V2 – SB5 (SB-03) | External | 1.77 $m^3/s$ | 1200mm | 1 in 333 | 22.15m AHD | 22.00m AHD |
| W2 – V5 | External | 1.38 $m^3/s$ | 1200mm | 1 in 322 | 21.00m AHD | 19.85m AHD |
| V5 – AA2 | Internal | 1.93 $m^3/s$ | 1350mm | 1 in 381 | 19.85m AHD | 18.80m AHD |
| AA2 – GPT4 | Internal | 2.34 $m^3/s$ | 1350mm | 1 in 300 | 18.80m AHD | 18.70m AHD |
| 22 – 23 | Internal | 0.68 $m^3/s$ | 750mm | 1 in 400 | 20.30m AHD | 20.20m AHD |
| 23 - 24 | Internal | 0.76 $m^3/s$ | 825mm | 1 in 314 | 20.20m AHD | 19.50m AHD |
| 24 – FF1 | Internal | 0.84 $m^3/s$ | 900mm | 1 in 348 | 19.50m AHD | 16.45m AHD |
| FF1 – SB6 (SB-04) | Internal | 2.02 $m^3/s$ | 1350mm | 1 in 267 | 16.45m AHD | 16.30m AHD |
| EP1 – FJ2 | Internal | 2.43 $m^3/s$ | 1350mm | 1 in 414 | 15.40m AHD | 14.35m AHD |
| FJ2 – WLRB-1A (WL-01) | Internal | 3.41 $m^3/s$ | 1500mm | 1 in 357 | 14.35m AHD | 14.00m AHD |
| 17 – 19 | Internal | 0.17 $m^3/s$ | 525mm | 1 in 371 | 17.50m AHD | 17.15m AHD |
| 18 – 19 | Internal | 0.10 $m^3/s$ | 450mm | 1 in 320 | 17.40m AHD | 17.15m AHD |
| 19 – 20 | Internal | 0.36 $m^3/s$ | 675mm | 1 in 400 | 17.15m AHD | 16.95m AHD |
| 16 – 20 | Internal | 0.11 $m^3/s$ | 450mm | 1 in 400 | 17.40m AHD | 16.95m AHD |
| 20 – 15 | Internal | 0.65 $m^3/s$ | 825mm | 1 in 378 | 16.95m AHD | 16.50m AHD |
| 15 – EZ1 | Internal | 0.95 $m^3/s$ | 1050mm | 1 in 413 | 16.50m AHD | 16.10m AHD |
| EZ1 – FD1 | Internal | 1.81 $m^3/s$ | 1200mm | 1 in 446 | 16.10m AHD | 14.90m AHD |
| FD1 – FM1 | Internal | 2.26 $m^3/s$ | 1350mm | 1 in 433 | 14.90m AHD | 14.15m AHD |
| FB1 – 14 | External | 0.44 $m^3/s$ | 750mm | 1 in 386 | 17.20m AHD | 16.50m AHD |
| EY2 – 13 | External | 0.50 $m^3/s$ | 750mm | 1 in 340 | 17.20m AHD | 16.70m AHD |
| 13 – 14 | External | 0.65 $m^3/s$ | 825mm | 1 in 300 | 16.70m AHD | 16.50m AHD |
| 14 – EZ1 | Internal | 0.82 $m^3/s$ | 900mm | 1 in 413 | 16.50m AHD | 16.10m AHD |
| FN1 – FM1 | Internal | 0.74 $m^3/s$ | 900mm | 1 in 438 | 14.80m AHD | 14.15m AHD |
| FM1 – WLRB2 (WL-02) | Internal | 2.80 $m^3/s$ | 1500mm | 1 in 300 | 14.15m AHD | 14.05m AHD |
| GX1 – GY1 | Internal | Constructed | | | | |
| 25 – GY1 | Internal | 0.15 $m^3/s$ | 525mm | 1 in 429 | 15.90m AHD | 15.20m AHD |
| GY1 – GY2 | Internal | Constructed | | | | |
| GY2 – GY3 | External | 2.18 $m^3/s$ | 1350mm | 1 in 436 | 14.20m AHD | 13.10m AHD |

| Reference node | Connection type | Design flow | Pipe size | Pipe Grade | IL (US) | IL (DS) |
|---|---|---|---|---|---|---|
| GY3 – WLRB4 (WL-04) | External | 2.18 $m^3/s$ | 1350mm | 1 in 300 | 13.10m AHD | 13.00m AHD |
| 26 – 28 | Internal | 0.10 $m^3/s$ | 450mm | 1 in 367 | 15.00m AHD | 14.70m AHD |
| 27 – 28 | Internal | 0.09 $m^3/s$ | 450mm | 1 in 325 | 14.90m AHD | 14.70m AHD |
| 28 – GZ1 | Internal | 0.29 $m^3/s$ | 600mm | 1 in 338 | 14.70m AHD | 14.30m AHD |
| 29 – 31 | Internal | 0.19 $m^3/s$ | 525mm | 1 in 407 | 15.90m AHD | 15.20m AHD |
| 30 – 31 | Internal | 0.16 $m^3/s$ | 525mm | 1 in 363 | 15.60m AHD | 15.20m AHD |
| 31 – 33 | Internal | 0.78 $m^3/s$ | 900mm | 1 in 420 | 15.20m AHD | 14.70m AHD |
| 32 – 33 | Internal | 0.12 $m^3/s$ | 450mm | 1 in 383 | 15.00m AHD | 14.70m AHD |
| 33 – GZ1 | Internal | 1.18 $m^3/s$ | 1050mm | 1 in 425 | 14.70m AHD | 14.30m AHD |
| GZ1 – HG1 | Internal | 1.27 $m^3/s$ | 1050mm | 1 in 417 | 14.30m AHD | 13.10m AHD |
| HG1 – WLRB3 (WL-03) | Internal | 3.17 $m^3/s$ | 1500mm | 1 in 250 | 13.10m AHD | 13.00m AHD |
| 35 – 36 | Internal | 0.67 $m^3/s$ | 825mm | 1 in 379 | 14.30m AHD | 13.10m AHD |
| 36 – WLRB4 (WL-04) | Internal | 2.80 $m^3/s$ | 1350mm | 1 in 400 | 13.10m AHD | 13.00m AHD |
| 37 – 38 | Internal | 0.28 m3/s | 600mm | 1 in 417 | 14.00m AHD | 13.10m AHD |
| 38 – WLRB4 (WL-04) | Internal | 1.25 m3/s | 1050mm | 1 in 300 | 13.10m AHD | 13.00m AHD |
| HM1 – HC2 | External | 0.34 m3/s | 675mm | 1 in 411 | 20.70m AHD | 20.25m AHD |
| HC2 – SB7 (SB-05) | External | 0.59 m3/s | 825mm | 1 in 400 | 20.25m AHD | 20.20m AHD |

As per SAC recommendations, CMA requirements and industry best practice, for each pipe outfall to a constructed waterway (DRs) the following GPTs have been included on specific discharge pipes, for primary treatment of flows, prior to waterway:

- GPT1 – located at outfall to DR-01 from EH1 (1050 dia pipe - external)
- GPT2 – is located at outfall to DR-01 from EK1 (1500 dia pipe - internal)
- GPT3 – is located at DX1 outfall to DR-01 from EA1 (1350 dia pipe - internal)
- GPT4 – is located at outfall to DR-02 from AA2 (1350 dia pipe - internal).

Figure 33 below shows the proposed pipe masterplan to service the PSP. Pipes indicated in blue service external catchments passing through the PSP and are DCP funded assets (refer Section 24.1, page 153 for details). Pipes shown in red service development areas internal to the PSP and are developer funded works (refer Section 24.2, page 154 for details).

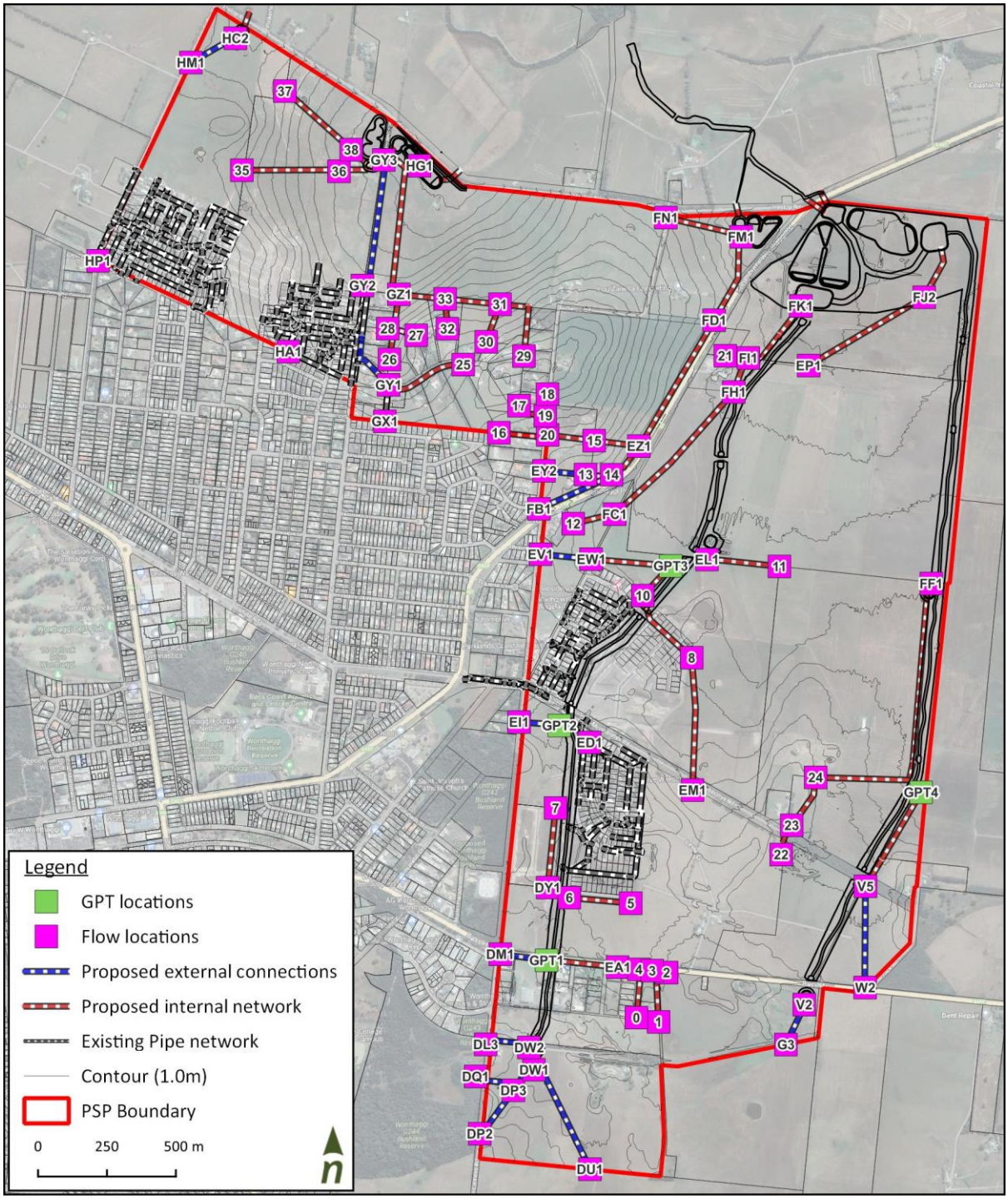



Figure 33. *Proposed trunk drainage network layout (master) plan with GPTs at waterway outfalls (green as numbered)*

# 9 Stormwater Quantity Management – Conveyance

The main considerations for waterways adjacent to and within a development precinct are the waterway corridors, constructed waterway designs (including waterway crossings), and flood levels. Proposed waterway corridors must demonstrate they are sufficient in terms of flow conveyance and providing river health and amenity opportunities in a future urbanised landscape.

## 9.1 Waterway corridor widths defined

A waterway corridor is defined as the waterway channel (bed to top of bank) and its associated riparian zones. The riparian zones consist of two parts:

- The vegetated buffer (VB) – protects riparian zone from urban zone 'edge' effects
- The core riparian zone (CRZ) – supports instream stability, ecology, food supply and habitats.

A typical waterway corridor section is shown below. The waterway channel width is defined by the hydraulic waterway width to contain up to the 1% AEP.

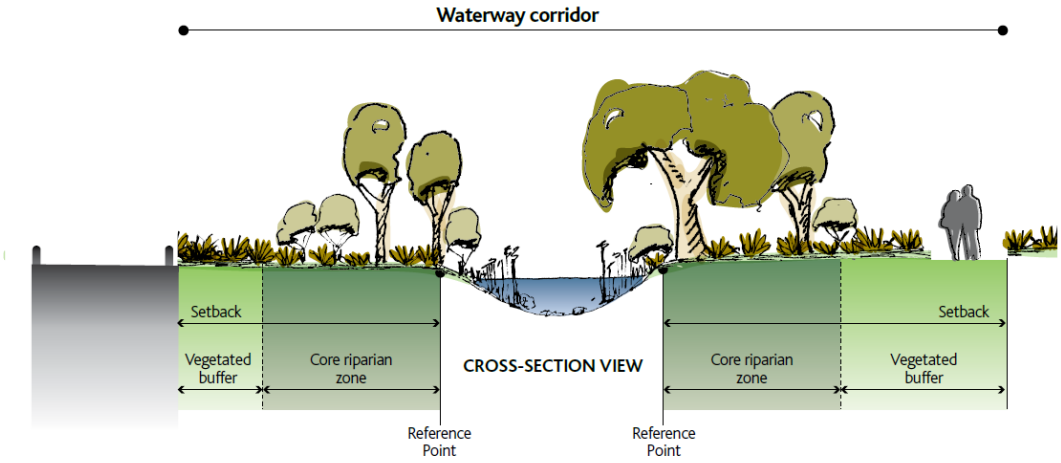



**Figure 34.** *Waterway corridor (source: Waterway Corridors, Guidelines for Greenfield Developments, Melbourne Water, 2019)*

Assigning a waterway corridor preserves areas of the riparian zone that protect or enhance native vegetation, instream health and biodiversity, and provides space for recreational infrastructure and activities (e.g. shared paths, furniture and (in some cases) stormwater treatment systems).

A fundamental principle is to provide continuity along the core riparian zone. Therefore, the strong preference is to locate shared paths and other infrastructure outside this zone. However, in some instances, stormwater treatment systems such as constructed wetlands and bio-retention systems may be located within the CRZ but should form a relatively small proportion of the area so as not to degrade its ecological function.

The existing waterways within the proposed development area have been significantly modified. As a result, the natural waterways have low value and are classified as rural drains. Two waterways are proposed within the development area, to the east and west of the precinct boundary. Following discussions with stakeholders and the West Gippsland Catchment Management Authority (WGCMA), an agreed 60m (minimum) waterway corridor width was determined for waterway corridors downstream of McGibbonys Road. Waterway corridor widths, upstream of McGibbonys Road, vary between 40m and 55m.

Therefore, constructed waterways (W-WW; DCP ref DR-01 and E-WW; DCP ref DR-02) have been functionally designed to safely contain and convey developed flows through the waterway corridor (up to the 1% AEP), provide habitat, and improve channel stability and visual amenity.

A summary of the waterway corridor widths required as part of the functional designs, is summarised in Table 18 and shown in Figure 35 below.

Table 18. Waterway corridor widths required

| DCP Location | Minimum Hydraulic Width Required (m) | Minimum Waterway Corridor Width Required (m) |
|---|---|---|
| A | 36 | 60 |
| B | 36 | 60 |
| C | 31 | 60* |
| D | 23 | 60* |
| E | 23 | 45^ |
| F | 23 | 45^ |
| G | 36 | 60 |
| H | 25 | 60 |
| I | 23 | 55 |

*CMA requires minimum 60m however, these widths are at 70m as per approved development prior to functional design process.

^CMA requirement not met at these developed locations; however the functional design process has accounted for this reduced width upstream and allowed for this in the downstream design.

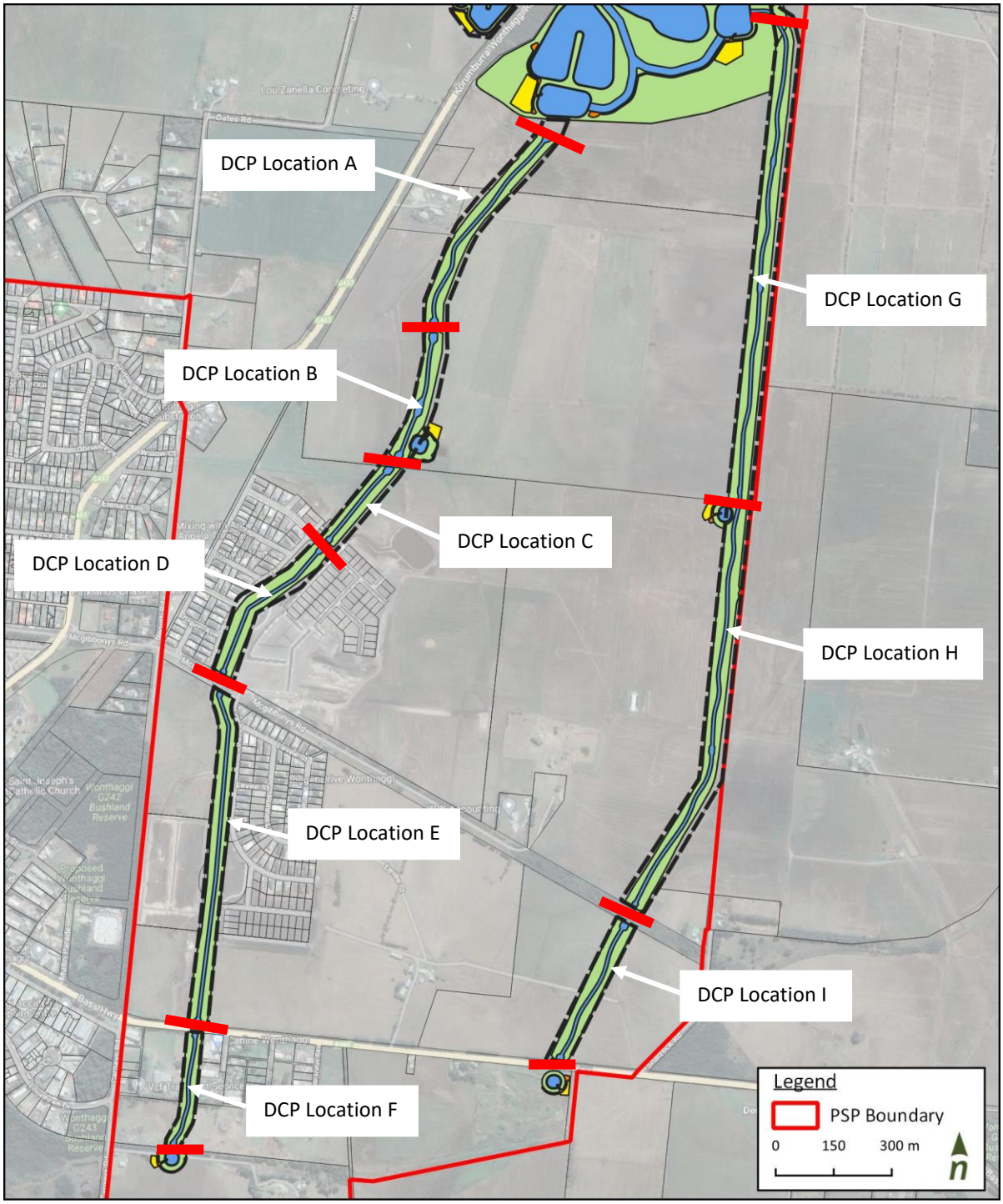



**Figure 35.** *Minimum Waterway Corridor widths as per DCP locations*

## 9.2 Waterway design

In lieu of clear guidance on designing constructed waterways being provided in the Infrastructure Design Manual (IDM), and no specific guidelines available from the WGCMA, design guidance from the Melbourne Water Constructed Waterways Design Manual was applied.

A one-dimensional steady state hydraulic model (HEC-RAS) of the study area was determined using design cross-sections for the proposed ultimate condition constructed waterway.

There are four primary variables in HEC-RAS modelling:

- Channel geometry (constructed waterway design cross sections)
- Downstream boundary conditions (normal depth from gauge or slope / known flood level)
- Hydraulic roughness (Manning's n) and
- Flow (derived during hydrologic analysis).

The derived flows and downstream boundary conditions have been informed by the hydrologic and hydraulic modelling. The hydraulic roughness (Manning's n) for the model is provided below.

**Table 19. Hydraulic parameters adopted for the HEC-RAS model**

| Hydraulic parameters | Description | | Value |
|---|---|---|---|
| **Manning's n** | High flow channel – | | 0.05 |
| | Low flow channel – | | 0.05 |
| **Boundary conditions** | WW-E & WW-W | – 1% AEP<br>– 50% AEP<br>– 1% AEP (Climate Change) | 16.52m AHD<br>15.40m AHD<br>16.62m AHD |
| | MOP | Normal Depth | 0.002m/m |

A summary of the HEC-RAS model layout is shown in Figure 36 below.

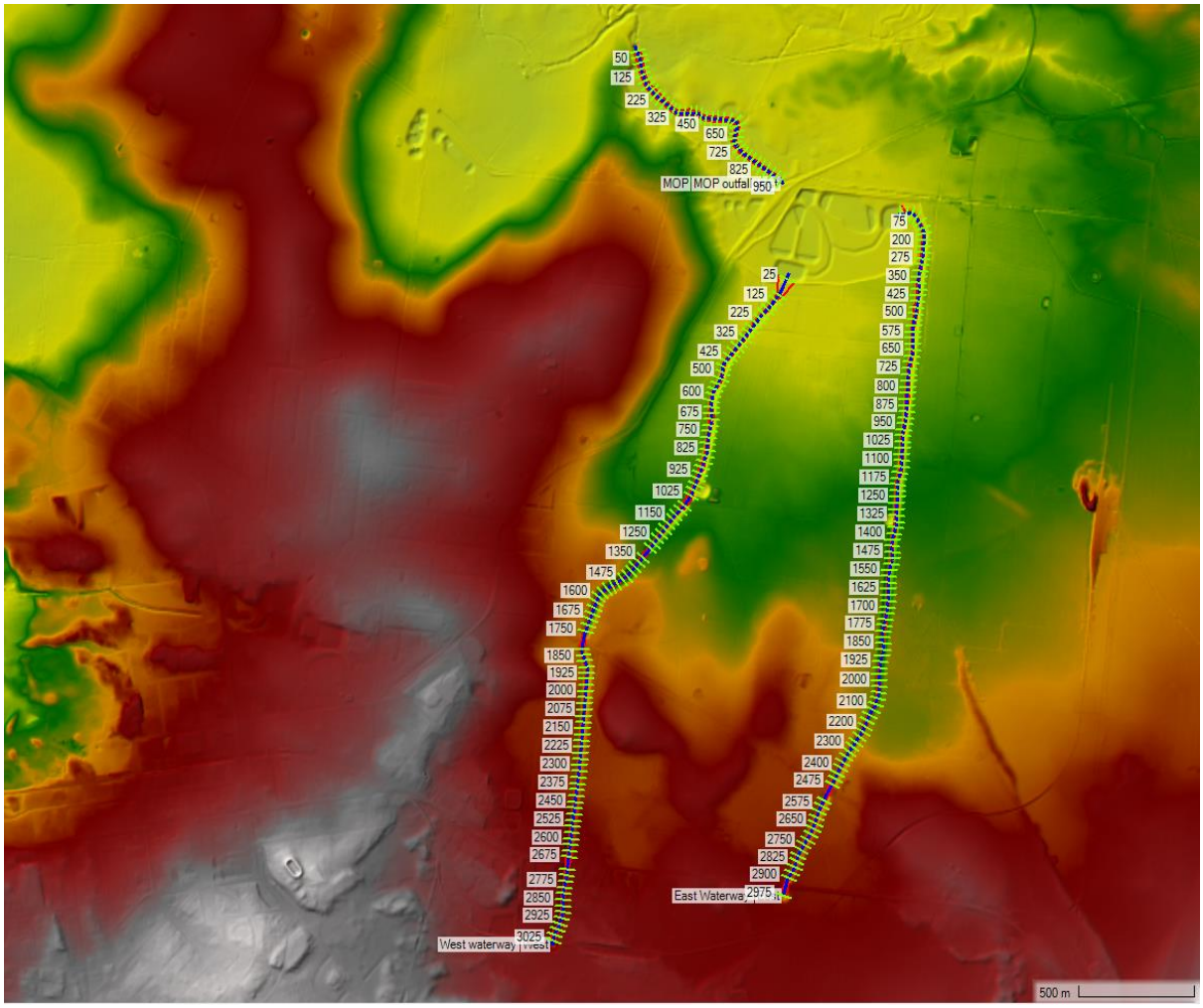



Figure 36. *HECRAS model layout*

## 9.3 Design flows

Flows were determined using the Wonthaggi North East PSP RORB determined in Section 8 (above). Design flow rates used in the HECRAS model are provided below.

Table 20. Design flow rates for HECRAS waterway designs

| Location | DCP ref | 50% AEP ($m^3/s$) | 1% AEP ($m^3/s$) | 1% AEP ($m^3/s$) CC |
|---|---|---|---|---|
| W-WW (ch 3025) | DR-01 | 3.44 | 15.57 | 19.53 |
| W-WW (ch 1750) | DR-01 | 4.85 | 20.59 | 26.10 |
| E-WW (ch 2975) | DR-02 | 3.30 | 17.73 | 22.89 |
| E-WW (ch 2475) | DR-02 | 4.52 | 20.87 | 27.19 |
| MOP (ch 950) | DR-03 | 2.47 | 15.54 | 18.80 |

## 9.4 Proposed culvert crossings

The Wonthaggi North East PSP includes a number of culvert crossings as part of the DCP. Culvert crossings are included within the DCP at existing roads and future major road alignments. The culvert crossings are designed to convey runoff up to and including the 1% AEP event. Culverts have been designed and modelled using TUFLOW for WLRB crossings and HEC-RAS for waterway crossings.

An overview (layout) of the proposed culvert structures is shown below (Figure 37) and supported with a summary of assets, DCP reference IDs, and asset locations in Table 21.

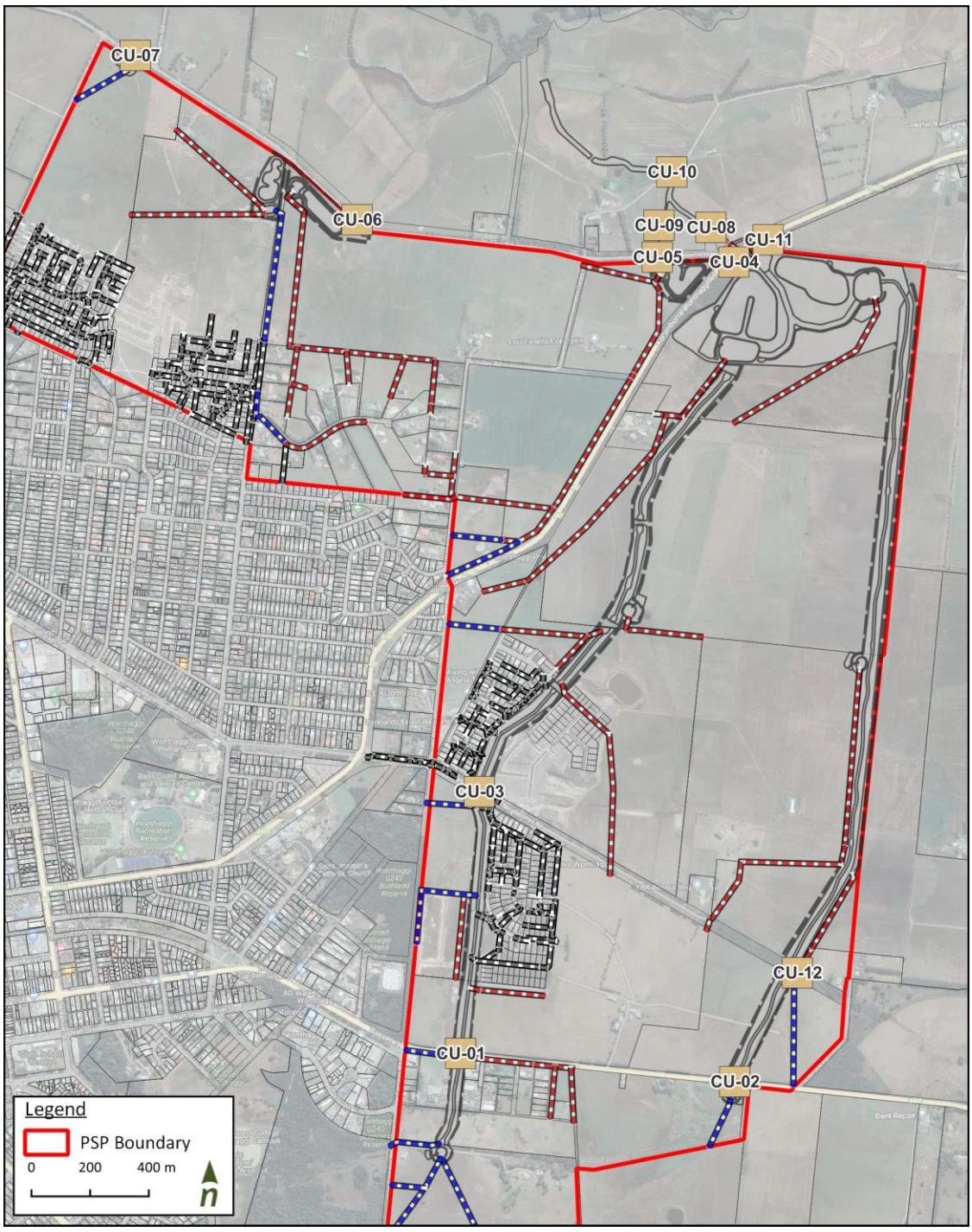



**Figure 37.** *Proposed culvert crossings within the Wonthaggi North East PSP*

An overview of the location and description of each culvert is provided in the table below.

Table 21. Wonthaggi North East PSP Culvert crossing overview

| DCP Ref. | Location | Description (DCP references) |
|---|---|---|
| CU-01 | Along Bass Highway | Culvert crossing of DR-01 along Bass Hwy |
| CU-02 | Along Bass Highway | Culvert crossing of DR-02 along Bass Hwy |
| CU-03 | Along McGibbonys Road | Culvert crossing of DR-01 along McGibbonys Road (partially constructed) |
| CU-04 | Along Korrumburra-Wonthaggi Road | Low flow outlet from WL-01 into DR-03 |
| CU-05 | Along Heslop Road | Outlet from WL-02 into DR-03 |
| CU-06 | Along Heslop Road | Outlet from WL-03 through downstream property |
| CU-07 | Along Heslop Road | Outlet from SB-05 through downstream property |
| CU-08 | Crossing of DR-03 | Downstream culvert crossing of the DR-03 system |
| CU-09 | Crossing of DR-03 | Downstream culvert crossing of the DR-03 system |
| CU-10 | Crossing of DR-03 | Downstream culvert crossing of the DR-03 system |
| CU-11 | Along Korrumburra-Wonthaggi Rd | High flow outlet (HFO) from WL-01 into DR-03 |
| CU-12 | Along future extension of McGibbonys Road alignment | Culvert crossing of DR-02 along McGibbonys Road |
| **Related reach No.** | **Future major road crossings** | **Location points** (as per Figure 36) |
| 1 | Immediately north of SB-01 | Stn 3025: Culvert crossing of DR-01 along future DCP major road alignment |
| 4 | Immediately south of SB-02 | Stn 1065: Culvert crossing of DR-01 along future DCP major road alignment |
| 5 | North of SB-02 | Stn 695: Culvert crossing of DR-01 along future DCP major road alignment |
| 6 | Immediately south of WL-01 | Stn 80: Culvert crossing of DR-01 along future DCP major road alignment |

**Notes:** The proposed culvert designs for CU-01 to CU-12 are included in the functional designs package. Cost estimate tables for culverts associated with stormwater-related PSP assets are provided in Appendix C, as these culverts service the PSP's stormwater management (drainage) requirements.

Culverts related to future road crossings do not have cost tables in this report, as these are related to the proposed future road alignments and are therefore not part of the stormwater-related PSP assets and costings.

# 10 Waterway Functional Design West-WW (DCP ref DR-01)

Following the Tranche 2 panel process it was noted that development approval had since been provided for a realignment of a section of W-WW (DR-01) to the north of Bass Hwy. In accordance with the SAC recommendations the alignment of DR-01, through parcels 65 and 66-R, has since been straightened to reflect the March 2022 Council-approved development plans.

## 10.1 Longitudinal slope

One of the key criteria for the waterway is to ensure that shear stress values are within an acceptable range. This is to ensure that the waterway is stable and to minimise the erosion potential. The shear stress threshold value is generally considered to be 45 N/m$^2$, which can increase by up to 10% during a 1% AEP flow event.

The longitudinal slope is dictated by invert controls at the downstream and upstream extents of the constructed waterway. The provided design features a change in slope along the alignment, discussed in Table 22. Note that this is the slope along the low flow channel will be slightly gentler than the high flow channel, due to meanders designed into the low flow alignment.

In order to accommodate piped connections between future developments (local drainage network) to the proposed stormwater-related PSP assets, the trunk stormwater drainage network has been designed (refer Section 8.3). A flattening in grade in both proposed constructed waterways was required to accommodate the proposed trunk stormwater drainage network. These grades are suitable for facilitating stable channel design in accordance with industry best practice guidelines.

Table 22. Longitudinal slope along low flow channel

| Reach | Upstream Boundary | Downstream Boundary | Upstream elevation (m AHD) | Downstream elevation (m AHD) | Average slope (1 in x) |
|---|---|---|---|---|---|
| 1 | Future road (stn 3025) | Bass Hwy (stn 2725) | 24.00 | 22.70 | 230 |
| 2 | Bass Hwy (stn 2675) | McGibbonys Rd (stn 1825) | 22.60 | 19.30 | 257 |
| 3 | McGibbonys Rd (stn 1750) | Centennial Dr (stn 1350) | 19.10 | 17.10 | 200 |
| 4 | Centennial Dr (stn 1300) | Future road (stn 1075) | 16.80 | 15.80 | 225 |
| 5 | Future road (stn 1025) | Future road (stn 700) | 15.50 | 15.05 | 722 |
| 6 | Future road (stn 675) | Future road (stn 100) | 15.05 | 14.35 | 821 |

## 10.2 Cross-section geometry

The cross-sectional geometry should be designed to accommodate the 4EY to 1EY flows in the low flow channel, and the 1% AEP flows in the full compound channel. These flows are determined using RORB modelling as discussed in the flood modelling section. The dimensions of the proposed channel cross section is shown in Table 23 below. The alternate slope along the alignment leads to the differing channel capacities for the reach section as shown Table 24.

Table 23. Channel cross-section geometry and design parameters

| Parameter | Low flow channel | High flow channel |
|---|---|---|
| Base width | 5.0 | Varies from 16m to 20m wide |
| Depth | 0.6 | - |
| Side slope | 1 in 3 | Typically 1 in 6 |
| Bench slope | - | 1 in 40 |
| Top width | 8.6 | Varies |
| Manning's n (assumed) | 0.05 | 0.05 |

Table 24. Channel design capacities

| Reach | Low flow capacity ($m^3/s$) | High flow capacity ($m^3/s$) |
|---|---|---|
| 1, 2, 3 | 2.2 | 27.4 |
| 4, 5, 6 | 2.7 | 31.4 |

## 10.3 W-WW (DR-01) culvert designs

These crossings have been designed to convey the 1% AEP design flows with minimum head loss. To meet these criteria the typical culvert arrangement consists of the following:

- Downstream of SB-01 (Future Road 1): 3 culvert cells, each opening 1.35m diameter (Figure 38)
- At Bass Hwy (proposed CU-01): 4 culvert cells, each opening 1.5m diameter (Figure 39)
- At McGibbonys Road (CU-03): 4 culvert cells, each opening 1.5m diameter (Figure 40)
- Centennial Dr (existing): 2 culvert cells, each opening 3.6m wide by 1.5m high (Figure 41)
- At proposed Future DCP Road Crossings proposed culverts: 3 culvert cells with 1 link slab, each opening 3.6m wide by 1.5m high (Figure 42).

The hydraulic model was run for two scenarios – culverts fully unimpeded and culverts 25% blocked.

The figures below show the culvert designs looking downstream from the upstream side.

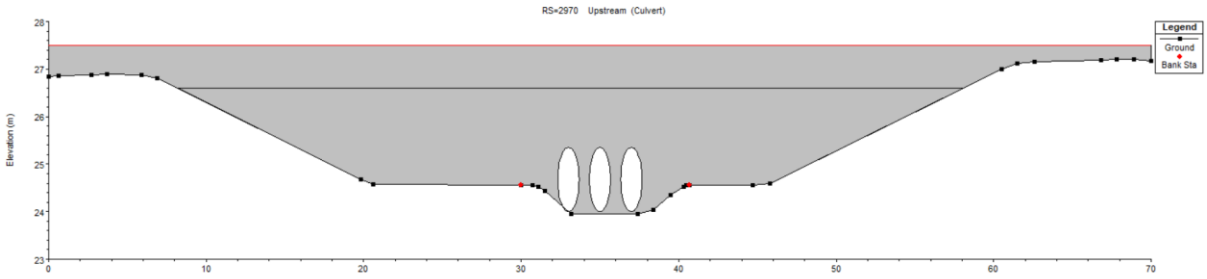



**Figure 38.** *Downstream of SB-01, Future Road 1 cross section (looking downstream)*

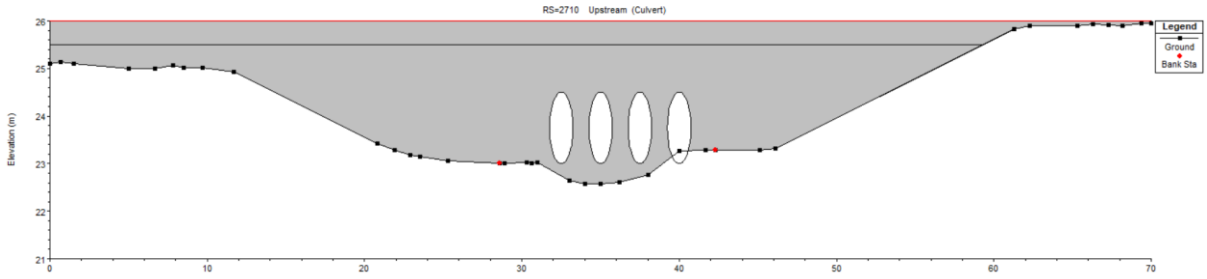



**Figure 39.** *Bass Hwy cross section (looking downstream) – DCP CU-01*

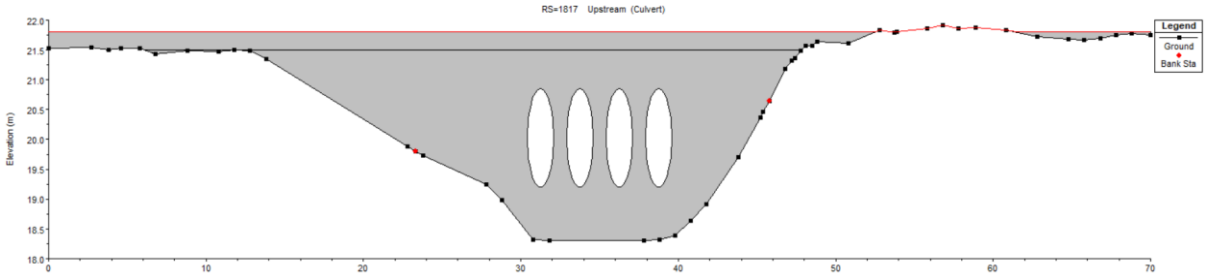



**Figure 40.** *McGibbonys Rd cross section (looking downstream) – CU-03*

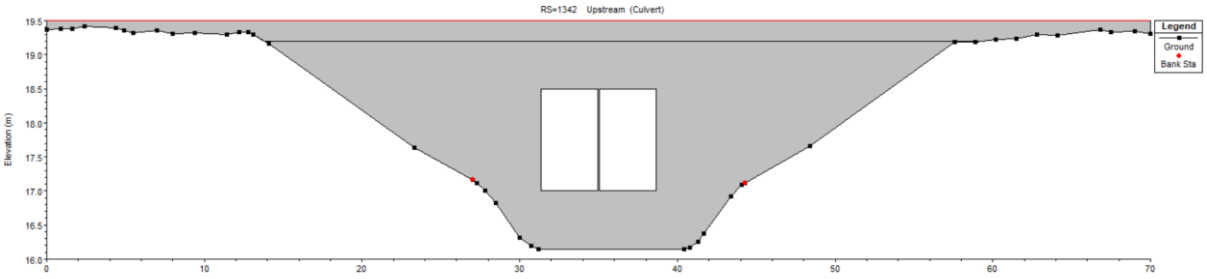



**Figure 41.** *Centennial Dr cross section (looking downstream) – existing culverts*

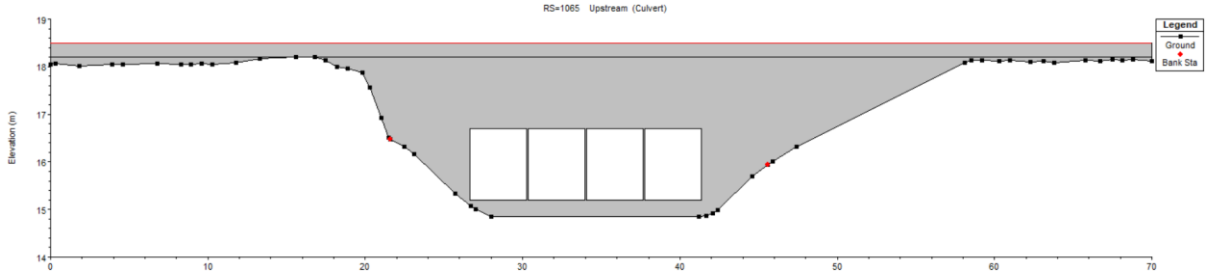



**Figure 42.** *Culverts under Future DCP road crossings design cross-sections (looking downstream)*

## 10.4 Results - ultimate culvert designs

The figures below show the longitudinal profile of the water surface for the 1% AEP flow within the western waterway, for open and blocked culvert scenarios.

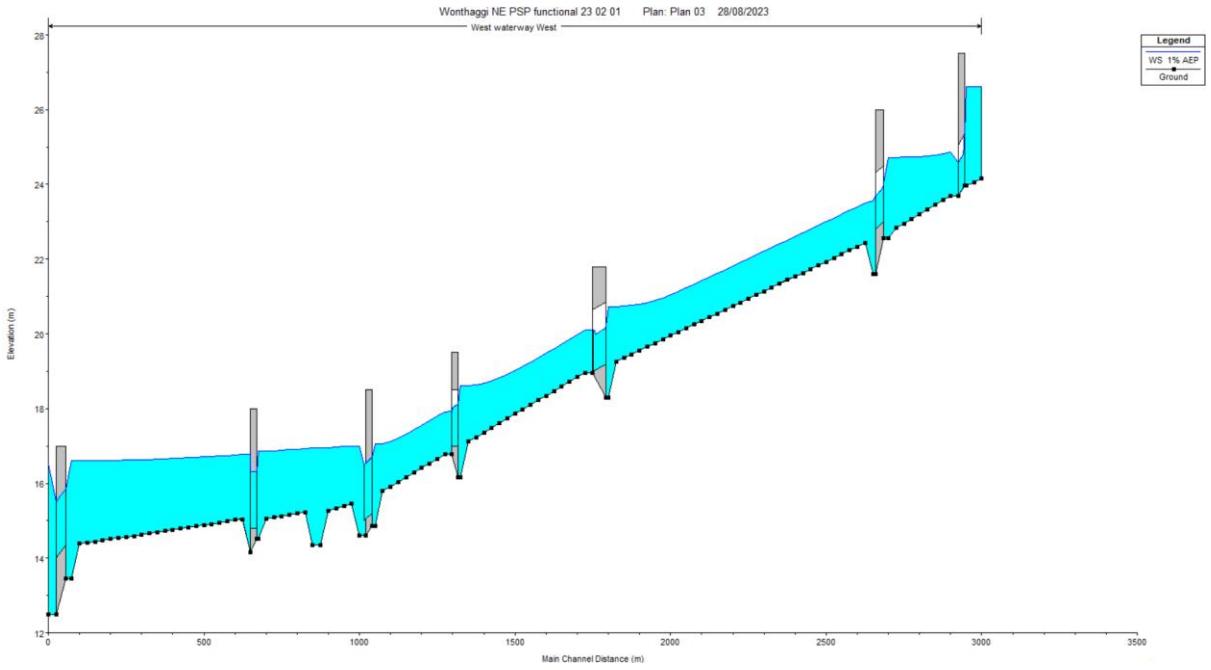



**Figure 43.** *1% AEP water surface elevation along the DR-01 waterway alignment with culverts unimpeded*

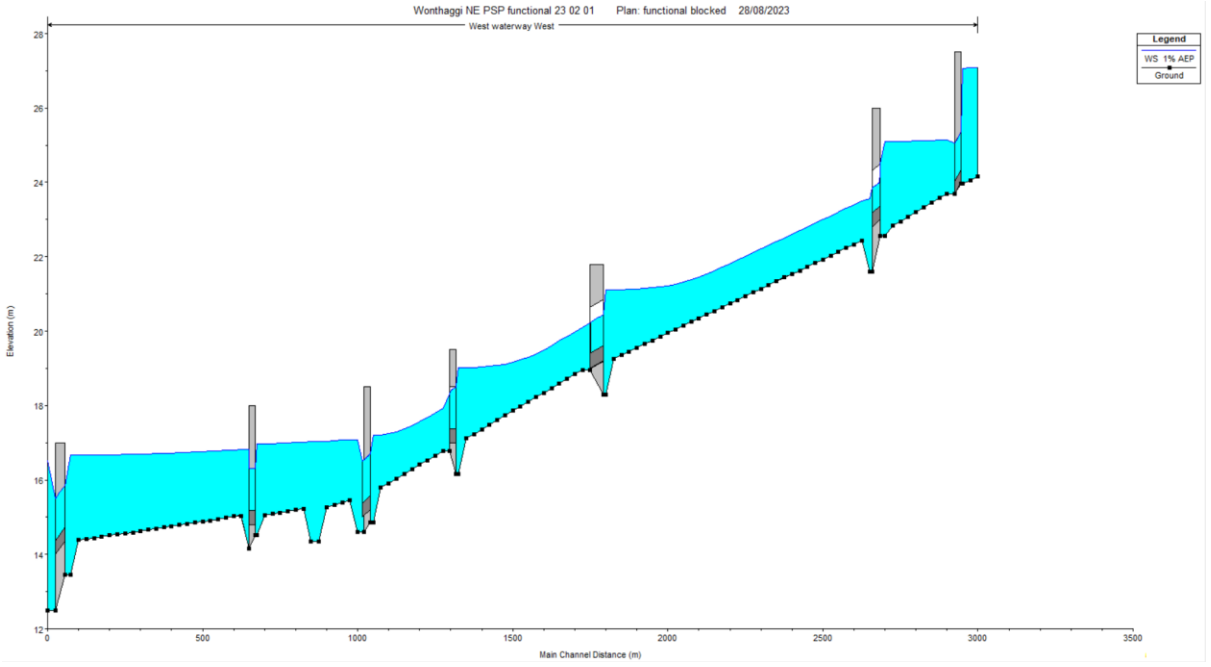



**Figure 44.** *1% AEP water surface elevation along the DR-01 waterway alignment with culverts 25% blocked*

The figures below represent results for the 50% AEP flow unimpeded and blocked.

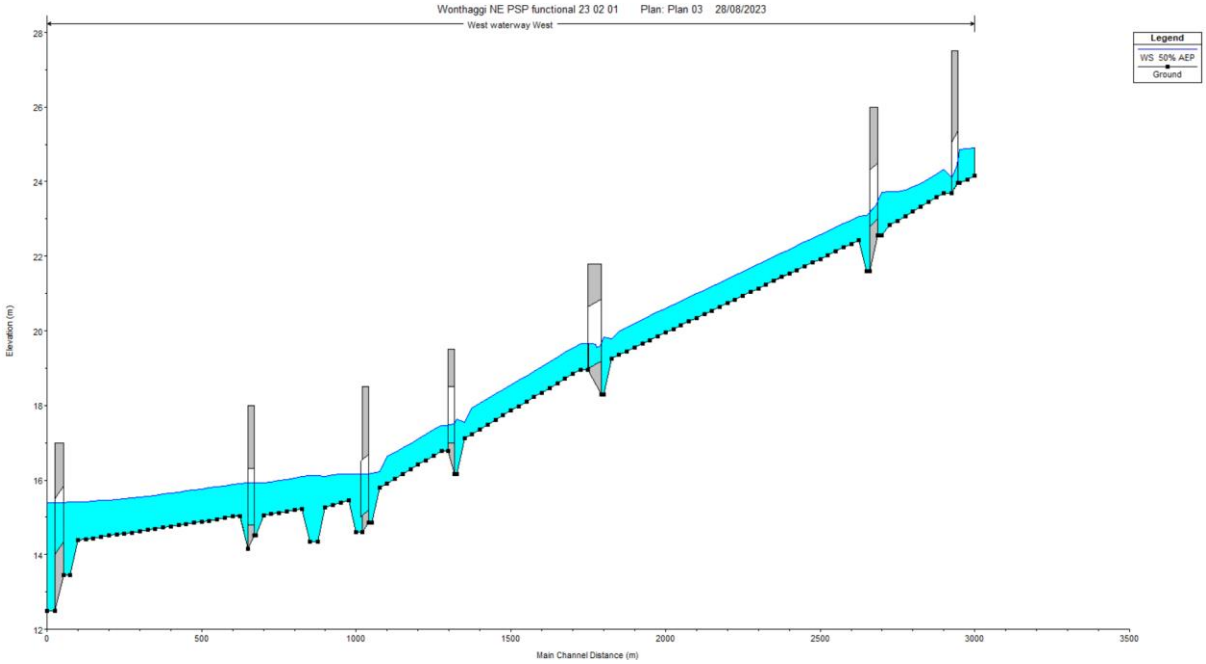



Figure 45. *50% AEP water surface elevation along the DR-01 waterway alignment with culverts unimpeded*

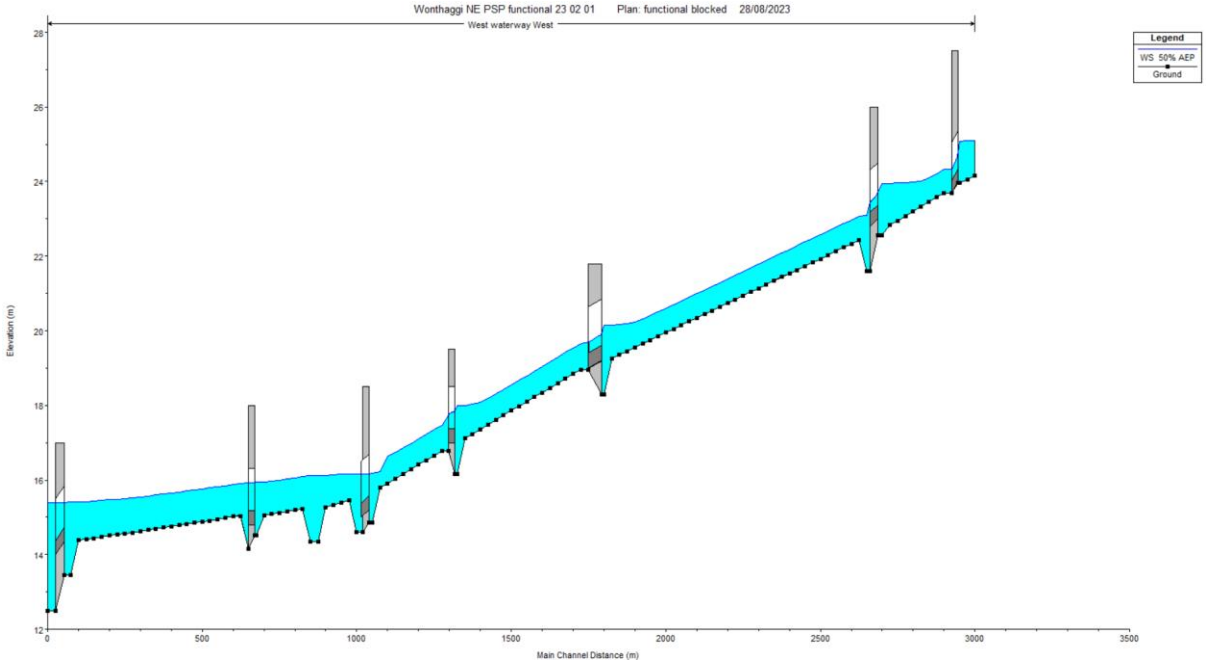



Figure 46. *50% AEP water surface elevation along the DR-01 waterway alignment with culverts 25% blocked*

The table below shows the hydraulic results for the open and blocked scenarios for the 1% AEP flow.

Table 25. Hydraulic results through culverts for both scenarios for the 1% AEP flow

| Culvert Crossing | Details | Open culverts | Blocked culverts |
|---|---|---|---|
| Downstream of SB-01 | | | |
| | Head loss (m) | 1.75 | 1.92 |
| | Freeboard to road (m)* | 0.77 | 0.41 |
| | Average velocity (m/s) | 0.60 | 0.43 |
| Bass Hwy (CU-01) | | | |
| | Head loss (m) | 1.16 | 1.54 |
| | Freeboard to road (m)* | 1.24 | 0.85 |
| | Average velocity (m/s) | 0.40 | 0.37 |
| McGibbonys Rd (CU-03) | | | |
| | Head loss (m) | 0.62 | 1.01 |
| | Freeboard to road (m)* | 1.15 | 0.75 |
| | Average velocity (m/s) | 0.85 | 0.82 |
| Centennial Dr (not PSP item) | | | |
| | Head loss (m) | 0.69 | 1.10 |
| | Freeboard to road (m)* | 0.98 | 0.49 |
| | Average velocity (m/s) | 0.92 | 0.87 |
| Future Culvert (stn 1065) | | | |
| | Head loss (m) | 0.07 | 0.14 |
| | Freeboard to road (m)* | 1.34 | 1.22 |
| | Average velocity (m/s) | 0.44 | 0.42 |
| Future Culvert (stn 695) | | | |
| | Head loss (m) | 0.06 | 0.13 |
| | Freeboard to road (m)* | 1.09 | 0.96 |
| | Average velocity (m/s) | 0.38 | 0.37 |
| Future Culvert (stn 80) | | | |
| | Head loss (m) | 0.08 | 0.15 |
| | Freeboard to road (m)* | 0.36 | 0.34 |
| | Average velocity (m/s) | 0.17 | 0.16 |

*Note: Road deck levels are assumed

The table below shows the hydraulic results for the open and blocked scenarios for the 50% AEP flow.

Table 26. Hydraulic results through culverts for both scenarios for the 50% AEP flow

| Culvert Crossing | | Open culverts | Blocked culverts |
|---|---|---|---|
| Downstream of SB-01 | | | |
| | Head loss (m) | 0.54 | 0.76 |
| | Freeboard to road (m)* | 2.62 | 2.42 |
| | Average velocity (m/s) | 0.55 | 0.49 |
| Bass Hwy (CU-01) | | | |
| | Head loss (m) | 0.62 | 0.85 |
| | Freeboard to road (m)* | 2.24 | 3.88 |
| | Average velocity (m/s) | 0.18 | 0.15 |
| McGibbonys Rd (CU-03) | | | |
| | Head loss (m) | 0.16 | 0.50 |
| | Freeboard to road (m)* | 1.94 | 1.61 |
| | Average velocity (m/s) | 0.52 | 0.50 |
| Centennial Dr (not PSP item) | | | |
| | Head loss (m) | 0.17 | 0.53 |
| | Freeboard to road (m)* | 1.96 | 1.56 |
| | Average velocity (m/s) | 0.57 | 0.55 |

| Culvert Crossing | | Open culverts | Blocked culverts |
|---|---|---|---|
| Future Culvert (stn 1065) | | | |
| | Head loss (m) | 0.00 | 0.02 |
| | Freeboard to road (m)* | 2.35 | 1.98 |
| | Average velocity (m/s) | 0.20 | 0.20 |
| Future Culvert (stn 695) | | | |
| | Head loss (m) | 0.01 | 0.02 |
| | Freeboard to road (m)* | 1.94 | 2.09 |
| | Average velocity (m/s) | 0.07 | 0.17 |
| Future Culvert (stn 80) | | | |
| | Head loss (m) | 0.01 | 0.01 |
| | Freeboard to road (m)* | 1.49 | 1.61 |
| | Average velocity (m/s) | 0.08 | 0.08 |

* Road deck levels are assumed

**Note:** Appropriate rock beaching will be required at the outlet of the culverts as they transition to the waterway.

### Fill Requirements

For residential allotments fill will be required to provide a minimum 600mm of freeboard above the 1% AEP flood level.

The HEC-RAS model indicates that the waterway corridor provides sufficient freeboard. There are no regions neighbouring the constructed waterway that are of concern. Table 27 provides the finished surface level, flood level and freeboard level for the west waterway corridor.

**Table 27. Constructed waterway (DR-01) design and 1% AEP flood levels**

| Chainage | River station | Flood level (m AHD) | Finished surface level (left) (m AHD) | Finished surface level (right) (m AHD) | Freeboard (m AHD) |
|---|---|---|---|---|---|
| 3000 | 3000 | 26.61 | 27.28 | 26.95 | 0.34 |
| 2970 | SB-01 crossing | | | | |
| 2900 | 2900 | 24.82 | 26.7 | 26.35 | 1.53 |
| 2800 | 2800 | 24.73 | 25.86 | 25.33 | 0.60 |
| 2710 | Bass Hwy culverts (CU-01) | | | | |
| 2600 | 2600 | 23.30 | 24.99 | 25.06 | 1.69 |
| 2500 | 2500 | 22.90 | 24.17 | 24.54 | 1.27 |
| 2400 | 2400 | 22.51 | 23.33 | 23.16 | 0.65 |
| 2300 | 2300 | 22.11 | 23.02 | 23.08 | 0.91 |
| 2200 | 2200 | 21.71 | 23.11 | 23.11 | 1.40 |
| 2100 | 2100 | 21.32 | 23.29 | 23.54 | 1.97 |
| 2000 | 2000 | 20.97 | 22.79 | 22.78 | 1.81 |
| 1900 | 1900 | 20.76 | 22.16 | 22.35 | 1.40 |
| 1817 | McGibbonys Road culverts (CU-03) | | | | |
| 1700 | 1700 | 19.86 | 21.04 | 21.16 | 1.18 |
| 1600 | 1600 | 19.36 | 20.96 | 21.02 | 1.60 |
| 1500 | 1500 | 18.91 | 20.87 | 20.65 | 1.74 |
| 1400 | 1400 | 18.64 | 19.7 | 19.53 | 0.89 |
| 1342 | Centennial Dr culverts (existing) | | | | |
| 1300 | 1300 | 17.92 | 18.85 | 18.83 | 0.91 |
| 1200 | 1200 | 17.43 | 18.41 | 18.47 | 0.98 |
| 1100 | 1100 | 17.05 | 18.23 | 18.23 | 1.18 |
| 1065 | Future Culvert (stn 1065) | | | | |
| 1000 | 1000 | 16.99 | 18.22 | 18.22 | 1.23 |

| Chainage | River station | Flood level (m AHD) | Finished surface level (left) (m AHD) | Finished surface level (right) (m AHD) | Freeboard (m AHD) |
|---|---|---|---|---|---|
| 900 | 900 | 16.95 | 18.06 | 18.06 | 1.11 |
| 800 | 800 | 16.90 | 17.84 | 17.84 | 0.94 |
| 700 | 700 | 16.85 | 17.84 | 17.84 | 0.99 |
| 695 | Future Culvert (stn 695) | | | | |
| 600 | 600 | 16.74 | 17.53 | 17.53 | 0.79 |
| 500 | 500 | 16.70 | 17.39 | 17.39 | 0.69 |
| 400 | 400 | 16.66 | 17.27 | 17.27 | 0.61 |
| 300 | 300 | 16.63 | 17.19 | 17.19 | 0.56 |
| 200 | 200 | 16.61 | 17.15 | 17.15 | 0.54 |
| 100 | 100 | 16.60 | 17.13 | 17.13 | 0.53 |
| 80 | Future Culvert (stn 80) | | | | |

## 10.5 Climate change modelling

In line with ARR2019 guidelines, the waterway functional design has been run for a RCP8.5 climate change scenario for the year 2100. The design has been run for the 1% AEP climate change scenario.

The waterway is designed to convey 1% AEP climate change flow rate for an open culvert scenario only. This is due to the fact a 25% blocked culvert scenario already represents an 'extreme' design case. The additional climate change flow rates will likely result in significant land take and depth increases when both scenarios are considered.

As a result, the waterway is designed to convey the climate change scenario in the freeboard depth provided between the 1% AEP flood depth and the proposed finished floor levels. A summary of the results are provided below.

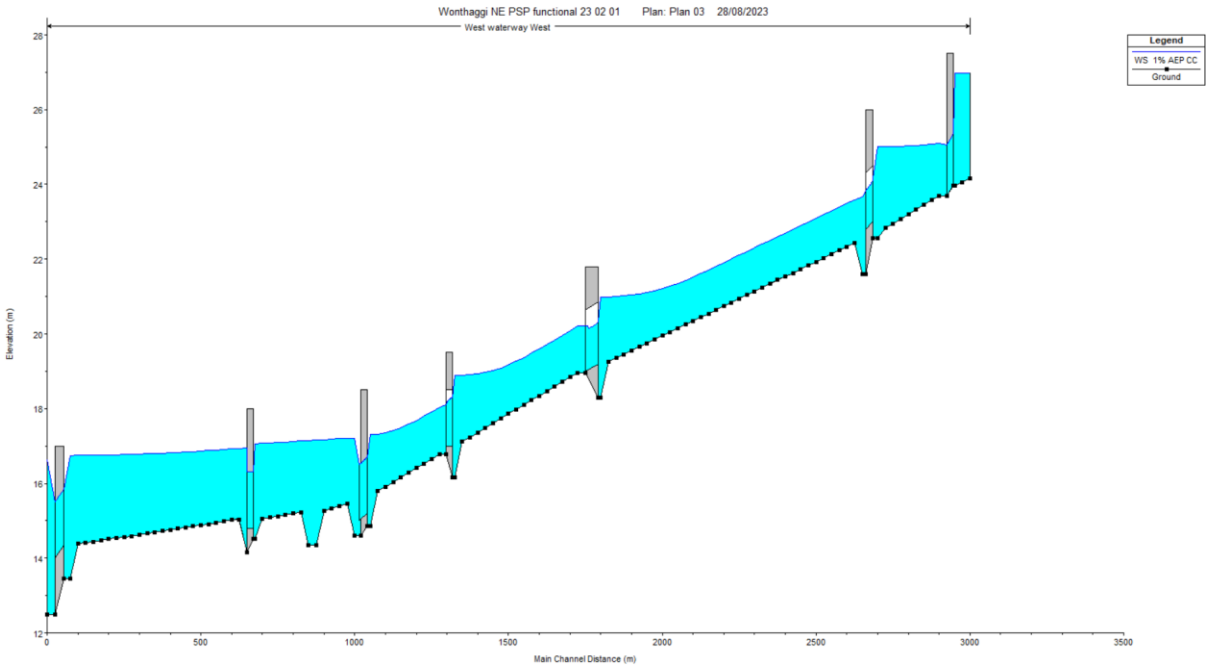



**Figure 47.** *1% AEP with climate change water surface elevation along the western waterway (DR-01) alignment*

## 10.6 West waterway (DR-01) shear stresses

Figure 48 shows the average shear stresses in the channel for the 1% AEP event calculated by HEC-RAS. There remains some isolated locations with higher shear stresses at pools along the alignment and transitions to culvert structures. Rock armouring will be shown/provided within the design details at locations of high local shear stresses.

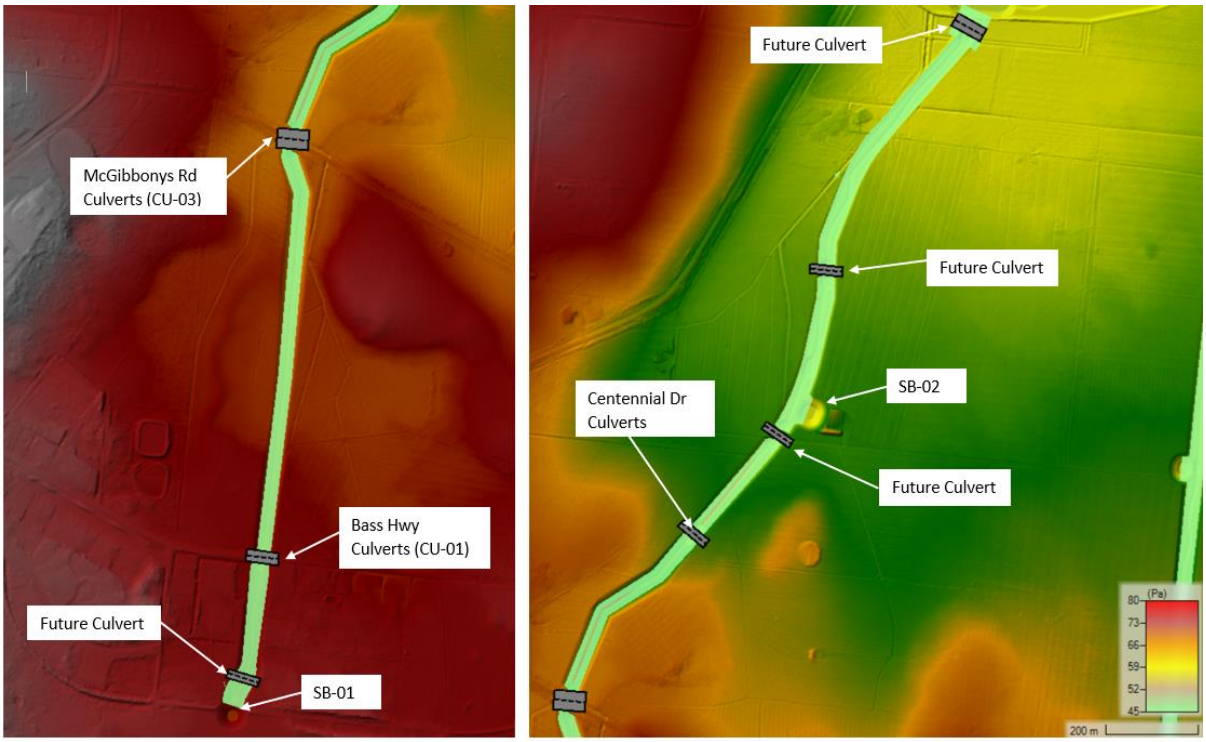



**Figure 48.** *Average shear stress (in N/m²) map through (DR-01) constructed waterway*

# 11 Waterway Functional Design East-WW (DCP ref DR-02)

## 11.1 Longitudinal slope

One of the key criteria for the waterway is to ensure that shear stress values are within an acceptable range. This is to ensure that the waterway is stable and to minimise the erosion potential. The shear stress threshold value is generally considered to be 45 N/m$^2$, which can increase by up to 10% during a 1% AEP flow event.

The longitudinal slope is dictated by invert controls at the downstream and upstream extents of the constructed waterway. The provided design features change in slope along the alignment, as discussed in the table below. Note: this is the slope along the low flow channel, which will be slightly gentler than the high flow channel due to meanders designed into the low flow alignment.

In order to accommodate piped connections between future developments (local drainage network) to the proposed stormwater-related PSP assets, the trunk stormwater drainage network has been designed (refer Section 8.3). A flattening in grade in both proposed constructed waterways was required to accommodate the proposed trunk stormwater drainage network. These grades are suitable for facilitating stable channel design in accordance with industry best practice guidelines.

**Table 28. Longitudinal slope along low flow channel**

| Reach | Upstream Boundary | Downstream Boundary | Upstream elevation (m AHD) | Downstream elevation (m AHD) | Average slope (1 in x) |
|---|---|---|---|---|---|
| 1 | Bass Hwy (stn 2900) | McGibbonys Rd (stn 2550) | 21.58 | 20.02 | 224 |
| 2 | McGibbonys Rd (stn 2475) | WLRB1A (stn 25) | 19.56 | 14.35 | 470 |

## 11.2 Cross-section geometry

The cross-sectional geometry should be designed to accommodate the 4EY to 1EY flows in the low flow channel, and the 1% AEP flows in the full compound channel. These flows are determined using RORB modelling as discussed in the flood modelling section. The proposed channel cross section dimensions are given in Table 29. The alternate slope along the alignment leads to the differing channel capacities for the reach sections outlined in Table 30.

**Table 29. Channel cross-section geometry and design parameters**

| Parameter | Low flow channel | High flow channel |
|---|---|---|
| Base width | 3.0 | 20m |
| Depth | 0.6 | 0.7 |
| Side slope | 1 in 3 | Typically 1 in 6 |
| Bench slope | - | 1 in 40 |
| Top width | 7.0 | 34.0 |
| Manning's n (assumed) | 0.05 | 0.05 |

Table 30. Channel design capacities

| Reach | Low flow capacity ($m^3/s$) | High flow capacity ($m^3/s$) |
|---|---|---|
| 1, 2 | 1.6 | 17.5 |

## 11.3 E-WW (DR-02) culvert designs

There are 2 culvert crossings through the section of the East Waterway (E-WW; DCP ref DR-02). These crossings have been designed to convey the 1% AEP design flows with minimum head loss. To meet these criteria the typical culvert arrangement will consist of the following:

- At Bass Hwy (proposed culvert CU-02): 3 culvert cells, each opening 1.65m diameter (Figure 49).
- At McGibbonys Rd (future extension) (proposed future culvert): 3 culvert cells, each opening 1.65m diameter (Figure 50).

The figures below show the culvert designs looking downstream from the upstream side.

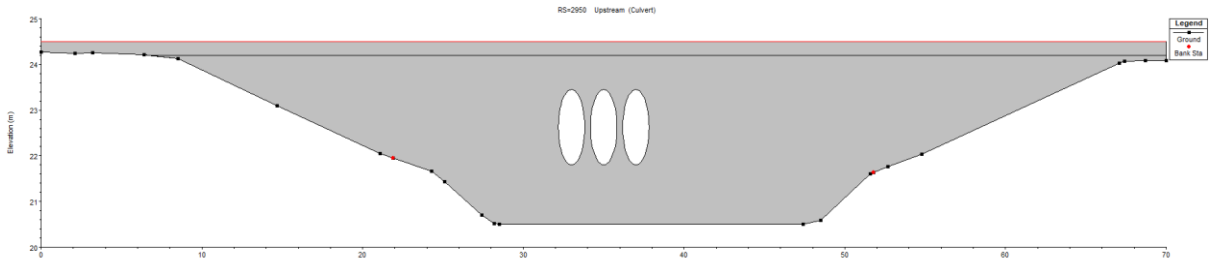



Figure 49. *Bass Hwy design cross section (looking downstream) – CU-02*

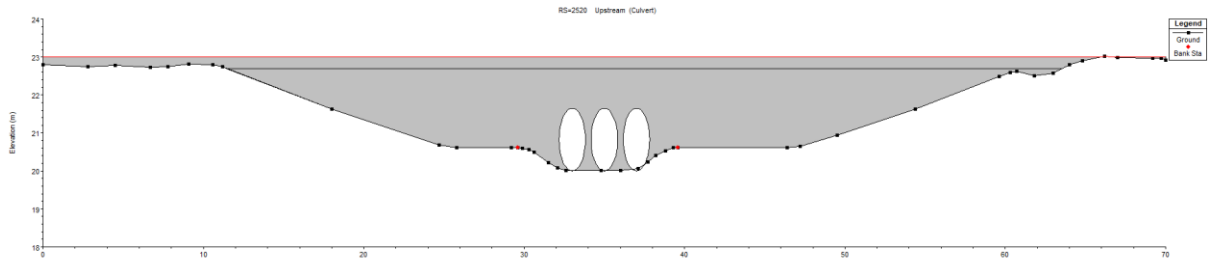



Figure 50. *McGibbonys Rd design cross section (looking downstream)*

## 11.4 Results – ultimate culvert designs

The hydraulic model was run for two scenarios: culverts fully unimpeded and culverts 25% blocked.

The figures below show the longitudinal profile of the water surface for the 1% AEP flow for culverts open and blocked.

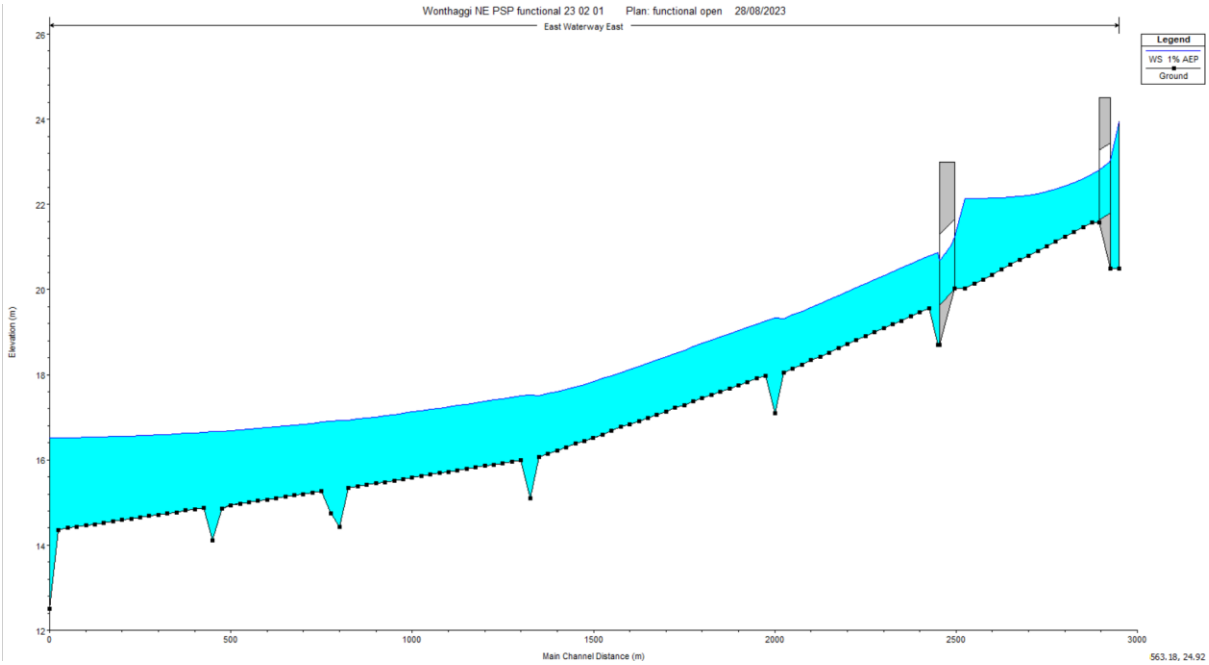



**Figure 51.** *1% AEP water surface elevation along the DR-02 waterway alignment with culverts unimpeded*

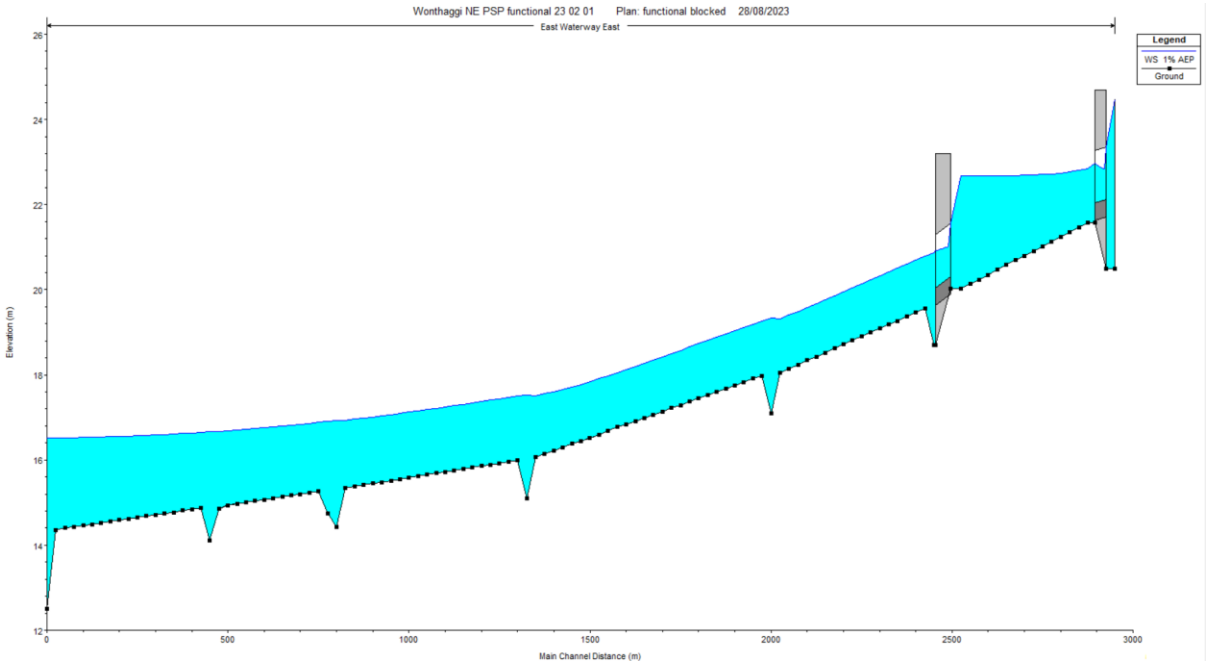



**Figure 52.** *1% AEP water surface elevation along the DR-02 waterway alignment with culverts 25% blocked*

The figures below show results for the 50% AEP flow for unimpeded and blocked.

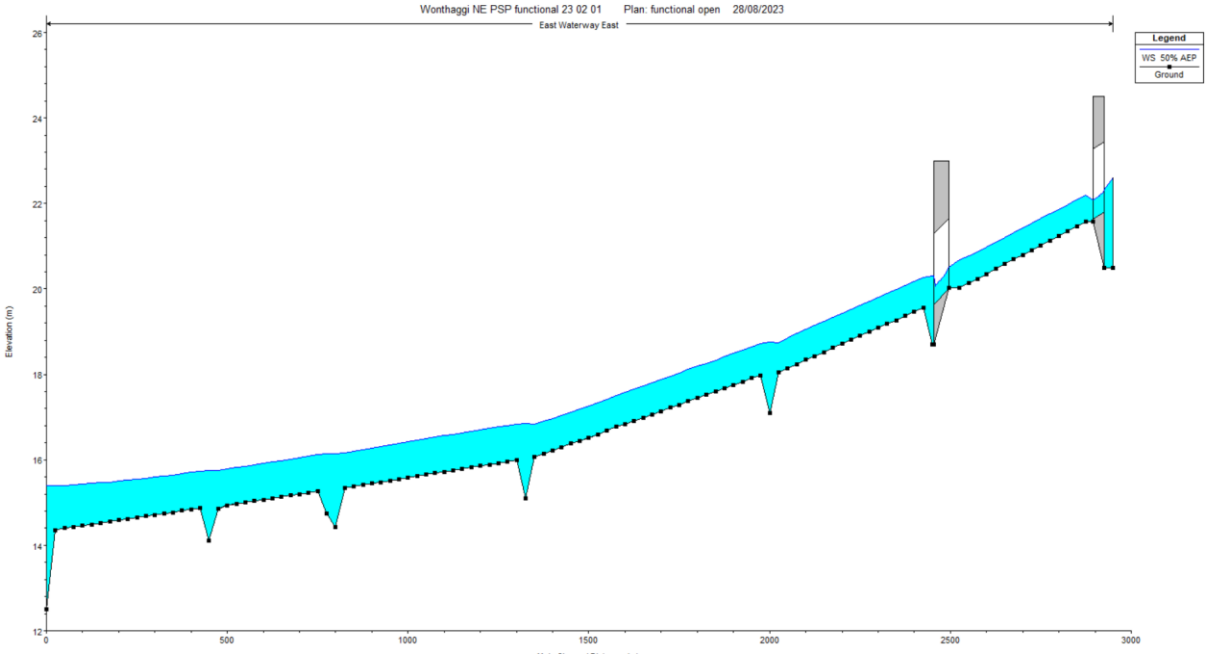



**Figure 53.** *50% AEP water surface elevation along the DR-02 waterway alignment with culverts unimpeded*

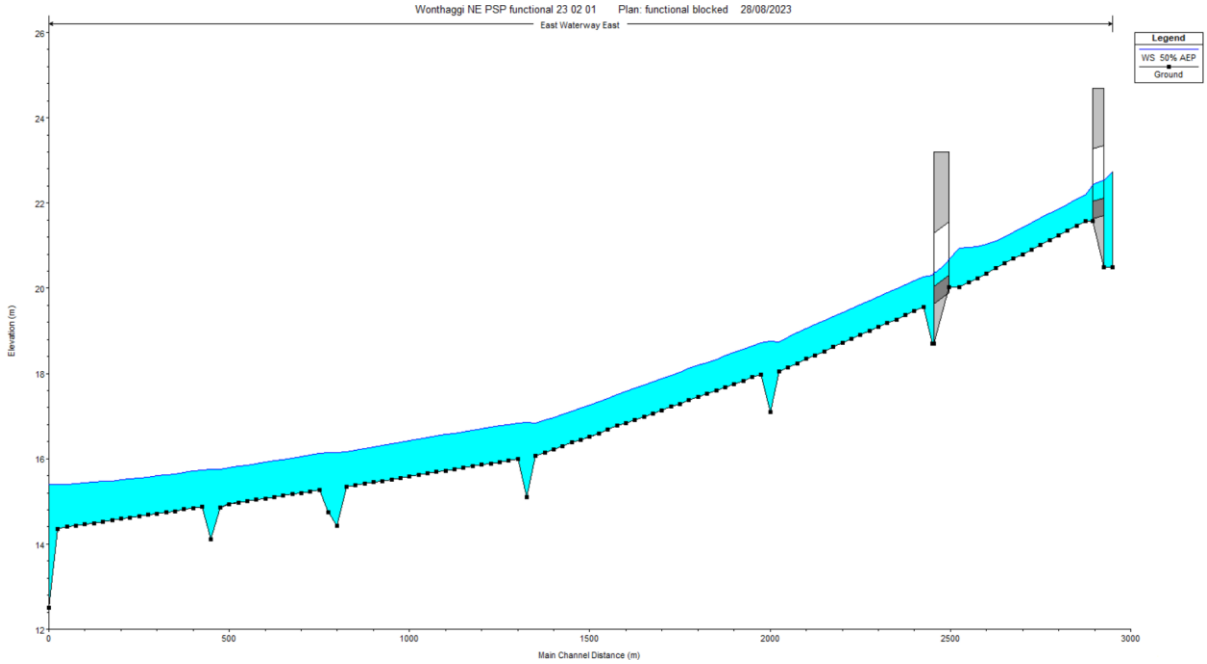



**Figure 54.** *50% AEP water surface elevation along the DR-02 waterway alignment with culverts 25% blocked*

The hydraulic results for the open and blocked scenarios for the 1% AEP flow are outlined in the table below.

Table 31. Hydraulic results through culverts for both scenarios for the 1% AEP flow

| Culvert Crossing | | Open culverts | Blocked culverts |
|---|---|---|---|
| Bass Hwy (CU-02) | | | |
| | Head loss (m) | 1.23 | 1.62 |
| | Freeboard to road (m)* | 0.63 | 0.30 |
| | Average velocity (m/s) | 0.71 | 0.58 |

| Culvert Crossing | | Open culverts | Blocked culverts |
|---|---|---|---|
| McGibbonys Rd proposed extension (CU-12) | | | |
| | Head loss (m) | 1.27 | 1.81 |
| | Freeboard to road (m)* | 0.93 | 0.50 |
| | Average velocity (m/s) | 0.49 | 0.43 |

*Note: Road deck levels are assumed

The hydraulic results for the open and blocked scenarios for the 50% AEP flow are outlined below.

Table 32. Hydraulic results through culverts for both scenarios for the 50% AEP flow

| Culvert Crossing | | Open culverts | Blocked culverts |
|---|---|---|---|
| Bass Hwy (CU-02) | | | |
| | Head loss (m) | 0.40 | 0.54 |
| | Freeboard to road (m)* | 1.89 | 1.96 |
| | Average velocity (m/s) | 0.41 | 0.41 |
| McGibbonys Rd proposed extension (CU-12) | | | |
| | Head loss (m) | 0.37 | 0.64 |
| | Freeboard to road (m)* | 2.37 | 2.26 |
| | Average velocity (m/s) | 0.43 | 0.27 |

* Road deck levels are assumed

**Note:** Appropriate rock beaching will be required at the outlet of the culverts as they transition to the waterway.

### Fill Requirements

It is required that residential allotments provide a minimum 600mm freeboard above the 1% AEP flood level. The HEC-RAS model indicates that the waterway corridor provides sufficient freeboard through the waterway corridor. There are no regions neighbouring the constructed waterway that are of concern. Table 33 provides the finished surface level, flood level and freeboard level.

Table 33. Constructed Waterway (DR-02) Design and 1% AEP Flood levels

| Chainage | River station | Flood level (m AHD) | Finished surface level (left) (m AHD) | Finished surface level (right) (m AHD) | Freeboard (m AHD) |
|---|---|---|---|---|---|
| 2975 | Bass Hwy Culverts (CU-02) | | | | |
| 2900 | 2900 | 22.71 | 23.79 | 23.93 | 1.08 |
| 2800 | 2800 | 22.35 | 23.37 | 23.51 | 1.02 |
| 2700 | 2700 | 22.19 | 23.27 | 22.93 | 0.74 |
| 2600 | 2600 | 22.14 | 22.90 | 22.90 | 0.76 |

| Chainage | River station | Flood level (m AHD) | Finished surface level (left) (m AHD) | Finished surface level (right) (m AHD) | Freeboard (m AHD) |
|---|---|---|---|---|---|
| 2520 | McGibbonys Rd Culverts (CU-12) | | | | |
| 2400 | 2400 | 20.60 | 21.29 | 21.29 | 0.69 |
| 2300 | 2300 | 20.23 | 20.50 | 20.46 | 0.23 |
| 2200 | 2200 | 19.85 | 20.10 | 20.10 | 0.25 |
| 2100 | 2100 | 19.49 | 19.77 | 19.85 | 0.28 |
| 2000 | 2000 | 19.27 | 19.79 | 19.82 | 0.52 |
| 1900 | 1900 | 18.96 | 19.84 | 19.81 | 0.85 |
| 1800 | 1800 | 18.66 | 19.62 | 19.69 | 0.96 |
| 1700 | 1700 | 18.35 | 19.55 | 19.67 | 1.20 |
| 1600 | 1600 | 18.05 | 19.24 | 19.23 | 1.18 |
| 1500 | 1500 | 17.78 | 19.02 | 18.97 | 1.19 |
| 1400 | 1400 | 17.56 | 18.62 | 18.62 | 1.06 |
| 1300 | 1300 | 17.47 | 18.45 | 18.50 | 0.98 |
| 1200 | 1200 | 17.34 | 18.23 | 18.14 | 0.80 |
| 1100 | 1100 | 17.22 | 17.93 | 17.95 | 0.71 |
| 1000 | 1000 | 17.10 | 17.74 | 17.76 | 0.64 |
| 900 | 900 | 16.98 | 17.60 | 17.60 | 0.62 |
| 800 | 800 | 16.91 | 17.43 | 17.30 | 0.39 |
| 700 | 700 | 16.82 | 17.23 | 17.13 | 0.31 |
| 600 | 600 | 16.74 | 16.98 | 17.13 | 0.24 |
| 500 | 500 | 16.67 | 17.03 | 17.13 | 0.36 |
| 400 | 400 | 16.62 | 17.26 | 17.13 | 0.51 |
| 300 | 300 | 16.58 | 17.13 | 17.13 | 0.55 |
| 200 | 200 | 16.55 | 17.13 | 17.13 | 0.58 |
| 100 | 100 | 16.52 | 17.13 | 17.13 | 0.61 |

## 11.5 Climate change modelling

In line with ARR2019 guidelines, the waterway functional design has been run for a RCP8.5 climate change scenario for the year 2100. The design has been run for the 1% AEP climate change scenario.

The waterway is designed to convey 1% AEP climate change flow rate for an open culvert scenario only. This is due to the fact a 25% blocked culvert scenario already represents an 'extreme' design case. The additional climate change flow rates will likely result in significant land take and depth increases when both scenarios are considered.

As a result, the waterway is designed to convey the climate change scenario in the freeboard depth provided between the 1% AEP flood depth and the proposed finished floor levels. A summary of the results are provided below.

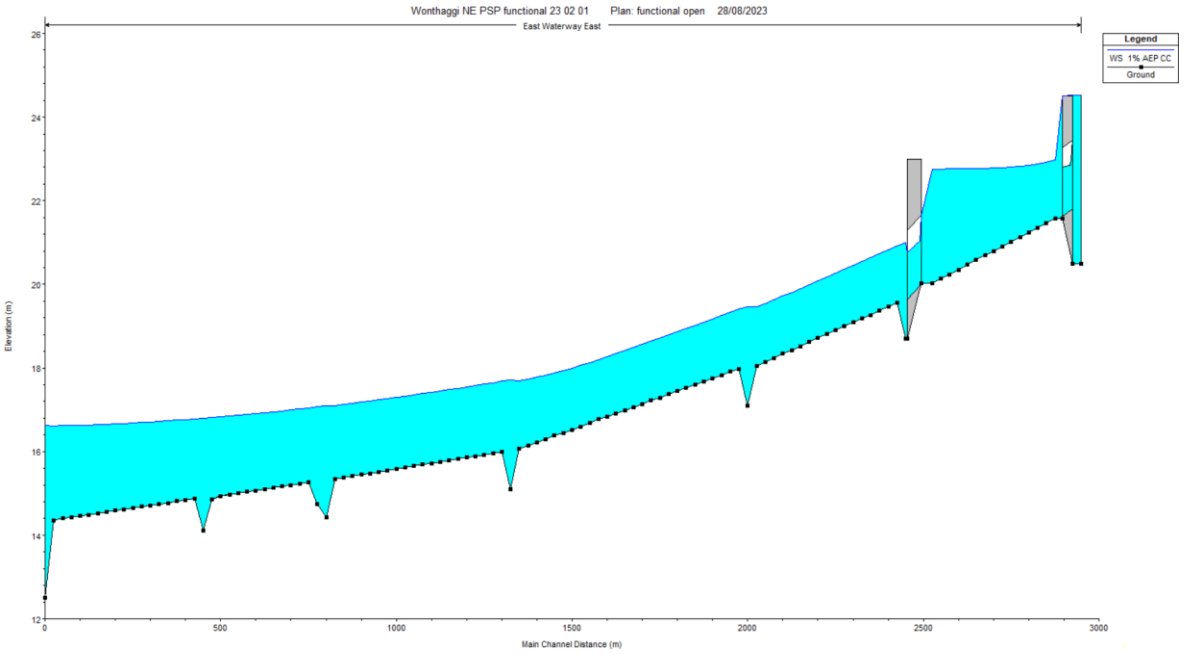



**Figure 55.** *1% AEP with climate change water surface elevation along the eastern waterway (DR-02) alignment*

## 11.6 East waterway (DR-02) shear stresses

Figure 56 shows the average shear stresses in the channel for the 1% AEP event calculated by HEC-RAS. There remain some isolated locations with higher shear stresses at pools along the alignment and transitions to culvert structures. Rock armouring will be provided within the design at locations of high local shear stresses.

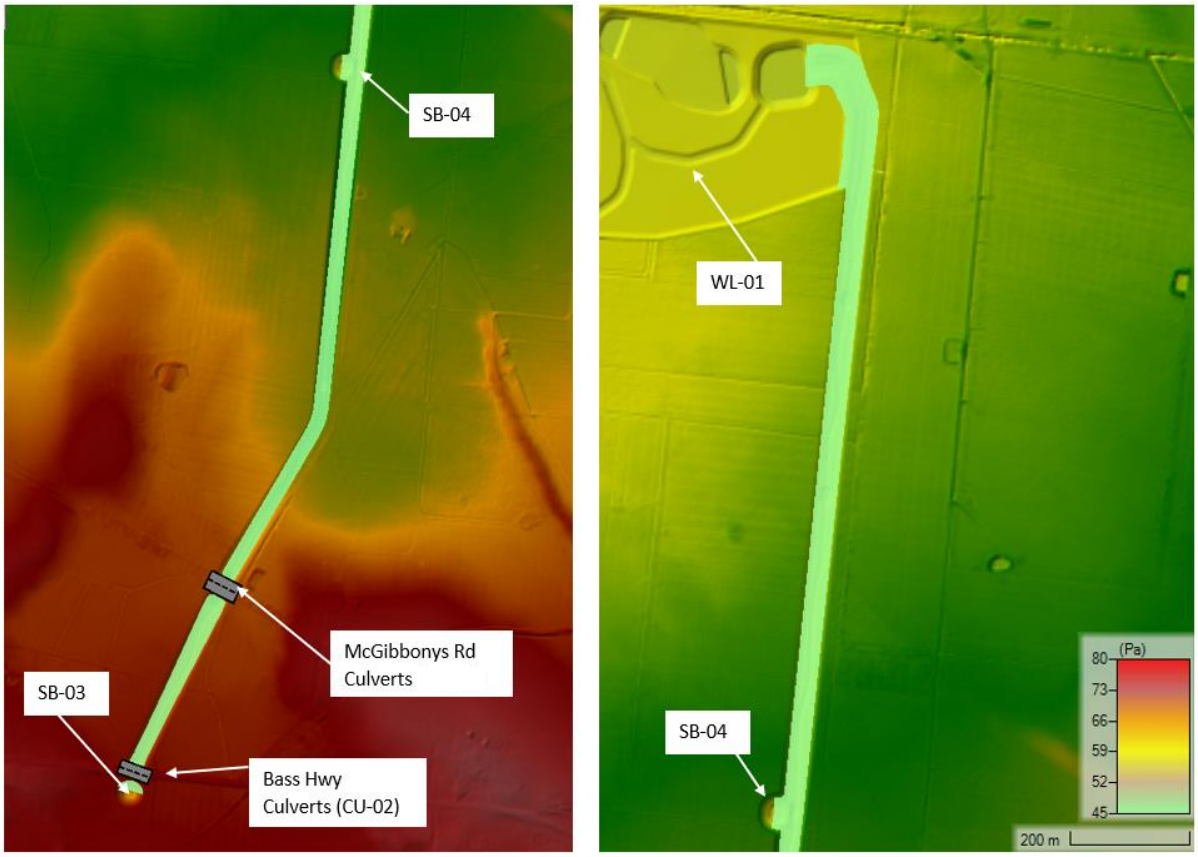



**Figure 56.** *Average shear stress map through constructed waterway (in N/m²)*

# 12 MOP – Main Outfall to Powlett River (DCP ref DR-03)

The main outfall from the PSP area has been designed to carry the 50% AEP flow from the WLRB1 (A and B; DCP ref WL-01) and WLRB2 (DCP ref WL-02) outflow location.

The main outfall alignment remains similar to the concept design proposed by Engeny (using the existing farm channel alignments) and extends to the upstream side of the Pinkerton Rd culvert before flows continue to the existing main outfall drain to the Powlett River. This is due to design constraints associated with crossing existing infrastructure along Korumburra-Wonthaggi Road (gas transmission main, desalination water supply main, and mains water supply line) and the need to ensure flows are transitioned through to the Powlett River.

A summary of the proposed alignment and the existing infrastructure is shown below.

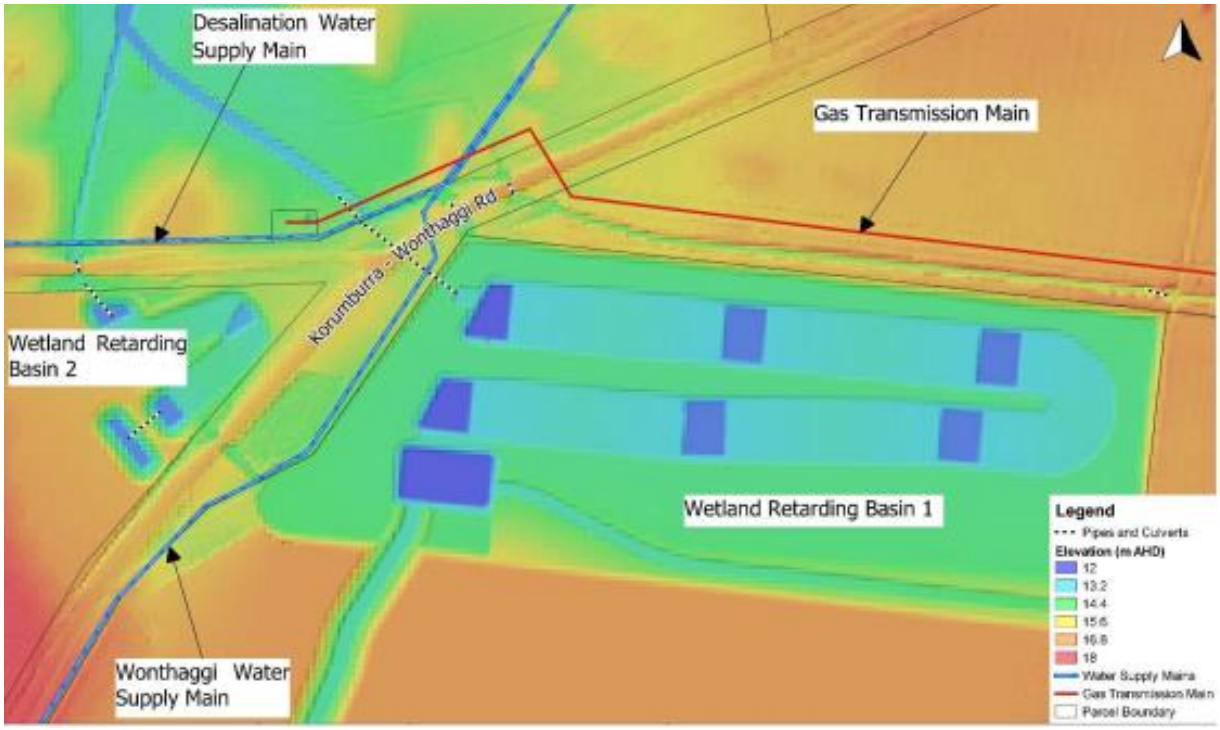



Figure 57. *Existing gas and water service pipelines (Engeny, August 2021)*

## 12.1 Service Crossings

As per the Engeny concepts and strategy development for the Wonthaggi North East PSP, Multinet and South Gippsland Water were contacted to confirm locations and levels of the gas and water mains, as well as the clearances and offsets required for each of these assets when a crossing is proposed.

Multinet require a 500mm vertical clearance to services and drains crossing the gas transmission main. As per discussions between Multinet and Engeny, the gas main is relatively new and specific legislative controls designed to protect the pipeline and areas around the pipeline, are in place. Therefore, potential relocation of the gas main should be considered as a last resort and preferably avoided where possible.

South Gippsland Water requires 300mm vertical clearance for drainage pipes crossing over water mains and 150mm vertical clearance for drainage pipes passing under water mains. As per discussions between South Gippsland Water and Engeny, crossing the mains (desalination pipeline or potable water main) would carry significant risks for both.

Any potential relocation of the desalination pipeline would be limited to winter months due to operational demand requirements through the summer period. Further, as advised, the line has limited flushing points,

therefore requiring large volumes of water to clean the line following relocation works, to ensure public health and safety.

The potable water supply main is the main supply for the Wonthaggi township. The storages within the township have a limited water reserve, and significant risk mitigation planning would be required to maintain town services, particularly if any potential relocation works did not proceed as scheduled.

Following a review of the proposed outfall crossing of Korumburra-Wonthaggi Rd by Craigie et.al (2021) a proposed 'alternate' outfall design was considered for the low flow outlet crossing from WLRB1.

The updated design considered 3 x 900mm (W) x 300mm (H) box culverts, which would transition to a single 1200mm (W) x 600mm (H) box culvert midway through the road crossing, once the existing services requiring appropriate cover were passed.

The proposed outfall arrangement is considered a more feasible and effective approach in comparison to a 10 x 300mm HDPE pipe arrangement (Engeny, 2021) given the propensity to blockages.

A summary of the layout is provided below.

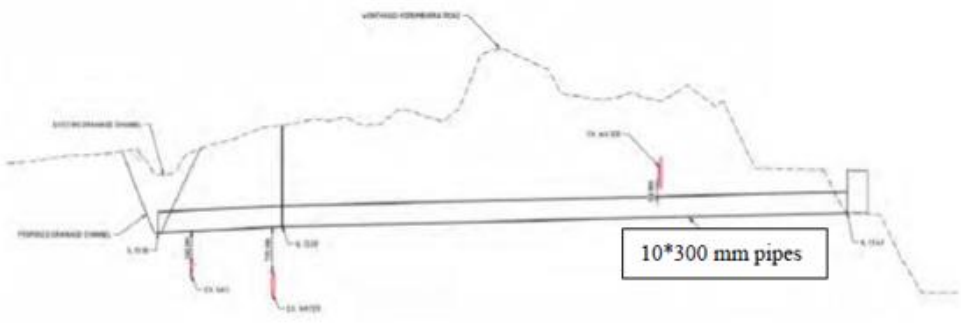



**Figure 1** **Engeny/Alluvium Proposal for WLRB1 lowflow outlet**

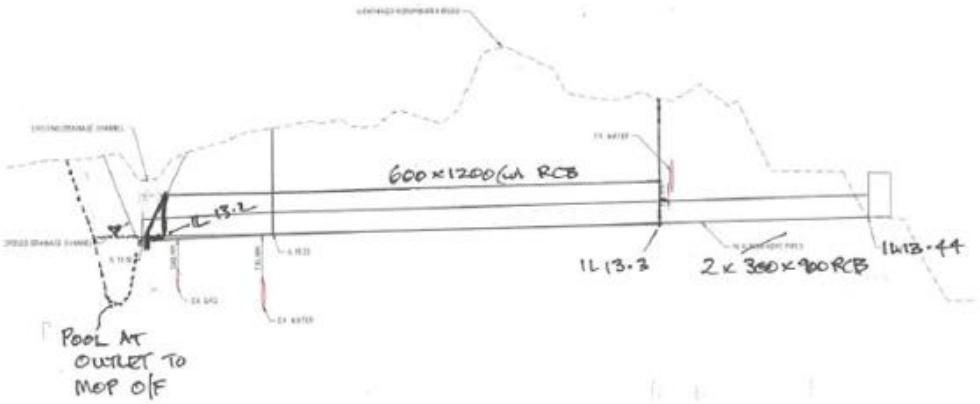



**Figure 2** **Suggested Alternative for WLRB1 lowflow outlet**

Figure 58. *Alternative low flow outlet arrangement CU-04 (Craigie, 2022)*

A high flow channel is proposed at the location of the gas main crossing (downstream of Korumburra-Wonthaggi Road) and is designed to carry the high flow outfall (HFO) from the WLRB1 asset.

The HFO channel, crossing the Multinet gas pipeline, requires a vertical separation of 700mm between the top of the gas main and the invert of the channel; with allowance for a 200mm thick concrete slab to protect the pipe from erosion.

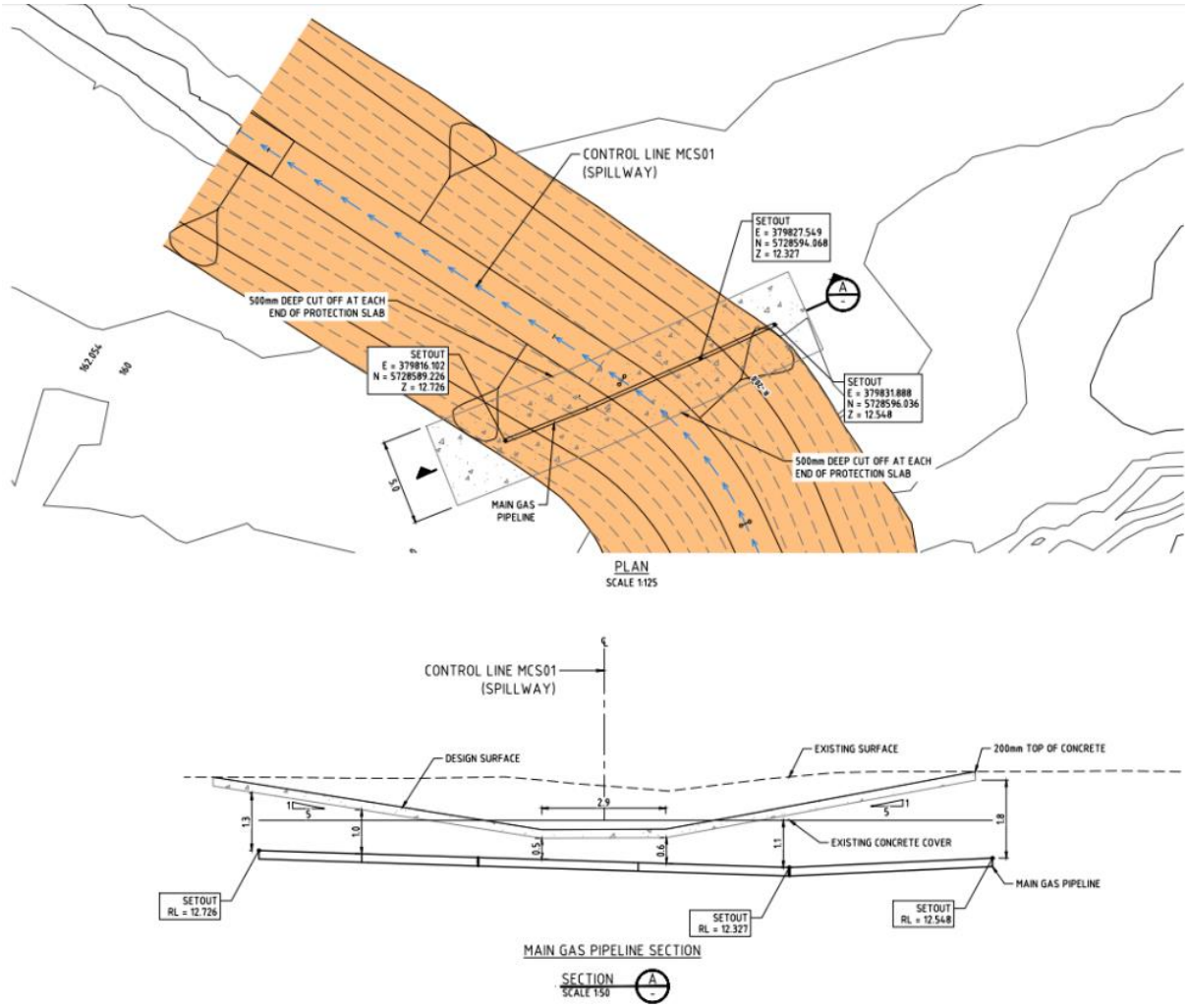



Figure 59. *Proposed channel crossing of the gas transmission main (Engeny, Aug 2021)*

## 12.2 Main Outfall to Powlett River (MOP, DR-03)

The main outfall connection to the Powlett River required further investigation to ensure concentrated retarding basin outflows from the Wonthaggi North East PSP do not impact on downstream landowners, prior to its ultimate outfall into the Powlett River. The original concepts (Engeny) and subsequent functional design (Alluvium) connected the PSP outfall to existing open farm channels, located on the subject property at 465 Heslop Road, north of the precinct.

The existing channel alignment runs roughly parallel to the Powlett River towards the west, before connecting into the river approximately 2km further downstream. The existing farm channel is undersized with respect to conveying the 50% AEP flow for the precinct, as identified by Engeny and Alluvium (September 2023).

An overview of the study area with three proposed culvert crossings is shown in Figure 60 below.

The three proposed culverts include DCP ref. CU-08, CU-09 and CU-10 for crossing the PSP's main outfall to the Powlett River (MOP, DCP ref DR-03). Refer to Section 9.4 for details on the proposed culvert designs.




Figure 60. *Ultimate outfall (DR-03) to Powlett River with outfall culverts shown.*

The capacity of the existing farm channels to receive PSP outfall discharges has been considered to resolve the ultimate outfall design of the PSP. The ultimate outfall design alignment passes through the downstream property and ensures no further flooding is experienced on the subject property as a result of the PSP (as per requirements). The outfall design also considered how flood conditions could be improved downstream (wherever possible) and considered potential erosion to the outfall channel from PSP discharges. The design ensures the protection of the existing riparian vegetation to maintain bank stability.

The proposed outfall connection has been designed with respect to the following:

- Confirmation of design invert levels from the end of the current design to the outfall to the Powlett River
- Confirmation of the current capacity of the existing farm channels in the 50% AEP event
- Hydraulic modelling (HEC-RAS) to confirm flood levels and sheer stresses through the system.

It is noted that the proposed main outfall design matches the existing farm drain invert level upstream of the Pinkerton Road bridge, to ensure the PSP area can freely drain to Powlett River. As part of the TUFLOW modelling completed for the PSP, flood levels along the Powlett River floodplain have shown no net increase in flood levels, as per the CMA requirement, ensuring there is no impact on the Pinkerton Road Bridge from the proposed developable area.

The main outfall design discharges through the existing farm drain alignment (not the river), as a result, no works are proposed within the Powlett River and no new drainage connections to the Powlett River have been proposed.

Following the TUFLOW modelling completed by Engeny, it was determined that the downstream outfall to Powlett reach was to remain in its current form. The drain alignment is too sensitive to change, and any alterations made to the existing outfall alignment, downstream of the original Engeny channel, results in increased flood levels further downstream within the Powlett River flood plain (refer Appendix E).

## 12.3 Longitudinal slope

One of the key criteria for the MOP design is to ensure shear stress values are within an acceptable range to achieve waterway stability and to minimise the erosion potential. The shear stress threshold value is generally considered to be 45 N/m$^2$.

The longitudinal slope is dictated by invert controls at the downstream and upstream extents of the constructed waterway. The provided design features change in slope along the alignment as shown in the table below. These grades are suitable for facilitating stable channel design and are in accordance with industry guidelines.

**Table 34. Longitudinal slope along low flow channel**

| Reach | Upstream Boundary | Downstream Boundary | Upstream elevation (m AHD) | Downstream elevation (m AHD) | Average slope (1 in x) |
|---|---|---|---|---|---|
| **Western tributary** | | | | | |
| 1a | WLRB2 Low Flow Out (stn 875) | Culvert CU-09 (stn 800) | 13.66 | 13.29 | 202 |
| 2a | Culvert CU-09 (stn 775) | Main connection (stn 700) | 13.25 | 12.94 | 242 |
| **Main MOP channel** | | | | | |
| 1 | WLRB1 Low Flow Out (stn 950) | Culvert CU-08 (stn 925) | 13.44 | 13.13 | 80 |
| 2 | Culvert CU-08 (stn 900) | Culvert CU-10 (stn 625) | 13.06 | 12.52 | 509 |
| 3 | Culvert CU-10 (stn 600) | Outlet (stn 0) | 12.47 | 11.34 | 530 |

## 12.4 Cross-section geometry

The cross-sectional geometry should be designed to accommodate the 50% AEP flow, as required through the 'subject property' (465 Heslop Rd) to convey the developed conditions outflow from the PSP to the Powlett River. These flows are determined using RORB modelling. The proposed channel cross section dimensions are provided in Table 35 below. The alternate slope along the alignment leads to the differing channel capacities for the reach sections, as shown in Table 36.

Table 35. Channel cross-section geometry and design parameters

| Parameter | Channel |
|---|---|
| Base width | 8 – 12 m |
| Depth | 0.5 – 3 m |
| Side slope | 1 in 3 |
| Manning's n (assumed) | 0.035 |

Table 36. Channel design capacities

| Reach | Capacity ($m^3/s$) |
|---|---|
| 1, 2, 3, 4 | 3.0 |

## 12.5 MOP (DR-03) culvert designs

The are 3 culvert crossings through the proposed outfall alignment. These crossings have been designed to convey the 50% AEP design flows with minimum head loss. To meet these criteria the typical culvert arrangement will consist of the following:

- MOP Crossing 1 (DCP CU-08): 9m wide bridge crossing of main MOP channel (refer to Figure 61).
- MOP Crossing 2 (DCP CU-09): 3m wide bridge crossing of western MOP tributary (refer to Figure 62).
- MOP Crossing 3 (DCP CU-10): 5 culvert cells, each opening 1.5m diameter (refer to Figure 63).

The figures below show culvert designs looking downstream from the upstream side.

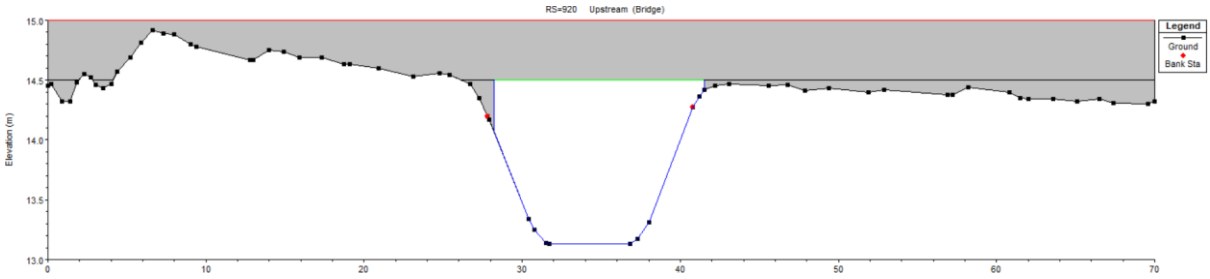



Figure 61. *Culvert (DCP CU-08) cross section (looking downstream)*

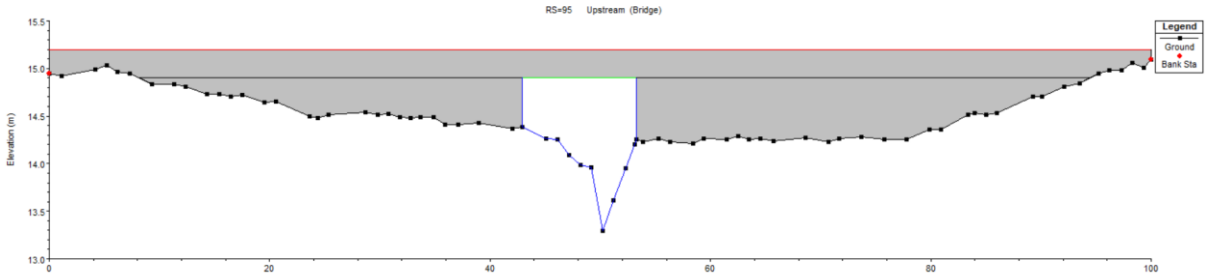



**Figure 62.** *Culvert (DCP CU-09) cross section (looking downstream)*

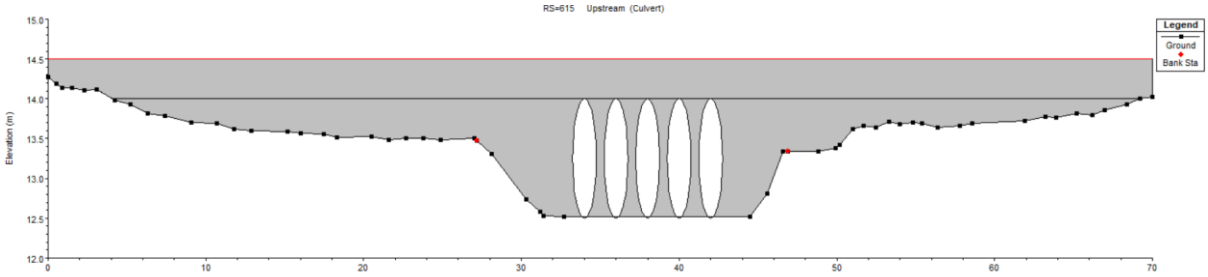



**Figure 63.** *Culvert (DCP CU-10) cross section (looking downstream)*

## 12.6 Results – ultimate culvert designs

The hydraulic model was run for two scenarios: culverts fully unimpeded and culverts 25% blocked. The figures below show the longitudinal profile of the water surface for the 50% AEP flow for culverts open (unimpeded) and blocked.

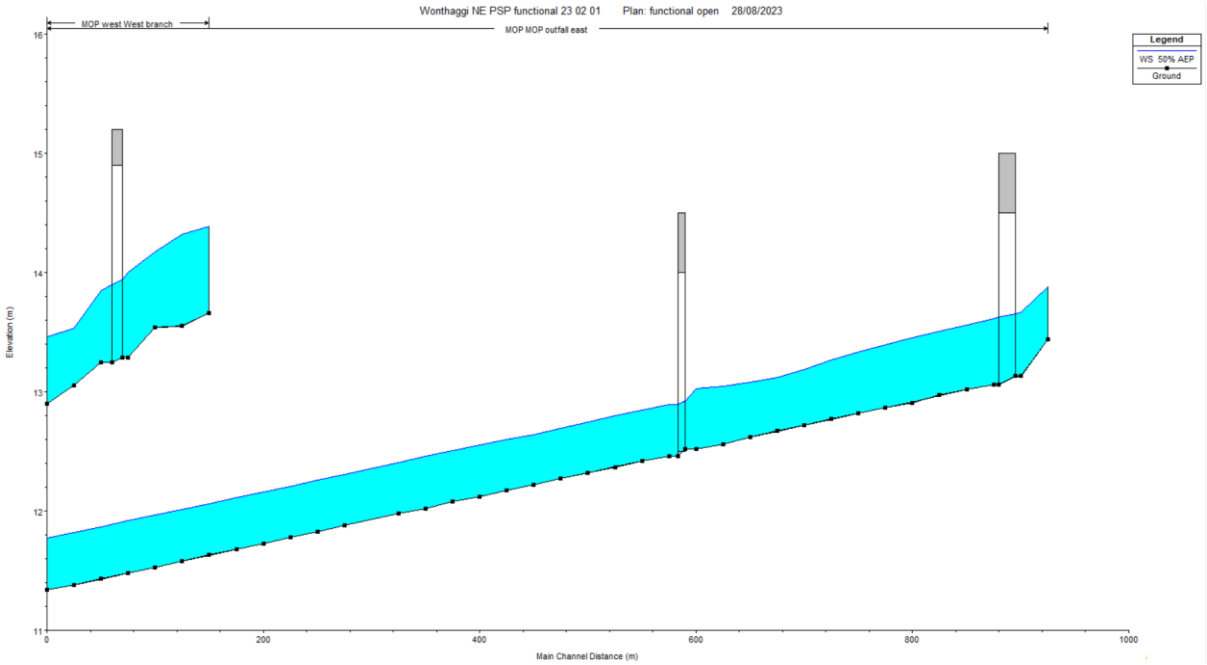



**Figure 64.** *50% AEP water surface elevation along the DR-03 waterway alignment with culverts unimpeded*

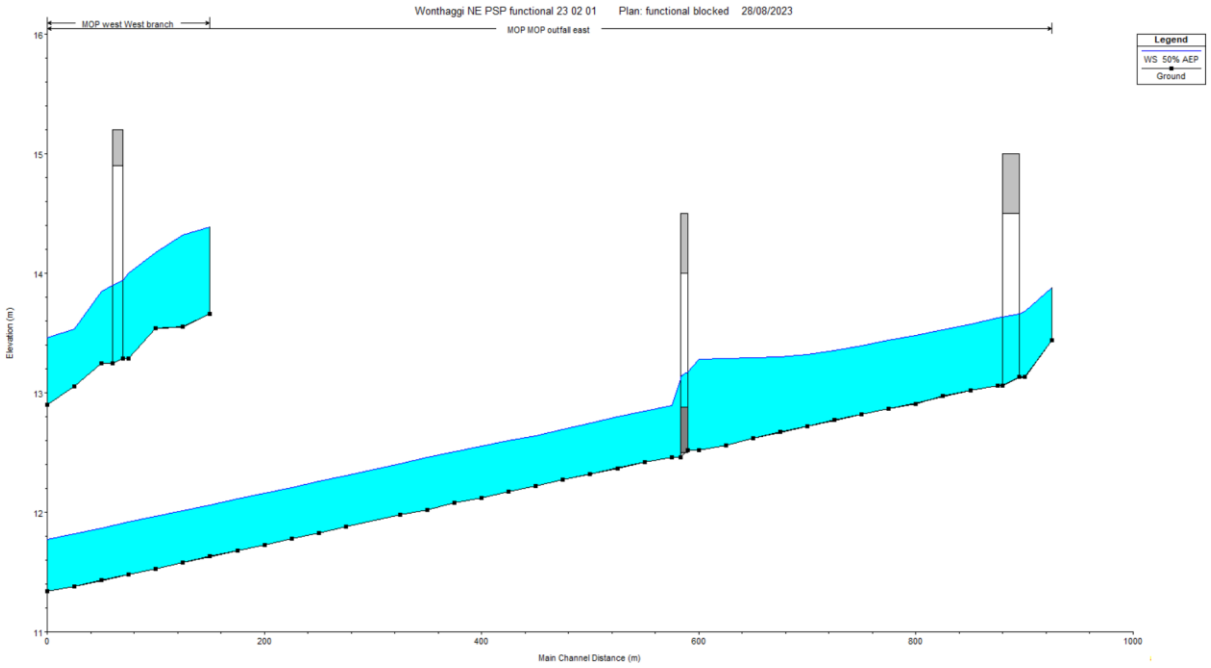



**Figure 65.** *50% AEP water surface elevation along the DR-03 waterway alignment with culverts blocked*

The hydraulic results for the open and blocked scenarios for the 50% AEP flow are outlined below.

**Table 37. Hydraulic results through culverts for both scenarios for the 50% AEP flow**

| Culvert Crossing | | Open culverts | Blocked culverts |
|---|---|---|---|
| **Western tributary** | | | |
| Culvert CU-09 | | | |
| | Head loss (m) | 0.15 | -* |
| | Average velocity (m/s) | 0.71 | -* |
| **Main MOP channel** | | | |
| Culvert CU-08 | | | |
| | Head loss (m) | 0.06 | -* |
| | Average velocity (m/s) | 0.56 | -* |
| Culvert CU-10 | | | |
| | Head loss (m) | 0.13 | 0.34 |
| | Average velocity (m/s) | 0.36 | 0.29 |

*Bridge structures, no blockage factor applicable

## 12.7 Waterway (DR-03) shear stresses – proposed downstream channel

Figure 66 shows the average shear stresses in the DR-03 channel for the 50% AEP event calculated by HEC-RAS. There remain some isolated locations with higher shear stresses at pools along the alignment and transitions to culvert structures. Rock armouring has been provided within the functional design at key locations of high local shear stresses.

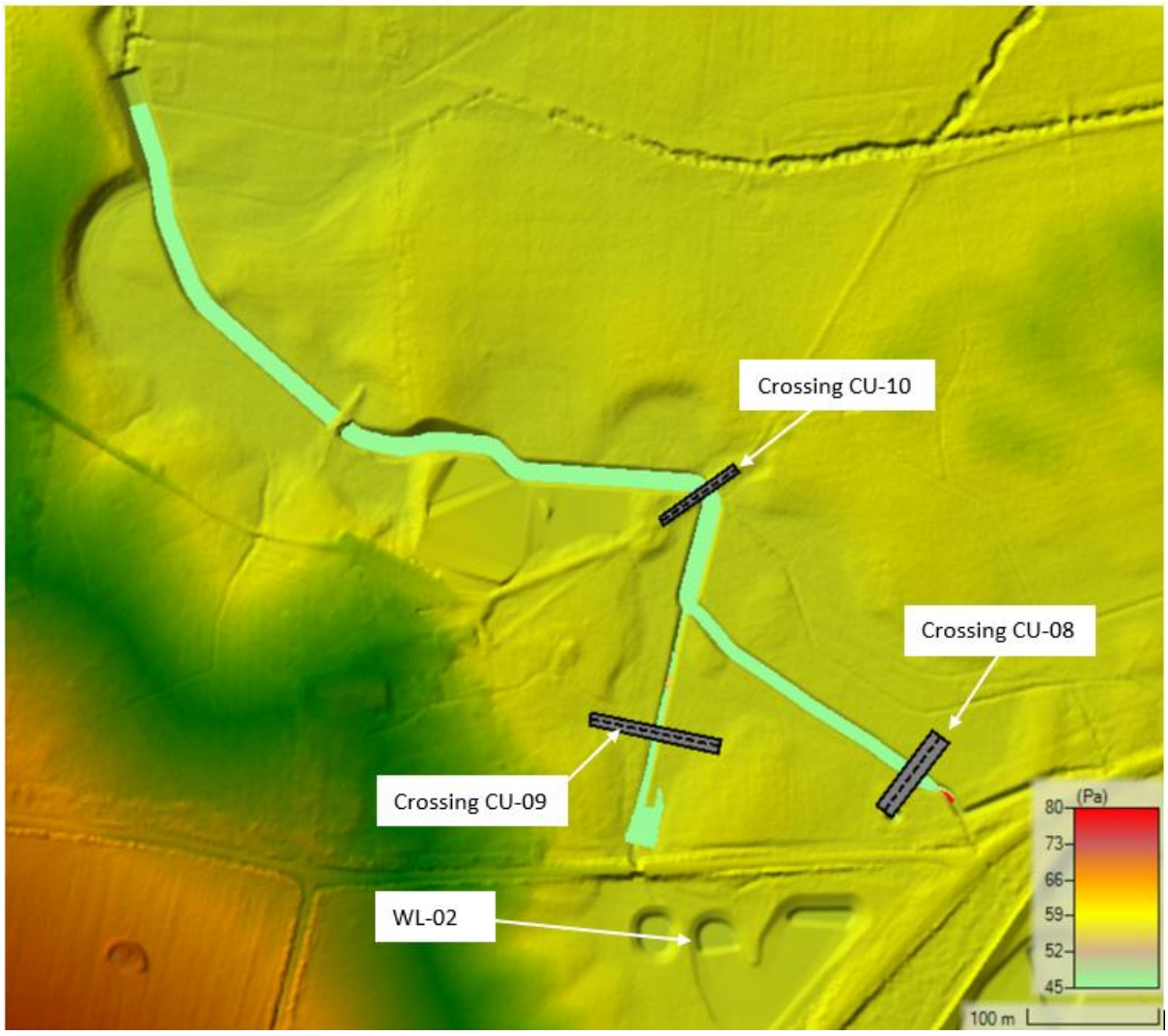



**Figure 66.** *Average shear stress map (in N/m²) through DR-03 constructed waterway – main outfall to Powlett. Note inset: red grading near WLRB1 (DCP ref WL-01).*

## 12.8 Downstream outfall channel (DR-03) shear stresses

The existing channel downstream of the proposed MOP outfall has been assessed with respect to shear stresses. Figure 67 shows the average shear stresses in the channel for the 50% AEP event calculated by HEC-RAS. There remain some isolated locations with high shear stresses along the alignment. Rock armouring will be required in order to stabilise the channel for further undercutting and degradation due to the increased frequency of inundation.

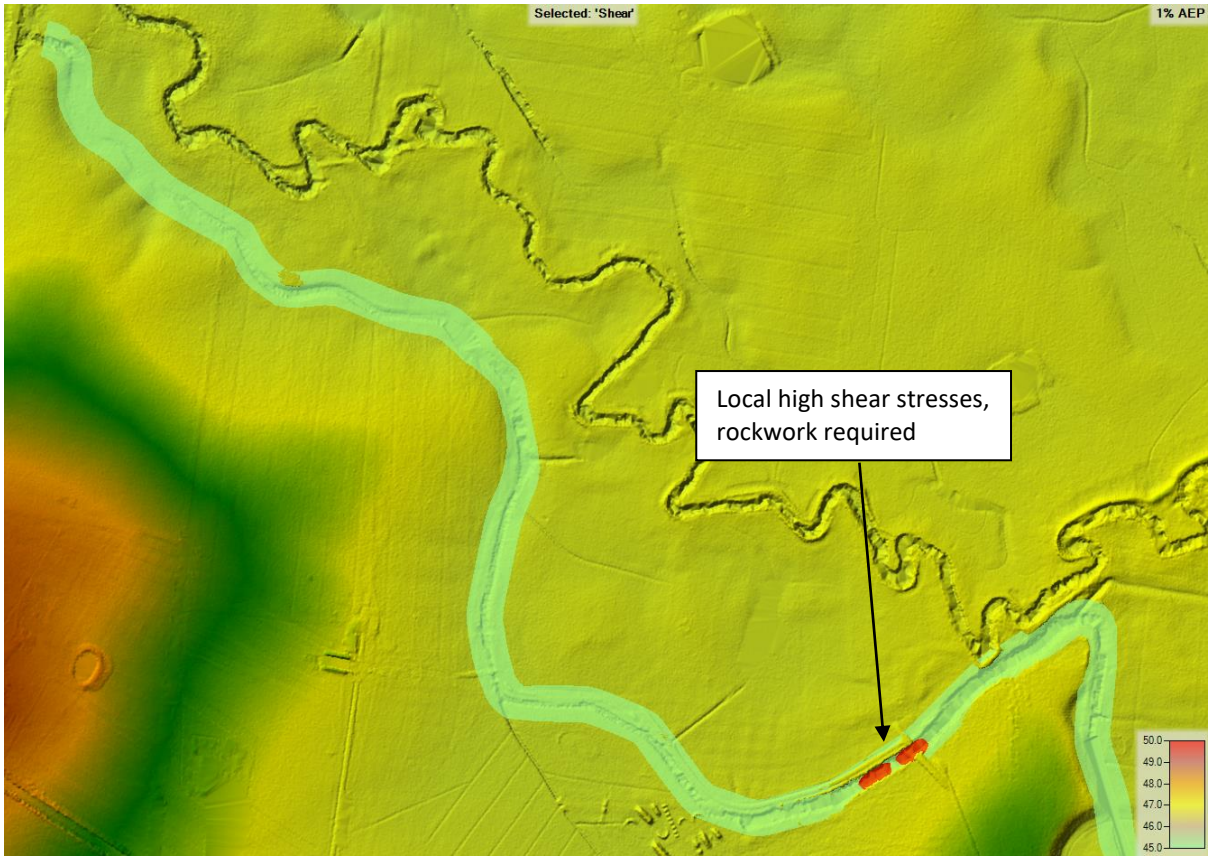



**Figure 67.** *Average shear stress map through constructed waterway (in N/m²) – existing channel downstream of DR-03*

Modelling of the refined functional design arrangement was undertaken by Engeny to test the impact of the revised MOP outfall channel on flood behaviour and conveyance. The results shown in the TUFLOW results (Appendix E), indicating that the channel downstream of the PSP through the subject property (465 Heslop Rd) constriction is very sensitive to changes in cross sectional flow area. Any change (either bigger or smaller) is altering how the floodplain behaves.

Therefore, the design extends from the PSP WLRB1 (WL-01) outfall to the existing choke point on the subject property. Minor rock stabilisation works may be required for the channel sections further downstream, between the choke point and Pinkerton Rd culverts, however this is to be tested at the detailed design stage. The previous Addendum design for the MOP has now been superseded.

# 13 Stormwater Quality Treatment

A key principle for the development of the Wonthaggi North East PSP is that all stormwater is to be treated to BPEM Guidelines before being discharged from the precinct to the receiving waterway environment (Powlett River). The following BPEM targets have been adopted:

- 70% removal of the Total Gross Pollutant load
- 80% removal of Total Suspended Solids (TSS)
- 45% removal of Total Nitrogen (TN)
- 45% removal of Total Phosphorus (TP).

Table 38 shows the multiple sub-catchments (as previously shown in Figure 19 above) that fall within, and external to the PSP, indicating contributing catchment areas (hectares) discharging to the proposed treatment assets for the WNE PSP.

**Table 38. Contributing catchments (sources) and receiving treatment asset**

| Asset | Area type | Area (ha) | Asset Size - NWL ($m^2$) | |
|---|---|---|---|---|
| | | | Inlet pond | Macrophyte Zone |
| WLRB 1A (DCP ref WL-01) | Existing External Agricultural | 442 | 8,000 | 25,000 |
| | PSP | 186 | | |
| | **Total** | **628** | | |
| WLRB 1B (DCP ref WL-01) | Existing External Agricultural | 119 | 9,000 | 33,000 |
| | External Urban | 156 | | |
| | PSP | 236 | | |
| | **Total** | **511** | | |
| WLRB2 (DCP ref WL-02) | Existing External Urban | 14 | 1,150 | 7,500 |
| | PSP | 59 | | |
| | **Total** | **73** | | |
| WLRB3 (DCP ref WL-03) | PSP | 52 | 1,500 | 7,400 |
| | **Total** | **52** | | |
| WLRB4 (DCP ref WL-04) | Existing External Urban | 23 | 900 | 5,850 |
| | PSP | 68 | | |
| | **Total** | **91** | | |
| SB7 (DCP ref SB-05) | Existing External | 9 | 500 | |
| | PSP | 11 | | |
| | **Total** | **20** | | |
| **Total catchment area** | | **1375** | | |

A MUSIC *(Model for Urban Stormwater Improvement Conceptualisation)* model was developed to estimate the pollutant loads generated from the developed conditions scenario. This was used to define the target pollutant load reduction, and therefore test the sizing and treatment capacity of assets required to meet the best practice targets. The modelling and asset sizing does not seek to treat existing residential areas upstream to best practice, only future residential areas proposed within the Precinct.

The catchment nodes used in the east catchment model have been calculated based on the areas, land uses, and associated fraction impervious values used in the RORB modelling. The MUSIC model layout is shown in Figure 68 below.

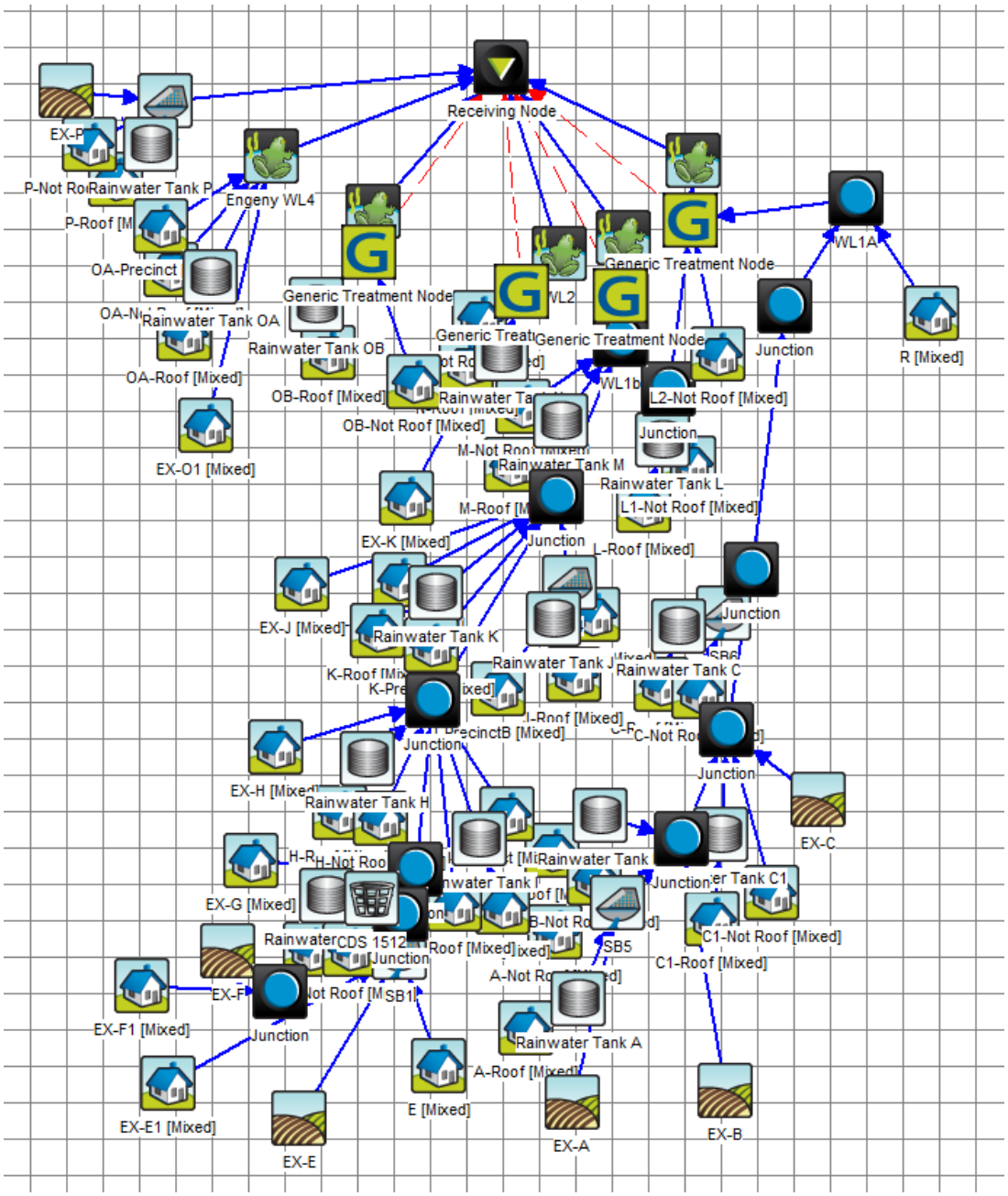



Figure 68. *MUSIC treatment model for the Wonthaggi North East PSP*

There is a large portion of external catchment, consisting of rural, agricultural and existing residential land use types, which drain through the proposed stormwater treatment wetland systems. The treatment requirements associated with the development of the Wonthaggi North East PSP is to treat the equivalent stormwater runoff generated from the proposed PSP area to best practice, and not the external existing township, or the agricultural catchments. As the wetland systems are proposed to treat the external catchments, the 'PSP area source load' has been calculated based on the source nodes within the MUSIC model, and the equivalent reduction loads (in kg/yr) have been calculated for the model.

## 13.1 MUSIC modelling treatment asset summary

The MUSIC modelling determined the sizing required for the four wetland assets located at each of the catchment low points, and the sediment basins located throughout the PSP area. The details of the required wetland treatment systems and sediment basins are provided in

Table 39 and Table 40 below.

Given the increased wetland size required to meet velocity threshold limits, the retarding basin / wetland assets have been redesigned within the land subject to inundation extent, to maximise the area for stormwater quantity and quality drainage works.

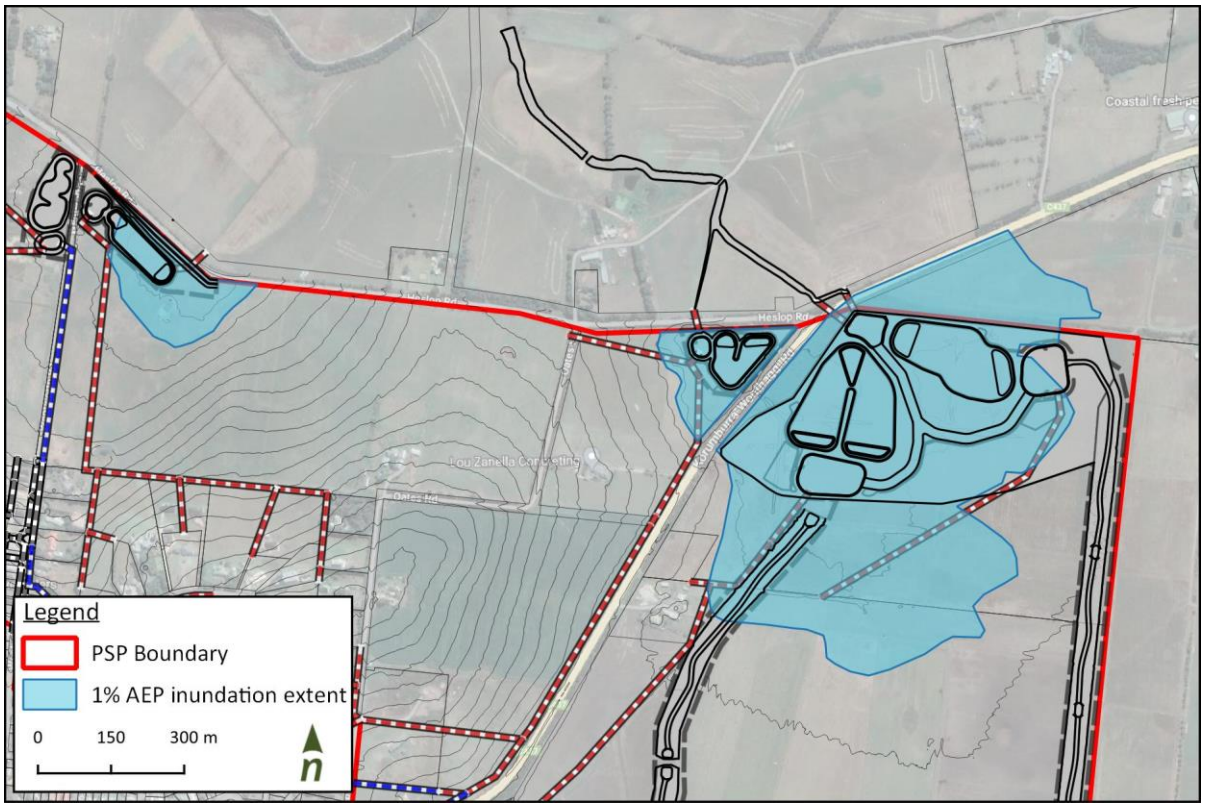



**Figure 69.** *Wetland assets and inundation extents*

The land within the inundation extent falls within the LSIO, for development to occur within this area, land would need to be filled 600mm above the 1% AEP flood level to protect any development from future flooding. A more cost-effective approach would be to co-locate stormwater assets within this inundation extent (maximise the use of this land for stormwater drainage purposes), and potentially freeing up developable land areas upstream in the PSP. A summary of the proposed treatment assets is provided below.

Table 39. Wetland treatment asset parameters for the Wonthaggi North East PSP

| Asset | WLRB1A | WLRB1B | WLRB2 | WLRB3 | WLRB4 |
|---|---|---|---|---|---|
| DCP reference | WL-01 | WL-01 | WL-02 | WL-03 | WL-04 |
| NWL area, $m^2$ | 25,000 | 33,000 | 7,500 | 7,400 | 5,850 |
| Inlet pond area, $m^2$ | 8,000 | 9,000 | 1,150 | 1,500 | 900 |
| Inlet pond volume $m^3$ | 6,400 | 7,200 | 920 | 1,200 | 791 |
| Ave. depth wetland, m | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 |
| Extended detention, m | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 |
| Extended detention time, hr | 24.0 | 24.0 | 48.0 | 48.0 | 72.0 |

Table 40. Sediment basin treatment asset parameters for the Wonthaggi North East PSP

| Asset | SB1 | SB4 | SB5 | SB6 | SB7 |
|---|---|---|---|---|---|
| DCP reference | (SB-01) | (SB-02) | (SB-03) | (SB-04) | (SB-05) |
| NWL area, $m^2$ | 950 | 1,400 | 900 | 1,000 | 500 |
| Average depth, m | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| Extended detention, m | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 |

## 13.2 Overall treatment performance

The modelling has assumed the upstream external catchment to the south remains as agricultural land, which has no prior treatment or control before directly out falling through the Wonthaggi North East PSP area.

The wetlands (WLRBs) for the PSP have been redesigned and 'upsized' in comparison to earlier concepts to meet velocity threshold requirements. The sediment basins have been upsized using the Fair and Geyer equation, where sediment basins are required to meet a 95% sediment capture efficiency of coarse particles ≥ 125 µm diameter for the peak 4EY (4 Exceedances per Year) event. Overall treatment performance has only considered meeting BPEM for the PSP area only. As a result, source loads generated from external catchments are not considered in the overall reduction results.

The results of the MUSIC modelling analysis demonstrates that BPEM targets are met with the performance of the wetland and sediment basin assets, as shown below.

Table 41. Total model inflow, PSP and external load, removal target

| | Removal target | Total model load | External load | PSP load | Removal target |
|---|---|---|---|---|---|
| TSS (kg/yr) | 80% | 901,000 | 207,180 | 693,820 | 555,056 |
| TP (kg/yr) | 45% | 2,070 | 599 | 1,471 | 662 |
| TN (kg/yr) | 45% | 15,500 | 4,812 | 10,688 | 4,810 |
| GP (kg/yr) | 70% | 176,000 | 34,479 | 141,521 | 99,065 |

Table 42. Overall MUSIC modelling results

| | Total model load | PSP load | Residual load | % Reduction Total model | Kg/yr removed | % Reduction PSP load only |
|---|---|---|---|---|---|---|
| TSS (kg/yr) | 901,000 | 693,820 | 306,000 | 66% | 595,000 | 86% |
| TP (kg/yr) | 2,070 | 1,471 | 917 | 56% | 1,153 | 78% |
| TN (kg/yr) | 15,500 | 10,688 | 10,700 | 31% | 4,800 | 45% |
| TGP (kg/yr) | 176,000 | 141,521 | 0 | 83% | 145,700 | 103% |

**Note:** While the overall treatment performance is higher for TSS, TP and TGP, it should be noted that this has occurred as a result of modelling to meet TN, which is only just at target.

Functional design details of the Wetland and Sediment Basin assets are provided in Sections 14 – 23.

# 14 Wetland Functional Design (WLRB-1A; DCP ref WL-01)

This section outlines the design calculations that have been undertaken to ensure the performance of the treatment system WLRB1A (DCP ref WL-01) complies with the appropriate guidelines. A plan view of the designed wetland system is shown below (see Appendix B for further design details and cross sections).

The Wetland Normal Water Level (NWL) is set at **14.00m AHD**, and the Top of Extended Detention (TED) is set at **14.35m AHD**.

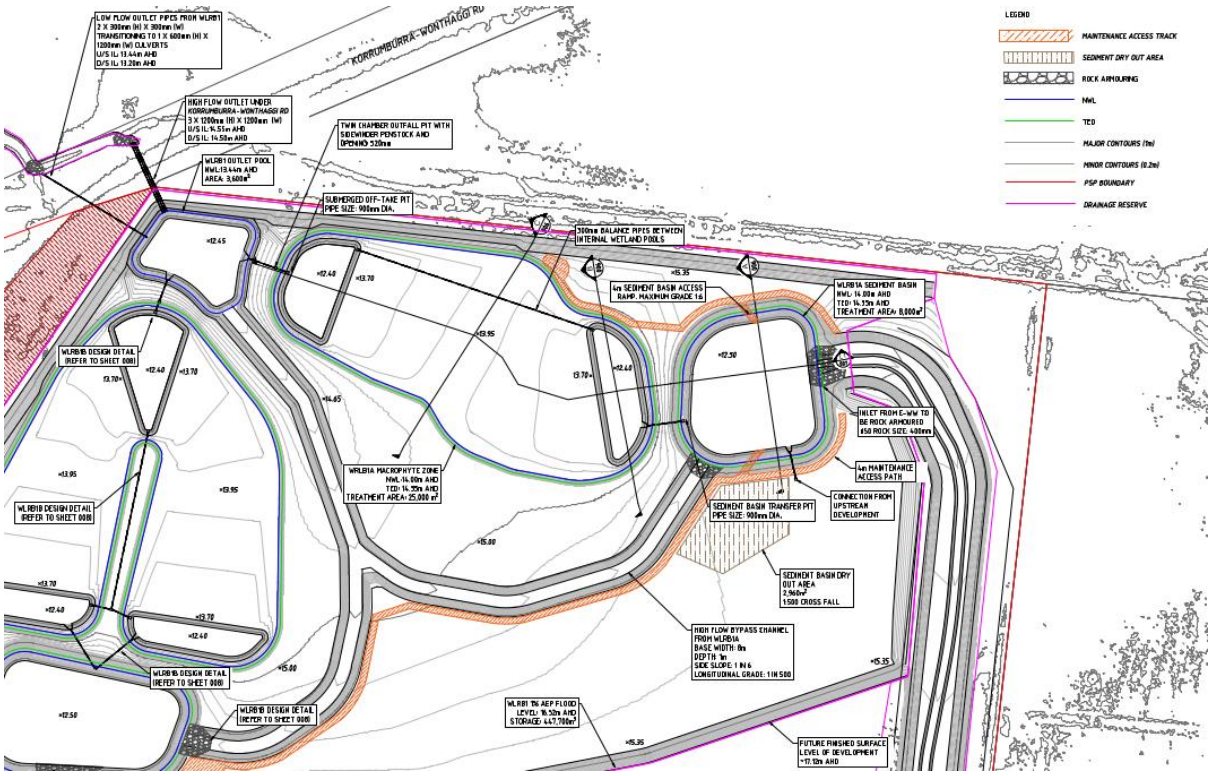



Figure 70. *Plan view of the designed wetland structure WLRB1A (WL-01) (east)*

## 14.1 Velocities

WLRB1A (DCP ref WL-01) is designed to treat the approx. 600 ha catchment out falling through the W-WW (DCP ref DR-01). The area of the WLRB1A (WL-01) macrophyte zone is proposed at 25,000 $m^2$ and 8,000 $m^2$ at the inlet pond, as established in the MUSIC modelling. Therefore a width of 79m is the maximum average width possible in the macrophyte zone to ensure an adequate width to length ratio.

The velocity through each treatment asset is considered here. A flow depth of 0.35m, which is the extended detention depth (EDD), has been assumed for 4EY, 1EY and 20% AEP events.

For WLRB1A (WL-01 )the minimum design width is 40m in the macrophyte zone and 25m in the inlet pond to meet velocity threshold requirements. The table below provides details on the minimum widths and velocities determined.

Table 43. System velocity calculations and design checks – WLRB1A (DCP ref WL-01)

| | Parameter | 4EY | 1EY | 20% AEP |
|---|---|---|---|---|
| Flow Conditions | Design flow ($m^3/s$) | 0.73 | 2.17 | 4.74 |
| | Flow depth (m) | 0.35 | 0.35 | 0.35 |
| Inlet pond | Width at NWL (m) | 25 | 25 | 25 |
| | Width at EDD (m) | 29.2 | 29.2 | 29.2 |
| | Average Width (m) | 27.1 | 27.1 | 27.1 |
| | Flow area ($m^2$) | 9.5 | 9.5 | 9.5 |
| | Flow velocity (m/s) | 0.08 | 0.23 | 0.50 |
| | Check | <0.5 OK | <0.5 OK | <0.5 OK |
| Macrophyte zone WLRB1A (WL-01) | Width at NWL (m) | 40 | 40 | 40 |
| | Width at EDD (m) | 44.2 | 44.2 | 44.2 |
| | Average Width (m) | 42.1 | 42.1 | 42.1 |
| | Flow area ($m^2$) | 15 | 15 | 15 |
| | Flow velocity (m/s) | 0.05 | 0.15 | 0.32 |
| | Check | <0.05 OK | <0.5 OK | <0.5 OK |

## 14.2 Inlet Pond

The inlet pond has been sized to ensure a capture efficiency greater than 95% for the 4EY peak flow and provide adequate sediment storage. The procedure outlined in *WSUD Engineering Procedures (2005)* has been followed and are based on the typical sediment loading rate of 1.6 $m^3$/ha/yr for a developed catchment. Provision for sediment dewatering has also been made. These areas assume a depth of 500mm and a sediment cleanout frequency of 5 years.

Table 44. Inlet pond design parameters and checks – WLRB1A (WL-01)

| | Parameter | Proposed design |
|---|---|---|
| Conditions | Contributing Catchment (ha) | 628 |
| | Area of Basin ($m^2$) | 8,000 |
| Capture Efficiency | Settling Velocity of Target Sediment (mm/s) [Particle size 125 µm] | 11 |
| | Hydraulic Efficiency (λ) | 0.11 |
| | Permanent Pool Depth, dp (m) | 0.50 |
| | Extended detention depth, de | 0.35 |
| | Number of CTSR's, n | 1.10 |
| | Depth below permanent pool that is sufficient to retain sediment, d* (m) | 0.50 |
| | Design Discharge ($m^3/s$) | 0.73 |
| | Capture Efficiency | 99.50%* |
| | Check (>95%) | OK |
| | Sediment Loading rate, Lo ($m^3$/ha/yr) | 1.6 |

| | | |
|---|---|---|
| Sediment Storage | Desired clean-out frequency, Fr | 5 |
| | Storage volume required, St | 1,480 |
| | Available sediment storage volume | 2,240 |
| | Check (Available storage > required storage) | OK |
| Sediment dewatering | Depth for dewatering area (m) | 0.50 |
| | Area required for dewatering ($m^2$) | 2,960 |

*Note: the WLRB1A inlet pond has been oversized to 'choke' the 4EY flow prior to outfall into the macrophyte area, in order to manage the frequency of inundation in the macrophyte zone, hence the higher than BPEM target for TSS being achieved. It should be noted that sizing is a factor of protecting the macrophyte zone, not overtreating the catchment inflows.

## 14.3 Levels

### Batter slopes

A minimum of 1(V):5(H) batter slopes have been adopted. In highly constrained options, batter slopes as steep as 1 in 3 could possibly be considered to minimise cut into the steep terrain, which would require "sedge planting" rather than mow-able grass. Another option would be to use benching and retaining walls.

These alternative approaches to managing the slope would require discussion and agreement with Council; therefore this report has adopted batter slopes of 1(V):6(H) to try and minimise a potentially very large asset footprint. Below the NWL, all batters up to -0.35m must be at least 1(V):8(H), after which they can steepen to 1(V):3(H).

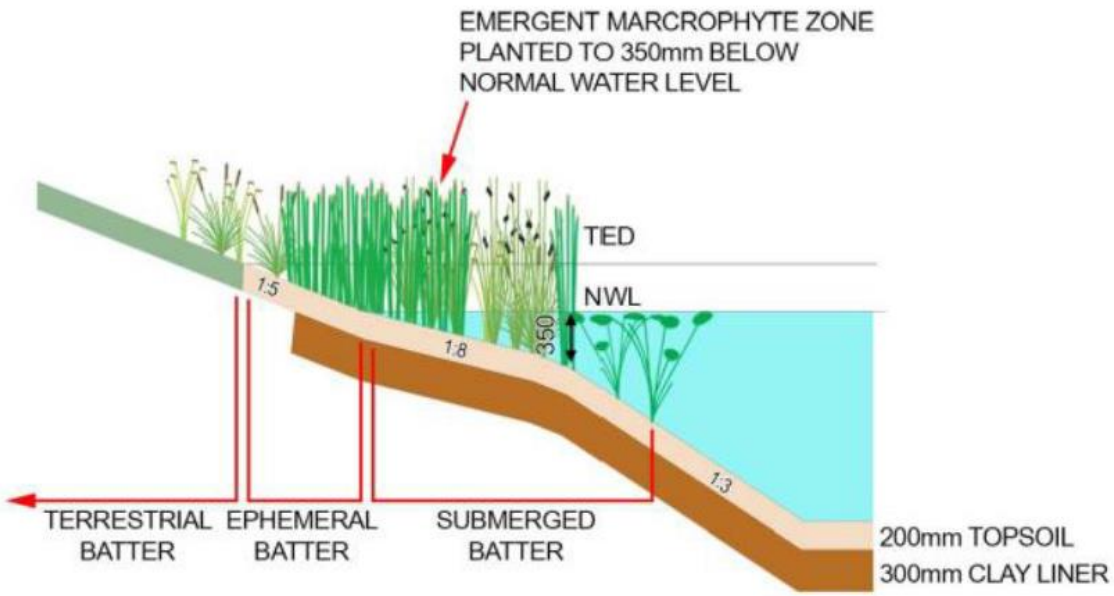



Figure 71. *Edge treatment for batter slopes (Melbourne Water 2014)*

### Below water surface

Plans have been provided for depths of the assets below the normal water level (NWL). This has been based on the following requirements and consideration of industry guidelines (Figure 72). A minimum grade of 1:150 is required through the macrophyte zone. For some wetlands, this means that an intermediate pool is necessary.

As discussed in Section 14.6 below, the effective normal water level remains high in the WLRB1A system, mainly due to the large upstream catchment flowing through the system. To manage the high effective normal water

level, the internal bathymetry bands have been raised by 50mm to prevent the vegetation from drowning out (Table 45).

Table 45. Macrophyte zone depth bands - WLRB1A (WL-01) (all depths relative to NWL)

| Parameter | Minimum depth (m) | Maximum depth (m) |
|---|---|---|
| Open water zone | -0.65 | -1.5 |
| Submerged marsh zone | -0.30 | -0.65 |
| Deep marsh zone | -0.10 | -0.30 |
| Shallow marsh zone | 0 | -0.10 |

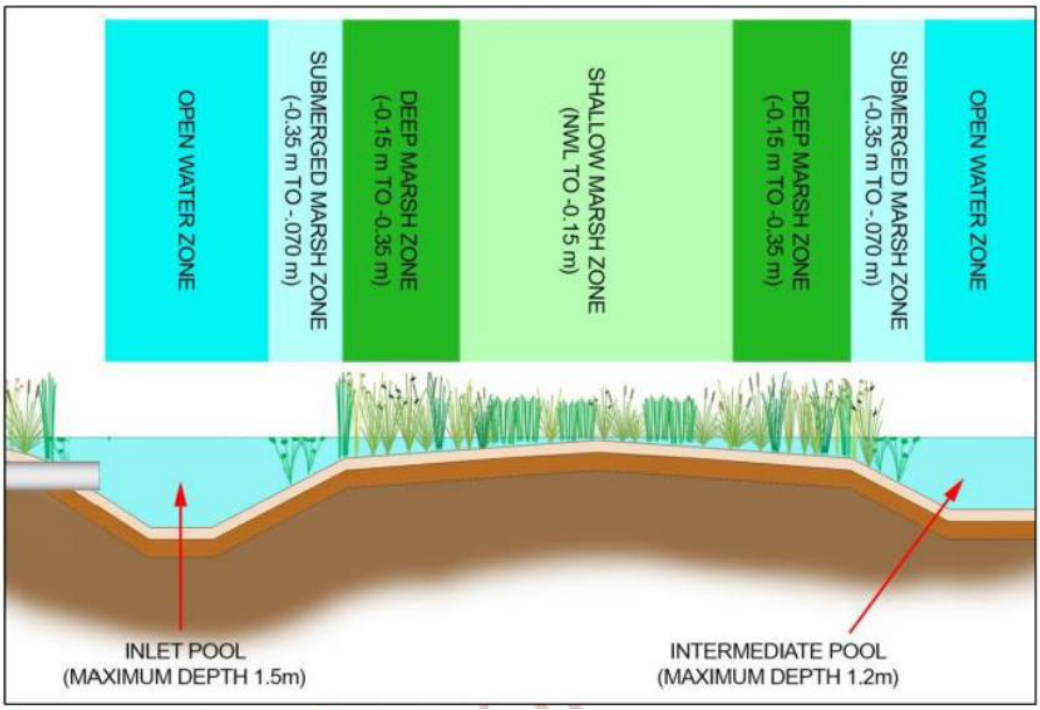



Figure 72. *Macrophyte zone planting bands (Melbourne Water, 2014)*

## 14.4 Connections

### Sediment pond to wetland outfall

There will be piped connections between the sediment ponds and the macrophyte zone to pass the 4EY peak flow. The connection will be an outlet pit, with the top of the pit at NWL to control the water level. A transfer pipe at the bottom of the pit will pass flows through to the wetland. The invert of the pipe on the wetland side should be set 500mm above the base of the pool.

The transfer pipeline is designed to 'choke' the 4EY flow entering the macrophyte zone to 0.30 $m^3/s$ in order to manage the inundation frequency of the wetland system. The remainder of runoff will divert through the high flow bypass and outfall directly to the outlet of the WLRB1 system. The wetland has been intentionally oversized to account for the offset in volumetric loads being untreated from the wetland.

## Wetland outfall

The MUSIC model developed during the functional design stage reflects the actual stage-storage-discharge relationship of the wetland's extended detention. The actual stage-storage-discharge relationship is represented using MUSIC's Custom Outflow and Storage Relationship function.

The water level in a wetland is controlled by an outlet usually in the macrophyte zone. The macrophyte zone outlet provides the hydrologic control of the water level, and flows in the macrophyte zone, to achieve the design detention time for treatment performance.

Outlet structures should be designed and located so that they can be easily accessed for maintenance. Outlet or overflow pits located within the outlet pool of the macrophyte zone should be accessible from the edge of the wetland, this means that the edge of the pit closest to the wetland margin should be in no more than 350mm depth.

The wetland outlet configuration consists of a submerged pipe connected to an outlet pit (containing the controlled weir outlet) located adjacent to the wetland above TED. The outlet pit should be easily accessible and have a hinged grated lid to enable access to the outlet control structure and overflow weir for maintenance.

Due to the large upstream catchment entering the wetland, the system has been designed as a flow through wetland in order to manage the frequency of inundation. An adjustable weir, such as a side-winding penstock, allows the inundation frequency to be adjusted easily. The required weir length is 520mm (i.e. the penstock opening) to ensure the 24-hour detention time. Figure 73shows the stage-storage-discharge relationship used in MUSIC.

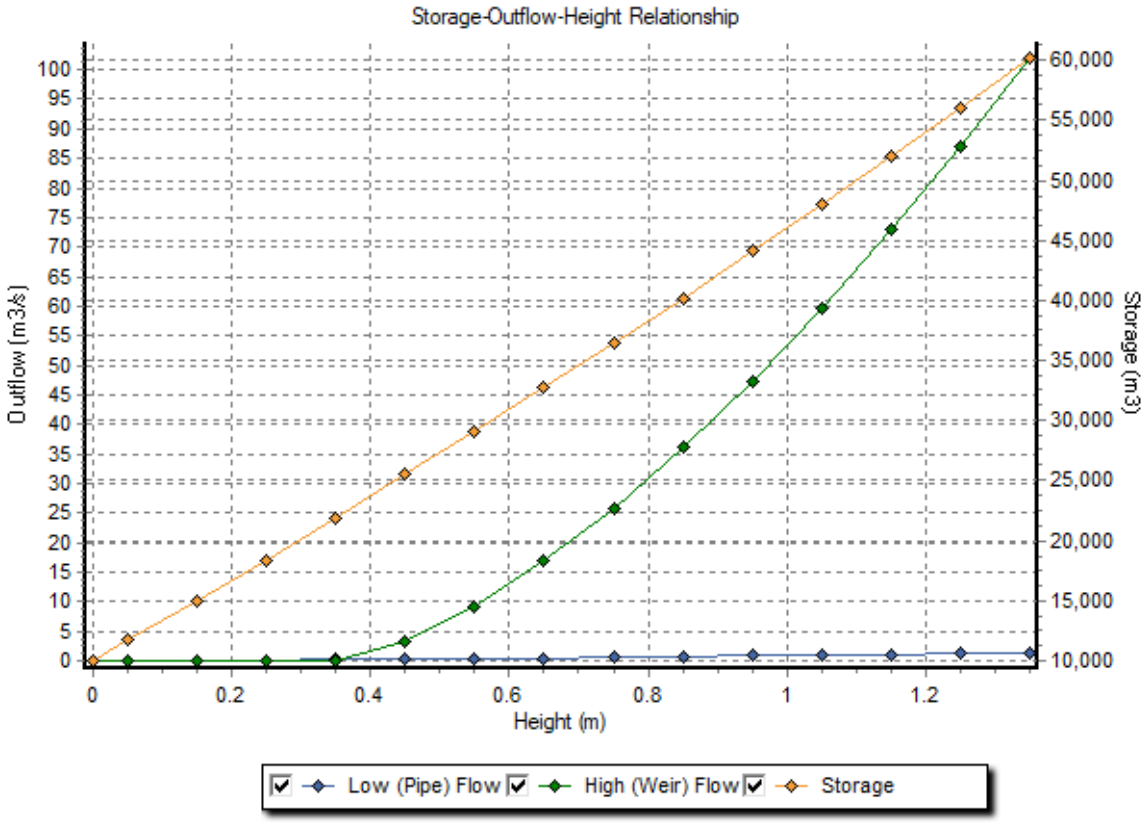



**Figure 73.** *Stage-storage-discharge relationship – WLRB1A (WL-01)*

## 14.5 Maintenance considerations

### Access tracks

Access paths should be at least 4m wide and with a cross fall no steeper than 1:20m. An access track has been located around the treatment system, ensuring access to the sediment basin and dewatering (dry out) areas.

A maintenance ramp will be provided to the sediment ponds, the ramp should extend from the base of the sediment pond to 0.5m above EDD. It will be 4m wide and no steeper than 1:5. It will be able to support a 20-tonne excavator and be constructed of either 200mm cement-treated crushed rock (6%) or compacted FCR.

### Maintenance drain

Maintenance drains are to be located in the sediment basins and wetland inlet and outlet pools. All maintenance drains will have a diameter of 300mm. They will have penstock/valves on the drains that are generally closed, except if the wetland or sediment basin needs to be slowly drained (e.g. for maintenance). Sediment basin dewatering should not be to the downstream pipe network.

The invert levels of the maintenance drains have been selected as the minimum levels at which free gravity draining will occur within the macrophyte zones.

### Sediment dewatering areas

A sediment dewatering area of 2,960m$^2$ has been provided adjacent to the sediment pond. This area will allow vehicle access to accumulated sediment to be taken from the sediment basin, dewatered on site, before it is transported off site, as per EPA waste transport regulations.

## 14.6 Vegetation

Plant suitability is based on consideration of the plant height and whether the water depth in the wetland will exceed 50% of the plant height for more than 20% of the time. If this is exceeded, it is considered that the plant will be inundated to excessive depths too frequently and is unlikely to grow successfully in these conditions, therefore affecting treatment performance of the system.

The water depth is determined using cumulative frequency analysis to determine the depth above NWL that will be exceeded 20% of the time, then the planting depth is added to this. The resulting depth is compared with 50% of the plant height to determine whether water depth will exceed this. If not, the plant is considered suitable (see below for a schematic explanation).

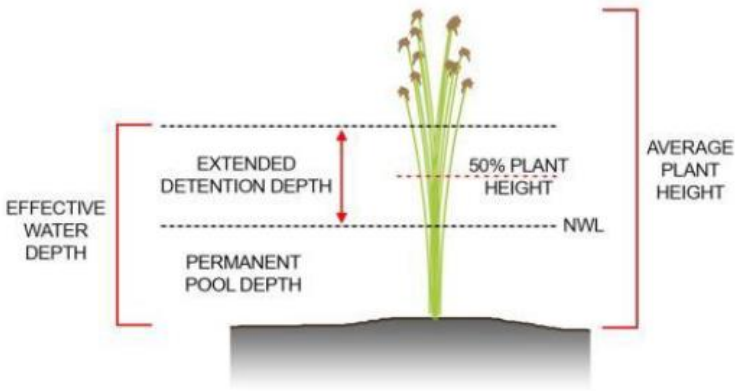
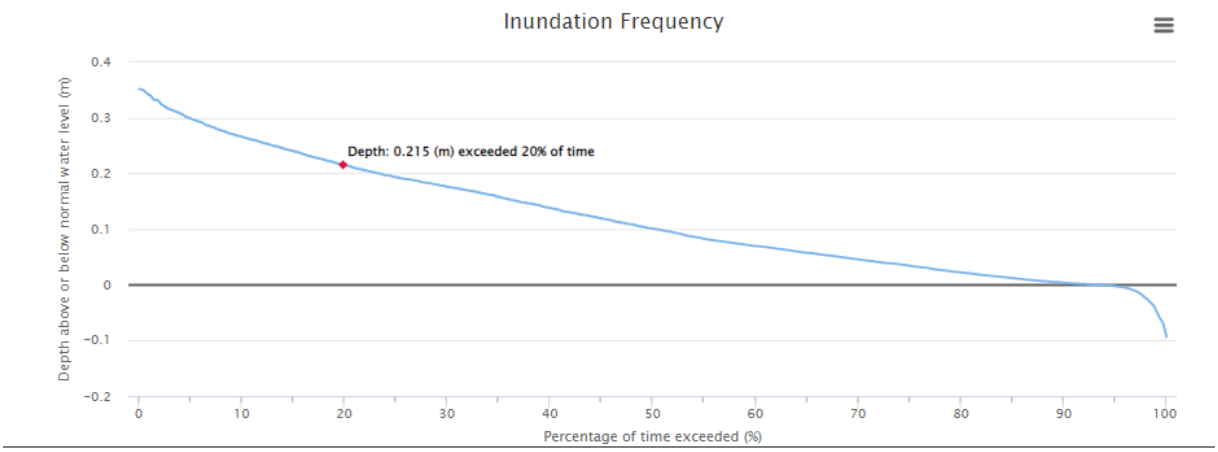



**Figure 74.** *Effective plant heights*

The "wetland analysis tool" enables data from the MUSIC model to be utilised to assess the compliance of a wetland to the Melbourne Water *Constructed Wetlands Design Manual* best practice standards. That is, wetland depths relative to heights. The results from the water level frequency analysis are given below.

Choose file WI1af.csv
FILE IS UPLOADED




Please select at least 3 plants for each of the shallow and deep marsh zones.

Clear Selection

| Name | Average plant height (m) | Shallow marsh plants | Deep marsh plants | Suitability |
|---|---|---|---|---|
| Sea Club-rush *Bolboschoenus caldwellii* | 1 | ☑ | | Shallow Only |
| Water Ribbons *Triglochin procerum* | 1 | ☑ | ☐ | |
| Jointed Club-rush *Baumea articulata* | 1.8 | ☑ | ☐ | Shallow and Deep |
| Tall Club-rush *Bolboschoenus fluviatilis* | 1.8 | ☐ | ☐ | |
| Marsh Club-rush *Bolboschoenus medianus* | 1.5 | ☐ | ☐ | |
| Leafy Twig-rush *Cladium procerum* | 2 | ☐ | ☐ | |
| River Club-rush *Schoenoplectus tabernaemontani* | 1.8 | ☐ | ☑ | |
| Tall Spike-rush *Eleocharis sphacelata* | 1.5 | | ☑ | Deep Only |
| Common reed *Phragmites australis* | 2.5 | | ☑ | |
| Common Spike-rush *Eleocharis acuta* | 0.5 | ☐ | | Unsuitable |

+ Add user defined plant

## Report

File: WI1af.csv
Shallow marsh zone meets deemed to comply criteria

Deep marsh zone meets deemed to comply criteria

Water level exceeded for 20% of time: 0.215 m

Water level exceeded for 50% of time: 0.101 m
·Warning: Effective normal water level is significantly above design normal water level. It is recommended that the effective water level of (xxx m) is adopted as the base for determining shallow and deep marsh zone depths and extents. It may be desirable to adjust the bypasses, outlet design or wetland size to reduce the difference in design and effective normal water level.

90th Percentile Residence Time: 1 days

**Figure 75.** *MUSIC auditor results – WLRB1A (WL-01)*

The water level frequency analysis demonstrates the proposed wetland with an extended detention depth of 350mm meets appropriate requirements with respect to plant heights and wetland depths. There needs to be a minimum of three plant species suitable for the shallow marsh zones and a minimum of three plant species suitable for the deep marsh zones.

The following requirements for planting vegetation should be followed:

- Up to 200mm above the NWL and 350mm below the NWL should be densely planted
- Shallow marsh zone should be densely planted with a minimum of three species
- Deep marsh zone should be densely planted with a minimum of three species
- Submerged marsh zone should be densely planted.

# 15 Wetland Functional Design (WLRB-1B; DCP ref WL-01)

This section outlines the design calculations that have been undertaken to ensure the performance of the treatment system WLRB1B (DCP ref WL-01) complies with the appropriate guidelines. A plan view of the designed wetland system is shown below (refer to Appendix B for further design details and cross sections).

The Wetland Normal Water Level (NWL) is set at **14.00m AHD**, and the Top of Extended Detention (TED) is set at **14.35m AHD**.

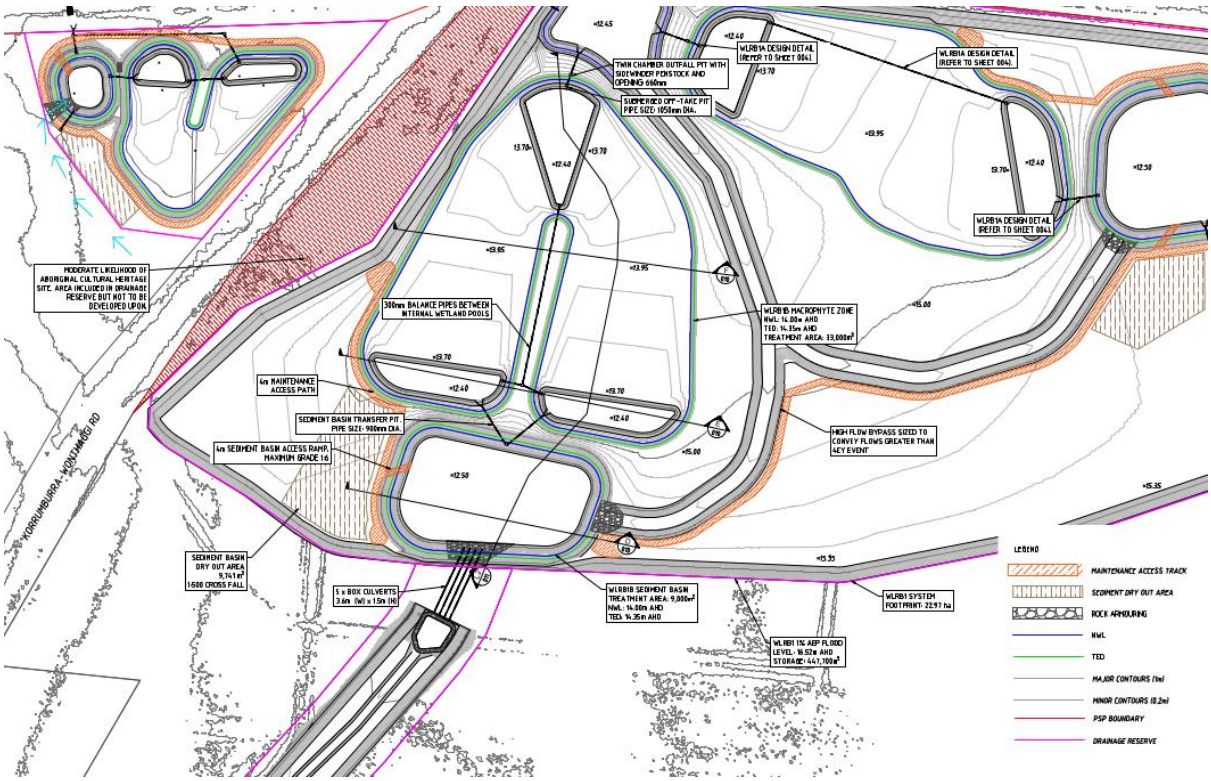



**Figure 76.** *Plan view of the designed wetland structure WLRB1B (WL-01) (west)*

## 15.1 Velocities

The area of the WLRB1B (DCP ref WL-01) macrophyte zone is proposed as 33,000m$^2$ and 9,000m$^2$ at the inlet pond, as established in the MUSIC modelling. Therefore, a width of 90m is the maximum average width possible in the macrophyte zone to ensure an adequate width to length ratio.

During the 4EY, 1EY and 20% AEP events, flows are 'split' along dual branches of the macrophyte zone, this ensures a length to width ratio is maintained, whilst allowing the wetland to meet the velocity requirements.

The velocity through each treatment asset is considered here. A flow depth of 0.35m, which is the extended detention depth, has been assumed for 4EY, 1EY and 20% AEP events.

For WLRB1B (WL-01), the minimum design width is 40m in the macrophyte zone and 48m in the inlet pond to meet velocity threshold requirements. The table below provides details on the minimum widths and velocities determined.

Table 46. System velocity calculations and design checks – WLRB1B (WL-01)

| | Parameter | 4EY | 1EY | 20% AEP |
|---|---|---|---|---|
| Flow Conditions | Design flow ($m^3/s$) | 1.40 | 4.10 | 8.61 |
| | Flow depth (m) | 0.35 | 0.35 | 0.35 |
| Inlet pond | Width at NWL (m) | 48 | 48 | 48 |
| | Width at EDD (m) | 52.2 | 52.2 | 52.2 |
| | Average Width (m) | 50.1 | 50.1 | 50.1 |
| | Flow area ($m^2$) | 17.5 | 17.5 | 17.5 |
| | Flow velocity (m/s) | 0.08 | 0.23 | 0.49 |
| | Check | <0.5 OK | <0.5 OK | <0.5 OK |
| Macrophyte zone WLRB1B | Width at NWL (m) | 40 | 40 | 40 |
| | Width at EDD (m) | 44.2 | 44.2 | 44.2 |
| | Average Width (m) | 42.1 | 42.1 | 42.1 |
| | Flow area ($m^2$) | 15 | 15 | 15 |
| | Flow velocity (m/s) | 0.05 | 0.14 | 0.29 |
| | Check | <0.05 OK | <0.5 OK | <0.5 OK |

## 15.2 Inlet Pond

The inlet pond has been sized to ensure a capture efficiency greater than 95% for the 4EY peak flow and provide adequate sediment storage. The procedure outlined in *WSUD Engineering Procedures (2005)* has been followed and are based on the typical sediment loading rate of 1.6 $m^3$/ha/yr for a developed catchment. Provision for sediment dewatering has also been made. These areas assume a depth of 500mm and a sediment cleanout frequency of 5 years.

Table 47. Inlet Pond design parameters and checks – WLRB1B (WL-01)

| | Parameter | Proposed design |
|---|---|---|
| Conditions | Contributing Catchment (ha) | 511 |
| | Area of Basin ($m^2$) | 9,000 |
| Capture Efficiency | Settling Velocity of Target Sediment (mm/s) [Particle size 125 µm] | 11 |
| | Hydraulic Efficiency (λ) | 0.11 |
| | Permanent Pool Depth, dp (m) | 0.50 |
| | Extended detention depth, de | 0.35 |
| | Number of CTSR's, n | 1.12 |
| | Depth below permanent pool that is sufficient to retain sediment, d* (m) | 0.50 |
| | Design Discharge ($m^3/s$) | 1.40 |

| | Parameter | Proposed design |
|---|---|---|
| | Capture Efficiency | 99.1%* |
| | Check (>95%) | OK |
| Sediment Storage | Sediment Loading rate, Lo ($m^3$/ha/yr) | 1.6 |
| | Desired clean-out frequency, Fr | 5 |
| | Storage volume required, St | 1,870 |
| | Available sediment storage volume | 3,468 |
| | Check (Available storage > required storage) | OK |
| Sediment dewatering | Depth for dewatering area (m) | 0.50 |
| | Area required for dewatering ($m^2$) | 3,741 |

*Note: the WLRB1B inlet pond has been oversized to 'choke' the 4EY flow prior to outfall into the macrophyte area, in order to manage the frequency of inundation in the macrophyte zone, hence the higher than BPEM target for TSS being achieved. It should be noted that sizing is a factor of protecting the macrophyte zone, not overtreating the catchment inflows.

## 15.3 Levels

### Below water surface

Plans have been provided for depths of the assets below the normal water level (NWL). This has been based on the following requirements and consideration of industry guidelines (Figure 72 above, Melbourne Water macrophyte zones). A minimum grade of 1:150 is required through the macrophyte zone. For some wetlands, this means that an intermediate pool is necessary.

As discussed in Section 15.6 below, the effective normal water level remains high in the WLRB1B (WL-01) system, mainly due to the large upstream catchment flowing through the system. To manage the high effective normal water level, the internal bathymetry bands have been raised by 50mm to prevent the vegetation from drowning out (Table 48).

**Table 48. Macrophyte zone depth bands (all depths relative to NWL) – WLRB1B (WL-01)**

| Parameter | Minimum depth (m) | Maximum depth (m) |
|---|---|---|
| Open water zone | -0.65 | -1.5 |
| Submerged marsh zone | -0.3 | -0.65 |
| Deep marsh zone | -0.1 | -0.3 |
| Shallow marsh zone | 0 | -0.1 |

## 15.4 Connections

### Sediment pond to wetland outfall

There will be piped connections between the sediment ponds and the macrophyte zone to pass the 4EY peak flow. The connection will be an outlet pit, with the top of the pit at NWL to control the water level. A transfer pipe at the bottom of the pit will pass flows through to the wetland. The invert of the pipe on the wetland side should be set 500mm above the base of the pool.

The transfer pipeline is designed to 'choke' the 4EY flow entering the macrophyte zone to 1.70 $m^3/s$ in order to manage the inundation frequency of the wetland system (macrophyte zone). The remainder of runoff will divert through the high flow bypass and outfall directly to the outlet of the WLRB1 (WL-01) system.

The wetland has been intentionally oversized to account for the offset in volumetric loads being untreated from the wetland.

### Wetland outfall

The MUSIC model developed during the functional design stage reflects the actual stage-storage-discharge relationship of the wetland's extended detention. The actual stage-storage-discharge relationship is represented using MUSIC's Custom Outflow and Storage Relationship function.

The water level in a wetland is controlled by an outlet usually in the macrophyte zone. The macrophyte zone outlet provides the hydrologic control of the water level and flows in the macrophyte zone to achieve the design detention time.

Outlet structures should be designed and located so that they can be easily accessed for maintenance. Outlet or overflow pits located within the outlet pool of the macrophyte zone should be accessible from the edge of the wetland, this means that the edge of the pit closest to the wetland margin should be located in no more than 350mm depth.

The wetland outlet configuration consists of a submerged pipe connected to an outlet pit (containing the controlled weir outlet) located adjacent to the wetland above TED. The outlet pit should be easily accessible and have a hinged grated lid to enable access to the outlet control structure and overflow weir for maintenance.

Due to the large upstream catchment entering the wetland, the system has been designed as a flow through wetland in order to manage the frequency of inundation. An adjustable weir, such as a side-winding penstock, allows the inundation frequency to be adjusted easily. The required weir length is 660mm (i.e. the penstock opening) to ensure the 24-hour detention time. Figure 77 shows the stage-storage-discharge relationship used in MUSIC for WLRB1B (DCP ref WL-01).

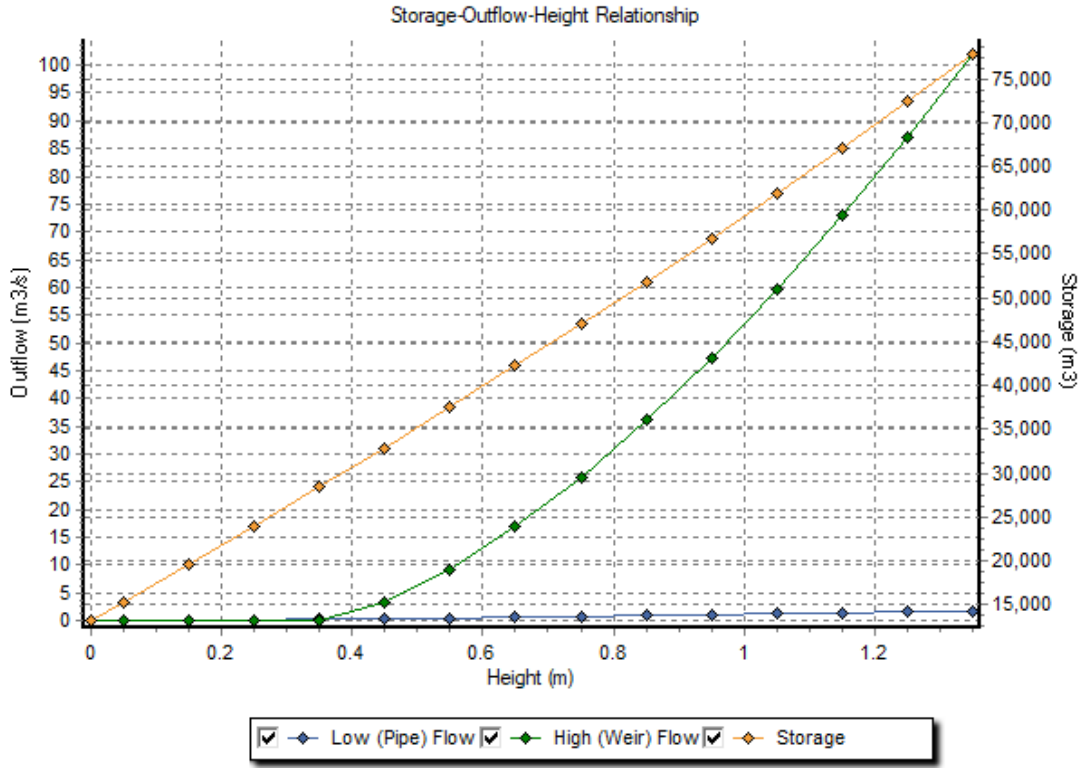



Figure 77. *Stage-storage-discharge relationship – WLRB1B (WL-01)*

## 15.5 Maintenance considerations

### Access tracks

Access paths should be at least 4m wide and with a cross fall no steeper than 1:20m. An access track has been located around the treatment system, ensuring access to the sediment basin and dewatering areas.

A maintenance ramp will be provided to the sediment ponds, the ramp should extend from the base of the sediment pond to 0.5m above EDD. It will be 4m wide and no steeper than 1:5. It will be able to support a 20-tonne excavator and be constructed of either 200mm of cement treated crushed rock (6%) or compacted FCR.

### Maintenance drain

Maintenance drains are to be located in the sediment ponds and wetland inlet and outlet pools. All maintenance drains will have a diameter of 300mm. They will have penstock/valves on the drains that are generally closed, except if the wetland or sediment basin needs to be slowly drained (e.g. for maintenance). Sediment basin dewatering should not be to the downstream pipe network.

The invert levels of the maintenance drains have been selected as the minim levels at which free gravity draining will occur within the macrophyte zones.

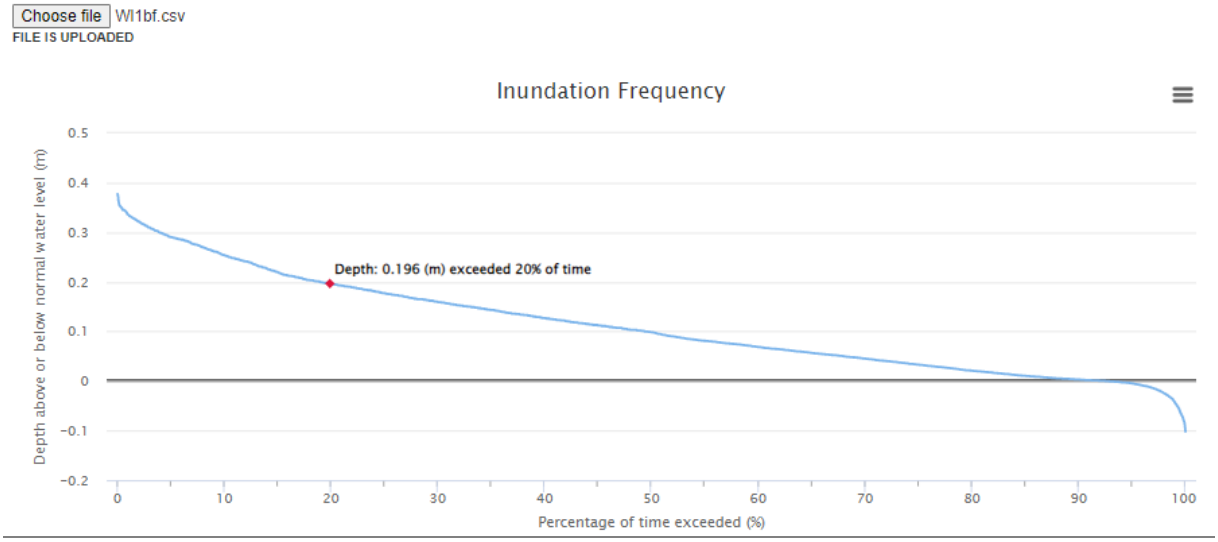
### Sediment dewatering areas

A sediment dewatering area of 3,741m$^2$ has been provided adjacent to the sediment pond. This area will allow accumulated sediment taken from the sediment basin to be dewatered on site before it is transported off site in accordance with EPA Victoria transport regulations. The location allows for vehicle access / hard stand.

## 15.6 Vegetation

Plant suitability is based on consideration of the plant height and whether the water depth in the wetland will exceed 50% of the plant height for more than 20% of the time. If this is exceeded, it is considered that the plant will be inundated to excessive depths too frequently and is unlikely to grow successfully in these conditions.

The "wetland analysis tool" enables data from the MUSIC model to be utilised to assess the compliance of a wetland to the Melbourne Water *Constructed Wetlands Design Manual*. That is, wetland depths relative to heights. The results from the water level frequency analysis are given below.



Please select at least 3 plants for each of the shallow and deep marsh zones.

Clear Selection

| Name | Average plant height (m) | Shallow marsh plants | Deep marsh plants | Suitability |
|---|---|---|---|---|
| Sea Club-rush *Bolboschoenus caldwellii* | 1 | ☑ | | Shallow Only |
| Water Ribbons *Triglochin procerum* | 1 | ☑ | ☐ | |
| Jointed Club-rush *Baumea articulata* | 1.8 | ☑ | ☐ | Shallow and Deep |
| Tall Club-rush *Bolboschoenus fluviatilis* | 1.8 | ☐ | ☐ | |
| Marsh Club-rush *Bolboschoenus medianus* | 1.5 | ☐ | ☐ | |
| Leafy Twig-rush *Cladium procerum* | 2 | ☐ | ☐ | |
| River Club-rush *Schoenoplectus tabernaemontani* | 1.8 | ☐ | ☑ | |
| Tall Spike-rush *Eleocharis sphacelata* | 1.5 | | ☑ | Deep Only |
| Common reed *Phragmites australis* | 2.5 | | ☑ | |
| Common Spike-rush *Eleocharis acuta* | 0.5 | ☐ | | Unsuitable |

+ Add user defined plant

## Report

File: Wl1bf.csv
Shallow marsh zone meets deemed to comply criteria

Deep marsh zone meets deemed to comply criteria

Water level exceeded for 20% of time: 0.196 m

Water level exceeded for 50% of time: 0.09855 m
·Warning: Effective normal water level is significantly above design normal water level. It is recommended that the effective water level of (xxx m) is adopted as the base for determining shallow and deep marsh zone depths and extents. It may be desirable to adjust the bypasses, outlet design or wetland size to reduce the difference in design and effective normal water level.

90th Percentile Residence Time: 1 days

**Figure 78.** *MUSIC auditor results – WLRB1B (WL-01)*

The water level frequency analysis demonstrates the proposed wetland with an extended detention depth of 350mm meets appropriate requirements with respect to plant heights and wetland depths. There needs to be a minimum of three plant species suitable for the shallow marsh zones and three plant species suitable for the deep marsh zones.

The following requirements for planting vegetation should be followed:

- Up to 200mm above the NWL and 350mm below the NWL should be densely planted
- Shallow marsh zone should be densely planted with a minimum of three species
- Deep marsh zone should be densely planted with a minimum of three species
- Submerged marsh zone should be densely planted.

# 16 Wetland Functional Design (WLRB2; DCP ref WL-02)

This section outlines the design calculations that have been undertaken to ensure the performance of the treatment system WLRB2 (DCP ref WL-02) complies with the appropriate guidelines. A plan view of the designed wetland system is shown in Figure 79 below (refer to Appendix B for further design details and cross sections).

The Wetland Normal Water Level (NWL) is set at **14.05m AHD**, and the Top of Extended Detention (TED) is set at **14.40m AHD**.

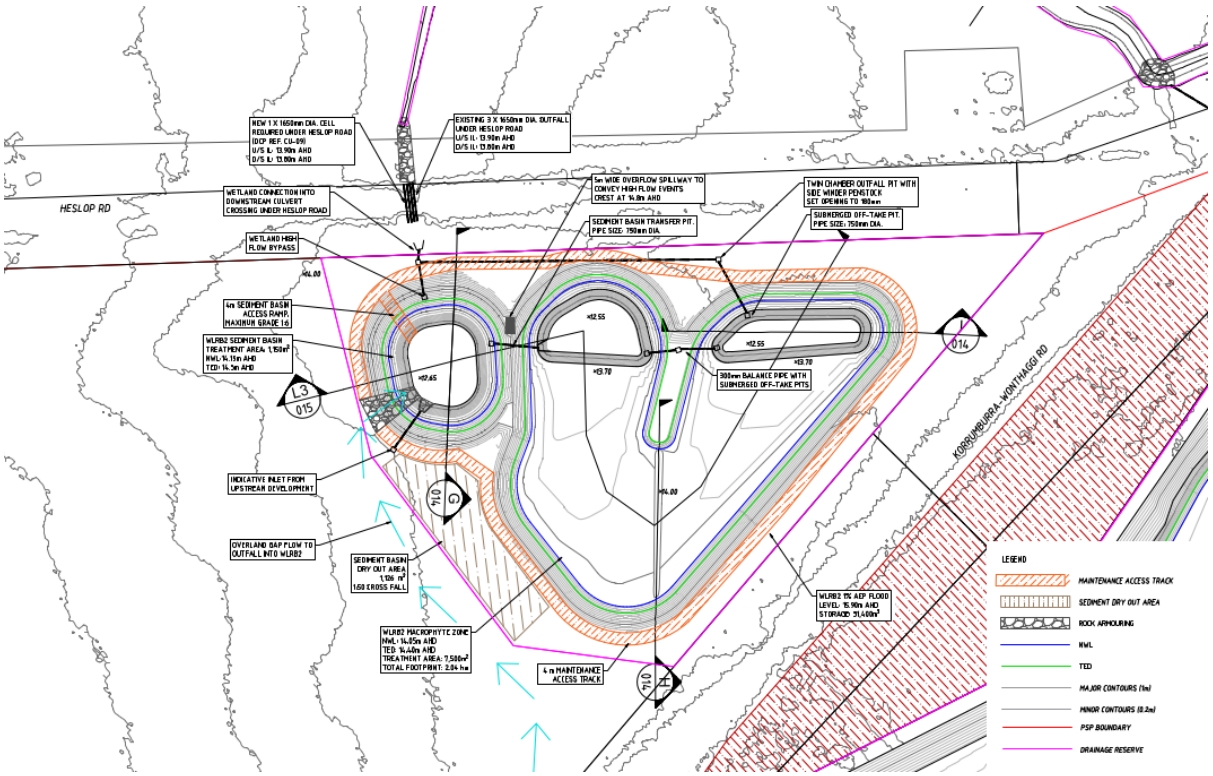



**Figure 79.** *Plan view of the designed wetland structure WLRB2 (DCP ref WL-02)*

## 16.1 Velocities

The area of the WLRB2 (DCP ref WL-02) macrophyte zone is proposed at 7,500 $m^2$ and 1,150 $m^2$ at the inlet pond, as established in the MUSIC modelling. Therefore, a width of 43m is the maximum average width possible in the macrophyte zone to ensure an adequate width to length ratio.

The velocity through each treatment asset is considered here. A flow depth of 0.35m, which is the extended detention depth, has been assumed for 4EY, 1EY and 20% AEP events.

For WLRB2 (WL-02), the minimum design width is 34m in the macrophyte zone and 14m in the inlet pond to meet velocity threshold requirements. The table below provides details on the minimum widths and velocities determined.

Table 49. System velocity calculations and design checks – WLRB2 (WL-02)

| | Parameter | 4EY | 1EY | 20% AEP |
|---|---|---|---|---|
| Flow Conditions | Design flow ($m^3/s$) | 0.62 | 1.37 | 2.80 |
| | Flow depth (m) | 0.35 | 0.35 | 0.35 |
| Inlet pond | Width at NWL (m) | 14 | 14 | 14 |
| | Width at EDD (m) | 18.2 | 18.2 | 18.2 |
| | Average Width (m) | 16.1 | 16.1 | 16.1 |
| | Flow area ($m^2$) | 5.6 | 5.6 | 5.6 |
| | Flow velocity (m/s) | 0.11 | 0.24 | 0.50 |
| | Check | <0.5 OK | <0.5 OK | <0.5 OK |
| Macrophyte zone WLRB1B | Width at NWL (m) | 34 | 34 | 34 |
| | Width at EDD (m) | 38.2 | 38.2 | 38.2 |
| | Average Width (m) | 36.1 | 36.1 | 36.1 |
| | Flow area (m2) | 13 | 13 | 13 |
| | Flow velocity (m/s) | 0.05 | 0.11 | 0.22 |
| | Check | <0.05 OK | <0.5 OK | <0.5 OK |

## 16.2 Inlet Pond

The inlet pond has been sized to ensure a capture efficiency greater than 95% for the 4EY peak flow and provide adequate sediment storage. The procedure outlined in *WSUD Engineering Procedures (2005)* has been followed and are based on the typical sediment loading rate of 1.6 $m^3$/ha/yr for a developed catchment. Provision for sediment dewatering has also been made. These areas assume a depth of 500mm and a sediment cleanout frequency of 5 years.

Table 50. Inlet Pond design parameters and checks – WLRB2 (WL-02)

| | Parameter | Proposed design |
|---|---|---|
| Conditions | Contributing Catchment (ha) | 73 |
| | Area of Basin ($m^2$) | 1,150 |
| Capture Efficiency | Settling Velocity of Target Sediment (mm/s) [Particle size 125 µm] | 11 |
| | Hydraulic Efficiency (λ) | 0.11 |
| | Permanent Pool Depth, dp (m) | 0.50 |

| | Parameter | Proposed design |
|---|---|---|
| | Extended detention depth, de | 0.35 |
| | Number of CTSR's, n | 1.12 |
| | Depth below permanent pool that is sufficient to retain sediment, d* (m) | 0.50 |
| | Design Discharge ($m^3/s$) | 0.62 |
| | Capture Efficiency | 96.4% |
| | Check (>95%) | OK |
| Sediment Storage | Sediment Loading rate, Lo ($m^3/ha/yr$) | 1.6 |
| | Desired clean-out frequency, Fr | 5 |
| | Storage volume required, St | 563 |
| | Available sediment storage volume | 603 |
| | Check (Available storage > required storage) | OK |
| Sediment dewatering | Depth for dewatering area (m) | 0.50 |
| | Area required for dewatering ($m^2$) | 1,126 |

## 16.3 Levels

### Batter slopes

A minimum of 1(V):5(H) batter slopes have been adopted. In highly constrained options, batter slopes as steep as 1 in 3 could possibly be considered to minimise cut into the steep terrain, which would require "sedge planting" rather than mowable grass. Another option would be to use benching and retaining walls.

These alternative approaches to managing the slope would require discussion and agreement with Council; therefore this report has adopted batter slopes of 1(V):6(H) to try and minimise a potentially very large total footprint. Below the NWL, all batters up to -0.35m must be at least 1(V):8(H), after which they can steepen to 1(V):3(H).

### Below water surface

Plans have been provided for depths of the assets below the NWL. This has been based on the following requirements and consideration of industry guidelines (as per Melbourne Water). A minimum grade of 1:150 is required through the macrophyte zone. For some wetlands, this means that an intermediate pool is required.

**Table 51. Macrophyte zone depth bands (all depths relative to NWL) – WLRB2 (WL-02)**

| Parameter | Minimum depth (m) | Maximum depth (m) |
|---|---|---|
| Open water zone | -0.70 | -1.5 |
| Submerged marsh zone | -0.35 | -0.70 |
| Deep marsh zone | -0.15 | -0.35 |

| Parameter | Minimum depth (m) | Maximum depth (m) |
|---|---|---|
| Shallow marsh zone | 0 | -0.15 |

## 16.4 Connections

### Sediment pond to wetland outfall

There will be piped connections between the sediment basin and the macrophyte zone to pass the 4EY peak flow. The connection will be an outlet pit, with the top of the pit at NWL to control the water level. A transfer pipe at the bottom of the pit will pass flows through to the wetland. The invert of the pipe on the wetland side should be set 500mm above the base of the pool.

The transfer pipeline is designed to 'choke' the 4EY flow entering the macrophyte zone to 0.31 $m^3/s$ in order to manage the inundation frequency of the wetland system. The remainder of runoff will divert through the high flow bypass and outfall directly to the outlet of the WLRB2 (WL-02) system.

The wetland has been intentionally oversized to account for the offset in volumetric loads being untreated from the wetland.

### Wetland outfall

The MUSIC model developed during the functional design stage reflects the actual stage-storage-discharge relationship of the wetland's extended detention. The actual stage-storage-discharge relationship is represented using MUSIC's Custom Outflow and Storage Relationship function.

The water level in a wetland is controlled by an outlet usually in the macrophyte zone. The macrophyte zone outlet provides the hydrologic control of the water level and flows in the macrophyte zone to achieve the design detention time.

Outlet structures should be designed and located so that they can be easily accessed for maintenance. Outlet or overflow pits located within the outlet pool of the macrophyte zone should be accessible from the edge of the wetland, this means that the edge of the pit closest to the wetland margin should be located in no more than 350mm depth.

The wetland outlet configuration consists of a submerged pipe connected to an outlet pit (containing the controlled weir outlet) located adjacent to the wetland above TED. The outlet pit should be easily accessible and have a hinged grated lid to enable access to the outlet control structure and overflow weir for maintenance.

An adjustable weir, such as a side-winding penstock, allows the inundation frequency to be adjusted easily. The required weir length is 180mm (i.e. the penstock opening) to ensure the 48-hour detention time. Figure 80 shows the stage-storage-discharge relationship used in MUSIC for WLRB2 (WL-02).

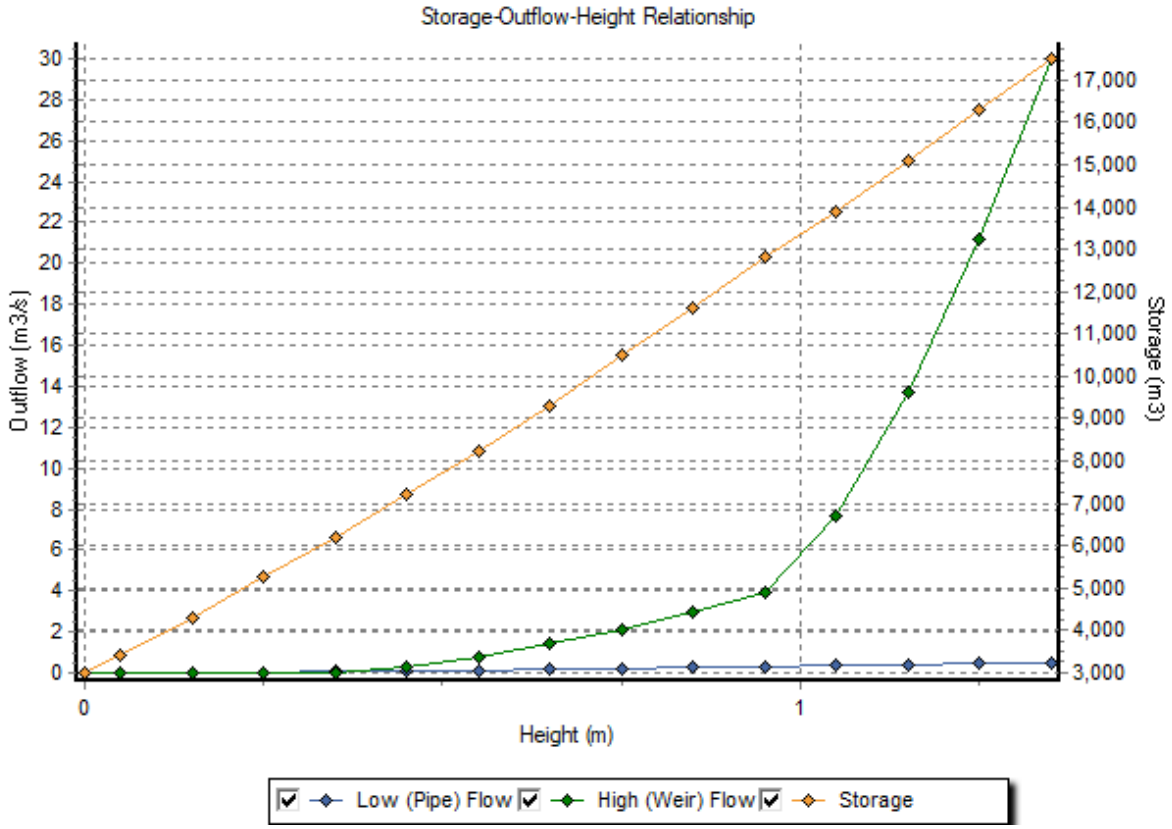



Figure 80. *Stage-storage-discharge relationship – WLRB2 (WL-02)*

## 16.5 Maintenance considerations

### Access tracks

Access paths should be at least 4m wide and with a cross fall no steeper than 1:20m. An access track has been located around the treatment system, ensuring access to the sediment basin and dewatering areas.

A maintenance ramp will be provided to the sediment ponds, the ramp should extend from the base of the sediment pond to 0.5m above EDD. It will be 4m wide and no steeper than 1:5. It will be able to support a 20-tonne excavator and be constructed of either 200mm cement-treated crushed rock (6%) or compacted FCR.

### Maintenance drain

Maintenance drains are to be located in the sediment ponds and wetland inlet and outlet pools. All maintenance drains will have a diameter of 300mm. they will have penstock/valves on the drains that are generally closed, except if the wetland or sediment basin needs to be slowly drained.

The invert levels of the maintenance drains have been selected as the minim levels at which free gravity draining will occur within the macrophyte zones.

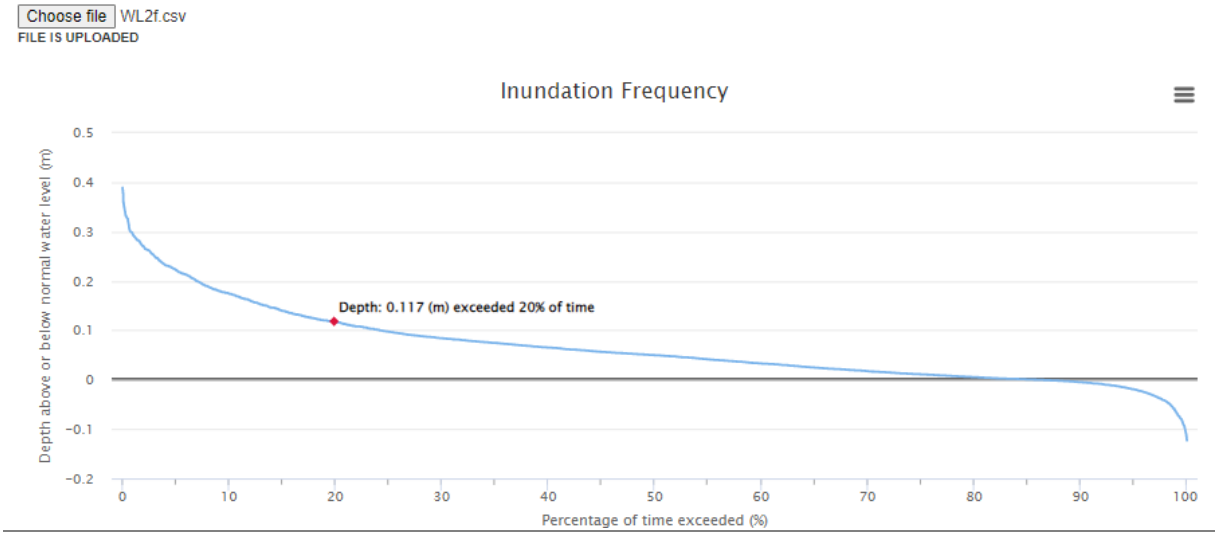
### Sediment dewatering areas

A sediment dewatering area of 1126m$^2$ has been provided adjacent to the sediment pond. This area will allow vehicle access to accumulated sediment to be taken from the sediment basin, dewatered on site, before it is transported off site as per EPA waste transport regulations.

## 16.6 Vegetation

Plant suitability is based on consideration of the plant height and whether the water depth in the wetland will exceed 50% of the plant height for more than 20% of the time. If this is exceeded, it is considered that the plant will be inundated to excessive depths too frequently and is unlikely to grow successfully in these conditions (see above for a schematic explanation).

The “wetland analysis tool” enables data from the MUSIC model to be utilised to assess the compliance of a wetland to the Melbourne Water *Constructed Wetlands Design Manual*. That is, wetland depths relative to heights. The results from the water level frequency analysis are given below.



Clear Selection

| Name | Average plant height (m) | Shallow marsh plants | Deep marsh plants | Suitability |
|---|---|---|---|---|
| Sea Club-rush *Bolboschoenus caldwellii* | 1 | ☑ | | Shallow Only |
| Jointed Club-rush *Baumea articulata* | 1.8 | ☑ | ☐ | Shallow and Deep |
| Tall Club-rush *Bolboschoenus fluviatilis* | 1.8 | ☑ | ☐ | |
| Marsh Club-rush *Bolboschoenus medianus* | 1.5 | ☐ | ☐ | |
| Leafy Twig-rush *Cladium procerum* | 2 | ☐ | ☐ | |
| River Club-rush *Schoenoplectus tabernaemontani* | 1.8 | ☐ | ☐ | |
| Water Ribbons *Triglochin procerum* | 1 | ☐ | ☑ | |
| Tall Spike-rush *Eleocharis sphacelata* | 1.5 | | ☑ | Deep Only |
| Common reed *Phragmites australis* | 2.5 | | ☑ | |
| Common Spike-rush *Eleocharis acuta* | 0.5 | ☐ | | Unsuitable |
| + Add user defined plant | | | | |

## Report

File: WL2f.csv
Shallow marsh zone meets deemed to comply criteria

Deep marsh zone meets deemed to comply criteria

Water level exceeded for 20% of time: 0.117 m

Water level exceeded for 50% of time: 0.04975 m
·Effective water level is within 50 mm of normal water level and is acceptable.

90th Percentile Residence Time: 2 days

**Figure 81.** *MUSIC auditor results – WLRB2 (WL-02)*

The water level frequency analysis demonstrates the proposed wetland with an extended detention depth of 350mm meets appropriate requirements with respect to plant heights and wetland depths. There needs to be a minimum of three plant species suitable for the shallow marsh zones and three plant species suitable for the deep marsh zones.

The following requirements for planting vegetation should be followed:

- Up to 200mm above the NWL and 350mm below the NWL should be densely planted
- Shallow marsh zone should be densely planted with a minimum of three species
- Deep marsh zone should be densely planted with a minimum of three species
- Submerged marsh zone should be densely planted.

# 17 Wetland Functional Design (WLRB3; DCP ref WL-03)

This section outlines the design calculations that have been undertaken to ensure the performance of the treatment system WLRB3 (DCP ref WL-03) complies with the appropriate guidelines. A plan view of the designed wetland system is shown in Figure 82 below (refer to Appendix B for further design details and cross sections).

The Wetland Normal Water Level (NWL) is set at **13.00m AHD**, and the Top of Extended Detention (TED) is set at **13.35m** AHD.

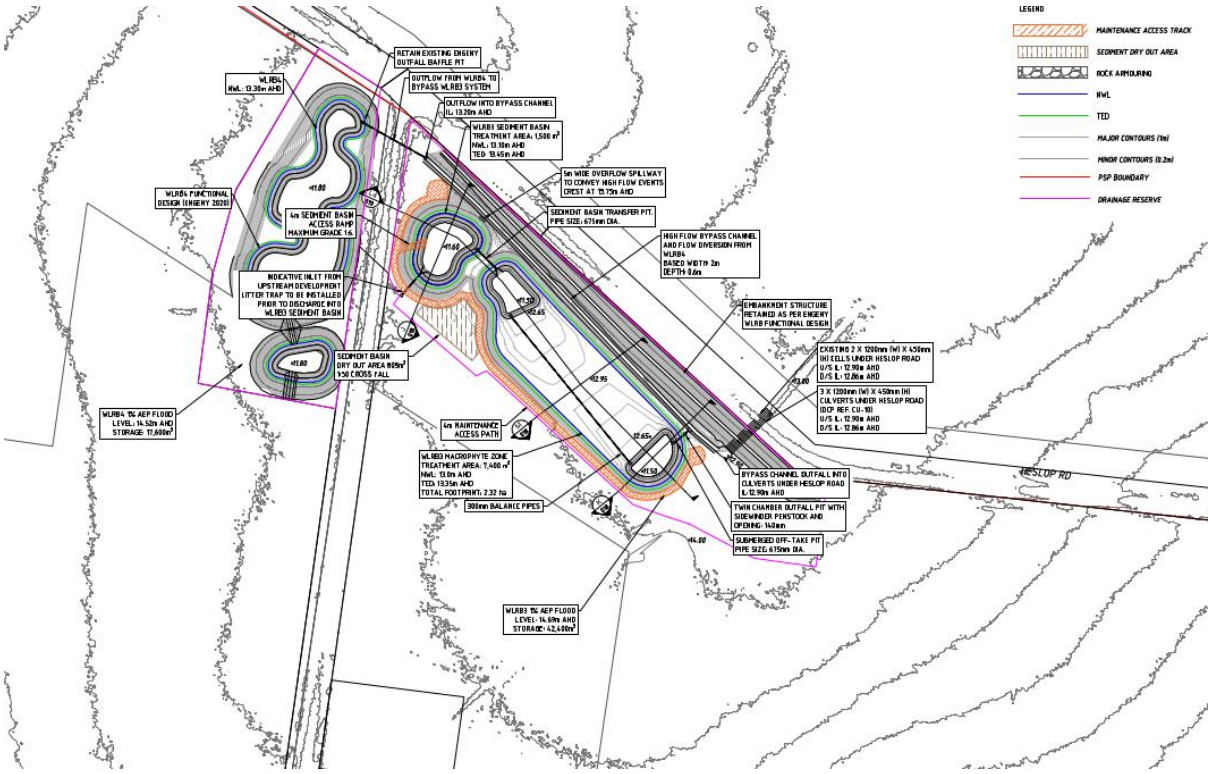



**Figure 82.** *Plan view of the designed wetland structure WLRB3 (WL-03)*

## 17.1 Velocities

The area of the WLRB3 (DCP ref WL-03) macrophyte zone is proposed at 7,400 $m^2$ and 1,500 $m^2$ at the inlet pond, as established in the MUSIC modelling. Therefore, a width of 43m is the maximum average width possible in the macrophyte zone to ensure an adequate width to length ratio.

The velocity through each treatment asset is considered here. A flow depth of 0.35m, which is the extended detention depth, has been assumed for 4EY,1EY and 20% AEP events.

For WLRB3 (WL-03), the minimum design width is 41m in the macrophyte zone and 17m in the inlet pond to meet velocity threshold requirements. The table below provides details on the minimum widths and velocities determined.

Table 52. System velocity calculations and design checks – WLRB3 (WL-03)

| | Parameter | 4EY | 1EY | 20% AEP |
|---|---|---|---|---|
| Flow Conditions | Design flow ($m^3/s$) | 0.74 | 1.62 | 3.17 |
| | Flow depth (m) | 0.35 | 0.35 | 0.35 |
| Inlet pond | Width at NWL (m) | 17 | 17 | 17 |
| | Width at EDD (m) | 21.2 | 21.2 | 21.2 |
| | Average Width (m) | 19.1 | 19.1 | 19.1 |
| | Flow area ($m^2$) | 6.7 | 6.7 | 6.7 |
| | Flow velocity (m/s) | 0.11 | 0.24 | 0.47 |
| | Check | <0.5 OK | <0.5 OK | <0.5 OK |
| Macrophyte zone WLRB1B | Width at NWL (m) | 41 | 41 | 41 |
| | Width at EDD (m) | 45.2 | 45.2 | 45.2 |
| | Average Width (m) | 43.1 | 43.1 | 43.1 |
| | Flow area ($m^2$) | 15 | 15 | 15 |
| | Flow velocity (m/s) | 0.05 | 0.11 | 0.21 |
| | Check | <0.05 OK | <0.5 OK | <0.5 OK |

## 17.2 Inlet Pond

The inlet pond has been sized to ensure a capture efficiency greater than 95% for the 4EY peak flow and provide adequate sediment storage. The procedure outlined in *WSUD Engineering Procedures (2005)* has been followed and are based on the typical sediment loading rate of 1.6 $m^3$/ha/yr for a developed catchment. Provision for sediment dewatering has also been made. These areas assume a depth of 500mm and a sediment cleanout frequency of 5 years.

Table 53. Inlet Pond design parameters and checks – WLRB3 (WL-03)

| | Parameter | Proposed design |
|---|---|---|
| Conditions | Contributing Catchment (ha) | 52 |
| | Area of Basin ($m^2$) | 1,500 |
| Capture Efficiency | Settling Velocity of Target Sediment (mm/s) [Particle size 125 µm] | 11 |
| | Hydraulic Efficiency (λ) | 0.11 |
| | Permanent Pool Depth, dp (m) | 0.50 |
| | Extended detention depth, de | 0.35 |
| | Number of CTSR's, n | 1.12 |
| | Depth below permanent pool that is sufficient to retain sediment, d* (m) | 0.50 |
| | Design Discharge ($m^3/s$) | 0.74 |
| | Capture Efficiency | 96.7% |
| | Check (>95%) | OK |
| | Sediment Loading rate, Lo ($m^3$/ha/yr) | 1.6 |

| | Parameter | Proposed design |
|---|---|---|
| Sediment Storage | Desired clean-out frequency, Fr | 5 |
| | Storage volume required, St | 402 |
| | Available sediment storage volume | 1,025 |
| | Check (Available storage > required storage) | OK |
| Sediment dewatering | Depth for dewatering area (m) | 0.50 |
| | Area required for dewatering ($m^2$) | 805 |

## 17.3 Levels

### Batter slopes

A minimum of 1(V):5(H) batter slopes have been adopted. In highly constrained options, batter slopes as steep as 1 in 3 could possibly be considered to minimise cut into the steep terrain, which would require "sedge planting" rather than mowable grass. Another option would be to use benching and retaining walls.

These alternative approaches to managing the slope would require discussion and agreement with Council; therefore this report has adopted batter slopes of 1(V):6(H) to try and minimise a potentially very large total footprint. Below the NWL, all batters up to -0.35m must be at least 1(V):8(H), after which they can steepen to 1(V):3(H).

### Below water surface

Plans have been provided for depths of the assets below the normal water level. This has been based on the following requirements and consideration of industry guidelines (as per Melbourne Water). A minimum grade of 1:150 is required through the macrophyte zone. For some wetlands, this means that an intermediate pool is required.

**Table 54. Macrophyte zone depth bands (all depths relative to NWL) – WLRB3 (WL-03)**

| Parameter | Minimum depth (m) | Maximum depth (m) |
|---|---|---|
| Open water zone | -0.70 | -1.5 |
| Submerged marsh zone | -0.3 | -0.70 |
| Deep marsh zone | -0.15 | -0.35 |
| Shallow marsh zone | 0 | -0.15 |

## 17.4 Connections

### Sediment pond to wetland outfall

There will be piped connections between the sediment ponds and the macrophyte zone to pass the 4EY peak flow. The connection will be an outlet pit, with the top of the pit at NWL to control the water level. A transfer pipe at the bottom of the pit will pass flows through to the wetland. The invert of the pipe on the wetland side should be set 500mm above the base of the pool.

The transfer pipeline is designed to 'choke' the 4EY flow entering the macrophyte zone to 0.37 $m^3/s$ in order to manage the inundation frequency of the wetland system (macrophyte zone). The remainder of runoff will divert through the high flow bypass and outfall directly to the outlet of the WLRB3 system.

The wetland has been intentionally oversized to account for the offset in volumetric loads being untreated from the wetland.

## Wetland outfall

The MUSIC model developed during the functional design stage reflects the actual stage-storage-discharge relationship of the wetland's extended detention. The actual stage-storage-discharge relationship is represented using MUSIC's Custom Outflow and Storage Relationship function.

The water level in a wetland is controlled by an outlet usually in the macrophyte zone. The macrophyte zone outlet provides the hydrologic control of the water level and flows in the macrophyte zone to achieve the design detention time.

Outlet structures should be designed and located so that they can be easily accessed for maintenance. Outlet or overflow pits located within the outlet pool of the macrophyte zone should be accessible from the edge of the wetland, this means that the edge of the pit closest to the wetland margin should be located in no more than 350mm depth.

The wetland outlet configuration consists of a submerged pipe connected to an outlet pit (containing the controlled weir outlet) located adjacent to the wetland above TED. The outlet pit should be easily accessible and have a hinged grated lid to enable access to the outlet control structure and overflow weir for maintenance.

An adjustable weir, such as a side-winding penstock, allows the inundation frequency to be adjusted easily. The required weir length is 140mm (i.e. the penstock opening) to ensure the 48-hour detention time. Figure 83 shows the stage-storage-discharge relationship used in MUSIC for WLRB3 (WL-03).

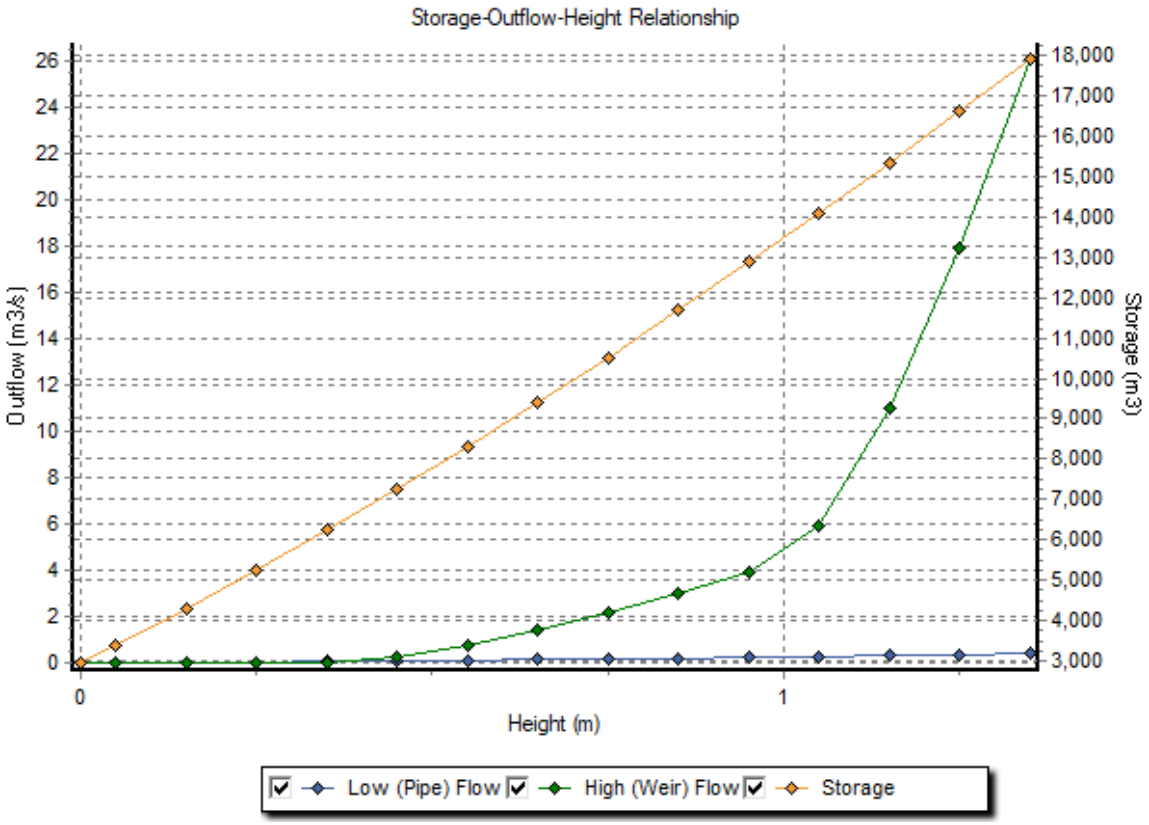



**Figure 83.** *Stage-storage-discharge relationship for WLRB3 (WL-03)*

## 17.5 Maintenance considerations

### Access tracks

Access paths should be at least 4m wide and with a cross fall no steeper than 1:20m. An access track has been located around the treatment system, ensuring access to the sediment basin and dewatering areas.

A maintenance ramp will be provided to the sediment ponds, the ramp should extend from the base of the sediment pond to 0.5m above EDD. It will be 4m wide and no steeper than 1:5. It will be able to support a 20-tonne excavator and be constructed of either 200mm of cement treated crushed rock (6%) or compacted FCR.

### Maintenance drain

Maintenance drains are to be located in the sediment ponds and wetland inlet and outlet pools. All maintenance drains will have a diameter of 300mm. they will have penstock/valves on the drains that are generally closed, except if the wetland or sediment pond needs to be slowly drained. Sediment basin dewatering should not be to the downstream pipe network.

The invert levels of the maintenance drains have been selected as the minim levels at which free gravity draining will occur within the macrophyte zones.

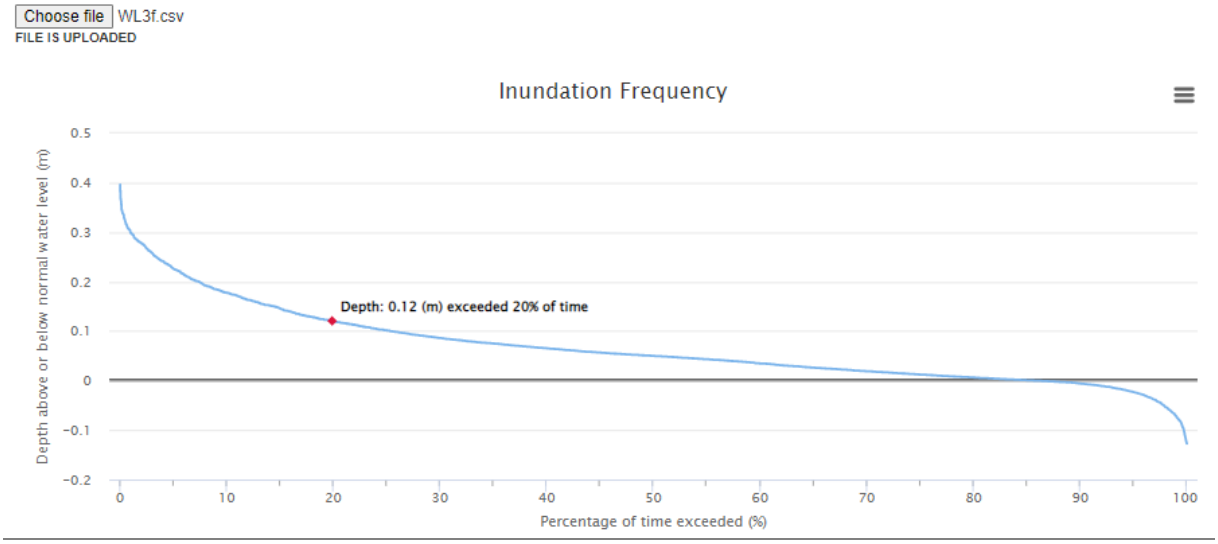
### Sediment dewatering areas

A sediment dewatering area of 805m$^2$ has been provided adjacent to the sediment pond. This area will allow accumulated sediment taken from the sediment basin to be dewatered on site before it is transported off site, in accordance with EPA Victoria transport regulations. The location allows for vehicle access / hard stand.

## 17.6 Vegetation

Plant suitability is based on consideration of the plant height and whether the water depth in the wetland will exceed 50% of the plant height for more than 20% of the time. If this is exceeded, it is considered that the plant will be inundated to excessive depths too frequently and is unlikely to grow successfully in these conditions (see above for schematic explanation).

The “wetland analysis tool” enables data from the MUSIC model to be utilised to assess the compliance of a wetland to the Melbourne Water *Constructed Wetlands Design Manual*. That is, wetland depths relative to heights. The results from the water level frequency analysis are given below.



Please select at least 3 plants for each of the shallow and deep marsh zones.

Clear Selection

| Name | Average plant height (m) | Shallow marsh plants | Deep marsh plants | Suitability |
|---|---|---|---|---|
| Sea Club-rush *Bolboschoenus caldwellii* | 1 | ☑ | | Shallow Only |
| Jointed Club-rush *Baumea articulata* | 1.8 | ☑ | ☐ | Shallow and Deep |
| Tall Club-rush *Bolboschoenus fluviatilis* | 1.8 | ☑ | ☐ | |
| Marsh Club-rush *Bolboschoenus medianus* | 1.5 | ☐ | ☐ | |
| Leafy Twig-rush *Cladium procerum* | 2 | ☐ | ☐ | |
| River Club-rush *Schoenoplectus tabernaemontani* | 1.8 | ☐ | ☐ | |
| Water Ribbons *Triglochin procerum* | 1 | ☐ | ☑ | |
| Tall Spike-rush *Eleocharis sphacelata* | 1.5 | | ☑ | Deep Only |
| Common reed *Phragmites australis* | 2.5 | | ☑ | |
| Common Spike-rush *Eleocharis acuta* | 0.5 | ☐ | | Unsuitable |

+ Add user defined plant

## Report

File: WL3f.csv
Shallow marsh zone meets deemed to comply criteria

Deep marsh zone meets deemed to comply criteria

Water level exceeded for 20% of time: 0.12 m

Water level exceeded for 50% of time: 0.04995 m
·Effective water level is within 50 mm of normal water level and is acceptable.

90th Percentile Residence Time: 2 days

**Figure 84.** *MUSIC auditor results – WLRB3 (WL-03)*

The water level frequency analysis demonstrates the proposed wetland with an extended detention depth of 350mm meets appropriate requirements with respect to plant heights and wetland depths. There needs to be a minimum of three plant species suitable for the shallow marsh zones and three plant species suitable for the deep marsh zones.

The following requirements for planting vegetation should be followed:

- Up to 200mm above the NWL and 350mm below the NWL should be densely planted
- Shallow marsh zone should be densely planted with a minimum of three species
- Deep marsh zone should be densely planted with a minimum of three species
- Submerged marsh zone should be densely planted.

# 18 Wetland Functional Design (WLRB4; DCP ref WL-04)

In line with the DCP findings and per Council's feedback, WLRB4 (WL-04) asset will be delivered under a council approved Development Plan. The functional design plans produced by Engeny (2020) should be referred to for the functional design of WLRB4 (WL-04).

Following review by Alluvium, the WLRB4 asset will no longer outfall into the WLRB3 system in order to remove the 'double treatment' of flows from WLRB4 into WLRB3 and reduce the overall size of WLRB3. WLRB4 will ultimately outfall under Heslop Road, as indicated in the Engeny functional design plans.

# 19 Sediment Basin Functional Design (SB1; DCP ref SB-01)

This section outlines the design calculations that have been undertaken to ensure the performance of the treatment system SB1 (DCP ref SB-01) complies with the appropriate guidelines. A plan view of the designed sediment basin is shown in Figure 85 below. Refer to Appendix B for further design details and cross sections.

The Sediment Basin Normal Water Level (NWL) is set at **24.65m AHD**, and the Top of Extended Detention (TED) is set at **25.00m AHD**.

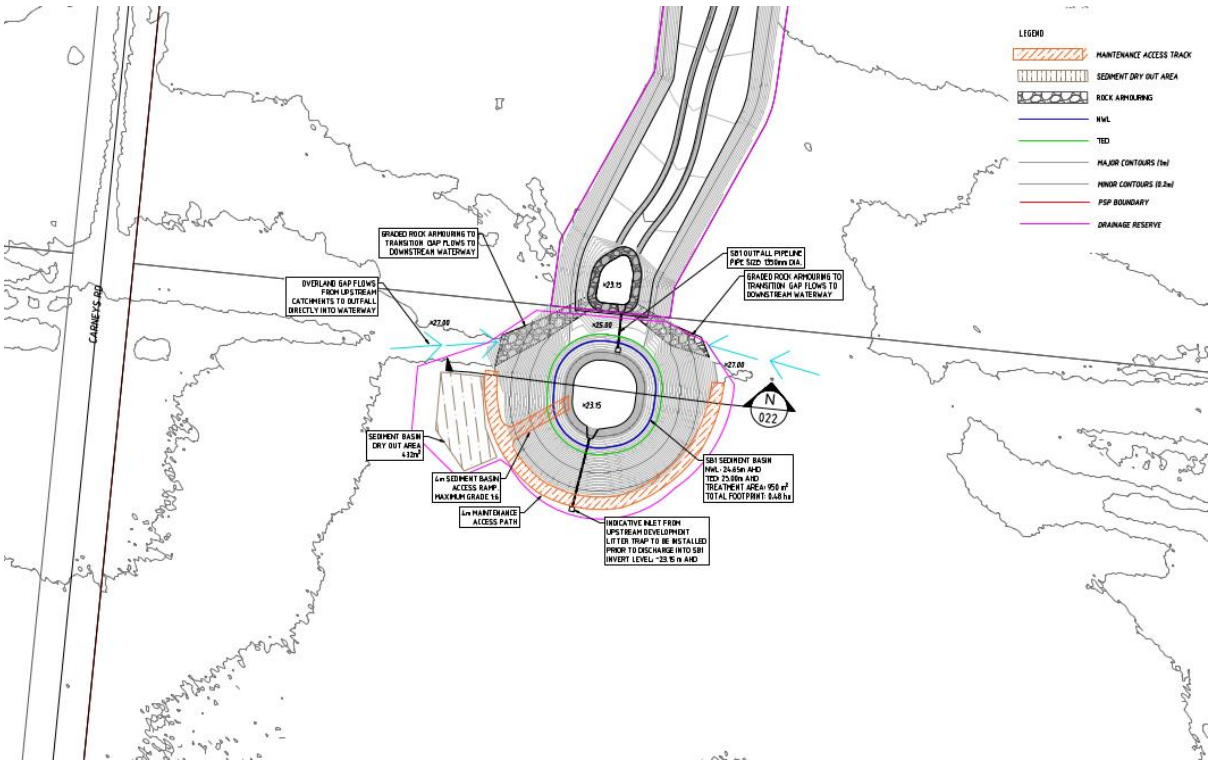



**Figure 85.** *Plan view of the designed sediment basin structure SB1 (SB-01)*

## 19.1 Velocities

As established in the MUSIC modelling, the area of the sediment basin SB1 (SB-01) will be 950 $m^2$.

A manual calculation has been used to check the flow velocities through the assets for the design. This calculates the flow area from the flow depth (between extended detention depth and normal water level) and the average width in that area. The average width is determined from the narrowest part of the macrophyte zone or sediment basin (the minimum design width).

For SB1 (SB-01) the minimum design width is 31m to meet velocity requirements.

Table 55. System velocity calculations and design checks – SB1 (SB-01)

| | Parameter | 4EY | 1EY | 20% AEP |
|---|---|---|---|---|
| Flow Conditions | Design flow ($m^3/s$) | 0.48 | 0.99 | 2.59 |
| | Flow depth (m) | 0.35 | 0.35 | 0.35 |
| Sediment Basin 1 (SB-01) | Width at NWL (m) | 14 | 14 | 14 |
| | Width at EDD (m) | 18.2 | 18.2 | 18.2 |
| | Average Width (m) | 16.1 | 16.1 | 16.1 |
| | Flow area ($m^2$) | 5.6 | 5.6 | 5.6 |
| | Flow velocity (m/s) | 0.09 | 0.18 | 0.46 |
| | Check | <0.5 OK | <0.5 OK | <0.5 OK |

## 19.2 Inlet pond

The sediment pond has been sized to ensure a capture efficiency greater than 95% for the 4EY peak flow and provide adequate sediment storage. The procedure outlined in *WSUD Engineering Procedures (2005)* has been followed and are based on the typical sediment loading rate of 1.6 $m^3$/ha/yr for a developed catchment. Provision for sediment dewatering has also been made. These areas assume a depth of 500mm and a sediment cleanout frequency of 5 years.

Table 56. Sediment pond design parameters and checks – SB1 (SB-01)

| | Parameter | Proposed design |
|---|---|---|
| Conditions | Contributing Catchment (ha) | 147 |
| | Area of Basin ($m^2$) | 950 |
| Capture Efficiency | Settling Velocity of Target Sediment (mm/s) [Particle size 125 µm] | 11 |
| | Hydraulic Efficiency (λ) | 0.11 |
| | Permanent Pool Depth, dp (m) | 0.50 |
| | Extended detention depth, de | 0.35 |
| | Number of CTSR's, n | 1.12 |
| | Depth below permanent pool that is sufficient to retain sediment, d* (m) | 0.50 |
| | Design Discharge ($m^3/s$) | 0.48 |
| | Capture Efficiency | 96.6% |
| | Check (>95%) | OK |
| Sediment Storage | Sediment Loading rate, Lo ($m^3$/ha/yr) | 1.6 |
| | Desired clean-out frequency, Fr | 5 |
| | Storage volume required, St | 216 |
| | Available sediment storage volume | 498 |
| | Check (Available storage > required storage) | OK |
| Sediment dewatering | Depth for dewatering area (m) | 0.50 |
| | Area required for dewatering ($m^2$) | 432 |

## 19.3 Maintenance considerations

### Access tracks

Access paths should be at least 4m wide and with a cross fall no steeper than 1:20m. An access track has been located around the treatment system, ensuring access to the sediment basin and dewatering areas.

A maintenance ramp will be provided to the sediment ponds, the ramp should extend from the base of the sediment pond to 0.5m above EDD. It will be 4m wide and no steeper than 1:5. It will be able to support a 20-tonne excavator and be constructed of either 200mm of cement treated crushed rock (6%) or compacted FCR.

### Sediment dewatering areas

A sediment dewatering area of 432m$^2$ has been provided adjacent to the sediment pond. This area will allow accumulated sediment taken from the sediment basin to be dewatered on site before it is transported off site, in accordance with EPA Victoria transport regulations. The location allows for vehicle access / hard stand.

# 20 Sediment Basin Functional Design (SB4; DCP ref SB-02)

This section outlines the design calculations that have been undertaken to ensure the performance of the treatment system SB4 (DCP ref SB-02) complies with the appropriate guidelines.

SB4 (SB-02) has been relocated to within the PSP waterway floodplain (DR-01) to reduce asset footprints and overall land take of developable area. The system remains offline to stream flows to ensure asset integrity, function and longevity is protected (e.g. from scour, resuspension of suspended solids) and to minimise impacts on council's future maintenance and / or asset renewal.

A plan view of the designed sediment basin is shown in Figure 86 below. Refer to Appendix B for further design details and cross sections. The Sediment Basin Normal Water Level (NWL) is set at **15.25m AHD**, and the Top of Extended Detention (TED) is set at **15.60m AHD**.

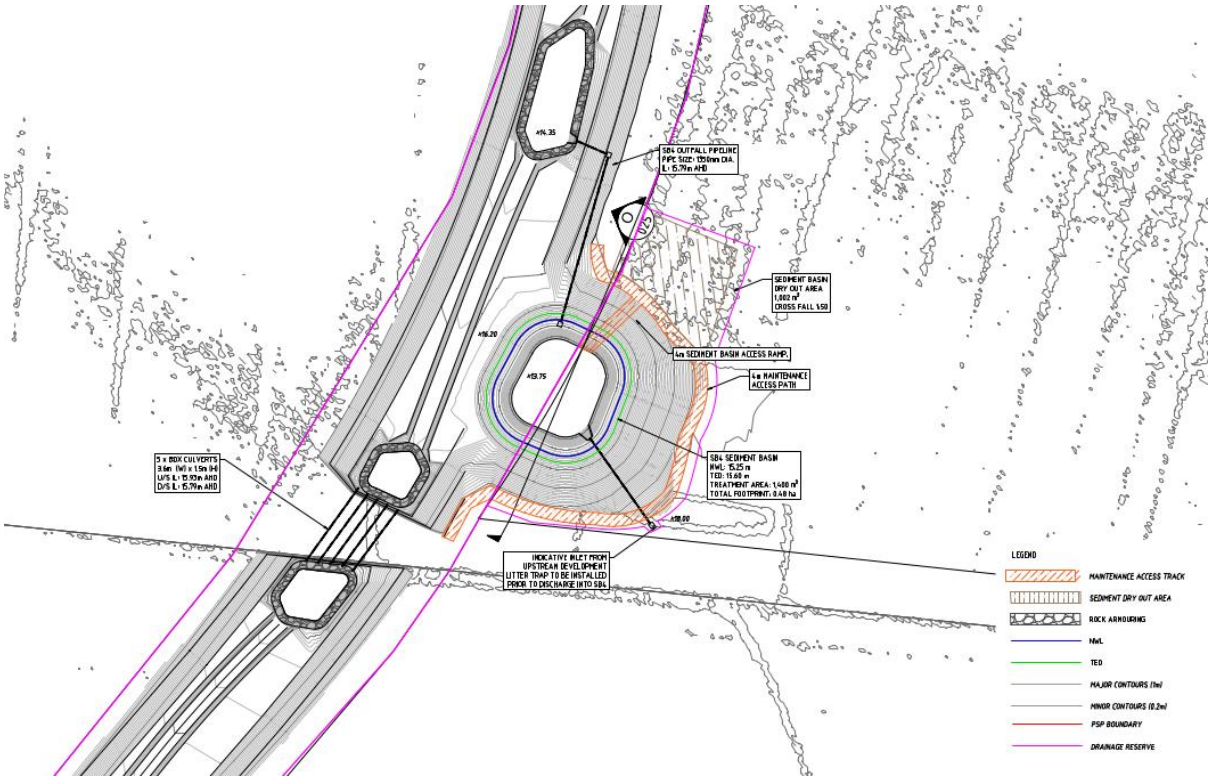



**Figure 86.** *Plan view of the designed sediment basin structure SB4 (SB-02)*

## 20.1 Velocities

As established in the MUSIC modelling, the area of the sediment basin SB4 (SB-02) will be 1,400 $m^2$.

A manual calculation has been used to check the flow velocities through the assets for the design. This calculates the flow area from the flow depth (between extended detention depth and normal water level) and the average width in that area. The average width is determined from the narrowest part of the macrophyte zone or sediment basin (the minimum design width).

For SB4 (SB-02) the minimum design width is 14m to meet velocity requirements.

Table 57. System velocity calculations and design checks – SB4 (SB-02)

| | Parameter | 4EY | 1EY | 20% AEP |
|---|---|---|---|---|
| Flow Conditions | Design flow ($m^3/s$) | 0.52 | 1.33 | 2.71 |
| | Flow depth (m) | 0.35 | 0.35 | 0.35 |
| Sediment Basin SB4 (SB-02) | Width at NWL (m) | 14 | 14 | 14 |
| | Width at EDD (m) | 18.2 | 18.2 | 18.2 |
| | Average Width (m) | 16.1 | 16.1 | 16.1 |
| | Flow area ($m^2$) | 5.6 | 5.6 | 5.6 |
| | Flow velocity (m/s) | 0.09 | 0.24 | 0.48 |
| | Check | <0.5 OK | <0.5 OK | <0.5 OK |

## 20.2 Design parameters

The sediment pond has been sized to ensure a capture efficiency greater than 95% for the 4EY peak flow and provide adequate sediment storage. The procedure outlined in *WSUD Engineering Procedures (2005)* has been followed and are based on the typical sediment loading rate of 1.6 $m^3$/ha/yr for a developed catchment. Provision for sediment dewatering has also been made. These areas assume a depth of 500mm and a sediment cleanout frequency of 5 years.

Table 58. Sediment pond design parameters and checks – SB4 (SB-02)

| | Parameter | Proposed design |
|---|---|---|
| Conditions | Contributing Catchment (ha) | 64 |
| | Area of Basin ($m^2$) | 1,400 |
| Capture Efficiency | Settling Velocity of Target Sediment (mm/s) [Particle size 125 µm] | 11 |
| | Hydraulic Efficiency (λ) | 0.11 |
| | Permanent Pool Depth, dp (m) | 0.50 |
| | Extended detention depth, de | 0.35 |
| | Number of CTSR's, n | 1.12 |
| | Depth below permanent pool that is sufficient to retain sediment, d* (m) | 0.50 |
| | Design Discharge ($m^3/s$) | 0.48 |
| | Capture Efficiency | 97.8% |
| | Check (>95%) | OK |
| Sediment Storage | Sediment Loading rate, Lo ($m^3$/ha/yr) | 1.6 |
| | Desired clean-out frequency, Fr | 5 |
| | Storage volume required, St | 501 |
| | Available sediment storage volume | 868 |
| | Check (Available storage > required storage) | OK |
| Sediment dewatering | Depth for dewatering area (m) | 0.50 |
| | Area required for dewatering ($m^2$) | 1,002 |

## 20.3 Maintenance considerations

### Access tracks

Access paths should be at least 4m wide and with a cross fall no steeper than 1:20m. An access track has been located around the treatment system, ensuring access to the sediment basin and dewatering areas.

A maintenance ramp will be provided to the sediment ponds, the ramp should extend from the base of the sediment pond to 0.5m above EDD. It will be 4m wide and no steeper than 1:5. It will be able to support a 20-tonne excavator and be constructed of either 200mm of cement treated crushed rock (6%) or compacted FCR.

### Sediment dewatering areas

A sediment dewatering area of 1,002m$^2$ has been provided adjacent to the sediment pond. This area will allow accumulated sediment taken from the sediment basin to be dewatered on site before it is transported off site, in accordance with EPA Victoria transport regulations. The location allows for vehicle access / hard stand.

# 21 Sediment Basin Functional Design (SB5; DCP ref SB-03)

This section outlines the design calculations that have been undertaken to ensure the performance of the treatment system SB5 (DCP ref SB-03) complies with the appropriate guidelines. A plan view of the designed sediment basin is shown below. Refer to Appendix B for further design details and cross sections.

The Sediment Basin Normal Water Level (NWL) is set at **22.00m AHD**, and the Top of Extended Detention (TED) is set at **22.35m AHD**.

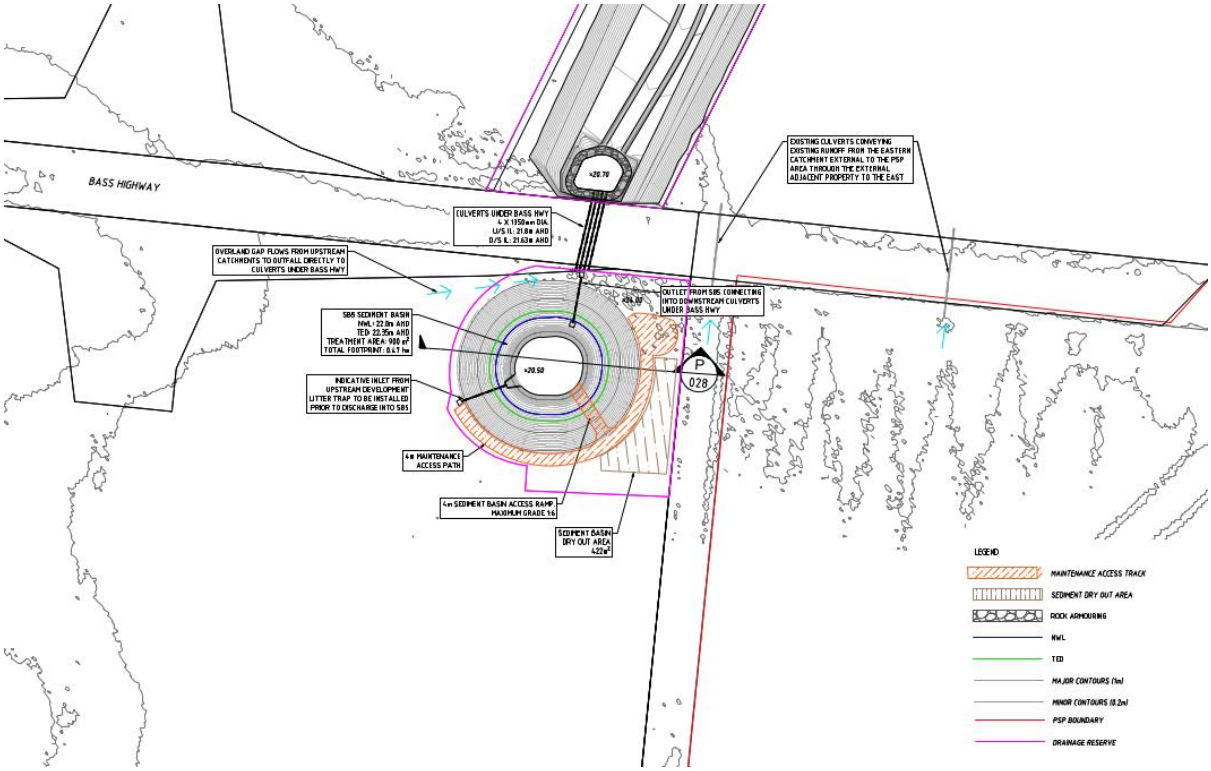



**Figure 87.** *Plan view of the designed wetland structure SB5 (DCP ref SB-03)*

## 21.1 Velocities

As established in the MUSIC modelling, the area of the sediment basin SB5 (DCP ref SB-03) will be 900 $m^2$.

A manual calculation has been used to check the flow velocities through the assets for the design. This calculates the flow area from the flow depth (between extended detention depth and normal water level) and the average width in that area. The average width is determined from the narrowest part of the macrophyte zone or sediment basin (the minimum design width).

For SB5 (DCP ref SB-03) the minimum design width is 12.5m to meet velocity requirements.

**Table 59. System velocity calculations and design checks – SB5 (SB-03)**

| | Parameter | 4EY | 1EY | 20% AEP |
|---|---|---|---|---|
| Flow Conditions | Design flow ($m^3/s$) | 0.27 | 0.56 | 1.35 |
| | Flow depth (m) | 0.35 | 0.35 | 0.35 |
| Sediment Basin SB5 (SB-03) | Width at NWL (m) | 12.5 | 12.5 | 12.5 |
| | Width at EDD (m) | 16.7 | 16.7 | 16.7 |
| | Average Width (m) | 14.6 | 14.6 | 14.6 |
| | Flow area ($m^2$) | 5.1 | 5.1 | 5.1 |

| | | | |
|---|---|---|---|
| Flow velocity (m/s) | 0.05 | 0.11 | 0.26 |
| Check | <0.5 OK | <0.5 OK | <0.5 OK |

## 21.2 Design parameters

The sediment pond has been sized to ensure a capture efficiency greater than 95% for the 4EY peak flow and provide adequate sediment storage. The procedure outlined in *WSUD Engineering Procedures (2005)* has been followed and are based on the typical sediment loading rate of 1.6 $m^3$/ha/yr for a developed catchment. Provision for sediment dewatering has also been made. These areas assume a depth of 500mm and a sediment cleanout frequency of 5 years.

**Table 60. Sediment pond design parameters and checks – SB5 (SB-03)**

| | Parameter | Proposed design |
|---|---|---|
| Conditions | Contributing Catchment (ha) | 147 |
| | Area of Basin ($m^2$) | 900 |
| Capture Efficiency | Settling Velocity of Target Sediment (mm/s) [Particle size 125 µm] | 11 |
| | Hydraulic Efficiency (λ) | 0.11 |
| | Permanent Pool Depth, dp (m) | 0.50 |
| | Extended detention depth, de | 0.35 |
| | Number of CTSR's, n | 1.12 |
| | Depth below permanent pool that is sufficient to retain sediment, d* (m) | 0.50 |
| | Design Discharge ($m^3$/s) | 0.27 |
| | Capture Efficiency | 98.1% |
| | Check (>95%) | OK |
| Sediment Storage | Sediment Loading rate, Lo ($m^3$/ha/yr) | 1.6 |
| | Desired clean-out frequency, Fr | 5 |
| | Storage volume required, St | 211 |
| | Available sediment storage volume | 216 |
| | Check (Available storage > required storage) | OK |
| Sediment dewatering | Depth for dewatering area (m) | 0.50 |
| | Area required for dewatering ($m^2$) | 422 |

## 21.3 Maintenance considerations

### Access tracks

Access paths should be at least 4m wide and with a cross fall no steeper than 1:20m. An access track has been located around the treatment system, ensuring access to the sediment basin and dewatering areas.

A maintenance ramp will be provided to the sediment ponds, the ramp should extend from the base of the sediment pond to 0.5m above EDD. It will be 4m wide and no steeper than 1:5. It will be able to support a 20-tonne excavator and be constructed of either 200mm of cement treated crushed rock (6%) or compacted FCR.

### Sediment dewatering areas

A sediment dewatering area of 422$m^2$ has been provided adjacent to the sediment pond. This area will allow accumulated sediment taken from the sediment basin to be dewatered on site before it is transported off site in accordance with EPA Victoria transport regulations. The location allows for vehicle access / hard stand.

# 22 Sediment Basin Functional Design (SB6; DCP ref SB-04)

This section outlines the design calculations that have been undertaken to ensure the performance of the treatment system SB6 (SB-04) complies with the appropriate guidelines.

SB6 (SB-04) has been relocated to within the PSP waterway floodplain (DR-01) to reduce asset footprints and overall land take of developable area. The system remains offline to stream flows to ensure asset integrity, function and longevity is protected (e.g. from scour, resuspension of suspended solids) and to minimise impacts on council's future maintenance and / or asset renewal. Its location south of the property boundary allows for practical delivery and development staging.

A plan view of the designed sediment basin is shown below. Refer to Appendix B for further design details and cross sections. The Sediment Basin Normal Water Level (NWL) is set at 16.30m AHD, and the Top of Extended Detention (TED) is set at 16.65m AHD.

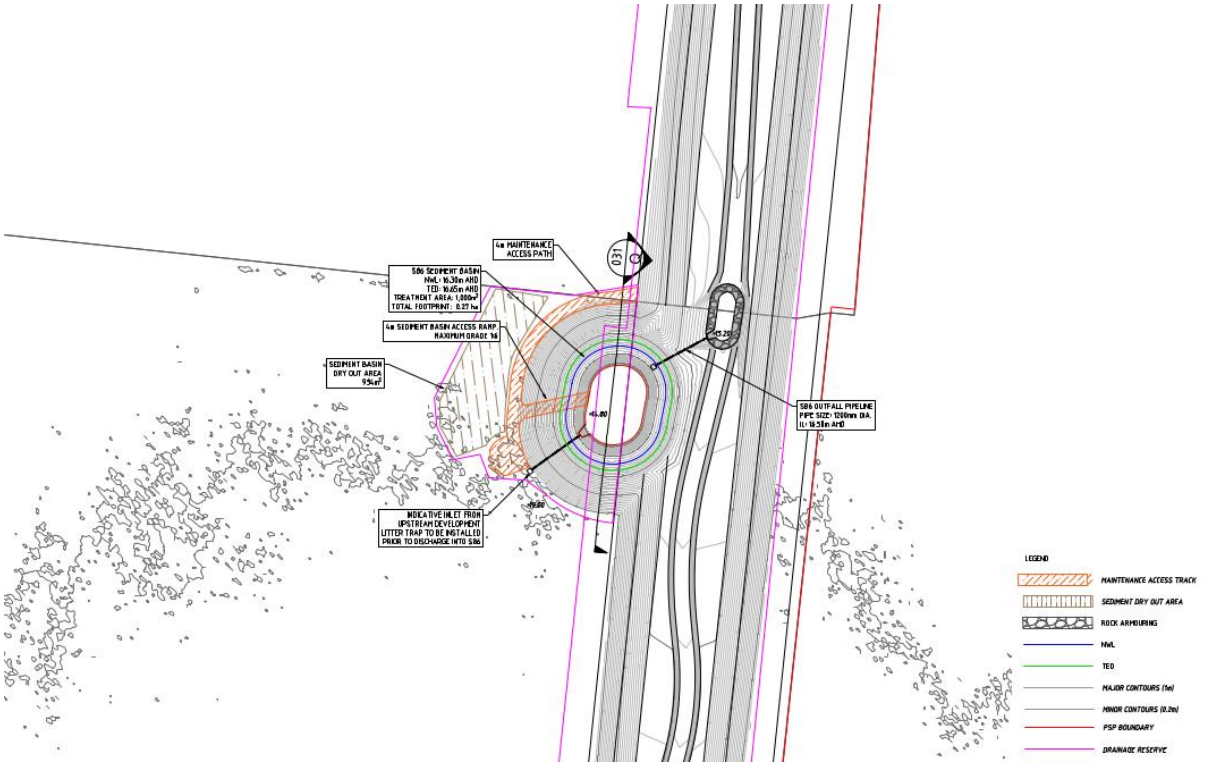



Figure 88. *Plan view of the designed wetland structure SB6 (SB-04)*

## 22.1 Velocities

As established in the MUSIC modelling, the area of the sediment basin SB6 (SB-04) will be 1,000 $m^2$.

A manual calculation has been used to check the flow velocities through the assets for the design. This calculates the flow area from the flow depth (between extended detention depth and normal water level) and the average width in that area. The average width is determined from the narrowest part of the macrophyte zone or sediment basin (the minimum design width).

For SB6 (SB-04) the minimum design width is 12.5m to meet velocity requirements.

Table 61. System velocity calculations and design checks – SB6 (SB-04)

| | Parameter | 4EY | 1EY | 20% AEP |
|---|---|---|---|---|
| Flow Conditions | Design flow ($m^3/s$) | 0.40 | 0.99 | 2.02 |
| | Flow depth (m) | 0.35 | 0.35 | 0.35 |
| Sediment Basin SB6 (SB-04) | Width at NWL (m) | 12.5 | 12.5 | 12.5 |
| | Width at EDD (m) | 16.7 | 16.7 | 16.7 |
| | Average Width (m) | 14.6 | 14.6 | 14.6 |
| | Flow area ($m^2$) | 5.1 | 5.1 | 5.1 |
| | Flow velocity (m/s) | 0.08 | 0.19 | 0.40 |
| | Check | <0.5 OK | <0.5 OK | <0.5 OK |

## 22.2 Design parameters

The sediment pond has been sized to ensure a capture efficiency greater than 95% for the 4EY peak flow and provide adequate sediment storage. The procedure outlined in *WSUD Engineering Procedures (2005)* has been followed and are based on the typical sediment loading rate of 1.6 $m^3$/ha/yr for a developed catchment. Provision for sediment dewatering has also been made. These areas assume a depth of 500mm and a sediment cleanout frequency of 5 years.

Table 62. Sediment pond design parameters and checks – SB6 (SB-04)

| | Parameter | Proposed design |
|---|---|---|
| Conditions | Contributing Catchment (ha) | 71 |
| | Area of Basin ($m^2$) | 1,000 |
| Capture Efficiency | Settling Velocity of Target Sediment (mm/s) [Particle size 125 µm] | 11 |
| | Hydraulic Efficiency (λ) | 0.11 |
| | Permanent Pool Depth, dp (m) | 0.50 |
| | Extended detention depth, de | 0.35 |
| | Number of CTSR's, n | 1.12 |
| | Depth below permanent pool that is sufficient to retain sediment, d* (m) | 0.50 |
| | Design Discharge ($m^3/s$) | 0.40 |
| | Capture Efficiency | 97.4% |
| | Check (>95%) | OK |
| Sediment Storage | Sediment Loading rate, Lo ($m^3$/ha/yr) | 1.6 |
| | Desired clean-out frequency, Fr | 5 |
| | Storage volume required, St | 467 |
| | Available sediment storage volume | 604 |
| | Check (Available storage > required storage) | OK |
| Sediment dewatering | Depth for dewatering area (m) | 0.50 |
| | Area required for dewatering ($m^2$) | 934 |

## 22.3 Maintenance considerations

### Access tracks

Access paths should be at least 4m wide and with a cross fall no steeper than 1:20m. An access track has been located around the treatment system, ensuring access to the sediment basin and dewatering areas.

A maintenance ramp will be provided to the sediment ponds, the ramp should extend from the base of the sediment pond to 0.5m above EDD. It will be 4m wide and no steeper than 1:5. It will be able to support a 20-tonne excavator and be constructed of either 200mm of cement treated crushed rock (6%) or compacted FCR.

## Sediment dewatering areas

A sediment dewatering area of 934m$^2$ has been provided adjacent to the sediment pond. This area will allow accumulated sediment taken from the sediment basin to be dewatered on site before it is transported off site, in accordance with EPA Victoria transport regulations. The location allows for vehicle access / hard stand.

# 23 Sediment Basin Functional Design (SB7; DCP ref SB-05)

This section outlines the design calculations that have been undertaken to ensure the performance of the treatment system SB7 (SB-0-5) complies with the appropriate guidelines. A plan view of the designed sediment basin is shown below. Refer to Appendix B for further design details and cross sections.

The Sediment Basin Normal Water Level (NWL) is set at **20.20m AHD**, and the Top of Extended Detention (TED) is set at **20.55m AHD.**

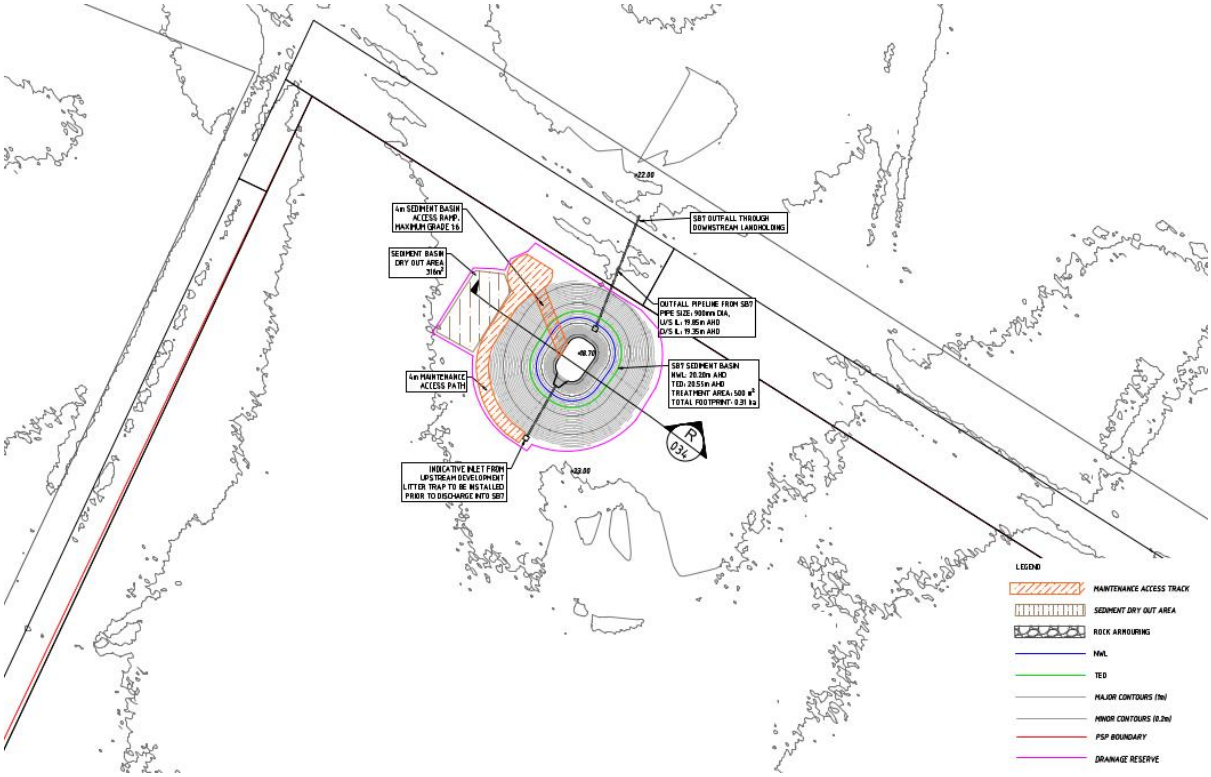



**Figure 89.** *Plan view of the designed wetland structure SB7 (SB-05)*

## 23.1 Velocities

As established in the MUSIC modelling, the area of the sediment basin SB7 (SB-05) will be 500m$^2$.

A manual calculation has been used to check the flow velocities through the assets for the design. This calculates the flow area from the flow depth (between extended detention depth and normal water level) and the average width in that area. The average width is determined from the narrowest part of the macrophyte zone or sediment basin (the minimum design width).

For SB7 (SB-05) the minimum design width is 13m to meet velocity requirements.

**Table 63. System velocity calculations and design checks – SB7 (SB-05)**

| | Parameter | 4EY | 1EY | 20% AEP |
|---|---|---|---|---|
| Flow Conditions | Design flow (m$^3$/s) | 0.09 | 0.27 | 0.59 |
| | Flow depth (m) | 0.35 | 0.35 | 0.35 |
| Sediment Basin SB6 (SB-05) | Width at NWL (m) | 13 | 13 | 13 |
| | Width at EDD (m) | 17.2 | 17.2 | 17.2 |
| | Average Width (m) | 15.1 | 15.1 | 15.1 |
| | Flow area (m$^2$) | 5.3 | 5.3 | 5.3 |

| | Parameter | 4EY | 1EY | 20% AEP |
|---|---|---|---|---|
| | Flow velocity (m/s) | 0.02 | 0.05 | 0.11 |
| | Check | <0.5 OK | <0.5 OK | <0.5 OK |

## 23.2 Design parameters

The sediment pond has been sized to ensure a capture efficiency greater than 95% for the 4EY peak flow and provide adequate sediment storage. The procedure outlined in *WSUD Engineering Procedures (2005)* has been followed and are based on the typical sediment loading rate of 1.6 $m^3$/ha/yr for a developed catchment. Provision for sediment dewatering has also been made. These areas assume a depth of 500mm and a sediment cleanout frequency of 5 years.

Table 64. Sediment pond design parameters and checks – SB7 (SB-05)

| | Parameter | Proposed design |
|---|---|---|
| Conditions | Contributing Catchment (ha) | 20 |
| | Area of Basin ($m^2$) | 500 |
| Capture Efficiency | Settling Velocity of Target Sediment (mm/s) [Particle size 125 µm] | 11 |
| | Hydraulic Efficiency (λ) | 0.11 |
| | Permanent Pool Depth, dp (m) | 0.50 |
| | Extended detention depth, de | 0.35 |
| | Number of CTSR's, n | 1.12 |
| | Depth below permanent pool that is sufficient to retain sediment, d* (m) | 0.50 |
| | Design Discharge ($m^3$/s) | 0.09 |
| | Capture Efficiency | 98.9% |
| | Check (>95%) | OK |
| Sediment Storage | Sediment Loading rate, Lo ($m^3$/ha/yr) | 1.6 |
| | Desired clean-out frequency, Fr | 5 |
| | Storage volume required, St | 158 |
| | Available sediment storage volume | 183 |
| | Check (Available storage > required storage) | OK |
| Sediment dewatering | Depth for dewatering area (m) | 0.50 |
| | Area required for dewatering ($m^2$) | 316 |

## 23.3 Maintenance considerations

### Access tracks

Access paths should be at least 4m wide and with a cross fall no steeper than 1:20m. An access track has been located around the treatment system, ensuring access to the sediment basin and dewatering areas.

A maintenance ramp will be provided to the sediment ponds, the ramp should extend from the base of the sediment pond to 0.5m above EDD. It will be 4m wide and no steeper than 1:5. It will be able to support a 20-tonne excavator and be constructed of either 200mm of cement treated crushed rock (6%) or compacted FCR.

### Sediment dewatering areas

A sediment dewatering area of 316$m^2$ has been provided adjacent to the sediment pond. This area will allow accumulated sediment taken from the sediment basin to be dewatered on site before it is transported off site, in accordance with EPA Victoria transport regulations. The location allows for vehicle access / hard stand.

# 24 Costings

Costing of the various stormwater quality treatment and storage options has been undertaken to provide a cost estimate at a functional design level. This includes the costs associated with the construction of the retarding basins, wetland treatment aspects of the designs, as well as the proposed waterway works. The cost estimates include all excavation, planting, and infrastructure requirements, although this will be subject to site constraints and complexity.

Construction estimation rates were used based on previous works within the area, and the Melbourne Water standard reimbursement rates for the southeast region, as the Bass Coast Shire Council region shares management between the WGCMA and Melbourne Water Catchments.

In preparation for Tranche 2 Panel Hearing, Alluvium hosted a Conclave of Professionals to address the proposed PSP designs and cost estimations. Following the Conclave and Tranche 2 SAC Recommendations Report, the cost estimates adopted have been adjusted as follows:

- stormwater pipe **costings are consistent with** the Engeny Stormwater Strategy high-level (concept) costs, with appropriate adjustment to current design, industry rates (including Council rates advice) and price guides (e.g., Rawlings Construction Handbook 2022)
- A line item for landscape maintenance costs (period 24 months) **has been added** to the cost estimates to allow for site establishment for all relevant stormwater assets
- A **nominal $50K** allowance **has been included** for Environmental Management and Reporting
- An **additional 0.5%** of the construction value **has been allowed**, specifically for erosion control site management for each of the proposed WLRB (WL) assets
- An itemised **per square metre** costing for maintenance tracks and shared paths **has been added**
- Costs for all stormwater pipes to have rubber ring joints **has been added**.

Delivery allowances have been added to all functional design cost sheets to reflect the following agreed allowances:

- Council fees **remain** at 3.25%. This fee includes supervision fees as per council advice
- Supervision and project management costs **have been adjusted** from 9% down to 4% given council supervision is included in council fees overall (as above)
- Vic Roads fees to **remain** at 1% for WL-01, given works under Korumburra-Wonthaggi Road (all other assets have applied 0%)
- Traffic management rate **has been adjusted** from 5% **down** to 2% given site is greenfield (no public roads)
- Survey and design **remain** at 5%
- Site establishment **remains** at 2.5%
- Contingency rate of 20% **has increased** to 35% (applied to all cost estimates) to account for potential unknowns / risks associated with geotechnical investigations and soil contamination risks, which were not available at the time of this functional design stage/was not undertaken as part of the PSP background studies.
- All proposed **wetland-retarding basin** (WL) asset cost sheets have allowed for further **technical study allowances** as follows:
    - Geotechnical Investigation allowance of $50K
    - Cultural Heritage Assessment allowance of $50K

- Flora and Fauna Study allowance of $30K
- Safety Assessment allowance of $20K.

Further, following discussions between Council, VPA and Alluvium, an excavation rate of approximately $25/m3 was adopted and applied to all PSP assets, on the basis that:

- The majority of excavation is undertaken in broad greenfield land areas (i.e. not in public roads)
- Much of the excavated material can be reused as filling on site
- There is little, to no, offsite disposal of excavated material required.

The excavation rates have been determined based on Melbourne Water's standard reimbursement rates; the excavation rate consists of:

- $10.90/m3 for bulk excavation works (i.e. cut)
- $11.70/m3 for reuse of onsite for filling (assuming 95% of cut is reused for filling)
- $19.20/m3 for disposal of excess cut (assuming 5% of bulk excavation is to be disposed offsite).

In revising cost estimates, the following volumes and reuse estimates have been adopted (and align with above conditions):

- An excavated volume of 5% has been assumed for offsite disposal
- An excavated volume of 95% has been assumed to be reused on site for filling
- An allowance of 5% has been assumed for some rock excavation / potential reuse in waterways
- Excavated topsoil has assumed 5% for removal and 95% for stockpiling on site for later reuse on site
- An allowance of 5% has been assumed to import clean topsoil to cover for topsoil losses (shortfall due to above).

The total cost estimate for Wonthaggi North East PSP stormwater management strategy is **$55,152,879** based on current (2022) industry rates and price guides; and the allowances as per above recommendations and the SAC Final Recommendations Report (August 2022).

This represents a 56% increase in cost estimates from the original high-level concept cost estimates in the Engeny Strategy 2019 (at $35,354,000) to these functional level cost estimates (Alluvium, 2022 rates). This is likely due to:

- Changes in industry rates between 2019 to current rates
- A more accurate earthworks modelling of proposed assets, which is undertaken at the functional design phase (not required at concept stage) to inform actual excavation costs
- Further design detail and refinements of wetland-retarding basins, inlet zones and sediment basins
- Constructed waterway infrastructure design considerations (i.e. sheer stress, velocity controls, etc) as per industry best practice *Constructed Waterway Design Manual* and *Waterway Corridor Guidelines for Greenfield Developments* (Melbourne Water).
- Additional costings allowances, as per submissions, panel hearing, and SAC recommendations, plus addition of the trunk drainage design and primary treatment at pipe outfalls to constructed waterways (as per SAC recommendations).

Additionally, while Engeny has been re-engaged by Council / VPA over this time, the scope of works did not include an updating of the original 2019 drainage strategy cost estimates, despite modelling updates and

concept design changes. While the original cost estimates remained unchanged, Alluvium's functional design process responded to the revised modelling and various strategy updates and recommendations.

A summary of the cost estimates for the Wonthaggi North East PSP stormwater management strategy is provided below. Costing estimates have been set out in a way that allows for staged construction of each asset (i.e. separating out asset specific costs).

A costing breakdown for each individual asset is provided in Appendix C.

## 24.1 Wonthaggi North East PSP Functional Designs – DCP Funded Costings Summary

| Item | Description of works | TOTAL | |
|---|---|---|---|
| A1 | DR-01 WEST WATERWAY (W-WW) | $ | 8,922,417 |
| A2 | DR-02 EAST WATERWAY (E-WW) | $ | 10,366,946 |
| A3 | DR-03 MAIN OUTFALL TO POWLETT RIVER (MOP) | $ | 1,435,271 |
| A4 | WL-01 WETLAND RETARDING BASIN 1 (WLRB1A&B) | $ | 16,806,080 |
| A5 | WL-02 WETLAND RETARDING BASIN 2 (WLRB2) | $ | 1,755,841 |
| A6 | WL-03 WETLAND RETARDING BASIN 3 (WLRB3) | $ | 2,252,825 |
| A7 | WL-04 WETLAND RETARDING BASIN 4 (WLRB4) | $ | 2,412,973 |
| A8 | SB-01 SEDIMENT BASIN 1 (SB1) | $ | 888,806 |
| A9 | SB-02 SEDIMENT BASIN 4 (SB4) | $ | 1,182,388 |
| A10 | SB-03 SEDIMENT BASIN 5 (SB5) | $ | 867,808 |
| A11 | SB-04 SEDIMENT BASIN 6 (SB6) | $ | 734,715 |
| A12 | SB-05 SEDIMENT BASIN 7 (SB7) | $ | 791,537 |
| A13 | CU-01 BASS HIGHWAY CULVERTS (4 x 1500mm dia.) | $ | 353,557 |
| A14 | CU-02 BASS HIGHWAY CULVERTS (3 x 1650mm dia.) | $ | 345,107 |
| A15 | CU-03 MCGIBBONYS ROAD (4 x 1650mm dia.) COST CALCULATED BY VPA | $ | 278,165 |
| A16 | CU-04 KORRUMBURRA - WONTHAGGI ROAD WL-01 LOW FLOW OUTLET | $ | 160,319 |
| A17 | CU-05 HESLOP ROAD WL-02 OUTLET | $ | 162,808 |
| A18 | CU-06 HESLOP ROAD WL-03 OUTLET | $ | 352,187 |
| A19 | CU-07 HESLOP ROAD SB-05 OUTLET | $ | 202,524 |
| A20 | CU-08 NEW CROSSING OVER DR-03 (DESIGNED AND COSTED BY CARDNO) | $ | 225,967 |
| A21 | CU-09 NEW CROSSING OVER DR-03 (DESIGNED AND COSTED BY CARDNO) | $ | 114,026 |
| A22 | CU-10 NEW CROSSING OVER DR-03 (DESIGNED AND COSTED BY CARDNO) | $ | 554,320 |
| A23 | CU-11 KORRUMBURRA - WONTHAGGI ROAD HIGH FLOW OUTLET | $ | 363,771 |
| A24 | PIPELINE EI1 – EH1 (400mm dia.) | $ | 109,816 |
| A25 | PIPELINE EH1 – DR-01 (200mm dia.) | $ | 18,792 |
| A26 | PIPELINE EV1 – EW1 (370mm dia.) | $ | 336,164 |
| A27 | PIPELINE DU1 – DW1 (281mm dia.) | $ | 495,639 |
| A28 | PIPELINE DP2 – DP3 (307mm dia.) | $ | 262,062 |
| A29 | PIPELINE DQ1 – DP3 (329mm dia.) | $ | 60,082 |
| A30 | PIPELINE DP3 – DW1 (317mm dia.) | $ | 108,243 |
| A31 | PIPELINE DW1 – SB1 (200mm dia.) | $ | 31,941 |
| A32 | PIPELINE DL3 – DW2 (330mm dia.) | $ | 155,034 |
| A33 | PIPELINE DM1 – GPT1 (486mm dia.) | $ | 159,732 |
| A34 | PIPELINE G3 – V2 (457mm dia.) | $ | 182,304 |
| A35 | PIPELINE V2 – SB-03 (333mm dia.) | $ | 22,788 |
| A36 | PIPELINE W2 – V5 (322mm dia.) | $ | 410,184 |
| A37 | PIPELINE FB1 – 14 (386mm dia.) | $ | 160,745 |
| A38 | PIPELINE EY2 – 13 (340mm dia.) | $ | 101,210 |
| A39 | PIPELINE 13 – 14 (300mm dia.) | $ | 40,500 |
| A40 | PIPELINE GY2 – GY3 (436mm dia.) | $ | 790,439 |
| A41 | PIPELINE GY3 – WL-04 (300mm dia.) | $ | 72,684 |
| A42 | PIPELINE HM1 – HC2 (411mm dia.) | $ | 94,041 |
| A43 | PIPELINE HC2 – SB-05 (400mm dia.) | $ | 10,125 |
| TOTAL | | $ | 55,152,879 |

## 24.2 Wonthaggi North East PSP Functional Designs – Developer funded costs

| Item | Description of works | TOTAL |
|---|---|---|
| B1 | PIPELINE 0 – 4 (600mm dia.) | $ 79,616 |
| B2 | PIPELINE 1 – 3 (750mm dia.) | $ 110,140 |
| B3 | PIPELINE 2 – 3 (825mm dia.) | $ 6,750 |
| B4 | PIPELINE 3 – 4 (1050mm dia.) | $ 46,980 |
| B5 | PIPELINE 4 – EA1 (1200mm dia.) | $ 96,849 |
| B6 | PIPELINE EA1 – GPT3 (1350mm dia.) | $ 417,933 |
| B7 | PIPELINE 5 – 6 (900mm dia.) | $ 177,977 |
| B8 | PIPELINE DY1 – 7 (675mm dia.) | $ 151,511 |
| B9 | PIPELINE EM1 – 8 (900mm dia.) | $ 363,528 |
| B10 | PIPELINE 8 – 10 (1050mm dia.) | $ 206,712 |
| B11 | PIPELINE 11 – EL1 (1050mm dia.) | $ 248,994 |
| B12 | PIPELINE EL1 – SB-02 (1350mm dia.) | $ 90,855 |
| B13 | PIPELINE 10 – EK1 (1050mm dia.) | $ 140,940 |
| B14 | PIPELINE EW1 – EK1 (1350mm dia.) | $ 526,959 |
| B15 | PIPELINE EK1 – GPT2 (1500mm dia.) | $ 79,853 |
| B16 | PIPELINE 12 – FC1 (525mm dia.) | $ 60,473 |
| B17 | PIPELINE FC1 – FH1 (750mm dia.) | $ 369,117 |
| B18 | PIPELINE FH1 – FI1 (825mm dia.) | $ 87,750 |
| B19 | PIPELINE 21 – FI1 (450mm dia.) | $ 13,284 |
| B20 | PIPELINE FI1 – FK1 (1050mm dia.) | $ 281,880 |
| B21 | PIPELINE FK1 – WL-01 (1050mm dia.) | $ 18,792 |
| B22 | PIPELINE V5 – AA2 (1350mm dia.) | $ 726,840 |
| B23 | PIPELINE AA2 – GPT4 (1350mm dia.) | $ 36,342 |
| B24 | PIPELINE 22 – 23 (750mm dia.) | $ 32,744 |
| B25 | PIPELINE 23 - 24 (825mm dia.) | $ 148,500 |
| B26 | PIPELINE 24 – FF1 (900mm dia.) | $ 802,791 |
| B27 | PIPELINE FF1 – SB-05 (1350mm dia.) | $ 36,342 |
| B28 | PIPELINE EP1 – FJ2 (1350mm dia.) | $ 872,208 |
| B29 | PIPELINE FJ2 – WL-01 (1500mm dia.) | $ 287,469 |
| B30 | PIPELINE 17 – 19 (525mm dia.) | $ 48,769 |
| B31 | PIPELINE 18 – 19 (450mm dia.) | $ 26,568 |
| B32 | PIPELINE 19 – 20 (675mm dia.) | $ 41,796 |
| B33 | PIPELINE 16 – 20 (450mm dia.) | $ 59,778 |
| B34 | PIPELINE 20 – 15 (825mm dia.) | $ 114,750 |
| B35 | PIPELINE 14 – EZ1 (900mm dia.) | $ 124,963 |
| B36 | PIPELINE 15 – EZ1 (1050mm dia.) | $ 155,034 |
| B37 | PIPELINE EZ1 – FD1 (1200mm dia.) | $ 581,094 |
| B38 | PIPELINE FD1 – FM1 (1350mm dia.) | $ 635,985 |
| B39 | PIPELINE FN1 – FM1 (900mm dia.) | $ 212,058 |
| B40 | PIPELINE FM1 – WL-02 (1500mm dia.) | $ 47,912 |
| B41 | PIPELINE 25 – GY1 (525mm dia.) | $ 117,045 |
| B42 | PIPELINE 26 – 28 (450mm dia.) | $ 38,192 |
| B43 | PIPELINE 27 – 28 (450mm dia.) | $ 16,605 |
| B44 | PIPELINE 28 – GZ1 (600mm dia.) | $ 56,869 |
| B45 | PIPELINE 29 – 31 (525mm dia.) | $ 111,193 |
| B46 | PIPELINE 30 – 31 (525mm dia.) | $ 56,572 |
| B47 | PIPELINE 31 – 33 (900mm dia.) | $ 151,470 |
| B48 | PIPELINE 32 – 33 (450mm dia.) | $ 36,531 |
| B49 | PIPELINE 33 – GZ1 (1050mm dia.) | $ 159,732 |
| B50 | PIPELINE GZ1 – HG1 (1050mm dia.) | $ 465,102 |
| B51 | PIPELINE HG1 – WL-03 (1500mm dia.) | $ 95,823 |
| B52 | PIPELINE 35 – 36 (825mm dia.) | $ 307,125 |
| B53 | PIPELINE 36 – WL-04 (1350mm dia.) | $ 45,428 |
| B54 | PIPELINE 37 – 38 (600mm dia.) | $ 168,332 |
| B55 | PIPELINE 38 – WL-04 (1050mm dia.) | $ 28,188 |
| B56 | GROSS POLLUTANT TRAP GPT1 (1050mm DIA. INCOMING PIPELINE) | $ 62,504 |
| B57 | GROSS POLLUTANT TRAP GPT2 (1500mm DIA. INCOMING PIPELINE) | $ 97,168 |
| B58 | GROSS POLLUTANT TRAP GPT3 (1350mm DIA. INCOING PIPELINE) | $ 86,396 |
| B59 | GROSS POLLUTANT TRAP GPT4 (1350mm DIA. INOMING PIPELINE) | $ 86,396 |
| | TOTAL | $ 10,755,504 |

# 25 Summary

Alluvium was engaged by the VPA to undertake a suite of stormwater drainage functional designs and associated cost estimates for the Wonthaggi North East Precinct Structure Plan (PSP) and Development Contributions Plan (DCP). This work was originally based on the WNEPSP Stormwater Management Plan (October 2019) undertaken by Engeny, with associated concept design layouts for the precinct. Subsequent studies and revisions to the modelling and Strategy was undertaken between 2019 and 2022 (Engeny). These revisions informed Alluvium's functional design work (April 2022).

Following the planning panels and amendments process (June 2022) Alluvium was re-engaged by the VPA (November 2022) to undertake a review of the Functional Design Report, functional asset designs and cost estimates in line with the Standing Advisory Committee's (SAC) recommendations. Engeny was also re-engaged by the VPA to work in parallel with Alluvium and refine and update the Revised Drainage Strategy (September 2022) and associated concept layouts, to the new *Revised Drainage Strategy* (September 2023).

In accordance with Section 10.2, Recommendations 1 and 2, Appendix H and Table 7 of the *VPA Projects SAC Final Recommendations Report* (August 2022), Alluvium has updated the Functional Design Report and drawings package to:

- Provide further clarity of purpose, outcomes, assumptions adopted and other relevant details of the stormwater design solution for the PSP
- Provide consistency between the PSP's *Revised Drainage Strategy* (Engeny 2023) and *Functional Design Report* and design set (Alluvium 2023) to enable other professionals to:
    - Understand and reproduce the PSP results, as well as making future amendments if needed
    - Assess and approve, with confidence, proposals from developers without needing to contact the original authors.

This Functional Design Report (and design package) aligns with the SAC Recommendations and the Revised Drainage Strategy (Engeny 2023). On all plans and sections (for all asset types) the proposed stormwater (drainage) reserves, 1% AEP flood level estimates, and potential for earth fill has been included. Further, the following items are noted.

## 25.1 Trunk stormwater network

A masterplan for the proposed trunk stormwater drainage network has been provided to ensure outfall connection is achievable from future development pad(s) to the proposed stormwater treatment/retarding PSP assets with minimal fill requirements.

The pipe master plan shows the existing pipe network, proposed external connections and proposed internal pipe network with asset alignments, levels / inverts, discharge points / outfall locations, primary treatment mechanism (as appropriate), and relevant waterway flood level estimates. Waterway peak flows and water depths at the trunk infrastructure outfall points are also provided for the 1% AEP, 10% AEP, and 50% AEP.

For pipes that outfall directly to a constructed waterway (DRs) a primary treatment asset (GPT) has been included. Costs for respective GPTs have been associated with delivery of the upstream pipe and summarised in Section 26.2 (Staging Recommendations).

## 25.2 Waterways & Corridors

Following the panel recommendations, waterway invert levels within the upstream reaches were lowered in order to provide appropriate outfalls for the trunk drainage network and sediment basins. The waterway grades were flattened to a minimum 1 in 800 to provide longitudinal grades suitable for waterway conveyance.

The redesign of W-WW and E-WW looked at adjusting the waterway inverts without compromising channel capacity in the 1% AEP, to reduce overall excavation and (DCP) costs, and consideration of a minimum waterway corridor width without compromising hydraulic capacity.

Consideration was given to the NWL of WLRB 1A and 1B (WL-01) and the interface with waterway levels. Both W-WW and E-WW inverts have been redesigned to 14.35m AHD to complement a revised WLRB1 NWL at 14.0m AHD. These were then re-modelled to determine performance outcomes. Designs were refined further to address emerging impacts of flooding to agricultural land east of the PSP (eastern levee on E-WW), with flows breaking out within the PSP during the 1% AEP. W-WW has been adjusted to remain outside an adjacent property as requested through stakeholder feedback.

Waterway and corridor aspects are outlined below for both PSP constructed waterways (DR-01 and DR-02) with recommended hydraulic and overall waterway corridor widths based on a road along the active edge of the corridor.

| Redesign | W-WW (DR-01) | E-WW (DR-02) |
|---|---|---|
| **Downstream invert** | 14.35m AHD | 14.35m AHD |
| **Hydraulic width** | Varies 23m - 36m | Varies 23m - 36m |
| **Waterway corridor width** | Varies 45m - 60m | Varies 55m - 60m |

## W-WW (DR-01)

The western waterway outfalls into WL-01, from the western draining catchment. Sediment basins SB-01 and SB-02 outfall into the western waterway, as well as Gross pollutant traps GPT1, GPT2 and GPT3. Key changes to the eastern waterway following the SAC recommendations include:

- The invert level of DR-01 was lowered in the upstream reaches, in order to provide appropriate outfall for the future development areas.
- Straightened DR-01 through parcels 65 and 65R (downstream of Bass Hwy and upstream of McGibbonys Road) as per council-approved development plans and SAC recommendations.

## E-WW (DR-02)

The eastern waterway outfalls into WL-01, from the eastern draining catchment. Sediment basins SB-03 and SB-04 outfall into the eastern waterway, as well as Gross pollutant trap GPT4. Key changes to the eastern waterway following the SAC recommendations include:

- The invert level of DR-02 was lowered in the upstream reaches in order to provide appropriate outfall for the future development areas.

## Main PSP outfall (DR-03)

The Main outfall to the Powlett (DR-03) receives outflows from the WL-01 and WL-02 catchments. DR-03 is required to manage regular stormwater runoff within the land downstream of the PSP boundary. An agreement was reached with the downstream landowner to manage the frequency of inundation within the landholding. As a result, DR-03 was designed to convey runoff for events up to and including the 50% AEP.

As part of the Engeny flood modelling, the influence of the Powlett River flows on the landholding was included in order to determine the frequency and extent of inundations within the subject site. It is noted there is a high

level of sensitivity to any design changes to the existing farm channels downstream of the PSP (to the north) through to the Powlett River (existing main outfall downstream of Pinkerton Rd).

The existing channel downstream of the PSP, through the constriction, is very sensitive to changes in cross sectional flow area, where any change was found to alter how the floodplain behaves. A fairly significant increase to flood depth (100-150mm) in the 50% AEP was found on the subject property (465 Heslop Rd, downstream of PSP). There is also some uncertainty on the existing conditions modelling given this area has not had detailed feature survey undertaken, and the presence of vegetation cover along the channel length needs consideration. The area to be surveyed is approximately 2km in length and should cost in the order of $20,000 to undertake. This estimate is indicative only and will vary slightly based on accessibility, line of sight etc.

The modelling undertaken on the MOP has therefore been based on a cross section at the upstream reach of the channel length and one a few hundred metres downstream. This design supersedes the previous Addendum MOP design.

Alluvium's functional design for the MOP is based on the best available information at the time of this project. A more detailed design would benefit from a full survey of the channel outfall to the Powlett River to better inform the MOP design, given current time constraints. It is anticipated that the overall cost to the DCP should not be significant given a channel width variation of a few metres is likely.

The design extends from the PSP's WLRB1 (WL-01) outfall to the existing choke point (on the subject property). Given flood behaviour sensitivity to any further modifications to the downstream channel sections, at future detailed design phase, detailed survey should be undertaken along the MOP outfall to Powlett River.

***Recommendation:*** the cross sectional flow area of the existing channel outfall (MOP) needs to be surveyed (approx. cost $20K) and further design undertaken as part of the detailed design stage to ensure flood behaviour is not made worse upstream or downstream.

## 25.3 Wetlands and Retarding Basins

### WLRB1 (WL-01)

Following the SAC recommendations, the WLRB1 system has been reviewed with respect to providing treatment and storage efficiencies. The overall footprint of the WLRB1 system has been reviewed with respect to the Engeny TUFLOW model results. The storage (retarding) requirements of the WLRB1 system remains the controlling factor with respect to the drainage reserve footprint.

WLRB1 A and B redesign sought to reduce excavation costs and achieve a reduction in the macrophyte zone, without compromising upstream and downstream conditions and achieve treatment performance. The redesign raised the NWL to 14.0m AHD. Macrophyte zones were reduced without compromising width to length ratio (stress) on the system (asset integrity) and sediment basins (wetland inlets) modelled in RORB.

Inverts to the upstream constructed waterways were raised to 14.0m AHD to transition with new wetland NWL. The remodelling noted positive increases in floodplain storage under all scenarios for WLRBs 1 and 3, necessary to accommodate the additional volumes of runoff being generated (hence, additional storage above the existing conditions will be required). The results provide a good indication of how the design changes have impacted on the available flood storage and decreased excavation volumes. DCP costs have come down considerably for WLRB1A and B (refer to detailed costings tables below).

A sensitivity check on WLRB2 (WL-02) and WLRB3 (WL-03) was undertaken to test for any negative impacts on performance with the redesign changes to WL-01, given the shared main outfall. The reduction in flood storage associated with WL-02 is offset by the increases in WL-01 and is also partly a function of removing a set of

culverts from under Wonthaggi-Korumburra Road and considered of low concern given the relative magnitudes and flow diversions in play.

### WLRB2 (WL-02)

As per Alluviums previous design recommendations, and supported by the SAC recommendations, WLRB2 (WL-02) has been reviewed to provide appropriate offsets from Heslop Road, and Korumburra-Wonthaggi Road. The design remains similar to the previous recommendations, only minor changes to layout and footprint have occurred.

### WLRB3 (WL-03)

As per Alluvium's previous recommendations and supported by the SAC recommendations, WLRB3 (WL-03) has been redesigned to allow an independent outfall for WL-03 and the Northern Views Estate WL-04 arrangement (as per S173). No changes have been made in relation to WL-04. A new culvert design (CU-06) has been provided for the outfall crossing of Heslop Road from WL-03 to the downstream channel.

## 25.4 Catchment contributions

The catchments external to the Wonthaggi NE PSP boundary have been designed to outfall into proposed PSP assets via a trunk drainage network. the trunk drainage network has been designed and costed as part of the functional design. Whilst external catchments require appropriate outfall into future stormwater drainage assets. There is no requirement for the PSP area to treat this catchment to BPEM. As a result, an offset has been applied by 'removing' the external catchment source loads from the overall contributing source loads in the MUSIC modelling.

Given the external catchment areas passing through the PSP, consideration was given to the appropriateness of attributing a fair and equitable apportionment of DCP costs (if any) to the landowners within the PSP, that arises from accommodating overland flows from outside the PSP area. A breakdown of PSP internal and external flows (catchment contributions) considered the following:

- overland flows generated within the PSP land under a fully developed scenario
- overland flows travelling through the PSP land from external catchments (likely benefitting from PSP assets)
- whether external flows have necessitated an upsizing of drainage assets (proportionate)
- proportion of external flows that use the PSP drainage infrastructure
- proportion of external agricultural catchment vs existing/proposed urban catchment.

It should be noted that while PSP assets have increased in size overall to accommodate catchment conditions, the increase cannot be directly apportioned to asset sizing, as the fraction imperviousness of the external (undeveloped) catchment(s) is lower than that of the proposed PSP (developed areas). Refer to:

- Table 1 – Catchment breakdowns within the PSP and external areas
- Figure 18 – Map of external drainage catchments and respective contributing 1% AEP flows (summary of surface flows to be managed by the PSP assets).

The accommodation of external catchment inflows was critical in ensuring in the developed scenario, PSP assets can perform as required for flood protection (quantity) and waterway protection (quality). Where surface waters from the external urban or external agricultural areas are currently not being retarded, the PSP assets need to account for this to ensure asset performance (and compliance) is met and maintained in accordance with industry best practice standards, guidelines, and State requirements for the duration of the PSP asset's design life (subject to appropriate maintenance regimes).

Further, the developed areas to the west of the WNEPSP currently have untreated flows passing through the PSP (as per Table 1). However, for areas developed prior to the introduction of the Victorian Planning

Provisions, Clause 56.07-4 (Residential Subdivisions), or its recent expansion to all development types (i.e. VC154), a retrospective apportionment of costs is not appropriate / possible given the age of these developments (pre-date the regulations).

Future development timing or likelihood of the external agricultural catchments to the east and south of the WNEPSP is currently an unknown. A future developed scenario through a future PSP will need to retard and treat the future PSP imperviousness flows to pre-developed conditions. As these areas remain as pre-developed (agricultural) condition, there is no apportionment of PSP costs appropriate – there is no change to land imperviousness to warrant apportionment.

Future opportunities for council – To improve overall catchment condition of receiving environments in the Wonthaggi region will require Council's future capital works consideration to determine retrofit opportunities for stormwater management measures to best practice / accordance with the State IWM Framework. Options for a precinct-scale treatment/retardation system and/or stormwater harvesting arrangement would contribute to environmental and social values, and longer-term cost-benefits/ liveability outcomes for council and community.

## 25.5 Sediment basins

The sediment pond has been sized to ensure a capture efficiency greater than 95% for the 4EY peak flow and provide adequate sediment storage. The procedure outlined in *WSUD Engineering Procedures (2005)* has been followed and are based on the typical sediment loading rate of 1.6 $m^3$/ha/yr for a developed catchment. Provision for sediment dewatering has also been made. These areas assume a depth of 500mm and a sediment cleanout frequency of 5 years.

The inlet ponds contributing to WLRB1 macrophyte areas have been intentionally over designed in order to 'choke' runoff entering into the macrophyte zones, this was designed in order to manage the significantly high inundation frequencies within the wetlands. High frequency of inundation has an impact on vegetation health, with high effective water levels presenting a high risk of drowning out vegetation. As a result, sediment basins have an efficiency greater than 95% for WLRB1.

## 25.6 Culvert crossings

Culvert crossings have been designed and costed in accordance with the SAC recommendations and VPA guidance. 11 culvert crossings have been proposed as part of the PSP, all culverts have been designed and modelling using HECRAS. In line with the approved Engeny strategy, a risk assessment was undertaken to determine a 25% blockage scenario was required to modelled in HECRAS. That is, modelling was undertaken to determine that waterways can safely convey runoff when all culverts are blocked by 25%.

## 25.7 Summary of redundant assets

The proof of concept and functional design stages of this study determined a number of assets that were deemed redundant to the future PSP delivery of stormwater related assets, due to being:

- An existing asset or under construction through other activity (council works, development approvals)
- Consolidated 4 independent SB assets (as per Engeny Strategy) to integrated assets with proposed wetland-retarding basin designs
- Small contributing catchments that could be accommodated by proposed downstream treatment assets (e.g. WLs)
- A non-PSP / DCP item (e.g., Centennial Dve)
- Removed from final Revised Drainage Strategy (Engeny, 2023).

**Note:** The table below shows E1 (Engeny Strategy) is to be retained, with upgrades proposed, to accommodate PSP flows. While E2, E3 and E4 are listed as 'redundant', as these are not related to / required by the PSP.

Table 65. Summary of redundant assets

| Culverts | Status | Description |
|---|---|---|
| **E1** (now DCP CU-05) | Existing | Outfall culvert from proposed WLRB2 (WL-02)<br>3 x 1650mm dia. pipe culverts under Heslop Road, incorporated as part of functional designs.<br>**To be retained and upgraded with additional culvert cells** (as per CU-05) to service PSP flows. |
| E2 | Existing | 3 x 1200mm(W) x 1200mm(H) Box culverts under Korumburra-Wonthaggi Rd, was incorporated as part of functional designs as per Engeny's TUFLOW (to confirm/inform flow conveyance).<br>Culvert services external to PSP flows from land area to NE of PSP (outside PSP boundary).<br>**To be retained as existing. No upgrades proposed. Not a PSP item.** |
| E3 | Existing | Circular pipe in existing channel, within 465 Heslop Rd property. Services farm access track at 1 x 1500mm dia. Considered by Engeny TUFLOW to confirm conveyance.<br>**Does not affect PSP outflows. Not a PSM item.** |
| E4 | Existing | Circular pipe in existing channel, downstream of Heslop Road, at proposed WLRB3 (WL-03) culverts; at 1 x 600mm dia. Culvert services external to PSP flows (outside PSP boundary).<br>**To be retained as existing. No upgrades proposed. Not a PSP item.** |
| R1 | Redundant | 4 x 1200mm (W) x 1200mm(H) existing box culverts under Korumburra-Wonthaggi Road south of intersection with Heslop Road.<br>**To be removed from PSP assets**. |
| R2 | Redundant | 1 x 600mm dia. circular culvert under Korumburra-Wonthaggi Road east of intersection with Heslop Road.<br>**To be removed from PSP assets**. |
| R3 | Redundant | 1 x 600mm dia. circular pipe in existing channel in 465 Heslop Road property just downstream of Korumburra-Wonthaggi Road.<br>**To be removed from PSP assets**. |
| **R4** (now DCP CU-06) | Existing | 2 x 1200mm(W) x 450mm(H) existing box culverts under Heslop Road, north of proposed WL-03<br>**To be retained and upgraded with additional culvert cells** (as per DCP CU-06) to service PSP flows. |

## 25.8 Revised PSP Cost Estimates

Following the remodelling and redesign of PSP assets as per the SAC recommendations, the cost estimates have been revised (updated) with 'general consistency' with Engeny's costings, noting that:

- Asset type, location, sizing and retarding capacity changed between the concept level and the functional level
- Engeny's costs are of a high-level based on concept designs and 2019 industry rates
- Alluvium's costs are further detailed based on functional designs and current (2022) industry rates, and as per Council, VPA, Conclave experts advice, and based on available price guides (e.g. Rawlings Construction Handbook 2022).

Cost estimate tables include:

- Allowances for crossing servicing infrastructure, specifically for culverts (CU-04, CU-05, CU-06, CU-11)
- Allowances for landscape maintenance costs for a period of 24 months for site establishment of all relevant stormwater assets
- Separation of excavation / spoil disposal / soil import
    - Excavated volume for offsite disposal
    - Excavated volume to be reused on site for filling
    - Allowance for some rock excavation / potential reuse in waterways (pool / riffles)
    - Excavated topsoil for removal and 95% stockpiling on site for reuse (filling)
    - Allowance for 5% losses of topsoil due to unsuitable quality
    - Allowance to import clean topsoil to cover for topsoil losses (shortfall due to above).

# 26 Practical Delivery & Development Staging

The WNEPSP Functional Design Report (this report) and associated functional design drawings are the proposed stormwater solution for the ultimate developed scenario of the precinct. Understanding that future development planning and approvals does not necessarily occur in a linear (upstream to downstream) sequence of land development / asset delivery, a more decentralised suite of PSP assets would be beneficial.

However, in the instance of WNEPSP the assets are largely centralised towards the northern extent of the precinct which has implications for development staging efficiency and cost-effectiveness in delivery. While the centralised layout of stormwater assets reduces maintenance challenges and associated costs ongoing, this presents challenges in practical delivery and development staging.

The centralised layout reduces the degree of flexibility in development / asset delivery. To minimise this impact, wherever possible, and allowing for site topography and precinct constraints, the proposed wetland-retarding basins have been located within a single parcel of land to improve the overall delivery process. Further, consideration and flexibility will be needed to allow for interim solutions, in strategic locations, to later provide for the ultimate solution.

## 26.1 Staging principles

A development staging approach should be based on the principal objectives of constructing the project in a timely, efficient, and cost-effective manner, ensuring impacts are avoided / minimised through the provision of appropriate management measures.

The development staging approach consists of the following key elements:

- If an upstream development occurs before a downstream area, the developer must provide a temporary outfall, at their expense and maintenance, to the satisfaction of the responsible authority.
- A developer may negotiate with downstream landowners / developers to establish agreements for temporary outfalls or delivering the ultimate asset.
- It is critical that development outfalls are provided for all staged works.
- Consideration of external flows conveyance, through the development, must be provided.

The development staging for the PSP must provide for:

- early delivery of the ultimate stormwater infrastructure, including stormwater quality treatment in accordance with best practice
- where this is not possible, the development must clearly demonstrate how any proposed interim solution adequately manages and treats stormwater generated from the development to best practice (or better)
- further, it must be demonstrated how the interim solution will better enable delivery of the ultimate solution and to be compliant / achieve best practice / be to the satisfaction of the responsible authority.

The above principles will need to be adhered to in order to ensure the ultimate strategy is achieved and impacts on receiving environs and surrounding landholders are avoided and/or minimised (mitigated).

## 26.2 Staging recommendations

The following development staging is recommended for the Wonthaggi North East PSP stormwater related assets delivery:

| Order | Asset | Comments & Recommendations |
|---|---|---|
| 1 | WLRB4 (WL-04) | Approved for construction delivery. Does not require other PSP stormwater assets to be constructed. Outfalls to existing table drain along Heslop Road and north through existing channel in downstream property. |
| 2 | WLRB3 (WL-03) | Outfalls into existing table drain along Heslop Road, then through existing farm channel on subject property to the north of PSP.<br>WL-03 retarding basin does not require DR-03 to be completed first as outfall is separate.<br>WL-03 construction to be in conjunction with CU-06 delivery, which is required to allow WL to outfall through downstream property. |
| 3 | WLRB2 (WL-02) | Outfalls into DR-03. WL-02 retarding basin does not require DR-03 to be completed first, to allow asset to outfall safely. Existing capacity of DR-03 suitable.<br>However, should WL-02 be delivered first, when DR-03 is under construction, an alternate / temporary outfall for WL-02 will be required during this time.<br>Works in the catchment will need to ensure the existing downstream properties and environs are protected prior to the ultimate outfall being established.<br>WL-02 construction to be in conjunction with CU-05 delivery, which is required to allow WL to outfall to DR-03. |
| 4 | MOP (DR-03) | DR-03 to be delivered prior to WLRB-1A and WLRB-1B (WL-01). The RB needs to outfall to this waterway (DR-03).<br>Works in the catchment will need to ensure the existing downstream properties and environs are protected prior to the ultimate waterway outfall being established.<br>***Recommendation:*** Investigate the potential head cut / erosion point (as shown in Figure 66) and install rock stabilisation works as necessary. Ensure this is completed prior to commencing DR-01 and DR-02 works.<br>DR-03 construction to be in conjunction with CU-08, C-09 and CU-10 delivery. |
| 5 | SB1 (SB-01) | SB-01 should be constructed as part of W-WW (DR-01) upstream works to protect downstream properties and environs from upstream sediment loading. |
| 6 | W-WW (DR-01) | Outfalls to DR-03 via WLRB1B (west). Requires DR-03 to be completed first to allow waterway asset to outfall safely. Does not require WLRB1B (west) to be completed first.<br>However, as development activity upstream will result in sediment loading to DR-01 and further downstream, temporary sediment basins will be required if DR-01 is delivered prior to WLRB-1B (WL-01).<br>Works in the catchment will need to ensure the existing downstream properties and environs are protected prior to the ultimate basin being established.<br>***Recommendation:*** Investigate the potential head cut / erosion point (as shown in Figure 48) and install rock stabilisation works as necessary. |

| Order | Asset | Comments & Recommendations |
|---|---|---|
| | | DR-01 construction to be in conjunction with delivery of CU-01 (Bass Hwy) if not yet delivered; and CU-03 (partially constructed, McGibbonys Rd). CU-01 could be delivered at any time as it rests within the public realm and could be delivered by Council prior to DR-01 delivery. |
| 7 | SB5<br>(SB-03) | SB-03 should be constructed as part of E-WW (DR-02) upstream works to protect downstream properties and environs from upstream sediment loading. |
| 8 | E-WW<br>(DR-02) | Outfalls to DR-03 via WLRB1A (east). Requires DR-03 to be completed first to allow waterway asset to outfall safely. Does not require WLRB1A (east) to be completed first.<br>However, as development activity upstream will result in sediment loading to DR-02 and further downstream, temporary sediment basins will be required if DR-02 is delivered prior to WLRB-1A (WL-01).<br>Works in the catchment will need to ensure the existing downstream properties and environs are protected prior to the ultimate basin being established.<br>***Recommendation:*** Investigate the potential head cut / erosion point (as shown in Figure 56) and install rock stabilisation works as necessary.<br>DR-02 construction to be in conjunction with delivery of CU-02 (Bass Hwy) and CU-12 (McGibbonys Rd extension). |
| 9 | WLRB - 1A & 1B<br>(WL-01) | Outfalls into DR-03. RB requires DR-03 to be completed to allow asset to outfall safely.<br>Works in the catchment will need to ensure the existing downstream properties and environs are protected prior to the ultimate basin and outfall being established.<br>WL-01 construction to be in conjunction with delivery of CU-04 (low flow outlet) and CU-11 (high flow outlet); required to allow WL to outfall to DR-03.<br>Note: as CU-11 is within public land, this may be constructed early in the staging process. It will also provide upstream staged development with a connection to the ultimate PSP outfall (DR-03) until WL-01 is constructed (subject to upstream primary treatment for protection of Powlett River). |
| 10 | SB4<br>(SB-02) | SB-02 should be constructed as part of W-WW (DR-01) works (downstream of McGibbonys Road) to protect downstream properties and environs from upstream sediment loading. SB could be used as an interim solution for staged construction works upstream, until the ultimate SB is delivered.<br>***Recommendation:*** SB-02 may be used as an interim solution for construction sediment controls of future upstream development. If a choke (control) was added, the interim solution may also provide flood retardation function to protect downstream properties, until the ultimate solution of WLRB1 (WL-01) is delivered. |
| 11 | SB6<br>(SB-04) | SB-04 should be constructed as part of E-WW (DR-02) works (downstream of McGibbonys Road) to protect downstream properties and environs from upstream sediment loading. SB could be used as an interim solution for staged construction works upstream, until the ultimate SB is delivered.<br>***Recommendation:*** SB-04 may be used as an interim solution for construction sediment controls of future upstream development. If a choke (control) was added, the interim solution may also provide flood retardation function to protect |

| Order | Asset | Comments & Recommendations |
|---|---|---|
| | | downstream properties, until the ultimate downstream solution of WLRB1 (WL-01) is delivered. |
| 12 | SB7<br>(SB-05) | SB-05 may be constructed at any time. It provides primary treatment function to a smaller upstream catchment.<br>SB-05 construction to be in conjunction with CU-07 delivery to allow SB to outfall through downstream property. |

Staging requirements for pipe outfalls to constructed waterways:

| Asset | Comments & Recommendations |
|---|---|
| EH1 / GPT1 | The delivery of pipe EH1 to DR-01 must be in conjunction with the delivery of GPT1 |
| EK1 / GPT2 | The delivery of EK1 to DR-01 must be in conjunction with the delivery of GPT2 |
| EA1 / GPT3 | The delivery of EA1 to DR-01 must be in conjunction with the delivery of GPT3 |
| AA2 / GPT4 | The delivery of AA2 to DR-02 must be in conjunction with the delivery of GPT4 |

# 27 References


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# APPENDICES

# Appendix A – Asset Tracking Summary of Changes

**Table 66. Taken from Alluvium's Proof of Concept Report (Table 1) – Summary of assets and revision updates**

The following table captures the changes from the DCP and Stormwater Management Strategy (Engeny, 2019) to the remodelling study (Engeny, March 2021) and revisions to the Strategy from March 2021- to September 2021), prior to the SAC Tranche 2 panel hearing and recommendations report. This table was produced by Alluvium to aide reader's tracking of assets and revisions that informed the functional design stages.

| Asset | As per DCP Assets | | As per Engeny – Final Strategy (2021) | | | Engeny | Proof of Concept - as per Alluvium | | |
|---|---|---|---|---|---|---|---|---|---|
| Design No. | DCP Asset ID | Asset type | Dimensions/ footprint | Asset Description (ID) | Issue | Asset ID Final Strategy (2021) | Proposed changes | Alluvium PoC ID | Updates since PoC (Council advice) |
| 1 | DR-01 | Constructed Waterway | Length (m) – TBC | Western Waterway (DR1) | Low sinuosity, leading to high velocity flows and channel scouring, and impacts on wetland performance / vegetation degradation | DR1 | Increase sinuosity to lower velocities and reduce bed scour / protect downstream assets / ensure long term increase in ecological value of new waterway | W-WW | |
| 2 | DR-02 | Constructed Waterway | Length (m) – TBC | Eastern Waterway (DR2) | Low sinuosity, leading to high velocity flows and channel scouring, and impacts on wetland performance / vegetation degradation | DR2 | Remove 90-degree bend at d/s to prevent short circuit / asset failure<br><br>Increase sinuosity to lower velocities and reduce bed scour / protect downstream assets / ensure long term increase in ecological value of new waterway | E-WW | |
| 3 | WL-01 /RB-01 | Wetland and Retarding Basin | Treatment Area 58,000 ($m^2$) | Wetland and Retarding Basin 1 | System is online which will lead to wetland scour, poor performance and vegetation losses | WL1 | Re-orient asset from 'online' system to 'offline' system (from waterways) to protect from wetland failure<br><br>Altered wetland form to improve performance / | WLRB1A (east)<br><br>WLRB1B (west) | |

| Asset | As per DCP Assets | | As per Engeny – Final Strategy (2021) | | | Engeny | Proof of Concept - as per Alluvium | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Advised by Engeny 13 Aug wetland is retarding approx. 200mm above NWL<br><br>Sept 2021 – WL retarding 320mm above NWL | | function and protect wetland integrity / vegetation survival<br><br>Wetland split to manage catchments size / waterway inflows (two inlet zones) to WLRB1A (east) and WLRB1B (west) | |
| 4 | WL-02 | Wetland and Retarding Basin | Treatment Area 8,000 ($m^2$) | Treatment Wetland | Advised by Engeny 13 Aug wetland is retarding approx. 100mm above NWL<br><br>Sept 2021 – WL retarding 170mm above NWL | WL2 | Now treatment and retarding function | WLRB2 |
| 5 | WL-03 | Wetland and Retarding Basin | Treatment Area 13,220 ($m^2$) | Wetland and Retarding Basin 3 | Advised by Engeny 13 Aug wetland is retarding approx. 100mm above NWL<br><br>Sept 2021 – WL retarding 144mm above NWL | WL3 | New concept to improve function and performance to BPEM | WLRB3 |
| 6 | WL-04 | Wetland and Retarding Basin | Treatment Area 5,850 ($m^2$) | Treatment Wetland | Advised by Engeny 13 Aug wetland is retarding approx. 100mm above NWL<br><br>Sept 2021 – WL retarding 166mm above NWL | WL4 | Now treatment and retarding function | WLRB4 |
| - | SB1 | Sediment Basin | Treatment Area 520 ($m^2$) | | Same location | SB1 | Recommend omit as small contributing catchment / negligible impact to PSP | N/A |

| Asset | As per DCP Assets | | As per Engeny – Final Strategy (2021) | | Engeny | Proof of Concept - as per Alluvium | | |
|---|---|---|---|---|---|---|---|---|
| | | | Footprint 2875 ($m^2$) | | | | | |
| 7 | SB2 | Sediment Basin | Treatment Area 810 ($m^2$) Footprint 4290 ($m^2$) | Same location | SB2 | Upsize - proposed treatment area: 1,000 ($m^2$) | SB2 | |
| 8 | SB3 | Sediment Basin | Treatment Area 700 ($m^2$) Footprint 2670 ($m^2$) | Same location | SB3 | Upsize - proposed treatment area: 1,500 ($m^2$) This is a critical SB as it is located at the headwaters of the proposed W-WW | SB3 | |
| 9 | SB4 | Sediment Basin | Treatment Area 850 ($m^2$) Footprint 4440 ($m^2$) | Moved to upstream (further south) location; reduce size | SB4 | To be resized & remodelled at Functional Stage – asset to be relocated further upstream (Engeny strategy - Proposed treatment area: 1,300 ($m^2$)) | SB4 | *GPT recommended in lieu of SB due to small catchment upstream. Council advises (Oct) GPT now installed by developer* |
| - | SB5 | Sediment Basin | Treatment Area 880 ($m^2$) Footprint 4380 ($m^2$) | Sept strategy suggest remove | SB5 | Removed - Consistent with Engeny & considered obsolete to PSP. | N/A | *School site: OD flow from Jean Dennis Rd to discharge into waterway via GPT to be approved by the landowner and constructed by Powlett Ridge. Town drainage from the south to be redirected to a GPT in the drainage reserve in Powlett Ridge stage 6 (Council advice, Oct)* |
| 10 | SB6 | Sediment Basin | Treatment Area 1030 ($m^2$) Footprint 5070 ($m^2$) | Same location | SB6 | Upsized Proposed treatment area: 1,400 ($m^2$) | SB6 | |

| Asset | As per DCP Assets | | As per Engeny – Final Strategy (2021) | | Engeny | Proof of Concept - as per Alluvium | |
|---|---|---|---|---|---|---|---|
| 11 | SB7 | Sediment Basin | Treatment Area 980 ($m^2$) Footprint 4900 ($m^2$) | Same location | SB7 | Upsized - proposed treatment area: 1,400 ($m^2$) | SB7 |
| - | SB8 | Sediment Basin | Treatment Area 1230 ($m^2$) Footprint 5990 ($m^2$) | Double ID – this is now the wetland inlet zone | SB8 | Removed. New WLRB1B design incorporates primary treatment (sediment forebay) therefore this independent SB is not required – obsolete to PSP. | N/A |
| - | SB9 | Sediment Basin | Treatment Area 700 ($m^2$) Footprint 5990 ($m^2$) | Upstream of Western waterway | SB9 | Removed. New WLRB1A design incorporates primary treatment (sediment forebay) therefore this independent SB not required – obsolete to PSP. | N/A |
| part of #4 design<br><br>new asset (25 Aug) | No ID | Sediment Basin | | New SB as inlet to WL1 | No ID | This sediment basin is already part of Alluvium's new WLRB1 concept design and has been sized accordingly to eliminate the need for SB8 and SB9. | N/A |
| part of #5 design | SB10 | Sediment Basin | Treatment Area 1080 ($m^2$) Footprint 4100 ($m^2$) | Now part of WL2 | SB10 | Relocated / integrated to be primary treatment / inlet zone for WLRB2 therefore does not require an Asset ID | N/A |
| part of #6 design | SB11 | Sediment Basin | Treatment Area 920 ($m^2$) Footprint 2800 ($m^2$) | Now part of WL3 | SB11 | Relocated / integrated to be primary treatment / inlet zone for WLRB3 therefore does not require an Asset ID | N/A |

| Asset | As per DCP Assets | | As per Engeny – Final Strategy (2021) | | | Engeny | Proof of Concept - as per Alluvium | | |
|---|---|---|---|---|---|---|---|---|---|
| part of #7 design | SB11A | Sediment Basin | Treatment Area 900 ($m^2$) Footprint 4320 ($m^2$) | | Now part of WL4 | SB11A | Relocated / integrated to be primary treatment / inlet zone for WLRB4 therefore does not require an Asset ID | N/A | |
| **12** | SB12 | Sediment Basin | Treatment Area 500 ($m^2$) Footprint 2620 ($m^2$) | | North-west corner of precinct | SB12 | Unchanged | SB12 | |
| **-** | SB13 | Sediment Basin | - | - | Missing from strategy layout 2021 (Engeny) | Missing from new layout | Removed - assumed not required | N/A | |
| **-** | SB14 | Sediment Basin | Treatment Area 500 ($m^2$) Footprint 2500 ($m^2$) | | | SB14 | Removed - recommended obsolete due to small catchment area. | N/A | |
| **13** | SB15 | Sediment Basin | Treatment Area 500 ($m^2$) Footprint 2500 ($m^2$) | | | SB15 | Upsized - proposed treatment area: 1,500 ($m^2$)<br>This is a critical SB as it is located at the headwaters of the proposed E-WW | SB15 | |
| **-** | - | - | | | New SB for revised WLRB1 - unnamed | NEW unnamed | Integrated as part of WLRB1 – not an independent asset design | N/A | |
| **14** | CU1 | Culvert | | Outfall to DR1 | Missing from new layout | No ID | Assumed no change – critical to W-WW | CU1 | *Council advises (Oct) existing rail bridge / culvert provides a drainage outlet for flows from the south.* |
| **-** | CU2 | Culvert | | Outfall to DR1 | Renamed Bass Highway/ CDS unit (culverts 18-19) | now Bass Highway/ CDS unit (culverts 18-19) | Existing CDS Unit & highway culverts (18-19) | N/A | *It was noted from late information provided that this culvert is not existing and required a design (was missing from Engeny final layout)* |

| Asset | As per DCP Assets | | As per Engeny – Final Strategy (2021) | | Engeny | Proof of Concept - as per Alluvium | | |
|---|---|---|---|---|---|---|---|---|
| 15 | CU3 | Culvert | Outfall to DR2 | Missing from new layout | No ID | Assumed no change – critical to E-WW | CU3 | |
| - | CU4 | Culvert | Outfall to DR1 | Inconsistent naming/ already existing | now McGibbonys (culverts 22-23) | Existing asset<br>Assumed no functional design required | N/A | *Northern end wall to be constructed in addition to ~5m pipe extension into drainage reserve (Council, Oct)* |
| 16 | CU5 | Culvert | Outfall to DR1 | Renamed C4 | Now C4 (culverts 23-23A) | Assumed no change | CU5 | |
| 17 | CU6 | Culvert | Outfall to DR1 | Renamed C5 | Now C5 (culverts 23B-23C) | Assumed no change | CU6 | |
| 18 | CU7 | Culvert | Outfall to DR1 | Renamed C6 | Now C6 (culverts 24-24A) | Assumed no change | CU7 | |
| 19 | CU8 | Culvert | Outfall to main outfall | | Missing from new layout | Assumed no change – critical to WLRB1 outfall to Main Outfall Powlett (River) | CU8 | |
| - | CU9 | Culvert | Outfall to main outfall | Existing | Missing from new layout | Assumed no functional design required existing asset – critical to WLRB2 outfall to main outfall – design to account for asset's existing levels | N/A | |
| 20 | CU10 | Culvert | Outfall to North Heslop Rd | | Missing from new layout | Assumed no change – critical to WLRB3 outfall to Heslop Rd | CU10 | |
| 21 | CU11 | Culvert | Outfall to North Heslop Rd | | Missing from new layout | Assumed no change – critical to WLRB4 outfall to Heslop Rd | CU11 | |
| 22 | CU12 | Culvert | Outfall to North Heslop Rd | | Missing from new layout | Assumed no change – related to SB12 in north-west corner of precinct to account for | CU12 | |

| Asset | As per DCP Assets | As per Engeny – Final Strategy (2021) | Engeny | Proof of Concept - as per Alluvium |
|---|---|---|---|---|
| | | | | untreated inflows to PSP assets. |
| 23 | Main Outfall | Precinct ultimate outfall | Main Outfall to Powlett River | No change – critical asset– Main Outfall to Powlett (MOP) River MOP |
| **Total DCP Assets** | **DCP = 29+** | | | **Total confirmed assets to design** **Alluvium = 23** |

# Appendix B – Functional Design Package (attached separately)

West Waterway (W-WW) DCP - (DR-01)

| Item | Description | Quantity | Unit | Rate $ | Amount $ | Comments |
|---|---|---|---|---|---|---|
| | **DR-01 WEST WATERWAY (W-WW) WORKS** | | | | | |
| **1** | **SITEWORKS** | | | | | |
| 1.1 | Site preparation | 1 | Item | $ 10,000 | $ 10,000 | |
| 1.2 | Diversion works | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.3 | Waterway re-shaping | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.4 | Stripping of topsoil | 477,310 | m3 | $ 1.30 | $ 620,503 | MW reimbursement rates for south east region (stripping) |
| **2** | **EARTHWORKS** | | | | | MW reimbursement rtes for south east region (earthworks rates) |
| 2.1 | Bulk Excavation | 84,357 | m3 | $ 10.90 | $ 919,491 | Excavation in broad greenfield land, excavated material to be reused on site for filling, allowance of 95% reuse on site for filling |
| 2.2 | Reuse of onsite cut for filling | 80,139 | m3 | $ 11.70 | $ 937,628 | Assumed 95% of bulk excvavation for reuse |
| 2.3 | Disposal of excess cut | 4,218 | m3 | $ 19.20 | $ 80,983 | Assumed 5% of bulk excavation |
| **3** | **DRAINAGE** | | | | | |
| 3.1 | Rockwork for waterway pool formation | | | | | |
| *3.1.1* | Supply and install D50=400mm rock, 800 mm thick to form pool No 1. | 118 | m3 | $ 197 | $ 23,246 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.2* | Supply and install D50=400mm rock, 800 mm thick to form Bass Hwy Inlet Pool. | 88 | m3 | $ 197 | $ 17,336 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.3* | Supply and install D50=400mm rock, 800 mm thick to form Bass Hwy Outlet Pool. | 104 | m3 | $ 197 | $ 20,488 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.4* | Supply and install D50=400mm rock, 800 mm thick to form pool No 2. | 96 | m3 | $ 197 | $ 18,912 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.5* | Supply and install D50=400mm rock, 800 mm thick to form Culvert 4 Inlet Pool. | 150 | m3 | $ 197 | $ 29,550 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.6* | Supply and install D50=400mm rock, 800 mm thick to form Culvert 4 Outlet Pool. | 129 | m3 | $ 197 | $ 25,413 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.7* | Supply and install D50=400mm rock, 800 mm thick to form SB4 outlet Transition Pool. | 224 | m3 | $ 197 | $ 44,128 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.8* | Supply and install D50=400mm rock, 800 mm thick to form Culvert 5 Inlet Pool. | 155 | m3 | $ 197 | $ 30,535 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.9* | Supply and install D50=400mm rock, 800 mm thick to form Culvert 5 Outlet Pool. | 123 | m3 | $ 197 | $ 24,231 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.10* | Supply and install D50=400mm rock, 800 mm thick to form Culvert 6 Inlet Pool. | 168 | m3 | $ 197 | $ 33,096 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.11* | Supply and install geofabric for all rock work | 449 | lm | $ 25 | $ 11,225 | |
| **4** | **LANDSCAPING** | | | | | |
| 4.1 | Re spread 200 mm topsoil for planting areas | 453,445 | m2 | $ 3.30 | $ 1,496,367 | Allowance of 95% of topsoil stripped from site, 5% assumed as unsuitable for reuse MW reimbursement rates for south east region (Topsoiling (80% from stockpile and 20% imported)) |
| 4.2 | Aquatic revegetation of the low flow waterway | 14,015 | m2 | $ 14.50 | $ 203,218 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.3 | Terrestrial revegetation of the high flow waterway | 61,494 | m2 | $ 16.80 | $ 1,033,099 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.4 | Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 to channel benches. | 23,052 | m2 | $ 7 | $ 161,364 | MW reimbursement rates for south east region (weed control matting) |
| 4.5 | Supply and install Coir logs along channel for temnporary erosion control. | 3,978 | lm | $ 20 | $ 79,560 | |
| **5** | **MISCELLANEOUS** | | | | | |
| 5.1 | | | Item | | | |
| 5.2 | Other *(Description)* | | Item | | | |
| | **SUB-TOTAL WORKS** | | | | $ 5,860,373 | |
| **6** | **DELIVERY** | | | | | |
| 6.1 | Council Fees | 3.25 | % | | $ 190,462 | |
| 6.2 | VicRoads Fees | - | % | | $ - | |
| 6.3 | Traffic Management | 2 | % | | $ 117,207 | |
| 6.4 | Environmental Management | 0.5 | % | | $ 29,302 | |
| 6.5 | Survey & Design | 5 | % | | $ 293,019 | |
| 6.6 | Supervision & Project Management | 4 | % | | $ 234,415 | |
| 6.7 | Site Establishment | 2.5 | % | | $ 146,509 | |
| 6.8 | Contingency | 35 | % | | $ 2,051,130 | |
| | **SUB-TOTAL DELIVERY** | | | | $ 3,062,045 | |
| **7** | **TOTAL ESTIMATED COST** | | | | $ 8,922,417 | |

| Item | Description | Quantity | Unit | Rate $ | Amount $ | Comments |
|---|---|---|---|---|---|---|
| | **DR-02 EAST WATERWAY (E-WW) WORKS** | | | | | |
| **1** | **SITEWORKS AND EARTHWORKS** | | | | | |
| 1.1 | Site preparation | 1 | Item | $ 10,000 | $ 10,000 | |
| 1.2 | Diversion works | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.3 | Waterway re-shaping | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.4 | Stripping of topsoil | 34,083 | m3 | $ 1.30 | $ 44,308 | MW reimbursement rates for south east region (stripping) |
| **2** | **EARTHWORKS** | | | | | MW reimbursement rtes for south east region (earthworks rates) |
| 2.1 | Bulk Excavation | 178,994 | m3 | $ 10.90 | $ 1,951,035 | Excavation in broad greenfield land, excavated material to be reused on site for filling, allowance of 95% reuse on site for filling |
| 2.2 | Reuse of onsite cut for filling | 170,044 | m3 | $ 11.70 | $ 1,989,518 | Assumed 95% of bulk excvavation for reuse |
| 2.3 | Disposal of excess cut | 8,950 | m3 | $ 19.20 | $ 171,834 | Assumed 5% of bulk excavation |
| **3** | **DRAINAGE** | | | | | |
| 3.1 | Rockwork for waterway pool formation | | | | | |
| *3.1.1* | Supply and install D50=400mm rock, 800 mm thick to form Bass Hwy Outlet Pool | 116 | m3 | $ 197 | $ 22,852 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.2* | Supply and install D50=400mm rock, 800 mm thick to form McGibbonys Rd Inlet Pool | 134 | m3 | $ 197 | $ 26,398 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.3* | Supply and install D50=400mm rock, 800 mm thick to form McGibbonys Rd Outlet Pool | 101 | m3 | $ 197 | $ 19,897 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.4* | Supply and install D50=400mm rock, 800 mm thick to form pool No 1. | 140 | m3 | $ 197 | $ 27,580 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.5* | Supply and install D50=400mm rock, 800 mm thick to form pool No 2. | 101 | m3 | $ 197 | $ 19,897 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.6* | Supply and install D50=400mm rock, 800 mm thick to form pool No 3. | 142 | m3 | $ 197 | $ 27,974 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.7* | Supply and install D50=400mm rock, 800 mm thick to form pool No 4. | 131 | m3 | $ 197 | $ 25,807 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.8* | Supply and install geofabric (Bidim A44 or equivalent) for all rock work | 343 | lm | $ 25 | $ 8,575 | |
| **4** | **LANDSCAPING** | | | | | |
| 4.1 | Re spread 200 mm topsoil for planting areas | 32,379 | m2 | $ 3.30 | $ 106,850 | Allowance of 95% of topsoil stripped from site, 5% assumed as unsuitable for reuse MW reimbursement rates for south east region (Topsoiling (80% from stockpile and 20% imported)) |
| 4.2 | Aquatic revegetation of the low flow waterway | 22,908 | m2 | $ 14.50 | $ 332,166 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.3 | Terrestrial revegetation of the high flow waterway | 95,245 | m2 | $ 16.80 | $ 1,600,116 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.4 | Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 to channel benches. | 38,519 | m2 | $ 7 | $ 269,633 | MW reimbursement rates for south east region (weed control matting) |
| 4.5 | Supply and install Coir logs along channel for temnporary erosion control. | 5,736 | lm | $ 20 | $ 114,720 | |
| **5** | **MISCELLANEOUS** | | | | | |
| 5.1 | | | Item | | | |
| 5.2 | Other (Description) | | Item | | | |
| | **SUB-TOTAL WORKS** | | | | $ 6,809,160 | |
| **6** | **DELIVERY** | | | | | |
| 6.1 | Council Fees | 3.25 | % | | $ 221,298 | |
| 6.2 | VicRoads Fees | - | % | | $ - | |
| 6.3 | Traffic Management | 2 | % | | $ 136,183 | |
| 6.4 | Environmental Management | 0.5 | % | | $ 34,046 | |
| 6.5 | Survey & Design | 5 | % | | $ 340,458 | |
| 6.6 | Supervision & Project Management | 4 | % | | $ 272,366 | |
| 6.7 | Site Establishment | 2.5 | % | | $ 170,229 | |
| 6.8 | Contingency | 35 | % | | $ 2,383,206 | |
| | **SUB-TOTAL DELIVERY** | | | | $ 3,557,786 | |
| **7** | **TOTAL ESTIMATED COST** | | | | $ 10,366,946 | |

| Item | Description | Quantity | Unit | Rate $ | Amount $ | Comments |
|---|---|---|---|---|---|---|
| | **DR-03 MAIN OUTFALL TO POWLETT RIVER (MOP) WORKS** | | | | | |
| **1** | **SITEWORKS AND EARTHWORKS** | | | | | |
| 1.1 | Site preparation | 1 | Item | $ 10,000 | $ 10,000 | |
| 1.2 | Diversion works | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.3 | Waterway re-shaping | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.4 | Stripping of topsoil | 3,486 | m3 | $ 1.30 | $ 4,532 | MW reimbursement rates for south east region (stripping) |
| **2** | **EARTHWORKS** | | | | | MW reimbursement rtes for south east region (earthworks rates) |
| 2.1 | Bulk Excavation | 16,910 | m3 | $ 10.90 | $ 184,319 | Excavation in broad greenfield land, excavated material to be reused on site for filling, allowance of 95% reuse on site |
| 2.2 | Reuse of onsite cut for filling | 16,065 | m3 | $ 11.70 | $ 187,955 | Assumed 95% of bulk excvavation for reuse |
| 2.3 | Disposal of excess cut | 846 | m3 | $ 19.20 | $ 16,234 | Assumed 5% of bulk excavation |
| **3** | **DRAINAGE** | | | | | |
| 3.1 | Rockwork for waterway pool formation | | | | | |
| *3.1.1* | Supply and install D50=400mm rock, 800 mm thick to form WLRB1 Outlet Pool | 151 | m3 | $ 197 | $ 29,747 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.2* | Supply and install D50=400mm rock, 800 mm thick to form WLRB2 Outlet Pool | 60 | m3 | $ 197 | $ 11,820 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.3* | Supply and install D50=400mm rock, 800 mm thick to form connection to existing downstream drain | 154 | m3 | $ 197 | $ 30,338 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.4* | Supply and install geofabric (Bidim A44 or equivalent) for all rock work | 80 | lm | $ 25 | $ 2,000 | |
| **4** | **LANDSCAPING** | | | | | |
| 4.1 | Re spread 200 mm topsoil for planting areas | 3,312 | m2 | $ 3.30 | $ 10,929 | Allowance of 95% of topsoil stripped from site, 5% assumed as unsuitable for reuse MW reimbursement rates for south east region (Topsoiling (80% from stockpile and 20% imported)) |
| 4.3 | Terrestrial revegetation of the high flow waterway | 17,430 | m2 | $ 16.80 | $ 292,824 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.4 | Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 to channel benches. | 17,430 | m2 | $ 7 | $ 122,010 | MW reimbursement rates for south east region (weed control matting) |
| **5** | **MISCELLANEOUS** | | | | | |
| 5.1 | | | Item | | | |
| 5.2 | Other (Description) | | Item | | | |
| | **SUB-TOTAL WORKS** | | | | $ 942,707 | |
| **6** | **DELIVERY** | | | | | |
| 6.1 | Council Fees | 3.25 | % | | $ 30,638 | |
| 6.2 | VicRoads Fees | - | % | | $ - | |
| 6.3 | Traffic Management | 2 | % | | $ 18,854 | |
| 6.4 | Environmental Management | 0.5 | % | | $ 4,714 | |
| 6.5 | Survey & Design | 5 | % | | $ 47,135 | |
| 6.6 | Supervision & Project Management | 4 | % | | $ 37,708 | |
| 6.7 | Site Establishment | 2.5 | % | | $ 23,568 | |
| 6.8 | Contingency | 35 | % | | $ 329,947 | |
| | **SUB-TOTAL DELIVERY** | | | | $ 492,564 | |
| **7** | **TOTAL ESTIMATED COST** | | | | $ 1,435,271 | |

| Item | Description | Quantity | Unit | Rate $ | Amount $ | Comments |
|---|---|---|---|---|---|---|
| | **WL-01 WETLAND RETARDING BASIN 1 (WLRB1A&B) WORKS** | | | | | |
| **1** | **SITEWORKS AND EARTHWORKS** | | | | | |
| 1.1 | Site preparation | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.2 | Diversion works | 1 | Item | $ 40,000 | $ 40,000 | |
| 1.3 | Geotechnical Investigation | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.4 | Cultural Heritage Assessment | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.5 | Flora and Fauna Study | 1 | Item | $ 30,000 | $ 30,000 | |
| 1.6 | Safety Assessment | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.7 | Stripping of topsoil | 45,940 | m3 | $ 1.30 | $ 59,722 | MW reimbursement rates for south east region (stripping) |
| **2** | **EARTHWORKS** | | | | | MW reimbursement rtes for south east region (earthworks rates) |
| 2.1 | Bulk Excavation | 297,854 | m3 | $ 10.90 | $ 3,246,609 | Excavation in broad greenfield land, excavated material to be reused on site for filling, allowance of 95% reuse on site |
| 2.2 | Reuse of onsite cut for filling | 282,961 | m3 | $ 11.70 | $ 3,310,647 | Assumed 95% of bulk excvavation for reuse |
| 2.3 | Disposal of excess cut | 14,893 | m3 | $ 19.20 | $ 285,940 | Assumed 5% of bulk excavation |
| **3** | **DRAINAGE (WLRB1a)** | | | | | |
| 3.1 | Rockwork | | | | | |
| *3.1.1* | Supply and install D50=400mm rock, 800 mm thick to form WL1A Wetland inlet | 438 | m3 | $ 197 | $ 86,286 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.2* | Supply and install D50=400mm rock, 800 mm thick to form WL1A Wetland overflow spillway | 155 | m3 | $ 197 | $ 30,535 | MW reimbursement rates for south east region (rockwork rate) |
| 3.2 | Concrete | | | | | |
| *3.2.1* | Supply and install reinforced N32 grade concrete weir to form WL1A Wetland spillway weir | 1 | Item | $ 10,000 | $ 10,000 | |
| *3.2.2* | Supply and install reinforced N32 grade concrete, 150 mm deep to form WL1A sediment basin base | 911 | m3 | $ 322 | $ 293,342 | Reinforced concrete slab 150mm thick (Rawlinsons publication) |
| 3.3 | Drainage | | | | | |
| *3.3.1* | Supply and install 900 mm dia RRJ sediment pond transfer pipe incl excavation, 20% crushed rock back fill (WL1A wetland) | 22 | m | $ 561 | $ 12,342 | MW reimbursement rates for south east region (900mm RRJ 20% FCR backfill) |
| *3.3.2* | Supply and install submerged offtake pit (WL1A wetland) | 1 | No. | $ 6,710 | $ 6,710 | |
| *3.3.3* | Supply and install 300 mm dia RRJ 20% backfill balance pipes (WL1A wetland) | 160 | m | $ 170 | $ 27,200 | MW reimbursement rates for south east region (300mm RRJ 20% FCR backfill) |
| *3.3.4* | Supply and install submerged offtake pits for balance pipes (WL1A wetland) | 2 | No. | $ 6,710 | $ 13,420 | |
| *3.3.5* | Supply and install 900 mm dia RRJ wetland outfall pipe incl excavation, 20% crushed rock back fill (WL1A wetland) | 25 | m | $ 561 | $ 14,025 | MW reimbursement rates for south east region (900mm RRJ 20% FCR backfill) |
| *3.3.6* | Supply and install twin chamber outfall pit with penstock and concrete weir (WL1A wetland) | 1 | No. | $ 15,000 | $ 15,000 | |
| 3.4 | Access Path | | | | | |
| *3.4.1* | Supply and install N32 grade concrete to form 4m wide sediment pond maintenance access ramp WL1A wetland | 160 | m2 | $ 61.90 | $ 9,904 | MW reimbursement rates for south east region (concrete access track) |
| *3.4.2* | Supply and install D50=200mm with Class 2 FCR backfill to form 4m wide maintenance access around WL1A wetland | 3,440 | m2 | $ 33.10 | $ 113,864 | MW reimbursement rates for south east region (crushed rock access track) |
| **4** | **DRAINAGE (WLRB1b)** | | | | | |
| 4.1 | Rockwork | | | | | |
| *4.1.1* | Supply and install D50=400mm rock, 800 mm thick to form WL1B Wetland inlet channel | 342 | m3 | $ 197 | $ 67,374 | MW reimbursement rates for south east region (rockwork rate) |
| *4.1.2* | Supply and install D50=400mm rock, 800 mm thick to form WL1B Wetland overflow spillway | 249 | m3 | $ 197 | $ 49,053 | MW reimbursement rates for south east region (rockwork rate) |
| 4.2 | Concrete | | | | | |
| *4.2.1* | Supply and install reinforced N32 grade concrete weir to form WL1B Wetland spillway weir | 1 | Item | $ 10,000 | $ 10,000 | |
| *4.2.2* | Supply and install reinforced N32 grade concrete, 150 mm deep to form WL1B sediment basin base | 1,026 | m3 | $ 322 | $ 330,372 | Reinforced concrete slab 150mm thick (Rawlinsons publication) |
| 4.3 | Drainage | | | | | |
| *4.3.1* | Supply and install 900 mm dia RRJ sediment pond transfer pipe incl excavation, 20% crushed rock back fill (WL1B wetland) | 60 | m | $ 561 | $ 33,660 | MW reimbursement rates for south east region (900mm RRJ 20% FCR backfill) |
| *4.3.2* | Supply and install submerged offtake pit (WL1B wetland) | 1 | No. | $ 6,710 | $ 6,710 | |
| *4.3.3* | Supply and install 300 mm dia RRJ 20% backfill balance pipes (WL1B wetland) | 141 | m | $ 170 | $ 23,970 | MW reimbursement rates for south east region (300mm RRJ 20% FCR backfill) |
| *4.3.4* | Supply and install submerged offtake pits for balance pipes (WL1B wetland) | 4 | No. | $ 6,710 | $ 26,840 | |
| *4.3.5* | Supply and install 1050 mm dia wetland outfall pipe incl excavation, crushed rock bedding and back fill (WL1B wetland) | 21 | m | $ 696 | $ 14,616 | MW reimbursement rates for south east region (1050mm RRJ 20% FCR backfill) |
| *4.3.6* | Supply and install twin chamber outfall pit with penstock and concrete weir (WL1B wetland) | 1 | No. | $ 15,000 | $ 15,000 | |
| 4.4 | Access Path | | | | | |
| *4.4.1* | Supply and install N32 grade concrete to form 4m wide sediment pond maintenance access ramp WL1B wetland | 82 | m2 | $ 61.90 | $ 5,076 | MW reimbursement rates for south east region (concrete access track) |
| *4.4.2* | Supply and install D50=200mm with Class 2 FCR backfill to form 4m wide maintenance access around WL1B wetland | 1,127 | m2 | $ 33.10 | $ 37,304 | MW reimbursement rates for south east region (crushed rock access track) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **5** | **LANDSCAPING (WLRB1a)** | | | | | |
| 5.1 | Re spread 200 mm topsoil for planting areas | 21,822 | m2 | $ 3.30 | $ 72,011 | Allowance of 95% of topsoil stripped from site, 5% assumed as unsuitable for reuse MW reimbursement rates for south east region (Topsoiling (80% from stockpile and 20% imported)) |
| 5.2 | Placement of 300 mm compacted clay liners for sedimentation basin and wetland (clay sourced onsite) | 45,167 | m2 | $ 8.00 | $ 361,336 | MW reimbursement rates for south east region (clay lining) |
| 5.3 | Supply and install submerged marsh planting. | 748 | m2 | $ 14.50 | $ 10,846 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 5.4 | Supply and install deep marsh planting (600cm3 tube, 2/m2). | 13,439 | m2 | $ 14.50 | $ 194,866 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 5.5 | Supply and install shallow marsh planting (600cm3 tube, 2/m2). | 7,451 | m2 | $ 14.50 | $ 108,040 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 5.6 | Supply and install wet ephemeral planting (90cm3 tube, 6/m2). | 2,179 | m2 | $ 14.50 | $ 31,596 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 5.7 | Supply and install dry ephemeral planting (90cm3 tube, 6/m2). | 5,723 | m2 | $ 16.80 | $ 96,146 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 5.8 | Supply and install sediment drying area planting (virocell planting, 6/m2). | 2,960 | m2 | $ 16.80 | $ 49,728 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 5.9 | Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 to TED to 350mm below NWL as specified for all Wet Ephemeral Planting | 23,069 | m2 | $ 7 | $ 161,483 | MW reimbursement rates for south east region (weed control matting) |
| 5.10 | Supply, install and maintain plant protection netting for a selected species in the aquatic zones. | 2 | No. | $ 20,000 | $ 40,000 | |
| **6** | **LANDSCAPING (WLRB1b)** | | | | | |
| 6.1 | Re spread 200 mm topsoil for planting areas | 21,822 | m2 | $ 3.30 | $ 72,011 | Allowance of 95% of topsoil stripped from site, 5% assumed as unsuitable for reuse MW reimbursement rates for south east region (Topsoiling (80% from stockpile and 20% imported)) |
| 6.2 | Placement of 300 mm compacted clay liners for sedimentation basin and wetland (clay sourced onsite) | 46,378 | m2 | $ 8.00 | $ 371,024 | MW reimbursement rates for south east region (clay lining) |
| 6.3 | Supply and install submerged marsh planting (600cm3 tube, 1/m2). | 1,020 | m2 | $ 14.50 | $ 14,790 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 6.4 | Supply and install deep marsh planting (600cm3 tube, 2/m2). | 17,590 | m2 | $ 14.50 | $ 255,055 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 6.5 | Supply and install shallow marsh planting (600cm3 tube, 2/m2). | 9,820 | m2 | $ 14.50 | $ 142,390 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 6.6 | Supply and install wet ephemeral planting (90cm3 tube, 6/m2). | 7,378 | m2 | $ 14.50 | $ 106,981 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 6.7 | Supply and install dry ephemeral planting (90cm3 tube, 6/m2). | 6,520 | m2 | $ 16.80 | $ 109,536 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 6.8 | Supply and install sediment drying area planting (virocell planting, 6/m2). | 3,741 | m2 | $ 16.80 | $ 62,849 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 6.9 | Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 to TED to 350mm below NWL as specified for all Wet Ephemeral Planting | 32,802 | m2 | $ 7 | $ 229,614 | MW reimbursement rates for south east region (weed control matting) |
| 6.10 | Supply, install and maintain plant protection netting for a selected species in the aquatic zones. | 2 | No. | $ 20,000 | $ 40,000 | |
| **7** | **MISCELLANEOUS** | | | | | |
| 7.1 | Allowance for timber bollards | 1 | Item | $ 3,000 | $ 3,000 | |
| 7.2 | Allowance for seats | 1 | Item | $ 35,000 | $ 35,000 | |
| 7.3 | Other (Description) | | Item | | | |
| | **SUB-TOTAL WORKS** | | | | $ 10,933,821 | |
| **8** | **DELIVERY** | | | | | |
| 8.1 | Council Fees | 3.25 | % | | $ 355,349 | |
| 8.2 | VicRoads Fees | 1 | % | | $ 109,338 | |
| 8.3 | Traffic Management | 2 | % | | $ 218,676 | |
| 8.4 | Environmental Management | 1 | Item | $50,000 | $ 50,000 | |
| 8.5 | Erosion Control Management | 0.5 | % | | $ 54,669 | |
| 8.6 | Survey & Design | 5 | % | | $ 546,691 | |
| 8.7 | Supervision & Project Management | 4 | % | | $ 437,353 | |
| 8.8 | Site Establishment | 2.5 | % | | $ 273,346 | |
| 8.9 | Contingency | 35 | % | | $ 3,826,837 | |
| | **SUB-TOTAL DELIVERY** | | | | $ 5,872,260 | |
| **9** | **TOTAL ESTIMATED COST** | | | | $ 16,806,080 | |

| Item | Description | Quantity | Unit | Rate $ | Amount $ | Comments |
|---|---|---|---|---|---|---|
| | **WL-02 WETLAND RETARDING BASIN 2 (WLRB2) WORKS** | | | | | |
| **1** | **SITEWORKS AND EARTHWORKS** | | | | | |
| 1.1 | Site preparation | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.2 | Diversion works | 1 | Item | $ 40,000 | $ 40,000 | |
| 1.3 | Geotechnical Investigation | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.4 | Cultural Heritage Assessment | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.5 | Flora and Fauna Study | 1 | Item | $ 30,000 | $ 30,000 | |
| 1.6 | Safety Assessment | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.7 | Stripping of topsoil | 4,089 | m3 | $ 1.30 | $ 5,316 | MW reimbursement rates for south east region (stripping) |
| **2** | **EARTHWORKS** | | | | | MW reimbursement rtes for south east region (earthworks rates) |
| 2.1 | Bulk Excavation | 9,505 | m3 | $ 10.90 | $ 103,605 | Excavation in broad greenfield land, excavated material to be reused on site for filling, allowance of 95% reuse on site |
| 2.2 | Reuse of onsite cut for filling | 9,030 | m3 | $ 11.70 | $ 105,648 | Assumed 95% of bulk excvavation for reuse |
| 2.3 | Disposal of excess cut | 475 | m3 | $ 19.20 | $ 9,125 | Assumed 5% of bulk excavation |
| **3** | **DRAINAGE** | | | | | |
| 3.1 | Rockwork | | | | | |
| *3.1.1* | Supply and install D50=400mm rock, 800 mm thick to form WL2 Wetland inlet | 133 | m3 | $ 197 | $ 26,201 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.2* | Supply and install D50=400mm rock, 800 mm thick to form WL2 Wetland overflow spillway | 82 | m3 | $ 197 | $ 16,154 | MW reimbursement rates for south east region (rockwork rate) |
| 3.2 | Concrete | | | | | |
| *3.2.1* | Supply and install reinforced N32 grade concrete weir to form WL2 Wetland spillway weir | 1 | Item | $ 10,000 | $ 10,000 | |
| *3.2.2* | Supply and install reinforced N32 grade concrete, 150 mm deep to form WL2 sediment basin base | 77 | m3 | $ 322 | $ 24,794 | Reinforced concrete slab 150mm thick (Rawlinsons publication) |
| 3.3 | Drainage | | | | | |
| *3.3.1* | Supply and install 600 mm dia RRJ sediment pond transfer pipe incl excavation, 20% crushed rock back fill (WL2 wetland) | 14 | m | $ 337 | $ 4,718 | MW reimbursement rates for south east region (600mm RRJ 20% FCR backfill) |
| *3.3.2* | Supply and install submerged offtake pit | 1 | No. | $ 6,710 | $ 6,710 | |
| *3.3.3* | Supply and install 300 mm dia RRJ 20% backfill balance pipes (WL2 wetland) | 20 | m | $ 219 | $ 4,380 | MW reimbursement rates for south east region (300mm RRJ 20% FCR backfill) |
| *3.3.4* | Supply and install submerged offtake pits for balance pipes | 3 | No. | $ 6,710 | $ 20,130 | |
| *3.3.5* | Supply and install 900 mm dia RRJ wetland high flow bypass pipeline incl excavation, 20% crushed rock back fill (WL2) | 10 | m | $ 561 | $ 5,610 | MW reimbursement rates for south east region (900mm RRJ 20% FCR backfill) |
| *3.3.6* | Supply and install submerged offtake pit for high flow bypass | 1 | No. | $ 6,710 | $ 6,710 | |
| *3.3.7* | Supply and install 750 mm dia RRJ wetland outfall pipe incl excavation, 20% crushed rock back fill | 135 | m | $ 441 | $ 59,535 | MW reimbursement rates for south east region (750mm RRJ 20% FCR backfill) |
| *3.3.8* | Supply and install twin chamber outfall pit with penstock and concrete weir | 1 | No. | $ 15,000 | $ 15,000 | |
| 3.4 | Access Path | | | | | |
| *3.4.1* | Supply and install N32 grade concrete to form 4m wide sediment pond maintenance access ramp WL2 wetland | 70 | m2 | $ 61.90 | $ 4,333 | MW reimbursement rates for south east region (concrete access track) |
| *3.4.2* | Supply and install D50=200mm with Class 2 FCR backfill to form 4m wide maintenance access around WL2 wetland | 1971 | m2 | $ 33.10 | $ 65,240 | MW reimbursement rates for south east region (crushed rock access track) |
| **4** | **LANDSCAPING** | | | | | |
| 4.1 | Re spread 200 mm topsoil for planting areas | 3,885 | m2 | $ 3.30 | $ 12,819 | Allowance of 95% of topsoil stripped from site, 5% assumed as unsuitable for reuse MW reimbursement rates for south east region (Topsoiling (80% from stockpile and 20% imported)) |
| 4.2 | Placement of 300 mm compacted clay liners for sedimentation basin and wetland (clay sourced onsite) | 9,714 | m2 | $ 8.00 | $ 77,712 | MW reimbursement rates for south east region (clay lining) |
| 4.3 | Supply and install submerged marsh planting. | 346 | m2 | $ 14.50 | $ 5,017 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.4 | Supply and install deep marsh planting (600cm3 tube, 2/m2). | 2,876 | m2 | $ 14.50 | $ 41,702 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.5 | Supply and install shallow marsh planting (600cm3 tube, 2/m2). | 3,412 | m2 | $ 14.50 | $ 49,474 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.6 | Supply and install wet ephemeral planting (90cm3 tube, 6/m2). | 1,082 | m2 | $ 14.50 | $ 15,689 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.7 | Supply and install dry ephemeral planting (90cm3 tube, 6/m2). | 3,960 | m2 | $ 16.80 | $ 66,528 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.8 | Supply and install sediment drying area planting (virocell planting, 6/m2). | 1,112 | m2 | $ 16.80 | $ 18,682 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.9 | Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 to TED to 350mm below NWL as specified for all Wet Ephemeral Planting | 7,370 | m2 | $ 7 | $ 51,590 | MW reimbursement rates for south east region (weed control matting) |
| 4.10 | Supply, install and maintain plant protection netting for a selected species in the aquatic zones. | 2 | No. | $ 20,000 | $ 40,000 | |
| **5** | **MISCELLANEOUS** | | | | | |
| 5.1 | Allowance for timber bollards | 1 | Item | $ 3,000 | $ 3,000 | |
| 5.2 | Allowance for seats | 1 | Item | $ 35,000 | $ 35,000 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SUB-TOTAL WORKS** | | | | $ 1,120,421 | |
| **6** | **DELIVERY** | | | | | |
| 6.1 | Council Fees | 3.25 | % | | $ 36,414 | |
| 6.2 | VicRoads Fees | 0 | % | | $ - | |
| 6.3 | Traffic Management | 2 | % | | $ 22,408 | |
| 6.4 | Environmental Management | 1 | Item | $ 50,000 | $ 50,000 | |
| 6.5 | Erosion Control Management | 0.5 | % | | $ 5,602 | |
| 6.6 | Survey & Design | 5 | % | | $ 56,021 | |
| 6.7 | Supervision & Project Management | 4 | % | | $ 44,817 | |
| 6.8 | Site Establishment | 2.5 | % | | $ 28,011 | |
| 6.9 | Contingency | 35 | % | | $ 392,147 | |
| | **SUB-TOTAL DELIVERY** | | | | $ 635,420 | |
| **7** | **TOTAL ESTIMATED COST** | | | | $ 1,755,841 | |

| Item | Description | Quantity | Unit | Rate $ | Amount $ | Comments |
|---|---|---|---|---|---|---|
| | **WL-03 WETLAND RETARDING BASIN 3 (WLRB3) WORKS** | | | | | |
| **1** | **SITEWORKS AND EARTHWORKS** | | | | | |
| 1.1 | Site preparation | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.2 | Diversion works | 1 | Item | $ 40,000 | $ 40,000 | |
| 1.3 | Geotechnical Investigation | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.4 | Cultural Heritage Assessment | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.5 | Flora and Fauna Study | 1 | Item | $ 30,000 | $ 30,000 | |
| 1.6 | Safety Assessment | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.7 | Stripping of topsoil | 5,908 | m3 | $ 1.30 | $ 7,680 | MW reimbursement rates for south east region (stripping) |
| **2** | **EARTHWORKS** | | | | | MW reimbursement rtes for south east region (earthworks rates) |
| 2.1 | Bulk Excavation | 15,455 | m3 | $ 10.90 | $ 168,460 | Excavation in broad greenfield land, excavated material to be reused on site for filling, allowance of 95% reuse on site |
| 2.2 | Reuse of onsite cut for filling | 14,682 | m3 | $ 11.70 | $ 171,782 | Assumed 95% of bulk excvavation for reuse |
| 2.3 | Disposal of excess cut | 773 | m3 | $ 19.20 | $ 14,837 | Assumed 5% of bulk excavation |
| **3** | **DRAINAGE** | | | | | |
| 3.1 | Rockwork | | | | | |
| *3.1.1* | Supply and install D50=400mm rock, 800 mm thick to form WL3 Wetland inlet | 96 | m3 | $ 197 | $ 18,912 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.2* | Supply and install D50=400mm rock, 800 mm thick to form WL3 Wetland overflow spillway | 115 | m3 | $ 197 | $ 22,655 | MW reimbursement rates for south east region (rockwork rate) |
| 3.2 | Concrete | | | | | |
| *3.2.1* | Supply and install reinforced N32 grade concrete weir to form WL3 Wetland spillway weir | 1 | Item | $ 10,000 | $ 10,000 | |
| *3.2.2* | Supply and install reinforced N32 grade concrete, 150 mm deep to form WL3 sediment basin base | 108 | m3 | $ 322 | $ 34,776 | Reinforced concrete slab 150mm thick (Rawlinsons publication) |
| 3.3 | Drainage | | | | | |
| *3.3.1* | Supply and install 675 mm dia RRJ sediment pond transfer pipe incl excavation, 20% crushed rock back fill (WL3 wetland) | 35 | m | $ 387 | $ 13,545 | MW reimbursement rates for south east region (675mm RRJ 20% FCR backfill) |
| *3.3.2* | Supply and install submerged offtake pit | 1 | No. | $ 6,710 | $ 6,710 | |
| *3.3.3* | Supply and install 300 mm dia RRJ 20% backfill balance pipes (WL3 wetland) | 122 | m | $ 219 | $ 26,718 | MW reimbursement rates for south east region (300mm RRJ 20% FCR backfill) |
| *3.3.4* | Supply and install submerged offtake pits for balance pipes | 2 | No. | $ 6,710 | $ 13,420 | |
| *3.3.5* | Supply and install 2 X 900 mm dia RRJ wetland high flow bypass pipeline incl excavation, 20% crushed rock back fill (WL3) | 368 | m | $ 561 | $ 206,448 | MW reimbursement rates for south east region (900mm RRJ 20% FCR backfill) |
| *3.3.6* | Supply and install submerged offtake pit for high flow bypass | 1 | No. | $ 6,710 | $ 6,710 | |
| *3.3.7* | Supply and install 675 mm dia RRJ wetland outfall pipe incl excavation, 20% crushed rock back fill | 16 | m | $ 387 | $ 6,192 | MW reimbursement rates for south east region (675mm RRJ 20% FCR backfill) |
| *3.3.8* | Supply and install twin chamber outfall pit with penstock and concrete weir | 1 | No. | $ 15,000 | $ 15,000 | |
| 3.4 | Access Path | | | | | |
| *3.4.1* | Supply and install N32 grade concrete to form 4m wide sediment pond maintenance access ramp WL3 wetland | 70 | m2 | $ 61.90 | $ 4,333 | MW reimbursement rates for south east region (concrete access track) |
| *3.4.2* | Supply and install D50=200mm with Class 2 FCR backfill to form 4m wide maintenance access around WL3 wetland | 2404 | m2 | $ 33.10 | $ 79,572 | MW reimbursement rates for south east region (crushed rock access track) |
| **4** | **LANDSCAPING** | | | | | |
| 4.1 | Re spread 200 mm topsoil for planting areas | 5,613 | m2 | $ 3.30 | $ 18,522 | Allowance of 95% of topsoil stripped from site, 5% assumed as unsuitable for reuse MW reimbursement rates for south east region (Topsoiling (80% from stockpile and 20% imported)) |
| 4.2 | Placement of 300 mm compacted clay liners for sedimentation basin and wetland (clay sourced onsite) | 10,090 | m2 | $ 8.00 | $ 80,720 | MW reimbursement rates for south east region (clay lining) |
| 4.3 | Supply and install submerged marsh planting. | 343 | m2 | $ 14.50 | $ 4,974 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.4 | Supply and install deep marsh planting (600cm3 tube, 2/m2). | 2,939 | m2 | $ 14.50 | $ 42,616 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.5 | Supply and install shallow marsh planting (600cm3 tube, 2/m2). | 3,359 | m2 | $ 14.50 | $ 48,706 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.6 | Supply and install wet ephemeral planting (90cm3 tube, 6/m2). | 1,190 | m2 | $ 14.50 | $ 17,255 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.7 | Supply and install dry ephemeral planting (90cm3 tube, 6/m2). | 2,810 | m2 | $ 16.80 | $ 47,208 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.8 | Supply and install sediment drying area planting (virocell planting, 6/m2). | 1,112 | m2 | $ 16.80 | $ 18,682 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.9 | Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 to TED to 350mm below NWL as specified for all Wet Ephemeral Planting | 7,488 | m2 | $ 7 | $ 52,416 | MW reimbursement rates for south east region (weed control matting) |
| 4.10 | Supply, install and maintain plant protection netting for a selected species in the aquatic zones. | 2 | No. | $ 20,000 | $ 40,000 | |
| **5** | **MISCELLANEOUS** | | | | | |
| 5.1 | Allowance for timber bollards | 1 | Item | $ 3,000 | $ 3,000 | |
| 5.2 | Allowance for seats | 1 | Item | $ 35,000 | $ 35,000 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SUB-TOTAL WORKS** | | | | $ 1,446,847 | |
| **6** | **DELIVERY** | | | | | |
| 6.1 | Council Fees | 3.25 | % | | $ 47,023 | |
| 6.2 | VicRoads Fees | 0 | % | | $ - | |
| 6.3 | Traffic Management | 2 | % | | $ 28,937 | |
| 6.4 | Environmental Management | 1 | Item | $ 50,000 | $ 50,000 | |
| 6.5 | Erosion Control Management | 0.5 | % | | $ 7,234 | |
| 6.6 | Survey & Design | 5 | % | | $ 72,342 | |
| 6.7 | Supervision & Project Management | 4 | % | | $ 57,874 | |
| 6.8 | Site Establishment | 2.5 | % | | $ 36,171 | |
| 6.9 | Contingency | 35 | % | | $ 506,396 | |
| | **SUB-TOTAL DELIVERY** | | | | $ 805,978 | |
| **7** | **TOTAL ESTIMATED COST** | | | | $ 2,252,825 | |

| Item | Description | Quantity | Unit | Rate $ | Amount $ | Comments |
|---|---|---|---|---|---|---|
| | **WL-04 WETLAND RETARDING BASIN 4 (WLRB4) WORKS** | | | | | |
| **1** | **SITEWORKS AND EARTHWORKS** | | | | | |
| 1.1 | Site preparation | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.2 | Diversion works | 1 | Item | $ 40,000 | $ 40,000 | |
| 1.3 | Geotechnical Investigation | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.4 | Cultural Heritage Assessment | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.5 | Flora and Fauna Study | 1 | Item | $ 30,000 | $ 30,000 | |
| 1.6 | Safety Assessment | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.7 | Stripping of topsoil | 3,408 | m3 | $ 1.30 | $ 4,430 | MW reimbursement rates for south east region (stripping) |
| **2** | **EARTHWORKS** | | | | | MW reimbursement rtes for south east region (earthworks rates) |
| 2.1 | Bulk Excavation | 31,007 | m3 | $ 10.90 | $ 337,976 | Excavation in broad greenfield land, excavated material to be reused on site for filling, allowance of 95% reuse on site |
| 2.2 | Reuse of onsite cut for filling | 29,457 | m3 | $ 11.70 | $ 344,643 | Assumed 95% of bulk excvavation for reuse |
| 2.3 | Disposal of excess cut | 1,550 | m3 | $ 19.20 | $ 29,767 | Assumed 5% of bulk excavation |
| **3** | **DRAINAGE** | | | | | |
| 3.1 | Rockwork | | | | | |
| *3.1.1* | Supply and install D50=400mm rock, 800 mm thick to form WL4 Wetland inlet | 88 | m3 | $ 197 | $ 17,336 | MW reimbursement rates for south east region (rockwork rate) |
| *3.1.2* | Supply and install D50=400mm rock, 800 mm thick to form WL4 Wetland overflow spillway | 136 | m3 | $ 197 | $ 26,792 | MW reimbursement rates for south east region (rockwork rate) |
| 3.2 | Concrete | | | | | |
| *3.2.1* | Supply and install reinforced N32 grade concrete weir to form WL4 Wetland spillway weir | 1 | Item | $ 10,000 | $ 10,000 | |
| *3.2.2* | Supply and install reinforced N32 grade concrete, 150 mm deep to form WL4 sediment basin base | 275 | m3 | $ 322 | $ 88,550 | Reinforced concrete slab 150mm thick (Rawlinsons publication) |
| 3.3 | Drainage | | | | | |
| *3.3.1* | Supply and install 600 mm dia RRJ sediment pond transfer pipe incl excavation, 20% crushed rock back fill (WL4 wetland) | 40 | m | $ 337 | $ 13,480 | MW reimbursement rates for south east region (600mm RRJ 20% FCR backfill) |
| *3.3.2* | Supply and install submerged offtake pit | 3 | No. | $ 6,710 | $ 20,130 | |
| *3.3.3* | Supply and install 300 mm dia RRJ 20% backfill balance pipes (WL4 wetland) | 97 | m | $ 219 | $ 21,243 | MW reimbursement rates for south east region (300mm RRJ 20% FCR backfill) |
| *3.3.4* | Supply and install submerged offtake pits for balance pipes | 2 | No. | $ 6,710 | $ 13,420 | |
| *3.3.5* | Supply and install 675 mm dia RRJ wetland outfall pipe incl excavation, 20% crushed rock back fill | 22 | m | $ 387 | $ 8,514 | MW reimbursement rates for south east region (675mm RRJ 20% FCR backfill) |
| *3.3.6* | Supply and install twin chamber outfall pit with penstock and concrete weir | 1 | No. | $ 15,000 | $ 15,000 | |
| 3.4 | Access Path | | | | | |
| *3.4.1* | Supply and install N32 grade concrete to form 4m wide sediment pond maintenance access ramp WL4 wetland | 88 | m2 | $ 61.90 | $ 5,447 | MW reimbursement rates for south east region (concrete access track) |
| *3.4.2* | Supply and install D50=200mm with Class 2 FCR backfill to form 4m wide maintenance access around WL4 wetland | 433 | m2 | $ 33.10 | $ 14,332 | MW reimbursement rates for south east region (crushed rock access track) |
| **4** | **LANDSCAPING** | | | | | |
| 4.1 | Re spread 200 mm topsoil for planting areas | 3,238 | m2 | $ 3.30 | $ 10,684 | Allowance of 95% of topsoil stripped from site, 5% assumed as unsuitable for reuse MW reimbursement rates for south east region (Topsoiling (80% from stockpile and 20% imported)) |
| 4.2 | Placement of 300 mm compacted clay liners for sedimentation basin and wetland (clay sourced onsite) | 7,433 | m2 | $ 8.00 | $ 59,464 | MW reimbursement rates for south east region (clay lining) |
| 4.3 | Supply and install submerged marsh planting. | 271 | m2 | $ 14.50 | $ 3,930 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.4 | Supply and install deep marsh planting (600cm3 tube, 2/m2). | 1,668 | m2 | $ 14.50 | $ 24,186 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.5 | Supply and install shallow marsh planting (600cm3 tube, 2/m2). | 3,525 | m2 | $ 14.50 | $ 51,113 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.6 | Supply and install wet ephemeral planting (90cm3 tube, 6/m2). | 689 | m2 | $ 14.50 | $ 9,991 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.7 | Supply and install dry ephemeral planting (90cm3 tube, 6/m2). | 4,978 | m2 | $ 16.80 | $ 83,630 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.8 | Supply and install sediment drying area planting (virocell planting, 6/m2). | 524 | m2 | $ 16.80 | $ 8,803 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.9 | Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 to TED to 350mm below NWL as specified for all Wet Ephemeral Planting | 5,882 | m2 | $ 7 | $ 41,174 | MW reimbursement rates for south east region (weed control matting) |
| 4.10 | Supply, install and maintain plant protection netting for a selected species in the aquatic zones. | 2 | No. | $ 20,000 | $ 40,000 | |
| **5** | **MISCELLANEOUS** | | | | | |
| 5.1 | Allowance for timber bollards | 1 | Item | $ 3,000 | $ 3,000 | |
| 5.2 | Allowance for seats | 1 | Item | $ 35,000 | $ 35,000 | |
| 5.3 | Other *(Description)* | | Item | | | |
| | **SUB-TOTAL WORKS** | | | | $ 1,552,035 | |
| **6** | **DELIVERY** | | | | | |
| 6.1 | Council Fees | 3.25 | % | | $ 50,441 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6.2 | VicRoads Fees | 0 | % | | $ | - | |
| 6.3 | Traffic Management | 2 | % | | $ | 31,041 | |
| 6.4 | Environmental Management | 1 | Item | $ 50,000 | $ | 50,000 | |
| 6.5 | Erosion Control Management | 0.5 | % | | $ | 7,760 | |
| 6.6 | Survey & Design | 5 | % | | $ | 77,602 | |
| 6.7 | Supervision & Project Management | 4 | % | | $ | 62,081 | |
| 6.8 | Site Establishment | 2.5 | % | | $ | 38,801 | |
| 6.9 | Contingency | 35 | % | | $ | 543,212 | |
| | **SUB-TOTAL DELIVERY** | | | | $ | 860,938 | |
| **7** | **TOTAL ESTIMATED COST** | | | | $ | 2,412,973 | |

| Item | Description | Quantity | Unit | Rate $ | Amount $ | Comments |
|---|---|---|---|---|---|---|
| | **SB-01 SEDIMENT BASIN 1 (SB1) WORKS** | | | | | |
| **1** | **SITEWORKS AND EARTHWORKS** | | | | | |
| 1.1 | Site preparation | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.2 | Diversion works | 1 | Item | $ 40,000 | $ 40,000 | |
| 1.3 | Geotechnical Investigation | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.4 | Cultural Heritage Assessment | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.5 | Flora and Fauna Study | 1 | Item | $ 30,000 | $ 30,000 | |
| 1.6 | Safety Assessment | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.7 | Stripping of topsoil | 1,047 | m3 | $ 1.30 | $ 1,361 | MW reimbursement rates for south east region (stripping) |
| **2** | **EARTHWORKS** | | | | | MW reimbursement rtes for south east region (earthworks rates) |
| 2.1 | Bulk Excavation | 6,466 | m3 | $ 10.90 | $ 70,479 | Excavation in broad greenfield land, excavated material to be reused on site for filling, allowance of 95% reuse |
| 2.2 | Reuse of onsite cut for filling | 6,143 | m3 | $ 11.70 | $ 71,870 | Assumed 95% of bulk excvavation for reuse |
| 2.3 | Disposal of excess cut | 323 | m3 | $ 19.20 | $ 6,207 | Assumed 5% of bulk excavation |
| **3** | **DRAINAGE** | | | | | |
| 3.1 | Rockwork | | | | | |
| *3.1.1* | Supply and install D50=400mm rock, 800 mm thick to form SB1 inlet | 22 | m3 | $ 197 | $ 4,334 | MW reimbursement rates for south east region (rockwork rate) |
| 3.2 | Concrete | | | | | |
| *3.2.1* | Supply and install reinforced N32 grade concrete, 150 mm deep to form base | 58 | m3 | $ 322 | $ 18,676 | Reinforced concrete slab 150mm thick (Rawlinsons publication) |
| 3.3 | Drainage | | | | | |
| *3.3.1* | Supply and install 600 mm dia RRJ sediment pond transfer pipe incl excavation, 20% crushed rock back fill (SB1) | 30 | m | $ 337 | $ 10,110 | MW reimbursement rates for south east region (600mm RRJ 20% FCR backfill) |
| *3.3.2* | Supply and install submerged offtake pit | 1 | No. | $ 6,710 | $ 6,710 | |
| 3.4 | Access Path | | | | | |
| *3.4.1* | Supply and install N32 grade concrete to form 4m wide sediment pond maintenance access ramp SB1 | 91 | m2 | $ 61.90 | $ 5,633 | MW reimbursement rates for south east region (concrete access track) |
| *3.4.2* | Supply and install D50=200mm with Class 2 FCR backfill to form 4m wide maintenance access around SB1 | 497 | m2 | $ 33.10 | $ 16,451 | MW reimbursement rates for south east region (crushed rock access track) |
| **4** | **LANDSCAPING** | | | | | |
| 4.1 | Re spread 200 mm topsoil for planting areas | 995 | m2 | $ 3.30 | $ 3,282 | Allowance of 95% of topsoil stripped from site, 5% assumed as unsuitable for reuse MW reimbursement rates for south east region (Topsoiling (80% from stockpile and 20% imported)) |
| 4.2 | Placement of 300 mm compacted clay liners for sedimentation basin | 1,198 | m2 | $ 8.00 | $ 9,584 | MW reimbursement rates for south east region (clay lining) |
| 4.3 | Supply and install submerged marsh planting. | 93 | m2 | $ 14.50 | $ 1,349 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.4 | Supply and install shallow marsh planting (600cm3 tube, 2/m2). | 285 | m2 | $ 14.50 | $ 4,133 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.5 | Supply and install wet ephemeral planting (90cm3 tube, 6/m2). | 246 | m2 | $ 14.50 | $ 3,567 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.6 | Supply and install dry ephemeral planting (90cm3 tube, 6/m2). | 2,047 | m2 | $ 16.80 | $ 34,390 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.7 | Supply and install sediment drying area planting (virocell planting, 6/m2). | 660 | m2 | $ 16.80 | $ 11,088 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.8 | Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 to TED to 350mm below NWL as specified for all Wet Ephemeral Planting | 531 | m2 | $ 7 | $ 3,717 | MW reimbursement rates for south east region (weed control matting) |
| 4.9 | Supply, install and maintain plant protection netting for a selected species in the aquatic zones. | 1 | No. | $ 20,000 | $ 20,000 | |
| **5** | **MISCELLANEOUS** | | | | | |
| 5.1 | Allowance for timber bollards | 1 | Item | $ 3,000 | $ 3,000 | |
| 5.2 | Allowance for seats | 1 | Item | $ 35,000 | $ 35,000 | |
| 5.3 | Other (Description) | | Item | | | |
| | **SUB-TOTAL WORKS** | | | | $ 550,940 | |
| **6** | **DELIVERY** | | | | | |
| 6.1 | Council Fees | 3.25 | % | | $ 17,906 | |
| 6.2 | VicRoads Fees | 0 | % | | $ - | |
| 6.3 | Traffic Management | 2 | % | | $ 11,019 | |
| 6.4 | Environmental Management | 1 | Item | $ 50,000 | $ 50,000 | |
| 6.5 | Erosion Control Management | 0.5 | % | | $ 2,755 | |
| 6.6 | Survey & Design | 5 | % | | $ 27,547 | |
| 6.7 | Supervision & Project Management | 4 | % | | $ 22,038 | |
| 6.8 | Site Establishment | 2.5 | % | | $ 13,773 | |
| 6.9 | Contingency | 35 | % | | $ 192,829 | |
| | **SUB-TOTAL DELIVERY** | | | | $ 337,866 | |
| **7** | **TOTAL ESTIMATED COST** | | | | $ 888,806 | |

| Item | Description | Quantity | Unit | Rate $ | Amount $ | Comments |
|---|---|---|---|---|---|---|
| | **SB-02 SEDIMENT BASIN 4 (SB4) WORKS** | | | | | |
| **1** | **SITEWORKS AND EARTHWORKS** | | | | | |
| 1.1 | Site preparation | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.2 | Diversion works | 1 | Item | $ 40,000 | $ 40,000 | |
| 1.3 | Geotechnical Investigation | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.4 | Cultural Heritage Assessment | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.5 | Flora and Fauna Study | 1 | Item | $ 30,000 | $ 30,000 | |
| 1.6 | Safety Assessment | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.7 | Stripping of topsoil | 977 | m3 | $ 1.30 | $ 1,270 | MW reimbursement rates for south east region (stripping) |
| **2** | **EARTHWORKS** | | | | | MW reimbursement rtes for south east region (earthworks rates) |
| 2.1 | Bulk Excavation | 8,138 | m3 | $ 10.90 | $ 88,704 | Excavation in broad greenfield land, excavated material to be reused on site for filling, allowance of 95% reuse |
| 2.2 | Reuse of onsite cut for filling | 7,731 | m3 | $ 11.70 | $ 90,454 | Assumed 95% of bulk excvavation for reuse |
| 2.3 | Disposal of excess cut | 407 | m3 | $ 19.20 | $ 7,812 | Assumed 5% of bulk excavation |
| **3** | **DRAINAGE** | | | | | |
| 3.1 | Rockwork | | | | | |
| *3.1.1* | Supply and install D50=400mm rock, 800 mm thick to form SB4 inlet | 32 | m3 | $ 197 | $ 6,304 | MW reimbursement rates for south east region (rockwork rate) |
| 3.2 | Concrete | | | | | |
| *3.2.1* | Supply and install reinforced N32 grade concrete, 150 mm deep to form base | 106 | m3 | $ 322 | $ 34,132 | Reinforced concrete slab 150mm thick (Rawlinsons publication) |
| 3.3 | Drainage | | | | | |
| *3.3.1* | Supply and install 1350 mm dia RRJ sediment pond transfer pipe incl excavation, 20% crushed rock back fill (SB4) | 120 | m | $ 1,005 | $ 120,600 | MW reimbursement rates for south east region (1350mm RRJ 20% FCR backfill) |
| *3.3.2* | Supply and install submerged offtake pit | 1 | No. | $ 6,710 | $ 6,710 | |
| 3.4 | Access Path | | | | | |
| *3.4.1* | Supply and install N32 grade concrete to form 4m wide sediment pond maintenance access ramp SB4 | 91 | m2 | $ 61.90 | $ 5,633 | MW reimbursement rates for south east region (concrete access track) |
| *3.4.2* | Supply and install D50=200mm with Class 2 FCR backfill to form 4m wide maintenance access around SB4 | 729 | m2 | $ 33.10 | $ 24,130 | MW reimbursement rates for south east region (crushed rock access track) |
| **4** | **LANDSCAPING** | | | | | |
| 4.1 | Re spread 200 mm topsoil for planting areas | 928 | m2 | $ 3.30 | $ 3,063 | Allowance of 95% of topsoil stripped from site, 5% assumed as unsuitable for reuse MW reimbursement rates for south east region (Topsoiling (80% from stockpile and 20% imported)) |
| 4.2 | Placement of 300 mm compacted clay liners for sedimentation basin | 1,742 | m2 | $ 8.00 | $ 13,936 | MW reimbursement rates for south east region (clay lining) |
| 4.3 | Supply and install submerged marsh planting. | 120 | m2 | $ 14.50 | $ 1,740 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.4 | Supply and install shallow marsh planting (600cm3 tube, 2/m2). | 355 | m2 | $ 14.50 | $ 5,148 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.5 | Supply and install wet ephemeral planting (90cm3 tube, 6/m2). | 313 | m2 | $ 14.50 | $ 4,539 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.6 | Supply and install dry ephemeral planting (90cm3 tube, 6/m2). | 2,414 | m2 | $ 16.80 | $ 40,555 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.7 | Supply and install sediment drying area planting (virocell planting, 6/m2). | 974 | m2 | $ 16.80 | $ 16,363 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.8 | Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 to TED to 350mm below NWL as specified for all Wet Ephemeral Planting | 668 | m2 | $ 7 | $ 4,676 | MW reimbursement rates for south east region (weed control matting) |
| 4.9 | Supply, install and maintain plant protection netting for a selected species in the aquatic zones. | 1 | No. | $ 20,000 | $ 20,000 | |
| **5** | **MISCELLANEOUS** | | | | | |
| 5.1 | Allowance for timber bollards | 1 | Item | $ 3,000 | $ 3,000 | |
| 5.2 | Allowance for seats | 1 | Item | $ 35,000 | $ 35,000 | |
| 5.3 | Other (Description) | | Item | | | |
| | **SUB-TOTAL WORKS** | | | | $ 743,769 | |
| **6** | **DELIVERY** | | | | | |
| 6.1 | Council Fees | 3.25 | % | | $ 24,172 | |
| 6.2 | VicRoads Fees | 0 | % | | $ - | |
| 6.3 | Traffic Management | 2 | % | | $ 14,875 | |
| 6.4 | Environmental Management | 1 | Item | $ 50,000 | $ 50,000 | |
| 6.5 | Erosion Control Management | 0.5 | % | | $ 3,719 | |
| 6.6 | Survey & Design | 5 | % | | $ 37,188 | |
| 6.7 | Supervision & Project Management | 4 | % | | $ 29,751 | |
| 6.8 | Site Establishment | 2.5 | % | | $ 18,594 | |
| 6.9 | Contingency | 35 | % | | $ 260,319 | |
| | **SUB-TOTAL DELIVERY** | | | | $ 438,619 | |
| **7** | **TOTAL ESTIMATED COST** | | | | $ 1,182,388 | |

| Item | Description | Quantity | Unit | Rate $ | Amount $ | Comments |
|---|---|---|---|---|---|---|
| | **SB-03 SEDIMENT BASIN 5 (SB5) WORKS** | | | | | |
| **1** | **SITEWORKS AND EARTHWORKS** | | | | | |
| 1.1 | Site preparation | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.2 | Diversion works | 1 | Item | $ 40,000 | $ 40,000 | |
| 1.3 | Geotechnical Investigation | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.4 | Cultural Heritage Assessment | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.5 | Flora and Fauna Study | 1 | Item | $ 30,000 | $ 30,000 | |
| 1.6 | Safety Assessment | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.7 | Stripping of topsoil | 976 | m3 | $ 1.30 | $ 1,269 | MW reimbursement rates for south east region (stripping) |
| **2** | **EARTHWORKS** | | | | | MW reimbursement rtes for south east region (earthworks rates) |
| 2.1 | Bulk Excavation | 5,814 | m3 | $ 10.90 | $ 63,373 | Excavation in broad greenfield land, excavated material to be reused on site for filling, allowance of 95% reuse |
| 2.2 | Reuse of onsite cut for filling | 5,523 | m3 | $ 11.70 | $ 64,623 | Assumed 95% of bulk excvavation for reuse |
| 2.3 | Disposal of excess cut | 291 | m3 | $ 19.20 | $ 5,581 | Assumed 5% of bulk excavation |
| **3** | **DRAINAGE** | | | | | |
| 3.1 | Rockwork | | | | | |
| *3.1.1* | Supply and install D50=400mm rock, 800 mm thick to form SB5 inlet | 17 | m3 | $ 197 | $ 3,349 | MW reimbursement rates for south east region (rockwork rate) |
| 3.2 | Concrete | | | | | |
| *3.2.1* | Supply and install reinforced N32 grade concrete, 150 mm deep to form base | 53 | m3 | $ 322 | $ 17,066 | Reinforced concrete slab 150mm thick (Rawlinsons publication) |
| 3.3 | Drainage | | | | | |
| *3.3.1* | Supply and install 1350 mm dia RRJ sediment pond transfer pipe incl excavation, 20% crushed rock back fill (SB5) | 20 | m | $ 1,005 | $ 20,100 | MW reimbursement rates for south east region (1350mm RRJ 20% FCR backfill) |
| *3.3.2* | Supply and install submerged offtake pit | 1 | No. | $ 6,710 | $ 6,710 | |
| 3.4 | Access Path | | | | | |
| *3.4.1* | Supply and install N32 grade concrete to form 4m wide sediment pond maintenance access ramp SB5 | 91 | m2 | $ 61.90 | $ 5,633 | MW reimbursement rates for south east region (concrete access track) |
| *3.4.2* | Supply and install D50=200mm with Class 2 FCR backfill to form 4m wide maintenance access around SB5 | 515 | m2 | $ 33.10 | $ 17,047 | MW reimbursement rates for south east region (crushed rock access track) |
| **4** | **LANDSCAPING** | | | | | |
| 4.1 | Re spread 200 mm topsoil for planting areas | 927 | m2 | $ 3.30 | $ 3,060 | Allowance of 95% of topsoil stripped from site, 5% assumed as unsuitable for reuse MW reimbursement rates for south east region (Topsoiling (80% from stockpile and 20% imported)) |
| 4.2 | Placement of 300 mm compacted clay liners for sedimentation basin | 1,138 | m2 | $ 8.00 | $ 9,104 | MW reimbursement rates for south east region (clay lining) |
| 4.3 | Supply and install submerged marsh planting. | 90 | m2 | $ 14.50 | $ 1,305 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.4 | Supply and install shallow marsh planting (600cm3 tube, 2/m2). | 274 | m2 | $ 14.50 | $ 3,973 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.5 | Supply and install wet ephemeral planting (90cm3 tube, 6/m2). | 239 | m2 | $ 14.50 | $ 3,466 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.6 | Supply and install dry ephemeral planting (90cm3 tube, 6/m2). | 1,604 | m2 | $ 16.80 | $ 26,947 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.7 | Supply and install sediment drying area planting (virocell planting, 6/m2). | 771 | m2 | $ 16.80 | $ 12,953 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.8 | Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 to TED to 350mm below NWL as specified for all Wet Ephemeral Planting | 513 | m2 | $ 7 | $ 3,591 | MW reimbursement rates for south east region (weed control matting) |
| 4.9 | Supply, install and maintain plant protection netting for a selected species in the aquatic zones. | 1 | No. | $ 20,000 | $ 20,000 | |
| **4** | **MISCELLANEOUS** | | | | | |
| 4.1 | Allowance for timber bollards | 1 | Item | $ 3,000 | $ 3,000 | |
| 4.3 | Allowance for seats | 1 | Item | $ 35,000 | $ 35,000 | |
| 4.4 | Other (Description) | | Item | | | |
| | **SUB-TOTAL WORKS** | | | | $ 537,148 | |
| **6** | **DELIVERY** | | | | | |
| 6.1 | Council Fees | 3.25 | % | | $ 17,457 | |
| 6.2 | VicRoads Fees | 0 | % | | $ - | |
| 6.3 | Traffic Management | 2 | % | | $ 10,743 | |
| 6.4 | Environmental Management | 1 | Item | $ 50,000 | $ 50,000 | |
| 6.5 | Erosion Control Management | 0.5 | % | | $ 2,686 | |
| 6.6 | Survey & Design | 5 | % | | $ 26,857 | |
| 6.7 | Supervision & Project Management | 4 | % | | $ 21,486 | |
| 6.8 | Site Establishment | 2.5 | % | | $ 13,429 | |
| 6.9 | Contingency | 35 | % | | $ 188,002 | |
| | **SUB-TOTAL DELIVERY** | | | | $ 330,660 | |
| **7** | **TOTAL ESTIMATED COST** | | | | $ 867,808 | |

| Item | Description | Quantity | Unit | Rate $ | Amount $ | Comments |
|---|---|---|---|---|---|---|
| | **SB-04 SEDIMENT BASIN 6 (SB6) WORKS** | | | | | |
| **1** | **SITEWORKS AND EARTHWORKS** | | | | | |
| 1.1 | Site preparation | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.2 | Diversion works | 1 | Item | $ 40,000 | $ 40,000 | |
| 1.3 | Geotechnical Investigation | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.4 | Cultural Heritage Assessment | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.5 | Flora and Fauna Study | 1 | Item | $ 30,000 | $ 30,000 | |
| 1.6 | Safety Assessment | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.7 | Stripping of topsoil | 597 | m3 | $ 1.30 | $ 776 | MW reimbursement rates for south east region (stripping) |
| **2** | **EARTHWORKS** | | | | | MW reimbursement rtes for south east region (earthworks rates) |
| 2.1 | Bulk Excavation | 2,720 | m3 | $ 10.90 | $ 29,648 | Excavation in broad greenfield land, excavated material to be reused on site for filling, allowance of 95% reuse |
| 2.2 | Reuse of onsite cut for filling | 2,584 | m3 | $ 11.70 | $ 30,233 | Assumed 95% of bulk excvavation for reuse |
| 2.3 | Disposal of excess cut | 136 | m3 | $ 19.20 | $ 2,611 | Assumed 5% of bulk excavation |
| **3** | **DRAINAGE** | | | | | |
| 3.1 | Rockwork | | | | | |
| *3.1.1* | Supply and install D50=400mm rock, 800 mm thick to form SB6 inlet | 29 | m3 | $ 197 | $ 5,713 | MW reimbursement rates for south east region (rockwork rate) |
| 3.2 | Concrete | | | | | |
| *3.2.1* | Supply and install reinforced N32 grade concrete, 150 mm deep to form base | 63 | m3 | $ 322 | $ 20,286 | Reinforced concrete slab 150mm thick (Rawlinsons publication) |
| 3.3 | Drainage | | | | | |
| *3.3.1* | Supply and install 1200 mm dia RRJ sediment pond transfer pipe incl excavation, 20% crushed rock back fill (SB6) | 9 | m | $ 844 | $ 7,596 | MW reimbursement rates for south east region (1200mm RRJ 20% FCR backfill) |
| *3.3.2* | Supply and install submerged offtake pit | 1 | No. | $ 6,710 | $ 6,710 | |
| 3.4 | Access Path | | | | | |
| *3.4.1* | Supply and install N32 grade concrete to form 4m wide sediment pond maintenance access ramp SB6 | 91 | m2 | $ 61.90 | $ 5,633 | MW reimbursement rates for south east region (concrete access track) |
| *3.4.2* | Supply and install D50=200mm with Class 2 FCR backfill to form 4m wide maintenance access around SB6 | 411 | m2 | $ 33.10 | $ 13,604 | MW reimbursement rates for south east region (crushed rock access track) |
| **4** | **LANDSCAPING** | | | | | |
| 4.1 | Re spread 200 mm topsoil for planting areas | 567 | m2 | $ 3.30 | $ 1,872 | Allowance of 95% of topsoil stripped from site, 5% assumed as unsuitable for reuse MW reimbursement rates for south east region (Topsoiling (80% from stockpile and 20% imported)) |
| 4.2 | Placement of 300 mm compacted clay liners for sedimentation basin | 1,257 | m2 | $ 8.00 | $ 10,056 | MW reimbursement rates for south east region (clay lining) |
| 4.3 | Supply and install submerged marsh planting. | 97 | m2 | $ 14.50 | $ 1,407 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.4 | Supply and install shallow marsh planting (600cm3 tube, 2/m2). | 293 | m2 | $ 14.50 | $ 4,249 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.5 | Supply and install wet ephemeral planting (90cm3 tube, 6/m2). | 252 | m2 | $ 14.50 | $ 3,654 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.6 | Supply and install dry ephemeral planting (90cm3 tube, 6/m2). | 1,280 | m2 | $ 16.80 | $ 21,504 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.7 | Supply and install sediment drying area planting (virocell planting, 6/m2). | 736 | m2 | $ 16.80 | $ 12,365 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.8 | Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 to TED to 350mm below NWL as specified for all Wet Ephemeral Planting | 545 | m2 | $ 7 | $ 3,815 | MW reimbursement rates for south east region (weed control matting) |
| 4.9 | Supply, install and maintain plant protection netting for a selected species in the aquatic zones. | 1 | No. | $ 20,000 | $ 20,000 | |
| **4** | **MISCELLANEOUS** | | | | | |
| 4.1 | Allowance for timber bollards | 1 | Item | $ 3,000 | $ 3,000 | |
| 4.3 | Allowance for seats | 1 | Item | $ 35,000 | $ 35,000 | |
| 4.4 | Other (Description) | | Item | | | |
| | **SUB-TOTAL WORKS** | | | | $ 449,730 | |
| **6** | **DELIVERY** | | | | | |
| 6.1 | Council Fees | 3.25 | % | | $ 14,616 | |
| 6.2 | VicRoads Fees | 0 | % | | $ - | |
| 6.3 | Traffic Management | 2 | % | | $ 8,995 | |
| 6.4 | Environmental Management | 1 | Item | $ 50,000 | $ 50,000 | |
| 6.5 | Erosion Control Management | 0.5 | % | | $ 2,249 | |
| 6.6 | Survey & Design | 5 | % | | $ 22,487 | |
| 6.7 | Supervision & Project Management | 4 | % | | $ 17,989 | |
| 6.8 | Site Establishment | 2.5 | % | | $ 11,243 | |
| 6.9 | Contingency | 35 | % | | $ 157,406 | |
| | **SUB-TOTAL DELIVERY** | | | | $ 284,984 | |
| **7** | **TOTAL ESTIMATED COST** | | | | $ 734,715 | |

| Item | Description | Quantity | Unit | Rate $ | Amount $ | Comments |
|---|---|---|---|---|---|---|
| | **SB-05 SEDIMENT BASIN 7 (SB7) WORKS** | | | | | |
| **1** | **SITEWORKS AND EARTHWORKS** | | | | | |
| 1.1 | Site preparation | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.2 | Diversion works | 1 | Item | $ 40,000 | $ 40,000 | |
| 1.3 | Geotechnical Investigation | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.4 | Cultural Heritage Assessment | 1 | Item | $ 50,000 | $ 50,000 | |
| 1.5 | Flora and Fauna Study | 1 | Item | $ 30,000 | $ 30,000 | |
| 1.6 | Safety Assessment | 1 | Item | $ 20,000 | $ 20,000 | |
| 1.7 | Stripping of topsoil | 652 | m3 | $ 1.30 | $ 848 | MW reimbursement rates for south east region (stripping) |
| **2** | **EARTHWORKS** | | | | | MW reimbursement rtes for south east region (earthworks rates) |
| 2.1 | Bulk Excavation | 3,178 | m3 | $ 10.90 | $ 34,640 | Excavation in broad greenfield land, excavated material to be reused on site for filling, allowance of 95% reuse |
| 2.2 | Reuse of onsite cut for filling | 3,019 | m3 | $ 11.70 | $ 35,323 | Assumed 95% of bulk excvavation for reuse |
| 2.3 | Disposal of excess cut | 159 | m3 | $ 19.20 | $ 3,051 | Assumed 5% of bulk excavation |
| **3** | **DRAINAGE** | | | | | |
| 3.1 | Rockwork | | | | | |
| *3.1.1* | Supply and install D50=400mm rock, 800 mm thick to form SB7 inlet | 28 | m3 | $ 197 | $ 5,516 | MW reimbursement rates for south east region (rockwork rate) |
| 3.2 | Concrete | | | | | |
| *3.2.1* | Supply and install reinforced N32 grade concrete, 150 mm deep to form base | 19 | m3 | $ 322 | $ 6,118 | Reinforced concrete slab 150mm thick (Rawlinsons publication) |
| 3.3 | Drainage | | | | | |
| *3.3.1* | Supply and install 900 mm dia RRJ sediment pond transfer pipe incl excavation, 20% crushed rock back fill (SB7) | 110 | m | $ 561 | $ 61,710 | MW reimbursement rates for south east region (900mm RRJ 20% FCR backfill) |
| *3.3.2* | Supply and install submerged offtake pit | 1 | No. | $ 6,710 | $ 6,710 | |
| 3.4 | Access Path | | | | | |
| *3.4.1* | Supply and install N32 grade concrete to form 4m wide sediment pond maintenance access ramp SB7 | 86 | m2 | $ 61.90 | $ 5,323 | MW reimbursement rates for south east region (concrete access track) |
| *3.4.2* | Supply and install D50=200mm with Class 2 FCR backfill to form 4m wide maintenance access around SB7 | 358 | m2 | $ 33.10 | $ 11,850 | MW reimbursement rates for south east region (crushed rock access track) |
| **4** | **LANDSCAPING** | | | | | |
| 4.1 | Re spread 200 mm topsoil for planting areas | 619 | m2 | $ 3.30 | $ 2,044 | Allowance of 95% of topsoil stripped from site, 5% assumed as unsuitable for reuse MW reimbursement rates for south east region (Topsoiling (80% from stockpile and 20% imported)) |
| 4.2 | Placement of 300 mm compacted clay liners for sedimentation basin | 701 | m2 | $ 8.00 | $ 5,608 | MW reimbursement rates for south east region (clay lining) |
| 4.3 | Supply and install submerged marsh planting. | 66 | m2 | $ 14.50 | $ 957 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.4 | Supply and install shallow marsh planting (600cm3 tube, 2/m2). | 202 | m2 | $ 14.50 | $ 2,929 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.5 | Supply and install wet ephemeral planting (90cm3 tube, 6/m2). | 193 | m2 | $ 14.50 | $ 2,799 | MW reimbursement rates for south east region (Aquatic revegetation) |
| 4.6 | Supply and install dry ephemeral planting (90cm3 tube, 6/m2). | 1,523 | m2 | $ 16.80 | $ 25,586 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.7 | Supply and install sediment drying area planting (virocell planting, 6/m2). | 314 | m2 | $ 16.80 | $ 5,275 | MW reimbursement rates for south east region (terrestrial revegetation) |
| 4.8 | Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 to TED to 350mm below NWL as specified for all Wet Ephemeral Planting | 395 | m2 | $ 7 | $ 2,765 | MW reimbursement rates for south east region (weed control matting) |
| 4.9 | Supply, install and maintain plant protection netting for a selected species in the aquatic zones. | 1 | No. | $ 20,000 | $ 20,000 | |
| **4** | **MISCELLANEOUS** | | | | | |
| 4.1 | Allowance for timber bollards | 1 | Item | $ 3,000 | $ 3,000 | |
| 4.3 | Allowance for seats | 1 | Item | $ 35,000 | $ 35,000 | |
| 4.4 | Other *(Description)* | | Item | | | |
| | **SUB-TOTAL WORKS** | | | | $ 487,052 | |
| **6** | **DELIVERY** | | | | | |
| 6.1 | Council Fees | 3.25 | % | | $ 15,829 | |
| 6.2 | VicRoads Fees | 0 | % | | $ - | |
| 6.3 | Traffic Management | 2 | % | | $ 9,741 | |
| 6.4 | Environmental Management | 1 | Item | $ 50,000 | $ 50,000 | |
| 6.5 | Erosion Control Management | 0.5 | % | | $ 2,435 | |
| 6.6 | Survey & Design | 5 | % | | $ 24,353 | |
| 6.7 | Supervision & Project Management | 4 | % | | $ 19,482 | |
| 6.8 | Site Establishment | 2.5 | % | | $ 12,176 | |
| 6.9 | Contingency | 35 | % | | $ 170,468 | |
| | **SUB-TOTAL DELIVERY** | | | | $ 304,485 | |
| **7** | **TOTAL ESTIMATED COST** | | | | $ 791,537 | |

CULVERTS

| Culvert ID | Culvert size | No. of Cells | Length (m) | Cost rate ($/m) | Culvert cost ($) | Base slab rate ($/m) | Base slab cost ($) | Link slab rate ($/m) | Link slab cost ($) | Headwall & Endwall volume (m3) | Headwall & Endwall cost rate ($/m3) | Headwall & Endwall cost ($) | Traffic management cost ($) | Total Cost ($) | Total Cost (plus contingency) ($) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CU-01** | 1500 | 4 | 30 | $ 1,583 | $ 189,960 | $ - | $ - | $ - | $ - | 19.84 | $ 3,037 | $ 60,254 | $ 11,680 | $ 261,894 | $ 353,557 |
| **CU-02** | 1650 | 3 | 30 | $ 1,840 | $ 165,600 | $ - | $ - | $ - | $ - | 25.80 | $ 3,037 | $ 78,355 | $ 11,680 | $ 255,635 | $ 345,107 |
| **CU-03** | (COSTED BY VPA) | - | - | $ - | $ - | $ - | $ - | $ - | $ - | - | $ - | $ - | $ - | $ 206,048 | $ 278,165 |
| **CU-04a** | 300*300 | 2 | 45 | $ 205 | $ 18,450 | $ 110 | $ 9,900 | $ - | $ - | 1.44 | $ 3,037 | $ 4,373 | $ 11,680 | $ 44,403 | $ 59,944 |
| **CU-04b** | 600*1200 | 1 | 50 | $ 837 | $ 41,850 | $ 250 | $ 12,500 | $ - | $ - | 2.74 | $ 3,037 | $ 8,321 | $ 11,680 | $ 74,351 | $ 100,374 |
| **CU-05** | 1650 | 1 | 45 | $ 1,840 | $ 82,800 | $ - | $ - | $ - | $ - | 8.60 | $ 3,037 | $ 26,118 | $ 11,680 | $ 120,598 | $ 162,808 |
| **CU-06** | 1200*600 | 3 | 45 | $ 837 | $ 112,995 | $ 618 | $ 83,430 | $ 618 | $ 27,810 | 8.22 | $ 3,037 | $ 24,964 | $ 11,680 | $ 260,879 | $ 352,187 |
| **CU-07** | 750 | 4 | 50 | $ 586 | $ 117,200 | $ - | $ - | $ - | $ - | 6.96 | $ 3,037 | $ 21,138 | $ 11,680 | $ 150,018 | $ 202,524 |
| **CU-08** | (COSTED BY CARDNO) | - | - | $ - | $ - | $ - | $ - | $ - | $ - | - | $ 3,037 | $ - | $ - | $ - | $ 225,967 |
| **CU-09** | (COSTED BY CARDNO) | - | - | $ - | $ - | $ - | $ - | $ - | $ - | - | $ 3,037 | $ - | $ - | $ - | $ 114,026 |
| **CU-10** | (COSTED BY CARDNO) | - | - | $ - | $ - | $ - | $ - | $ - | $ - | - | $ 3,037 | $ - | $ - | $ - | $ 554,320 |
| **CU-11** | 1200*1200 | 3 | 50 | $ 1,063 | $ 106,300 | $ 618 | $ 92,700 | $ 618 | $ 30,900 | 9.18 | $ 3,037 | $ 27,880 | $ 11,680 | $ 269,460 | $ 363,771 |
| **CU-12** | 1650 | 3 | 30 | $ 1,840 | $ 165,600 | $ - | $ - | $ - | $ - | 25.80 | $ 3,037 | $ 78,355 | $ - | $ 243,955 | $ 329,339 |

## Appendix D – Alluvium response to Craigie/Daff Preliminary Drainage Review

| | Feedback & Recommendations (Craigie/Daff) - Preliminary Drainage Review (Dec 2021) | Changes made by Alluvium Consulting and reflected in the April 2022 Drainage Report |
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| | **Discussion of Wetland Sizing** | |
| 1 | Given the very high costs proposed, strict adherence to the very conservative MWC DTC guidelines should be tempered with practical considerations. We acknowledge the DTC approach may have proved the easiest pathway to project approvals in greater Melbourne, but in this regional setting longer term maintenance costs for over-sized assets will be a significant burden on limited Council budgets. | Engeny has re-run the storage elevation component of the TUFLOW model per the below scope:<br>1. Re-run TUFLOW model for the following two scenarios:<br>• DEM of revised wetland footprint @ 13.6 AHD with modified downstream channel outfall and updated outfall pipe arrangement provided by Alluvium.<br>• DEM of revised wetland footprint @ 14.0 AHD with modified downstream channel outfall and updated outfall pipe arrangement provided by Alluvium.<br>• DEM of revised wetland footprint @ 14.0 AHD with modified downstream channel outfall and updated outfall pipe arrangement provided by Alluvium. This run includes updates to the constructed waterways, which were raised to match the proposed higher wetland level.<br><br>2. Re-run TUFLOW model for the following events:<br>• 50% AEP and 1% AEP excluding Powlett River flows<br>• 1% AEP including Powlett River flows<br><br>3. Review previous flood mapping results for the existing and developed conditions to determine if wetlands 2 and 3 could also be raised from a flooding/retardation point of view.<br><br>Alluvium has adjusted wetland sizes and designs accordingly, with most of the changes focused on WLRB1a and WLRB1b, and the two constructed waterways. Alluvium has reduced the macrophyte zones of all wetlands (WLRB4 footprint has been approved by Council so no changes made). Alluvium has raised the normal water level of WLRB1a and WLRB1b to reduce overall excavation costs, without compromising flood storage requirements and water quality treatment compliance. |
| 2 | Particularly in a location such as this where the wetland area is well and truly drowned out in events less than 1EY (1 year) the DTC approach taken by Alluvium should be revisited to better acknowledge the reality of the site environment and to scale back the treatment outcomes. 1EY flood level is 15.4 m cf. wetland NWL of 13.6 m and TEDD of 13.95 m. | Refer to item 1. |
| 3 | The 4EY flow estimates should be checked first. These appear to have been adopted as 40% of 1EY flows entering the basins (although this is hard to confirm from the report). | Alluvium has completed this check. |
| 4 | Given the large size of the inlet sediment ponds and hydraulic control separation from the macrophyte zones, the retarding effects of the inlet ponds could be incorporated into a separate version of the RORB model to determine peak outflow rate into the macrophyte zones in the 4EY event. The ARR 2019 rainfall data allows direct simulation of events less than 1 EY. (It should be noted that this model structure would not be suited to large flood event simulations). | Refer to item 1. |
| 5 | Based on our experience it is likely that 4EY flow peaks entering the macrophyte zone would be significantly mitigated with this design approach. Reduction in flows would directly reduce macrophyte zone width and then length and hence overall area. We recommend this be done. | Refer to item 1. |
| 6 | Macrophyte areas could also be reduced by about 25% just by adopting a length to width ratio of 3 which should still be sufficient to ensure plug flow through the wetland. We recommend this be adopted. | Refer to item 1. |
| 7 | Lastly a 2D model such as TUFLOW can be used to confirm actual hydraulic behaviour in the macrophyte zone during the 4EY event and show the velocity criteria of 0.05 m/s will be achieved. This work should form part of final design. | No action. This is an issue for the detailed design phase. |

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| | **Discussion of Cost Items and Rates** | |
| 8 | The designs for the East and West Waterways are similar so that quantities should be about the same for both consultants. Despite this Alluvium estimated base costs of $38.6M cf. Engeny at $16.4M, an increase of 235%. | Alluvium has raised the invert of the two constructed waterways to reduce overall excavation quantities associated with the development of the PSP and DCP without losing flood conveyance and capacity. |
| 9 | (Note: Alluvium report high flow capacity of the lower reaches of both waterways as the same at 31.4 m3/s whereas Engeny get 21 m3/s for E-WW. This needs to be clarified given the same RORB model is used. If Alluvium have over-estimated the required capacity, then this will be reflected in higher quantities and costs) | Alluvium has completed this check. |
| | **Cost Rates** | |
| 10 | One partial explanation for cost differentials would be that the Engeny cost estimates are from the 2019 report. Their November 2021 update didn't include new cost estimates. We accept that construction rates are likely to have been significantly increased from 2019 but certainly not by 235%. | Alluvium has updated costing rates and items using region-specific costing estimates. |
| 11 | The excavation rate of $38 per cubic metre for the bulk excavation of the retarding basins, wetlands and waterways appears to be high and needs to be justified. We understand rates around $25 or less are currently used in south eastern Melbourne | Alluvium has included a lower excavation rate of $25/m3. |
| 12 | Importation of topsoil for all earthworks projects within the PSP also needs to be justified. There is no explanation offered in the report. In nearly all drainage projects topsoil removed during the construction of the water asset is returned following excavation. Sometimes topsoil removed from adjacent roads is also used. The estimates allow a base cost of $10M just for the importation of topsoil. If there is a geotechnical reason for such a massive extra cost, then this needs to be clearly stated. | Alluvium have revised cost estimates using the following volumes and reuse estimates:<br>• An excavated volume of 5% assumed for offsite disposal<br>• An excavated volume of 95% assumed to be reused on site for filling<br>• An allowance of 5% assumed for some rock excavation / potential reuse in waterways<br>• Excavated topsoil has assumed 5% for removal and 95% for stockpiling on site for later reuse on site<br>• An allowance of 5% assumed to import clean topsoil to cover for topsoil losses (shortfall due to above). |
| 13 | The total supervision costs of 12.25% comprising 3.25% council fees and 9.0% supervision and project management appears excessive and should be reviewed. | No action for Alluvium - VPA to consider. |
| | **Other Design Suggestions to Reduce Costs** | |
| | **(a) Wetland NWL** | |
| 14 | One factor that will significantly affect final costs is the NWL chosen for wetland design. Currently Engeny and Alluvium both have NWL at 13.6 m for WLRB1. We believe this is way too low given natural surface levels of about 16 m and downstream inverts about 13.1 (after construction of the outfall). | Refer to item 1. |
| 15 | It is recommended that macrophyte zone NWL be raised to 14.2 m in WLRB1. That equates to excavation saving of about 60,000 m3 for the Alluvium WLRB1a+b design. At their base rate of $38/m3 that is a saving of $2.3M. | Refer to item 1. |
| 16 | The higher NWL also increases clearance over inevitable vegetation growth in the MOP outfall over time and enhances hydraulic grade for culvert/pipe outfall design. | Refer to item 1. |
| 17 | In turn this change in NWL raises the invert levels of the lower portions of the E-WW and W-WW waterways so that further significant savings in excavation can be made on those assets. Such invert raising should not significantly impact on calculated flood levels or finished surface levels. | Refer to item 1. |
| 18 | Grades averaging 1 in 750 are achievable in the lower reaches of both waterways with the raised NWL which are still within normal guidelines. Inclusion of online pools for habitat and aesthetic values can also increase effective bed grades. We have not had time to check the other wetlands, but similar comments and potential savings may apply. | Refer to item 1. |

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| | **(b) SB4/SB6 Locations** | |
| 19 | These basins are currently shown as offline to W-WW and E-WW occupying large areas of otherwise developable land. It is our view that these basins should be integrated online to reduce land take, earthworks, plantings and to improve aesthetics. Design would need to satisfy velocity and maintenance criteria, but we expect no real problems. We see significant cost savings and greatly improved waterway corridor aesthetics accruing through this change. | Alluvium have relocated SB4 and SB6 into the respective waterway corridors. These SBs have been integrated into the waterway 'floodplains' to reduce overall land take. |
| | **(c) WLRB1 Low flow outlet** | |
| 20 | The current Alluvium low flow outlet design for WLRB1a+b reflects the Engeny proposal. It provides for 10*300 mm pipes (length ~100 m), to get under/over the gas main and the water mains. Figure 1 refers. | Alluvium have included an updated design comprising 3 x 900mm (W) x 300mm (H) box culverts, which would transition to a single 1200mm (W) x 600mm (H) box culvert midway through the road crossing, once the existing services requiring appropriate cover was passed.<br>The proposed outfall arrangement is considered a more feasible and effective approach in comparison to a 10 x 300mm HDPE pipe arrangement (Engeny, 2021) given the propensity to blockages. |
| 21 | There will be inevitable operation and maintenance problems with this design. There are more practical and less costly arrangements available which should be considered in future design. A quick check on the capacity of the designed outlet system at headwater level of 14.5 m (crest of the high flow outlet culverts under Wonthaggi Korumburra Road) shows that no more than 650 l/s can be discharged to the MOP outfall. Figure 2 shows a suggested alternative that matches this capacity with a simple box culvert arrangement. A small pool should be added at the outlet end to the MOP outfall regardless of whatever design solution is adopted. | |
| | **(d) Asset Locations and alignments** | |
| 22 | Although not part of our brief we would like to suggest that flexibility be retained in the PSP DCP wording to allow future subdivisional and drainage asset design to be varied from the adopted functional layouts, subject to still meeting the best practice performance requirements for drainage.<br>Our experience convinces us that unless the wording is flexible it will prove to be difficult to adjust drainage asset location/alignment/shape in future design.<br>One example is the functional design report mentions that roads should be constructed alongside the W-WW and E-WW waterways. We believe there is a need to create more interest in the layout of the subdivision and variety in the lots to assist in long term success of waterway design and ongoing maintenance.<br>This could be achieved by having a number of sections along the waterways where lots face directly onto the waterway with only a pedestrian/maintenance track between the lots and the waterway. A small lane could run along the rear of these lots to give access to their garages. The owners of these lots have “ownership” of the waterway that they are overlooking. The main road would have to dogleg around these areas which would help restrict high speeds along these roads. We understand this arrangement was shown in a number of PSPs in northern Melbourne. It is ideally suited to pockets of medium density development as well. | Alluvium has considered this, but no change proposed to designs. |
| 23 | (e) Contributions The drainage costs for this PSP were always going to be high because of the large areas outside the PSP that have to drain through the PSP. Page 12 of Alluviums’ report states that 720 ha of agriculture and existing/proposed urban catchments external to the PSP drain to WLRB1a and WLRB1b. A drainage contribution from the external existing and proposed urban areas should be considered in a similar manner to the way they are treated in the Melbourne Water area. No contributions are sought from rural areas as they have not increased the runoff i.e., no increase in impervious areas. | Alluvium has completed an analysis of volume data from external catchments. |
| | Although we didn’t mention it in our report, another point that could be considered in determining the width of E-WW is the width of vegetated buffer that needs to be set aside on the eastern side of the waterway. This width should be less that that recommended in Melbourne Water’s guidelines as the eastern side of the waterway is rural and not urbanised i.e. the width of the vegetated buffer should be less on the eastern side of the waterway than on the western side. | Alluvium have shifted the eastern waterway as close to the eastern boundary of the PSP as possible while maintaining a total 19m minimum offset for bushfire protection through the waterway corridor. |

Appendix E – TUFLOW modelling output maps (Engeny, 2023)