Rhelm

# Riverstone East Stage 3

## Water Cycle Management Strategy Report

Department of Planning and Environment

RR-04-1809-02

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*Cover image: View of First Ponds Creek crossing of Windsor Road (looking downstream)*

# Executive Summary

The Riverstone East Precinct has been identified for future homes and jobs growth as part of Sydney's North West Growth Area (NWGA). Stages 1 and 2 of the Precinct were re-zoned to support residential development in 2016, with Stage 3 being the only remaining stage yet to be re-zoned. The Rouse Hill Regional Park is located within the Stage 3 precinct but will not be rezoned as part of the subject planning proposal.

Rhelm has undertaken a water cycle management assessment based upon the Indicative Layout Plan (ILP) developed by Hatch/Roberts Day (Revision E, dated 01/09/23). This assessment addresses:

- Stormwater quality management,
- Stormwater quantity management, and
- Riparian corridors.

***Site Overview***

The Precinct is located in the Blacktown City Council local government area (LGA) and comprises a 378 ha area of land between the Riverstone Stages 1 and 2 Precincts and Windsor Road.

In its current state, the Precinct is predominantly comprised of sparsely vegetated rural land zoned RU4 – Primary Production. The site is traversed by a number of watercourses and overland flow paths draining north-east to Killarney Chain of Ponds and north-west towards First Ponds Creek. Both Killarney Chain of Ponds and First Ponds Creek flow to Wianamatta-South Creek just upstream of its confluence with the Hawkesbury-Nepean River (*Dyarubbin*).

***Data and Literature Review***

A comprehensive data and literature review was undertaken to collate the available data relevant to the study, and to review applicable design guidelines to inform the development of the water cycle management strategy. The review considered data from:

- Blacktown City Council,
- Department of Planning and Environment,
- Bureau of Meteorology, and
- Technical reports and models relevant to the Precinct.

***Stormwater Quality Management***

An existing scenario MUSIC model was established to define baseline stormwater volumes and pollutant loading of site discharge for comparison against post-development conditions as part of a neutral or beneficial effect on water quality (NorBE) assessment.

A stormwater treatment train comprising the following features was established to manage the pollutant loading from the fully developed site under the adopted development scenario:

- Rainwater tanks,
- Grassed swales,
- Gross pollutant traps,
- Sediment basins,
- Bioretention basins,
- Constructed wetlands, and

- Stormwater harvesting ponds.

Results of the MUSIC modelling indicate that whilst not fully achieving NorBE, the proposed treatment train sufficiently reduces pollutant loads to a level that is consistent with the objectives of the *State Environmental Planning Policy (Biodiversity and Conservation)* 2021. The proposed treatment strategy also achieves the minimum pollutant reduction targets stipulated in the *Growth Centres Development Control Plan* (DCP) 2010 (updated in 2021) but does not meet those from the *Technical guidance for achieving Wianamatta-South Creek stormwater management targets* (Wianamatta-South Creek Guidelines) (DPE, 2022). Additional on-lot treatment for medium and high-density residential zones would be required to achieve the pollutant reduction targets from the Wianamatta-South Creek Guidelines (DPE, 2022).

***Stormwater Quantity Management***

The primary stormwater quantity management objective for the Precinct is to mimic natural hydrology as much as practical, both for design storm events and environmental flow conditions.

An on-site detention basin strategy was developed to mitigate the increase in site flows associated with higher imperviousness of the developed catchment, with the performance of the proposed basins assessed using the XP-RAFTS hydrologic model and TUFLOW hydraulic model developed for the *Flood Impact and Risk Assessment* (Rhelm, 2023). The detention basins have been co-located with regional water quality treatment basins where possible in order to minimise land take. No detention has been proposed for the First Ponds Creek catchment based on the outcomes of regional flood modelling as part of the *First Ponds Creek Flood Assessment* (CSS, 2021) and the companion study to this water cycle management strategy, being the *Riverstone East Stage 3 Flood Impact and Risk Assessment* (Rhelm, 2023).

In summary, flood modelling results revealed that the proposed basins successfully reduce post-development flows to pre-development levels for the Killarney Chain of Ponds catchments.

The site Stream Erosion Index (SEI) was calculated using the results of the XPRAFTS and MUSIC models and was found to meet the required 3.5:1 ratio in the Growth Centres DCP 2010 for all key discharge locations.

MUSIC water balance modelling for selected wet, dry and average rainfall years was undertaken to determine the reliability of proposed stormwater harvesting measures at meeting predicted demands. Results of this assessment found that proposed harvesting measures will meet over 70% of stormwater re-use demands in average rainfall years and over 50% of demands in dry years.

Flow durations curves were produced for the existing and post-development site, as well as a natural site of equivalent area, for comparison against the flow duration targets stipulated in the Wianamatta-South Creek Guidelines (DPE, 2022). Despite not meeting the Wianamatta-South Creek flow duration targets, the post-development curves were found to mimic that of a natural catchment.

***Morphology and Design Riparian Channels***

The locality was characterised historically by a chain of ponds morphology. However, most ponds have either been removed or converted into farm dams. Where channels are present, these were found to be generally poorly defined across the Precinct and lacking in vegetation coverage. As such, vegetated engineered creek channels and associated riparian areas have been proposed for the site first order watercourses to assist in achieving both flood conveyance and biodiversity objectives.

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## Acronyms and Abbreviations

| | |
|---|---|
| AHD | Australian Height Datum |
| AEP | Annual Exceedance Probability |
| ARI | Average Recurrence Interval |
| ARR | Australian Rainfall and Runoff |
| BCC | Blacktown City Council |
| BoM | Bureau of Meteorology |
| DCP | Development Control Plan |
| DPE | Department of Planning and Environment |
| DPIE | Department of Planning, Industry and Environment (now largely DPE) |
| Ha | Hectares |
| IFD | Intensity-Frequency-Duration |
| ILP | Indicative Layout Plan |
| LEP | Local Environment Plan |
| LGA | Local Government Area |
| LiDAR | Light Detention and Ranging |
| $m^2$ | Square metres |
| $m^3$ | Cubic metres |
| kL | Kilolitres |
| ML | Megalitres |
| m/s | Metres per second |
| $m^3/s$ | Cubic metres per second |
| mAHD | metres to Australian Height Datum |
| mm | Millimetres |
| m/s | Metres per second |
| NoRBE | Neutral or Beneficial Effect |
| NSW | New South Wales |
| OEH | Office of Environment and Heritage (now DPE) |
| OSD | On Site Detention |
| VRZ | Vegetated Riparian Zone |
| WSUD | Water sensitive urban design |

# 1 Introduction

The Riverstone East Precinct has been identified for future homes and jobs growth as part of Sydney's North West Growth Area (NWGA). Stages 1 and 2 of the Precinct were re-zoned to support residential development in 2016, with Stage 3 being the only remaining stage yet to be re-zoned. The Rouse Hill Regional Park is located within the Stage 3 precinct but will not be rezoned as part of the subject planning proposal.

Rhelm Pty Ltd (Rhelm), supported by Enspire Solutions (Enspire) have been engaged by the Department of Planning and Environment (DPE) to prepare a water cycle management strategy to inform the development of a Precinct Plan and development guidelines for Riverstone Stage 3 (the Precinct).

This assessment addresses:

- Stormwater quality management,
- Stormwater quantity management, and
- Riparian corridors.

The area to the west of First Ponds Creek (referred to as the Junction Road site) has not been included in the analysis as the proposed land use will generally remain similar to existing in this area. The small area of proposed low density residential will be subject to Council's water cycle management controls and has not been considered as part of the regional stormwater management strategy described in this report.

## 1.1 Study Area

The Precinct comprises a 378 ha area of land bounded by bound by Windsor Road to the north-east, Tallawong Precinct to the south and the Stage 2 Precinct to the west (bounded by First Ponds Creek). The entirety of the Precinct is located within the Blacktown City Council local government area (LGA).

The Precinct contains a number of watercourses, the most significant being Killarney Chain of Ponds (a tributary of Wianamatta-South Creek and the Dyarubbin-Hawkesbury Nepean River system) which drains in a northerly direction through the southern portion of the Precinct. Other major watercourses include First Ponds Creek which runs along the western boundary of the site. Both Killarney Chain of Ponds and First Ponds Creek drain to sets of culverts crossing Windsor Road and form a confluence approximately 530m north of the site (within the Box Hill Precinct).

The Precinct also contains a number of waterbodies (possible remnant chain of pond features, which is the historic morphologic character of the creeks of the locality, these are now mostly farm dams) located along watercourses and overland flow paths. The most significant dams are those located on the AJ Bush and Sons site (1106 Windsor Road) and along the downstream tributary of First Ponds Creek. None of these waterbodies or dams were identified as declared dams by Dam Safety NSW under the *Dam Safety Regulation*, 2019 as at April 2023.

The study area and relevant waterway features are shown in **Figure 1-1**.

## 1.2 Report Structure

The report is structured as follows:

- Data Review (**Section 2**)
- Development Controls and Guidelines (**Section 3**)

- Catchment and Meteorological Characteristics (**Section 4**)
- Indicative Layout Plan (**Section 5**)
- Stormwater Quality Management (**Section 6**)
- Stormwater Quantity Management (**Section 7**)
- Riparian Corridors (**Section 8**)
- Conclusion and Recommendations (**Section 9**).

This report should be read in conjunction with the *Riverstone Stage 3 – Flood Impact and Risk Assessment* (Rhelm, 2023) which details the hydrologic and hydraulic modelling methodology and outcomes.

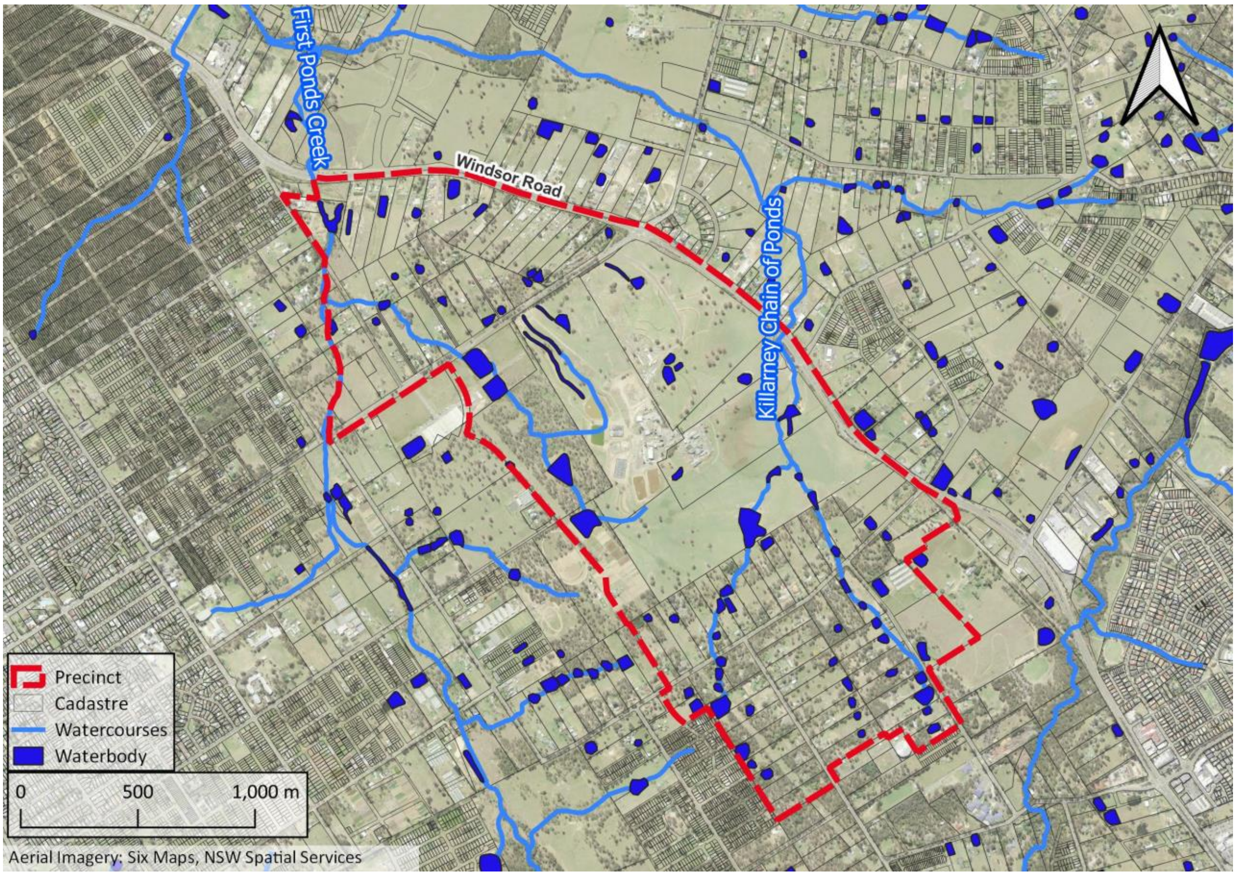



**Figure 1-1 Study Area**

# 2 Data Review

## 2.1 Site Inspection

A site tour/inspection was undertaken on 16 March 2023 to gain an appreciation of the character of the study area. Given the scale of the Precinct, the tour was largely conducted via bus and thus detailed inspection of key site features relevant to water cycle management (such as watercourses and waterbodies) was limited.

A further site inspection was undertaken on 5 May 2023 to confirm the details of accessible cross drainage structures across the Precinct.

## 2.2 Previous Water Cycle Management Studies and Reports

Previous studies undertaken for the locality relevant to the water cycle management strategy are summarised below.

### 2.2.1 Alex Avenue and Riverstone Precincts – Water Sensitive Urban Design and Flooding Report (GHD, 2008)

The Growth Centres Commission (GCC) engaged GHD to undertake a flooding and water sensitive urban design (WSUD) assessment in support of a planning proposal to rezone the 1,600 ha Riverstone and Alex Avenue precincts (located to the west of the Riverstone Stage 3 precinct).

Key objectives of the water cycle management component were to suitably manage the quantity and quality of stormwater runoff from the development via reducing post-development flows to pre-development levels and adopting the following stormwater management targets:

- 85% reduction in total suspended solids (TSS)
- 65% reduction in total phosphorus (TP)
- 45% reduction in total nitrogen (TN)
- 90% reduction in gross pollutants
- Stream erosion index of 3.5-5.

On-site detention targets were achieved via both regional detention basins and lot-scale detention assumptions to attenuate runoff from the developed catchments. XP-RAFTS hydrologic modelling software was used to compare pre and post-development flowrates and develop permissible site discharge (PSD) and minimum required storage volumes at key discharge points.

A stormwater treatment train comprising of gross pollutant traps, grassed swales, regional bioretention basins (co-located in detention basins) and public wetlands was established to treat developed runoff. MUSIC software was used to assess the effectiveness of proposed treatment measures and demonstrate compliance with reduction targets and stream flow index (SEI) requirements.

### 2.2.2 Post Exhibition Flooding and Water Cycle Management (incl. Climate Change impact on Flooding (GHD, 2010)

This study was commissioned by DPE as an update to the *Alex Avenue and Riverstone Precincts – Water Sensitive and Urban Design and Flooding* (GHD, 2008).

Key updates from the GHD (2008) study included rationalisation of the riparian corridors and consolidation of a number of detention/bioretention basins to maximise developable land and produce an improved economic outcome. This included an integrated analysis of the Riverstone and Riverstone

East precincts, with the nomination of a number of online basins along First Ponds Creek. Modelling and mapping was updated to reflect the design changes in the post-development scenario.

This study also included the assessment of climate change impacts on detention basins via increasing 1% AEP design rainfalls by 20% to account for potential increases in rainfall intensity.

### 2.2.3 Water Cycle Management Report (Mott MacDonald, 2015)

This flooding and water cycle management assessment was commissioned by DPE in support of the rezoning of the 656 Ha Riverstone East site, inclusive of the Stage 3 precinct.

Similar to the GHD (2008) study, the objective of the on-site detention strategy was to reduce post-development flows to pre-development levels for a full range of design storm events up to and including the 1% AEP. This was achieved through a network of both offline and online detention basins, inclusive of two basins along First Ponds Creek which accept flows from both the Riverstone and Riverstone East precincts. Hydrologic modelling to determine basin volumes was determined using XP-RAFTS software, with impacts on flooding confirmed in a TUFLOW hydraulic model of the study area.

The same stormwater pollutant reduction targets as those in GHD (2008) were adopted in the Mott Macdonald (2015) study. A stormwater treatment train comprising rainwater tanks, grassed swales, gross pollutant traps and regional bioretention basins was proposed to manage the quality of stormwater discharging from the Riverstone East Precinct. Proposed bioretention basins include both offline basins adjacent to the riparian corridors and online basins on first order streams, co-located within detention basins. MUSIC modelling was undertaken to demonstrate compliance with the water quality targets.

### 2.2.4 Water Cycle Management Report Post Exhibition (Mott MacDonald, 2016)

Following public exhibition of the Mott MacDonald (2015) report, the flooding and water cycle management assessment was updated to address comments received during exhibition. This included some adjustments to the base case hydrologic model assumptions and refinements to the on-site detention basin design. No major changes were made to the WSUD strategy; however, proposed conveyance swales were removed from the MUSIC model.

The modelling and drawing series/mapping were updated to reflect the changes made from the 2015 study.

## 2.3 Waterway Health Data

### 2.3.1 Waterway Health Ratings

A spatial data file (reference ‘Waterway quality health grades.shp’) containing waterway health ratings at two locations along First Ponds Creek was provided by Blacktown City Council to inform this strategy. The locations are as follows:

- Location 1 – upstream of Gordon Road
- Location 2 – downstream of Windsor Road.

Data collected at these locations are not considered a direct indicator of discharge quality from the Precinct as Location 1 is upstream of the Precinct and the portion of the Precinct catchment draining to Location 2 only constitutes a small portion of the overall catchment. However, ratings obtained from the digital spatial data provided by Council have been reproduced in **Table 2-1** as an indicator of overall water quality in First Ponds Creek.

**Table 2-1 Waterway Health Ratings**

| Location | Rating* | | | |
|---|---|---|---|---|
| | 2019-2020 | 2019-2020 | 2020-2021 | 2021-2022 |
| Location 1 | C | C | C | D |
| Location 2 | C | C | D | C |

** **Rating score guide: –A - Excellent:** Water quality indicators are within guideline limits more than 90% of the time. Diverse waterbug community with species sensitive to pollution present. Good riparian vegetation with native plant diversity and coverage. **–B - Good:** Water quality indicators are within guideline limits 85% of the time. Moderately diverse waterbug community with some pollution sensitive species not present. Riparian vegetation has moderate native plant diversity and coverage, with some weed infestations. **–C - Fair:** Water quality indicators are within guideline limits 70% of the time. Waterbug community only contains pollution tolerant species. Riparian vegetation is lacking native diversity and coverage, and weeds are likely to be present and possibly dominating. **–D - Poor:** Water quality indicators are within guideline limits less than 50% of the time. Waterbug community only contains pollution tolerant species. Riparian vegetation is lacking native plant diversity, and weeds are most likely to be dominating.*

### 2.3.2 Rapid Riparian Assessment

Digital spatial data files containing riparian corridor condition classifications at selected locations from a 2015 survey (file reference 'Rapid Riparian Assessment 2015.shp') and 2020 survey (file reference 'Rapid Riparian Assessment 2020.shp') were provided by Blacktown City Council.

Classifications from the more recent 2020 assessment are shown in **Figure 2-1**. Two locations are within the Precinct on a tributary of First Ponds Creek, showing a Fair and Poor condition.

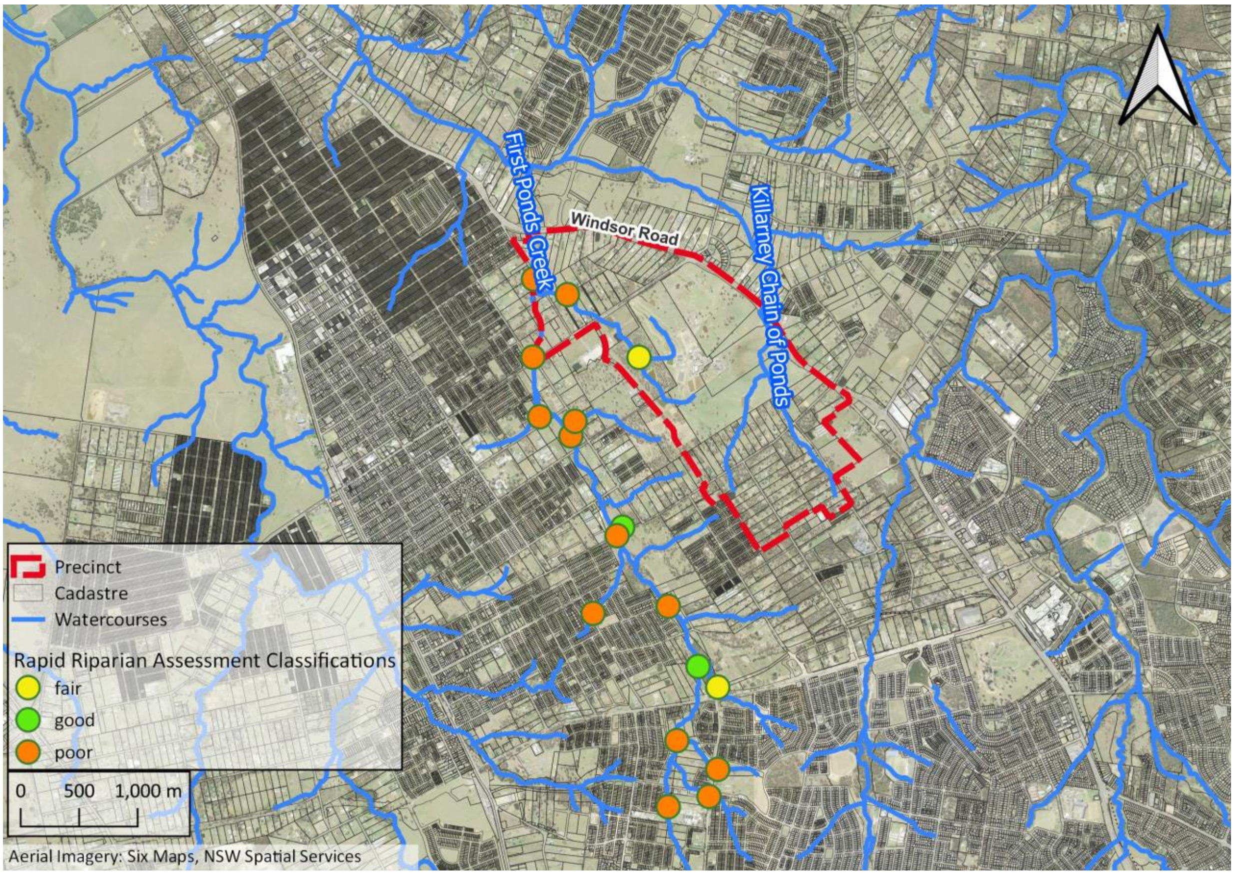



**Figure 2-1 Rapid Riparian Assessment Classifications (Source: Blacktown City Council)**

## 2.4 Existing Models/Modelling Data

A summary of available water cycle management models/modelling data relevant to the Precinct and how this data has been used in the assessment is provided in **Table 2-2**.

**Table 2-2 Available Models/Modelling Data**

| Data Source | Data Type | Relevance to the Assessment |
|---|---|---|
| *First Ponds Creek Flood Assessment* (CSS, 2021) | XP-RAFTS Model | XP-RAFTS models for the existing (file reference 'First Ponds Creek - existing combined model-20191017.xp') and developed (file reference 'first ponds creek developed_2021.xp') scenario have been provided by Council for use in the assessment.<br>These models cover both the First Ponds Creek and Killarney Chain of Ponds catchments and have been used for preliminary sizing of proposed detention basins and calculation of design flowrates for proposed stormwater treatment measures. |
| *Water Cycle Management Report – Riverstone East* (Mott MacDonald, 2016) | XP-RAFTS Model | XP-RAFTS models for the existing (file reference '141127 Ex-MM Riverstone East, 100yr - 0.04 0.025.xp) and developed (file reference '150107 Pr-MM Riverstone East, 100yr - 0.035 0.015 - Online basins w NWRL-Basin 1 change - Copy.xp') scenarios have been provided.<br>This model utilises ARR1987 hydrologic procedures and does not contain sufficient sub-catchment delineation in the Alex Avenue precinct. As such, the CSS (2021) model has been used in preference to this model for the assessment. |
| | MUSIC Model | A post-development MUSIC model covering the entire Riverstone East site (inclusive of Stage 3) has been provided.<br>This model has not been used in the assessment due to the availability of base meteorological data and node parameters in Council's MUSIC-Link template and the adoption of a different stormwater treatment strategy compared to Mott MacDonald (2016). |
| *Water Cycle Management Report – Riverstone East* (Mott MacDonald, 2016) | 12D Design Strings | Basin and channel design strings associated with the Mott MacDonald (2016) assessment have been provided. These have not been used as the design of these features has changed substantially in the updated assessment. |

# 3 Development Controls and Guidelines

The subject site is located within the North West Priority Growth Area (NWGA) and therefore development at the site is expected to be regulated in the future under the *State Environmental Planning Policy (Precincts—Central River City)* 2021 (noting that other portions of the Riverstone East area are regulated under Appendix 11 of the SEPP). The *Blacktown City Council Growth Centre Precincts Development Control Plan* (2010) which was amended in 2021 is also expected to apply. The SEPP is an environmental planning instrument (EPI) which designates land uses and development in the study area, while the DCP regulates development with specific guidelines and parameters.

Being a tributary of the Hawkesbury-Nepean system, which is identified as a 'regulated catchment', the site falls under the provisions of the *State Environmental Planning Policy (Biodiversity and Conservation)* 2021. The DPE Policy team has confirmed the applicability of the SEPP (Biodiversity and Conservation) 2021.

The site is also located in the Wianamatta-South Creek catchment where stormwater management plans for development are required to comply with *Technical guidance for achieving Wianamatta-South Creek stormwater management targets* (Wianamatta-South Creek Guidelines) (DPE, 2022). The related provisions of the Wianamatta-South Creek Guidelines (DPE, 2022) as they apply to the Precinct as concurrent design objectives have been considered, with the adopted stormwater management targets (refer **Section 6.1**) being the greater of the two standards with respect to beneficial outcomes for receiving waters.

## 3.1 State Environmental Planning Policy (Precincts—Central River City) 2021

Part 3.5 of the Precincts—Central River City SEPP 2021 provides a number of clauses regarding development on flood prone and major creeks land; however, this SEPP has no directly relevant clauses relating to water-cycle management.

## 3.2 State Environmental Planning Policy (Biodiversity and Conservation) 2021

Part 6.6 of the SEPP (Biodiversity and Conservation) 2021 applies to development within regulated catchments in NSW. Clauses relevant to water cycle management are reproduced below.

*6.6 Water quality and quantity*

*(1) In deciding whether to grant development consent to development on land in a regulated catchment, the consent authority must consider the following—*

*(a) whether the development will have a neutral or beneficial effect on the quality of water entering a waterway,*

*(b) whether the development will have an adverse impact on water flow in a natural waterbody,*

*(c) whether the development will increase the amount of stormwater run-off from a site,*

*(d) whether the development will incorporate on-site stormwater retention, infiltration or reuse,*

*(e) the impact of the development on the level and quality of the water table,*

*(f) the cumulative environmental impact of the development on the regulated catchment,*

*(g) whether the development makes adequate provision to protect the quality and quantity of ground water.*

*(2) Development consent must not be granted to development on land in a regulated catchment unless the consent authority is satisfied the development ensures—*

*(a) the effect on the quality of water entering a natural waterbody will be as close as possible to neutral or beneficial, and*

*(b) the impact on water flow in a natural waterbody will be minimised.*

## 3.3 Blacktown Local Environment Plan 2015

Whilst the LEP does not directly apply to the Precinct as the SEPP (Precincts—Central River City) 2021 is the relevant EPI, clauses relating to water cycle management have been reproduced below for information purposes.

*7.3 Riparian land and watercourses*

*(1) The objectives of this clause are as follows—*

*(a) water quality within watercourses,*

*(b) the stability of the bed and banks of watercourses,*

*(c) aquatic and riparian habitats,*

*d) ecological processes within watercourses and riparian areas.*

*(2) This clause applies to the following land—*

*(a) land that is a watercourse,*

*(b) land that is within 40 metres of the top of the bank of a watercourse.*

*(3) In deciding whether to grant development consent for development on land to which this clause applies, the consent authority must consider—*

*(a) whether or not the development is likely to have any adverse impact on the following—*

*(i) the water quality and flows within the watercourse,*

*(ii) aquatic and riparian species, habitats and ecosystems of the watercourse,*

*(iii) the stability of the bed and banks of the watercourse,*

*(iv) the free passage of fish and other aquatic organisms within or along the watercourse,*

*(v) any future rehabilitation of the watercourse and riparian areas, and*

*(b) whether or not the development is likely to increase water extraction from the watercourse, and*

*(c) any appropriate measures proposed to avoid, minimise or mitigate the impacts of the development.*

*(4) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that—*
*(a) the development is designed, sited and will be managed to avoid any significant adverse environmental impact, or*
*(b) if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or*

*(c) if that impact cannot be minimised—the development will be managed to mitigate that impact.*

## 3.4 Blacktown City Council Growth Centre Precincts Development Control Plan (2010)

Section 2.3.1 of the Blacktown City Council Growth Centre Precincts DCP (2010, updated in 2021) provides water cycle management related development objectives and controls for the precinct. These are reproduced below.

*Objectives*

*(a) to manage the flow of stormwater from urban parts of the Precinct to replicate, as closely as possible, pre-development flows;*

*Controls - General*

*3. Stormwater is to be managed primarily through the street network in accordance with Council's Water Sensitive Urban Design Development Control Plan.*

*4. Roads on primary drainage lines shown on the Key elements of the water cycle management and ecology strategy figure, in the relevant Precinct Schedule, are to be constructed in the locations shown, and are to be designed in accordance with specifications of Council in relation to management of stormwater flows and quality.*

*• prevent damage by stormwater to the built and natural environment,*

*• reduce nuisance flows to a level which is acceptable to the community,*

*• provide a stormwater system which can be economically maintained and which uses open space in a compatible manner,*

*• minimise urban water run-off pollutants to watercourses, and*

*8. Where practical, development shall attenuate up to the 50% AEP peak flow for discharges into the local tributaries, particularly Category 1 and 2 creeks. This will be achieved using detention storage within water quality features and detention basins.*

*9. The developed 1% AEP peak flow is to be reduced to pre-development flows through the incorporation of stormwater detention and management devices.*

*11. The trunk stormwater system is to be constructed and maintained by Council in accordance with the Riparian and Water Cycle Management Strategy at Appendix B, and to achieve water quality targets set by the Department of Environment, Climate Change and Water in Table 2-1.*

Water quality and stream erosion targets specified in Table 2-1 of the Growth Centre Precincts DCP (2010) are reproduced below.

Stormwater management objective:

- 85% reduction in TSS
- 65% reduction in TP
- 45% reduction in TN
- 90% reduction in gross pollutants
- Stream erosion control ratio of 3.5-5.0:1

An ‘ideal’ stormwater outcome is also reported as an aspirational target:

- 95% reduction in TSS
- 95% reduction in TP
- 85% reduction in TN
- 100% reduction in gross pollutants
- Stream erosion control ratio of 1:1.

The ideal stormwater outcome identified in the DCP is very challenging to achieve and beyond the targets set for the wider catchment (see **Section 3.6**).

## 3.5 WSUD Developer Handbook – MUSIC Modelling and Design Guideline (2020)

Blacktown City Councils WSUD Developer Handbook – MUSIC Modelling and Design Guideline (2020) details the requirements for water quality modelling for the Precinct. This guideline has been utilised for modelling and design assumptions in the water cycle management assessment.

## 3.6 Wianamatta-South Creek Stormwater Management Guidelines (2022)

Chapter 1 of the Wianamatta-South Creek Guidelines (DPE, 2022) presents two operational water quality target options for proposed development within the Wianamatta-South Creek catchment. These targets are as follows:

Option 1 – annual load reduction:

- 90% reduction in TSS
- 80% reduction in TP
- 65% reduction in TN
- 90% reduction in gross pollutants

Option 2 – allowable mean annual load:

- <80kg/ha/year of TSS
- <0.3kg/ha/year of TP
- <3.5kg/ha/year of TN
- <16kg/ha/year of gross pollutants

In addition to water quality targets, the Wianamatta-South Creek Guidelines (DPE, 2022) provide two stormwater flow target options. These are as follows:

Option 1 – mean annual runoff volume (MARV):

- MARV ≤2 ML/ha/y at the point of discharge to the local waterway
- 90%ile flow of 1,000–5,000 L/ha/day at the point of discharge to the local waterway
- 50%ile flow of 5-100 L/ha/day at the point of discharge to the local waterway
- 10%ile flow of 0 L/ha/day at the point of discharge to the local waterway

Option 2 – flow percentiles:

- 95%ile flow of 3,000–15,000 L/ha/day at the point of discharge to the local waterway
- 90%ile flow of 1,000–5,000 L/ha/day at the point of discharge to the local waterway
- 75%ile flow of 100–1,000 L/ha/day at the point of discharge to the local waterway
- 50%ile flow of 5-100 L/ha/day at the point of discharge to the local waterway
- Cease to flow to be between 10% and 30% of the time.

The practicality of meeting these flow duration objectives was explored as part of the water cycle management assessment and is discussed in **Section 7.5**.

# 4 Catchment and Meteorological Characteristics

## 4.1 Catchment Mapping

Sub-catchment mapping has been completed across the precinct as part of the development of Council's XP-RAFTS hydrologic models of the First Ponds Creek and Killarney Chain of Ponds catchments. Baseline sub-catchment mapping across the study area (prior to the recent development of the Riverstone and Box Hill precincts) is shown in **Figure 4-1.**

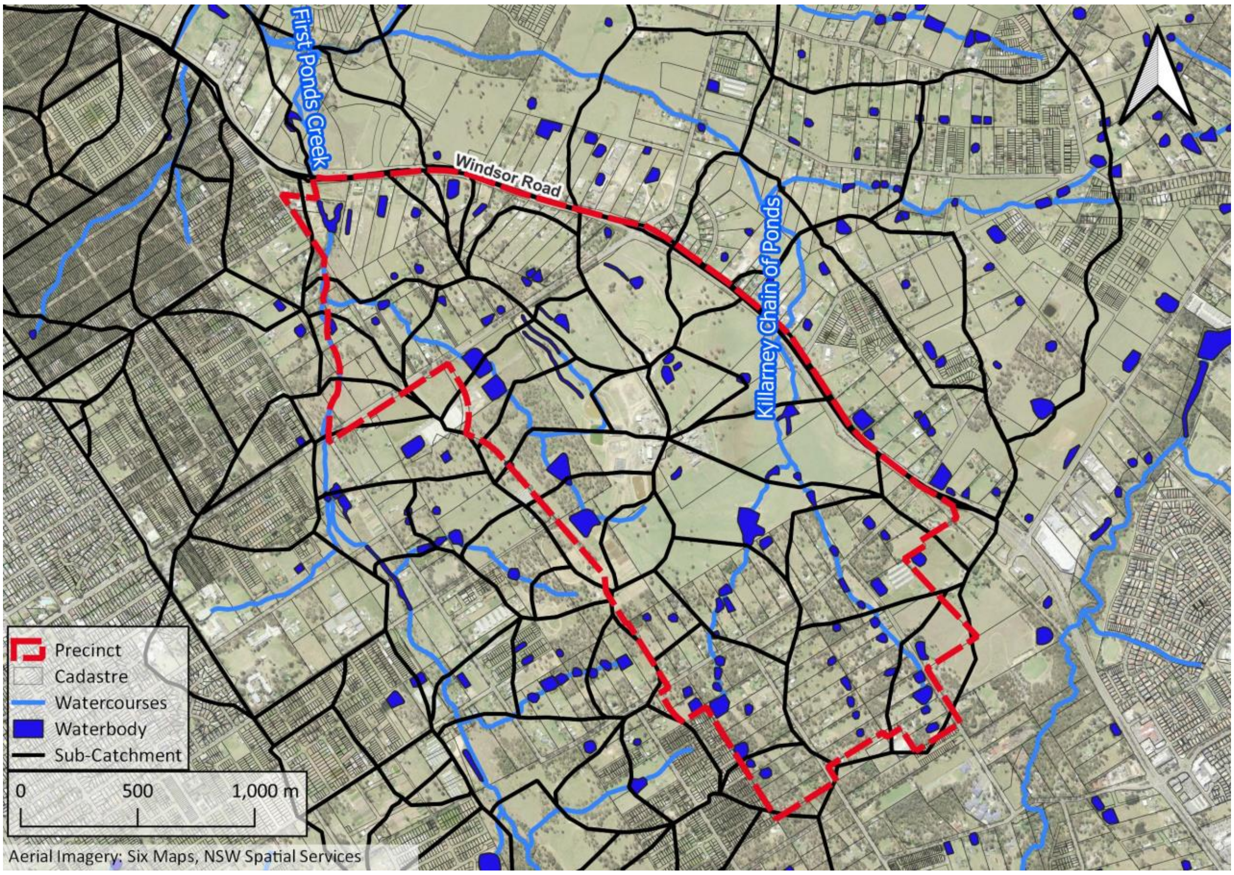



**Figure 4-1 Precinct Sub-Catchment Mapping**

## 4.2 Topography and Drainage

The site grades to the north-east towards Killarney Chain of Ponds and north-west towards First Ponds Creek, with moderate slopes in the range of 1-10% observed across the majority of the site. **Figure 4-2** shows the topography of the Precinct and surrounds based on 2019 LiDAR data.

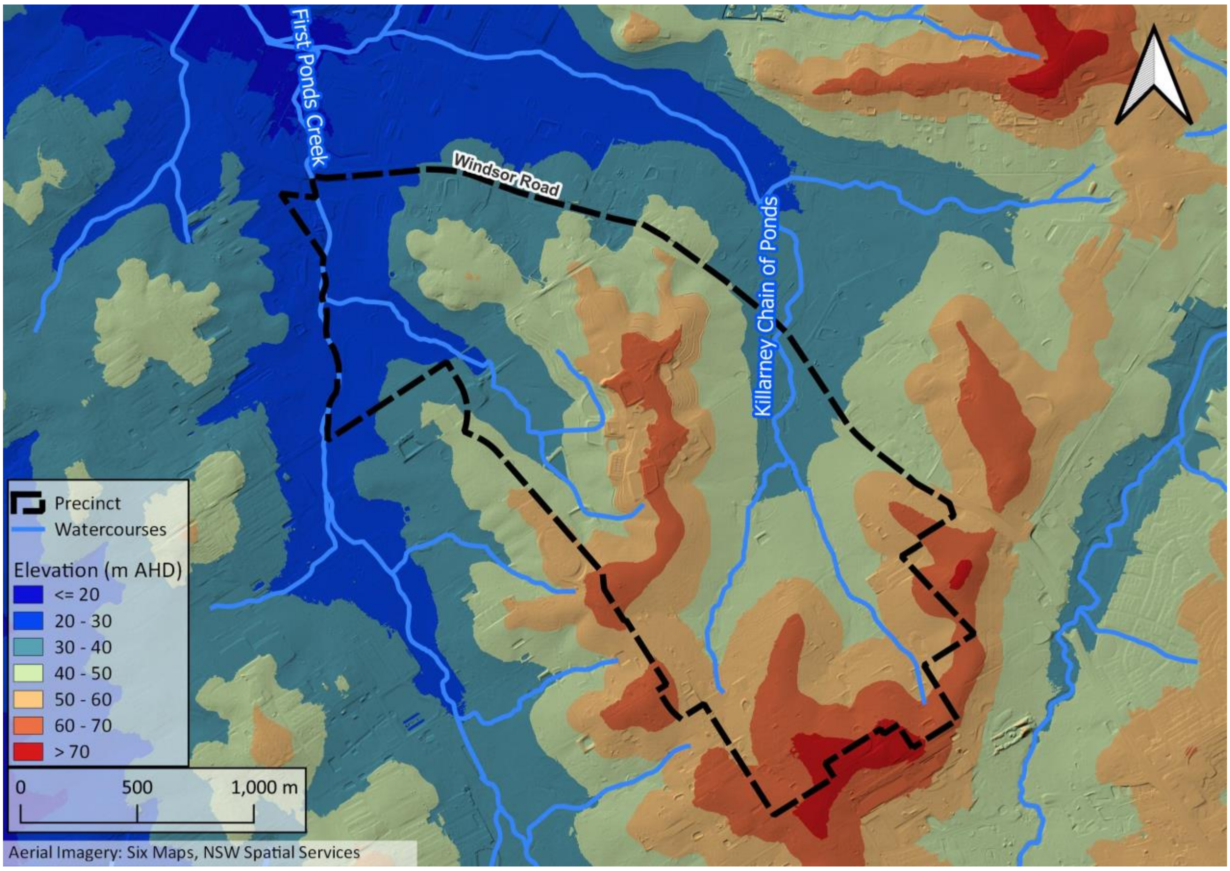



**Figure 4-2 Precinct Topography**

## 4.3 Land Use

The site is predominantly comprised of sparsely vegetated rural land zoned RU4 – Primary Production. The proposed Rouse Hill Regional Park is located in the south-eastern portion of the site where the current land use is also rural in nature, with a lower percentage of vegetation coverage than the remainder of the site. Existing land use information across the study area has been sourced from the Blacktown LEP 2015 and is shown in **Figure 4-3**.

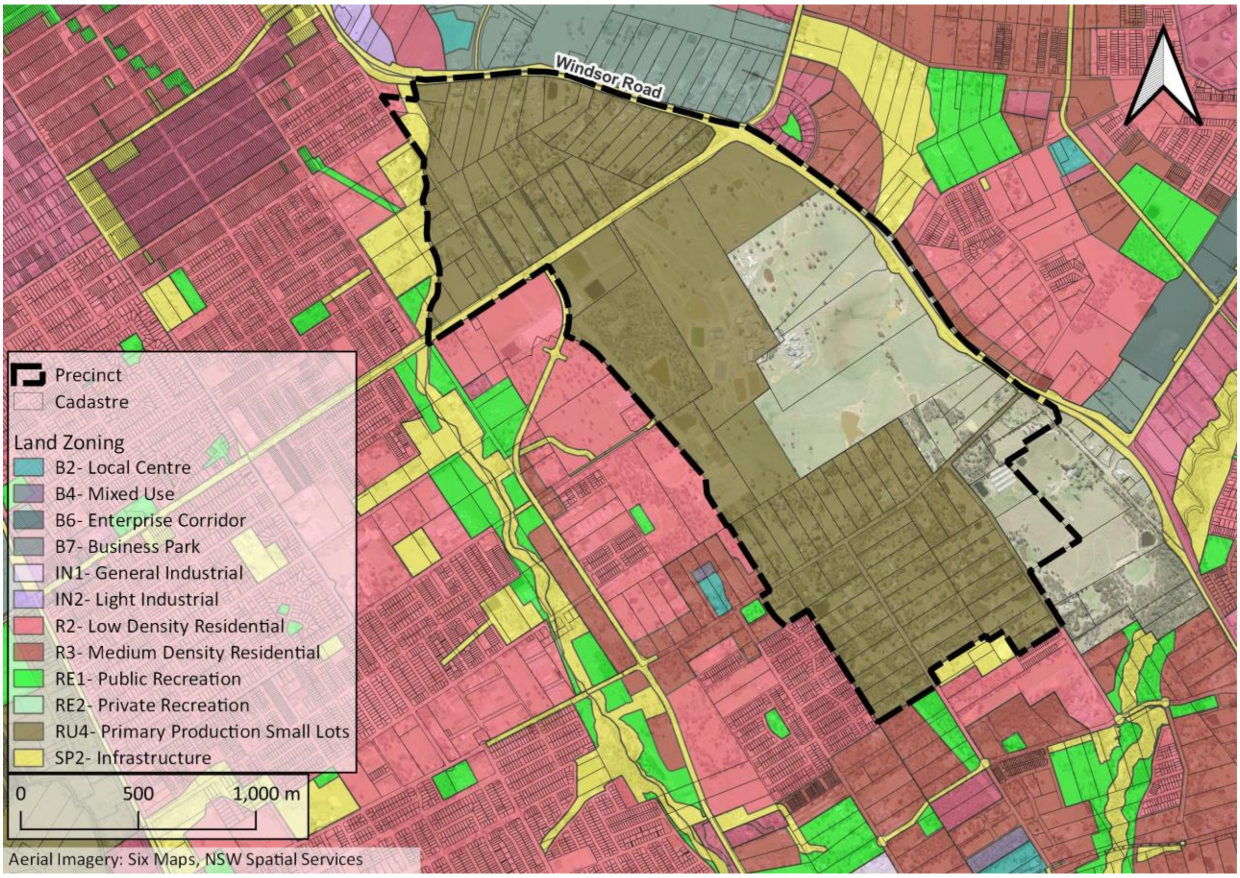



**Figure 4-3 Existing Land Zoning**

## 4.4 Soils

DPE's mapped soil landscapes (eSPADE) cover the study area and indicate a Blacktown soil landscape across the majority of the Precinct. This soil landscape is characterised by loam topsoils underlain by clay loam and light to medium clay. A hydrologic soil group of C (slow infiltration) covers the majority of the Precinct, with some Group D (very slow infiltration) soils present around the major drainage lines.

## 4.5 Rainfall

Daily rainfall data relevant to the study area has been sourced from the Richmond – UWS Hawkesbury meteorological station (Station 067021). This station is located approximately 15km from the Precinct and contains the longest timeseries of recorded rainfall data of the nearby stations (139 years).

Rainfall statistics for this gauge from BoM are summarised in **Table 4-1**. These statistics show that:

- Mean annual rainfall is 804 mm
- Annual rainfall has ranged from 268 – 1718 mm
- Highest daily rainfall recorded was 309 mm in May 1889.

Table 4-1 Monthly Climate Statistics for Station 067021 (Source: BoM, Accessed 2 August 2023)

| Statistic Element (for Years 1881-2023) | January | February | March | April | May | June | July | August | September | October | November | December | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean rainfall (mm) | 96.5 | 94.5 | 94 | 67.3 | 55.9 | 60.5 | 45.6 | 42 | 42.1 | 57.4 | 73.6 | 75.1 | 804 |
| Highest rainfall (mm) | 375.7 | 442.4 | 569 | 338.9 | 529 | 360.6 | 285.6 | 465.3 | 180.1 | 217.8 | 449.6 | 327 | 1718.2 |
| Date of Highest rainfall | 1972 | 1990 | 2022 | 1946 | 1889 | 1950 | 1904 | 1986 | 1892 | 2004 | 1961 | 1947 | 1950 |
| Lowest rainfall (mm) | 7.4 | 3 | 3 | 1.6 | 1.1 | 0.8 | 0 | 0 | 0 | 1.3 | 2.5 | 0 | 268 |
| Date of Lowest rainfall | 1929 | 1939 | 1965 | 1980 | 2008 | 1883 | 1972 | 1946 | 1957 | 1968 | 1915 | 2019 | 1944 |
| Decile 1 monthly rainfall (mm) | 21.6 | 11 | 17.4 | 11.6 | 7.5 | 5.3 | 5.2 | 4 | 8.4 | 12.7 | 14.8 | 14.2 | 527.4 |
| Decile 5 (median) monthly rainfall (mm) | 74.2 | 74.3 | 66.5 | 50.7 | 30.6 | 38.6 | 27.8 | 24 | 33.4 | 43.5 | 66.2 | 55.6 | 796 |
| Decile 9 monthly rainfall (mm) | 188 | 190.1 | 188.6 | 131.7 | 121.3 | 152 | 108 | 86.2 | 86.2 | 127.4 | 139 | 158.2 | 1076 |
| Highest daily rainfall (mm) | 198.6 | 175.2 | 209 | 160 | 309.4 | 101.6 | 138.4 | 210 | 103.4 | 94.8 | 131.8 | 88.1 | 309.4 |
| Date of Highest daily rainfall | 11/01/1949 | 10/02/1992 | 4/03/2022 | 16/04/1946 | 28/05/1889 | 1/06/1897 | 27/07/1952 | 6/08/1986 | 2/09/1970 | 20/10/1987 | 18/11/1961 | 10/12/1920 | 28/05/1889 |
| Mean number of days of rain | 11.2 | 11.2 | 11.5 | 9.7 | 9 | 10 | 8.4 | 7.9 | 8.2 | 9.1 | 10.2 | 10.2 | 116.6 |
| Mean number of days of rain >= 1 mm | 7.7 | 7.5 | 7.8 | 6.3 | 5.5 | 5.7 | 4.6 | 4.8 | 5.3 | 6.1 | 7.2 | 7.3 | 75.8 |
| Mean number of days of rain >= 10 mm | 2.6 | 2.7 | 2.5 | 1.8 | 1.3 | 1.6 | 1.1 | 1.1 | 1.1 | 1.7 | 2.4 | 2.3 | 22.2 |
| Mean number of days of rain >= 25 mm | 1 | 1 | 1 | 0.6 | 0.4 | 0.6 | 0.4 | 0.3 | 0.2 | 0.5 | 0.7 | 0.7 | 7.4 |

# 5 Indicative Layout Plan

An Indicative Layout Plan (ILP) has been developed by Hatch/Roberts Day (Revision E, dated 01/09/23) with consideration to the outcomes of baseline constraints analysis (including water cycle management) and an Enquiry by Design (EBD) workshop. This ILP has been used as a basis for post-development land use characteristics adopted in the water cycle management assessment.

The ILP is shown in **Figure 5-1**.

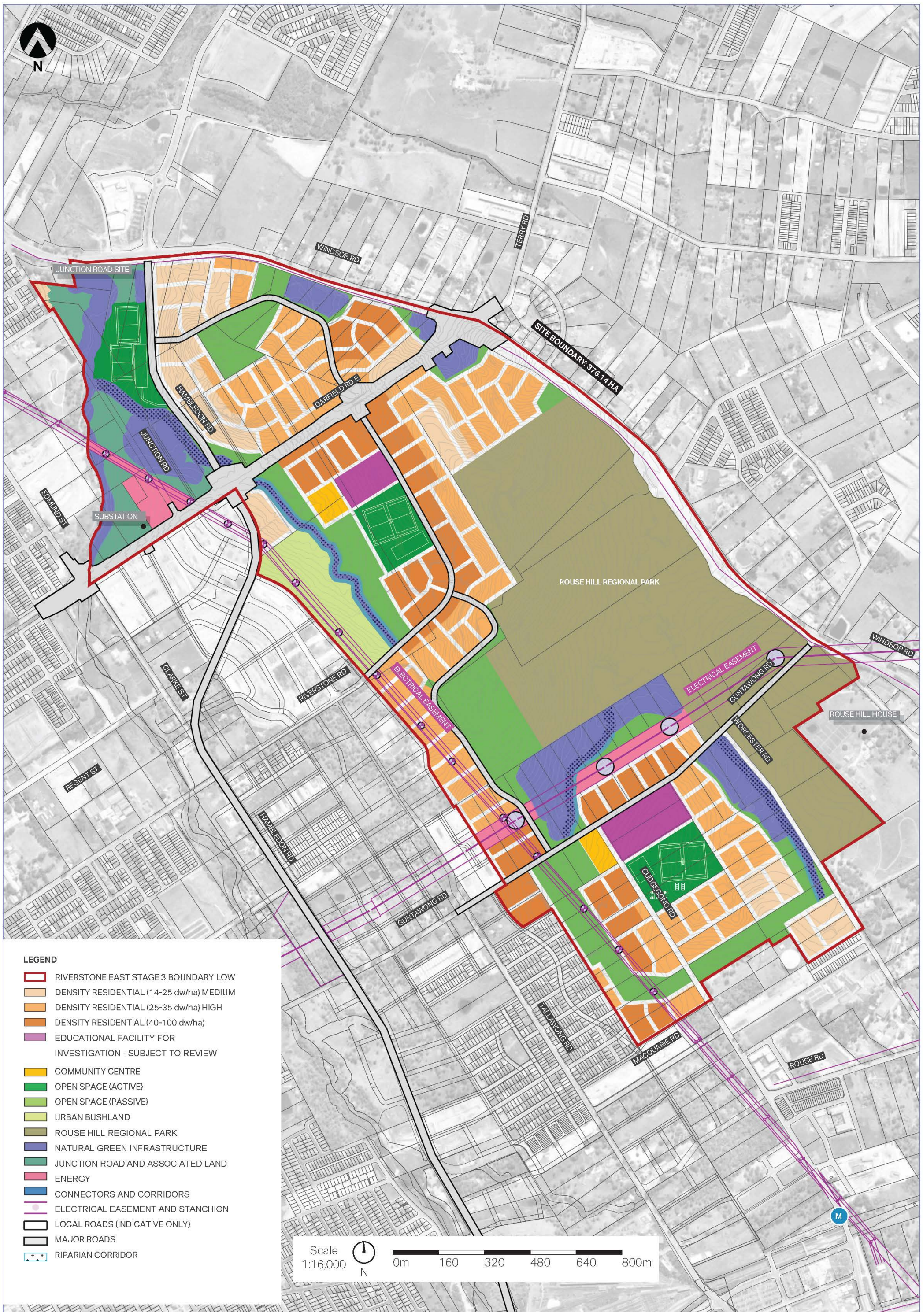



Figure 5-1 Indicative Layout Plan

# 6 Stormwater Quality Management

## 6.1 Stormwater Quality Targets

As outlined in **Section 3**, a number of different stormwater quality targets apply to the Precinct. A summary of these different stormwater targets and their applicability to the Precinct stormwater management strategy is provided in **Table 6-1**.

**Table 6-1 Summary of Range of Stormwater Quality Targets**

| Target | Applicability to the Assessment |
| --- | --- |
| BCC Growth Centres DCP minimum reduction targets of:<br>• 85% reduction in TSS<br>• 65% reduction in TP<br>• 45% reduction in TN<br>• 90% reduction in gross pollutants | These are the considered the minimum requirement in terms of pollutant reduction targets applicable to the Precinct. |
| BCC Growth Centres DCP aspirational reduction targets of:<br>• 95% reduction in TSS<br>• 95% reduction in TP<br>• 85% reduction in TN<br>• 100% reduction in gross pollutants | Although a desirable outcome in terms of catchment water quality, compliance with these targets is not mandated in the BCC Growth Centres DCP and is not considered economically viable given the quantum of stormwater management measures required to reduce pollutant loads by the target percentages. |
| Wianamatta-South Creek Guidelines (DPE, 2022) reduction targets of:<br>• 90% reduction in TSS<br>• 80% reduction in TP<br>• 65% reduction in TN<br>• 90% reduction in gross pollutants<br>These reduction targets were found to be more achievable for the subject site than the allowable mean annual load option (refer **Section 3.6**) in the Wianamatta-South Creek Guidelines (DPE, 2022). | These have been adopted as the target reduction in pollutant loading in the development of the Precinct water cycle management strategy. However, strict compliance with these targets is not considered essential given that catchment runoff will only pass through a small (1km) length of Wianamatta-South Creek before discharging to the Dyarubbin-Hawkesbury Nepean River. |
| Neutral or beneficial effect (NorBE) on water quality compared to existing conditions. The *Using MUSIC in the Sydney Drinking Water Catchment* (Water NSW, 2023) guidelines suggest aiming for the following MUSIC modelling results to demonstrate this will be achieved:<br>• 10% reduction in TSS, TP and TN compared to existing conditions<br>• Post-development pollutant concentrations less than pre-development for 50-98% of the time<br>The additional reductions in pollutant loading are to account for uncertainties inherent in MUSIC modelling. | Achieving NorBE is necessary for compliance with the SEPP (Biodiversity and Conservation) 2021 (refer **Section 3.2**).<br>Applying the 10% reduction in loads compared to existing is considered overly conservative for the subject assessment given the significant level of conservativeness in developed site imperviousness assumptions (refer **Section 6.4.1**). |

## 6.2 Existing Scenario MUSIC Modelling

A base case MUSIC model (version 6.3.0) was established to quantify existing pollutant loading from the Precinct and upstream catchments for the purpose of the NorBE assessment. Details of the base case MUSIC modelling are provided in the following sections.

### 6.2.1 Sub-Catchment Delineation

MUSIC sub-catchments upstream and within the site were delineated using the hydrologic model sub-catchment delineation from Council's existing scenario XP-RAFTS model of Killarney Chain of Ponds and First Ponds Creek.

MUSIC modelling does not benefit from the same level of sub-catchment delineation as is typically required for design event hydrologic/flood modelling. As such, sub-catchments were consolidated around major drainage lines and equated to a total of 12 in the base case model.

**Figure 6-1** shows the sub-catchment delineation adopted in the base case MUSIC model. Note that some areas outside of the Precinct are located within the catchments for analysis.

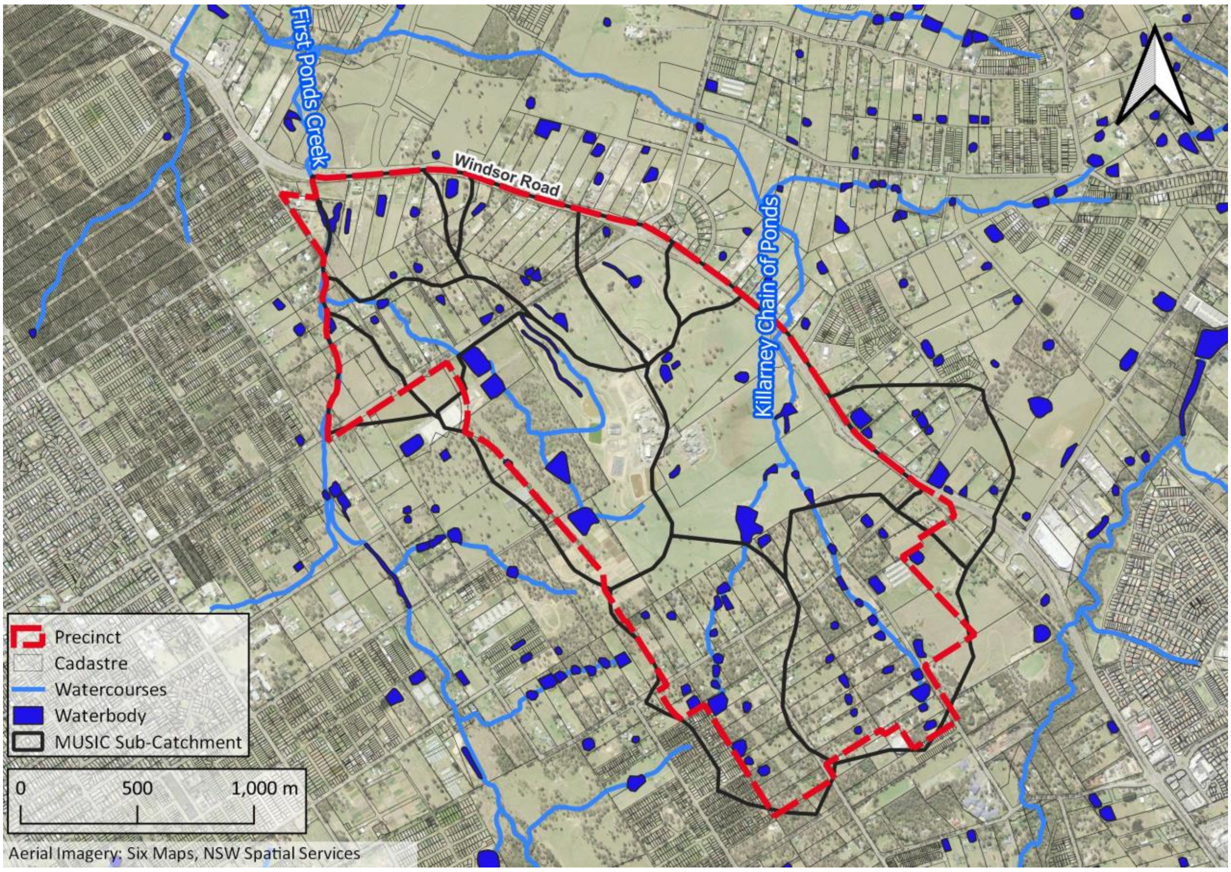



**Figure 6-1 MUSIC Sub-Catchments – Existing Scenario**

### 6.2.2 Base Information

Base meteorological data from Council's MUSIC-link (version 6.34) was adopted for the purpose of the water quality assessment. This utilises 6-minute rainfall pluviograph data from the Liverpool (Whitlam Centre) meteorological station (Station 067035) over a 9-year period from 1967 to 1976. This station is approximately 30km south of the Precinct and reported a MAR of 857 over the analysed time period.

The MUSIC-link base meteorological data also includes monthly average potential evapotranspiration (PET) data which equates to an annual rate of 1261mm/year.

### 6.2.3 Source Nodes

Source node types within each sub-catchment were defined based on land use zoning, aerial imagery and site observations (**Figure 6-2**). BCC's default MUSIC source nodes and parameters were adopted where appropriate. Alternate source node parameters from the NSW MUSIC Modelling Guidelines (BMT WBM, 2015) were used where no BCC nodes were available for the land use type (e.g. agricultural). Source node parameters for the existing scenario land use types are summarised in **Table 6-2**.

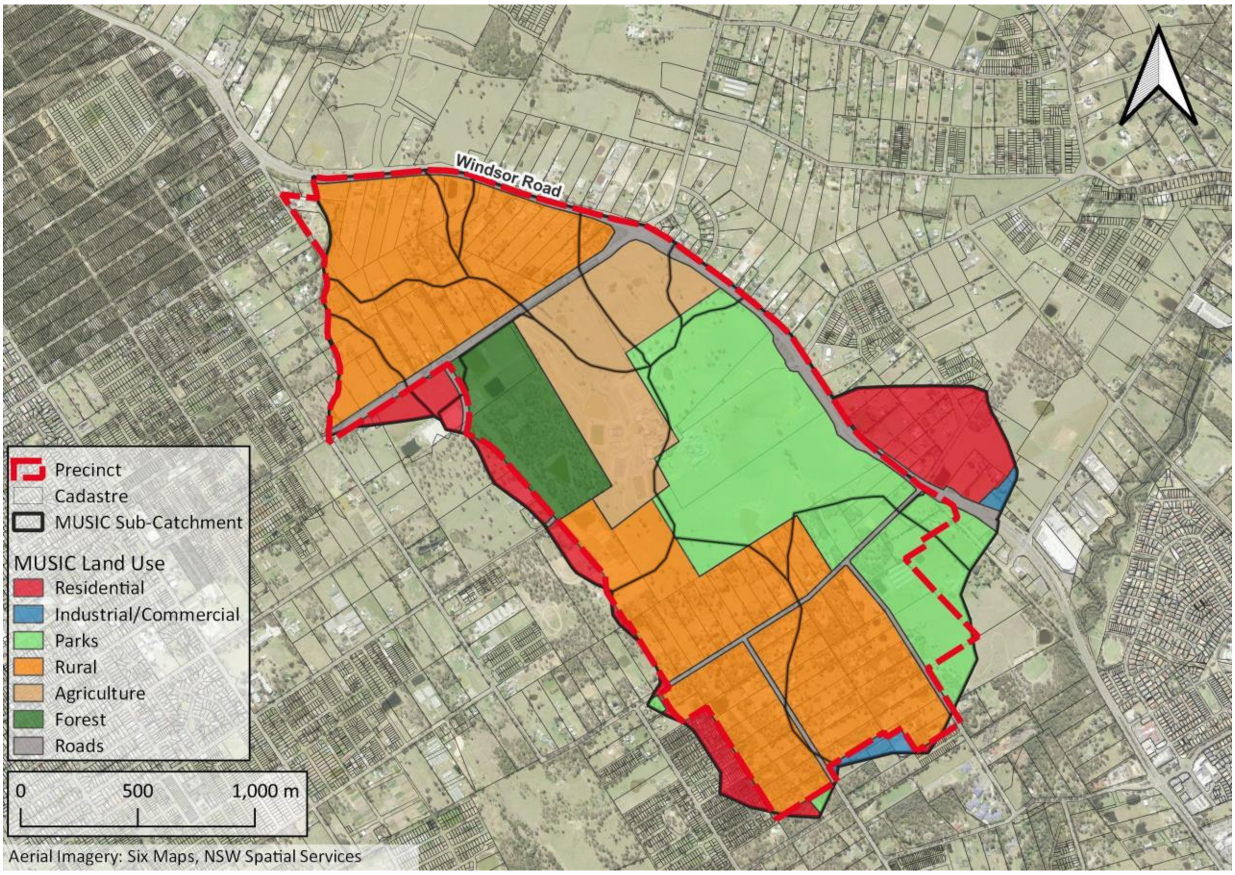



**Figure 6-2 MUSIC Land Use – Existing Scenario**

Table 6-2 Adopted MUSIC Source Node Parameters

| | | Land Use | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Residential | Industrial/ Commercial | Parks | Rural | Agriculture | Forest | Roads |
| Percentage Impervious | | 85 | 90 | 5 | 5 | 5 | 0 | 85 |
| **Impervious Area Properties** | | | | | | | | |
| Rainfall Threshold (mm/day) | | 1.4 | | | | | | |
| **Pervious Area Properties** | | | | | | | | |
| Soil Storage Capacity (mm) | | 170 | | | | | | |
| Initial Storage (% of Capacity) | | 30 | | | | | | |
| Field Capacity (mm) | | 70 | | | | | | |
| Infiltration Capacity Coefficient – a | | 210 | | | | | | |
| Infiltration Capacity Coefficient – b | | 4.7 | | | | | | |
| **Groundwater Properties** | | | | | | | | |
| Initial Depth (mm) | | 10 | | | | | | |
| Daily Recharge Rate (%) | | 50 | | | | | | |
| Daily Baseflow Rate (%) | | 4 | | | | | | |
| Daily Deep Seepage Rate (%) | | 0 | | | | | | |
| **Total Suspended Solids Generation (log mg/L)** | | | | | | | | |
| Base Flow | Mean | 1.20 | 1.20 | 1.20 | 1.15 | 1.30 | 0.78 | 1.20 |
| | Std Dev | 0.17 | 0.17 | 0.17 | 0.17 | 0.13 | 0.13 | 0.17 |
| Storm Flow | Mean | 3.00 | 3.00 | 3.00 | 1.95 | 2.15 | 1.60 | 2.43 |
| | Std Dev | 0.32 | 0.32 | 0.32 | 0.32 | 0.31 | 0.20 | 0.32 |
| **Total Phosphorus Generation (log mg/L)** | | | | | | | | |
| Base Flow | Mean | -0.85 | -0.85 | -0.85 | -1.22 | -1.05 | -1.22 | -0.85 |
| | Std Dev | 0.19 | 0.19 | 0.19 | 0.19 | 0.13 | 0.13 | 0.19 |
| Storm Flow | Mean | -0.30 | -0.30 | -0.30 | -0.66 | -0.22 | -1.10 | -0.30 |
| | Std Dev | 0.25 | 0.25 | 0.25 | 0.25 | 0.30 | 0.22 | 0.25 |
| **Total Nitrogen Generation (log mg/L)** | | | | | | | | |
| Base Flow | Mean | 0.11 | 0.11 | 0.11 | -0.05 | 0.04 | -0.52 | 0.11 |
| | Std Dev | 0.12 | 0.12 | 0.12 | 0.12 | 0.13 | 0.13 | 0.12 |
| Storm Flow | Mean | 0.30 | 0.30 | 0.30 | 0.30 | 0.48 | -0.05 | 0.34 |
| | Std Dev | 0.19 | 0.19 | 0.19 | 0.19 | 0.26 | 0.24 | 0.19 |

### 6.2.4 Treatment Nodes

#### *6.2.4.1 Ponds*

Pond treatment nodes sourced from BCC's MUSIC nodes were used to represent the likely degree of treatment provided by the existing farm dams within the study area. Given the significant quantity and spread of farm dams throughout the study area, it was assumed that each sub-catchment area would be treated by 50% of the combined pond area within each MUSIC sub-catchment. Each pond was assumed to have an average depth of 1m and a nominally small hydraulic residence time close to 0.

#### *6.2.4.2 Generic Treatment Nodes*

Generic treatment nodes were used to represent the assumed local stormwater treatment for new residential areas external to the Precinct where runoff would bypass the locations of regional treatment measures previously nominated in Mott MacDonald (2016). Treatment percentages were set to achieve BCC's minimum reduction targets (refer **Section 6.1**) for these areas.

### 6.2.5 Results

**Table 6-3** summarises the results of the MUSIC water quality assessment for the existing scenario, including the percentage reduction compared to untreated catchment runoff.

**Table 6-3 Existing Scenario Pollutant Loads**

| Pollutant | Catchment (un-treated) Loads (kg/yr) | Catchment Outflow Loads (kg/yr) | Percentage Reduction % |
|---|---|---|---|
| Total Suspended solids (TSS) | 178,000 | 60,400 | 66.1 |
| Total Phosphorus (TP) | 361 | 189 | 47.7 |
| Total Nitrogen (TN) | 2,450 | 1,780 | 27.5 |
| Gross Pollutants | 17,700 | 1,390 | 92.1 |

## 6.3 Stormwater Management Strategy

A stormwater treatment train was developed to target typical pollutants associated with urban runoff including gross pollutants, suspended sediment (TSS), nutrients (nitrogen and phosphorus) and hydrocarbons. In addition to stormwater treatment, the stormwater management strategy includes stormwater harvesting measures for the capture and re-use of stormwater to reduce potable water demands across the Precinct.

Features of the proposed treatment train are summarised in **Table 6-4**. **Figure 6-3** shows the location of proposed regional treatment basins.

Concept design drawings of proposed stormwater management measures are attached in **Appendix A.**

**Table 6-4 Proposed Stormwater Treatment Train**

| Treatment Measures | | Description[1] |
|---|---|---|
| **On-lot measures** | Rainwater tanks | Rainwater tanks are proposed on each new allotment to capture rainwater for internal and external re-use. |
| **At-source measures** | Grassed swales | Grassed swales are proposed to treat runoff from public open space and sporting field areas, reducing the reliance on end of line treatment measures. |
| **End of line measures** | Gross pollutant traps (GPTs) | GPTs are proposed on the downstream end of Precinct stormwater drainage lines prior to discharging to riparian corridors or direct to regional treatment measures. These are primary treatment measures targeting gross pollutants and coarse sediment. The GPTs will also contain oil baffles to capture hydrocarbons and satisfy Section 11.6.1 of Council's WSUD Developer Handbook – MUSIC Modelling and Design Guideline (2020). |
| | Sediment ponds | Sediment ponds are proposed as a secondary treatment measure for the two Killarney Chain of Ponds tributaries and First Ponds Creek tributary, targeting coarse to medium sediment. |
| | Constructed wetlands | Constructed wetlands are proposed as tertiary treatment measures for the two Killarney Chain of Ponds tributaries, targeting finer sediment and nutrients. In addition to a stormwater treatment function, the wetlands will provide significant ecological benefits via creating a habitat for a range of fauna. |
| | Bioretention basins | Bioretention basins are proposed as tertiary treatment measures for the First Ponds Creek tributary and major Precinct drainage lines, targeting finer sediment and nutrients. For portions of the site where on-site detention is required, bioretention basins will be co-located within detention basins to minimise land take. |
| | Harvesting ponds | Stormwater harvesting ponds are proposed at the downstream end of the major site catchments (First Ponds Creek and Killarney Chain of Ponds tributaries) and will be the main source of water for landscape irrigation of public open space and sporting fields within the Precinct. The proposed harvesting scheme will reduce stormwater runoff volumes discharging from the Precinct will also reduce the reliance on potable water servicing.<br><br>Recycled water servicing from the Rouse Hill Water Recycling Plant was considered but ultimately set aside due to the ability of the proposed stormwater harvesting measures to provide a reliable water supply (refer **Section 7.4**) and additional stormwater infrastructure requirements to provide an equivalent level of treatment without the proposed harvesting scheme in place. |

[1] Refer Section 6.4.3 for performance assumptions made for each measure

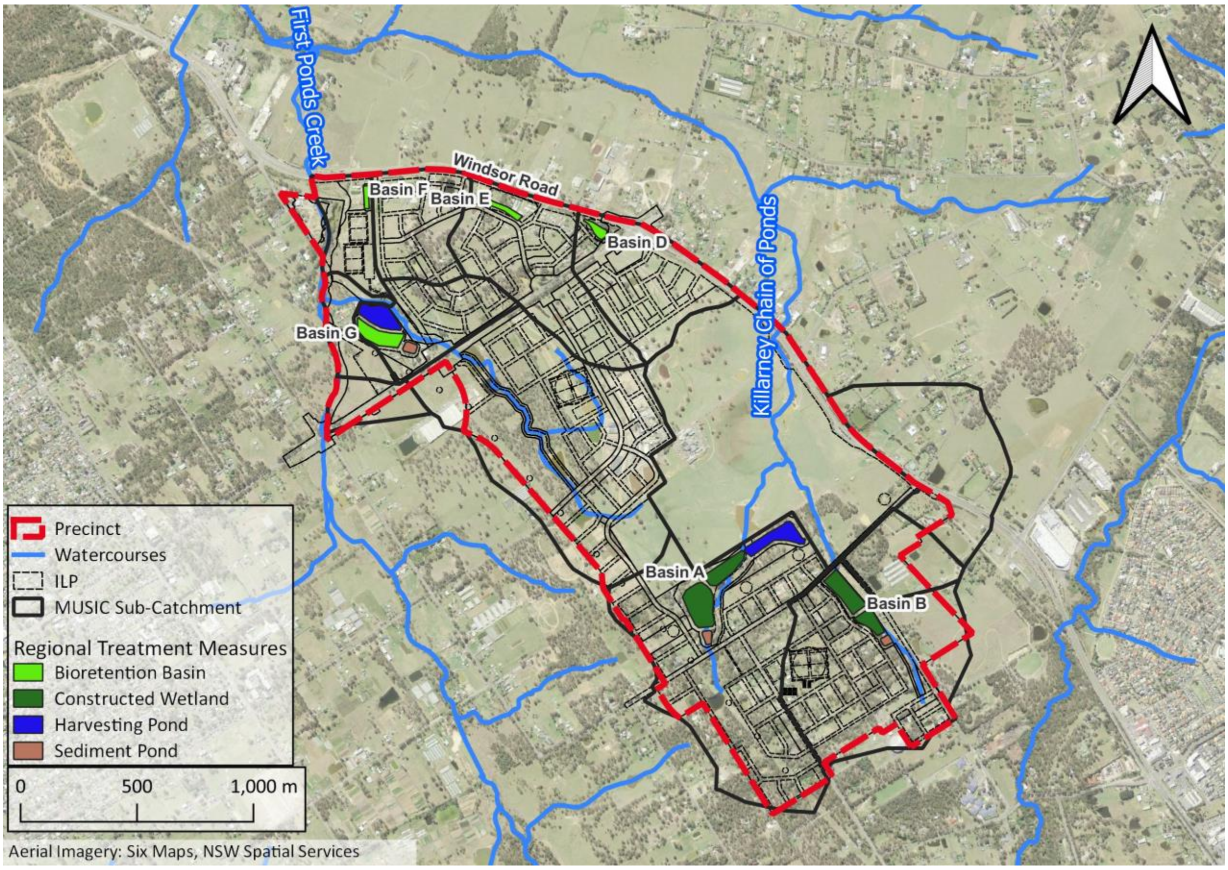



**Figure 6-3 Regional Treatment Measures**

## 6.4 Post-Development (ILP) Scenario MUSIC Modelling

### 6.4.1 Sub-Catchment Delineation

Similarly to the base case MUSIC model, the sub-catchment delineation for the post-development model with the ILP as proposed in **Section 5** is a consolidated version on the delineation from the corresponding XP-RAFTS model, equating to a total of 13 MUSIC sub-catchments. The sub-catchment delineation adopted in the post-development MUSIC model is included in **Figure 6-3**.

### 6.4.2 Source Nodes

Source nodes representing post-development land uses were obtained from BCC's default MUSIC nodes. The post-development land use is shown in **Figure 6-4**.

For proposed residential and community centre/school areas, the land use was split into roof, driveway and landscaping areas. **Table 6-5** shows the surface type split for these land uses.

Percentage impervious values were assigned in accordance with the recommended values in the WSUD Developer Handbook – MUSIC Modelling and Design Guideline (BCC, 2020). These values are considered conservative given the impervious fraction used in MUSIC modelling is typically based on effective impervious area (EIA) rather than total impervious area (TIA). The adopted percentage imperviousness for post-development land use types is shown in **Table 6-6**.

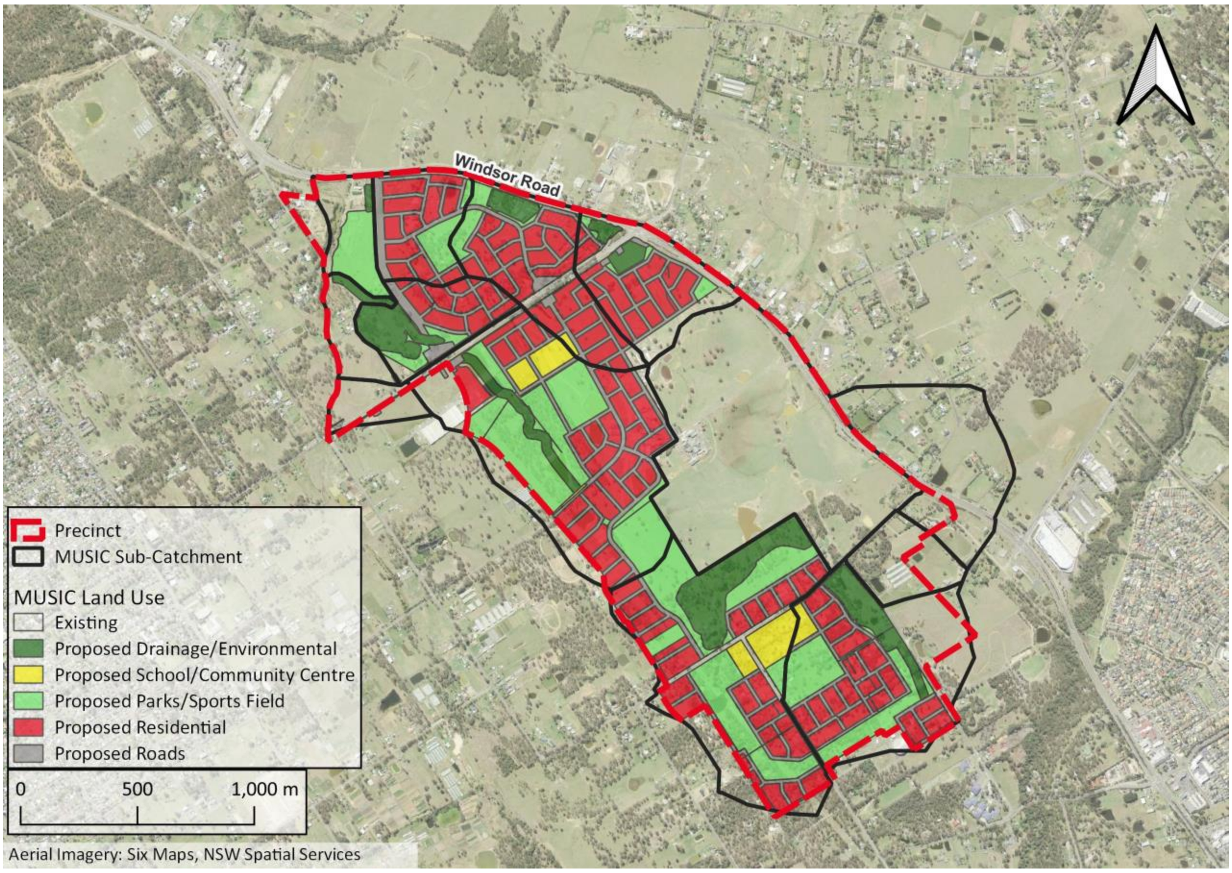



**Figure 6-4 MUSIC Land Use - Post-Development Scenario**

**Table 6-5 Post-Development Land Use Split**

| Land Use | Source Node Type (% of total area) | | | |
|---|---|---|---|---|
| | BCC Roof Area | BCC Road Areas (driveways) | BCC Other Impervious Areas | BCC Pervious Areas |
| Residential | 60 | 10 | 15 | 15 |
| School/Community Centre | 30 | 10 | 10 | 50 |

Table 6-6 Post-Development Source Nodes and Imperviousness

| Land Use | Source Node Type | Percentage Impervious |
|---|---|---|
| Proposed Residential | As per **Table 6-5** | 85 |
| Potential School/Community Centre | As per **Table 6-5** | 50 |
| Proposed Parks/Sports Field | Residential | 20[2] |
| Proposed Roads | Sealed road | 95 |
| Proposed Drainage/Environmental | Forest | 5 |

## 6.4.3 Treatment Nodes

Seven treatment node types have been included in the MUSIC models to represent elements of the treatment train:

- Rainwater Tanks,
- Swales,
- Continuous Deflective Separation (CDS) GPTs,
- Sediment Basins,
- Bioretention,
- Ponds (wetlands), and
- Ponds (harvesting).

It is assumed that farm dams within the Precinct will be remediated and filled as part of the development and thus have been excluded for the portions of the MUSIC model where development is proposed.

### *6.4.3.1 Rainwater Tanks*

Default rainwater tank treatment nodes were used in the post-development MUSIC model. Adopted residential rainwater tank assumptions are as follows:

- Tank sizing of 4kL per allotment, modelled at 90% of the total volume in MUSIC to allow for air space and sedimentation,
- Tanks assumed to receive 100% of roof runoff from each dwelling, and
- Assumed rainwater re-use rates of:
    - Internal re-use rate of 0.1kL/day/lot
    - External re-use rate of 25kL/year/lot

DCP controls will be required to enforce the minimum rainwater tank volumes and contributing roof area assumptions. Multiple slimline tanks may be required to capture runoff from the entire roof area.

### *6.4.3.2 Swales*

Swale treatment nodes were obtained from BCC's default MUSIC nodes. Swales have been proposed as an at-source treatment measure for public open space and sporting fields, with an assumed length of 200m per hectare of public open space/sporting field. This has been modelled as 100m/ha to allow for distributed catchment inflows along the length of the swales.

Key swale parameters are summarised in **Table 6-7.**

[2] This is lower than the 50% recommended in the WSUD Developer Handbook – MUSIC Modelling and Design Guideline (BCC, 2020). A SEPP/DCP clause will be required to enforce a maximum 20% imperviousness for public open space areas.

Table 6-7 Swale Parameters

| Parameter | |
|---|---|
| **Low Flow Bypass ($m^3$/s)** | 0 |
| **Bed Slope (%)** | 0.5 |
| **Base Width (m)** | 1 |
| **Top Width (m)** | 5 |
| **Depth (m)** | 0.4 |
| **Vegetation Height (m)** | 0.05 |
| **Exfiltration Rate (mm/hr)** | 0 |

#### *6.4.3.3 CDS GPTs*

CDS GPT treatment nodes were obtained from BCC's default MUSIC nodes. A single CDS node was used for each major post-development sub-catchment to represent the aggregate of GPTs located at the outlet of individual stormwater drainage lines into riparian corridors or treatment basins. The high flow bypass rate has been set at the 4EY flowrate for each sub-catchment.

Key GPT parameters are summarised in **Table 6-8**.

Table 6-8 CDS GPT Parameters

| CDS GPT | | |
|---|---|---|
| | **Input (mg/L)** | **Output (mg/L)** |
| **Low Flow Bypass ($m^3$/s)** | 0 | |
| **High Flow Bypass ($m^3$/s)** | 4EY flowrate | |
| **Total Suspended Solids** | 0 | 0 |
| | 75 | 75 |
| | 1000 | 300 |
| **Total Phosphorous** | 0 | 0 |
| | 0.5 | 0.5 |
| | 10 | 7 |
| **Total Nitrogen** | 0 | 0 |
| | 50 | 50 |
| **Gross pollutants** | 0 | 0 |
| | 100 | 2 |

#### *6.4.3.4 Sediment Basins*

Sediment basin nodes were obtained from BCC's default MUSIC nodes and used to represent the corresponding portions of Basins A, B and G (**Figure 6-3**). The surface area of each basin was calculated in accordance with Section 11.3.1 of the WSUD Developer Handbook – MUSIC Modelling and Design Guideline (BCC, 2020). Modelled volumes are based on the upper 2/3 of the permanent water depth to account for sedimentation in the base. High flow bypass rates were set at either the 4EY design flowrate or the flowrate required to keep velocities in downstream wetlands (**Section 6.4.3.6**) sufficiently low.

Key sediment basin parameters are summarised in **Table 6-9**.

Table 6-9 Sediment Basin Parameters

| Parameter | Basin A | Basin B | Basin G |
|---|---|---|---|
| **Low Flow Bypass ($m^3/s$)** | | 0 | |
| **High Flow Bypass ($m^3/s$)** | 1.35 | 1.35 | 3.6 |
| **Surface Area ($m^2$)** | 1,823 | 1,489 | 2,207 |
| **Extended Detention Depth (m)** | | 0.35 | |
| **Permanent Pool Volume ($m^3$)** | 1,411 | 1,162 | 1,775 |
| **Exfiltration Rate (mm/hr)** | | 0 | |
| **Evaporative Loss as % of PET** | | 75 | |
| **Notional Detention Time (hrs)** | 5.71 | 4.67 | 6.92 |

### *6.4.3.5 Bioretention*

Default bioretention treatment nodes were used to represent the regional bioretention basins in the post-development MUSIC model, with the sizing and parameterisation based on Section 11.8 of the WSUD Developer Handbook – MUSIC Modelling and Design Guideline (BCC, 2020). High flow bypass has been set at the 4EY flow.

Key bioretention basin parameters are summarised in **Table 6-10**.

Table 6-10 Bioretention Parameters

| Parameter | Basin D | Basin E | Basin F | Basin G |
|---|---|---|---|---|
| **Upstream Catchment Area (Ha)** | 24.7 | 30.4 | 17.6 | 92.9 |
| **Low Flow Bypass ($m^3/s$** | | 0 | | |
| **High Flow Bypass ($m^3/s$)** | 1.3 | 2.0 | 1.2 | 3.6 |
| **Filter Area ($m^2$)** | 3,065 | 2,958 | 1,927 | 10,000 |
| **Filter Depth (m)** | | 0.8 | | |
| **Extended Detention Depth (m)** | 0.3 | 0.3 | 0.3 | 0.3 |
| **Saturated Hydraulic Conductivity (mm/hr)** | | 100 | | |
| **TN Content of Filter Media (mg/kg)** | | 800 | | |
| **Orthophosphate Content of Filter Media (mg/kg)** | | 40 | | |
| **Lined Base** | | Yes | | |
| **Vegetated with Effective Nutrient Removal Plants** | | Yes | | |

### *6.4.3.6 Ponds (wetlands)*

Given the macrophyte zone overflow will be located at the downstream end of the two proposed constructed wetlands (Basins A and B), pond treatment nodes with k and C* values adjusted to match those of a wetland were used in lieu of the default wetland nodes where the overflow is assumed to be located upstream of the macrophyte zone. The high flow bypass rate for the wetlands has been set at a value to limit design velocities to a maximum of 0.05m/s in the shallow marsh zones in the 4EY event as opposed to conveying full 4EY flows through the macrophyte zone. The modelled permanent pool volume accounts for 10% of the macrophyte zone volume being occupied by stored sediment.

Key wetland parameters are summarised in **Table 6-11**.

**Table 6-11 Wetland Parameters**

| Parameter | Basin A | Basin B |
|---|---|---|
| **Upstream Catchment Area (Ha)** | 59.7 | 49.3 |
| **Low Flow Bypass ($m^3/s$)** | 0 | |
| **High Flow Bypass ($m^3/s$)** | 1.35 | 1.35 |
| **Surface Area ($m^2$)** | 29,022 | 19,487 |
| **Extended Detention Depth (m)** | 0.35 | |
| **Permanent Pool Volume ($m^3$)** | 10,188 | 6,932 |
| **Exfiltration Rate (mm/hr)** | 0 | |
| **Evaporative Loss as % of PET** | 125 | |
| **Notional Detention Time (hrs)** | S | 61.1 |

### *6.4.3.7 Ponds (harvesting)*

Default pond treatment nodes were used to represent the stormwater harvesting components of Basins A and G. The k and C* values for these ponds have been set to 0 (no treatment) given their main function as harvesting/re-use measures and location at the downstream end of the treatment train. The modelled re-use rates have been based on an assumed irrigation rate of 0.4kL/year over 80% of pervious open space/sporting field areas (17.9 Ha for Basin A and 24.4 Ha for Basin G).

Key harvesting pond parameters are summarised in **Table 6-12**.

**Table 6-12 Wetland Pond Harvesting Parameters**

| Parameter | Basin A | Basin G |
|---|---|---|
| **Upstream Catchment Area (Ha)** | 119.3 | 92.9 |
| **Low Flow Bypass ($m^3/s$)** | 0 | |
| **High Flow Bypass ($m^3/s$)** | 100 | 3.6 |
| **Surface Area ($m^2$)** | 15,435 | 11,908 |
| **Extended Detention Depth (m)** | 1.1 | 0.35 |
| **Permanent Pool Volume ($m^3$)** | 17,359 | 15,005 |
| **Exfiltration Rate (mm/hr)** | 0 | |
| **Evaporative Loss as % of PET** | 75 | |
| **Notional Detention Time (hrs)** | 2.38 | 5.97 |
| **Re-use Rate (kL/year)** | 71,729 | 97,456 |

### 6.4.4 Results

#### *6.4.4.1 NorBE Assessment*

**Table 6-13** shows existing and post-development pollutant loading for the purpose of the NorBE assessment.

A comparison of the existing and post-development TSS, TP and TN concentrations for runoff-generating events is provided in **Figure 6-5** to **Figure 6-7**.

**Table 6-13 Existing vs Post-Development Load Comparison (NorBE Assessment)**

| Pollutant | Existing Outflow Loads (kg/yr) | Post-Development Outflow Loads (kg/yr) | Percentage Reduction/Increase % |
|---|---|---|---|
| Total Suspended solids (TSS) | 60,400 | 47,300 | -21.7 |
| Total Phosphorus (TP) | 189 | 186 | -1.6 |
| Total Nitrogen (TN) | 1,780 | 1,920 | +7.9 |
| Gross Pollutants | 1,390 | 371 | -73.3 |

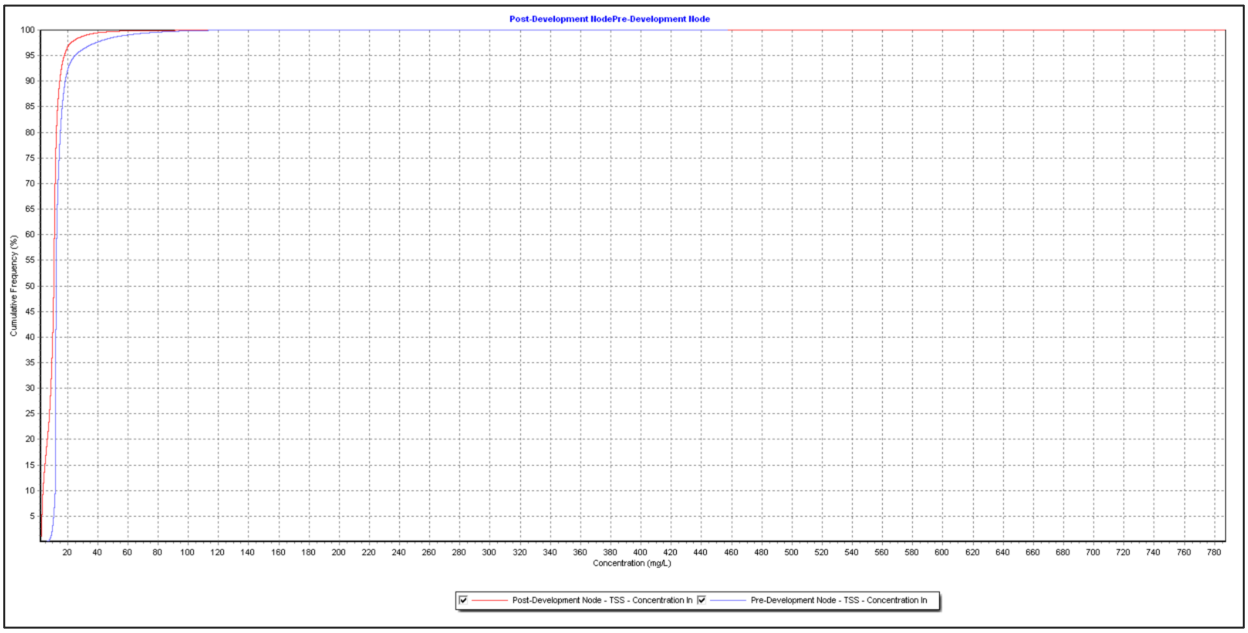



**Figure 6-5 Existing vs Post-Development Concentration Comparison – TSS**

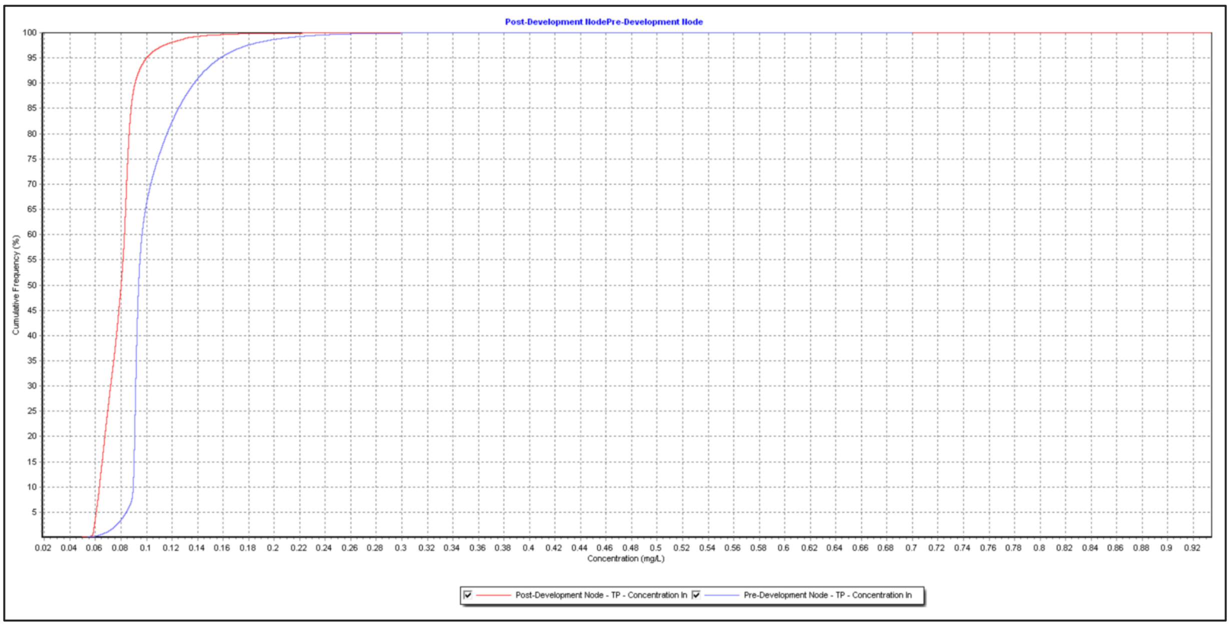



**Figure 6-6 Existing vs Post-Development Concentration Comparison – TP**

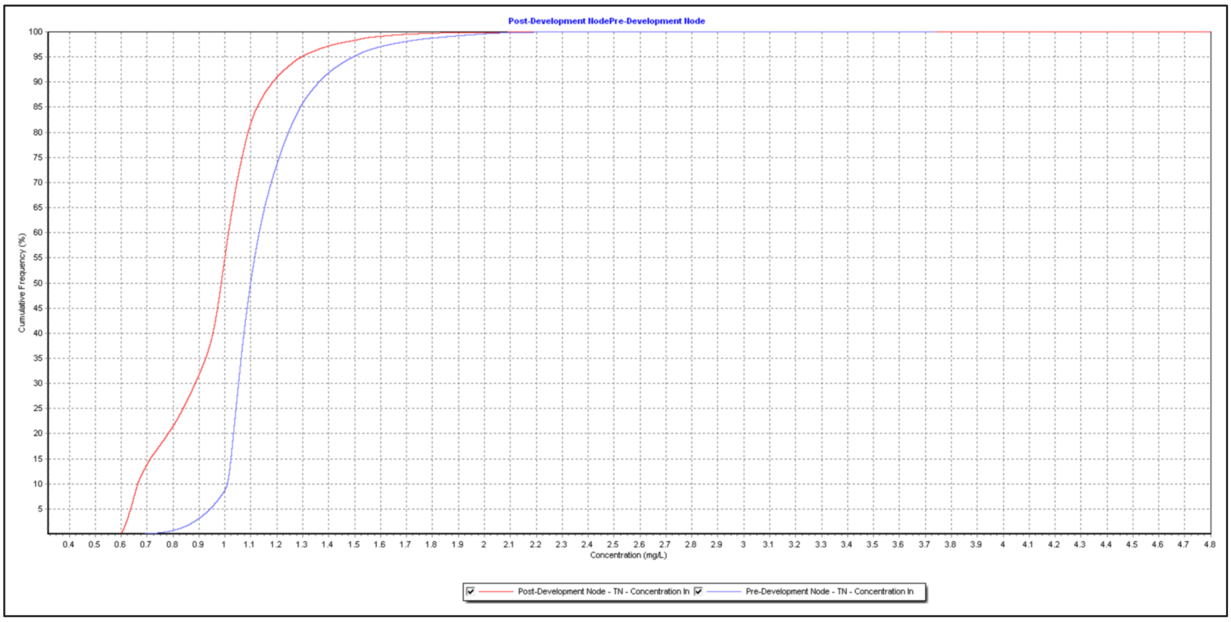



**Figure 6-7 Existing vs Post-Development Concentration Comparison – TN**

The results presented in **Table 6-13** show that the post-development TN loads are higher than those that would be required to meet the NorBE criteria stipulated in the *Using MUSIC in the Sydney Drinking Water Catchment* (Water NSW, 2023). **Figure 6-5** to **Figure 6-7** show that post-development TSS, TP and TN concentrations are less than pre-development levels for the 50$^{th}$ to 95$^{th}$ percentile runoff generating events demonstrating compliance with the NorBE concentration targets in the *Using MUSIC in the Sydney Drinking Water Catchment* (Water NSW, 2023).

Although not achieving NorBE from a pollutant loading perspective, the slight increases in would not be expected to adversely impact downstream waterway health as increases in TN compared to the existing scenario are only minor (approximately 8%) and do not correspond with an increase in nitrogen concentration. The achieved water quality outcomes are thus considered to be consistent with Part 6.6 – Clause 2 (a) of the SEPP (Biodiversity and Conservation) 2021.

#### *6.4.4.2 Pollutant Load Reductions*

For the purpose of assessing post-development pollutant load reductions compared to an un-treated scenario, sub-catchments where land use will not change substantially as a result of the proposed development (such as Rouse Hill Regional Park) were removed from the model. The MUSIC sub-catchments for this scenario are shown in **Figure 6-8**.

The results of the percentage reduction-based assessment presented in **Table 6-14**.

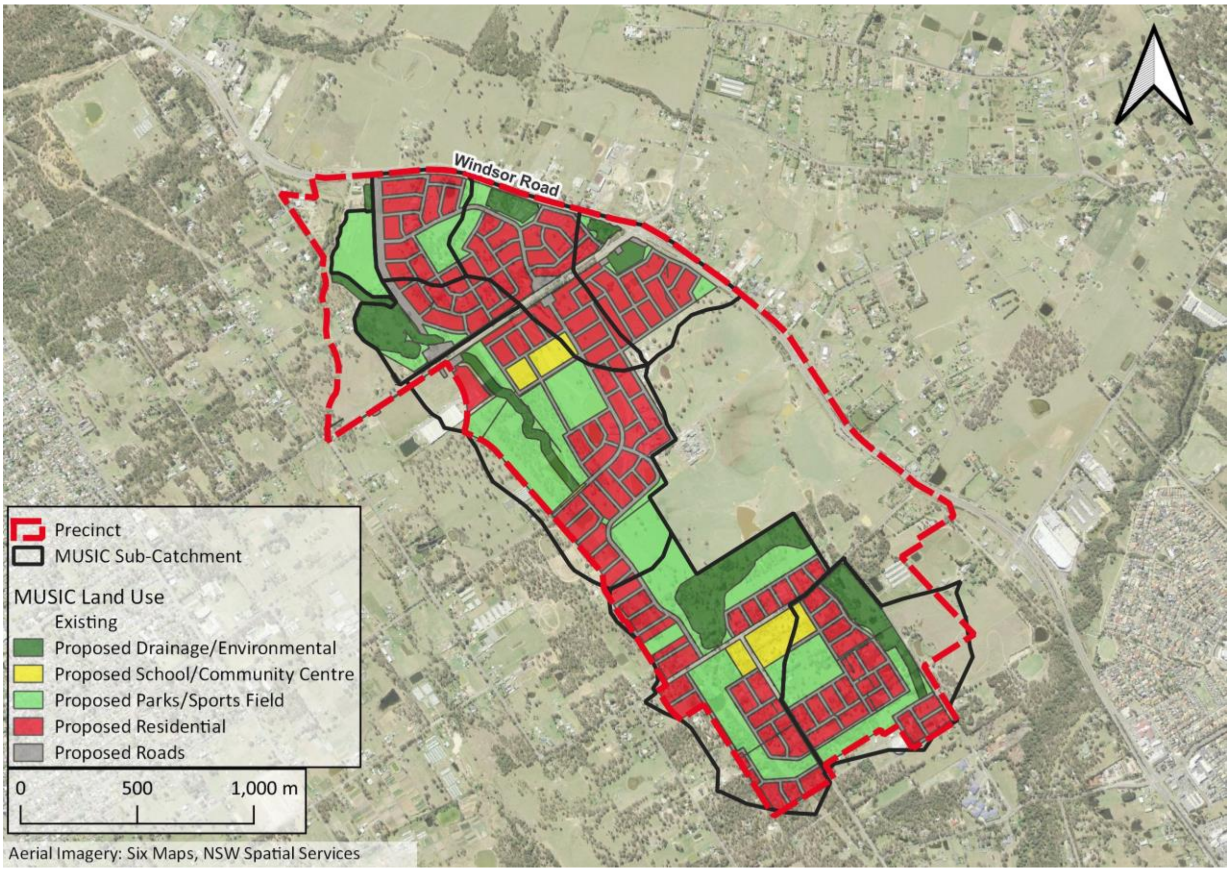



**Figure 6-8 MUSIC Sub-Catchments – Percentage Reduction-Based Assessment**

**Table 6-14 Post-Development Pollutant Load Reductions (BCC/Wianamatta Assessment)**

| Pollutant | Post-Development Un-Treated Loads (kg/yr) | Post-Development Outflow Loads (kg/yr) | Percentage Reduction % |
|---|---|---|---|
| Total Suspended solids (TSS) | 298,000 | 35,100 | 88.2 |
| Total Phosphorus (TP) | 566 | 147 | 74.1 |
| Total Nitrogen (TN) | 3,590 | 1,560 | 56.4 |

| Pollutant | Post-Development Un-Treated Loads (kg/yr) | Post-Development Outflow Loads (kg/yr) | Percentage Reduction % |
|---|---|---|---|
| Gross Pollutants | 37,600 | 89 | 99.8 |

The MUSIC results shown in **Table 6-14** indicate the proposed treatment train achieves compliance with BCC's minimum reduction targets but does not achieve DPE's Wianamatta-South Creek reduction targets. Additional on-lot tertiary treatment measures such as membrane filters or bioretention systems would be required to achieve these reduction targets. This could be provided for medium and high-density residential zones in accordance with Section 11.1 of the WSUD Developer Handbook – MUSIC Modelling and Design Guideline (BCC, 2020).

A MUSIC-Link report for the post-development MUSIC modelling has been attached in **Appendix B**.

# 7 Stormwater Quantity Management

## 7.1 Stormwater Quantity Objectives

Stormwater detention objectives for the Precinct are to reduce post-development flows to less than or equal to pre-development flows design storm events ranging from the 50% AEP up to and including the 1% AEP.

Objectives for environmental flows are to mimic existing site runoff volumes and durations as much as practical.

## 7.2 Regional Detention Assessment

### 7.2.1 Basin Design

A regional detention basin strategy was developed to mitigate the increase in site flows associated with higher imperviousness of the developed catchment. Proposed detention basins were sized using the XP-RAFTS hydrologic model and TUFLOW hydraulic model developed for the *Flood Impact and Risk Assessment* (Rhelm 2023).

For the Killarney Chain of Ponds catchment, detention basins have been located online of the two first order watercourses draining to the Rouse Hill Regional Park and at major topographical low points along the north-eastern Precinct boundary. For the First Ponds Creek catchment, the *First Ponds Creek Flood Assessment* (CSS, 2021) and *Riverstone East Stage 3 Flood Impact and Risk Assessment* (Rhelm, 2023) indicate that flows and flood levels are generally lower in the fully developed state of the catchment than the base case condition (circa 2010), with the exception of more frequent events such as the 20% AEP. As such, no detention has been proposed for the site catchments draining to First Ponds Creek. Further discussion and flood impact mapping is provided in the *Riverstone East Stage 3 Flood Impact and Risk Assessment* (Rhelm, 2023).

Proposed basin design parameters/assumptions are as follows:

- Primary outlet pipes sized to convey 50% AEP flows,
- Secondary outlet weir to convey 1% AEP flows,
- Maximum 1.5m depth above the invert of primary outlet pipes/culverts in a 1% AEP event,
- Minimum 0.5m freeboard to top of embankment levels in a 1% AEP event,
- Maximum 1m storage depth over wetland planting in a 1% AEP event,
- Maximum 0.8m storage depth over bioretention filters in a 1% AEP event,
- Extended detention depth excluded in detention storage calculations,
- Typical 1V:5H batter/embankment slopes for maintainability and safe emergency egress,
- Maximum batter/embankment slopes of 1V:4H,
- Minimum 1% base slope to promote drainage, and
- 4m wide berm width with a maintenance access road around the basin perimeter.

**Figure 7-1** shows the location of proposed detention basins across the Precinct and flow reporting locations downstream of the basins. **Table 7-1** summarises key design features of each basin.

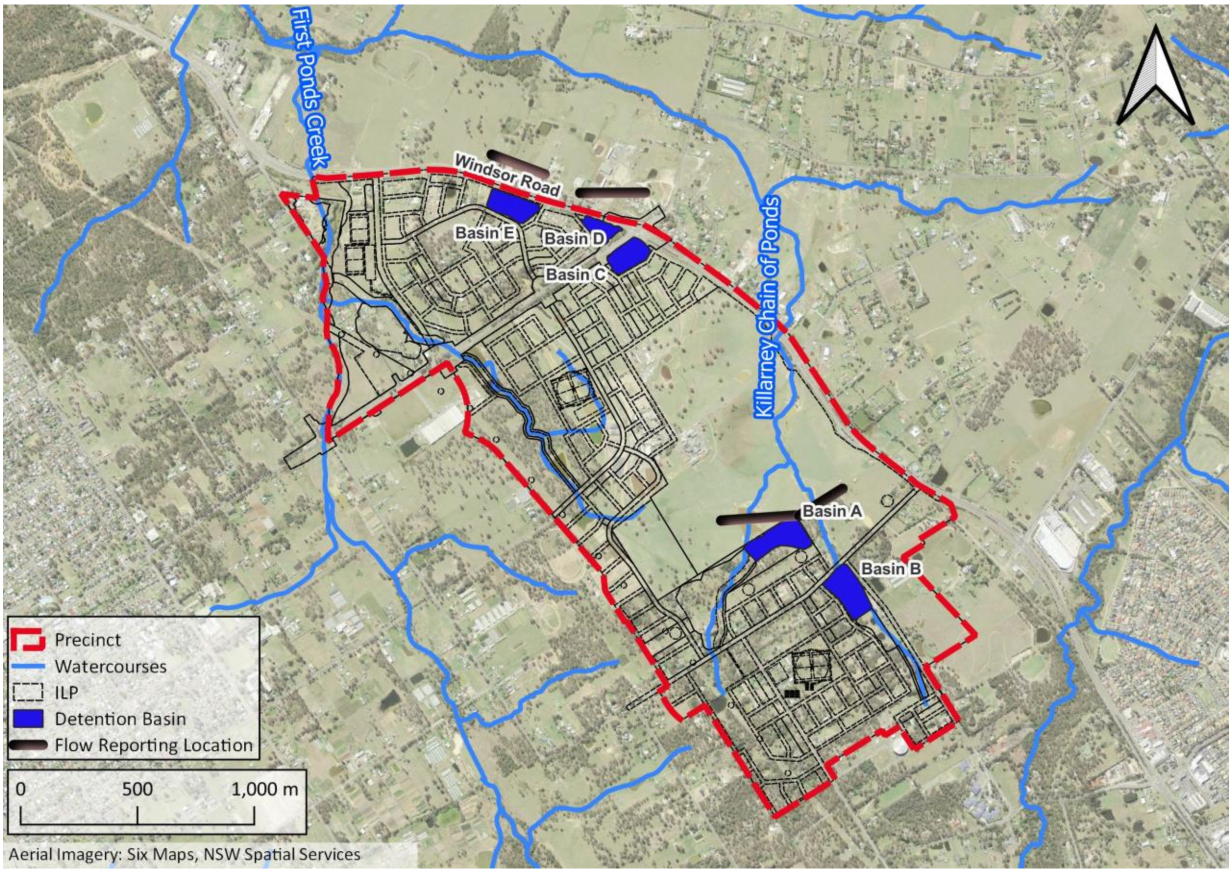



**Figure 7-1 Detention Basin Locations**

**Table 7-1 Detention Basin Properties**

| Detention Basin | Primary Outlet | Secondary Outlet | 1% AEP Storage ($m^3$) |
|---|---|---|---|
| A | 0.9 diameter RCP | 40m wide weir | 24,960 |
| B | 1.05 diameter RCP (wetland)<br>1.2W x 0.9H RCBC (riparian corridor) | 15m wide weir | 6,280 |
| C | 0.9 diameter RCP | 2 x 1200sq pit | 7,520 |
| D | 0.525 diameter RCP | 10m wide weir | 4,190 |
| E | 0.675 diameter RCP | 10m wide weir | 9,570 |

### 7.2.2 Results

Flows were extracted from the existing and post-development TUFLOW model at the locations shown in **Figure 7-1** to assess the performance of the proposed basins at reducing post-development flows to pre-development levels across the Killarney Chain of Ponds catchment.

The results of the detention assessment for a range of storm events from the 50% to 1% AEP are shown in **Table 7-2**.

**Table 7-2 Pre and Post-Development Flow Comparison**

| Location | Pre-Development Flow (m3/s) | | | | Post-Development Flow (m3/s) | | | |
|---|---|---|---|---|---|---|---|---|
| | 50% AEP | 10% AEP | 5% AEP | 1% AEP | 50% AEP | 10% AEP | 5% AEP | 1% AEP |
| Basin A | 1.20 | 2.55 | 4.35 | 9.70 | 1.22 | 3.39 | 5.69 | 9.03 |
| Basin B | 2.12 | 6.80 | 9.36 | 15.48 | 1.84 | 6.07 | 7.45 | 10.49 |
| Basin D | 0.75 | 1.85 | 2.62 | 3.85 | 0.62 | 1.27 | 1.47 | 2.45 |
| Basin E | 0.99 | 2.40 | 3.19 | 5.02 | 0.91 | 1.59 | 2.40 | 3.83 |

The results shown in **Table 7-2** suggest the proposed detention basins generally reduce post-development flows to pre-development levels for design storm events ranging from the 50% AEP to the 1% AEP. The exception to this is Basin A where the low flow diversion from Basin B results in higher flows immediately downstream for the 10% AEP, 10% AEP and 5% AEP events. Flood impact mapping indicates that this altered flow distribution does not produce a significant flood level increase at the confluence of the two Killarney Chain of Ponds tributaries.

## 7.3 Stream Erosion Index

The stream erosion index (SEI) is the ratio of post-development flow to pre-development flow above the 'stream-forming flowrate' and relates to the additional erosion that can be caused by increased runoff from developed catchments. This has been calculated as follows:

- The existing 50% AEP total flow at key site discharge locations was estimated using existing scenario XP-RAFTS model results from the *Flood Impact and Risk Assessment* (Rhelm, 2023).
- The critical flow was calculated at 25% of the 50% AEP flow.
- Results of the base case and post-development MUSIC models were interrogated to determine the average annual volume of runoff for events where flows exceed the critical flow.
- The ratio of resultant post-development annual volume was compared to the existing scenario to determine the SEI.

The stream erosion indices at key discharge locations are shown in **Table 7-3**.

**Table 7-3 Stream Erosion Index**

| Location | SEI | Comment |
|---|---|---|
| Downstream Basin A/B | 0.31 | SEI meets the 'ideal' 1:1 ratio in the Growth Centres DCP 2010. |
| Downstream Basin D | 2.29 | SEI meets the maximum 3.5:1 ratio in the Growth Centres DCP 2010. |
| Downstream Basin E | 2.19 | SEI meets the maximum 3.5:1 ratio in the Growth Centres DCP 2010. |
| Downstream Basin F | 1.80 | SEI meets the maximum 3.5:1 ratio in the Growth Centres DCP 2010. |
| Downstream Basin G | 1.03 | SEI meets the maximum 3.5:1 ratio in the Growth Centres DCP 2010. |

## 7.4 Water Balance Assessment

A water balance assessment has been undertaken using the post-development MUSIC model described in **Section 6.4** to determine the reliability of proposed stormwater harvesting measures at meeting predicted demands across varying climatic conditions. For this assessment, daily rainfall data from the Richmond – UWS Hawkesbury meteorological station (Station 067021) was analysed over a 123-year period from 1900 to 2023. This meteorological data set was used in preference to the stations nominated in the WSUD Developer Handbook – MUSIC Modelling and Design Guideline (BCC, 2020) due to the close proximity to the site as well as the length of the data series and coverage of a wider variety of climatic conditions, including the millennium drought and 2022 floods.

Rainfall depths for wet (90$^{th}$ percentile), dry (10$^{th}$ percentile) and average (50$^{th}$ percentile) rainfall years were obtained from Bureau of Meteorology statistics for Station 067021 (**Table 7-4)**, with results from representative years extracted from the timeseries for the purpose of the water balance assessment.

**Table 7-4 Wet, Dry and Average Year Rainfall Depths**

| | Wet Year | Dry Year | Average Year |
|---|---|---|---|
| **Rainfall (mm)** | 1076 | 527 | 796 |
| **Representative Year** | 1989 | 2006 | 1970 |

Results of the MUSIC water balance assessment for the two proposed stormwater harvesting ponds (Basins A and G) and combined rainwater tanks for the Basin A catchment are summarised in **Table 7-5**. This includes re-use demands and deficits for the representative wet, dry and average rainfall years.

**Table 7-5 Water Balance Results**

| | Basin A | | | Basin G | | | Rainwater Tanks (Basin A) | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Wet Year** | **Dry Year** | **Average Year** | **Wet Year** | **Dry Year** | **Average Year** | **Wet Year** | **Dry Year** | **Average Year** |
| **Re-Use Requested (ML/yr)**[3] | 63.7 | 79.1 | 67.5 | 86.5 | 107.4 | 91.7 | 36.2 | 39.5 | 37.0 |
| **Re-Use Supplied (ML/yr)** | 63.7 | 71.2 | 64.4 | 85.3 | 87.4 | 87.5 | 29.7 | 23.4 | 28.4 |
| **Deficit (ML/yr)** | 0.0 | 7.9 | 3.1 | 1.2 | 20.0 | 4.2 | 6.5 | 16.1 | 8.6 |
| **% Re-use Demand Met** | 100 | 90.0 | 95.3 | 98.7 | 81.3 | 95.4 | 82.0 | 59.1 | 76.6 |

The results shown in **Table 7-5** suggest that the proposed stormwater harvesting basins will provide a reliable source of water for irrigation of public open space areas and the rainwater tanks will meet the majority of lot-scale re-use demands. The dry year results also suggest that the proposed harvesting measures will provide the majority of re-use demands under projected climate change conditions where annual rainfall totals are expected to decrease.

## 7.5 Flow Duration Assessment

Flow duration curves were generated for the existing and post-development MUSIC models using the same daily rainfall data as the water balance assessment (**Section 7.4**). Flow duration curves were also generated for a natural catchment of equivalent area but with zero imperviousness. **Figure 7-2** shows a

[3] The average external re-use rate is scaled based on daily PET – rainfall and thus varies based on the rainfall patterns of a particular year.

comparison of the generated curves with the flow duration targets from the Wianamatta-South Creek Guidelines (DPE, 2022).

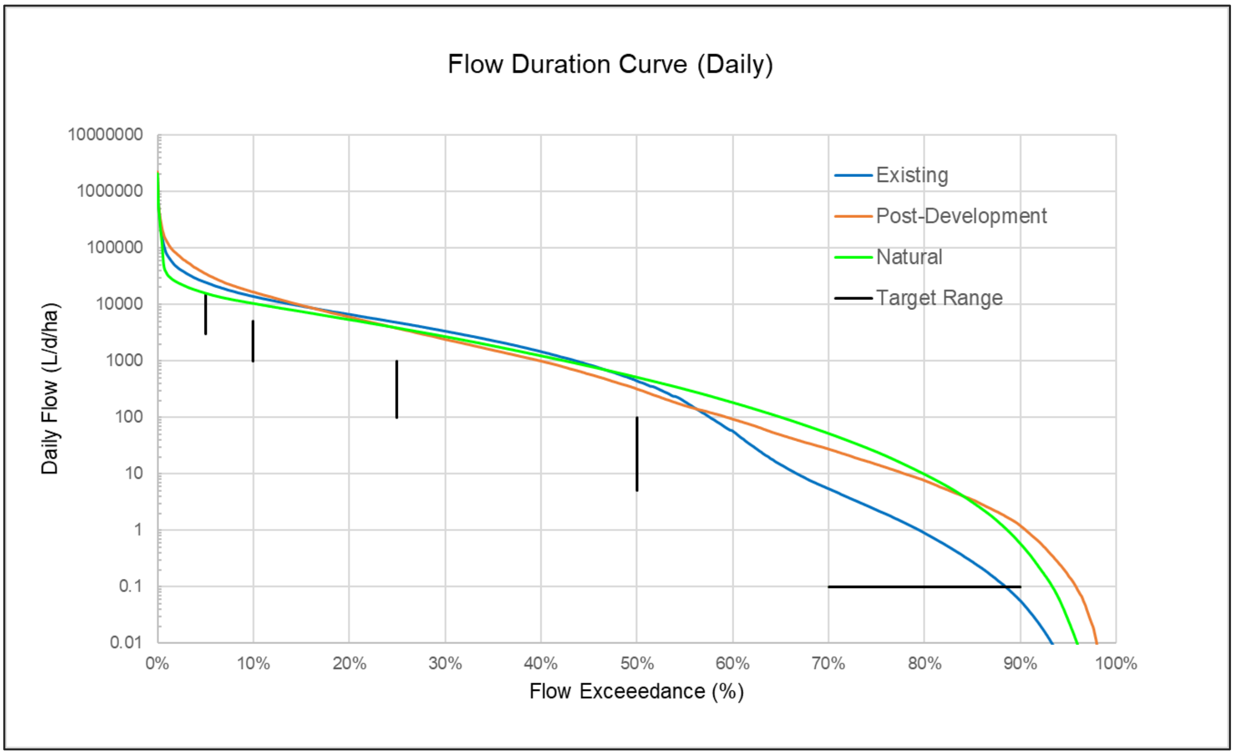



**Figure 7-2 Flow Duration Curve Comparison**

**Figure 7-2** shows that the flow duration curve for the overall site discharge is above the range required in the Wianamatta-South Creek Guidelines (DPE, 2022), including the curve from the natural/undeveloped catchment scenario.

The flow duration curve of the developed site is similar that of the existing site and of a natural catchment with an equivalent area and is therefore considered to meet the hydrological objectives for the development.

# 8 Riparian Corridors

## 8.1 Riparian Corridor Objectives

The core objectives for riparian corridors are:

- Land should be set aside for the provision of riparian corridors and establish formal creeks where they are currently ill-defined.
- Corridors provide an opportunity to better control flood flows that currently extend beyond existing top of banks.
- Riparian corridors should perform a broad range of environmental functions including:
  - Water quality improvements – shading of creeks reduces water temperature, vegetation provides an additional filter for surface flows discharged to the watercourses
  - Wildlife corridor – a linkage for fauna to utilise.

## 8.2 Requirements under the Water Management Act (2000)

DPE Water (formerly the Natural Resource Access Regulator) is responsible for matters under the *Water Management Act*, 2000 (WM Act) and associated regulation. The management of development on waterfront land (being that land within 40 m of the top of the highest bank of an identified waterway) is the subject of Part 3 of the WM Act.

In support of this Act, DPE Water has prepared *Guidelines for Riparian Corridors* (DPE Water, 2018). These guidelines describe the use of the 'Strahler' system for stream ordering to identify the width of riparian corridor (referred to as vegetated riparian zone or VRZ) that is required to be associated with an identified waterway. Schedule 2 of the WM (General) Regulation (2018) indicates that Strahler stream ordering should be undertaken using the hydroline dataset, being an online geographical information system.

VRZ requirements are specified in Table 1 of DPE Water (2018) and reproduced in **Table 8-1**.

**Table 8-1 Recommended Riparian Corridor Widths (Source: DPE Water, 2018)**

| Watercourse type | VRZ width (each side of watercourse) | Total RC width |
|---|---|---|
| **1st order** | 10 metres | 20 metres + channel width |
| **2nd order** | 20 metres | 40 metres + channel width |
| **3rd order** | 30 metres | 60 metres + channel width |
| **4th order and greater** | 40 metres | 80 metres + channel width |

*Note: Where a watercourse does not exhibit the features of a defined channel with bed and banks, DPE Water may determine that the watercourse is not waterfront land for the purposes of the WM Act.*

## 8.3 Riparian Corridor Design

A waterway and riparian corridor concept design was prepared using general natural channel design principles with the intention to meet the objectives listed in **Section 8.1**.

A cross section of the concept developed is shown in **Figure 8-1**. **Figure 8-2** shows the extent of the proposed riparian corridors based on the Strahler stream order and noting that the northern mapped watercourse extending from the A J Bush and Sons site would be eligible for declassification based on a review of LiDAR topographical data.

The design cross section for waterways has the following key features:

- Retention of existing watercourse bed levels where possible

- Low flow channel to convey 50% AEP flows – 1:3 bank slopes with a 2m bed width and 1m depth.
- High-flow channel component to convey flows up to the 0.2% AEP – 1:6 bank slopes.
- Freeboard component to assist in conveying PMF flows and provide 0.5m freeboard above 0.2% AEP flood levels – 1:8 bank slopes.

It has been assumed that the corridor would be vegetated with appropriate local plant species at a relatively dense planting scale to achieve biodiversity and flood hydraulics objectives.

Note that no corridor design or works are proposed for First Ponds Creek itself (for example as a half creek corridor) given the creek forms the Precinct north-western boundary. It has been assumed that this reach of the creek and its riparian area (being that portion located within the Precinct) would be the subject of a vegetation management plan.

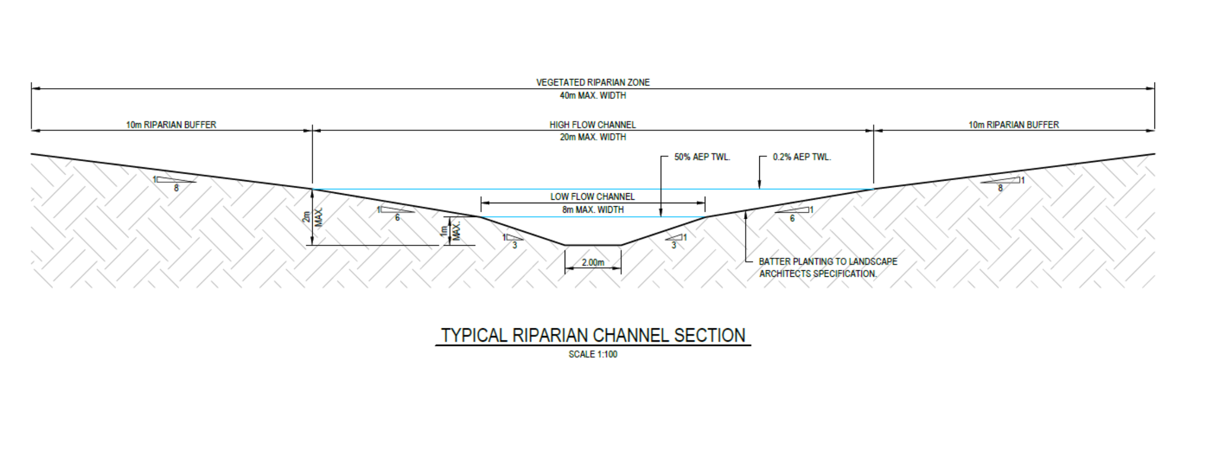



**Figure 8-1 Concept Riparian Corridor Cross Section**

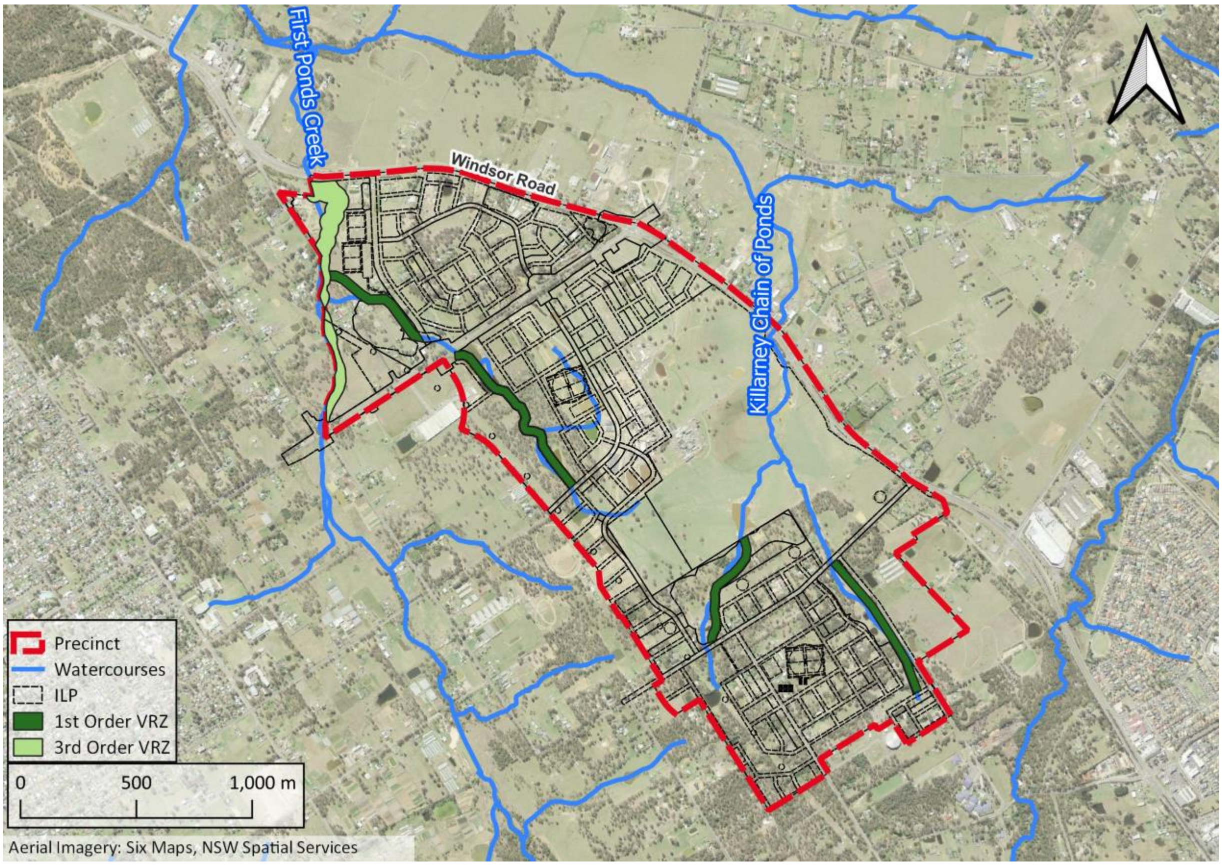



**Figure 8-2 Proposed Riparian Corridors**

# 9 Conclusion

A water cycle management strategy has been developed for the proposed re-zoning and development of per the Riverstone East Stage 3 Precinct.

Hydrologic, hydraulic and water quality modelling undertaken as part of the assessment revealed that stormwater quality, quantity and waterway health objectives can be achieved for the Precinct with the implementation of the following strategy:

- Provision of a suitably sized stormwater treatment train including lot scale and regional treatment measures to manage pollutant loading from the developed site. Additional on-lot treatment for medium and high-density residential zones would be required to achieve the pollutant reduction targets from the Wianamatta-South Creek Guidelines (DPE, 2022),
- Implementation of a stormwater harvesting system comprising lot scale rainwater tanks and regional harvesting ponds to reduce site discharge volumes and reliance on potable water,
- Provision of regional detention basins to limit post-development flows to pre-development levels for the Killarney Chain of Ponds catchments, and
- Establishment of defined riparian channels with appropriate planting to achieve both flood control and biodiversity functions.

# 10 References

Catchment Simulation Solutions (2021) *First Ponds Creek Flood Assessment*, Prepared for Blacktown City Council, Draft.

DPE (2022) *Technical guidance for achieving Wianamatta-South Creek stormwater management targets*, September 2022.

GHD (2008) *Alex Avenue and Riverstone Precincts – Water Sensitive Urban Design and Flooding Report*, Prepared for the Greater Cities Commission.

GHD (2010) *Alex Avenue and Riverstone Precincts – Post Exhibition Flooding and Water Cycle Management (incl. Climate Change impact on Flooding)*, Prepared for the Department of Planning and Environment.

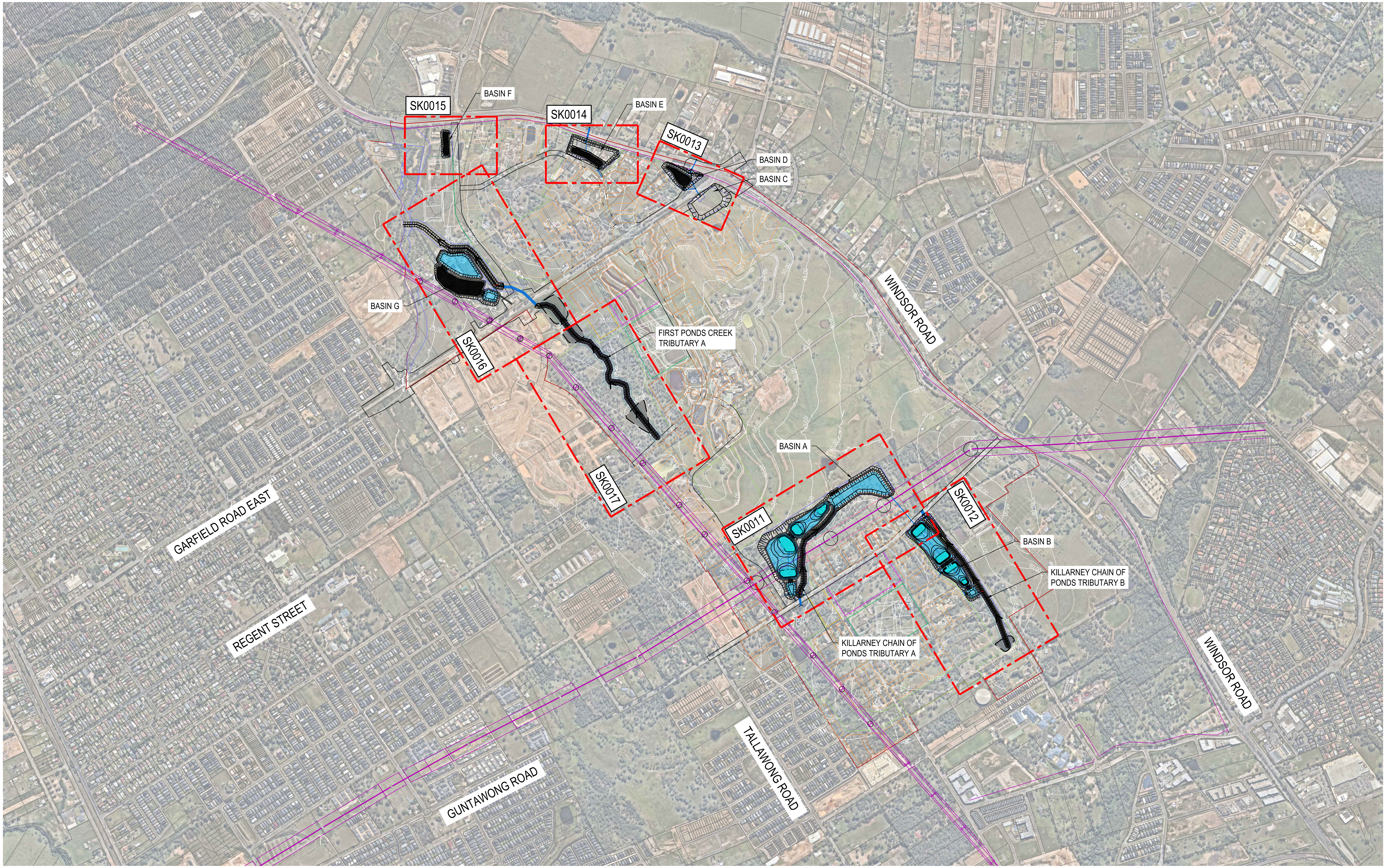
Mott Macdonald (2015) *Water Cycle Management Report – Riverstone East*, Prepared for the Department of Planning.

Mott Macdonald (2016) *Water Cycle Management Report – Riverstone East*, Prepared for the Department of Planning.

Water NSW (2023) *Using MUSIC in Sydney Drinking Water Catchment – A Water NSW Current Recommended Best Practice*, February 2023.

# Appendix A

Concept Water Cycle Management Drawings

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| 2 | 8/09/2023 | ISSUED FOR INFORMATION | SHH | | | CEV |
| 1 | 8/08/2023 | ISSUED FOR COORDINATION | SHH | | | CEV |

Client

Scale

0 150 300 450 600 750m

SCALE 1:7500 @A1

North

N



enspire

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Project
RIVERSTONE EAST
STAGE 3

Title
WATER CYCLE MANAGEMENT STRATEGY
GENERAL ARRANGEMENT PLAN

Scale 1:7500
Date 08/08/2023
Size A1
Datum MGA94

Status
FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number
SK0010-220121-00

Revision
3

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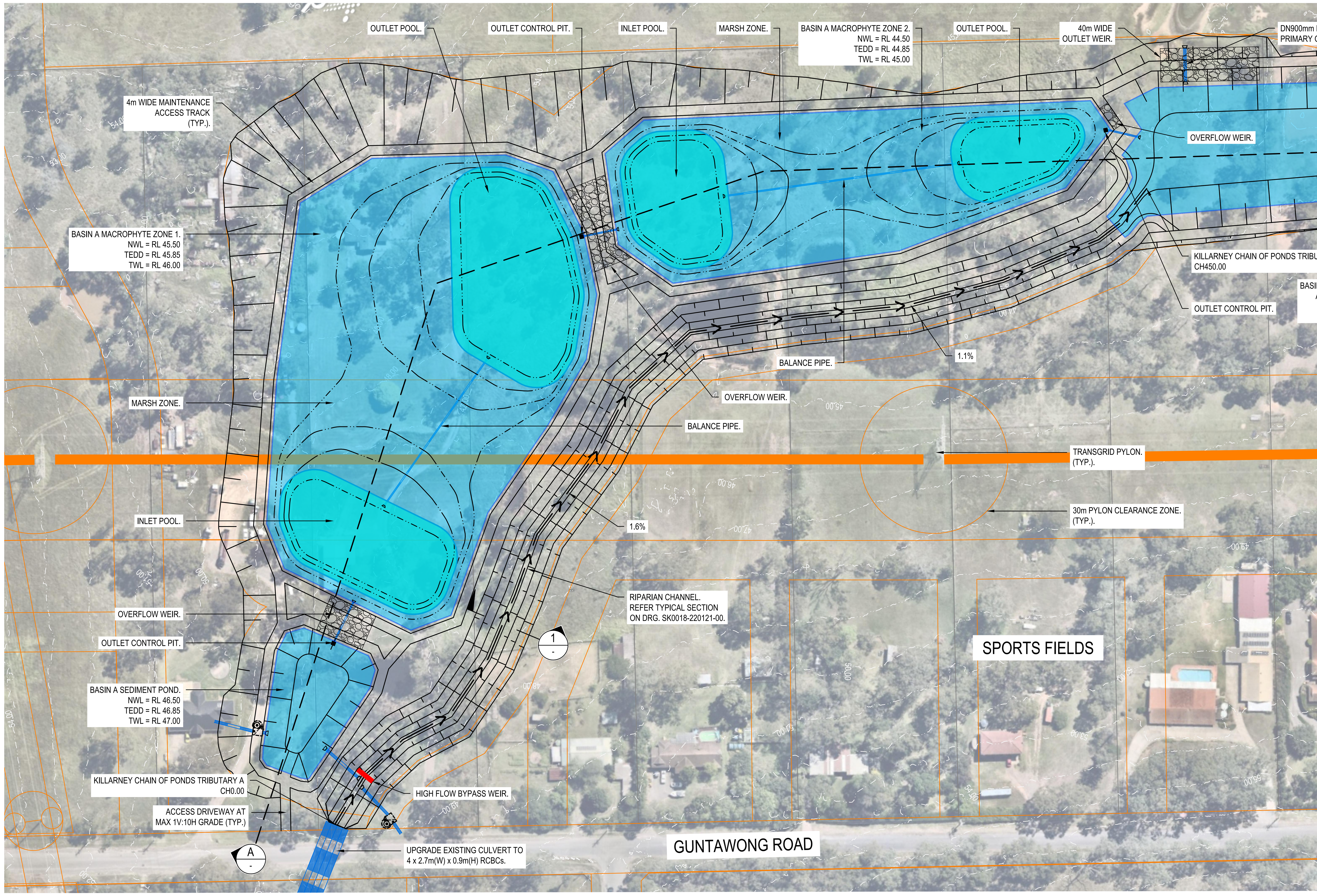
DATE PLOTTED: 15 September 2023 8:59 AM BY : SHAWN HOTONG

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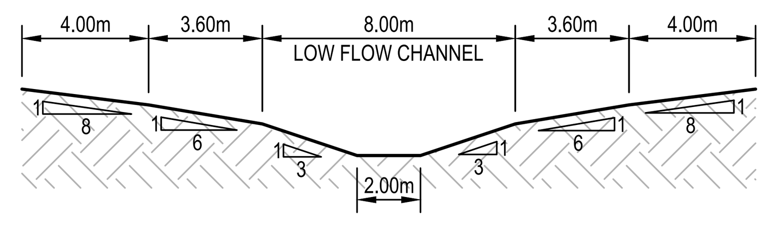


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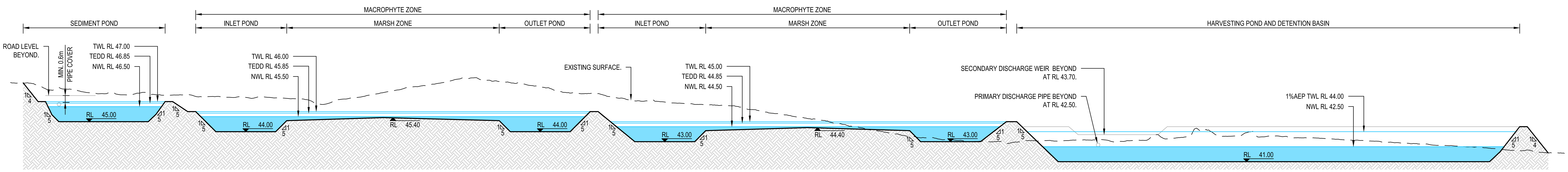
## NOTES:

1. REFER DRG. SK0018-220121-00 FOR TYPICAL DETAILS OF RIPARIAN CHANNELS, SEDIMENT PONDS, WETLANDS AND BIORETENTION BASINS.
2. GROSS POLLUTANT TRAPS TO BE PROVIDED ON ALL LOCAL DRAINAGE LINES PRIOR TO OUTLET INTO RIPARIAN CORRIDORS/BASINS.

## LEGEND

- EXISTING SURFACE CONTOUR
- BATTER
- SURFACE FALL (1.0%)
- STORMWATER DRAINAGE LINE
- SURFACE INLET PIT/JUNCTION PIT
- INLET / OUTLET POND
- WATER BODY
- BIORETENTION MEDIA
- GROSS POLLUTANT TRAP
- RIPARIAN CHANNEL INVERT
- INDICATIVE LAYOUT PLAN
- GARFIELD ROAD EAST CONCEPT UPGRADE

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| 2 | 8/09/2023 | ISSUED FOR INFORMATION | SHH | | | CEV |
| 1 | 8/08/2023 | ISSUED FOR COORDINATION | SHH | | | CEV |

Client

Scale: SCALE 1:200 (0, 5, 10, 15, 20m) @A1; SCALE 1:1000 (0, 20, 40, 60, 80, 100m) @A1

North



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Project: RIVERSTONE EAST STAGE 3

Title: WATER CYCLE MANAGEMENT STRATEGY
BASIN A & KILLARNEY CHAIN OF PONDS TRIBUTARY A

Scale: AS SHOWN
Date: 08/08/2023
Size: A1
Datum: MGA94

Status: FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: SK0011-220121-00
Revision: 4

DATE PLOTTED: 15 September 2023 3:04 PM BY : SHAWN HOTONG

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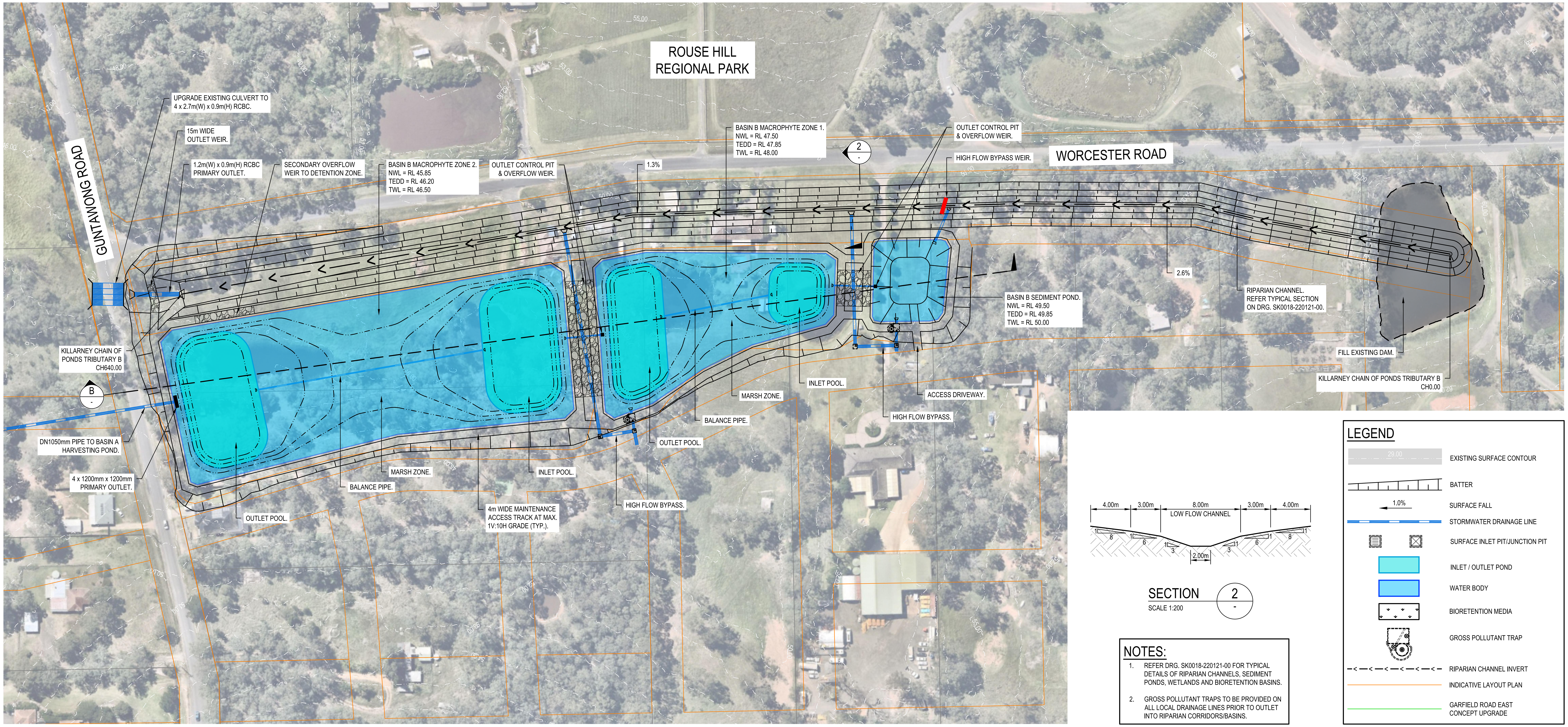


## SITE PLAN
SCALE 1:1000

4.00m | 3.00m | 8.00m LOW FLOW CHANNEL | 3.00m | 4.00m | 2.00m

## SECTION 2
SCALE 1:200

## NOTES:
1. REFER DRG. SK0018-220121-00 FOR TYPICAL DETAILS OF RIPARIAN CHANNELS, SEDIMENT PONDS, WETLANDS AND BIORETENTION BASINS.
2. GROSS POLLUTANT TRAPS TO BE PROVIDED ON ALL LOCAL DRAINAGE LINES PRIOR TO OUTLET INTO RIPARIAN CORRIDORS/BASINS.

## LEGEND
- EXISTING SURFACE CONTOUR
- BATTER
- SURFACE FALL (1.0%)
- STORMWATER DRAINAGE LINE
- SURFACE INLET PIT/JUNCTION PIT
- INLET / OUTLET POND
- WATER BODY
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- GROSS POLLUTANT TRAP
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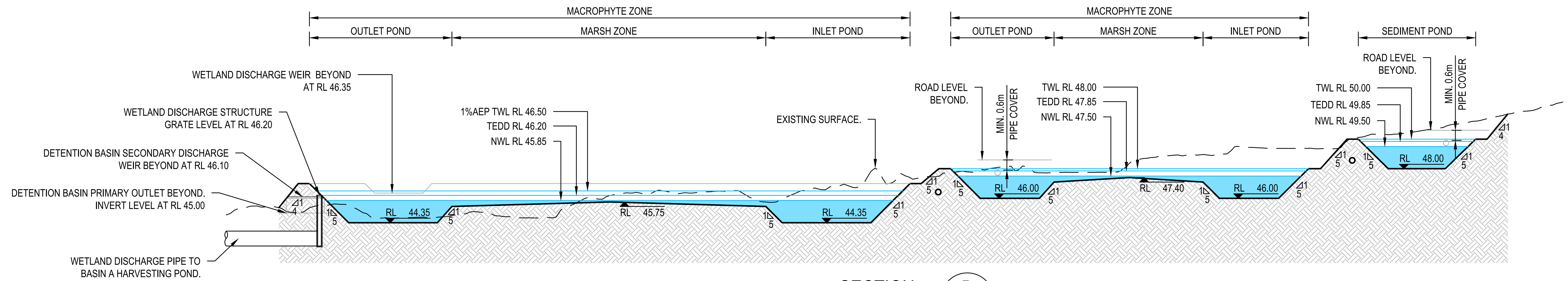
- INDICATIVE LAYOUT PLAN
- GARFIELD ROAD EAST CONCEPT UPGRADE




## SECTION B
SCALE (H) 1:1000
SCALE (V) 1:200

| REV. | DATE | DESCRIPTION | DRN. | DES. | VERIF. | APPD. |
|---|---|---|---|---|---|---|
| 4 | 15/09/2023 | ISSUED FOR INFORMATION | SHH | JPS | LCC | CEV |
| 3 | 15/09/2023 | ISSUED FOR INFORMATION | SHH | JPS | LCC | CEV |
| 2 | 8/09/2023 | ISSUED FOR INFORMATION | SHH | | | CEV |
| 1 | 8/08/2023 | ISSUED FOR COORDINATION | SHH | | | CEV |

Client

Scale: SCALE 1:200 (0, 5, 10, 15, 20m) @A1; SCALE 1:1000 (0, 20, 40, 60, 80, 100m) @A1

North



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Project: RIVERSTONE EAST STAGE 3

Title: WATER CYCLE MANAGEMENT STRATEGY BASIN B & KILLARNEY CHAIN OF PONDS TRIBUTARY B

Scale: AS SHOWN
Date: 08/08/2023
Size: A1
Datum: MGA94

Status: FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: SK0012-220121-00
Revision: 4

DATE PLOTTED: 15 September 2023 3:04 PM BY : SHAWN HOTONG

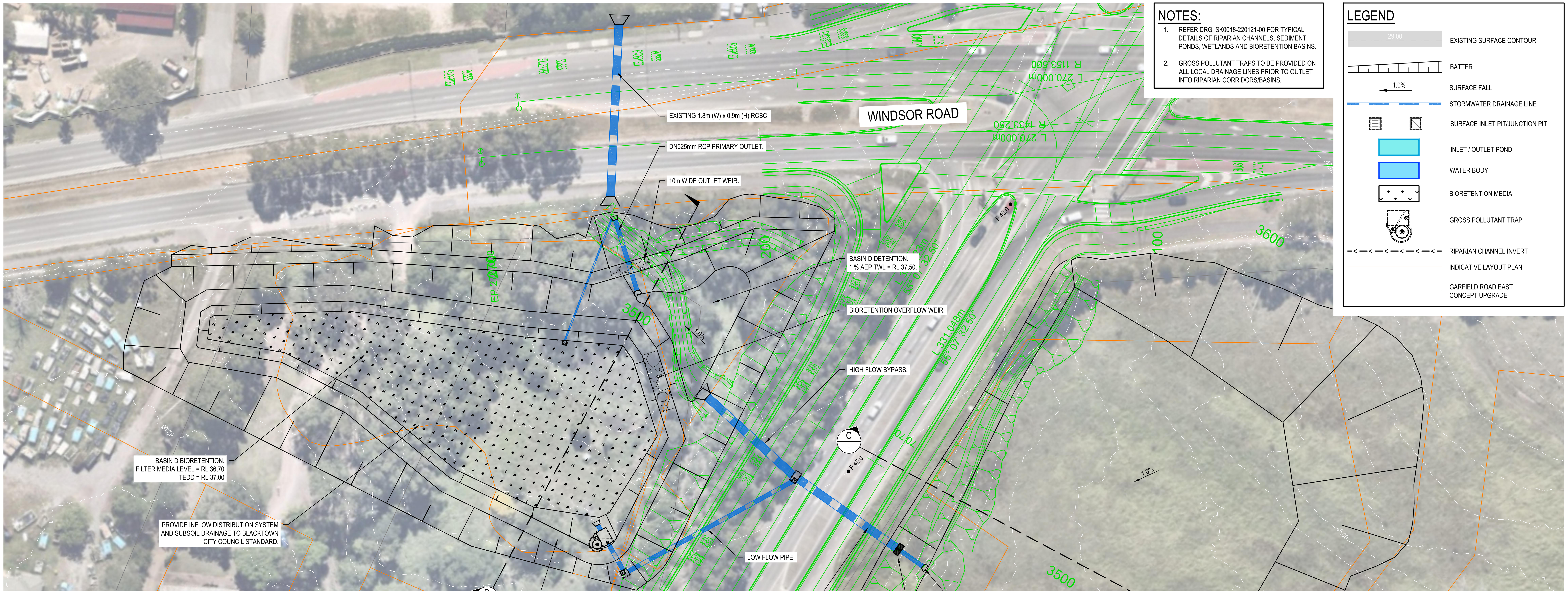
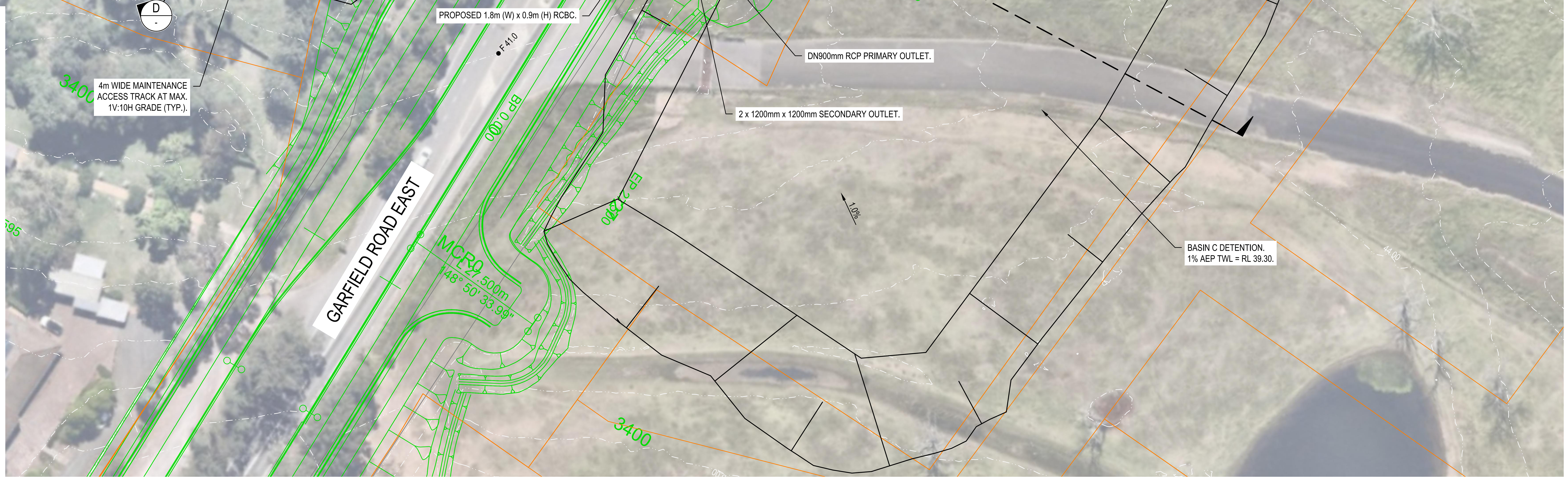
CAD File: P:\220121 RiverstoneEastStg3SAP\D-Civil\00-SiteWide\Drawings\4-Sketches\DWG\SK0011-SK0021-220121-00-Enspire-R04-230915-RiverstoneEastStg3WCMSPlans.dwg

## NOTES:

1. REFER DRG. SK0018-220121-00 FOR TYPICAL DETAILS OF RIPARIAN CHANNELS, SEDIMENT PONDS, WETLANDS AND BIORETENTION BASINS.
2. GROSS POLLUTANT TRAPS TO BE PROVIDED ON ALL LOCAL DRAINAGE LINES PRIOR TO OUTLET INTO RIPARIAN CORRIDORS/BASINS.

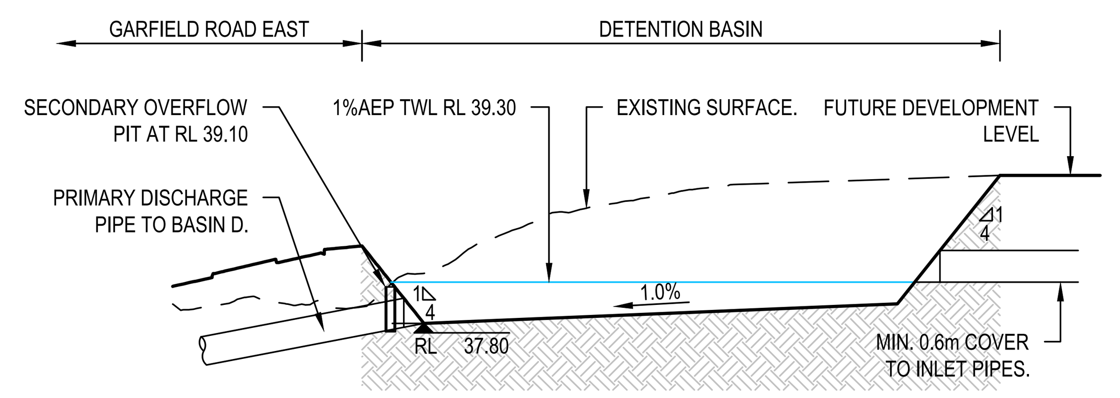
## LEGEND

- EXISTING SURFACE CONTOUR
- BATTER
- SURFACE FALL
- STORMWATER DRAINAGE LINE
- SURFACE INLET PIT/JUNCTION PIT
- INLET / OUTLET POND
- WATER BODY
- BIORETENTION MEDIA
- GROSS POLLUTANT TRAP
- RIPARIAN CHANNEL INVERT
- INDICATIVE LAYOUT PLAN
- GARFIELD ROAD EAST CONCEPT UPGRADE

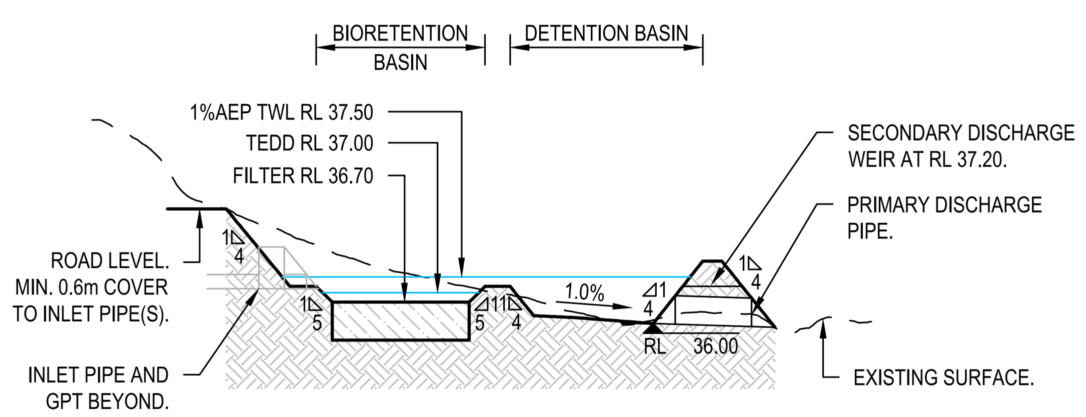




SITE PLAN
SCALE 1:500

SCALE 1:200 @A1




SECTION C
SCALE (H) 1:1000
SCALE (V) 1:200




SECTION D
SCALE (H) 1:1000
SCALE (V) 1:200

| REV. | DATE | DESCRIPTION | DRN. | DES. | VERIF. | APPD. |
|---|---|---|---|---|---|---|
| 4 | 15/09/2023 | ISSUED FOR INFORMATION | SHH | JPS | LCC | CEV |
| 3 | 15/09/2023 | ISSUED FOR INFORMATION | SHH | JPS | LCC | CEV |
| 2 | 8/09/2023 | ISSUED FOR INFORMATION | SHH | | | CEV |
| 1 | 8/08/2023 | ISSUED FOR COORDINATION | SHH | | | CEV |

Client

Scale: SCALE 1:500 @A1; SCALE 1:1000 @A1

North



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Project: RIVERSTONE EAST STAGE 3

Title: WATER CYCLE MANAGEMENT STRATEGY BASIN C AND BASIN D

Scale: AS SHOWN
Date: 08/08/2023
Size: A1
Datum: MGA94

Status: FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: SK0013-220121-00
Revision: 4

DATE PLOTTED: 15 September 2023 3:05 PM BY : SHAWN HOTONG

CAD File: P:\220121 RiverstoneEastStg3SAP\D-Civil\00-SiteWide\Drawings\4-Sketches\DWG\SK0011-SK0021-220121-00-Enspire-R04-230915-RiverstoneEastStg3WCMSPlans.dwg


## NOTES:

1. REFER DRG. SK0018-220121-00 FOR TYPICAL DETAILS OF RIPARIAN CHANNELS, SEDIMENT PONDS, WETLANDS AND BIORETENTION BASINS.
2. GROSS POLLUTANT TRAPS TO BE PROVIDED ON ALL LOCAL DRAINAGE LINES PRIOR TO OUTLET INTO RIPARIAN CORRIDORS/BASINS.

## LEGEND

- EXISTING SURFACE CONTOUR
- BATTER
- SURFACE FALL
- STORMWATER DRAINAGE LINE
- SURFACE INLET PIT/JUNCTION PIT
- INLET / OUTLET POND
- WATER BODY
- BIORETENTION MEDIA
- GROSS POLLUTANT TRAP
- RIPARIAN CHANNEL INVERT
- INDICATIVE LAYOUT PLAN
- GARFIELD ROAD EAST CONCEPT UPGRADE

BIORETENTION BASIN
DETENTION BASIN
1%AEP TWL RL 33.00
TEDD RL 32.50
FILTER RL 32.20
RL 31.50
SECONDARY DISCHARGE WEIR AT RL 32.60.
PRIMARY DISCHARGE PIPE.
ROAD LEVEL. MIN. 0.6m COVER TO INLET PIPE(S).
INLET PIPE AND GPT BEYOND.
1.0%
EXISTING SURFACE.

SECTION E
SCALE (H) 1:1000
SCALE (V) 1:200

SITE PLAN
SCALE 1:500

SCALE 1:200 @A1

| REV. | DATE | DESCRIPTION | DRN. | DES. | VERIF. | APPD. |
|---|---|---|---|---|---|---|
| 4 | 15/09/2023 | ISSUED FOR INFORMATION | SHH | JPS | LCC | CEV |
| 3 | 15/09/2023 | ISSUED FOR INFORMATION | SHH | JPS | LCC | CEV |
| 2 | 8/09/2023 | ISSUED FOR INFORMATION | SHH | | | CEV |
| 1 | 8/08/2023 | ISSUED FOR COORDINATION | SHH | | | CEV |

Client

Scale: SCALE 1:500 @A1; SCALE 1:1000 @A1

North



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Project: RIVERSTONE EAST STAGE 3

Title: WATER CYCLE MANAGEMENT STRATEGY BASIN E

Scale: AS SHOWN
Date: 08/08/2023
Size: A1
Datum: MGA94

Status: FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: SK0014-220121-00
Revision: 4

DATE PLOTTED: 15 September 2023 3:05 PM BY : SHAWN HOTONG

CAD File: P:\220121 RiverstoneEastStg3SAP\D-Civil\00-SiteWide\Drawings\4-Sketches\DWG\SK0011-SK0021-220121-00-Enspire-R04-230915-RiverstoneEastStg3WCMSPlans.dwg


## NOTES:

1. REFER DRG. SK0018-220121-00 FOR TYPICAL DETAILS OF RIPARIAN CHANNELS, SEDIMENT PONDS, WETLANDS AND BIORETENTION BASINS.
2. GROSS POLLUTANT TRAPS TO BE PROVIDED ON ALL LOCAL DRAINAGE LINES PRIOR TO OUTLET INTO RIPARIAN CORRIDORS/BASINS.

## LEGEND

- EXISTING SURFACE CONTOUR
- BATTER
- SURFACE FALL (1.0%)
- STORMWATER DRAINAGE LINE
- SURFACE INLET PIT/JUNCTION PIT
- INLET / OUTLET POND
- WATER BODY
- BIORETENTION MEDIA
- GROSS POLLUTANT TRAP
- RIPARIAN CHANNEL INVERT
- INDICATIVE LAYOUT PLAN
- GARFIELD ROAD EAST CONCEPT UPGRADE



SECTION F -
SCALE (H) 1:1000
SCALE (V) 1:200

0 5 10 15 20m
SCALE 1:200 @A1

SITE PLAN
SCALE 1:500

| REV. | DATE | DESCRIPTION | DRN. | DES. | VERIF. | APPD. |
|---|---|---|---|---|---|---|
| 4 | 15/09/2023 | ISSUED FOR INFORMATION | SHH | JPS | LCC | CEV |
| 3 | 15/09/2023 | ISSUED FOR INFORMATION | SHH | JPS | LCC | CEV |
| 2 | 8/09/2023 | ISSUED FOR INFORMATION | SHH | | | CEV |
| 1 | 8/08/2023 | ISSUED FOR COORDINATION | SHH | | | CEV |

Client

Scale
0 10 20 30 40 50m
SCALE 1:500 @A1
0 20 40 60 80 100m
SCALE 1:1000 @A1

North: N



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Project: RIVERSTONE EAST STAGE 3
Title: WATER CYCLE MANAGEMENT STRATEGY BASIN F

Scale: AS SHOWN
Date: 08/08/2023
Size: A1
Datum: MGA94

Status: FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: SK0015-220121-00
Revision: 4

DATE PLOTTED: 15 September 2023 3:05 PM BY : SHAWN HOTONG

CAD File: P:\220121 RiverstoneEastStg3SAP\D-Civil\00-SiteWide\Drawings\4-Sketches\DWG\SK0011-SK0021-220121-00-Enspire-R04-230915-RiverstoneEastStg3WCMSPlans.dwg

## LEGEND

- 29.00 — EXISTING SURFACE CONTOUR
- BATTER
- 1.0% — SURFACE FALL
- STORMWATER DRAINAGE LINE
- SURFACE INLET PIT/JUNCTION PIT
- INLET / OUTLET POND
- WATER BODY
- BIORETENTION MEDIA
- GROSS POLLUTANT TRAP
- RIPARIAN CHANNEL INVERT
- INDICATIVE LAYOUT PLAN
- GARFIELD ROAD EAST CONCEPT UPGRADE

## NOTES:

1. REFER DRG. SK0018-220121-00 FOR TYPICAL DETAILS OF RIPARIAN CHANNELS, SEDIMENT PONDS, WETLANDS AND BIORETENTION BASINS.
2. GROSS POLLUTANT TRAPS TO BE PROVIDED ON ALL LOCAL DRAINAGE LINES PRIOR TO OUTLET INTO RIPARIAN CORRIDORS/BASINS.


SITE PLAN
SCALE 1:1000

SECTION 3 -
SCALE 1:200

SECTION 4 -
SCALE 1:200

SECTION G -
SCALE (H) 1:1000
SCALE (V) 1:200

| REV. | DATE | DESCRIPTION | DRN. | DES. | VERIF. | APPD. |
|---|---|---|---|---|---|---|
| 4 | 15/09/2023 | ISSUED FOR INFORMATION | SHH | JPS | LCC | CEV |
| 3 | 15/09/2023 | ISSUED FOR INFORMATION | SHH | JPS | LCC | CEV |
| 2 | 8/09/2023 | ISSUED FOR INFORMATION | SHH | | | CEV |
| 1 | 8/08/2023 | ISSUED FOR COORDINATION | SHH | | | CEV |

Client

Scale: SCALE 1:200 @A1 (0 5 10 15 20m); SCALE 1:1000 @A1 (0 20 40 60 80 100m)

North



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Project: RIVERSTONE EAST STAGE 3

Title: WATER CYCLE MANAGEMENT STRATEGY BASIN G & FIRST PONDS CREEK TRIBUTARY A SHEET 01

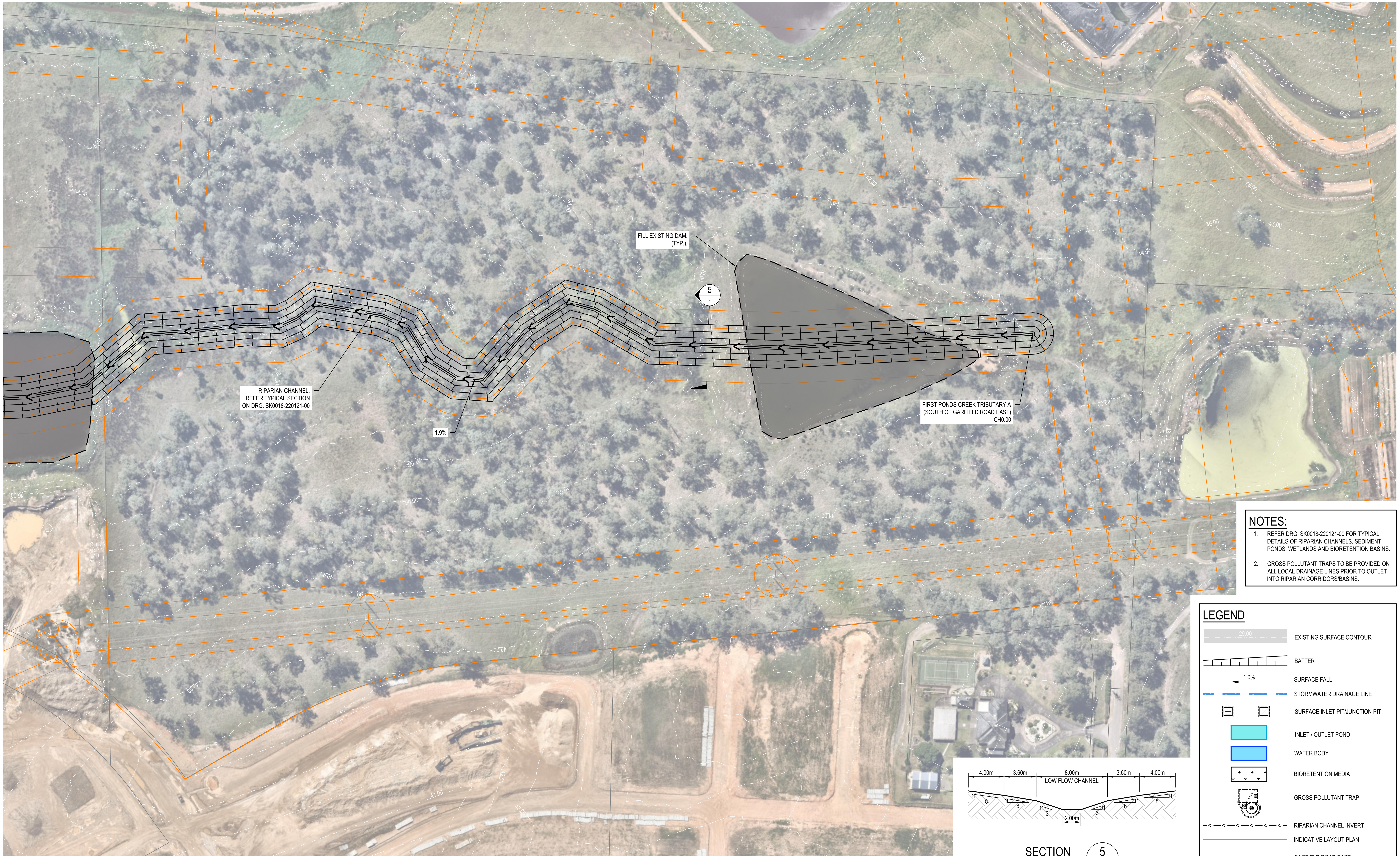
Scale: AS SHOWN
Date: 08/08/2023
Size: A1
Datum: MGA94

Status: FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: SK0016-220121-00
Revision: 4

DATE PLOTTED: 15 September 2023 3:05 PM BY : SHAWN HOTONG

CAD File: P:\220121 RiverstoneEastStg3SAP\D-Civil\00-SiteWide\Drawings\4-Sketches\DWG\SK0011-SK0021-220121-00-Enspire-R04-230915-RiverstoneEastStg3WCMSPlans.dwg




## SITE PLAN

SCALE 1:1000

## NOTES:

1. REFER DRG. SK0018-220121-00 FOR TYPICAL DETAILS OF RIPARIAN CHANNELS, SEDIMENT PONDS, WETLANDS AND BIORETENTION BASINS.
2. GROSS POLLUTANT TRAPS TO BE PROVIDED ON ALL LOCAL DRAINAGE LINES PRIOR TO OUTLET INTO RIPARIAN CORRIDORS/BASINS.

## LEGEND

- EXISTING SURFACE CONTOUR
- BATTER
- SURFACE FALL (1.0%)
- STORMWATER DRAINAGE LINE
- SURFACE INLET PIT/JUNCTION PIT
- INLET / OUTLET POND
- WATER BODY
- BIORETENTION MEDIA
- GROSS POLLUTANT TRAP
- RIPARIAN CHANNEL INVERT
- INDICATIVE LAYOUT PLAN
- GARFIELD ROAD EAST CONCEPT UPGRADE

4.00m | 3.60m | 8.00m LOW FLOW CHANNEL | 3.60m | 4.00m | 2.00m

## SECTION 5

SCALE 1:200

| REV. | DATE | DESCRIPTION | DRN. | DES. | VERIF. | APPD. |
|---|---|---|---|---|---|---|
| 4 | 15/09/2023 | ISSUED FOR INFORMATION | SHH | JPS | LCC | CEV |
| 3 | 15/09/2023 | ISSUED FOR INFORMATION | SHH | JPS | LCC | CEV |
| 2 | 8/09/2023 | ISSUED FOR INFORMATION | SHH | | | CEV |
| 1 | 8/08/2023 | ISSUED FOR COORDINATION | SHH | | | CEV |

Client

Scale: SCALE 1:200 @A1 (0, 5, 10, 15, 20m); SCALE 1:1000 @A1 (0, 20, 40, 60, 80, 100m)

North



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Project: RIVERSTONE EAST STAGE 3

Title: WATER CYCLE MANAGEMENT STRATEGY BASIN G & FIRST PONDS CREEK TRIBUTARY A SHEET 02

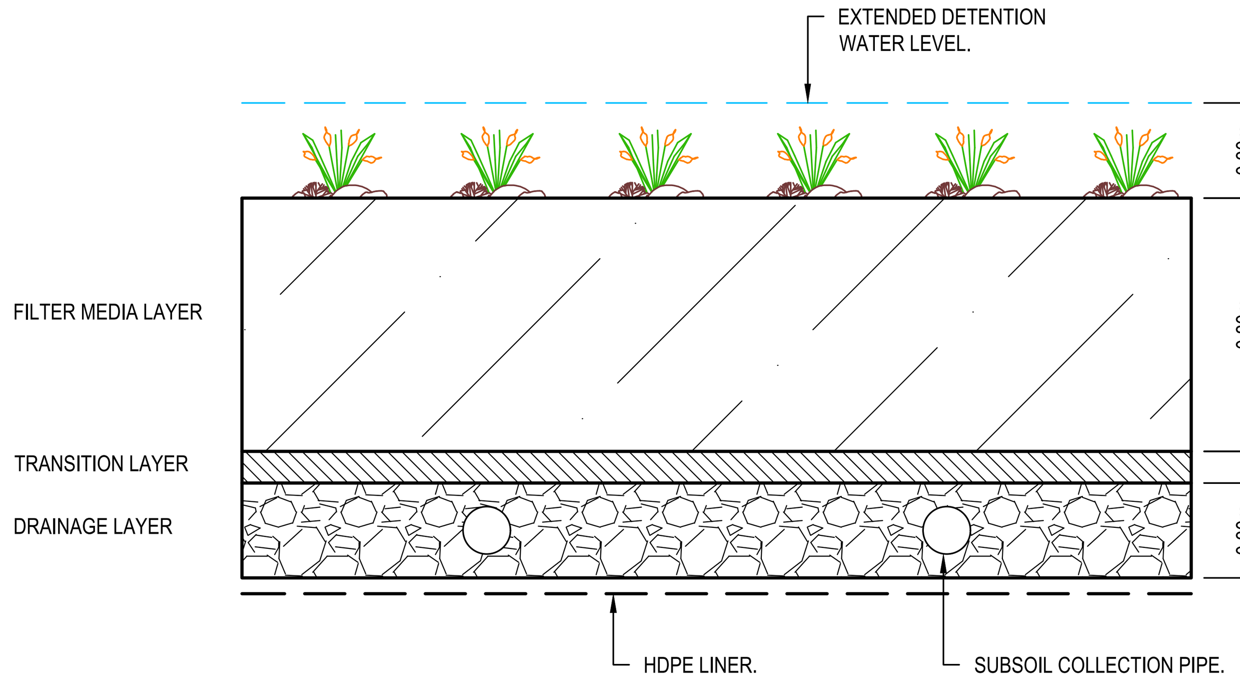
Scale: AS SHOWN
Date: 08/08/2023
Size: A1
Datum: MGA94

Status: FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: SK0017-220121-00
Revision: 4

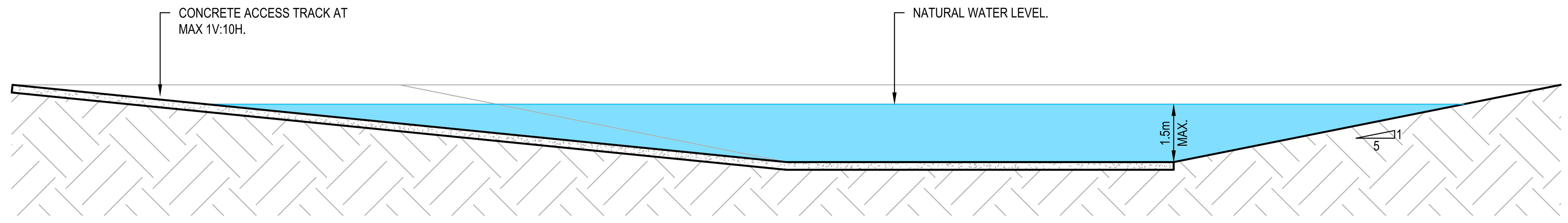
DATE PLOTTED: 15 September 2023 3:06 PM BY : SHAWN HOTONG

CAD File: P:\220121 RiverstoneEastStg3SAP\D-Civil\00-SiteWide\Drawings\4-Sketches\DWG\SK0011-SK0021-220121-00-Enspire-R04-230915-RiverstoneEastStg3WCMSPlans.dwg



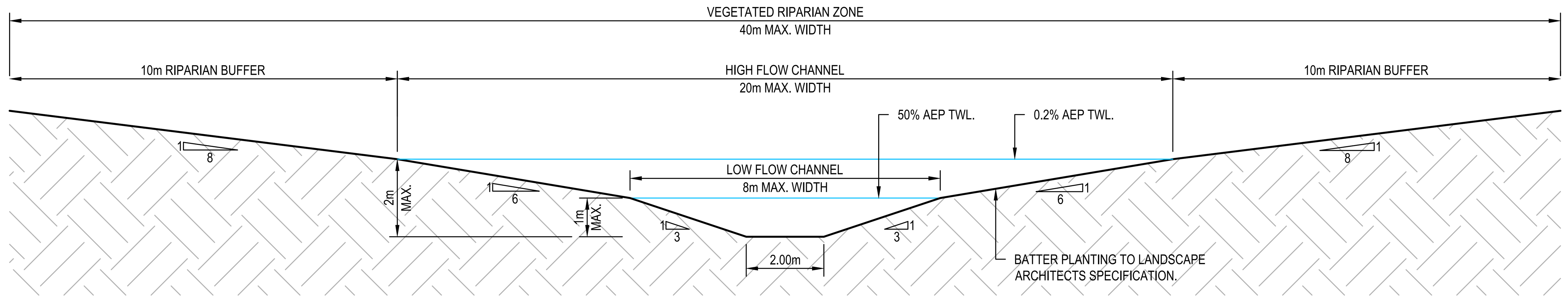

## TYPICAL BIORETENTION SECTION

SCALE 1:20



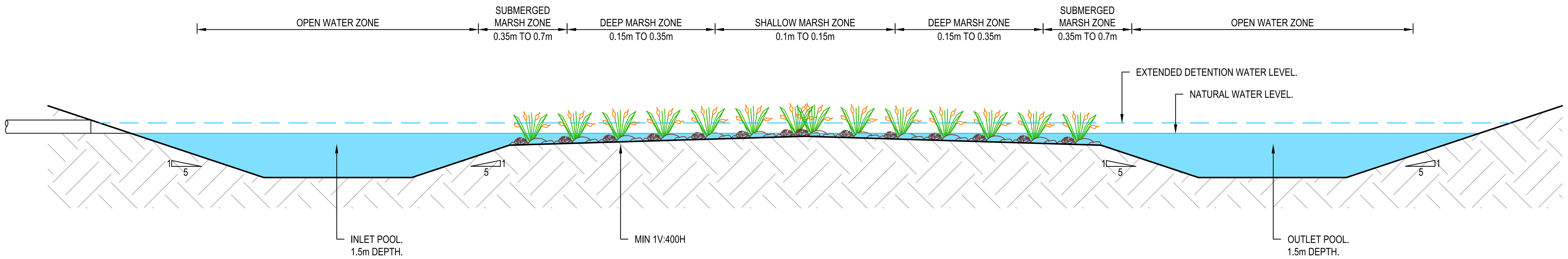

## TYPICAL SEDIMENT POND SECTION

SCALE 1:100




## TYPICAL RIPARIAN CHANNEL SECTION

SCALE 1:100




## TYPICAL MACROPHYTE ZONE SECTION

SCALE 1:100

| REV. | DATE | DESCRIPTION | DRN. | DES. | VERIF. | APPD. |
|---|---|---|---|---|---|---|
| 3 | 15/09/2023 | ISSUED FOR INFORMATION | SHH | JPS | LCC | CEV |
| 2 | 8/09/2023 | ISSUED FOR INFORMATION | SHH | | | CEV |
| 1 | 8/08/2023 | ISSUED FOR COORDINATION | SHH | | | CEV |

Client

Scale: SCALE 1:20 @A1 (0, 0.5, 1, 1.5, 2m); SCALE 1:100 @A1 (0, 1, 2, 4, 6, 8, 10m)

North



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Project: RIVERSTONE EAST STAGE 3

Title: WATER CYCLE MANAGEMENT STRATEGY TYPICAL DETAILS

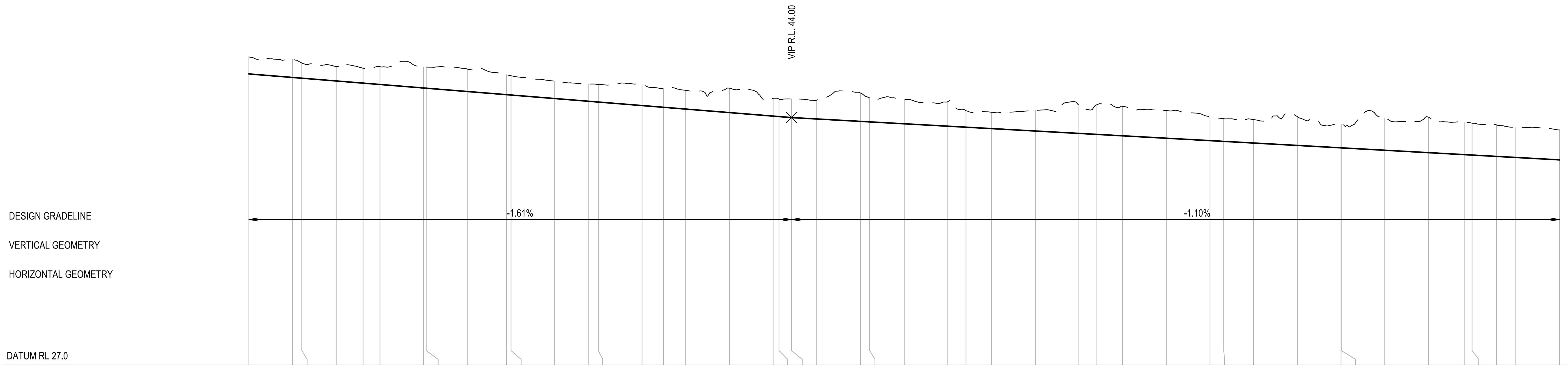
Scale: AS SHOWN
Date: 08/08/2023
Size: A1
Datum: MGA94

Status: FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: SK0018-220121-00
Revision: 3

CAD File: P:\220121 RiverstoneEastStg3SAP\D-Civil\00-SiteWide\Drawings\4-Sketches\DWG\SK0011-SK0021-220121-00-Enspire-R03-230915-RiverstoneEastStg3WCMSPlans.dwg

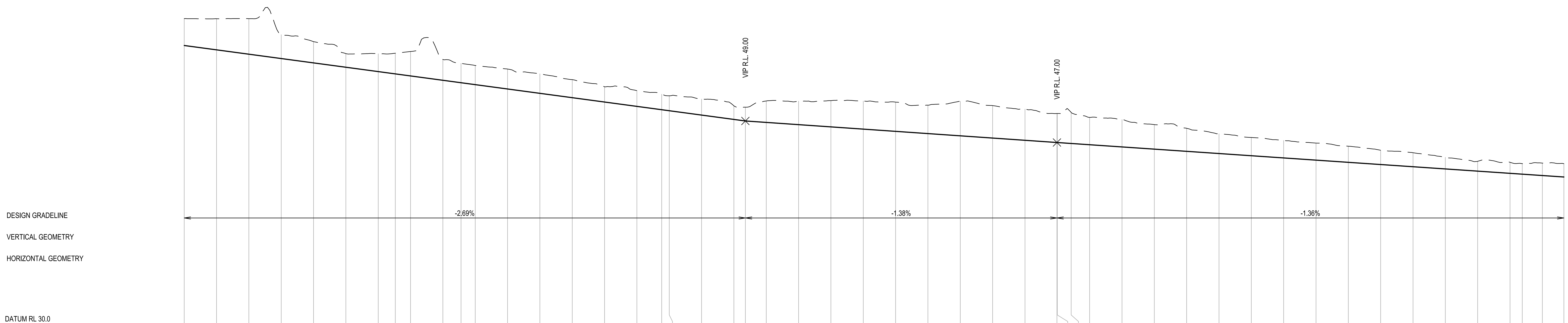
DATE PLOTTED: 15 September 2023 8:49 AM BY : SHAWN HOTONG




| CHAINAGE | FINISHED SURFACE | EXISTING SURFACE |
|---|---|---|
| 0.00 | 47.00 | 48.17 |
| 15.00 | 46.76 | 47.99 |
| 18.18 | 46.71 | 47.75 |
| 30.00 | 46.52 | 47.51 |
| 39.21 | 46.37 | 47.39 |
| 45.00 | 46.28 | 47.50 |
| 60.00 | 46.03 | 47.45 |
| 60.91 | 46.02 | 47.47 |
| 75.00 | 45.79 | 47.33 |
| 88.48 | 45.58 | 46.94 |
| 90.00 | 45.55 | 46.87 |
| 105.00 | 45.31 | 46.50 |
| 116.51 | 45.12 | 46.30 |
| 120.00 | 45.07 | 46.28 |
| 135.00 | 44.83 | 46.26 |
| 142.41 | 44.71 | 45.97 |
| 150.00 | 44.59 | 45.87 |
| 165.00 | 44.34 | 46.02 |
| 180.00 | 44.10 | 45.32 |
| 182.03 | 44.07 | 45.27 |
| 186.34 | 44.00 | 45.27 |
| 195.00 | 43.90 | 45.20 |
| 210.00 | 43.74 | 45.68 |
| 213.16 | 43.70 | 45.37 |
| 225.00 | 43.57 | 45.26 |
| 240.00 | 43.41 | 45.09 |
| 246.22 | 43.34 | 44.47 |
| 255.00 | 43.24 | 44.37 |
| 270.00 | 43.08 | 44.49 |
| 285.00 | 42.91 | 44.84 |
| 291.19 | 42.84 | 44.88 |
| 300.00 | 42.75 | 44.77 |
| 315.00 | 42.58 | 44.48 |
| 330.00 | 42.42 | 44.05 |
| 334.72 | 42.36 | 43.93 |
| 345.00 | 42.25 | 43.86 |
| 360.00 | 42.08 | 44.07 |
| 375.00 | 41.92 | 43.55 |
| 375.09 | 41.92 | 43.55 |
| 390.00 | 41.75 | 43.97 |
| 405.00 | 41.59 | 44.03 |
| 417.29 | 41.45 | 43.68 |
| 420.00 | 41.42 | 43.62 |
| 428.37 | 41.33 | 43.50 |
| 435.00 | 41.26 | 43.31 |
| 450.00 | 41.09 | 43.15 |

## KILLARNEY CHAIN OF PONDS TRIBUTARY A LONGITUDINAL SECTION

SCALE 1:1000 HORI
SCALE 1:200 VERT




| CHAINAGE | FINISHED SURFACE | EXISTING SURFACE |
|---|---|---|
| 0.00 | 56.00 | 58.50 |
| 15.00 | 55.60 | 58.49 |
| 30.00 | 55.19 | 58.49 |
| 45.00 | 54.79 | 57.00 |
| 60.00 | 54.39 | 56.36 |
| 75.00 | 53.98 | 55.24 |
| 90.00 | 53.58 | 55.23 |
| 97.94 | 53.37 | 55.28 |
| 105.00 | 53.18 | 55.44 |
| 120.00 | 52.77 | 54.71 |
| 128.41 | 52.55 | 54.34 |
| 135.00 | 52.37 | 54.15 |
| 150.00 | 51.97 | 53.82 |
| 165.00 | 51.56 | 53.38 |
| 180.00 | 51.16 | 52.84 |
| 195.00 | 50.76 | 52.17 |
| 210.00 | 50.35 | 51.81 |
| 221.50 | 50.04 | 51.48 |
| 225.00 | 49.95 | 51.33 |
| 240.00 | 49.55 | 51.02 |
| 255.00 | 49.14 | 50.41 |
| 260.31 | 49.00 | 50.28 |
| 270.00 | 48.87 | 50.86 |
| 285.00 | 48.66 | 50.84 |
| 300.00 | 48.45 | 50.89 |
| 315.00 | 48.24 | 50.84 |
| 330.00 | 48.04 | 50.75 |
| 345.00 | 47.83 | 50.46 |
| 360.00 | 47.62 | 50.82 |
| 375.00 | 47.41 | 50.43 |
| 390.00 | 47.21 | 50.10 |
| 404.83 | 47.00 | 49.69 |
| 405.00 | 47.00 | 49.69 |
| 411.44 | 46.91 | 49.80 |
| 420.00 | 46.79 | 49.33 |
| 435.00 | 46.59 | 49.12 |
| 450.00 | 46.39 | 48.66 |
| 465.00 | 46.18 | 48.32 |
| 480.00 | 45.98 | 47.81 |
| 495.00 | 45.77 | 47.47 |
| 510.00 | 45.57 | 47.19 |
| 525.00 | 45.37 | 46.95 |
| 540.00 | 45.16 | 46.65 |
| 555.00 | 44.96 | 46.28 |
| 570.00 | 44.76 | 46.06 |
| 585.00 | 44.55 | 45.63 |
| 600.00 | 44.35 | 45.26 |
| 615.00 | 44.14 | 45.17 |
| 620.68 | 44.07 | 45.04 |
| 630.00 | 43.94 | 45.09 |
| 640.00 | 43.80 | 45.04 |

## KILLARNEY CHAIN OF PONDS TRIBUTARY B LONGITUDINAL SECTION

SCALE 1:1000 HORI
SCALE 1:200 VERT

| REV. | DATE | DESCRIPTION | DRN. | DES. | VERIF. | APPD. |
|---|---|---|---|---|---|---|
| 1 | 15/09/2023 | ISSUED FOR INFORMATION | SHH | JPS | LCC | CEV |

Client

Scale: 0 5 10 15 20m — SCALE 1:200 @A1; 0 20 40 60 80 100m — SCALE 1:1000 @A1

North



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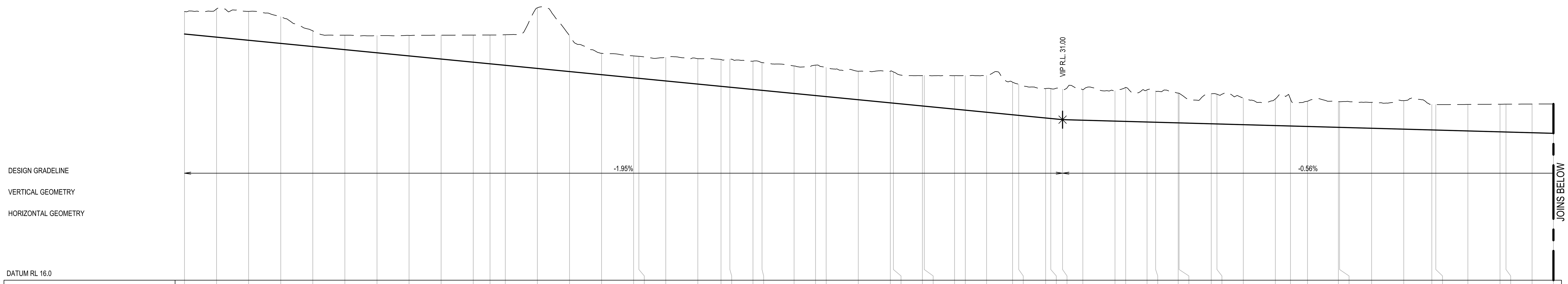
Phone: 02 9922 6135 enspiresolutions.com.au

Project: RIVERSTONE EAST STAGE 3
Title: WATER CYCLE MANAGEMENT STRATEGY RIPARIAN CHANNEL LONGSECTIONS SHEET 01
Scale: AS SHOWN
Date: 14/09/2023
Size: A1
Datum: MGA94
Status: FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION
Project Number/Drawing Number: SK0019-220121-00
Revision: 1

DATE PLOTTED: 15 September 2023 8:49 AM BY : SHAWN HOTONG

CAD File: P:\220121 RiverstoneEastStg3SAP\D-Civil\00-SiteWide\Drawings\4-Sketches\DWG\SK0011-SK0021-220121-00-Enspire-R03-230915-RiverstoneEastStg3WCMSPlans.dwg




DESIGN GRADELINE

VERTICAL GEOMETRY

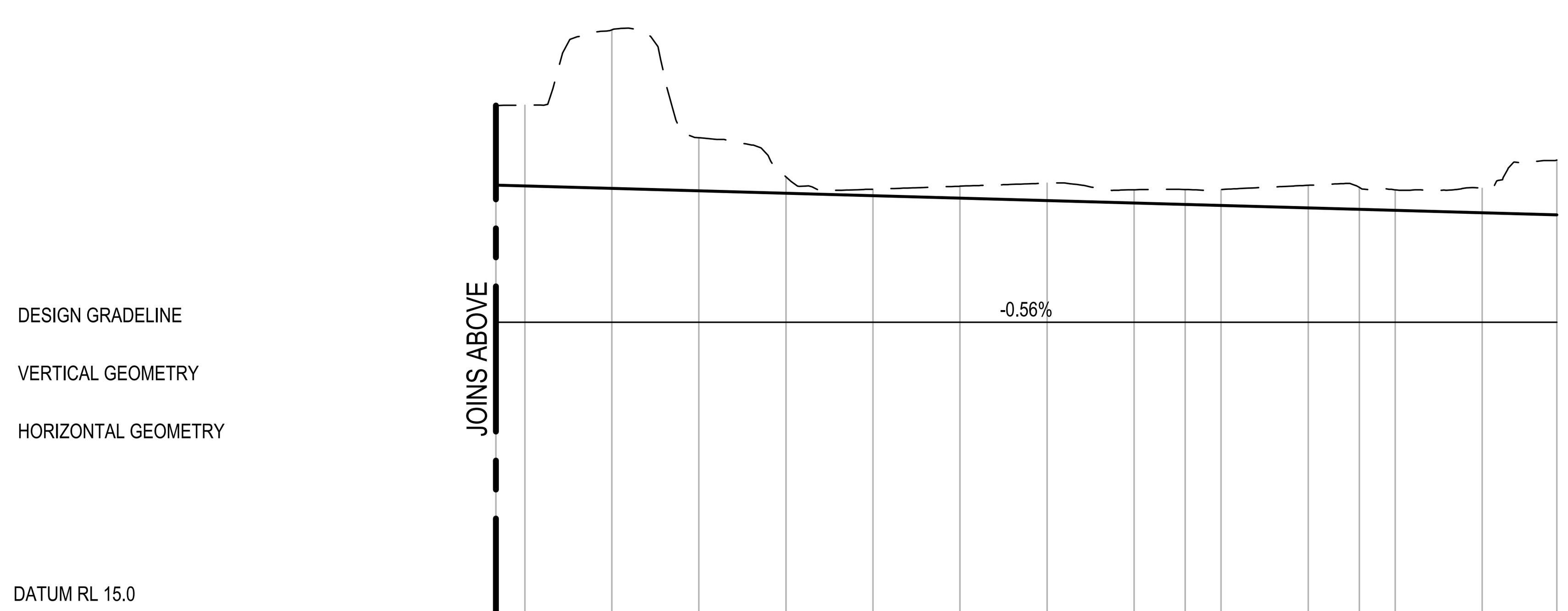
HORIZONTAL GEOMETRY

DATUM RL 16.0

| CHAINAGE | FINISHED SURFACE | EXISTING SURFACE |
|---|---|---|
| 0.00 | 39.00 | 41.11 |
| 15.00 | 38.71 | 41.35 |
| 30.00 | 38.42 | 41.12 |
| 45.00 | 38.12 | 40.62 |
| 60.00 | 37.83 | 39.30 |
| 75.00 | 37.54 | 38.89 |
| 90.00 | 37.25 | 38.85 |
| 105.00 | 36.95 | 38.87 |
| 120.00 | 36.66 | 38.89 |
| 135.00 | 36.37 | 38.90 |
| 142.85 | 36.22 | 38.91 |
| 150.00 | 36.08 | 38.93 |
| 165.00 | 35.78 | 41.45 |
| 180.00 | 35.49 | 38.85 |
| 195.00 | 35.20 | 37.20 |
| 210.00 | 34.91 | 36.96 |
| 212.44 | 34.86 | 36.92 |
| 225.00 | 34.62 | 36.82 |
| 240.00 | 34.32 | 36.70 |
| 250.84 | 34.11 | 36.62 |
| 255.00 | 34.03 | 36.65 |
| 265.76 | 33.82 | 36.47 |
| 270.00 | 33.74 | 36.34 |
| 285.00 | 33.45 | 36.02 |
| 295.02 | 33.25 | 36.10 |
| 300.00 | 33.15 | 35.88 |
| 315.00 | 32.86 | 35.52 |
| 330.00 | 32.57 | 35.53 |
| 331.42 | 32.54 | 35.46 |
| 345.00 | 32.28 | 35.12 |
| 345.89 | 32.26 | 35.14 |
| 360.00 | 31.98 | 35.11 |
| 365.06 | 31.89 | 35.11 |
| 375.00 | 31.69 | 35.11 |
| 387.14 | 31.46 | 34.50 |
| 390.00 | 31.40 | 34.31 |
| 402.60 | 31.15 | 33.90 |
| 405.00 | 31.11 | 33.90 |
| 410.52 | 31.00 | 33.83 |
| 420.00 | 30.95 | 33.81 |
| 435.00 | 30.86 | 33.69 |
| 440.03 | 30.84 | 34.01 |
| 450.00 | 30.78 | 33.78 |
| 454.03 | 30.76 | 33.66 |
| 464.56 | 30.70 | 33.48 |
| 465.00 | 30.70 | 33.46 |
| 480.00 | 30.61 | 33.43 |
| 482.67 | 30.60 | 33.38 |
| 495.00 | 30.53 | 33.01 |
| 510.00 | 30.45 | 32.94 |
| 517.04 | 30.41 | 32.93 |
| 525.00 | 30.36 | 32.73 |
| 539.46 | 30.28 | 32.69 |
| 540.00 | 30.28 | 32.67 |
| 555.00 | 30.19 | 32.62 |
| 570.00 | 30.11 | 32.78 |
| 583.14 | 30.04 | 32.42 |
| 585.00 | 30.03 | 32.41 |
| 600.00 | 29.94 | 32.42 |
| 615.00 | 29.86 | 32.44 |
| 617.83 | 29.84 | 32.45 |
| 630.00 | 29.78 | 32.46 |
| 640.00 | 29.72 | 32.47 |

## FIRST PONDS CREEK TRIBUTARY A (SOUTH OF GARFIELD ROAD EAST) LONGITUDINAL SECTION

SCALE 1:1000 HORI
SCALE 1:200 VERT




DESIGN GRADELINE

VERTICAL GEOMETRY

HORIZONTAL GEOMETRY

DATUM RL 15.0

| CHAINAGE | FINISHED SURFACE | EXISTING SURFACE |
|---|---|---|
| 640.00 | 29.72 | 32.47 |
| 645.00 | 29.69 | 32.48 |
| 660.00 | 29.61 | 35.08 |
| 675.00 | 29.52 | 31.35 |
| 690.00 | 29.44 | 30.01 |
| 705.00 | 29.36 | 29.58 |
| 720.00 | 29.27 | 29.69 |
| 735.00 | 29.19 | 29.79 |
| 750.00 | 29.11 | 29.57 |
| 758.82 | 29.06 | 29.57 |
| 765.00 | 29.02 | 29.57 |
| 780.00 | 28.94 | 29.72 |
| 788.82 | 28.89 | 29.65 |
| 795.00 | 28.86 | 29.56 |
| 810.00 | 28.77 | 29.62 |
| 822.83 | 28.70 | 30.58 |

## FIRST PONDS CREEK TRIBUTARY A (SOUTH OF GARFIELD ROAD EAST) LONGITUDINAL SECTION

SCALE 1:1000 HORI
SCALE 1:200 VERT

| REV. | DATE | DESCRIPTION | DRN. | DES. | VERIF. | APPD. |
|---|---|---|---|---|---|---|
| 1 | 15/09/2023 | ISSUED FOR INFORMATION | SHH | JPS | LCC | CEV |

Client

Scale 0 5 10 15 20m SCALE 1:200 @A1
0 20 40 60 80 100m SCALE 1:1000 @A1

North



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Enspire Solutions Pty Ltd
Level 4, 153 Walker Street, North Sydney NSW 2060
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Phone: 02 9922 6135
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Project: RIVERSTONE EAST STAGE 3

Title: WATER CYCLE MANAGEMENT STRATEGY RIPARIAN CHANNEL LONGSECTIONS SHEET 02

Scale: AS SHOWN
Date: 14/09/2023
Size: A1
Datum: MGA94

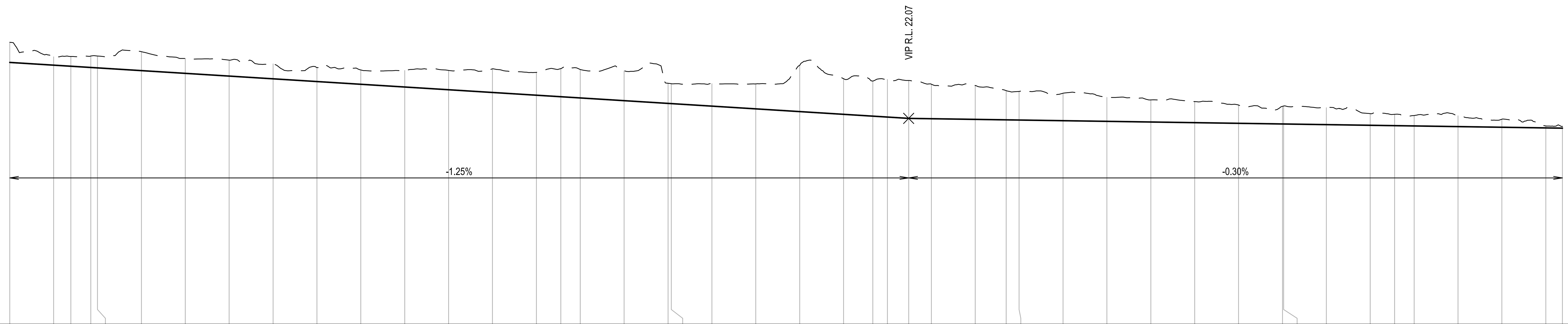
Status: FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: SK0020-220121-00

Revision: 1

DATE PLOTTED: 15 September 2023 8:49 AM BY : SHAWN HOTONG

CAD File: P:\220121 RiverstoneEastStg3SAP\D-Civil\00-SiteWide\Drawings\4-Sketches\DWG\SK0011-SK0021-220121-00-Enspire-R03-230915-RiverstoneEastStg3WCMSPlans.dwg




DESIGN GRADELINE

VERTICAL GEOMETRY

HORIZONTAL GEOMETRY

DATUM RL 8.0

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FINISHED SURFACE | 25.90 | 25.71 | 25.64 | 25.55 | 25.53 | 25.34 | 25.15 | 24.97 | 24.78 | 24.59 | 24.40 | 24.22 |
| EXISTING SURFACE | 27.27 | 26.27 | 26.30 | 26.33 | 26.33 | 26.63 | 26.17 | 26.05 | 25.79 | 25.55 | 25.38 | 25.35 |
| CHAINAGE | 0.00 | 15.00 | 20.87 | 27.68 | 30.00 | 45.00 | 60.00 | 75.00 | 90.00 | 105.00 | 120.00 | 135.00 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FINISHED SURFACE | 24.03 | 23.84 | 23.66 | 23.55 | 23.47 | 23.28 | 23.10 | 23.08 | 22.91 | 22.72 | 22.53 | 22.35 |
| EXISTING SURFACE | 25.35 | 25.45 | 25.22 | 25.47 | 25.41 | 25.32 | 24.47 | 24.44 | 24.44 | 24.43 | 25.71 | 24.78 |
| CHAINAGE | 150.00 | 165.00 | 180.00 | 188.35 | 195.00 | 210.00 | 225.00 | 226.11 | 240.00 | 255.00 | 270.00 | 285.00 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FINISHED SURFACE | 22.22 | 22.16 | 22.07 | 22.05 | 22.00 | 21.97 | 21.96 | 21.91 | 21.87 | 21.82 | 21.78 |
| EXISTING SURFACE | 24.62 | 24.73 | 24.66 | 24.41 | 24.32 | 23.97 | 23.91 | 23.79 | 23.50 | 23.33 | 23.22 |
| CHAINAGE | 294.99 | 300.00 | 307.25 | 315.00 | 330.00 | 340.59 | 345.00 | 360.00 | 375.00 | 390.00 | 405.00 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FINISHED SURFACE | 21.73 | 21.69 | 21.69 | 21.64 | 21.60 | 21.57 | 21.55 | 21.51 | 21.46 | 21.42 | 21.40 |
| EXISTING SURFACE | 22.98 | 22.89 | 22.92 | 22.80 | 22.39 | 22.35 | 22.27 | 22.25 | 22.01 | 21.55 | 21.53 |
| CHAINAGE | 420.00 | 435.00 | 435.38 | 450.00 | 465.00 | 473.35 | 480.00 | 495.00 | 510.00 | 525.00 | 530.68 |

## FIRST PONDS CREEK TRIBUTARY A (NORTH OF GARFIELD ROAD EAST) LONGITUDINAL SECTION

SCALE 1:1000 HORI
SCALE 1:200 VERT

| REV. | DATE | DESCRIPTION | DRN. | DES. | VERIF. | APPD. |
|---|---|---|---|---|---|---|
| 1 | 15/09/2023 | ISSUED FOR INFORMATION | SHH | JPS | LCC | CEV |

Client

Scale
0 5 10 15 20m
SCALE 1:200 @A1
0 20 40 60 80 100m
SCALE 1:1000 @A1

North



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Level 4, 153 Walker Street, North Sydney NSW 2060
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Phone: 02 9922 6135
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Project
RIVERSTONE EAST
STAGE 3

Title
WATER CYCLE MANAGEMENT STRATEGY
RIPARIAN CHANNEL LONGSECTIONS
SHEET 03

Scale
AS SHOWN
Date
14/09/2023
Size
A1
Datum
MGA94

Status
FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number
SK0021-220121-00

Revision
1

DATE PLOTTED: 15 September 2023 8:49 AM BY : SHAWN HOTONG

CAD File: P:\220121 RiverstoneEastStg3SAP\D-Civil\00-SiteWide\Drawings\4-Sketches\DWG\SK0011-SK0021-220121-00-Enspire-R03-230915-RiverstoneEastStg3WCMSPlans.dwg

Rhelm

# Appendix B

MUSIC-Link Report

# MUSIC-***link*** Report

| Project Details | | Company Details | |
|---|---|---|---|
| **Project:** | Riverstone East Stage 3 WCM | **Company:** | |
| **Report Export Date:** | 14/09/2023 | **Contact:** | |
| **Catchment Name:** | j1809_music_dev_08 | **Address:** | |
| **Catchment Area:** | 436.783ha | **Phone:** | |
| **Impervious Area*:** | 53.49% | **Email:** | |
| **Rainfall Station:** | 67035 LIVERPOOL(WHITLAM | | |
| **Modelling Time-step:** | 6 Minutes | | |
| **Modelling Period:** | 1/01/1967 - 31/12/1976 11:54:00 PM | | |
| **Mean Annual Rainfall:** | 857mm | | |
| **Evapotranspiration:** | 1261mm | | |
| **MUSIC Version:** | 6.3.0 | | |
| **MUSIC-link data Version:** | 6.34 | | |
| **Study Area:** | Blacktown | | |
| **Scenario:** | Blacktown Development | | |

* takes into account area from all source nodes that link to the chosen reporting node, excluding Import Data Nodes

| Treatment Train Effectiveness | | Treatment Nodes | | Source Nodes | |
|---|---|---|---|---|---|
| **Node: Post-Development Node** | **Reduction** | **Node Type** | **Number** | **Node Type** | **Number** |
| **Flow** | 23.6% | Pond Node | 8 | Urban Source Node | 82 |
| **TSS** | 86.5% | Rain Water Tank Node | 10 | Forest Source Node | 10 |
| **TP** | 71.8% | Sedimentation Basin Node | 3 | | |
| **TN** | 54% | Bio Retention Node | 4 | | |
| **GP** | 99.2% | Swale Node | 9 | | |
| | | Generic Node | 2 | | |
| | | GPT Node | 6 | | |

## Comments

Refer to Section 6 of the Water Cycle Management Assessment (Rhelm, 2023) for commentary on deviations from BCC standard source and treatment node parameters

## Passing Parameters

| Node Type | Node Name | Parameter | Min | Max | Actual |
|---|---|---|---|---|---|
| Bio | Bioretention | Hi-flow bypass rate (cum/sec) | None | None | 1.3 |
| Bio | Bioretention | Hi-flow bypass rate (cum/sec) | None | None | 1.2 |
| Bio | Bioretention | Hi-flow bypass rate (cum/sec) | None | None | 2 |
| Bio | Bioretention | Hi-flow bypass rate (cum/sec) | None | None | 3.6 |
| Bio | Bioretention | PET Scaling Factor | 2.1 | 2.1 | 2.1 |
| Bio | Bioretention | PET Scaling Factor | 2.1 | 2.1 | 2.1 |
| Bio | Bioretention | PET Scaling Factor | 2.1 | 2.1 | 2.1 |
| Bio | Bioretention | PET Scaling Factor | 2.1 | 2.1 | 2.1 |
| Forest | CA02-Drainage/Environmental | Area Impervious (ha) | None | None | 0.088 |
| Forest | CA02-Drainage/Environmental | Area Pervious (ha) | None | None | 1.709 |
| Forest | CA02-Drainage/Environmental | Total Area (ha) | None | None | 1.798 |
| Forest | CA05-Drainage/Environmental | Area Impervious (ha) | None | None | 0.091 |
| Forest | CA05-Drainage/Environmental | Area Pervious (ha) | None | None | 1.924 |
| Forest | CA05-Drainage/Environmental | Total Area (ha) | None | None | 2.016 |
| Forest | CA16-Drainage/Environmental | Area Impervious (ha) | None | None | 0.249 |
| Forest | CA16-Drainage/Environmental | Area Pervious (ha) | None | None | 5.265 |
| Forest | CA16-Drainage/Environmental | Total Area (ha) | None | None | 5.515 |
| Forest | CA16-Drainage/Environmental Bypass | Area Impervious (ha) | None | None | 0.187 |
| Forest | CA16-Drainage/Environmental Bypass | Area Pervious (ha) | None | None | 3.954 |
| Forest | CA16-Drainage/Environmental Bypass | Total Area (ha) | None | None | 4.142 |
| Forest | CA19-Drainage/Environmental | Area Impervious (ha) | None | None | 0.176 |
| Forest | CA19-Drainage/Environmental | Area Pervious (ha) | None | None | 3.721 |
| Forest | CA19-Drainage/Environmental | Total Area (ha) | None | None | 3.898 |
| Forest | CA19-Drainage/Environmental Bypass | Area Impervious (ha) | None | None | 0.066 |
| Forest | CA19-Drainage/Environmental Bypass | Area Pervious (ha) | None | None | 1.399 |
| Forest | CA19-Drainage/Environmental Bypass | Total Area (ha) | None | None | 1.466 |
| Forest | CF02B-Drainage/Environmental | Area Impervious (ha) | None | None | 0.019 |
| Forest | CF02B-Drainage/Environmental | Area Pervious (ha) | None | None | 0.387 |
| Forest | CF02B-Drainage/Environmental | Total Area (ha) | None | None | 0.407 |
| Forest | CF06-Drainage/Environmental | Area Impervious (ha) | None | None | 0.223 |
| Forest | CF06-Drainage/Environmental | Area Pervious (ha) | None | None | 4.708 |
| Forest | CF06-Drainage/Environmental | Total Area (ha) | None | None | 4.932 |
| Forest | CF07-Drainage/Environmental | Area Impervious (ha) | None | None | 0.158 |
| Forest | CF07-Drainage/Environmental | Area Pervious (ha) | None | None | 3.086 |
| Forest | CF07-Drainage/Environmental | Total Area (ha) | None | None | 3.245 |
| Forest | CF13-Drainage/Environmental | Area Impervious (ha) | None | None | 0.059 |
| Forest | CF13-Drainage/Environmental | Area Pervious (ha) | None | None | 1.062 |
| Forest | CF13-Drainage/Environmental | Total Area (ha) | None | None | 1.122 |
| GPT | CDS 3030 | Hi-flow bypass rate (cum/sec) | None | None | 2.3 |
| GPT | CDS 3030 | Hi-flow bypass rate (cum/sec) | None | None | 2.5 |

Only certain parameters are reported when they pass validation

| Node Type | Node Name | Parameter | Min | Max | Actual |
|---|---|---|---|---|---|
| GPT | CDS 3030 | Hi-flow bypass rate (cum/sec) | None | None | 3.6 |
| GPT | CDS 3030 | Hi-flow bypass rate (cum/sec) | None | None | 1.2 |
| GPT | CDS 3030 | Hi-flow bypass rate (cum/sec) | None | None | 2 |
| GPT | CDS 3030 | Hi-flow bypass rate (cum/sec) | None | None | 1.3 |
| Pond | CA07-Pond | % Reuse Demand Met | None | None | 0 |
| Pond | CA11-Pond | % Reuse Demand Met | None | None | 0 |
| Pond | CA16 Wetland | % Reuse Demand Met | None | None | 0 |
| Pond | CA18-Pond | % Reuse Demand Met | None | None | 0 |
| Pond | CA19 Wetland | % Reuse Demand Met | None | None | 0 |
| Pond | CF13-Pond | % Reuse Demand Met | None | None | 0 |
| Pond | Storage Pond | % Reuse Demand Met | None | None | 92.872 |
| Pond | Storage Pond | % Reuse Demand Met | None | None | 90.85 |
| Post | Post-Development Node | % Load Reduction | None | None | 23.6 |
| Post | Post-Development Node | GP % Load Reduction | 90 | None | 99.2 |
| Post | Post-Development Node | TN % Load Reduction | 45 | None | 54 |
| Post | Post-Development Node | TP % Load Reduction | 65 | None | 71.8 |
| Post | Post-Development Node | TSS % Load Reduction | 85 | None | 86.5 |
| Sedimentation | Blacktown Only Sedimentation Basin | Exfiltration Rate (mm/hr) | 0 | 0 | 0 |
| Sedimentation | Blacktown Only Sedimentation Basin | Exfiltration Rate (mm/hr) | 0 | 0 | 0 |
| Sedimentation | Blacktown Only Sedimentation Basin | Exfiltration Rate (mm/hr) | 0 | 0 | 0 |
| Sedimentation | Blacktown Only Sedimentation Basin | High Flow Bypass Out (ML/yr) | None | None | 16.42 |
| Sedimentation | Blacktown Only Sedimentation Basin | High Flow Bypass Out (ML/yr) | None | None | 28.8717 |
| Sedimentation | Blacktown Only Sedimentation Basin | High Flow Bypass Out (ML/yr) | None | None | 22.70 |
| Sedimentation | Blacktown Only Sedimentation Basin | Notional Detention Time (hrs) | None | None | 4.67 |
| Sedimentation | Blacktown Only Sedimentation Basin | Notional Detention Time (hrs) | None | None | 5.71 |
| Sedimentation | Blacktown Only Sedimentation Basin | Notional Detention Time (hrs) | None | None | 6.92 |
| Swale | Blacktown Only Swale 2020 | Bed slope | 0.005 | 0.01 | 0.005 |
| Swale | Blacktown Only Swale 2020 | Bed slope | 0.005 | 0.01 | 0.005 |
| Swale | Blacktown Only Swale 2020 | Bed slope | 0.005 | 0.01 | 0.005 |
| Swale | Blacktown Only Swale 2020 | Bed slope | 0.005 | 0.01 | 0.005 |
| Swale | Blacktown Only Swale 2020 | Bed slope | 0.005 | 0.01 | 0.005 |
| Swale | Blacktown Only Swale 2020 | Bed slope | 0.005 | 0.01 | 0.005 |
| Swale | Blacktown Only Swale 2020 | Bed slope | 0.005 | 0.01 | 0.005 |
| Swale | Blacktown Only Swale 2020 | Bed slope | 0.005 | 0.01 | 0.005 |
| Swale | Blacktown Only Swale 2020 | Bed slope | 0.005 | 0.01 | 0.005 |
| Urban | CA02-Driveways | Area Impervious (ha) | None | None | 1.6 |
| Urban | CA02-Driveways | Area Pervious (ha) | None | None | 0 |
| Urban | CA02-Driveways | Total Area (ha) | None | None | 1.6 |
| Urban | CA02-Misc Impervious | Area Impervious (ha) | None | None | 2.368 |
| Urban | CA02-Misc Impervious | Area Pervious (ha) | None | None | 0 |

Only certain parameters are reported when they pass validation

| Node Type | Node Name | Parameter | Min | Max | Actual |
|---|---|---|---|---|---|
| Urban | CA02-Misc Impervious | Total Area (ha) | None | None | 2.368 |
| Urban | CA02-Misc Pervious | Area Impervious (ha) | None | None | 0 |
| Urban | CA02-Misc Pervious | Area Pervious (ha) | None | None | 2.499 |
| Urban | CA02-Misc Pervious | Total Area (ha) | None | None | 2.499 |
| Urban | CA02-New Roads | Area Impervious (ha) | None | None | 7.263 |
| Urban | CA02-New Roads | Area Pervious (ha) | None | None | 0.404 |
| Urban | CA02-New Roads | Total Area (ha) | None | None | 7.668 |
| Urban | CA02-Park/Sports Field | Area Impervious (ha) | None | None | 0.530 |
| Urban | CA02-Park/Sports Field | Area Pervious (ha) | None | None | 2.126 |
| Urban | CA02-Park/Sports Field | Total Area (ha) | None | None | 2.657 |
| Urban | CA02-Parks | Area Impervious (ha) | None | None | 0.025 |
| Urban | CA02-Parks | Area Pervious (ha) | None | None | 0.503 |
| Urban | CA02-Parks | Total Area (ha) | None | None | 0.529 |
| Urban | CA02-Resi_Roof | Area Impervious (ha) | None | None | 9.209 |
| Urban | CA02-Resi_Roof | Area Pervious (ha) | None | None | 0 |
| Urban | CA02-Resi_Roof | Total Area (ha) | None | None | 9.209 |
| Urban | CA02-Roads | Area Impervious (ha) | None | None | 1.775 |
| Urban | CA02-Roads | Area Pervious (ha) | None | None | 0.324 |
| Urban | CA02-Roads | Total Area (ha) | None | None | 2.1 |
| Urban | CA05-Driveways | Area Impervious (ha) | None | None | 0.874 |
| Urban | CA05-Driveways | Area Pervious (ha) | None | None | 0 |
| Urban | CA05-Driveways | Total Area (ha) | None | None | 0.874 |
| Urban | CA05-Misc Impervious | Area Impervious (ha) | None | None | 1.311 |
| Urban | CA05-Misc Impervious | Area Pervious (ha) | None | None | 0 |
| Urban | CA05-Misc Impervious | Total Area (ha) | None | None | 1.311 |
| Urban | CA05-Misc Pervious | Area Impervious (ha) | None | None | 0 |
| Urban | CA05-Misc Pervious | Area Pervious (ha) | None | None | 1.311 |
| Urban | CA05-Misc Pervious | Total Area (ha) | None | None | 1.311 |
| Urban | CA05-New Roads | Area Impervious (ha) | None | None | 4.512 |
| Urban | CA05-New Roads | Area Pervious (ha) | None | None | 0.251 |
| Urban | CA05-New Roads | Total Area (ha) | None | None | 4.764 |
| Urban | CA05-Park/Sports Field | Area Impervious (ha) | None | None | 0.237 |
| Urban | CA05-Park/Sports Field | Area Pervious (ha) | None | None | 0.927 |
| Urban | CA05-Park/Sports Field | Total Area (ha) | None | None | 1.165 |
| Urban | CA05-Parks | Area Impervious (ha) | None | None | 0.163 |
| Urban | CA05-Parks | Area Pervious (ha) | None | None | 3.174 |
| Urban | CA05-Parks | Total Area (ha) | None | None | 3.338 |
| Urban | CA05-Roads | Area Impervious (ha) | None | None | 3.944 |
| Urban | CA05-Roads | Area Pervious (ha) | None | None | 0.720 |
| Urban | CA05-Roads | Total Area (ha) | None | None | 4.665 |

Only certain parameters are reported when they pass validation

| Node Type | Node Name | Parameter | Min | Max | Actual |
|---|---|---|---|---|---|
| Urban | CA05-Roof | Area Impervious (ha) | None | None | 5.245 |
| Urban | CA05-Roof | Area Pervious (ha) | None | None | 0 |
| Urban | CA05-Roof | Total Area (ha) | None | None | 5.245 |
| Urban | CA07- Roads | Area Impervious (ha) | None | None | 5.059 |
| Urban | CA07- Roads | Area Pervious (ha) | None | None | 0.924 |
| Urban | CA07- Roads | Total Area (ha) | None | None | 5.984 |
| Urban | CA07-Parks | Area Impervious (ha) | None | None | 3.667 |
| Urban | CA07-Parks | Area Pervious (ha) | None | None | 71.19 |
| Urban | CA07-Parks | Total Area (ha) | None | None | 74.86 |
| Urban | CA11-Business park | Area Impervious (ha) | None | None | 1.037 |
| Urban | CA11-Business park | Area Pervious (ha) | None | None | 0.115 |
| Urban | CA11-Business park | Total Area (ha) | None | None | 1.153 |
| Urban | CA11-Parks | Area Impervious (ha) | None | None | 0.293 |
| Urban | CA11-Parks | Area Pervious (ha) | None | None | 5.694 |
| Urban | CA11-Parks | Total Area (ha) | None | None | 5.988 |
| Urban | CA11-Residential | Area Impervious (ha) | None | None | 20.49 |
| Urban | CA11-Residential | Area Pervious (ha) | None | None | 3.567 |
| Urban | CA11-Residential | Total Area (ha) | None | None | 24.06 |
| Urban | CA11-Roads | Area Impervious (ha) | None | None | 2.476 |
| Urban | CA11-Roads | Area Pervious (ha) | None | None | 0.452 |
| Urban | CA11-Roads | Total Area (ha) | None | None | 2.929 |
| Urban | CA16- Residential | Area Impervious (ha) | None | None | 5.628 |
| Urban | CA16- Residential | Area Pervious (ha) | None | None | 0.979 |
| Urban | CA16- Residential | Total Area (ha) | None | None | 6.608 |
| Urban | CA16-Driveways | Area Impervious (ha) | None | None | 2.156 |
| Urban | CA16-Driveways | Area Pervious (ha) | None | None | 0 |
| Urban | CA16-Driveways | Total Area (ha) | None | None | 2.156 |
| Urban | CA16-Misc Impervious | Area Impervious (ha) | None | None | 3.02 |
| Urban | CA16-Misc Impervious | Area Pervious (ha) | None | None | 0 |
| Urban | CA16-Misc Impervious | Total Area (ha) | None | None | 3.02 |
| Urban | CA16-Misc Pervious | Area Impervious (ha) | None | None | 0 |
| Urban | CA16-Misc Pervious | Area Pervious (ha) | None | None | 4.733 |
| Urban | CA16-Misc Pervious | Total Area (ha) | None | None | 4.733 |
| Urban | CA16-New Roads | Area Impervious (ha) | None | None | 8.036 |
| Urban | CA16-New Roads | Area Pervious (ha) | None | None | 0.447 |
| Urban | CA16-New Roads | Total Area (ha) | None | None | 8.484 |
| Urban | CA16-Park/Sports Field | Area Impervious (ha) | None | None | 2.844 |
| Urban | CA16-Park/Sports Field | Area Pervious (ha) | None | None | 11.39 |
| Urban | CA16-Park/Sports Field | Total Area (ha) | None | None | 14.243 |
| Urban | CA16-Park/Sports Field Bypass | Area Impervious (ha) | None | None | 0.816 |

Only certain parameters are reported when they pass validation

| Node Type | Node Name | Parameter | Min | Max | Actual |
|---|---|---|---|---|---|
| Urban | CA16-Park/Sports Field Bypass | Area Pervious (ha) | None | None | 3.271 |
| Urban | CA16-Park/Sports Field Bypass | Total Area (ha) | None | None | 4.088 |
| Urban | CA16-Parks | Area Impervious (ha) | None | None | 0.040 |
| Urban | CA16-Parks | Area Pervious (ha) | None | None | 0.778 |
| Urban | CA16-Parks | Total Area (ha) | None | None | 0.819 |
| Urban | CA16-Resi Roof | Area Impervious (ha) | None | None | 10.36 |
| Urban | CA16-Resi Roof | Area Pervious (ha) | None | None | 0 |
| Urban | CA16-Resi Roof | Total Area (ha) | None | None | 10.36 |
| Urban | CA16-Roads | Area Impervious (ha) | None | None | 2.117 |
| Urban | CA16-Roads | Area Pervious (ha) | None | None | 0.387 |
| Urban | CA16-Roads | Total Area (ha) | None | None | 2.505 |
| Urban | CA16-School Roof | Area Impervious (ha) | None | None | 1.285 |
| Urban | CA16-School Roof | Area Pervious (ha) | None | None | 0 |
| Urban | CA16-School Roof | Total Area (ha) | None | None | 1.285 |
| Urban | CA18-Parks | Area Impervious (ha) | None | None | 0.576 |
| Urban | CA18-Parks | Area Pervious (ha) | None | None | 11.19 |
| Urban | CA18-Parks | Total Area (ha) | None | None | 11.769 |
| Urban | CA18-Roads | Area Impervious (ha) | None | None | 0.442 |
| Urban | CA18-Roads | Area Pervious (ha) | None | None | 0.080 |
| Urban | CA18-Roads | Total Area (ha) | None | None | 0.523 |
| Urban | CA19- Resi Roof | Area Impervious (ha) | None | None | 7.59 |
| Urban | CA19- Resi Roof | Area Pervious (ha) | None | None | 0 |
| Urban | CA19- Resi Roof | Total Area (ha) | None | None | 7.59 |
| Urban | CA19-Driveways | Area Impervious (ha) | None | None | 1.37 |
| Urban | CA19-Driveways | Area Pervious (ha) | None | None | 0 |
| Urban | CA19-Driveways | Total Area (ha) | None | None | 1.37 |
| Urban | CA19-Industrial | Area Impervious (ha) | None | None | 2.017 |
| Urban | CA19-Industrial | Area Pervious (ha) | None | None | 0.225 |
| Urban | CA19-Industrial | Total Area (ha) | None | None | 2.243 |
| Urban | CA19-Misc Impervious | Area Impervious (ha) | None | None | 2.003 |
| Urban | CA19-Misc Impervious | Area Pervious (ha) | None | None | 0 |
| Urban | CA19-Misc Impervious | Total Area (ha) | None | None | 2.003 |
| Urban | CA19-Misc Pervious | Area Impervious (ha) | None | None | 0 |
| Urban | CA19-Misc Pervious | Area Pervious (ha) | None | None | 2.425 |
| Urban | CA19-Misc Pervious | Total Area (ha) | None | None | 2.425 |
| Urban | CA19-New Roads | Area Impervious (ha) | None | None | 6.671 |
| Urban | CA19-New Roads | Area Pervious (ha) | None | None | 0.371 |
| Urban | CA19-New Roads | Total Area (ha) | None | None | 7.043 |
| Urban | CA19-Park/Sports Field | Area Impervious (ha) | None | None | 1.971 |
| Urban | CA19-Park/Sports Field | Area Pervious (ha) | None | None | 7.716 |

Only certain parameters are reported when they pass validation

| Node Type | Node Name | Parameter | Min | Max | Actual |
|---|---|---|---|---|---|
| Urban | CA19-Park/Sports Field | Total Area (ha) | None | None | 9.688 |
| Urban | CA19-Parks | Area Impervious (ha) | None | None | 0.512 |
| Urban | CA19-Parks | Area Pervious (ha) | None | None | 9.953 |
| Urban | CA19-Parks | Total Area (ha) | None | None | 10.466 |
| Urban | CA19-Residential | Area Impervious (ha) | None | None | 0.157 |
| Urban | CA19-Residential | Area Pervious (ha) | None | None | 0.027 |
| Urban | CA19-Residential | Total Area (ha) | None | None | 0.185 |
| Urban | CA19-Roads | Area Impervious (ha) | None | None | 1.790 |
| Urban | CA19-Roads | Area Pervious (ha) | None | None | 0.327 |
| Urban | CA19-Roads | Total Area (ha) | None | None | 2.118 |
| Urban | CA19-School Roof | Area Impervious (ha) | None | None | 0.316 |
| Urban | CA19-School Roof | Area Pervious (ha) | None | None | 0 |
| Urban | CA19-School Roof | Total Area (ha) | None | None | 0.316 |
| Urban | CF02_A-Driveways | Area Impervious (ha) | None | None | 0.811 |
| Urban | CF02_A-Driveways | Area Pervious (ha) | None | None | 0 |
| Urban | CF02_A-Driveways | Total Area (ha) | None | None | 0.811 |
| Urban | CF02_A-Misc Impervious | Area Impervious (ha) | None | None | 1.217 |
| Urban | CF02_A-Misc Impervious | Area Pervious (ha) | None | None | 0 |
| Urban | CF02_A-Misc Impervious | Total Area (ha) | None | None | 1.217 |
| Urban | CF02_A-Misc Pervious | Area Impervious (ha) | None | None | 0 |
| Urban | CF02_A-Misc Pervious | Area Pervious (ha) | None | None | 1.217 |
| Urban | CF02_A-Misc Pervious | Total Area (ha) | None | None | 1.217 |
| Urban | CF02_A-New Roads | Area Impervious (ha) | None | None | 5.445 |
| Urban | CF02_A-New Roads | Area Pervious (ha) | None | None | 0.303 |
| Urban | CF02_A-New Roads | Total Area (ha) | None | None | 5.749 |
| Urban | CF02_A-Park/Sports Field | Area Impervious (ha) | None | None | 0.580 |
| Urban | CF02_A-Park/Sports Field | Area Pervious (ha) | None | None | 2.381 |
| Urban | CF02_A-Park/Sports Field | Total Area (ha) | None | None | 2.962 |
| Urban | CF02_A-Roads | Area Impervious (ha) | None | None | 0.656 |
| Urban | CF02_A-Roads | Area Pervious (ha) | None | None | 0.119 |
| Urban | CF02_A-Roads | Total Area (ha) | None | None | 0.776 |
| Urban | CF02_A-Roof | Area Impervious (ha) | None | None | 4.867 |
| Urban | CF02_A-Roof | Area Pervious (ha) | None | None | 0 |
| Urban | CF02_A-Roof | Total Area (ha) | None | None | 4.867 |
| Urban | CF02_B-Park/Sports Field | Area Impervious (ha) | None | None | 1.076 |
| Urban | CF02_B-Park/Sports Field | Area Pervious (ha) | None | None | 4.414 |
| Urban | CF02_B-Park/Sports Field | Total Area (ha) | None | None | 5.491 |
| Urban | CF02_B-Roads | Area Impervious (ha) | None | None | 0.447 |
| Urban | CF02_B-Roads | Area Pervious (ha) | None | None | 0.081 |
| Urban | CF02_B-Roads | Total Area (ha) | None | None | 0.529 |

Only certain parameters are reported when they pass validation

| Node Type | Node Name | Parameter | Min | Max | Actual |
|---|---|---|---|---|---|
| Urban | CF02_B-Rural | Area Impervious (ha) | None | None | 0.206 |
| Urban | CF02_B-Rural | Area Pervious (ha) | None | None | 3.797 |
| Urban | CF02_B-Rural | Total Area (ha) | None | None | 4.004 |
| Urban | CF06-Driveways | Area Impervious (ha) | None | None | 0.591 |
| Urban | CF06-Driveways | Area Pervious (ha) | None | None | 0 |
| Urban | CF06-Driveways | Total Area (ha) | None | None | 0.591 |
| Urban | CF06-Misc Impervious | Area Impervious (ha) | None | None | 0.887 |
| Urban | CF06-Misc Impervious | Area Pervious (ha) | None | None | 0 |
| Urban | CF06-Misc Impervious | Total Area (ha) | None | None | 0.887 |
| Urban | CF06-Misc Pervious | Area Impervious (ha) | None | None | 0 |
| Urban | CF06-Misc Pervious | Area Pervious (ha) | None | None | 0.887 |
| Urban | CF06-Misc Pervious | Total Area (ha) | None | None | 0.887 |
| Urban | CF06-New Roads | Area Impervious (ha) | None | None | 3.954 |
| Urban | CF06-New Roads | Area Pervious (ha) | None | None | 0.220 |
| Urban | CF06-New Roads | Total Area (ha) | None | None | 4.175 |
| Urban | CF06-Park/Sports Field | Area Impervious (ha) | None | None | 0.342 |
| Urban | CF06-Park/Sports Field | Area Pervious (ha) | None | None | 1.374 |
| Urban | CF06-Park/Sports Field | Total Area (ha) | None | None | 1.717 |
| Urban | CF06-Roads | Area Impervious (ha) | None | None | 0.621 |
| Urban | CF06-Roads | Area Pervious (ha) | None | None | 0.113 |
| Urban | CF06-Roads | Total Area (ha) | None | None | 0.735 |
| Urban | CF06-Roof | Area Impervious (ha) | None | None | 3.548 |
| Urban | CF06-Roof | Area Pervious (ha) | None | None | 0 |
| Urban | CF06-Roof | Total Area (ha) | None | None | 3.548 |
| Urban | CF06-Rural | Area Impervious (ha) | None | None | 0.033 |
| Urban | CF06-Rural | Area Pervious (ha) | None | None | 0.613 |
| Urban | CF06-Rural | Total Area (ha) | None | None | 0.647 |
| Urban | CF07- Roads | Area Impervious (ha) | None | None | 2.755 |
| Urban | CF07- Roads | Area Pervious (ha) | None | None | 0.503 |
| Urban | CF07- Roads | Total Area (ha) | None | None | 3.259 |
| Urban | CF07-Driveways | Area Impervious (ha) | None | None | 2.28 |
| Urban | CF07-Driveways | Area Pervious (ha) | None | None | 0 |
| Urban | CF07-Driveways | Total Area (ha) | None | None | 2.28 |
| Urban | CF07-Misc Impervious | Area Impervious (ha) | None | None | 3.287 |
| Urban | CF07-Misc Impervious | Area Pervious (ha) | None | None | 0 |
| Urban | CF07-Misc Impervious | Total Area (ha) | None | None | 3.287 |
| Urban | CF07-Misc Pervious | Area Impervious (ha) | None | None | 0 |
| Urban | CF07-Misc Pervious | Area Pervious (ha) | None | None | 4.484 |
| Urban | CF07-Misc Pervious | Total Area (ha) | None | None | 4.484 |
| Urban | CF07-New Road | Area Impervious (ha) | None | None | 10.98 |

Only certain parameters are reported when they pass validation

| Node Type | Node Name | Parameter | Min | Max | Actual |
|---|---|---|---|---|---|
| Urban | CF07-New Road | Area Pervious (ha) | None | None | 0.612 |
| Urban | CF07-New Road | Total Area (ha) | None | None | 11.601 |
| Urban | CF07-Park/Sports Field | Area Impervious (ha) | None | None | 4.806 |
| Urban | CF07-Park/Sports Field | Area Pervious (ha) | None | None | 19.25 |
| Urban | CF07-Park/Sports Field | Total Area (ha) | None | None | 24.06 |
| Urban | CF07-Parks | Area Impervious (ha) | None | None | 0.031 |
| Urban | CF07-Parks | Area Pervious (ha) | None | None | 0.619 |
| Urban | CF07-Parks | Total Area (ha) | None | None | 0.651 |
| Urban | CF07-Resi Roof | Area Impervious (ha) | None | None | 12.081 |
| Urban | CF07-Resi Roof | Area Pervious (ha) | None | None | 0 |
| Urban | CF07-Resi Roof | Total Area (ha) | None | None | 12.081 |
| Urban | CF07-Residential | Area Impervious (ha) | None | None | 7.470 |
| Urban | CF07-Residential | Area Pervious (ha) | None | None | 1.300 |
| Urban | CF07-Residential | Total Area (ha) | None | None | 8.771 |
| Urban | CF07-School Roof | Area Impervious (ha) | None | None | 0.996 |
| Urban | CF07-School Roof | Area Pervious (ha) | None | None | 0 |
| Urban | CF07-School Roof | Total Area (ha) | None | None | 0.996 |
| Urban | CF13- Roads | Area Impervious (ha) | None | None | 0.016 |
| Urban | CF13- Roads | Area Pervious (ha) | None | None | 0.002 |
| Urban | CF13- Roads | Total Area (ha) | None | None | 0.019 |
| Urban | CF13-New Roads | Area Impervious (ha) | None | None | 0.036 |
| Urban | CF13-New Roads | Area Pervious (ha) | None | None | 0.002 |
| Urban | CF13-New Roads | Total Area (ha) | None | None | 0.039 |
| Urban | CF13-Park/Sports Field | Area Impervious (ha) | None | None | 0.002 |
| Urban | CF13-Park/Sports Field | Area Pervious (ha) | None | None | 0.009 |
| Urban | CF13-Park/Sports Field | Total Area (ha) | None | None | 0.012 |
| Urban | CF13-Rural | Area Impervious (ha) | None | None | 0.346 |
| Urban | CF13-Rural | Area Pervious (ha) | None | None | 6.372 |
| Urban | CF13-Rural | Total Area (ha) | None | None | 6.719 |
| Urban | CF17- Roads | Area Impervious (ha) | None | None | 1.242 |
| Urban | CF17- Roads | Area Pervious (ha) | None | None | 0.226 |
| Urban | CF17- Roads | Total Area (ha) | None | None | 1.469 |
| Urban | CF17-New Roads | Area Impervious (ha) | None | None | 0.244 |
| Urban | CF17-New Roads | Area Pervious (ha) | None | None | 0.013 |
| Urban | CF17-New Roads | Total Area (ha) | None | None | 0.258 |
| Urban | CF17-Residential | Area Impervious (ha) | None | None | 1.906 |
| Urban | CF17-Residential | Area Pervious (ha) | None | None | 0.331 |
| Urban | CF17-Residential | Total Area (ha) | None | None | 2.238 |
| Urban | CF17-Rural | Area Impervious (ha) | None | None | 0.148 |
| Urban | CF17-Rural | Area Pervious (ha) | None | None | 2.730 |

Only certain parameters are reported when they pass validation

| Node Type | Node Name | Parameter | Min | Max | Actual |
|---|---|---|---|---|---|
| Urban | CF17-Rural | Total Area (ha) | None | None | 2.879 |

Only certain parameters are reported when they pass validation

## Failing Parameters

| Node Type | Node Name | Parameter | Min | Max | Actual |
|---|---|---|---|---|---|
| Forest | CA02-Drainage/Environmental | Baseflow Total Nitrogen Mean (log mg/L) | 0.11 | 0.11 | -0.52 |
| Forest | CA02-Drainage/Environmental | Baseflow Total Nitrogen Standard Deviation (log mg/L) | 0.12 | 0.12 | 0.13 |
| Forest | CA02-Drainage/Environmental | Baseflow Total Phosphorus Mean (log mg/L) | -0.85 | -0.85 | -1.52 |
| Forest | CA02-Drainage/Environmental | Baseflow Total Phosphorus Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.13 |
| Forest | CA02-Drainage/Environmental | Baseflow Total Suspended Solids Mean (log mg/L) | 1.2 | 1.2 | 0.78 |
| Forest | CA02-Drainage/Environmental | Baseflow Total Suspended Solids Standard Deviation (log mg/L) | 0.17 | 0.17 | 0.13 |
| Forest | CA02-Drainage/Environmental | Stormflow Total Nitrogen Mean (log mg/L) | 0.3 | 0.34 | -0.05 |
| Forest | CA02-Drainage/Environmental | Stormflow Total Nitrogen Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.24 |
| Forest | CA02-Drainage/Environmental | Stormflow Total Phosphorus Mean (log mg/L) | -0.89 | -0.3 | -1.1 |
| Forest | CA02-Drainage/Environmental | Stormflow Total Phosphorus Standard Deviation (log mg/L) | 0.25 | 0.25 | 0.22 |
| Forest | CA02-Drainage/Environmental | Stormflow Total Suspended Solids Standard Deviation (log mg/L) | 0.32 | 0.32 | 0.2 |
| Forest | CA05-Drainage/Environmental | Baseflow Total Nitrogen Mean (log mg/L) | 0.11 | 0.11 | -0.52 |
| Forest | CA05-Drainage/Environmental | Baseflow Total Nitrogen Standard Deviation (log mg/L) | 0.12 | 0.12 | 0.13 |
| Forest | CA05-Drainage/Environmental | Baseflow Total Phosphorus Mean (log mg/L) | -0.85 | -0.85 | -1.52 |
| Forest | CA05-Drainage/Environmental | Baseflow Total Phosphorus Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.13 |
| Forest | CA05-Drainage/Environmental | Baseflow Total Suspended Solids Mean (log mg/L) | 1.2 | 1.2 | 0.78 |
| Forest | CA05-Drainage/Environmental | Baseflow Total Suspended Solids Standard Deviation (log mg/L) | 0.17 | 0.17 | 0.13 |
| Forest | CA05-Drainage/Environmental | Stormflow Total Nitrogen Mean (log mg/L) | 0.3 | 0.34 | -0.05 |
| Forest | CA05-Drainage/Environmental | Stormflow Total Nitrogen Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.24 |
| Forest | CA05-Drainage/Environmental | Stormflow Total Phosphorus Mean (log mg/L) | -0.89 | -0.3 | -1.1 |
| Forest | CA05-Drainage/Environmental | Stormflow Total Phosphorus Standard Deviation (log mg/L) | 0.25 | 0.25 | 0.22 |
| Forest | CA05-Drainage/Environmental | Stormflow Total Suspended Solids Standard Deviation (log mg/L) | 0.32 | 0.32 | 0.2 |
| Forest | CA16-Drainage/Environmental | Baseflow Total Nitrogen Mean (log mg/L) | 0.11 | 0.11 | -0.52 |
| Forest | CA16-Drainage/Environmental | Baseflow Total Nitrogen Standard Deviation (log mg/L) | 0.12 | 0.12 | 0.13 |
| Forest | CA16-Drainage/Environmental | Baseflow Total Phosphorus Mean (log mg/L) | -0.85 | -0.85 | -1.52 |
| Forest | CA16-Drainage/Environmental | Baseflow Total Phosphorus Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.13 |
| Forest | CA16-Drainage/Environmental | Baseflow Total Suspended Solids Mean (log mg/L) | 1.2 | 1.2 | 0.78 |
| Forest | CA16-Drainage/Environmental | Baseflow Total Suspended Solids Standard Deviation (log mg/L) | 0.17 | 0.17 | 0.13 |
| Forest | CA16-Drainage/Environmental | Stormflow Total Nitrogen Mean (log mg/L) | 0.3 | 0.34 | -0.05 |
| Forest | CA16-Drainage/Environmental | Stormflow Total Nitrogen Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.24 |
| Forest | CA16-Drainage/Environmental | Stormflow Total Phosphorus Mean (log mg/L) | -0.89 | -0.3 | -1.1 |
| Forest | CA16-Drainage/Environmental | Stormflow Total Phosphorus Standard Deviation (log mg/L) | 0.25 | 0.25 | 0.22 |
| Forest | CA16-Drainage/Environmental | Stormflow Total Suspended Solids Standard Deviation (log mg/L) | 0.32 | 0.32 | 0.2 |
| Forest | CA16-Drainage/Environmental Bypass | Baseflow Total Nitrogen Mean (log mg/L) | 0.11 | 0.11 | -0.52 |
| Forest | CA16-Drainage/Environmental Bypass | Baseflow Total Nitrogen Standard Deviation (log mg/L) | 0.12 | 0.12 | 0.13 |
| Forest | CA16-Drainage/Environmental Bypass | Baseflow Total Phosphorus Mean (log mg/L) | -0.85 | -0.85 | -1.52 |
| Forest | CA16-Drainage/Environmental | Baseflow Total Phosphorus Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.13 |

| | | | | | |
|---|---|---|---|---|---|
| Forest | CA16-Drainage/Environmental Bypass | Stormflow Total Nitrogen Mean (log mg/L) | 0.3 | 0.34 | -0.05 |

Only certain parameters are reported when they pass validation

| Node Type | Node Name | Parameter | Min | Max | Actual |
|---|---|---|---|---|---|
| Forest | CA16-Drainage/Environmental Bypass | Stormflow Total Nitrogen Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.24 |
| Forest | CA16-Drainage/Environmental Bypass | Stormflow Total Phosphorus Mean (log mg/L) | -0.89 | -0.3 | -1.1 |
| Forest | CA16-Drainage/Environmental Bypass | Stormflow Total Phosphorus Standard Deviation (log mg/L) | 0.25 | 0.25 | 0.22 |
| Forest | CA16-Drainage/Environmental Bypass | Stormflow Total Suspended Solids Standard Deviation (log mg/L) | 0.32 | 0.32 | 0.2 |
| Forest | CA19-Drainage/Environmental | Baseflow Total Nitrogen Mean (log mg/L) | 0.11 | 0.11 | -0.52 |
| Forest | CA19-Drainage/Environmental | Baseflow Total Nitrogen Standard Deviation (log mg/L) | 0.12 | 0.12 | 0.13 |
| Forest | CA19-Drainage/Environmental | Baseflow Total Phosphorus Mean (log mg/L) | -0.85 | -0.85 | -1.52 |
| Forest | CA19-Drainage/Environmental | Baseflow Total Phosphorus Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.13 |
| Forest | CA19-Drainage/Environmental | Baseflow Total Suspended Solids Mean (log mg/L) | 1.2 | 1.2 | 0.78 |
| Forest | CA19-Drainage/Environmental | Baseflow Total Suspended Solids Standard Deviation (log mg/L) | 0.17 | 0.17 | 0.13 |
| Forest | CA19-Drainage/Environmental | Stormflow Total Nitrogen Mean (log mg/L) | 0.3 | 0.34 | -0.05 |
| Forest | CA19-Drainage/Environmental | Stormflow Total Nitrogen Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.24 |
| Forest | CA19-Drainage/Environmental | Stormflow Total Phosphorus Mean (log mg/L) | -0.89 | -0.3 | -1.1 |
| Forest | CA19-Drainage/Environmental | Stormflow Total Phosphorus Standard Deviation (log mg/L) | 0.25 | 0.25 | 0.22 |
| Forest | CA19-Drainage/Environmental | Stormflow Total Suspended Solids Standard Deviation (log mg/L) | 0.32 | 0.32 | 0.2 |
| Forest | CA19-Drainage/Environmental Bypass | Baseflow Total Nitrogen Mean (log mg/L) | 0.11 | 0.11 | -0.52 |
| Forest | CA19-Drainage/Environmental Bypass | Baseflow Total Nitrogen Standard Deviation (log mg/L) | 0.12 | 0.12 | 0.13 |
| Forest | CA19-Drainage/Environmental Bypass | Baseflow Total Phosphorus Mean (log mg/L) | -0.85 | -0.85 | -1.52 |
| Forest | CA19-Drainage/Environmental Bypass | Baseflow Total Phosphorus Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.13 |
| Forest | CA19-Drainage/Environmental Bypass | Baseflow Total Suspended Solids Mean (log mg/L) | 1.2 | 1.2 | 0.78 |
| Forest | CA19-Drainage/Environmental Bypass | Baseflow Total Suspended Solids Standard Deviation (log mg/L) | 0.17 | 0.17 | 0.13 |
| Forest | CA19-Drainage/Environmental Bypass | Stormflow Total Nitrogen Mean (log mg/L) | 0.3 | 0.34 | -0.05 |
| Forest | CA19-Drainage/Environmental Bypass | Stormflow Total Nitrogen Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.24 |
| Forest | CA19-Drainage/Environmental Bypass | Stormflow Total Phosphorus Mean (log mg/L) | -0.89 | -0.3 | -1.1 |
| Forest | CA19-Drainage/Environmental Bypass | Stormflow Total Phosphorus Standard Deviation (log mg/L) | 0.25 | 0.25 | 0.22 |
| Forest | CA19-Drainage/Environmental Bypass | Stormflow Total Suspended Solids Standard Deviation (log mg/L) | 0.32 | 0.32 | 0.2 |
| Forest | CF02B-Drainage/Environmental | Baseflow Total Nitrogen Mean (log mg/L) | 0.11 | 0.11 | -0.52 |
| Forest | CF02B-Drainage/Environmental | Baseflow Total Nitrogen Standard Deviation (log mg/L) | 0.12 | 0.12 | 0.13 |
| Forest | CF02B-Drainage/Environmental | Baseflow Total Phosphorus Mean (log mg/L) | -0.85 | -0.85 | -1.52 |
| Forest | CF02B-Drainage/Environmental | Baseflow Total Phosphorus Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.13 |

| | | | | | |
|---|---|---|---|---|---|
| Forest | CF02B-Drainage/Environmental | Stormflow Total Nitrogen Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.24 |
| Forest | CF02B-Drainage/Environmental | Stormflow Total Phosphorus Mean (log mg/L) | -0.89 | -0.3 | -1.1 |
| Forest | CF02B-Drainage/Environmental | Stormflow Total Phosphorus Standard Deviation (log mg/L) | 0.25 | 0.25 | 0.22 |
| Forest | CF02B-Drainage/Environmental | Stormflow Total Suspended Solids Standard Deviation (log mg/L) | 0.32 | 0.32 | 0.2 |
| Forest | CF06-Drainage/Environmental | Baseflow Total Nitrogen Mean (log mg/L) | 0.11 | 0.11 | -0.52 |
| Forest | CF06-Drainage/Environmental | Baseflow Total Nitrogen Standard Deviation (log mg/L) | 0.12 | 0.12 | 0.13 |
| Forest | CF06-Drainage/Environmental | Baseflow Total Phosphorus Mean (log mg/L) | -0.85 | -0.85 | -1.52 |

Only certain parameters are reported when they pass validation

| Node Type | Node Name | Parameter | Min | Max | Actual |
|---|---|---|---|---|---|
| Forest | CF06-Drainage/Environmental | Baseflow Total Phosphorus Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.13 |
| Forest | CF06-Drainage/Environmental | Baseflow Total Suspended Solids Mean (log mg/L) | 1.2 | 1.2 | 0.78 |
| Forest | CF06-Drainage/Environmental | Baseflow Total Suspended Solids Standard Deviation (log mg/L) | 0.17 | 0.17 | 0.13 |
| Forest | CF06-Drainage/Environmental | Stormflow Total Nitrogen Mean (log mg/L) | 0.3 | 0.34 | -0.05 |
| Forest | CF06-Drainage/Environmental | Stormflow Total Nitrogen Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.24 |
| Forest | CF06-Drainage/Environmental | Stormflow Total Phosphorus Mean (log mg/L) | -0.89 | -0.3 | -1.1 |
| Forest | CF06-Drainage/Environmental | Stormflow Total Phosphorus Standard Deviation (log mg/L) | 0.25 | 0.25 | 0.22 |
| Forest | CF06-Drainage/Environmental | Stormflow Total Suspended Solids Standard Deviation (log mg/L) | 0.32 | 0.32 | 0.2 |
| Forest | CF07-Drainage/Environmental | Baseflow Total Nitrogen Mean (log mg/L) | 0.11 | 0.11 | -0.52 |
| Forest | CF07-Drainage/Environmental | Baseflow Total Nitrogen Standard Deviation (log mg/L) | 0.12 | 0.12 | 0.13 |
| Forest | CF07-Drainage/Environmental | Baseflow Total Phosphorus Mean (log mg/L) | -0.85 | -0.85 | -1.52 |
| Forest | CF07-Drainage/Environmental | Baseflow Total Phosphorus Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.13 |
| Forest | CF07-Drainage/Environmental | Baseflow Total Suspended Solids Mean (log mg/L) | 1.2 | 1.2 | 0.78 |
| Forest | CF07-Drainage/Environmental | Baseflow Total Suspended Solids Standard Deviation (log mg/L) | 0.17 | 0.17 | 0.13 |
| Forest | CF07-Drainage/Environmental | Stormflow Total Nitrogen Mean (log mg/L) | 0.3 | 0.34 | -0.05 |
| Forest | CF07-Drainage/Environmental | Stormflow Total Nitrogen Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.24 |
| Forest | CF07-Drainage/Environmental | Stormflow Total Phosphorus Mean (log mg/L) | -0.89 | -0.3 | -1.1 |
| Forest | CF07-Drainage/Environmental | Stormflow Total Phosphorus Standard Deviation (log mg/L) | 0.25 | 0.25 | 0.22 |
| Forest | CF07-Drainage/Environmental | Stormflow Total Suspended Solids Standard Deviation (log mg/L) | 0.32 | 0.32 | 0.2 |
| Forest | CF13-Drainage/Environmental | Baseflow Total Nitrogen Mean (log mg/L) | 0.11 | 0.11 | -0.52 |
| Forest | CF13-Drainage/Environmental | Baseflow Total Nitrogen Standard Deviation (log mg/L) | 0.12 | 0.12 | 0.13 |
| Forest | CF13-Drainage/Environmental | Baseflow Total Phosphorus Mean (log mg/L) | -0.85 | -0.85 | -1.52 |
| Forest | CF13-Drainage/Environmental | Baseflow Total Phosphorus Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.13 |
| Forest | CF13-Drainage/Environmental | Baseflow Total Suspended Solids Mean (log mg/L) | 1.2 | 1.2 | 0.78 |
| Forest | CF13-Drainage/Environmental | Baseflow Total Suspended Solids Standard Deviation (log mg/L) | 0.17 | 0.17 | 0.13 |
| Forest | CF13-Drainage/Environmental | Stormflow Total Nitrogen Mean (log mg/L) | 0.3 | 0.34 | -0.05 |
| Forest | CF13-Drainage/Environmental | Stormflow Total Nitrogen Standard Deviation (log mg/L) | 0.19 | 0.19 | 0.24 |
| Forest | CF13-Drainage/Environmental | Stormflow Total Phosphorus Mean (log mg/L) | -0.89 | -0.3 | -1.1 |
| Forest | CF13-Drainage/Environmental | Stormflow Total Phosphorus Standard Deviation (log mg/L) | 0.25 | 0.25 | 0.22 |
| Forest | CF13-Drainage/Environmental | Stormflow Total Suspended Solids Standard Deviation (log mg/L) | 0.32 | 0.32 | 0.2 |
| Pond | CA16 Wetland | Evaporative Loss as % of PET | 75 | 75 | 125 |
| Pond | CA16 Wetland | Number of CSTR Cells | 2 | 2 | 4 |
| Pond | CA16 Wetland | Total Nitrogen - k (m/yr) | 40 | 40 | 150 |
| Pond | CA16 Wetland | Total Phosphorus - C* (mg/L) | 0.09 | 0.09 | 0.06 |
| Pond | CA16 Wetland | Total Phosphorus - k (m/yr) | 300 | 300 | 1000 |
| Pond | CA16 Wetland | Total Suspended Solids - C* (mg/L) | 12 | 12 | 6 |

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| Node Type | Node Name | Parameter | Min | Max | Actual |
|---|---|---|---|---|---|
| Pond | CA19 Wetland | Total Phosphorus - C* (mg/L) | 0.09 | 0.09 | 0.06 |
| Pond | CA19 Wetland | Total Phosphorus - k (m/yr) | 300 | 300 | 1000 |
| Pond | CA19 Wetland | Total Suspended Solids - C* (mg/L) | 12 | 12 | 6 |
| Pond | CA19 Wetland | Total Suspended Solids - k (m/yr) | 400 | 400 | 1500 |
| Pond | Storage Pond | Extended detention depth (m) | 0.25 | 1 | 1.1 |
| Pond | Storage Pond | Total Nitrogen - C* (mg/L) | 1 | 1 | 0 |
| Pond | Storage Pond | Total Nitrogen - C* (mg/L) | 1 | 1 | 0 |
| Pond | Storage Pond | Total Nitrogen - k (m/yr) | 40 | 40 | 0 |
| Pond | Storage Pond | Total Nitrogen - k (m/yr) | 40 | 40 | 0 |
| Pond | Storage Pond | Total Phosphorus - C* (mg/L) | 0.09 | 0.09 | 0 |
| Pond | Storage Pond | Total Phosphorus - C* (mg/L) | 0.09 | 0.09 | 0 |
| Pond | Storage Pond | Total Phosphorus - k (m/yr) | 300 | 300 | 0 |
| Pond | Storage Pond | Total Phosphorus - k (m/yr) | 300 | 300 | 0 |
| Pond | Storage Pond | Total Suspended Solids - C* (mg/L) | 12 | 12 | 0 |
| Pond | Storage Pond | Total Suspended Solids - C* (mg/L) | 12 | 12 | 0 |
| Pond | Storage Pond | Total Suspended Solids - k (m/yr) | 400 | 400 | 0 |
| Pond | Storage Pond | Total Suspended Solids - k (m/yr) | 400 | 400 | 0 |
| Rain | Rainwater Tank | % Reuse Demand Met | 80 | None | 74.6742 |
| Rain | Rainwater Tank | % Reuse Demand Met | 80 | None | 74.4292 |
| Rain | Rainwater Tank | % Reuse Demand Met | 80 | None | 74.6734 |
| Rain | Rainwater Tank | % Reuse Demand Met | 80 | None | 74.4556 |
| Rain | Rainwater Tank | % Reuse Demand Met | 80 | None | 74.48 |
| Rain | Resi Rainwater Tank | % Reuse Demand Met | 80 | None | 74.69 |
| Rain | Resi Rainwater Tank | % Reuse Demand Met | 80 | None | 74.58 |
| Rain | School Rainwater Tank | % Reuse Demand Met | 80 | None | 36.58 |
| Rain | School Rainwater Tank | % Reuse Demand Met | 80 | None | 35.81 |
| Rain | School Rainwater Tank | % Reuse Demand Met | 80 | None | 34.06 |
| Urban | CA02-Resi_Roof | Baseflow Total Nitrogen Mean (log mg/L) | 0.32 | 0.32 | 0.11 |
| Urban | CA02-Resi_Roof | Baseflow Total Phosphorus Mean (log mg/L) | -0.82 | -0.82 | -0.85 |
| Urban | CA02-Resi_Roof | Baseflow Total Suspended Solids Mean (log mg/L) | 1.1 | 1.1 | 1.2 |
| Urban | CA05-Roof | Baseflow Total Nitrogen Mean (log mg/L) | 0.32 | 0.32 | 0.11 |
| Urban | CA05-Roof | Baseflow Total Phosphorus Mean (log mg/L) | -0.82 | -0.82 | -0.85 |
| Urban | CA05-Roof | Baseflow Total Suspended Solids Mean (log mg/L) | 1.1 | 1.1 | 1.2 |
| Urban | CA16-Resi Roof | Baseflow Total Nitrogen Mean (log mg/L) | 0.32 | 0.32 | 0.11 |
| Urban | CA16-Resi Roof | Baseflow Total Phosphorus Mean (log mg/L) | -0.82 | -0.82 | -0.85 |
| Urban | CA16-Resi Roof | Baseflow Total Suspended Solids Mean (log mg/L) | 1.1 | 1.1 | 1.2 |
| Urban | CA16-School Roof | Baseflow Total Nitrogen Mean (log mg/L) | 0.32 | 0.32 | 0.11 |
| Urban | CA16-School Roof | Baseflow Total Phosphorus Mean (log mg/L) | -0.82 | -0.82 | -0.85 |
| Urban | CA16-School Roof | Baseflow Total Suspended Solids Mean (log mg/L) | 1.1 | 1.1 | 1.2 |
| Urban | CA19- Resi Roof | Baseflow Total Nitrogen Mean (log mg/L) | 0.32 | 0.32 | 0.11 |

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| Node Type | Node Name | Parameter | Min | Max | Actual |
|---|---|---|---|---|---|
| Urban | CA19- Resi Roof | Baseflow Total Phosphorus Mean (log mg/L) | -0.82 | -0.82 | -0.85 |

| | | | | | |
|---|---|---|---|---|---|
| Urban | CA19-School Roof | Baseflow Total Suspended Solids Mean (log mg/L) | 1.1 | 1.1 | 1.2 |
| Urban | CF02_A-Roof | Baseflow Total Nitrogen Mean (log mg/L) | 0.32 | 0.32 | 0.11 |
| Urban | CF02_A-Roof | Baseflow Total Phosphorus Mean (log mg/L) | -0.82 | -0.82 | -0.85 |
| Urban | CF02_A-Roof | Baseflow Total Suspended Solids Mean (log mg/L) | 1.1 | 1.1 | 1.2 |
| Urban | CF02_B-Rural | Baseflow Total Nitrogen Mean (log mg/L) | 0.11 | 0.11 | -0.05 |
| Urban | CF02_B-Rural | Baseflow Total Phosphorus Mean (log mg/L) | -0.85 | -0.85 | -1.22 |
| Urban | CF02_B-Rural | Baseflow Total Suspended Solids Mean (log mg/L) | 1.2 | 1.2 | 1.15 |
| Urban | CF06-Roof | Baseflow Total Nitrogen Mean (log mg/L) | 0.32 | 0.32 | 0.11 |
| Urban | CF06-Roof | Baseflow Total Phosphorus Mean (log mg/L) | -0.82 | -0.82 | -0.85 |
| Urban | CF06-Roof | Baseflow Total Suspended Solids Mean (log mg/L) | 1.1 | 1.1 | 1.2 |
| Urban | CF06-Rural | Baseflow Total Nitrogen Mean (log mg/L) | 0.11 | 0.11 | -0.05 |
| Urban | CF06-Rural | Baseflow Total Phosphorus Mean (log mg/L) | -0.85 | -0.85 | -1.22 |
| Urban | CF06-Rural | Baseflow Total Suspended Solids Mean (log mg/L) | 1.2 | 1.2 | 1.15 |
| Urban | CF07-Resi Roof | Baseflow Total Nitrogen Mean (log mg/L) | 0.32 | 0.32 | 0.11 |
| Urban | CF07-Resi Roof | Baseflow Total Phosphorus Mean (log mg/L) | -0.82 | -0.82 | -0.85 |
| Urban | CF07-Resi Roof | Baseflow Total Suspended Solids Mean (log mg/L) | 1.1 | 1.1 | 1.2 |
| Urban | CF07-School Roof | Baseflow Total Nitrogen Mean (log mg/L) | 0.32 | 0.32 | 0.11 |
| Urban | CF07-School Roof | Baseflow Total Phosphorus Mean (log mg/L) | -0.82 | -0.82 | -0.85 |
| Urban | CF07-School Roof | Baseflow Total Suspended Solids Mean (log mg/L) | 1.1 | 1.1 | 1.2 |
| Urban | CF13-Rural | Baseflow Total Nitrogen Mean (log mg/L) | 0.11 | 0.11 | -0.05 |
| Urban | CF13-Rural | Baseflow Total Phosphorus Mean (log mg/L) | -0.85 | -0.85 | -1.22 |
| Urban | CF13-Rural | Baseflow Total Suspended Solids Mean (log mg/L) | 1.2 | 1.2 | 1.15 |
| Urban | CF17-Rural | Baseflow Total Nitrogen Mean (log mg/L) | 0.11 | 0.11 | -0.05 |
| Urban | CF17-Rural | Baseflow Total Phosphorus Mean (log mg/L) | -0.85 | -0.85 | -1.22 |
| Urban | CF17-Rural | Baseflow Total Suspended Solids Mean (log mg/L) | 1.2 | 1.2 | 1.15 |

Only certain parameters are reported when they pass validation

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