# Sandhills Wetland

## Basis of Design Report

| | |
|---|---|
| Client | : Byron Shire Council |
| Prepared by | : Australian Wetlands Consulting Pty Ltd |
| Project # | : 1-191194_1c |
| Date | : December 2021 |

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AWC

# Sandhills Wetland

## Basis of Design Report

# Project control

Project name: **Sandhills Wetland**
Basis of Detailed Design

Job number: 1-191194_1C
Client: Byron Shire Council
Contact: Matt Plain (Planit Consulting)

Prepared by: Australian Wetlands Consulting Pty Ltd

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| Date: | Revision: | Prepared by: | Reviewed by: | Distributed to: |
|---|---|---|---|---|
| 18/11/2021 | A | Katrina Curran and Katie Menzies | Damian McCann | Matt Plain |
| 2/12/2021 | B | Katrina Curran | Matt Plain | |
| 22/12/2021 | C | Katrina Curran | Project Team | Matt Plain |

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# 1 Introduction and Background

Sandhills Reserve is located in the heart of Byron Bay behind Clarkes Beach. Byron Shire Council (BSC) seeks to reinstate a wetland system within and around the existing drainage feature (Figure 1-1) in the eastern portion of the site consistent with consecutive adopted strategy studies and plans.

BSC has advised that the objectives of the project include improving the site's environmental and cultural values, flood mitigation, stormwater treatment and storage, integration with catchment water cycle management objectives, providing education and recreation opportunities and creating connections between key sites in and around town centre for example. This technical report is focused on the objectives most relevant to the detailed design but that should not be interpreted as diminishing the value of the other objectives BSC instruct they will deliver through other components of project delivery.

*Figure 1-1 Existing drainage feature within the Sandhills Estate conveying untreated stormwater to Clarkes Beach*

A concept design was developed by Australian Wetlands Consulting (AWC) in 2019 for a constructed stormwater wetland (AWC, 2019) which comprised of four wetland cells and a grassed swale designed to manage and treat urban stormwater flows at the site (Appendix A). The integration of flood storage was a priority project objective, and the concept design aimed to maximise storage

while enhancing ecological values and providing water treatment. Flood storage identified in the Preferred Byron Drainage Strategy (BMT WBM, 2015) indicated that a 30,000m$^2$ wetland would provide the necessary flood storage to reduce flood impacts in around the site. A large wetland footprint was designed to achieve the flood storage objective, resulting in substantial project costs and significant modification to the site and its vegetation.

In 2020, following consultation with Council and Arakwal, a revised concept report was prepared by AWC which compared three options for the constructed wetland layout (AWC, 2020). The final preferred option featured three wetland cells occupying 1.8ha in the eastern portion of the site. A number of inlet ponds and open water zones have been included in the design and positioned to provide flow buffering and enhance aesthetics. The layout of the preferred wetland option is provided in Appendix B.

AWC have subsequently been engaged to prepare a detailed design for the wetland which will consider additional studies and information that have been undertaken since the completion of the concept design. This report provides a summary of the previously completed concept design (Section 2), the information which will inform the detailed design and information gaps required to be filed (Section 3).

## 1.1 Project Objectives

The broad aim of this project is to develop the detailed design for the wetland at the Sandhills site that recognises and balances a number of various functions intended for the site including flood storage, improves water quality at the Clarkes beach outlet and enhances local environmental and cultural values.

The specific objectives for the Sandhills wetland technical detailed design are as follows:

- Protect and enhance Aboriginal cultural values of the area
- Allow access to water and sewer infrastructure for maintenance and emergency purposes
- Showcase best practice water sensitive urban design
- Improve water quality at the stormwater outlet to Clarkes beach
- Maximise flood storage to mitigate flooding of the sports field and town centre
- Improve visual and environmental amenity of the site
- Consider geotechnical investigations, detail survey and flora and fauna mapping
- Identify potential issues with the concept design
- Assess the performance of the proposed wetland for both flood capacity and treatment through modelling

# 2 Summary of Sandhills Wetland Concept Design

Key elements of the concept design (AWC, 2018 & 2020) are outlined in the following sections. These elements have been revisited during the initial phase of the detailed design and updated as necessary (refer to Section 3).

A total urban catchment area of almost 37.6 hectares generates stormflows which discharge through the Sandhills site and via an outfall at Clarkes Beach. The stormwater treatment wetland within the eastern portion of the site will capture flows from 21.4 ha of urban and urban fringe catchments. This includes flows from Lighthouse Road and Massinger Street. The final concept design consists of three wetland cells (Cell W1, Cell W2 and Cell W3) with a combined footprint of 1.8 ha.

## 2.1 Inlet Zones

Inlets (or sedimentation) ponds within the wetland cells have been included to provide flow buffering and a dedicated place for the deposition and periodic removal of sediment. Inlet ponds have been positioned adjacent to the inlet of each wetland cell for ease of access for routine inspections and maintenance. The inlet ponds proposed are to be 0.8 – 1.0m deep have been sized to remove 90% of sediments ≥125µm. Details of the inlet zones, including sizing, will be revisited during the detailed design phase using available hydrological data and information on site soils.

Small open water zones are proposed at spillways to facilitate maintenance, enhance water quality, provide refugia for aquatic species and enhance aesthetics. Access to open water zones will be restricted by dense planting. Further assessment of site safety and the requirement for additional features such as safety benches and fencing will be undertaken during detailed design with consideration of visual amenity.

A key consideration for inlet zones during detailed design is the presence of any Potential Acid Sulphate Soil (PASS) materials.

## 2.2 Wetland Vegetation

A preliminary plant species list was provided in the concept design which included plants species known to be found on the site (Kooyman, 2018) and ecological understanding of local wetland environments. This list will be updated based on findings from the latest vegetation mapping. The focus of the Detailed Design is to enhance and regenerate existing site vegetation including frog habitat.

## 2.3 Inlets and Outlets

The concept design proposed using the existing infrastructure for the inlets to cells W1 and W2. These are to be retained and will not be significantly modified. The concept design proposed an inlet to the third wetland cell in the south-west of the site adjacent to Cowper St which would allow flows generated in the southern Byron township to enter the wetland system. Review of topographic survey indicates that flows cannot be conveyed to the wetland from the south due to the invert level of the pipe. It may be possible to install a pit in the corner of the sports field to

relieve localised flooding and convey flows into the wetland. The design of this structure is not included in the current detailed design scope.

Three weirs were included in the concept design to convey flows between wetland Cells W1–W2 and Cells W2–W3. Trafficable weirs are proposed to provide access around and through the wetland. Sizing of the weirs will be revisited during the detailed design to ensure they can safely convey the required flows.

Given the changes made to of the initial concept design following a revised scope (AWC, 2020) the outlet from cell W4 and conveyance of flows to the outlet at Clarkes Beach will require careful consideration during the detailed design. Exfiltration through the sand will be facilitated where possible to reduce the visual and environmental impacts associated with the release of stormwater on Clarkes Beach.

## 2.4 Access and Pathways

A number of pathways were included in the concept design plan to provide access for maintenance to wetland and existing Council infrastructure and to deliver public amenity by providing cycling and walking routes which allow for appreciation of the site and connection to the CBD, Arakwal Cultural Centre, beach, sports fields and surrounding area. The preliminary layout of pathways will need to be modified to complement the final detailed design. AWC recommends the preparation of detailed design for the pathway design in parallel with the wetland design. Presently the scope of works only includes the wetland design.

Pathways within and around the wetland will need to be considered during the detailed design to ensure access and safety requirements are integrated on the site. Additional pricing for pathway design has been provided by AWC.

# 3 Basis of Detailed Design

The following sections outline the information which will be used to inform the development of the detailed design and revision of the concept design. Since the completion of the concept design several additional studies and assessments have been undertaken which provide further knowledge of the site and its constraints.

## 3.1 Environmental Assessment Requirements

The Planning Secretary's Environmental Assessment Requirements (SEARs) have been provided. Under Section 4.12(8) of the *Environmental Planning and Assessment Act 1979* (EP&A act), an Environmental Impact Statement (EIS) is required to gain approval and must assess the proposal against all relevant environmental planning instruments.

A full and comprehensive ecological assessment is required to be undertaken given the known presences of threatened species and/ or their associated habitat. The EIS will assess impacts to:

- Biodiversity
- Acid sulphate soils
- Flooding, stormwater, and coastal erosion
- Cumulative impacts from both construction and operational activities considering other proposals in the vicinity

The key issues that the detailed design will need to respond to include the groundwater dependent ecosystems and frog habitat (refer to Section 3.2). Groundwater assessment is discussed in Section 3.5.

## 3.2 Ecology

An ecological investigation was conducted by the project team and mapping vegetation communities (Figure 3-1) and threatened fauna on the site (Figure 3-2). AWC acknowledges the potential issues outlined in the SEARS and recognises that threatened species (such as the Wallum Froglet (*Crinia tinnula*)) and their habitat need to be considered in the detailed design to avoid and minimise any potential negative impacts. Redesigning of the wetland footprint is required to avoid ecologically sensitive areas.

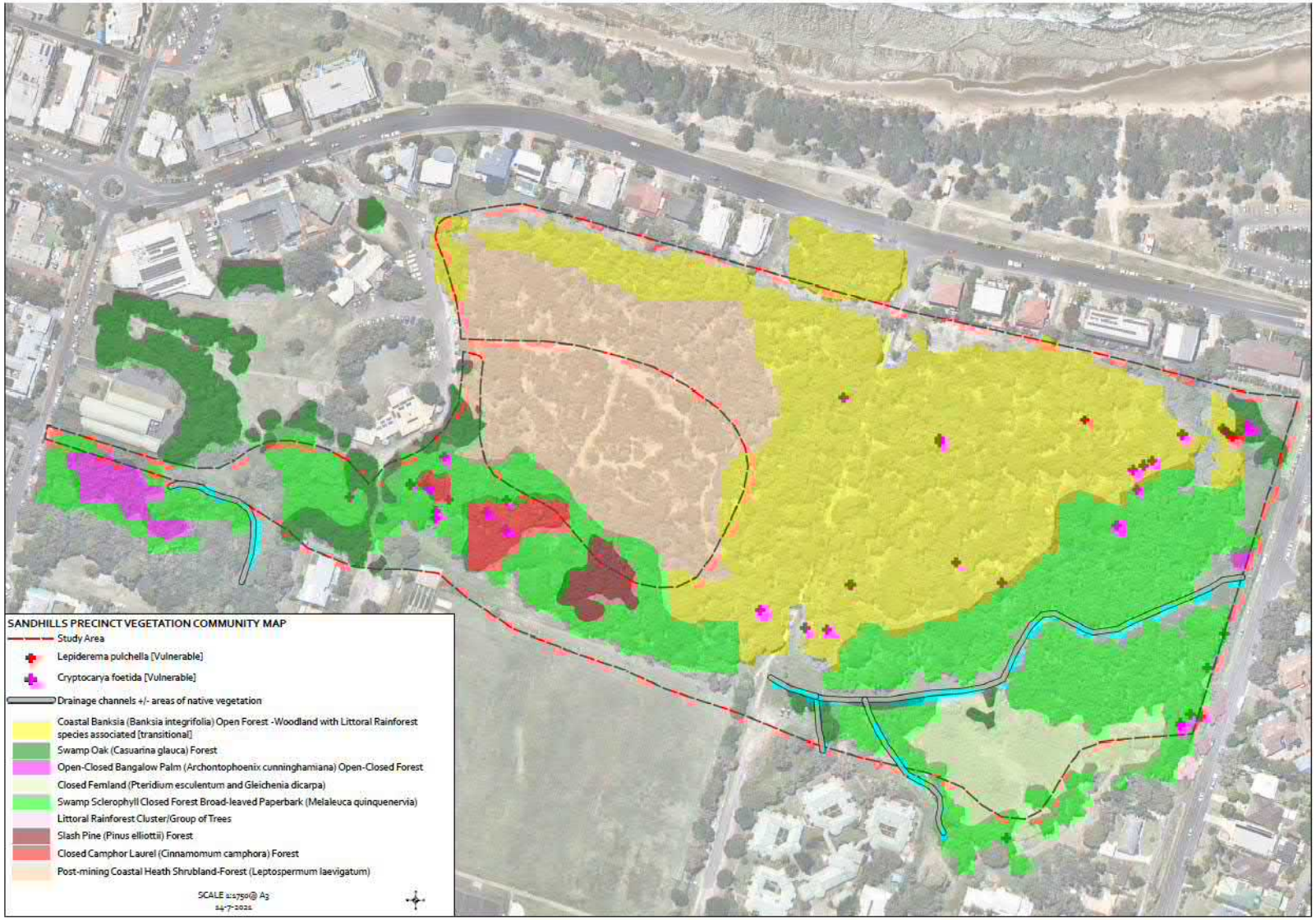


*Figure 3-1 Sandhills vegetation communities map (Planit 2021)*

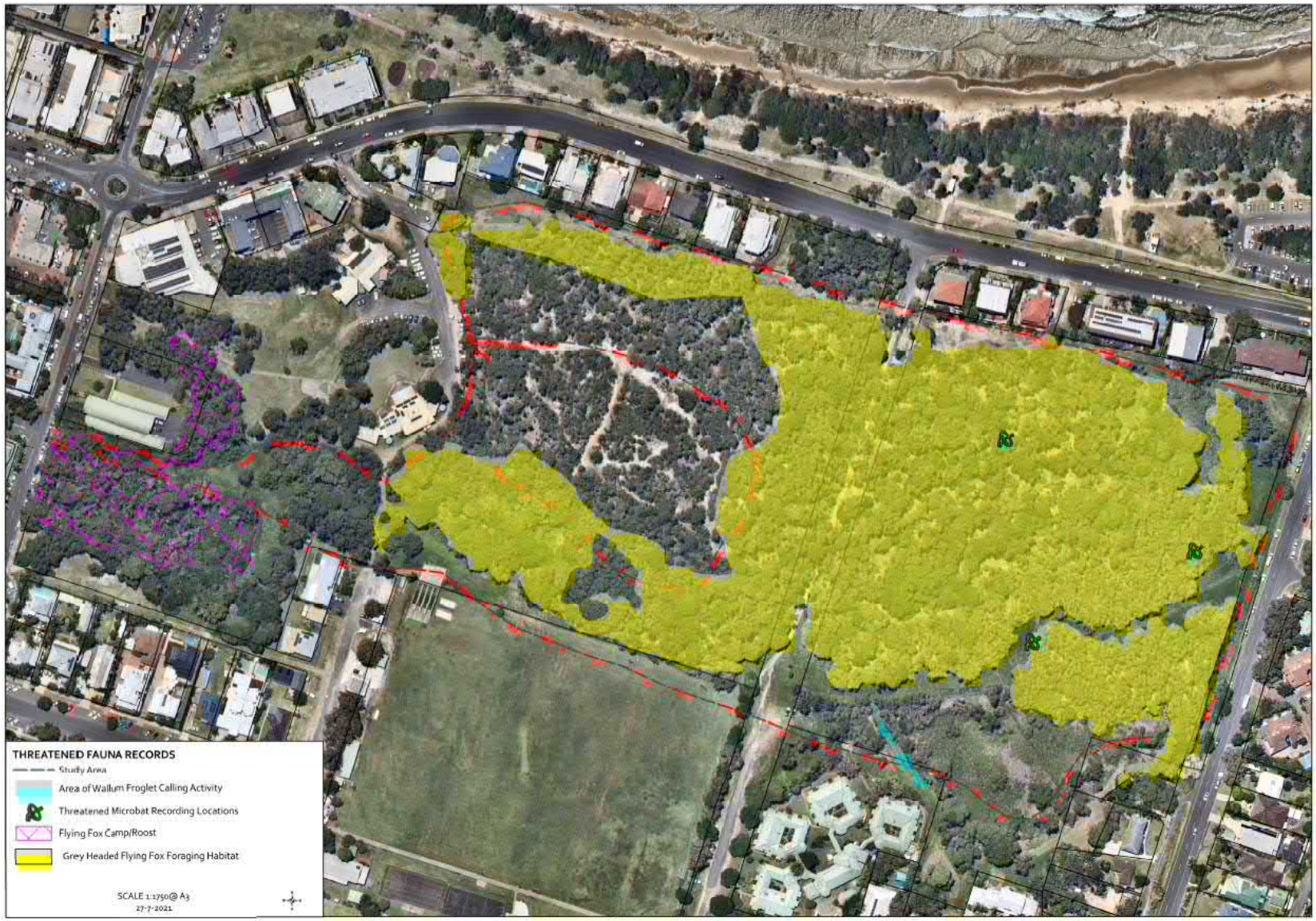


*Figure 3-2 Sandhills threaten fauna records map (Planit, 2021)*

## 3.3 Detailed Topographic Survey

The detailed design must respond to the natural layout of the site to ensure that stormwater will move appropriately through the system and interface with the existing stormwater network. Detailed survey of the site was provided in September 2021 (Byron Bay Surveyors, 2021) which provides the natural surface levels and the levels of key infrastructure on the site.

Some 2021 survey data levels are different to the previous survey used in the concept design which affects certain key levels within the wetland system. Most significantly, the stormwater pipe proposed to discharge flows to the southern-most inlet zone of cell W3 (receiving flows from Cowper Street and the catchment to the south of the site) has an invert level below the proposed standing water level of cell W3 and thus does not allow for free flow of water into the wetland from this catchment. A submerged inlet is not considered feasible due to the very low grade of the stormwater pipe running to the north along Cowper Street.

## 3.4 Water Quality

Improving the stormwater quality at the stormwater outlet to Clarkes beach (the discharge point from the site) is a key objective for the project. Regular testing by Council has recorded poor water quality on many occasions. The latest water quality data is provided in Table 3-1. Of particular concern are the high levels of *E. coli* and Enterococci which indicate faecal coliform pollution presenting a risk to public health on Clarkes Beach.

*Table 3-1 Stormwater quality at Clarkes beach outlet, Source Byron Shire Council (2021)*

| Date | Conductivity ($\mu Scm^{-1}$) | *E. coli* (MPN/100mL) | Enterococci (cfu/100mL) | Suspended solids (mg/L) | Total Phosphorus (mg/L) | Total Nitrogen (mg/L) |
|---|---|---|---|---|---|---|
| 19/02/2020 | 39,292 | 395 | 370 | 30 | 0.07 | 1.28 |
| 6/03/2020 | 39,991 | 1,850 | 200 | 6 | 0.07 | 1.24 |
| 9/04/2020 | 256 | 650 | 700 | 9.5 | 0.04 | 0.92 |
| 8/05/2020 | 37,968 | 345 | 650 | 9.5 | 0.03 | 0.77 |
| 11/06/2020 | 457 | 2,755 | 670 | 4.7 | 0.05 | 0.7 |
| 15/07/2020 | 38,266 | 857 | 1,470 | 8.5 | 0.04 | 0.9 |
| 13/08/2020 | 241 | 63 | 70 | 9 | 0.04 | 1 |
| 24/09/2020 | 7,725 | 31 | 380 | 16 | 0.02 | 0.82 |
| 17/12/2020 | 202 | 6,510 | 6,200 | 16 | 0.06 | 0.75 |
| 25/02/2021 | 244 | 486 | 960 | 8.5 | 0.07 | 1.51 |
| 25/03/2021 | 175 | 432 | 1,360 | 132 | 0.26 | 2.61 |

Pollution modelling of the revised concept design using the modelling software MUSIC was undertaken to assess the treatment effectiveness of the wetlands. The MUSIC model uses a 6-minute timestep and is in accordance with the MUSIC Modelling Guidelines (Water by Design, 2010). The layout of the model is provided in Figure 3-3.

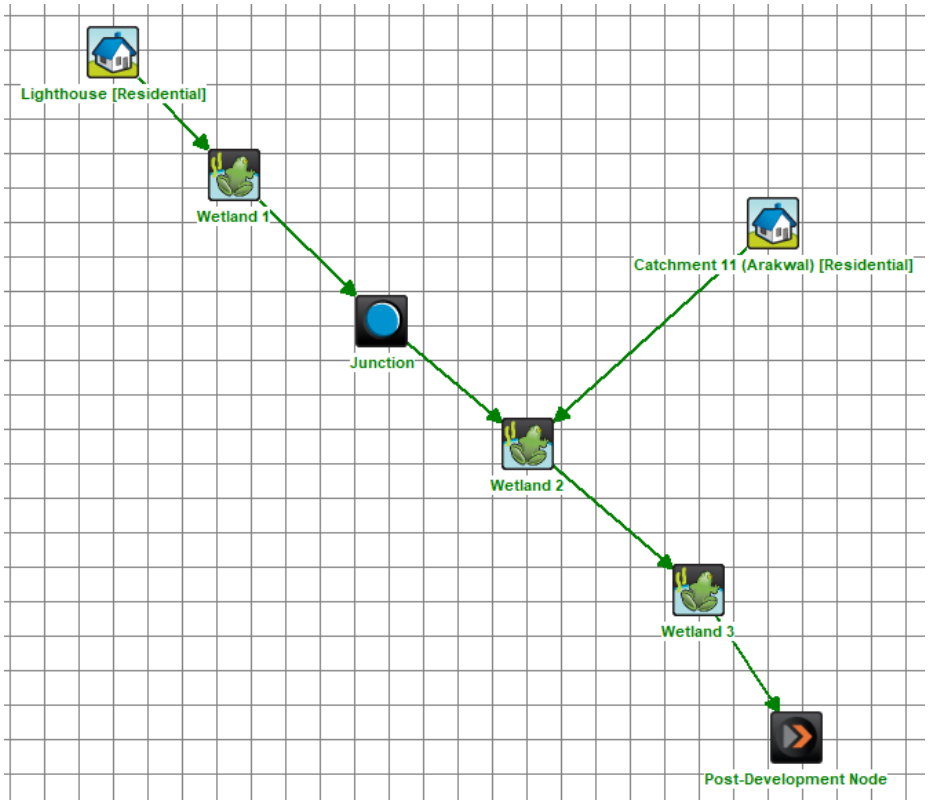


*Figure 3-3 MUSIC model layout*

The results of the MUSIC model indicate that the wetland will provide high levels of treatment for stormwater flows (Table 3-2). The modelled reduction in nutrients demonstrates that the wetland will significantly improve the quality of water discharging to Clarkes Beach. The model predicts a 44% reduction in flows and 50% reduction in Total Nitrogen. Review of the wetland node water balance indicates that the flow reductions can be attributed to infiltration.

*Table 3-2: MUSIC model results for the Detailed Design*

| Parameter | % Reduction | BSC DCP Required Reductions (%) |
|---|---|---|
| Total Suspended Solids (kg/yr) | 71.6 | NA |
| Total Phosphorus (kg/yr) | 66 | 80 |
| Total Nitrogen (kg/yr) | 52.1 | 40 |
| Gross pollutants | 100 | NA |

## 3.5 Groundwater and Acid Sulphate Soils

Soil sampling was conducted on the 29 June 2021 (ENV, 2021) comprising six boreholes, located within the footprint of the three wetland cells, to a maximum depth of 5.0 m BGL (Below Ground Level). The sampling was undertaken during a period of wet weather and encountered groundwater between a depth of 1 and 2.5 m BGL (Table 3-4) with the variation due to the undulating ground surface and proximity to surface drains.

Borehole sampling results indicate groundwater levels are higher in the vicinity of wetland cell 1 and in some elevated areas of the site. Boreholes sampled adjacent to the existing drain show groundwater is lowered around the drain as would be expected. This indicates that the existing drain is the main control on local groundwater levels.

*Table 3-3– Summary of groundwater level results from borehole log records*

| BH | Surface level (m AHD) | GW (BGL) | GW level (m AHD) | Wetland design floor (m AHD) |
|---|---|---|---|---|
| 1 | 3.3 | 1.5 | 1.5 | 1.8 |
| 2 | 4.49 | 2.45 | 2.04 | 2.3 |
| 3 | 2.75 | 2.0 | 0.75 | 2.3 |
| 4 | 2.74 | 1 | 1.75 | 2 |
| 5 | 2.68 | 1.5 | 1.18 | 1.8 |
| 6 | 2.95 | 1.5 | 1.45 | 1.45 |

A comparison of the revised concept wetland design indicate that all wetland floor levels are above the recorded groundwater levels (Table 3-4). The seasonal fluctuations in groundwater levels are recognised as an important design consideration. The planned installation of ground and surface water loggers will further inform design and ensure that wetland floors and groundwater levels are considered in conjunction with the intended flood mitigation function of the wetland.

When waterlogged, as would generally occur within a wetland ASS materials are generally benign and do not pose a significant risk (Sullivan *et al.*,2018). However, disturbance and exposure to oxygen can result in deoxygenation of waterbodies and a number of hazards including acidification of soil and drainage waters leading to fish kills and loss of biodiversity in wetlands. It is essential to recognise that in some cases soil acidity is not associated with environmental hazard. Acidic soils are found within acidophilic ecosystems which require acidic conditions for ecosystem health. The presence of acid frog habitats on the site indicates that the surface acidic conditions would be classified as natural and low risk. Key issues that need to be considered in the wetland construction and design include protection and maintenance of this naturally acidic frog habitat.

Typically, Actual Acid Sulphate Soils (AASS) overlie potential acid sulphate soils (PASS). Analytical results of the soil samples indicate that the majority of the material sampled comprised AASS with potential acid sulphate soils PASS occurring at discrete sample points and at depth. The maximum sampling depth through the centre of the wetland envelope was 2.5 m BGL, therefore it is generally assumed that PASS could potentially occur in soils between 2.0 and 5.0 m BGL. Comparison of wetland floor construction depths and PASS levels indicate that all proposed construction levels are above the PASS levels except W1 (BH2) (Table 3-5). It is intended to move wetland Cell W1 to the west following review of the concept design by BSC which may allow for avoidance of PASS materials in this area. It is also possible that the wetland floor can be raised to avoid interaction with the PASS layer (this will reduce the amount of excavation). Further sampling is recommended within wetland Cell W1 to assist with the detailed design.

*Table 3-4 Borehole, PASS level and wetland floor construction depth*

| BH | PASS level (m AHD) | Wetland floor construction depth (m AHD) | Comment |
|---|---|---|---|
| 1 | 1.3 | 1.5 | Excavation above PASS |
| 2 | 2.49 | 2 | Excavation below PASS |
| 3 | 0.75 | 2 | Excavation above PASS |
| 4 | 0.74 | 1.7 | Excavation above PASS |
| 5 | 0.68 | 1.5 | Excavation above PASS |
| 6 | 0.95 | 1.5 | Excavation above PASS |

Further consideration of the depth of excavation and location of deep zones is also required based on the depths of PASS materials. Deep zones are proposed for two purposes; firstly, to function as inlet zones for sedimentation of suspended pollutants, and secondly to provide for habitat and refugia for aquatic biota. The PASS levels within the wetland indicate that deep zones as currently proposed will be within the PASS materials. Further design work and investigation is pertinent to determine if avoidance of PASS materials is essential based on groundwater levels and the importance of deep zones for aesthetics and habitat.

## 3.6 Flooding

Flood storage was an important requirement for the Sandhills wetland concept design as identified in the Preferred Byron Drainage Strategy (WBM BMT, 2015). Flood storage is provided within the wetland at levels above the operating water level and extended detention depth. The revised Concept Design had a reduced footprint and as such a reduced flood storage volume.

The wetland footprint is proposed to be further reduced in the detailed design phase in response to the additional information on site ecology and other proposed future uses of the site. A flexible outlet arrangement is proposed for the wetland this will allow for additional storage to be provided if required in the future. An additional option to relieve flooding on the sports field has been identified but is not included in the current detailed design.

No assessment of flood storage and behavior via modelling (e.g. RAFTS and TUFLOW) has been completed nor costed as part of the detailed design. The SEAR identifies that the following must be demonstrated:

- Consistency with floodplain risk management plans
- Compatibility with flood hazard
- Identification of any potential significant adverse flood affects to adjacent properties
- Appropriate measures to manage risk to life from flood
- Implications of the development over the full range of potential flooding

The proposed wetland does not involve any modifications to the outlet and movement of water into the site. The existing inflow points are all to be maintained and unaltered. The invert of all pipes has been considered in the design and cell floors and operating water levels are all below incoming pipes to prevent any impacts to upstream catchments and properties. The removal of fill from the site will provide additional storage on the site but ultimately it is the size and capacity of the existing pipe and outflow to the beach that constrains flood behaviour on the site both the existing condition and post wetland construction. It is identified that the culverts under Lawson Street are

to be upgraded in the future, this will allow greater discharge via the beachfront and further reduce flooding in the township. The Belongil Floodplain Risk Management Plan also identified possible berms adjacent to Cowper St and the southern boundary of the site to contain floodwater during major events. These are not included in the wetland detailed design.

The design intent is to capture and slowly release rainfall events whilst allowing for safe conveyance of larger events. The existing drainage channel and adjacent sport fields are inundated in the 10-year event (10% AEP). The proposed wetland footprint provides a flood storage volume of 6000m$^3$ which extends beyond the mapped area for the existing 10 year event. The wetland will allow flows to spread out and reduce upstream impacts, but the highly complex nature of the site and catchment inflows indicates that modelling outside of the current design scope is required to understand the implications of the development for the full range of storm events.

## 3.7 Design Storm Flows

Inlets and outlets and connections between wetland cells will be designed to ensure that storm flows are managed through the wetland cells. Sizing of inlet pipes and overflow structures must consider the following:

- 3 month or 1 year design flows
- 100 year design flows

In the case of the Sandhills wetland no modification is proposed to the current inflow arrangement into Cells W1 and W2. The more frequent flows will be used for the sizing of inlet sedimentation zones. High flows have been obtained from information supplied by Planit Consulting which include the modelled discharge (DRAINS) for the upgraded pipe currently under construction as part of the Lighthouse Road upgrades. Review of the drawings identifies that the pipe discharge is 2.335m$^3$/s, which is understood to be the 20% AEP or approximately 5 year ARI.

The flows entering into Cell W1 has been determined using the rational method. A summary of the key design flows ae summarised below in Table

*Table 3-5 Design flows for the Sandhills Wetland*

| Wetland Cell | Inlet flow (m$^3$/sec) | Overflow (m$^3$/sec) |
|---|---|---|
| W1 | 0.247 | 1 |
| W2 | 2.35 | 3.35 |

## 3.8 Hydraulic Control Structures

Hydraulic control structures within the Sandhills wetland will serve three purposes:

1. To restrict low flows to provide the desired hydraulic residence time for water quality improvement
2. To convey flows between cells
3. To safely convey the high flows across the wetland

The restriction of inflows to ensure water quality improvement will be provided by accessible riser outlet to provide the staged discharge for the range of depths within the wetland cell. A piped connection from the riser outlet will convey flows into the next downstream wetland cell. Weirs are located between Cell W1 and Cell W2 to convey flows up to the Q100 yr ARI storm.

The key hydraulic structures to be designed for the Sandhills wetland including their locations and contributing catchment and flows is summarised in Table 3-7.

A new stormwater outlet is being constructed at the inlet to Cell W1 as part of the Lighthouse Road upgrades these works have been reviewed and are suitable for integration with the wetland design.

*Table 3-6 Summary of required hydraulic structures, contributing catchments and source from which flow was determined*

| Wetland Cell | Inlet | Outlet | Overflow weir | Contributing catchment | Flows obtained from |
|---|---|---|---|---|---|
| W1 | No modification proposed | New pit and pipe to convey flows to Cell W2 | Designed for 1% AEP | Lawson Street and adjacent residential properties in the north | Rational method calculations |
| W2 | No modification proposed | New pit and pipe to convey flows to Cell W3 | Designed for 1% AEP | Massinger Street and Paterson Lane to the east | DRAINS model developed for Lighthouse Road upgrade works (Planit, 2021) |
| W3 | New pit and pipe to convey design flows from W3 and minor drainage channels | New pit and riser to tie in with existing outlet pipe and pit | None | Combined flows from both Cell W1 and Cell W2 | Sum of the W1 and W2 flows |

# 4 Detailed Design (Rev A)

Following the provision of additional site information from the project team there has been some revision to the wetland footprint and design levels. This has been completed in response to additional information provided, in particular the site ecology, ASS sampling and topographic survey. The following modifications have been made to the preferred concept:

1. Lowered wetland floor levels in response to
    - Site survey
    - Existing drainage system outlet levels
    - Grade to properties adjacent to the site (prevent upstream impacts)
    - Providing suitable levels for enhancement of frog habitat (Cell W3)
2. Relocation and reshaping of Cell W1 as requested by BSC
3. Modifications to Cell W2 to allow better access to services
4. Reshaping of Cell W2 enhance hydrological function
5. Reshaping of Cell W3 avoid impacts to frog habitat
6. Removal of central berm in Cell W3
7. Removal of inlet from stormwater pipe flowing north along Cowper Street

The revised wetland footprint will now result in approximately 20,000$m^3$ of cut and provide approximately 6000$m^3$ of storage (dependent on preceding conditions).

The detailed design revised layout plan is provided in Appendix C

# 5 Next Steps and Conclusion

The following steps have been undertaken to finalise the progress the Sandhills wetland detailed design:

- Review of new survey data and correction of for levels
- Review of ASS and groundwater sampling results
- Assessment of design flows
- Reshaping of cells to minimise impacts on local ecology

The following additional information is required:

- Additional groundwater monitoring (in progress)
- Surface water monitoring (in progress)
- Additional ASS sampling (in progress)
- Confirmation and discussion of pathway design

The next steps to finalise the detailed design are as follows:

- Presentation of design and discussion with Project Team
- Finalisation of detailed design documentation including:
    - Layout plans
    - Sections
    - Hydraulic Control Structures
    - Planting plans
    - Bill of Quantities
    - Technical Specification

# 6 References

AWC (2019). *Sandhills Estate WSUD Draft Concept Design Report*, prepared for Byron Shire Council

Byron Bay Surveying (2021). Plan of Detail Survey- Sandhills Wetland

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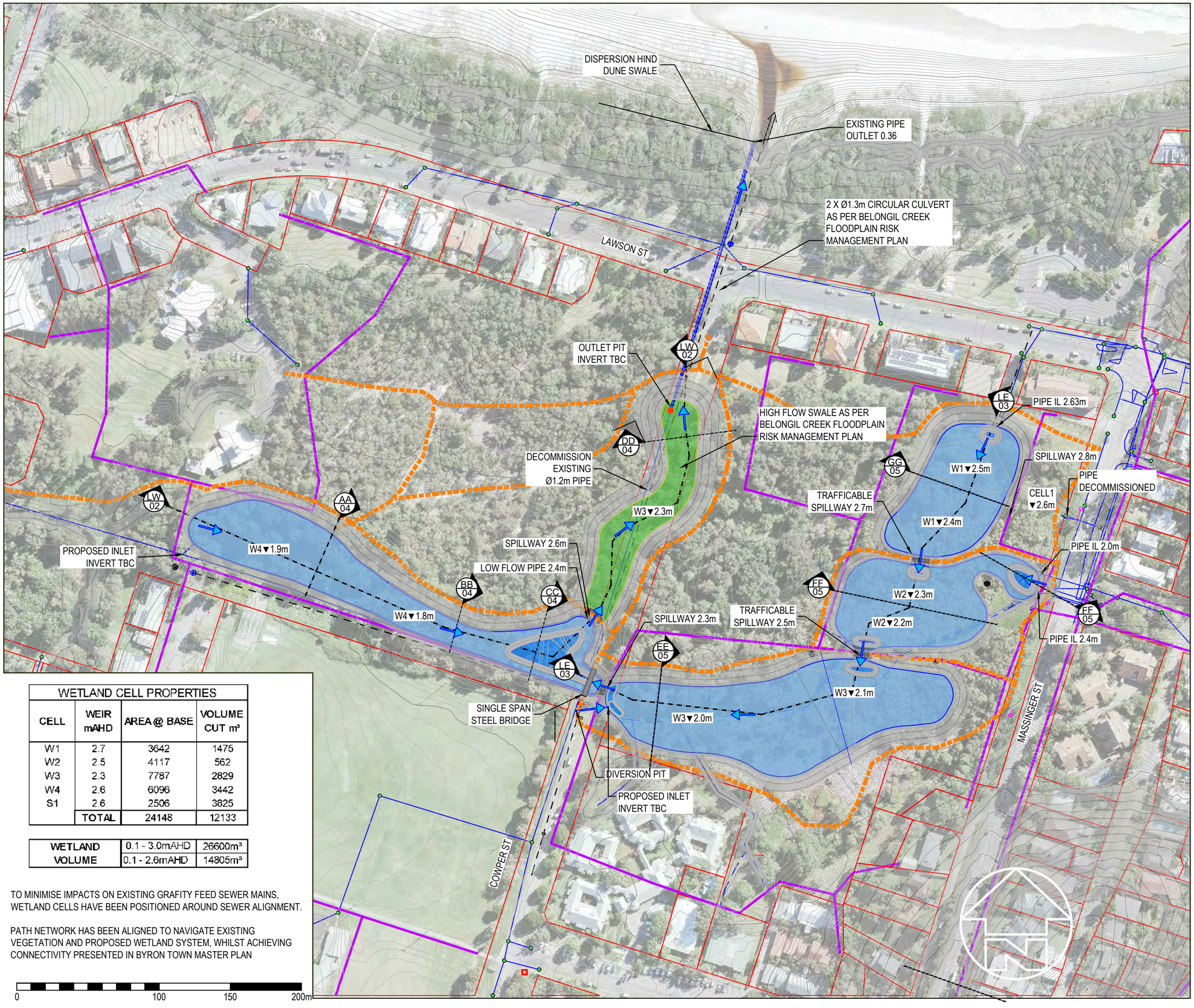
Sullivan, L., Ward, N., Toppler, N., and Lancaster, G. (2018). *National Acid Sulphate Soils Guidance: National acid sulphate soils sampling and identification methods manual.* Department of Agriculture and Water Resources, Canberra.

WBM BMT (2015). Belongil Creek Floodplain Risk Management Plan

# Appendix A – Concept Design




| WETLAND CELL PROPERTIES | | | |
|---|---|---|---|
| CELL | WEIR mAHD | AREA @ BASE | VOLUME CUT m³ |
| W1 | 2.7 | 3642 | 1475 |
| W2 | 2.5 | 4117 | 562 |
| W3 | 2.3 | 7787 | 2829 |
| W4 | 2.6 | 6096 | 3442 |
| S1 | 2.6 | 2506 | 3825 |
| | TOTAL | 24148 | 12133 |

| | | |
|---|---|---|
| WETLAND VOLUME | 0.1 - 3.0mAHD | 26600m³ |
| | 0.1 - 2.6mAHD | 14805m³ |

TO MINIMISE IMPACTS ON EXISTING GRAFITY FEED SEWER MAINS, WETLAND CELLS HAVE BEEN POSITIONED AROUND SEWER ALIGNMENT.

PATH NETWORK HAS BEEN ALIGNED TO NAVIGATE EXISTING VEGETATION AND PROPOSED WETLAND SYSTEM, WHILST ACHIEVING CONNECTIVITY PRESENTED IN BYRON TOWN MASTER PLAN

0 100 150 200m

**LEGEND**

- WETLAND (DEPTH 0.0 - 0.3m)
- OPEN WATER ZONE (DEPTH 1.0 - 2.0m)
- EPHEMERAL CREEK
- PROPOSED WALKING / ACCESS TRACK
- EXISTING SEWER ALIGNMENT
- EXISTING SEWER ALIGNMENT
- S/W PIPE HEADWALL
- PROPOSED ROCK SPILLWAY
- FLOW DIRECTION
- EXISTING TRUNK DRAINAGE
- EXISTING STORMWATER PIT
- CADASTRAL BOUNDARIES
- PROPOSED STORMWATER PIPE

*PROJECT*

**SANDHILLS WETLAND CONCEPT DESIGN AND WATERWAY REHABILITATION PLAN**

*DRAWING*

**GENERAL ARRANGEMENT PLAN**

*CLIENT*

**BYRON SHIRE COUNCIL**

| REV. | ISSUE / AMENDMENTS | DATE |
|---|---|---|
| A | 50% CONCEPT DESIGN | 12.11.2018 |
| A | 90% CONCEPT DESIGN | 07.12.2018 |

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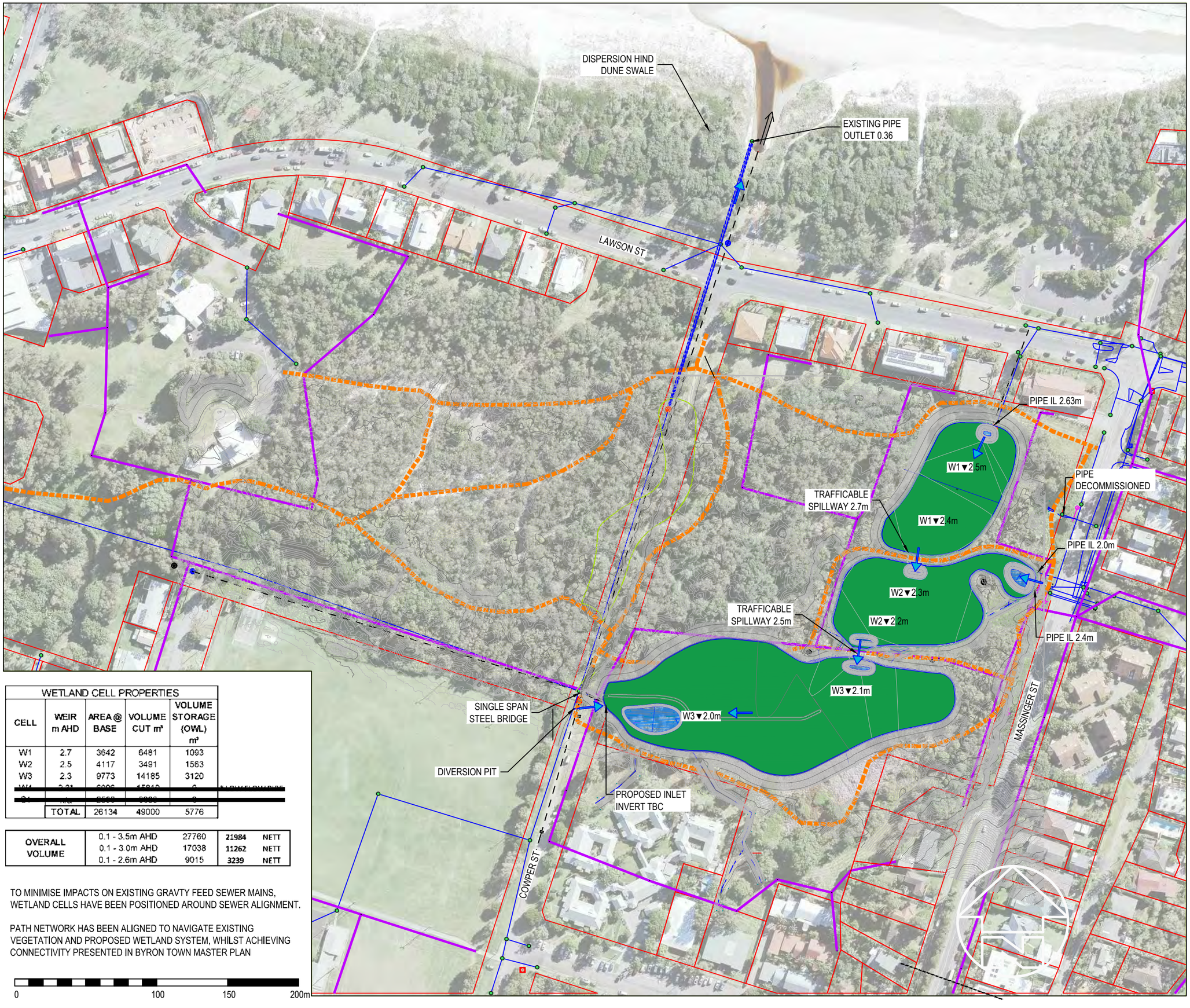
| | | | |
|---|---|---|---|
| SCALE | 1:2000 @ A3 (0 50 100m) | DWG No. | 1-181030_01 |
| DESIGNED | SS/KC/RBS | CAD FILE No. | 1-181030.dwg |
| DRAWN | SS/RBS | | |
| CHECKED | MB | REV. | B |
| DRAWING CREATED | 06/11/2018 | | |

# Appendix B – Preferred Concept Design




| WETLAND CELL PROPERTIES | | | | |
|---|---|---|---|---|
| CELL | WEIR m AHD | AREA @ BASE | VOLUME CUT m³ | VOLUME STORAGE (OWL) m³ |
| W1 | 2.7 | 3642 | 6481 | 1093 |
| W2 | 2.5 | 4117 | 3491 | 1563 |
| W3 | 2.3 | 9773 | 14185 | 3120 |
| ~~W4~~ | ~~2.31~~ | ~~6006~~ | ~~15218~~ | ~~0~~ |
| ~~S1~~ | ~~NIL~~ | ~~6502~~ | ~~6002~~ | ~~0~~ |
| | TOTAL | 26134 | 49000 | 5776 |

| | | | | |
|---|---|---|---|---|
| OVERALL VOLUME | 0.1 - 3.5m AHD | 27760 | **21984** | NETT |
| | 0.1 - 3.0m AHD | 17038 | **11262** | NETT |
| | 0.1 - 2.6m AHD | 9015 | **3239** | NETT |

TO MINIMISE IMPACTS ON EXISTING GRAVTY FEED SEWER MAINS, WETLAND CELLS HAVE BEEN POSITIONED AROUND SEWER ALIGNMENT.

PATH NETWORK HAS BEEN ALIGNED TO NAVIGATE EXISTING VEGETATION AND PROPOSED WETLAND SYSTEM, WHILST ACHIEVING CONNECTIVITY PRESENTED IN BYRON TOWN MASTER PLAN

0 100 150 200m

***LEGEND***

- WETLAND (DEPTH 0.0 - 0.3m)
- OPEN WATER ZONE (DEPTH 1.0 - 2.0m)
- EPHEMERAL CREEK
- EXTENT OF PONDING AT RL.3.5m AHD
- PROPOSED WALKING / ACCESS TRACK
- EXISTING SEWER ALIGNMENT
- EXISTING SEWER ALIGNMENT
- S/W PIPE HEADWALL
- PROPOSED ROCK SPILLWAY
- FLOW DIRECTION
- EXISTING TRUNK DRAINAGE
- EXISTING STORMWATER PIT
- CADASTRAL BOUNDARIES
- PROPOSED STORMWATER PIPE

*PROJECT*

**SANDHILLS WETLAND CONCEPT DESIGN AND WATERWAY REHABILITATION PLAN**

*DRAWING*

**GENERAL ARRANGEMENT PLAN SCENARIO 1**

*CLIENT*

**BYRON SHIRE COUNCIL**

| REV. | ISSUE / AMENDMENTS | DATE |
|---|---|---|
| A | REHABILITATION PLAN | 17.12.2018 |
| B | REHABILITATION PLAN | 14.06.2019 |
| C | REHABILITATION PLAN | 13.08.2019 |
| D | MODIFIED & STAGED PLAN | 25.02.2020 |

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| | | | |
|---|---|---|---|
| SCALE | 1:2000 @ A3 | DWG No. | 1-181030_01 |
| 0 | 50 100m | | |
| DESIGNED | SS/KC/RBS | CAD FILE No. | 1-181030.dwg |
| DRAWN | SS/RBS | | |
| CHECKED | MB | REV. | D |
| DRAWING CREATED | 06/11/2018 | | |

# Appendix C – Detailed Design Layout Plan

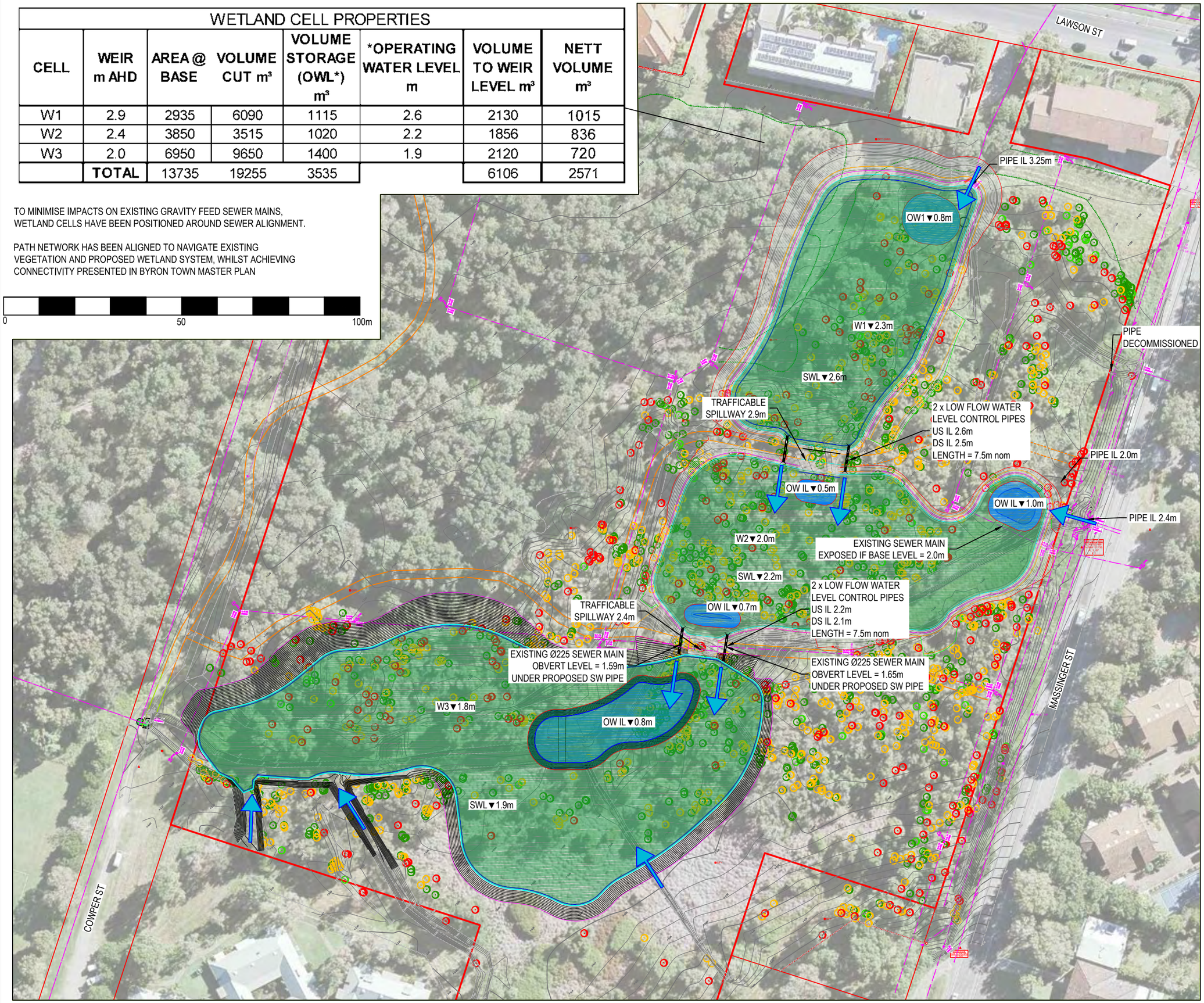
## WETLAND CELL PROPERTIES

| CELL | WEIR m AHD | AREA @ BASE | VOLUME CUT m³ | VOLUME STORAGE (OWL*) m³ | *OPERATING WATER LEVEL m | VOLUME TO WEIR LEVEL m³ | NETT VOLUME m³ |
|---|---|---|---|---|---|---|---|
| W1 | 2.9 | 2935 | 6090 | 1115 | 2.6 | 2130 | 1015 |
| W2 | 2.4 | 3850 | 3515 | 1020 | 2.2 | 1856 | 836 |
| W3 | 2.0 | 6950 | 9650 | 1400 | 1.9 | 2120 | 720 |
| | **TOTAL** | 13735 | 19255 | 3535 | | 6106 | 2571 |

TO MINIMISE IMPACTS ON EXISTING GRAVITY FEED SEWER MAINS, WETLAND CELLS HAVE BEEN POSITIONED AROUND SEWER ALIGNMENT.

PATH NETWORK HAS BEEN ALIGNED TO NAVIGATE EXISTING VEGETATION AND PROPOSED WETLAND SYSTEM, WHILST ACHIEVING CONNECTIVITY PRESENTED IN BYRON TOWN MASTER PLAN

0 50 100m




### LEGEND

- WETLAND (DEPTH 0.0 - 0.3m)
- OPEN WATER ZONE (DEPTH 1.0 - 2.0m)
- PROPOSED WALKING / ACCESS TRACK
- EXISTING SEWER ALIGNMENT
- EXISTING SEWER ACCESS
- S/W PIPE HEADWALL
- PROPOSED ROCK SPILLWAY
- FLOW DIRECTION
- EXISTING TRUNK DRAINAGE (COUNCIL)
- EXISTING STORMWATER PIT
- CADASTRAL BOUNDARIES
- PROPOSED STORMWATER PIPE

PROJECT
**SANDHILLS WETLAND DETAIL DESIGN & WATERWAY REHABILITATION PLAN**

DRAWING
**GENERAL ARRANGEMENT PLAN PREFERRED SCENARIO**

CLIENT
**BYRON SHIRE COUNCIL**

| REV. | ISSUE / AMENDMENTS | DATE |
|---|---|---|
| A | DETAIL DESIGN | 17.11.2021 |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| | | | |
|---|---|---|---|
| SCALE | 1:1000 @ A3 | DWG No. | 1-191194_01 |
| DESIGNED | SS/KC/RBS | CAD FILE No. | 1-191194.dwg |
| DRAWN | SS/RBS | | |
| CHECKED | MB | REV. | A |
| DRAWING CREATED | 29/09/2021 | | |


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