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CONSTRUCTION WATER MANAGEMENT PLAN (CWMP)

Sandhills Stormwater Management System
Cowper Street, Byron Bay NSW 2481

For:
Byron Shire Council

By:
ENV Services Pty Ltd

Date:
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Scope of Engagement and Limitations:

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1 Introduction

1.1 Background

ENV Services Pty Ltd (ENV) were engaged by Byron Shire Council ('Council' or 'the client') to prepare a Construction Water Management Plan (CWMP) to facilitate the construction of three (3) wetland cells within the parcel of land identified as Lot 383 DP728202 (herein referred to as the 'site'). The site is located at Cowper Street, Byron Bay NSW 2481. The regional location of the site is shown as Figure 1, Appendix A.

The purpose of this CWMP is to detail specific construction water (surface water and rainfall event) management and water treatment methodologies (if required) to successfully construct the three wetland cells (W1, W2 & W3) proposed within the development (Appendix B).

1.2 Proposed Development

ENV understands that Council intends to develop the site as a constructed wetland with walking tracks for public recreation use. The constructed wetland is to be situated in the eastern part of the site and will comprise three (3) cells (W1, W2 and W3) with trafficable spillways connecting each cell. Additionally 1,500 m of walking tracks will be constructed across the site area to facilitate recreational use of the site. Design drawings are provided in Appendix B.

Following review of Wetlands Construction Options Report (Planit, 2022) it is understood that the preferred construction methodology is to undertake the entirety of the proposed scope in a logical, sequential and sustainable order. This methodology consists of the systematic staging of construction of each wetland whereby the following phases; clearing and grubbing, bulk earthworks, stormwater, topsoiling and planting, inlet and outlet works and compensatory planting shall be carried out.

1.3 Stakeholder Identification

Table 1 outlines immediate direct (internal) and indirect (external) stakeholders with an interest or concern in construction works associated with the proposed woks outlined in Section 1.2.

Table 1: Stakeholder Identification

Stakeholder	Role or Position	Status
Byron Shire Council	Client & Local Authority	Internal
Planit Consulting	Planning Consultants	Internal
TBD	Construction Contractor	Internal
Surrounding Property Owners	Potentially Impacted	External
Arakwal People	Aboriginal Traditional Custodians	External

2 Reference Documentation

The following CWMP has been developed following review of the following letters, investigations and management plans:

- Australian Wetlands Consulting (2022). Re Sandhills Wetland Project, Lot 457 DP1087879 and Lot 383 DP 728202, Byron Bay – Response to SEARs 1587. Dated November 2022
- ENV Solutions (2023 V2). Acid Sulfate Soils Management Plan. Sandhills Wetland Project – Cowper Street, Byron Bay NSW. Dated December 2023.
- ENV Solutions (2023 Rev1). Detailed Site Investigation. Sandhills Wetland Project, Cowper Street, Byron Bay NSW. Dated November 2023.
- Geolink (2007). Sandhills Estate – A Strategic Planning Study. Dated February 2007.
- Planit Consulting (2022). Wetland Construction Options Report. Dated June 2022.

2.1 Relevant Standards, Guidelines and Literature

Standards & Guidelines:

- Australian & New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018): Default Guideline Values (DGV's) for physiochemical (PC) stressors and toxicants.
- Australian and New Zealand Environment and Conservation Council (ANZECC) & Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ), 2000.

Literature:

- Cachman, M. & Preene, M. 2013. Groundwater Lowering in Construction: A Practical Guide to Dewatering, 2nd Edition, CRC Press, New York.
- Tchobanoglous, G. et al, 2003, Wastewater Engineering Treatment and Reuse: Metcalf & Eddy, 4th edn, McGraw-Hill, New York.

2.2 General Environmental Duty

The Protection of the Environment Operations Act 1997 lists obligations and duties to prevent environmental harm, nuisances, and contamination for all persons in NSW General Environmental Duty means a person must not carry out an activity that causes or is likely to cause environmental harm, unless measures to prevent or minimise the harm have been taken.

2.3 Construction Water Management Plan Objectives

The objectives of the CWMP are to describe the site specific construction water management methodology, outline water treatment requirements, suitable construction methodologies and define monitoring and reporting procedures to be implemented during wetland construction water management & water treatment works. In addition, this CWMP outlines effective management procedures to prevent environmental harm resulting from the discharge of water from the site.

3 Site Characteristics

3.1 Site Identification Details and Location

Site identification details have been summarised in Table 2. The site location and current layout are depicted in Figure 1 and Figure 2, Appendix A. The proposed wetland and walking track layout, provided by the client, is shown as Figure 3, Appendix A.

Table 2: Site Details

Site Address	Cowper Street, Byron Bay NSW
Real Property Description	Lot 383 DP728202
Site Area	5.4 Hectares (approximate) **Wetland Cells:** 2.075 hectares and **Walking tracks:** 700 m (linear) (approximate) Refer to Figures 2 and 3, Appendix A
Local Government Area	Byron Shire Council

The site comprises an approximate 5.4 ha area of undeveloped land (with exception of pedestrian access through the Cowper Street Road reserve, running north-south through the western boundary of the site), surface water drains and several underground Council services (sewer, stormwater, and recycled water main).

3.2 Land Use Zoning

The site us zoned as Deferred Matter Under the Byron Local Environmental Plan ((BLEP) 2014)). Under the 1998 BLEP, the site is zoned Part 1(d) Investigation and Part 7(b) Coastal Habitat.

3.3 Surrounding Environment

Surrounding land uses are summarised in Table 3.

Table 3: Surrounding Land Use

Direction	Environment
North	Residential properties proceeded by the Pacific Ocean.
East	Residential properties.
South	Residential properties and sports fields;
West	Byron Youth Activities Centre, Byron Court House, and the central business district.

3.4 Topography

The site is relatively flat and low lying, with an elevation ranging between 2 and 5 m Australian Height Datum (AHD) within the area of site proposed to be utilized as wetland cells. (Elvis Spatial Data). Land surrounding the site generally grades down to the south-west. Land to the east of

the site (Massinger Street and the proceeding area) is elevated. Surface runoff may flow into the site from Massinger Street.

3.5 Geology & Soils

The site is situated within the Tyagarah soil landscape. The Tyagarah soil landscape is generally summarised as follows (NSW Department of Planning, Industry and Environment, 2020):

Soils - deep (>150 cm), moderately well-drained minimal Prairie Soils near basaltic areas. Deep (>150 cm), well-drained Podzols and Acid Peats near barrier systems

Geology - Quaternary estuarine alluvium overlain by and/or mixed with Quaternary (Pleistocene) sands. The sands are generally aeolian, originating from the adjacent beach ridge systems.

Subsurface investigations by ENV Solutions outlined in the sites Acid Sulfate Soils Management Plan (ASSMP) (ENV, 2021A) identified a mix of Silty Clays, Sandy Clays, Clayey Sands and Sands throughout the site. A copy of the borehole logs from this investigation are provided in Appendix C.

3.6 Acid Sulfate Soils

The Strategic Planning Study (GeoLINK, 2007) identifies that the Department of Land & Water Conservation have mapped the site as having acid sulfate soils (ASS) risk: Class 5 risk in the northern portion and Class 3 risk for the remainder of the site. An excerpt of the ASS risk mapping is provided as Figure 4, Appendix A.

ENV completed field programs on 29-30 June 2021, 25 November 2021 and 31 August 2023. The ASS investigation indicated the presence of Actual Acid Sulfate Soil (AASS) and Potential Acid Sulfate Soil (PASS) material on-site, with the Net Acidity exceeding the adopted action criteria in samples collected from the natural ground surface to a depth of 5.0 mBGL (ENV, 2021a).

ENV (2023) states that a comparison of reported analytical results (i.e. chromium reducible sulfur suite – CRS) with the geologic profile recorded during the sampling program (refer to borehole logs, Appendix C), indicate that the material can be managed as three (3) treatment units:

- **Unit 1** - Associated with samples BH1_0.65, BH5_0.0, EX3_1.3 (noting that this material occurred as a discrete soil stratum. Material at these sample locations comprised silts. The maximum Net Acidity recorded was at BH5_0.0 (344 mol H+/t) with an applicable liming rate of 26 kg $CaCO_3$/t DW. To facilitate practical application and mixing of lime, all soils from the surface to the maximum depth of the silt layer (0.7 mBGL at BH1, 0.4 mBGL at BH5 & 1.5m BGL at EX3) shall be treated as Unit 1.
- **Unit 2** – Associated with all samples up to a depth of 4.0 mBGL (excluding Unit 1). Soils associated with this management unit primarily comprise sand-clay mixtures and sand. The maximum Net Acidity recorded was at BH1_3.0 (184 mol H+/t) with an applicable liming rate of 14 kg $CaCO_3$/t DW.
- **Unit 3** – Associated with material at a depth of 4.0 -5 mBGL and below comprising clay. The maximum Net Acidity recorded was at BH1_4.5 (724 mol H+/t) with an applicable liming rate of 54 kg $CaCO_3$/t DW.

ASS borehole locations are presented in Figure 5, Appendix A.

For the management of each treatment unit, the maximum applicable liming rate has been adopted.

Table 4: Summary of ASS Liming Rates

Treatment Unit	Depth Interval* (mBGL)	Liming Rate ($CaCO_3$/t DW)	Typical soils
Unit 1	BH1 – 0.0 to 1.0, BH5 – 0.0 to 0.5 EX3 – 1.3 to 1.5	26	Silt
Unit 2	0.0 to 4.0 (excluding Unit 1)	14	Sand/Sandy Clays
Unit 3	4.0 to 5.0	54	Clay

3.7 Surface Water

The site features a highly modified watercourse and constructed drain that is fed by a piped urban network with outlets onto the site from the north-east, east and south (Figure 8, Appendix A). This watercourse is classed as a first order stream in accordance with the Water Management Regulation (2018). The proposed wetland works include widening and deepening of the existing channel in order to form the wetland cell(s) and to allow for stormwater flows to spread out through the wetland.

A surface water logger was installed within the existing on-site waterway, and surface water level monitoring undertaken for a one (1) year period between December 2021 and December 2022. Large fluctuations in surface water level were observed throughout the monitoring period, correlating with rainfall events and the status of the outlet (blocked or free flowing) onto Clarkes Beach.

High surface water levels were recorded during periods where the outlet was inundated by sand subsequently preventing surface water drainage of the site. A summary of surface water levels during the most recent six (6) months of monitoring is presented in Table 5.

Table 5: Summary of Surface Water Levels Onsite (June 2022 – December 2022)

ID	Min (mAHD)	Max (mAHD)	Mean (mAHD)
SW1	1.99	2.71	2.04

3.8 Groundwater

A search of regional groundwater bores was undertaken on 15 August 2023 using the WaterNSW Realtime Database. Six (6) licensed groundwater bores within 500 m of the site were listed on the database. Details of these bores are summarised in Table 6. The location of these bores is shown in Figure 6, Appendix A.

Three of the licensed bores identified on the WaterNSW database have a listed purpose of 'Domestic'.

The township of Byron Bay is serviced by reticulated water supply. On this basis, it is reasonably assumed that any (potential) water extraction is used for irrigation of gardens or other non-consumption purposes.

The site and surrounding areas' topography and surface drainage indicate that contextually, localised groundwater likely flows to the south-west.

Table 6: Summary of Licensed Groundwater Bores within 500m

Bore ID	Distance (approximate) & Direction	Purpose	Installation Depth (m)	Standing Water Level (m)	Completion Date
GW306318	100 m South	Monitoring Bore	4.6	-	2007
GW300932	150 m South	Domestic, Recreation	10.0	-	1997
GW306401	170 m South	Monitoring Bore	1.5	0.6	2007
GW301091	250 m South	Domestic	7.0	-	1995
GW303447	200 m West	Dewatering	13.0	-	-
GW303689	220 m West	Domestic	3.1	1.8	1981

Groundwater monitoring was undertaken at three locations throughout the site between January 2022 – December 2022. Monitoring well locations are presented in Figure 7, Appendix A. All monitoring well locations are within the envelope of the proposed wetland cells.

Large fluctuations in groundwater level were observed at all well locations, with the greatest fluctuations observed in response to rainfall events, including the Northern Rivers Flood Event, occurring in February/March 2022. Groundwater levels for the most recent six (6) months of data are summarised in Table 7.

Table 7: Summary of Groundwater Levels (June 2022 - December 2022)

Well ID	Min (mAHD)	Max (mAHD)	Mean (mAHD)
GW1	1.95	2.50	2.29
GW2	2.05	2.89	2.46
GW3	1.07	1.97	1.29

3.9 Baseline Groundwater Quality

Monthly groundwater quality monitoring was undertaken by Australian Wetlands Consulting (AWC) between January 2022 and October 2022 at three locations (Figure 7, Appendix A). Groundwater quality monitoring results are presented in Appendix D. All monitoring locations are located within the envelope of the proposed wetland cells, and as such water quality range values presented in Table 8 have been derived from minimum and maximum values presented in the entire groundwater quality data set, encompassing all three monitoring locations.

Presented in Table 8, baseline groundwater quality can be described as slightly acidic to slightly alkaline (pH = 5.11 – 8.40) and high in solids (Total Suspended Solids (TSS) = 191 – 23,280 mg/L). In addition, physiochemical analysis shows the baseline groundwater environment to be freshwater (Electrical Conductivity (EC): 110 - 680 µS/cm).

Furthermore, guided by sampling recommendations presented in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZEC/ARMCANZ 2000), baseline

aluminium (total) concentrations were measured between 70 – 490 µg/L and iron (total) concentrations ranged between 70 – 2440 µg/L.

Table 8: Baseline Groundwater Quality

Parameter	Groundwater Quality (Baseline Range)
Physiochemical	
pH	5.11 – 8.40
Total Suspended Solids (mg/L)	191 – 23,280
Electrical Conductivity (EC) (µs/cm^{-1})	110 - 680
Metals	
Aluminium (µg/L)	70 – 490
Iron (µg/L)	70 – 2,440

In assessing further groundwater toxicants, AWC (2022) identified significant nutrient concentrations in groundwater throughout monitoring locations associated with a degraded catchment. No petroleum hydrocarbons were reported in the AWC baseline data set (AWC 2022), and on this basis have not been considered as a potential groundwater contaminant further in this report.

3.10 Receiving Environment Water Quality.

Depicted in Appendix A, Figure 8, stormwater and surface water drainage within Lot 457 flows in a general southwestern direction towards Middleton Street, directly west of the site. Field assessments of the local stormwater network indicate that stormwater is eventually discharged into the lower reaches of Belongil Creek, located approximately 1.7km west of the site at its closest point.

Byron Shire Council undertake physiochemical, nutrient and E. Coli monthly water quality monitoring within the unnamed waterway commencing at the eastern end of Byron Street, approximately 900m west of the site. This waterway feeds stormwater discharge from the Byron township into Belongil Creek and is considered to represent the receiving environment for the purposes of this CWMP, should construction water be discharged from the site. The Council monitoring location is presented in Figure 9, Appendix A. The most recent nine (9) months data from this location were accessed on the 16 August 2023 to determine baseline receiving environment physiochemical water quality values. As no toxicant data was available from the Council monitoring data set, ENV have utilised a sample collected on the 31 January 2023 from Belongil Creek, directly down gradient of the Council monitoring location, to determine baseline receiving environment toxicant values. This sample location is presented in Appendix A, Figure 9.

Presented in Table 9, surface water within the receiving environment can be described as neutral (pH = 6.30 – 6.50) and low in solids (TSS: 7–11 mg/L). In addition, physiochemical analysis shows the receiving environment to be freshwater to brackish (Electrical Conductivity (EC): 240 - 4223 µS/cm). Dissolved aluminium was measured at <50 µg/L where baseline iron (Dissolved) was recorded at 930 µg/L.

Guided by sampling recommendations presented in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZEC/ARMCANZ 2000), concentration of iron (dissolved) was shown to be elevated (930 µg/L) when compared against the low reliability threshold of 300 µg/L stipulated within the ANZECC/ARMCANZ 2000 Volume 2. Furthermore, concentrations of arsenic (2 µg/L), manganese (240 µg/L), and zinc (23 µg/L) were detected in the receiving waters.

In assessing hydrocarbons, no hydrocarbons were detected in the baseline receiving environment water quality sample.

Table 9: Receiving Environment Baseline Water Quality

Parameter	Receiving Environment Water Quality (Baseline Range)
Physiochemical	
pH	6.30 – 6.50
Total Suspended Solids (mg/L)	7 - 11
Electrical Conductivity (µS/cm^{-1})	240 – 4,223
Metals	
Aluminium (Dissolved) (µg/L)	<50
Iron (Dissolved) (µg/L)	930

Guided by both the ANZG (2018) and ANZECC/ARMCANZ (2000), the receiving environment ecosystem would be recognised as being 'slightly to moderately disturbed' as defined in Section 3.1.3.1 of the ANZECC/ARMCANZ (2000). On this basis, for slightly to moderately disturbed ecosystems, a 95th percentile (%) level of protection on toxicant Default Guideline Values (DGVs) is recommended.

3.11 Discharge Location

Construction water is to be managed through the hierarchy specified in Section 5 of this report, whereby discharge water (if required) is preferentially directed into Lot 457 and/or re-used on site. Should water treatment be required, treated water is to be discharged into the Council stormwater network on the western side of Cowper Street. The proposed treated water discharge location is presented in Figure 8, Appendix A.

4 Water Quality Objectives (WQO)

The Water Quality Objectives included within this Construction Water Management Plan have been produced in accordance with the guidance principles outlined within the ANZG (2018) framework. Which states:

- *'Water/sediment quality objectives should reflect the level of water/sediment quality necessary — sometimes in the longer term — to meet the agreed management goals. They reflect what could be considered 'good' or 'fit-for-purpose' water/sediment quality.'*
- *'Water/sediment quality objectives may need to be refined if they are not achievable. Typically, they may not be achievable on the basis of cultural and spiritual, socioeconomic or technical considerations.'*

4.1 Discharge to Land

As outlined in Section 5 of this report, the preferred approach for disposal of construction water (if required) is through the discharge to land (on-site) methodology whereby water is re-infiltrated into the ground on-site, or re-used for construction purposes (i.e., dust suppression, vegetation rehabilitation). In accordance with the Transport for New South Wales (TfNSW) (formerly RTA) Technical Guideline EMS-TG-011, Environmental Management of Construction Site Dewatering (RTA, 2011), the objective of discharging extract water to land within the site boundary is to remove the direct discharge to, or pollution of, waters. To avoid impacts to vegetation or soil, pH testing and a visual oil/grease inspection is to be undertaken of extracted water prior to discharge to land. As suspended solids in water are either deposited on the surface or retained in underlying soil layers, no TSS criterion applies to discharge to land (on-site). Routine daily monitoring shall be required when discharging to land. WQO's presented in Table 10 are to be complied with during the implementation of this methodology along with the visual assessment of onsite discharge locations to ensure discharged water is not flowing overland off-site into receiving environment waterbodies. These monitoring requirements are detailed in latter sections of this report.

Table 10: Water Quality Objectives (WQO's) (Discharge to Land)

Parameter	Water Quality Objective (WQO)
Physicochemical	
pH	5.10 – 8.40[1]
Electrical Conductivity (EC) (µs/cm^{-1})	110 – 680[1]
Oil & Grease (Visual)	No visual observations[2]

Table Notes:

1. Derived from baseline groundwater quality range values collated by AWC (Appendix D).
2. Derived from Transport for New South Wales (TfNSW) (formerly RTA) Technical Guideline EMS-TG-011, Environmental Management of Construction Site Dewatering (RTA, 2011)

In deriving guideline values for water quality objectives, the ANZG (2018) states that the preferred approach to deriving physical and chemical stressor values is to use localised reference site data which is the subject receiving environment in this case. Reference guideline values define a measurable level of change from a natural reference condition that, although the ecological consequences are unknown, is considered unlikely to result in adverse effects. Re-infiltration within the site boundary or on-site re-use of captured surface water is not considered to cause a measurable level of change within surface water conditions external to the site, or in

the shallow groundwater aquifer underlying the site, and as such no further Water Quality Objectives are required for re-infiltration or discharge of water to land within the site boundary. Management and monitoring measures to minimise environmental risk are outlined in latter sections of this report.

4.2 Discharge to Waters

Following review of baseline water quality, Table 11 outlines water quality objectives for the discharge to waters of treated construction water, developed in consultation with the ANZECC/ARMCANZ (2000) guideline as recommended by *Australian and New Zealand Guideline for Fresh and Marine Water Quality* (ANZG 2018). These WQO's apply to all discharged water not infiltrated or re-used on site.

Guided by both the ANZG (2018) and ANZECC/ARMCANZ (2000), the receiving environment ecosystem would be recognised as being 'slightly to moderately disturbed' as defined in Section 3.1.3.1 of the ANZECC/ARMCANZ (2000). On this basis, for slightly to moderately disturbed ecosystems, a 95th percentile (%) level of protection on toxicant Default Guideline Values (DGVs) is recommended.

Here, physical & chemical WQO's for pH, dissolved oxygen & turbidity have been developed using default trigger values for lowland rivers (i.e. South-eastern Australia: flowing rivers) presented in Tables 3.3.2 – 3.3.3 in the ANZECC/ARMCANZ (2000). These values have been cross referenced with site-specific baseline receiving environment water quality values.

Table 11: Water Quality Objectives (WQO's) (Discharge to Waters)

Parameter	Water Quality Objective (WQO)
Physicochemical	
pH	6.5 – 8.0 [1]
Total Suspended Solids (TSS)	< 50[2]
Turbidity (NTU)	< 50[2]
Electrical Conductivity (EC) (µs/cm^{-1})	125 – 2,200
Metals	
Aluminium (µg/L)	< 55[3]
Iron (µg/L)	< 300 [4]

Table notes:

1. Derived from ANZECC/ ARMCANZ (2000) – (Table 3.3.2).
2. Derived from ANZECC/ ARMCANZ (2000) – (Table 3.3.3).
3. Derived from ANZG (2018) - 95% Species Protection for Toxicants (Freshwater)
4. Derived from ANZECC/ ARMCANZ (2000) – Low Reliability Threshold (Iron).

5 Construction Water Management Plan

This Construction Water Management Plan (CWMP) has been prepared to address construction methodology and water disposal/treatment processes (if required) during the construction of three (3) proposed wetland cells that may intercept on-site surface water or be impacted by rainfall events within the Byron Sandhills site, located at Lot 383 DP728202, Byron Bay NSW 2481.

5.1 Construction Methodology

In accordance with the Wetlands Construction Options Report (Planit Consulting, 2022), the recommended construction methodology for the Sandhills Wetland project is to undertake the works in a staged, logical and sequential manner.

This would involve the clearing and grubbing, bulk earthworks, stormwater works, topsoiling and planting and inlet and outlet works to be undertaken for each wetland cell prior to commencing construction of the next cell. The works are to be scheduled for the Byron Bay dry season, which is considered to occur between May – December (Planit Consulting, 2022). It is recommended that construction of the cells commences with the downgradient wetland (W3), and progressively works upgradient, finishing with the construction of the uppermost wetland cell (W1).

Works are to be undertaken in this manner in order to maximise flood mitigation and stormwater treatment/storage capabilities throughout the project timeline and minimise environmental risk from the proposed development.

5.1.1 Bulk Earthworks

A review of the historic groundwater and surface water levels at the site indicate that during the bulk earthworks for all wetland cells (W1 – W3), the surface water/groundwater interface may be intercepted, or rainfall events may cause the build-up of captured stormwater within partially or fully formed wetland cell(s). It is proposed to undertake bulk excavation works using long reach excavators, capable of excavating in a wet environment with reduced ground disturbance.

This methodology is proposed to mitigate environmental risk and changes to subsurface hydrology by ensuring that no dewatering of groundwater is required to construct the wetland cells. The methodology for management of captured water within the wetland cells during the construction process is described in the following sections of this CWMP.

5.1.2 Surface Water Removal

If surface water is present in a wetland cell during the construction and/or planting of the cell to a degree that the works cannot be completed, then this water may need to be removed to allow for the safe and sustainable completion of works.

If required, a deep well sump will be installed at the low point of the excavation. Slotted deep wells will be screened and installed to depth where the annulus will be backfilled with a high permeability material (i.e., sand/washed gravel). Once installed, high-head submersible pumps will direct extracted water into the adjacent Lot 457, or into the front end of the water treatment plant in accordance with Section 5.2 – 5.3 of this CWMP.

5.1.3 Dewatering Flow Calculations

Described in previous sections of this report, groundwater and surface water levels may fluctuate during the construction period. Conditions will be highly dependent on climatic factors (i.e.,

rainfall) both prior to, and during construction. Estimate flow rates have been determined based on both design rainfall and expected existing stormwater storage onsite.

Assuming a 5Ha catchment area and a 24-hour duration 0.25 Annual Recurrence Interval (ARI) design rainfall event, stormwater inflows may approach 35 L/s. This design rainfall event has been selected based on the expected construction duration of up to 6 months. Considering historical surface and groundwater levels recorded on site, a further 5L/s inflow to the construction area may be encountered.

These flow calculations are estimated only and should be used only as a guide. It should be noted that flow rates will be considerably lower during periods of low rainfall.

5.1.4 Pump Requirements

Considering the proposed construction methodologies and flow rates detailed in previous sections of this report, high head submersible pumps would be expected to provide the robust solution required for this application. While flow rates have been calculated up to 40L/s, the likelihood of stormwater inflows maintaining such volumes over a prolonged period is unlikely. It may therefore be unnecessary to size pumps capable of managing these volumes. Due to the dependence on climatic conditions, the selection of dewatering pumps will be at the discretion of the contractor responsible for managing water onsite.

With consideration to the assumptions and details outlined above, three submersible pumps capable of pumping 8 L/s would be expected to manage water effectively for the majority of the construction period.

5.2 Construction Water Disposal (Infiltration & Re-Use)

In accordance with the Transport for New South Wales (TfNSW) (formerly RTA) Technical Guideline EMS-TG-011, Environmental Management of Construction Site Dewatering (RTA, 2011), onsite reuse of captured stormwater or detained surface water should be considered a priority for all dewatering activities. Reuse of water on the site may reduce the need for imported or extracted water and provide a lower risk to the environment than direct discharge to the environment. Minimum requirements for any reuse activity are that the recharge of the aquifer through infiltration should not cause the ponding or runoff of water, which may subsequently cause concentrated runoff and unauthorised discharge (RTA, 2011). On this basis, all construction waters requiring discharge from the wetland cell(s) during construction activities is to be managed in the following hierarchy;

1. Infiltration of discharged water into the groundwater table within the adjacent Lot 457.
2. Onsite re-use of extract water in the form of vegetation establishment/rehabilitation, dust suppression, earthworks compaction and/or plant/vehicle wash down.
3. Discharge water off site. Infiltration and onsite reuse may be limited by climatic or site conditions (i.e. saturated ground) and water may need to be treated and discharged into Council stormwater infrastructure. Water treatment processes required to meet discharge to land WQO's are described in Section 5.4 of this report.

No water treatment processes are proposed for infiltration or on-site re-use of discharged waters, with water to remain representative of its baseline quality. Monitoring for parameters outlined in Table 10 will ensure that changes in discharge water quality are consistently monitored throughout any dewatering and on-site water management process.

5.2.1 Infiltration and On-site Re-Use

Captured construction water is to be infiltrated into soils within Lot 457 of the site using a sprinkler system, or beneficially re-used on site for the purpose of rehabilitation, dust suppression, earthworks, compaction and/or plant/vehicle wash down. Reuse of water on the site may reduce the need for imported or extracted water and provide a lower risk to the environment than direct discharge to the environment. On-site reuse should not cause the ponding or runoff of water, which may then cause concentrated runoff and unauthorised discharge (RTA, 2011). Should ponding or overland flow of on-site discharge water be observed, then a Water Treatment Plant is to be instated in accordance with the hierarchy of disposal methodology outlined in Section 5.2 of this report.

5.2.2 Discharge to Waters

If the methodologies referred to in the water disposal hierarchy referred to in Section 5.2 are not viable due to variables such as aquifer recharge, climatic conditions (i.e. saturated ground) or slow infiltration rates onsite then captured water may need to be discharged into the Council stormwater infrastructure located adjacent to Cowper Street (Appendix A, Figure 8). Discharge water is to meet WQO's outlined in Section 4 of this report prior to discharge. Treatment processes, along with monitoring requirements are detailed in latter sections of this report.

5.3 Water Treatment Process

Following on from earlier sections of this CWMP, captured water that cannot be re-used or infiltrated onsite will require treatment prior to discharge from the site. Treated groundwater will need to meet WQO's presented in Table 11.

To achieve this, a Water Treatment Plant (WTP) will need to be established onsite & commissioned by a suitably qualified engineer or scientist. At a minimum, ENV would recommend processes that include:

- pH correction
- Metals precipitation/aeration capability
- Solids removal capability

A process flow diagram (PFD) of a standard water treatment system incorporating all required processes is presented in Appendix F.

5.3.1 pH Correction & Metals Removal

Baseline pH values (pH: 5.11 – 8.40) observed within the baseline groundwater data indicates that the pH may fall outside of discharge to waters WQO's presented in Table 11. On this basis, a pH correction/metals removal process must be included as part of the water treatment process prior to discharge off site.

On this basis, an automated pH dosing system is recommended where operational setpoints should be refined as part of the commissioning process to ensure the risk of pH over/under correction is mitigated. Furthermore, maintaining a neutral pH will aid in the precipitation of metals in extracted water. Dose rates should be determined by an appropriately qualified person (i.e. environmental engineer/ industrial chemist or equivalent).

5.3.2 Aeration & Metals Removal

The WTP will allow for an aeration capability via blower or counter-current air stripper. This process will be utilised to aid in the precipitation of metals present in captured water (in combination with Section 5.4.1 above).

5.3.3 Coagulant Assisted Solids Removal

Assisted utilising an appropriately selected flocculant, coagulant and/or polymer, the solids separation process primarily works to remove suspended solids prior to discharge. Water treatment contractors shall install a solids removal process in the form of a lamella plate separator. Although sediment loads should be managed upfront (i.e. 'socking' or backfilling spears), the system should be suitably sized to handle flow rates specified in the earlier sections of this report.

As recommended by the NSW Blue Book - flocculant, coagulant and/or polymer dose rates should be determined & managed by an appropriately qualified person (i.e. environmental engineer/ industrial chemist or equivalent).

6 Environmental Risk

Referencing Section 3.7 (Surface Water), Section 3.8 (Groundwater), Section 5.2 (Construction Water Disposal) and Section 5.3 (Groundwater Treatment Process) the following assessment of environmental risk can be determined.

6.1 Potential Construction Water Impacts

Potential on-site and off-site construction water impacts may include drawdown of the water table or impacts to the receiving environment (Belongil Creek) from the release of water containing elevated levels of pH, electrical conductivity, dissolved heavy metals, and/or total suspended solids (or turbidity).

6.1.1 Groundwater Aquifer Drawdown

Any captured water is to be infiltrated back into the aquifer or re-used on site where possible, limiting the potential for significant changes to groundwater hydrology within, and adjacent to, the site. All treated water is to meet WQO's outlined in Section 3 of this report prior to infiltration, re-use or discharge. Furthermore, the proposed construction methodology works to minimise the extraction of water to the greatest possible & practicable extent (i.e., undertake works in dry periods, working within wet excavations where required, no installation of groundwater extraction wells)

Monitoring measures outlined in this Plan work to ensure that groundwater level and quality are frequently assessed for any potential groundwater impacts. On this basis, impacts associated with groundwater aquifer drawdown both on and adjacent to the site are considered to be minimal – negligible.

6.1.2 Groundwater Users

A total of six (6) licensed groundwater bores within 500 m of the site were listed on the Water NSW database, with the closest located 100m south of the proposed works. Infiltration of discharged water back into the water table on-site ensures minimal influence on groundwater hydrology will occur in relation to construction dewatering works. No extraction of groundwater is proposed to take place within the outlined construction methodology.

Furthermore, groundwater levels are to be monitored throughout the construction phase of the project as described in Section 7 of this Plan, where any changing trends in groundwater SWL's intend to be reviewed regularly to assess for impact. On this basis, the risk of impacts to sensitive groundwater users adjacent to the site is considered minimal – negligible.

6.1.3 Groundwater Dependant Ecosystems

A review of the Bureau of Meteorology (BOM) Groundwater Dependent Ecosystem (GDE) Atlas indicates that a high potential for GDE's to occur exists both on and adjacent to the site. Any discharged water is to be infiltrated back into the shallow groundwater aquifer or re-used on site where possible, limiting the potential for significant changes to groundwater hydrology within, and adjacent to, the site. Works are to be undertaken in a staged manner to minimise any potential groundwater aquifer drawdown. All treated water is to meet WQO's outlined in Section 4 of this Plan prior to discharge.

Furthermore, monitoring measures outlined in Section 7 ensure that groundwater level and quality are frequently assessed at multiple points across the site for potential groundwater impacts. On this basis, impacts to GDE's both on and adjacent to the site from construction water and groundwater draw down is considered to be minimal – negligible.

6.1.4 Receiving Environment (Belongil Creek)

As described in earlier sections of this report, the preferred approach to management of extract water is on-site infiltration, or beneficial re-use within the site boundary. In accordance with the Transport for New South Wales (TfNSW) (formerly RTA) Technical Guideline EMS-TG-011, Environmental Management of Construction Site Dewatering (RTA, 2011), the objective of discharging extract water to land within the site boundary is to remove the direct discharge to, or pollution of waters. To avoid impacts to vegetation or soil, pH testing and a visual oil/grease inspection is to be undertaken of extract water prior to discharge to land. Daily monitoring of discharge water quality will be undertaken along with the ongoing visual assessment of the discharge footprint to ensure water doesn't enter surface water bodies adjacent or downgradient of the site. This monitoring is to be carried out daily during dewatering activities.

Monitoring will ensure that any changes to the receiving environment are noted and addressed as per Action & Analysis in Section 8 of this report, prior to impact to the receiving environment.

On this basis, the environmental risk to the receiving environment (Belongil Creek) from dewatering activities is expected to be negligible.

6.1.5 Acid Sulfate Soils (ASS)

The sites Acid Sulfate Soils Management Plan (ENV, 2021a) identified AASS and PASS exceeding adopted action criterion from natural ground surface to a maximum depth of 5m BGL.

The proposed construction methodology works to minimise captured water extraction volumes to the greatest possible & practicable extent (i.e., work in dry periods, progressive staging of construction) to minimise the risk to oxidisation of AASS and PASS adjacent to the wetland excavations. Furthermore, monitoring and action/analysis measures outlined in Section 7 and 8 of this report aim to ensure that any impacts to water quality are noted and mitigated prior to being discharged to land or the receiving environment.

6.1.6 Odour

Sensitive receivers that may be exposed to potential odour pollution from construction and water treatment activities are identified as users of the recreational areas associated with Clarkes Beach, north of the site. Minimal odour pollution is expected to be generated from the proposed works.

Any odour pollution will be addressed by the water treatment contractor or project manager on a complaint's basis, should complaints be received. Adequate signage, including a 24-hour contact number, must be displayed externally to the site to allow for complaints to be reported.

6.1.7 Noise

Sensitive receivers that may be exposed to potential noise pollution from construction and water management activities are identified as neighbouring residents. Minimal noise pollution is expected to be generated from the proposed dewatering works.

Any noise pollution will be addressed by the water treatment contractor or Project Manager on a complaint's basis, should complaints be received. Adequate signage, including a 24-hour contact number, must be displayed externally to the site to allow for complaints to be reported.

6.1.8 Subsidence

As discussed in earlier sections of this CWMP, the proposed construction design & operation methodology aim to minimise impacts to surface water and groundwater, and where possible avoid pumping of captured surface water, or discharge off-site.

Daily monitoring of water quality and flow rates is to be undertaken by a suitably qualified scientist/engineer as per Section 7 of this report. Monitoring will ensure that discharge water and receiving environment water quality is meeting WQO's set out in Section 4 of this report prior to entering Belongil Creek. The implementation of all monitoring and action requirements outlined in Section 7 and 8 of this CWMP ensures that the potential environmental risk of the construction water aspect of this project is considered minimal – negligible.

7 Validation & Monitoring

The purpose of the validation and monitoring process is to provide a framework for water treatment contractors to collect, interpret, act and report on the performance of the water treatment process, if required. Ultimately to ensure treatment measures are satisfactory and meet WQOs outlined in Section 4 of this report.

The CWMP promotes a combination of collection techniques including analytical field sampling and telemetric data collection (i.e., real time).

7.1 Discharge to Land

Prior to on-site discharge, a sample will need to be collected from the outlet of the WTP and validated (utilising NATA certified laboratory) against WQO's outlined in Section 4 of this report. Extracted water will be circulated internally within the wetland cell until chemical analysis of the discharge sample has been verified to meet the WQOs.

Once discharge has commenced, an additional sample will be collected and validated every seven (7) days (or as required under the guidance of a suitably qualified person) for the duration of dewatering water works onsite as part of the continual discharge monitoring program.

Standard turn-around-time (TAT) for sample analysis should be a maximum five (5) days for all sample analytes.

7.1.1 Analytical Sampling Methodology

At the frequency outlined above, laboratory samples will be collected from the discharge point. The samples will:

- Represent a waste or element of the environment from which it is taken.
- Not be contaminated during collection, where analyte concentrations will not change between the time of collection and analysis.
- Be collected by an appropriately qualified person.
- Include sampling utilising correct sampling methodologies.
- Be a representative sample(s); and,
- Be labelled, preserved, stored, and transported appropriately for analysis.

Samples will be analysed by a National Association of Testing Authority (NATA) laboratory and will be inclusive of analytes outlined in Table 10.

7.1.2 Daily Field Monitoring

To ensure captured water dewatering & dewatering water treatment processes are being managed effectively during the discharge to land process, daily field monitoring will be included as part of the ongoing monitoring process. Daily monitoring will cover monitoring of extract water quality.

- Visual inspection of extraction (pumping) process and discharge to land footprint.
- pH assessment of extracted water, to be undertaken with calibrated Horiba U-52 water quality meter.
- Electrical Conductivity (EC) assessment, to be undertaken with calibrated Horiba U-52 water quality meter.

- Flow (m/s OR m^3/ hour) assessment. Flow measurements are to be constantly measured using a calibrated 4" Woltman WST SB flow meter that will be included in the dewatering plant. Daily and totalised flow volumes will be recorded within the daily report.

Discharge water quality is to be field monitored for all outlined parameters daily. Should any parameter fall out of the specified range then action & analysis steps outlined in Section 8 of this report are to be followed.

Daily observations will be recorded and stored onsite where a daily report will be provided and presented to the Principal Contractor outlining physiochemical changes across the process, high level plant function/ performance summary and flow (rate & totalised volume).

7.2 Discharge to Waters

7.2.1 Analytical Field Sampling Frequency

Prior to discharge, a sample will need to be collected from the outlet of the WTP and validated (utilising NATA certified laboratory) against WQO's outlined in Section 4 of this report. Treated water will be circulated internally until chemical analysis of the discharge sample has been verified to meet the WQOs.

Once discharge has commenced, an additional sample will be collected and validated every seven (7) days (or as required under the guidance of a suitably qualified person) for the duration of dewatering works onsite as part of the continual discharge monitoring program.

Standard turn-around-time (TAT) for sample analysis should be a maximum five (5) days for all sample analytes.

7.2.2 Analytical Sampling Methodology

At the frequency outlined above, laboratory samples will be collected from the discharge point. The samples will:

- Represent a waste or element of the environment from which it is taken.
- Not be contaminated during collection, where analyte concentrations will not change between the time of collection and analysis.
- Be collected by an appropriately qualified person.
- Include sampling utilising correct sampling methodologies.
- Be a representative sample(s); and,
- Be labelled, preserved, stored, and transported appropriately for analysis.

Samples will be analysed by a National Association of Testing Authority (NATA) laboratory and will be inclusive of analytes outlined in Table 11.

7.2.3 Daily Field Monitoring

To ensure dewatering water treatment processes are being managed effectively during the discharge to waters process, daily field monitoring will be included as part of the ongoing monitoring process. Daily monitoring will cover aspects of all treatment steps, these include but are not limited to:

- Visual inspection of treatment process.

- pH assessment, to be undertaken with calibrated Horiba U-52 water quality meter. Automated pH correction undertaken using continuous measurement pH probe located within the water treatment plant.
- Turbidity (NTU) assessment, to be undertaken with calibrated Horiba U-52 water quality meter. Continuous Turbidity assessment to be also undertaken with turbidity probe located within the water treatment plant.
- Electrical Conductivity (EC) assessment, to be undertaken with calibrated Horiba U-52 water quality meter.
- Flow (m/s OR m^3/ hour) assessment. Flow measurements are to be constantly measured using a calibrated 4" Woltman WST SB flow meter that will be included in the water treatment plant. Daily and totalised flow volumes will be recorded within the daily report.

Discharge water quality is to be field monitored for all outlined parameters daily to ensure compliance with the WQOs. Should any parameter fall out of the specified range then action & analysis steps outlined in Section 8 of this report are to be followed.

Daily observations will be recorded and stored onsite where a daily report will be provided and presented to the Principal Contractor outlining physiochemical changes across the process, high level plant function/ performance summary and flow (rate & totalised volume).

7.3 Groundwater Standing Water Level

Continuous standing water level monitoring is to be undertaken within at least one (1) down hydraulic gradient groundwater monitoring well at the site, external to the extent of the wetland cell excavations, during construction works. It is recommended this is undertaken using an Onset HOBO Water Level Logger or similar. In accordance with the SEARS response letter (AWC, 2022) a groundwater and surface water level monitoring program has been developed to inform wetland design, and this program should be continued for a minimum 12-month period following wetland system establishment and planting in order to identify and mitigate any impacts on groundwater and surface water levels.

8 Action & Analysis

The following section aims to provide water treatment operators with the ability to effectively assess treatment performance following receipt of monitoring data and make accurate decisions to ensure risk treatment processes are upheld. Analysis and action processes are detailed in the sections below.

As both dewatering methodology options will undergo similar monitoring the action & analysis will remain the same regardless of the chosen dewatering methodology. It should be noted that dewatering Option 2 will require the steps outlined in this section too be undertaken for all WTP in use.

8.1 pH Correction

Daily Check:

- Telemetric OR physiochemical check out of specification.

Action:

- Check and re calibrate pH probe.
- Check chemical (base) dosing pump to ensure its functionality.
- Check chemical drum to ensure chemical volume is sufficient.

IF pH probe still out of specified range:

- Replace pH probe with critical spare.
- Notify relevant stakeholders of change.
- Dewatering Manager to note in daily dewatering management plan report.

Analytical Check:

- Analytical pH results outside of specified WQO's.

Action:

- Shut down or put into recycle.
- Re-calibrate pH probes.
- Check proportional bands (or equivalent pH control process).
- Implement changes and monitor.
- Notify relevant stakeholders (internal & external).
- Dewatering Manager to note in daily dewatering management plan report.
- Re-sample and validated once pH corrections have occurred.
- Re assess risk and treatment methodology (if pH challenges persist).
- Additional treatment units or methodologies may need to be employed.

8.2 Turbidity (NTU) & Total Suspended Solids (TSS)

Daily Check & Analytical Check:

- Turbidity (NTU) physiochemical check outside of specified limits.
- Turbidity (NTU) analytical check out of specification.
- Turbidity (NTU) telemetric result out of specification.

Action:

- Check and Turbidity probe (PLC Unit and Horiba U-52 meter).
- Re measure Turbidity in fresh sample collected from discharge of treatment train.
- Assess result.
- Check chemical dosing pump(s) to ensure its functionality.
- Check chemical drum to ensure chemical volume is sufficient.
- Check sediment level in treatment tank.

IF NTU still out of specified range:

- Review NTU treatment methodology.
- Conduct assisted flocculation checks (i.e., Jar Test) to re define and optimize dose rates.
- Implement NTU treatment methodology change.
- Dewatering Manager to note in daily dewatering management plan report.
- Additional treatment units or methodologies may need to be employed.

8.3 Metals Precipitation

Daily Check & Analytical Check:

- Metals (Fe, Al) Spectrophotometer check outside of specified limits
- Metals (Fe, Al) analytical check outside of specified limits
- Metals precipitation

Action:

- Check Spectrophotometer
- Re measure metals concentrations in fresh sample collected from discharge of treatment train.
- Assess result.
- Check counter current air stripper (aeration) to ensure its functionality.

If metals (Fe, Al) still outside of specified range

- Re circulate discharge water back to excavation
- Review metals treatment methodology

- Implement metals treatment methodology change (additional treatment units may be necessary)
- Re measure metals concentrations in fresh sample collected from discharge (circulating back to excavation)
- Assess result.
- Once metals concentrations meet WQO's, return discharging to receiving environment.

9 Contingency/Emergency Response Plan

Referencing Section 6 (Environmental Risk), Section 7 (Validation & Monitoring) and Section 8 (Action & Analysis), this Contingency/Emergency Response Plan has been developed to outline contingency measures to ensure no adverse impacts to the receiving environment, along with emergency response measures should adverse impacts (i.e., iron staining, reductions in water quality of receiving environment) be noted during any required discharge of construction water from within the wetland cell(s) envelope.

9.1 Contingency

Multiple contingency measures have been implemented throughout this CWMP to ensure that no adverse impact to the receiving environment of Belongil Creek during the construction programme. These contingency measures include, but are not limited to, the following;

- Daily field monitoring for all parameters outlined in Section 4 WQO's. Monitoring to be undertaken with a calibrated Horiba U-52 water quality meter (physiochemical) to assess for any variance from baseline range conditions.
- Continuous monitoring of groundwater SWL to ensure no impacts are observed within the underlying shallow groundwater aquifer.
- If discharge to waters is required, installation of primary and secondary water treatment measures is to be implemented including continuous flocculation, pH correction and metals precipitation.
- Analytical validation sampling prior to discharge and then weekly thereafter during any discharge of water. Validation used to ensure that the WTP is successful in achieving WQO's prior to discharge into the receiving environment.
- Action and analysis steps presented Section 8 of this report to be followed should any parameter fall outside of the specified range of WQO's at any point during the monitoring process.

9.2 Emergency Response

With the implementation of all outlined monitoring and contingency measures included in this report, the environmental risk of this project is considered minimal – negligible. Should contingency measures fail to mitigate environmental impacts to the receiving environment and impacts to the receiving environment are observed/recorded, then the following emergency response measures should be undertaken.

1. Stop works.
2. Notify Byron Shire Council and all other relevant Regulatory Authorities (i.e., NSW EPA, NSW Department of Primary Industries).

Works must not continue until the effects and extent of environmental impacts have been assessed by the requisite Regulating Authority. The Regulatory Authority will determine the necessity and/or requirement for remedial or corrective actions.

10 Approvals

10.1 Department of Planning, Industry and Environment (DPIE)

In accordance with Schedule 1 of the Water Management (General) Regulation 2018, the following works constitute excluded works and do not require a DPIE water supply work approval or water access license.

Schedule 1 Excluded works

Schedule 1 Clause 2

Dams solely for flood detention and mitigation—

(a) from which no water is reticulated or pumped, and

(b) that are located on a minor stream.

Schedule 1 Clause 3

Dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority (other than Landcom or the Superannuation Administration Corporation or any of their subsidiaries) to prevent the contamination of a water source, that are located on a minor stream.

Schedule 1 Clause 4

Dams approved in writing by the Minister for specific environmental management purposes—

(a) that are located on a minor stream, and

(b) from which water is used solely for those environmental management purposes.

An application is to be prepared to DPIE Water demonstrating that the proposed Sandhills Wetland Project meets these exemption requirements. This application will require approval from DPIE Water prior to works commencement. If the above requirements cannot be met, then a water supply work approval and specific purpose water access license will be required.

10.2 Council

Prior to lodging the DPIE approvals exemption request described in Section 10.1, the Project Manager will need to seek Council approval of this CWMP, where this will need to be included in the DPIE application. Council approval of this CWMP is considered to be an acceptance of the treatment and discharge methodology described in this Plan.

11 Reporting & Record Keeping

A dewatering report will be supplied, summarising the results of monitoring within two weeks of cessation of discharges.

During any dewatering process, a daily report will need to be completed by the onsite Dewatering Contractor. The report will note any exceedance in discharge criteria, as well as any other comments relating to the dewatering process. If there are multiple discharge points, daily reports must record data from each discharge.

Any complaints shall be noted in the site logbook and corrective action taken (where appropriate and practicable) to prevent recurrence. Complaints and complaints management are the responsibility of the Principal Contractor where their policy will be adopted as best practice.

12 Appendices

Table 12: Appendices

Appendix Reference	Appendix Title
Appendix A	Figures
Appendix B	Engineering Drawings
Appendix C	Geotechnical Bore Logs
Appendix D	Baseline Water Quality Results
Appendix E	Water Treatment Process Flow Diagram (PFD)

13 Appendix A

Legend

Site Location (Approximate)

0 200 400 m

Image source: SIXMaps (2015)

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

Figure 1 – Site Location
Sandhills Wetland
Cowper Street, Byron Bay, NSW

Project: 216010
Client: Byron Shire Council
Date: 14/12/2023

Legend

Site Location (Approximate)

Lot Boundary

0 30 60 m

ENV Solutions
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Figure 2 – Existing Site Layout
Sandhills Wetland
Cowper Street, Byron Bay, NSW

Project: 216010
Client: Byron Shire Council
Date: 14/12/2023

Image source: SIXMaps (2015)

Legend

Site Location (Approximate)

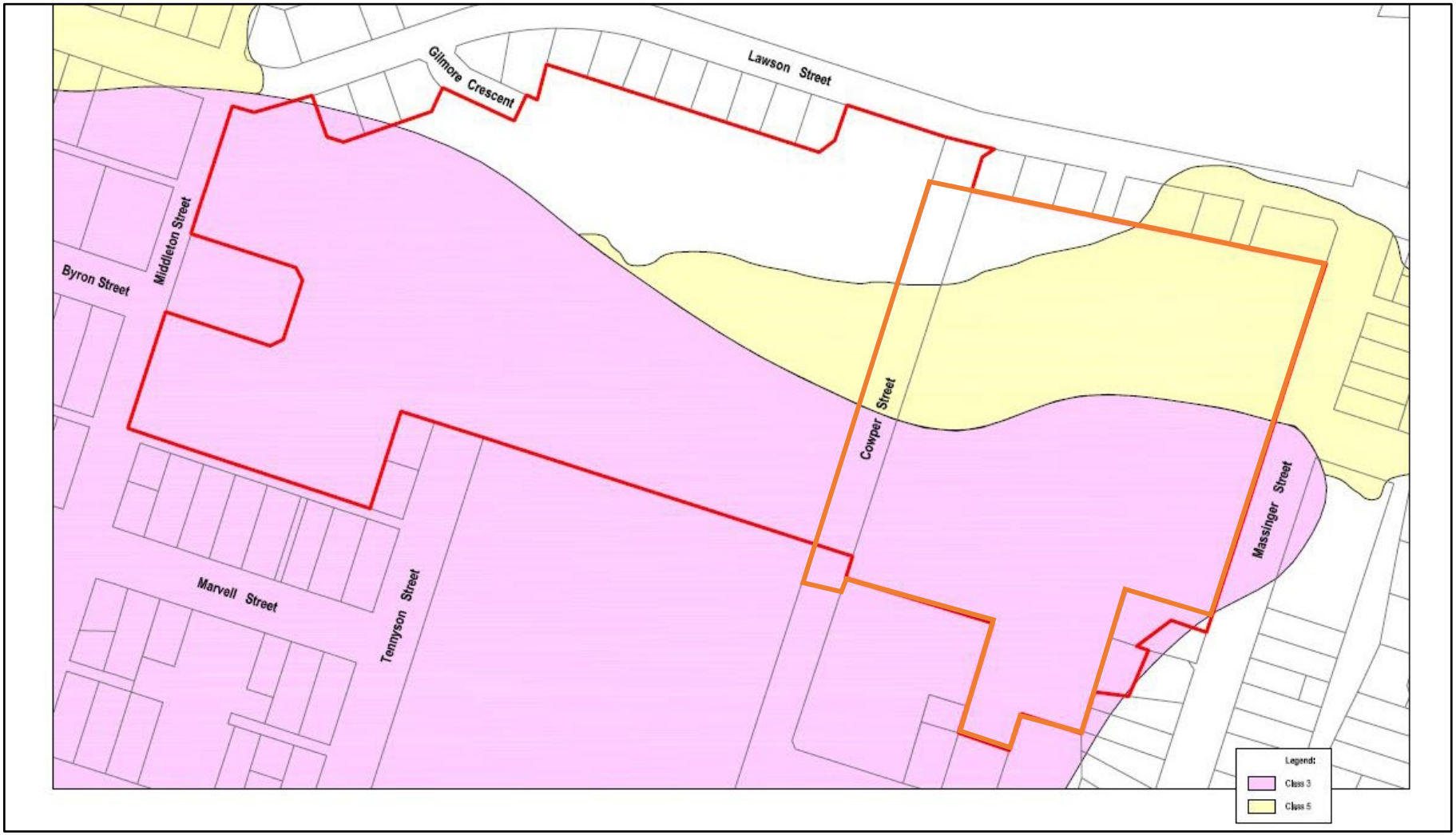
0 30 60 m

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

Figure 3 – Proposed Development
Sandhills Wetland
Cowper Street, Byron Bay, NSW

Project: 216010
Client: Byron Shire Council
Date: 14/12/2023

Image source: SIXMaps (2015) & Planit Consulting (2021)



Legend

Strategic Planning Study Boundary

Site Location (Approximate)

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

Figure 4 – Acid Sulfate Soil Risk
Sandhills Wetland
Cowper Street, Byron Bay, NSW

Project: 216010
Client: Byron Shire Council
Date: 14/12/2023

Image source: GeoLink (2007)

Legend

Site Location (Approximate)

ASS Borehole (Approximate)

0 30 60 m

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

Figure 5 – Acid Sulfate Soil Boreholes
Sandhills Wetland
Cowper Street, Byron Bay, NSW

Project: 216010
Client: Byron Shire Council
Date: 14/12/2023

Image source: SIXMaps (2015) & Planit Consulting (2021)

Legend

Site Location (Approximate)

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Figure 6 – Groundwater Resources
Sandhills Wetland
Cowper Street, Byron Bay, NSW

Project: 216010
Client: Byron Shire Council
Date: 14/12/2023

Image source: WaterNSW (2021)

Legend

Site Location (Approximate)

Groundwater Well Location (approximate)

0 30 60 m

ENV Solutions
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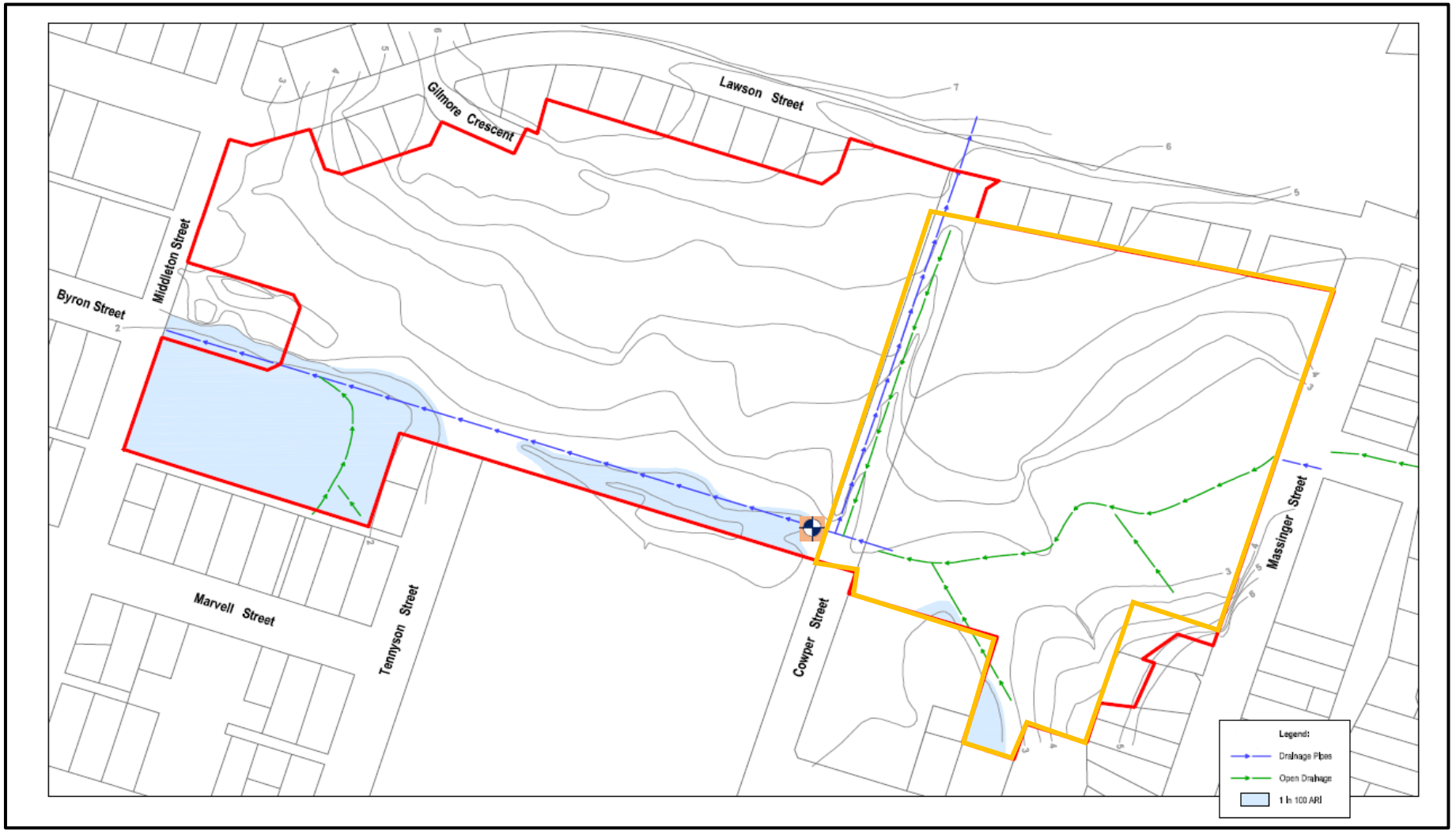
Figure 7 – Monitoring Well Locations
Sandhills Wetland
Cowper Street, Byron Bay, NSW

Project: 216010
Client: Byron Shire Council
Date: 14/12/2023

Image source: SIXMaps (2015) & Planit Consulting (2021)



Legend

Strategic Planning Study Boundary

Site Location (Approximate)

Discharge Location

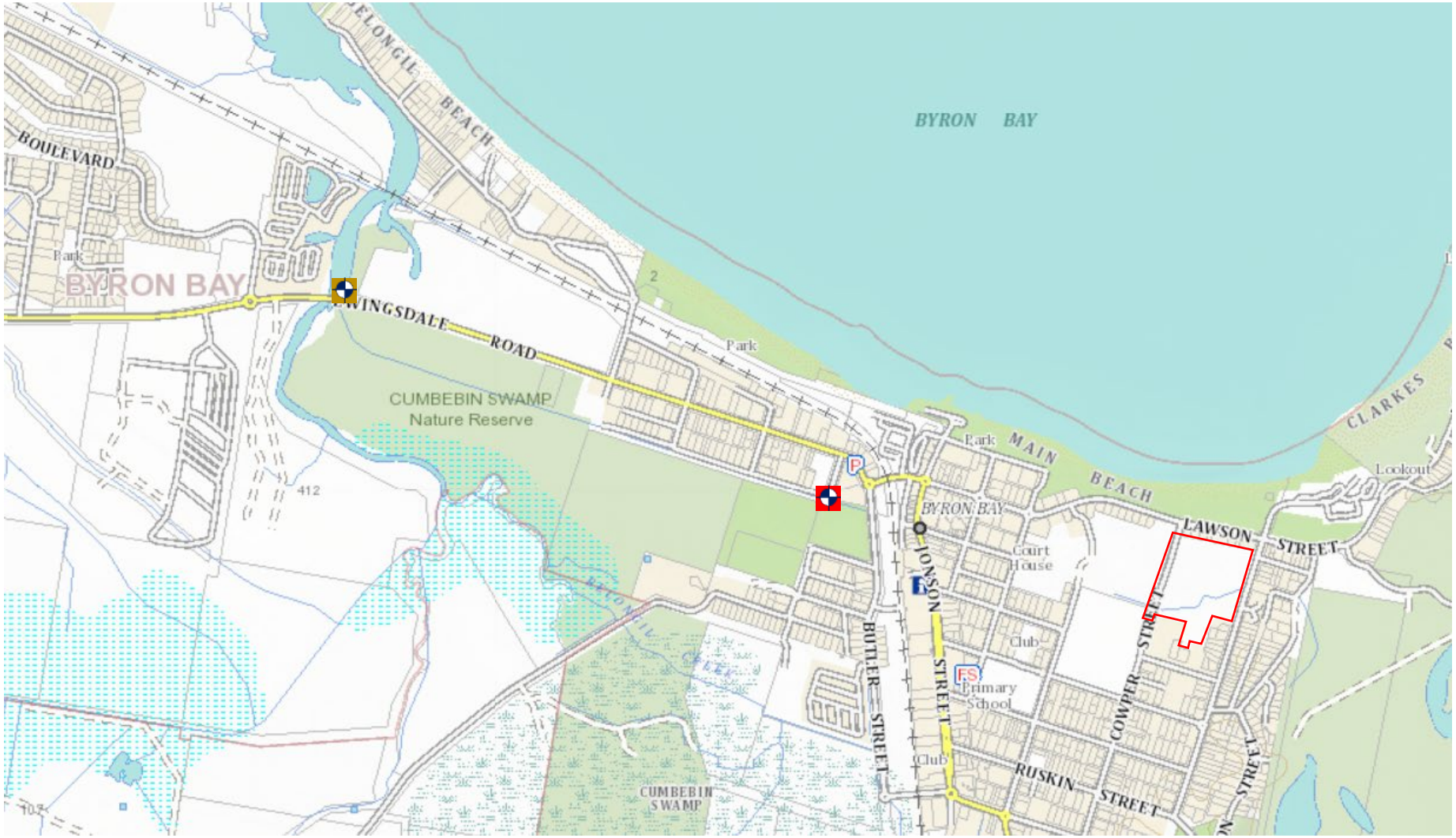
0 30 60 m

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

Figure 8 – Discharge Location
Sandhills Wetland
Cowper Street, Byron Bay, NSW

Project: 216010
Client: Byron Shire Council
Date: 14/12/2023

Image source:Geolink (2007)



Legend

- Site Location (Approximate)
- Council Monitoring Location (BC07)
- Toxicant Sample Location

0 0.2 0.4 km

Image source:Geolink (2007)

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

Figure 9 – RE Monitoring Location
Sandhills Wetland
Cowper Street, Byron Bay, NSW

Project: 216010
Client: Byron Shire Council
Date: 14/12/2023

14 Appendix B

SANDHILLS WETLAND
DETAILED DESIGN PACKAGE

REV F - FOR TENDER 25.08.2023 100%

AWC
Australian Wetlands Consulting Pty Ltd
25 LESLIE ST
BANGLOW NSW 2479
P (02) 6685 5466 | 1300 998 514
www.awconsult.com.au

CLIENT

Byron Shire Council

SHEET NO.	DRAWING NAME	SCALE
1-191194_DD_001	COVER SHEET & LOCALITY PLAN	1:1000@A1
1-191194_DD_002	SITE CONTEXT & SHEET LAYOUT PLAN	1:600@A1
1-191194_DD_003	SITE CUT & FILL PLAN	1:600@A1
1-191194_DD_004	SITE EXTENTS	1:600@A1
1-191194_DD_101	EARTHWORKS & LAYOUT PLAN 01	1:250@A1
1-191194_DD_102	EARTHWORKS & LAYOUT PLAN 02	1:250@A1
1-191194_DD_103	EARTHWORKS & LAYOUT PLAN 03	1:250@A1
1-191194_DD_201	EARTHWORKS - SECTIONS CELL 1	AS SHOWN
1-191194_DD_202	EARTHWORKS - SECTIONS CELL 2	AS SHOWN
1-191194_DD_203	EARTHWORKS - SECTIONS CELL 3	AS SHOWN
1-191194_DD_301	CIVIL DETAILS - CELL 1 INLET	AS SHOWN
1-191194_DD_302	CIVIL DETAILS - CELL 1 OUTLETS	AS SHOWN
1-191164_DD_303	CIVIL DETAILS - CELL 2 OUTLETS	AS SHOWN
1-191164_DD_304	CIVIL DETAILS - CELL 3 OUTLET	AS SHOWN
1-191164_DD_305	CIVIL DETAILS - GENERAL	AS SHOWN
1-191194_DD_401	CIVIL & LANDSCAPE SPECIFICATION	NA
1-191194_DD_402	CIVIL & LANDSCAPE SPECIFICATION	NA
1-191194_DD_500	LANDSCAPE PLANTING SCHEDULES	NA
1-191194_DD_501	LANDSCAPE MATERIALS & PLANTING PLAN 01	1:250@A1
1-191194_DD_502	LANDSCAPE MATERIALS & PLANTING PLAN 02	1:250@A1
1-191194_DD_503	LANDSCAPE MATERIALS & PLANTING PLAN 03	1:250@A1
1-191194_DD_601	LANDSCAPE SECTIONS	1:50@A1
1-191194_DD_602	LANDSCAPE SECTIONS	1:50@A1
1-191194_DD_603	LANDSCAPE SECTIONS	1:50@A1
1-191194_DD_701	LANDSCAPE DETAILS - SEATING NODES	AS SHOWN
1-191194_DD_702	LANDSCAPE DETAILS - HARDWORKS	AS SHOWN
1-191194_DD_703	LANDSCAPE DETAILS - SOFTWORKS	AS SHOWN
1-191194_DD_704	LANDSCAPE DETAILS - PLANTING MATRIXES	AS SHOWN
1-191194_DD_801	LANDSCAPE PLANTING SPECIFICATION	NA

NOTES:
Not for Construction. Do not scale off drawings.

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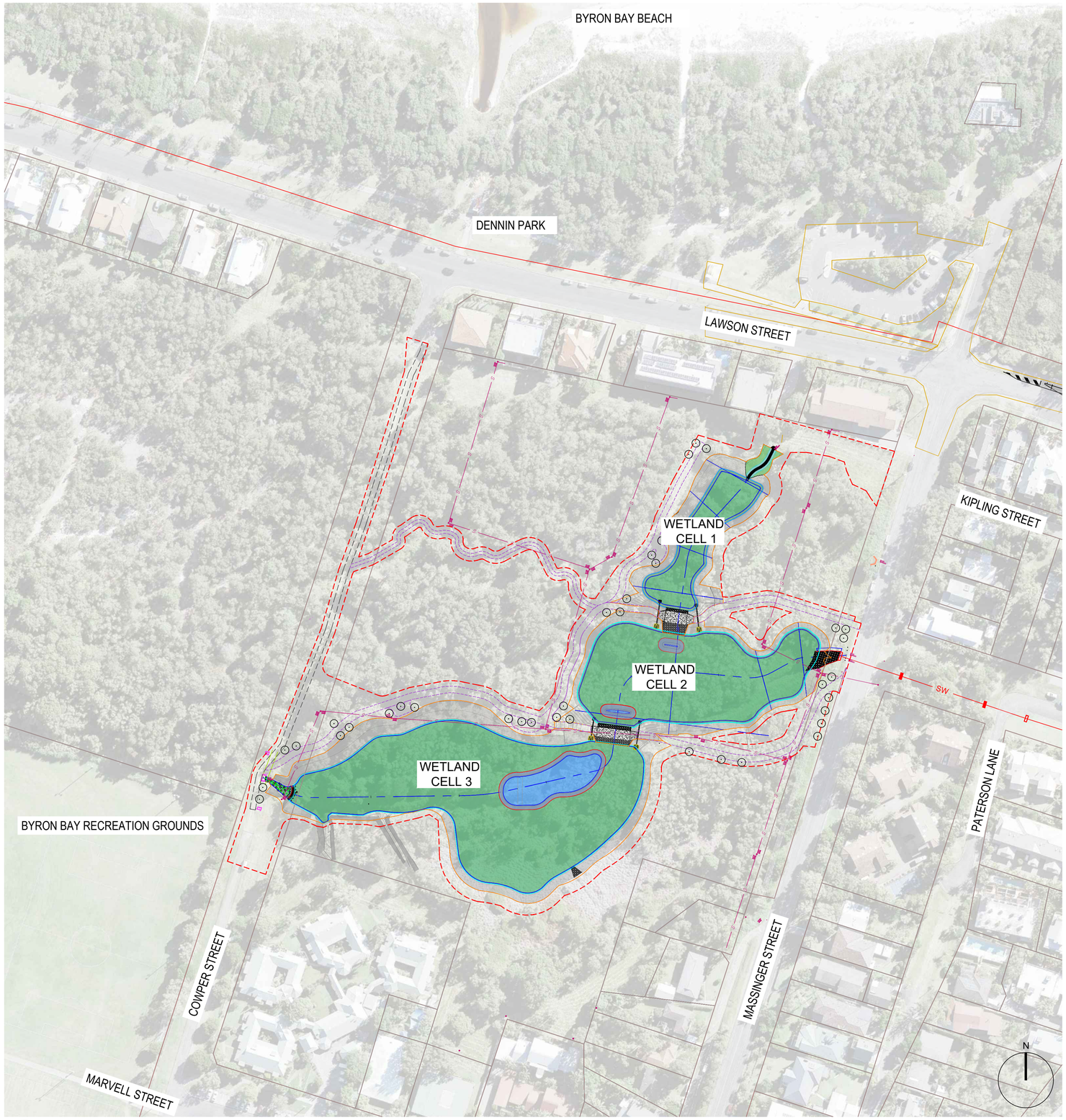
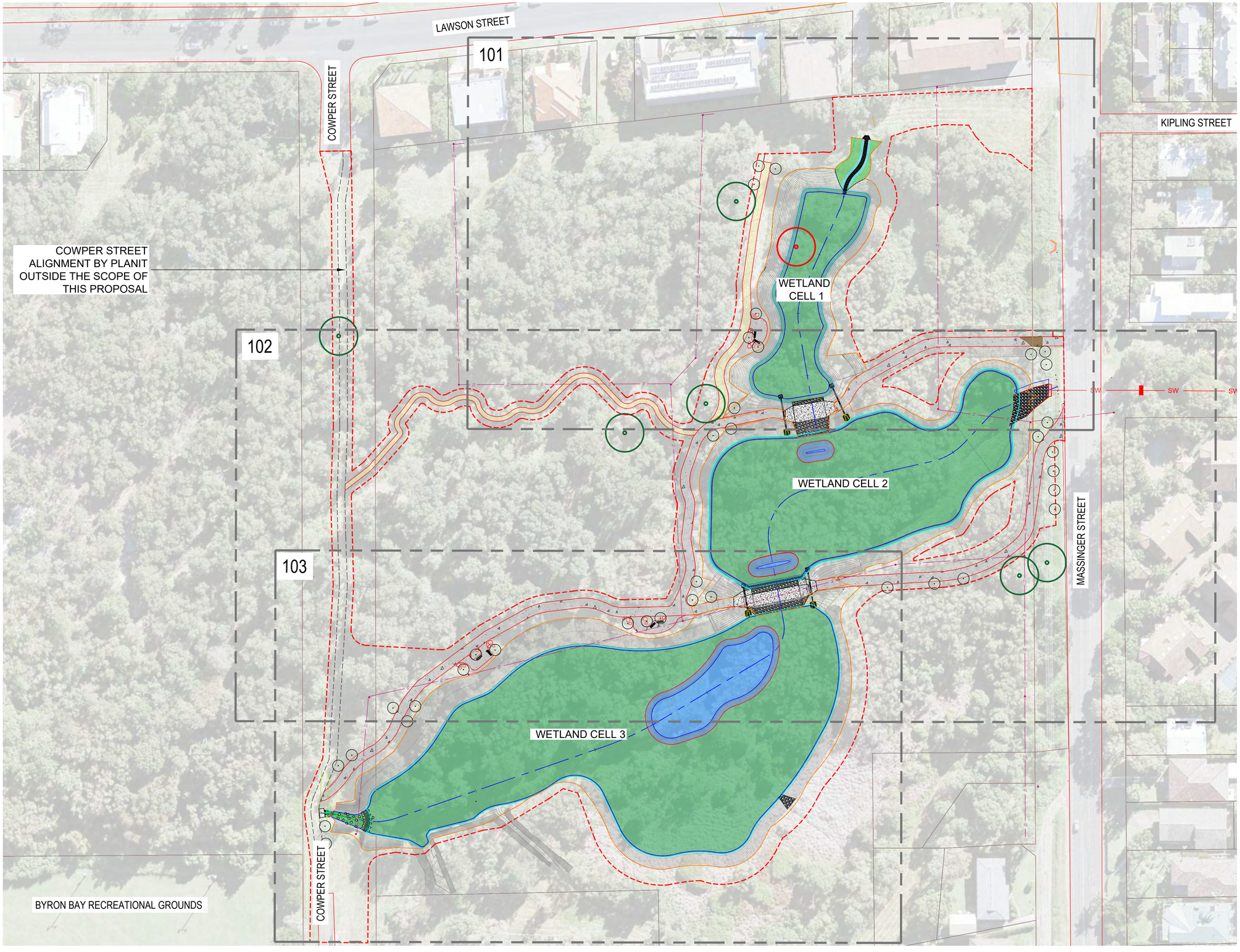


01/001 **LOCALITY PLAN**



LEGEND

- CONCRETE CYCLEWAY — REFER DETAIL 02_702
- DECOMPOSED GRANITIC SAND PATH — REFER DETAIL 01_702
- EXISTING TREE RETAINED — PROTECTED TO MEET AS 4970-2009
- PROPOSED FEATURE TREE — REFER PLANTING PLANS 501-503
- EXTENT OF EARTH WORKS
- OPERATING WATER LEVEL (OWL)
- FINISHED FLOOR LEVEL (FFL)
- EXTENT OF WORKS
- PROPOSED 0.2m CONTOURS
- SEWER INFRASTRUCTURE
- SEWER ACCESS HOLE
- S/W PIPE HEADWALL
- CADESTRAL BOUNDARIES
- COWPER STREET ALIGNMENT
- EXISTING TREE REMOVED

AWC
Australian Wetlands Consulting Pty Ltd
25 LESLIE ST, BANGALOW NSW 2479
P (02) 6687 1550 | 1300 998 514
www.awconsult.au

CLIENT: Byron Shire Council

DRAWING:
SITE CONTEXT & SHEET LAYOUT PLAN

PROJECT:
SANDHILLS WETLAND
DETAILED DESIGN PACKAGE

REV.	ISSUE / AMENDMENTS	DATE
A	*PRE -DETAILED DESIGN PACKAGE COUNCIL REVIEW*	*17.11.2021*
B	*DETAILED DESIGN PACKAGE 70%*	*28.02.2022*
C	*DETAILED DESIGN PACKAGE 100%*	*02.11.2022*
D	*DETAILED DESIGN PACKAGE AMENDMENTS 100%*	*17.11.2022*
E	*DETAILED DESIGN PACKAGE AMENDMENTS 100%*	*13.12.2022*
F	*FOR TENDER*	*25.08.2023*

N

DO NOT SCALE FROM PLANS, TO BE ADAPTED ON SITE BY CONTRACTOR & CONFIRMED BY THE PROJECT SUPERVISOR, SIZING, CALCULATIONS, STRUCTURES, & COMPACTION TO BE CONFIRMED BY ENGINEER OR SUITABLY QUALIFIED PERSONS. ENGINEERS CERTIFICATE BY OTHERS.

SCALE 1:600 @ A1 (0 5 10 15 20 25m)
REV. F

DESIGNED KC
DRAWN RS/TC
CHECKED DM

CAD FILE No. **1-91194_SANDHILLS_DD.DWG**
SHEET No. **1-191194_DD_002**

LEGEND

- CUT DEPTH 3.0-2.0m
- CUT DEPTH 2.0 - 1.0m
- CUT DEPTH 1.0 - 0.5m
- CUT DEPTH 0.5-0m
- FILL DEPTH 0-0.25m
- FILL DEPTH 0.25-0.5m
- FILL DEPTH 0.5-0.75m
- FILL DEPTH 0.75-1m
- EXTENT OF WORKS
- SEWER INFRASTRUCTURE

SETOUT NOTE:
SETOUT COORDINATES TO BE PROVIDED IN DWG. DIGITAL FORMAT FOR CONSTRUCTION

SERVICES NOTE:
LOCATIONS OF ALL SERVICES TO BE CONFIRMED ON SITE. REFER TO GENERAL ARRANGEMENT PLANS FOR STORMWATER AND SEWAGE PIPES

*** BULKING FACTOR NOTE**:
A BULKING FACTOR HAS NOT BEEN APPLIED TO THESE EARTHWORKS VOLUMES.

CONTAMINATED CUT NOTE:
REFER TO ENV SOLUTIONS (2021) FOR DETAILS ON SITE CUT MATERIALS AND THE ACID SULPHATE SOIL MANAGEMENT PLAN (ENV SOLUTIONS 2021)

CUT & FILL TABLE

WETLAND CELL	Topsoil m³ (300mm assumed)	cut vol m³ 300mm below FSL	fill vol m³	Planting Media m³	Excess spoil m³
1	719	1903	120	725	1783
2	1566	3235	102	1993	3238
3	2785	9700	15	2512	9685
Paths	256	25	625	240	-600
TOTAL	**3636**	**15642**	**1122**	**3437**	**14520**
* This includes the open Water Sections					

AWC
Australian Wetlands Consulting Pty Ltd
25 LESLIE ST, BANGALOW NSW 2479
P (02) 6687 1550 | 1300 998 514
www.awconsult.com.au

CLIENT: Byron Shire Council

DRAWING:
SITE CUT & FILL PLAN

PROJECT:
SANDHILLS WETLAND
DETAILED DESIGN PACKAGE

REV.	ISSUE / AMENDMENTS	DATE
A	*PRE -DETAILED DESIGN PACKAGE COUNCIL REVIEW*	*17.11.2021*
B	*DETAILED DESIGN PACKAGE 70%*	*28.02.2022*
C	*DETAILED DESIGN PACKAGE 100%*	*02.11.2022*
D	*DETAILED DESIGN PACKAGE AMENDMENTS 100%*	*17.11.2022*
E	*DETAILED DESIGN PACKAGE AMENDMENTS 100%*	*13.12.2022*
F	*FOR TENDER*	*25.08.2023*

N

DO NOT SCALE FROM PLANS, TO BE ADAPTED ON SITE BY CONTRACTOR & CONFIRMED BY THE PROJECT SUPERVISOR, SIZING, CALCULATIONS, STRUCTURES, & COMPACTION TO BE CONFIRMED BY ENGINEER OR SUITABLY QUALIFIED PERSONS. ENGINEERS CERTIFICATE BY OTHERS.

SCALE
1:600 @ A1
0 5 10 15 20 25m

REV. **F**

DESIGNED KC
DRAWN RS/TC
CHECKED DM

CAD FILE No.
1-91194_SANDHILLS_DD.DWG

SHEET No.
1-191194_DD_003

16 Appendix C

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

BOREHOLE LOG BH01

PROJECT NUMBER 216010
PROJECT NAME Sandhills Wetland Project
CLIENT Byron Shire Council
ADDRESS Cowper St, Byron Bay NSW

DRILLING DATE 29/06/2021
TOTAL DEPTH 5.0 m
DRILLING COMPANY ENV Solutions
DRILLING METHOD Solid Flight Augur

COMMENTS Cowper St, near 'Invert'

LOGGED BY Ben Pieterse

Depth (m)	Graphic Log	Material Description Surface: Grass	Samples (ASS)	Samples (Contam)	Additional Observations
0		CLAY: brown, soft, dense, wet, high organic content	BH1_0.1		No anthropogenic refuse, staining or non-natural odour encountered
0.2		SAND: yellow, dry-moist, fine-medium, loose			
0.4			BH1_0.5		
0.6		Sandy SILT: black, moist, dense, fine, soft	BH1_0.65		
0.8		SAND: grey, moist, fine-medium, loose			
1			BH1_1.0		
1.2		SAND: brown, wet, fine-medium, soft. Saturated from 1.5m			
1.4		▽	BH1_1.5		
1.6					GW from 1.5 m Sulfur odour
1.8					
2			BH1_2.0		
2.2					
2.4			BH1_2.5		
2.6					
2.8					
3			BH1_3.0		
3.2					
3.4			BH1_3.5		
3.6					
3.8		As above, with green-brown colouration			
4			BH1_4.0		
4.2		Sandy CLAY: grey-brown, saturated, medium-firm, dense, fine.			Slight sulfur odour
4.4			BH1_4.5		
4.6					
4.8					
5			BH1_5.0		
5.2		EOH at target depth of 5.0m			
5.4					

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

BOREHOLE LOG BH02

PROJECT NUMBER 216010
PROJECT NAME Sandhills Wetland Project
CLIENT Byron Shire Council
ADDRESS Cowper St, Byron Bay NSW

DRILLING DATE 29/06/2021
TOTAL DEPTH 5.0 m
DRILLING COMPANY ENV Solutions
DRILLING METHOD Solid Flight Augur

COMMENTS In grass verge north of wetland cell 1

LOGGED BY Ben Pieterse

Depth (m)	Graphic Log	Material Description Surface: Grass	Samples (ASS)	Samples (Contam)	Additional Observations
0		Sandy CLAY topsoil, brown, wet, firm, organic. (fill)	BH2_0.1		No anthropogenic refuse, staining or non-natural odour encountered Fill material from surface to 0.55 m
0.2		Sandy CLAY: brown, wet, firm, fine-medium with pale brown CLAY banding (fill)			
0.4			BH2_0.5		
0.6		SAND: yellow, dry-moist, fine-medium, loose (natural)			
0.8					
1			BH2_1.0		
1.2					
1.4			BH2_1.5		
1.6					
1.8					
2		Sandy CLAY: grey, moist, soft-medium, fine. Increasign moisture until saturated at 2.5 m	BH2_2.0		Sulfur odour GW from 2.5 m
2.2					
2.4		▽	BH2_2.5		
2.6					
2.8					
3		Clayey SAND: grey, saturated, soft, medium sands.	BH2_3.0		No odour
3.2					
3.4			BH2_3.5		
3.6					
3.8					
4			BH2_4.0		
4.2					
4.4			BH2_4.5		
4.6					
4.8					
5			BH2_5.0		
5.2		EOH at target depth of 5.0m			
5.4					

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

BOREHOLE LOG BH3 // S-06

PROJECT NUMBER 216010
PROJECT NAME Sandhills Wetland Project
CLIENT Byron Shire Council
ADDRESS Cowper St, Byron Bay NSW

DRILLING DATE 29/06/2021
TOTAL DEPTH 2.5 m
DRILLING COMPANY ENV Solutions
DRILLING METHOD Hand Augur

COMMENTS

LOGGED BY Tony Coyle

Depth (m)	Graphic Log	Material Description	Samples (ASS)	Samples (Contam)	Additional Observations
0		Clayey SAND: organic, dark brown, soft, medium sands	BH3_0.0		No anthropogenic refuse, staining or non-natural odour encountered
0.2		Clayey SAND, brown, firm, medium sands, well sorted, moist		S-06_0.4 + QA1 & QA1A	
0.4			BH3_0.5		
0.6					
0.8					
1			BH3_1.0		
1.2		SAND: yellow, well sorted, increasing moisture until saturated from 2.0			Slight sulfur odour
1.4			BH3_1.5		
1.6					
1.8					
2		▽	BH3_2.0		
2.2					
2.4			BH3_2.5		
2.6		EOH at 2.5 m, borehole collapsing in watertable			
2.8					
3					
3.2					
3.4					
3.6					
3.8					
4					
4.2					
4.4					
4.6					
4.8					
5					
5.2					
5.4					

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

BOREHOLE LOG BH4 // S-08

PROJECT NUMBER 216010
PROJECT NAME Sandhills Wetland Project
CLIENT Byron Shire Council
ADDRESS Cowper St, Byron Bay NSW

DRILLING DATE 29/06/2021
TOTAL DEPTH 2.5 m
DRILLING COMPANY ENV Solutions
DRILLING METHOD Hand Augur

COMMENTS

LOGGED BY Tony Coyle

Depth (m)	Graphic Log	Material Description	Samples (ASS)	Samples (Contam)	Additional Observations
0		Sandy CLAY: dark grey, very high organic content, spongy-soft	BH4_0.0		No anthropogenic refuse, staining or non-natural odour encountered
0.2		Clayey SAND: dark brown, well sorted, moist			
0.4			BH4_0.5		
0.6		SAND: brown, moist, firm, medium sands, well-sorted			
0.8					
1			BH4_1.0		
1.2		Clayey SAND: yellow, saturated, firm. No material recovered from 2.0 m			
1.4			BH4_1.5		
1.6					
1.8					
2			BH4_2.0		
2.2					
2.4					
2.6		EOH at 2.5 m, borehole collapsing in watertable			
2.8					
3					
3.2					
3.4					
3.6					
3.8					
4					
4.2					
4.4					
4.6					
4.8					
5					
5.2					
5.4					

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

BOREHOLE LOG BH5 // S-13

PROJECT NUMBER 216010
PROJECT NAME Sandhills Wetland Project
CLIENT Byron Shire Council
ADDRESS Cowper St, Byron Bay NSW

DRILLING DATE 29/06/2021
TOTAL DEPTH 2.5 m
DRILLING COMPANY ENV Solutions
DRILLING METHOD Hand Augur

COMMENTS

LOGGED BY Tony Coyle

Depth (m)	Graphic Log	Material Description	Samples (ASS)	Samples (Contam)	Additional Observations
0		Silty CLAY: black, moist, fine, spongy	BH5_0.0		No anthropogenic refuse, staining or non-natural odour encountered
0.2		Silty CLAY: black, high silt precentage			
0.4		Clayey SAND: grey, firm	BH5_0.5		
0.6					
0.8					
1			BH5_1.0		
1.2					
1.4		▽	BH5_1.5		
1.6					
1.8					
2			BH5_2.0		
2.2		Silty SAND: black			
2.4			BH5_2.5		
2.6		EOH at 2.5 m, borehole collapsing in watertable			
2.8					
3					
3.2					
3.4					
3.6					
3.8					
4					
4.2					
4.4					
4.6					
4.8					
5					
5.2					
5.4					

produced by ESlog.ESdat.net on 02 Jul 2021

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

BOREHOLE LOG BH6 // S-25

PROJECT NUMBER 216010
PROJECT NAME Sandhills Wetland Project
CLIENT Byron Shire Council
ADDRESS Cowper St, Byron Bay NSW

DRILLING DATE 29/06/2021
TOTAL DEPTH 2.0 m
DRILLING COMPANY ENV Solutions
DRILLING METHOD Hand Augur

COMMENTS

LOGGED BY Tony Coyle

Depth (m)	Graphic Log	Material Description	Samples (ASS)	Samples (Contam)	Additional Observations
0		Silty CLAY: black, moist, fine, spongy	BH6_0.0		No anthropogenic refuse, staining or non-natural odour encountered
0.2		Silty CLAY: black, high silt precentage			
0.4		Clayey SAND: grey, firm	BH6_0.5		
0.6					
0.8					
1			BH6_1.0		
1.2					
1.4			BH6_1.5		
1.6					
1.8					
2			BH6_2.0		
2.2		EOH at 2.5 m, borehole collapsing in watertable			
2.4					
2.6					
2.8					
3					
3.2					
3.4					
3.6					
3.8					
4					
4.2					
4.4					
4.6					
4.8					
5					
5.2					
5.4					

produced by ESlog.ESdat.net on 02 Jul 2021

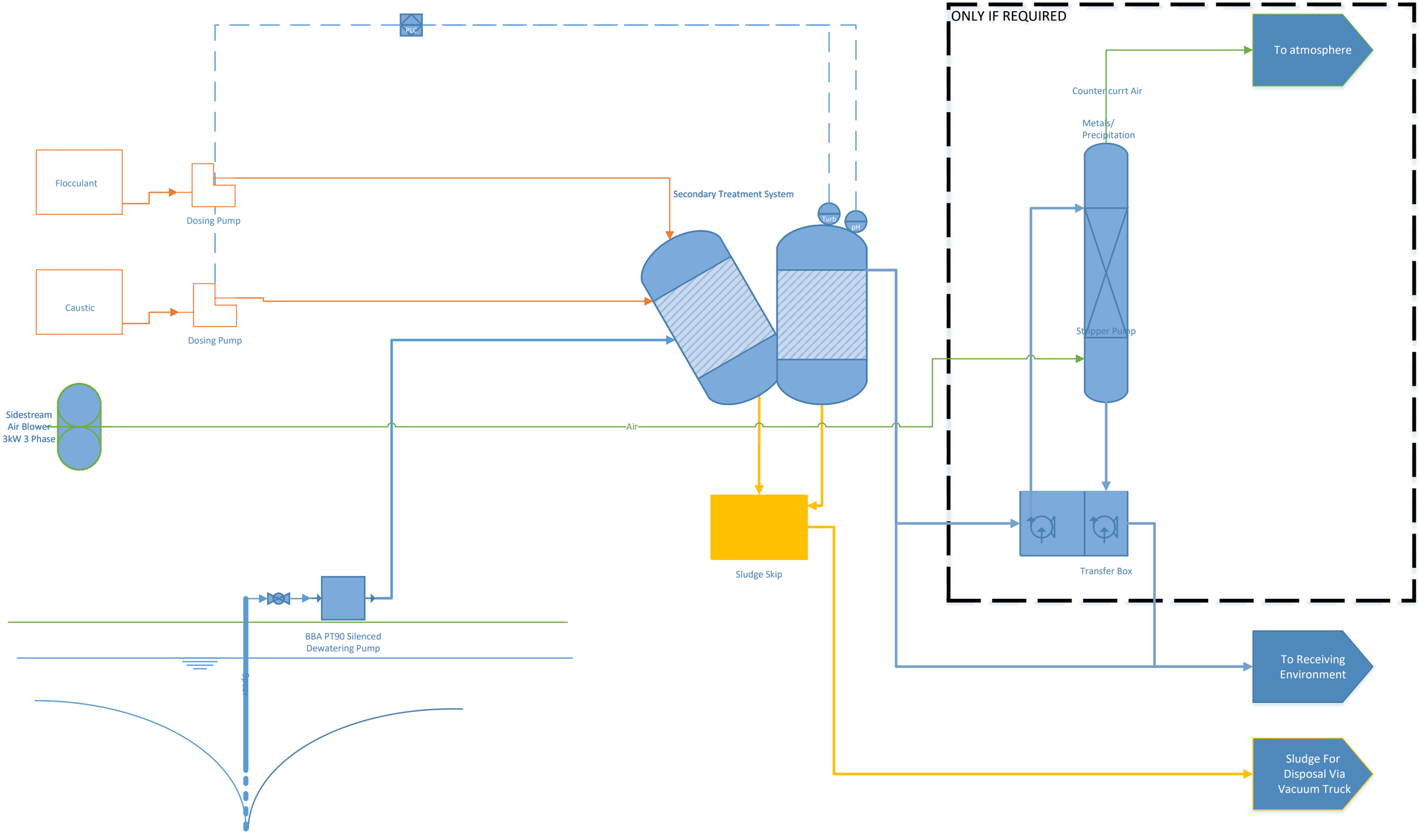
17 Appendix D

Parameter	Max	75th%ile	Ave	Median	25th%ile	Min
pH	6.10	6.01	5.95	5.95	5.86	5.79
Conductivity (EC) (dS/m)	0.54	0.45	0.42	0.42	0.41	0.28
Total Dissolved Salts (mg/L)	344.08	308.72	288.92	286.96	276.08	191.08
Total Suspended Solids (mg/L)	7120.00	5020.00	4111.44	4100.00	2963.00	1450.00
Bicarbonate (Alkalinity) (mg/L CaCO3 equivalent)	76.00	74.14	74.16	71.34	65.04	59.88
Acidity (mg/L CaCO3)	0.00	0.00	0.00	0.00	0.00	0.00
Acidity (mg/L CaCO3)	55.05	77.85	59.67	55.05	42.45	22.50
Acidity (mg/L CaCO3)	83.39	140.70	107.25	136.85	82.65	24.50
Water Hardness (mg/L CaCO3 equivalent)		89.94	81.69	85.65	71.91	55.39
Biochemical Oxygen Demand5 (mg/L O2)	6.60	4.20	3.42	2.80	2.60	2.30
Total Phosphorus (mg/L P)	4.76	2.44	2.11	2.20	1.41	0.20
Phosphate (mg/L P)		0.01	0.01	0.01	0.01	0.01
Total Nitrogen (mg/L N)	5.38	3.52	3.03	3.17	2.47	0.72
Total Kjeldahl Nitrogen (mg/L N)	5.34	3.68	3.14	3.21	2.53	0.71
NOx	0.04	0.03	0.02	0.01	0.01	0.00
Nitrate (mg/L N)		0.03	0.02	0.03	0.02	0.01
Nitrite (mg/L N)	0.03	0.01	0.01	0.01	0.01	0.01
Ammonia (mg/L N)	0.17	0.18	0.15	0.17	0.10	0.09
Sodium (mg/L)	86.02	79.03	72.91	69.25	65.83	51.62
Potassium (mg/L)		2.73	2.39	2.36	2.05	1.84
Calcium (mg/L)	18.58	15.31	13.48	13.86	11.51	8.86
Magnesium (mg/L)	13.76	12.84	11.66	11.76	10.66	8.08
Sodium Absorption Ratio (SAR)		3.67	3.50	3.50	3.25	3.02
Chloride (mg/L)	103.70	99.19	90.55	98.26	79.17	52.78
Sulfur	30.87	6.29	9.13	3.73	3.05	1.68
Sulfate (mg/L SO42-)	92.62	18.87	27.38	11.19	9.16	5.05
Chloride/Sulfate Ratio	19.51	10.73	8.74	8.58	4.19	0.68
Aluminium (mg/L)		0.20	0.19	0.16	0.14	0.12
Iron (mg/L)	0.99	0.68	0.44	0.29	0.18	0.15

Parameter	Max	75th%ile	Ave	Median	25th%ile	Min
pH	8.40	6.19	6.36	6.09	6.05	5.86
Conductivity (EC) (dS/m)	0.68	0.47	0.45	0.43	0.40	0.35
Total Dissolved Salts (mg/L)	463.08	317.56	306.45	295.12	270.64	237.32
Total Suspended Solids (mg/L)	8780.00	4950.00	4606.44	3480.00	3320.00	1475.00
Bicarbonate (Alkalinity) (mg/L CaCO3 equivalent)	233.00	103.00	89.76	62.60	54.78	34.58
Acidity (mg/L CaCO3)	0.00	0.00	0.00	0.00	0.00	0.00
Acidity (mg/L CaCO3)	23.95	26.60	21.83	23.95	17.50	0.00
Acidity (mg/L CaCO3)	50.90	75.00	52.42	50.90	33.50	0.00
Water Hardness (mg/L CaCO3 equivalent)		116.78	138.80	108.20	100.90	85.96
Biochemical Oxygen Demand5 (mg/L O2)	13.60	8.13	5.68	3.00	2.60	1.70
Total Phosphorus (mg/L P)	1.54	1.85	1.41	1.54	1.24	0.20
Phosphate (mg/L P)		0.01	0.01	0.01	0.01	0.01
Total Nitrogen (mg/L N)	5.39	3.57	5.89	3.08	2.78	1.93
Total Kjeldahl Nitrogen (mg/L N)	5.36	4.00	6.16	3.08	2.69	1.93
NOx	0.03	0.03	0.11	0.02	0.01	0.00
Nitrate (mg/L N)		0.04	0.18	0.02	0.01	0.01
Nitrite (mg/L N)	0.02	0.02	0.01	0.01	0.01	0.01
Sodium (mg/L)	94.47	61.92	60.91	56.08	54.86	51.08
Potassium (mg/L)		2.11	1.71	1.36	1.16	1.02
Calcium (mg/L)	102.72	28.53	39.64	27.60	25.15	21.00
Magnesium (mg/L)	11.62	10.12	9.67	9.54	9.25	7.96
Sodium Absorption Ratio (SAR)		2.41	2.34	2.39	2.33	1.59
Chloride (mg/L)	105.16	92.75	86.31	83.90	78.37	73.49
Sulfur	45.08	10.42	12.00	6.50	4.76	3.57
Sulfate (mg/L SO42-)	135.23	31.25	36.00	19.51	14.28	10.70
Chloride/Sulfate Ratio	7.76	7.36	4.35	3.99	2.50	0.58
Aluminium (mg/L)		0.24	0.19	0.22	0.10	0.07
Iron (mg/L)	1.69	0.24	0.35	0.19	0.15	0.07

Parameter	Max	75th%ile	Ave	Median	25th%ile	Min
pH	5.69	5.52	5.44	5.45	5.32	5.11
Conductivity (EC) (dS/m)	0.47	0.37	0.28	0.30	0.12	0.11
Total Dissolved Salts (mg/L)	316.88	251.60	188.93	201.28	82.96	74.12
Total Suspended Solids (mg/L)	23280.00	8310.00	7938.94	5408.50	4846.20	3325.00
Bicarbonate (Alkalinity) (mg/L CaCO3 equivalent)	52.00	22.74	21.01	17.97	13.46	10.60
Acidity (mg/L CaCO3)	15.70	7.79	5.21	2.58	0.00	0.00
Acidity (mg/L CaCO3)	76.30	48.35	42.61	38.35	30.97	27.10
Acidity (mg/L CaCO3)	108.00	97.86	70.85	67.00	48.96	18.75
Water Hardness (mg/L CaCO3 equivalent)	74.29	59.79	47.77	45.09	27.62	24.57
Biochemical Oxygen Demand5 (mg/L O2)	4.80	2.30	2.21	2.00	1.78	1.00
Total Phosphorus (mg/L P)	6.03	3.54	2.79	3.13	1.33	0.39
Phosphate (mg/L P)	0.08	0.01	0.02	0.01	0.01	0.01
Total Nitrogen (mg/L N)	8.79	6.28	5.01	4.54	3.63	1.93
Total Kjeldahl Nitrogen (mg/L N)	8.74	6.50	5.03	4.51	3.47	1.93
NOx	0.18	0.06	0.06	0.05	0.02	0.01
Nitrate (mg/L N)	0.16	0.07	0.07	0.05	0.04	0.03
Nitrite (mg/L N)	0.03	0.03	0.02	0.02	0.02	0.01
Ammonia (mg/L N)	0.28	0.10	0.09	0.07	0.02	0.01
Sodium (mg/L)	64.78	64.15	46.47	53.04	22.20	20.05
Potassium (mg/L)	2.37	0.91	0.85	0.63	0.32	0.28
Calcium (mg/L)	8.30	7.00	5.15	4.57	3.31	2.20
Magnesium (mg/L)	13.48	10.52	8.48	8.18	4.74	4.57
Sodium Absorption Ratio (SAR)	3.61	3.37	2.86	3.29	1.91	1.65
Chloride (mg/L)	80.77	62.53	47.75	51.73	27.80	12.13
Sulfur	43.34	18.13	18.18	16.02	13.48	4.25
Sulfate (mg/L SO42-)	130.03	54.40	54.54	48.05	40.43	12.75
Chloride/Sulfate Ratio	2.02	1.25	1.13	1.09	0.87	0.52
Aluminium (mg/L)	2.89	1.08	1.01	0.73	0.62	0.49
Iron (mg/L)	2.44	1.46	1.06	0.93	0.48	0.16

18 Appendix E



REV	DESCRIPTION	DATE	DRAWN	DESIGN	CHECK	APP.
A	ISSUED FOR INFORMATION	16/06/16	JKF	JKF	RM	RM

Client:

ENV Solutions Pty Ltd
PO BOX 248
Ballina NSW 2478
admin@envsolutions.com.au

Project:

Typical – Dewatering System Overview

Drawing Title:

Process Flow Diagram

Size: **A3** Job No: **ENV** Drawing No: **0001** Revision: **A**