NOTICE OF MEETING

WATER, WASTE AND SEWER ADVISORY COMMITTEE MEETING

A Water, Waste and Sewer Advisory Committee Meeting of Byron Shire Council will be held as follows:

Venue	**Conference Room, Station Street, Mullumbimby**
Date	**Tuesday, 10 October 2017**
Time	**4.00pm**

Phil Holloway
Director Infrastructure Services

I2017/1449
Distributed 03/10/17

CONFLICT OF INTERESTS

What is a "Conflict of Interests" - A conflict of interests can be of two types:

Pecuniary - an interest that a person has in a matter because of a reasonable likelihood or expectation of appreciable financial gain or loss to the person or another person with whom the person is associated.

Non-pecuniary – a private or personal interest that a Council official has that does not amount to a pecuniary interest as defined in the Local Government Act (eg. A friendship, membership of an association, society or trade union or involvement or interest in an activity and may include an interest of a financial nature).

Remoteness – a person does not have a pecuniary interest in a matter if the interest is so remote or insignificant that it could not reasonably be regarded as likely to influence any decision the person might make in relation to a matter or if the interest is of a kind specified in Section 448 of the Local Government Act.

Who has a Pecuniary Interest? - a person has a pecuniary interest in a matter if the pecuniary interest is the interest of the person, or another person with whom the person is associated (see below).

Relatives, Partners - a person is taken to have a pecuniary interest in a matter if:

- The person's spouse or de facto partner or a relative of the person has a pecuniary interest in the matter, or
- The person, or a nominee, partners or employer of the person, is a member of a company or other body that has a pecuniary interest in the matter.

N.B. "Relative", in relation to a person means any of the following:

(a) the parent, grandparent, brother, sister, uncle, aunt, nephew, niece, lineal descends or adopted child of the person or of the person's spouse;

(b) the spouse or de facto partners of the person or of a person referred to in paragraph (a)

No Interest in the Matter - however, a person is not taken to have a pecuniary interest in a matter:

- If the person is unaware of the relevant pecuniary interest of the spouse, de facto partner, relative or company or other body, or
- Just because the person is a member of, or is employed by, the Council.
- Just because the person is a member of, or a delegate of the Council to, a company or other body that has a pecuniary interest in the matter provided that the person has no beneficial interest in any shares of the company or body.

Disclosure and participation in meetings

- A Councillor or a member of a Council Committee who has a pecuniary interest in any matter with which the Council is concerned and who is present at a meeting of the Council or Committee at which the matter is being considered must disclose the nature of the interest to the meeting as soon as practicable.
- The Councillor or member must not be present at, or in sight of, the meeting of the Council or Committee:
  (a) at any time during which the matter is being considered or discussed by the Council or Committee, or
  (b) at any time during which the Council or Committee is voting on any question in relation to the matter.

No Knowledge - a person does not breach this Clause if the person did not know and could not reasonably be expected to have known that the matter under consideration at the meeting was a matter in which he or she had a pecuniary interest.

Participation in Meetings Despite Pecuniary Interest (S 452 Act)

A Councillor is not prevented from taking part in the consideration or discussion of, or from voting on, any of the matters/questions detailed in Section 452 of the Local Government Act.

Non-pecuniary Interests - Must be disclosed in meetings.

There are a broad range of options available for managing conflicts & the option chosen will depend on an assessment of the circumstances of the matter, the nature of the interest and the significance of the issue being dealt with. Non-pecuniary conflicts of interests must be dealt with in at least one of the following ways:

- It may be appropriate that no action be taken where the potential for conflict is minimal. However, Councillors should consider providing an explanation of why they consider a conflict does not exist.
- Limit involvement if practical (eg. Participate in discussion but not in decision making or vice-versa). Care needs to be taken when exercising this option.
- Remove the source of the conflict (eg. Relinquishing or divesting the personal interest that creates the conflict)
- Have no involvement by absenting yourself from and not taking part in any debate or voting on the issue as if the provisions in S451 of the Local Government Act apply (particularly if you have a significant non-pecuniary interest)

RECORDING OF VOTING ON PLANNING MATTERS

Clause 375A of the Local Government Act 1993 – Recording of voting on planning matters

(1) In this section, **planning decision** means a decision made in the exercise of a function of a council under the Environmental Planning and Assessment Act 1979:
  (a) including a decision relating to a development application, an environmental planning instrument, a development control plan or a development contribution plan under that Act, but
  (b) not including the making of an order under Division 2A of Part 6 of that Act.

(2) The general manager is required to keep a register containing, for each planning decision made at a meeting of the council or a council committee, the names of the councillors who supported the decision and the names of any councillors who opposed (or are taken to have opposed) the decision.

(3) For the purpose of maintaining the register, a division is required to be called whenever a motion for a planning decision is put at a meeting of the council or a council committee.

(4) Each decision recorded in the register is to be described in the register or identified in a manner that enables the description to be obtained from another publicly available document, and is to include the information required by the regulations.

(5) This section extends to a meeting that is closed to the public.

BUSINESS OF MEETING

1. APOLOGIES

2. DECLARATIONS OF INTEREST – PECUNIARY AND NON-PECUNIARY

3. ADOPTION OF MINUTES FROM PREVIOUS MEETINGS

3.1 Water, Waste and Sewer Advisory Committee Meeting held on 14 September 2017

4. STAFF REPORTS

Infrastructure Services

4.1 State Government Water and Sewerage Performance Reports 4
4.2 Byron Shire Effluent Management Strategy (Draft)...18
4.3 Vallances Road Plan of Management 41
4.4 Update on the review of Council's Integrated Waste Management and Resource Recovery Strategy..98
4.5 Response to Alan Dickens Questions 105
4.6 Items For the Committee Requested by Duncan Dey..133

STAFF REPORTS - INFRASTRUCTURE SERVICES

Report No. 4.1	**State Government Water and Sewerage Performance Reports**
Directorate:	Infrastructure Services
Report Author:	Peter Rees, Manager Utilities
File No:	I2017/1234
Theme:	Community Infrastructure Water Supplies

Summary:

The attached documents are the Department of Primary Industries (Water) triple bottom line Performance Report for Byron Shire Council's Water and Sewerage operations in 2015-16. This report is prepared by the DPI Water for all Local Government water and sewerage authorities. It is prepared from data submitted by Councils through financial special schedules and operational data annual submissions.

The Best Practice Guidelines and performance reports have proved to be valuable tools for assessing the performance of the Water Supply and Sewerage operations. The performance reports provide a benchmark tool for setting operational targets and continuously improving performance. Water and Sewerage operations have embedded the key KPIs in monthly management reports. This has streamlined the data collating and analysis process and provided significant benefits to the overall performance of the group.

It forms part of the National Water Initiative of the Federal Government for Water Utilities with greater than 10,000 assessments.

RECOMMENDATION:

That the Water Waste and Sewer Advisory Committee note the continuing improving performance in both cost and service delivery for the Water and Sewer services.

Attachments:

1 Water Supply TBL 2015-16 BYRON, E2017/82391 , page 9⇩
2 Water Supply Action Plan 2015-16 - Byron Shire Council, E2017/82390 , page 11⇩
3 SewerageTBL 2015-16 BYRON, E2017/82389 , page 13⇩
4 Sewerage Action Plan 2015-16 - Byron Shire Council, E2017/82388 , page 15⇩

Report

The NSW Best Practice Management Guidelines for Water Supply and Sewerage were developed to encourage effective and efficient delivery of water supply and sewerage services. The guidelines set out six criteria for achievement of best practice management. Byron Shire Council has conducted audits and achieved compliance with all of the best practice guidelines for both Water and Sewerage.

It should be noted however, to continue to achieve BPM Council needs to prepare a new 30 year Integrated Water Cycle Management Strategy. Utilities has commenced this process and expect to finalise a draft early in the new year.

Performance reporting is one of the best practice criteria. The data submitted covers the triple bottom line concept of performance measurement. The triple bottom line concepts are economic, environmental and social. One key element of the compilation of the performance report is the collection of accurate data. The water and sewerage business has, over the past fifteen years, progressively implemented systems to enable the accurate and timely collection of the required data. The businesses utilize this performance data to produce monthly production reports that measure the performance of the operations.

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The performance data for 2015-16 was submitted to DPI Water in the time frames required. Copies of the Water Supply and Sewerage 2015-16 Performance Reports are included as attachments to this report. Also included in the report this year are recommended action plans as a result of the reported data.

Characteristics

A significant indicator in this group is the number of employees per 1000 properties. Byron Shire has a slightly higher than average result for sewerage operations with 1.8 employees per 1000 properties, whereas water operations has a lower than average with 0.8 employees per 1000 properties. In Byron Shire however, there is a high degree of multi skilling with many employees working across both areas of operation. If the groups are combined there are a total of 2.6 employees per 1000 properties compared to the state median of 3.2.

A key characteristic of Byron Shire's water and sewerage employee profile is the high proportion of staff in the field versus staff in the office (Engineers and Managers). In the operations section we have 29 field staff and 4 office based staff; with 10% of the field staff being apprentices and trainees.

Social – Charges & Bills

Byron Shire has been rated as satisfactory to very good in all Social – Charges performance indicators. The typical residential bill for water is less than the state median. The typical residential bill for sewerage remains significantly higher but the gap will close over the coming years.

Social – Health

Byron Shire's social – health performance remains in the highest performance percentile for all the water indicators. For sewerage the ratings were satisfactory to very good.

Social – Levels of Service

Byron Shire continues to achieve excellent results in both the water and sewerage key indicators of customer service. For water the result 0 complaints per 1000 properties versus a state median of 3. For sewerage the result was 1 versus a state median of 0.9. For water supply, quality performance still outperforms the state median with only 1.0 complaint per 1000 properties versus 3 across the state.

One area of concern that continues to require monitoring is odour complaints in the sewerage performance. Council's result has improved in recent years from 2.1 to 1.0 complaints per 1000 properties compared to a state median of 0.9. These complaints are associated with sewer pump stations. Council has several pump stations located in heavily populated areas. Odour control devices have been installed on all of these sites however more work is required.

Environmental

Water – The "Average Annual Residential Water Consumption" for coastal LWUs indicator has fallen to 169 kL/property. The Real Losses/ Leakage indicator curiously however, has increased from 50 litres/service connection/day to 90. This data requires more analysis.

Sewer – The key sewer environmental performance was positive with most key indicators being rated as good to very good. Compliance with Suspended Solids in EPA licences was highlighted as "may require review". This result was entirely attributable to the aging Ocean Shores STP. Council has prepared a process review and has commenced the project to either upgrade this facility – which would require a total rebuild – or transfer to the new Brunswick Valley STP.

The latter option has the potential to reduce the whole of life NPV of the required Ocean Shores STP upgrade project by approximately $12.6 million as well as allowing the construction of the originally proposed wetlands and effluent storage ponds for the Brunswick Valley Sewage Augmentation scheme. Council is progressing the project and has resolved to undertake a Risk Assessment analysis of the transfer option. This work is in progress.

Another indicator that has reduced in relative terms is the percentage of effluent recycled. This has fallen from 14% in 2014-15 to 11% in 2015-16. This is due to one of the two farmers utilising the Main Arm scheme not using water and the maturation of both the Byron bay 24 Hectare Melaleuca and the Bangalow Bamboo plantations reducing the volume of water required.

It should be noted however, these figures do not include the water recycled in Councils 27 hectares of wetlands at Byron Bay and Ocean Shores. It is estimated that approximately 300 megalitres per annum of recycled water is utilised by these schemes. This usage has not been reported – an oversight that will be corrected in the current year reporting. If this figure is included, Council's percentage of effluent recycled would increase to approximately 20%.

Economic

Water – The water fund is free from debt and is forecast to be cash positive for the foreseeable future with significant levels of cash to be generated that will provide flexibility when considering capital projects such as the Mullumbimby Water Treatment Plant upgrade.

The water economic efficiency was excellent with all the key measures (Management, Treatment, and Water Mains) at less than the State median cost. The break up of the total Operations and Maintenance Cost per property is

Rous Bulk Water	$211
Management	$137
Operations	$89
Maintenance	$30
Chemicals	$5

Clearly the largest cost source is Rous Water which has been the sole driver of the increase in this cost indicator over the past 10 years. During this time O&M and Management costs controlled by Council have actually decreased.

Sewer – The sewer financial economic performance achieved significant improvement this year with loan repayments dropping from $489 to $347 per property; return on assets increasing to 3.6% (up from 1.6%) and the Economic Real Rate of Return increasing from 4% to 6% this year. This is due in part to rationalising of the loan portfolio and active management of the financial assets by Council's Finance Manager.

The Sewer Fund still has a large outstanding debt due to the $80 million capital upgrade programme completed in 2011. The recently completed Strategic Business Plan indicates the Sewer Fund could become debt free by 2021. As with the Water Fund this will provide flexibility when planning for the next round of major capital works of the Ocean Shores STP upgrade (2020) and the Byron Bay STP upgrade (2025).

One issue that needs to be considered is the rehabilitation of the decommissioned sewage treatment plant sites at South Byron, Brunswick Heads and Mullumbimby. It has always been assumed these would be revenue neutral. This currently does not look like being achieved and will need to be factored into future planning although it is not expected to have a material impact.

The sewer economic efficiency has also demonstrated significant improvement with the all key indicators either static or falling. The operating cost per property / per 100 km of main / per kilolitre all fell this year and continue to show a 10 year downward trend. The graph of the OMA over the past 10 years clearly demonstrates Council has held costs static over this time which represents a real reduction after inflation.

This compares favourably to the state situation where overall costs have been increasing and has been achieved without compromising the outputs of lower overflows, improved odour complaints, higher safety standards and higher standards of sewage treatment. It is expected Council will achieve a quantum reduction in OMA if the aging Ocean Shores treatment plant is closed and transferred to the new Brunswick Valley facility.

This overall financial health is due to the economic efficiency of the day to day operations and the efficient execution of the major capital projects. Council recently commissioned 2 new reservoirs (Cooper Shoot and Bangalow) which were both completed within the forecast budget of $5 million. This reflects the active approach to overall cost control in the Water and Sewer Services.

Financial Implications

The continued good performance in the water and sewerage operations is contributing to the overall health of the water and sewerage funds. This provides Council with the financial capacity to implement community aspirations in these areas.

Statutory and Policy Compliance Implications

It is a requirement of the NSW DPI Water Best Practice Management Guidelines that these performance reports are reported to Council.

Byron Shire Council — TBL Water Supply Performance — 2015-16

WATER SUPPLY SYSTEM - Byron Shire Council serves a population of 20,700 (11,450 connected properties). Byron Council is a reticulator with 85% of its supply comprising a fully treated bulk water supply provided by Rous County Council. Water is drawn from Rocky Creek to supply Byron Bay, Bangalow, Brunswick Heads and Ocean Shores. Mullumbimby is supplied from its own water treatment works at Laverty's Gap.The water supply network comprises 1 direct filtration works (2.9 ML/d), 12 service reservoirs (24 ML), 8 pumping stations, 3.9 ML/d delivery capacity into the distribution system, 22 km of transfer and trunk mains and 247 km of reticulation. Byron Shire Council is a reticulator with 79% of its supply provided by Rous Water. 92% of water supplied is potable and 8% nonpotable (recycled).

BPM IMPLEMENTATION - Byron Shire Council achieved 100% implementation of the outcomes required by the NSW BPM Framework, however, Council needs to prepare a 30-year IWCM Strategy, Financial Plan and Report in accordance with the July 2014 IWCM Check List (www.water.nsw.gov.au) to maintain 100% BPM Implementation.

PERFORMANCE - The 2016-17 typical residential bill was $596 which was close to the statewide median of $625 (Indicator 14). The economic real rate of return was 3.1% which was greater than the statewide median (Indicator 43). The operating cost (OMA) per property was $471 which was close to the statewide median of $440 (Indicator 49). Water quality complaints were less than the statewide median of 3 (Indicator 25). Compliance with ADWG was achieved for microbiological water quality (100% of the population, 2 of 2 zones compliant), chemical water quality and physical water quality. There were no failures of the chlorination system or the treatment system. Byron Shire Council reported no water supply public health incidents. Council has a risk-based Drinking Water Management System (DWMS) and had 0 days of water restrictions. Current replacement cost of system assets was $96M ($8,000 per assessment). Cash and investments were $13.3M and revenue was $9.8M (excluding capital works grants).

IMPLEMENTATION OF OUTCOMES REQUIRED BY THE NSW BEST-PRACTICE MANAGEMENT (BPM) FRAMEWORK

(1) Complete Current Strategic Business Plan & Financial Plan	**YES**		**(3) Sound water conservation implemented**	**YES**
(2) (2a) Pricing - Full Cost Recovery, without significant cross subsidies	Yes		**(4) Sound drought management implemented**	**YES**
(2b,2c) Pricing - Appropriate Residential Charges	Yes		**(5) Complete performance reporting (by 15 September)**	**YES**
(2d) Pricing - Appropriate Non-residential Charges	Yes		**(6) Integrated water cycle management strategy**	**YES***
(2e) Pricing - DSP with Commercial Developer Charges	Yes		**IMPLEMENTATION OF ALL OUTCOMES**	**100%**

TRIPLE BOTTOM LINE (TBL) PERFORMANCE INDICATORS

		NWI	No.	Indicator	Unit	RESULT	RANKING Size Group 1	RANKING All LWUs	MEDIANS Statewide	MEDIANS National
						Col 1	Col 2	Col 3	Col 4	Col 5
UTILITY	CHARACTERISTICS	C1	1	**Population served: 20,700** (Number of assessments: 11,930)						
		C4	2	**Number of connected properties:** Council is within Size Group 1: (>10,000 properties)		11,450				
			3	**Residential connected properties**	% of total	87			91	
			4	**New residences connected to water supply**	%	1.6	2	1	1.0	
		A3	5	**Properties served**	prop/km	43			33	34
			6	**Rainfall**	% median annual rainfall	103	2	3	104	
		W11	7	**Total urban water supplied at master meters**	ML	3,040			6,900	9,770
			8	**Peak week to average consumption**	%				142	
			9	**Renewals expenditure**	% CRC	2.9	1	1	0.6	
			10	**Employees**	per 1,000 prop	0.8	1	1	1.5	
SOCIAL	CHARGES & BILLS	P1		**Residential tariff structure for 2016-17:** inclining block; independent of land value; access charge $179						
		P1.3	12a	**Residential water usage charge for 2015-16 for usage <450 kL**	c/kL (2015-16)	242	2	2	228	190
			12	**Residential water usage charge for 2016-17 for usage <450 kL**	c/kL (2016-17)	247	2	2	230	
		P3	14a	**Typical residential bill for 2015-16**	$/assessment (2015-16)	584	2	2	601	623
			14	**Typical residential bill for 2016-17**	$/assessment (2016-17)	596	2	1	625	
			15	**Typical developer charge for 2016-17**	$/ET (2016-17)	3,560	4	4	5,600	
		F4	16	**Residential revenue from usage charges**	% residential bills	71	3	3	73	66
		F5	17	**Revenue** - Water	$/prop	860	4	4	928	921
	HEALTH		18	**Water Supply Coverage** (% of Urban Population with reticulated WS)	% of population	99.6	2	1	99.2	
		H4	19b	**% population with chemical compliance**	% of population	100	1	1	100	
		H3	20a	**% population with microbiological compliance**	% of population	100	1	1	100	100
	SERVICE LEVELS	C9	25	**Water quality complaints**	per 1,000 prop	1	3	3	3	2
		C10	26	**Water service complaints**	per 1,000 prop	0	1	1	4	0.5
		C17	27	**Incidence of unplanned interruptions**	per 1,000 prop	13	2	3	32	90
		A8	30	**Number of water main breaks**	per 100km main	7	2	2	9	13
			32	**Total days lost**	%	0.3	2	2	3.5	
ENVIRON-MENTAL	NATURAL RESOURCE MANAGEMENT	W12	33	**Average annual residential water supplied - STATEWIDE result**	kL/prop	169	3	2	162	181
			33a	**Average annual residential water supplied - COASTAL LWUs**	kL/prop	169	**5**	4	155	
		A10	34	**Real losses** (leakage)	L/connection/day	90	4	3	70	76
			35	**Energy consumption**	kWh/ML	41	1	1	660	
		E12	36a	**Net greenhouse gas emissions** - WS & Sge	t CO2 eq per 1,000 prop	170	1	1	390	402
ECONOMIC	FINANCE		42	**Current replacement cost**	$/assessment	8,100	**5**	**5**	17,400	
		F17	43	**Economic real rate of return** - Water	%	3.1	2	1	2.3	2.8
			44	**Return on assets** - Water	%	3.6	2	2	1.7	
		F22	45	**Net Debt to equity** - WS & Sge	%	11	2	1	-3	7
		F23	46	**Interest cover** - WS & Sge		3	1	1	34	2
			47	**Loan payment** - Water	$/prop	0	4	3	11	
		F24	47b	**Net profit after tax** - WS & Sge	$'000	6,400	3	1	3,800	9300
	EFFICIENCY		48	**Operating cost (OMA) per 100km of main**	$'000	1,110	2	3	1,120	
		F11	49	**Operating cost (OMA) per property - Note 9**	$/prop	471	4	2	440	485
			50	**Operating cost (OMA) per kilolitre**	c/kL	98	1	3	120	
			51	**Management cost**	$/prop	137	2	2	148	
			52	**Treatment cost**	$/prop	21	1	1	59	
			53	**Pumping cost**	$/prop				28	
			54	**Energy cost**	$/prop				17	
			55	**Water main cost**	$/prop	54	1	1	71	
		F28	56	**Capital Expenditure**	$/prop	243	3	2	212	193

NOTES :

1 Col 2 rankings are on a % of LWUs basis - best reveals performance compared to LWUs in a similar Size Group (ie. Result in Col 1 is compared with LWUs in Size Group 1).

2 Col 3 rankings are on a % of LWUs basis - best reveals performance compared to all NSW LWUs (ie. Result in Col 1 is compared with all NSW LWUs).

3 Col 4 (Statewide Median) is on a % of connected properties basis- best reveals statewide performance (gives due weight to larger LWUs & reduces effect of smaller LWUs).

4 Col 5 (National Median) is the median value for the 75 utilities reporting water supply performance in the National Performance Report 2015-16 (www.bom.gov.au).

5 LWUs are required to annually review key projections & actions in the later of their IWCM Strategy and financial plan and their Strategic Business Plan and to annually 'roll forward', review and update their 30-year total asset management plan (TAMP) and 30-year financial plan.

6 Byron Shire Council is a reticulator - costs include operating costs. Water harvesting and water treatment are provided by Rous County Council.

7 2016-17 Non-res tariff: Access Chg based on Service Connection* (40mm: $716), Two Part: Usage Chg 265c/kL.

8 Non-residential water supplied was 30% of potable water supplied (excluding non-revenue water).
Non-residential revenue was 29% of annual rates and charges. This indicates fair pricing of services between the residential and non-residential sectors.

9 Operating cost (OMA/ property) was $471, components were bulk supply ($211), management ($137), operation ($89), maintenance ($30) & chemical ($5).

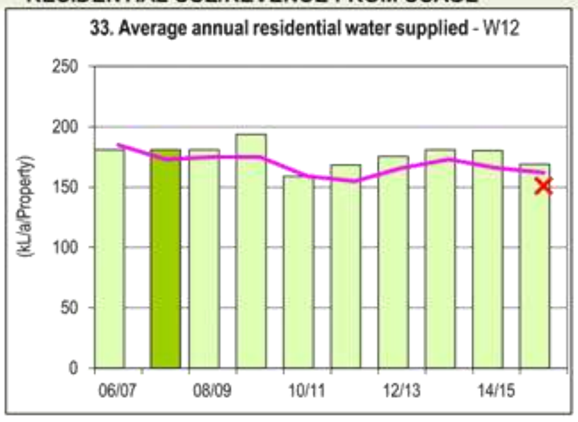
10 Rehabilitations included 1.1% of water mains, 1.04% of service connections and 3.3% of water meters. Renewals expenditure was $1,036,000/100km of main.

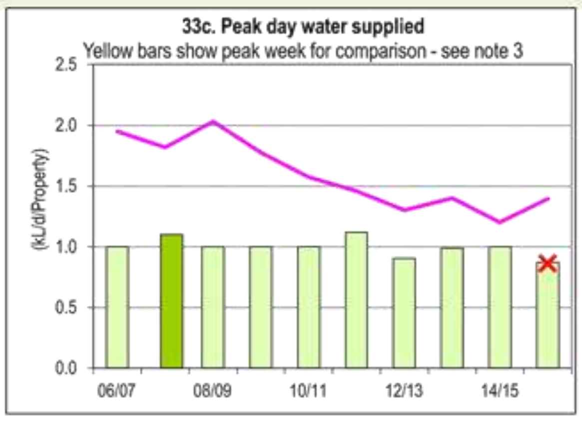
11 Byron Shire Council has 5 fully qualified water treatment operators who meet the requirements of the National Certification Framework.

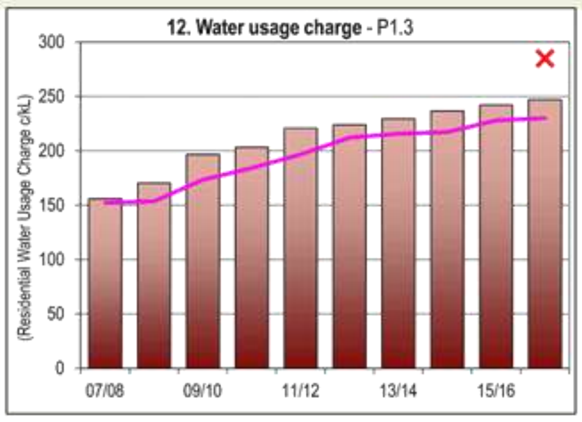
Byron Shire Council — TBL Water Supply Performance (page 2) — 2015-16

(Results shown for 10 years together with Statewide Median and 2015-16 Top 20%)

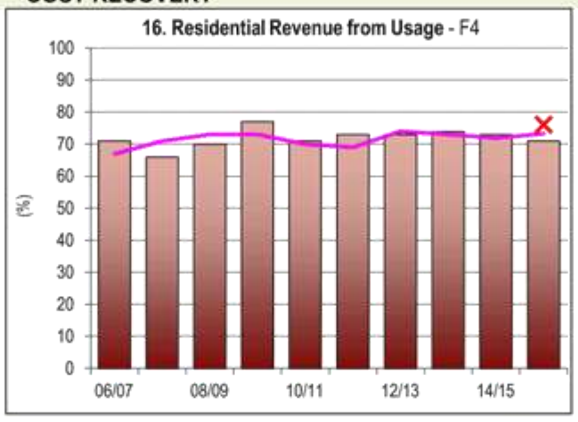
RESIDENTIAL USE/REVENUE FROM USAGE

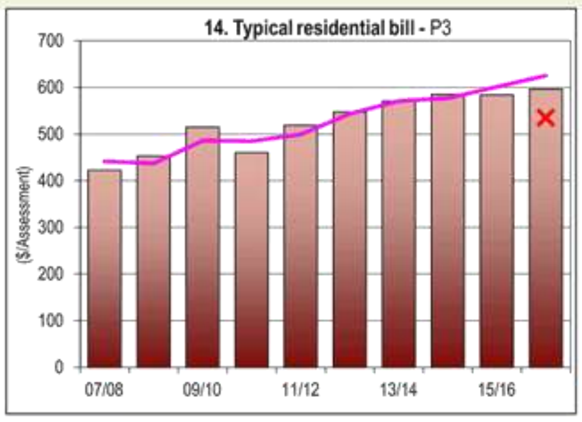


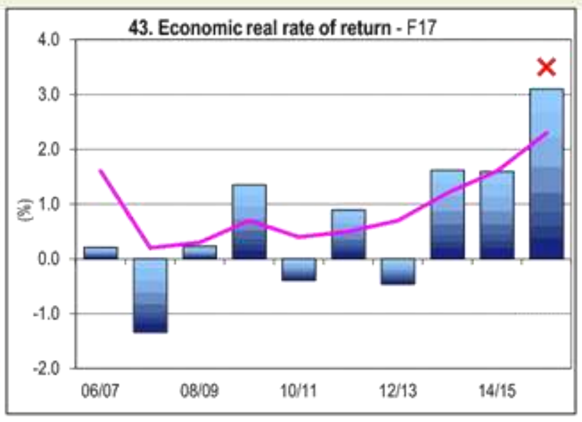




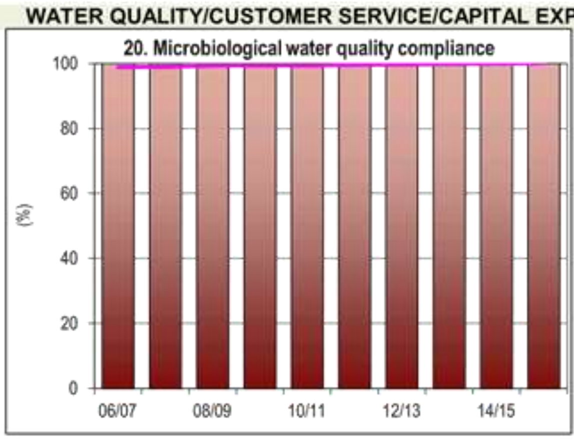
COST RECOVERY

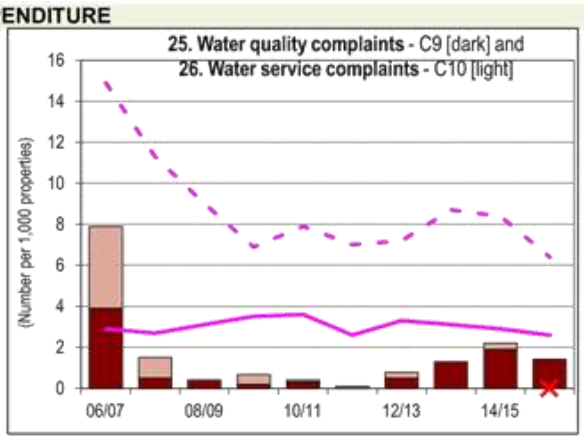


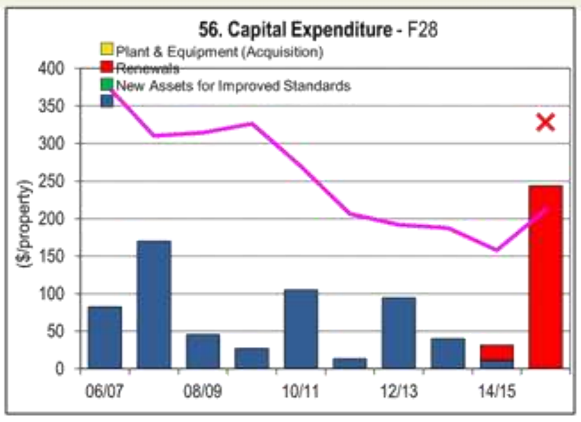




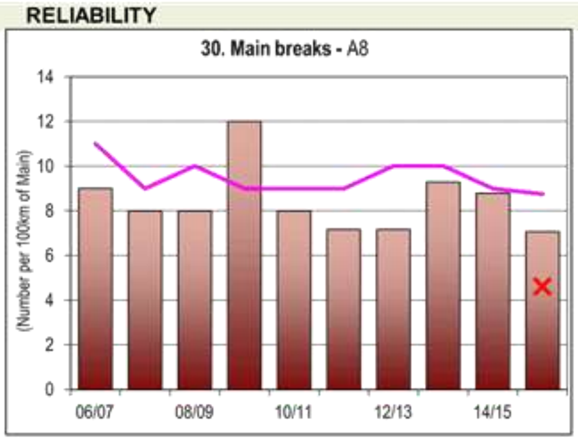
WATER QUALITY/CUSTOMER SERVICE/CAPITAL EXPENDITURE

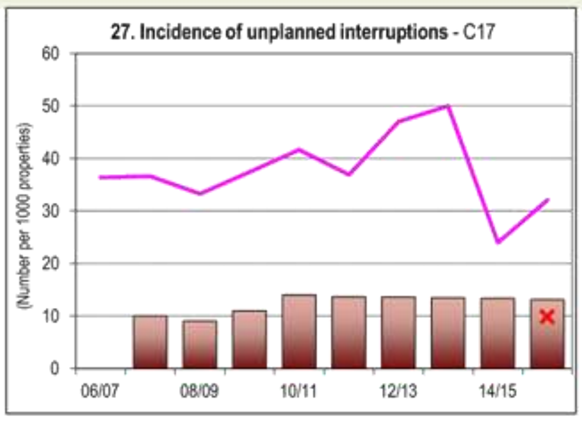


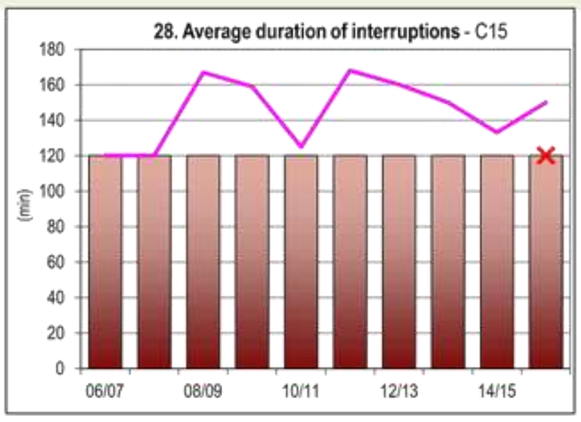




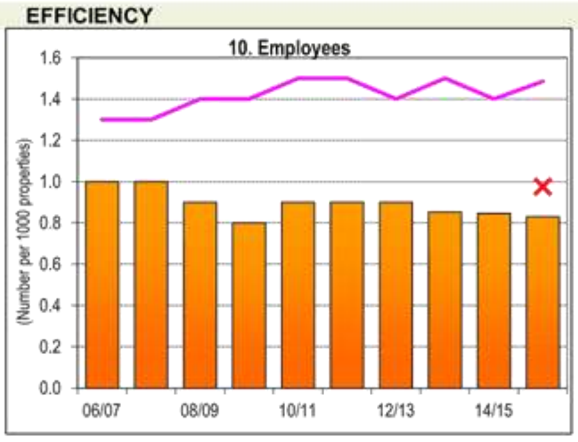
RELIABILITY

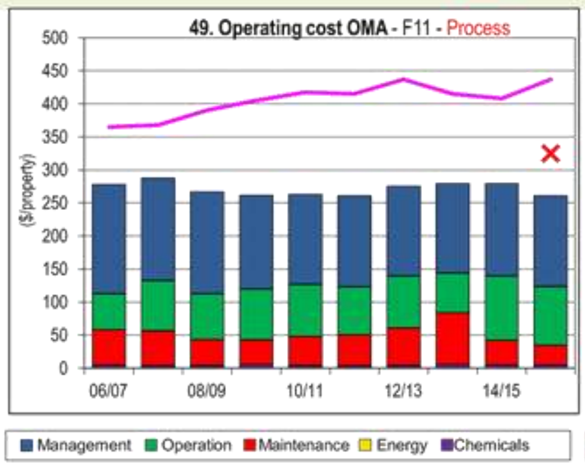


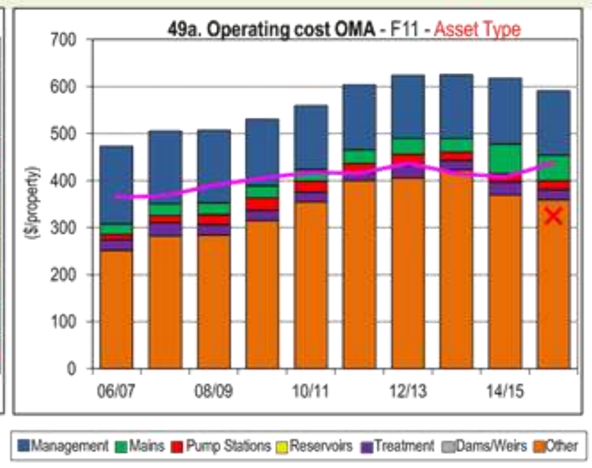




EFFICIENCY







NOTES:

1 Costs are in Jan 2016$ except for graphs 12 and 14, which are in Jan 2017$.
2 Microbiological water quality compliance up to 2010-11 was on the basis of 2004 NHMRC/NRMMC Australian Drinking Water Guidelines (ADWG) and for 2011-12 to 2015-16 compliance was on the basis of the 2011 ADWG.
3 Indicator 33c - Yellow bars show Peak Week Water Supplied for comparison with Peak Day Water Supplied shown in green.
4 Indicators 33 and 33c - Green shading of bars shows % of time Drought Water Restrictions applied in each year: 0 - 30% 30-50% >50% of time

LEGEND
State Median for all years
Top 20% for 2015-16 ✕

Byron Shire Council Water Supply – Action Plan Page 1

Summary
In 2015-16, Byron Shire Council implemented all the water supply outcomes required by the *NSW Best-Practice Management Framework* and its performance has been [to be completed by Council].

Key actions from Council's Strategic Business Plan:
- *Insert achievements for Key Action 1 here for Byron Shire Council*
- *Insert achievements for Key Action 2 here for Byron Shire Council*

INDICATOR		RESULT[2]		COMMENT/DRIVERS	ACTION
	Best-Practice Management Framework	*Implemented all the Best-Practice Required Outcomes[1]*	*Very good*	*Implementation demonstrates effectiveness and sustainability of water supply business. 100% implementation is required for eligibility to pay an 'efficiency dividend'.*	*Prepare a new 30-year IWCM Strategy, Financial Plan and Report in accordance with the July 2014 IWCM Check List (www.water.nsw.gov.au).*
CHARACTERISTICS					
5	*Connected property density*	*43 per km of main* *Highest ranking (1, 1)*		*A connected property density below 30 can significantly increase the cost per property of providing services, as will also a high number of small discrete water supply schemes.*	
9	*Renewals expenditure*	*2.9%* *Highest ranking (1, 1)*	*Very good*	*Adequate funds must be programmed for works outlined in the Asset Management Plan – page 3 of the 2014-15 NSW Performance Monitoring Report.*	***FOR INDICATORS 9 to 56*** *Where ranking is low, investigate reasons including past performance and trends, develop remedial action plan and summarise in this column.*
10	*Employees*	*0.8 per 1,000 props* *Highest ranking (1, 1)*			
SOCIAL - CHARGES					
12	*Residential water usage charge*	*247 c/kL* *High ranking (2, 2)*	*Good*	*Benefits of strong pricing signals are shown on page 5 of the 2014-15 NSW Performance Monitoring Report.*	
13	*Residential access charges*	*$179 per assessment* *Highest ranking (1, 1)*	*Good*		*See 16.*
14	*Typical residential bill[3] (TRB)*	*$596 per assessment* *High ranking (2, 2)*	*Good*	*TRB should be consistent with projection in the financial plan. Drivers – OMA Management Cost and Capital Expenditure.*	*See 43.*
15	*Typical developer charges*	*$3600 per ET* *Low ranking (4, 4)*			
16	*Residential revenue from usage charges*	*70% of residential bills* *Median ranking (3, 3)*	*Satisfactory*	*≥ 75% of residential revenue should be generated through usage charges.*	
SOCIAL – HEALTH					
19	*Physical quality compliance*	*Yes* *Highest ranking (1, 1)*	*Very good*		
19a	*Chemical quality compliance*	*Yes* *Highest ranking (1, 1)*	*Very good*		
20	*Microbiological compliance[4]*	*Yes* *Highest ranking (1, 1)*	*Very good*	*Critical indicator. LWUs should annually review their DWMS in accordance with NSW guidelines[4].*	

1. Council needs to annually 'roll forward', review and update its 30-year total asset management plan (TAMP) and 30-year financial plan, review Council's TBL Performance Report and prepare an ***Action Plan*** *to Council. The Action Plan is to include any actions identified in Council's annual review of its DWMS (Indicator 20) and any section 61 Reports from DPI Water. Refer to pages 21, 98 and 102 of the 2015-16 NSW Water Supply and Sewerage Performance Monitoring Report.*

2. The ranking relative to similar size LWUs is shown first (Col. 2 of TBL Report) followed by the ranking relative to all LWUs (Col. 3 of TBL Report).

3. Review and comparison of the 2016-17 ***Typical Residential Bill (Indicator 14)*** *with the projection in the later of your IWCM Strategy and financial plan and your Strategic Business Plan is* ***mandatory****.*
In addition, if both indicators 43 and 44 are negative, you must report your proposed 2017-18 typical residential bill to achieve full cost recovery.

4. ***Microbiological compliance (Indicator 20)*** *is a* ***high priority*** *for each NSW LWU. Corrective action for non-compliance (≤97%), or any 'boil water alerts' must be reported in your Action Plan. Refer to pages 5, 6 and 21 of the 2015-16 NSW Water Supply and Sewerage Performance Monitoring Report (www.water.nsw.gov.au) and NSW Guidelines for drinking water quality management systems, NSW Health and NSW Office of Water, 2013.*

Byron Shire Council Water Supply – Action Plan Page 2

	INDICATOR	RESULT		COMMENT/DRIVERS	ACTION
SOCIAL – LEVELS OF SERVICE					
25	Water quality complaints	1.4 per 1,000 props Median ranking (3, 3)	Satisfactory	Critical indicator of customer service.	
26	Service complaints	0 per 1,000 props Highest ranking (1, 1)	Very good	Key indicator of customer service.	
27	Average frequency of unplanned interruptions	13 per 1,000 props High ranking (2, 3)	Good	Key indicator of customer service, condition of network and effectiveness of operation.	
30	Number of main breaks	7 per 100km of main High ranking (2, 2)	Good	Drivers – condition and age of water mains, ground conditions.	
32	Total Days Lost	0.3% High ranking (2, 2)	Good		
ENVIRONMENTAL					
33	Average annual residential water supplied	169 kL per prop Median ranking (3, 2)		Drivers – available water supply, climate, location (Inland or coastal), pricing signals (Indicator 3), restrictions.	
34	Real losses (leakage)	90 L/c/d Low ranking (4, 3)	May require review	Loss reduction is important where an LWU is facing drought water restrictions or the need to augment its water supply system.	
ECONOMIC					
43	Economic Real Rate of Return (ERRR)	3.1% High ranking (2, 1)	Good	Reflects the rate of return generated from operating activities (excluding interest income and grants). An ERRR or ROA of ≥ 0% is required for full cost recovery.	
44	Return on assets (ROA)	3.6% High ranking (2, 2)		See 43.	
45	Net debt to equity	11% High ranking (2, 1)	Good	LWUs facing significant capital investment are encouraged to make greater use of borrowings – page 13 of the 2014-15 NSW Performance Monitoring Report.	
46	Interest cover	3 Highest ranking (1, 1)		Drivers – in general, an interest cover > 2 is satisfactory.	
47	Loan payment	$0 per prop Low ranking (4, 3)		The component of TRB required to meet debt payments. Drivers – expenditure on capital works, short term loans.	
49	Operating cost (OMA)	$471 per prop Low ranking (4, 2)	May require review	Prime indicator of the financial performance of an LWU. Drivers – development density, level of treatment, management cost, topography, number of discrete schemes and economies of scale.	Review components carefully to ensure efficient operating cost.
51	Management cost	$137 per prop High ranking (2, 2)	Good	Typically about 40% of the OMA. Drivers – No. of employees. No. of small discrete water schemes.	
52	Treatment cost	$21 per prop Highest ranking (1, 1)	Very good	Drivers – type and quality of water source. Size of treatment works	
53	Pumping cost		Not reported	Drivers – topography, development density and location of water source.	
55	Water main cost	$54 per prop Highest ranking (1, 1)	Very good	Drivers – age and condition of mains. Ground conditions. Development density.	
56	Capital expenditure	$243 per prop Median ranking (3, 2)	Satisfactory	An indicator of the level of investment in the business. Drivers – age and condition of assets, asset life cycle and water source.	

Byron Shire Council — TBL Sewerage Performance — 2015-16

SEWERAGE SYSTEM - Byron Shire Council serves a population of 20,500 (10,920 connected properties) and has 4 sewage treatment works providing secondary and tertiary treatment. The system comprises 57,000 EP treatment capacity (Intermittent Extended Aeration (Activated Sludge), Biological Nutrient Removal and Membrane Biological Reduction), 82 pumping stations (66 ML/d), 76 km of rising mains and 208 km of gravity trunk mains and reticulation. 11% of effluent was recycled (Indicator 27) and the treated effluent is discharged to land and river. Byron Shire Council has 4 Pollution Incident Response Management Plans (PIRMPs) for their sewage treatment works.

BPM IMPLEMENTATION - Byron Shire Council achieved 100% implementation of the outcomes required by the NSW BPM Framework, however, Council needs to prepare a 30-year IWCM Strategy, Financial Plan and Report in accordance with the July 2014 IWCM Check List (www.water.nsw.gov.au) to maintain 100% BPM Implementation.

PERFORMANCE - Residential growth for 2015-16 was 2.4% which is higher than the statewide median. The 2016-17 typical residential bill was $1149 which was well above the statewide median of $718 (Indicator 12). The economic real rate of return was 6% which was greater than the statewide median (Indicator 46). The operating cost per property (OMA) was $662 which was well above the statewide median of $470 (Indicator 50). Sewage odour complaints were above the statewide median of 0.9 (Indicator 21). Byron Council reported no public health incidents. 1 of 4 sewage treatment works were compliant at all times. Council did not comply with the SS, P & Faecal Coliforms requirements of the environmental regulator for effluent discharge. The current replacement cost of system assets was $206M ($18,100 per assessment), cash and investments were $15M and revenue was $19.2M (excluding capital works grants).

IMPLEMENTATION OF OUTCOMES REQUIRED BY THE NSW BEST-PRACTICE MANAGEMENT (BPM) FRAMEWORK

(1) Complete current strategic business plan & financial plan	**YES**	**(2e) Pricing** - DSP with commercial developer charges	Yes
(2) **(2a) Pricing** - Full Cost Recovery without significant cross subsidies	Yes	**(2f) Pricing** - Liquid trade waste approvals & policy	Yes
(2b) Pricing - Appropriate Residential Charges	Yes	**(3) Complete performance reporting** (by 15 September)	**YES**
(2c) Pricing - Appropriate Non-Residential Charges	Yes	**(4) Integrated water cycle management strategy**	**YES***
(2d) Pricing - Appropriate Trade Waste Fees and Charges	Yes	**IMPLEMENTATION OF ALL OUTCOMES**	**100%**

TRIPLE BOTTOM LINE (TBL) PERFORMANCE INDICATORS

		NWI	No.	Indicator	Units	RESULT Col 1	RANKING Size Group 1 Col 2	RANKING All LWUs Col 3	MEDIANS Statewide Col 4	MEDIANS National Col 5
UTILITY	CHARACTERISTICS	C5	1	**Population served: 20,500** (Number of assessments: 11,370)						
		C8	2	**Number of connected properties:** Council is within Size Group 1: (>10,000 properties)		10,920				
		C6	3	**Residential connected properties**	No.	9,360				
			4	**New residences connected to sewerage**	%	2.4	1	1	1.2	
		A6	5	**Properties served**	prop/km main	38			38	40
		W18	6	**Volume of sewage collected**	ML	3,264			4,900	5,610
			7	**Renewals expenditure**	% CRC	0.6	2	3	0.5	
			8	**Employees**	per 1,000 prop	1.8	3	3	1.7	
SOCIAL	CHARGES & BILLS	P4		**Description of residential tariff structure for 2016-17:** access charge/prop with 185 c/kL usage charge ; independent of land value						
		P6	12a	**Typical residential bill for 2015-16** (access charge of $802)	$/assessment (2015-16)	1121	5	5	697	703
			12	**Typical residential bill for 2016-17** (access charge of $850)	$/assessment (2016-17)	1149	5	5	718	
			13	**Typical developer charge for 2016-17**	$/ET (2016-17)	9,990	1	1	4,700	
			14	**Non-residential sewer usage charge for 2016-17**	c/kL (2016-17)	247	2	1	159	
		F6	15	**Revenue** - Sge	$/prop	1,760	1	1	1,095	1032
	HEALTH		16	**Sewerage Coverage** (% of Urban Population with Reticulated Sge Service)	% of population	99.6	1	1	97.8	
		E3	17	**Percent of sewage treated to a tertiary level**	%	100	2	2	95	85
			18	**Percent of sewage volume treated that was compliant**	%	94	3	3	100	
	SERVICE LEVELS		21	**Odour complaints**	per 1,000 prop	1.0	4	4	0.9	
		C11	22	**Service complaints** - Sge	per 1,000 prop	1.0	1	1	5	1
		C16	23a	**Average sewerage interruption**	min	60	1	1	108	101
			25	**Total days lost**	%	0.3	2	2	3.5	
ENVIRONMENTAL	NATURAL RESOURCE MANAGEMENT	W19	26	**Volume of sewage collected**	kL/prop	299	5	5	234	202
		W26	26a	**Total recycled water supplied**	ML	370	4	2	740	1,580
		W27	27	**Recycled water**	% of effluent	11	3	3	11	17
		E8	28	**Biosolids reuse**	%	100	1	1	100	90
			30	**Energy consumption** (1% renewable)	kWh/ML	1,088	4	5	810	
		E12	32	**Net greenhouse gas emissions** - WS & Sge	t CO2 eq per 1,000 prop	170	1	1	390	402
	ENVIRONMENTAL PERFORMANCE		33	**90th Percentile licence limits for effluent discharge:** BOD 10 mg/L; SS 15 mg/L; Total N 10 mg/L; Total P 0.5 mg/L						
			34	**Compliance with BOD in licence**	%	100	1	1	100	
			35	**Compliance with SS in licence**	%	98	5	4	100	
		A14	36	**Sewer main breaks and chokes**	per 100km main	21	2	2	38	20
			37a	**Sewer overflows**	per 100km main	2	1	3	14	
		E13	37b	**Sewer overflows reported to environmental regulator**	per 100km main	2.5	4	5	0.9	0.8
			39	**Non residential & trade waste sewage volume**	% of sewage	25	3	2	20	
ECONOMIC	FINANCE		43	**Revenue from non-residential & trade waste charges**	% of revenue	25	2	2	19	
			44	**Revenue from trade waste charges**	% of revenue	2.0	2	2	1.0	
		F18	46	**Economic real rate of return** - Sge	%	6.0	1	1	2.5	2.9
			46a	**Return on assets** - Sge	%	3.6	1	1	1.8	
			48a	**Loan payment** - Sge	$/prop	347	1	1	83	
	EFFICIENCY		49	**Operating cost (OMA) per 100 km of main**	$'000	2,550	5	5	1,700	
		F12	50	**Operating cost (OMA) per property - Note 9**	$/prop	662	5	5	470	429
			51	**Operating cost (OMA) per kL**	c/kL	221	4	4	208	
			52	**Management cost**	$/prop	158	2	3	164	
			53	**Treatment cost**	$/prop	268	5	5	159	
			54	**Pumping cost**	$/prop	117	5	5	59	
			55	**Energy cost**	$/prop	64	5	5	34	
			56	**Sewer main cost**	$/prop	103	5	5	51	
		F29	57	**Capital Expenditure**	$/prop	110	5	4	186	212

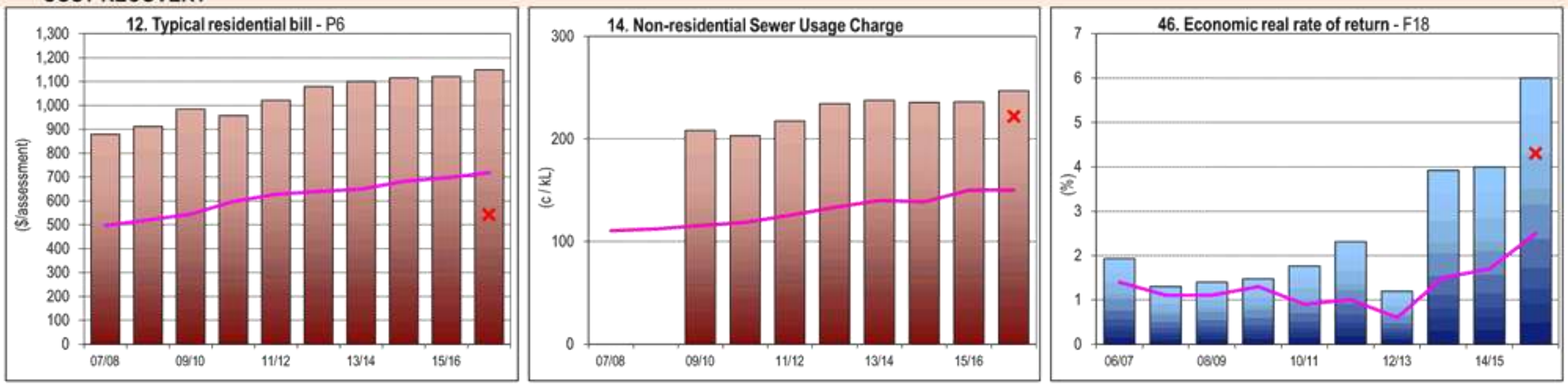
NOTES :

1 Col 2 rankings are on a % of LWUs basis - best reveals performance compared to similar sized LWUs (ie. Result in Col 1 is compared with LWUs in Size Group 1).
2 Col 3 rankings are on a % of LWUs basis - best reveals performance compared to all NSW LWUs (ie. Result in Col 1 is compared with all NSW LWUs).
3 Col 4 (Statewide Median) is on a % of connected properties basis- best reveals statewide performance (gives due weight to larger LWUs & reduces effect of smaller LWUs).
4 Col 5 (National Median) is the median value for the 74 utilities reporting sewerage performance in the National Performance Report 2015-16 (www.bom.gov.au).
5 LWUs are required to annually review key projections and actions in the later of their IWCM Strategy and financial plan and their Strategic Business Plan and to annually 'roll forward', review and update their 30-year total asset management plan (TAMP) and 30-year financial plan.
6 Non-residential access charge - $819, proportional to square of size of service connection. Sewer usage charge - 247 c/kL.
7 Non-residential and trade waste volume was 25% of total sewage collected.
Non-residential revenue was 25% of revenue from access, usage & trade waste charges, indicating fair pricing of services between the residential and non-residential sectors.
8 Compliance with Total N in Licence was 100%. Compliance with Total P in Licence was 99%.
9 Operating cost (OMA)/property was $662. Components were: management ($158), operation ($259), maintenance ($130), energy ($64), chemical ($39) & effluent/biosolids ($12).
10 Renewals expenditure was $429,000/100km of main.
11 Council has 6 fully qualified wastewater treatment operators who meet the NSW Certification requirements.

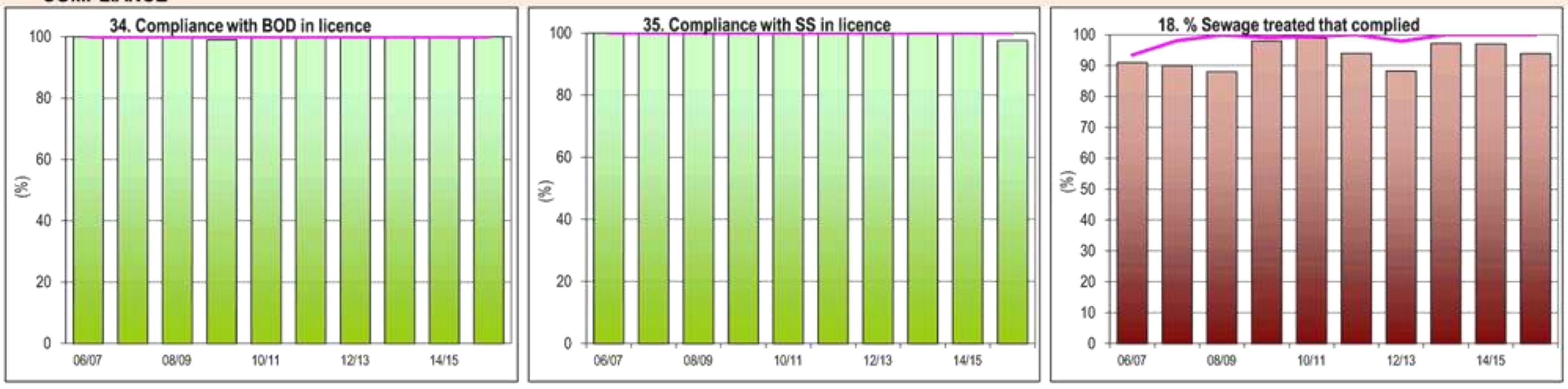
Byron Shire Council TBL Sewerage Performance (page 2) 2015-16

(Results shown for 10 years together with Statewide Median and 2015-16 Top 20%)

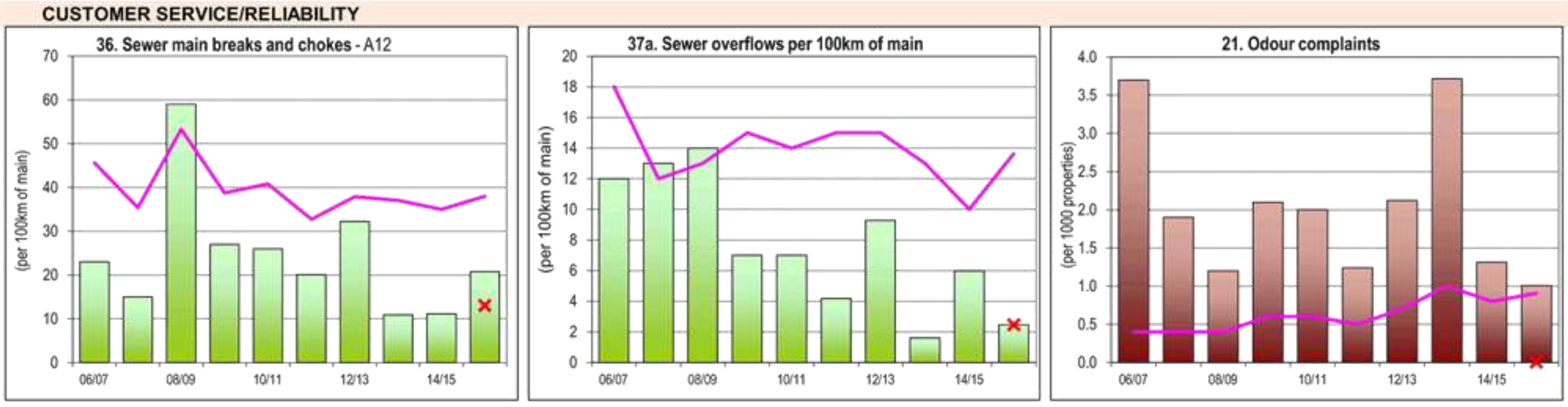
COST RECOVERY



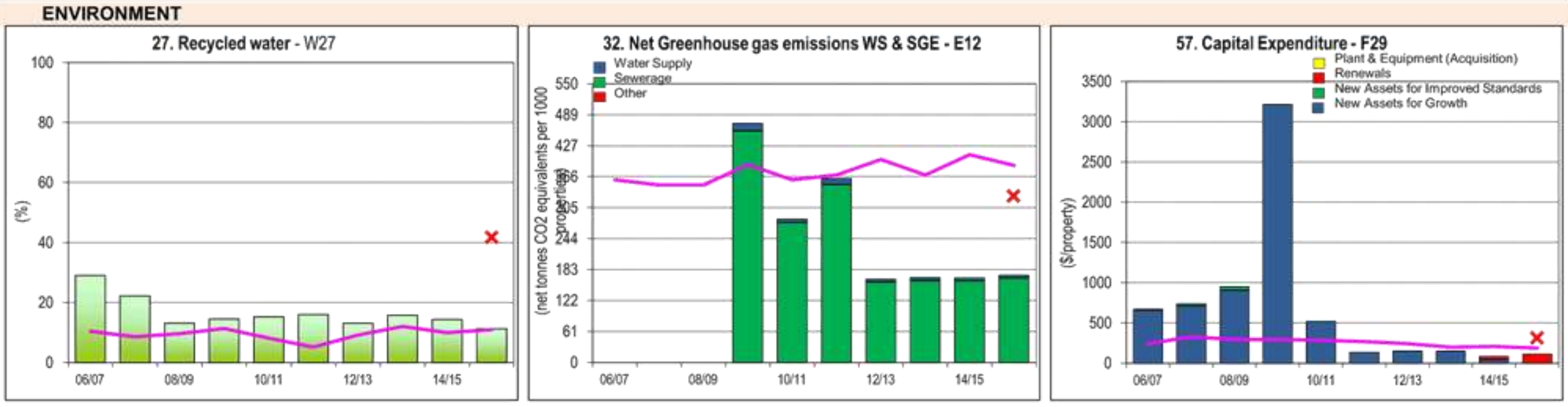
COMPLIANCE



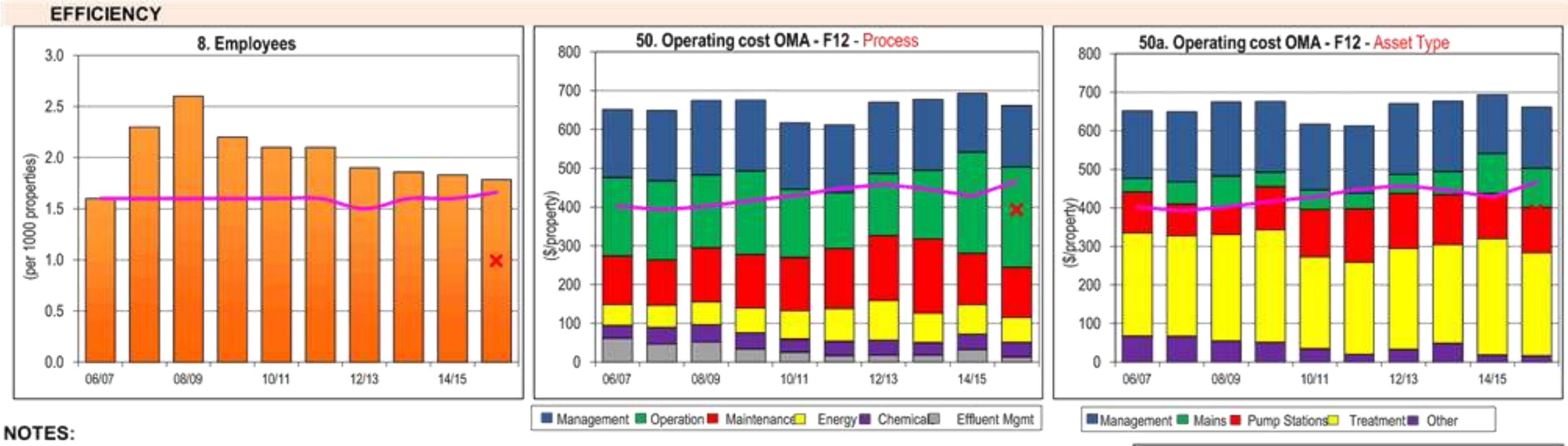
CUSTOMER SERVICE/RELIABILITY



ENVIRONMENT



EFFICIENCY



NOTES:

1 Costs are in Jan 2016$ except for graphs 12 and 14, which are in Jan 2017$.

LEGEND

State Median for all years

Top 20% for 2015-16

Byron Shire Council Sewerage – Action Plan Page 1

Summary

In 2015-16, Byron Shire Council implemented all the sewerage outcomes required by the *NSW Best-Practice Management Framework* and its performance has been [to be completed by Council].

Key actions from Council's Strategic Business Plan:

- *Insert achievements for Key Action 1 here for Byron Shire Council*
- *Insert achievements for Key Action 2 here for Byron Shire Council*

INDICATOR		RESULT[2]		COMMENT/DRIVERS	ACTION
	Best-Practice Management Framework	Implemented all the Best Practice Required Outcomes[1]	Very good	Implementation demonstrates effectiveness and sustainability of water supply and sewerage business. 100% implementation is required for eligibility to pay an 'efficiency dividend'.	Prepare a new 30-year IWCM Strategy, Financial Plan and Report in accordance with the July 2014 IWCM Check List (www.water.nsw.gov.au).
CHARACTERISTICS					
5	Connected property density	38 per km of main	Similar to the statewide median of 38	A connected property density below about 30 can significantly increase the cost per property of providing services.	
7	Renewals expenditure	0.6% High ranking (2, 3)	Good	Adequate funds must be programmed for works outlined in the Asset Management Plan – page 3 of the 2014-15 NSW Performance Monitoring Report.	**FOR INDICATORS 7 to 57** Where ranking is low, investigate reasons including past performance and trends, develop remedial action plan and summarise in this column.
8	Employees	1.8 per 1,000 props Median ranking (3, 3)	Satisfactory		
SOCIAL – CHARGES					
12	Typical residential bill[3] (TRB)	$1149 per assessment Lowest ranking (5, 5)		TRB should be consistent with projection in the financial plan. Drivers – OMA Management Cost and Capital Expenditure.	
13	Typical Developer Charges	$9990 per ET Highest ranking (1, 1)	Good		
14	Non-residential sewer usage charge	247c/kL High ranking (2, 1)	Good	Similar to OMA cost of 221c/kL.	
SOCIAL - HEALTH					
16	Sewerage coverage	99.6% Highest ranking (1, 1)	Very good		
17	Percent sewage treated to tertiary level	100% High ranking (2, 2)	Good		
18	Percent of sewage volume that complied	94% Median ranking (3, 3)	Satisfactory	Key indicator of compliance with regulator.	
19	Sewage treatment works compliant at all times	1 of 4		Key indicator of compliance with regulator.	
SOCIAL – LEVELS OF SERVICE					
21	Odour Complaints	1 per 1,000 props Low ranking (4, 4)	May require review	Critical indicator of customer service and operation of treatment works.	
22	Service complaints	1 per 1,000 props Highest ranking (1, 1)	Very good	Key indicator of customer service.	
23a	Average Duration of Interruption	60 minutes Highest ranking (1, 1)	Very good	Key indicator of customer service, condition of network and effectiveness of operation.	
25	Total Days Lost	0.3% High ranking (2, 2)	Good		

1. Council needs to annually 'roll forward', review and update its 30-year total asset management plan (TAMP) and 30-year financial plan, review Council's TBL Performance Report and prepare an ***Action Plan*** *to Council. The Action Plan is to include any actions identified in Council's section 61 Reports from DPI Water. Refer to pages 21, 98 and 102 of the 2015-16 NSW Water Supply and Sewerage Performance Monitoring Report.*

Byron Shire Council Sewerage – Action Plan Page 2

	INDICATOR	RESULT		COMMENT/DRIVERS	ACTION
ENVIRONMENTAL					
26	Volume of sewage collected per property	299 kL Lowest ranking (5, 5)		Compare sewage collected to water supplied.	
27	Percentage effluent recycled	11% Median ranking (3, 3)	Satisfactory	Key environmental indicator. Drivers – availability of potable water, demand, proximity to customers, environment.	
28	Biosolids reuse	100% Highest ranking (1, 1)	Very good	Key environmental indicator.	
32	Net Greenhouse gas emissions (WS & Sge)	170 t CO2/1000 props Highest ranking (1, 1)	Very good	Drivers – gravity vs pumped networks, topography, extent of treatment.	
34	Compliance with BOD in licence	100% Highest ranking (1, 1)	Very good	Key indicator of compliance with regulator requirements.	
35	Compliance with SS in licence	98% Lowest ranking (5, 4)	May require review	Drivers – algae in maturation ponds, impact of drought.	
36	Sewer main breaks and chokes	21 per 100km of main High ranking (2, 2)	Good	Drivers – condition and age of assets, ground conditions.	
37a	Sewer overflows to the environment	2 per 100km of main Highest ranking (1, 3)	Very good	Drivers – condition of assets, wet weather and flooding.	
39	Non-residential percentage of sewage collected	25% Median ranking (3, 2)		For non-residential, compare % of sewage collected to indicator 43 (% of revenue).	
ECONOMIC					
43	Non-residential revenue	25% High ranking (2, 2)	Good	See 39 above.	
46	Economic Real Rate of Return (ERRR)	6% Highest ranking (1, 1)	Good	Reflects the rate of return generated from operating activities (excluding interest income and grants). An ERRR or ROA of ≥ 0% is required for full cost recovery.	
46a	Return on assets	3.6% Highest ranking (1, 1)		See 46.	
47	Net debt to equity	11% High ranking (2, 1)	Good	LWUs facing significant capital investment are encouraged to make greater use of borrowings – page 14 of the 2014-15 NSW Performance Monitoring Report.	
48	Interest cover	3 Highest ranking (1, 1)		Drivers – in general, an interest cover of > 2 is satisfactory.	
48a	Loan payment	$347 per prop Highest ranking (1, 1)	Good	The component of TRB required to meet debt payments. Drivers – expenditure on capital works, short term loans.	
50	Operating cost (OMA)	$662 per prop Lowest ranking (5, 5)	May require review	Prime indicator of the financial performance of an LWU. Drivers – development density, level of treatment, management cost, topography, number of discrete schemes and economies of scale.	Review carefully to ensure efficient operating cost.
52	Management cost	$158 per prop High ranking (2, 3)	Good	Drivers –number of discrete schemes, number of employees. Typically about 40% of OMA.	
53	Treatment cost	$268 per prop Lowest ranking (5, 5)	May require review	Drivers – type and level of treatment, economies of scale.	
54	Pumping cost	$117 per prop Lowest ranking (5, 5)	May require review	Drivers – topography, development density, effluent recycling.	
56	Sewer main cost	$103 per prop Lowest ranking (5, 5)	May require review	Drivers – topography, development density, effluent recycling.	
57	Capital expenditure	$110 per prop Lowest ranking (5, 4)	May require review	An indicator of the level of investment in the business. Drivers – age and condition of assets, asset life cycle.	

2. The ranking relative to similar size LWUs is shown first (Col. 2 of TBL Report) followed by the ranking relative to all LWUs (Col. 3 of TBL Report).

3. Review and comparison of the 2016-17 ***Typical Residential Bill (Indicator 12)*** *with the projection in your Strategic Business Plan is* ***mandatory****.*
In addition, if both indicators 46 and 46a are negative, you must report your proposed 2017-18 typical residential bill to achieve full cost recovery.

Report No. 4.2 **Byron Shire Effluent Management Strategy (Draft)**
Directorate: Infrastructure Services
Report Author: Peter Rees, Manager Utilities
File No: I2017/1235
Theme: Community Infrastructure
Sewerage Services

Summary:

The attached document has been prepared as a shire wide effluent management strategy replacing the 2006 adopted Byron Bay Effluent Management Strategy. The Byron Bay strategy focussed on 3 streams of recycled water use:-

- Urban Reuse Corridor
- Regeneration Projects
- Rural Lands Project

Of these streams, the urban reuse corridor has been the most successful in terms of identified connections with over 70% of the identified users being connected. The quantity of recycled water used however has been low with the largest user being the Byron Bay Golf Course.

Regeneration projects have been the most successful as far as recycled water usage particularly if the wetlands are considered for their water usage. The number of projects, however, has been limited with only the West Byron Wetlands and the Melaleuca Plantation being implemented.

The largest identified project in the 2006 strategy was the Tyagarah Turf Farm. The project was put on hold by Council in 2007 when the Turf Farm pulled out of the project and it became unviable. Ironically, the new owner of the Turf farm has approached Council to restart the project.

For the shire wide strategy, it is therefore recommended Regeneration and Rural lands (including Biomass cropping) projects be the mainstay of the Effluent Management Strategy with continued expansion of the Byron Bay Urban Reuse corridor.

RECOMMENDATION:

That the Water Waste and Sewer Advisory Committee note the Byron Shire Effluent Management Strategy and recommend its adoption by Council.

Or

The Committee have an extraordinary meeting to workshop the strategy.

Attachments:

1 Byron Shire Effluent Management Strategy Rev 2, E2017/86469 , page 20⇩

Report

In 2006 Council adopted the Byron Bay Effluent Management Strategy which has directed Council's recycled water schemes. When expanding the Byron Bay urban recycled water scheme in 2016, it was suggested by the General Manager that it was an appropriate time to review the strategy and consider the whole shire when doing so.

The draft strategy has been developed for the next 10 years and is attached. It has built on Council's successes to date and also the general industry progression in recycled water use. For Byron Shire's strategy the important points to note are

Urban recycled water schemes (dual reticulation) generally do not provide the biggest volume of recycled water usage. The strategy therefore does not propose development of any further schemes in the Shire other than maximising the usage of the existing scheme in Byron Bay.

The strategy pursues schemes that provide Council with a large degree of control of the amount of recycled water usage – projects such as wetlands and biomass cropping.

The key points of the draft strategy are therefore:-

- Dual reticulation has been allowed for in the new West Byron development in accordance with the current draft DCP for the area.
- Expansion of the urban scheme west along Ewingsdale Road to the farm and the Hospital site.
- Reactivation of the Tyagarah Turf Farm recycled water project following discussions with the new owner.
- Wetland expansion in the Belongil catchment.
- Wetland expansion at Brunswick Valley STP
- Wetland expansion at the old Ocean Shores STP
- Biomass crops at Brunswick Valley and Bangalow STPs.

The draft strategy has to date been driven by staff and is now ready to be workshopped through the Councillors and the Water Waste and Sewer Committee.

Financial Implications

Not applicable

Statutory and Policy Compliance Implications

Not applicable

Byron Shire Effluent Management Strategy (draft)

2017 – 2027

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Byron Shire Council
June 2017

Byron Shire Effluent Management Strategy 2017—2027

EXECUTIVE SUMMARY

The Byron Shire Effluent Management Strategy 2017 – 2027 establishes the path for effluent management in the Byron Shire over the next ten years. This document formalises our vision that ***sewage will be managed in an ecologically sustainable way that has no adverse impact on the natural environment; protects public health; achieves maximum resource recovery; and meets the needs and expectations of existing and future communities.***

The endangered Black-necked Stork at the Byron Bay Integrated Water Management Reserve

The community vision for effluent management was adopted in 1999 and has since shaped the development of effluent management strategies in the Shire. Community aspirations for high levels of effluent reuse has seen the development of the multi-award winning Byron Bay Integrated Water Management Reserve and one of the largest recycled water schemes in Australia—the Byron Bay Urban Recycled Water Scheme.

Council's experience in operating effluent management schemes has provided valuable insight into the future directions of effluent management in the Byron Shire. In the absence of high water using industries, and in an area that receives sufficient rainfall, Council has been challenged to find ways to significantly increase levels of effluent reuse. One of the main differences in Council's approach to effluent management in the next decade, will be the focus on effluent management projects which Council can apply controls to maximise effluent application.

Wetlands and Environmental Schemes form the key direction in effluent management for the Byron Shire Effluent Management Strategy 2017 - 2027. These applications provide Council with the ability to proactively manage effluent reuse to provide long term demand security. This strategy has been developed based on the determination that, not only do wetlands and environmental projects have the lowest level of risks and offer the highest levels of security for long term use, but this application is also capable of using the volumes of effluent required to achieve the community objectives.

The successful implementation of the Byron Bay Integrated Water Management Reserve in achieving, not only high levels of effluent reuse through evapotranspiration and seepage but also in the environmental remediation of localised acid sulphate soil and habitat loss, has resonated in Council's key direction.

Council have commenced investigations into other viable Council controlled land applications that have the potential to achieve high levels of effluent reuse. The Biomass Hub project has provided Council with a unique opportunity. Biomass cropping at some sewage treatments plants is being considered as a viable option for maximising the evapotranspiration of effluent. The prospect of using the effluent for the irrigation of a biomass crop, to be harvested for bioenergy production, is emerging as one of the preferred effluent management strategies. According to the Zero Emissions Byron report, bioenergy could provide for 28 % of the shire's electricity needs. This project provides Council with an opportunity to showcase sustainability and significantly contribute to the community's zero missions target.

The Byron Bay Urban Recycled Water Scheme will continue to develop until full capacity. All sporting fields and nurseries along the Urban Corridor use recycled water for irrigation purposes, and recently the scheme has extended to include flushing of public toilets with the local Hotels and caravan parks connecting imminently. An upgrade to the system will be considered based on a secure demand, although it is considered growth will be small and incremental. Urban schemes are not considered viable for the remaining urban areas in the Byron Shire and will not be pursued.

The Council operated rural scheme, Main Arm Recycled Water Scheme, has been the least successful with the scheme failing to meet community aspirations. The uncertainty with the operation of rural schemes due to external limitations such as high rainfall, along with the practical business considerations of private landowners, increase the risks associated with the development of rural schemes. Whereby in theory, rural reuse projects are able to utilise high volumes of effluent, the inherent constraints increase the risk and uncertainty for long term security. A sale of land or a change of business can highly impact on Council's ability to achieve the goals and objectives of the effluent management strategy.

Reliance on small businesses and farming enterprises to achieve the community objectives for effluent management have not provided the long term security that the Byron community desire. Nevertheless Council is investigating the construction of a recycled water main for rural use in the Byron Bay Scheme and will be supporting farming enterprises in suitable locations.

The community aspirations for effluent management have not as yet been realised, and consequently it is proposed Council will actively pursue projects which Council controls to maximise effluent reuse. A key to the long term success of the strategy will be to ensure that demand for the resource keeps up with supply.

The vulnerable Comb - Crested Jacana

Byron Shire Effluent Management Strategy 2017—2027

EXECUTIVE SUMMARY

INTRODUCTION

VISION, GUIDING PRINCIPLES & OBJECTIVES

STRATEGIC DIRECTION

STRATEGIC PROGRAM

RISK BASED IMPLEMENTATION

APPENDICES

Byron Shire Council

INTRODUCTION

The Byron Shire Effluent Management Strategy 2017—2027 provides the strategic direction in effluent management for Byron Shire. The Strategy has been developed based on the visions, guiding principles and objectives already adopted by Byron Shire Council and emphasises Council's commitment to managing its effluent systems to ensure community objectives, regulatory requirements and improved environmental outcomes are achieved.

The Sewage Management Strategy (1999) set the path for effluent management, developing the vision and guiding principles that would shape the development of effluent strategies across the shire. The Byron Bay Effluent Management Strategy (2005) subsequently developed a set of objectives to align community expectations with the management of effluent in Byron Bay. These Strategies were developed through extensive consultative committee processes represented by Councillors, community members, Council staff, and State Government. The Byron Shire Effluent Management Strategy 2017—2027 builds on the intent of both these documents.

The Byron Shire Effluent Management Strategy 2017—2027 sets out how the objectives for effluent management will be achieved in terms of Council's key strategic directions, specific projects, effluent reuse potential and timeframes. The Strategy is focussed on the beneficial use of treated effluent in urban, rural and environmental applications. In the context of effluent management, the strategy does not attempt to address issues such as sewage minimisation, sewage source control, in-stream sewage quality, sewage treatment process management, or biosolids management.

Improvements in the operation and management of Byron Shire sewage and effluent systems since the early 2000's have seen financial, social and environmental outcomes across the Shire. Council has implemented beneficial reuse at all sewage treatment plants (STP) with varying treatment processes and effluent quality dictating the effluent applications that are applied to each scheme. The schemes for each of the four sewage treatment plants operated by Byron Shire Council are outlined in the table below.

Strategic Direction for Effluent Management in the Byron Shire

STP	Key Direction 2006 - 2016	Key Direction 2017- 2027
Byron Bay	• Byron Bay Urban Recycled Water Scheme • Byron Bay Integrated Wetland Management Reserve	• Urban scheme - expansion to full capacity • Wetland scheme - Belongil Catchment expansion • Rural scheme - Western Corridor
Brunswick Valley	• Main Arm Recycled Water Scheme	• Rural scheme - expansion • Wetland / Environmental scheme: ⇒ Brunswick Valley Sustainability Reserve (wetland regeneration and biomass cropping) ⇒ Ocean Shores Wetlands
Bangalow	• Bangalow STP Bamboo Plantation	• Environmental scheme - Biomass cropping
Ocean Shores	• Ocean Shores Wetlands	• STP decommissioned - Ocean Shores sewage loads and wetlands integrated into Brunswick Valley EMS

There is a significant level of risk and uncertainty with the development and use of recycled water schemes. Each of the effluent applications are driven by a number of external forces which dictate the current and future demands for the recycled water resource. Predicting how these drivers will evolve over the next decade, and how they will ultimately affect recycled water demand, is fraught with a multiplicity of uncertainties.

Vision

Sewage will be managed in an ecologically sustainable way that has no adverse impact on the natural environment; protects public health; achieves maximum resource recovery; and meets the needs and expectations of existing and future communities

Guiding Principles

1. **Consideration that the nature of the receiving environment, in combination with the level to which wastewater has been treated, determines the options for effluent reuse and/or disposal**
2. **The nature of sewage collection, treatment, reuse and disposal may determine the scale and nature of land-use within a catchment**
3. **Sewage or effluent disposal to natural waterways or to the ocean shall be considered only as last resort. Reuse is preferred to disposal and land disposal is preferred to disposal in water in the event that reuse is not feasible**

Objectives

- Maximum resource utilisation
- Maximise the beneficial use of sewage effluent
- Eliminate effluent discharge to surface water
- Maximise the creation of useful products from effluent reuse projects
- Link the development of effluent reuse options with the progressive increase of STP loads
- Use effluent management to achieve broader environmental objectives e.g. acid sulphate soil remediation, habitat regeneration, zero emission targets
- Understand, monitor and manage the impact of effluent discharge
- Maximise evapotranspiration as the preferred mechanism for assimilation to the environment
- Use assimilation pathways and practices to produce effluent surface water run-off that mimics background environmental flows
- Prioritise and resource effluent management appropriately

STRATEGIC DIRECTION

Current Effluent Reuse (average 2010 - 2016)

	Byron Bay	Brunswick Valley	Bangalow	Ocean Shores
Urban	15 %	-	-	-
Wetlands/ Environmental	23 %	-	13 %	Unknown
Rural		8 %	-	-
Total Reuse	38 %	8 %	13 %	-

Constraints limited effluent use in urban, rural and environmental applications have influenced the key directions in the 2017-2027 strategy:

- An absence of high water using industries limiting options for rural and urban applications
- Climatic conditions such as a pronounced wet season which limits the need for irrigation at certain times of the year
- Environmental considerations limiting irrigation opportunities e.g. the presence of shallow water tables or site and soil suitability
- Lack of commercial demand for long term security of supply
- Commercial considerations of private users provide a elevated risk for long term demand and supply security e.g. reduced production, ceased operations
- Reliance on private users to achieve Council's effluent management objectives inhibits Council's ability to manage, adapt and maximise effluent use

Opportunities for recycled water use in urban, rural and environmental applications provide the key directions for the 2017-2027 strategy:

- Wetlands and Environmental schemes provide Council with a high degree of confidence and long term security of supply
- Wetland and Environmental projects can be controlled and adapted by Council to maximise effluent application
- Sustainably sourced biomass for bioenergy projects is evolving as a preferred option for effluent management
- Development of the proposed Biomass Hub project will support a biomass cropping industry to feed renewable energy generation.
- The Brunswick Valley STP and Bangalow site has available land for wetlands or biomass cropping
- Future urban opportunities include dual reticulation for new housing developments in Byron Bay to offset increased sewage loads
- Rural opportunities justify the construction of the Byron Bay (Western Corridor) rural scheme

Projected Effluent Reuse (2027)

	Byron Bay	Brunswick Valley	Bangalow	Ocean Shores
Urban	15 %	-	-	Ocean Shores wetlands will be integrated into Brunswick Valley EMS
Wetlands / Environmental	55 %	29 %	100 %	
Rural	11 %	19 %		
Total Reuse	81 %	48 %	100 %	

Byron Shire Effluent Management Strategy 2017—2027

WETLAND & ENVIRONMENTAL schemes form the primary direction for effluent management in the Byron Shire Effluent Management Strategy 2017 - 2027. The combination of effluent reuse potential with other valuable environmental outcomes makes wetland and environmental projects highly desirable. These applications not only have the ability to maximise effluent reuse, they also support Council goals towards ecological sustainable development.

Byron Shire Council operates three wetland and environmental recycled water schemes:

1. Byron Bay Integrated Wetland Management Reserve (BBIWMR)
2. Ocean Shores Wetlands
3. Bangalow STP onsite bamboo plantation

Wetland utilise a significant volume of effluent through evapotranspiration and seepage. It has been estimated that the BBIWMR 40ha site uses approximately 400 ML/year of effluent, providing a significant flow path for Byron Bay STP effluent. Wetlands take time to establish to optimise evapotranspiration rates, but given suitable land and efficient operational management, this option has the potential to maximise effluent reuse in suitable areas and significantly contribute to achieving the EMS Objectives. Furthermore the ability of wetlands to sequester carbon will contribute to Council's executive direction to reduce greenhouse gas emission targets.

Biomass cropping for bioenergy production is evolving as a viable option for long term effluent management. With the emergence of a bioenergy industry in Australia, Council is proceeding with a feasibility study for the development of a Biomass Hub in the Byron Shire. The prospect that Council can facilitate effluent management for the irrigation of a viable biomass stream to feed bioenergy facilities, is being considered as a strategic direction in Byron Shire. Bioenergy as a means of energy generation can significantly reduce the high energy and environmental costs associated with sewage treatment. Council have available land area around the Brunswick Valley, Bangalow and Ocean Shores STP's to facilitate the development of this application. This project has multiple benefits, not the least being the development of a small scale industry with the potential to use high volumes of effluent while assisting Council towards its zero emissions targets.

URBAN schemes will continue to contribute to effluent management over the next ten years in the Byron Shire. Byron Shire Council operates one urban recycled water scheme: Byron Bay Urban Recycled Water Scheme (BBURWS). Recycled water is suitable for the following unrestricted purposes:

- Dual reticulation – toilet flushing
- Municipal use – sporting fields, nurseries, parks and gardens, and standpipe access

The BBURWS was implemented in accordance with the Byron Bay EMS 2005 and has the potential to reuse 1 ML/day of the effluent produced at Byron Bay STP. Currently the scheme is at 70 % capacity with the Byron Bay Golf Course the major user of the recycled water. Council will continue to expand the BBURWS, although it is anticipated that growth over the next ten years will be slow and incremental. The opportunities are limited as the majority of suitable businesses and sporting fields are already connected to the recycled water main, or will be imminently. Unless there is a significant development (industry or housing), the BBURWS has minimal capacity for growth, and will not achieve high levels of reuse. Any future upgrade of the BBURWS will be determined based on security of demand e.g. dual reticulation for the proposed West Byron housing development.

Urban schemes for small villages are not considered viable for the smaller villages of Brunswick Valley, Bangalow and Ocean Shores. The volumes of recycled water used for urban purposes are relatively low per application and will only be a minor contributor to effluent reuse. While urban reuse represents only a small percentage of the STP flow, the schemes are highly resource dependent. Urban schemes are high risk due to public health considerations and require high levels of treatment, monitoring and reporting as per the regulatory requirements, and as such requires a high level of Council resourcing.

RURAL schemes will be a minor contributor to effluent management over the next ten years in the Byron Shire. Byron Shire Council operates one rural recycled water scheme: Main Arm Recycled Water Scheme (MARWS). Recycled water is used for irrigation purposes on two adjacent cattle grazing enterprises.

The MARWS has a total capacity of 3.6 ML/day of which currently approx. 4 % is utilised. The MARWS has the capacity to recycle 100% of the Brunswick Valley effluent flow given the users. No new rural water users along the MARWS corridor have connected to the scheme since it was installed or have been identified as potentially suitable.

Although rural schemes have potential to reuse significant volumes of effluent, the Main Arm scheme has not achieved the community aspirations, with recycled water use well below minimum expectations. Rural recycled water requirements are highly variable with irrigation influenced by a number of external (environmental and commercial) factors. Farmers must address a complex set of issues when selecting farming operations and determining optimal strategies. The community's effluent management objectives for maximising effluent reuse will not always be consistent with farm goals.

The Biomass Hub project may provide an incentive for the rural scheme expansion and Council will explore bioenergy cropping opportunities with landowners along the MARWS corridor as the Biomass Hub project develops.

Council has commenced investigations to develop the Byron Bay rural scheme (Western Corridor) with the purpose to supply recycled water to The Farm, Byron Hospital and surrounding landowners. An extension of the Western Corridor main to Tyagarah will be implemented based on supply security. Re-establishing the Tyagarah turf farm project is under consideration with a new owner reinitiating interest for the resource.

Byron Bay

BACKGROUND

The Byron Bay effluent management system, comprising of the Byron Bay Integrated Water Management Reserve (BBIWMR) and the Byron Bay Urban Recycled Water Scheme (BBURWS), recycles 38% of effluent from the Byron Bay STP.

The effluent management system was developed in 2005 as part of the Byron Bay STP (previously West Byron STP) upgrade and included the decommissioning of the South Byron STP. A ten year moratorium had been placed on development in Byron Bay due to aging sewage treatment infrastructure and highly degraded waterways. A condition of approval for the augmented Byron Bay STP included no increase in nutrient loads discharged to the Belongil Catchment. With the increased sewage loads diverted from South Byron STP, a community consultative committee formed to develop a strategy that would ensure a high level of environmental protection. Subsequently, the Byron Bay EMS 2005 was developed and the BBIWMR and BBURWS established.

The BBIWMR was developed as a major integrated environmental project that used effluent for the environmental remediation of acid sulphate soils, wetland and catchment degradation, loss of critical habitat and fish kills. The 40 ha site consists of multiple management areas including constructed treatment cells; a habitat cell (Cell H), and the 24 Ha Melaleuca regeneration site. The BBIWMR has evolved to be an intrinsic part of the Belongil landscape, providing important habitat for many species including endangered and vulnerable birds and frogs. The multi-award winning project has exceeded Council's expectations and has reached projected reuse potential. The BBIWMR uses approximately 400 ML/year of effluent, providing a significant flow path for Byron Bay STP effluent.

The BBURWS corridor runs from the Byron Bay STP to the Byron Bay Golf Course (South Byron) suppling a very high quality recycled water for the purpose of dual reticulation (toilet flushing) and unrestricted urban municipal use (irrigation). Historically, Council commenced suppling recycled water to the Byron Bay Golf Club from South Byron STP in the early 1980's.

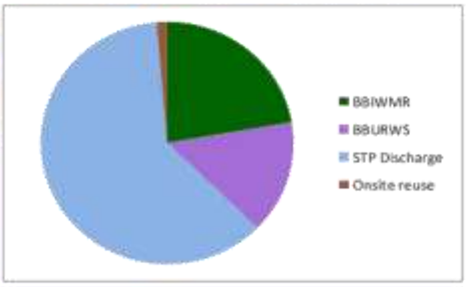
Rural land in Ewingsdale, Myocum and Tyagarah was assessed in the Byron Bay EMS (2005) as suitable for recycled water irrigation. The Tyagarah Turf farm had expressed interest in using high volumes of recycled water with an EIS undertaken in 2005. However, due to commercial considerations of the landowner the project did not eventuate with Council resolving to defer construction of the pipeline until sufficient customers were secured. Melaleuca regeneration in the low lying agricultural land of the Belongil Catchment was also identified as a future option for reuse.

Growth in the Byron Shire has been relatively controlled over the last ten years and current planning indicates the sewage system will reach full capacity in 2025. Full development of the Byron Bay EMP 2005 program was reliant on growth. The rate of growth in Byron Bay over the last ten years was at the lower end of the range of scenarios presented. The minimum effluent reuse required was in line with the forecast growth curve to ensure the nutrient targets for the Belongil Catchment have been reached. The BBURWS is at 70% capacity.

Wetland Reuse
400 ML/year
23% of STP inflow

Urban Reuse
272 ML/year
15% of STP inflow

EFFLUENT FLOWS 2011—2016



KEY STRATEGIC DIRECTION

Constructed Wetland Regeneration

Wetland & Environmental

Opportunities are being investigated in the low lying agricultural land in the Belongil Catchment for wetland regeneration. Based on the current reuse achieved at the BBIWMR, 80 ha of constructed wetlands is required to assimilate approx. 800 ML of effluent annually. Council has not yet acquired the land.

Council must commence negotiations with Landowners to secure the remaining land. **Stage 2** will be pursued incrementally to offset increased sewage loads and allow Council the time to consult with Landowners.

Urban

The BBURWS will continue to develop until full capacity: 1 ML/year. There is sufficient capacity remaining to supply another 0.3 ML/year. Unless there is a major development in Byron Bay, it is not anticipated that the capacity of the scheme will be reached within the timeline of this EMP. Demand for the recycled water is low as the majority of potential businesses and sporting fields are already connected, or will be imminently.

Dual reticulation for new housing developments in the Byron Bay scheme will be pursed where appropriate to offset increased sewage loads. A Recycled Water Facility upgrade will be considered based on demand.

The real benefit of this scheme is the displacement of drinking water imported into the catchment from Rocky Creek.

Rural

The development of the rural project has been staged. **Stage 1** includes the construction of the Western Corridor main. Design investigations have commenced. The Western Corridor will provide recycled water to the neighbouring properties around "The Farm", Byron Hospital and surrounding enterprises. **Stage 2** will involve the extension of the Western Corridor to Tyagarah. Council resolved to defer Stage 2 until demand can be secured. Preliminary discussions have commenced in 2017 with the new owner of the Tyagarah Turf Farm who has expressed interest to connect to the scheme.

Brunswick Valley

BACKGROUND

The Main Arm Recycled Water Scheme (MARWS) was developed in 2003 with the installation of a recycled water main from the Mullumbimby STP to the farm dams on two rural properties on Main Arm Road, Mullumbimby. The sewage system was augmented in 2010 with the closure of Mullumbimby and Brunswick Heads STPs and the commissioning of the new Brunswick Valley STP. This created an increased volume of effluent available for reuse however, demand for recycled water has not increased with supply.

Rural Reuse
51 ML/year
8 % of STP Inflow

The MARWS has the capacity to recycle 100% of the effluent produced at the Brunswick Valley STP. Currently the MARWS recycles 8% of inflow.

There have been no new connections to the MARWS pipeline since the scheme commenced. Further to this, demand from the two users has significantly decreased with recipients failing to meet the agreed minimum volumes of use. On commencement of the scheme high volumes of treated effluent was reused for irrigation purposes. The application has decreased by more than 60%.

The MARWS was developed based on potential demand projections. The demand estimates, which may have been influenced by environmental conditions (e.g. drought) and/or business considerations, proved to be optimistic and has not yielded the volume of reuse anticipated.

Rural application is reliant on private landholders to ensure their farming enterprise utilises the recycled water resource and thereby achieves the effluent management objectives of the community. Under this application commercial decisions made by landowners can significantly impact the volumes of effluent reused.

Experience in the MARWS has influenced Council to shift the focus in effluent management to applications that Council can operate to maximise effluent reuse and ensure long term supply security.

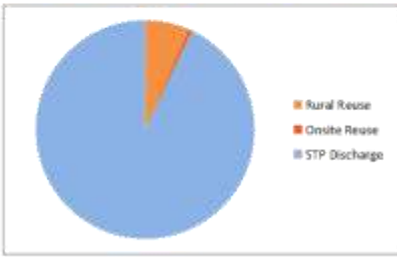
The development of an urban scheme was considered for Mullumbimby, but due to the low volumes of water used in this application, especially for the smaller villages in the Shire, Council have directed resources towards more beneficial higher water demand uses. With the success of the BBIWMR, Council is investigating the development of the Brunswick Valley Sustainability Reserve.

Council is in the preliminary stages of a land use investigation for the Brunswick Valley STP site. The proposed sustainability project will involve constructed wetlands, biomass cropping and renewable energy production including solar farming and co-generation.

Biomass cropping to feed renewable energy generation is evolving as a viable option for recycled water irrigation opportunities. The proposed Byron Shire Council Biomass Hub project has instigated a potential industry for biomass cropping. Given industry growth, the MARWS recycled water corridor may provide a financial incentive for landowners to consider biomass cropping.

Current planning for the Brunswick Valley STP indicates that STP capacity will be reached in 2035 with the closure of the Ocean Shores STP and the transfer of Ocean Shores sewage loads. With this impending increase of effluent loads, Council is actively diverting the appropriate resources to support the development of a project that will see high levels of effluent used for beneficial reuse.

EFFLUENT FLOWS 2011—2016



KEY STRATEGIC DIRECTION

Brunswick Valley Integrated Water and Energy Management Reserve

Wetlands & Environmental

Development of the Brunswick Valley Sustainability Reserve for:

- Constructed wetlands
- Biomass cropping

Other types of cropping will also be considered based on water consumption.

Ocean Shores Wetland will be upgraded as part of the Brunswick Valley EMS. Given the construction of the proposed sewage transfer pipeline, council will install a recycled water main from the Brunswick Valley STP to be used for environmental applications at the established Ocean Shores Wetlands and decommissioned STP site.

With appropriate management, this integrated approach could see the majority of dry weather flow diverted for beneficial reuse

Rural

Council will continue to explore opportunities along the MARWS recycled water corridor. No interested users have been identified.

The MARWS pipeline has a total capacity to supply 3.6 ML/day. There is sufficient capacity remaining to supply 3.5 ML/day of recycled water. Council could pursue this area for biomass cropping if a successful industry is created through the Biomass Hub Project.

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Bangalow

BACKGROUND

Bangalow STP commenced using effluent for onsite land applications in 2003. In collaboration with the SCU, innovative trials for Bamboo, Hemp and Kenaf were conducted. The trails set out to identify crops that have a high water (effluent) uptake as well as a high end product value (e.g. fibre).

In 2006, Council expanded the bamboo plantation across 5.23ha as part of the Bangalow effluent strategy. The scheme recycles 13 % of effluent from Bangalow STP.

After ten years of recycled water irrigation the bamboo plantation project is close to completion, with harvesting of the bamboo scheduled for 2018.

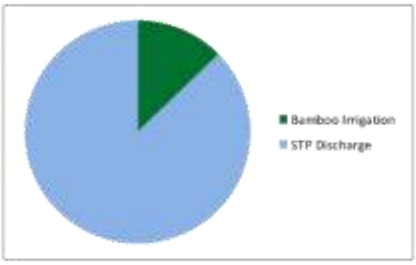
The development of the proposed Biomass Hub project has opened prospects for biomass cropping. Council see this as an opportunity for expanding effluent reuse at the Bangalow STP.

Environmental Reuse (bamboo)

18 ML/year

13 % of STP Inflow

EFFLUENT FLOWS 2011—2016



KEY STRATEGIC DIRECTION

Biomass Cropping

Wetland and Environmental

Biomass cropping investigations undertaken as part of the Brunswick Valley STP project will steer the development of a biomass plantation at the Bangalow STP.

Bangalow STP has available land onsite for biomass cropping. The currently irrigated 5.23 ha can be expanded to approx. 20 ha (including the northern Paddock). Council will consider expanding the cropping area as a way to increase effluent reuse

Ocean Shores

BACKGROND

The Ocean Shores Wetland was constructed in 1997 as part of the Ocean Shores effluent management system. The volume of effluent assimilated through the wetlands is not metered.

The Ocean Shores STP has reached full capacity, and Council is assessing options, of which the outcome will impact on the future direction of effluent management in Ocean Shores.

Council's current planning identifies that the Ocean Shores STP will be decommissioned within the next 5 years, and it is proposed that all sewage loads will be transferred to the Brunswick Valley STP.

Given the construction of the proposed sewage transfer pipeline, Council propose to install a recycled water main from the Brunswick Valley STP to be used for environmental applications at the established Ocean Shores Wetlands and decommissioned STP site.

Wetland Reuse

unknown

KEY STRATEGIC DIRECTION

Integrate into Brunswick Valley EMS:

- Decommission Ocean Shore STP
- Ocean Shores Wetlands upgrade

Wetland and Environmental

The Ocean Shores Wetland will be upgraded as part of the development of the Brunswick Valley EMS.

The use of this site for environmental remediation will assist Council achieve the EMS Objectives for Brunswick Valley STP.

Future options for the development of the Ocean Shores STP decommissioned site could include wetlands expansion and / or biomass cropping.

STRATEGIC PROGRAM

The strategic program outlined in the following pages provides a pathway for maximising effluent reuse in the Byron Shire. Council's experience over the last fifteen years provides valuable insight and has steered the direction of this strategy. Although the program provides for maximising reuse, inherent risks and uncertainties exists which have the potential to impact on the successful implementation of the strategy.

	Byron Bay			Brunswick Valley			Bangalow		
Year	STP Inflow (ML/yr)	Total Reuse (ML/yr)	Annual Reuse (%)	STP Inflow (ML/yr)	Total Reuse (ML/yr)	Annual Reuse (%)	STP Inflow (ML/yr)	Total Reuse (ML/yr)	Annual Reuse (%)
2006 - 2016	1825	701	38	757	63	8	139	18	13
2017 - 2019	1,840	1194	65	548	63	11	139	50	36
2020 - 2023	2,000	1,609	80	1,327	463	35	150	100	67
2023 - 2027	**2,200**	**1,809**	**82**	**1,387**	**663**	**48**	**150**	**150**	**100**

Byron Bay

Full development of the Byron Bay effluent management program is based on wetlands and environmental projects. These applications have the ability to assimilate high volumes of treated effluent into the environment thereby achieving the high levels of reuse desired by the community. The demand for recycled water in the urban and rural context will not balance the supply. The success of this strategy is reliant on Council acquiring the available land for wetlands regeneration. Council must commence community consultation to determine if this option has community support and proceed with Stage 1 of the land acquisition.

Full development of the Byron Bay effluent management program will see Council achieve the community objectives. The Byron Bay EMS 2005 calculated that at the Byron Bay STPs ultimate capacity of 2,200 ML/year, a reuse volume of 1,200 ML/year would be required to achieve the nutrient discharge loads. The proposed effluent reuse program goes well beyond this requirement with a potential volume of 1,809 ML /year projected.

Given the current growth pattern, the Byron Bay STP will reach full capacity in 2025 (2,200 ML/year). This includes the initial stages of the proposed West Byron Development, with dual reticulation for the development included in the program. Should the West Byron Development proceed, there is an opportunity to offset the increased sewage loads with wetland regeneration and dual reticulation for toilet flushing and out door garden use.

Brunswick Valley

Full development of the Brunswick Valley effluent management program is dependent on the construction of the Brunswick Valley Sustainability Reserve. The success of this strategy is reliant on Council's planning including optimising land use at the Brunswick Valley STP site, specifically to achieve high evapotranspiration as well as the development of the proposed Biomass Hub project.

The proposed Biomass Hub project has the potential to support the development of a small scale biomass cropping industry that if managed efficiently is capable of achieving high levels of reuse. Although in the initial stages, this project is growing momentum and has full Council support. The development of a biomass industry could reinitiate interest in the MARWS Corridor. The prospect of a secure water supply and a market demand for the end product may provide an incentive for farmers along the MARWS corridor. Council will pursue interest in this area given the success of the initial stages of the Biomass cropping investigations.

Given the anticipated increase loads from the Ocean Shores STP in 2020, Council must ensure a suitable strategy is in place.

Bangalow

Full development of the Bangalow effluent management program will involve an environmental cropping regime similar to the current Bamboo project. Council will develop the northern Paddocks at the Bangalow STP to increase the irrigation area and volume of effluent applied. This area is used for biosolid application and has excess nitrogen and phosphorous available for suitable plant uptake. Council will consider biomass cropping given the proposed Biomass Hub project is successfully implemented . Alternative cropping will be undertaken as required.

STRATEGIC PROGRAM

Year	Effluent Management Program	Reuse Volume (ML / year)				
		STP Onsite	Urban	Wetlands	Rural	Cumulative Total Reuse
Byron Bay						
2006 - 2016	Current (average 2010—2016)	29	272	400	-	**701**
2017	**Urban Expansion BBURWS** Toilet connection Private Business • The Northern Hotel • The Railway Hotel • The Beach Hotel • First Sun Caravan Park • Byron Holiday Park • Habitat development		13	-	-	**714**
	Toilet connections Sporting Fields • Rec Grounds Rugby Toilets • Red Devils Park		1	-	-	**715**
	Irrigation Sporting Field • Byron Golf Course—expansion of irrigation to a further 4 ha		28	-	-	**743**
	Irrigation Nursery • Eden at Byron		0.5	-	-	**743.5**
2018	**Urban Expansion BBURWS** • Elements of Byron • Sunrise Hotel		0.5	-	-	**744**
	Rural Expansion Western Corridor Stage 1 • The Farm • Flicks Property Irrigation • Hospital		-	-	50	**794**
2019	**Urban Expansion BBURWS** Private Businesses along Urban Corridor • Anticipated - not identified		?	-	-	
	Rural Expansion Western Corridor Stage 2 • Tyagarah Turf Farm		-	-	200	**994**
	Wetlands Expansion Stage 1 • 20 ha Low lying land in Belongil Catchment		-	200	-	**1194**
2020 - 2022	**Wetlands Expansion Stage 2** • 40 ha Low lying land in Belongil Catchment		-	400	-	**1594**
	Expansion BBURWS • Dual Reticulation for new housing developments (aligned with development)		5	-	-	**1599**
2023 - 2027	**Expansion BBURWS** continued • Dual Reticulation (development aligned)		10	-	-	**1609**
	Wetlands Expansion Stage 2 continued • 20 ha Low lying land in Belongil Catchment (development aligned)		-	200	-	**1809**
	Total Volume per Application by 2027	**29**	**330**	**1200**	**250**	

Byron Shire Effluent Management Strategy 2017—2027

STRATEGIC PROGRAM

Year	Effluent Management Program	Reuse Volume (ML / year)				
		STP Onsite	Urban	Wetlands / Enviro	Rural	Cumulative Total Reuse
Brunswick Valley						
2006 - 2016	Current (average 2010 - 2016) • Brunswick Valley STP • Ocean Shores STP	3	-	-	60	**63**
2017 - ongoing	**Rural expansion of MARWS** • As suitable user/s applies		-	-	u/k	**63**
2019 - 2020	**Wetland and Environmental** • Brunswick Valley Wetlands • Biomass Plantation			100 200		**363**
2021 – 2023	**Wetland and Environmental** • Ocean Shores Wetland		-	100	-	**463**
2024 - 2027	**Rural expansion of MARWS** • Biomass cropping along MARWS corridor				200	**663**
	Total per Application	**3**	**NIL**	**400**	**260**	
Bangalow						
2006 - 2016	Current (average 2008 - 2016)	u/k	-	18	-	**18**
2017 - 2018	Bamboo Harvesting	-	-	0	Nil	**0**
2019 - 2027	**Wetland and Environmental** • Biomass Plantation	-	-	150	Nil	**150**
	Total per Application	**u/k**	**Nil**	**150**	**Nil**	

RISK BASED IMPLEMENTATION

Risks & Uncertainty

There is a significant level of risk and uncertainty with the development and use of recycled water schemes. The greatest risk with the use of recycled water is to public health due to the potential exposure to harmful pathogens. These risks have been assessed to ensure the required controls and barriers are in place for a safe supply. However, there is also the risk in developing effluent schemes that do not provide the long term demand security required.

Urban and rural applications are driven by a number of external forces which in turn dictate their current and future demands for recycled water. Unfortunately, predicting how these forces will evolve over the next decade, and how they will ultimately affect effluent demand, is fraught with a multiplicity of uncertainties. The inherent uncertainty in the Byron Shire Effluent Management Strategy is the unpredictability of the future outcome, primarily due to the external risks that Council cannot control.

This strategy has been developed based on the determination that, not only do wetlands and environmental projects have the lowest level of risks and offer the highest levels of security for long term supply management, but they are also capable of using the volumes of effluent required to achieve the strategic objectives.

	RISKS		UNCERTAINTY	
Urban	Urban Schemes are assessed as high risk due to the human health consequences associated with use including • Uncontrolled public assess • Potential for cross connections with the potable water supply	HIGH	The BBURWS has provided Council with a secure reliable flow path for Byron Bay STP effluent. Reuse volumes show a consistent use pattern, although seasonal and annual variability exists. The most significant advancement in the urban scheme will be the connection of dual reticulation in new developments. Projected effluent reuse volumes are often difficult to predict for new urban developments. Although household demand can be estimated with accuracy; the rate of development and the number of households joining the scheme over time is significantly more	MEDIUM
Rural	Rural schemes have significantly lower risks than urban schemes due to Controlled Public Access. Nevertheless, significant controls are required to ensure no environmental degradation or decline in crop health. Commercial uncertainty is highlighted as one of the major risk facing recycled water schemes. Should a user reduce production, cease operations or relocate, the viability of the scheme is reduced.	MEDIUM	The development of new rural schemes have the highest levels of uncertainty and risk. Although significant potential exists, the long term outcome of rural schemes to maximise effluent reuse is limited by external factors including environmental and commercial constraints. Council lacks the confidence to rely on rural schemes to provide a secure long term demand flow. The MARWS was developed based on potential demand projections which did not eventuate. Not only did the recipients fail to use the agreed minimum volume; but no new users connected to the scheme over the last 15 years. The demand projection for the recycled water use was perhaps optimistic for an area with such high rainfall, and commercial externalities were not factored into the projected use. Farmers must address a complex set of issues pertaining to risk, uncertainty, prices, and opportunity costs, when selecting farming activities and determining optimal strategies. The Byron Shire objectives for maximising effluent reuse are not always consistent with farm goals. Council must assess these risks when developing a new rural scheme and ensure there are sufficient controls in place (through a robust Recycled Water Agreement) to reduce the uncertainties in developing a rural scheme that does not achieve the required use.	HIGH
Wetlands / Environmental	The health risks associated with wetlands and environmental schemes are greatly reduced by Controlled Public Access. Nevertheless, significant controls are required to ensure no environmental degradation or decline in crop health. Wetlands associated with STP's, in fact, reduce the risks for environmental pollution by providing a risk management buffer zone, that can be operated should a hazardous event occur.	LOW	Effluent applications for wetlands and environmental purposes afford Council with a high level supply security. Experience with the BBIWMR and Bangalow Bamboo crop has proved with confidence that this application can achieve high volumes of reuse. The long term demand for the resource will be maximised by a Council owned, managed and operated application. The proposed Biomass Hub project provides the key direction for Brunswick Valley and Bangalow EMS. The project has yet to be approved by Council, although early investigations indicates that this integrated project will proceed. The fact that Council already own available land at Brunswick Valley, Bangalow and Ocean Shores STP's, provides Council with a higher degree of security that wetland and or environmental projects will proceed. The regeneration of wetlands forms the key direction for Byron Bay EMS. This application involves the acquisition of land through either a voluntary lease arrangement or land sale. Council has not acquired the land necessary, nor has community consultation commenced, within the Belongil Catchment which highlights the inherent uncertainty with the Byron Bay EMS.	MEDIUM

RISK BASED IMPLEMENTATION

Risk Management Framework Council takes a risk management approach to the operation of the recycled water systems in accordance with the *Australian Guidelines for Water Recycling – Managing Health and Environmental Risks 2006* (AGWR). The AGWR sets out the framework for the management of recycled water quality, providing a structured risk-based approach. These guidelines form the primary guidance for recycled water quality and management in Australia.

Wastewater Management System Council's Waste Water Management System is based on the AGWR Risk Management Framework, describing the nature of the recycled water systems and how it is operated and managed. The Wastewater Management System is one of the key requirements for Section 60 approval. All information pertinent to the recycled water schemes is detailed in the Wastewater Management System.

Recycled Water Agreements The recycled water agreement is the product of negotiations between the Byron Shire Council and the end users. Under the recycled water agreement, the parties agree to a set of obligations and responsibilities under which the water recycling scheme will operate. To reduce the uncertainty with the connect of commercial users and ensure the viability of new schemes, Council must ensure strong commitment from the users with an agreed minimum volume of recycled water applied.

The recycled water agreement establishes: • the rights and obligations of the parties and supports these with legal sanctions; • who should perform certain tasks and when and who bears the costs; • who bears the risks associated with supply and use of the product; and • the commercial terms under which recycled water is supplied.

Monitoring and Controls Council have monitoring and controls in place in accordance with the level of risk for each recycled water scheme. Of upmost importance is to ensure the quality of the effluent is suitable for the intended use. Critical control points, developed as part of the risk management system, provide the triggers to ensure water of unsafe quality is not supplied to the user. Human health and environmental monitoring are routinely undertaken by Council.

Funding and Costings Effluent management schemes in Byron Shire were originally developed with the assistance of government funding. Infrastructure such as recycled water storage tanks and irrigation equipment were purchased with no direct costs to the end user. Although not available at this time, Council will continue to explore funding opportunities for the continual development recycled water schemes. Currently the cost for recycled water schemes are recovered thorough developer contributions under Section 64 of the Local Government Act.

The recycled water user agreement sets out conditions for who is responsible for the cost of the infrastructure for the recycled water scheme. In general Council will cover the costs of supplying recycled water to the premises. That is, Council will provide recycled water to the user's boundary and then it is the responsibility of the user to pay for any additional infrastructure required on their premises, for example storage tanks, irrigation equipment and/or internal plumbing.

The cost of providing recycled water is not recovered in the current pricing structure. The present value of the recycled water use is in meeting the Council's discharge requirements and community aspirations. The pricing reflects the role of recycled water as part of Council's integrated water resource planning system.

Council charge a minimum cost for the recycled water based on consumption, providing a financial incentive to connect to the recycled water scheme. The recycled water is charged at 1 cent per kilolitre, which is considerably lower that potable water charges (< $2.50 per kilolitre).

Council have developed a policy to ensure equitable access to the recycled water schemes offering a two-tiered approach to connect commercial businesses to the recycled water schemes. The business can either pay upfront for the recycled water infrastructure or enter in to a cost recovery agreement with Council. Replacing potable water with recycled water will provide major cost savings for commercial users and therefore the payback period for these schemes is expected to be short.

Whilst generally Council will only cover costs to the user's boundary, Council holds the right to determine the validity of providing any extra funds to projects where it is considered necessary.

APPENDIX 1 Key Milestones in Effluent Reuse Development

Year	Milestone
Byron Shire	
1999 August	Byron Shire Council adopted a *Sewage Management Strategy* setting out the vision, guiding principles and objectives for sewage management within Byron Shire.
2017	Water, Waste and Sewer Committee / Coastal Estuary Catchments Panel established
Byron Bay	
1980's	Byron Golf Club commenced recycled water irrigation from South Byron STP effluent
1997	Byron Bay Wastewater Steering Committee established, identifying the need to develop a comprehensive *Effluent Management Strategy* for Byron Bay.
1997 - 2006	Ten year moratorium placed on development in Byron Bay due to the lack of sewage treatment capacity
2000 May	Belongil Rehabilitation Working Group established to develop Byron Bay STP effluent management
2000 - 2001	Environmental Assessments undertaken for Byron Bay Sewerage System augmentation
2001	24 Ha Melaleuca Regeneration project commenced
2002 December	Byron Bay Sewerage System augmentation approved by Council
2004 July	Byron Bay Sewerage Augmentation System commenced construction
2002 - 2003	Environmental Reporting undertaken for Byron Bay Urban Recycled Water Scheme
2005	Byron Bay Effluent Management Strategy developed, setting out the objectives for effluent management in Byron Bay.
2005 November	South Byron STP closed, with transfer of sewage load to the Byron Bay STP
2006	Byron Bay Urban Recycled Water Scheme commenced (sporting fields, nurseries)
2016	Byron Bay Urban Recycled Water Scheme extension completed (public toilets)
2016	Capacity Assessment of the Belongil Creek Drainage System – Development of a preferred STP Effluent flow path (AWC and BMT WBM)
Brunswick Valley	
2002 - 2004	Environmental Reporting undertaken for Main Arm Recycled Water Scheme
2004	Main Arm Recycled Water Scheme commenced (rural applications)
2010	Brunswick Valley STP commissioned
2017	Biomass production for bioenergy ?
Ocean Shores	
1996	Ocean Shores STP upgraded
1997?	Ocean Shores Wetland constructed
Bangalow	
2002	BSC conducts trials, in partnership with Southern Cross University, investigating the potential for 'Mop Crops' to assimilate effluent
2003 October	Bangalow Recycled Water Scheme Onsite Bamboo Irrigation commenced

APPENDIX 2 Current STP Flows

Year	STP Location	STP Inflow (ML)	Recycled Water (ML)	Wetlands (ML)	Total Reuse (ML)
2016	Byron Bay	1939	211	400	611
	Brunswick Valley	705	45	-	45
	Bangalow	122	0	-	0
	Ocean Shores	539	-		
2015	Byron Bay	1800	274	400	674
	Brunswick Valley	871	17	-	17
	Bangalow	134	6	-	6
	Ocean Shores	572	-		
2014	Byron Bay	1797	297	400	697
	Brunswick Valley	564	84	-	84
	Bangalow	122	12	-	12
	Ocean Shores	524	-		
2013	Byron Bay	1950	287	400	687
	Brunswick Valley	856	64	-	64
	Bangalow	161	16	-	16
	Ocean Shores	598	-		
2012	Byron Bay	1805	294	400	694
	Brunswick Valley	821	53	-	53
	Bangalow	135	30	-	30
	Ocean Shores	605	-		
2011	Byron Bay	1727	287	400	687
	Brunswick Valley	726	42	-	42
	Bangalow	135	24	-	24
	Ocean Shores	565	-		
2010	Byron Bay	1754	257	400	657
	Bangalow	141	24		24
2009	Byron Bay	1717	175	400	575
	Bangalow	159	28		28
2008	Byron Bay	1716	204	400	604
	Bangalow	144	20		20
2007	Byron Bay	1483	199	400	599

APPENDIX 3 Byron Bay Effluent Management Strategy (2005) Review

Year	BBURWS	ML/ year	Wetland Regen	ML/ year	Rural Land	ML/ year	Total ML	10 Year Review
Short Term 2006 - 2007								
2006	BBIWMR Berms (4ha)	20	BBIWMR 24 ha	236			411	All short term urban reuse corridor and regeneration projects commenced in 2007, with the exception of the standpipe at the Council depot which was installed in 2010.
	Byron Bay Bowls Club	5	BBIWMR Cell "H"	41				
	Byron Golf Course	96						
	Rugby League Club	5						
	Byron High School	5						
	B.B.H.N. Nursery	1.3						
	EnVite Nursery	1.4						
2007	BBIWMR Berms (4ha)	20	BBIWMR 24 ha	15			478	
	Urban Reuse Standpipe Commercial (non-potable)	10						
	Byron Bay Recreation Ground	22						
Medium Term 2008 - 2010								
2008	Main to Clarke's Beach Reserve	15	BBIWMR NW site STP	59	Tyagarah Farms	32	915	• Main to Clarks Beach reserve installed 2016. • Sunnybrand Chickens closed. • Bection – (now Elements) already use rainwater and bore water onsite. • Habitat—infrastructure installed 2015 • West Byron has not developed as yet. Dual reticulation to occur with new developments • 4 x Standpipes throughout BB township installed 2016 • West Byron playing fields (Cavanbah Centre) reuse commenced 2010 • Tyagarah Farms – Not viable (turf farmer no longer there) - currently being explored in the new program.
	Sunny brand Chickens	55	BBIWMR 24 ha	40				
	Becton (now Elements)	22	Cavanbah Centre	98				
	Belongil Fields (West Byron)	42						
	Brandon Saul Development (Habitat)	4						
	Urban Reuse Standpipe – Commercial (non-potable)	10						
	West Byron 249 Ewingsdale Rd Playing Field (Cavanbah Centre)	60						
2009	Sunrise Park, Belongil Crt,	1	BBIWMR 24 ha	28	Tyagarah Farms	150	1099	Sunrise Park and Julian Rocks—not considered viable Butler Street upgrade
	Julian Rocks Dr (drainage reserves)							
	Butler St (oval & netball)	5						
2010	Byron Recreational Ground	9	BBIWMR 24 ha	3	Tyagarah Farms	100	1211	• Irrigation expanded at Recreation Grounds in 2016
Long Term								
2011	Council Parks & Gardens + Railway Park + Byron St	2	BBIWMR 24 ha	8	Expansion of Reuse	100	1331	• BBURWS extension main installed 2016 for irrigation of parks and gardens • Rural lands expansion (western corridor) will commence in 2018
	Private Controlled Urban Reuse	10						
2015	Private Controlled Urban Reuse	10			Expansion of Reuse	100	1441	• Negotiations with Hotels for toilet flushing commenced in 2016 with the installation of the extension main

Byron Shire Effluent Management Strategy 2017—2027

APPENDIX 4 Supporting Documents

- Sewage Management Strategy for Byron Shire (BSC 1999)
- WBM Ecological Assessment of Tallow and Belongil Creeks (WBM 2000),
- Byron Shire Effluent Reuse Study (OWRU March 2000)
- Belongil Estuary Management Plan (2000)
- Main Arm EIS and EMP (2002)
- Byron Bay Sewerage Augmentation Design Development and Concept Design (GHD 2001)
- Byron Bay Sewerage Augmentation Scheme Environmental Impact Statement (2002),
- Use of Reclaimed Water in Tyagarah District (AWM 2003)
- Plan of Management for 249 Ewingsdale Rd (LandArc 2004)
- Tyagarah Effluent Reuse Pipeline Review of Environmental Factors (BSC 2005)
- Byron Bay Effluent Management Strategy (BSC 2005)
- Byron Bay Urban Recycle Water Scheme EMP (2007)
- Byron Shire Council Draft Wastewater Management System (2016)
- BBURWS Section 60 Applications (2017)
- Valances Road Plan of Management: Conceptual Land Use Investigations (2017)
- Biomass Prospectus (2017)

Report No. 4.3	**Vallances Road Plan of Management**
Directorate:	Infrastructure Services
Report Author:	Peter Rees, Manager Utilities
File No:	I2017/1259
Theme:	Community Infrastructure Sewerage Services

Summary:

At the 23 February 2017 ordinary meeting Council resolved to prepare a Plan of Management (POM) for the 108 hectare Vallances Road site encompassing a suite of sustainability initiatives that demonstrate a virtuous cycle that would be a showcase for the area and our community's values.

The attached draft document presents the proposed Plan of Management for the site. It should be noted, as discussed at the February 2017 Strategic Planning Workshop, it is proposed to undertake extensive community consultation to identify activities to be undertaken on the Affordable Housing and Community Initiatives project area.

RECOMMENDATION:

That the Water Waste and Sewer Advisory Committee note the Vallances Road Plan of Management.

Attachments:

1 Vallances Road Plan of Management - Rev 1, E2017/86476 , page 44⇩

Report

At the 23 February 2017 meeting, Council resolution 17-054 resolved:

1. *That Council note the report.*
2. *That the proposed POM be prepared in conjunction with the Waste Water and Sewerage Committee.*
3. *That the terms of reference for the POM include the following:*
    a) *Estimated costing for the initiatives and their budgetary feasibility in light of related projects in water and sewerage.*
    b) *Possible timeframes for their implementation.*
    c) *Financial viability of the potentially positive fiscal options.*
    d) *Environmental advantages and costs.*
    e) *The implications of not including the replacement of the Mullumbimby sewer system.*
    f) *The marginal utility of improving the quality of current treatment (without wetland polishing) and utilising it in an effective reuse system.*
    g) *considers options for agricultural enterprises that utilises effluent reuse on the property.*
4. *The POM should clearly examine and advise on all and each of the initiatives in the staff report in a holistic manner as they are part of a much bigger system with increasing demands.*
5. *That the Vallances Road Agistment contract review include eligibility criteria which seeks to ensure that appointed contractors are of good character and have acted lawfully and appropriately in previous contract activities*

The attached document is the draft Plan of Management (POM) for the Valances Rd site. The POM has essentially added more detail to the original proposal presented to Council in February this year. The draft document also complies with the State Government requirements for development of a Plan of Management for Community Land.

The POM has divided the area into 7 key activity areas as follows

1. Brunswick Valley STP Project areas – this includes the process plant and proposed wetlands and effluent storage areas
2. Solar Farms – this is actually 2 areas with one for the BVSTP solar farm and the other for a community solar farm
3. Biomass project areas – for growing of biomass crops utilising biosolids and recycled water and using the crops for power generation
4. Environmental land use project areas – this will be a combination of revegetation areas; rehabilitation of mangroves and billabongs; river bank stabilisation works
5. Affordable Housing and Community Initiatives project area – it is recommended this area be put out for public consultation to determine the best use alternatives. Some immediate land use options that are available are eco tourism; educational/interpretative centres; and community gardens. It has not as yet been determined if the existing structures on the site including the 2 existing dwellings are a benefit or a hindrance at this stage.
6. Community access – possibly somewhat controversially, the POM has identified the main access thoroughfare to the site as being via the existing rail line and bridge that connects to an inactive road reserve into the western boundary. This would require significant will on the part of Council to bring to fruition. Parking would be at Lot 4 at the end of Station Street with access along the rail / road corridor by foot / bicycle / electric cars.
7. Throughout the site would be a network of walkways and information portals explaining the "virtuous cycle" of waste conversion to energy; solar power; carbon sequestration; environmental habitat; mangroves and riparian protection.

The site has real potential to be both a showcase for the area and our community's values.

A catalyst to bringing the project alive is the proposed closing of the Ocean Shores STP and transferring the effluent to the Brunswick Valley site. The will initiate a $10 million plus spend that, given the healthy financial position of the Sewer Fund, can be expanded to include many of the ancillary projects identified in the draft POM.

In relation to Item 3(e) it should also be noted the issue of reducing stormwater entering the gravity sewer system in Mullumbimby is a separate project and has no impact on this proposed Plan of Management.

In relation to Item 3(f) there is considered to be no marginal utility in removing wetlands and in lieu upgrading the BVSTP recycled water system to include dual reticulation standard. These effluent streams can happen in parallel as occurs at the Byron Bay STP.

Financial Implications

The implementation of the draft Plan of Management for valances Rd could occur under the umbrella of the OSSTP transfer project with little material impact on the sewer reserve funds. Depending on the final configuration of the Affordable Housing and Community Initiatives project area; and the power generation projects, the site could in effect generate income that would be beneficial to the sewer reserve funds.

Statutory and Policy Compliance Implications

The draft Vallances Rd Plan of Management document has attempted to embody Council’s strategic objectives embodied in

- Biodiversity Conservation Strategy
- Sustainable Agriculture Strategy
- Low Carbon Strategy 2014
- Climate Change Strategic Planning Policy
- Community Gardens Policy
- Corporate Sustainability Policy

PLAN OF MANAGEMENT

VALLANCES ROAD, MULLUMBIMBY

Prepared for: Byron Shire Council

Prepared by: Planit Consulting

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Document Information

Document Title	Plan of Management – Vallances Road, Mullumbimby		
Date Commenced			
Responsible Directorate			
Date Adopted		Resolution No	
Review Timeframe			
Last Review Date		Next Review Date	

Document Reference No.	Date Amended	Details/Comments

EXECUTIVE SUMMARY

The purpose of this Operational Plan of Management is to provide a framework for the management and development of Community Land under Council's control. Council has responsibility for two main types of public land; Crown Land whose control is vested in Council under the Crown Lands Act 1989, and Council owned and managed Community Land dedicated under the Local Government Act 1993.

The land included in this Plan of Management is a large parcel of land formed by two lots (cumulatively 111.3 ha) owned by Byron Shire Council (BSC). The site is located within a rural area to the north of the Brunswick River, approximately 1km to the north-east of the Mullumbimby CBD. These lots are classified as Operational Land and Community Land, and are identified as Lot 1 on DP 952598 (125 Vallances Road, Mullumbimby) and Lot 1 on DP 129374 (Valances Road, Mullumbimby) respectively.

The sites are located in Mullumbimby, to north-east of the township and bordered by the Brunswick River to the south. The land is locally known as Vallances Road and includes the Brunswick Valley Sewage Treatment Plan (BVSTP).

The Project Areas, outcomes and actions intended from this Plan of Management include the following:

- **Environmental Land Use Project Areas**
  - Native trees and plants revegetation and rehabilitation.
  - Brunswick River bank stabilisation.
  - Boardwalks & walkways.
  - Irrigation with recycled BVSTP effluent.
  - Fertilising and soil amendment with BVSTP biosolids.

- **Community & Housing Project Areas**
  - Affordable / community housing (subject to rezoning).
  - Use of existing corridors and rights-of-way.
  - Education & interpretation centre.
  - Community gardens.
  - Camping and tourist/visitor accommodation.

- **Brunswick Valley Sewage Treatment Plant (BVSTP) Project Areas**
  - Upgrades to BVSTP in order to accept the flow from the Ocean Shores STP.
  - Effluent storage ponds to buffer flows in order to facilitate effluent reuse and further polishing.
  - Constructed wetlands for effluent polishing.

- Recycled water generation for irrigation and other valuable uses.
- Biomass anaerobic digestion to generate biogas for electricity generation, heating and cooling.
- Digested biomass dewatering for reuse as fertilizer and soil amendment.

- **Biomass Project Areas**
  - Biomass coppice crops cultivated for bioenergy and other valuable uses, e.g. oil crops such as hemp.
  - Use of recycled water for crop irrigation.
  - Land application of dewatered biomass for reuse as fertilizer and soil amendment.

- **Solar Farm Project Areas**
  - Solar photovoltaic arrays for electricity generation
    - Community solar farm
    - Council BVSTP solar farm

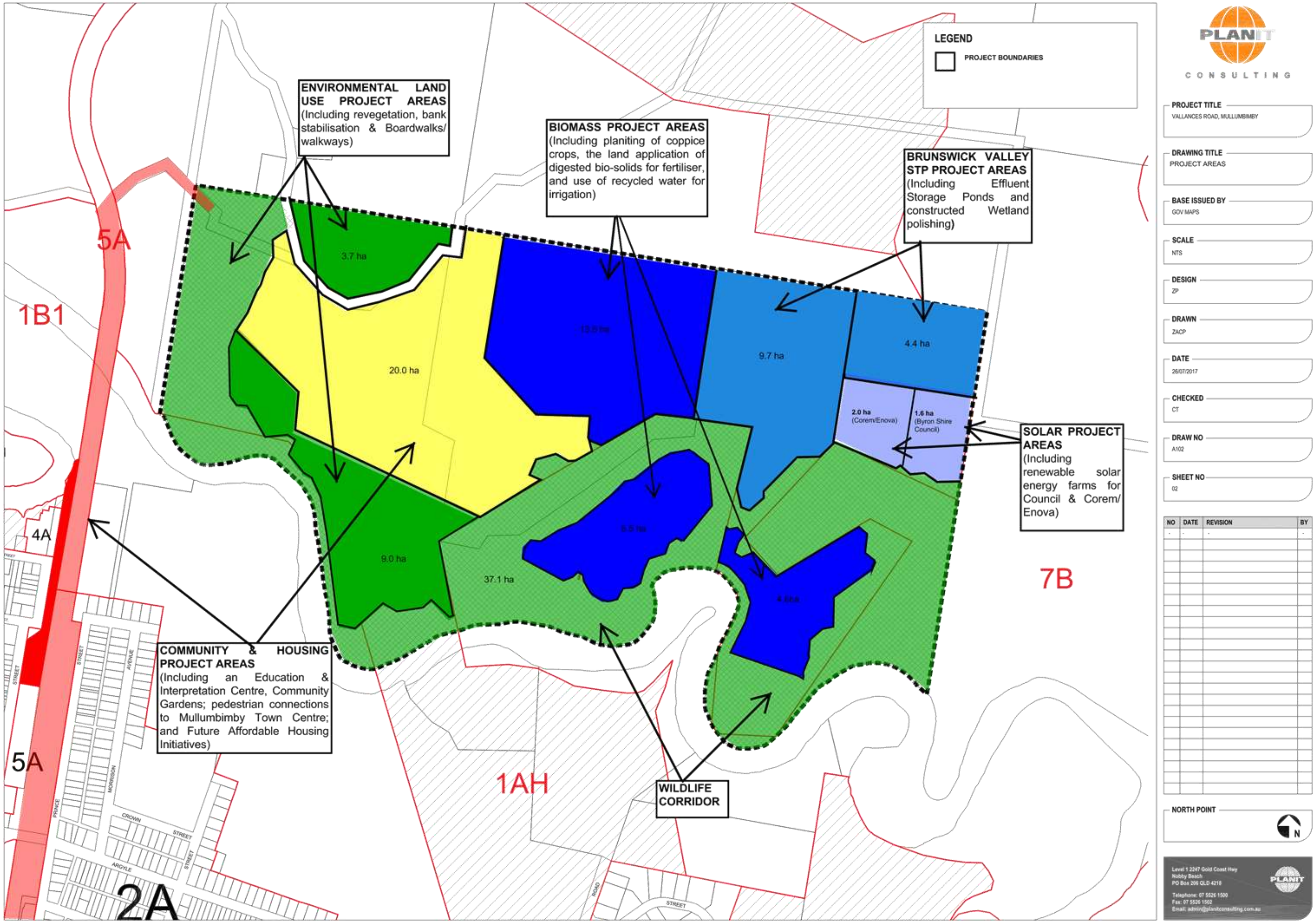
Please refer to **Map 1** for the project areas.

The table overleaf summarises these actions in greater detail, and in specific relation to the POM categorisation areas as well as the existing permissible developments under current zoning.

The next phases of work can address screening and prioritizing the POM actions for implementation. In doing so, Council may wish to consider the following issues in greater detail:

- Public review and consultation prior to finalising the Plan of Management Actions.
- Prioritisation of Actions and identification of specific works.
- Statutory instruments, reviews, and approvals that may be required for the Actions and resulting specific works.
- Estimating costs, and funding sources and methods, for the Actions and specific works.
- Estimating timelines for implementation of the Actions and specific works.
- Detailed next steps for implementing the priority Actions and specific works.

In addition to the table below, **Section 5** and **Appendix 1** summarise in detail the strategic actions of these projects, and the strategic objectives of the projects. **Section 6** recommends actions to be implemented in order to achieve the outcomes intended by this Plan of Management.


LEGEND
PROJECT BOUNDARIES
ENVIRONMENTAL LAND USE PROJECT AREAS (Including revegetation, bank stabilisation & Boardwalks/ walkways)
BIOMASS PROJECT AREAS (Including planiting of coppice crops, the land application of digested bio-solids for fertiliser, and use of recycled water for irrigation)
BRUNSWICK VALLEY STP PROJECT AREAS (Including Effluent Storage Ponds and constructed Wetland polishing)
SOLAR PROJECT AREAS (Including renewable solar energy farms for Council & Corem/ Enova)
COMMUNITY & HOUSING PROJECT AREAS (Including an Education & Interpretation Centre, Community Gardens; pedestrian connections to Mullumbimby Town Centre; and Future Affordable Housing Initiatives)
WILDLIFE CORRIDOR
3.7 ha
20.0 ha
9.7 ha
4.4 ha
2.0 ha (Corem/Enova)
1.6 ha (Byron Shire Council)
9.0 ha
37.1 ha
5A
1B1
4A
5A
2A
1AH
7B
PLANIT CONSULTING
PROJECT TITLE
VALLANCES ROAD, MULLUMBIMBY
DRAWING TITLE
PROJECT AREAS
BASE ISSUED BY
GOV MAPS
SCALE
NTS
DESIGN
ZP
DRAWN
ZACP
DATE
26/07/2017
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DRAW NO
A102
SHEET NO
02
NO DATE REVISION BY
NORTH POINT
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PLAN OF MANAGEMENT - SUMMARY

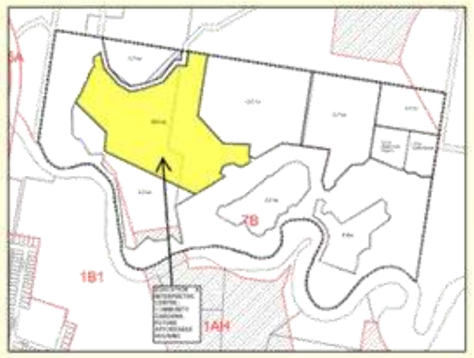
NATURAL AREA (WETLAND)

[Proposes uses include Environmental Land Uses including rehabilitation and wildlife corridors]

ACTION	KEY PROPOSALS	AREA (APPROX.)	ZONING	SUMMARY OF PERMISSIBLE USES
Environmental Land Project Areas	o Native trees and plants revegetation and rehabilitation. o Brunswick River bank stabilisation. o Boardwalks & walkways. o Irrigation with recycled BVSTP effluent. o Fertilising and soil amendment with BVSTP biosolids.	49.8 ha	Rural 2 – Rural Landscape Deferred Matter (LEP 2014) Coastal Habitat (LEP 88)	• Environmental Facility • Environmental protection works • Information and Education Facility • Recreation Area • Flood Mitigation Works

PARK USE

[Proposed Uses include Community Gardens, an Education and Interpretive Centre; and future Affordable / Community Housing (Subject to Re-zoning)]

ACTION	KEY PROPOSALS	AREA (APPROX.)	ZONING	SUMMARY OF PERMISSIBLE USES
Community & Housing Project Area  	o Sustainable community housing (subject to rezoning). o Use of existing rail corridor, bridge and Council road right-of-way to access the site o Promote low-footprint development via foot traffic, bicycle, and/or e-vehicles o Leading-edge, multi-purpose educational facility to highlight innovations in sustainable land management. o Provision of community gardens o Potential for camping and tourist/visitor accommodation.	20.0 ha	RU1 – Primary Production RU2 – Rural Landscape	• Affordable Housing (*Subject to re-zoning of the land) • Community Facility • Restaurant or Cafe • Environmental Facility • Information & Education Facility • Recreation Area • Camping Ground • Eco Tourist Facilities • Tourist and Visitor Accommodation (ONLY Bed & Breakfast and Farm-Stay Accommodation)

GENERAL COMMUNITY USE
[Proposed uses include: Eco-Pursuits and sustainable technologies such as the Brunswick Valley Sewage Treatment Plant (STP), Biomass Coppice Crops, Land application of Digested Bio-solids; Recycled Water Irrigation; STP Effluent Storage and Wetlands Polishing; and other Bioenergy]

ACTION	KEY PROPOSALS	AREA (APPROX.)	ZONING	SUMMARY OF PERMISSIBLE USES
Biomass Project Areas	○ Planting of biomass coppice crops for harvesting and use in generation of bioenergy and other valuable use, e.g. oil crops such as hemp. ○ Use of recycled BVSTP effluent for irrigation. ○ Land application of dewatered BVSTP biomass for fertiliser and soil amendment.	23.8 ha	RU1 – Primary Production RU2 – Rural Landscape	• Agriculture • Extensive Agriculture • Intensive Plant Agriculture • Horticulture • Intensive Livestock Agriculture • Farm Building • Rural Industry
BVSTP Project Areas	○ Upgrades to BVSTP to accept Ocean Shores STP flows ○ Effluent storage ponds to buffer flows in order to facilitate effluent reuse and further polishing. ○ Constructed wetlands for effluent polishing. ○ Recycled water generation for irrigation and other valuable uses. ○ Biomass anaerobic digestion to generate biogas for electricity generation, heating and cooling. ○ Digested biomass dewatering for reuse as fertilizer and soil amendment.	14.1 ha	RU1 – Primary Production RU2 – Rural Landscape	• Sewerage System • Extensive Agriculture • Rural Industry • Intensive Plant Agriculture • Horticulture • Intensive Livestock Agriculture • Farm Building • Rural Industry
Solar Farm Project Areas 	○ Installation of solar photovoltaic arrays for: • Byron Shire Council for use in the operation of the BVSTP • Community (community-owned electricity retailer) ○ Excess electricity to be net-metered and sold to generate a sustainable source of revenue.	3.6 ha	RU1 – Primary Production RU2 – Rural Landscape	• Electricity Engineering • Solar Energy System • Rural Industry

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1. INTRODUCTION

The purpose of this Operational Plan of Management is to provide a framework for the management and development of Community Land under Council's control. Council has responsibility for two main types of public land; Crown Land whose control is vested in Council under the Crown Lands Act 1989, and Council owned and managed Community Land or Operational Land dedicated under the Local Government Act 1993.

A Plan of Management provides Council with an appropriate framework for the future management of public land in accordance with all relevant legislation. The Plan is community driven and provides for the community's vision for the land, including permitted uses and establishes strategies and an action plan for the implementation of the desired outcomes.

The purpose of this Plan of Management is to provide a guide for the future use, development and management of the site. The land included in this Plan of Management is Community and Operational Land identified as Lot 1 on DP 952598 (125 Vallances Road, Mullumbimby) and Lot 1 on DP 129374. The sites are located in Mullumbimby, to north-east of the township and bordered by the Brunswick River to the south.

The land is locally known as Vallances Road and includes the Brunswick Valley Sewage Treatment Plan (STP). It is intended to develop the site as a whole for sustainable eco-pursuits, renewable energy technologies and innovative environmental processes.

1.1. Structure of this Plan of Management

This Plan of Management is divided into the following sections:

1. **Introduction** – provides the purpose of the Plan and the details of the land applicable under this Plan of Management.
2. **Site Details** – Provides a description of the land, current uses and purposes, zoning, vegetation and locational context.
3. **Legislative Framework** – Outlines the statutory framework, the statutory categorisation and core objectives for the land.
4. **Strategic Framework** – this section outlines the strategic actions and policies shaping this Plan of Management.
5. **Future Use and Development of the Land** – provides the authorised (proposed and potential) developments on the land.
6. **Recommendations –** provides recommendations in order to facilitate future use and development of the land
7. **Summary –** provides a synopsis of the Plan of Management and intended outcomes.
8. **Appendices –** provide information applicable to this Plan of Management.

1.2. Land covered by this Plan

This Plan of Management applies to Operational Land identified as Lot 1 on DP 952598 (125 Vallances Road, Mullumbimby) and Community Land identified as Lot 1 on DP 129374 (Sewerage Works- Vallances Rd, Mullumbimby).

The property details are shown below and the complete Plan of Management Area shown overleaf (refer **Map 2**).

<table>
<tr><th></th><th>Lot / DP</th><th>Physical Address</th><th>Area</th><th>Classification</th></tr>
<tr><td>1</td><td>1/DP952598</td><td>125 Vallances Road, Mullumbimby</td><td>25.4 ha (254,189.32m²)</td><td>Operational</td></tr>
<tr><td colspan="4">
</td><td>Source: Byron Shire Council, 2017</td></tr>
<tr><td>2</td><td>1/DP129374</td><td>Sewerage Woks – Vallances Road, Mullumbimby</td><td>85.9ha (859,015.52m²)</td><td>Community</td></tr>
<tr><td colspan="4">
</td><td>Source: Byron Shire Council, 2017</td></tr>
</table>

All public land must be classified by council as either "Community" or "Operational" land (as per Section 25 – 26 of the *Local Government Act 1993*). The main effect of classification is to restrict the alienation and use of the land.

Operational Land has no special restrictions other than those that may apply to any piece of land (i.e covenants on title, easements etc). Operational Land is public land that may be sold by Council.

Classification as Community Land reflects the importance of the land to the community because of its use or special features. Generally, it is land intended for public access and use, or where other restrictions applying to the land create some obligation to maintain public access (such as a trust deed, or dedication under section 94 of the *Environmental Planning and Assessment Act 1979*).

This gives rise to the restrictions in the Local Government Act and the requirement for a plan of Management, which are intended to preserve the qualities of the land. Community land:

- cannot be sold;
- cannot be leased, licenced or any other estate granted over the land for more than 21 years; and
- must have a plan of management prepared for it.

Public land is initially classified as either Operational or Community Land by one of the following means:

1. by resolution of Council, prior to or when the land is acquired; or
2. by a Local Environmental Plan prepared under the EP&A Act 1979; or
3. by operation of the Local Government Act –
    a. applies to certain land controlled by council at 1 July 1993, or
    b. where council has since acquired land and there is no resolution to classify the land;

The most common way in which to classify or re-classify land is by resolution of Council. Lot 1/DP952598 was reclassified via Amendment 1 to the Byron LEP 2014 on 16 October 2015, for the original intention of selling of this land. Refer to Schedule 4 of the *Byron Local Environmental Plan 2014*.

For the purposes of the Plan of Management, it is noted that as both parcels of land are generally intended for use by the public or by Council on behalf of the public, or by the public, there is no requirement for Council to reclassify the current Community Land to Operational unless the intent is to sell the entirety of the land or enter a lease longer than 21 years. Similarly, there is no requirement for Council to reclassify the existing Operational Land to Community Land, except for the purposes of continuity under this Plan of Management.

Should Council choose to reclassify either parcel, the procedures are set out within the *Local Government Act 1993* and clarified by Practice Note 1: Public land Management, issued by the Department of Local Government.


LEGEND
SITE BOUNDARY
PLANIT
PROJECT TITLE
DRAWING TITLE
BASE ISSUED BY
SCALE
DESIGN
DRAWN
DATE
CHECKED
DRAW NO
SHEET NO
NO DATE REVISION BY
NORTH POINT
N

2. SITE DETAILS

2.1. Condition of the Land

The subject site is a large parcel of land formed by two lots (cumulatively 111.3 ha) owned by Byron Shire Council (BSC). The site is located within a rural area to the north of the Brunswick River, approximately 1km to the north-east of the Mullumbimby CBD.

The north-east portion of the site is currently used for a sewage treatment plant (STP), operated by BSC. The remainder of the site is largely vacant and used for agistment and livestock grazing. The site accommodates two dwellings (one circa 1980's, the other circa 1920's) with other structures and features associated with an old plant nursery, all towards the south eastern corner.

The site's natural features include about 2.4km of river frontage along the Brunswick River, two large oxbow lagoons (or billabongs) about 1 km in length each, and a small stream close to the south-western property boundary.

The landscape is made up of gently undulating slopes and estuarine flood plains. The vegetation is largely disturbed as a result of the historical use of the sites for agistment.

Figure 2 – Portion of Site as viewed from Vallances Road

2.2. Existing Zoning of the Land

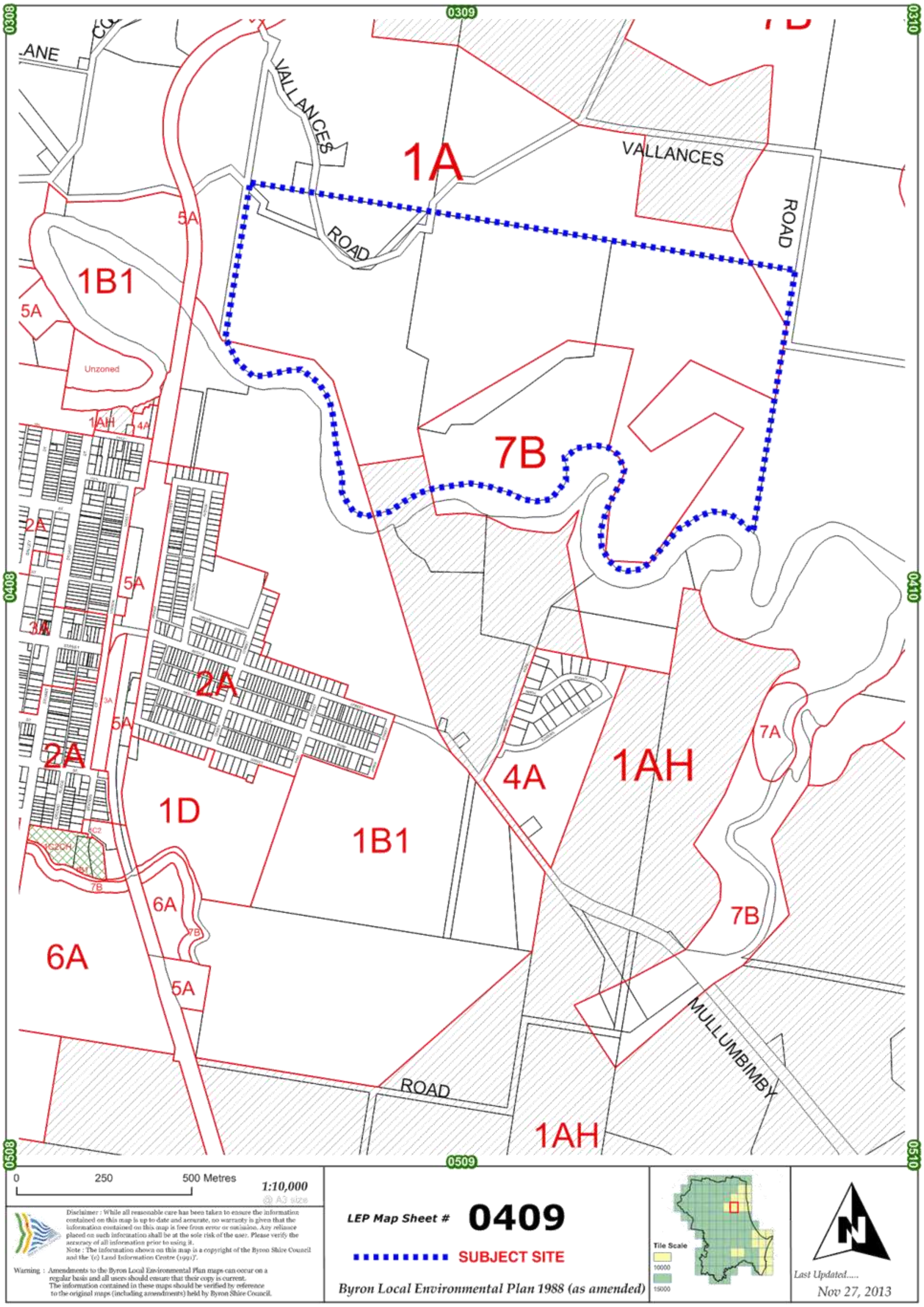
The land is currently zoned RU1 (Primary Production), RU2 (Rural Landscape) and DM (Deferred Matter) under the Byron Local Environmental Plan 2014. The DM-designated land is land that is primarily zoned 7(b) Coastal Habitat Zone under Byron Local Environmental Plan 1988 (LEP 88).

However; it is noted that there are a number of zoning inconsistencies, with several parts of the DM-designed land under LEP 2014 being zoned 1(a) General Rural zone, 1(a)(h) – General Rural (Hatched) and 1(b)(1) – Agricultural Protection under LEP 88. These areas of inconsistencies are subject to the provisions of LEP 88.

The details of the existing zoning of the sites is shown below, and identified in the maps overleaf (refer **Map 3** and **Map 4**).

Lot / DP	Physical Address	Zoning (LEP 88)	Zoning (LEP 2014)
1/DP952598	125 Vallances Road, Mullumbimby	**1(a)** – General Rural **7(b)** – Coastal Habitat Zone	**RU1** – Primary Production **RU2** – Rural Landscape **DM** – Deferred Matter
1/DP129374	Sewerage Works – Vallances Road, Mullumbimby	**1(a)** – General Rural **1(a)(h)** – General Rural (Hatched) – subject to Clause 38A **1(b)(1)** – Agricultural Protection **7(b)** – Coastal Habitat Zone (Part Lot)	**RU1** – Primary Production **RU2** – Rural Landscape **DM** – Deferred Matter

The primary development of the eco-pursuits on this land are focused on those areas of land Zoned RU1 (Primary Production) or RU2 (Rural Landscape) under LEP 2014 (refer **Map 5**). All areas of Deferred Matter and subject to LEP 88 have been retained as a wildlife corridor for environmental and conservation purposes.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VALLANCES
VALLANCES
ROAD
ROAD
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5A
Unzoned
1AH
4A
7B
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5A
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2A
3A
5A
2A
1D
1B1
4A
1AH
7A
6A
7B
6A
7B
5A
7B
MULLUMBIMBY
ROAD
1AH
0
250
500 Metres
1:10,000
@ A3 size
Disclaimer : While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no warranty is given that the information contained on this map is free from error or omission. Any reliance placed on such information shall be at the sole risk of the user. Please verify the accuracy of all information prior to using it.
Note : The information shown on this map is a copyright of the Byron Shire Council and the '(c) Land Information Centre (1991)'.
Warning : Amendments to the Byron Local Environmental Plan maps can occur on a regular basis and all users should ensure that their copy is current. The information contained in these maps should be verified by reference to the original maps (including amendments) held by Byron Shire Council.
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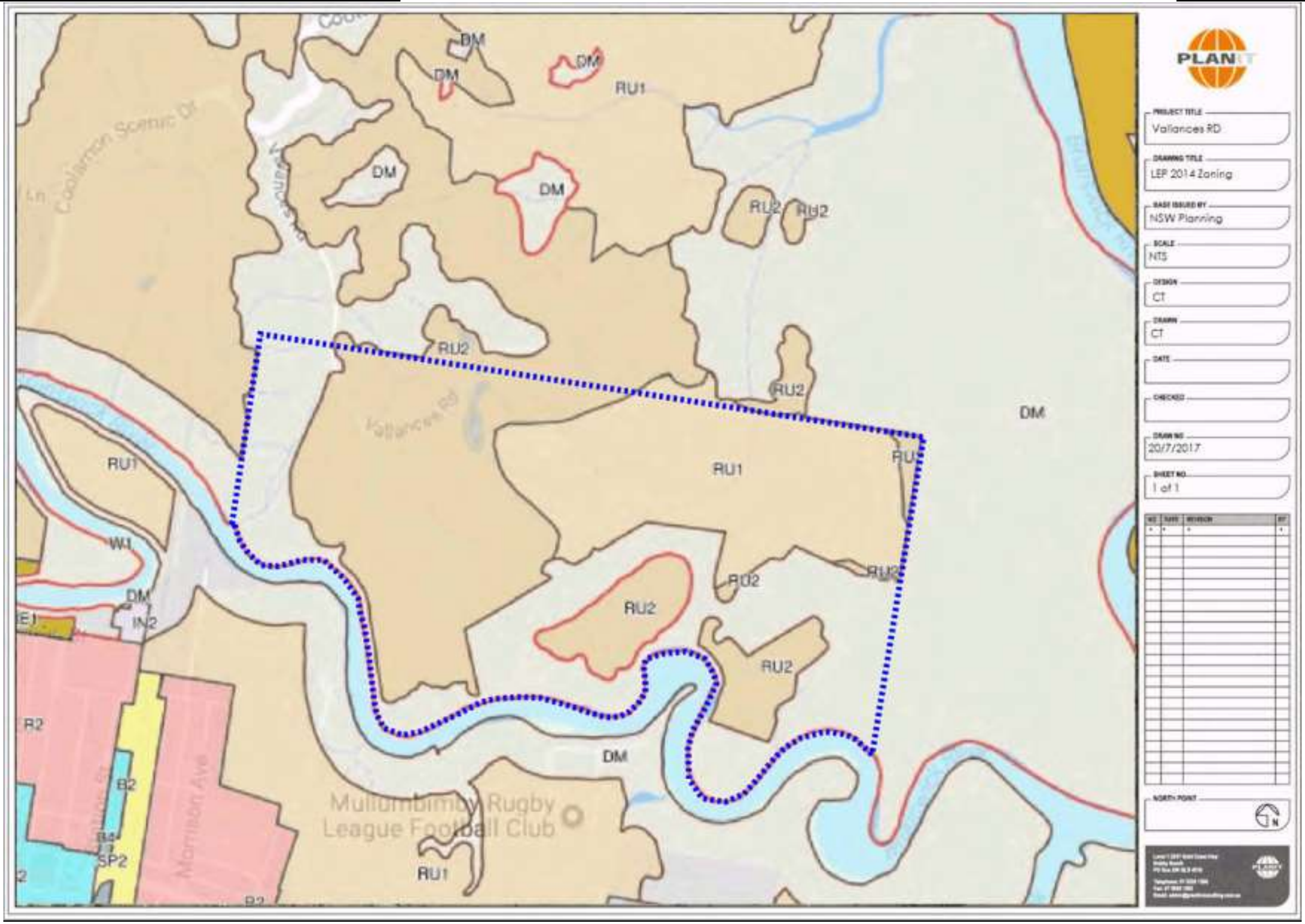
Byron Local Environmental Plan 1988 (as amended)
Tile Scale
10000
15000
Last Updated.....
Nov 27, 2013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DRAWING TITLE
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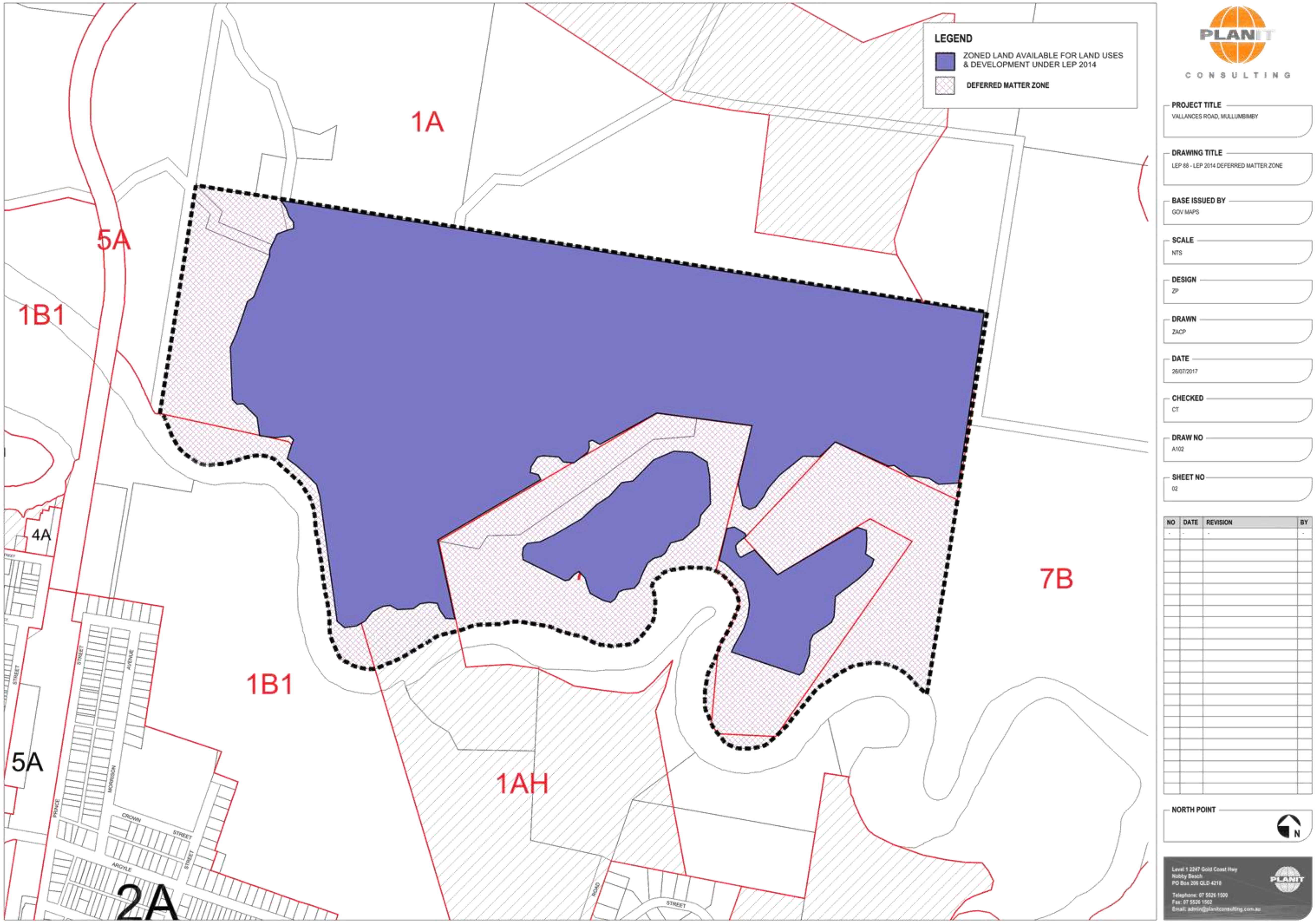
NSW Planning
SCALE
NTS
DESIGN
CT
DRAWN
CT
DATE
CHECKED
DRAWING NO
20/7/2017
SHEET NO.
1 of 1
NORTH POINT
RU1
RU2
DM
W1
IN2
R2
B2
B4
SP2
Mullumbimby Rugby League Football Club
Coolamon Scenic Dr
Mortison Ave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DEFERRED MATTER ZONE
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5A
1B1
4A
1B1
5A
2A
1AH
7B
PLANIT
CONSULTING
PROJECT TITLE
VALLANCES ROAD, MULLUMBIMBY
DRAWING TITLE
LEP 88 - LEP 2014 DEFERRED MATTER ZONE
BASE ISSUED BY
GOV MAPS
SCALE
NTS
DESIGN
ZP
DRAWN
ZACP
DATE
26/07/2017
CHECKED
CT
DRAW NO
A102
SHEET NO
02
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DATE
REVISION
BY
NORTH POINT
N
Level 1 2247 Gold Coast Hwy
Nobby Beach
PO Box 206 QLD 4218
Telephone: 07 5526 1500
Fax: 07 5526 1502
Email: admin@planitconsulting.com.au

Below is a summary of the zone objectives and the permissible uses (with /without consent) in each zone. The land uses relevant to the ecological and sustainable development intent of the site have been highlighted in bold where relevant. These uses are discussed further in Section 5.

2.2.1 RU1 – Primary Production

The relevant LEP 2014 objectives for the RU1 – Primary Production zone are:

- *To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.*
- *To encourage diversity in primary industry enterprises and systems appropriate for the area.*
- *To minimise the fragmentation and alienation of resource lands.*
- *To minimise conflict between land uses within this zone and land uses within adjoining zones.*
- *To encourage consolidation of lots for the purposes of primary industry production.*
- *To enable the provision of tourist accommodation, facilities and other small-scale rural tourism uses associated with primary production and environmental conservation consistent with the rural character of the locality.*
- *To protect significant scenic landscapes and to minimise impacts on the scenic quality of the locality.*

Works on this portion of land which would be permissible without development consent include:

- ***Environmental protection works; Extensive agriculture****; Home-based child care; Home occupations*

The following land uses, activities and development on this portion of land would be permissible, subject to development consent:

- *Airstrips; Animal boarding or training establishments; Business identification signs;* ***Camping grounds; Community facilities****; Dual occupancies; Dwelling houses;* ***Environmental facilities****; Extractive industries;* ***Farm buildings****;* ***Flood mitigation works****; Forestry; Helipads; Home businesses; Home industries; Industrial retail outlets; Industrial training facilities;* ***Intensive livestock agriculture; Intensive plant agriculture****; Landscaping material supplies; Open cut mining; Places of public worship; Plant nurseries;* ***Recreation areas; Restaurants or cafes****; Roads; Roadside stalls;* ***Rural industries****; Rural supplies; Rural workers' dwellings; Secondary dwellings;* ***Tourist and visitor accommodation****; Veterinary hospitals*

2.2.2 RU2 – Rural Landscape

The relevant LEP 2014 objectives for the RU2 – Rural Landscape zone are:

- *To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.*
- *To maintain the rural landscape character of the land.*
- *To provide for a range of compatible land uses, including extensive agriculture.*
- *To enable the provision of tourist accommodation, facilities and other small-scale rural tourism uses associated with primary production and environmental conservation consistent with the rural character of the locality.*
- *To protect significant scenic landscapes and to minimise impacts on the scenic quality of the locality*

Works on this portion of land which would be permissible without development consent include:

- ***Environmental protection works; Extensive agriculture;*** *Home-based child care; Home occupations*

The following land uses, activities and development on this portion of land would be permissible, subject to development consent:

- **Agricultural produce industries**; **Agriculture;** Airstrips; Animal boarding or training establishments; Business identification signs; **Camping grounds**; Cemeteries; Child care centres; **Community facilities**; Crematoria; Depots; Dual occupancies; Dwelling houses; **Eco-tourist facilities; Environmental facilities**; Extractive industries; **Farm buildings**; **Flood mitigation works**; Forestry; Funeral homes; Garden centres; Health consulting rooms; Helipads; Home businesses; Home industries; Hostels; Industrial retail outlets; Industrial training facilities; **Information and education facilities**; Landscaping material supplies; Livestock processing industries; Neighbourhood shops; Places of public worship; Plant nurseries; **Recreation areas**; Recreation facilities (indoor); Recreation facilities (outdoor); Respite day care centres; **Restaurants or cafes**; Roads; Roadside stalls; Rural supplies; Rural workers' dwellings; Secondary dwellings; Stock and sale yards; Storage premises; **Tourist and visitor accommodation**; Transport depots; Truck depots; Veterinary hospitals; Warehouse or distribution centres.

2.2.3 DM - Deferred Matter

The DM - Deferred Matter designation under LEP 2014 consists of the following zonings under LEP 88:

- 1(a) – General Rural;

- 1(a)(h) – General Rural (Hatched);
- 1(b)(1) – Agricultural Protection; and
- 7(b) – Coastal Habitat Zone.

Although each of these areas has specific objectives and land use permissibility under LEP 88 these are not addressed in this plan of management as all works proposed are to take place outside of the DM area.

Any future works on this land will be required to be in accordance with the relevant provisions of LEP 88.

2.3. Existing Uses and Facilities

The primary use of the site is the Brunswick Valley Sewage Treatment Plant (STP), constructed and operated under the Brunswick Valley Sewage Augmentation scheme. The STP requires a 500m radius buffer around the sewerage infrastructure, which extends outside the subject sites' boundaries (refer **Map 6**).

The Brunswick Valley STP has been operating since 2010. The STP was constructed to facilitate better wastewater management practices in the Mullumbimby and Brunswick Heads areas, and improved water quality in the Brunswick River estuary.

The STP facilities include the operation of a physical, chemical and biological treatment plant and off-site recycled water irrigation storage. Treated effluent is available to the Main Arm Irrigation Scheme which currently irrigates treated effluent onto dairy pasture. Biosolids recycling is also available to local farms for use as a soil conditioner.

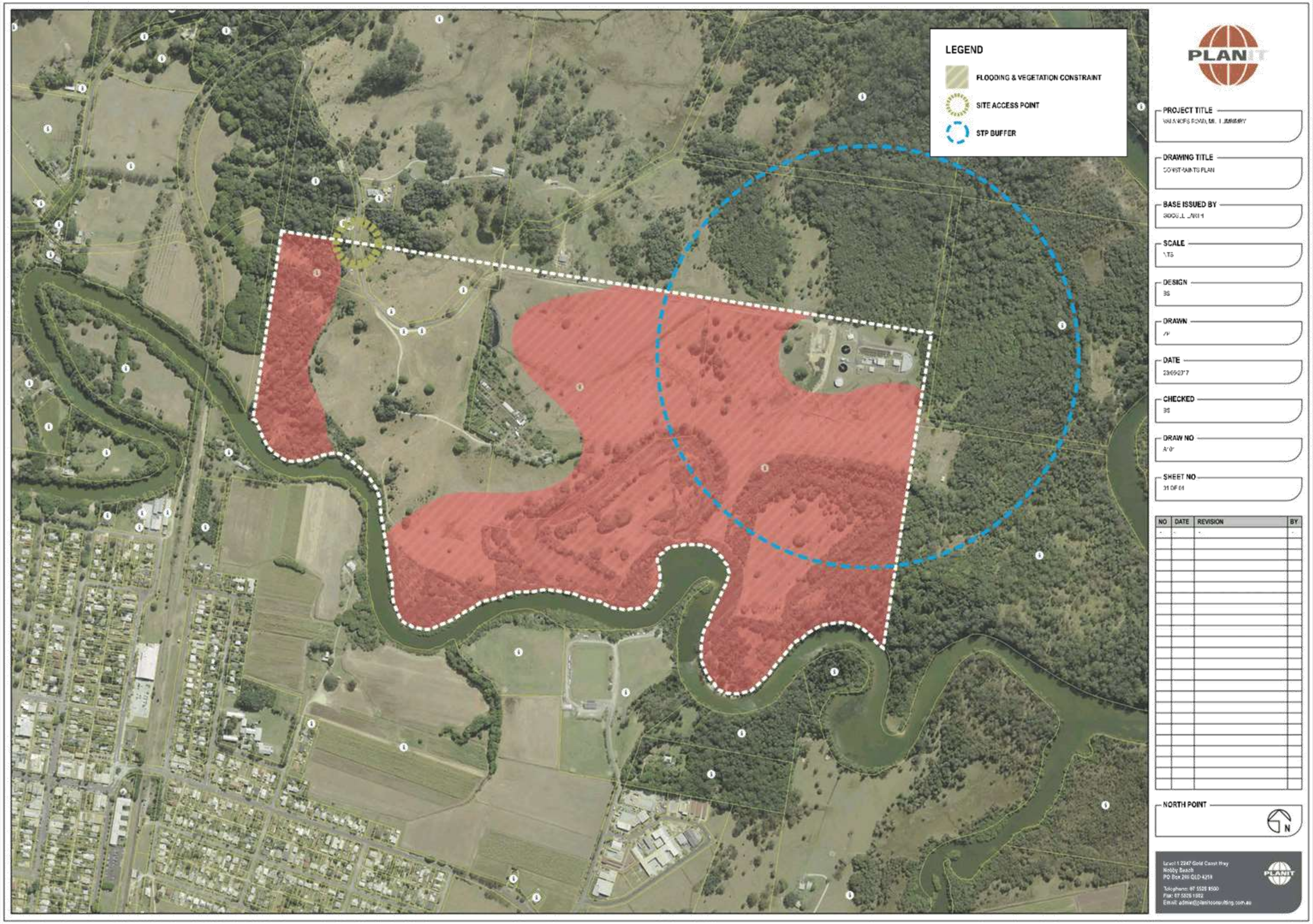
The remainder of the site is largely vacant and used for agistment and livestock grazing. The site accommodates two dwellings (one circa 1980's, the other circa 1920's) with other structures and features associated with an old plant nursery, all towards the south eastern corner.

A table of existing uses is provided below:

Lot / DP	Physical Address	Existing Uses
1/DP952598	125 Vallances Road, Mullumbimby	• Extensive Agriculture (Agistment/Grazing) • Dwelling (x 2) • Farm Building
1/DP129374	Sewerage Woks – Vallances Road, Mullumbimby	• Sewerage System • Extensive Agriculture (Agistment/Grazing) • Environmental protection Works

Figure 5 - Historical Grazing Areas **Source: Byron Shire Council**

Figure 6 – Existing Sewage Treatment Plant **Source: SIXmaps, 2017**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FLOODING & VEGETATION CONSTRAINT
SITE ACCESS POINT
STP BUFFER
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DRAWING TITLE
CONSTRAINTS PLAN
BASE ISSUED BY
SCALE
DESIGN
DRAWN
DATE
CHECKED
DRAW NO
SHEET NO
NO
DATE
REVISION
BY
NORTH POINT
N
Nobby Beach
PLANIT

2.4. Existing Vegetation

With approximately 2.5km of frontage to the Brunswick River and associated riparian riverbank vegetation, the site is a significant ecological zone and provides an important fish habitat leading into the Cape Byron Marine Reserve.

About 80% of the site consists of cleared land that supports exotic pasture and has been used for cattle grazing since the 1940s. The remaining 20% consists of heavily vegetated areas of mangrove forest and woodland, saltmarsh, swamp sclerophyll forest and woodland, wet sclerophyll forest, rainforest (some dominated by Camphor Laurel), and Brushbox forest (refer **Map 7**).

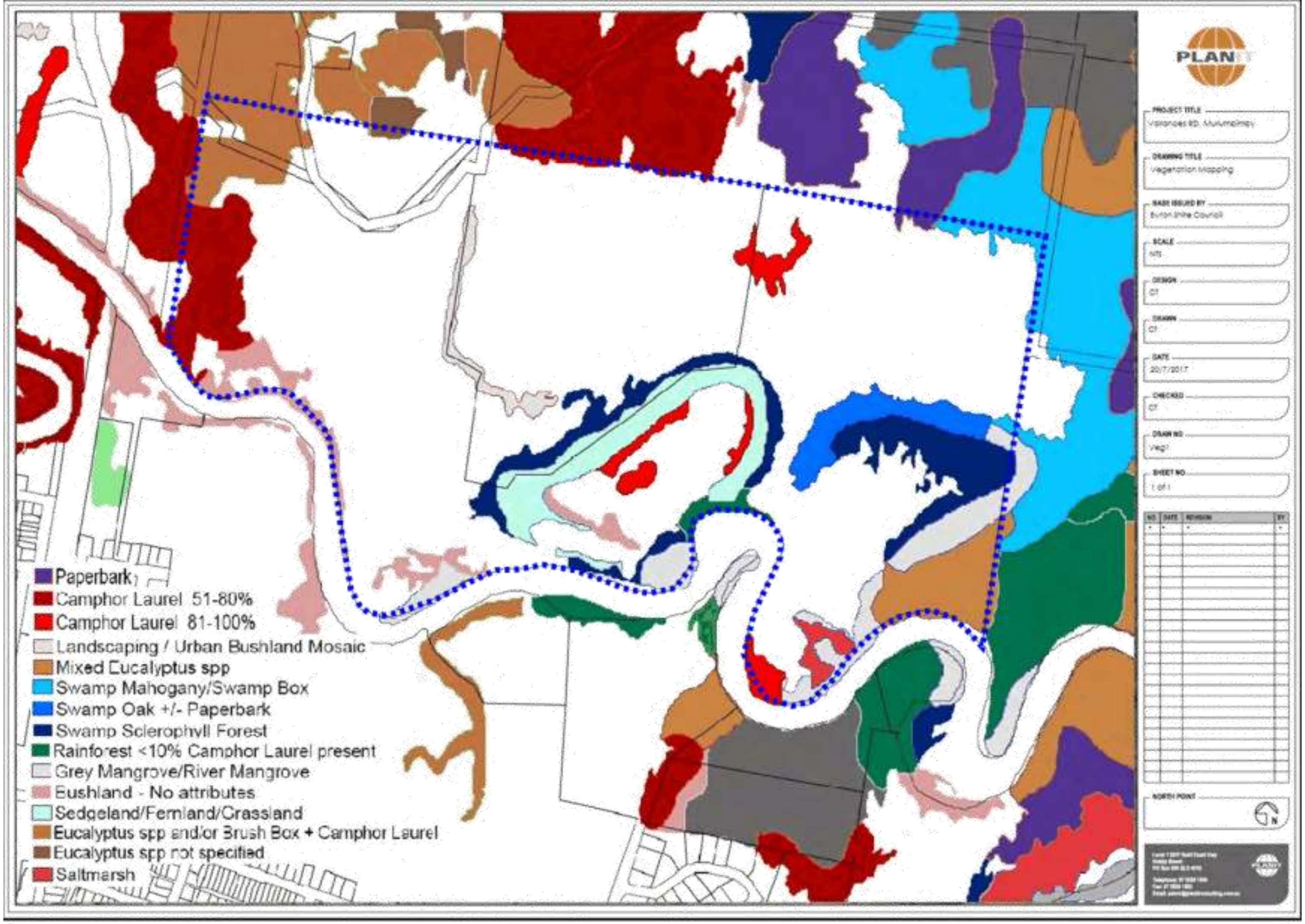
Endangered Ecological Communities represented on the site include Coastal Saltmarsh, Swamp Oak Floodplain Forest, Swamp Sclerophyll Forest on Coastal Floodplains, Subtropical Coastal Floodplain Forest, Lowland Rainforest on Floodplain and Freshwater Wetlands. These areas are designated as High Value Conservation Vegetation and form part of the wildlife corridor through the site (refer **Map 8**).

Eight threatened flora species have been recorded: Hairy Joint Grass (*Arthraxon hispidus* – V), Marblewood (*Acacia bakeri*-V), White Lace Flower (*Archidendron hendersonii* – V), Giant Ironwood (*Choicarpa subargentea* – E), Davidson's Plum (*Davidsonia jersyana* - E), Rough Shelled Queensland Nut (*Macadamia tetraphylla* – V) and Spiny Gardenia (*Randia moorei* – E).

Three threatened fauna species have been recorded in native vegetation at the site. The Koala (*Phascolarctos cinereus* - V), the Bush Hen (*Amaurornis olivaceus* - V), and the Rose-Crowned Fruit Dove (*Ptilinopus regina* –V).

Native vegetation on the site is severely fragmented and occurs in narrow corridors along riparian zones. The site has historically suffered from edge effects and was moderately to severely infested with over 40 species of environmental weeds. However; the subject site has undergone extensive regeneration and revegetation projects between 2006 and 2009 (*Bush Generation Outcomes for Vallances Road 2007-2009*, Byron Shire Council 2009).

Revegatated areas focused on the Camphor Laurel Forest; Swamp Sclerophyll Forest and Woodland; Swamp Sclerophyll Forest; Grey Mangrove/River Mangrove Forest and Woodland; Salt marsh, with the removal of Weeds including Camphor Laurel, Groundsel, Grasses, Coastal Morning Glory, Winter Senna, and Lantana.


Paperbark
Camphor Laurel 51-80%
Camphor Laurel 81-100%
Landscaping / Urban Bushland Mosaic
Mixed Eucalyptus spp
Swamp Mahogany/Swamp Box
Swamp Oak +/- Paperbark
Swamp Sclerophyll Forest
Rainforest <10% Camphor Laurel present
Grey Mangrove/River Mangrove
Bushland - No attributes
Sedgeland/Fernland/Grassland
Eucalyptus spp and/or Brush Box + Camphor Laurel
Eucalyptus spp not specified
Saltmarsh
PLAN
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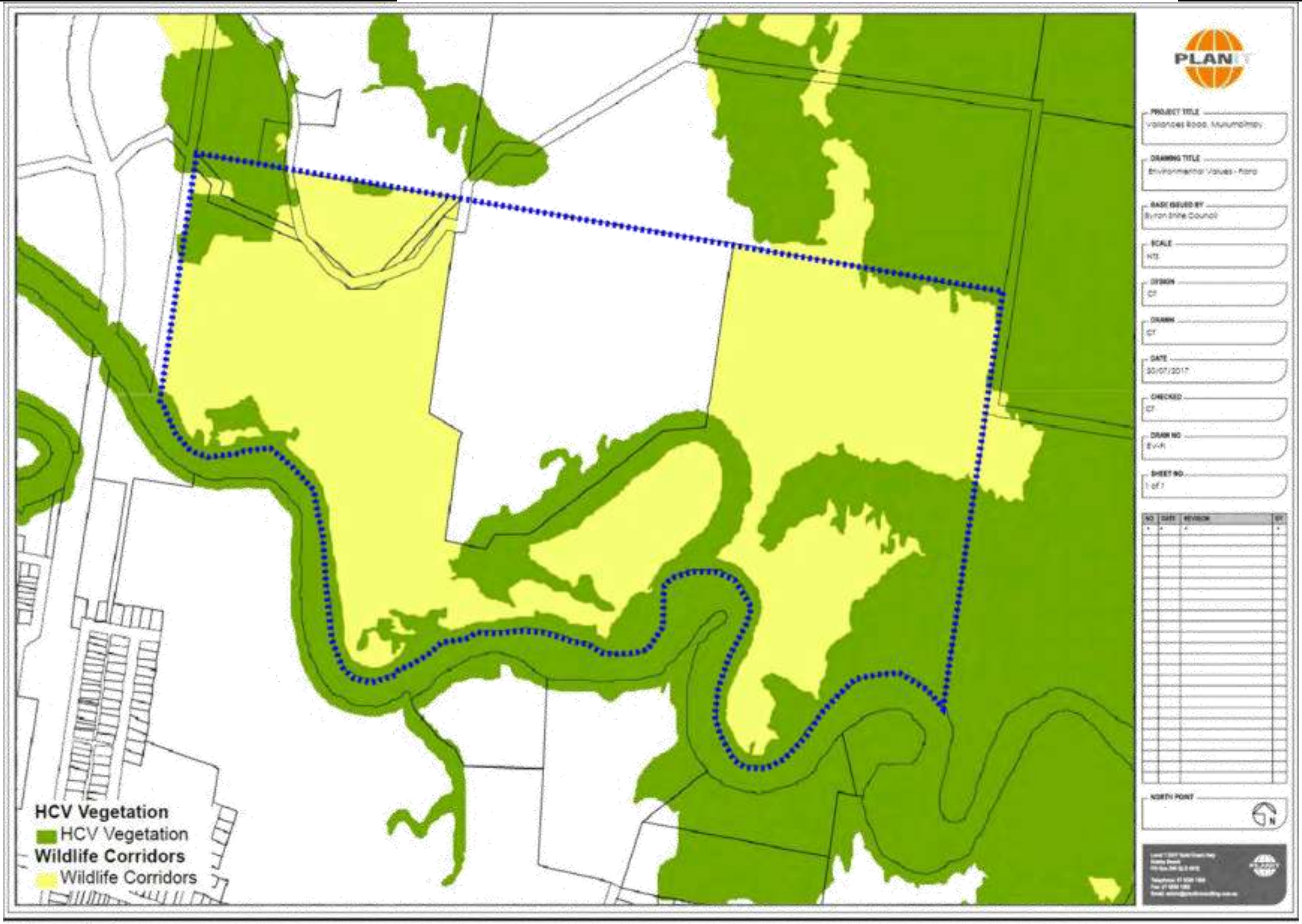
DRAWING TITLE
Vegetation Mapping
SCALE
DESIGN
DRAWN
DATE
CHECKED
SHEET NO
NORTH POINT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HCV Vegetation
Wildlife Corridors
Wildlife Corridors
PROJECT TITLE
Valances Road, Mullumbimby
DRAWING TITLE
Environmental Values - Flora
BASE ISSUED BY
Byron Shire Council
SCALE
NTS


Figure 10 – River Mangroves/ Brunswick River


Figure 11- Heavily Modified Agistment Areas


Figure 12 –Swamp Mahogany/Swamp Box


Figure 13 – Camphor Laurel

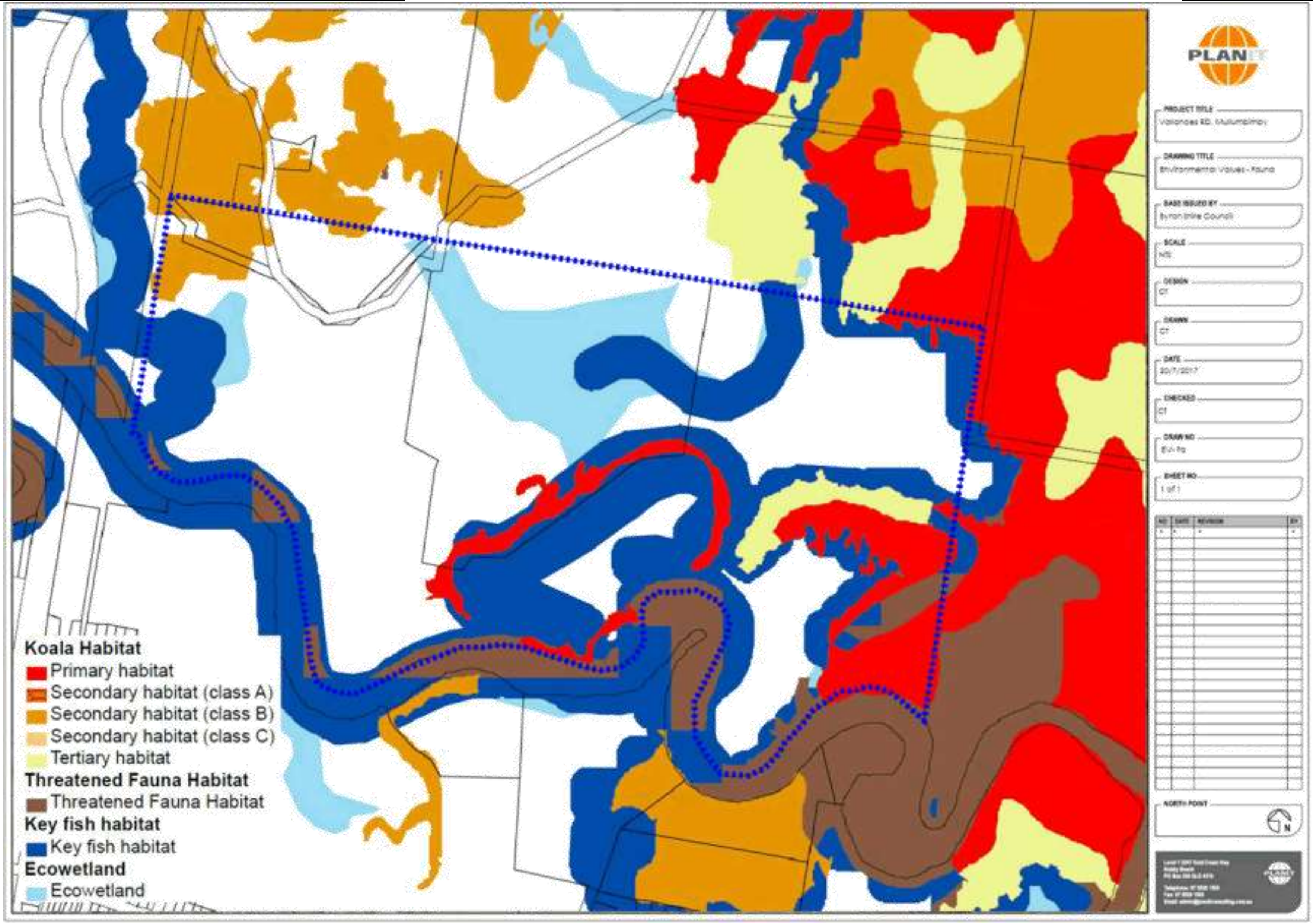
2.5. Existing Fauna

The subject site plays an important ecological role in the Brunswick Valley, forming part of an important wildlife corridor that connected the coastal floodplains with the sub-coastal hinterland.

Fauna Surveys conducted in 2009 revealed the site had at least 133 terrestrial invertebrate species inhabiting the site. This included 104 bird species (two threatened), 13 mammal species (three threatened), nine frog species and seven reptile species (refer **Map 9**).

There is evidence that the rehabilitation of native vegetation has improved the habitat for threatened fauna species previously recorded at Vallances Road. While bush regeneration works were underway at the site, Bush Hens and Rose-Crowned Fruit Doves have been heard calling in the surrounding vegetation.

Prior to bush regeneration activities commencing, repeated and targeted searches failed to locate any Koalas in the vegetation of the eastern oxbow. In 2009, Koalas have been sighted on two separate occasions feeding and resting in Tallowwoods in the eastern oxbow. The removal of Lantana from the understory may have facilitated the return of koalas to this forested area (*Bush Regeneration Outcomes for Vallances Road 2007-2009, Byron Shire Council*).


Koala Habitat
Primary habitat
Secondary habitat (class A)
Secondary habitat (class B)
Secondary habitat (class C)
Tertiary habitat
Threatened Fauna Habitat
Threatened Fauna Habitat
Key fish habitat
Key fish habitat
Ecowetland
Ecowetland
PROJECT TITLE
DRAWING TITLE
Environmental Values - Fauna
BASE ISSUED BY
Byron Shire Council
SCALE
NTS
DESIGN
CT
DRAWN
CT
DATE
20/7/2017
CHECKED
CT
SHEET NO
1 of 1
NORTH POINT

3. LEGISLATIVE FRAMEWORK

Under the legislative requirements of the Local Government Act 1993, Council is required to prepare and adopt Plans of Management for all public land. A Plan of Management is not statutorily required for land classified as Operational land, however for the purpose of continuity across the site and future land uses, a single Plan of Management has been prepared across both the Community and Operational Land.

The minimum requirements under the Act state that a Plan of Management must:

- Categorise the land in accordance with Clause 36(4) and (5);
- Contain objectives for the management of the land;
- Contain performance targets;
- Specify the means of achieving the objectives and performance targets; and
- Specify how achievement of the objectives and performance targets is to be assessed (s.36 (3)).

It is important to note that Plans of Management cannot override legislation. Council must comply with all relevant laws that apply to the use of the land, in addition to the Plan of Management. This includes other parts of the Local Government Act 1993, the Environmental Planning and Assessment Act and planning instruments such as Local Environmental Plans (LEP).

In relation to the Byron Local Environmental Plan 1988 (LEP 88) and the Byron Local Environmental Plan 2014 (LEP 2014), the Plan of Management must be consistent with the permissible uses for the land detailed in the LEP.

3.1. Objectives

This section of the Plan of Management addresses the following objectives:

- To identify land categories;
- To establish core objectives for each of the community land categories;
- To develop a list of practical steps that will be taken to achieve the objectives;
- To develop a list of practical measures of assessment to measure the success of the strategies

3.2. Land Affected by Threatened Species

The Local Government Act was amended in 1999 to integrate the management of Community Land with threatened species laws. Council therefore must comply with the full range of threatened species laws.

Reference to the Byron Biodiversity Conservation Strategy for Lot 1 DP 952598 and Lot 1 DP 129374 indicates some vegetation with significant floristic value and includes areas of land deemed to be of a High Conservation Value. As such, it is recommended that further environmental surveys be undertaken to assess whether a threatened community or threatened plant species occur on site, as listed under the schedules of the Threatened Species Conservation (TSC) Act 1995.

The site contains the following fauna and fauna significance:

- High Conservation Value Vegetation;
- Wildlife Corridors;
- Primary Kola Habitat;
- Threatened Fauna Habitat;
- Key Fish Habitat; and
- Ecowetland.

The land subject to these significant habitats has been classified accordingly, in accordance with the classification below.

3.3. The Categorisation of Community Land

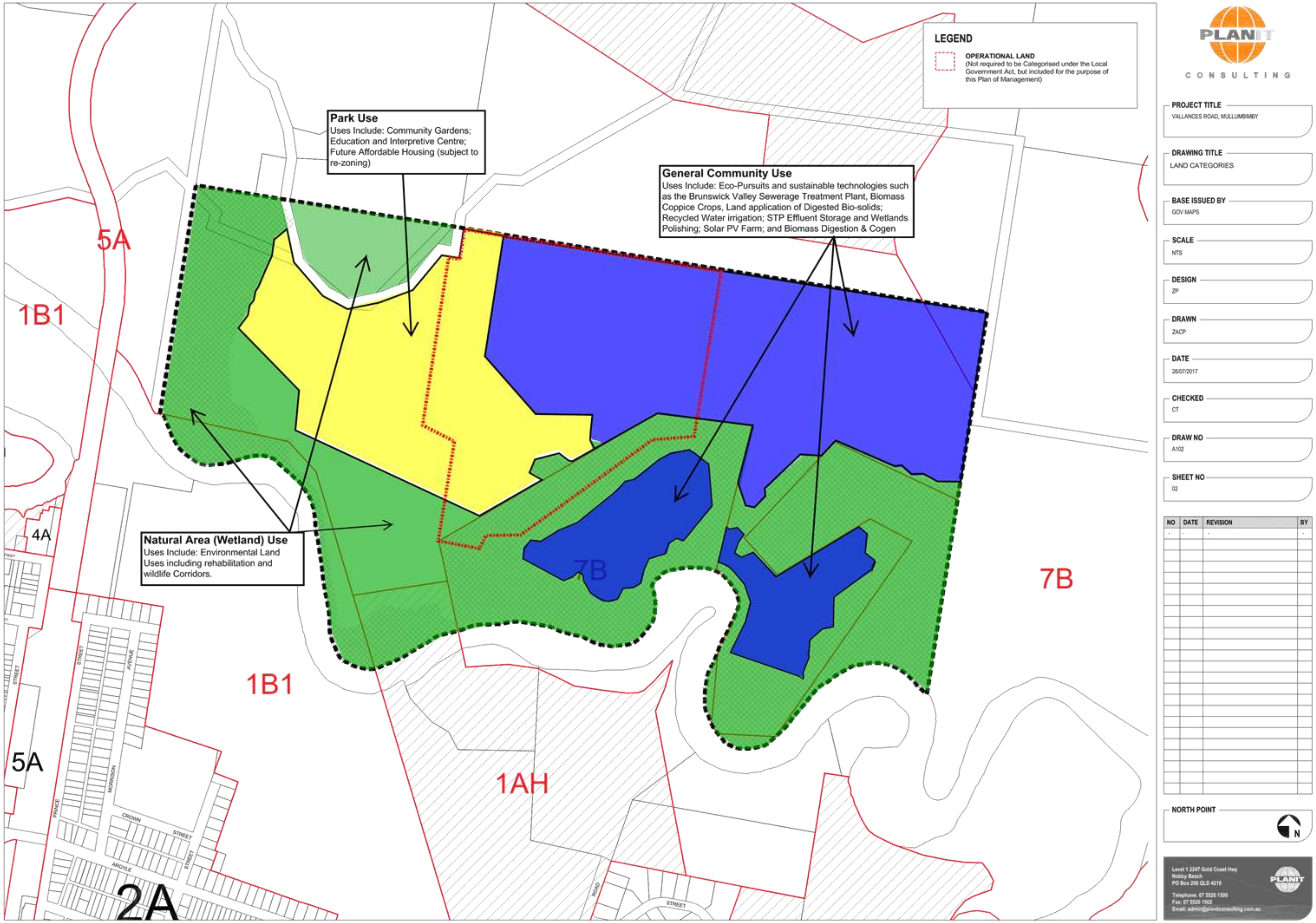
Section 36 of the Local Government Act 1993, states that Council must categorise community land as one or more of the following:

- *Natural area, further categorised as (bushland, wetland, escarpment, watercourse, foreshore, a category prescribed by the regulations)*
- *Sportsground;*
- *Park;*
- *Area of cultural significance; or*
- *General community use*

This Plan of Management categorises the land subject to this Plan into the following:

Categorisation	Indicative Land uses	Mapped	Area (Approx.)
Natural Area (Wetland)	Environmental Land Uses including rehabilitation and wildlife corridors	Green	45ha
Park	Community Gardens, Education & Interpretive Centre, future Affordable Housing.	Yellow	20ha
General Community Use	Eco-Pursuits and sustainable technologies such as the Brunswick Valley Sewage Treatment Plant, Biomass Coppice Crops, Land application of Digested Bio-solids; Recycled Water irrigation; STP Effluent Storage and Wetlands Polishing; Solar PV Farm; and Biomass Digestion & Cogen	Blue	46.3ha

Refer to the Concept Land Use Plan (**Map 10**) below.


LEGEND
OPERATIONAL LAND
(Not required to be Categorised under the Local Government Act, but included for the purpose of this Plan of Management)
Park Use
Uses Include: Community Gardens; Education and Interpretive Centre; Future Affordable Housing (subject to re-zoning)
General Community Use
Uses Include: Eco-Pursuits and sustainable technologies such as the Brunswick Valley Sewerage Treatment Plant, Biomass Coppice Crops, Land application of Digested Bio-solids; Recycled Water irrigation; STP Effluent Storage and Wetlands Polishing; Solar PV Farm; and Biomass Digestion & Cogen
Natural Area (Wetland) Use
Uses Include: Environmental Land Uses including rehabilitation and wildlife Corridors.
5A
1B1
4A
7B
1AH
2A
PLANIT
CONSULTING
PROJECT TITLE
VALLANCES ROAD, MULLUMBIMBY
DRAWING TITLE
LAND CATEGORIES
BASE ISSUED BY
GOV MAPS
SCALE
NTS
DESIGN
ZP
DRAWN
ZACP
DATE
26/07/2017
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N

3.4. Guidelines for Categorisation

The Local Government Regulations (General) provides guidelines for each of the above categories. Under the Local Government Regulations 2005, these categories are defined as follows:

3.4.1 Natural Area

Natural Area: *Land should be categorised as a natural area under section 36 (4) of the Act if the land, whether or not in an undisturbed state, possesses a significant geological feature, geomorphological feature, landform, representative system or other natural feature or attribute that would be sufficient to further categorise the land as bushland, wetland, escarpment, watercourse or foreshore under section 36 (5) of the Act.*

Note.
Section 36A of the Act provides that community land that has been declared a critical habitat under the Threatened Species Conservation Act 1995 or the Fisheries Management Act 1994 must be categorised as a natural area.

Section 36B of the Act provides that community land all or part of which is directly affected by a recovery plan or threat abatement plan under the Threatened Species Conservation Act 1995 or the Fisheries Management Act 1994 must be categorised as a natural area.

Section 36C of the Act provides that community land that is the site of a known natural, geological, geomorphological, scenic or other feature that is considered by the council to warrant protection or special management considerations, or that is the site of a wildlife corridor, must be categorised as a natural area.
(Underlined for emphasis)

Natural Area (Wetland): *Land that is categorised as a natural area should be further categorised as wetland under section 36 (5) of the Act if the land includes marshes, mangroves, backwaters, billabongs, swamps, sedgelands, wet meadows or wet heathlands that form a waterbody that is inundated cyclically, intermittently or permanently with fresh, brackish or salt water, whether slow moving or stationary.*

3.4.2 Park

Park: *Land should be categorised as a park under section 36 (4) of the Act if the land is, or is proposed to be, improved by landscaping, gardens or the provision of non-sporting equipment and facilities, for use mainly for passive or active recreational, social, educational and cultural pursuits that do not unduly intrude on the peaceful enjoyment of the land by others.*

3.4.3 General Community Use

General Community Use: *Land should be categorised as general community use under section 36 (4) of the Act if the land:*

(a) may be made available for use for any purpose for which community land may be used, whether by the public at large or by specific sections of the public, and

(b) is not required to be categorised as a natural area under section 36A, 36B or 36C of the Act and does not satisfy the guidelines under clauses 102–105 for categorisation as a natural area, a sportsground, a park or an area of cultural significance.(Underlined for emphasis).

3.5. Core Objectives for Community Land

The core objectives for community land categories outlined in the Local Government Act 1993 assist in determining the way that the land may be used and managed. While it is noted that the subject site contains both operational and community land, categories have been applied to the site as a whole, to allow for future reclassifications to Operational or Community as required.

The following objectives are applicable to the land categories:

Section 36K of the Act states that the core objectives for management of community land categorised as a natural area and further categorised as a **Wetland** are:

(a) to protect the biodiversity and ecological values of wetlands, with particular reference to their hydrological environment (including water quality and water flow), and to the flora, fauna and habitat values of the wetlands, and

(b) to restore and regenerate degraded wetlands, and

(c) to facilitate community education in relation to wetlands, and the community use of wetlands, without compromising the ecological values of wetlands.

Section 36G of the Act states that the core objectives for community land categorized as a **Park** are:

(a) to encourage, promote and facilitate recreational, cultural, social and educational pastimes and activities, and

(b) to provide for passive recreational activities or pastimes and for the casual playing of games, and

(c) to improve the land in such a way as to promote and facilitate its use to achieve the other core objectives for its management.

Section 36I of the Act states that the core objectives for management of community land categorised as a **General Community Use** are:

To promote, encourage and provide for the use of the land, and to provide facilities on the land, to meet the current and future needs of the local community and of the wider public:

(a) in relation to public recreation and the physical, cultural, social and intellectual welfare or development of individual members of the public, and

(b) in relation to purposes for which a lease, licence or other estate may be granted in respect of the land (other than the provision of public utilities and works associated with or ancillary to public utilities).

3.6. Granting a lease or licence on Community Land

A lease, licence or other estate may be granted, in accordance with an express authorisation by this plan of management, providing the lease, licence or other estate is for a purpose prescribed in Section 46 of the Local Government Act 1993. The purpose must be consistent with core objectives for the category of the community land.

The Local Government Act 1993 allows Council to grant leases or licences over all or part of community land. The use of land under a lease or licence must be compatible with the Local Environmental Plan or Council requirements and provide benefits and services or facilities for the users of the land. Terms and conditions of a lease should reflect the interests of Council and the public and ensure proper management and maintenance.

The following conditions must be met when granting a lease or licence over community land:

(a) The lease, licence or other estate must not be granted for a period (including any period for which the lease could be renewed by the exercise of an option) exceeding 21 years;

(b) A lease, licence or other estate may be granted only by tender in accordance with s.46A of the Local Government Act 1993 (as amended) and cannot exceed a term of 5 years (including any period for which the lease could be renewed by the exercise of an option), unless it satisfies the requirements as scheduled in s.47, or is otherwise granted to a non – profit organisation.

(c) The Plan of Management must expressly authorise a lease or licence.

Council must:

- Give public notice of the proposal;
- Exhibit notice of the proposal on the land to which the proposal relates;
- Give notice of the proposal to such persons who appear to own or occupy land adjoining community land; and
- Give notice of the proposal to any other person (owner or occupier of land in the vicinity of the community land), if in the opinion of the Council the subject to the proposal is likely to form the primary focus of the person's enjoyment of community land.

4. STRATEGIC FRAMEWORK

4.1. STRATEGIC OBJECTIVES

The objective of this Plan of Management is to provide for a range of community and sustainable land use initiatives that meet Council's sustainability strategies and environmental intents in the following general areas:

- Environmental Initiatives
- Community & Housing Initiatives
- Sewerage Treatment Plant Initiatives
- Biomass Initiatives
- Solar Initiatives

Byron Shire Council's applicable sustainability and environmental policies are summarized below.

4.2. Biodiversity Conservation Strategy

The Byron Biodiversity Conservation Strategy (BCS) is a long term, on-going project that is intended to provide a range of biodiversity conservation directions, on-ground actions and funding options that will work toward improving biodiversity management and practices across the Shire.

The Byron Biodiversity Conservation Strategy aims to:

- Protect, restore and maintain ecosystems and ecological processes through the delivery of on-ground works and planning controls;

The Vallances Road site can deliver on the aims and objectives of the Strategy through:

- Improvement of the condition of ecosystems and increase the extent of native vegetation cover through targeted ecological restoration works;
- Rehabilitate riparian zone along the Brunswick River;
- Establish environmental corridor through the site; and
- Community education and engagement opportunities.

Refer to the Key Project Areas in **Section 5** and **Appendix 1** for further details.

4.3. Sustainable Agriculture Strategy

- A range of agricultural opportunities are able to be conducted.
- The intensity, scale and mix of these land uses will be driven by the community and provides the opportunity to deliver a Food Empowerment Project (FEP).

- By integrating and valuing by-products from the STP such as heat and biosolids, a closed loop system can be developed.
- Through this closed loop system recovery, re-use or recycling, this project can reduce emissions, waste and raw materials requirements.

Refer to the Key Project Areas in **Section 5** and **Appendix 1** for further details.

4.4. Low Carbon Strategy 2014

- Minimum 30% reduction in greenhouse gas emissions below 2003/04 levels by 2020.
- As part of achieving this target Council is investigating all potentials to utilise sources of organic waste materials, termed "biomass", produced in the Shire. Biomass is organic matter, typically from commercial or farming activities, which could be put to its highest available reuse value as feedstock to a bioenergy plant.
- Municipal STPs produce biosolids as a waste, which is a source of biomass that can be anaerobically digested to produce biogas that, in turn, has high energy value.
- A review of the relevant scheme and legislative controls does enable the use of the site for a bioenergy facility

Refer to the Key Project Areas in **Section 5** and **Appendix 1** for further details.

4.5. Climate Change Strategic Planning Policy

The Climate Change Strategic Planning Policy provides climate change flood planning scenarios for the years 2050 and 2100. The 2050 flood planning scenario is to be used for any Council strategic, infrastructure and operational planning document or designs that may be affected by climate change. The 2050 flood planning scenario will apply to most development for land use planning

The Vallances Road site is affected by flooding and consistent with this policy land uses decisions are informed by flooding and ecosystem buffering. The Conceptual land use plan identifies an environmental zone which seeks to protected/restore the riparian zone of the Brunswick River.

This area also incorporates land which is flood affected. The passive land use area also contains land which is flood affected but removed from desired ecological corridor.

Changes to landform may extend the range of uses permitted.

Refer to the Key Project Areas in **Section 5** and **Appendix 1** for further details.

4.6. Community Gardens Policy

Council recognises community gardens as social assets that enhance local food security and provide opportunities for recreational, cultural, economic, health and educational pursuits.

The Vallances Road site is able to fulfil a number of the objectives of this policy through:

- Provision of new community gardens on Council owned and managed land.
- Promote knowledge and access in relation to nutritious, organic and locally produced foods to enhance regional food security within the context of climate change and peak oil
- Provide opportunities for outdoor learning that support Council's sustainability education
- Initiatives
- Position Byron Shire Council as a leader in advancing sustainability within the community
- Community gardens may be able to be established in the passive or active land use area of the site.

Refer to the Key Project Areas in **Section 5** and **Appendix 1** for further details.

4.7. Corporate Sustainability Policy

The policy objectives include:

- Continually improve the sustainability performance of Council.
- Support the efforts of the wider Byron Shire community in the transition to a low carbon community
- Acknowledge the inter-relationships between social, economic and environmental considerations in all decision-making.
- Support efforts to reduce Council's ecological footprint, including corporate energy consumption, potable water consumption, greenhouse emissions and waste generation across all programs, assets and services.

Vallances Road provides the opportunity to integrate a range of complementary and interrelated land uses and management actions that can achieve the sustainability objectives.

Refer to the Key Project Areas in **Section 5** and **Appendix 1** for further details.

5. FUTURE USE AND DEVELOPMENT OF THE LAND

In accordance with the Section 36 (3A)(b) of the Local Government Act 1993, a Plan of Management must expressly authorise any proposed or potential developments on community land. The following authorisation is provided in general terms only, and any specific works will require some level of further detail and investigation.

The following table details the developments that this Plan of Management expressly authorised for Vallances Road, Mullumbimby. The definitions of these uses are as per the Byron Local Environmental Plan 2014, except where otherwise noted.

Note:

LEGEND	
O	**Permitted Without Consent** [Assessment under Part 5 of the EP&A Act (Review of Environmental Factors) still required]
C	**Permitted With Consent** [Assessment under Part 4 of the EP&A Act (Development Consent) required]
X	**Prohibited**

1. ENVIRONMENTAL LAND USE PROJECT AREA

Action	Environmental Land Use & Wildlife Corridor
Land Classification	Natural Area (Wetland)
Area	49.8 ha total
Detailed Description	• **Revegetation / Rehabilitation:** Revegetation of wetland areas disturbed by historical grazing; removal of weed species; replanting of wildlife corridors with native species. This will include ongoing follow-up maintenance of already worked areas and expansion into new areas as time and resources permit. • **Bank Stabilisation:** Brunswick River bank stabilisation works to occur in specific locations, and sediment and erosion control measures implemented. Use of log treatment method, whereby large logs are driven vertically into the river bed at approximately 2-4 metre spacing at various angles to the river bank. By angling the poles, the waters energy is dissipated, slowing the flow thereby reducing the impact on the river bank. In addition, debris

	is slowed and settles behind the logs providing valuable real estate for trees and mangroves to gain a foothold and stabilise the river bank. • **Boardwalks & Walkways:** A series of connected walkways winding around the wetlands and raised boardwalks through the billabongs as not to impact on the billabong sensitive habitat, is envisaged for this site. These walkways and raised boardwalks would ultimately enhance the access and enjoyment for people with disabilities, older people, their families and carers.					
Zoning (LEP 2014)	• RU2 • DM - Deferred Matter* *Deferred Matter under LEP 2014 relates to land zoned 1(a) General Rural; 1(a)(h) General Rural (Hatched); 1(b)(1) Agricultural; and 7(b) Coastal Habitat under LEP 88.					
Authorised Scale of Development	Development and/or works permitted on the land include, but are not limited to: • **Environmental Facility (1)** • **Environmental Protection Works (2)** • **Information and Education Facility (3)** • **Recreation Area (4)** • **Flood Mitigation Works (5)**					
Existing Permissibility		**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
	RU2	**C**	**O**	**C**	**C**	**C**
	DM	**Subject to provisions of LEP 88**				
Possible exemptions under SEPP Infrastructure?	Possible SEPP exemptions for **Environmental Protection Works (2)** and **Flood Mitigation Works (5)**. Further planning investigations to be undertaken					

2. COMMUNITY & HOUSING PROJECT AREA

Action	**Affordable Housing, Community Gardens, and Education & Interpretive Centre**
Land Classification	Park

Area	20.0 ha total									
Detailed Description	• **Affordable / Community Housing:** It is intended to work towards innovative sustainable community housing provision, there may be the potential, subject to re-zoning, to create affordable housing on the land. • **Use of Existing Rail Corridor:** It is intended to utilise the existing rail corridor, bridge and Council road right-of-way to allow for pedestrian access to the site. The innovative use of these existing corridors will allow ease of access to the community land from Mullumbimby Town Centre. This will result in a low-footprint development, with an emphasis on foot traffic, bicycle, and/or e-vehicles. • **Education and Interpretation Centre:** There is the potential to create a leading-edge educational facility to highlights innovations found in the nexus between sewage treatment innovations, bioenergy and biomass management, native plant replanting, and many other aspects of sustainable land management. • **Community Gardens:** Provision of community gardens that serve the local community. The gardens could be used as educational and information centres promoting sustainable living initiatives, job-creation, and to increase the provision of fresh and affordable produce to the local community. This facility could host school groups, drop-ins from the general public, residential caretakers, and on-site experts-in-residence programmes.									
Zoning (LEP 2014)	• RU1 • RU2									
Authorised Scale of Development	Development and/or works permitted on the land include, but are not limited to: • **Community Facility (1)** • **Community Garden (2)** (defined under Community Gardens Policy) • **Restaurant or Café (3)** • **Environmental Facility (4)** • **Information and Education Facility (5)** • **Recreation Area (6)** • **Camping Ground (7)** • **Eco Tourist Facilities (8)** • **Tourist and Visitor Accommodation** (ONLY Bed & Breakfast and Farm Stay Accommodation) **(9)** • **Affordable / Community Housing (10)**									
		(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**

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Existing Permissibility	RU1	C	N/A	C	C	X	C	C	X	C	X
	RU2	C	N/A	C	C	C	C	C	C	C	X
Possible exemptions under SEPP Infrastructure?	No exemptions permissible.										

3. BVSTP PROJECTS AREA

Action	**Brunswick Valley Sewage Treatment Plant and associated by product technologies**
Land Classification	General Community Use
Area	14.1 ha total

Detailed Description	• **Upgrades to BVSTP:** Upgrades to the BVSTP to include capacity from the Ocean Shores STP.
	• **Effluent storage ponds & Wetlands Effluent polishing:** wetlands and an effluent storage pond will create a community resource that not only further "polishes" already high quality treated effluent but also achieves an innovative and integrated range of environmental and social objectives. These objectives included:
	  • Maximise the resource value of recycled water.
	  • Further polish and limit the nutrient input to the sensitive waters of the Brunswick River.
	  • Create a natural and effective assimilation pathway to return surplus flows to the water cycle.
	  • Restore an area of pre-disturbance vegetation and habitat.
	  • Integrate operational objectives with broad regional environmental objectives including the creation of an extended and extensive wildlife corridor.
	  • Preserve, protect and encourage threatened species and associated habitat areas.
	  • Buffer and protect billabong and wetland areas.
	  • Achieve sustainable constructed wetlands that are reliable and flexible.

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Incorporate innovative water management approaches and technology.
Deliver an asset that the Byron Shire community is proud of and recognised as a model for environmental protection and sustainable water management.

Recycled water: Innovative recycling of tertiary-treated STP effluent as irrigation water for use on coppice crops on the site, as well as for re-establishment and expansion of native plants. This recycled water also has nutrient value to the crops, providing nitrogen and phosphorous, which are required for plant growth.
Biomass Anaerobic Digestion: Advanced sustainable bioenergy technologies exist which can produce electricity, heating, cooling, biofuels, and other valuable by-products for reclamation and reuse. These technologies divert wastes from landfill, displace the use of fossil fuels. It is intended to use Biomass Anaerobic digestion for biogas generation.
Dewatered biomass: Biosolids represent a sustainable supply of high-value soil amendment and fertilizer for coppice crops and native plants. Utilising this STP by-product results in the diversion of what would otherwise be a waste stream, and savings of the disposals costs.

</td></tr>
<tr><td>Zoning (LEP 2014)</td><td colspan="7">RU1
RU2</td></tr>
<tr><td>Authorised Scale of Development</td><td colspan="7">Development and/or works permitted on the land include, but are not limited to:

Sewerage System (1)
Extensive Agriculture (2)
Rural Industry (3)
Environmental Protection Works (4)
Intensive Plant Agriculture (5)
Horticulture (6)
</td></tr>
<tr><td rowspan="3">Existing Permissibility</td><td></td><td>(1)</td><td>(2)</td><td>(3)</td><td>(4)</td><td>(5)</td><td>(6)</td></tr>
<tr><td>RU1</td><td>See below</td><td>O</td><td>C</td><td>O</td><td>C</td><td>C</td></tr>
<tr><td>RU2</td><td>See below</td><td>O</td><td>X</td><td>O</td><td>C</td><td>C</td></tr>
<tr><td>Possible exemptions under SEPP Infrastructure?</td><td colspan="7">SEPP exemptions for Sewerage System (1).</td></tr>
</table>

4. BIOMASS PROJECTS AREA

Action	Biomass Coppice Crops and associated bio-projects
Land Classification	General Community Use
Area	23.8 ha total
Detailed Description	• **Biomass Coppice Crops:** Planting of coppice crops for harvesting and use in generation of bioenergy and other sustainable uses/products to occur across the project area. This may include other valuable uses, such as the growth of oil crops like hemp. This will be the primary source of bioenergy across the site, and will utilize recycled water for irrigation. Byron Council is currently conducting a Bioenergy feasibility study that will determine what coppice crops and biomass will be most suitable for a bioenergy facility. Biosolids application for beneficial agricultural use will continue on site for the time being. • **Recycled Water:** Innovative recycling of tertiary-treated STP effluent as irrigation water for use on coppice crops on the site, as well as for re-establishment and expansion of native plants. This recycled water also has nutrient value to the crops, providing nitrogen and phosphorous, which are required for plant growth. • **Land Application of Biomass:** Biosolids represent a sustainable supply of high-value soil amendment and fertilizer for coppice crops and native plants.
Zoning (LEP 2014)	• RU1 • RU2
Authorised Scale of Development	Development and/or works permitted on the land include, but are not limited to: • **Agriculture (1)** • **Extensive Agriculture (2)** • **Intensive Plant Agriculture (3)** • **Horticulture (4)** • **Intensive Livestock Agriculture (5)** • **Farm Building (6)** • **Rural Industry(7)**

Existing Permissibility

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
RU1	X	O	C	C	C	C	C
RU2	C	O	C	C	C	C	X

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Possible exemptions under SEPP Infrastructure?	No exemptions permissible.

5. SOLAR PROJECTS AREA

Action	**Renewable Solar PV Energy farms**		
Land Classification	General Community Use		
Area	3.6 ha total		
Detailed Description	• **Solar photovoltaic arrays:** Solar photovoltaic arrays are intended to be installed in proximity to the STP and the electricity produced can be used in many fashions, including: to power the many electric motors in the STP treatment process; heating and cooling of STP or other nearby buildings; and drying biomass crops, if necessary. • **BVSTP Solar Farm:** 1.6 ha of land adjacent to the BVSTP to be used by Byron Shire Council for solar electricity generation and use in the operation of the BVSTP • **Community Solar Farm:** 2.0 ha of land adjacent to the BVSTP to be used by a community organisation for solar electricity generation. • **Electricity Generation:** Excess electricity to be net metered and sold to generate a sustainable source of revenue.		
Zoning (LEP 2014)	• RU1 • RU2		
Authorised Scale of Development	Development and/or works permitted on the land include, but are not limited to: • **Electricity Generating Works (1)** • **Solar Energy System (2)** • **Rural Industry (3)**		

Existing Permissibility		(1)	(2)	(3)
	RU1	**See below**	**See below**	**C**

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	RU2	**See Below**	**See Below**	**X**
Possible exemptions under SEPP Infrastructure?	SEPP exemptions for **Electricity Generating Works (1)** and **Solar Energy System (2)**, subject to conditions. Further planning investigations to be undertaken			

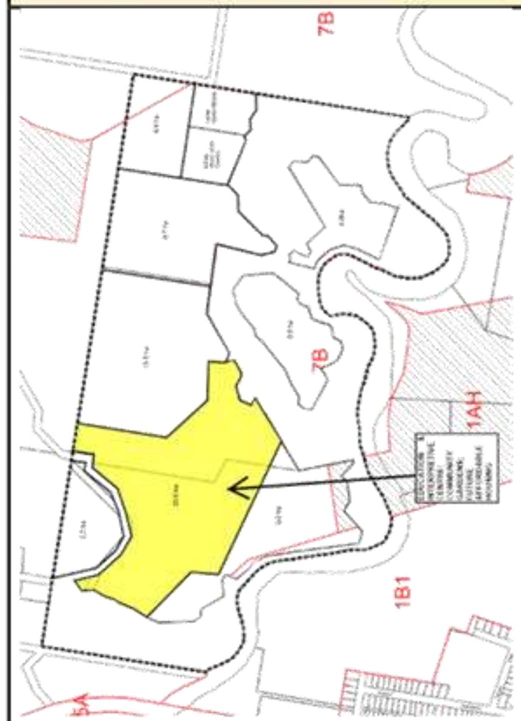
6. RECOMMENDATIONS

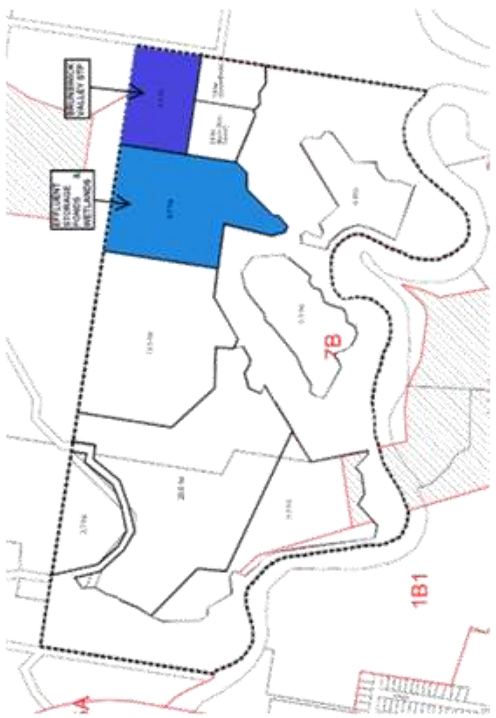
In the next phases of follow-on work regarding implementing the Actions from this Plan of Management, Council may wish to consider the following issues in greater detail:

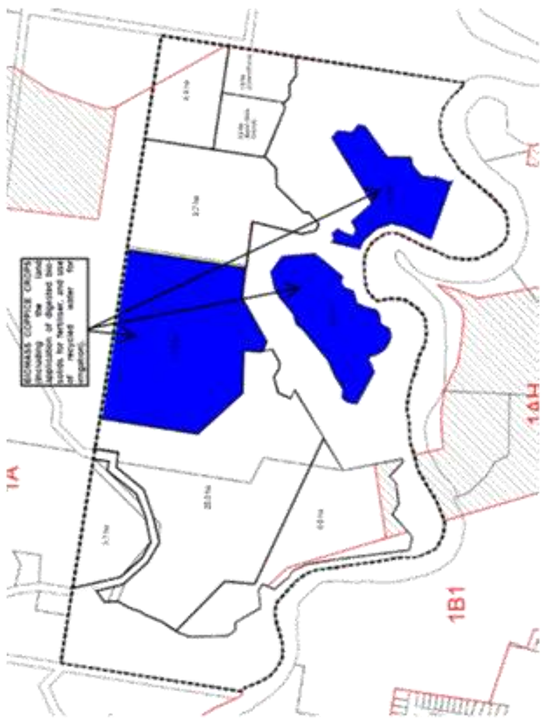
- Public review and consultation requirements of the Plan of Management process prior to finalising the document.
- Prioritisation of potential Actions in the final Plan of Management, and identification of specific works.
- Statutory instruments, reviews, and approvals that may be required for the Actions and resulting specific works.
- Detailed Ecological Assessment to confirm extent of threatened Species areas within the site.
- Rezoning and planning processes required to facilitate the affordable housing Project Area.
- Estimating costs, and funding sources and methods, for the Actions and specific works.
- Estimating timelines for implementation of the Plan of Management Actions and specific works.
- Detailed next steps for implementing the priority Actions and specific works from the Plan of Management.

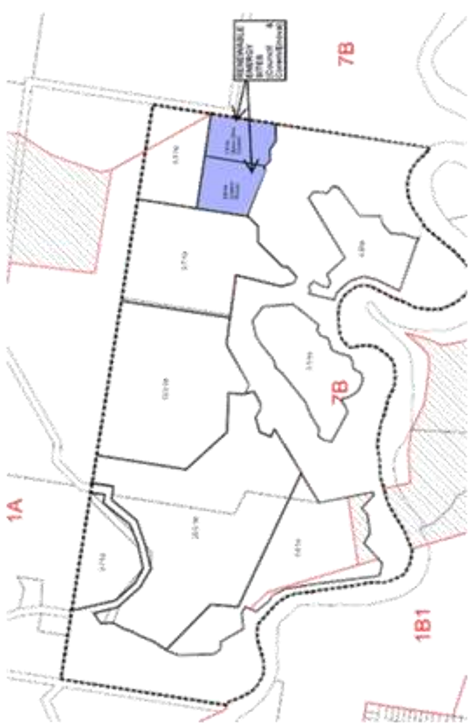
APPENDIX 1 SUMMARY AND STRATEGIC GUIDANCE

PROJECT AREA	PROJECT DESCRIPTION/ ACTIONS	POTENTIAL PARTNERS	POTENTIAL FUNDING SOURCES	TIMELINE	ESTIMATED COST
Environmental Land Project Area					
	• **Revegetation / Rehabilitation:** Revegetation of wetland areas disturbed by historical grazing; removal of weed species; replanting of wildlife corridors with native species. This will include ongoing follow-up maintenance of already worked areas and expansion into new areas as time and resources permit.	• Brunswick Valley Land Care • Mudgha Magolgen • Community NGOs • Other departments in Byron Shire Council (Biodiversity Regeneration crew)	• Sewer fund • Grant funding	• Can commence immediately	• TBA
	• **Bank Stabilisation:** Brunswick River bank stabilisation works to occur in specific locations, and sediment and erosion control measures implemented. Use of log treatment method, whereby large logs are driven vertically into the river bed at approximately 2-4 metre spacing at various angles to the river bank. By angling the poles, the waters energy is dissipated, slowing the flow thereby reducing the impact on the river bank. In addition, debris is slowed and settles behind the logs providing valuable real estate for trees and mangroves to gain a foothold and stabilise the river bank.	• Australian Wetlands • Other departments in Byron Shire Council • DPI Fisheries • Local fishing clubs	• Sewer fund • Grant funding	• Can commence immediately	• $300K
	• **Boardwalks & Walkways:** A series of connected walkways winding around the wetlands and raised boardwalks through the billabongs as not to impact on the billabong sensitive habitat, is envisaged for this site. These walkways and raised boardwalks would ultimately enhance the access and enjoyment for people with disabilities, older people, their families and carers.	• Brunswick Valley Land Care •	• Sewer fund • Grant funding	• Can commence immediately	• $200K
	• **Constructed Wetlands:** The construction of wetlands will create a community resource that not only further "polishes" already high quality treated effluent but also achieves an innovative and integrated range of environmental and social objectives, including restoration of areas of pre-disturbed vegetation; creation of an extended and extensive wildlife corridor; and preserve, protect and encourage threatened species and associated habitat areas.	•	• Sewer fund	• Can commence immediately	• $2,000K

PROJECT AREA	PROJECT DESCRIPTION/ ACTIONS	POTENTIAL PARTNERS	POTENTIAL FUNDING SOURCES	TIMELINE	ESTIMATED COST
Community & Housing Project Area					
	• **Affordable / Community Housing:** It is intended to work towards innovative sustainable community housing provision, there may be the potential, subject to re-zoning, to create affordable housing on the land. • **Use of Existing Rail Corridor:** It is intended to utilise the existing rail corridor, bridge and Council road right-of-way to allow for pedestrian access to the site. The innovative use of these existing corridors will allow ease of access to the community land from Mullumbimby Town Centre. This will result in a low development footprint, with an emphasis on foot traffic, bicycle, and/or e-vehicles. • **Education and Interpretation Centre:** There is the potential to create a leading-edge educational facility to highlights innovations found in the nexus between sewage treatment innovations, bioenergy and biomass management, native plant replanting, and many other aspects of sustainable land management. There is also the potential to add tourist / visitor accommodation to this centre. • **Community gardens:** Provision of community gardens that serve the local community. The gardens could be used as educational and information centres promoting sustainable living initiatives, job-creation, and to increase the provision of fresh and affordable produce to the local community. This facility could host school groups, drop-ins from the general public, residential caretakers, and on-site experts-in-residence programmes.	Affordable Housing • Third party developers • Community development and housing agencies • Community NGOs Education Centre • Primary and secondary schools • Tertiary education users • Community groups	Affordable Housing • Third party developers • Grant funding Education Centre • BSC Sewer funds • Grant funding	Community consultation to be undertaken first	• TBA • $1,000K

PROJECT AREA	PROJECT DESCRIPTION/ ACTIONS	POTENTIAL PARTNERS	POTENTIAL FUNDING SOURCES	TIMELINE	ESTIMATED COST
Brunswick Valley Sewage Treatment Plant Project Areas					
	• **Upgrades to BVSTP:** Upgrades to the BVSTP to include capacity for flows from the Ocean Shores STP. • **Effluent storage ponds & Wetlands Effluent polishing:** wetlands and an effluent storage pond will create a community resource that not only further "polishes" already high quality treated effluent but also achieves an innovative and integrated range of environmental and social objectives. These objectives included: • Buffering to maximise the resource value of recycled water. • Further polish and limit the nutrient input to the sensitive waters of the Brunswick River. • Create a natural and effective assimilation pathway to return surplus flows to the water cycle. • Integrate operational objectives with broad regional environmental objectives including the creation of an extended and extensive wildlife corridor. • Preserve, protect and encourage threatened species and associated habitat areas. • Restore areas of pre-disturbance vegetation and habitat; protect billabong and wetland areas. • Achieve sustainable constructed wetlands that are reliable and flexible. • Incorporate innovative water management approaches and technology. • Deliver an asset that the Byron Shire community is proud of and recognised as a model for environmental protection and sustainable water management. • **Recycled water:** Innovative recycling of tertiary-treated STP effluent as irrigation water for use on biomass coppice crops on the site, as well as for re-establishment and expansion of native plants. This recycled water also has nutrient value to the crops, providing nitrogen and phosphorous, which are required for plant growth. • **Biomass Anaerobic Digestion:** Advanced sustainable bioenergy technologies exist which can produce electricity, heating, cooling, biofuels, and other valuable by-products for reclamation and reuse. These technologies divert wastes from landfill, displace the use of fossil fuels. It is intended to use Biomass Anaerobic Digestion for biogas generation. • **Dewatering Bomass:** Biosolids represent a sustainable supply of high-value soil amendment and fertilizer for	• Other Council department • Wildlife groups • Farmers for agistment and irrigation • Technology companies for R&D purposes	• BSC Sewer Fund • Grant funding	• 2020 subject to Council Approval • Can commence immediately	• $10,000K • $3,000K

PROJECT AREA	PROJECT DESCRIPTION/ ACTIONS	POTENTIAL PARTNERS	POTENTIAL FUNDING SOURCES	TIMELINE	ESTIMATED COST
	coppice crops and native plants. Utilising this STP by-product results in the diversion of what would otherwise be a waste stream, and savings of the disposals costs.				
Biomass Project Areas					
	• **Biomass Coppice Crops:** Planting of coppice crops for harvesting and use in generation of bioenergy and other sustainable uses/products to occur across the project area. This will be the primary source of bioenergy across the site, and will utilize recycled water for irrigation. Byron Council is currently conducting a Bioenergy feasibility study that will determine what coppice crops and biomass will be most suitable for a bioenergy facility. Biosolids application for beneficial agricultural use will continue on site for the time being. • **Recycled Water:** Innovative recycling of tertiary-treated STP effluent as irrigation water for use on coppice crops on the site, as well as for re-establishment and expansion of native plants. This recycled water also has nutrient value to the crops, providing nitrogen and phosphorous, which are required for plant growth. • **Application of Dewatered Biomass:** Dewatered biosolids represent a sustainable supply of soil amendments and fertilizer for coppice crops and native plants. Utilising this STP by-product results in the diversion of what would otherwise be a waste stream, and savings of the disposals costs.	• Universities • Private third parties for R&D	• BSC Sewer Fund • grant funding • Third party R&D programmes	Dependent on Biomass pre feasibility project – possible start 2020	• $3,000K

PROJECT AREA	PROJECT DESCRIPTION/ ACTIONS	POTENTIAL PARTNERS	POTENTIAL FUNDING SOURCES	TIMELINE	ESTIMATED COST
Solar Farm Project Areas					
	• **Solar PhotovoltaicAarrays:** Solar photovoltaic arrays are intended to be installed in proximity to the STP and the electricity produced can be used in many fashions, including: to power the many electric motors in the STP treatment process; heating and cooling of STP or other nearby buildings; and drying biomass crops, if necessary. • **BVSTP Solar Farm:** 1.6 ha of land adjacent to the BVSTP to be used by Byron Shire Council for solar electricity generation and use in the operation of the BVSTP • **Community Solar Farm:** 2.0 ha of land adjacent to the BVSTP to be used by a community organisation for solar electricity generation. • **Electricity Generation:** Excess electricity to be net metered and sold to generate a sustainable source of revenue.	• Council • Other departments in Byron Shire Council •	Council • BSC Sewer Fund • Other departments in Byron Shire Council • Community • Byron Shire Council (in-kind funding)	Immediately Immediately	$200 K In kind funds (land rental income)

Report No. 4.4	**Update on the review of Council's Integrated Waste Management and Resource Recovery Strategy**
Directorate:	Infrastructure Services
Report Author:	Lloyd Isaacson, Team Leader Resource Recovery and Quarry
File No:	I2017/1262
Theme:	Community Infrastructure Waste and Recycling Services

Summary:
The attached presentation provides an update on the status of the review of Council's Integrated Waste Management and Resource Recovery Strategy.

RECOMMENDATION:

That the report on the update of the review of Council's Integrated Waste Management and Resource Recovery Strategy be noted.

Attachments:

1 Presentation to September 2017 WWSAC - Update on the review of Council's Integrated Waste Management & Resource Recovery Strategy, E2017/88593 , page 100⇩

Report

The attached presentation provides an update on the status of the review of Council's Integrated Waste Management and Resource Recovery Strategy

Financial Implications

Nil

Statutory and Policy Compliance Implications

Nil

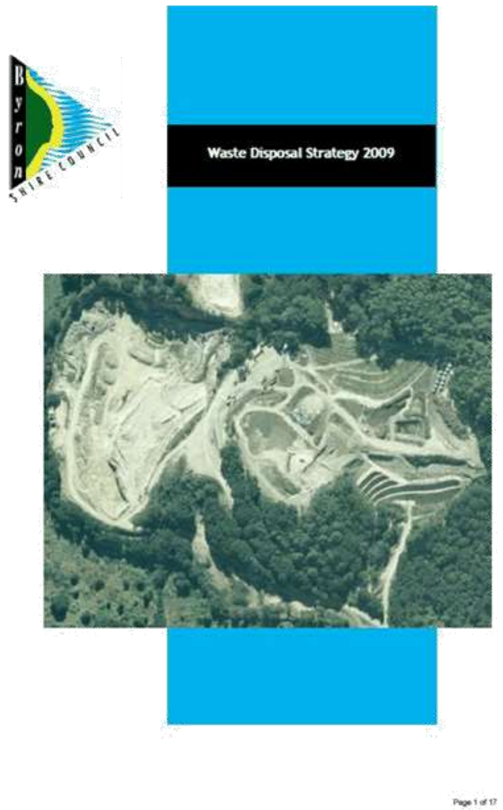

Update on the review of Council's
Integrated Waste Management &
Resource Recovery Strategy
Lloyd Isaacson, Team Leader
Resource Recovery and Quarry
Traditional home of
the Bundjalung people
Byron Shire Council

Introduction

- Overview of Current Operations/Strategy
- Current Status of the Integrated Waste Management and Resource Recovery Strategy review

Byron Shire Council www.byron.nsw.gov.au

Where we are now….



- WDS 2009 presents 4 waste disposal options
  - Option 1 – Myocum Landfill – Stage 2 Southern Expansion
  - Option 2 – Myocum Landfill – Quarry Landfill Development
  - Option 3 – Regional Landfill
  - **Option 4 – Utilise South East Queensland Landfills**

Byron Shire Council www.byron.nsw.gov.au

Option 4 –SE Qld Landfills

- Triple Bottom Line Benefits
  - Environmental
    - Lower GHG Emissions
    - Improved Management of BRRC and Myocum Landfill
  - Financial
    - Operational savings enable funding of resource recovery infrastructure and programs
  - Social
    - Elimination of environmental complaints.
    - Satisfaction and approval from neighbours for a recycling facility as opposed to a landfill facility

Byron Shire Council www.byron.nsw.gov.au

Current Status of the IWMRR Strategy

- Strategy Objective
  - ***To provide a clearly defined path towards maximizing resource recovery and maintenance of a landfill free Shire***
- 4 Stage Process
  - **Stage 1 – Project inception and site visits**
    - **Complete**
  - **Stage 2 – Business as usual analysis**
    - **Complete**
  - Stage 3 – Alternative Waste Treatment options analysis
    - Currently being developed – dependence on regional collaboration for viable AWT options due to scale and throughput requirements
    - Regional data request completed 4 September
  - Stage 4 – Strategy Development

Byron Shire Council www.byron.nsw.gov.au

Report No. 4.5	**Response to Alan Dickens Questions**
Directorate:	Infrastructure Services
Report Author:	Peter Rees, Manager Utilities
File No:	I2017/1268
Theme:	Community Infrastructure Sewerage Services

Summary:

Mr Alan Dickens as a member of the Water Sewer and Waste Advisory Committee asked for questions to be tabled at the next committee meeting.

RECOMMENDATION:

That the Committee note the report.

Attachments:

1 Ocean Shores STS EPA Licence 784 Non compliance events 1999 to 2017, E2017/86814 , page 107⇩

Report

On July 27 2017, Mr Alan Dickens as a member of the Water Sewer and Waste Advisory Committee asked for questions to be tabled at the next committee meeting. Please find below the questions and responses for each.

How many EPA license breeches including dates and types of breeches plus location have occurred at Ocean Shores Treatment Plant?

Please refer to the attached file for the requested information.

The upgrading of Ocean Shores sewer pump stations 5004 and 5009, how will this effect the hydraulic load on Ocean Shores STP?

The upgrades have no effect on the hydraulic loading of the Ocean Shores STP – 5009 is being retrofitted with a pump to take care of lower flows, 5004 renewal is for the civil structures [existing pumps being utilised].

Why when asked by a member of Brunswick Progress Association in 2016 did the utility manager supply that the Design size for Ocean Shores STP was 1.9 ML/day when he had a report from GH&D presented in 2005 stating Ocean Shores could only treat 1.1 ML/day?

The Manager Utilities did not have access to the 2005 report at the time of preparing the response.

The Manager Utilities role was created in 2014/15 and was an amalgamation of Strategic Planning and Operations of Water and Sewerage under the one role.

Financial Implications

Nil

Statutory and Policy Compliance Implications

Nil

Ocean Shores STS

Non-compliance events

- **22 September 1999**
  - Licence exceedence, Faecal Coliforms monitored at 490 (90%ile is 200cfu/100mL)
  - Reason for non-compliance, recontamination within the constructed wetland
  - Action taken to commit to an investigation of options.
  - Action to be taken to prevent recurrence is ongoing investigation into the causes of Coliforms regrowth in the wetland system (EPA PRP1 & PRP2).

- **20 October 1999**
  - Licence exceedence, Faecal Coliforms monitored at 300 (90%ile is 200cfu/100mL)
  - Reason for non-compliance, recontamination within the constructed wetland
  - Action taken to commit to an investigation of options.
  - Action to be taken to prevent recurrence is ongoing investigation into the causes of Coliforms regrowth in the wetland system (EPA PRP1 & PRP2).

- **21 November 1999**
  - Monitoring requirement, no reading recorded for flows.
  - Reason for non-compliance, inflow meter malfunction on rising main.
  - Action taken to restore function of meter
  - Action to be taken to prevent recurrence is ongoing monitoring of meter and its operation.

- **22 November 1999**
  - Monitoring requirement, no reading recorded for flows.
  - Reason for non-compliance, inflow meter malfunction on rising main.
  - Action taken to restore function of meter
  - Action to be taken to prevent recurrence is ongoing monitoring of meter and its operation.

- **23 November 1999 to 27 April 2000**
  - Monitoring requirement, no reading recorded for flows.
  - Reason for non-compliance, inflow meter taken out of service.
  - Action taken to repair meter, parts ordered (still waiting).
  - Action to be taken to prevent recurrence is ongoing monitoring of meter and its operation.

- **1 December 1999**
  - Licence exceedence, Faecal Coliforms monitored at 320 (90%ile is 200cfu/100mL)
  - Reason for non-compliance, recontamination within the constructed wetland
  - Action taken to commit to an investigation of options.
  - Action to be taken to prevent recurrence is ongoing investigation into the causes of Coliforms regrowth in the wetland system (EPA PRP2).

- **12 January 2000**
  - Licence exceedence, Faecal Coliforms monitored at 1,620 (90%ile is 200cfu/100mL)
  - Reason for non-compliance, recontamination within the constructed wetland
  - Action taken to commit to an investigation of options.
  - Action to be taken to prevent recurrence is ongoing investigation into the causes of Coliforms regrowth in the wetland system (EPA PRP2).

- **9 February 2000**
  - Licence exceedence, Faecal Coliforms monitored at 303 (90%ile is 200cfu/100mL)
  - Reason for non-compliance, recontamination within the constructed wetland
  - Action taken to commit to an investigation of options.
  - Action to be taken to prevent recurrence is ongoing investigation into the causes of Coliforms regrowth in the wetland system (EPA PRP2).

- **23 February 2000**
  - Licence exceedence, Faecal Coliforms monitored at 1,490 (90%ile is 200cfu/100mL)
  - Reason for non-compliance, recontamination within the constructed wetland. Faecal Coliform counts before entry to the wetland system but after UV disinfection (Results indicated a count of 0 cfu/100mL, well within limits).
  - Action taken to commit to an investigation of options.
  - Action to be taken to prevent recurrence is ongoing investigation into the causes of Coliforms regrowth in the wetland system (EPA PRP2).

- **8 March 2000**
  - Licence exceedence, Faecal Coliforms monitored at 204 (90%ile is 200cfu/100mL)

- Reason for non-compliance, recontamination within the constructed wetland
- Action taken to commit to an investigation of options.
- Action to be taken to prevent recurrence is ongoing investigation into the causes of Coliforms regrowth in the wetland system (EPA PRP2).

- **22 March 2000**
  - Licence exceedence, Faecal Coliforms monitored at 1,360 (90%ile is 200cfu/100mL)
  - Reason for non-compliance, recontamination within the constructed wetland
  - Action taken to commit to an investigation of options.
  - Action to be taken to prevent recurrence is ongoing investigation into the causes of Coliforms regrowth in the wetland system and remedial works (EPA PRP2).

- **5 April 2000**
  - Licence exceedence, Faecal Coliforms monitored at 967 (90%ile is 200cfu/100mL)
  - Reason for non-compliance, recontamination within the constructed wetland
  - Action taken to commit to an investigation of options.
  - Action to be taken to prevent recurrence is ongoing investigation into the causes of Coliforms regrowth in the wetland system and remedial works (EPA PRP2).

- **19 April 2000**
  - Licence exceedence, Faecal Coliforms monitored at >1,000 (90%ile is 200cfu/100mL)
  - Reason for non-compliance, recontamination within the constructed wetland
  - Action taken to commit to an investigation of options.
  - Action to be taken to prevent recurrence is ongoing investigation into the causes of Coliforms regrowth in the wetland system and remedial works (EPA PRP2).

- **13 June 2001**
  Licence exceedence: Faecal Coliform monitored at 860cfu/100mL (100%ile limit is 600cfu/100mL)
  Reason for non-compliance: Regrowth of Faecal Coliforms in the wetland system.
  Action taken: Installation of new transfer pipeline and wet weather bypass to protect the wetland.

- **27 June 2001**

Licence exceedence: Faecal Coliform monitored at 311cfu/100mL (90%ile limit is 200cfu/100mL)
Reason for non-compliance: Regrowth of Faecal Coliforms in the wetland system.
Action taken: Installation of new transfer pipeline and wet weather bypass to protect the wetland.

- **11 July 2001**
  Licence exceedence: Faecal Coliform monitored at 244cfu/100mL (90%ile limit is 200cfu/100mL)
  Reason for non-compliance: Regrowth of Faecal Coliforms in the wetland system.
  Action taken: Installation of new transfer pipeline and wet weather bypass to protect the wetland.

- **25 July 2001**
  Licence exceedence: Faecal Coliform monitored at 430cfu/100mL (90%ile limit is 200cfu/100mL)
  Reason for non-compliance: Regrowth of Faecal Coliforms in the wetland system.
  Action taken: Installation of new transfer pipeline and wet weather bypass to protect the wetland.

- **22 August 2001**
  Licence exceedence: Faecal Coliform monitored at 680cfu/100mL (90%ile limit is 600cfu/100mL)
  Reason for non-compliance: Regrowth of Faecal Coliforms in the wetland system.
  Action taken: Installation of new transfer pipeline and wet weather bypass to protect the wetland.

- **05 September 2001**
  Licence exceedence: Faecal Coliform monitored at 360cfu/100mL (90%ile limit is 200cfu/100mL)
  Reason for non-compliance: Regrowth of Faecal Coliforms in the wetland system.
  Action taken: Installation of new transfer pipeline and wet weather bypass to protect the wetland.

- **11 September 2001**
  Licence exceedence: Daily monitoring of volume not done.
  Reason for non-compliance: Faulty flow meter on rising main No.2.
  Action taken: Fault rectified.

- **19 September 2001**
  Licence exceedence: Faecal Coliform monitored at 430cfu/100mL (90%ile limit is 200cfu/100mL)

Reason for non-compliance: Regrowth of Faecal Coliforms in the wetland system.
Action taken: Installation of new transfer pipeline and wet weather bypass to protect the wetland.

- **03 October 2001**
  Licence exceedence: Faecal Coliform monitored at 510cfu/100mL (90%ile limit is 200cfu/100mL)
  Reason for non-compliance: Regrowth of Faecal Coliforms in the wetland system.
  Action taken: Requested that wetland be taken off-line and EPA sampling site be relocated.

- **17 October 2001**
  Licence exceedence: Faecal Coliform monitored at 400cfu/100mL (90%ile limit is 200cfu/100mL)
  Reason for non-compliance: Contaminated sampling bottle. Residual algae may have been present after cleaning of UV system causing interference with the disinfection process.
  Action taken: Monitoring of Faecal Coliforms to be done on a weekly basis and visual check for algae in the UV system.

- **19 December 2001**
  Licence exceedence: Faecal Coliform monitored at 440cfu/100mL (90%ile limit is 200cfu/100mL)
  Reason for non-compliance: Regrowth of Faecal Coliforms sampling pit due to outflow arrangement.
  Action taken: Pit altered.

- **31 December 2001 – 03 January 2002**
  Licence exceedence: Daily monitoring of volume not done.
  Reason for non-compliance: Faulty flow meter on rising main No.1.
  Action taken: Fault rectified.

- **30 January 2002**
  Licence exceedence: Faecal Coliform monitored at 210cfu/100mL (90%ile limit is 200cfu/100mL)
  Reason for non-compliance: Failure of UV lamps to ignite due to work in progress. Residual algae may have been present after cleaning of UV system causing interference with the disinfection process
  Action taken: UV system restored to normal operation.

- **30 March 2002 – 08 April 2002**
  Licence exceedence: Daily monitoring of volume not done.
  Reason for non-compliance: Faulty flow meter on rising main No.1.
  Action taken: Fault rectified.

- **08 May 2002**
  Licence exceedence: pH result of 6.4 (100%ile limit is 6.5-8.5)
  Reason for non-compliance: Process control equipment error.
  Action taken: Soda Ash dosing to correct pH, equipment calibration program instigated.

- **17 July 2002**
  Licence exceedence: pH result of 6.3 (100%ile limit is 6.5-8.5)
  Reason for non-compliance: Operator error.
  Action taken: Soda Ash dosing to correct pH.

- **15 September 2002**
  Licence exceedence: Daily monitoring of volume not done.
  Reason for non-compliance: Faulty flow meter on rising main No.2.
  Action taken: Fault rectified.

- **04 December 2002 – 19 January 2003**
  Licence exceedence: Daily monitoring of volume not done.
  Reason for non-compliance: Faulty flow meter on rising mains.
  Action taken: Fault rectified.

- **12 February 2003**
  Licence exceedence: pH result of 6.3 (100%ile limit is 6.5-8.5)
  Reason for non-compliance: Wetland back on-line, algae growth in wetland.
  Action taken: Soda Ash dosing to correct pH.

- **24 February 2003**
  Licence exceedence: Sewage overflow from Pump Station 5002, 5003, 5004, 5012.
  Reason for non-compliance: Extremely high rainfall and infiltration causing system to be flooded: Overflow observed to be very dilute.
  Action taken: Containment of surcharges.

- **02 July 2003**
  a) Location: Sewerage Manhole associated with rising main from SPS5003 Corner of Warrambool Road and Rajah Road, Ocean Shores.
  b) Date, estimated start time and duration: 02 July 2003 for 10minutes.
  c) Estimated volume: 1000L
  d) Description of receiving environment: Nature Strip and storm water system.
  e) Dry or wet weather overflow: Wet weather overflow.

f) Probable cause of overflow: Power outages in area caused sewage to be stored in gravity system. When power was restored the rising main could not discharge to the next point and consequently overflowed at the manhole (Designed system has rising main pump to the manhole and then allows flow to gravitate down to the next pump station SPS5004).
g) Actions taken to stop the overflow happening: No action taken.
h) Actions taken to clean up the overflow: Clean area with fresh water.
i) Actions taken to prevent the overflow happening again: No action taken. Have since removed sewerage manhole, as it was a potential overflow point. Replaced manhole with an air valve and converted entire pipeline to a true rising main.

- **03 July 2003**
  a) Location: Sewerage Manhole 34/3 near 39 Elizabeth Avenue, South Golden Beach.
  b) Date, estimated start time and duration: 03 July 2003.
  c) Estimated volume: 100L
  d) Description of receiving environment: Back yard of property.
  e) Dry or wet weather overflow: Wet weather overflow.
  f) Probable cause of overflow: Blockage caused a back-up in gravity sewer system.
  g) Actions taken to stop the overflow happening: Cleared blockage in sewer main.
  h) Actions taken to clean up the overflow: Hosed down effected grassed area with fresh water.
  i) Actions taken to prevent the overflow happening again: Scheduled sewer mains maintenance program.

- **25 July 2003**
  a) Location: Sewerage Manhole associated with rising main from SPS5003 Corner of Warrambool Road and Rajah Road, Ocean Shores.
  b) Date, estimated start time and duration: 25 July 2003 for 10minutes.
  c) Estimated volume: 500L
  d) Description of receiving environment: Nature Strip and storm water system.
  e) Dry or wet weather overflow: Dry weather overflow.
  f) Probable cause of overflow: Air lock in rising main causing restriction in flow. Designed system has rising main pump to the manhole and then allows flow to gravitate down to the next pump station SPS5004.
  g) Actions taken to stop the overflow happening: Turn pump station SPS5003 off.

h) Actions taken to clean up the overflow: Clean area with fresh water.
i) Actions taken to prevent the overflow happening again: Eliminated air lock by removing cap in gravity section of main, which was trapping air. Have since removed sewerage manhole, as it was a potential overflow point. Replaced manhole with an air valve and converted entire pipeline to a true rising main.

- **04 September 2003**
  a) Location: Broken sewerage rising main from SPS5001 on Rajah Rd, immediately north of the Ocean Shores shopping centre, Ocean Shores.
  b) Date, estimated start time and duration: 04 September 2003 other information unavailable.
  c) Estimated volume: 1000L
  d) Description of receiving environment: Nature Strip/Footpath and storm water system.
  e) Dry or wet weather overflow: Dry weather overflow.
  f) Probable cause of overflow: Rising main rupture by heavy vehicle parking over alignment of pipeline.
  g) Actions taken to stop the overflow happening: Turn pump station SPS5001 off.
  h) Actions taken to clean up the overflow: Disinfected and cleaned area with fresh water.
  i) Actions taken to prevent the overflow happening again: Repaired rising main.

- **23 September 2003**
  a) Location: Sewerage Manhole associated with rising main from SPS5003 Corner of Warrambool Road and Rajah Road and SPS5004 Rajah Road, Ocean Shores.
  b) Date, estimated start time and duration: 23 September 2003 at 10am for 2 hours
  c) Estimated volume: 100L
  d) Description of receiving environment: Nature Strip/Footpath and drainage easement.
  e) Dry or wet weather overflow: Dry weather overflow.
  f) Probable cause of overflow: Pump failure of SPS5004.
  g) Actions taken to stop the overflow happening: Immediate shut down of pumps station SPS5001, SPS5002 and SPS5003. Repair SPS5004.
  h) Actions taken to clean up the overflow: Disinfected and cleaned area with fresh water and pressure cleaner.
  i) Actions taken to prevent the overflow happening again: Upgrade of telemetry communication system done to increase

reliability of alarm signalling and install red strobe lights on pump station cabinets to alert if telemetry system does fail.

- **29 October 2003**
  a) Location: Sewerage Manhole associated with rising main from SPS5003 Corner of Warrambool Road and Rajah Road and SPS5004 Rajah Road, Ocean Shores.
  b) Date, estimated start time and duration: 26 October 2003 for 3 days.
  c) Estimated volume: 15kL
  d) Description of receiving environment: Roadside drainage and Brunswick River.
  e) Dry or wet weather overflow: Dry and wet weather overflow.
  f) Probable cause of overflow: Pump failure of SPS5005.
  g) Actions taken to stop the overflow happening: Immediately repaired and started SPS5005. As soon as the overflow was discovered Council's Health & Compliance Officer, Jon Rushforth, was notified and attended the site of the overflow. The local Oyster Growers Association was also contacted by telephone.
  h) Actions taken to clean up the overflow: Washed down area with fresh water.
  i) Actions taken to prevent the overflow happening again: Upgrade of telemetry communication system done to increase reliability of alarm signalling and install red strobe lights on pump station cabinets to alert if telemetry system does fail.

- **02 December 2003**
  a) Location: Boundary Riser at 16 Rajah Road, Ocean Shores.
  b) Date, estimated start time and duration: 02 December 2003.
  c) Estimated volume: 100L
  d) Description of receiving environment: Rear of property.
  e) Dry or wet weather overflow: Dry weather overflow.
  f) Probable cause of overflow: Broken boundary riser not allowing flow to get through.
  g) Actions taken to stop the overflow happening: Advised owner not to use toilet/shower while repair is underway. Repaired boundary riser.
  h) Actions taken to clean up the overflow: Hosed down area with fresh water.
  i) Actions taken to prevent the overflow happening again: No actions taken.

- **03 December 2003**
  a) Location: Sewerage Manhole 6A/3 46 Narooma Drive, Ocean Shores.

b) Date, estimated start time and duration: 03 December 2003 at 8am for 2.5 hours.
c) Estimated volume: 100L
d) Description of receiving environment: Back yard of property.
e) Dry or wet weather overflow: Dry weather overflow.
f) Probable cause of overflow: Blockage caused a back-up in gravity sewer system.
g) Actions taken to stop the overflow happening: Cleared blockage in sewer main.
h) Actions taken to clean up the overflow: Hosed down effected grassed area with fresh water.
i) Actions taken to prevent the overflow happening again: Scheduled sewer mains maintenance program.

- **04 December 2003**
  a) Location: Boundary Riser at 16 Rajah Road, Ocean Shores.
  b) Date, estimated start time and duration: 02 December 2003.
  c) Estimated volume: 100L
  d) Description of receiving environment: Rear of property.
  e) Dry or wet weather overflow: Dry weather overflow.
  f) Probable cause of overflow: Broken boundary riser not allowing flow to get through.
  g) Actions taken to stop the overflow happening: Advised owner not to use toilet/shower while repair is underway. Repaired boundary riser.
  h) Actions taken to clean up the overflow: Hosed down area with fresh water.
  i) Actions taken to prevent the overflow happening again: No actions taken.

- **18 December 2003**
  a) Location: Sewerage Manhole 6H/7 9 Yengarie Way, Ocean Shores.
  b) Date, estimated start time and duration: 18 December 2003 at 1.46pm.
  c) Estimated volume: 100L
  d) Description of receiving environment: Back yard of property.
  e) Dry or wet weather overflow: Dry weather overflow.
  f) Probable cause of overflow: Blockage caused a back-up in gravity sewer system.
  g) Actions taken to stop the overflow happening: Cleared blockage (root ball) in sewer main.
  h) Actions taken to clean up the overflow: Hosed down effected grassed area with fresh water.
  i) Actions taken to prevent the overflow happening again: Scheduled sewer mains maintenance program.

- **24 December 2003**
  a) Location: Sewerage Manhole 7D/1 at the corner of Balemo Drive and Aloota Crescent, Ocean Shores.
  b) Date, estimated start time and duration: 24 December 2003.
  c) Estimated volume: 100L
  d) Description of receiving environment: Front yard of property.
  e) Dry or wet weather overflow: Dry weather overflow.
  f) Probable cause of overflow: Blockage caused a back-up in gravity sewer system.
  g) Actions taken to stop the overflow happening: Removed blockage (root ball) from manhole.
  h) Actions taken to clean up the overflow: Hosed down effected grassed area with fresh water.
  i) Actions taken to prevent the overflow happening again: Scheduled sewer mains maintenance program.

- **23 January 2004**
  a) Location: Sewage Pump Station SPS5012 Terrara Court, Ocean Shores.
  b) Date, estimated start time and duration: 23 January 2004, started at 11pm for 1 hour.
  c) Estimated volume: 1kL
  d) Description of receiving environment: Creek surrounding Golf Club.
  e) Dry or wet weather overflow: Wet weather overflow.
  f) Probable cause of overflow: Electrical failure of SPS5012 due to electrical storm, power outage.
  g) Actions taken to stop the overflow happening: Electrician and maintenance staff called in to repair and restore service to normal.
  h) Actions taken to clean up the overflow: All debris was collected and removed also hosed off area with fresh water.
  i) Actions taken to prevent the overflow happening again: Upgrade of telemetry communication system done to increase reliability of alarm signalling and install red strobe lights on pump station cabinets to alert if telemetry system does fail.

- **24 January 2004**
  a) Location: Sewage Pump Station SPS5003 Boondoon Crescent, Ocean Shores.
  b) Date, estimated start time and duration: 24 January 2004, started at 2am for 7 hours.
  c) Estimated volume: 2kL
  d) Description of receiving environment: Stormwater drain and surrounding grassed area.
  e) Dry or wet weather overflow: Wet weather overflow.

f) Probable cause of overflow: Electrical failure of SPS5003 due to electrical storm, power outage.
g) Actions taken to stop the overflow happening: Electrician and maintenance staff called in to repair and restore service to normal.
h) Actions taken to clean up the overflow: All debris was collected and removed also hosed off area with fresh water.
i) Actions taken to prevent the overflow happening again: Upgrade of telemetry communication system done to increase reliability of alarm signalling and install red strobe lights on pump station cabinets to alert if telemetry system does fail.

- **24 February 2004**
  a) Location: Sewage Pump Station SPS5003 Boondoon Crescent, Ocean Shores.
  b) Date, estimated start time and duration: 24 February 2004, started at 8pm for 45 minutes.
  c) Estimated volume: 2kL
  d) Description of receiving environment: Stormwater drain and surrounding grassed area.
  e) Dry or wet weather overflow: Wet weather overflow.
  f) Probable cause of overflow: Pump controller failure of SPS5003, both circuit breakers were open.
  g) Actions taken to stop the overflow happening: Reset circuit breakers and pump controllers and pumps were able to resume pumping.
  h) Actions taken to clean up the overflow: Hosed off area with fresh water.
  i) Actions taken to prevent the overflow happening again: Upgrade of electrical system with soft starters.

- **03 March 2004**
  a) Location: Sewerage Manhole 4P/8 11 Naomi Glen, Ocean Shores.
  b) Date, estimated start time and duration: 03 March 2004 at 9.30am for 2 hours.
  c) Estimated volume: 200L
  d) Description of receiving environment: Bush land.
  e) Dry or wet weather overflow: Dry weather overflow.
  f) Probable cause of overflow: Blockage caused a back-up in gravity sewer system.
  g) Actions taken to stop the overflow happening: Cleared blockage (tree roots removed) in sewer main.
  h) Actions taken to clean up the overflow: Hosed down effected grassed area with fresh water.
  i) Actions taken to prevent the overflow happening again: Scheduled sewer mains maintenance program.

- **04 March 2004**
  a) Location: Sewerage Manhole 2B/11 3 Weeronga Way, Ocean Shores.
  b) Date, estimated start time and duration: 04 March 2004 at 1.30pm for 1 hours.
  c) Estimated volume: 100L
  d) Description of receiving environment: Bush land.
  e) Dry or wet weather overflow: Dry weather overflow.
  f) Probable cause of overflow: Blockage caused a back-up in gravity sewer system.
  g) Actions taken to stop the overflow happening: Cleared blockage (tree roots removed) in sewer main.
  h) Actions taken to clean up the overflow: Hosed down effected grassed area with fresh water.
  i) Actions taken to prevent the overflow happening again: Scheduled sewer mains maintenance program.

- **06 March 2004**
  a) Location: Wetland V-notch overflow at Ocean Shores STW.
  b) Date, estimated start time and duration: 06 March 2004 for 1 day.
  c) Estimated volume: 1000kL
  d) Description of receiving environment: Brunswick River.
  e) Dry or wet weather overflow: Wet weather bypass.
  f) Probable cause of overflow: High rainfall coupled with a large inflow to the STW and the failure of wetland effluent return pump station.
  g) Actions taken to stop the overflow happening: Restarted the pump station.
  h) Actions taken to clean up the overflow: No action taken for the event, bypass was very diluted due to rainfall.
  i) Actions taken to prevent the overflow happening again: Installation of a bypass flow-monitoring device connected to our telemetry system will be completed by August 2004, this will also include alarming for any pump failure in the future.

- **13 March 2004**
  a) Location: Boundary Riser at 42 Tongarra Drive, Ocean Shores.
  b) Date, estimated start time and duration: 13 March 2004 at 12pm for 4.5 hours.
  c) Estimated volume: 100L
  d) Description of receiving environment: Front yard.
  e) Dry or wet weather overflow: Dry weather overflow.
  f) Probable cause of overflow: Tree roots in boundary riser.
  g) Actions taken to stop the overflow happening: Informed residents not to use toilets, showers, etc.

h) Actions taken to clean up the overflow: Hosed down area with fresh water.
i) Actions taken to prevent the overflow happening again: Tree roots removed with plunger and Mo-Flo (Sulphuric Acid).

- **23 April 2004**
  a) Location: Sewage Pump Station SPS5013 Matong Swamp Pacific Highway, Ocean Shores.
  b) Date, estimated start time and duration: 23 April 2004, started at 9am for 1 day.
  c) Estimated volume: 2kL
  d) Description of receiving environment: Bush land and wetland area.
  e) Dry or wet weather overflow: Dry weather overflow.
  f) Probable cause of overflow: Electrical failure of SPS5013.
  g) Actions taken to stop the overflow happening: Reset pump station and restored service to normal.
  h) Actions taken to clean up the overflow: All debris was collected and removed also hosed off area with fresh water.
  i) Actions taken to prevent the overflow happening again: Upgrade of telemetry communication system done to increase reliability of alarm signalling and install red strobe lights on pump station cabinets to alert if telemetry system does fail.

- **24 April 2004**
  j) Location: Boundary Riser at 9 Berimbilla Court, Ocean Shores.
  k) Date, estimated start time and duration: 24 April 2004 at 10am for 2 hours.
  l) Estimated volume: 100L
  m) Description of receiving environment: Front yard.
  n) Dry or wet weather overflow: Dry weather overflow.
  o) Probable cause of overflow: Paper blockage in boundary riser.
  p) Actions taken to stop the overflow happening: Informed residents not to use toilets, showers, etc.
  q) Actions taken to clean up the overflow: Collected and removed paper and hosed down area with fresh water.
  r) Actions taken to prevent the overflow happening again: Inspection of house lines to be carried with CCTV.

- **18 October 2000**

Rising sewer main failure and sewage overflow at Coomburra Crescent, Ocean Shores.
Reason for non-compliance, main failure and scour valve left open after main was repaired.
Action taken to correct problem was to repair the main, contain the overflow and clean/disinfect area of concern.

Action to be taken to prevent recurrence is indicating correct close/open direction of valves.

- **24 November 2000**

Rising sewer main rupture and sewage seepage at Boondoon Crescent, Ocean Shores.
Reason for non-compliance, main failure.
Action taken to correct problem was to contain seepage and repair main.
Action to be taken to prevent recurrence is to implement asset maintenance management system to minimise this type of event.

- **24 February 2003**

Licence exceedence: Sewage overflow from Pump Station 5002, 5003, 5004, 5012.
Reason for non-compliance: Extremely high rainfall and infiltration causing system to be flooded: Overflow observed to be very dilute.
Action taken: Containment of surcharges.

- **15 May 2003**

Non-compliance: Daily monitoring volume 9360kL exceeded 8000kL limit.
Reason for non-compliance: High rainfall event of 135mm in two days.

- **25 January 2004 to 01 March 2004**

Non-compliance: Did not record daily inflow volumes.
Reason for non-compliance: Magnetic Flow recorders were faulty, out of calibration and were replaced with new models.
Action taken: Monitored outflow and used "Load Calculation Protocol" Action 'A' Threshold.

- **14 July 2004**
  Non-compliance: Did not analyse or sample from EPA Site.
  Reason for non-compliance: No outflow to enable sampling or analysis to be carried out.
  Action taken: No action taken.

- **06 October 2004**
  Licence exceedence: Ammonia-N result of 14.3mg/L (100%ile limit is 10mg/L)
  Reason for non-compliance: High result is attributed to increase in bacteria activity in the wetland causing a breakdown of residual organic matter in the wetland. The particulate organic matter accounts for the increase of the ammonia level.
  Action taken: Monitor and wait for algae in the wetland to take up the available Ammonia and reduce the Ammonia-N level.

- **12 January 2005**
  Licence exceedence: Ammonia-N result of 10.2mg/L (100%ile limit is 10mg/L)
  Reason for non-compliance: The result is attributed to the high ammonia content (114mg/L) of the septic pond supernatant being returned to the head of the works.
  Action taken: The supernatant is being pretreated in the Pasveer Channel at the plant before being returned to the head of the works.

- **29 June 2005**
  Non-compliance: Daily monitoring volume 8395kL exceeded 8000kL limit.
  Reason for non-compliance: High rainfall events preceding and including 29 June 2005. Rainfall: 201m in three days.

- **2 July 2005**
  Non-compliance: Daily monitoring volume 80365kL exceeded 8000kL limit.
  Reason for non-compliance: High rainfall events preceding 2 July 2005. Rainfall: 594m in preceding five days.

- **18 January 2006**
  Non-compliance: Ammonia-N monitored at 5.4mg/L (90%ile limit is 5.0mg/L)
  Reason for non-compliance: High rainfall event and leachate processing at plant caused higher than usual Ammonia-N.

- **18 January 2006**
  Non-compliance: Faecal Coliforms monitored at 860cfu/mL (100%ile limit is 600cfu/100mL)
  Reason for non-compliance: High rainfalls lead to the UV disinfection unit operating at below efficiency.

- **20 January 2006**
  Non-compliance: Daily monitoring volume missed, and likely to exceeded 8000kL limit.
  Reason for non-compliance: Flow meter error, High rainfall events preceding and including 20 January 2006. Rainfall: 405m in two days.

- **21 January 2006**
  Non-compliance: Daily monitoring volume 10349kL exceeded 8000kL limit.
  Reason for non-compliance: High rainfall events preceding and including 21 January 2006. Rainfall: 482m in three days.

- **01 February 2006**
  Non-compliance: Faecal Coliforms monitored at 600cfu/mL (100%ile limit is 600cfu/100mL)
  Reason for non-compliance: High rainfall, leachate processing and biosolid processing all contributed to non-compliance.

- **15 February 2006**
  Non-compliance: Missed Total Nitrogen sample and analyse.
  Reason for non-compliance: Operator error.

- **15 February 2006**
  Non-compliance: Faecal Coliforms monitored at 270cfu/mL (90%ile limit is 200cfu/100mL)
  Reason for non-compliance: High rainfall, leachate processing and biosolid processing all contributed to non-compliance. A resample taken on 20 February 2006 yielded a compliant result of 49cfu/100mL.

- **06 March 2006**
  Non-compliance: Daily monitoring volume 9398kL exceeded 8000kL limit.
  Reason for non-compliance: High rainfall events preceding and including 6 March 2006. Rainfall: 414m in seven days.

- **26 April 2006**
  Non-compliance: Ammonia-N monitored at 12mg/L (100%ile limit is 10mg/L)
  Reason for non-compliance: Waste delivered from the Blues festival suspected to contain a chemical, which had a detrimental effect on the works.

- **07 June 2006**
  Non-compliance: pH monitored at 6.2 (100%ile limit is 6.5 to 8.5).
  Reason for non-compliance: The result is a consequence of processes occurring through the wetland. Results of pH 6.5 are being recorded in the catchpond, upstream of the wetland unit. Further monitoring and investigation within the wetland unit is progressing as we have also experienced uncharacteristically high levels of NOx.
  Action taken: On-going process monitoring. Installation of bulk storage and dosing facilities for liquid Soda Ash to enable pH correction at Ocean Shores STW.

- **21 June 2006**
  Non-compliance: pH monitored at 6.3 (100%ile limit is 6.5 to 8.5).

Reason for non-compliance: The result is a consequence of processes occurring through the wetland. Results of pH 6.8 are being recorded in the catchpond, upstream of the wetland unit. Further monitoring and investigation within the wetland unit is progressing.
Action taken: On-going process monitoring. Installation of bulk storage and dosing facilities for liquid Soda Ash for pH correction at Ocean Shores STW.

- **22 & 23 May 2007**
  Non-compliance: Daily monitoring volume missed.
  Reason for non-compliance: Operator error – Relief operator, failed to record data.
  Action taken: Reminded operator of duties.

- **02 January 2008**
  Non-compliance: Total Nitrogen monitored at 15.2mg/L (90%ile limit is 15mg/L).
  Reason for non-compliance: Treatment process was in flood mode from 02-07 Jan 08, also receiving leachate and processing sludge.
  Action taken: Wait for flow to recede and close process monitoring.

- **02 January 2008**
  Non-compliance: Ammonia-N monitored at 14.0mg/L (100%ile limit is 10mg/L).
  Reason for non-compliance: Treatment process was in flood mode from 02-07 Jan 08, also receiving leachate and processing sludge.
  Action taken: Wait for flow to recede and close process monitoring.

- **04 January 2008**
  Non-compliance: Daily monitoring volume 11463kL exceeded 8000kL limit.
  Reason for non-compliance: High rainfall events 168mm on 04 Jan.

- **05 January 2008**
  Non-compliance: Daily monitoring volume 9548kL exceeded 8000kL limit.
  Reason for non-compliance: High rainfall events preceding and including 05 Jan 08. Rainfall: 231mm in two days.

- **04 February 2008**
  Non-compliance: Daily monitoring volume 9763kL exceeded 8000kL limit.
  Reason for non-compliance: High rainfall events preceding and including 04 Feb 08. Rainfall: 280mm in two days.

- **06 January 2009**

Non-compliance: Total Nitrogen monitored at 19.1 mg/L (90%ile limit is 15mg/L).
Reason for non-compliance: Treatment process was biologically overloaded sometime over the Christmas New Year period from an unknown source.
Action taken: Increased aeration. Close process monitoring. Checked grease traps in catchment for maintenance regime.

- **06 January 2009**
  Non-compliance: Ammonia-N monitored at 17.89 mg/L (100%ile limit is 10 mg/L).
  Reason for non-compliance: Treatment process was biologically overloaded sometime over the Christmas New Year period from an unknown source.
  Action taken: Increased aeration. Close process monitoring. Checked grease traps in catchment for maintenance regime.

- **17 February 2009**
  Non-compliance: pH monitored at 6.4 (100%ile limit is 6.5).
  Reason for non-compliance: Alum dosing at catchpond failed on open due to a power disruption.
  Action taken: Pump reset.

- **21 May 2009**
  Non-compliance: Daily monitoring volume 9,920 kL exceeded 8,000 kL limit
  Reason for non-compliance: Consistently high rainfall from 19 May 2009 to 23 May 2009 with 403.5mm received.

- **1 September 2010**
  Non-compliance: No concentration test undertaken for BOD
  Reason for non-compliance: A sample was taken however due to a Laboratory error, was not analysed.
  Action taken: No action taken

- **4 October 2010**
  Non-compliance: Daily monitoring volume 8,893 kL exceeded 8,000 kL limit
  Reason for non-compliance: High rainfall
  Action taken: No action taken

- **5 October 2010**
  Non-compliance: Sewage Treatment Plant Bypass from wetlands
  Reason for non-compliance: High rainfall

Action taken: No action taken

- **11 October 2010**
  Non-compliance: Daily monitoring volume 8,183 kL exceeded 8,000 kL limit
  Reason for non-compliance: High rainfall
  Action taken: No action taken

- **25 – 26 December 2010**
  Non-compliance: Sewage Treatment Plant Bypass from wetlands
  Reason for non-compliance: High rainfall
  Action taken: No action taken

- **28 December 2010**
  Non-compliance: Daily monitoring volume 9,150 kL exceeded 8,000 kL limit
  Reason for non-compliance: High rainfall
  Action taken: No action taken

- **7 January 2011**
  Non-compliance: Daily monitoring volume 8,118 kL exceeded 8,000 kL limit
  Reason for non-compliance: High rainfall
  Action taken: No action taken

- **7 – 10 January 2011**
  Non-compliance: Sewage Treatment Plant Bypass from wetlands
  Reason for non-compliance: High rainfall
  Action taken: No action taken

- **12 October 2012**
  Non-compliance: Nitrogen (Ammonia) result of 7.28 mg/L at EPA Point 3. The 90^{th} percentile limit is 5 mg/L
  Reason for non-compliance: Inadequate aeration
  Action taken: Increased aeration times

- **26 January 2012**
  Non-compliance: Daily monitoring volume 11,285 kL exceeded 8,000 kL limit
  Reason for non-compliance: High rainfall
  Action taken: No action taken

- **27-31 January 2012**
  Non-compliance: Sewage Treatment Plant Bypass from wetlands
  Reason for non-compliance: High rainfall
  Action taken: No action taken

- **15 February 2012**
  Non-compliance: pH result of 6.4 recorded at EPA Point 3. The 100th percentile limit is 6.5.
  Reason for non-compliance: Caustic dosing out of sync with alum dosing
  Action taken: Caustic dosing increased

- **24 February 2012**
  Non-compliance: Sewage Treatment Plant Bypass from wetlands
  Reason for non-compliance: High rainfall
  Action taken: No action taken

- **19 April 2012**
  Non-compliance: Sewage Treatment Plant Bypass from wetlands
  Reason for non-compliance: High rainfall
  Action taken: No action taken

- **18 May – 25 May 2012**
  Non-compliance: Sewage Treatment Plant Bypass from wetlands
  Reason for non-compliance: Failure of UV Disinfection Plant
  Action taken: Repaired UV Plant. Sample taken at overflow point on 22/5/2012 indicates all parameters within licence limits.

- **11 June – 15 June 2012**
  Non-compliance: Sewage Treatment Plant Bypass from wetlands
  Reason for non-compliance: High rainfall
  Action taken: No action

- **28 January – 31 January 2013**
  Non-compliance: Sewage Treatment Plant Bypass from wetlands
  Reason for non-compliance: High rainfall
  Action taken: No action

- **20 February – 28 February 2013**
  Non-compliance: Sewage Treatment Plant Bypass from wetlands
  Reason for non-compliance: High rainfall
  Action taken: No action

- **4 March – 7 March 2013**
  Non-compliance: Sewage Treatment Plant Bypass from wetlands
  Reason for non-compliance: High rainfall
  Action taken: No action

- **28 January 2013**

Non-compliance: Daily monitoring volume 8,757 kL exceeded 8,000 kL limit
Reason for non-compliance: High rainfall
Action taken: No action taken

- **30 January 2013**
  Non-compliance: Daily monitoring volume 10,650 kL exceeded 8,000 kL limit
  Reason for non-compliance: High rainfall
  Action taken: No action taken

- **20 February 2013**
  Non-compliance: Daily monitoring volume 8,013 kL exceeded 8,000 kL limit
  Reason for non-compliance: High rainfall
  Action taken: No action taken

- **22 February 2013**
  Non-compliance: Daily monitoring volume 8,131 kL exceeded 8,000 kL limit
  Reason for non-compliance: High rainfall
  Action taken: No action taken

- **23 February 2013**
  Non-compliance: Daily monitoring volume 9,444 kL exceeded 8,000 kL limit
  Reason for non-compliance: High rainfall
  Action taken: No action taken

- **3 March 2013**
  Non-compliance: Daily monitoring volume 12,299 kL exceeded 8,000 kL limit
  Reason for non-compliance: High rainfall
  Action taken: No action taken

- **23 May 2012**
  Non-compliance: No quality parameters were analysed at EPA Point 3 in accordance with clause M2.1
  Reason for non-compliance: The UV Disinfection Plant was being rebuilt – no flow was going through Point 3.
  Action taken: Effluent was discharging from the V Notch in the wetlands. A sample was taken at this point on 22/5/2012. All parameters were within licence limits.

- **5 October & 12 November 2012**
  Non-compliance: Daily flow volume not recorded at EPA Point 2

Reason for non-compliance: Operator error.
Action taken:

2 July 2013
Licence clause L4.1 Volume and Mass Limits – Total daily flow recorded at EPA Point 2 was 8019 kilolitres exceeding the limit of 8000.
Reason: Heavy rainfall received in the catchment
Action taken: Nil

8 January 2014
Licence clause L3.4 Concentration Limits – Nitrogen (ammonia) concentration recorded as 14.4 mg/L exceeding the 100^{th} percentile limit of 5 mg/L
Reason: Failure of alum dosing pump causing a variation in dosing rate
Action taken: Dosing pump repaired.

2 July 2013
Licence clause L4.1 Volume and Mass Limits – Total daily flow recorded at EPA Point 2 was 12,636 kilolitres exceeding the limit of 8000.
Reason: High intensity rainfall received in the catchment
Action taken: Ongoing investigation of inflow into the sewerage system.

30July 2014
Licence clause L3.4 Concentration Limits – Nitrogen (ammonia) concentration recorded as 14.9 mg/L exceeding the 100^{th} percentile limit of 10 mg/L
Reason: The nitrification/denitrification process was lost due to low alkalinity. Onsite Ammonia testing results did not indicate an issue leading up to the event as given by the following readings from the outlet of the Intermittent Aeration Tank: 6th July 3.16mg/L 7th 6.3mg/L 8th 1.2mg/L 11th 0.15mg/L 14th 0.6mg/L & 20th 0.6mg/L.
Action taken: the Aeration rate was increased. Sugar was added to the process and all functions of plant were double checked. Continuing to monitor, adding extra Soda Ash to lift Alkalinity back up to 70-80 mg/L.

27 June 2015
Licence clause L4.1 Volume and Mass Limits – Total daily flow recorded at EPA Point 2 was 8092 kilolitres exceeding the limit of 8000.
Reason: High intensity rainfall received in the catchment
Action taken: Ongoing investigation of inflow into the sewerage system.

24/3/2016; 1-2/4/2016
Licence clause M7.1 Requirement to monitor Volume – no daily inflow data was recorded at monitoring Point 2.
Reason: Operator error.
Action taken: Operator training.

24 June 2015
Licence clause L3.4 Concentration Limits – pH recorded as 10.1 exceeding the 100^{th} percentile limit of 8.5
Reason: Operator error undertaking localised manual dosing
Action taken: The Operator was disciplined.

24 June 2015
Licence clause L3.4 Concentration Limits – Solids Suspended concentration recorded as 43 mg/L exceeding the 100^{th} percentile limit of 40 mg/L
Reason: Operator error
Action taken: The Operator was disciplined.

5 August 2015
Licence clause L3.4 Concentration Limits – Solids Suspended concentration recorded as 21 mg/L exceeding the 90^{th} percentile limit of 20 mg/L
Reason: Some suspended solids coming from the wetlands. Suspended solids coming out of the Intermittent aeration tank upstream of the wetlands was < 5 mg/L.
Action taken: Nil.

14 October 2015
Licence clause L3.4 Concentration Limits – Solids Suspended concentration recorded as 23 mg/L exceeding the 90^{th} percentile limit of 20 mg/L
Reason: Some suspended solids coming from the wetlands. Suspended solids coming out of the Intermittent aeration tank upstream of the wetlands was < 5 mg/L.
Action taken: Nil.

25 November 2015
Licence clause L3.4 Concentration Limits – Solids Suspended concentration recorded as 24 mg/L exceeding the 90^{th} percentile limit of 20 mg/L
Reason: Some suspended solids coming from the wetlands. Suspended solids coming out of the Intermittent aeration tank upstream of the wetlands was < 5 mg/L.
Action taken: Nil.

13 April 2016
Licence clause L3.4 Concentration Limits – Faecal Coliform reading of 650 cfu/100 mL exceeding the 100th percentile limit of 600 cfu/100 mL
Reason: An unknown error had caused the aeration time to be cut down by 30% causing a failure in the process.
Action taken: Aeration times adjusted.

13 April 2016
Licence clause L3.4 Concentration Limits – Nitrogen (ammonia) concentration recorded as 32.2 mg/L exceeding the 100th percentile limit of 10 mg/L
Reason: The nitrification/denitrification process was lost due to reduced aeration. An unknown error had caused the aeration time to be cut down by 30% causing a failure in the process.
Action taken: the Aeration rate was increased. WAS was reduced to assist with re establishment of the biological process. Continuing to monitor.

13 April 2016
Licence clause L3.4 Concentration Limits - Nitrogen 100th percentile (ammonia) exceedence at EPA Point 3 of 34.2 mg/L
Reason: The nitrification/denitrification process was lost due to reduced aeration. An unknown error had caused the aeration time to be cut down by 30% causing a failure in the process.
Action taken: the Aeration rate was increased. WAS was reduced to assist with re establishment of the biological process. Continuing to monitor.

Monitoring Frequency

1 December 2016
Licence clause M7.1 Requirement to monitor Volume – no daily inflow data was recorded at monitoring Point 2.
Reason: Meter was out of order.
Action taken: Meter repaired with less than 24 hours outage.

Concentration Limits

27 April 2016
Licence clause L3.4 Nitrogen (ammonia) recorded as 31.5 mg/l exceeding the 100th percentile limit of 10 mg/l.
Reason: Process adjustment error causing unbalanced aeration in demand tank due to removal of leachate to the site and transportation to Byron Treatment Plant
Action taken: Aeration input bought back in balance. Staffs are aware of error and it will not be repeated.

27 April 2016

Licence clause L3.4 Concentration Limits – Nitrogen (total) recorded as 32.5mg/l exceeding the 100th percentile limit of 25 mg/l.
Reason: Process adjustment error causing unbalanced aeration in demand tank due to removal of leachate to the site and transportation to Byron Treatment Plant
Action taken: Aeration input bought back in balance. Staff are aware of error and it will not be repeated.

4 January 2017

Licence clause L3.4 Concentration Limits – Nitrogen (ammonia) recorded as 13.3 mg/l exceeding the 100th percentile limit of 10 mg/l
Reason: Possible sampling error – as immediate re-testing found ammonia to be well within tolerance.
Action taken: No further action taken

Report No. 4.6	**Items For the Committee Requested by Duncan Dey**
Directorate:	Infrastructure Services
Report Author:	Peter Rees, Manager Utilities
File No:	I2017/1269
Theme:	Community Infrastructure Sewerage Services

Summary:

This report has presented 2 topics for discussion as requested by committee member Duncan Dey.

RECOMMENDATION:

That the Committee note the report.

Attachments:

1 Capacity Assessment of the Belongil Creek Drainage System Report No 16722b_ByronSTP_AlternativeFlowPath_BSC_opt, E2017/13761 , page 135⇩

Report

It was requested by committee member Duncan Dey to table the following items at the next Water Waste and Sewer Advisory Committee meeting.

1. *the capacity (and its exceedence) of the receiving environment downstream from Byron STP;*

2. *the comparative values of increasing size of STPs versus reducing stormwater sent to them, and for Brunz Valley STP in particular.*

In relation to question 1, Council initiated a 12 month study on the sustainable capacity of the Belongil. The resulting report was presented to the Coastal Estuary Catchment Panel at its March 2017 meeting.

The study found the capacity of the Belongil was adequate to undertake planning an upgrade of the Byron Bay Sewage Plant to 10 ML/day average dry weather flow. On this basis it could be concluded there have been no exceedences of the receiving environment downstream of the Byron Bay STP.

The study's report is attached for information.

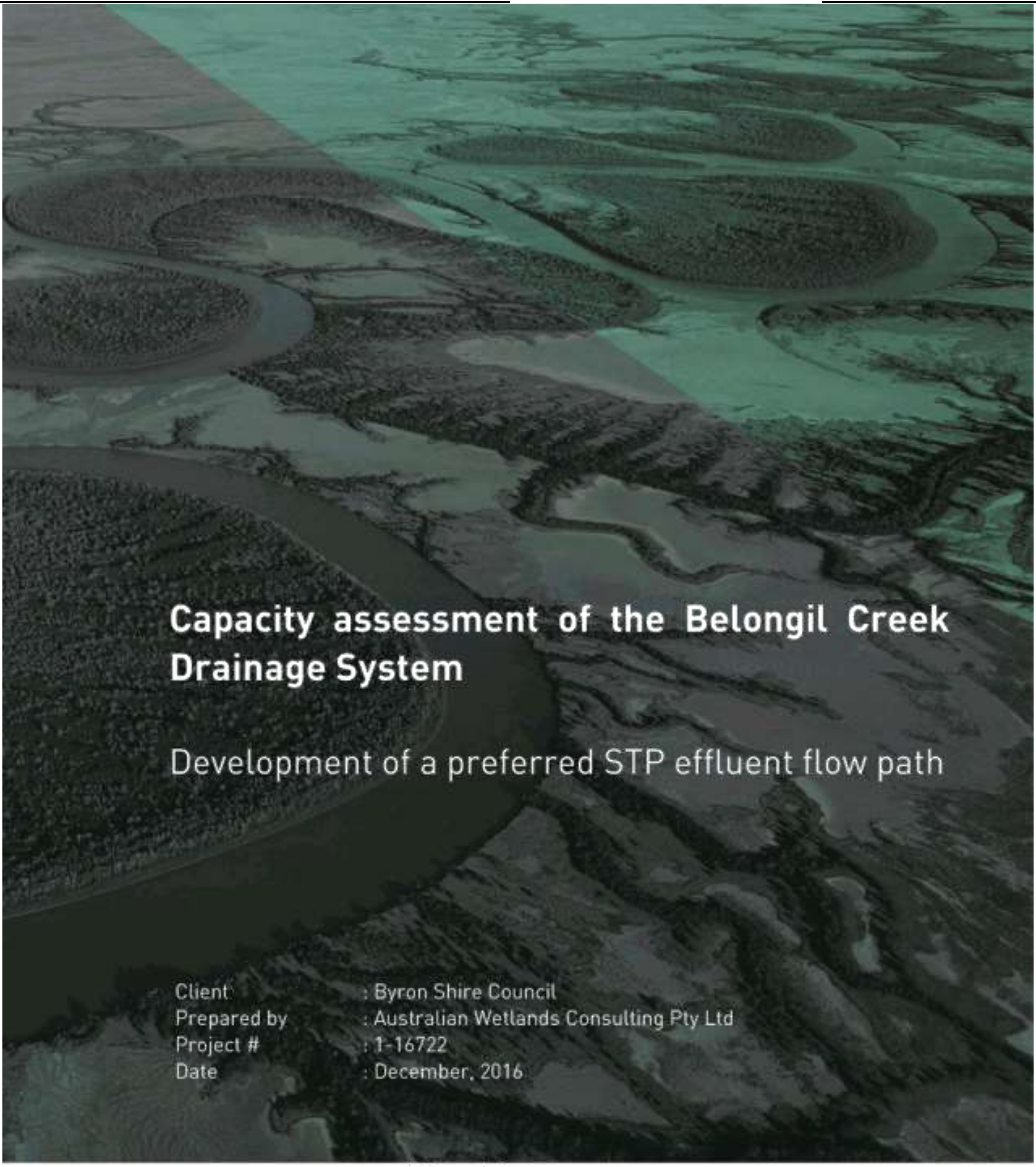
For the second item, it is proposed this item be discussed at the meeting.

Financial Implications

Nil

Statutory and Policy Compliance Implications

Nil



Capacity assessment of the Belongil Creek Drainage System

Development of a preferred STP effluent flow path

Client	: Byron Shire Council
Prepared by	: Australian Wetlands Consulting Pty Ltd
Project #	: 1-16722
Date	: December, 2016

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Capacity assessment of the Belongil Creek Drainage System

Development of a preferred STP effluent flow path

Project control

Project name: **Capacity assessment of the Belongil Creek Drainage System**
Development of a preferred STP effluent flow path

Job number: 1-16722-1a
Client: Byron Shire Council
Contact: Peter Rees

Prepared by: Australian Wetlands Consulting Pty Ltd

70 Butler Street / PO Box 2605
Byron Bay, NSW, 2481

P | (02) 6685 5466
F | (02) 6680 9406
E | byron@awconsult.com.au

Date:	Revision:	Prepared by:	Reviewed by:	Distributed to:
20/12/2016	A	Mark Bayley Damion Cavanagh (BMT WBM)	Damian McCann	1 x PDF to Peter Rees
XX/01/2017	B	Mark Bayley Damion Cavanagh (BMT WBM)	Damian McCann	1 x PDF to Peter Rees

Executive Summary

The Byron Bay Sewage Treatment Plant (BB STP) forms part of the Byron Bay Integrated Water Management Reserve (BBIWMR), which currently discharges up to 3ML per day of dry weather flow into the upper Union Drain. On top of this discharge, a large area (24 ha) of regenerating flood plain forest is irrigated with treated effluent – at an approximate rate of 1 ML/day. In recent years the discharge of STP effluent into the upper Union Drainage system has caused significant concern from adjoining landholders. Due to increased development within Byron Bay, effluent inflow rates are projected to increase over the next 5-10 years. As a result of this increase, Byron Shire Council (BSC) seek guidance on a sustainable effluent release pathway – for current BB STP flows and projected 5ML/day and 8ML/day flows. To determine a sustainable effluent release pathway for the BB STP a number of investigations where undertaken:

- A broad scale, catchment wide ecological assessment, focusing on areas directly adjoining the Estuary and drainage system,
- An assessment of the fate of effluent released from the current discharge location since transfer of effluent from the South Byron Sewage Treatment Plant (SB STP) to the BB STP,
- An assessment of drain water levels, rainfall and estuary opening events using 10 water level loggers deployed throughout the catchment,
- An assessment of the geology and presence of Acid Sulphate Soil (ASS) of the Effluent Irrigation Area land west of the BBIWMR,
- The development of two alternative effluent release pathways, and
- Hydrologic, hydraulic and water quality modelling investigations on current and proposed effluent release pathways under current and proposed effluent flows.

Ecologically, the Belongil Creek, ICOLL and drainage system provides a large expanse of high quality habitat for various terrestrial and aquatic species. Swamp forest (large proportion mapped as SEPP 14), mangroves, saltmarsh and regenerating areas with the STP provide high quality habitat for multiple species listed under the TSC Act and EPBC Act. Known breeding habitat for several species such as the Little Tern and Pied Oyster Catcher occurs within the catchment, meaning that conservation of these environments is essential for the sustainability of the local population. Overall the catchment hosts an array of high value ecological features including threatened species habitat (flora and fauna), EECs, SEPP 14 wetland and wildlife corridors (regional and sub regional).

Detailed site analysis of the effluent irrigation area, land to the west of the BBIWMR and Belongil drainage system has inferred that the increase in flows associated with the transfer of effluent from the SB STP to the WB STP in 2006 with the adjoining has resulted in:

- A decrease in artificial estuary opening events,
- A potential increase in water table height west of the BBIWMR, resulting in an increase in the frequency, extend and depth of surface water inundation,
- A reduction in peat fires and acid discharge events, and
- The occurrence of both PASS/ASS within the upper Union Drain area.

The receiving environment for BB STP discharges is the low-lying tidal floodplain of Belongil Creek. Assessing hydraulic impacts in this environment required consideration of the estuarine and meteorological conditions that may prevail in this catchment, including the effects of a variable entrance openings and variable catchment responses to meteorological conditions. The models established for the Hydraulic Capacity Assessment (HCA) include a SOURCE hydrologic model and a linked 1 dimensional (D) / 2D TUFLOW hydraulic model of major drainage channels and overbank floodplain areas. Both models were validated in unison using a mixture of qualitative and quantitative approaches and a good model fit was achieved. As such the models accurately predict the timing and magnitude of catchment flow events, but also in the areas of interest they were able to demonstrate an accurate prediction of water levels for tides within the channels and the influence on catchment runoff events.

For the existing BB STP discharge location and the alternative effluent release Option 1 location, there are significant areas of the floodplain predicted to experience increases in duration of inundation. Generally this inundation has been predicted to occur downstream (to the south) of Ewingsdale Road in the main portion of the floodplain. The flatter channel gradient and influence of tide height/entrance conditions increases the duration of water ponding in this floodplain. The differences in the time of inundation are typically less than 2%. For the he alternative effluent release Option 2 location, the predicted increases in duration are significantly less than for the two other alternatives.

A rapid assessment approach was applied to investigate potential changes in water quality (salinity, nitrogen and phosphorus) in the Belongil Creek estuary resulting from increasing discharge volumes from the BB STP (with discharge quality remaining static). As such the water quality modelling provides ancillary information to the HCA component. The model developed accounts for key flow components (i.e. BB STP, catchment and tidal exchange), pollutant inputs/outputs (i.e. STP, catchment and oceanic exchange) and nutrient processes (i.e. settlement, sediment release and denitrification) and provides a temporal prediction of pollutant concentrations within the estuary. Given that the model is non-dimensional the model predictions are volume averaged. The models used for the assessment were adapted from the Tallow and Belongil Creeks Ecological Study.

The results identify that for salinity, decreasing the BB STP discharge volumes (i.e. to 1 ML/d) increases the average salinity of the estuary over the modelling period. Whilst increasing the discharge volumes to 5 ML/d or 8 ML/d, decreases the average estuary salinity. Similarly with predicted TN and TP concentrations, decreasing the BB STP discharge volumes (i.e. to 1 ML/d) decreases the average total nutrient concentrations in the estuary over the modelling period. Whilst increasing the discharge volumes to 5 ML/d or 8 ML/d, increases predicted total nutrient concentrations within the Belongil Estuary. Peak total nutrient increases of up to 92% are seen for TP for the 8ML/d discharge scenario, but these peaks are short lived and occur at times with either a very low tidal range (due to entrance closure) and/or to a lesser degree dry weather periods which reduce catchment runoff. Considered as a long term median (over the 4+ year modelling period) the TN changes are less than 3% and TP changes less than 2% for the 8ML discharge scenario.

Recommendations

The main recommendation resulting from this study is to provide an alternative effluent release pathway via Option 2 – release into the Industrial Estate drain. While the results of the investigations presented in this report support an alternative effluent release pathway, it is advised that some degree of discharge from the existing release point (EPA 4) continues. This continued discharge is required to ensure that acidic runoff off events and/or peat fires do not occur within the upper drainage catchment - as have occurred in the past. A detailed Environmental Monitoring Plan, complete with triggers and actions is required to inform the delivery of the alternative effluent release pathway. This monitoring plan will provide guidance on the incremental decrease of effluent at EPA 4, and the incremental increase of effluent release to Option 2. The plan will outline key environmental variables to measure, frequency of data collection and triggers which will guide the further increase/decrease of effluent at the two proposed discharged locations (existing and Option 2)

While this report supports the provision of an alternative release pathway, the timeframe to implement this is undecided. Nevertheless, numerous short term actions can be implemented immediately to potential reduction inundation depth, frequency and duration of land west of the BBIWMR:

- Remove concrete lip north of pipes draining the upper Union Drain on Ewingsdale Road,
- Ensure pipes draining the upper Union Drain on Ewingsdale Road are inspected after every decent rainfall events, and cleaned if capacity is impacted by >20%,
- Reduce the weir level from EPA 4 drain within BBIWMR by 100mm or to a level which ensures limited inundation of land west of the Cavanbah Centre, and
- Block drain to the northwest of the irrigation area, ensuring all water draining the BBIWMR travels south.

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1 Introduction

The Byron Bay STP (BB STP) forms part of the Byron Bay Integrated Water Management Reserve (BBIWMR), which currently discharges approximately 3ML per day of dry weather flow into the upper Union Drain. On top of this discharge, a large area (24 ha) of regenerating flood plain forest is irrigated with treated effluent. In recent years the discharge of BB STP effluent into the upper Union Drainage system has caused significant concern from adjoining landholders. Figure 1-1 displays the location of the BBIWMR and the broader study area

Since the closure of the South Byron Bay STP (SB STB), effluent from the entire township now enters the Belongil Creek and drainage system, potentially increasing the frequency of artificial opening events of the Belongil Estuary ICOLL (Australian Wetlands, 2013). Figure 1-2 provides a summary of major activities undertaken by the Byron Shire Council on the upgrade of the Byron township sewage system since the 1980's and 90's.

Currently the BB STP is operating at 72% capacity – approximately 5ML/day, with a design capacity of 6.95 ML/day. Under current land use strategies, Byron Shire Council will need to upgrade the STP to receive up to 10 ML/day by 2025.

The approved EIS for the upgrade of the BB STP predicted no impact to regional groundwater levels. Following development of the BB STP, a post development impact verification project confirmed groundwater behaviour predictions modelled in the EIS. Notwithstanding this, doubt still exists as to the fate and impact of the effluent discharged from the BB STP. In light of this concern, the aim of this report is to investigate the sustainable capacity of the Belongil Creek and drainage system to receive treated effluent from the BB STP. Key objectives of the current study are to:

- Define and determine the sustainable capacity for current and future BB STP release flows in the Belongil Creek
- Determine the impact/s of the current flows (at 3ML/day) compared to the aspirational flows (of 1ML/day) on the drainage system and farmland upstream of Ewingsdale Road
- Assess whether throughput from the BB STP Constructed Wetlands and 24 ha Melaleuca Wetland (BBIWMR) is also charging those drains
- Identify alternative flow path/s for BB STP treated effluent discharge
- Enhance environmental and scenic values (beautification) of the Belongil Catchment.

These objectives will be achieved by undertaking an:

- assessment into the potential options of treated effluent release, including a mix of options
- modelling potential scenarios for BB STP discharge with consideration to
    - the relative contribution to the flows from the BB STP discharges and rainfall
    - the impacts of discharges with the Belongil estuary open and closed
- thorough assessment and understanding of project risks
- determination of all regulatory and formal requirements.


AWC
Project: Byron Bay STP alternative effluent release assessment
Figure 1.1: Location of the BBIWMR and broader study site
Legend
Major drains
Marine Park
Belongil Estuary Catchment
BBIWMR
SEPP14 Wetlands
Union Drain
0 200 400 600 m
Date - 16/12/2016
A3 Scale - 1:30000
SOURCE:
Care was taken in the creation of this map. AWC should be consulted as to the suitability of the information shown herein prior to the commencement of any works based on the information provided. AWC cannot accept any responsibility for errors, omissions or positional accuracy. There are no warranties, expressed or implied as to the suitability of this map for a particular purpose. However, notification of any errors will be appreciated.

Figure 1-2: Flow diagram of major activities undertaken by the Byron Shire Council on the township sewage systems since 1980's

1.1 Defining the 'sustainable' capacity of the Belongil Creek with regards to effluent release

In the assessment of the current and any future alternative effluent release pathways, it is important to ensure that the sustainability of the Belongil Creek. Sustainability can be defined as capacity to endure, and thus the ability for systems to exist indefinitely. Sustainability within an urban context is often coined "sustainable development" and involves consideration of three factors: social, economic and environmental (Figure 1-3).

Using these three factors, a set of sustainability criteria have been developed to enable assessment of the sustainability of the various STP effluent release pathways/scenarios. These criteria are outlined in Table 1-1 (overleaf), and will be used to evaluate each of the alternative effluent release pathways.

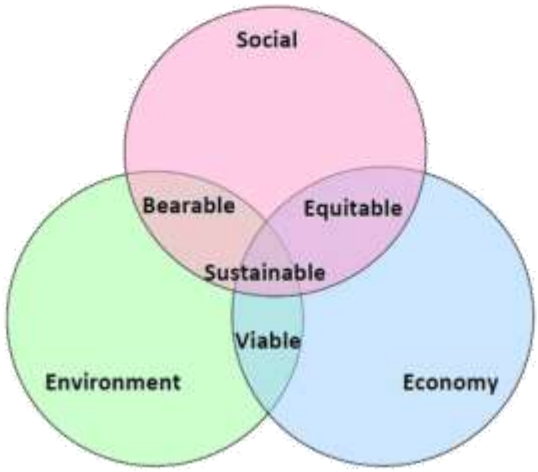


Figure 1-3: Factors governing sustainability

Table 1-1: Preliminary sustainable capacity assessment criteria

Relevant sustainability factor	Sustainability Criteria		
	Aim	Objective	Key assessment method
Social	Achieves the community's aspirations for sewage management in Byron Bay	Meets Council's vision and goals as stated in the Effluent Management Strategy (2006/ Doc #610368)	Qualitative assessment against objectives and recommendations
	Maintenance and improvement of the aesthetic and recreational values of the Belongil Catchment	Water level and conductivity regime of the Belongil Creek/Drain and ICOLL must not affect existing vegetation communities which may affect visual amenity of the Belongil Estuary.	Use of existing water quality models
Economic	Maintain and enhance economic value of the Belongil Estuary and its catchment.	Maintenance of the current and projected economic value of the current land use within the Belongil Catchment	Qualitative landuse value assessment Hydraulic / hydrologic model and water quality model
		Ensure preferred effluent discharge option is within Council's financial capacity.	Council budget
Environmental	Maintain and enhance downstream ecological values of the Belongil Creek, ICOLL and its catchment.	Reduction acid discharge events from the upper catchment: • pH levels within the Belongil Estuary should meet stated water quality objectives	Review past water quality data and known management of ASS on coastal floodplains of NNSW
		No deterioration of existing flora and fauna communities which inhabit the Belongil Creek and ICOLL	Hydraulic / hydrologic model
		Water quality and conductivity profile of the Belongil Creek and ICOLL should meet stated water quality objectives	Water quality model
		Reduction in peat fires	Hydraulic / hydrologic model
		No impact on tidal bird roosting at the mouth of the Belongil Estuary	Hydraulic / hydrologic model
		Meets the objectives and recommendations of the Belongil Estuary MP	Qualitative assessment against objectives and recommendations

2 The Byron Bay STP and the Belongil catchment

The BB STP forms a component of the Byron Bay Integrated Water Management Reserve (BBIWMR), located on a 100ha property off Bayshore Drive in the Belongil Creek catchment (Figure 1-1). The BBIWMR includes a 22ha constructed wetland system and a 24ha Melaleuca wetland effluent irrigation area. Land-use zones within the site include 5A Special Uses, 7A Wetland Zone (SEEP 14) and 7B Coastal Habitat Zone. Site topography is very flat (<2%) and of low relief - with the entire site below 10m AHD. The watertable throughout much of the Belongil Catchment is high, as indicated by the surface drainage system that directs most surface and groundwater flow to the Belongil Creek (Figure 1-1).

Historically, much of the Belongil catchment was waterlogged swamp or wetland, vegetated by wet heath and swamp plant communities. The catchment is low-lying, with most of the area below 4m AHD (ERM, 2001). The natural drainage pattern of the catchment has been altered by human activities such as sand mining in the northern dune system, drainage of land in the western and southern parts of the catchment and urban development in the east (ERM, 2001).

In 1913, following the clearing of wetlands within the catchment, the Union Drain was constructed (hand dug) by the Belongil Creek Drainage Union. The Union drain extends 3 – 4 km across the former wetland area with a network of drains feeding into it, eventually discharging to The Cape Byron Marine Park at the Belongil Beach.

It has been estimated that approximately 80% of the Belongil Creek catchment has been cleared and or drained (for residential, industrial, agricultural and pastoral uses) which has resulted in changes to both the flow and quality of surface and groundwater quality, including issues associated with Acid Sulphate Soils (ERM, 2001).

All land in the low lying areas of the catchment is prone to flooding when the entrance to Belongil Creek estuary is closed. Flood mitigation practices in the catchment have included drainage of wetland areas (as described above) and artificially opening the Belongil Creek estuary entrance to allow surface waters to escape into the ocean. Artificial opening of the estuary entrance has been occurring for approximately 50 years and were historically triggered when the water level at the Ewingsdale Road bridge gauge reached 1.2m AHD. Since 2001, the water level trigger for artificial estuary opening was reduced to 1m AHD following a recommendation in the Belongil Estuary Management Plan (2001) to reduce turbidity following openings. Investigations are currently underway into the potential impacts of the entrance opening regime on system hydrology and ecology.

2.1 Historical Studies within the catchment

2.1.1 Belongil Creek Estuary Processes Study (1997)

Objective: Data compilation study prepared to form the basis for the preparation of an Estuary Management Study for BSC. Belongil Creek Estuarine Management Committee was formed by BSC in 1994, with the objective to "ensure the long-term sustainability of the Belongil Creek, while managing estuarine resources for the community".

Study Area: Study area comprises the 30 ha Belongil creek system (ICOLL) & Cumbebin Swamp and the 2840 ha catchment which surrounds.

Hydrology and Water Quality: During storm events, rainfall runoff is enters the catchment through various drains. Flood levels have been modelled to reach levels of up to 2.6 AHD at the creek mouth. The West Byron STP, Sunny Brand Chicken Farm, Yagers Piggery, domestic rubbish tip, Byron industrial estate and township were all identified as point sources for pollution within the catchment. Over the monitoring period, levels of nutrients and faecal coliforms exceeded the ANZECC water quality guidelines (1992) for the primary contact recreation and protection of aquatic ecosystems (estuarine waters). A detailed assessment of groundwater hydrodynamics and quality was not undertaken. Chlorophyll-a levels were high, indicating eutrophication within the estuary.

Estuary Foreshore and Waterway Usage: Restricted access to majority of the foreshore due to intact riparian vegetation. Access was limited to recreational uses such as canoeing, fishing and occasionally swimming.

Hydrodynamic Processes: The main hydrodynamic processes affecting the opening and closure of the creek were onshore sand transport and catchment flooding. The entrance is exposed to northward littoral drift, caused by dominant south-easterly swells. The mouth of the estuary is breached by either mechanical opening by BSC or by built up floodwaters. Tidal ranges vary throughout the catchment, with average water levels vary from 0.2-1.2 AHD.

Ecology: During the study six vegetation communities, 55 Threatened fauna species, 57 fish species and 7 nationally rare or Threatened plant species were identified to occur currently or in the past. Overall the creek was observed to have high levels of biodiversity and environmental value however fish kills have been recorded in the past after heavy rainfall (low DO and pH).

Conclusion: Belongil Creek ICOLL – medium to poor water quality, water quality decreases after heavy rainfall or when entrance is closed. Increasing developments within the catchment likely to increase the negative effects associated with storm water runoff and waste discharges.

2.1.2 Belongil Estuary Study and Management Plan (2001)

Objective: Create an integrative management plan to "sustain a healthy productive and attractive estuary where balanced and co-ordinated management of resources ensures sustainability of diverse natural systems whilst maintaining or meeting community needs.

Study Area: Belongil Estuary, Cumbebin Swamp and surrounding slopes.

Current pressures on the estuary include: poor storm water quality originating from urban and rural precincts, acid runoff (from rural areas during adverse seasonal conditions) and potentially from point sources of pollution (old landfill site at Butler street, WB STP and Sunnybrand Chicken Factory – circa 2001).

Threatening processes include invasion of exotic species (namely Bitou Bush) and introduction of feral animals (dogs and foxes).

Community perception that wastewater discharged from WB STP has resulted in pollutants being retained in the estuary when the mouth is closed. Results from this study suggest that this community view is not correct and ASS present a much greater risk to ecosystem health. Study into water quality, ASS soils, entrance management, recreation and visual amenity, riparian zone management, flooding, estuary and wetland ecology, cultural heritage, development.

Brief History: Large areas of Cumbebin wetlands cleared in 1960-70s. Construction of drains allowed the agricultural use of low lying previously swampy sites.

Key values: The plant and animal communities of the Belongil Estuary and catchment are diverse and of considerable conservation significance. They include the wetlands of the Cumbebin Swamp and other smaller areas of State significance. Additional areas of conservation importance include floodplain rainforest in the upper catchment (an endangered ecological community), eucalypt and mangrove forest and woodlands, littoral rainforest, saltmarsh and estuary flats. Habitats within the Belongil catchment support over 60 threatened species, including an endangered land snail, several frogs and numerous birds and mammals.

Water/Soil: The Belongil Estuary is impacted by poor quality stormwater. This stormwater originates from urban and rural precincts, acid runoff from rural areas during adverse seasonal conditions, potential point sources of pollution and potential impacts that relate to residential development within the catchment.

The soil profile of the catchment consists of the following soils which may contain potential acid sulfate soils (PASS): estuarine sediments, sandplain and swamp soils. Tulau (1999) identifies the Belongil catchment as a "hotspot" for ASS. Past studies have identified that no lowland sites near the lower estuary were found to contain acid sulfate soils, however several samples found PASS (acidity increase with depth).It is suggested that the "geology of the estuarine and floodplain deposits are complex and cannot be fully characterised without more data".

Urban stormwater management and the artificial opening of the estuary entrance: Poor water quality in terms of ANZECC Guidelines, particularly in relation to DO and faecal coliforms. Surface sediments were not contaminated by organochlorines, hydrocarbons, heavy metals or inorganics.

Management (High priority): reduction of pollutant loads at source, complete Butler Street wetland system.

2.1.3 Byron Bay Sewerage Augmentation Scheme– Environmental Impact Statement [EIS] (2001)

Objective: Assess potential impacts to the environment resulting in the upgrade of the WB STP

Study Area: WB STP, Belongil Creek, Estuary and Catchment

Surface and ground water: Negligible increase in nutrients delivered to the Belongil Estuary, with no net increase in nutrient loads delivered to the estuary post upgrade of the WB STP (achieved via effluent reuse projects). Creation and management of a 24ha effluent irrigation area will result in a decrease in acidic runoff from ASS. While no flooding is predicted within the vicinity of the WB STP as a result of the upgrade, BSC commits to assisting local landholders in drain maintenance. It is predicted that there would be no adverse effect on groundwater resources in the region, or impact on the properties of the surrounding landholders.

Terrestrial and aquatic ecology: With the construction of the 24ha effluent irrigation area, Grass Owl and Acid Frog Habitat was lost. This impact was addressed via the preservation and conservation of land in the north west of the WB STP land. No impact was predicted on aquatic ecology.

Social Benefit and Human Health Risk: Numerous benefits were reported in regards to the upgrade of the WB STP. These mostly included benefits surrounding the closure of the South Byron STP and the inclusion of UV disinfection as part of the proposed upgrade to the WB STP.

Heritage: No currently known sites of Indigenous cultural significance would be affected by the Project. A portion of the proposed pipeline route would pass through the site of the early village of Cavanbah. Archaeological assessment of the section of the pipeline route through Cavanbah would be undertaken prior to construction.

Other Anthropogenic disturbances (Air, Noise & Visual, Traffic): No adverse odor expected, decrease in odor at the South Byron STP site. Increased noise and vehicle traffic during construction phase; will return to normal following construction. Visual impact will be minimal; the proposed Melaleuca regeneration to the south of West Byron STP would enhance the scenic quality.

Conclusion: As part of the proposed upgrade to the WB STP, various construction, operational and monitoring plan where suggested to ensure that predicted impacts were mitigated.

2.1.4 Belongil Creek Entrance Opening Strategy (EOS): Review of Environmental Factors (2005)

Objective: To address the potential impacts associated with the opening of Belongil Creek entrance.

Impacts: Direct impacts include physical damage to dune infauna and flora associated with opening of the entrance using machinery and access routes used by the machinery. These impacts are expected to be minor, however the works will have an impact on threatened species habitat (turtles and Little Terns). In contrast, indirect impacts are likely to be diverse and extensive throughout the catchment. This is due to the extensive low relief wetland system adjacent to the current estuary. Physical impacts are likely to include: lowering of groundwater levels, changes in surface water hydrology of swamps, divergence from the natural breakout range, reduction of areas inundated by floods, increased tidal influence, increased transport of ASS products from the soil profile, increased salt penetration, extreme water quality events, flocculation events, increased marine influence on estuary, increased oxidation of PASS, changes to coastal erosion. These physical changes will impact on the hydrology resulting in flow-on effects on agricultural and urban drainage and vegetation communities. More specifically physical impacts may have the following effects on ecological values: decline in seagrass, reduction in area of non-forested freshwater wetlands, changes to swamp forest vegetation, mangrove increase, loss of sandflats/saltmarsh, change in mangrove diversity, erosion of littoral rainforest at the entrance, direct impact on weed spread, shift from ICOLL to estuarine fish assemblages, fish kills and their associated impacts on fauna habitat.

Threatened species assessment: The report has concluded that the following species are known to or have the potential to occur within the study area: Mitchell's Rainforest Snail, Wallum sedgefrog, Marine turtles, Osprey, Migratory shorebirds, Pied oystercatcher and Little tern

Alternatives: Several alternatives are proposed including: alleviate flooding in the urban and industrial areas of Byron Bay, mitigate fish kills associated with high flow events, protection of ecological communities that have arisen in response to the historical opening regime, mitigate the impacts of ASS runoff.

Long Term Recommendations: Given that many of the draft EOS impacts that trigger an EIS may be effectively mitigated by current initiatives in ASS, stormwater and drainage management, the study recommend that resources may be most effectively used by postponing the commencement of any EIS, until revised management strategies and mitigation strategies have been put in place, and a revised EOS has been drafted. It is recommended that an integrated approach to management and planning be developed as soon as possible. Predicted sea level rise (0.5m by 2100; WBM, 1999) will render artificial entrance opening largely ineffective for the mitigation of flooding in Byron Bay due to possible inundation from the ocean. The EOS should therefore avoid promoting false expectations in the community with regards to "flood proofing" by artificial entrance opening.

Short Term Recommendations: Due to the potentially long time frame required to establish a total catchment plan, the several short term actions are recommended for the interim.

2.1.5 The Byron Effluent Reuse Wetland Scientific Report (2006)

Objective: Seven Chapters that investigate the science and implementation of the effluent irrigation project at the BB STP.

History of the peat acid sulfate soil: The Byron Bay peat-lands are low lying coastal peats that have formed in the interdune swale. Pollen and phytolith records and Charcoal counts indicate peat forming vegetation is composed of Sphagnum, *Cyperaceae* and *Restionaceae* species throughout its history and that the area has experienced an increase in fire activities over the past 5000 years.

Acid sulfate soil distribution: Of particular importance, this study identified the presence of two distinct pyrite layers within the peat profile. This study also demonstrated that there are actionable concentrations of pyrite throughout the entire peat soil profile of the effluent reuse site. It is therefore likely that some acid products will be generated at any time that the groundwater levels are below field capacity. The presence of two pyrite layers poses important management considerations, and these are explored more thoroughly in later chapters. The subsurface pyrite layer was accreted more than 5,000 years ago when sea levels were around 1m higher than present levels. At this time, the wetland was an inland estuary with an environment high in sulfate, iron and organic material – the necessary ingredients for pyrite production.

Acid sulfate soils, pyrite dynamics: The acid sulfate soil mapping programme (Chapter 4) clearly demonstrated the presence of surface pyrite in the waterlogged area in the eastern portion of the effluent reuse wetland, no evidence of significant surface pyrite deposits in the non-waterlogged sites. The presence of surface pyrite in the effluent-logged site meant that effluent irrigation could result in the build-up of potential acidity. Surface pyrite layers were found to form when the peat soil remains waterlogged for extended periods of time, creating highly reducing conditions. Waterlogging for a decade in the eastern portion of the site resulted in a concentrated pyrite layer, pyrite formation is an acid consuming reaction. The almost neutral pH levels and low redox values in the waterlogged eastern portion of the site, in which high concentrations of surface pyrite were measured, bear testimony to the acid consuming nature of pyrite formation. However, when the water table falls after periods of extended waterlogging, this quickly exposes the pyrite layer to atmospheric oxygen, resulting in oxidation and the subsequent liberation of acidity.

Acid sulfate soils: pyrite formation – pot trials: This chapter presented results from a controlled pot-trial experiment that examines some key questions:

1. Does effluent increase the rate of surface pyrite formation?
2. Does the height of the water table affect the rate of surface pyrite formation?
3. Can pyrite formation be suppressed by fluctuating the water tables?

This experiment demonstrated that

- **Effluent promotes the formation of surface pyrite.** Surface pyrite management must therefore be a primary management consideration for the Byron Effluent Reuse Wetland.
- **Ponding water promotes pyrite formation.** The management regime of the wetland should minimise surface ponding, especially for prolonged periods of time.
- **Fluctuating the water table decreases the rate of pyrite formation.** A fluctuating watertable inhibits the rate of surface pyrite formation, and the higher the frequency of

fluctuation, the greater the inhibition. The management regime should aim to maximise the rate of fluctuation.

Melaleuca growth and establishment: Between December 2001 and December 2005, approximately 700,000 Melaleuca saplings were densely hand-planted in the 24 ha Byron Effluent Reuse Wetland with the aim of establishing a Melaleuca wetland that approximates the ecological nature of its predevelopment state

2.1.6 Byron Bay Effluent Management Strategy

Objectives: Objectives of the Byron Bay Effluent Management Strategy include: eliminate surface discharge to Belongil Creek from the West Byron STP; maximise the creation of useful products from effluent reuse projects; link the development of effluent reuse options with the progressive increase of load to the West Byron STP; use effluent to achieve broader environmental objectives e.g. acid sulphate soil remediation and habitat regeneration; understand, monitor and manage the impact of effluent discharge to the Belongil catchment; maximise evapotranspiration as the preferred mechanism for assimilation to the environment; use assimilation pathways and practices to produce effluent surface water run-off that mimics background environmental flows; and prioritise and resource effluent management appropriately.

The Byron Bay Effluent Management Strategy (BBEMS) addresses how objectives in the BBWSC will be achieved. The scheme covers specific projects, effluent reuse potential and timeframes. Three major areas of effluent reuse potential were identified in the development of this strategy and presented in the Program: Urban Reuse Corridor; Regeneration Projects; Rural Lands Projects.

Effluent reuse provisions are identified in this Strategy to address the short-term loading with the transfer of the South Byron STP. This will ensure that there is no negative impact upon the Belongil Creek due to effluent discharge.

Urban Reuse Corridor: The Byron Bay Sewerage Augmentation Scheme required a sewage rising main to be constructed to transfer the existing South Byron STP sewage load to the West Byron STP. Construction of this major rising main provided the opportunity to lay a return effluent pipeline in the same trench. The urban reuse corridor is a strategically significant opportunity for effluent reuse both now and into the future. Potential constraints such as availability of suitable soils and shallow water tables will need to be managed.

Regeneration Projects: The West Byron Melaleuca Wetland Regeneration Project involves the regeneration of native melaleuca wetland on a 24-hectare area in the southwest corner of the West Byron STP site. The project will achieve the objectives of acid sulphate soil remediation, wetland regeneration, habitat restoration and effluent reuse. The combination of effluent reuse potential with other valuable environmental outcomes makes regeneration projects highly desirable. However, the extended period required to establish and mature these projects means that other effluent reuse applications are required in order to achieve the minimum requirement

Rural Lands Projects: Effluent reuse opportunities include irrigation of pasture, crops and forestry in areas that have the most suitable soils for effluent irrigation. Land suitable for rural lands projects exist to the west of the West Byron STP site.

Conclusion: Maximising all effluent reuse opportunities (urban corridor, regeneration projects, and rural lands projects) will help to improve the water quality in Belongil Creek.

2.1.7 Bryon Bay Integrated Water Management Reserve Groundwater Impact Verification (2010)

Objective: The objective of the report was to provide a review of previous studies on modelling used as part of the 2001 Environmental Impact Statement and potential groundwater impact of the BBIWMR on local and surrounding environments of the Belongil Catchment. The primary aim of this report is to verify the predictions made in computer simulation models used to assess the likely impacts of the BBSAS on groundwater levels and quality. The degree of certainty will be assessed by comparing modelled data (PPK 2001) with actual data that has been collected since 1999.

Findings: Comparison of the PPK MODFLOW model (2001) with field data measured between 1999 and 2009 was undertaken, and it can be concluded that the model parameters and outcomes derived by PPK (2001) accurately reflect the hydraulic behaviour of the catchment watertable.

Conclusion: The report draws the following conclusions: Watertable fluctuates in accordance with rainfall events, effluent irrigation or increases in BB STP load has little influence on watertable level; on average, the quality of groundwater the catchment has not decreased since implementation; it is unlikely that the BBIWMR will have any impact on upper catchment flooding due to the extensive network of drains within the BBIWMR and the Belongil catchment (assuming the Belongil Estuary artificial opening strategy is maintained); data collected since 1999 correlates with models used in the BBSAS EIS; and analysis of the watertable within study area demonstrated that on site irrigation practices implemented since 2004 have not had an adverse impact on groundwater quality or the standing water level (SWL) of the aquifer/s.

3 Acid sulfate soils and hydrogeology

Soil on the south-western quarter of the BBIWMR are Holocene aged (<10,000 year old (yo)) clay, silt and peat, while soil over the remainder of the site and to the north, east and south-east of the site are shallow hardened Pleistocene aged (1.6 million yo [Myo] to 10,000 yo) sediments. Most of these geological formations can potentially form acid sulfate soil (ASS), with the entire BBIWMR falling within a "high priority area" for ASS as demarcated by Tulau (1999).

Groundwater beneath the BBIWMR can be classed as an unconfined aquifer (see glossary) and rapidly receives water via infiltrating rain and surface water, discharging to the comprehensive drainage system within the Catchment. The aquifer consists of three main geological units (all alluvial):

- upper sand (top unit) which is extremely permeable (Holocene aged);
- underlying hardened sand (Pleistocene aged 'coffee rock'); and
- a deeper sand unit (Pleistocene aged dune sand).

The upper sand unit is reported as being 2-3 metres thick (from the surface) and is in hydraulic connection with Belongil Creek and local drains and lagoons with a watertable at about 1.0-1.5 metres depth.

The underlying hardened sand contains a dark coloured organic zone and reduced permeability at close to 0 m AHD (reported to be continuous beneath the site). This layer has been cemented in places and has a measured hydraulic conductivity (K, see glossary) in the order of 0.1 m/day (AGC 1997, p2.1). It is therefore hypothesised that this layer may actually act as a barrier to deeper percolation of groundwater and facilitates horizontal shallow migration of groundwater to local discharge points.

The deeper sand unit is reported to consist of interbedded sands, gravels and silty clays above bedrock (reported to be at between 20 and 40 metres depth in the area) with a measured K in the range of 10-50 m/day (PPK 2001, Table 5.17 p103).

The unconfined aquifer beneath the BBIWMR is regionally significant because of its reasonable to fair quality and yield (0.5-2.0 L/sec), however, based on registered users it is not highly used (e.g. In July 2000 there were eight registered private groundwater users in the catchment, ERM (2001)).

Other groundwater users may include registered spear points along the Belongil dune ridge. ERM (2001, p10.24) report this use to be "fairly common" but limited to "watering of gardens". Such occurrence is not expected to influence the hydrogeology either at or surrounding the BBIWMR.

A preliminary assessment of the presence for Acid Sulfate Soils (ASS) has been undertaken across farm land adjacent to the BBIWMR, as shown in Figure 3-1. Previous documentation on the presence of ASS in this area is lacking and there have been general mixed thoughts among stakeholders as to whether ASS is present across this area. The aim of this assessment was twofold:

1. Identify the presence, depth and strength of ASS, and
2. Assess soil and hydrogeology across investigation zone to determine possible connection of groundwater between the BBIWMR and farm land to the west.

As shown in Figure 3-1, the area of investigation is mapped as having a high probability of occurrence of ASS, with Byron Shire Council also mapping the area as Class 2 Acid Sulfate Soils on the Byron Local Environment Plan 2014 (Acid Sulfate Soils Map – Sheet ASS_003). While these maps do not describe the severity of acid sulfate soils, they do provide a preliminary indication that acid sulfate soils could be present in those areas.

3.1 Methods

After determination of probability of ASS occurrence through a desktop assessment (see above), a detailed soil investigation was carried out to including field tests of soil properties, soil sample collection and laboratory analysis. It must be noted that the investigation was not in accordance with the ASSMAC Guidelines (ASSMAC, 1998) in that the density of samples boreholes was reduced and the depth was preliminary only and not specific to any proposed excavation depths.

Nine boreholes were made to a depth of approximately 2.0m, using a Dormer hand auger at the locations shown on Figure 3-1. Each borehole had the following assessment/investigation undertaken:

- Determination of soil properties through field tests including colour, texture and structure through each profile, and
- Soil samples taken:
  - at 500mm increments, or change in soil type in the profile
  - to a depth of 2.5m where possible
  - no sample was taken if the soil was predominantly peat material

The laboratory analysis of soil was undertaken at SCU Lismore to determine the presence of Potential ASS and Actual ASS.

The elevation of each borehole was obtained via LIDAR information taken from the locations of each borehole within a GIS platform.

In accordance with methods outlined in Hirst et al (2009), the saturated hydraulic conductivity (Ksat) of the soil within land adjoining the BBIWMR was assessed at two sites, as shown in Figure 3-1. Saturated hydraulic conductivity of soil defines its ability to transmit water when subject to a hydraulic gradient. In the case of the land adjoining the BBIWMR, this hydraulic gradient can be described as water flow from the paddock through the drainage system or from the groundwater to the surface water within the drains.

The test used can be defined as a modified shallow pit test based on established field based methods outlined in Bouwer and Rice (1983) and Boast and Langebartel (1984) and allows for the rapid assessment of Ksat in shallow groundwater environments.

At each of the sites shown in Figure 3-1, two 50cm x 50cm x 60cm (L x W x D) test pits were dug (Plate 3-1) and a 80cm Odyssey water level logger positioned to record changes in the level of water within the pit. Using a 10L bucket, water within the pit was rapidly bailed out and the logger set to record the level of water within the pit every 5secs. Each pit was assessed three times.

Test pit 1 **_Test pit 2_**

Plate 3-1: Photograph of test pits located in land west of the BBIWMR (refer to Figure 3-1.

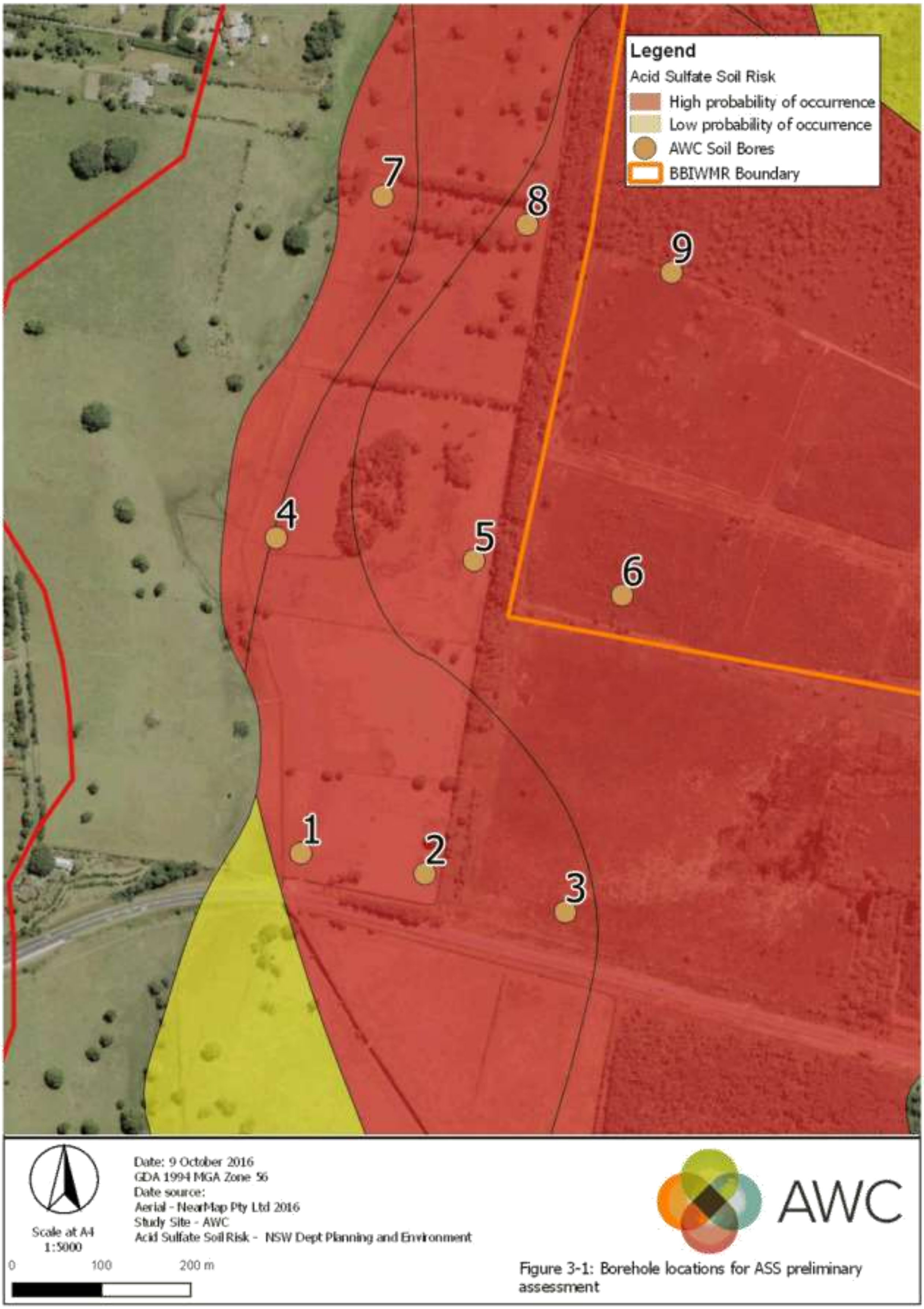


Figure 3-1: Borehole locations for ASS preliminary assessment

3.2 Results and discussion

3.2.1 Acid sulfate soil and geology

Appendix A displays bore logs for each bores assessed, showing elevation of soil layers, soil descriptions and the location of samples taken for ASS analysis. A summary of the pertinent information obtained from each bore is displayed in Table 3-2. The bore logs taken from this assessment show that there is typically peat dominated topsoil over the area of investigation. The depth of this layer varies across the site. Beneath the consolidated peat topsoil horizon a layer of peat/sand clay with a very low bearing capacity is common which forms a sloppy mud when trying to extract. A mix of sand layers and/or clay subsoils were encountered that form an aquitard, accentuating the saturated nature of the upper layer. Appendix A displays bore logs and descriptions from all bores 1 through to 6.

The determination of Potential Acid Sulfate Soil (PASS) is dependent on soil texture and values of reduced inorganic sulfur provided by laboratory analysis; these values are provided in Table 3-3. Displayed on the bore logs within Appendix A, soil samples were taken for the laboratory analysis of ASS at all sites. A summary of these results are provided in Table 3-3, with full laboratory results provided in Appendix A.

Sixteen of the 28 samples collected across the nine boreholes indicated the presence of PASS, with many being substantially above the classification value, with PASS present at all boreholes. Generally soil underlying the peat showed signs of the presence of PASS/ASS. This soil was generally classified as a coarse grey/brown sand, often wet and unconsolidated. Comparing these results with that of work undertaken in the preparation of the BBIWMR Environmental Impact Statement (EIS) indicates some small changes to the geological conceptual site model is required.

The Byron Bay Sewerage Augmentation Scheme– Environmental Impact Statement (2001) reported a Holocene peat/mud underlain much of the BB STP area, with a low saturated hydraulic conductivity (kSat) of 0.2m/day). The bore logs conducted as part of this project have confirmed that this low saturated hydraulic conductivity peat/mud layer is not present beneath the effluent irrigation area or the area south of the effluent irrigation area. Rather, the high kSat (25m/day) Holocene sand is present, extending westward to Moran's Hill, and the Upper Union Drain. Additionally, a narrow band of clay is present running parallel with the Upper Union Drain, extending at least 1m below the peat topsoil. An updated geological conceptual model of the BBIWMR and adjoin land is presented in Figure 3-3, showing the approximate location of soil bores, key geographical features and various components of the BB STP. As can be seen on this figure, a highly porous Holocene Sand is present below the irrigation area and wetlands drains/ponds, extending into the farmland to the west of the BBIWMR.

As shown in Figure 3-3, the invert of the Upper Union Drain and Moran's Hill Drain sites at approximately 1.5mAHD, intercepting the Holocene peat layer and extending into, but through, the Holocene Sand layer. Drawing on data and information taken from the Bryon Bay Integrated Water Management Reserve Groundwater Impact Verification study undertaken in 2010, groundwater moves in a westerly and southerly direction from the BBIWMR.

3.2.2 Saturated hydraulic conductivity

Using the data analysis methods outlined in Hirst et al (2009), the Ksat at each of the sites was estimated. As shown in Figure 3-2, the time it took for the test pits to refill with water was short, with each of the pits reaching 80% static water level in under 5 minutes. This rate of water influx, based on Hirst et al (2009), equates to a high Ksat value, with both pits yielding values between 15 and 100 m/day (Table 3-1).

These results are inconsistent with that previously reported for the Holocene Peat Layer, which was reported to have a low Ksat value of 0.2m/day (Byron Bay Sewerage Augmentation Scheme– Environmental Impact Statement, 2001).

Table 3-1: Ksat results from Test pits 1 and 2.

	Pit 1	Pit 2
Depth to water table	16cm	20cm
Pit width and breadth	50cm x 50cm	50cm x 50cm
Pit depth	60cm	60cm
Test 1	>15, <100m day	>15, <100m day
Test 2	>15, <100m day	>15, <100m day
Test 3	>15, <100m day	>15, <100m day

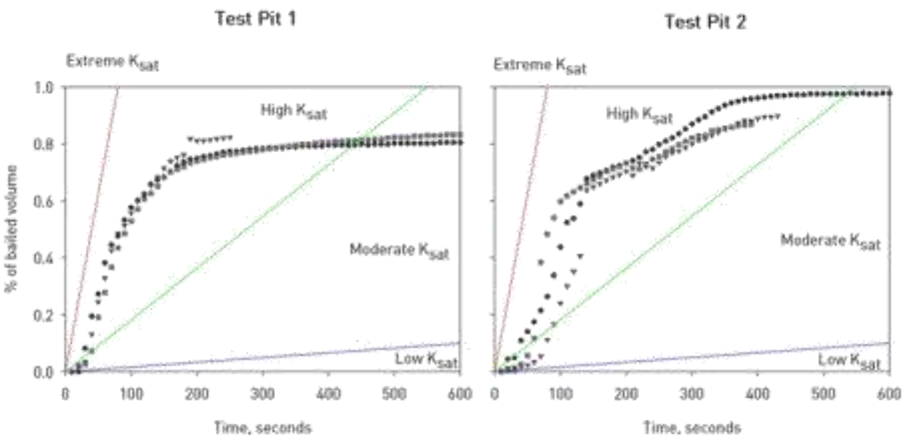


Figure 3-2: Graphs used to estimate Ksat. Different plots on each graph relate to replicate assessments.

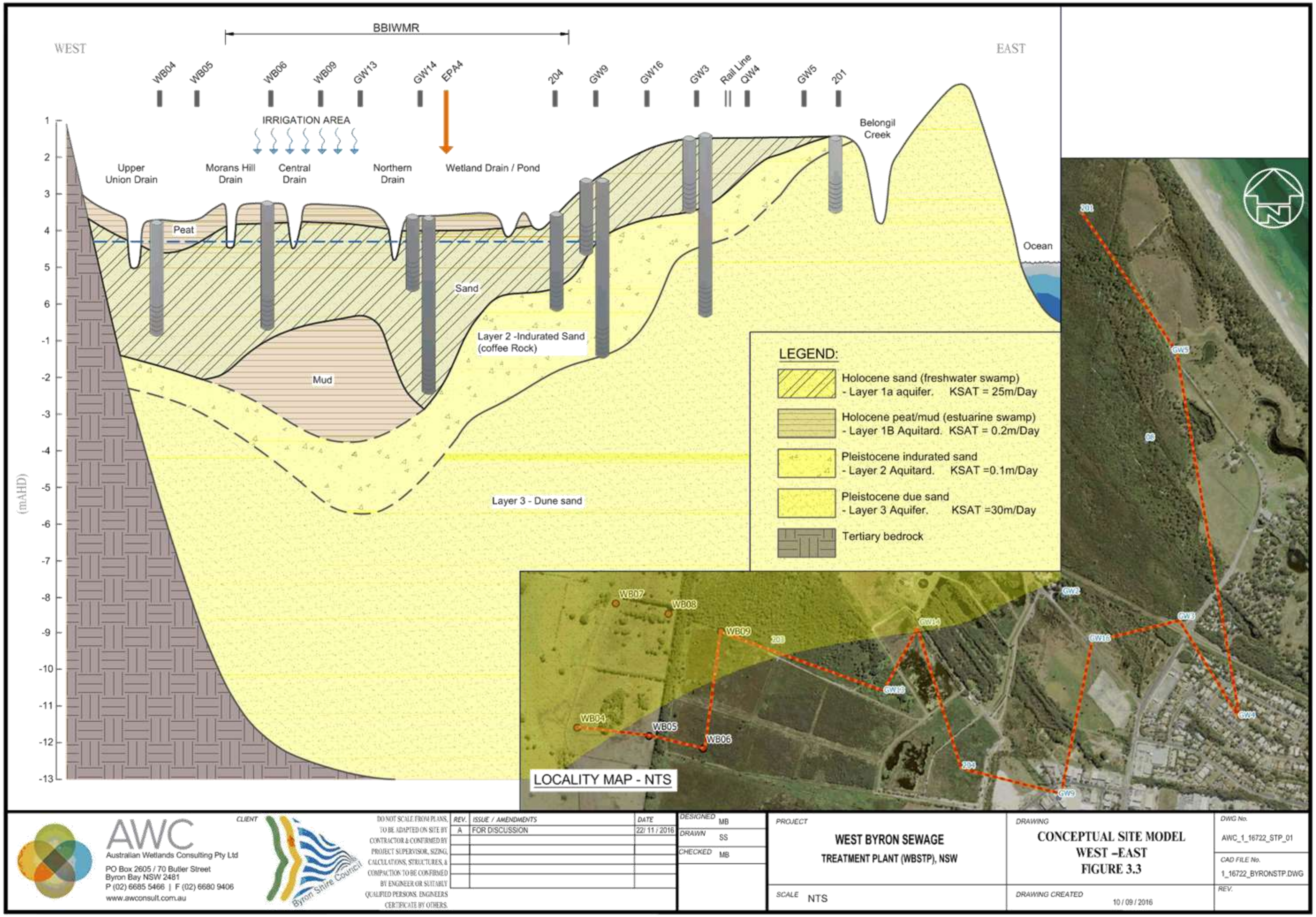
Table 3-2: Basic soil characteristics at each bore

Bore	Elevation (mAHD)		Soil Type	Description
	From	to		
WB01	1.57	1.07	Peat	Dark brown. High organic matter content. Extensive root component in top 200mm
	1.07	-0.43	Sand	Coarse, dark grey. Wetter and less bearing at depth, increase in fine material.
WB02	1.99	1.49	Peat	Dark brown. High organic peat topsoil
	1.49	0.74	Sand	Coarse, dark grey. Abrupt change to coarse grey sand
	0.74	-0.01	Sand	Coarse, brown. Very low bearing. Could not collect samples deeper than 1.5m due to sloppy soil
WB03	2.19	1.39	Peat	Consolidated brown peat with high density roots. Wet.
	1.39	0.99	Peat	Dark drown unconsolidated peat
	0.99	0.19	Sand	Loose/unconsolidated with trace of clay
WB04	1.79	1.49	Peat	Dark brown
	1.49	1.39	Sand	Coarse, dark grey
	1.39	0.49	Clay	Grey/brown fine clay, wet, very low bearing capacity
	0.49	0.29	Sand	Grey coarse sand, unconsolidated. Wet.
WB05	2.09	1.19	Peat	Dark brown
	1.19	0.89	Sand	Coarse, dark grey
	0.89	0.29	Sand	Coarse grey/Brown
	0.29	-0.31	Sand	Coarse grey, compact
WB06	2.79	0.99	Peat	Dark brown peat, roots in top 500mm. Wet. Becoming more loose/unconsolidated with depth
	0.99	0.79	Sand	Grey sand. Wet. Very loose/unconsolidated
WB07	2.16	1.86	Peat	Dark brown peat topsoil
	1.86	1.76	Clay	Mottled grey/orange very stiff clay, variable structure
	1.76	0.16	Clay	Medium grey very stiff clay, Wet
WB08	2.21	1.71	Peat	Brownish/black peat topsoil. Wet.
	1.71	1.31	Peat	Dark brown/grey sand with minor peat. Wet
	1.31	0.21	Sand	Coarse dark grey/brown sand. Wet
WB09	2.44	1.74	Peat	Dark black/brown peaty sand topsoil. Moist.
	1.74	0.44	Sand	Brown sand, loose and wet. Unconsolidated

Table 3-3 Laboratory results - Acid Sulfate Soil (shaded cells infer positive determination of PASS)

Bore	Laboratory sample	Depth, mm	Texture#	Reduced Inorganic Sulphur (% chromium reducible S)	
				[%Scr]	[mole H+/tonne]
WB01	WB - 1 A		Fine	**1.017**	**634**
	WB - 1 B		Fine	**0.840**	**524**
	WB - 1 C		Fine	**1.444**	**901**
WB02	WB - 2 A		Medium	**0.957**	**597**
	WB - 2 B		Medium	**0.171**	**107**
	WB - 2 C		Medium	**0.149**	**93**
WB03	WB - 9A		Medium	**0.242**	**151**
	WB - 9B		Medium	0.024	15
WB04	WB - 4 A		Medium	**0.339**	**211**
	WB - 4 B		Fine	0.042	26
	WB - 4 C		Medium	0.029	18
WB05	WB - 3 A		Fine	**1.159**	**723**
	WB - 3 B		Fine	**0.796**	**496**
	WB - 3 C		Fine	0.064	40
	WB - 3 D		Medium	**0.293**	**183**
WB06	WB - 8A		Coarse	**0.751**	**468**
WB07	WB - 5 A		Fine	0.017	11
	WB - 5 B		Fine	0.013	8
	WB - 5 C		Fine	0.051	32
	WB - 5 D		Fine	**0.100**	**62**
WB08	WB - 6 A		Fine	0.018	11
	WB - 6 B		Fine	0.060	37
	WB - 6 C		Coarse	0.024	15
	WB - 6 D		Coarse	**0.030**	**19**
WB09	WB - 7 A		Fine	0.051	32
	WB - 7 B		Fine	**0.511**	**319**
	WB - 7 C		Fine	0.031	19
	WB - 7 D		Medium	**0.073**	**46**

Classification of Potential Acid Sulfate Soil material if: coarse Scr>0.03%S or 19mole H+/t; medium Scr>0.06%S or 37mole H+/t; fine Scr>0.1%S or 62mole H+/t (Source: EAL results sheet as per QUASSIT Guidelines)


BBIWMR
WEST
EAST
WB04 WB05 WB06 WB09 GW13 GW14 EPA4 204 GW9 GW16 GW3 Rail Line QW4 GW5 201
IRRIGATION AREA
Upper Union Drain
Morans Hill Drain
Central Drain
Northern Drain
Wetland Drain / Pond
Belongil Creek
Ocean
Peat
Sand
Mud
Layer 2 -Indurated Sand (coffee Rock)
Layer 3 - Dune sand
(mAHD)
LEGEND:
Holocene sand (freshwater swamp) - Layer 1a aquifer. KSAT = 25m/Day
Holocene peat/mud (estuarine swamp) - Layer 1B Aquitard. KSAT = 0.2m/Day
Pleistocene indurated sand - Layer 2 Aquitard. KSAT =0.1m/Day
Pleistocene due sand - Layer 3 Aquifer. KSAT =30m/Day
Tertiary bedrock
LOCALITY MAP - NTS
AWC
Australian Wetlands Consulting Pty Ltd
PO Box 2605 / 70 Butler Street
Byron Bay NSW 2481
P (02) 6685 5466 | F (02) 6680 9406
www.awconsult.com.au
CLIENT
Byron Shire Council
DO NOT SCALE FROM PLANS. TO BE ADAPTED ON SITE BY CONTRACTOR & CONFIRMED BY PROJECT SUPERVISOR. SIZING, CALCULATIONS, STRUCTURES, & COMPACTION TO BE CONFIRMED BY ENGINEER OR SUITABLY QUALIFIED PERSONS. ENGINEERS CERTIFICATE BY OTHERS.
REV. ISSUE / AMENDMENTS DATE
A FOR DISCUSSION 22/11/2016
DESIGNED MB
DRAWN SS
CHECKED MB
PROJECT
WEST BYRON SEWAGE TREATMENT PLANT (WBSTP), NSW
SCALE NTS
DRAWING
CONCEPTUAL SITE MODEL WEST –EAST FIGURE 3.3
DRAWING CREATED 10 / 09 / 2016
DWG No. AWC_1_16722_STP_01
CAD FILE No. 1_16722_BYRONSTP.DWG
REV.

3.3 Conclusion

The presence of ASS and PASS was confirmed on land within and adjoining the BBIWMR and effluent discharge location on all soils beneath the topsoil – with the exception of a small number of samples of 'clay' located in a lens running north/south alongside Morans Hill Drain. Topsoil across the effluent irrigation area and farm land west of the BBIWMR is dominated by peat, with a high saturated hydraulic conductivity. A high water table was present at all soil bore sites, with indurated sand underlying all soil bores.

An updated conceptual site model of the BBIWMR and adjoining farmland was built. From this updated model it can be seen that there are limited pathways for effluent loss within the upper groundwater system. This is attributed to:

- the indurated sand layer preventing vertical loss of groundwater to the tertiary dune system,
- basalt rock to the west prevents western movement of groundwater,
- the railway track to the north, and
- Ewingsdale road to the south.

Since 1997 no acid discharge events or peat fires has occurred from the Upper Union Drainage catchment – two types of negative environmental events known to have occurred across this area in the past.

4 Assessment of the current fate of effluent delivered to the BB STP, CW and irrigation area

Effluent from the BB STP is lost via four main pathways: 1) discharge to the upper union drain; 2) discharge via irrigation of 24ha of floodplain forest regeneration; 3) discharge to the urban water reuse scheme; and 4) evapotranspiration from the 22ha constructed wetland system and 24ha effluent irrigation area. Drainage of effluent from the BB STP is primarily governed by a weir location within the BBIWMR prior to effluent entering the Upper Union Drain catchment. This weir provides permanent inundation of most land south of the effluent irrigation area and west of the Cavanbah Sports Centre. A secondary hydrologic control for STP effluent draining from the Upper Union Drain catchment occurs at the pipes flowing south within the Union Drain on Ewingsdale Road. In recent years there has been concern and speculation as to the ultimate fate of effluent discharged within the BBIWMR and its influence of the broader hydrology of the Belongil Catchment. This section of the report aims to collate historical information regarding the effluent release from the BBIWMR, artificial Belongil Estuary opening events, Union Drain water levels, local hydrogeology and stable isotope analysis, with the information used to investigate the fate of effluent discharged with the BBIWMR.

4.1 Methodology

A data set spanning from April 2000 to October 2016 was assessed for trends in effluent discharge, effluent irrigation, rainfall and estuary artificial opening events. This data was sourced directly from BSC. Over the last 5 years, numerous water level loggers (Odyssey Capacitance Water Level Loggers, 1.0 – 1.5m length) have been placed in the Union Drain System, one logger (Ewingsdale Bridge) has been deployed for 5 years, while others have only been deployed for 1-2 years (Table 4-1). Three loggers have also been placed in bores within the upper drainage catchment to assess fluctuations in water table movement. Each water level logger had been set to record water level every 10mins, and survey into to mAHD to display water level / water table height in mAHD. Figure 4-1 displays a map, showing the location of these water level loggers, and the date in which they were deployed.

Over the past 10-20 years 'Stable Isotopes' have been used to trace sewage plumes in both aquatic and terrestrial environments. This 'tracing' technique is based on the phenomenon that the source of energy and trophic connectivity within an ecosystem can be traced via stable isotopes. For example, stable nitrogen and carbon isotope ratios from human and animal sewage can be compared to that of the stable nitrogen and carbon isotope ratios within the receiving environment to help determine the flow pathway of effluents within the receiving environment. Samples within a receiving environment that have a 'Human Sewage Signature' indicates that those particular components of the ecosystem are obtaining nutrients sourced from effluent. Over 50 aquatic plant samples were taken within and adjoining the effluent irrigation area for analysis of both carbon and nitrogen stable isotope ratios ($^{13}C/^{12}C$ and $^{15}N/^{14}N$), at the site shown in Figure 4-1.

Table 4-1: Logger deployment information

Logger Name	Serial Number	Level datum	Date installed	Last download	Date removed
Logger 1	4720	mAHD	29 April 2015	9 June 2016	9 June 2016
Logger 2	4738	mAHD	29 April 2015	Still deployed	30 November 2016
Logger 3	4739	mAHD	29 April 2015	9 June 2016	9 June 2016
Logger 4	4737	mAHD	29 April 2015	Still deployed	30 November 2016
Logger 5	42111	mAHD	29 April 2015	Still deployed	30 November 2016
Logger 6	4740	mAHD	28 April 2015	Still deployed	30 November 2016
Bore North	42110	mAHD	21 May 2015	9 June 2016	9 June 2016
Bore South	42112	mAHD	21 May 2015	Still deployed	30 November 2016
Bore East	4298	mAHD	21 May 2015	Still deployed	30 November 2016
Ewingsdale Bridge	42494	mAHD	3 June 2011	Still deployed	30 November 2016


AWC
Project: Byron Bay STP alternative effluent release assessment
Figure 4-1: Location of ydroperiod loggers, effluent discharge points and stable isotope collection points
Legend
Photograph
BSC Loggers
Tidswell WL Logger locations
Bore WL Logger locations
WL Logger locations
Belongil Estuary Boundary
Stable Isotope sample locations
0 50 100 150 200 m
0 0.25 0.5 0.75 1 km
Date - 01/12/2016
A3 Scale - 1:4000
SOURCE:
Aerial - NearMap Pty Ltd 2016
Study Site - AWC
Care was taken in the creation of this map. AWC should be consulted as to the suitability of the information shown herin prior to the commencement of any works based on the information provided. AWC cannot accept any responsibility for errors, omissions or positional accuracy. There are no warranties, expressed or implied as tot he suitability of this map for a particular purpose. However, notification of any errors will be appreciated.
Ewingsdale Bridge
Union Drain
North
South
East
811
810
1
799
798
801
800
797
3
816
807
808
796
795
809
794
793
792
791
790
789
788
787
803
804
2
806
4
5
6
805
814
813
815
812
802

4.2 Results and Discussion

4.2.1 Assessment of effluent discharge volumes and artificial estuary opening events

Effluent delivery to the BB STP increased in 2006 with the closure of the South Byron STP. As shown in Table 4-2, raw influent into the BB STP increased from median 2ML/day in 1999-2005 to median 4.6ML/day from 2006 onwards. While some of this inflow is reused via the 24ha effluent irrigation scheme or urban reuse (median 0.8ML/day), the majority of the treated effluent is discharged to the environment via the upper union drain (median 3.85Ml/day). Figure 4-2 displays mean monthly effluent flow data between 1999 and 2016, showing high variation in effluent inflow and effluent irrigation volumes, with urban reuse volume relatively uniform over the data collection period. Interestingly, the variation between monthly inflow volumes increases post 2006 which can be attributed to monthly rainfall; increased rainfall results in an increase in STP inflow. This relationship is best illustrated in Figure 4-3, showing a highly significant relationship between monthly rainfall and monthly STP inflow volume. Additional variation in STP inflow can be attributed to school holiday periods when monthly inflow can increase by as much as 1.5ML/day.

When water levels within the Belongil Estuary reach 1.0mAHD at the Ewingsdale Bridge, BSC are permitted (under license from OEH) to artificially open the mouth of the Belongil Estuary to alleviate flood pressures on the CBD of Byron Bay. Pre 2006, artificial estuary opening events occurred on average 5 times a year, generally following >100mm of rain over a 7 day period. Post 2006, artificial estuary opening events have occurred less frequently - an average of 2 times year (Figure 4-2). While estuary opening events have decreased since the transfer of South Byron STP effluent, the rainfall required over a 7 day period to trigger an estuary opening event has appeared to decrease. There are many factors which influence the openings of ICCOLL's, ranging from oceanic conditions, storm surges, longshore drift, sand accumulation and land erosion works. Thus the decrease in the frequency in the artificial estuary opening events may not be wholly attributed to an increase in STP inflow volumes since 2006. However some key observations can be made:

- 7 day accumulated rainfall prior to an estuary opening event post 2006 is less than that pre 2006,
- Water level within the Belongil ICOLL slowly increases if the estuary mouth is closed. This increase can result in levels exceeding 1.0mAHD with no rainfall, generally within 7-10 days, and
- The Belongil Estuary mount is open for longer periods of time post 2006.

From these observations it would appear that since the transfer of the South Byron STP the ~2ML/day increase of treated effluent discharged into the Upper Union Drain has resulted in the more regular unassisted estuary openings. This would have flow on effects for the catchment, including a decrease in flood events within the Byron CBD and likely lower water levels within the lower Belongil Estuary.

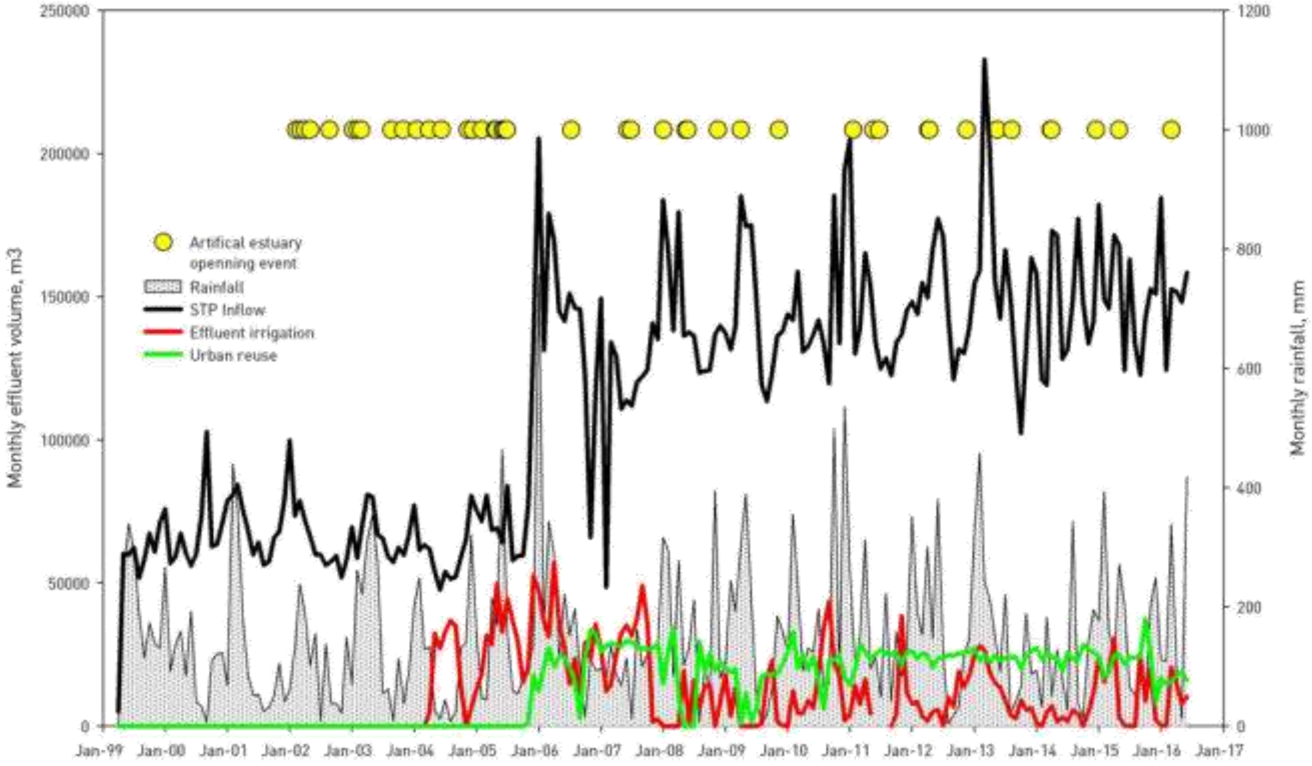


Figure 4-2: BB STP inflow, irrigation and reuse volumes between 1999 and 2016. Artificial estuary opening events also shown.

Table 4-2: Historical effluent delivery to BB STP. All values median ML/day.

Year	Inflow	Irrigation of effluent	Urban Reuse	Discharge to environment
Pre transfer of SB STP				
1999	1.98	0.00	0.00	1.98
2000	2.05	0.00	0.00	2.05
2001	2.22	0.00	0.00	2.22
2002	2.01	0.00	0.00	2.01
2003	2.05	0.00	0.00	2.05
2004	1.92	0.00	0.00	1.92
2005	2.26	1.12	0.00	1.14
Median	**2.05**	**0**	**0**	**2.01**
Post transfer of SB STP				
2006	4.62	1.02	0.79	2.80
2007	4.02	0.79	0.95	2.29
2008	4.39	0.00	0.69	3.71
2009	4.42	0.00	0.58	4.24
2010	4.47	0.43	0.81	3.23
2011	4.42	0.53	0.82	3.07
2012	4.66	0.00	0.81	3.85
2013	5.05	0.14	0.80	4.11
2014	4.73	0.01	0.80	3.93
2015	4.88	0.21	0.79	3.87
2016	5.32	0.15	0.59	4.58
Median	**4.62**	**0.15**	**0.8**	**3.85**

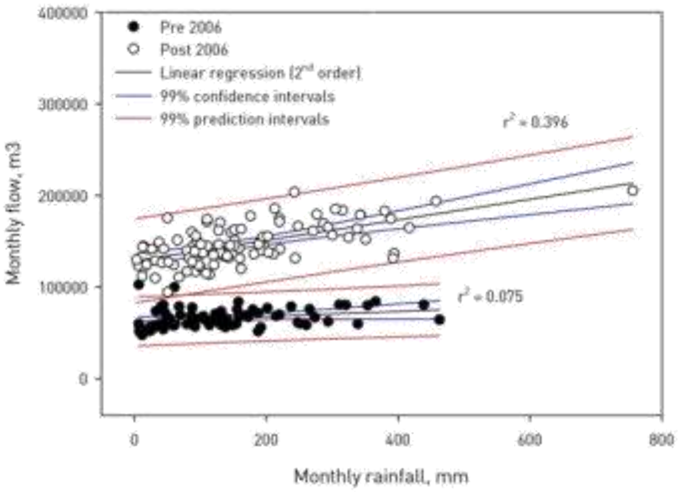


Figure 4-3: Person correlation analysis between rainfall and effluent flow pre and post 2006.

4.2.2 Drain water level assessment

One of the key factors to understanding the influence of the BB STP flows on the hydrology of the catchment is understanding the relationship between the water level within the Union Drain/Belongil Estuary, rainfall, the status of the estuary mouth (open or closed) and the discharge of effluent from the BB STP. As stated in Section 4.1, a network of 10 water level loggers have been established within the catchment, gauging the water level within the drains, creek, estuary and groundwater on an hourly basis (refer to Figure 4-1 for locations of loggers). Data gathered from the network of loggers are displayed graphically in Appendix B. Over the duration of the monitoring period, a number of key observations have been made on the dynamic nature of the water levels within the Union Drain system, Belongil Estuary, rainfall BB STP effluent release:

- Increase in drain and water table level resulting from rainfall,
- Extent of tidal influence into upper drain system, and
- Connection between BB STP effluent flow and drain water levels.

Water levels, groundwater and rainfall

Across all monitoring sites, water levels increase as a result of rainfall. The frequency, magnitude and duration of elevated surface/ground waters as a result of rainfall varies considerably both temporally and spatially. Generally, 50-100mm of rainfall over 2 days will result in elevated ground and surface waters to the extent where extensive flooding occurs across land west of the BBIWMR. This relationship is best illustrated in Figure 4-4, with a series of 50mm + rainfall events in late 2015 which lead to surface flooding. On three occasions between Early November and Late December flooding of the adjoining paddock occurred; preceding the initial two events ~60mm of rainfall was recorded, with 106mm recorded preceding the third event. Interestingly, 60mm of rain falling on the 9/11/2015 resulted in an increase in drain water levels from 1.47 – 1.7mAHD but did not result in flooding of the paddocks. This appears to be the influence of the water level within the drains/groundwater prior to rainfall events. For example, when the drain water level is <~1.4mAHD at Logger 3, 50mm of rainfall will not result in flooding. However, when the water level is >1.7mAHD 50mm of rainfall will result in flooding.

Figure 4-5 illustrates how the water level at Logger 4 increases to a level greater than the drain invert for a period of 4 days following 311mm over two days. The photograph adjoining this graph shows the extent of flooding on the same rainfall event across the land west of the BBIWMR (refer to Figure 4-1 for location and direction of photograph).

While the drainage system of the upper union drain network demonstrably transports effluent efficiently, it is highly likely that since the increased discharge from BB STP in 2006, the regional water table has increased. While this is difficult to demonstrate quantitatively without 'pre 2006' data, the geological cross section presented earlier in Figure 3-3 indicates little pathways for effluent loss outside of the flow under Ewingsdale Road culverts in the Upper Union Drainage system. Furthermore, anecdotal observations by landowners over the past 10 years suggest the water table has increased. This increase in the water table would likely result in an increase in the frequency, duration and depth of inundation resulting from rainfall events owing to the reduced soil store available (in comparison to pre 2006).

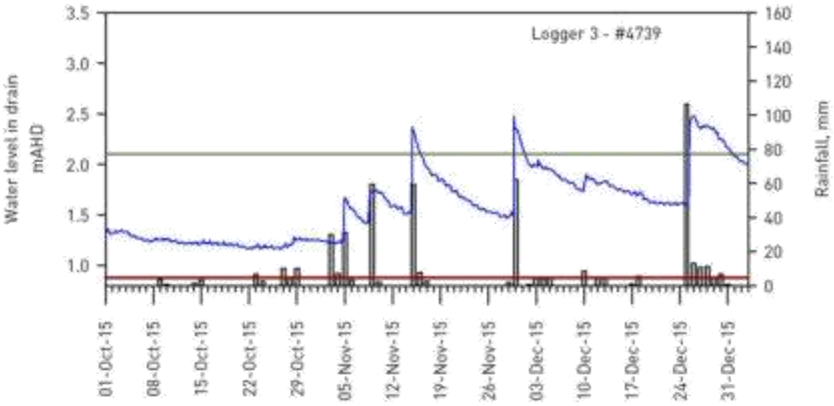


Figure 4-4: Graphical and representation of impact of rainfall events in late June 2015 on water levels in drains. Note location of Logger 3 and photograph on Figure 4-1. The green line represents natural surface level.

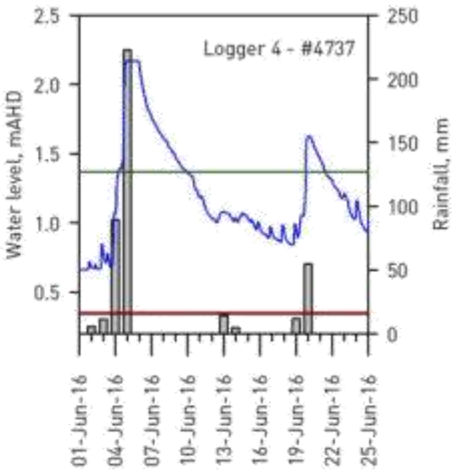
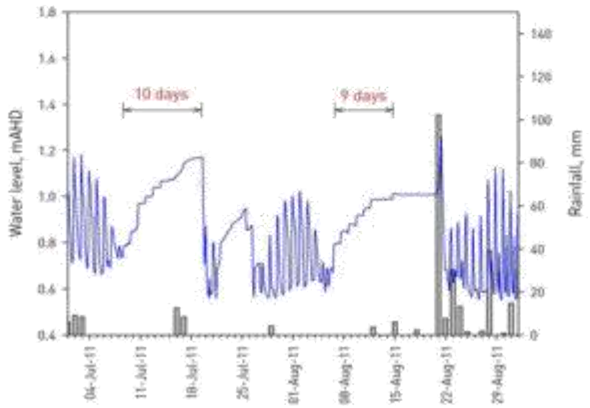


Figure 4-5: graphical and photographic representation of flood events in early and late June 2006. Note location of Logger 4 and photograph on Figure 4-1

Influence of 'closed estuary' on drain system.

Owing to the extremely flat catchment, water levels within the Belongil Estuary substantially influence water levels within the Union and Upper Union drainage system. When the estuary mouth is open, tidal fluctuations in water levels have been recorded north of Ewingsdale Road, at Logger sites 4, 5 and 6. Conversely, when the mouth of the estuary is closed, the level of water within entire Union Drain system rises, as illustrated in Figure 4-6 showing the water level at the Ewingsdale Bridge and the Upper Union Drain over a period with estuary open and closed events. The static water level within the estuary and drainage system appears to be set by the opening status of the estuary mouth and tidal fluctuations.

With an estuary closed event, the water level within the estuary and drainage system incrementally increases 3-5cm per day under non rainfall conditions, reaching a level whereby it overtops the natural sand bar at the estuary mouth OR Council artificially open the mouth of the estuary –as discussed earlier in Section 3.2.1. Under a 'closed' estuary, water levels within the upper union drainage system can be >0.5m when compared to water level under an 'open' estuary regime – however estuary closed events occur only 2-3 times per year and generally for periods <7-10 days.



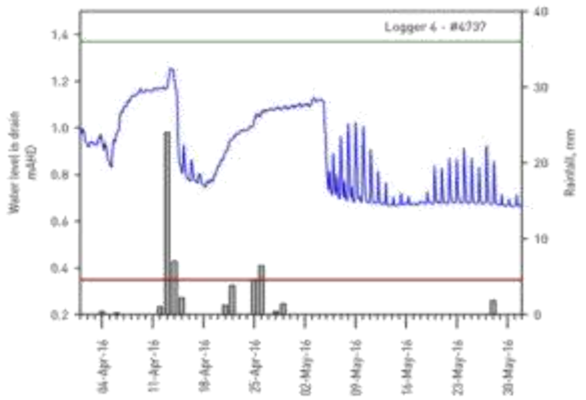


Figure 4-6: Effect of closed estuary mouth on water levels within Belongil Estuary and drain. Logger showing water levels at Ewingsdale Bridge (top graph) and Upper Union Drain (Bottom graph, Logger 4737)

Connection between BB STP effluent flow, irrigation area and drain water levels

Over the past 5-10 years there has been speculation around the effect, if any, of BB STP effluent flow and irrigation on the water levels within Upper Union Drain system. While the EIS (2001) undertaken as part of the BB STP upgrade, work conducted by Bolton (2006) and a post EIS data verification study (AWC, 2010) reported no significant impact to adjoining lands as a result of the upgrade of the BB STP, adjoining landholders remain adamant that there has been an impact. This impact has been defined as:

- more water within the Upper Union Drainage System, and
- increased frequency depth and duration of flooded paddocks.

Unfortunately, all work previous to this study has not included any bores or monitoring sites located on land to the west of the BBIWMR. Additionally, Bolton (2006) investigated the effect of 100m^3/day of irrigation water on surrounding water table levels – significantly less than the mean 370m^3/day irrigation volumes reported in Section 4.2.1 earlier.

It has been reported numerous times that a shallow groundwater mound is present within the BBIWMR, within the vicinity of the constructed wetlands, with groundwater flow moving in all directions but predominantly to the south, west and east (EIS, 2001) owing to the likely influence of the railway line on shallow horizontal groundwater movement.

Appendix B displays water level data from all monitoring points across the Belongil catchment. As can be seen from these figures, the water level in the Upper Union and Union Drainage system, Belongil Creek and shallow groundwater within and adjoining the BBIWMR varies significantly. This variation is largely driven by rainfall, tidal exchange and the opening status of the Belongil Estuary (refer to proceeding section for discussion). As noted in Section 4.2.1, effluent from the BB STP is released to environment via effluent irrigation or direct discharge into the drainage system. Graphs within Appendix B, plot effluent flow alongside drain water level and rainfall for Logger 2 - #4738. As can be seen from this graph, increases in effluent flow generally occur as a result of rainfall and naturally, drain water levels increase in response to rainfall making it difficult to decipher the influence of effluent release on water levels within the drain. However an extract of the data displayed in for Logger 2 - #4738, is provided in Figure 4-7, showing an isolated STP effluent increase of 14ML (compared to 2-3ML/day) on approximately 6th August, 2015 with no corresponding rainfall in the same period. Drain water levels rose in response to this event by approximately 100mm for a period of about 4 days suggesting that effluent discharge does not unduly increase drain water levels.

In previous reports on the assessment of the influence of BB STP effluent on adjoining land uses, STP effluent flow has been estimated at 1-2% of all flows within the Belongil Creek and Estuary. While this is correct, this value is calculated at the Estuary mouth, where tidal exchange and catchment inflow are at their respective maximum. Assessing the influence of BB STP effluent release on catchment flow further up the catchment, within the proximity to it discharge point, provides a somewhat different result. Illustrated in Figure 4-8, catchment flow (data extracted from the results of modelling presented in Section 7) within the Upper Union Drain north of Ewingsdale Road contributes a median 36% of all flows, with the remaining 64% attributed to flow from the BB STP. High or low rainfall periods influence this result considerably, as shown in Figure 4-8, with flow during dry weather being sourced predominantly from the BB STP – often exceeding 90%. During rainfall period, catchment runoff dominates flow in the upper union drainage system, with STP effluent accounting for less than 10% of all flows dependent upon rainfall volumes.

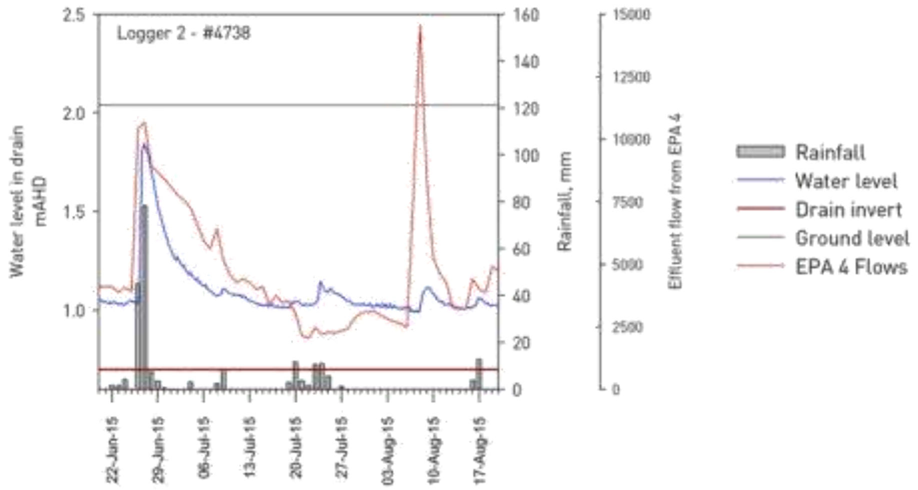


Figure 4-7: Effluent release, rainfall and drain water level

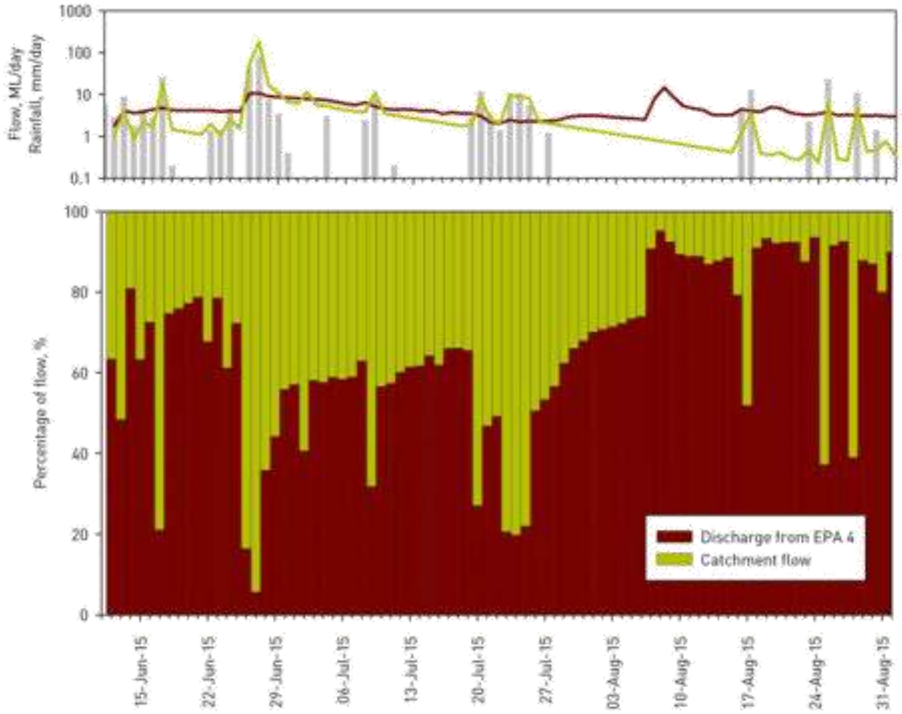


Figure 4-8: Catchment and STP Effluent flow at Upper Union Drain / Ewingsdale Road culvert for select period between June and September 2015. Grey bars represent daily rainfall

4.2.3 Stable isotope assessment

Plants and animals assimilate both stable forms of Nitrogen (N) (14N and 15N) and Carbon (C) (13C and 12C), however they will preference the heavier 15N and 13C where it is available (Mazumder, 2013). Nutrients within human sewage, among other forms of catchment pollution, are usually dominated by these 'heavy' forms for N and C, and as such, ecosystems receiving human effluent may become elevated in the 15N and 13C, relative to the percentage of 14N and 12C.

Results from the stable isotope assessment are provided in Table 4-3, showing little variation in delta 13C values and marginal variation in delta 15N values from the vegetation sampled. Theoretically, trophic groups within ecosystems which are 'impacted' by sewage will have a higher delta 15N and delta 13C values when compared to ecosystems not impacted by sewage. As can be seen from Table 4-3, there is very little difference in 13C values between the sites tested, however there is large variation in 15N values. Site 814, located upstream of the railway line, can be used as a proxy 'control site' – representing a site unlikely to be hydrologically influenced by the operation of the BB STP. At key effluent discharge locations (787-8 – EPA 4, wetland outlet; 802 and 803 – Effluent irrigation outlet), 15N was measured at levels greater than 5, which is reported as being indicative of sites impacted by sewage (Mazumder, 2013).

While the results presented in Table 4-3 do not track 'effluent' from its discharge location through to the Union Drain and Belongil drainage system, it does indicate sewage derived enrichment of the ecosystem within the BBIWMR. This enrichment appears to dissipate prior to entry to the Union Drain and Belongil drainage system, with ecosystem components not showing enriched levels of 15N and/or 13C.

Table 4-3: Results from stable isotope assessment. Refer to Figure 4-1 for locations of samples

SAMPLE ID	%N	%C	d15N	d13C
787	3.85	44.11	10.2	-30.2
788	2.17	41.76	5.9	-30.0
789	3.87	41.48	2.4	-37.4
790	2.99	40.09	2.9	-37.1
791	3.32	39.43	3.4	-32.2
792	1.86	41.50	3.2	-31.4
793	2.56	42.45	4.1	-35.1
794	0.98	46.87	3.4	-29.8
795	1.68	42.41	2.7	-30.0
797	1.57	48.83	1.1	-29.9
798	1.34	52.08	-0.6	-30.0
800	1.17	47.79	-2.1	-27.8
801	0.25	46.52	-0.2	-30.2
802	1.78	47.02	8.8	-31.4
803	3.49	44.23	18.7	-33.4
804	1.87	42.19	4.2	-29.5
805	2.25	37.32	5.1	-31.1
806	1.48	36.06	3.3	-28.6
808	1.41	51.73	-1.0	-32.3
809	1.63	37.68	1.4	-27.4
810	0.72	32.38	1.7	-29.1
811	2.03	41.25	3.9	-29.0
812	0.87	52.78	2.7	-31.5
813	1.06	39.18	3.2	-31.8
814	0.75	45.47	0.0	-33.8
815	1.74	38.65	4.5	-32.3
816	1.26	39.82	-0.7	-26.4

4.3 Conclusion

Since the transfer of the South Byron STP, effluent discharge from the BB STP has increased from a median 2.01ML/day to 3.85ML/day, plus an additional 0.15ML/day used on the effluent irrigation area and a further 0.8ML/day allocated for urban reuse. This increase in discharge can be attributed to the transfer of South Byron STP effluent, plus the apparent increase in flows resulting from storm water infiltration into the sewer system during wet weather. The increase in discharge from the BB STP has resulted in a decrease in the frequency of artificial estuary opening events, reducing from five to six opening events annually to two. Tidal influence when the mouth of the estuary is observed far upstream, with the drainage of the entire catchment influenced when the mouth of the Belongil Estuary is closed.

With the lack of any data on drain and groundwater levels west of the BBIWMR it is difficult to conclusively assess the impact of the increased BB STP flow on the frequency, duration and depth of "flood events". BB STP effluent accounts for a large percentage of flow in the upper catchment, up to 90% during dry weather and reducing down as low as 10% during large rainfall events. As presented in the preceding section, the geology of the land north of Ewingsdale Road creates limited opportunities for effluent losses outside of evapotranspiration or transport through upper union drain system. While the drainage system of the upper union drain network demonstrably transports effluent efficiently, it is highly likely that since the increased discharge from BB STP in 2006, the regional water table has increased. This would result in an increase in the frequency, duration and depth of inundation resulting from rainfall events owing to the reduced soil store available (in comparison to pre 2006).

5 Review and assessment of current flora and fauna values of the Belongil Creek and drainage system

The Belongil Creek, Estuary and Catchment have immense ecological value and social value, with parts of the catchment encompassing the Cumbebin National Park and Cape Byron Marine Park. Furthermore, numerous areas of the catchment are protected under State and/or Federal legislation (e.g. SEPP 14 Coastal Wetlands; EPBC Act). The assessment of current and future effluent release options and volumes must take into account the ecological value of the Belongil Creek, Estuary and Catchment. As defined in Section 1.1, a sustainable effluent release pathway must ensure a balance between economic, social and environmental factors. This section of the report aims to assess the current ecological value of the Belongil Creek, Estuary and its Catchment for the purpose to understand the ecological implications of each wastewater discharge scenario

5.1 Methodology

Two methods where used to assess the current ecological value of the Belongil Creek, Estuary and Catchment:

- Database searches and literature review, followed by
- Field work to ground truth information gained from database searches and literature review.

Prior to field work, searches of the following databases, registers and listings were completed to identify any matters of significance or potential issues:

- Atlas of NSW Wildlife - identify threatened species listed under the *Threatened Species Conservation Act 1995* (TSCA), and *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA) that have records in the local area;
- Protected Matters Search Tool – EPBC;
- SIXMaps Vegetation, Byron Vegetation mapping; and
- Byron Shire Council Local Environmental Plan (LEP) 2014 – Schedule 5;

A review of literature and background studies was also completed to determine constraints or issues relating to:

- Byron Shire Council LEP 2014 (zoning, heritage and general provisions);
- State Environmental Planning Policy No. 44 (Koala Habitat Protection);
- State Environmental Planning Policy No. 14 (Coastal Wetlands); and
- Existing literature on the Belongil Catchment.

Field work for the assessment of the current ecological value of the Belongil Creek, Estuary and Catchment: included:

- Ground truthing of native vegetation present, including description and mapping of the major vegetation communities on the site;
- Identification and mapping of any Endangered Ecological Communities listed under the Threatened Species Conservation Act 1995 (TSC Act), and Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act); and
- Threatened flora and fauna habitat.

5.1.1 Survey Limitations

No targeted Threatened species surveys were conducted. Vegetation communities were classified per class (Keith 2004), due to the large area of study site sufficient data was not collected to determine Plant Community Type (PCT).

5.2 Results and discussion

5.2.1 Existing Flora

A search of the NSW Wildlife Atlas (01/08/2016), based on an area of 10km by 10km centered on the BB STP, confirmed records of 23 Threatened flora species listed under the TSC Act 1995, including 15 species also listed under the EPBC Act 1999 (Table 5.1).

A review of Schedule 1 of the TSC Act 1995 indicates that 11 EECs are recorded to occur within the locality, the following communities are known to or are likely to occur within the study area:

- Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions;
- Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions;
- Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion;
- Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion; and
- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.

Table 5-1. Threatened Flora species recorded in the Locality

Scientific Name	Common Name	Status		Records
		TSC	EPBC	
Allocasuarina defungens	Dwarf Heath Casuarina	E1	E	1,144
Davidsonia jerseyana	Davidson's Plum	E1, 2	E	36
Archidendron hendersonii	White Lace Flower	V	-	24
Xylosma terrae-reginae	Queensland Xylosma	E1	-	8
Cryptocarya foetida	Stinking Cryptocarya	V	V	113
Endiandra floydii	Crystal Creek Walnut	E1	E	1
Endiandra muelleri subsp. bracteata	Green-leaved Rose Walnut	E1	-	7
Owenia cepiodora	Onion Cedar	V	V	1
Tinospora tinosporoides	Arrow-head Vine	V	-	19
Syzygium hodgkinsoniae	Red Lilly Pilly	V	V	7
Syzygium moorei	Durobby	V	V	44
Diuris sp. aff. chrysantha	Byron Bay Diuris	E1,2	-	5
Geodorum densiflorum	Pink Nodding Orchid	E1,2	-	121
Phaius australis	Southern Swamp Orchid	E1,2	E	8
Pterostylis nigricans	Dark Greenhood	V, 2	-	26
Arthraxon hispidus	Hairy Jointgrass	V	V	9
Floydia praealta	Ball Nut	V	V	2
Grevillea hilliana	White Yiel Yiel	E1	-	1
Hicksbeachia pinnatifolia	Red Boppel Nut	V	V	6
Macadamia integrifolia	Macadamia Nut	P	V	5
Macadamia tetraphylla	Rough-shelled Bush Nut	V	V	38
Acronychia littoralis	Scented Acronychia	E1	E	9
Melicope vitiflora	Coast Euodia	E1	-	2
Diploglottis campbellii	Small-leaved Tamarind	E1,2	E	1
V= Vulnerable; E= Endangered; CE= Critically Endangered species pursuant to the TSC Act or EPBC Act				

Vegetation mapping

Mapping of the majority of the site was generally found to be consistent with profile description and extent mapped in Figure 5-1. Vegetation communities were classified as per Plant Community

Class in the NSW Vegetation Information System (VIS) Classification Database (Version 2.0, Office of Environment & Heritage 2012, Keith 2004).

The catchment is largely dominated by Coastal Swamp Forest, namely Broadleaved Paperbark Swamp Forest with patches of Littoral Rainforest and Coastal Freshwater Lagoons scattered throughout. Coastal Freshwater Lagoons are common at the STP site and scattered over sections of pastoral land greater than ~1km from the coast. There is a strip of Mangrove Swamp which follows the southern bank of Belongil creek. A strip of Saltmarsh, up to 100m in width in some section boarders the inland section of the Mangrove Swamp.

Coastal Swamp Forests

Majority of the Coastal Swamp Forests on site are classified as Paperbark Swamp Forest of the Coastal Lowlands of the North Coast. Condition and species composition varies over the study area, however in general the community comprises a low-mid dense paperbark forest, typically 15-20 m tall, with minimal shrub cover and dense graminoid groundcover. The canopy is dominated by Broadleaved Paperbark (*Melaleuca quinquenervia*), Willow Bottlebrush (*Callistemon salignus*), with occasional stands of Swamp Oak (*Casuarina glauca*) and with scattered stands of Swamp Mahogany (*Eucalyptus robusta*). Ground cover is dominated by species such as Bare Twig Rush (*Baumea juncea*) and Tassel Rope-rush (*Restio tetraphyllus*).

Littoral Rainforest

Several stands of Littoral Rainforest exist within the study area, all within 1km of the coast. The community is dominated by a dense canopy of Rainforest trees (Figs, Palms), Tuckeroo (*Cupaniopsis anacardioides*) and Lilly Pilly (*Acmena spp.*). In most stands the understorey is relatively sparse and dominated by herbs and several ubiquitous vines. There are relatively few ferns, although these and epiphytes become common in sheltered locations.

Saltmarsh

The Saltmarsh community within the study area comprises a mosaic of closed to open herbland and grassland dominated by Marine Couch (*Sporobolus virginicus*), Bare Twig Rush (*Baumea juncea*), Common Reed (*Phragmites australis*) and Mangrove Fern (*Acrostichum speciosum*). The community occurs in hypersaline estuarine mudflats subject to occasional tidal inundation.

Coastal Dune Dry Sclerophyll Forest

Sections of Coast Banksia woodland occur on highly elevated land within close proximity to the coast and amongst Swamp Forest. The community comprises an open woodland, with scattered Coastal Banksia, Heath leaved Banksia and Broad-leaved Paperbark. Groundcover dominated by Bare Twig Rush (*Baumea juncea*), Coastal Banksia (*Banksia integrifolia*), Mangrove Fern (*Acrostichum speciosum*), Raspwort (*Gonocarpus spp.*), Tassel Rope-rush (*Restio tetraphyllus*), Blady Grass (*Imperata cylindrica*), with sections of Bracken (*Pteridium spp.*).

Coastal Freshwater Lagoon

Common throughout STP site and occasional elsewhere, comprised of Common Reed grassland on gently undulating plains of Aeolian and estuarine origin. This community has an absent canopy with dense wet heath species dominated by Red-fruit Saw Sedge (*Gahnia sieberiana*), Common Reed

(*Phragmites australis*), Setaria (exotic), Bulrush (*Typha orientalis*) with scattered exotic pines. Pines become dense in some sections (predominantly within the south eastern corner of the STP) creating a dense canopy with thick pine needle ground cover.

Coastal Heath Swamp

There are several patches of coastal heath swamp sparsely scattered throughout the study area. The community comprises a matrix of tall dense sedgeland/fernland and Banksia/Grass Tree heathland. In most stands the sedgeland has an absent canopy and is dominated by Bats-wing Fern (Histiopteris incisa), Tassel Cord Rush (*Restio tetraphyllus*), Swamp Water Fern (*Blechnum indicum*), Red-fruit Saw Sedge (*Gahnia sieberiana*) and Coral Fern (*Gleichenia microphylla*). In some sections Spear Grasstree (*Xanthorrhoea resinifera*), *Leptospermum spp.* and several *Banksia spp.* (fern-leaved & heath-leaved) are also abundant.

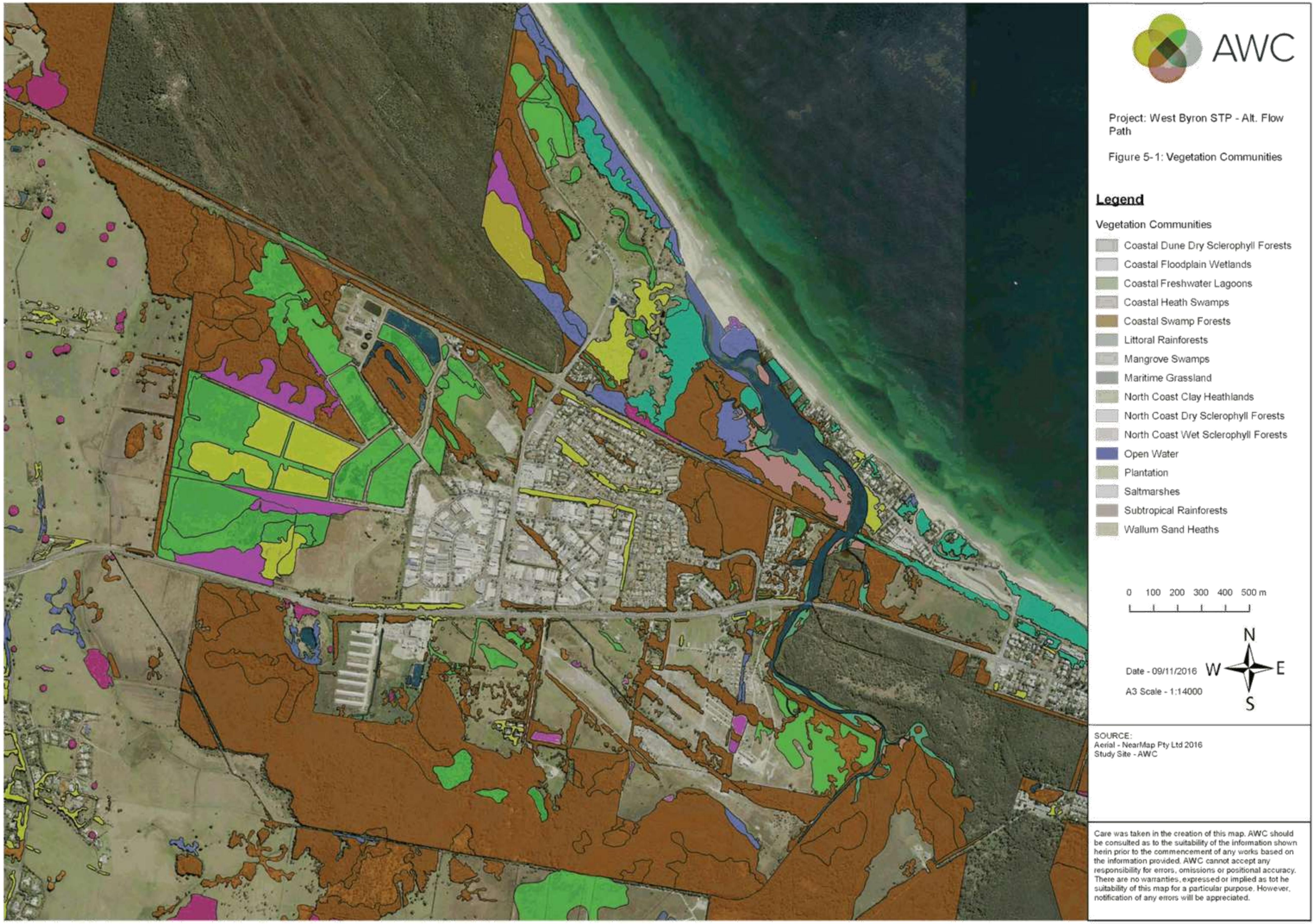
SEPP 14 – Wetland

There is a large area (> 300 ha) of SEPP 14 wetland mapped within the study area (Figure 5-2). Much like the rest of the vegetation within the study area, the SEPP14 wetland has experienced various levels of disturbance, depending on location.

Vegetation Condition

The vegetation in the Belongil catchment has been impacted upon by various anthropogenic activities including: clearing, alteration of drainage lines, agricultural practices (such as grazing), urbanisation, increase in pollution from stormwater runoff and entrance opening. It is expected that much of the Belongil catchment was a mosaic of *Melaleuca quinquenervia* forest, freshwater swamps, *Casuarina glauca* forest on slightly higher or more exposed ground, rainforest patches (often with *Melaleuca*) and saltmarsh. Generally, within vegetation stands the condition is moderate-good with weed species relatively sparsely distributed. Typical species include Winter Senna, Lantana, asparagus fern, Coastal Morning Glory and Umbrella Tree. Three listed noxious weed species were recorded:

- Groundsel Bush (*Baccharis halimifolia*);
- Crofton Weed (*Ageratina adenophora*); and
- Bitou Bush (*Chrysanthemoides monilifera subsp rotunda*).


AWC
Project: West Byron STP - Alt. Flow Path
Figure 5-1: Vegetation Communities
Legend
Vegetation Communities
Coastal Dune Dry Sclerophyll Forests
Coastal Floodplain Wetlands
Coastal Freshwater Lagoons
Coastal Heath Swamps
Coastal Swamp Forests
Littoral Rainforests
Mangrove Swamps
Maritime Grassland
North Coast Clay Heathlands
North Coast Dry Sclerophyll Forests
North Coast Wet Sclerophyll Forests
Open Water
Plantation
Saltmarshes
Subtropical Rainforests
Wallum Sand Heaths
0 100 200 300 400 500 m
N
W
E
S
Date - 09/11/2016
A3 Scale - 1:14000
SOURCE:
Aerial - NearMap Pty Ltd 2016
Study Site - AWC
Care was taken in the creation of this map. AWC should be consulted as to the suitability of the information shown herin prior to the commencement of any works based on the information provided. AWC cannot accept any responsibility for errors, omissions or positional accuracy. There are no warranties, expressed or implied as tot he suitability of this map for a particular purpose. However, notification of any errors will be appreciated.


AWC
Project: West Byron STP - Alt. Flow Path
Figure 5-2: SEPP 14 - Wetlands
Legend
SEPP14 Wetlands
0 100 200 300 400 500 m
N
W
E
S
Date - 09/11/2016
A3 Scale - 1:14000
SOURCE:
Aerial - NearMap Pty Ltd 2016
Study Site - AWC
Care was taken in the creation of this map. AWC should be consulted as to the suitability of the information shown herin prior to the commencement of any works based on the information provided. AWC cannot accept any responsibility for errors, omissions or positional accuracy. There are no warranties, expressed or implied as tot he suitability of this map for a particular purpose. However, notification of any errors will be appreciated.

5.2.2 Terrestrial and aquatic fauna

A search of the NSW Wildlife Atlas (01/08/2016), based on an area of 10km by 10km centered on the site returned confirmed records of 57 Threatened fauna species listed under the TSC Act 1995, including 20 species also listed under the EPBC Act 1999 (Table 5.2).

Threatened Fauna

Two confirmed Threatened fauna species, Eastern Osprey (*Pandion haliaetus*) and Pied Oyster Catcher (*Haematopus longirostris*) which are listed under the *TSC Act 1995*, were recorded during the survey. However due to the small survey effort relative to large area of the study site and occurrence of suitable habitat in the area it is likely that the following species occur within the study area:

- Wallum Froglet;
- Olongburra Frog;
- Wompoo Fruit-Dove;
- Superb Fruit-Dove;
- Black-necked Stork;
- Spotted Harrier;
- Pale-vented Bush-hen;
- Beach-stone Curlew;
- Bush-stone Curlew;
- Sooty Oystercatcher;
- Curlew Sandpiper;
- Eastern Curlew;
- Little Tern;
- Glossy Black Cockatoo;
- Eastern Grass Owl;
- Swift Parrot;
- Common Planigale;
- Common Blossom Bat;
- Koala;
- Long-nosed Potoroo;
- Grey-headed Flying-fox;
- Little Bentwing-bat;
- Eastern Bentwing-bat; and
- Southern Myotis.

Migratory/Marine Fauna

Two species, the Rainbow Bee-eater (*Merops ornatus*) and Cattle Egret (*Bubulcus ibis*) listed as Migratory/Marine under the *EPBC Act 1999* were recorded during the survey. It is expected that numerous other species also occur within the study area.

Existing Habitat Values

The suitability of the study area for typical vertebrate fauna groups is described as follows:

Amphibians: The drains and low-lying swamp forest in the study area provide suitable habitat for a range of Threatened amphibian species, including Wallum Froglet (*Crinia tinnula*) and Olongburra Frog (*Litoria olongburensis*). Other common species likely to occur including Peron's Tree Frog (*Litoria peroni*), Tyler's Tree Frog (*L. tyleri*), Bleating Tree Frog (*L. dentata*) and Green Tree Frog (*L. caerulea*).

Reptiles: Habitat for reptiles various throughout the study area, with established litter layer within Littoral Rainforest and drier conditions are more suitable to species such as the Robust Ctenotus, Lace Monitor (*Varanus varius*), and Yellow-faced Whip Snake (*Demansia psammophis*). Species such as the Green Tree Snake (*Dendrelaphis punctulata*), Carpet Python (*Morelia spilota*), Marsh Snake (*Hemiaspis signata*), Burtons Snake Lizard (*Lialis burtonis*) and several skink species are likely to occur over most of the area, both dry and moist.

Birds: A diversity of birds was recorded and is considered typical of the suite of species which occur in coastal swamp forest, wetlands, saltmarsh, rainforest and peri-urban environments. During flowering periods, it would be expected that nectivorous species such as lorikeets, honeyeaters, Wattlebirds and Friarbirds would commonly occur. Drainage line and creek environments provide habitat for the aquatic bird species including Ducks and White Ibis (*Threskiornis moluccus*), White-faced Heron (*Egretta novaehollandiae*) and Egret species, while the open water provides good hunting opportunities for marine raptors such as the Osprey (*Pandion haliaetus*) and White-bellied Sea-eagle (*Haliaeetus leucogaster*). Due to their secluded nature, the sand dunes and beach environments near the mouth of the estuary provide good quality foraging and breeding habitat for several shorebirds including the Pied Oyster Catcher (*Haematopus longirostris)* and Little Tern (*Sternula albifrons*). There is a known breeding location for Pied Oyster Catchers currently sections off on the southern side of the mouth, and a pair was observed during the survey.

Mammals: During the survey, numerous scats likely attributed to macropod species (Swamp Wallaby) were observed along with diggings believed to be that of the Long-nosed Bandicoot were relatively common in the eastern portion of the site. The dense ground cover on site is likely to support species rodent species such as the Bush, Swamp and Black Rats and Grassland Melomys (*Melomys burtoni*). Paperbarks are likely to form part of the larger foraging range for microchiropteran bats, furthermore Banksias, Paperbarks and other flowering trees are likely to provide a nectar source for Grey-headed flying foxes (*Pteropus poliocephalus*) and glider species. Preferred feed tree species for Koala (*Phascolarctos cinereus*), (Swamp Mahogany, Forest Red Gum) are limited to throughout the study area and records in the locality are scarce (Atlas of NSW Wildlife), however the site may be used on occasion by wandering animals for both feeding and shelter.

Aquatic habitat: Mangroves found in the lagoon are particularly valuable as a nursery, providing food and shelter for a great diversity of aquatic macroinvertebrates, small animals, and fish. Native fish that live in in the catchment include freshwater, estuarine and marine species such as the Striped Gudgeon (*Gobiomorphus australis*), Sea Mullet (*Mugil cephalus*), Dusky Flathead (*Platycephalus fuscus*), Luderick (*Girella tricuspidata*), and Sand Whiting (*Sillago ciliata*).

Corridors: The study area is located at the intersection of several wildlife corridors which act to connect wildlife to the north, south and west. These corridors connect the area to Tyagarah NR to the north and Arakwal NP to the east. This connectivity benefits a broad range of fauna assemblages, especially gap-shy woodland birds and arboreals. Habitat links throughout most of the study area could facilitate movement of moderate to highly mobile species. In large sections of the area trees and other habitat links are close enough for gliders and most passerine birds to transverse throughout the site. Pastoral woodland, which is common throughput the study area, increases the risk of predation (eg by foxes and wild dogs) and harassment by dominating species such as Noisy Miners. Ewingsdale Road, which runs west-east, through the centre of the site acts as a biodiversity barrier to many species both physical and behaviourally. The road increases the risk of vehicle collision whilst exposing the species to predators. There are no dedicated fauna underpasses or crossing bridges in place to help facilitate the movement fauna across the highway in the vicinity of the site.

Table 5-2. Threatened Fauna Recorded within the locality

Scientific Name	Common Name	NSW Status	Conservation Status
Crinia tinnula	Wallum Froglet	V,P	
Mixophyes iteratus	Giant Barred Frog	E1, P	E
Litoria aurea	Green and Golden Bell Frog	E1,P	V
Litoria olongburensis	Olongburra Frog	V,P	V
Caretta caretta	Loggerhead Turtle	E1,P	E
Chelonia mydas	Green Turtle	V,P	V
Eretmochelys imbricata	Hawksbill Turtle	P	V
Ptilinopus magnificus	Wompoo Fruit-Dove	V,P	
Ptilinopus regina	Rose-crowned Fruit-Dove	V,P	
Ptilinopus superbus	Superb Fruit-Dove	V,P	
Macronectes giganteus	Southern Giant Petrel	E1,P	E
Macronectes halli	Northern Giant-Petrel	V,P	V
Pterodroma leucoptera leucoptera	Gould's Petrel	V,P	E
Pterodroma neglecta neglecta	Kermadec Petrel (west Pacific subspecies)	V,P	V
Pterodroma nigripennis	Black-winged Petrel	V,P	
Ephippiorhynchus asiaticus	Black-necked Stork	E1,P	
Ixobrychus flavicollis	Black Bittern	V,P	
Circus assimilis	Spotted Harrier	V,P	
Hieraaetus morphnoides	Little Eagle	V,P	
Lophoictinia isura	Square-tailed Kite	V,P,3	
Pandion cristatus	Eastern Osprey	V,P,3	
Grus rubicunda	Brolga	V,P	
Amaurornis moluccana	Pale-vented Bush-hen	V,P	
Burhinus grallarius	Bush Stone-curlew	E1,P	
Esacus magnirostris	Beach Stone-curlew	E4A,P	
Haematopus fuliginosus	Sooty Oystercatcher	V,P	
Haematopus longirostris	Pied Oystercatcher	E1,P	
Irediparra gallinacea	Comb-crested Jacana	V,P	
Calidris ferruginea	Curlew Sandpiper	E1,P	CE,C,J,K
Calidris tenuirostris	Great Knot	V,P	CE,C,J,K
Numenius madagascariensis	Eastern Curlew	P	CE,C,J,K
Onychoprion fuscata	Sooty Tern	V,P	
Sternula albifrons	Little Tern	E1,P	C,J,K
Calyptorhynchus lathami	Glossy Black-Cockatoo	V,P,2	
Glossopsitta pusilla	Little Lorikeet	V,P	
Tyto longimembris	Eastern Grass Owl	V,P,3	
Tyto novaehollandiae	Masked Owl	V,P,3	
Tyto tenebricosa	Sooty Owl	V,P,3	
Carterornis leucotis	White-eared Monarch	V,P	
Stagonopleura guttata	Diamond Firetail	V,P	
Dasyurus maculatus	Spotted-tailed Quoll	V,P	E
Planigale maculata	Common Planigale	V,P	
Phascolarctos cinereus	Koala	V,P	V
Potorous tridactylus	Long-nosed Potoroo	V,P	V
Pteropus poliocephalus	Grey-headed Flying-fox	V,P	V
Syconycteris australis	Common Blossom-bat	V,P	
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V,P	
Miniopterus australis	Little Bentwing-bat	V,P	
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V,P	
Myotis macropus	Southern Myotis	V,P	
Nyctophilus bifax	Eastern Long-eared Bat	V,P	
Scoteanax rueppellii	Greater Broad-nosed Bat	V,P	
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	V,P	
Megaptera novaeangliae	Humpback Whale	V,P	V
Thersites mitchellae	Mitchell's Rainforest Snail	E1	CE
V= Vulnerable; E= Endangered; CE= Critically Endangered species pursuant to the TSC Act or EPBC Act			

5.2.3 Potential ecological impacts resulting from altered catchment hydrology

Changed hydrology and hydraulics have the potential to have severe consequences on the ecological values within a vegetation community, particularly groundwater dependent ecosystems (GDE's). Many species have a 'threshold' or tolerance level to particular conditions, when exceeded these conditions effect the health of that species, in turn altering ecosystem structure. In the Belongil Estuary in particular, the interaction of natural variation, changes in land use and changes brought about by artificial opening of the estuary mouth makes the impacts of any entrance opening strategy difficult to quantify. However, the physical impacts discussed above are known to have the potential to result in the following impacts on ecological values:

- Altered species composition;
- altered species distribution;
- species mortality;
- altered species richness;
- altered species abundance; and
- altered community structure.

A decline in condition of vegetation

In some cases, alternations in the water regime are known to result in a decline in the health of individual plant species. Plants that are present in swamps, wetlands and saltmarshes establish under specific conditions that suit their anatomy and physiology. If the environment experiences a change for an extended period of time, the condition of these species can decline. The severity of this decline in health is dependent on the extent of change.

The anatomy and physiology of plants governs the ability of each species to respond to changes in their environment. An Increase in the duration or depth of inundation may restrict access to sufficient oxygen, and this lack of oxygen in the soil results in lower soil conditions that lead to the development of toxic compounds that can affect plants. In response to a restriction to oxygen plants may initially wilt, drop leaves and branches, and ultimately die if the duration of inundation is sustained. Each plant species responds to inundation differently. For example, common wetland tree species such as *Melaleuca* are unable to respond to extensive and rapid changes in water levels however they tolerate several years of continuous inundation before tree death occurs. Therefore, the impact of a changed water regime may not be recognised until years after a change has been implemented.

Changes in species distribution and abundance

Changes in water regime can change species distribution within a wetland. If changes in hydrology are beyond the ability of a particular species to adapt, the vegetation community may begin to shift, altering the species distribution throughout the ecosystem. A change in species distribution may only occur if there is: another location that meets its water requirements and other conditions such as suitable soil type, an area is available for colonisation and seeds or vegetative parts that are able to reach that location.

Many species can tolerate an increase or decrease in conditions (such as salinity, inundation level) for a short period, however if exposure extends beyond a time period, a negative influence may be experienced. For example, when *M. quinquenervia* is exposed to increased salinity levels (above 10 dS/m) germination percentage is greatly decreased. The species can tolerate these higher salinity levels for short periods however, if salinity is permanently increased, germination percentage will decrease, most likely resulting in dieback of this species, reducing canopy cover and altering the ecosystem structure. (IERM, 2005).

Loss of species or change in species composition

Altered hydrology can change the species composition present at a wetland, in turn transitioning from one vegetation community to another. In some circumstances, more sensitive species may decline, while more tolerant species may increase in abundance (native or exotic). These changes in composition can be short, medium or long term, depending upon the changes that have occurred and the resilience of the species to variability (DEC, 2014). For example, if Paperbark Swamp Forest is inundated for extended periods, canopy species such as *Melaleuca quinquenervia* and *Eucalyptus robusta* may die back. Depending on salinity levels, the ecosystem may transition into a treeless vegetation community such as freshwater wetland or saltmarsh (DEC, 2014).

The discharge of stormwater into saltmarsh communities can alter the salinity regimes, increases nutrient levels and facilitates the spread of introduced species. If a saltmarsh habitat is inundated for an extended period, the community can experience a dieback of saltmarsh species, changing the species composition of the marsh. Common Reed (*Phragmites australis*) spreads rapidly to form extensive stands in tidally isolated saltmarshes and alters the landscape, hydrology, ecology and function of the entire community. Where tides have been excluded from saltmarsh habitats for extended periods, vegetation will change to either freshwater or terrestrial communities (NSW Gov, 2008).

Changes in nutrient loads can also affect ecosystem function downstream from a development. For example, in coastal wetlands an increase in the loads of nutrients (such as nitrogen and phosphorus) and suspended solids entering waterways in runoff after rain are taken up by some types of aquatic plants, particularly macro algae and phytoplankton. When exposed to high nutrients these plants become dominant over plants living on the waterbody floor (seagrasses and benthic microalgae) (OEH, 2013).

Additionally, weeds compete with native wetland species and habitats, and when the community is exposed to changed conditions, they may replace them altogether. Common weeds in coastal wetlands include Lantana (*Lantana camara*), Salvinia (*Salvinia molesta*) and Caulerpa (*Caulerpa taxifolia*), (OEH, 2013).

Impacts to Fauna

When a vegetation community experiences a shift in vegetation composition and structure the habitats of native fauna are also altered. In the past, the Belongil catchment have seen fauna habitat be jeopardised through the clearance of vegetation and alterations in the hydrological and salinity regime of Belongil Creek. (IERM, 2005)

Individual species survive within specific ranges of temperature, water regime and chemical conditions. When these ranges are exceeded the species has several options; adaptation or migration or they will locally die out. As with flora, the sensitivity of a particular species is determined by physiology (e.g. metabolic requirements and tolerances to climatic conditions), ecology (e.g. life history, habitat use, behaviour, dispersal and biotic and abiotic interactions) and genetic diversity.

Changes in the natural water-regime may disrupt natural processes such as triggers (fish spawning), migration etc. resulting in a decline in native fish populations. Species of mammals, birds, reptiles, frogs, fish, invertebrates, fungi, plants and bacteria may all be affected. Altered hydrology can lead to invasion by new species (both native and introduced), as the new water regime provides suitable conditions where they did not exist before (Harding, 2012).

Sensitivity of many species to changes in environment is dependent on the phase of their lifecycle. Frogs are a good example as they have the ability to migrate to favorable conditions, however if the water levels dry rapidly, during the breeding season, tadpoles will not be able to mature past their aquatic phase. In these ways, altered water regime can have significant impacts on a wetland's species composition. Altered water regimes have the potential to influence the habitat of fauna through the depletion of seedbanks through flooding or drying; reducing plant growth and therefore reducing foraging and shelter sources; disrupting pollination, symbiosis and other biological interactions.

Changes in population distributions

Highly mobile species, with the ability to disperse can show significant population-scale changes in distribution in response to changes to the hydrology regime. Migratory birds may also be affected the changes (disruptions to the synchronicity of migration and prey flushes), ultimately altering the timing of environmental cues to migrate (DEC, 2014).

5.3 Conclusion

The Belongil Creek, ICOLL and drainage system provides a large expanse of high quality habitat for various terrestrial and aquatic species. Habitat quality varies throughout the catchment varies, with some sections have experienced high levels of disturbance in the past. However, swamp forest (large proportion mapped as SEPP 14), mangroves, saltmarsh and regenerating areas with the STP provide high quality habitat for multiple species listed under the TSC Act and EPBC Act. Known breeding habitat for several species such as the Little Tern and Pied Oyster Catcher occurs within the catchment, meaning that conservation of these environments is essential for the sustainability of the local population. Furthermore, the following Endangered Ecological Communities (EECs) are known to occur within the catchment:

- Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions;
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions;
- Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions;
- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions,

Overall the catchment hosts an array of high value ecological features including threatened species habitat (flora and fauna), EECs, SEPP 14 wetland, GDE's and wildlife corridors (regional and sub regional). Many values are dependent upon the prevailing hydrological regime and are sensitive to changes in hydrology. Management actions must demonstrably have no adverse effect on these vegetation communities.

6 Identification of alternative flow paths for the discharge of STP effluent

A key output of this project is the identification of a preferred effluent release pathway, which will be determined via assessing a range of effluent discharge scenarios against the sustainability criteria established in Section 1.1. Previous consultation was conducted with BSC on a range of effluent release pathways, with many options being discussed, evaluated and ranked (AWC, 2016). Based on this discussion and process, the two highest ranking alternative effluent release scenarios have been investigated in study (Figure 6-1):

- Existing release site.
- Option 1: Pipe to Ewingsdale Road and discharge west Island Quarry, south Ewingsdale Road.
- Option 2: Discharge to Industrial Estate drainage system.

The hydraulic/hydrologic model and water quality model developed for the study area (refer to Sections 7 and 8) will be post-processed under a range of effluent release scenarios, outlined in Table 6-1 and shown diagrammatically in Figure 6-1 . These models will identify:

- the maximum spatial extent and duration of water inundation resulting from the various effluent release scenarios, and
- the impact of the various release scenarios on the background water quality of the Belongil ICOLL.

Furthermore, the results of the modelling will be compared against key environmental values and threats determined during the targeted environmental assessment (Section 5). Each effluent release scenario will be qualitatively assessed against all of the identified sustainability criteria presented in Section 1.1.

Table 6-1: Effluent release scenarios

Scenario number	Flow scenario	Effluent release*	Release description
1	"Control"	1ML/d	Pre closure of South Byron STP
Do nothing Scenarios			
2a	Current flow	3ML/d	Release at current discharge location (EPA 4), under estuary open and closed and high low rain events
2b	2025 flow	5ML/d	Increased load based on 2025 projected population
2c	2050 flow	8ML/d	Increased load based on 2050 projected population
Various outflow scenarios. Discharge at several locations as per identification of alternative flow paths			
3a	Current	3ML/d	1 ML discharged to Upper Union Drain; 2 ML discharged to Industrial Estate drain, shown as **Option 1** in Figure 6-1
3b	2025	5ML/d	1 ML discharged to Upper Union Drain; 4 ML discharged to Industrial Estate drain, shown as **Option 1** in Figure 6-1
3c	2050	8ML/d	1 ML discharged to Upper Union Drain; 7 ML discharged to Industrial Estate drain, shown as **Option 1** in Figure 6-1
4a	Current	3ML/d	1 ML discharged to Upper Union Drain; 2 ML discharged via **Option 2,** shown in Figure 6-1
4b	2025	5ML/d	1 ML discharged to Upper Union Drain; 4 ML discharged via **Option 2** shown in Figure 6-1
4c	2050	8ML/d	1 ML discharged to Upper Union Drain; 7 ML discharged via **Option 2** shown in Figure 6-1
Notes: *: Assuming 1 ML urban reuse per year			


AWC
Project: Byron Bay STP alternative effluent release assessment
Figure 6.1: Existing and alternative effluent release pathways
Legend
Belongil catchment boundary
Option 1 effluent release pathway
Existing release pathway
Option 2 effluent release pathway
BBIWMR
0
200
400
600 m
Date - 16/12/2016
A3 Scale - 1:30000
SOURCE:
Aerial - NearMap Pty Ltd 2016
Study Site - AWC
Care was taken in the creation of this map. AWC should be consulted as to the suitability of the information shown herin prior to the commencement of any works based on the information provided. AWC cannot accept any responsibility for errors, omissions or positional accuracy. There are no warranties, expressed or implied as tot he suitability of this map for a particular purpose. However, notification of any errors will be appreciated.

7 Hydraulic capacity assessment of the Belongil Creek and Drainage system

A Hydraulic Capacity Assessment (HCA) has been completed across the drainage systems and floodplain of the Belongil Creek catchment. The HCA assesses the potential changes in inundation behavior of the various STP discharge volumes and locations presented in Section 6.

Due to the low lying nature of much of the Belongil Creek catchment and the fact that its drainage lines are extensively tidal it has been necessary to assess the potential effects of varying STP discharges on the capacity of the existing drainage system for a range of estuarine and meteorological conditions. Principally this includes the status of the entrance of Belongil Creek, which in being an ICOLL, varies from fully closed to fully open. The added effect of variable meteorological conditions on catchment flows is another overlay which requires consideration in assessing the longer term capacity of the existing drainage system to convey flows.

7.1 Methodology

The adopted assessment approach has been to complete long term continuous simulation (over a nearly five year period) that represents a range of estuarine and meteorological/catchment conditions that could be considered representative of long term system operation. From this the effects of modification (i.e. scenarios) could be determined.

The HCA has been completed using a number of modelling tools including:

- A SOURCE hydrologic model over the Belongil Creek catchment that provides hydrologic inputs to the hydraulic model; and
- A TUFLOW linked 1 dimensional / 2 dimensional hydraulic model of the floodplain regions and drainage networks.

7.1.1 Hydrology Model Overview

The SOURCE hydrologic model has been constructed using a range of locally specific data including a digital elevation model (DEM) of the catchment, catchment land use mapping and SILO meteorological data. As the Belongil catchment is ungauged, traditional model calibration methods were not possible, as such model parameters were established through a joint validation process with the hydraulic model which involved:

- Qualitative assessment using historical photographs identifying inundation patterns during significant rain events in a particular portion of the catchment; and
- Qualitative and quantitative assessment comparing recorded water levels from a water level logger in the Union Drain to water levels predicted by the hydraulic model.

Model parameters were able to be refined to provide an acceptable validation outcome, indicating that predicted catchment hydrology adequately represented actual catchment hydrology. This validation process was able to be performed across a number of critical sub-catchments of the Belongil Creek system where drainage infrastructure exists, noting that these drains can overflow to the floodplain if water levels exceed the bank full height.

Further detailed descriptions of hydrologic model establishment and validation are provided in Appendix C.

7.1.2 Hydraulic Model Overview

The hydraulic model developed for the HCA has been adapted from the flood model developed for the Belongil Creek Flood Study completed in 2009. The flood study model was modified to allow simulation over long time periods and hence inform the HCA. Key modifications have included:

- Change in model resolution from 10m grid size in floodplain areas to a 25 m grid size in the floodplain areas;
- Accepting hydrology from the SOURCE hydrology model at identified sub-catchment locations in place of the design event hydrology utilised for the flood study;
- Updates to LiDAR in the floodplain regions to make use of newer higher resolution information;
- Incorporating new project specific survey information for key drainage lines on the Union drain and surrounds. This survey information was introduced as 1 dimensional elements within the hydraulic model formulation;
- Incorporation of a tidally varying downstream boundary. Incorporation of this downstream boundary was necessary to inform entrance conditions were during the simulation period. Being an ICOLL the Belongil Creek estuary operates between fully open and fully closed, however, bathymetric data to describe entrance conditions was not available for hydraulic modelling. The use of recorded water levels within Belongil Creek (at the Ewingsdale Bridge) overcomes this data limitation; and
- The West Byron STP flows were introduced into selected drainage channels to assess hydraulic capacity effects and potential floodplain inundation as required.

As identified above the hydrologic and hydraulic models were validated in unison using a range of qualitative and quantitative methods. Adjustments were made within the hydraulic model to ensure accurate representation of catchment flow dynamics.

Further detailed descriptions of hydraulic model establishment and validation are provided in Appendix E.

7.1.3 West Byron STP Discharge Scenarios

To test the impact of the STP flows on the floodplain and estuary three different release locations were tested, including:

- Existing – The exiting discharge location;
- Option 1 – Tributary of Union Drain South of Ewingsdale Road; and
- Option 2 – Industrial Estate Drain.

For each for these locations a total release from the West Byron STP of 3, 5 and 8 ML/day has been modelled. For environmental reasons a discharge of 1 ML/day is maintained at the existing discharge site. For example for the 5ML/day release Option 2, 1 ML/day is released at the existing discharge location and 4 ML/day is released via Option 2 (i.e. in the Industrial Estate Drain).

The STP discharge locations in the hydraulic model are presented in Figure 17-2 (Located in Appendix E). A total of 10 simulations were run, these are outlined in Table 7-1.

Table 7-1 : TUFLOW Simulation Configurations

Simulation Name	Discharge at Existing Location (ML/day)	Additional Output Location	Additional Output Discharge (ML/day)
Existing 1ML Base Case	1.0	N/A	N/A
Existing 3ML	3.0	N/A	N/A
Existing 5ML	5.0	N/A	N/A
Existing 8ML	8.0	N/A	N/A
Option 1 3ML	1.0	Option 1	2.0
Option 1 5ML	1.0	Option 1	4.0
Option 1 8ML	1.0	Option 1	7.0
Option 2 3ML	1.0	Option 2	2.0
Option 2 5ML	1.0	Option 2	4.0
Option 2 8ML	1.0	Option 2	7.0

7.2 Results and discussion

For each of the simulations presented in Table 6-1 the model was run for the period 17/09/2011 to 15/04/2016. Duration and inundation depth greater than 1 cm was recorded. For the existing location, 1ML/day STP discharge the duration of inundation is presented in Figure 7-1. The duration is presented as a percentage. The total simulation duration was 1,672 days or 40,128 hours, so an inundation of 10% indicates that the cell was wet for 4,013 hours of the simulation.

For the 3, 5 and 8ML/day STP discharges the duration of inundation was compared back to the existing 1ML/day base case. Any change in inundation duration for the three locations and three discharge rates are presented in Figure 7-2 through to Figure 7-10. These are presented as a percentage of the total simulation time. For example a value a 1% indicates that for the entire 4.5 year simulation the duration of inundation has increased by 401.3 hours or approximately 17 days.

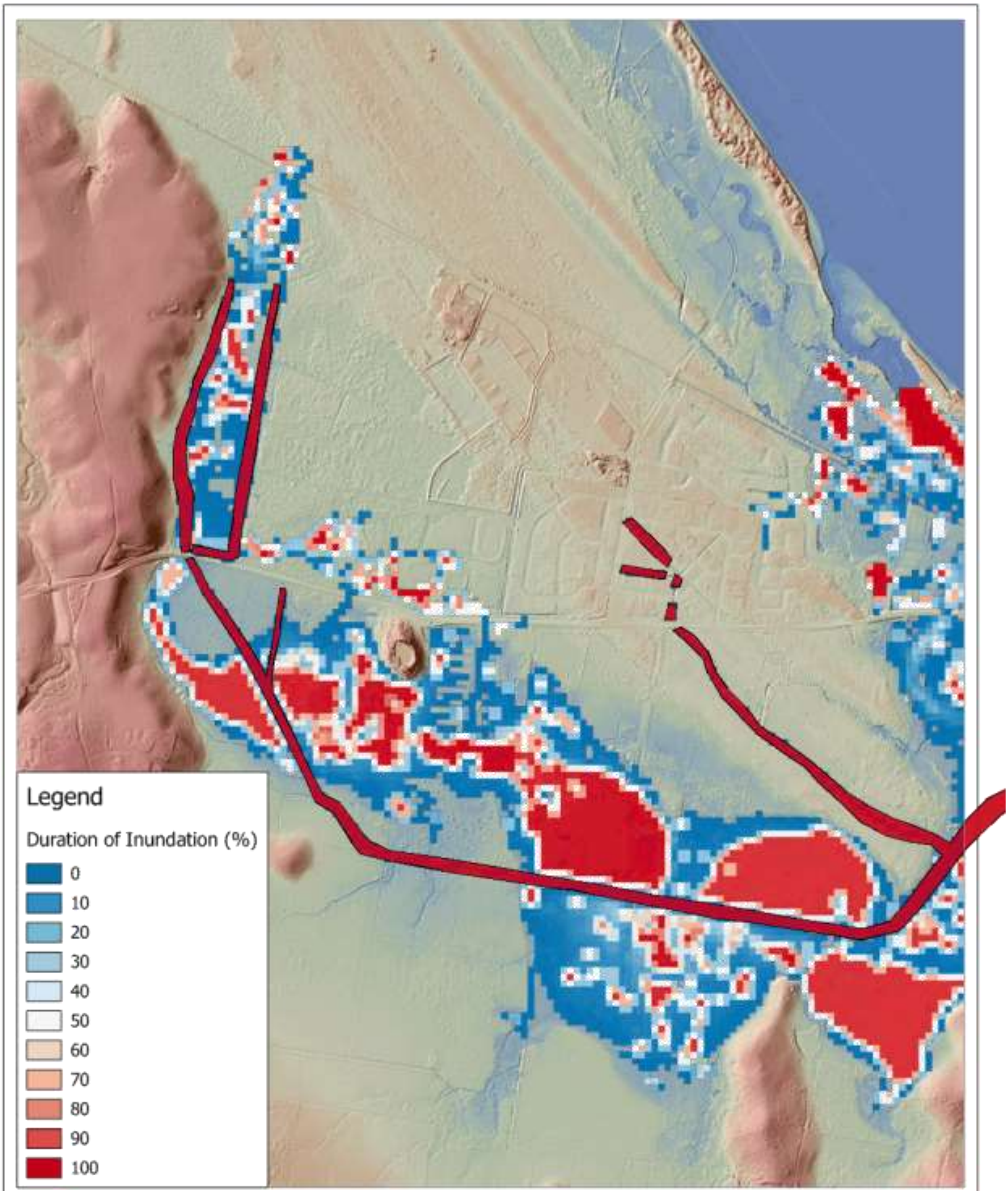
The difference in duration mapping presents a relative assessment of the modelled alternatives, back to a 1ML discharge in the existing output location. If an area, for example the lower Creek or drain is wet 100% of the time, this shows up as a 0% difference in time of inundation, even though the depth of inundation may vary.

For the existing STP discharge location and Option 1 location, there are significant areas of the floodplain which are predicted to experience an increase in duration of inundation. This does not necessarily occur, at the discharge location itself, but rather further downstream. The flatter channel gradient and influences of the tidal level / entrance condition can cause additional duration of water ponding in the floodplain. The differences in the time of inundation are typically less than 2%.

For the Option 2 location, the predicted increases in duration are significantly less than for the two other alternatives.

7.3 Conclusion

Several scenarios were assessed as part of the HCA which included varying outfall locations and/or increases in effluent discharge volumes. Impacts were assessed on a relative basis by comparison back to a 1ML discharge in the existing discharge location. For the existing STP effluent discharge location and Option 1 location, there are significant areas of the floodplain predicted to experience increases in duration of inundation. Generally this inundation has been predicted to occur downstream (to the south) of Ewingsdale Road in the main portion of the floodplain. The flatter channel gradient and influences of the tidal level / entrance condition cause the additional duration of water ponding in these floodplain locations. The differences in the time of inundation are typically less than 2%, or 34 days. For the Option 2 location, the predicted increases in duration are significantly less than for the two other alternatives.



Title:
Duration of Inundation
Existign Location, 1ML/day discharge

Figure: 7-1

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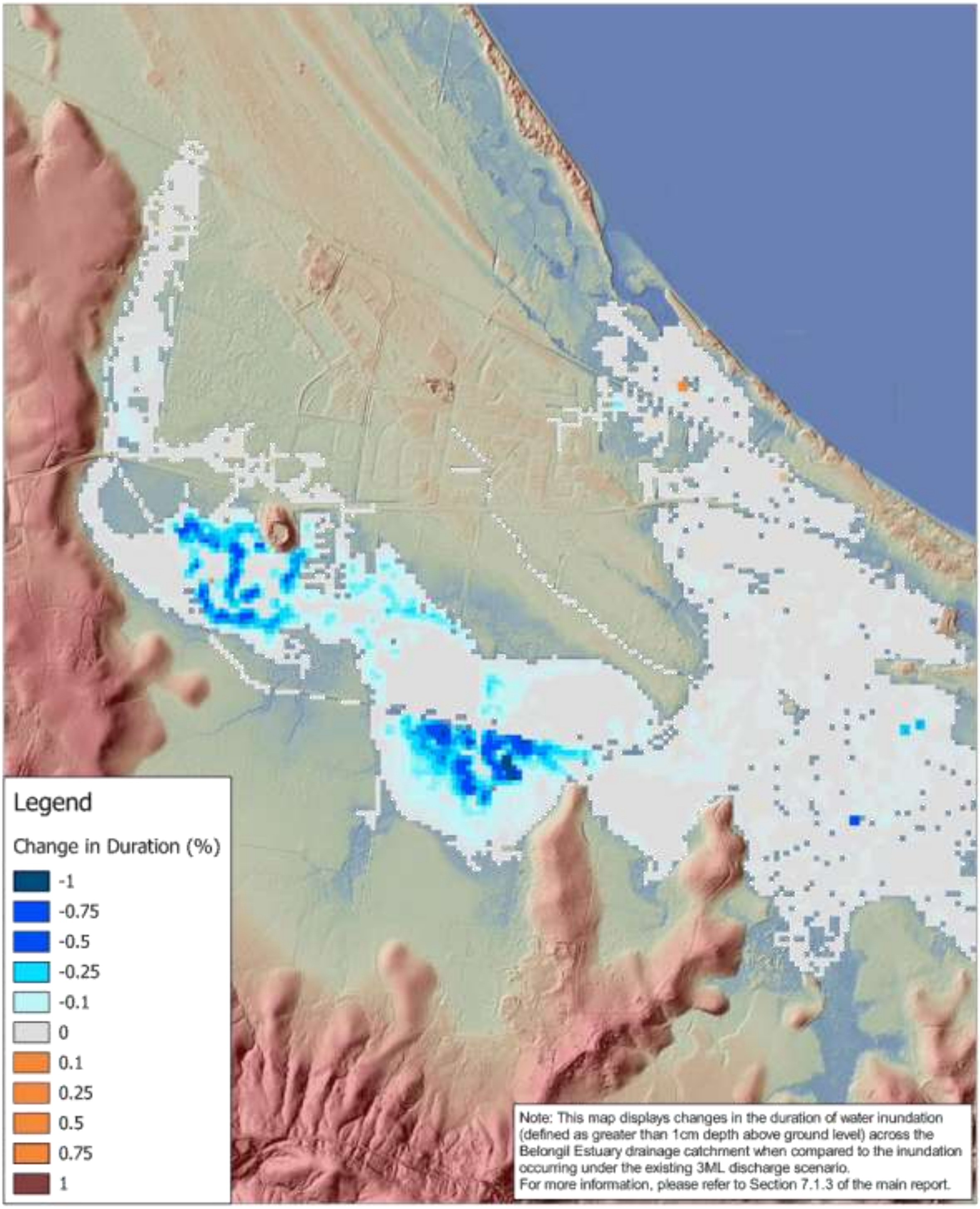

Title:
Difference in Duration
Existing Location, 1ML/day discharge

Figure: 7.2

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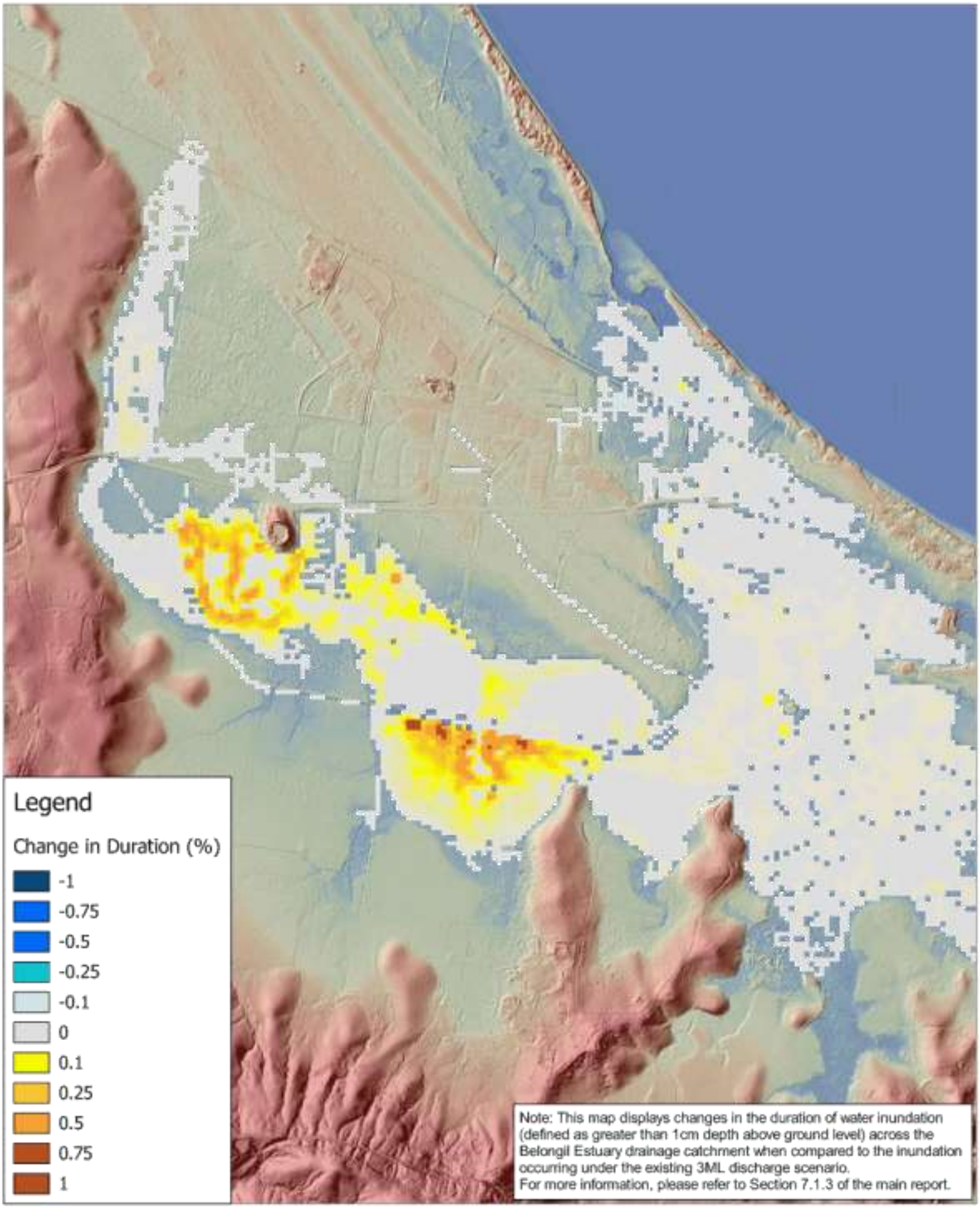

Title:

Difference in Duration
Existing Location, 5ML/day discharge

Figure: 7.3

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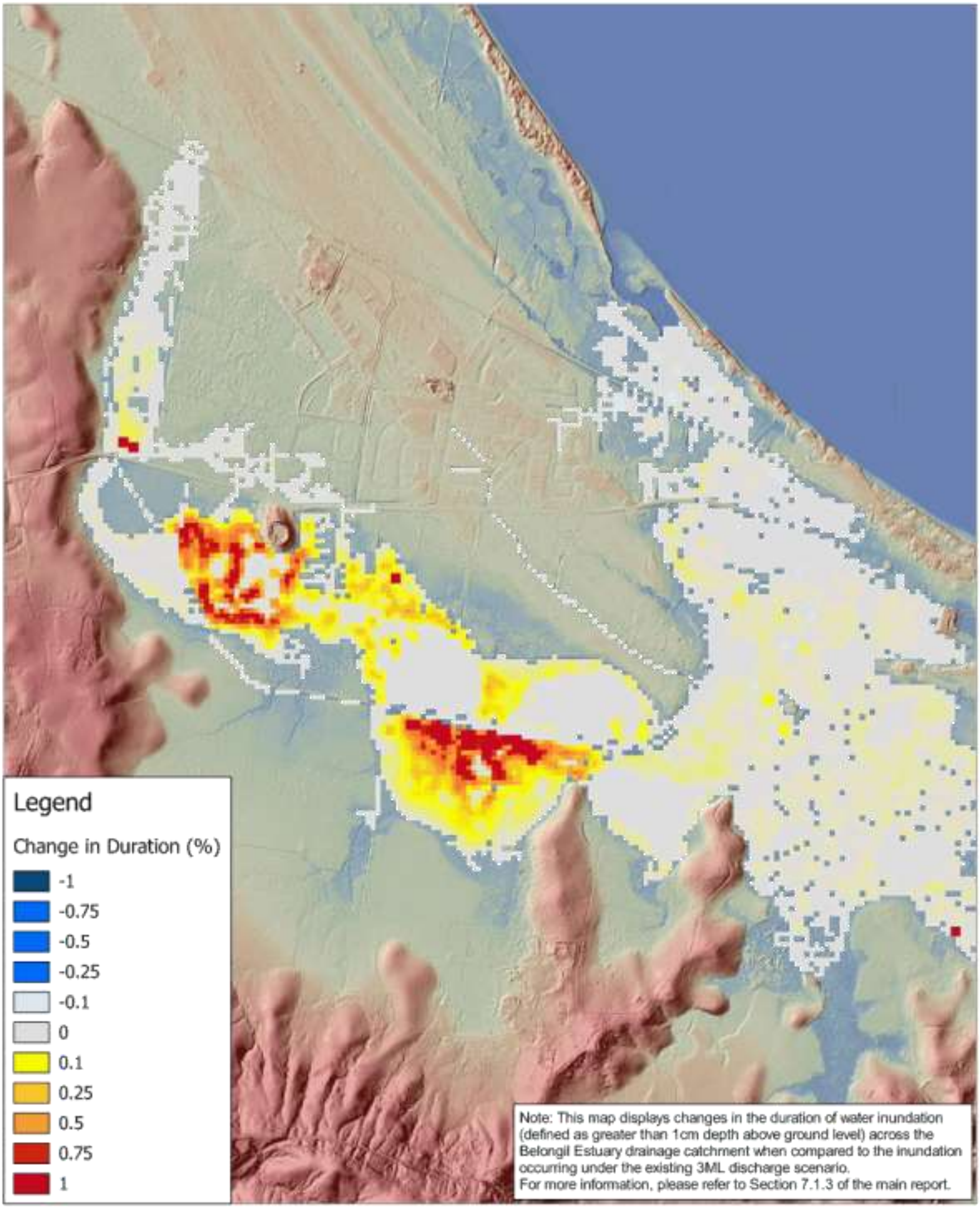

Title:
Difference in Duration
Existing Location, 8ML/day discharge

Figure: **7.4**

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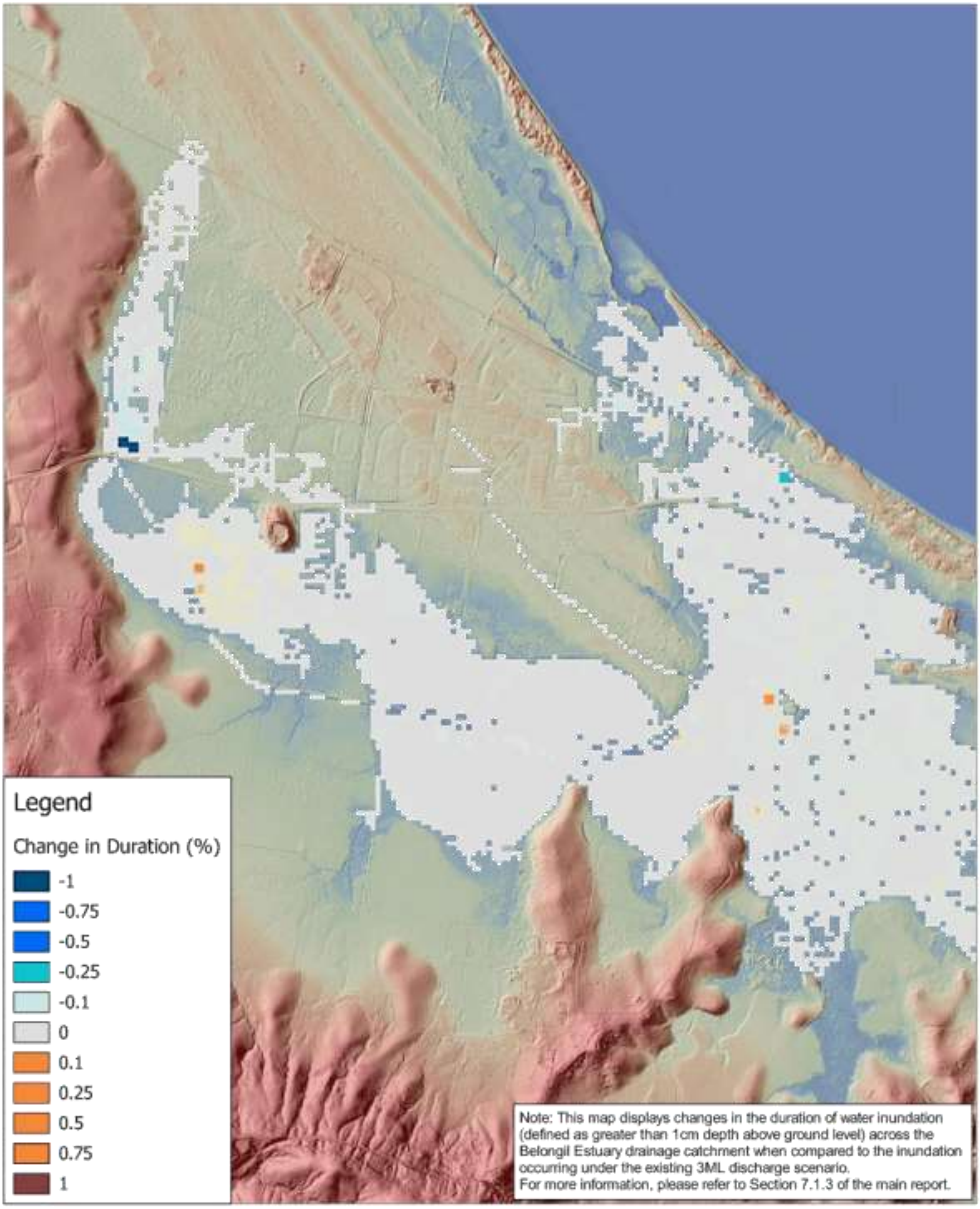

Title:

Difference in Duration
Option 1 Location, 3ML/day discharge

Figure: **7.5**

Rev: **B**

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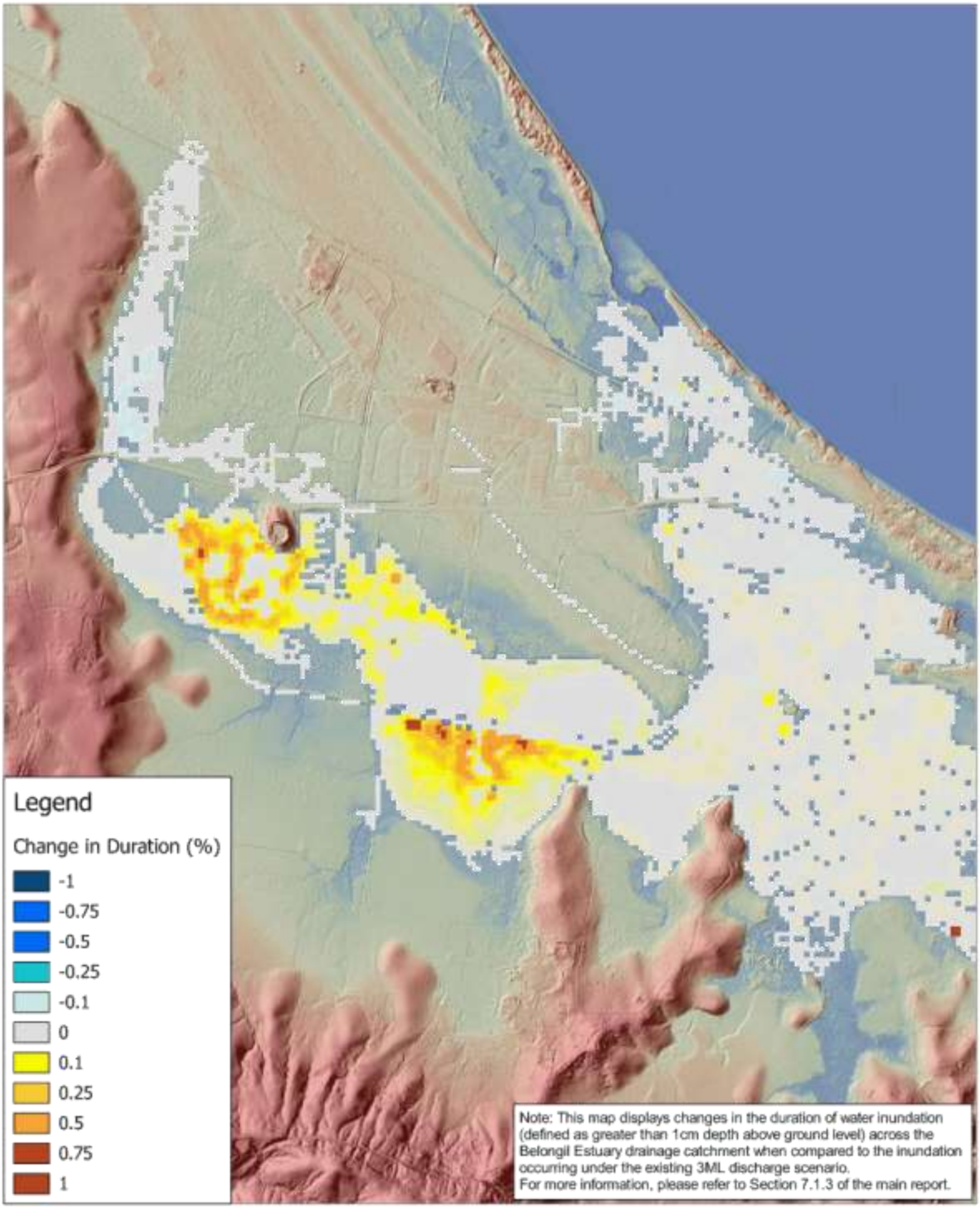

Title:
Difference in Duration
Option 1 Location, 5ML/day discharge

Figure: 7.6 Rev: B

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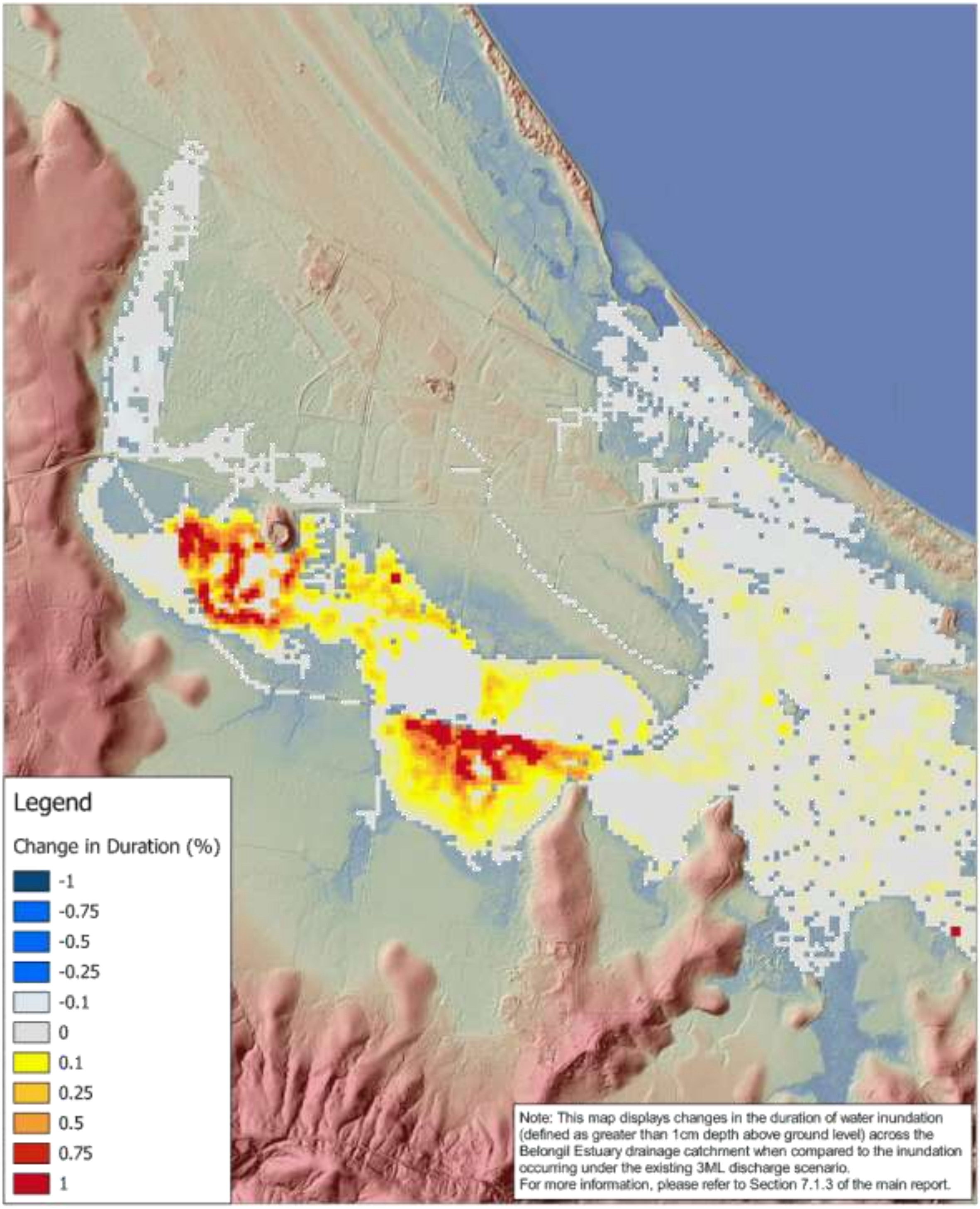

Title:
Difference in Duration
Option 1 Location, 8ML/day discharge

Figure: **7.7**

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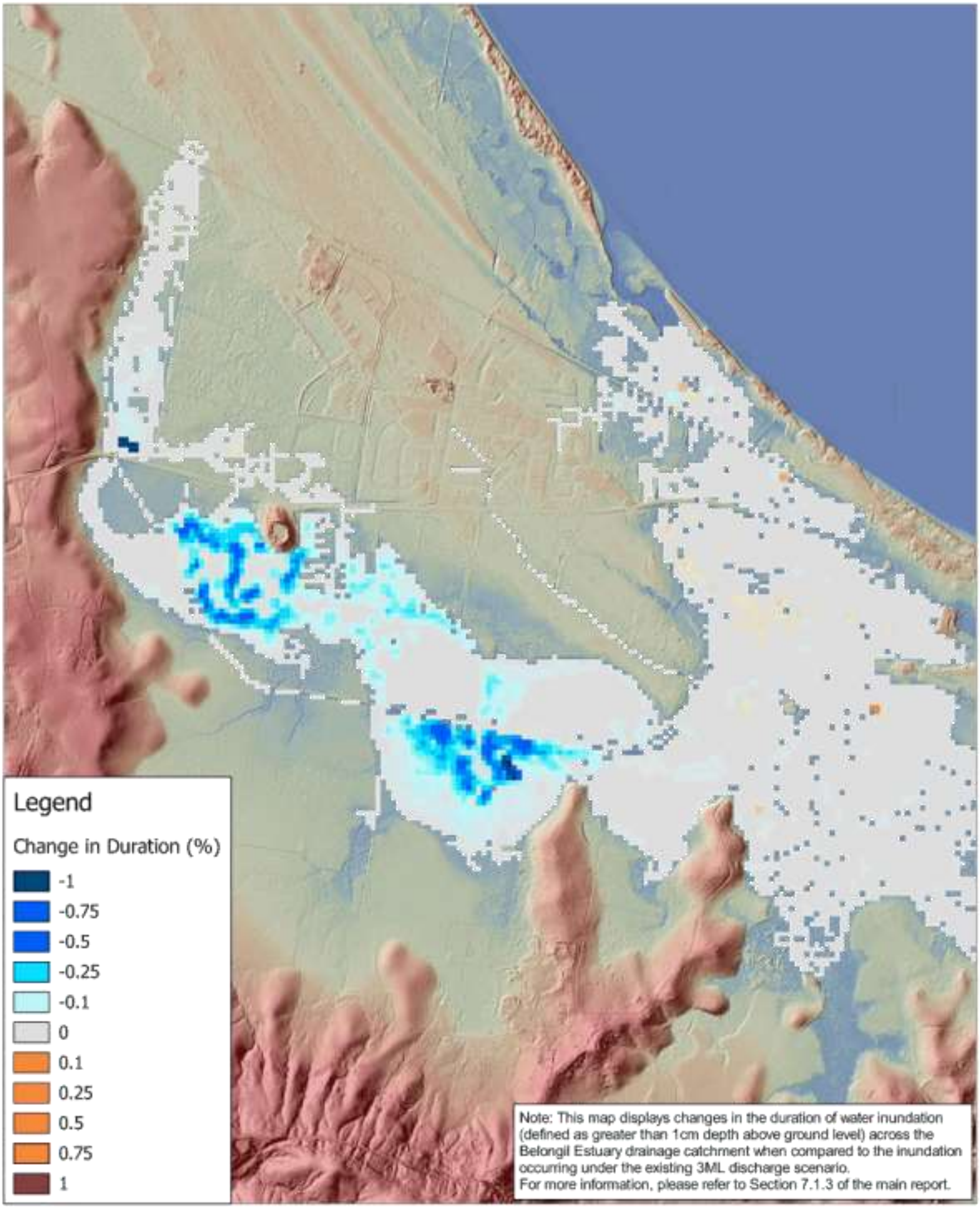

Title:

Difference in Duration
Option 2 Location, 3ML/day discharge

Figure: 7.8

Rev: B

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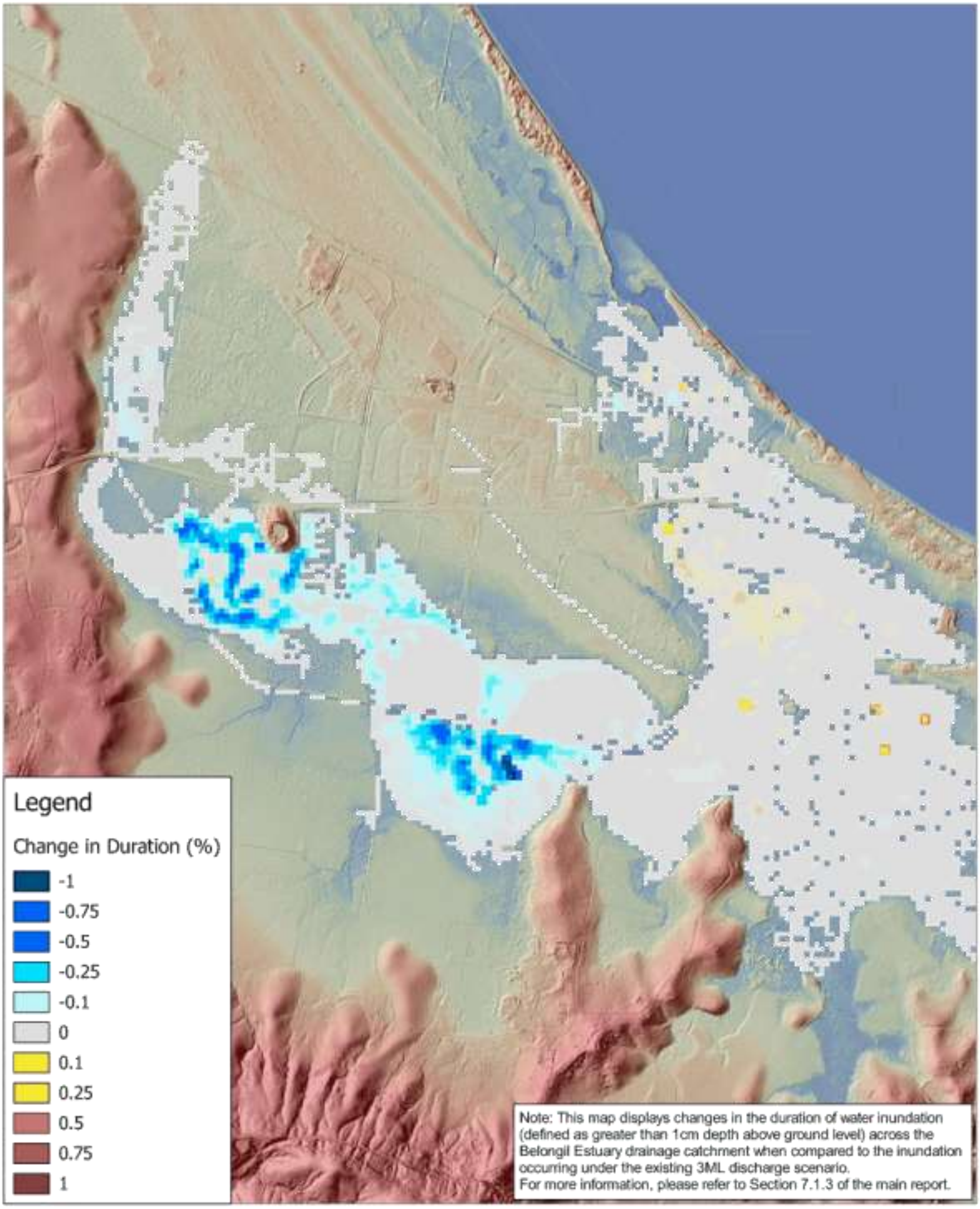

Title:

Difference in Duration
Option 2 Location, 5ML/day discharge

Figure: **7.9**

Rev: **B**

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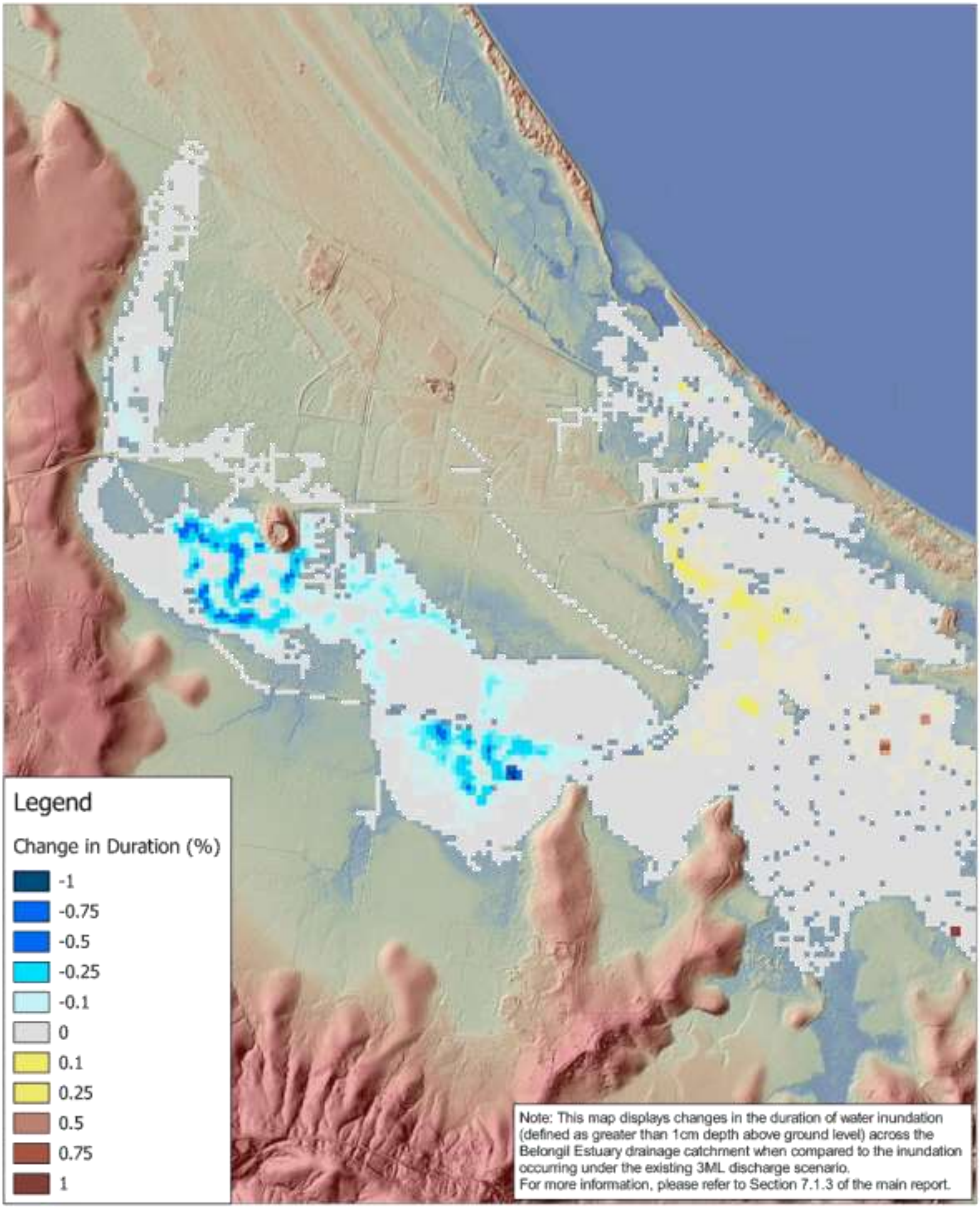

Title:

Difference in Duration
Option 2 Location, 8ML/day discharge

Figure: **7-10**

Rev: **B**

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8 Water quality impact assessment of release scenarios of the Belongil ICOLL

In addition to the HCA water quality modelling has been completed to provide an understanding of potential water quality changes within the Belongil Creek estuary resulting from increasing discharges from the West Byron STP.

8.1 Methodology

A rapid assessment water quality model has been developed to ascertain potential impacts to the estuary. The model accounts for key flow and pollutant inputs to the estuary and it is able to provide a temporal understanding (i.e. changes over time) of potential changes in key pollutant concentrations. However, due to its formulation (i.e. it is a non-dimensional model) it cannot provide spatial information (i.e. locations of change). The rapid assessment water quality model has been established to provide an understanding of potential estuarine water quality changes resulting from changes to discharge quantities from the West Byron STP.

The water quality model utilised for this project was originally developed as part of the Tallow and Belongil Creeks Ecological Study prepared by BMT WBM for Byron Shire Council in 2000. This study developed both salinity and water quality models of the estuary that were calibrated to local conditions and observed data. The model itself is a non-dimensional water quality model which provides volume averaged results for modelled constituents, which for this study has included salt and nutrients. The model has been established over a multi-year period where sufficient data exists to allow it to simulate flow and water quality metrics.

The original existing model has been updated to incorporate recorded West Byron STP discharges, modelled catchment discharge data (from the SOURCE model), tidal exchange information specific to the modelling period (derived from recorded tide level information for the estuary) and updated estuarine area and volume relationships derived from the updated Digital Elevation Model for the Belongil Creek estuary and catchment.

The effects of revisions to catchment runoff, tidal exchanges and the estuarine area / volume relationships were validated over a two year period in 1994 and 1995 using available water level and salinity data collated by Manly Hydraulics Laboratory as part of an earlier investigation of the estuary. Model parameters from this validated model were then applied to models established for a later period (i.e. 2011 to 2016) that were utilised for the purposes of impact assessment.

Insufficient nutrient data exists for the estuary to validate the performance of the water quality model over the 2011 to 2016 period, however, as key model parameters relating to nutrients (i.e. settlement, sediment release and biological uptake) have not been changed from the original calibrated model it is considered that the model will still be able to adequately assess nutrient dynamics.

Further detailed descriptions of water quality model establishment and validation are provided in Appendix D.

8.1.1 West Byron STP Discharge Scenarios

The water quality modelling has assessed the following key scenarios:

- Existing Case – Approximately 3ML release per day from the West Byron STP;
- Scenario – 1 ML release per day;
- Future Scenario – 5 ML release per day; and
- Future Scenario – 8 ML release per day.

Unlike the hydraulic modelling, the water quality scenarios are release location independent. The water quality modelling is focused on potential impacts to the estuary as opposed to the drainage channels which have been assessed as part of the HCA. The modelling assumes that water reaches the estuary with the same quality irrespective of release location. Indeed, the water quality utilised for the STP discharges is based on monitored data from the STP wetland itself prior to release to the drainage channels. It is likely that the water quality could change with its extended passage along drainage channels. The extent of these changes is expected to be minimal and STP effluent would be expected to further naturalise given the extensively vegetated nature of the existing and potential discharge paths.

8.2 Results and discussion

8.2.1 Existing Case

Existing case results are included along with the scenario results to allow for comparisons of results. Note total suspended solids were not modelled for the estuary as the West Byron STP (like most modern STPs) contributes very low concentrations (and loads) of suspended sediments to the drainage network.

The results graphs include the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC, 2000) guideline trigger values for slightly disturbed ecosystems in south east Australia. These Water Quality Objectives (WQOs) are generally recognised by OEH as the default trigger values for estuaries of this type. Locally specific trigger values can be derived, but extensive condition assessment and consultation is required to derive the locally specific environmental values and WQOs for a waterway. This has not yet been done for the Belongil Creek. As such the default trigger values (shown in Table 8-1) are recommended for use where no locally specific guideline values exist. The trigger values apply to waterways experiencing ambient conditions.

Table 8-1: Default trigger values for slightly disturbed ecosystems in south-east Australia (Adapted from Tables 3.3.2 and 3.3.3, chapter 3, ANZECC 2000)

Ecosystem type	Chl-a (µg/L)	Turbidity (NTU)	TP (mg/L)	Sol P (mg/L)	TN (mg/L)	NOx (mg/L)	NH_4 (mg/L)	DO (%sat)	pH
Estuaries	4	0.5-10	0.03	0.005	0.30	0.015	0.015	80-110	7.0-8.5

8.2.2 1 ML, 5 ML and 8 ML scenarios

To assess the 1 ML, 5 ML and 8 ML scenarios the discharges from the West Byron STP were adjusted by differences in the flow volumes. As agreed with Byron Shire Council there was no attempt at scaling of flows from the STP to account for the influence of stormwater infiltration or other potential loading factors. It was also assumed that the STP produced the same quality of effluent as had been determined from the monitored data provided for the period 2011 to 2016.

Results have been presented as both a time-series in Figure 8-1 to Figure 8-3 (over 2012 only to make data more legible) and as box and whisker plots as shown in **Error! Reference source not found.** to **Error! Reference source not found.**. The box and whisker plots utilise data from the full modelling period (i.e. 2012 to 2016).

The box and whisker style plots provide a representation of the median (centre bar within the box), 20th and 80th percentile values (upper and lower bounds of the box), plus an indication of the spread of the data as provided by the "whisker" which extends upwards and downwards from the box and measures 1.5 times the interquartile range (i.e. range between 20th and 50th percentile, or 50th and 80th percentile). Maximum and minimum records, where present in the display range of the graph, are also shown typically by a star. The water quality objective where present is included on the graph as well. This style of graph is useful for understanding the spread of data, particularly for long datasets where there is a reduced variation in the observed results.

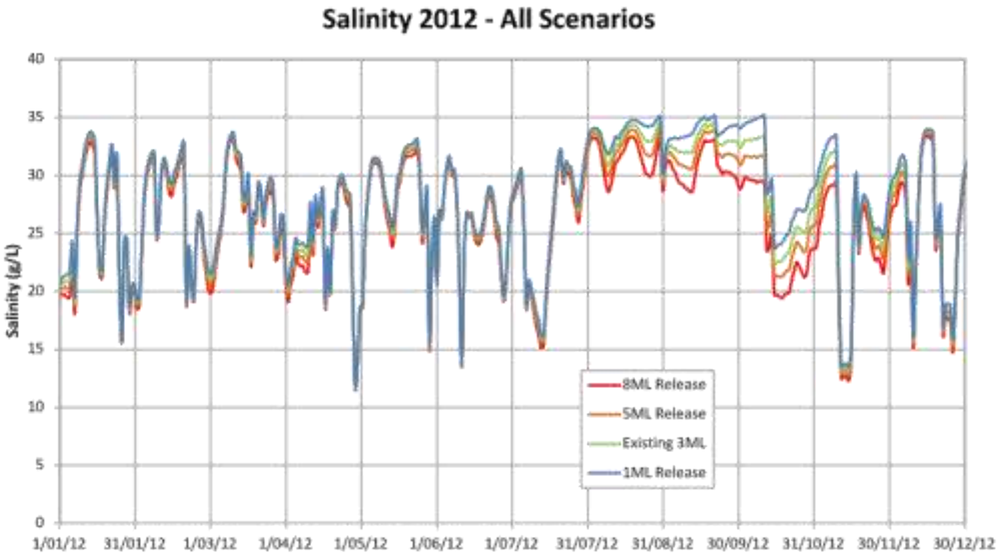


Figure 8-1 : Total Nitrogen Concentrations – All Scenarios

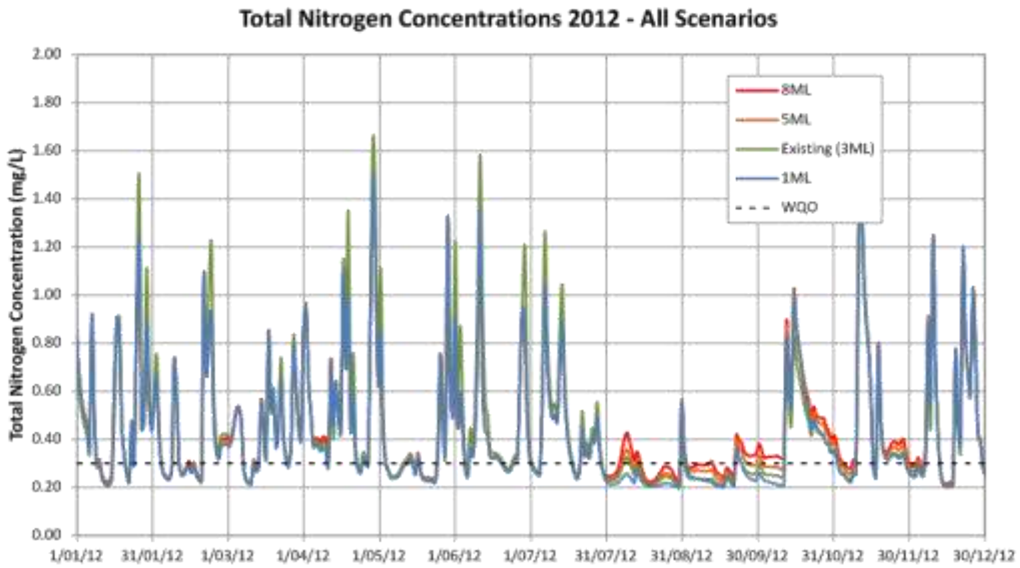


Figure 8-2 : Total Nitrogen Concentrations – All Scenarios

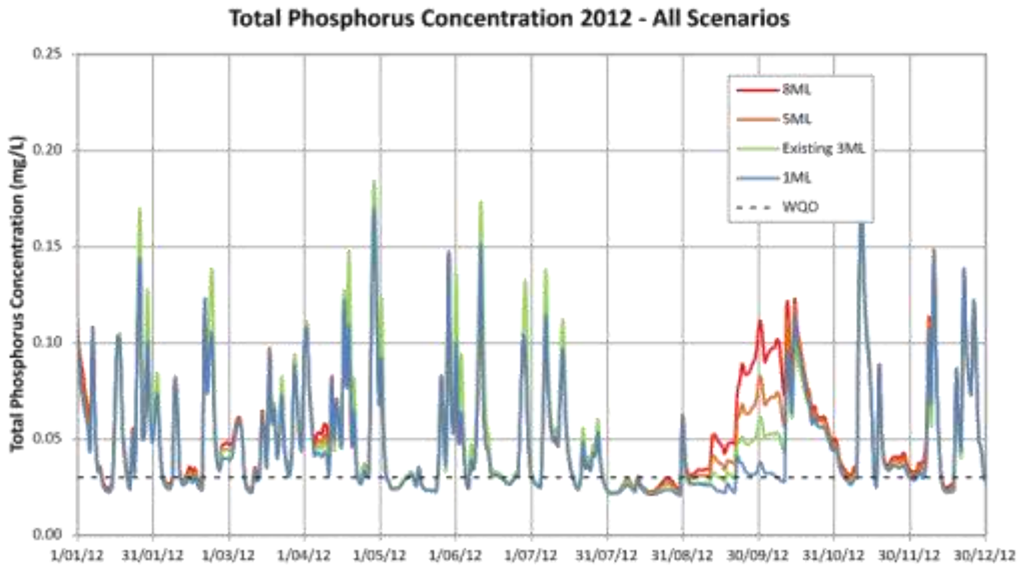


Figure 8-3 : Total Phosphorus Concentrations – All Scenarios

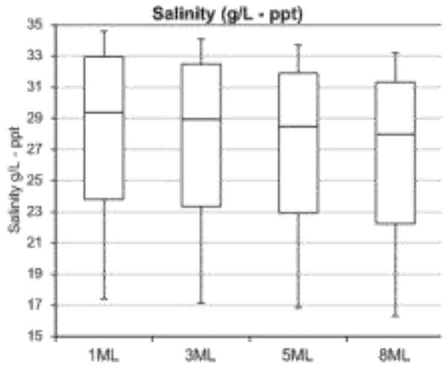


Figure 8-4 : Modelled Salinity concentrations for selected Scenarios

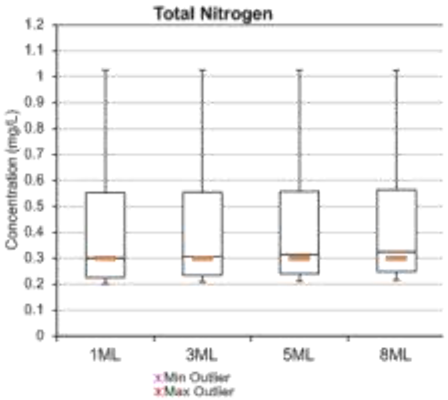


Figure 8-5 : Modelled TN concentrations for selected Scenarios

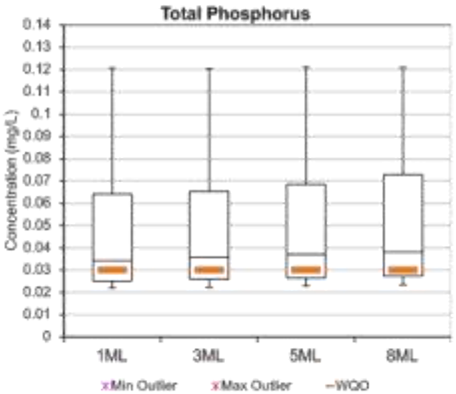


Figure 8-6 : Modelled TP concentrations for selected Scenarios

8.2.3 Salinity

The results identify that for salinity, decreasing the West Byron STP discharge volumes (i.e. to 1 ML/d) increases the average salinity of the estuary over the modelling period, while increasing the discharge volumes (i.e. to 5 ML/d or 8 ML/d) decreases the average salinity across the estuary.

In terms of the scale of change the following results were obtained (all results are compared to the existing case):

- 1 ML/d resulted in a maximum increase in salinity of 7.9% with a median increase of 1.1% over the modelling period. In terms of modelled salinity concentrations a maximum increase in concentration of 1.9 ppt and median increase in concentration of 0.33 ppt were predicted;
- 5 ML/d resulted in a maximum decrease in salinity of 7.1% with a median decrease of 1.2% over the modelling period. In terms of modelled salinity concentrations a maximum decrease in concentration of 1.7 ppt and median decrease in concentration of 0.32 ppt were predicted;
- ML/d resulted in a maximum decrease in salinity of 16.4% with a median decrease of 3.0% over the modelling period. In terms of modelled salinity concentrations a maximum decrease in concentration of 4 ppt and median decrease in concentration of 0.8 ppt were predicted;

The long term median results are a function of increased or decreased dilution over a longer period within the estuary with a decrease in STP flows results in decreased dilution, etc. The peak values are caused by either a very low tidal range (due to entrance closure) providing opportunity for increased evaporation or dilution in estuary and/or dry weather periods reducing catchment runoff and there salt diluting effects within the estuary.

8.2.4 Total Nitrogen

The results identify that for TN, decreasing the West Byron STP discharge volumes (i.e. to 1 ML/d) decreases the average TN concentrations of the estuary over the modelling period. Whilst increasing the discharge volumes (i.e. to 5 ML/d or 8 ML/d) increases predicted TN concentrations.

In terms of the scale of change the following results were obtained (all results are compared to the existing case):

- 1 ML/d resulted in a maximum decrease in TN of 17% with a median reduction of 1.1% over the modelling period. In terms of modelled TN concentrations a maximum decrease in concentration of 0.05 mg/L and median decrease in concentration of 0.003 mg/L were predicted;
- 5 ML/d resulted in a maximum increase in TN of 16% with a median increase of 1.1% over the modelling period. In terms of modelled TN concentrations a maximum increase in concentration of 0.05 mg/L and median decrease in concentration of 0.003 mg/L were predicted;
- 8 ML/d resulted in a maximum increase in TN of 39% with a median increase of 2.7% over the modelling period. In terms of modelled TN concentrations a maximum increase in concentration of 0.12 mg/L and median increase in concentration of 0.007 mg/Lt were predicted.

The long term median results are a function of a number of factors including changes in STP plant loadings and estuarine dilution during certain conditions. The effect of increased STP loadings can be seen between the 3 ML/d and 5 ML/d scenarios while the effect of dilution can be seen (as for the salinity scenarios) between the 1 ML/d and other scenarios. Peak values occur when either a very low tidal range (due to entrance closure) and/or dry weather period occurs affecting tidal exchange or catchment flows.

8.2.5 Total Phosphorus

The results identify that for TP, decreasing the West Byron STP discharge volumes (i.e. to 1 ML/d) decreases the average TP concentrations of the estuary over the modelling period. Whilst increasing the discharge volumes (i.e. to 5 ML/d or 8 ML/d) increases predicted TP concentrations.

In terms of the scale of change the following results were obtained (all results are compared to the existing case):

- 1 ML/d resulted in a maximum decrease in TP of 4% with a median reduction of 0.9% over the modelling period. In terms of modelled TP concentrations a maximum decrease in concentration of 0.003 mg/L and median decrease in concentration of 0.0003 mg/L were predicted;
- 5 ML/d resulted in a maximum increase in TP of 39% with a median increase of 0.8% over the modelling period. In terms of modelled TP concentrations a maximum increase in concentration of 0.02 mg/L and median decrease in concentration of 0.0003 mg/L were predicted;
- 8 ML/d resulted in a maximum increase in TP of 92% with a median increase of 2.0% over the modelling period. In terms of modelled TP concentrations a maximum increase in concentration of 0.05 mg/L and median increase in concentration of 0.0007 mg/L were predicted.

As for TN, the long term median results are a function of a number of factors including changes in STP plant loadings and estuarine dilution during certain conditions. The effect of increased STP loadings can be seen between the 3 ML/d and 5 ML/d scenarios, while the effect of dilution can be seen (as for the salinity scenarios) between the 1 ML/d and other scenarios. Peak values occur when either a very low tidal range (due to entrance closure) and/or dry weather period occurs affecting tidal exchange or catchment flows.

8.3 Conclusion

Several scenarios were assessed as part of the study which included varying outfall locations and/or increases in effluent discharge volumes. Impacts were assessed on a relative basis by comparison back to the existing case (in which approximately 3 ML/d is discharged at the West Byron STP). The model assessed potential changes in salinity, total nitrogen and total phosphorus and results identify that for salinity, decreasing the West Byron STP discharge volumes (i.e. to 1 ML/d) increases the average salinity of the estuary over the modelling period. Whilst increasing the discharge volumes to 5 ML/d or 8 ML/d, decreases the average estuary salinity. Peak salinity reductions of up to 16% are seen for the 8ML/d discharge scenario, but these peaks are short lived and occur only at time when there is either a very low tidal range (due to entrance closure) and to a lesser degree dry weather periods reducing catchment runoff. Considered as a long term median (over the 4+ year modelling period), salinity changes for all scenarios were less than 3%.

Similarly with predicted TN and TP concentrations, decreasing the West Byron STP discharge volumes (i.e. to 1 ML/d) decreases the average total nutrient concentrations in the estuary over the modelling period. Whilst increasing the discharge volumes to 5 ML/d or 8 ML/d, increases predicted total nutrient concentrations within the Belongil Estuary. Peak total nutrient increases of up to 92% are seen for TP for the 8ML/d discharge scenario, but these peaks are short lived and occur at times with either a very low tidal range (due to entrance closure) and/or to a lesser degree dry weather periods which reduce catchment runoff. Considered as a long term median (over the 4+ year modelling period) the TN changes are less than 3% and TP changes less than 2% for the 8ML discharge scenario.

Modelling has shown that short term changes in salinity and total nutrient can occur at times when the entrance is obstructed and can be further exacerbated when combined with a low rainfall period (which reduces catchment runoff to the estuary). During these periods, which are typically of the order of weeks to a couple of months, nutrients and salinity levels can increase more noticeably, but would be still be regarded to fall within the range of water quality observed in an ICOLL style estuary.

Without any clear driver for further assessment, more detailed water quality modelling is unlikely to be warranted.

9 Sustainable assessment of effluent release scenarios

Changes in catchment hydrology have the ability to affect the physical & chemical processes within a catchment, which can in turn impact on the various environmental values of the Belongil Estuary. A summary of the potential physical and chemical impacts are listed below:

- Increased flow rate: increased erosion; shallow rooted plants washed away;
- Increased water depth: water depths may exceed threshold levels of many species;
- Increased times of inundation: times of inundation may exceed threshold levels of many species;
- Decreased groundwater table: potential oxidation of ASS/PASS layers and export of acid and drying of peat layers causing fire risks
- Increased/decreased salinity levels: increase in freshwater input into system;
- Increased nutrient loadings; and
- Time that Belongil Creek Estuary mouth is open may in turn increase tidal influences and salinity, whilst reducing tannins in water and water levels within the estuary.

This section of the report assesses the two alternative (+existing) effluent release options presented in Section 6, in light of the sustainability criteria presented in Section 1.1. Each of the proposed two effluent release pathways plus the existing release pathway, have been assessed against the sustainability criteria listed in Table 1-1, this assessment is presented in Table 9-1

Based on the qualitative assessment undertaken in Table 9-1, Release Option 2 provides the most sustainable effluent release option, while providing some degree of continued effluent discharge to the upper drainage catchment. The proceeding section explores the impacts / benefits adopting Release Option 2 as the preferred effluent release pathway.

Table 9-1: Sustainability Assessment of existing and proposed effluent release pathways

	Sustainability Criteria – Aim	Sustainability Criteria – Objective	Existing release scenario	Release Option 1	Release Option 2
Social	Achieves the community's aspirations for sewage management in Byron Bay	Meets Council's vision and goals as stated in the Effluent Management Strategy (2006/ Doc #610368)	All scenarios meet Council's vision and goals as stated in the Effluent Management Strategy		
	Maintenance and improvement of the aesthetic and recreational values of the Belongil Catchment	Water level and conductivity regime of the Belongil Creek/Drain and ICOLL must not affect existing vegetation communities which may affect visual amenity of the Belongil Estuary.	Same result for all scenarios, with little change in water quality and conductivity values within the estuary across all proposed effluent flow regimes		
Economic	Maintain and enhance economic value of the Belongil Estuary and its catchment.	Maintenance of the current and projected economic value of the current land use within the Belongil Catchment	Potential decrease in agricultural land value from current inundation regime	Potential decrease in agricultural land value from current modelled inundation regime	Yes, no increase in inundation to catchment land uses.
		Ensure preferred effluent discharge option sits within the financial means of the Council.	Yes, no change	Yes, minimal costs	Yes, minimal costs
Environmental	Maintain and enhance downstream ecological values of the Belongil Creek, ICOLL and its catchment.	Reduction of acid discharge events from the upper catchment. pH levels within the Belongil Estuary should meet stated water quality objectives	No anticipated change, recent WQ data showing limited acidic discharge events	Due to the similar location of effluent discharge under Option 1, no anticipated change, recent WQ data showing limited acidic discharge events	Possible change in WQ due to decrease of water table in upper catchment. Can be managed through operational control of effluent release
		No deterioration of existing flora and fauna communities which inhabit the Belongil Creek and ICOLL	Increased inundation of mapped SEPP 14, possibly resulting in impacts to vegetation health and regeneration	Increased inundation of mapped SEPP 14, possibly resulting in impacts to vegetation health and regeneration	No increase in inundation across catchment.
		Water quality and conductivity profile of the Belongil Creek and ICOLL should meet stated water quality objectives	Same result for all scenarios, with little change in water quality and conductivity values within the estuary across all proposed effluent flow regimes		
		Reduction in peat fires	No anticipated increase based on recent absence of peat fires from the upper catchment	Due to the similar location of effluent discharge under Option 1, no anticipated increase based on recent absence of peat fires from the upper catchment	Possible increase in peat fires due to drying of the peat layers from a reduction of the water table level. Can be managed through operational control of effluent release
		No impact on tidal bird roosting at the mouth of the Belongil Estuary	No anticipated change, estuary mouth is open more frequently which results low water levels and greater bird roosting areas		
		Meets the objectives and recommendations of the Belongil Estuary MP	Meets the objectives of the Belongil Estuary MP, until effluent release increases, whereby increased inundation occurs that could possibly result in impacts to vegetation health and regeneration of wetlands.		Partly meets the objectives of the Belongil Estuary MP, however continued effluent release at existing outlet required to maintain water table heights

9.1 Impacts of the Proposed Flow Path – Option 1.

9.1.1 Inundation

The aim of the alternative drainage flow path is for a stable inundation time to be maintained in response to an increase in the output to 8 ML. Conclusions are drawn on the assumption that the STP will increase its flow to 8 ML.

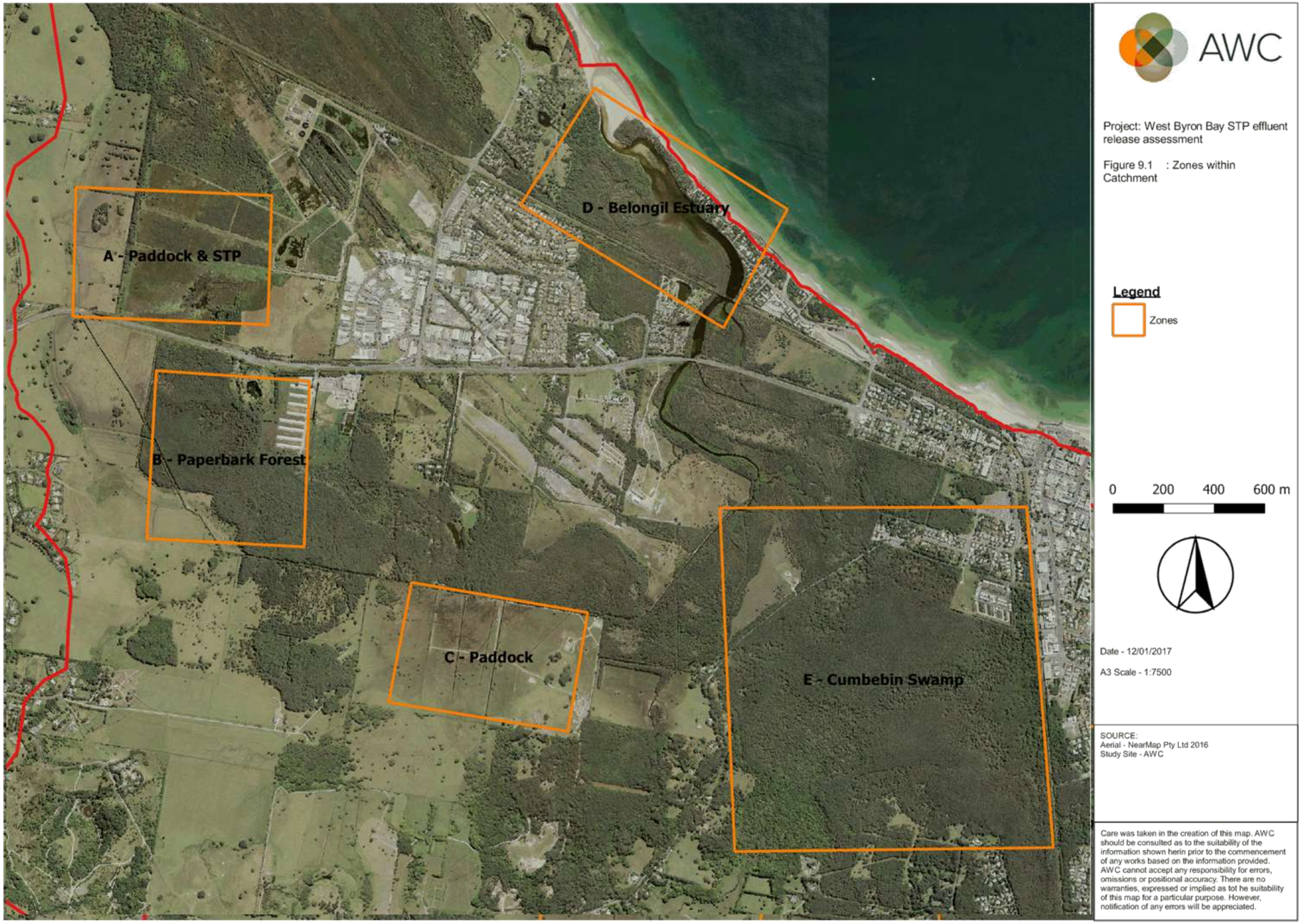
Existing

All scenario results have been compared back to the existing case result (i.e. average approximately 3 ML/day discharge). The highest inundation times are focused in a section of Paperbark Swamp Forest towards the western section and paddocks along the southern section of the subject area. These areas currently experience a maximum inundation time of 331 hours over the model period.

If the flow is increased to 8 ML the average inundation time would increase substantially. In general, the distribution of inundation will remain stable however the average time would show a dramatic increase. Sections along the western and southern edges of the study area would likely experience an increase of inundation in excess of 1000 hours/model period.

If the existing drainage system is retained, an increased output would likely result in:

- Paperbark Swamp Forest in west (Section B in Figure 9.1): Increased time of in inundation resulting in a change of species composition, including die back of *Melaleuca quinquenervia*. Species such as Common Reed (*Phragmites*) and Bulrush (*Typha*) are likely to become dominant, creating a monoculture and reducing diversity. The vegetation composition is likely to transition from a forested swamp/wetland to a treeless community. Fauna species such as Grey-headed Flying Fox, Common Blossom Bat, several Glider species, Regent Honeyeater, Swift Parrot, Australasian Bittern, Large-footed Myotis, Olongburra Frog and Wallum Froglet, which are highly dependent on Paperbark Swamp Forest, will experience a shift and potential loss in habitat. Existing habitat will remain within the locality for those highly mobile species (such as Black-necked Stork), however it is unlikely that remaining vegetation is sufficient to support all species displaced. Species with low mobility will be exposed to these abrupt changes and those unable to adapt, such as Wallum Froglet and Olongburra frog will not survive. It must be noted that this section of vegetation is mapped as SEPP14 – Wetland and is of high ecological value;
- Paddocks & Wetlands in south (Section C in Figure 9.1): Flooding and inundation times will increase, resulting in a larger extent of open water. This vegetation currently experiences periods of drying, however under the increased output, the vegetation would remain wet for longer periods (if not permanently), species transition to sedges, rushes around the outskirts with deeper areas dominated by aquatic plant species;
- Belongil estuary and surrounding vegetation (Section D in Figure 9.1): There is likely to be little change in inundation and therefore ecological structure will remain stable; and
- Cumbebin Swamp (Section E in Figure 9.1): Slight increase in inundation times and extent of inundation, meaning that some low-lying areas may see a slight transition to contain more wetland species such as an understory of sedges and rushes. Additionally, this area may see a slight shift to a treeless community with a small amount of *Melaleuca quinquenervia* dieback.


AWC
Project: West Byron Bay STP effluent release assessment
Figure 9.1 : Zones within Catchment
Legend
Zones
A - Paddock & STP
B - Paperbark Forest
C - Paddock
D - Belongil Estuary
E - Cumbebin Swamp
0 200 400 600 m
Date - 12/01/2017
A3 Scale - 1:7500
SOURCE:
Aerial - NearMap Pty Ltd 2016
Study Site - AWC
Care was taken in the creation of this map. AWC should be consulted as to the suitability of the information shown herin prior to the commencement of any works based on the information provided. AWC cannot accept any responsibility for errors, omissions or positional accuracy. There are no warranties, expressed or implied as tot he suitability of this map for a particular purpose. However, notification of any errors will be appreciated.

Option 1

Option one is likely to experience similar impacts to the existing drainage system.

Option 2

With an output of 8 ML, Option two will experience a slight decrease in inundation times in the western section of the catchment. With an output of 8 ML, the eastern section of the catchment will experience a very slight increase in inundation, however the percentage is much lower than alternative options. Similar to the existing scenario and Option one, the most noticeable impacts will be seen in a section of Paperbark Swamp Forest (Section B) along the western section and in the paddocks along the southern section of the study area (Section C). Overall the impacts would be minimal and the vegetation composition is likely to remain relatively stable. However, the potential exists for the following impacts to occur:

- Paperbark Swamp Forest in west may experience a slight decrease in inundation times. Some sections may experience a decrease in sedge/rush ground cover, with grasses and small herbs becoming more abundant. The dominant canopy species (*Melaleuca quinquenervia*) is able to adapt to such changes and is likely to remain stable.
- Paddocks & Wetlands in the south may experience slightly drier conditions, with time and extent of open water likely to decrease. The extent of change is not likely to result in the transition from wetland to swamp. If no outside influences (land management) are experienced, vegetation such as Common Reed (*Phragmites*) and Bulrush (*Typha*), which are more highly adapted to changes in hydrology and water quality may increase in the area.
- Belongil Estuary and surrounding vegetation: There is likely to be little change in inundation and therefore ecological structure will remain stable; and
- Cumbebin Swamp: Unlikely to experience any significant impacts, however the potential does exist for a slight increase in wetland species.

9.1.2 Salinity

The natural variation of salinity levels within the estuary over the sample period is approximately 22 ppt. Results did show that a large volume discharged from the STP results in a slight decrease in the average salinity, however only by a few percent, unless unusual conditions prevail. When the flow was modeled with an 8ML discharge, estuarine salinity was shown to decrease by ~16%. This occurred during a period of reduced tidal levels (i.e. closure) with dry weather and the time experienced was limited. Modeling results for salinity fall within the natural variation of the estuary (maximum difference between 1 ML and 8 ML is ~6 ppt) and as such, changes in salinity as a result of alternative flow scenarios are not likely to have an impact on the ecology.

The salinity and inundation tolerances of common species within the catchment are identified in Table 9-2. In most scenarios, these conditions will not be exceeded as a result of the proposed flow path (Option two) and as such, conditions are likely to remain stable. However, during times of extreme weather, high rainfall, low rainfall, low tidal range and estuary entrance closure, the risk does exist for salinity and nutrient levels to change for a period long enough to influence aquatic communities within the catchment. As such it is recommended that an adaptive management approach is implemented through the establishment of a monitoring program which would allow for extreme environmental conditions and changes in vegetation structure to be tracked, allowing for quick responses and adaptations in STP flow outputs if required. Monitoring should include a mixture of vegetation transects (focused in areas of SEPP 14) correlated with water data (inundation times, nutrient and salinity levels).

*Table 9-2: Salt tolerance of common species in the area. *Values obtained from Chambers et al, 1995 & Clarke et al, 1970.*

Species	Salinity		Optimum Growth	Water Depth Tolerance
Freshwater wetland species				
Paspalum distichum	4-10 ppt	brackish	freshwater, <4 ppt	tolerant of limited tidal inundation and water logging
Cladium procerum	~< 5 ppt		summer freshwater	large approx 1 m
Cyperus eragrostis	~< 5 ppt		summer freshwater	large approx 1 m
Blechnum indicum	5 ppt	brackish	summer freshwater	
Eleocharis acuta	0 ppt	freshwater	freshwater +nutrient	1.2 m (large tolerance of season flooding) 1 m
Eleocharis dulcis	1 ppt	freshwater	freshwater +nutrient	1.2 m (large tolerance of season flooding) 1 m
Melaleuca quinquenervia	35 ppt	up to seawater	20% seawater + nutrient	
Casuarina glauca	15 ppt	40% seawater	20% seawater + nutrient	
Lepironia articulata	5 ppt	brackish	summer freshwater	
Baumea articulata	0 ppt	freshwater	freshwater +nutrient	0.7 m (large tolerance of seasonal flooding) 0.8 m
Typha orientalis	5 ppt	brackish	summer freshwater	0.8 m (large tolerance of season flooding) 1 m
Salvinia molesta	10 ppt	28% seawater for 5-7 days		floating plant
Myriophyllum aquaticum	< 10 ppt		freshwater +nutrient	
Saltwater wetland species				
Juncus krausii	15 ppt	40% seawater	20% seawater + nutrient	higher saltmarsh
Sporobolus virginicus	35 ppt	<100% seawater	20% seawater + nutrient	medium saltmarsh
Sarcocornia quinqueflora	70 ppt	150-200% seawater	20% seawater + nutrient	low saltmarsh (high tolerance of water logging)
Suaeda australis	35 ppt	100% seawater	20% seawater + nutrient	low - medium saltmarsh
Triglochlin procerum	21-35 ppt	60-100% seawater	20% seawater + nutrient	low - high saltmarsh
Bacopa monnieri	35 ppt	100% seawater		30cm if clear
Aegicerus corniculatum	35 ppt	100% seawater	20% seawater + nutrient	mangroves
Avicennia marina	35 ppt	100% seawater	20% seawater + nutrient	mangroves

**Values obtained from Chambers et al, 1995 & Clarke et al, 1970.*

9.1.3 Nutrients

At most times during year modeling shows only negligible differences in the level of TN and TP between the existing and 8 ML scenario. At some points during the model a difference is notable with nutrient levels in the 8 ML scenario exceeding those with lower output. The 8 ML/d resulted in a maximum increase in TN of 39% with a median increase of 2.7% over the modelling period. Additionally, the 8 ML/d resulted in a maximum increase in TP of 92% with a median increase of 2.0% over the modelling period. Peak values correspond with environmental conditions such as periods of dry weather or low tidal ranges, often caused by estuary entrance closure.

The increases in nutrients illustrated in the model are relatively low, with short lived peaks, however the potential for excessive growth of naturally occurring organisms, such as algae does exist during peak events. Excessive growth of algae can deplete oxygen levels in the water making the water unsuitable for aquatic wildlife. Species such as Common Reed (*Phragmites)* and Bulrush (*Typha*) are also known to out-compete other wetland species in times of increased nutrients. These impacts may be experienced within areas inundated with water, such as within drainage lines, estuary, wetlands and during flooding events within swamp forest. Whilst significant impacts are unlikely, the greatest risk exists when dry weather coincides with entrance closure.

9.1.4 ASS/PASS

Historically, the upper drainage catchment has discharged acidic waters as a result of extensive catchment drainage. In recent years this acidic discharge (or fish kills) has not been recorded, presumably as a result of increased water table heights resulting from a combination of effluent irrigation and increased effluent discharge.

It can be assumed that under the existing effluent release scenario and Option 1 (along with increased effluent flow), that existing and resulting increased water table height will not cause increase in acidic discharge from the upper catchment.

If release Option 1 was adopted in full, there is a potential for increased acidic discharge and peat fires in the upper catchment and fish kills within the Belongil Estuary. As such, there is some degree of 'need' for continued effluent to discharge into the upper drainage system to ensure limited acidic discharge and zero fish kills within the Belongil Estuary. The actual daily volume of discharge required in the upper drainage system to maintain the environmental values of the Belongil Catchment is unknown at this stage.

An incremental decrease in flows to the upper union drain catchment coupled with an incremental increase in flows to Option 2, alongside intensive monitoring (water level, conductivity, pH) to gauge potential impacts to the Environmental Values of the Belongil Estuary and its catchment, is recommended.

9.2 Conclusion

Via the adoption of Option two, it is expected that minimal impacts will occur on ecological structure and function within the catchment. If the existing flow path is maintained, increased output from the STP is highly likely to decrease inundation times in some patches within the catchment, resulting in vegetation shifts, altering habitat values for the many threatened species known to frequent the area.

During times of extreme weather, high rainfall, low rainfall, low tidal range and estuary entrance closure, the risk does exist for salinity and nutrient levels to change for a period long enough to influence aquatic communities within the catchment.

Due to the presence of ASS/PASS in the upper catchment of the Belongil Estuary, the historical occurrence of acid discharge (+associated fish kills within the Belongil Estuary) and peat fires, a continued discharge of effluent form the existing location (EPA 4) is recommended. The exact volume of discharge required to negate acid export events and peat fires is unknown, thus an adaptive effluent release management response is recommend – linked to key monitoring of catchment responses. This adaptive management approach should be implemented through the establishment of a monitoring program which allows for extreme environmental conditions and changes in vegetation structure and groundwater surface water quality to be tracked. Monitoring would inform adaptive management responses, and adaptations in STP flow outputs if required. Monitoring should include a mixture of vegetation transects within key habitat types correlated with water data (inundation times, nutrient, pH and salinity levels). This is detailed further in Section 10.

10 Additional effluent irrigation areas

The 24 ha effluent irrigation area located within the BBIWMR (Plate 10-1) provides a unique pathway for effluent loss (via evapotranspiration) that has the added benefits of environmental rehabilitation. This rehabilitation can provide many benefits to the Belongil Estuary catchment including:

- increased biodiversity,
- a reduction in the exposure of acid sulfate soils,
- a reduction in peat fires,
- improved treatment of effluent and reduction of nutrient loads to the Estuary,
- complete removal of effluent from the Belongil Catchment, and
- the sequestration of carbon.

From the information presented in Section 7 and 9 of this report, the inundation pattern of the Belongil Estuary catchment will change with increased effluent loads and the provision of an alternative effluent release pathway. While increased effluent irrigation areas have not been assessed in this report as a supplementary or alternative effluent discharge pathway, they should be investigated where suitable sites occur and landholders are supportive. Increased effluent irrigation may provide a hydraulic/nutrient buffering capacity for the catchment in times of high effluent production (holidays periods). This could have the potential to reduce nutrient concentrations within the Estuary during periods when the Belongil ICOLL is closed during dry weather – a key time where nutrients within the ICOLL increase as a result of the BB STP effluent discharge (refer to Section 8).

Plate 10-1: Effluent irrigation area within BBIWMR

11 Conclusions and recommendations

This study has investigated the current fate of effluent discharged within the BBIWMR and its influence on the upper catchment drainage system under a range of current and predicted operating regimes. Detailed site analysis of the effluent irrigation area, land to the west of the BBIWMR and Belongil drainage system has inferred that the increase in flows associated with the transfer of effluent from the SB STP to the BB STP with the adjoining has resulted in:

- A decrease in artificial estuary opening events,
- A potential increase in water table heights west of the BBIWMR, resulting in an increase in the frequency, extent and depth of surface water inundation, and
- A reduction in peat fires and acid discharge events.

Ecologically, the Belongil Creek, ICOLL and drainage system provides a large expanse of high quality habitat for various terrestrial and aquatic species. Swamp forest (large proportion mapped as SEPP 14), mangroves, saltmarsh and regenerating areas with the STP provide high quality habitat for multiple species listed under the TSC Act and EPBC Act. Known breeding habitat for several species such as the Littler Tern and Pied Oyster Catcher occurs within the catchment, meaning that conservation of these environments is essential for the sustainability of the local population. Overall the catchment hosts an array of high value ecological features including threatened species habitat (flora and fauna), EECs, SEPP 14 wetland and wildlife corridors (regional and sub regional).

In order to assess the impact of various effluent release scenarios on the Belongil Creek, ICOLL and drainage system and Hydrologic, Hydraulic and Water Quality models where developed. These models ran various effluent release scenarios, including current effluent relapse and projected effluent release (5ML and 8ML) at three locations; Existing discharge point and two alternative locations. For the existing STP discharge location and Option 1 location, there are significant areas of the floodplain predicted to experience increases in the duration of inundation with increase effluent discharge. Generally this inundation has been predicted to occur downstream (to the south) of Ewingsdale Road in the main portion of the floodplain (SEPP 14 wetland area north of Union Drain). The flatter channel gradient and influences of the tidal level / entrance conditions are the cause of additional water ponding in these floodplain locations, though the differences in the time of inundation are typically less than 2%. For the Option 2 discharge location, the predicted increases in duration are significantly less than for the two other alternatives.

From a water quality perspective, modelling results identify that for salinity, decreasing the West Byron STP discharge volumes (i.e. to 1 ML/d) increases the average salinity of the estuary over the modelling period, while increasing the discharge volumes to 5 ML/d or 8 ML/d, decreases the average estuary salinity. Peak salinity reductions of up to 16% are seen for the 8ML/d discharge scenario, but these peaks are short lived and occur only at time when there is either a very low tidal range (due to entrance closure), or to a lesser degree, during dry weather periods. Considered as a long term median (over the 4+ year modelling period), salinity changes for all scenarios were less than 3%.

Similarly with predicted TN and TP concentrations, decreasing the West Byron STP discharge volumes (i.e. to 1 ML/d) decreases the average total nutrient concentrations in the estuary over the modelling period, while increasing the discharge volumes to 5 ML/d or 8 ML/d, increases predicted total nutrient concentrations. Peak total nutrient increases of up to 92% are seen for TP for the 8ML/d discharge scenario, but these peaks are short lived and at time when there is either a very low tidal range (due to entrance closure), or to a lesser degree, during dry weather periods. Considered as a long term median (over the 4+ year modelling period) the TN changes are less than 3% and TP changes less than 2%.

Overall the water quality modelling completed for this project has identified that the future scenarios result in minor change to the long term median total nutrient and salinity concentrations of the estuary. This outcome is a function of the high level treatment effected at the Byron STP and subsequent extended travel time of treated effluent through the partially vegetated Union drainage system.

Modelling has shown that short term changes in salinity and total nutrient can occur at times when the entrance is obstructed and can be further exacerbated when combined with a low rainfall period (which reduces catchment runoff to the estuary). During these periods, which are typically of the order of weeks to a couple of months, nutrients and salinity levels can increase more noticeably, but would be still be regarded to fall within the range of water quality observed in an ICOLL style estuary.

Without any clear driver for further assessment, more detailed water quality modelling is unlikely to be warranted.

11.1 Recommendations

The main recommendation resulting from this study is to provide an alternative effluent release pathway via Option 2 – release into the Industrial Estate drain. While the results of the investigations presented in this report support an alternative effluent release pathway, it is advised that some degree of discharge from the existing release point (EPA 4) continues. This continued discharge is required to ensure that acidic runoff off events and/or peat fires do not occur within the upper drainage catchment - as have occurred in the past. Unfortunately the minimum volume of effluent required to be released from the existing release point (EPA 4) is unknown at this stage. As such an effluent release transfer and monitoring program will need to be developed. This monitoring program should be developed to monitor ground and surface water levels, pH and conductivity on an hourly basis at a minimum of two sites. The results from this monitoring should be used to inform the ultimate volumes of effluent discharged into the current and proposed disposal pathways.

Whilst ecological impacts associated with Option 2 are predicted to be minimal, monitoring sites should be established to validate modelling and inform adaptive management. It is recommended that vegetation transects are established within the areas mapped as SEPP 14, focusing on sections that are predicted to experience the highest increase in inundation times. Byron Shire Council currently conducts monitoring of vegetation structure (via transects) within Belongil Estuary. The data collected in these transects should be utilised in addition to monitoring recommended above. Regular monitoring is essential to validate modeling and ensure that changes to flow regimes are not affecting ecological structure within the catchment.

While this report supports the provision of an alternative release pathway, the timeframe for implementation is undecided. Nevertheless, numerous short term actions can be implemented immediately to potentially reduce inundation depth, frequency and duration of land west of the BBIWMR:

- Remove the concrete lip north of pipes draining the upper Union Drain on Ewingsdale Road,
- Ensure pipes draining the upper Union Drain on Ewingsdale Road are inspected after every decent rainfall events, and cleaned if capacity is impacted by <20%, and
- Reduce weir level from EPA 4 drain within BBIWMR by 100mm or to a level which ensures limited inundation of land west of the Cavanbah Centre.

A detailed Environmental Monitoring Plan, complete with triggers and actions is required to inform the delivery of the alternative effluent release pathway. This monitoring plan will provide guidance on the incremental decrease of effluent at EPA 4, and the incremental increase of effluent release to Option 2. The plan will outline key environmental variables to measure, frequency of data collection and triggers which will guide the further increase/decrease of effluent at the two proposed discharged locations (existing and Option 2)

While increased effluent irrigation areas have not been assessed in this report as a supplementary or alternative effluent discharge pathway, they should be investigated where suitable sites occur and landholders are supportive.

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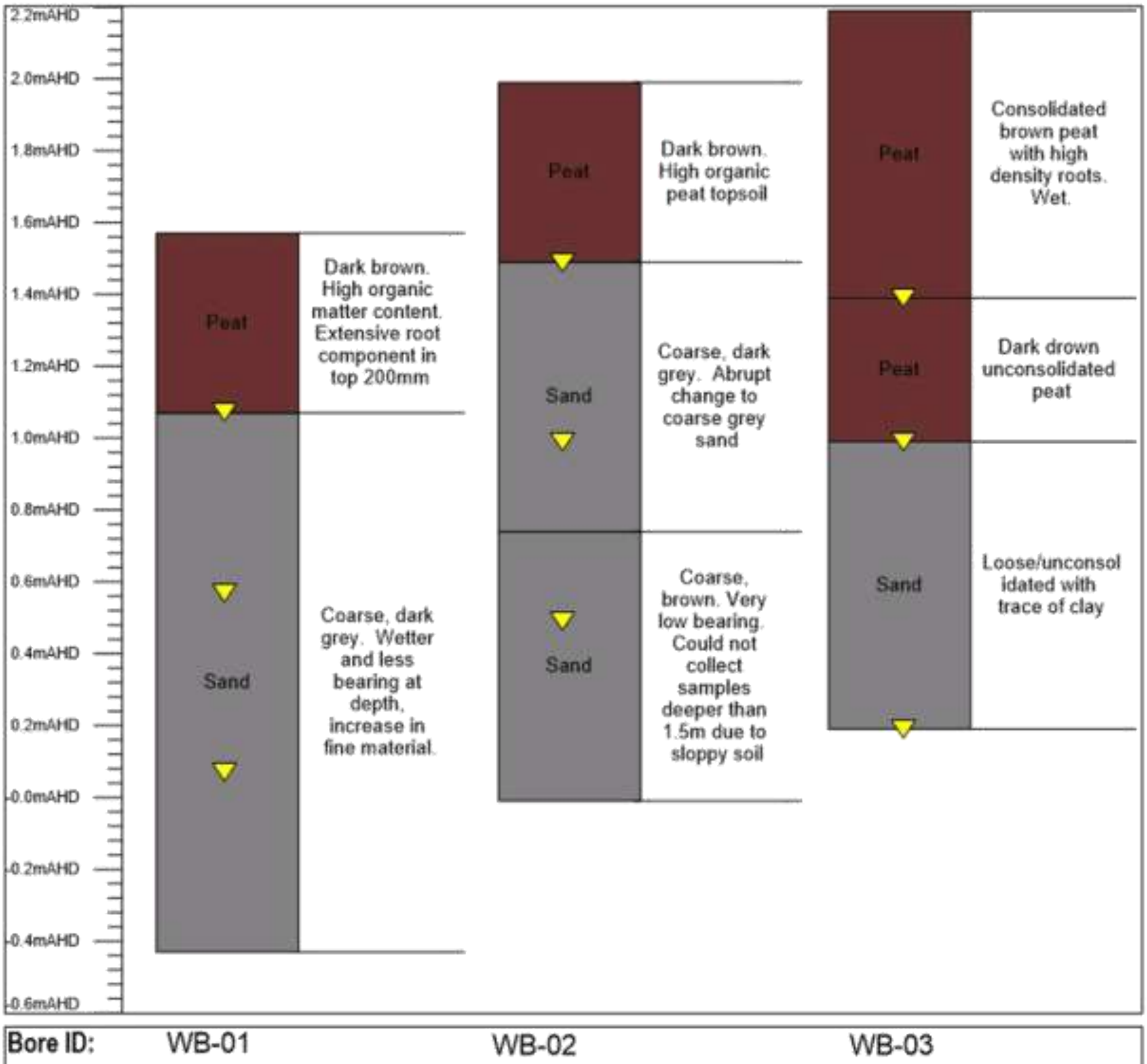
13 Appendix A – Soil bore logs and ASS results

West Byron STP Alternative Flow Path Investigation

Client: Byron Shire Council
Field work date: 14 & 17 Sept 2016
Project: West Byron STP Alternative Flow Path Investigation
Job Number: 1-16722
Staff: Jesse Munro
Drill type / method: Hand auger

AWC

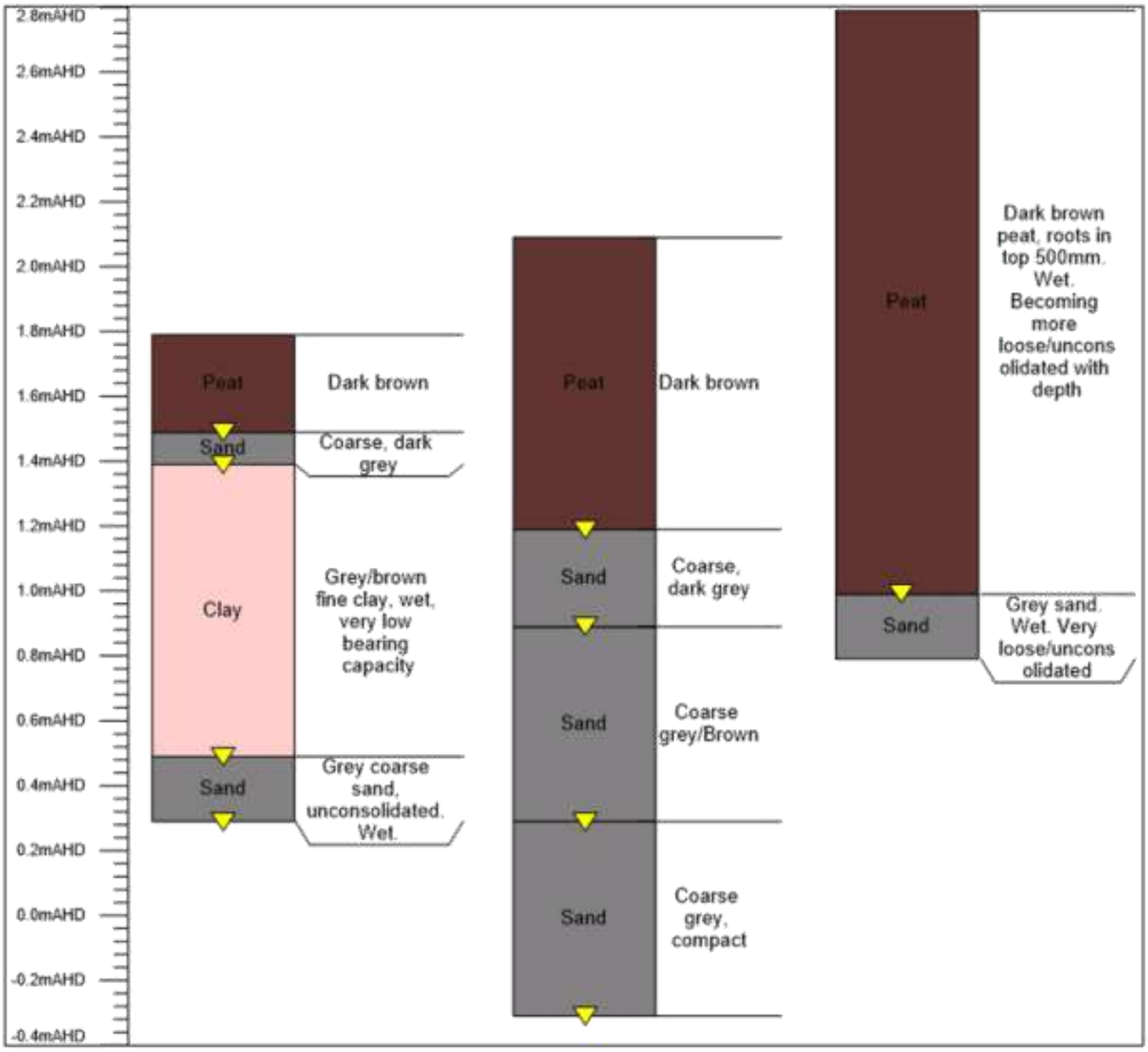


Units of mesaure: mAHD approximate
Yellow triangle represents approximate location of ASS sample
Red line indicates minimum depth to ASS as defined by >19 mole H^+/tonne

West Byron STP Alternative Flow Path Investigation

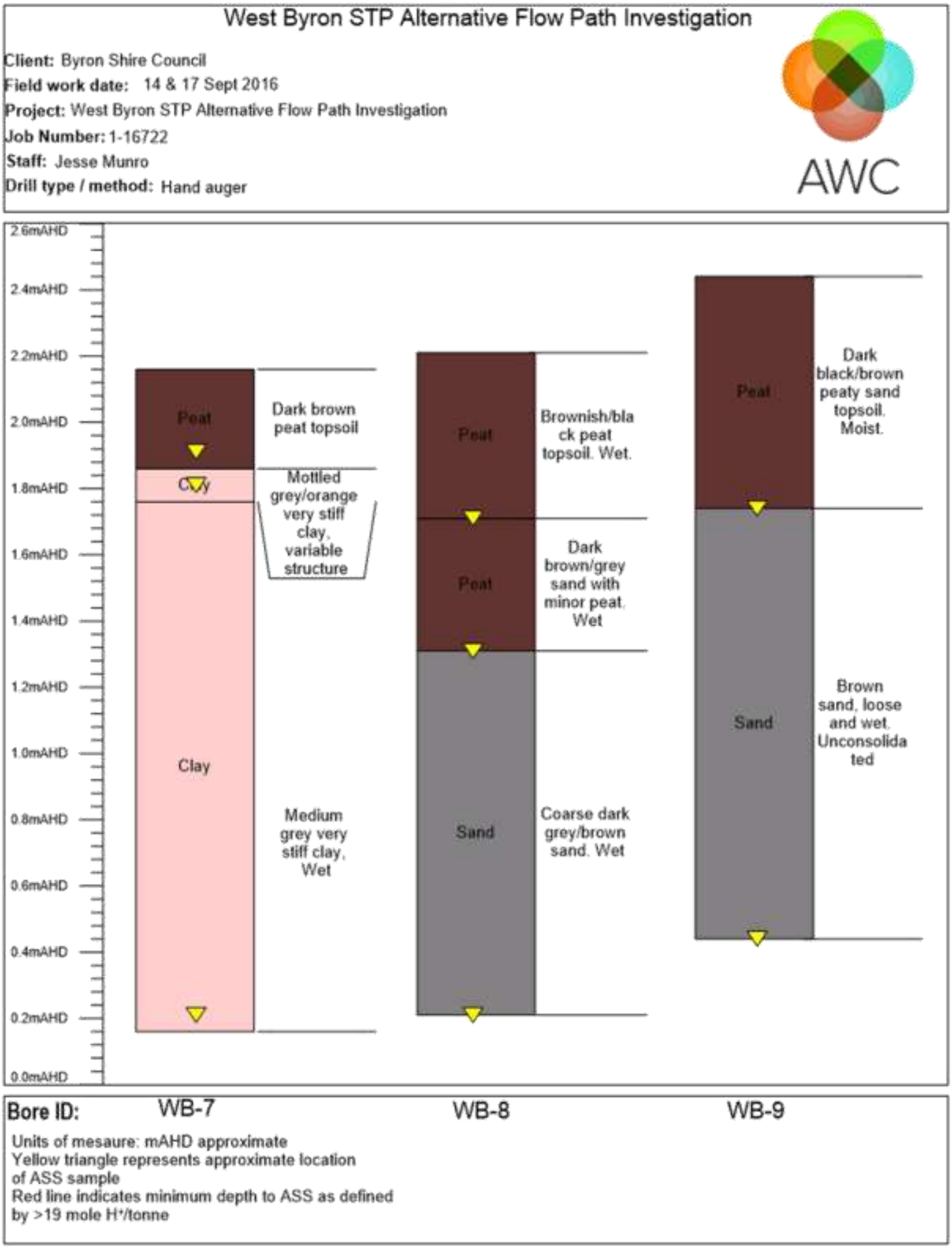
Client: Byron Shire Council
Field work date: 14 & 17 Sept 2016
Project: West Byron STP Alternative Flow Path Investigation
Job Number: 1-16722
Staff: Jesse Munro
Drill type / method: Hand auger

AWC



Bore ID: WB-04 WB-05 WB-06

Units of mesaure: mAHD approximate
Yellow triangle represents approximate location of ASS sample
Red line indicates minimum depth to ASS as defined by >19 mole H⁺/tonne


West Byron STP Alternative Flow Path Investigation
Client: Byron Shire Council
Field work date: 14 & 17 Sept 2016
Project: West Byron STP Alternative Flow Path Investigation
Job Number: 1-16722
Staff: Jesse Munro
Drill type / method: Hand auger
AWC
2.6mAHD
2.4mAHD
2.2mAHD
2.0mAHD
1.8mAHD
1.6mAHD
1.4mAHD
1.2mAHD
1.0mAHD
0.8mAHD
0.6mAHD
0.4mAHD
0.2mAHD
0.0mAHD
Peat
Dark brown peat topsoil
Clay
Mottled grey/orange very stiff clay, variable structure
Clay
Medium grey very stiff clay, Wet
Peat
Brownish/black peat topsoil. Wet.
Peat
Dark brown/grey sand with minor peat. Wet
Sand
Coarse dark grey/brown sand. Wet
Peat
Dark black/brown peaty sand topsoil. Moist.
Sand
Brown sand, loose and wet. Unconsolidated
Bore ID:
WB-7
WB-8
WB-9
Units of mesaure: mAHD approximate
Yellow triangle represents approximate location of ASS sample
Red line indicates minimum depth to ASS as defined by >19 mole H⁺/tonne

14 Appendix B – Water level logger graphs

15 Appendix C – Detailed methodology on hydrologic model.

15.1 Introduction

This section outlines the catchment modelling completed by BMT WBM. The catchment modelling was completed as a key component of the study to provide catchment flows. Flows were determined at numerous locations within the catchment (such as flows to the Union Drain) as well as an overall flow to the Belongil Creek estuary itself. This hydrologic data has been used to inform both a hydraulic model and a water quality model, as described in later sections of this report.

The catchment modelling results have been verified by qualitative and quantitative means as described in Section 17.6. It should be clearly stated that the validation process applied is not a traditional calibration where modelled flows are compared to a recorded flow set at a gauging station. This was not possible as there were no gauged flow stations in the catchment. The validation process applied has been done to ensure that the model provides an adequate reflection of the timing and magnitude of flows in the catchment. This increases confidence in use of the model for the study.

15.2 Model Framework

The SOURCE quantity and quality modelling framework simulates current catchment characteristics and responses, in addition to evaluating the impacts of specific changes, such as the addition of point source flows. SOURCE is not one model, but a framework in which groups of different models can be selected and linked such that the most suitable model to describe a particular aspect of a catchment can be developed and applied.

For the Belongil catchment, the SIMHYD hydrology module (see Figure 15-1) has been utilised as it is a commonly applied hydrologic model which has been applied by BMT WBM successfully in smaller coastal catchments in similar investigations in northern NSW.

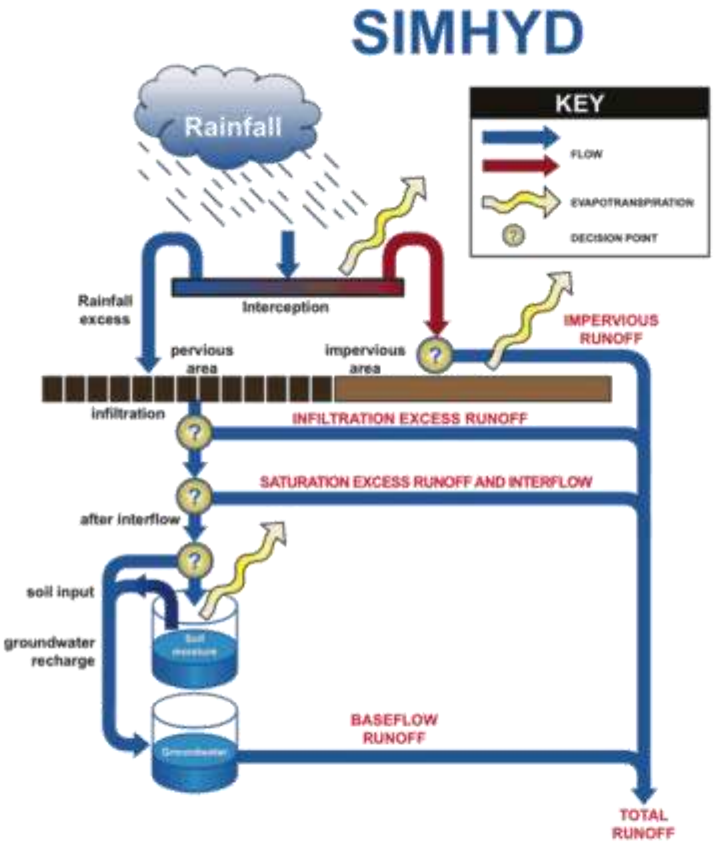


Figure 15-1: Overview of the SIMHYD Model

15.2.1 Data Requirements for a SOURCE Model

The SOURCE modelling framework requires a number of data sets including:

- A digital elevation model (DEM) for sub-catchment delineation;
- A land use map to provide a basis for functional unit definitions;
- Climate data (daily rainfall and evaporation data);
- Water quality data and/or Event Mean Concentration (EMC) / Dry Weather Concentration (DWC) data for pollutant export model parameterisation (if available);
- Hydrologic data for model calibration or validation (if available); and
- Point source (e.g. wastewater treatment plant) flow and quality data if applicable.

The following section summarises the data used to construct the Belongil SOURCE model.

15.2.2 Digital Elevation Model (DEM)

The DEM is discussed in Section 17.3.3 which overviews the hydraulic model construction process. From the DEM sub-catchments are identified and applied within the SOURCE model as described below.

15.2.3 Sub-catchment Map

A sub-catchment map for Belongil Creek was utilised from previous flood modelling completed by BMT WBM within the same catchment for Byron Shire Council. This earlier sub-catchment map was verified against:

- Computer generated sub-catchments were developed from a more recent 1m gridded LiDAR (circa 2012);
- The most current drainage layers from Byron Council, showing trunk drainage and stormwater asset locations such as culverts;
- Site specific knowledge of the 'lay of the land' and observations of local drainage paths, particularly in the vicinity of the West Byron STP.

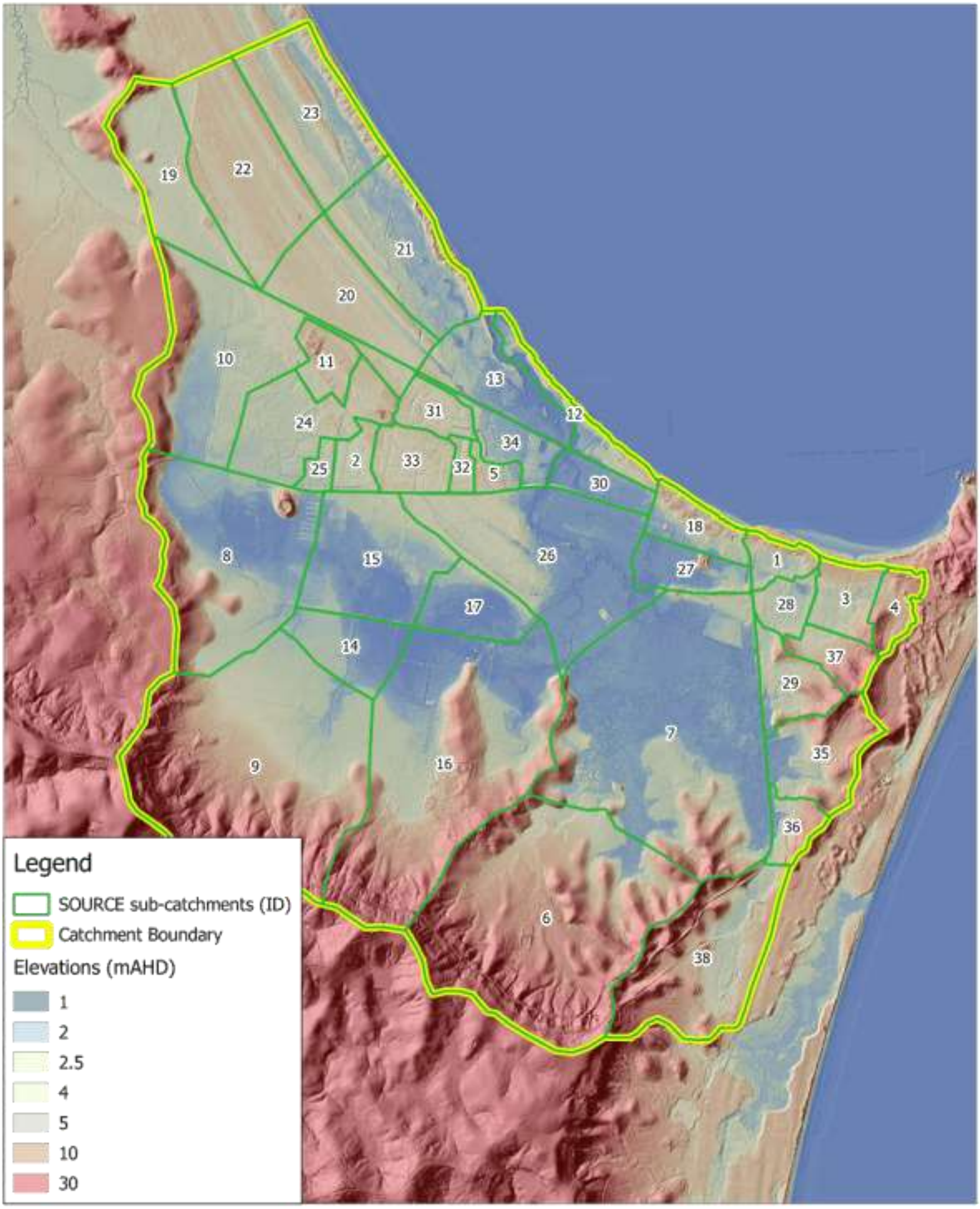
The resultant sub-catchment map contains 38 sub-catchments and is shown in Figure 15-2. These sub-catchments are used to provide hydrologic inputs to the hydraulic model as described in Section 1.3.1.

Land Use

A land use data set for the Belongil Creek catchment was developed from the State-wide Land Use Mapping Program completed by the NSW Government. This dataset contains over 500 detailed land use classes which are grouped under 14 major categories. This data was modified from the original to reduce the total number of land uses (Functional Units) to 8. The data reclassification is shown in Table 15-1. Total areas for each land use are shown in Table 15-2. The land use map used in the SOURCE model is shown in Figure 15-3.

As can be seen in Figure 15-3 the Program mapped the existing Belongil Fields Conference and Holiday Centre as an urban land use. This centre and adjoining lands may become part of the proposed West Byron Development. This proposed development is approximately 108 ha and would comprise a mixture of land uses including residential (low to medium density), conservation, light industrial and open space.

For the purposes of the current study, no modifications to the State generated land use layer have been made. However, significant development such as the proposed West Byron could influence surface and groundwater interactions, surface peak flows and discharge volumes, as well as water quality (depending on applied mitigation within the development).



Title:
Belongil Creek SOURCE Subcatchment Map

Figure: 15-2

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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Table 15-1 : Functional Units Used in SOURCE Based on Land Use Type

Functional Unit	Major Land use Category	Detailed Land use Class
Forest	Conservation Area	National park
		Private conservation agreement
		State forest
		Tree lot
	Special Category	Foreshore protection - vegetated fore dune (coastal feature)
	Tree & Shrub Cover	Hardwood plantation
		Native forest
		Native forest - regeneration
		Native woody shrub
		Softwood plantation
		Tree lot - exotic species
		Windbreak or tree corridor
	Urban	Urban recreation
	Wetland	Floodplain swamp
		Floodplain swamp - back swamp
		Floodplain swamp - billabong
		Mangrove
		Mudflat
		Swamp
Grazing	Grazing	Degraded land (salt site, eroded area)
		Grazing
		Recently cleared land
		Sown, improved perennial pastures
		Sown, improved perennial pastures
		Volunteer, naturalised, native or improved pastures
Horticulture	Horticulture	Building associated with horticultural industry
		Nursery
		Orchard - tree fruits
		Orchard - tree fruits - irrigated
		Pecan, macadamia and other nuts
		Shade house or glass house (includes hydroponic use)
		Tea Tree Plantation
		Tea Tree Plantation - irrigated
Intensive Use	Cropping	Cropping - continuous or rotation
	Intensive Animal Production	Horse stud and/or horse breeding facilities
		Intensive animal production - poultry
	Mining & Quarrying	Derelict mining land
		Mine site
		Quarry
	Power Generation	Electricity substation
		Energy corridor
	Special Category	Farm Infrastructure
	Transport & Other Corridors	Aerodrome/airport
		Communications facility
	Urban	Abandoned urban or industrial area
		Industrial/commercial
		Landfill (garbage)
		Sawmill
		Sewage disposal ponds
		Surf club and/or coastal car parking facilities
Road	Transport & Other Corridors	Road or road reserve
Rural Residential	Urban	Alternate life style community under multiple occupancy
		Cemetery
		Rural residential
		Small to medium forested or wilderness blocks with isolated residential buildings.
Urban	Urban	Area recently under development for urban, commercial and/or industrial uses
		Caravan park or mobile home village

Functional Unit	Major Land use Category	Detailed Land use Class
		Government and private facilities
		Residential
		Surf club and/or coastal car parking facilities
Water	River & Drainage System	Aquaculture
		Drainage channel
		Drainage depression in cropping paddock
		Drainage or water supply channel
		Farm dam
		Irrigation dam
		Irrigation supply channel
		Marina
		Prior stream
		River, creek or other incised drainage feature
		Water supply pressure reservoir including water filtration plant
	Special Category	Beach
		Cliff/rock outcrop
		Sand spit/estuarine sand island
	Wetland	Floodplain swamp - billabong

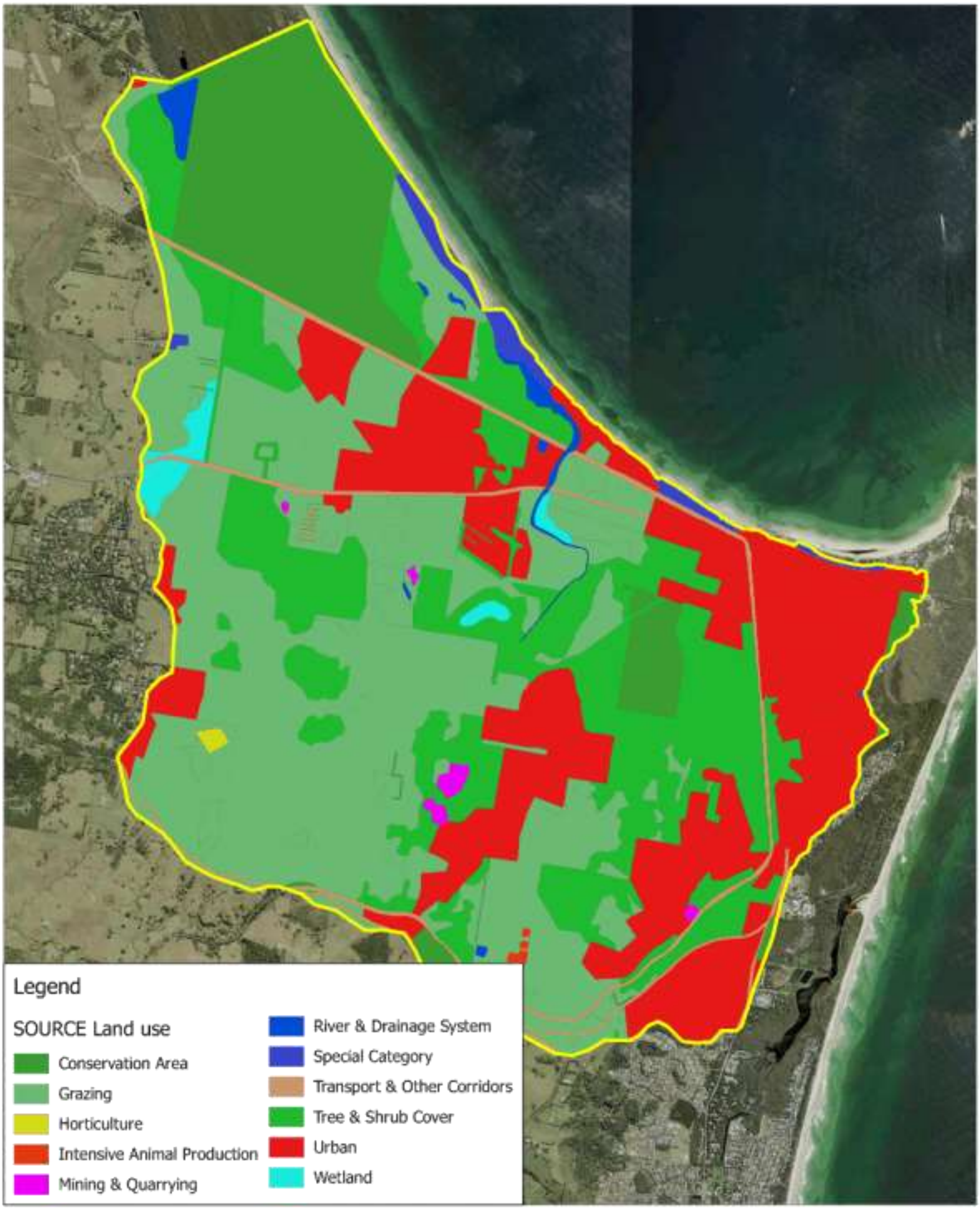
Table 15-2 :Land Use Area Breakdown

Functional Unit Name	Current Land use	
	Area (ha)	Percentage of Total (%)
Forest	1,178	40.0%
Grazing	1,069	36.3%
Horticulture	3	0.1%
Intensive Use	182	6.2%
Road	26	0.9%
Rural Residential	197	6.7%
Urban	261	8.9%
Water	32	1.1%
Total	2,947	100.0%

Rainfall and Evapo-transpiration

Rainfall and potential evapo-transpiration (PET) data imported to the SOURCE model domain is processed to produce a single time-series for each sub-catchment.

Daily rainfall and potential evapotranspiration (PE) data for the SOURCE model was sourced from the Bureau of Meteorology (BOM) SILO gridded datasets for the catchment over the period 1st January 1990 to 1st July 2016. Table 15-3 includes yearly total rainfall and PE data for a randomly selected Belongil Creek sub-catchment. As the SILO data is supplied as a gridded GIS dataset, each grid point provides a unique rainfall and PE dataset. As such varying rainfall and PE datasets are applied to each catchment from the gridded SILO datasets.



Title:

Belongil Creek SOURCE Land use Map

Figure: **15-3**

Rev: **A**

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Table 15-3 : Annual Rainfall and Evaporation

Year	Annual Rainfall [A]	Annual PE
1990	**1,736** [B]	1,527
1991	1,634	1,626
1992	1,327	1,531
1993	1,344	1,542
1994	**1,897**	1,529
1995	1,377	1,482
1996	**2,033**	1,521
1997	1,534	1,553
1998	1,373	1,539
1999	**2,877**	1,428
2000	1,241	1,493
2001	1,453	1,552
2002	1,209	1,597
2003	**1,870**	1,497
2004	1,298	1,586
2005	1,569	1,598
2006	**2,425**	1,544
2007	1,319	1,557
2008	**2,030**	1,465
2009	**2,046**	1,558
2010	**2,354**	1,389
2011	1,629	1,430
2012	**1,803**	1,496
2013	**1,945**	1,499
2014	1,267	1,496
2015	**1,897**	1,493
2016 (Partial)	965	732
Mean (26 Years)	**1,711**	**1,520**

[A] Taken from sub-catchment 12 of the model
[B] Bold blue text indicates values above the 26 year average rainfall

Hydrology Parameters

The hydrology component of Belongil Creek SOURCE model has been parameterised using the SIMHYD rainfall-runoff model. SOURCE has procedures for calibrating the SIMHYD parameters whereby it utilises an internal numeric optimiser to bring modelled results as close as possible to observed (i.e. 'real') data.

As the Belongil Creek catchment has no flow gauging stations an alternate method has been applied. This method has two parts as described below:

- Qualitative assessment using photographs that identify inundation patterns during significant rain events in a particular portion of the catchment; and
- Qualitative assessment comparing recorded water levels from a water level logger in the Union Drain to water levels predicted by the hydraulic model (described later in this section).

The process of model 'validation' by comparing predicted water levels (from the hydraulic model) to observed water levels in the Union drain is not a typical optimisation method. Essentially the predicted water levels and shape of runoff hydrographs were compared to observed water level data and adjustments made to hydrology model parameters to provide for a better model fit.

Further details of this process and outcomes are described in Section 17.6. The adopted hydrology parameters are included in Table 15-4.

Table 15-4 : Adopted SIMHYD Parameters

Parameter	Adopted Value
Impervious Threshold	1 mm
Rainfall Soil Interception Store	3.4 mm
Pervious Fraction	See below
Soil Moisture Store Coefficient	40 mm
Infiltration Shape	3
Infiltration Coefficient	300
Interflow Coefficient	0.41
Recharge Coefficient	0.6
Baseflow Coefficient	0.08

Pervious fractions adopted within SimHYD are provided below:

- Forest – 100%
- Grazing – 100%
- Horticulture – 100%
- Intensive Use – 35%
- Road – 35%
- Rural Residential – 90%
- Urban – 65%
- Water – 0%

The model was initially parameterised using procedures outlined in Chiew and Siriwardena (2005). However, as part of the validation, adjustments were made to certain parameters to increase runoff volume timing. This was achieved through specific adjustments to the Soil Moisture Store Coefficient (SMSC), recharge coefficient and infiltration coefficient. Generally, parameters were modified within suggested ranges identified within SOURCE.

It is recognised that hydrology parameters would vary between sub-catchments depending on a range of factors, but due study limitations in respect of validation, parameters have been applied to all sub-catchments.

Outcomes of the validation process completed within the hydraulic model are outlined in Section 17.6.

Pollutant Export Parameters

SOURCE supports a limited range of pollutant generation processes. For the Belongil Creek catchment model an Event Mean Concentration (EMC) / Dry Weather Concentration (DWC) pollutant generation process was selected. The use of EMC/ DWC is common in many daily time step catchment water quality models. It does have the limitation that it cannot be used to model water quality for particular storm events. This model does however facilitate the estimation of long term or mean annual pollutant exports and should be interpreted in this way.

In the present study, literature values have been used to derive and allocate EMC/DWC values for each land use represented by the model and apply these EMC/DWC values across the entire catchment area. As more information is collated and data analysis is undertaken in the catchment, it would be possible to modify EMC/DWC values for individual land uses in individual sub-catchments.

Extensive research and analysis of local water quality data has been carried out by Chiew and Scanlon (2002) to determine land use based EMC and DWC values for the south-east Queensland region. The median values from this study have been used, and are shown in Table 15-5.

Table 15-5: Adopted EMC and DWCs for TSS, TN and TP

Land Use Name	TSS		TN		TP	
	EMC (mg/L)	DWC (mg/L)	EMC (mg/L)	DWC (mg/L)	EMC (mg/L)	DWC (mg/L)
Forest	20	10	1.5	0.4	0.06	0.03
Grazing	260	10	2.08	0.7	0.3	0.07
Horticulture	300	10	1.95	0.7	0.32	0.07
Intensive Use	550	10	5.2	0.7	0.45	0.07
Road	130	7	1.6	1.5	0.28	0.11
Rural Residential	130	10	1.6	0.7	0.28	0.07
Urban	130	7	1.6	1.5	0.28	0.11
Water (Rainfall)	0	0	0	0	0	0

Point Sources (Quantity)

The Belongil Creek SOURCE model contains the West Byron STP. A time series of flow from the STP was obtained from the Byron Shire Council and applied as a point source within the hydraulic model (refer to Section 1.3.1). It was not necessary to add this flow to the hydrology model as it was able to be added within the hydraulic model (either approach would yield the same outcome and results).

Effluent release data for the west Byron STP (at site EPA5 minus allowances for seepage and evapotranspiration losses in the wetland areas) is presented in Figure 15-4. Flow modifications for the purposes of modelling scenarios with different release volumes were performed by addition or subtraction of flows to the existing daily flows. No attempt was made to scale flows for scenarios.

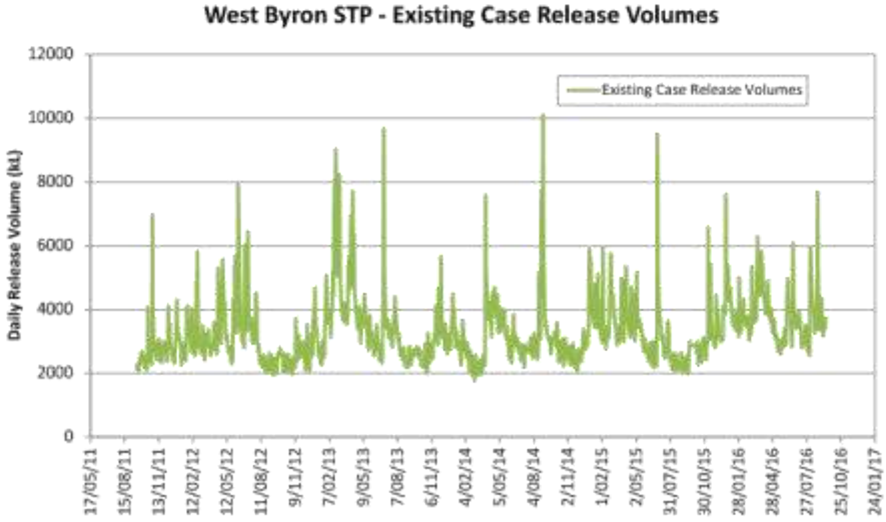


Figure 15-4: Daily West Byron STP Effluent Release Volumes

Table 15-6 : Annual West Byron STP Effluent Release

Year	Flow (ML/y)
2011 (partial)	290
2012	1,120
2013	1,290
2014	1,150
2015	1,200
2016 (partial)	790

Point Sources (Quality)

The Belongil Creek SOURCE model contains the West Byron STP. Recorded water quality data from EPA 3 was used to create a time series of water quality being discharged from the STP. Given that the recordings were made within the STP itself, they do not account for the additional nutrient processing which would be expected with travel down the Union drain prior to entry to the Belongil Creek estuary.

Byron Shire Council supplied the water quality monitoring data. The data has been presented in Figure 15-5.

Table 15-7 presents key statistics relating to the effluent quality data. It is noted that pollutant concentrations are low for STPs and show little peakiness with median and average values being quite similar. The wetland treatment system appears to be effective in reducing pollutant concentrations. Table 15-8 presents calculated pollutant export loads which combines measured discharge and quality datasets.

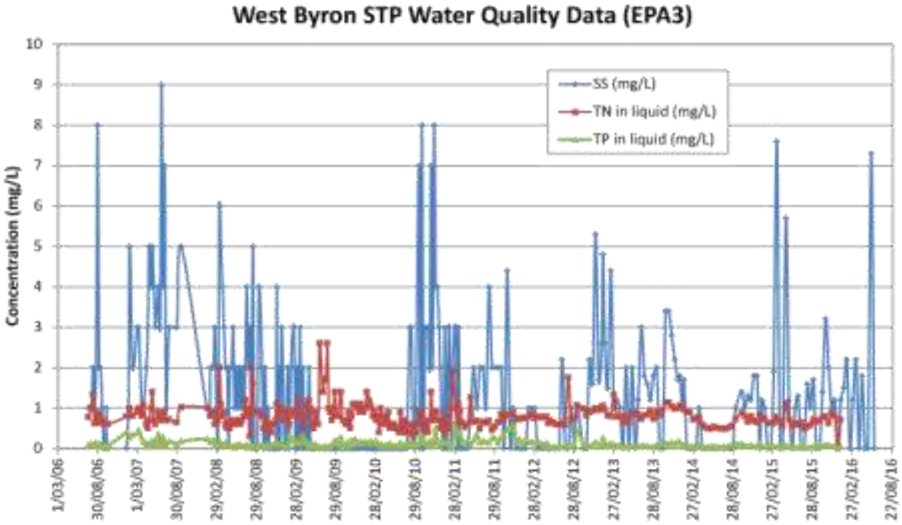


Figure 15-5 : West Byron Effluent Quality Data

Table 15-7: West Byron STP Effluent Quality Statistical Metrics (Available Data)

Parameter	Mean	Median	25th Perc	75th Perc	90th Perc
TSS (mg/L)	1.87	1.70	0.04	3.00	4.00
TN (mg/L)	0.80	0.76	0.60	0.90	1.10
TP (mg/L)	0.12	0.09	0.06	0.15	0.22

Table 15-8: West Byron STP Pollutant Export Loads (Available Data)

Year	TSS (kg/y)	TN (kg/y)	TP (kg/y)
2011 (partial)	352	228	99
2012	762	899	128
2013	2,327	1,157	115
2014	643	770	78
2015	1,568	807	57
2016 (partial)	861	490	37
Total	**6,514**	**4,353**	**514**

15.3 Model Validation

Model validation is described further within the Hydraulic modelling section. With respect to the hydrology model, as described earlier in this section, adjustments were made to the hydrology parameters via a qualitative process involved the hydraulic model. Essentially the hydraulic model provided insight as to whether the timing and quantity of flow being predicted from the hydrology were appropriate.

15.4 Model Results

The SOURCE model has been developed using available data. As previously mentioned, limited flow and water quality data is available to make an accurate prediction of flows and pollutant loads from the catchment. Flows presented in this section are suitable for use in this study, taking into considerations its limitations.

The final Belongil Creek SOURCE model layout is shown in Figure 15-6. The figure shows the individual sub-catchments, and drainage linkages through to the Belongil Creek estuary and ultimately a discharge to the Byron Bay embayment.

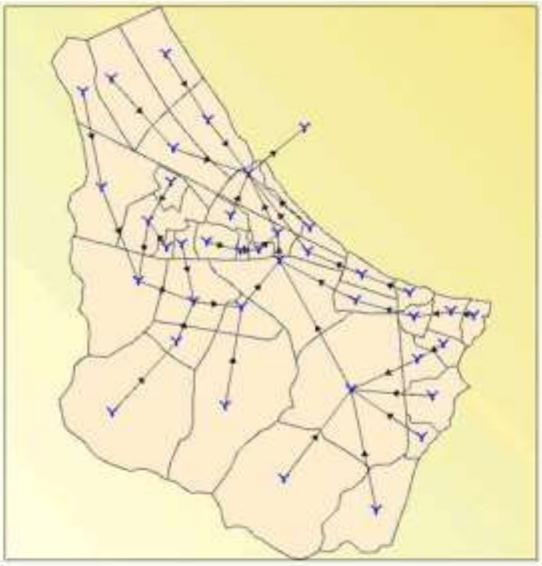


Figure 15-6: Belongil Creek SOURCE Model

Within the SOURCE model estimated flows and constituent loads can be extracted at any node, link or sub-catchment in the model domain. A range of predicted values (flows and loads) are provided in the following sections.

15.4.1 Catchment Flows

Modelled annual flows as delivered from the Belongil Creek catchment are provided in Table 15-9. This table also shows the mean annual flows from the Belongil Creek catchment.

Table 15-9: Modelled Annual and Mean Annual Flows to Belongil Creek (1990 –2016)

Year	Flow (ML)	Year	Flow (ML)
1990	28,300	2004	19,000
1991	25,900	2005	24,200
1992	14,200	2006	47,100
1993	16,100	2007	14,300
1994	33,700	2008	34,700
1995	18,300	2009	38,700
1996	35,500	2010	41,800
1997	20,800	2011	22,700
1998	17,500	2012	30,900
1999	54,000	2013	35,600
2000	14,500	2014	15,400
2001	23,100	2015	28,600
2002	16,300	2016 (partial)	17,100
2003	33,200	**Mean Annual**	**27,200**

15.4.2 Pollutant Export

Modelled annual pollutant loads as delivered from the Belongil Creek catchment are provided in Table 15-10. This table also shows the mean annual pollutant loads to Belongil Creek.

Table 15-10: Modelled Annual and Mean Annual Pollutant Loads from Belongil Creek (1990 –2016)

Year	TSS (T/y)	TN (T/y)	TP (T/y)
1990	3,510	46	5.0
1991	2,920	39	4.0
1992	1,720	22	2.0
1993	1,950	25	3.0
1994	3,930	52	5.0
1995	2,240	29	3.0
1996	4,750	61	6.0
1997	2,480	33	3.0
1998	2,070	27	3.0
1999	6,690	87	9.0
2000	1,820	23	2.0
2001	3,200	40	4.0
2002	1,950	26	3.0
2003	4,450	57	6.0
2004	2,260	30	3.0
2005	3,270	42	4.0
2006	5,310	71	7.0
2007	1,800	23	2.0
2008	4,470	57	6.0
2009	5,240	67	7.0
2010	5,560	71	7.0
2011	2,560	34	4.0
2012	3,940	51	5.0

Year	TSS (T/y)	TN (T/y)	TP (T/y)
2013	4,750	60	6.0
2014	2,060	26	3.0
2015	3,530	46	5.0
2016 (partial)	2,080	27	3.0
Mean Annual	**3,400**	**44**	**4.5**

15.4.3 Comparisons of Catchment and STP flows

Presented in

Table 15-11 are effluent releases from the West Byron STP and catchment flows to Belongil Creek flows as predicted by the SOURCE model. The data indicates (that over the four year period) the STP contributed less than 5% of the total outflow to the Belongil Creek estuary with the remainder being catchment runoff.

Table 15-11: Comparison of Catchment and STP Flows to Belongil Creek

Year	Catchment Flow (ML)	STP Flow (ML)	% STP Contribution to Total Flow
2012	30,900	1,120	3.5%
2013	35,600	1,290	3.5%
2014	15,400	1,150	6.9%
2015	28,600	1,200	4.0%
4 yr Avg.	**27,625**	**1,190**	**4.5%**

15.4.4 Comparisons of Catchment and STP loads

Presented in Table 15-12 is available pollutant loading data for the West Byron STP and Belongil Creek catchment as predicted by the SOURCE model. West Byron STP loads have been calculated by combining measured effluent discharge volumes and monitored pollutant concentrations (at EPA3). The data identifies that the STP pollutant loading is substantially lower than the predicted catchment loading and in the case of total nutrients represents around 2% of the total current contribution (for the period 2012 to 2015).

Table 15-12: Comparison of Catchment and STP Pollutant Loadings to Belongil Creek

Year	Catchment TSS (T/y)	STP TSS (T/y)	Catchment TN (T/y)	STP TN (T/y)	Catchment TP (T/y)	STP TP (kg/y)
2012	3,940	0.8	51	0.9	5.4	0.13
2013	4,750	2.3	60	1.2	6.4	0.12
2014	2,060	0.6	26	0.8	2.8	0.08
2015	3,530	1.6	46	0.8	4.8	0.06
4 yr Avg.	**3,570**	**1.3**	**46**	**0.9**	**4.9**	**0.10**

15.4.5 Assumptions and Limitations

The SOURCE hydrology and pollutant export model has a number of limitations as outlined below:

- Hydrology models are normally calibrated and validated through a process that compares modelled catchment flows to recorded catchment flows. The Belongil catchment has no flow gauge hence traditional means of calibration (model optimisation) are not available. It would be useful to consider installing a flow gauge to collect daily flows within suitable parts of the catchment, which is difficult given that it is mostly tidal.
- Model validation has been performed through qualitative measures as were able to be established by the study team to ascertain and confirm model performance.
- EMC/DWC values specific to South East Queensland have been applied within SOURCE for the purposes of calculating catchment pollutant exports. Locally derived values would improve model accuracy. It is noted that STP loads are low in comparison to catchment contributions and as such improvements to the EMC/DWC values are unlikely to significantly affect study outcomes in this instance.

16 Appendix D – Detailed methodology on water quality model.

This section outlines the water quality modelling completed by BMT WBM. The water quality modelling provides ancillary information to the hydrologic and hydraulic modelling work. It has been established to provide an understanding of potential water quality changes within the Belongil Creek estuary resulting from increasing discharges from the West Byron STP.

A rapid assessment water quality model has been developed to ascertain potential impacts to the estuary. The model accounts for key flow and pollutant inputs to the estuary and it is able to provide a temporal (i.e. changes over time) understanding of potential changes in key pollutant concentrations. However, due to its formulation it cannot provide spatial information (i.e. locations of change), such functionality is in the realm of more complex 1 and 2 dimensional water quality models. Within estuaries normally 2 dimensional water quality models are utilised provided there is sufficient information to build and calibrate them.

The rapid assessment water quality model provides a useful insight into potential system changes without excessive data demands, and can be used to identify the need for further modelling.

16.1 Model Framework

To assess whole of system changes in water quality, a rapid assessment non-dimensional water quality model has been built for the Belongil Creek estuary. The model has been established over a multi-year period where data exists to adequately describe estuary function, catchment inputs and the West Byron STP effluent flows and loads (refer to Figure 16-1). The periods selected also allow for elements of traditional model calibration.

Previously, BMT WBM as part of the Tallow and Belongil Creeks Ecological Study completed for Byron Shire Council developed a non-dimensional water quality model for the Belongil Creek estuary. This box model has been reinstated, updated and applied for use in this study as described in the following sections.

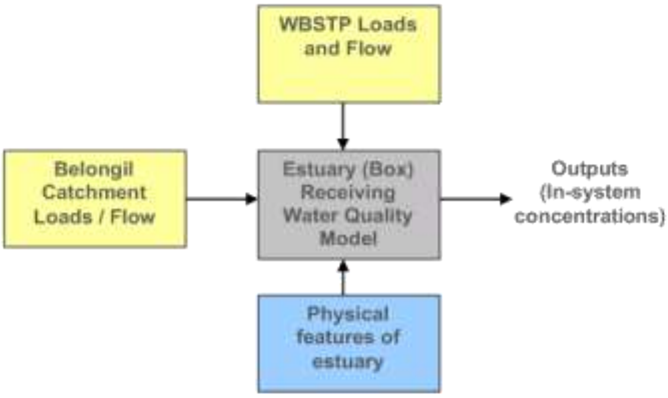


Figure 16-1: Schematic of the rapid assessment water quality model

Other features of the model include:

- Daily time-step operation; and
- Allowances for key processes such as settlement, sediment release, biological uptake and denitrification.

1.1 Data Requirements

Key datasets used to inform the water quality model include:

- West Byron STP discharge data;
- Belongil Creek water quality data;
- Catchment discharge data;
- Volumetric data for the Belongil Creek estuary; and
- Belongil Creek tidal data.

1.1.1 West Byron STP discharge data

West Byron effluent release and water quality data has been obtained from Byron Shire Council for a period extending from September 2011 to July 2016. This effluent release and water quality data is presented in Sections 0 and 0.

1.1.2 Belongil Creek water quality data

The following datasets were identified in respect of water quality:

- Belongil Creek (at Ewingsdale Road bridge) salinity logging. Data compiled by Byron Shire Council and available over June 2011 to April 2016;
- Belongil Creek salinity logging. Data compiled by MHL as part of the Belongil Creek Water Quality Monitoring project completed for the Department of Land and Water Conservation (MHL, 1997). Salinity monitoring period included 1994 and 1995. This data was previously obtained by BMT WBM as part of the Tallow and Belongil Creeks Ecological Study;

- Periodic Creek monitoring associated with entrance opening events. Typically these monitoring activities occur up to three or four times per year, but are always associated with entrance opening events and as such do not represent suitable ambient monitoring; and
- Belongil Creek monitoring associated with the Belongil Estuary Entrance Management Reports Stage 1 (AWC, 2008). Water quality data presented in this report was available over the period of 2007 to 2008. This data did not align with any period where water level logging data was available.

1.1.3 Catchment discharge data

Catchment inputs to the estuary will be obtained from the SOURCE hydrology and pollutant export model. The model has been established using locally specific information and runs over the period of 1990 to 2016. Model establishment and results are further described in Section Appendix E.

1.1.4 Volumetric data

Estuarine bathymetry data, LiDAR and drain survey information has been used to determine estuarine volume at different water levels. All bathymetry, LiDAR and survey have been incorporated into a digital elevation model of the estuary in a GIS package. The DEM has been interrogated using the GIS package to identify estuarine volumes at different water levels.

Accurate estimation of estuarine volume is important within the water quality model to be able to identify accurate concentrations of constituents such as salt and nutrients.

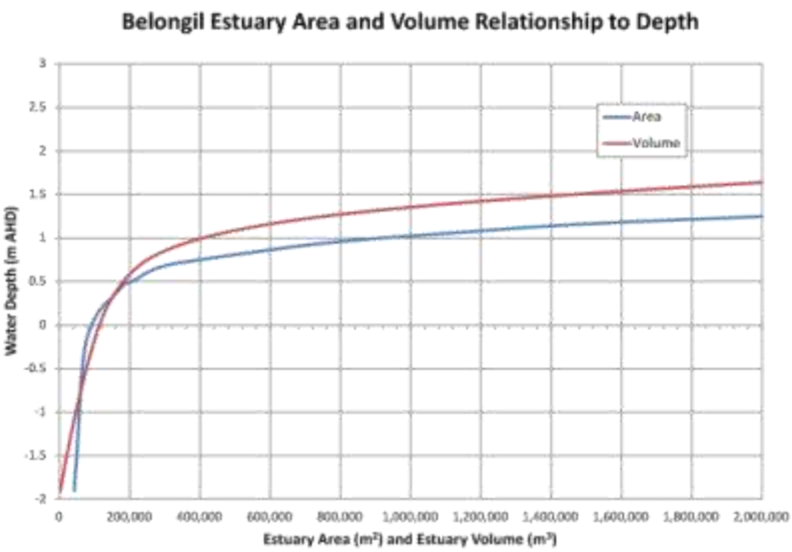


Figure 16-2: Estuary area and volume relationships with water elevation

1.1.5 Belongil Creek tidal data

A key input to the water quality model has been tide level data. Tide level data is used in the model to calculate the quantity of tidal exchange happening over each daily period. As the Belongil Creek estuary mouth is subject to periods of partial or complete closure, daily tidal exchange can vary significantly. As such a methodology was identified to determine daily tidal exchange based on logged water level data within the Belongil Creek estuary.

Two long term tide level records were identified:

- Data obtained from the Manly Hydraulics Laboratory for the Belongil Creek Water Quality Monitoring Project which recorded tide levels from December 1994 to December 1996 (MHL, 1997). This data was logged in the lower estuary several metres downstream (closer to mouth) than the Belongil Creek bridge (refer Figure 16-3).
- Data obtained from Byron Shire Council in the Belongil Creek at the Ewingsdale Road bridge. This data is collected as part of ongoing estuary monitoring work by way of period contracts. Several datasets were obtained and compiled to produce a water level time-series which extends from June 2011 to April 2016 (refer Figure 16-4).

1.1.6 Establishment

Using the abovementioned datasets the salinity and nutrient models developed as part of the Tallow and Belongil Creeks Ecological Study (WBM Oceanics, 2000) were updated. Based on availability of key datasets, the models operate from September 2011 to April 2016.

The key updates to the pre-existing models were made to the following aspects:

- Tide exchange – by use of daily tidal levels in the creek at either the MHL or Council recordings site. Algorithms were derived to convert daily tidal levels into an estimation of tidal exchange to account for the variability in tidal exchange in an estuary with a variable entrance;
- Runoff volumes – these were updated to the latest hydrologic model output from SOURCE; and
- STP volumes – these were updated to the information provided by Council for the periods of interest.

Previously established (calibrated) parameter values for nutrient processes including settlement, sediment release, biological uptake and denitrification were not modified.

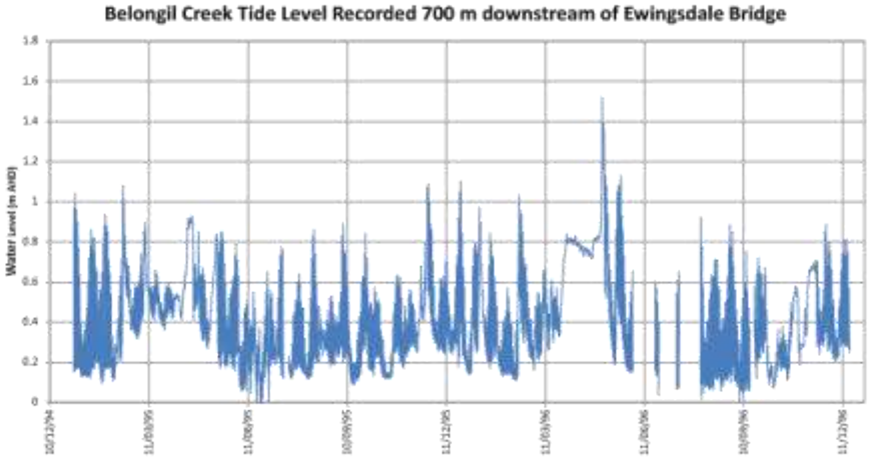


Figure 16-3: Recorded tide levels in Belongil Creek 700 m downstream of Ewingsdale Bridge

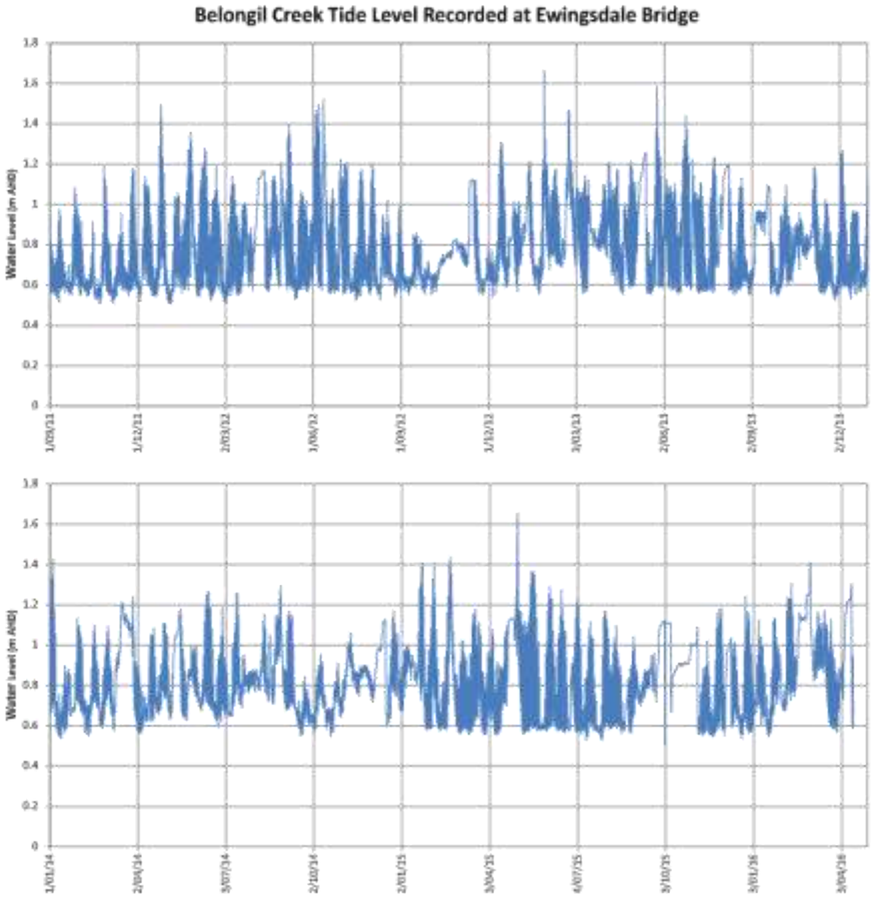


Figure 16-4 : Recorded tide levels in Belongil Creek at Ewingsdale Bridge

1.2 Model Validation

The performance of the salinity model has been verified with available water quality for the estuary. Logged salinity is the only available long term water quality dataset which could be used for model validation purposes. Two salinity datasets are available for model validation, including the MHL dataset covering a two year period (1994 to 1995) and a shorter period at the Ewingsdale Road Bridge crossing. The MHL recording site is several hundred metres downstream towards the entrance from the bridge recording site.

Figure 16-5 and Figure 16-6 have been provided to identify model performance over two differing year long periods. The first validation period occurs in 1995 where an MHL recorded salinity dataset has been used. The second validation period occurs in 2013-14 where a Council recorded salinity dataset has been used. The results identify:

- A sound match of observed and modelled data over 1995. The model matches salinity dynamics for the duration and is able to capture step changes in water quality associated with events such as entrance closures and opening.
- A less sound fit was achieved over the 2013-14 period with differences in the predicted 'ambient' salinity and a lower ability to identify step changes in data.

Despite the poorer fit observed for the 2013-14 period, the model is considered to be adequate. Validation of these models requires the use of an observed dataset in a location which is broadly representative of conditions throughout the estuary (as the model assumes complete mixing). The MHL recording location appears to be such a location, while the Council recording site appears to be too far upstream and is overly influenced by freshwater flows. This would explain the models general over-estimation of salinity throughout the estuary. The validity of the observed data over November and December 2013 period is also questionable, as the data suggests the estuary is totally freshwater for several weeks which is considered unlikely as rainfall over this period was not exceptional (Oct 13 – 73mm, Nov 13 – 196 mm and Dec 13 – 36 mm).

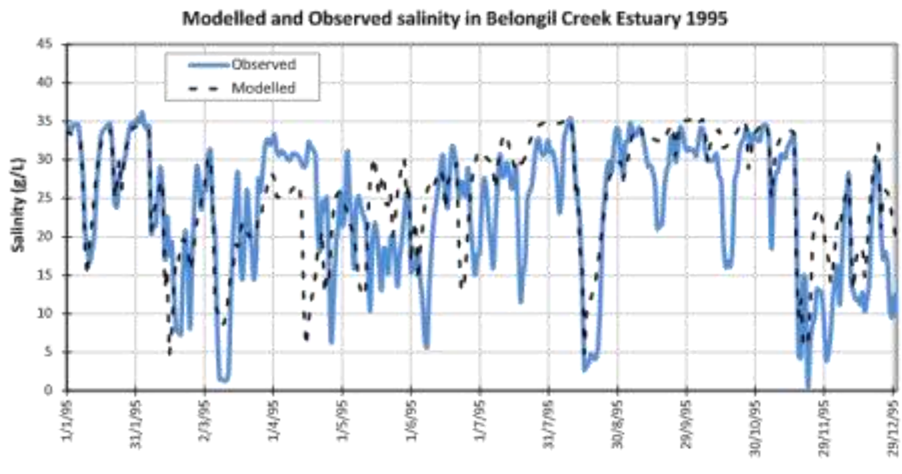


Figure 16-5: Model Validation Period 1995 - MHL Recorded Salinity Data

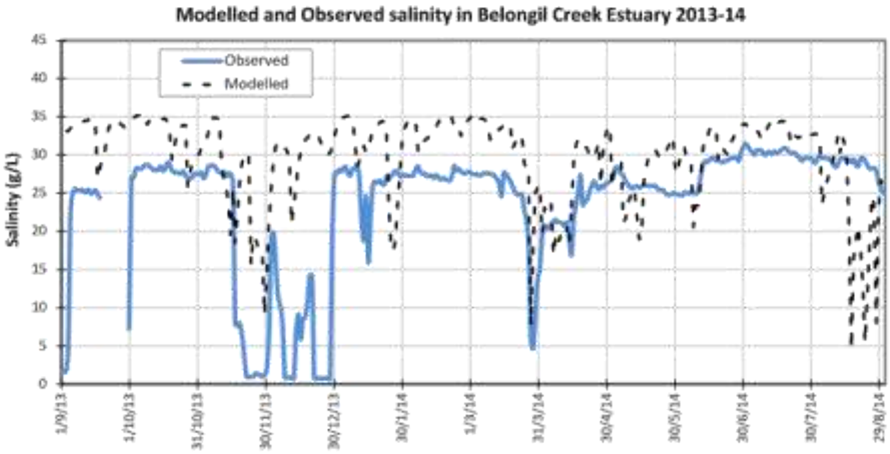


Figure 16-6 : Model Validation Period 2014 - Council Recorded Salinity Data

The model validation process indicates that the salinity data provides an adequate representation of likely salinity conditions based on available information. The outcome indicates that the model provides accurate representation of both inflows (STP and catchment inputs) and tidal exchange processes, all of which determine estuarine salinity on a daily basis.

The validation process identifies that the key driver of water quality in the estuary, i.e. the water balance, is accurate and as such estimates of nutrient dynamics should also be accurate. Other specific nutrient processing model parameters previously developed through the Tallow and Belongil Creeks Ecological Study have been retained in the current model as there was insufficient data available to provide a better calibration dataset. However, no validation was possible for nutrients as no long term water quality data was available for the estuary over the periods which the model was able to be established.

1.2.1 Water Balance

A water balance was performed for the estuary taking into consideration modelled catchment inputs, West Byron STP effluent releases and modelled tidal exchange. A water balance was performed over 2012 to 2015 (i.e. 4 years) to identify the relative contributions of flow to the estuary. Figure 16-7 identifies that the key contributor of water to the estuary is the tide (68%), followed by catchment flows (31%) followed lastly by STP discharges (1%). As such the dominant factor controlling water quality in the estuary will be tidal exchange capacity. Hence if tidal exchange is increased, it will play an even more significant role in moderating water quality.

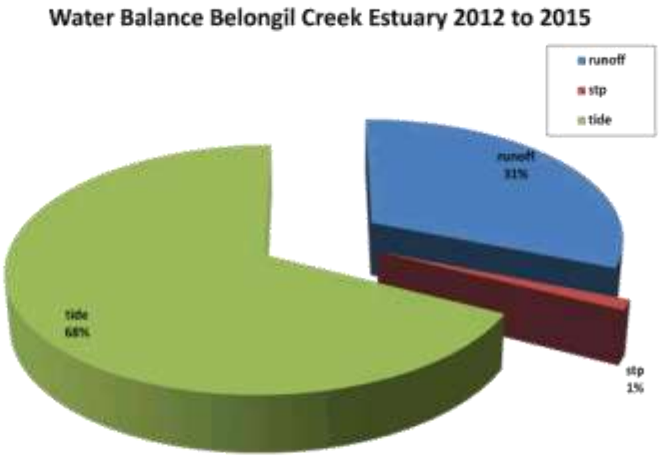


Figure 16-7: Water Balance Belongil Creek Estuary

1.3 Assumptions and Limitations

The water quality models have the following key limitations and assumptions:

- The water quality model is a volume averaged model which assumes complete mixing occurs through the estuary on each daily time step. This is a limitation of the model as complete mixing is unlikely to occur in the estuary volume in each daily time step. Operating in this fashion the model is unable to provide spatial representation of changes in water quality.
- Model performance has been verified using salinity dynamics only. There was no ability to verify model performance against long term water quality datasets. It is however expected that the model should perform adequately as it was previously calibrated to local conditions including salinity and water quality data as part of a previous study.
- Catchment flows are derived from the SOURCE model which is uncalibrated. The SOURCE model however did go through a qualitative refinement process to match predicted flows against observed datasets (i.e. water levels and inundation extents). While not a complete calibration, model performance is adequate for the purposes of this study. Additionally catchment flows are a smaller contributor of flow volume to the estuary than tidal exchange volume and the effect of inaccuracies in the catchment flows are diminished accordingly.
- EMC/DWC values specific to South East Queensland have been applied within SOURCE for the purposes of calculating catchment pollutant exports. The use of non-site specific parameters may introduce some error into the predicted catchment pollutant inputs to the estuary.

17 Appendix E – Detailed methodology on hydraulic model.

For the purposes of the Hydraulic Capacity Assessment (HCA) potential changes in inundation behaviour with varying STP discharge rates and locations has been assessed. Due to the low catchment relief and largely tidally influenced floodplain it has been necessary to assess potential changes under a range of estuarine and meteorological conditions, e.g., estuary mouth open and closed, and also during wet and dry periods.

The adopted assessment approach has been to complete long term continuous simulation (over a nearly five year period) that represents a typical range of estuarine and meteorological/catchment conditions and could be considered representative of longer term system operation. From this the effects of modification (i.e. scenarios) can be determined.

17.1 TUFLOW Hydraulic Modelling Framework

The two-dimensional (2D) and one-dimensional (1D) hydraulic modelling software package TUFLOW has been used for all hydraulic modelling in this study. A brief description of the program is provided below.

TUFLOW solves the full 2D shallow water equations based on the scheme developed by Stelling (1984) and improved by Syme (1991) and Syme (1999). The solution is based around the alternating direction implicit finite difference method. A square grid is used to define the discretisation of the computational domain.

TUFLOW models have been successfully checked against rigorous test cases (Syme 1991; Syme, Nielsen, and Charteris 1998), and calibrated and applied to a large range of real-world tidal and flooding applications.

17.2 Hydraulic Modelling background

The Belongil Creek Flood Study was undertaken for Byron Shire Council by SMEC Pty Ltd and completed in 2009. The purpose of the flood study was to define the catchment flood behaviour and associated risk to the towns of Byron Bay and Ewingsdale. A TUFLOW hydraulic model was created as part of the Flood Study.

Following the completion of the Flood Study, BMT WBM completed the Belongil Creek Floodplain Risk Management Plan (FRMS). As part of the FRMS a number of updates were made to the TUFLOW hydraulic model (BMT WBM, 2015).

The updated TUFLOW model created for the FRMS was used as the basis of the hydraulic modelling presented below. A number of updates were made to this model for the purpose of this HCA. The updates to the TUFLOW model for the purpose of the HCA are outlined in the section below.

17.3 Hydraulic Model Updates

17.3.1 Simulation Period

In order to capture the influences of the STP flows, it was necessary to revise the model approach from short duration event based modelling (which is typical of flood modelling), to modelling a longer continuous period. In order to keep the simulation times manageable a number of other changes were required, as described further below. The actual simulation period selected extends from 17/09/2011 to 15/04/2016, a period of 1,672 days (approximately 4.5 years). This period was selected based on availability of key datasets such as tidal water level data.

17.3.2 Cell Size

The FRMS hydraulic model was designed to run a limited number of shorter duration (typically <1 day) flood events. However, for the hydraulic capacity assessment the model was required to run for a much longer period, i.e. approximately 5 years. In order for the runtimes of the longer term simulation to be manageable, the cell size of the model was increased to reduce the computational load. The FRMS modelling utilised a cell size of 10 m, for the HCA a cell size of 25 m was utilised. This allowed for continuous long term simulation to be completed (for the existing case and identified scenarios) within the timeframe of the project.

17.3.3 Digital Elevation Model

Since the original flood study model (SMEC, 2009), revised LiDAR (elevation) data was collected in October 2012. Since the flood study model had been built and calibrated with previous data, not all flood modelling was updated to the 2012 Lidar. For the HCA the 1m LiDAR collected in 2012 has been used as the primary elevation data source for the floodplain areas.

Additional survey data is incorporated in a number of areas, including:

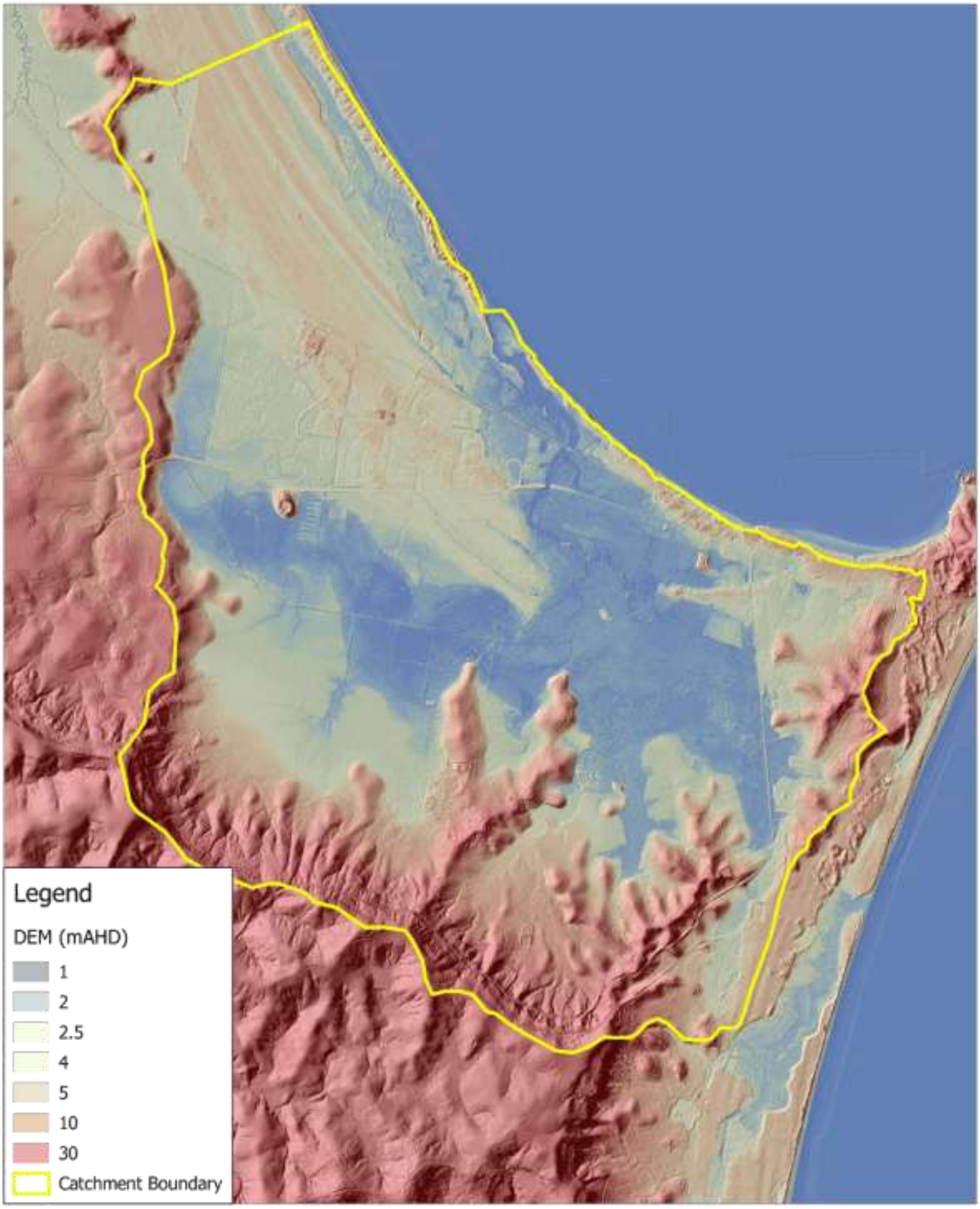
- Hydrosurvey of the Creek, this data was collected by the Department of Public Works and Services in 1997.
- Cross-sectional survey include in the FRMS model; and
- Additional cross-section survey collected by AWC (see Section 1.3.2).

An updated DEM of the catchment is provided in

Figure 17-1.

1.3.1 Revised Boundaries

As part of the SMEC (2009) Flood Study a hydrologic model was created in the XP-RAFTS software. As the XP-RAFTS model cannot account for groundwater effects or water quality and these elements are important to this study, the SOURCE modelling framework was utilised to provide catchment hydrology and water quality datasets (refer Appendix D). Therefore, for the HCA the TUFLOW hydraulic model was configured to use the SOURCE inflow locations and boundary data as opposed to the XP RAFTS boundaries utilised in the Flood Study and FRMS.



Title:
Updated Digital Elevation Model for the Belongil Creek Catchment

Figure: 17-1

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17.3.4 New 1D survey

AWC collected additional survey of the drains within the study area. This was included into the model as 1D sections, which is linked to the 2D areas on the floodplain. The updated 1D locations are presented in

Figure 17-2.

A number of 1D sections outside of the area of interest (e.g. pipes and culverts within the Byron Bay township) were removed from the HCA hydraulic model, to provide for faster computational runtimes and better model stability. These modifications would have no significant effect on the accuracy of the model in floodplain regions.

17.3.5 Extent

The downstream boundary condition of the original Flood Study and FRMS was modified for this project. This was done as insufficient data on entrance bathymetric changes exists over any period, and would have presented a significant limitation for the continuous simulation modelling approach.

The status of the entrance plays a large role in determining water levels within the estuary downstream of the discharge location (i.e. upper estuary and Union drain). To overcome this key potential limitation, water level data recorded at the Ewingsdale Bridge (see Section 1.3.3) has been applied to drive estuarine hydraulics as a downstream boundary condition. This approach overcomes the need for detailed entrance bathymetric datasets to drive the tidal exchange component of the hydraulic model.

Due to the reconfiguration of the hydraulic model with a revised downstream boundary location a revised hydraulic model area was required. The revised hydraulic model boundary is presented in in

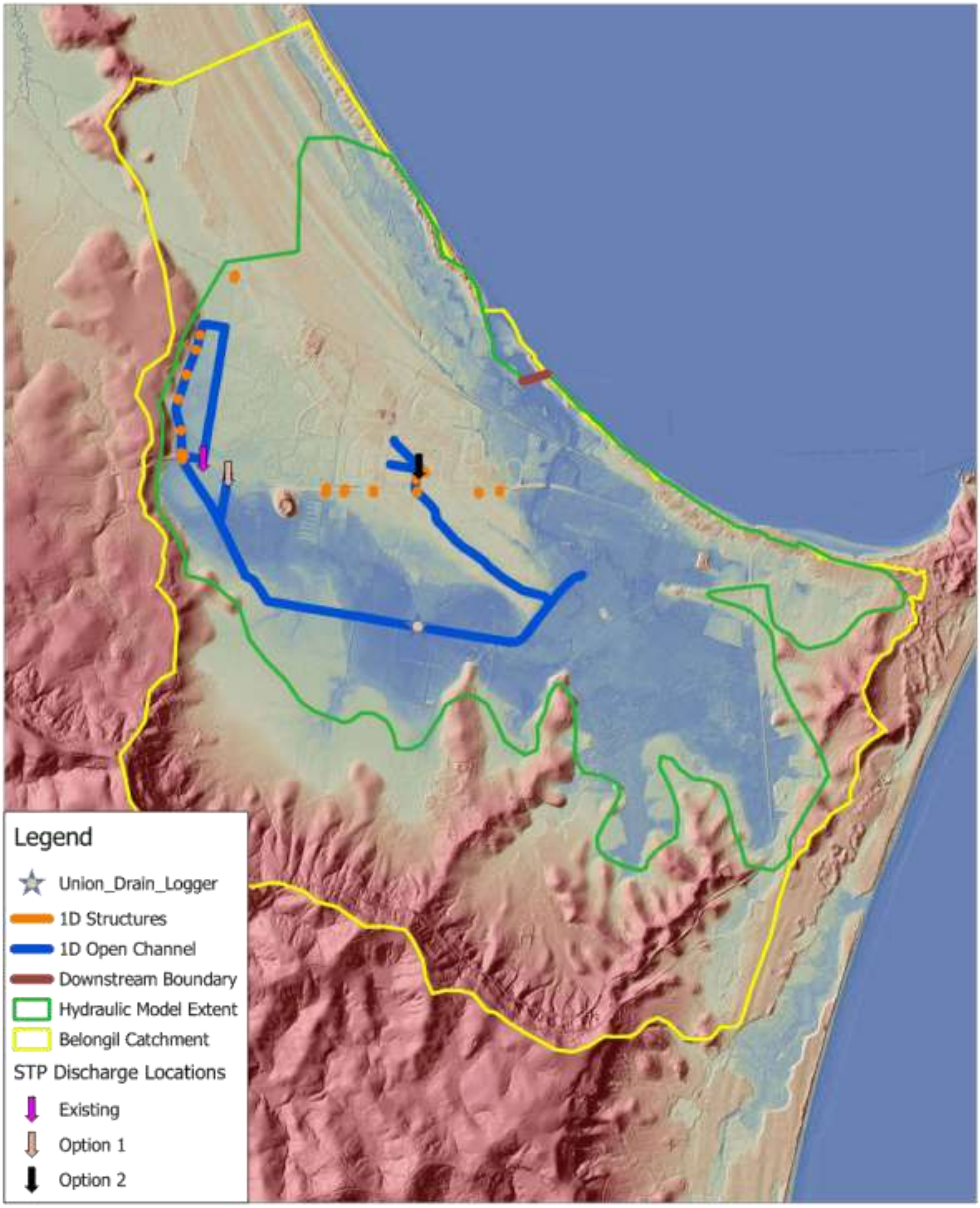
Figure 17-2.

17.4 Boundaries

For the HCA the simulation is run continuously for a period from 17/09/2011 to 15/04/2016, a period of 1,672 days (approximately 4.5 years). This period was chosen as all relevant boundary conditions are available;

- Downstream water levels at Ewingsdale Bridge (for the estuary);
- Catchment flows from SOURCE model; and
- STP discharge data.

Each of these boundaries is described further below.



Title:
Hydraulic Model Configuration

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17.4.1 Downstream Water Levels

A water level recorder has been operated at the Ewingsdale Bridge crossing of the Belongil Creek estuary since 2011. The water level recorder is owned by Byron Shire Council but has been operated by third parties since installation as part of an ongoing entrance opening monitoring program.

Water levels are recorded hourly and a datum corrected version (to m AHD) from 3 June 2011 to 15 April 2016 was provided to BMT WBM by AWC for use in this study. This water level is applied as the downstream boundary of the hydraulic model in the location presented in

Figure 17-2.

The water level ranges from 0.50 to 1.66 m AHD with a mean value of 0.78 m AHD. The time series data is presented in Figure 17-3.

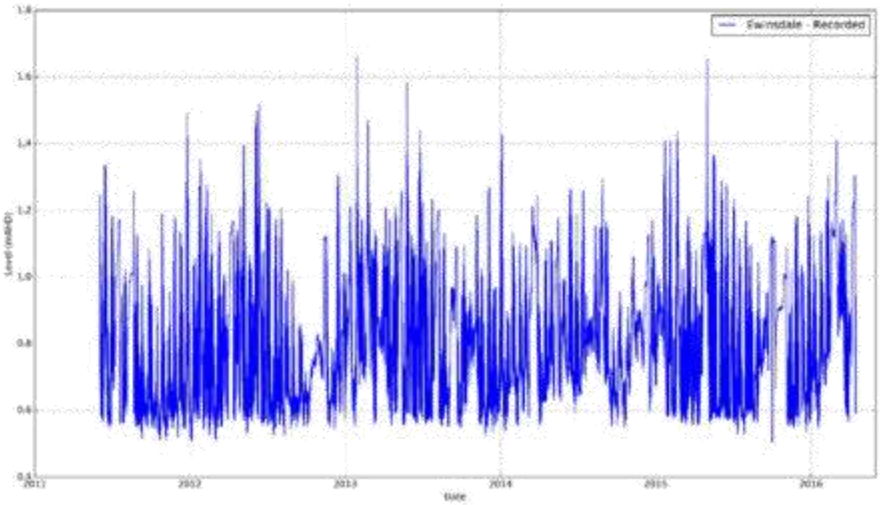


Figure 17-3: Downstream Water Level Data

17.4.2 Catchment Flows

The catchment flows have been generated from the SOURCE model as described in Appendix D. The catchment flows are applied as a mixture of 1D and 2D boundaries, with 1D boundaries applied in the drains and 2D boundaries applied in other areas.

17.4.3 STP Flows

Byron Shire Council provided daily flows from the West Byron STP at site EPA5 minus allowances for seepage and evapotranspiration losses in the wetland areas. For the existing case modelling these are applied as a flow boundary to the 1D channel as shown in

Figure 17-2.

The STP flow data is recorded daily and commences 17 September 2011 and concludes on 15 September 2016. The time series boundary for the existing case data STP flows is presented in

Figure 17-4.

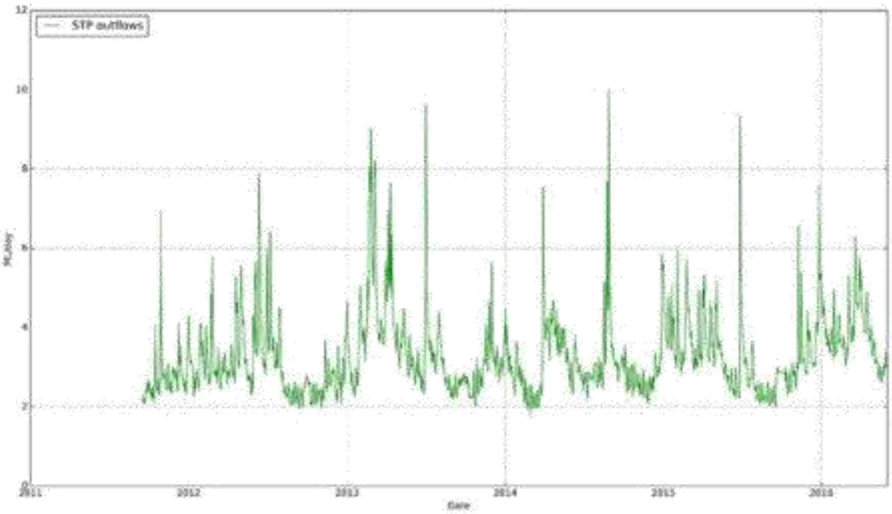


Figure 17-4: STP Flow Boundary Data

17.5 Hydraulic Model Parameters

This section describes the hydraulic model parameters used for the HCA modelling.

17.5.1 Manning's Roughness

The Manning's n values are consistent with those used in the FRMS as presented in Table 17-1. A number of smaller drains were included in the model as 1D model sections. These drains were not included in the FRMS and have been included with a Manning's n value of 0.08 based on photos and site inspection.

Table 17-1 : Adopted Manning's n Values

Land Use Category	Manning's n
Medium Grass Floodplain	0.055
Roads - all road reserve	0.013
Short Grass / Bare Earth	0.03
Residential	0.03
Buildings	1.0
Forested	0.15
Water Bodies	0.025
Creek Lower (2D)	0.025
Unmaintained Floodplain	0.12
Basins	0.03
Swamp	0.08

17.5.2 Structures

There are a number of hydraulic structures included in the hydraulic model. Most notable for the HCA are the culverts in the drains and underneath Ewingsdale Road. These culverts are known to periodically experience blockage and are maintained in a cleared state by Byron Shire Council. Detailed records of these blockages over time are not available, hence, for the purpose of the HCA, these culverts have been assumed to be unblocked.

17.6 Model Validation

To calibrate a hydraulic model, the typical approach is to use calibrated hydrologic inflows and recorded downstream water level to drive the hydraulic model and then compare to observed water levels and flows within the hydraulic model. As the Belongil Creek catchment has no flow gauging stations an alternate method has been applied. This method has two parts as described below:

- Qualitative assessment using photographs that identify inundation patterns during significant rain events in a particular portion of the catchment; and
- Qualitative assessment comparing recorded water levels from a water level logger in the Union Drain to water levels predicted by the hydraulic model.

The process of model 'validation' by comparing predicted water levels (from the hydraulic model) to observed water levels in the Union drain is not a typical optimisation method as it assumes that the hydrologic inputs had been calibrated, which was not possible in this instance.

To overcome this limitation, a number of hydrologic and hydraulic model iterations were performed manually whereby both water levels and the shape of runoff hydrographs were compared to observed water level data (in Union Drain). Over numerous model runs a sufficiently accurate validation was achieved.

Figure 17-5 provides approximate location details of the inundation photos and the location of the water level recorded in the Union drain.

Figure 17-5 Validation Data Locations

17.6.1 Photo Record of Inundation Events

A number of photos of representing inundation in the floodplain have been provided to or taken by AWC and third parties. Whilst it has not been possible to obtain an inundation level that could be used for model validation, they do allow for a qualitative comparison of extent of inundation.

The exact timing of the photos is unknown in relation to the inundation events, however, the key information they have provided are the existence of a flow connection between the drain lines and 'paddock' and the general extent of inundation. The inundation events resulted from rainfall as follows

- April 2009 - Approximate rainfall totals – 2 April 10mm, 3 April 67mm, 4 April 58 mm and 5 April 12 mm. Refer Figure 17-6; and
- May 2009 - Approximate rainfall totals – 42 mm 19th May, 8 mm 20th May, 136mm 21st May, 132 22nd May and 32 mm 23rd May. Refer Figure 17-7; and
- June 2016 – Approximate rainfall totals - 3 June 9 mm, 4 June 45 mm and 5 June 166 mm. Refer Figure 17-8.

Figure 17-6: Photo Inundation: April 2009 [Source, Tidswell]

Figure 17-7: Photo Inundation: May 2009 (Source, Tidswell)

Figure 17-8: Photo Inundation: June 2016 (Source AWC)

17.6.2 Model Representation of Inundation Events

The hydraulic model operates over a period from 2011 to April 2016 and as such does not allow for inundation mapping of these events, however, a visual comparison of inundation extent for a flood event in January 2013 was undertaken (refer Figure 17-10). During this event the following approximate rainfall totals were recorded at Cape Byron Lighthouse 39 mm on the 27th January, 90 mm on the 28th January and 29 mm on the 29th January.

This inundation shows that the model predicts significant inundation in the floodplain area to the north of Ewingsdale Road which is consistent with the provided photographs.

Union Drain Logger Data

The water level logger in Union Drain has a record from the 12/03/2013 through to 26/09/2014 and then again from 15/10/2015 through to 15/04/2016. This is presented in Figure 17-9 below, noting that the x-axis is from 2011-2016 as per the Ewingsdale Bridge data and the STP flows.

The vertical datum of this water level logger was adjusted by application of a vertical shift of 0.17m. This was done to bring predicted water levels at the Union drain in line with those recorded at the Ewingsdale Bridge during periods when both recorders would have been expected to demonstrate matching water levels, e.g. during periods of entrance closure.

There appears to be a difference in datum between the 2013-2014 data period and the shorter 2015-2016 period. Therefore, the time-series validation has been conducted using the longer 2013-2014 data set.

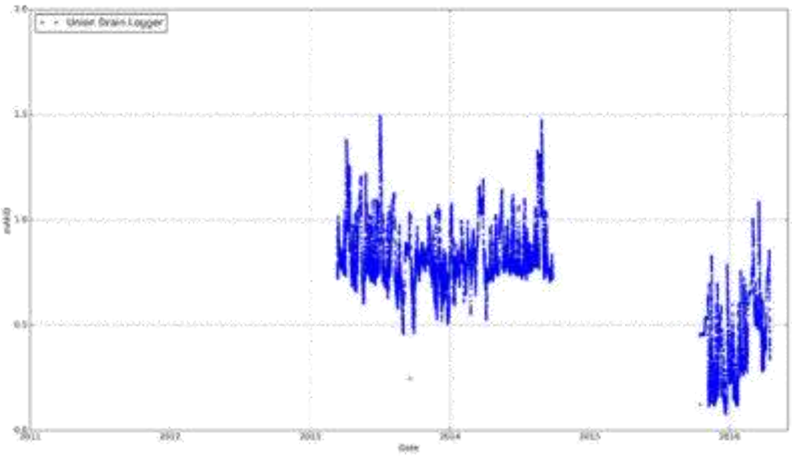
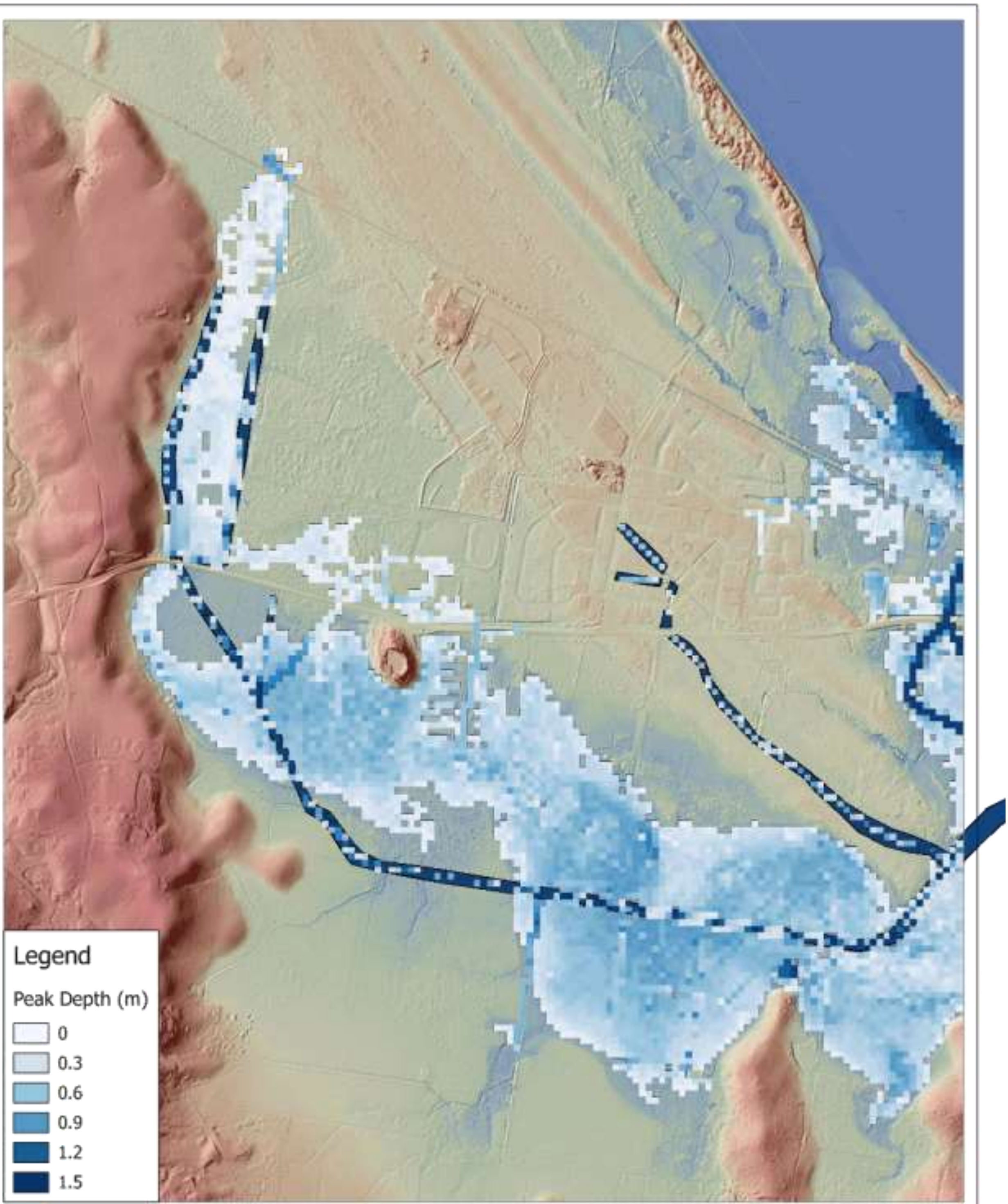


Figure 17-9: Datum Shifted Union Drain Logger Data



Title: **Peak Inundation Depth January 2013**		Figure: **17-10**	Rev: **A**
BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.	N 0 250 500 750 m	BMT WBM www.bmtwbm.com.au	

Filepath: "C:\Projects\B22117_Belongil_STP\Mapping\QGIS\HYD_009_depths_Jan_2013_ex_1ML.qgs"

Comparisons of observed and modelled water levels in the Union Drain at the logger location are provided in Figure 17-11. The upper left panel represents the observed v's modelled water level, the upper right panel presents a variation on a cumulative frequency type graph which aims to demonstrate the alignment of observed and predicted water levels at different water depths. The lower panel is a time-series of observed versus modelled water level within the Union Drain.

For the performance measures described above the values calculated for the period 12/03/2013 through to 26/09/2014 are:

- Nash Sutcliffe Coefficient of Efficiency (NSE) for hourly data, 0.64;
- The percent bias, -3.3;
- The Root Mean Squared Error (RMSE), 0.09; and
- Correlation of determination (R^2), 0.76.

The above indicators are consistent with a good model fit with observed data, and indicate that the model is suitable for the purpose of the HCA.

In particular the model performs well on the upper sections of the tidal cycle and also during the flood peaks. Over a longer period it would appear that the union drain "clogs up" over time, presumably with vegetation and / or sediment.

For example in Figure 17-12, which shows the modelled and observed water levels in Union drain over a 4 month period from June 2013 to October 2013. Throughout June and July the minimum water level observed is approximately 0.8 m AHD. However, after an entrance close at the start of August and subsequent opening around the 10th of August, the water levels at the bottom of the tide drop down to approximately 0.5 m AHD.

The result appears to indicate that a "flushing" of the drain has occurred and more tidal propagation is occurring up the Union Drain. Over a longer period, this seems to be varying. Accordingly, the hydraulic model has been configured to provide an intermediate position, with the model over-predicting the tidal range during some periods, but under-predicting for others. It is noted that this largely affects the lower water level values (typically below 0.8 m AHD) which are likely to be contained entirely within the Union Drain. For the HCA which also considers inundation in the floodplain, water is only able to leave the Union drain at higher elevations (above 0.8 m AHD) and as such is more important to considerations of floodplain inundation. It is reiterated that the model performs better for the higher water levels which have an overall greater significance in this investigation.

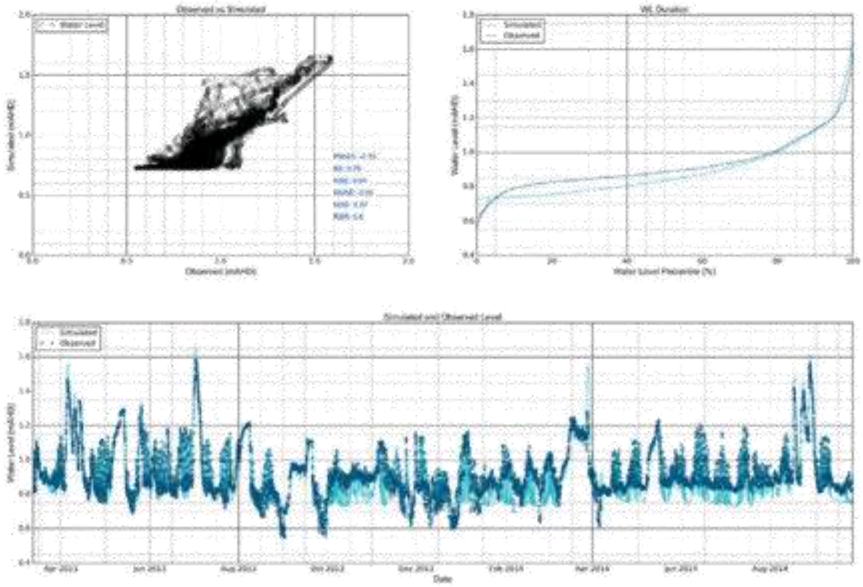


Figure 17-11: Water Level Validation – 2013 to 2014

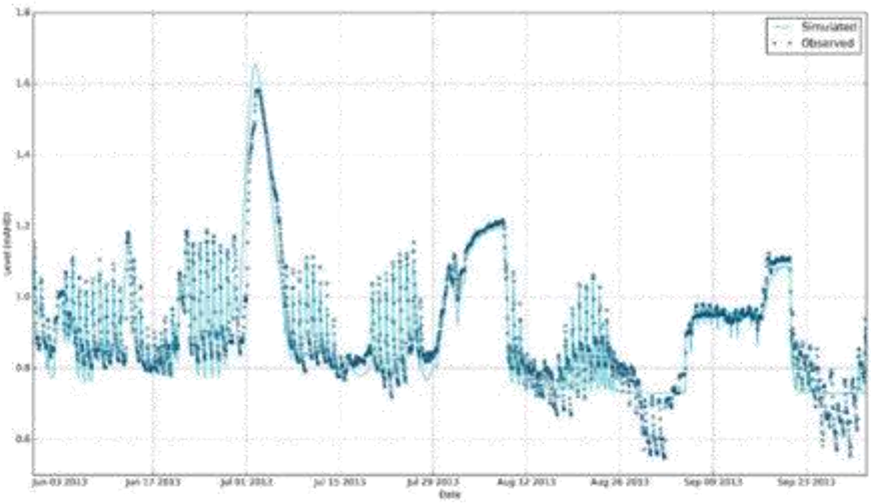


Figure 17-12: Water Level Validation – June to September 2013

17.6.3 Effect of Land Use Change

The proposed West Byron development would influence land use styles in this portion of the overall Belongil catchment. This could influence surface and groundwater interactions, surface peak flows and discharge volumes, as well as water quality (depending on applied mitigation within the development).

This may have implications for the long term drainage capacity of the existing drainage line that bisects the proposed West Byron development site. To identify if there are likely to be capacity issues, water level results for the 8ML discharge at Option 2 (which directs the maximum amount of STP effluent through the drain) were extracted from the model run at two locations along this drainage line. The two points of extraction coincide with locations where actual drain survey data was obtained for use in the study and as such provide an accurate representation of the existing drain profile at these locations. The locations of the extraction / survey points are shown on Figure 17-2.

Extracted water level data across the approximately 5 year modelling period has been processed to derive 25th, 50th and 75th percentile values, and an observed maximum water level across the entire period. The results are plotted within the drain profile as shown in Figure 17-13 and Figure 17-14. It can be seen that for median flows (50th percentile), the drains have ample capacity to convey increased flows. It is worth noting that even the maximum (peak) flood flows from events that occurred during the modelling period did not exceed the drain capacity.

These results indicate that the use of the Option 2 release point is appropriate to the 2050 timeframe and potentially beyond.

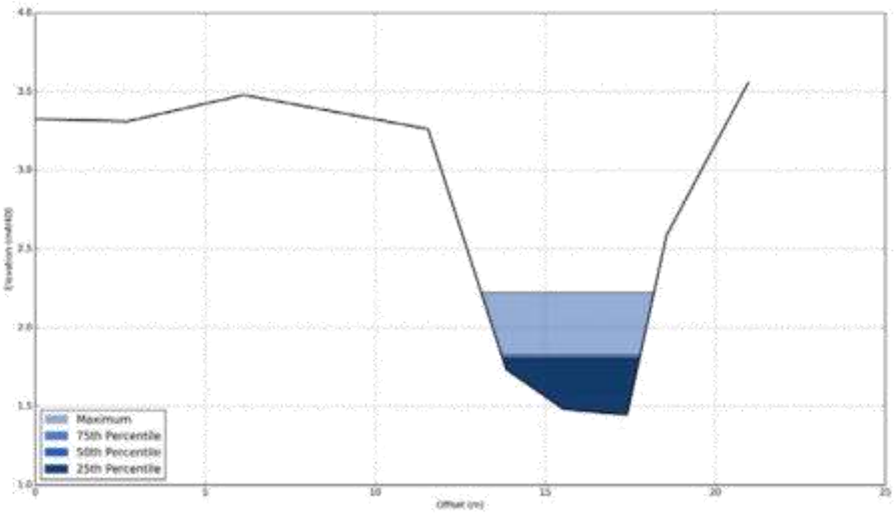


Figure 17-13: Modelled water level data at Location 1

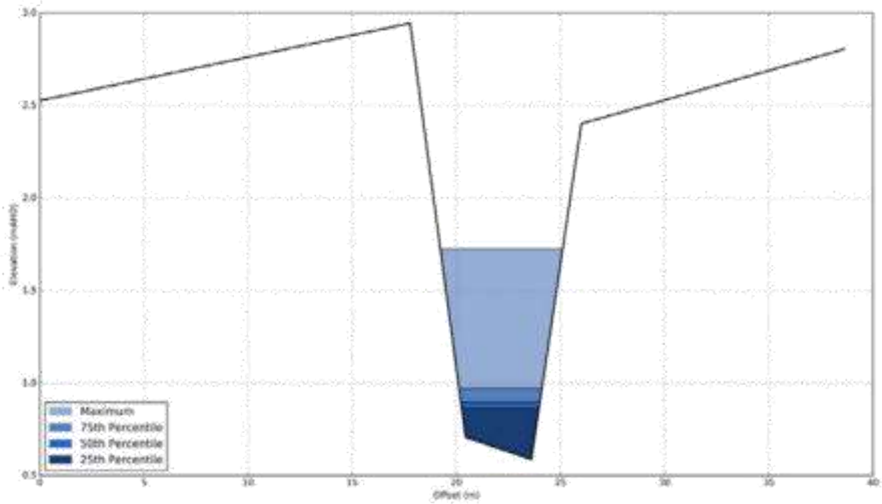


Figure 17-14: Modelled water level data at Location 2

17.7 Assumptions and Limitations

The interpretation of the inundation and difference in inundation maps presented in the report should be completed with an appreciation for the limitations in their accuracy. While the points below highlight these limitations, it is important to note that the results presented provide an up-to-date methodology and set of models.

- The updated hydraulic model has not has not been fully calibrated;
- The DEM has been generated from LiDAR data with an unknown vertical accuracy. In areas of dense vegetation or standing water the LiDAR elevations are likely to have been based on interpolation.
- No soil infiltration or evaporation is applied to the hydraulic model. Allowance for these is made in the hydrology model. In some locations within the floodplain, where the DEM is "bumpy" due to high vegetation cover, water ponds for the remainder of the simulation.
- The estuary mouth is not modelled directly (i.e. the sediment transport is not included in the hydraulic model). The modelling assumes that changes in the flows from the STP do not alter the open / closing regime at the entrance. STP flows are estimated to account for around 5% of the total flows from the catchment to the estuary (for the existing case).

Byron Bay

PO Box 2605
Byron Bay NSW 2481
P 02 6685 5466
byron@awconsult.com.au

www.awconsult.com.au