

Tablelands Regional Council

Atherton STP - Planning and Environmental Evaluation

Environmental Evaluation Investigation Report

June 2019

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1. Introduction

1.1 Background

Tablelands Regional Council (TRC) own and operate sewage treatment plants (STP) at Yungaburra, Atherton, Tinaroo, Ravenshoe, Millaa Millaa and Malanda. To operate these STPs TRC hold Environmental Authority (EA) EPPR00584813, (refer to Appendix A) which includes Environmental Relevant Activity (ERA) 63(1d) for Atherton, for sewage treatment >4000 but <10,000EP and ERA 58 for Regulated Waste Treatment (operating a facility for the receiving and treating regulated waste).

The Atherton STP is located on Lot 1 RP889324 and Lot 2 RP74174 off Grove Street, Atherton QLD (the site). The EA outlines specific standards for sewerage treatment and authorises the release of contaminants to the waters of Mazlin Creek, prescribing release limits for multiple quality characteristics.

The Department of Environment and Science (DES) (administering authority) under the provisions of the Environmental Protection Act 1994 (EP Act), issued a Notice to conduct or commission an Environmental Evaluation 101/0009070 (Environmental Evaluation Notice) for the site on 21 June 2018 (refer to Appendix B) on the grounds that it may cause environmental harm. An environmental evaluation is a compliance tool under the EPA Act used to assess an activity or event that has caused, or is likely to cause, environmental harm in order to facilitate a solution to manage the activity or event.

Part A of the Environmental Evaluation Notice sets-out the grounds for the environmental investigation (Table 1) with Part B outlining the requirements including reporting (Table 2).

Table 1-1: EE Notice Part A - Relevant Grounds

Item Number	Facts & Circumstances Reference	Grounds
1		An activity or proposed activity is causing, or is likely to cause environmental harm.
	3	Over the last fifteen months, the STP has been non-compliant with prescribed maximum release limits in the EA. Exceedance notification of the release limits for contaminants were provided as follows: a. 21 April 2017 – for Free Residual Chlorine; b. 7 August 2017 – for Ammonia Nitrogen and 5-Day Biological Oxygen Demand; c. 5 January 2018 – for Ammonia Nitrogen and Total Nitrogen.
	12	Limited receiving environment monitoring in Mazlin Creek, undertaken by you (TRC), indicates that the water quality objectives for Mazlin Creek are not being achieved.
	13	The department considers that the activity conducted by you on the premises (sewage treatment) is likely to cause environmental harm due to the concentrations of ammonia and total nitrogen measured in some treated effluent and the water quality monitoring undertaken in Mazlin Creek.
	14	Given the above, the department is satisfied that it is appropriate and reasonable to require you to conduct an environmental investigation relating to the sewage treatment activity.

Table 1-2: EE Notice Part B Requirements

Item Number	Due Date	Relevant Matters
1	1 November 2018	TRC must engage an appropriately qualified person to complete an investigation to determine the source, cause and extent of environmental harm to Mazlin Creek from the activities of the Atherton STP. The investigation must consider:
a		the environmental values, water quality objectives and management goals of the waters as specified in Schedule 1 of the Environmental Protection (Water) Policy 2009 "Barron River Basin, Environmental Values and Water Quality Objectives Basin 110 and adjacent coastal waters"; and
b		the limits in the EA EPPR00584813; and
c		the measured water quality, sediment quality and key communities in the creek both upstream and downstream of the activity, at the mixing zone, during the wet season, during the dry season and during intermittent high flow events; and
d		any relevant reports prepared by other governmental or professional research organisations that relate to the receiving environment.
2	28 June 2019	You must provide an investigation report prepared by the appropriately qualified person that describes the:
a		potentially affected receiving waters; and
b		measured impact of the Atherton STP discharge on the receiving waters; and
c		water and sediment quality targets within the receiving environment to be achieved including clarification of contaminant concentrations or levels indicating adverse environmental impacts on the receiving environment.
3	28 June 2019	You must provide a final report prepared by an appropriately qualified person that considers the investigation report and:
a		reviews and assesses the influent flow characteristics to the Atherton STP based on all available and relevant current and historical data; and
b		reviews and assesses the current and likely future service demand needs of the plant in accordance with the Planning Guidelines for Water Supply and Sewerage April 2010 including amendments dated March 2014 (the guidelines); and
c		determines the current plants' capacity and performance to meet the defined service needs; and
d		identifies all feasible short term and long term asset and non-asset service improvements and efficiencies to both the sewage treatment and treated effluent management processes required to protect the environmental values, meet the water quality objectives and achieve the management goal of maintaining and improving the waters of Mazlin Creek; and
e		includes an options analysis to determine a corrective program of improvements to the sewage treatment activity that balances financial, social and environmental risk; and
f		identifies a reasonable implementation program for any improvements, efficiencies and/or measures required to protect all environmental values of Mazlin Creek.

1.2 Purpose of this report

This report serves to address the requirements under the environmental evaluation in accordance with the requirements outlined in Section B (Parts 1 & 2) of the Notice. In particular, this investigation report describes the following matters:

- Potentially affected receiving waters
- Measured impact of the STP discharge on the receiving waters considering the environmental values, water quality objectives and management goals specified in Schedule 1 of the Environmental Protection (Water) Policy 2009 "Barron River Basin, Environmental Values and Water Quality Objectives Basin 110 and adjacent coastal waters
- The measured water and sediment quality targets within the receiving environment (upstream and downstream, at the mixing zone, during the wet season, during the dry season and intermittent high flow events) to be achieved including clarification of contaminant concentrations or levels indicating adverse environmental impacts on the receiving environment.

This report is to be considered in conjunction with a Planning Report for the Atherton STP that will address the following matters in relation to the EE Notice.

- Reviews and assesses the influent flow characteristics to the Atherton STP based on all available and relevant current and historical data
- Reviews and assesses the current and likely future service demand needs of the STP
- Determines the current plants' capacity to meet the defined service needs
- Identifies all feasible short term and long term asset service improvements and efficiencies to both the sewage treatment and treated effluent management processes required to protect the environmental values, meet the water quality objectives and achieve the management goal of maintaining and improving the waters of Mazlin Creek
- Includes an options analysis to determine a corrective program of improvements to the sewage treatment activity that balances financial, social and environmental risk
- Identifies a reasonable implementation program for any improvements, efficiencies and/or measures required to protect all environmental values of Mazlin Creek.

1.3 Scope of Works

The following work was undertaken to fulfil the purpose of this report:

- Desktop review of relevant studies, planning reports and literature relating to the Atherton STP operations, characteristics of the receiving and surrounding catchment, past and current monitoring assessments and results.
- Site investigations of the receiving environment for the Atherton STP.
- Additional monitoring of the STP immediately downstream of Release Point W1 prior to the confluence with Mazlin Creek with field measurements, collection and submission of samples to National Association of Testing Authorities (NATA) accredited laboratory for analysis.
- Review and analysis of monitoring data for the Atherton STP.
- Preparation of this report for TRC outlining methodology and findings of the assessment including recommendations.

1.4 Statement of Limitations

This report, Tableland Regional Council Environmental Investigation Report May 2019, presents the findings of the desktop assessment and review of monitoring undertaken to date for the Atherton STP in the assessment of potential environmental harm caused by the STP's operations. This report has been prepared by by GHD for Tablelands Regional Council and may only be used and relied on by Tablelands Regional Council for the purpose agreed between GHD and the Tablelands Regional Council as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Tablelands Regional Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Tablelands Regional Council and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of infrastructure, services, topography and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and / or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Atherton STP Facility

2.1 Site Location & Operation

Atherton STP is located at Lot 1 on Plan RP 889324 with the authorised contaminant release area (Irrigation Area) located on part of Lot 2 on Plan RP741754, off Grove Street, Atherton. Atherton STP location approximately 1.3 km from the town centre, receiving environment monitoring points and site details are given in Figure 1 and Table 2-1.

Under the TRC Planning Scheme Zone Maps 2016, the site is zoned as Atherton Industrial Estate Community Facilities. The site lies at the confluence of Priors Creek and Mazlin Creek in a broad valley upstream of Tinaroo Dam, in the upper catchment of the Barron River, which ultimately discharges into the Coral Sea / Great Barrier Reef. Refer to Figure 2.

The Barron River catchment covers approximately 219,000 hectares and is one of the most regulated of a wet tropics streams with five major water impoundments and/or weirs and an extensive irrigation network.

Neighbouring land use to the STP consists of a small industrial estate, rural residential properties used for cattle grazing and a public BMX track. Upstream, agricultural land is located to the north of Mazlin Creek and either side of Kennedy Highway. Further agricultural land is upstream of Priors Creek. Both creeks also receive runoff from urban areas of Atherton. Agricultural cropping land surrounds Atherton to the north, south and east. To the west is Mount Baldy and to the North West, Herberton Range State Forest. Downstream, Mazlin Creek flows east through valued agricultural land discharging into Tinnaroo Dam, which is primarily an irrigation storage dam, with a reported 205 000 ML/a assured irrigation supply to the Mareeba-Dimbullah irrigation area. Discarge from the dam travels through Mareeba, Kuranda and the Barron River National Park before entering the Coral Sea north of Cairns CBD.

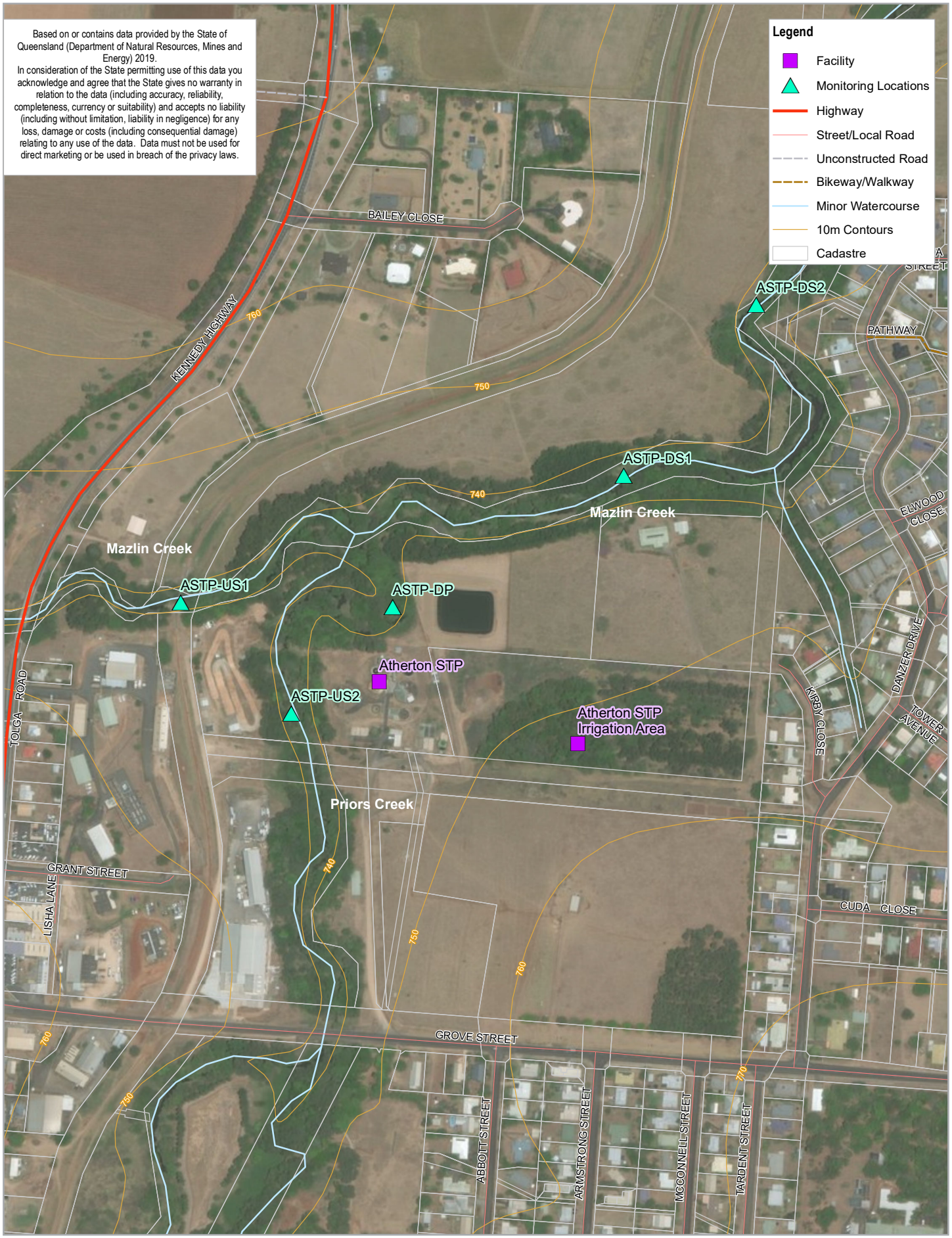
The Atherton STP consists of sequential batch reactors that use physical, chemical and biological processes such as aeration, settling, microbial digestion, filtration and chlorination.

TRC intercepts treated effluent prior to Release Point W1, which is pumped to the irrigation dam located on the site, for subsequent third party irrigation (golf course and farmland). TRC have prioritised effluent re-use, to reduce the discharge to the receiving environment and to reduce the demand on surface waters. Third-party agreements are in place to irrigate the Atherton Golf Course and a farm. Irrigation demand typically reduces in the wet season, hence further reuse options are being investigated by TRC for further irrigation users. This also involves possible supply arrangements with reuse customers to secure minimum and maximum limits on irrigation requirements in an effort to manage treated effluent discharges to the receiving environment (TRC Manager, Water and Waste, 26 October 2018). Any excess treated effluent is discharged directly from the Chlorine Contact Tank (licenced discharge point) to the receiving waters of Priors Creek via Release Point W1. Dewatered, aerobically digested sludge is disposed of to landfill or reused (NRA EIMP 2017).

It is noted GHD have identified some discrepancies between site conditions and those identified in the EE Notice and EA EPPR00584813 listed below for clarification.

- Site investigations and desktop assessment using historical mapping identifies the STP Release Point W1 outfall discharges directly into Priors Creek approximately 88 meters upstream from the confluence with Mazlin Creek (the current identified receiving water). As such this investigation has also considered the various influences and catchments of both Priors and Mazlin Creeks in the assessment.

- The irrigation area on the EA is not currently being utilised by TRC, as third-party irrigation demands have been prioritised, however it remains as a potential irrigation area for the future.



Paper Size ISO A4

0 30 60 90 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Tablelands Regional Council
Water Quality and Aquatic Sampling Sites

Atherton STP

Project No. **42-20841**
Revision No. **A**
Date **23 /01/ 2019**

FIGURE 1

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Print date: 23 Jan 2019 - 08:41

Data source: TRC: Facility (2019), Monitoring Locations (2019); DNRME: Roads (2018), Watercourse (2014), 10m Contours (2016), Cadastre (2018); Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: ACJackson

Table 2-1: Site Details

Items	Details
Environmental Authority	EPPR00584813
EA Holder	Tablelands Regional Council
Lot/Plan	Lot 1 on Plan RP889324 Part Lot 2 on Plan RP741754 (Irrigation Area)
Size (ha) Lot 1 on Plan RP889324	7.47 ha
Bioregion	Wet Tropics
Subregion	Atherton
Catchment	Barron River
Subcatchment	Mazlin Creek

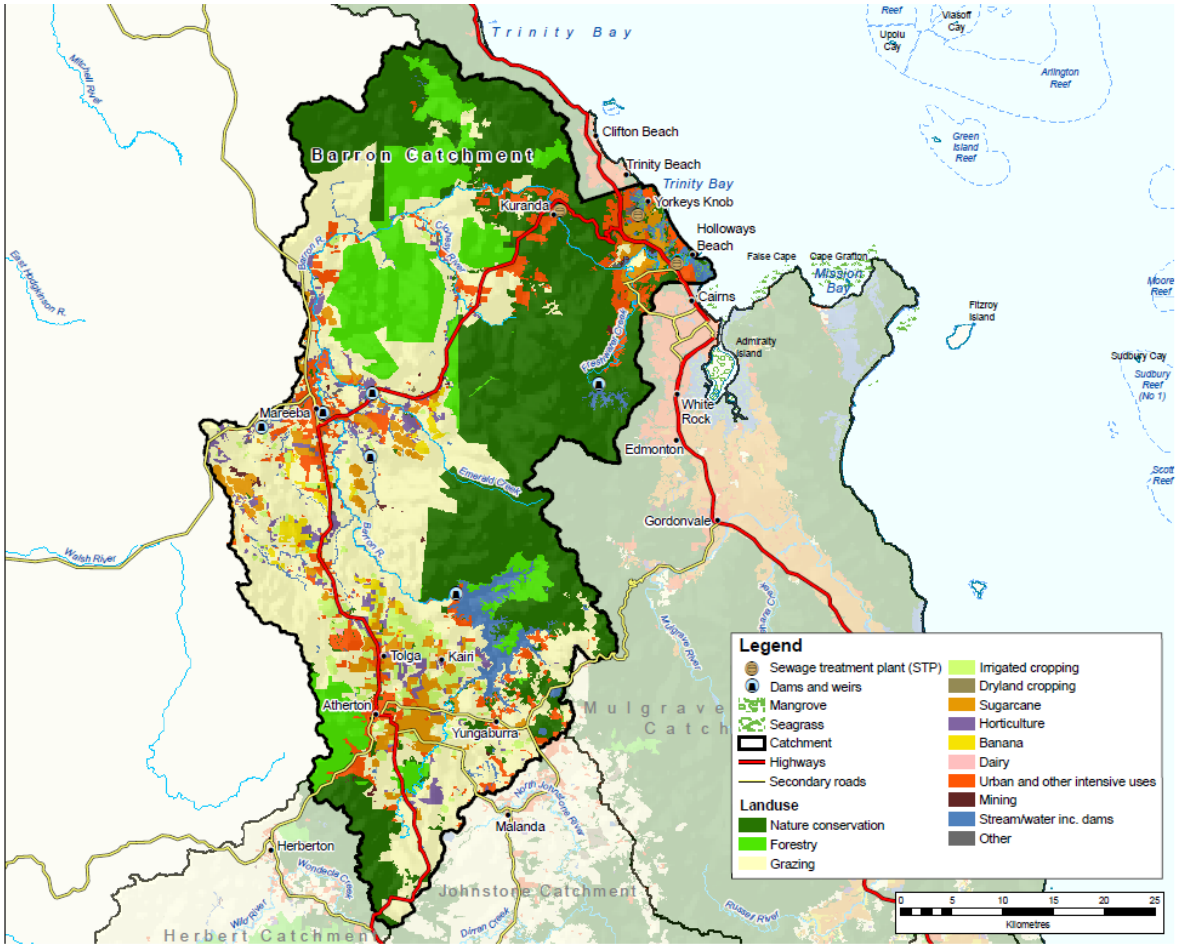


Figure 2: Land Uses in the Barron Catchment (Source: Reef Plan 2050)

2.2 Effluent Parameter Testing & EA Requirements

The EA EPPR00584813 (Appendix A) outlines relevant conditions according to ERA 63 (1d) pertaining to Atherton STP that are relevant to the EE Notice issued. These are outlined in Table 2-2.

Table 2-2: EA Conditions

EA Reference	Condition	Item Summary
Part 1		General Conditions for all TRC Sites
Part 3		Site Specific Conditions Atherton STP
	WT3-3 Schedule 2	Sewage or treated sewage effluent is permitted to overflow from the sewage reticulation system in accordance with the requirements of the EA and the discharge of effluent from Release Point W1 to Mazlin Creek according to Schedule 2 of the EA. It is noted that the authorised release point W1 does not have any recorded GPS location points on the EA
	WT3-4	Total quantity of contaminants authorised to be released from W1 during dry weather.
	WT3-5 Table 1	Release Quality Characteristic Limits authorised from Release Point W1
	WT3-8 Table 2	Monitoring Frequency
	L3-1	Outlines the defined contaminant release area described as part of Lot 2 RP741754 and is shown in Schedule 2 as the Irrigation Area
	W3-2	Requires sludge to be sampled for specific metal concentrations at least once every three years.

The current EA (Appendix A) assumes the majority of treated effluent is discharged to Mazlin Creek from Release Point W1 with Condition WT3-4 stating that the total quantity of contaminants released from Release Point W1 during any dry weather day must not exceed 2,200 cubic metres.

The current Atherton STP License is stringent particularly with regard to nitrogen and phosphorous, typical of Licenses discharging to Great Barrier Reef catchments. The release of contaminants to waters from Release Point W1 must comply with each of the limits as outlined in Table 2-3. The Planning Report provides a discussion of the EA release limits (refer to section 3 of the Planning Report).

Table 2-3: EA Release Quality Characteristic Limits

Quality Characteristics	Release Limit	Limit Type
5-Day Biochemical Oxygen Demand (mg/L)	5 10 20	80th percentile (short term) 80th percentile (long term) maximum
Suspended Solids (mg/L)	7 15 30	80th percentile (short term) 80th percentile (long term) maximum
pH (pH units)	6.5 to 8.5	range
Dissolved Oxygen (mg/L)	2	maximum
Free Residual Chlorine (mg/L)	0.7(1)	maximum
Ammonia Nitrogen (mg/L) (2)	2 4	80th percentile (long term) maximum
Total Nitrogen (mg/L)	5 10	50th percentile maximum

Quality Characteristics	Release Limit	Limit Type
Total Phosphorus as P (mg/L)	1 2	50th percentile maximum
Oil and Grease (mg/L)	10	maximum
Faecal Coliforms (organisms / 100mL)	150 (3) 600	median (4) 80th percentile (5)

Notes:

1. Measured at the chlorine contact tank after a minimum twenty (20) minutes detention period
2. The holder of this EA must further dilute the effluent whenever necessary to ensure that the measured ammonia concentration in water at Mazlin Creek does not exceed 1mg/L.
3. ANZECC guidelines for primary contact recreation (swimming, bathing and other direct water contact sports)
4. Median for this quality characteristic must be based on the results of at least five samples, with individual samples being collected at in intervals of not less than thirty (30) minutes
5. "80th percentile" for this quantity characteristic means that the measured values of the quality characteristic must not be greater than the release limit for any more than one out of five.

The parameters listed in the EA Condition WT3-8 Table 2 Monitoring Frequency, which are required to be monitored from Release Point W1 are outlined in Table 2-4.

Table 2-4: Monitoring Frequency

Quality Characteristics	Frequency
5-Day BOD	Fortnightly
Suspended Solids	Fortnightly
pH	Weekly
Specific Conductance	Weekly
DO	Weekly
Temperature – Celcius degrees	Weekly
Ammonia Nitrogen	Fortnightly
Free Residual Chlorine	Fortnightly
Oil & Grease	Fortnightly
Faecal Coliforms (Organisms/100ml)	Fortnightly

The parameters listed in the EA Condition W3-2 that are required to be monitored every three years include:

- Total Zinc
- Total Copper
- Total Aluminium
- Total Chromium
- Total Cadmium
- Organochlorine pesticides.

TRC currently undertakes fortnightly testing of the STP effluent and routinely tests influent quality (TRC Meeting, 1 November 2018).

Monitoring of the receiving environment occurs under an Environmental Impact Monitoring Program (EIMP) designed by NRA Environmental Consultants (NRA, 2017) who completed the

first year of monitoring and reporting for the program over 2017-2018 (NRA, 2018). Current EIMP monitoring following the EIMP Design Report by NRA is undertaken by GHD for the 2018-2019 annual period.

It is noted, that some minor changes to monitoring locations have occurred from the initial EIMP Design Report, including the addition of a monitoring site immediately downstream of Release Point W1 on Priors Creek, prior the confluence and influence of Mazlin Creek. In addition to EIMP sampling, TRC operators have recently commenced fortnightly testing of this monitoring point to improve data related to discharge within the mixing zone (Aleisha Miles, TRC Meeting, 31 January 2019).

2.3 Effluent Release Characteristics

2.3.1 Effluent Release Flow Rates

Based on 2018 flow meter records Atherton STP produces an average of 2,030 kL/day of treated effluent as shown in Figure 3.

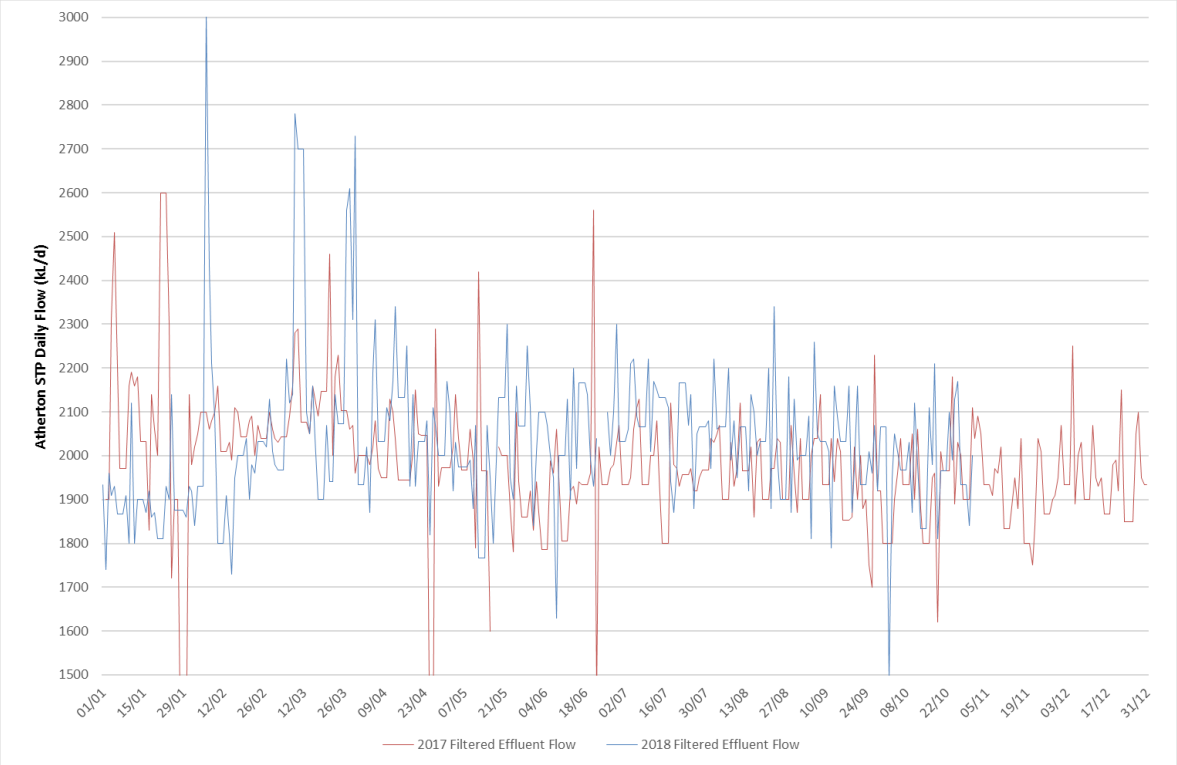


Figure 3: STP Daily Flow Meter Records

Flows appear to be highly variable and seasonal. In recent years, effluent is preferentially diverted to irrigation use during the dry season. At the commencement of this investigation the TRC Operators reported that due to high irrigation demands during the dry season, the STP has nill to very limited discharge events to receiving waters.

It is noted that the actual volumes of treated effluent transferred to the irrigation dam and the actual discharge characteristics to the creek (volumes and frequency) at the time of each exceedence is unable to be verified.

TRC have recently installed flow meters to monitor flow rates more accurately capturing all wastewater directed to the receiving environment.

The operators take daily reads from the following flow meters:

- Influent

- End of CCT race discharging to Mazlin Creek mixing zone
- Start of CCT race
- End of CCT race sent to irrigation dam
- Irrigation Dam flows sent to off site reuse (Golf Club or Farm).

2.3.2 Release Quality Characteristics

Examination of TRC data, generally over the past 4.4 years, the Atherton STP has been largely compliant with its release quality characteristic limits outlined under WT3-5 of the EA. The data indicates that on short duration occasions maximum values have exceeded limits for BOD_5, free chlorine, ammonia, total nitrogen and total phosphorous.

For details on the historic licence compliance, refer to Section 3.1.2 and Appendix C of the Atherton STP Planning Report.

2.4 Stream Flow Characteristics

Actual stream flow data for Priors and Mazlin Creeks at the time of the exceedance events do not exist.

No stream gauges exist for either Priors Creek or Mazlin Creek upstream of the Atherton STP. The closest stream gauge DNRM operates is a gauging station on Mazlin Creek at the Railway Bridge (details in provided in Table 2-5), approximately 7.8 km downstream. This includes a proportionally larger catchment downstream of the STP. It is theoretically possible to back-calculate stream flows at the Mazlin/Priors Creek confluence, however significant assumptions would be required introducing uncertainty into the data.

The hydrograph (Figure 4) below the catchment reflects a distinct wet and dry season flow regime, with little to no flow variation over the dry season. The wet season of 2018 recorded the fifth highest discharge rate for the catchment since 1991.

For discussion purposes, estimated flow / dilution graphs are included as Figure 5 and Figure 6 (Log Scale).

Table 2-5: Stream Flow Gauging Station Mazlin Creek Railway Bridge

STP	Nearest Gauging Station	Number of Gauging Station	Operated by	Eastings*	Northings*
Atherton	Mazlin Creek at Railway Bridge	110018A	DNRM	345651	8094577

* GPS Coordinates are in GDA94, Zone 55.

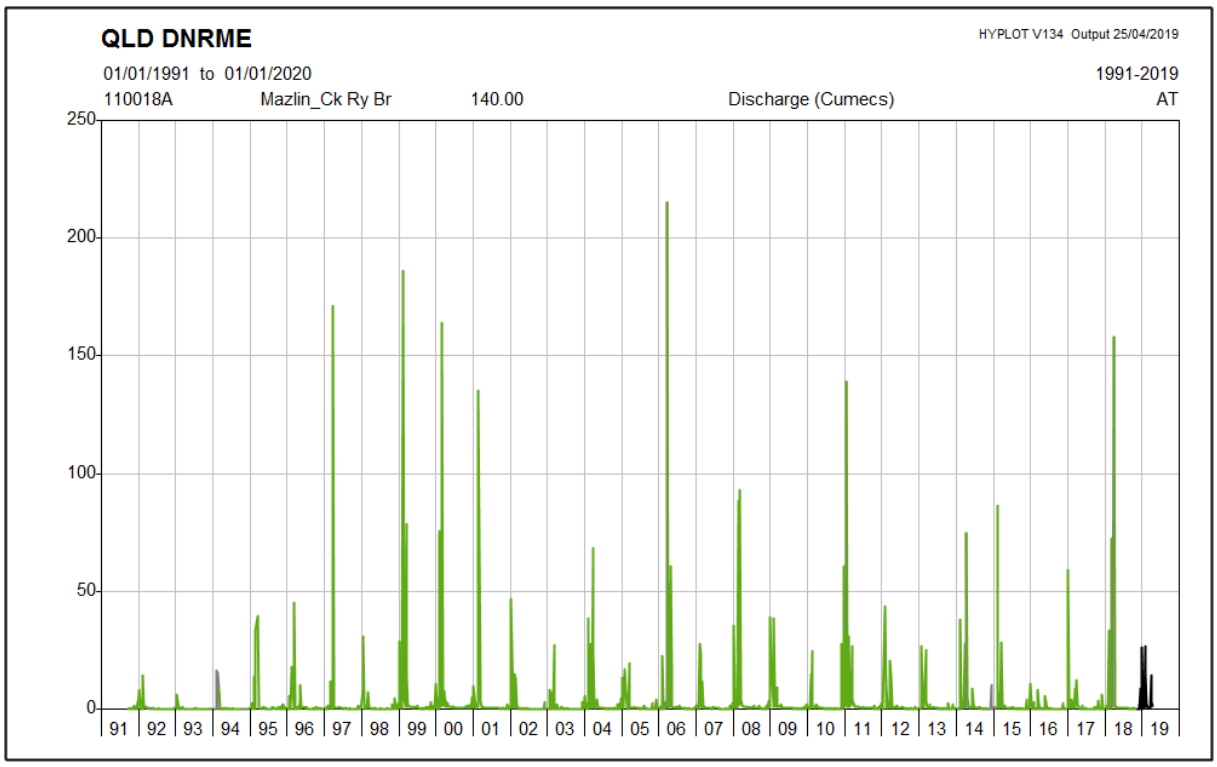


Figure 4: Hydrograph of Mazlin Creek (7.8 km downstream) of Atherton STP showing typical wet/dry seasonality in flows

(Source: QLD DNRME, accessed 15 April 2019)

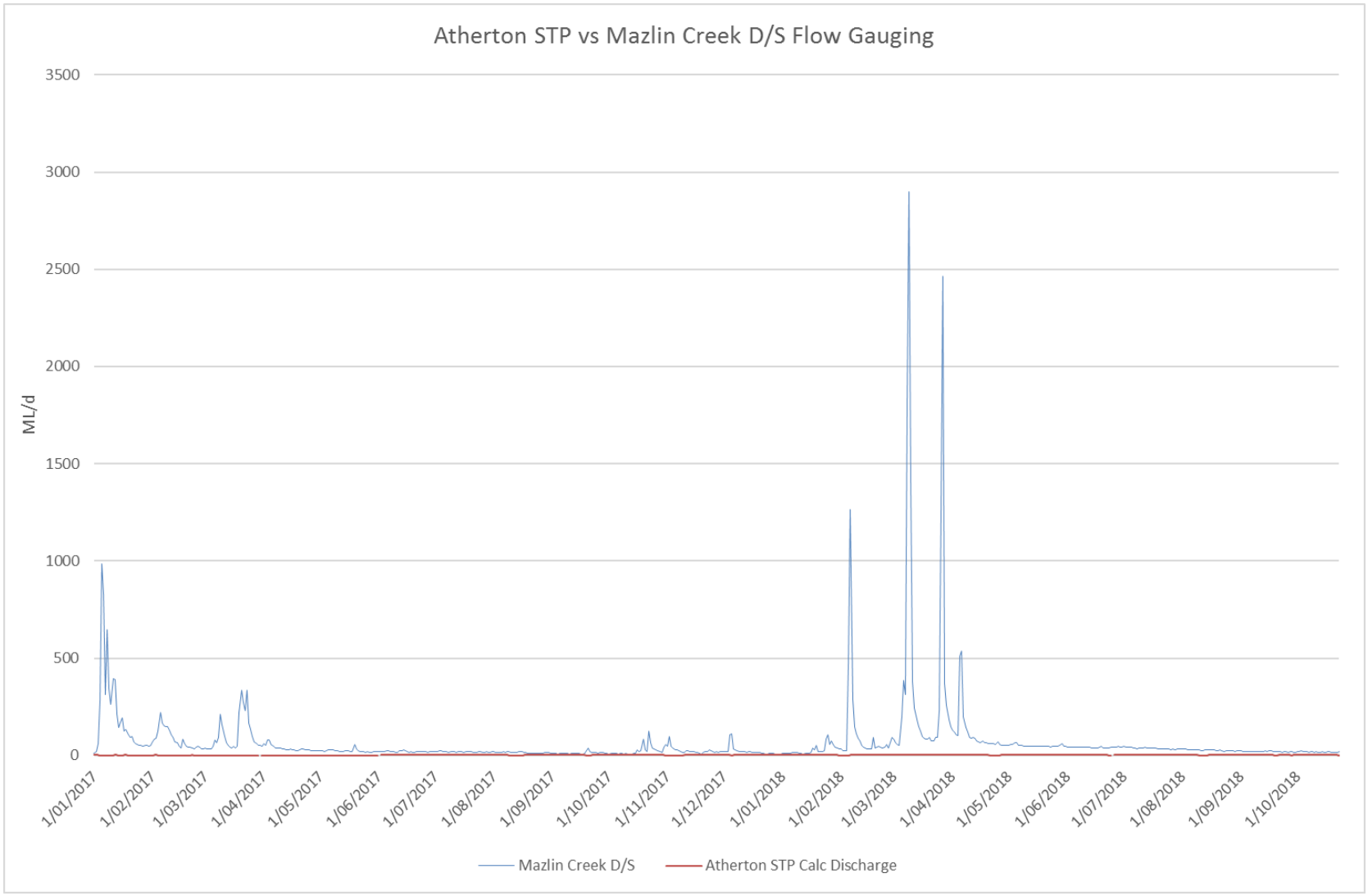


Figure 5: Atherton STP Discharge vs Mazlin Creek Flow Data

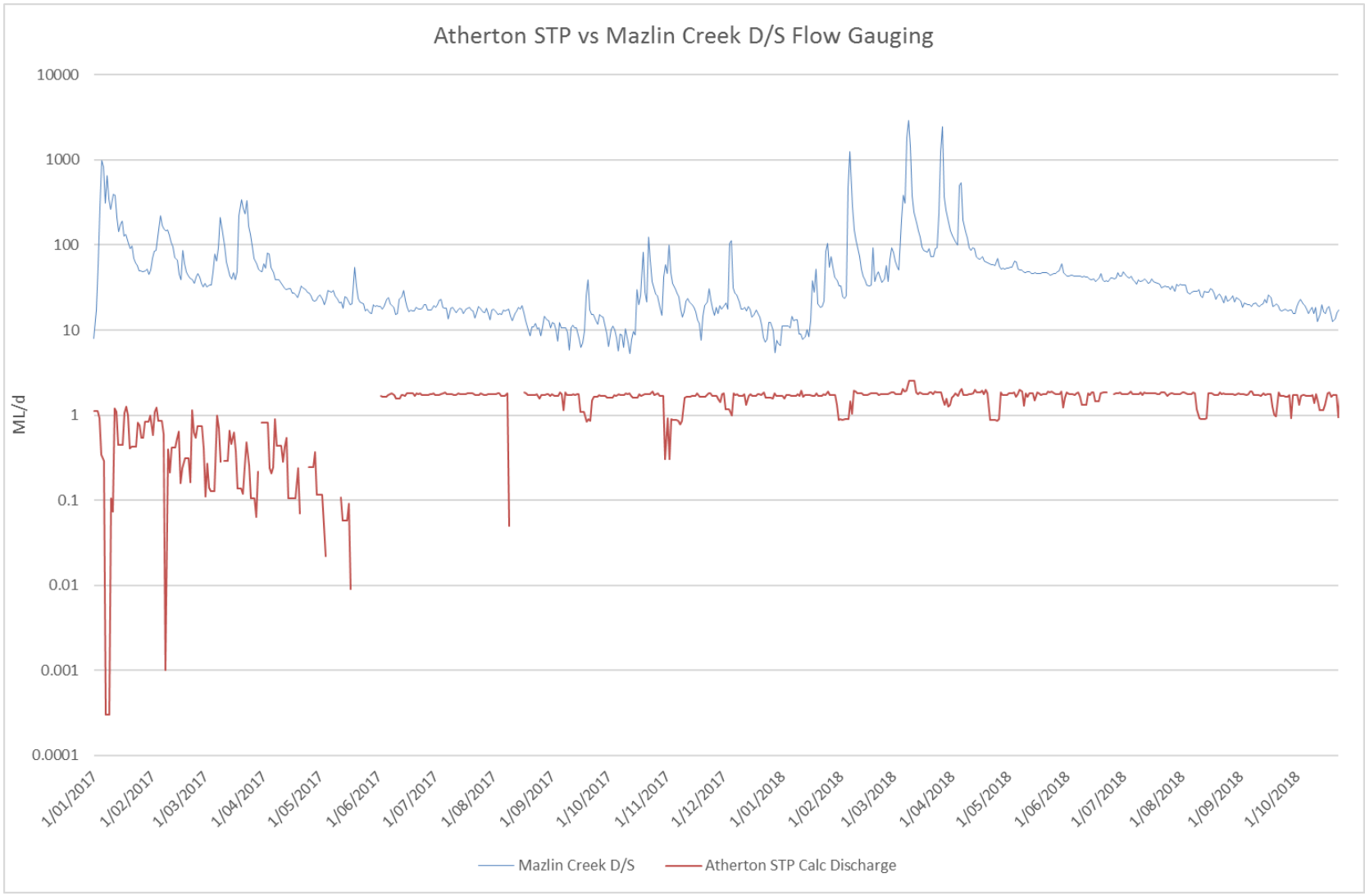


Figure 6: Atherton STP Discharge vs Mazlin Creek Flow Data (Log Scale)

Note: at the time of preparing this report discharge flow rates (i.e. taking into account irrigation rates) was not available.

2.5 Release Point W1 Clarifications

EA EPPR00584813 currently permits the release of sewage overflow from the Atherton STP in accordance with the requirements of the EA and the discharge of effluent from Release Point W1 to Mazlin Creek according to Schedule 2 of the EA.

Desktop studies undertaken in preparation for this report found discrepancies between the receiving waters stated in the EA and NRA's EIMP Design Report (NRA, 2017), DES websites and literature sources, with apparent confusion as to the correct naming of the watercourse to which the plant discharges.

Site investigations and review of historical aerials has confirmed Release Point W1 discharges directly into Priors creek, as it meanders along the northern boundaries of Atherton STP, flowing into Mazlin Creek approximately 88 meters downstream from the site (Figure 8). Whilst spatially this not a large concern, with regard to water quality assessments, any measurements downstream of the plant must be considered with influences of the Mazlin Creek catchment (also of considerable size and agricultural inputs upstream). To clarify this potential influence and effects of downstream readings, another downstream monitoring point has been established on Priors Creek (downstream of Release Point W1) which will enable the mixing zone characteristics on Priors Creek to be analysed before mixing with waters from the Mazlin Creek catchment. This monitoring point has been included in both TRC fortnightly monitoring and the EIMP sampling program (shown in Figure 1 as ASTP-DP).



Figure 7: Historical imagery from 1949 clarifying the location of the confluence between Priors and Mazlin Creek in relation to Release Point W1

(Source: QImagery, QLD Government. Accessed 1/11/2018)



Figure 8: Release Point W1 (Priors Creek)

3. EE Exceedance Events

The DES EE notice specifies exceedance notifications over a fifteen month period of time prior to 21 June 2018 with respect to three specific occasions and specific parameters. Namely exceedance notifications of the release limits for specific contaminants were provided as follows:

a. 21 April 2017 for Free Residual Chlorine

b. 7 August 2017 for Annmonia Nitrogen and 5-Day Biological Oxygen Demand; and

c. 5 January 2018 for Ammonia Nitrogen and Total Nitrogen.

Circumstances at Atherton STP surrounding these dates and parameters recorded are summarised below. The DES Exeedence Event Notice (final) is attached as Appendix B.

3.1 Exceedance a 21 April 2017 Free Residual Chlorine

On the 22 March 2017, TRC's treatment operators collected samples from the sampling and insitu monitoring point with lab results received on the 28 March indicating an exceedance to the free chlorine maximum limit (0.7 mg/L) of 4.6 mg/L. TRC's notification to the previous Department of Environment and Heritage Protection (DEHP) now DES, states that at the time all treated effluent was directed to the irrigation dam with 120 kL of effluent treated on 21 March 2017. Operators believe an overestimation of dosing strength may have occurred, as previously implemented corrective measures proved effective and resulted in improved effluence quality. The error was rectified immediately after 23 March 2017 with 0.5 mg/L subsequently recorded.

TRC stated they believed no environmental harm had occurred from this exceedance, as all treated effluent was directed to the irrigation dam. Further, monitoring of the receiving environment chlorine concentration in Mazlin Creek on the 22 March recorded to be 0.02 mg/L coinciding with a significant 55 mm rainfall event in the catchment.

3.2 Exceedance b 7 August 2017 Ammonia N and 5 - Day BOD

On 1 August 2017, TRC's treatment operators collected samples from the sampling and insitu monitoring point. Lab results received on the 7 August identified an exceedance of BOD of 41 mg/L (limit 20 mg/L) and Ammonia of 7.8 mg/L (limit 4 mg/L). TRC alleged that due to all other components of the treatment process proving functional, increased effluent received by the STP during the period 28 -31 July 2017 may have contained potential contamination causing detrimental impacts to the bacterium.

A number of subsequent corrective actions where implemented by plant operators with operators commencing immediate dilution of the effluent discharge from the STP with a potable water hydrant. This process continued until ammonia concentrations had decreased to below values seen upstream.

3.3 Exceedance c 5 January 2018 Ammonia N and Total Nitrogen

On the 29 November 2017, TRC's treatment operators collected samples from the sampling and insitu monitoring point with lab results detecting an exceedance of Total Nitrogen of 37 mg/L (limit 10 mg/L) and Ammonia of 33 mg/L (limit 4 mg/L). TRC's investigation determined that the exceedance of total nitrogen and ammonia within the final effluent was likely due to sampling error. More specifically, it is suspected that the irrigation dam was sampled twice with one of the samples erroneously labelled as final effluent sample. TRC therefore deemed that the ammonia

and total nitrogen concentration observed within the final effluent is a false result as no disturbance in the treatment process was identified.

At this time, TRC pumped all treated effluent to the irrigation dam, which subsequently overflowed excess waters to release point W1. It was suspected that due to climatic conditions the contents of the dam inverted and contaminated the discharged effluent, resulting in the elevated results. Sampling in Mazlin Creek during this period also detected a spike in ammonia, which indicates there was an exceedance.

TRC subsequently adapted operations to pump only the required volume of treated effluent to the irrigation dam, with excess discharging directly from the CCT to the receiving environment, to ensure inversions in the irrigation dam do not contaminate future effluent discharges.

4. Receiving Environment Environmental Values and Water Quality Objectives

Queensland waterways are managed under the Queensland Environmental Protection (Water) Policy 2009 (EPP (Water)), which groups watercourses into river basins for water quality management activities (NRA EIMP Design Report, Oct 2017). The location of the Atherton STP is within the Barron River Basin Environmental Values (EV) and Water Quality Objectives (WQO) Basin 110 and adjacent coastal waters. The purpose of the Barron River Basin document is to identify locally relevant environmental values and water quality objectives for the region based on local historical data and in close consultation with the community.

When describing the receiving environment, it is essential to consider the EVs of the receiving watercourse. EVs are listed in Section 6 of the EPP (Water) and the Barron River basin has been assigned EVs (Schedule 1 of the EPP (Water) Basin 110).

The Atherton STP is adjacent to the confluence of Priors and Mazlin Creeks. The receiving environment is the lower reach of Priors Creek that intercepts with Mazlin Creek watercourse. Mazlin Creek is included in the Atherton Division for surface and groundwaters.

Potential impacts to each of the EVs is considered with the relevant management goals.

4.1 Management Goals

Mazlin Creek is designated as a “moderately disturbed” (MD) aquatic ecosystem according to the EPP (Water) Basin 110 report.

The management goals for the EVs are determined based on the condition of the receiving environment, with the intent prescribed in Section 14 (2) of the EPP (Water), as follows:

- For moderately disturbed waters, ‘the measures for the indicators are maintained at levels that achieve the water quality objectives for the water’ or ‘the measures for the indicators of the environmental values are improved to achieve the water quality objectives for the water’.

4.2 Environmental Values

Environmental values identified for (Priors and) Mazlin Creeks under the Barron River Basin EPP (Water) are as follows:

- Aquatic ecosystems
- Irrigation
- Farm supply / use
- Stock water
- Human consumption
- Visual appreciation
- Cultural and spiritual values.

Contaminants in treated effluent discharge to receiving waters has the potential to cause environmental harm. Treated effluent generally contains elevated levels of organic matter, nutrients, pathogens, disinfection by-products and contaminants such as metals.

Some of the potential issues of concern include asphyxiation of aquatic life (e.g. from low dissolved oxygen), algal blooms, changes to the structure and function of aquatic ecosystems, smothering of fauna and fauna and risks to public health (DES, 2016)

Key water quality contaminants of concern include:

- Carbonaceous material
- Nutrients
- Suspended solids
- Metals/metalloids
- Pesticides
- Residual disinfectants
- Pharmaceuticals.

4.3 Water Quality Objectives

4.3.1 Overview

Priors and Mazlin Creeks are located within the Barron River Basin coastal freshwater catchment for which environmental values and WQOs adopted by the Queensland Government are detailed in the Environmental Protection (Water) Policy 2009 Environmental Protection (Water) Policy 2009 "Barron River Basin, Environmental Values and Water Quality Objectives Basin 110 and adjacent coastal waters (Barron River Basin EPP Water)" dated November 2014.

Under the National Water Quality Management Strategy (ANZECC & ARMCANZ 2000) water quality framework and the Environmental Protection Policy (Water), properly developed and approved local guidelines hold higher precedence over state and national guidelines.

The following provides an overview of relevant WQOs associated with these EV's. As outlined in the Barron River Basin EPP Water:

- WQOs for metals and other toxicants in sediments, in all cases reference is made to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) 2018. Previously the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (October 2000) prepared by the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).
- WQOs for metals and other toxicants in waters, where not stated in the Barron River Basin EPP Water, are referred to the ANZECC guidelines.
- The Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018 (AWQG) supersede ANZECC 2000. The AWQG include default guideline values for physical and chemical stressors, local water quality information still applies as the first reference point. In Queensland this includes:
  - Environmental Protection Policy (Water) scheduled EVs and WQOs
  - Queensland Water Quality Guidelines 2009 (QWQG) in the absence of EPP Water scheduled values.

Where Queensland values as outlined within these documentation are not available, the AWQG 2018 are generally applied.

The EIMP Design Report (NRA 2017) prepared previously for TRC applies this framework and adopted surface water assessment criteria accordingly to determine Water Quality Objectives

(WQOs) for Mazlin Creek receiving waters. Where WQO's were not available for a parameter or environmental value, EHP (2014a-c) defer to default guideline values in EHP (2009) , ANZECC & ARMCANZ (2000), NHMRC (2011) and NHMRC (2008) have been applied. NRA note that the WQO's for aquatic ecosystem values may be amended with reference data to inform the development to site-specific guideline values (SSGV) however until sufficient data is available default guidelines values are to be applied. Similarly, for sediment quality objectives, NRA has applied default guideline values for ecosystem protection published by Simpson *et al.* (2013).

With relation to aquatic ecosystems, NRA have nominated aquatic macroinvertebrates as the primary biological indicator, however noting that there are no current aquatic macroinvertebrate objectives for the Barron River Basin, reference data is to be collected with the view to future development of SSGV's in alignment with the QWQG (EHP 2009) for biological indicators in moderately disturbed waters.

4.3.2 WQO's Adopted for this Report

For this investigation, GHD has applied the same WQOs as those outlined NRA's EIMP Design Report 2017 to maintain consistency with current and previous monitoring undertaken by NRA, GHD and TRC and continue to build a meaningful data set for analysis and future development of SSGV's.

The WQO's that have been referred to in this report are identified in Table 4-1. The WQO for moderately disturbed ecosystems, specifically all developed fresh waters, are relevant for the entire Barron River basin, catchment specific WQO's have not been developed for the Barron River basin.

Table 4-1: Adopted WQO's

Parameter	Guideline Value (referred to as MDGV's)	Comment as to Source
Total suspended solids	8 mg/L	WQO for moderately disturbed ecosystems and 'all developed fresh waters'
pH	6.0-8.0	WQO for moderately disturbed ecosystems and 'all developed fresh waters'
Free Chlorine	<0.003 mg/L	WQO for tropical aquaculture
Faecal coliforms	10 CFU/100mL	WQO for irrigation used for raw human food crops Note that the WQO for stock watering is 100 CFU/100mL
Ammonia	0.01 mg/L	WQO for moderately disturbed ecosystems and 'all developed fresh waters'
Total nitrogen	0.34 mg/L	WQO for moderately disturbed ecosystems and 'all developed fresh waters'
Total phosphorus	0.025 mg/L	WQO for moderately disturbed ecosystems and 'all developed fresh waters'
Electrical conductivity	106 µS/cm	The 80th percentile for all surface waters

It is noted that WQO's are not intended for use as discharge to water release limits. As detailed in Table 4-2, the WQO's are significantly more stringent than the current License requirements. These WQO's cannot be cost effectively, or reasonably achieved using current best available sewage treatment processes.

Also of note in consideration of WQO's is the EA note 2:

The holder of this EA must further dilute the effluent whenever necessary to ensure that the measured ammonia concentration in water at Mazlin Creek does not exceed 1 mg/L.

Table 4-2: EA Release Limits and WQO's

Characteristic	Current License	WQO	Magnitude
Ammonia	4 mg/L Maximum 2 mg/L 80th percentile Long Term	0.01 mg/L	1/400 1/200
Total Nitrogen	10 mg/L Maximum 5 mg/L 50th percentile Long Term	0.034 mg/L	1/294 1/147
Total Phosphorous	2 mg/L Maximum 1 mg/L 50th percentile Long Term	0.025 mg/L	1/80 1/40

Table 4-3: Water Quality Objectives for Mazlin Creek receiving waters from Atherton STP (NRA, 2017)

Parameter	Units	WQOs for relevant EVs											
		Aquatic ecosystems[1]	Irrigation[2]	Farm supply/use[2]	Stock water[1]	Aquaculture	Human consumption[2]	Primary recreation[1]	Secondary recreation	Visual appreciation[3]	Drinking water[1,6]	Industrial use[4]	Cultural and spiritual values[5]
Total suspended solids	mg/L	**8**	-	-	-		-			-			-
pH	pH units	**6.0-8.0**	6.0-9.0	6.0-9.0	-		-			-			-
Electrical conductivity	µS/cm	**92**[g]	950	950	2985[c]		-			-			-
Dissolved oxygen	% saturation	**85-120**	-	-	-		-			-			-
Turbidity	NTU	**15**	-	-	-		-			-			-
Temperature	°C	-	-	-	-		-			-			-
Ammonia as nitrogen	µg/L	**10**	-	-	-		-			-			-
Total nitrogen	µg/L	**340**	500	500	-		-			-			-
Nitrate as nitrogen	µg/L	**7200**[c]	-	-	90400[e]		-			-			-
Total oxidised nitrogen	µg/L	**50**	-	-	-		-			-			-
Total phosphorous	µg/L	**25**	50	50	-		-			-			-
Filterable reactive phosphorous	µg/L	**8**	-	-	-		-			-			-
Oil and grease[7]	mg/L	-	-	-	-		-			-			-
Free residual chlorine[7]	µg/L	-	-	-	-		-			-			-
Total residual chlorine	µg/L	**3**	-	-	-		-			-			-
Chloride	mg/L	**14**	175	175	-		-			-			-
Sodium	mg/L	**11**	115	115	-		-			-			-
Dissolved aluminium	µg/L	**55**[a]	-	-	-		-			-			-
Total aluminium	µg/L	-	**5000**	**5000**	**5000**		-			-			-
Dissolved boron	µg/L	**370**[a]	-	-	-		-			-			-
Total boron	µg/L	-	**500**	**500**	5000		-			-			-
Dissolved cadmium	µg/L	**0.2**[a]	-	-	-		-			-			-
Total cadmium	µg/L	-	**10**	**10**	**10**		-			-			-
Dissolved chromium	µg/L	**1**[a]	-	-	-		-			-			-
Total chromium	µg/L	-	**100**	**100**	1000		-			-			-
Dissolved copper	µg/L	**1.4**[d]	-	-	-		-			-			-
Total copper	µg/L	-	**200**	**200**	400		1000			-			-
Dissolved iron	µg/L	**300**[d]	-	-	-		-			-			-
Total iron	µg/L	-	**200**	**200**	-		-			-			-
Dissolved lead	µg/L	**3.4**[a]	-	-	-		-			-			-
Total lead	µg/L	-	2000	2000	**100**		-			-			-
Dissolved nickel	µg/L	**11**[a]	-	-	-		-			-			-
Total nickel	µg/L	-	**200**	**200**	1000		-			-			-
Dissolved mercury	µg/L	**0.06**[a]	-	-	-		-			-			-
Total mercury	µg/L	-	2	2	**2**		-			-			-
Dissolved zinc	µg/L	**8**[d]	-	-	-		-			-			-
Total zinc	µg/L	-	**2000**	**2000**	20000		5000			-			-
Faecal coliforms	CFU/100 mL	-	**10**	**10**	100		14			-			-
Intestinal enterococci	CFU/100 mL	-	-	-	-		-			-			-
Chlorophyll-a	µg/L	**1.5**	-	-	-		-			-			-
Cyanobacteria as *Microcystis*	cells/mL	-	-	-	**11500**[a]		-			50000[f]			-

Values **bolded and underlined** were the most conservative guideline for each parameter and were selected as the WQO for the Environmental Impact Monitoring Program (EIMP).
Shaded columns indicate that EV does not apply to this subcatchment.
- No value.
WQO: water quality objective.
EV: environmental value.
[1] Values are from EHP (2014a) unless otherwise indicated.
[2] Guidelines are from ANZECC and ARMCANZ (2000) unless otherwise indicated. Farm use is assumed to include irrigation/agricultural use rather than drinking water supply.
[3] There are no numerical guidelines for the 'visual use' category of the ANZECC and ARMCANZ (2000) guidelines for recreational water quality and aesthetics. EHP (2014a) states that the water should be free from visible materials that may settle to form objectionable deposits; floating debris, oil, scum and other matter; substances producing objectionable colour, odour, taste or turbidity; and substances and conditions that produce undesirable aquatic life. The WQOs for cyanobacteria and primary recreation apply.

[4] The industrial use EV is protected by WQOs for other EVs, such as the aquatic ecosystems requirements (EHP 2014a).
[5] EHP (2014a) states that the cultural and spiritual values EV is protected by protecting or restoring indigenous and non-indigenous cultural heritage consistent with any relevant policies and plans. For the purposes of the EIMP, it is assumed that the protection of the aquatic ecosystems EV would result in the protection of cultural heritage.
[6] Drinking water guidelines for pathogens and cyanobacteria from NHMRC 2016 were not considered suitable for use as EIMP WQOs because they are set for treated (*ie* disinfected) drinking waters, rather than raw drinking water in the vicinity of off-takes before treatment.
[7] No published WQOs available for oil and grease and free residual chlorine. Oil and grease and free residual chlorine are included here due to Environmental Authority (EA) requirements to monitor these parameters in the release waters.
[a] Guideline value from ANZECC and ARMCANZ (2000).
[b] Guideline value for forms of N as toxicants from Hickey (2002).
[c] Calculated from the total dissolved solids guideline by dividing by a factor of 0.67, as per ANZECC and ARMCANZ (2000)
[d] It is acknowledged that EHP (2014a) presents regional specific WQOs for copper, iron, and zinc, but there was no information in the source document (Raymond & McNeil 2013) about whether the values represent total or dissolved metal fractions. Therefore, a decision was made to use the default ANZECC and ARMCANZ (2000) guidelines as it is appropriate to compare dissolved metal test data to these values.
[e] Value for nitrate as nitrogen converted from nitrate (NO_3) by multiplying by a factor of 0.226.
[f] EHP (2014a) states that the visual appreciation WQO for cyanobacteria is the same value used to protect the primary recreation EV.
[g] Electrical conductivity value for the Wet Tropics salinity zone from QWQGs (EHP 2013).

5. Environmental Setting

5.1 Climate and Meteorology

Weather data was accessed from Climate Data Online, Bureau of Meteorology on 26 November 2018. A weather station was opened at Solar Crescent Atherton in 2009 whereby rainfall data has been recorded at an elevation of 769 m. The lowest annual rainfall since 2009 was recorded in 2016 of 995.8 mm. The highest annual rainfall since 2009 was in 2010, with 1999.0 mm recorded at Solar Crescent.

The wettest month is typically January but can be February and the driest is often September but can be July or August.

Mean rainfall data per month is available from Walkamin Research Station, where the weather station has been operational since 1965 at an elevation of 594 m and is located north of Atherton (Figure 9).

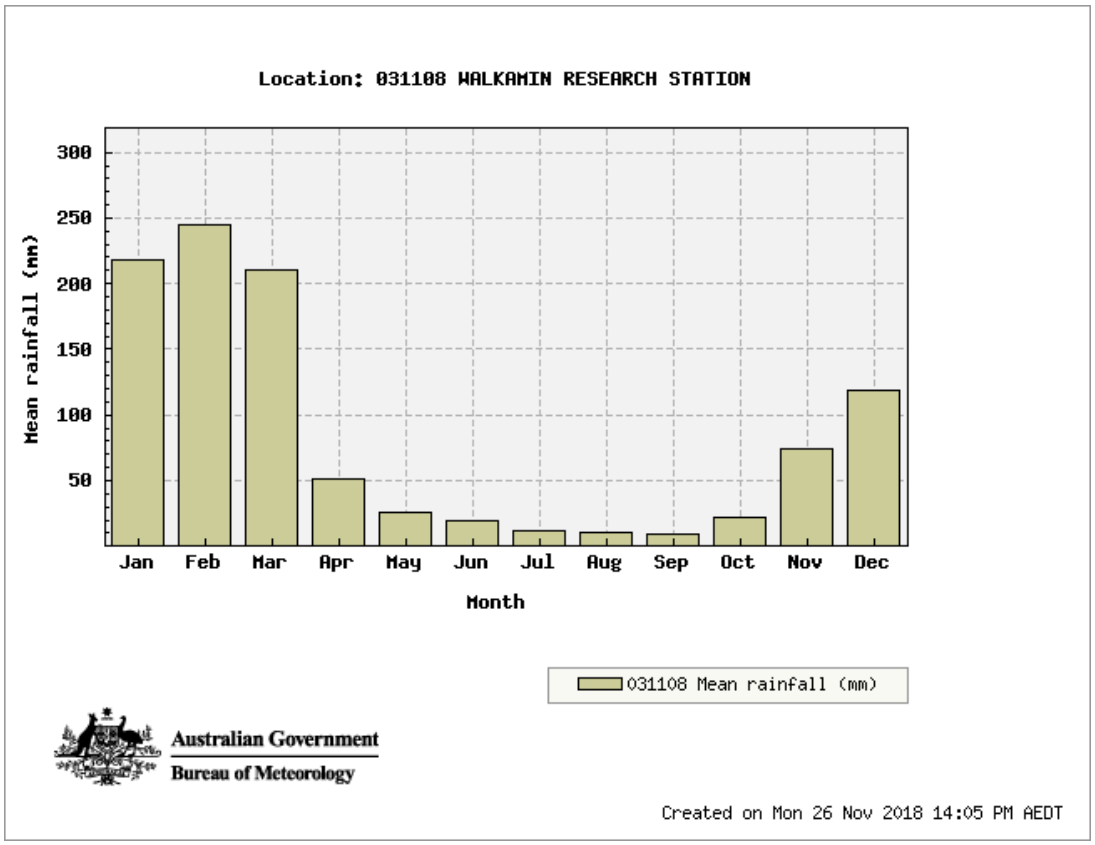


Figure 9: Mean Monthly Rainfall Walkamin Research Station

Temperature data is only available from Walkamin Research Station. The mean lowest temperature per annum since 1965 is 6.2 °C, with the lowest temperature typically recorded in July and that being 2.6°C in July 1984.

The mean highest temperature per annum since 1965 is 29.2 °C, with the highest temperature typically recorded in December, (but can be November or January) and that being 39.8°C in November 1990 and again in January 1994.

Rainfall and streamflow conditions around the time of each exceedance is shown in Figure 10. The exceedences appear to have occurred during or immediately post minor rainfall events however only the first exceedance occurred with elevated stream discharge (Figure 10). The exceedence events, as identified by DES are not associated with high rainfall events.

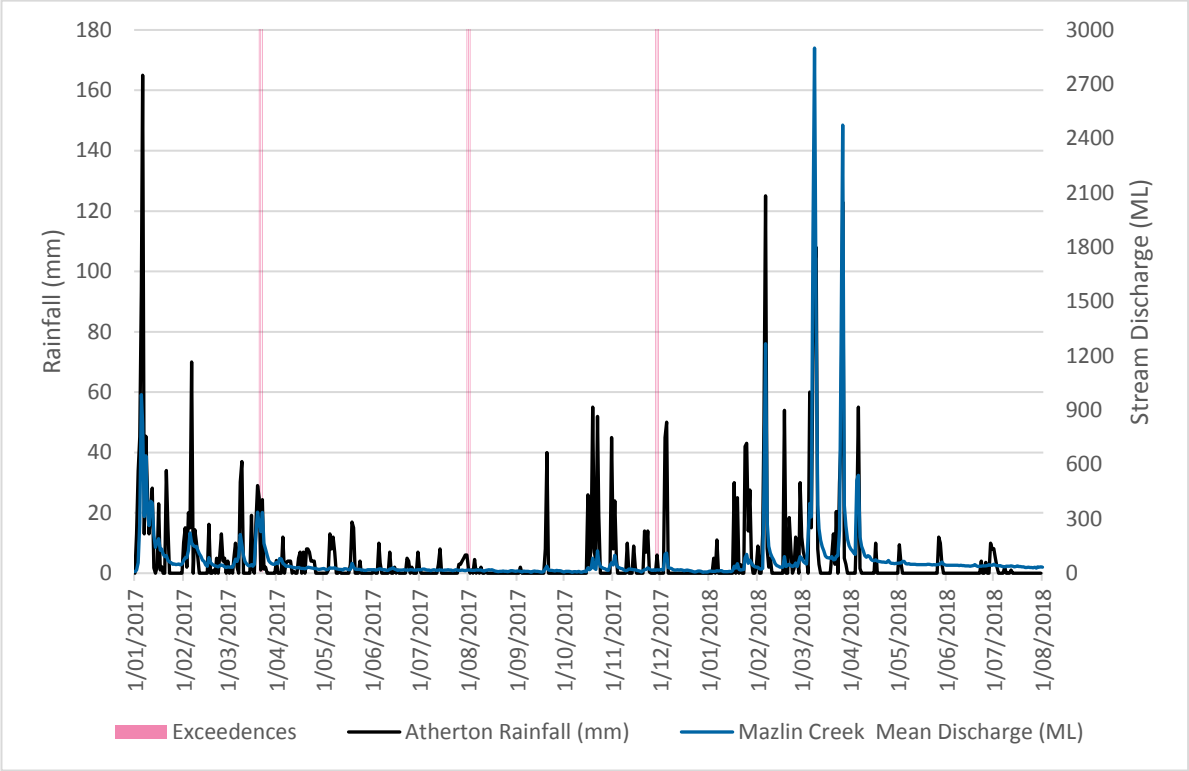


Figure 10: Rainfall and Streamflow Discharge (ML) around the time of each exceedence event

5.2 Topography and Surrounding Landuse

The site is located within gentle undulating terrain through which Priors Creek and Mazlin Creek have developed deep incision channels, with steep to near vertical river banks with evidence of past slumping and channel reworking. In many areas the incision phase has ceased with the exposure of bedrock which now form multiple kink points diversifying channel hydrology, increasing natural aeration and habitat availability The riparian zone is largely well vegetated although some areas are weed dominated which indicates high nutrients and disturbance, very typical of a rural catchment. Some river bank areas on Mazlin Creek directly opposite and downstream of the STP is accessed directly by cattle as evidenced by bank disturbance, causing localised erosion and direct input of nutrients and faecal matter into the waterway.

A search of the State Planning Policy DSDMIP maps on 16 November 2018 shows the Atherton STP area to be within a flood hazard area Level 1 Queensland floodplain assessment overlay.

5.3 Geology and Soils

5.3.1 Geology

To the east of Atherton is the Great Escarpment which descends to the coastal plain. To the west lies the Great Dividing Range. The height above sea level is 700-800 m at Atherton.

The geology of the modern landscape of the Tablelands has two main components:

- Old rocks including granites, commonly mineralised. The first rocks formed are sedimentary rocks which were then buried and altered so that they are now folded into steeply dipping beds.

- Basalts erupted upon this older bedrock. Granites intruded with eruption of rhyolitic lavas. Granite and rhyolite are derived from similar magmas, rich in quartz. The granite crystallises deep within the earth's crust, at least 5 km depth, whereas the rhyolite is the same magma erupted to the surface. Granite is very coarse grained because it cools slowly, while the rhyolite is fine grained because it cools quickly.

Mineralisation fluids circulating during metamorphism, as well as through and around the granite intrusions have introduced metals into fractures and cavities. The main ores are gold, copper and zinc in the Hodgkinson rocks, and tin and wolfram in the granites.

Basalts come from the earth's mantle, about 35 km down. The magma rises through the earth's crust and is erupted at a temperature around 1200-1300 degrees celcius through volcanoes. The Tablelands lavas flowed down creek and through river valleys, eventually filling them as it cooled. Most individual basalt flows are only a few metres thick so much of the Atherton Tableland basalt deposits consist of many flows (Tropical Tablelands Tourism, 2016).

The area around Atherton STP is underlain by Atherton Basalt, Tertiary to Quaternary age surface geology, according to the Regional Hodgkinson-Laura Basins extent. (Hodgkinson-Laura Basins Regional Mapping, Mines Online Maps 16 November 2018).

5.3.2 Soils

Deep, red, rich and fertile basalt derived soils predominate in the Atherton Tablelands at altitude 600 m to 1100 m. The soils in the vicinity of Atherton STP are described in Table 5-1:

Table 5-1: Atherton Soils

Mapping Unit Soil	Australian Soil Classification	Great Soil Group	Major Attributes of Principal Soil	Details
Tolga	Red Ferrosol	Euchrozem	Soils derived from basaltic rocks. Very gently (1-3%) sloping to gently (3-10%) sloping rises	Very deep, neutral, pedal, uniform fine texture profile with dark or red, light clay A1 horizon (0.10 – 0.30m) with 2-10% manganese nodules over (where present) red, apedal, light clay B1 (0.46-0.80m) horizon with 2-10% manganese nodules grading to red light to light medium clay B2 horizons (0.80-1.80m) with 2-20% manganese nodules.

Source: Soils of the Atherton Tablelands (Sheet 1), QDNRM, 1991-1994 Mapping, Scale 1:50,000, sourced 30 November 2018

Both Mazlin and Priors Creek catchment have significant soil erosion evident with a number of large erosion gullies formed and impacting into the riparian zone. These would contribute, together with more generalised sheet erosion, considerable sediment loads into the system that may also carry other pollutants thereby impacting water quality. Gully erosion in some cases appears to be exacerbated by maintenance practices with the use of herbicide for weed control. Overuse of herbicide prevents vegetation from binding and holding the soil which can be effective in preventing sediment and other pollutants from entering the waterway (Figure 11 and Figure 12).



Figure 11: Eroding drainage line maintained with herbicide on adjoining property to the south of the Atherton STP



Figure 12: Drainage line with gully erosion undermining stormwater infrastructure entering Priors Creek upstream of the Atherton STP

5.4 Cultural Heritage

A Cultural Heritage Search was conducted on 16 November 2018 and 21 May 2019 with a 1,000 m buffer distance. The locality is attributed with being an Aboriginal Intangible Place, site ID EM-0007-1. The Cultural Heritage Party for the area is both the Tableland Yidinji People and the Tableland Yidinji #3 People, managed by the Wadjanbarra Tableland Yidinji Aboriginal Corporation RNTBC Atherton.

However, there are no Aboriginal or Torres Strait Islander cultural heritage site polygons recorded in this specific area. There are no cultural heritage bodies, management plans,

designated landscape areas or registered study cultural heritage areas in the specific search area.

5.5 Contaminated Land

A search of the Environmental Management Register (EMR) and the Contaminated Land Register (CLR) dated 16 November 2018 and 21 May 2019 revealed that the site is not included on either the EMR nor the CLR.

5.6 Matters of State Environmental Significance

A search of the DES Environmental Reports Matters of State Environmental Significance (MSES) dated 16 November 2018 and 21 May 2019 for the selected area supports the SPP biodiversity policy. A vegetation management watercourse is mapped as present within the regulated vegetation areas. Refer to Table 5-2.

Table 5-2: Summary of MSES present for the Site

Protected Areas	Area (ha)	Area (%)
8b Regulated Vegetation – Endangered/Of concern in Category B (remnant)	2.66	35.6
8c Regulated Vegetation – Category R (GBR riverine regrowth)	1.62 + 0.06 = 1.68	21.7 + 1.03 = 22.73
8d Regulated Vegetation – Essential habitat	2.66	35.6
8e Regulated Vegetation – intersecting a watercourse	Length: 0.4 km	N/A

5.7 Wet Tropics World Heritage Area

A search of the WHA general map on 16 November 2018 shows that the Atherton STP is not located within the WTWHA. The closest marked WTWHA area is to the south between Herberton to the West and Malanda to the East, as well as to the north and east of Tinaroo Dam.

5.8 Regional Ecosystems

A search of the DES Regional Ecosystems Biodiversity Status on 16 November 2018 and 21 May 2019 for the selected area of interest shows pre-clearing regional ecosystems indicating endangered dominant vegetation within the broad vegetation groups of rainforests and scrubs. In particular complex notophyll vineforest on basalt.

A search of the DNRME Regulated Vegetation Management Map (GDA 1994 MGA Zone 55) on 16 November 2018 demonstrates that the area is considered to be coastal. Refer to Table 5-3 for details of the vegetation categories.

A search of the DES protected plants flora survey trigger map on 16 November 2018 revealed the site to be located in a high risk area.

Table 5-3: Vegetation Categories

Vegetation Category	Area (ha)	Description	Requirements
Category C	2.66	High value regrowth areas	Exempt clearing work or notification and compliance with managing Category C regrowth vegetation accepted development vegetation clearing code.

Vegetation Category	Area (ha)	Description	Requirements
Category R	1.68	Regrowth within 50 m of a watercourse or drainage feature in the GBR catchment areas.	Exempt clearing work or notification and compliance with managing Category R regrowth vegetation accepted development vegetation clearing code or area management plans.
Category X	3.19	Clearing on freehold land, indigenous land and leasehold land for agriculture and grazing purposes only is exempt clearing work under the DNRME vegetation management framework.	No permit or notification required on freehold land, indigenous land and leasehold land for agriculture and grazing only.

The DNRME Vegetation Management Supporting Map searched on 16 November 2018 and 21 May 2019 shows Category C area containing endangered regional ecosystems and essential habitat on the essential habitat map, for sections of the Priors Creek watercourse and the junction to Mazlin Creek watercourse lying adjacent to the search area for Atherton STP.

Category C area high value regrowth vegetation in particular is within the watercourse of Priors and Mazlin Creeks and there is a Category R reef regrowth watercourse vegetation area along the creek banks and easements. This can be also evidenced from the historical aerial imagery in Figure 7 depicting a much denuded catchment, cleared for agriculture and settlement much of which has regrown in patches of varying quality

The area housing Atherton STP infrastructure and irrigation dam is Category X exempt clearing

The mapped Regional ecosystems marked on the Atherton STP property Lot 1 on Plan RP889324 and Lot 2 on Plan RP741754 are described in Table 5-4.

Table 5-4: Regional Ecosystems Present

Regional Ecosystem	VMA Status	Category	Area	Short Description	Structure Category
7.3.37	Endangered	C	0.28	Complex semi-evergreen notophyll vine forest of uplands on alluvium.	Dense
7.8.3a	Endangered	C	2.38	Complex semi-evergreen notophyll vine forest of uplands on basalt.	Dense
Non-remnant	None	R	1.68	None (Regrowth within 50m of a watercourse)	None
Non-remnant and plant	None	X	8.66	None	None

5.9 Flora and Fauna

A search of DES Biodiversity and Conservation Values on 16 November 2018 and 21 May 2019 has shown the Aquatic Conservation Assessment (ACA) Riverine Subcatchment Significance (riverine wetlands) was rated overall to be high for the area. In particular, riverine aquatic conservation significance was rated very high in the areas of diversity and richness, threatened species and ecosystems and priority species and ecosystems. Naturalness catchment rated high, connectivity medium and naturalness aquatic rated low.

The search then listed biodiversity and conservation values relating to threatened and priority flora and or fauna species recorded on or within 4 km of the assessment area.

6. Sampling Methodology

6.1 Sampling Locations

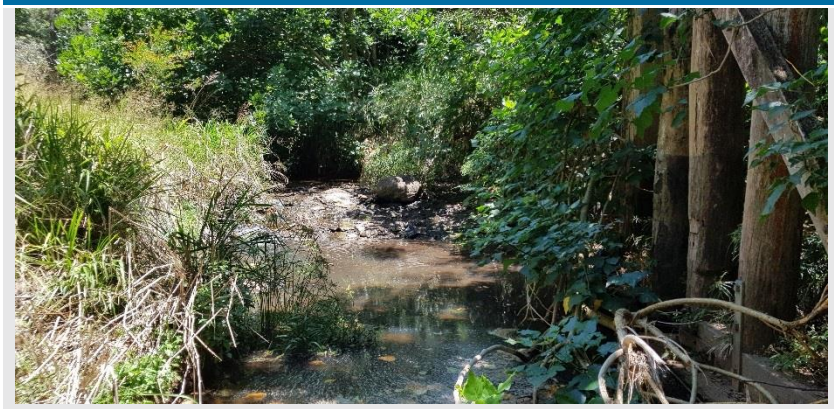
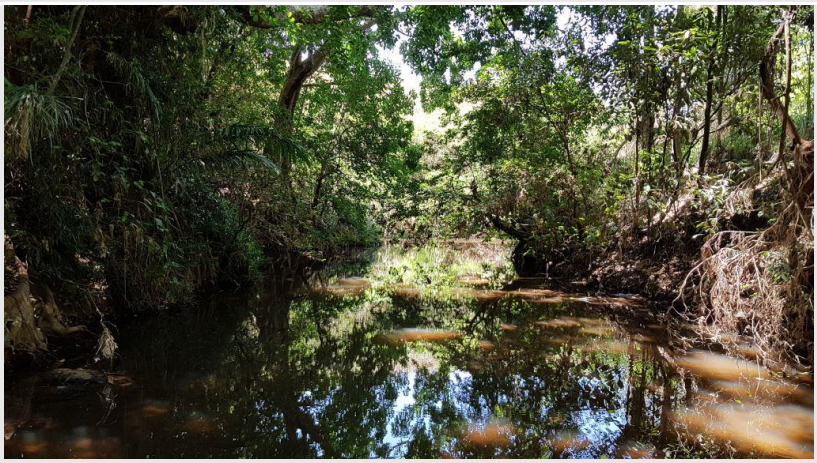
For this investigation, GHD has continued monitoring of EIMP sites as per NRA's EIMP Design Report to maintain consistency with current and previous monitoring undertaken by NRA, GHD and TRC and continue to build a meaningful data set for analysis. Sampling locations include control sites in lieu of 'reference sites' used as benchmarks to assess impacts located upstream of the Atherton STP. Refer to Table 6-1.

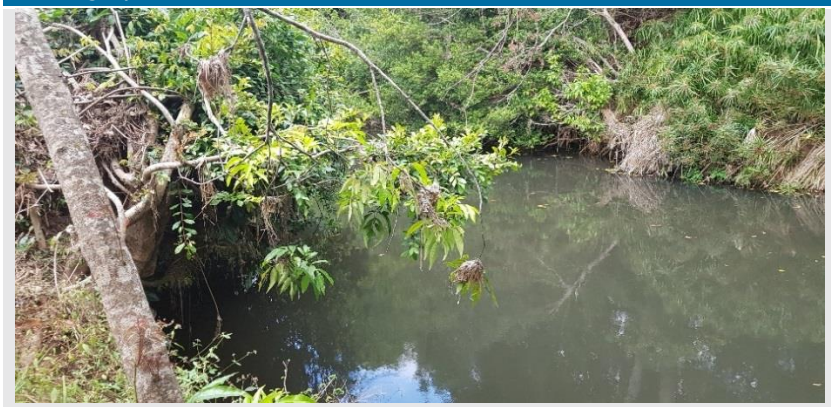
Table 6-1: Sampling locations for Water Quality, Macroinvertebrates and Sediment

Site	Location	Site Reference	Environment Type	Easting (MGA) Zone 55 K	Northing (MGA) Zone 55 K
ASTP-US1	Mazlin Creek approximately 300 meters upstream from the confluence to Priors Creek	Upstream	Unaffected environment	0338222	8091802
ASTP-US2	Priors Creek approximately 250 metres upstream from the Atherton STP Release Point W1	Upstream	Unaffected environment	0338334	8091747
ASTP-DP*	Priors Creek Directly downstream of Release Point W1, approximately 80m upstream from the confluence with Mazlin Creek.	Downstream	Receiving environment	0338436	8091792
ASTP-DS1	Mazlin Creek after the confluence to Priors Creek, approximately 400 metres downstream from Release Point W1	Downstream	Receiving environment	0338671	8091939
ASTP-DS2	Mazlin Creek approximately 700 metres downstream from Release Point W1	Downstream	Receiving environment	0338828	8092139

*The additional sampling site (ASTP-DP) has been implemented in Priors Creek directly below Release Point W1 to improve monitoring of the mixing zone prior to the influence of Mazlin Creek waters.

Table 6-2: Site Photos of Atherton STP EIMP and Water Quality Monitoring Locations

Site	Photograph
ASTP-US1 (Mazlin Cr US1)	
ASTP-US2 (Priors Cr US2)	
ASTP-DP (Priors Creek DP) (photo taken November 2018)	
ASTP-DS1 (Mazlin Cr DS1)	

Site	Photograph
ASTP-DS2 (Mazlin Cr DS2)	

6.2 Water Samples

6.2.1 Collection

Surface water samples (September 2018 onwards) were collected with reference to the relevant sections of DES Monitoring and Sampling Manual (2018), GHD sampling protocols and following the methodology outlined in the NRA EIMP Design Report (NRA, 2017), where appropriate.

For surface water the following insitu water quality parameters are measured and recorded:

- pH in pH units.
- Temperature in ºC.
- Dissolved Oxygen (DO) in mg/L and %.
- Electrical Conductivity (EC) in µS/cm.
- Eh (Redox) in mV.
- Turbidity in NTU.

Subsequent to the recording of water quality parameters, surface water samples were collected and placed in laboratory-supplied containers appropriately preserved, specific to each analyte. Samples requiring heavy metals analysis were lab-filtered. All samples were stored in a chilled storage container immediately after collection for delivery to a NATA accredited laboratory for analysis under Chain of Custody (CoC) documentation.

6.2.2 Assessment of Results

Water quality data is essential for understanding the impacts of an activity on receiving water and is the primary indicator used in receiving environment monitoring programs (EHP 2014).

In assessing potential STP impact on the quality of local receiving water environments (water quality), three (3) methods were adopted as follows:

- Identification of variations between upstream and downstream surface water quality (where applicable)
- Comparison of laboratory analysis results with adopted references and/or guidelines
- Assessment of trends in parameter concentrations at specific receiving water monitoring locations.

6.3 Sediment Samples

6.3.1 Collection

Stream sediment samples were collected with reference to the relevant sections of DES Monitoring and Sampling Manual (2018), GHD sampling protocols and following the methodology outlined in the NRA EIMP Design Report (NRA, 2017), where appropriate.

Collection of stream sediment samples consisted of the following:

- Sampling was undertaken using a decontaminated plastic bucket and clean nitrile gloves. All equipment used at multiple sample locations was decontaminated prior to every sample collection using phosphate free detergent and potable water to rinse.
- A composite sediment sample was collected with constituents from 10 sub-locations at the site, with sediment taken from a depth of no more than 5 cm at each sub-location.
- Samples were collected directly into a decontaminated plastic bucket where the sample was homogenised and split into their relevant laboratory supplied bags. Samples were stored on ice immediately following collection and kept on ice until arrival at the laboratory.

6.4 Macroinvertebrates and Habitat Assessment

6.4.1 Sampling and Sample Processing

Three replicate Rapid Bioassessment (RBA) samples were collected at each site with sufficient water and habitat, in accordance with the protocols outlined in the DES Monitoring and Sampling Manual (DES 2018) and QLD AUSRIVAS manual (NRM 2001) where possible. Replicate sampling was conducted to provide a gauge of intra-site variability.

The edge habitat was sampled at each site. Edge habitat is defined as the section of water up to 0.50 m from the bank with little or no current and includes backwaters and isolated pools (DES 2018). Macroinvertebrate samples were collected using a 250 µm mesh net (ISO 1983). Sampling of the Edge habitat was undertaken by sweeping the net in an upwards direction, perpendicular to the bank, along a 10 m stretch (cumulative). Areas of overhanging or submerged habitat (e.g. logs, leaf litter, tree roots) were targeted but aquatic vegetation was avoided where possible.

For two of the Edge samples, the collected material was placed into a sorting tray and macroinvertebrates picked for a minimum of 30 minutes by experienced aquatic ecologists using forceps and pipettes. A maximum of 10 of each taxa were picked except where the family could not be determined in the field (i.e. chironomids). If new taxa (not previously detected in a sample) were collected between 20 and 30 minutes, picking continued for another 10 minutes. If no new taxa were found after 10 minutes, then processing ceased. If new taxa were found, the 10-minute processing cycle was continued up to a total sorting time of 1 hour.

The third Edge sample was preserved as a bulk (un-picked) sample and sub-sorted in the laboratory. Live-picked and bulk samples were preserved in 70% methylated spirits and clearly labelled with information including site, habitat, sampling method, date and sampler before transport to a GHD laboratory.

The water levels, strength of flows and safety constraints have dictated that sampling be conducted from the bank at some freshwater sites and sampling at some sites was constrained, which may have led to reduced quality of samples.

6.4.2 Identification

In accordance with QLD AUSRIVAS protocols (NRM 2001), 10% of the bulk sample was sorted and the animals identified.

Macroinvertebrates were identified using published taxonomic keys, unpublished working keys, and an extensive specimen reference collection maintained by GHD. Most macroinvertebrates were identified to family level with some exceptions in accordance with QLD AUSRIVAS protocols (NRM 2001). Chironomidae (Diptera) were identified to sub-family (e.g. Orthocladiinae, Chironominae and Tanypodinae). Groups such as Collembola, Nematoda, Oligochaeta and Acarina were identified to class or order level, as were the micro-crustacea Ostracoda, Copepoda and Cladocera. Reference specimens will remain the property of GHD.

For Quality Assurance purposes 5% of samples (i.e. 1 sample) were re-analysed by a separate GHD taxonomist. The percentage of correct taxa identified was 100% in the QA sample (see Appendix E). The macroinvertebrate raw data is provided in Appendix F.

6.4.3 Metric Calculation

The following biotic metrics have been calculated for macroinvertebrate samples (DES 2018):

Taxa richness and PET richness: Taxa richness refers to the number of different families/groups contained in a sample. PET richness refers to the number of macroinvertebrate families belonging to the Plecoptera, Ephemeroptera and Trichoptera groups. The animals within these three Orders tend to be sensitive to pollution and other disturbances, making them a useful indicator of in-stream health.

SIGNAL-2: (Stream Invertebrate Grade Number – Average Level) (Chessman 2003) is a simple scoring system for macroinvertebrates of Australian rivers. SIGNAL-2 is a biotic index based on pollution sensitivity values (grade numbers) assigned to aquatic macroinvertebrates that have been derived from published and unpublished information on their tolerance to pollutants, such as sewage and nitrification (Chessman 1995).

Macroinvertebrates are assigned a grade between 1 (most tolerant) and 10 (most sensitive). Families in a sample that have not been assigned a grade are excluded from the analysis and the total number of families that have a SIGNAL-2 grade is the SIGNAL-2 richness. The overall SIGNAL-2 score for each site is calculated as the average of the SIGNAL-2 grades for the taxa within a sample.

Proportion of sensitive taxa: The proportion of sensitive taxa is calculated as the percentage of taxa within the sample with a SIGNAL-2 of 8 or higher (Marshall et al. 2001). The use of this metric allows for an additional measure of the sensitivity of the macroinvertebrate community at each site.

Proportion of tolerant taxa: The proportion of tolerant taxa is calculated as the percentage of taxa within the sample with a SIGNAL-2 of 3 or less (Marshall et al. 2001). Lower proportions of tolerant taxa indicate improved community condition.

7. Sampling Results and Measured Impact

7.1 Water Quality

This section presents the results of the water quality assessment. Specific reporting and graphical representations have been provided on key parameters of concern.

7.1.1 Overview of Sampling and Results

October 2016 to March 2019 (TRC Operators)

TRC operators have collected and submitted for analysis surface water samples (once or twice monthly) over the period of October 2016 to March 2018. The locations sampled include:

- Mazlin Creek Upstream (Mazlin Cr US1) (38 sampling events)
- Priors Creek Upstream (Priors Cr US2) (42 sampling events)
- Mazlin Creek Downstream (Mazlin Cr DS2) (43 sampling events).

In addition, TRC collected and submitted for analysis surface water samples at the Priors Creek Discharge Point/Mixing Zone (Priors Ck DP) over the period November 2018 to April 2019 (four sampling events).

A summary of surface water parameters collected by TRC operators provides some insight to background water quality issues apparent for both Priors and Mazlin Creek catchments (Table 7-1). The percentiles presented in Table 7-1 are for the full data set and not those typically referred to as long-term or short-term under EA's.

The data between June 2017 to June 2018 was incorporated into the Annual EIMP Report for the period of July 2017 to June 2018 prepared by NRA. It was the first EIMP Annual Report to be produced for TRC.

This data has been utilised in the key parameters of concern results presentation (refer to Section 7.1.2 onwards).

September 2018 to Current (GHD)

As identified in Section 6, GHD have been conducting the EIMP sampling and analysis for the 2018-2019 period. The results that are able to be included within this Report are for the period September 2018 to March 2019 (seven sampling events). The sites sampled are as per Table 6-1. Table 7-2 provides the statistical analysis for the results available to date.

This data has been utilised in the key parameters of concern results presentation (refer to Section 7.1.2 onwards).

Table 7-1: Summary of Surface Water Characteristics collected by TRC Operators Fortnightly (12/10/2016 – 9/4/2019)

	Site/Statistic [1]	5-day BOD	Suspended Solids	pH	Dissolved Oxygen	Free Chlorine	Faecal coliforms	Ammonia	Total Nitrogen	Total Phosphorous	Electrical Conductivity	Oil and Grease
	Units	mg/L	mg/L	pH units	mg/L	mg/L	CFU/100mL	mg/L	mg/L	mg/L	µS/cm	mg/L
	MDGV's [2]	**-**	**8**	**6.0 - 8.0**	**-**	**0.003**	**10**	**0.01**	**0.34**	**0.025**	**106**	**-**
CONTROL SITES	**Mazlin Creek ASTP-US1 [3]**											
	Min	<2	<1	7.1	3.9	**<0.02**	**450**	**<0.02**	0.31	**0.03**	69	<1
	20th percentile	<2	3.08	7.2	6.5	**0.02**	**1084**	**<0.02**	**0.44**	**0.04**	80	<1
	Median	<2	4.50	7.4	7	**0.02**	**1600**	**<0.02**	**0.66**	**0.05**	**110**	<1
	80th percentile	<2	6.00	7.5	7.6	**0.05**	**2220**	**0.02**	**1**	**0.062**	**120**	<1
	Max	7.2	86.00	7.7	8.3	**1.2**	**20000**	**0.06**	**1.3**	**0.16**	**130**	<1
	Priors Creek ASTP-US2 [4]											
	Min	<2	1.5	7	6.1	**<0.01**	**450**	**<0.02**	0.27	0.02	45	<1
	20th percentile	<2	2.4	7.1	6.8	**0.01**	**868**	**<0.02**	0.336	**0.03**	69.2	<1
	Median	<2	4	7.2	7.45	**0.02**	**1600**	**<0.02**	**0.435**	**0.03**	78	<1
	80th percentile	<2	6	7.3	8.1	**0.04**	**2400**	**0.02**	**0.574**	**0.04**	85.8	<1
	Max	6.5	**80**	7.5	8.8	**0.09**	**16000**	**0.05**	**1**	**0.13**	**120**	<2
RECEIVING SITES	**Mazlin Creek ASTP-DS2**											
	Min	<2	<1	7.1	5.3	**0.01**	**400**	**<0.02**	0.05	<0.02	45	<1
	20th percentile	<2	3.20	7.26	6.72	**0.02**	**666**	**<0.02**	**0.458**	**0.05**	81	<1
	Median	<2	4.8	7.4	7.4	**0.03**	**1350**	**0.03**	**0.75**	**0.08**	**110**	<1
	80th percentile	<2	6.62	7.5	7.68	**0.05**	**2220**	**0.15**	**1.1**	**0.14**	**150**	<1
	Max	6.1	**98**	7.7	8.5	**0.1**	**20000**	**1.8**	**3.6**	**0.2**	**340**	<1
	Priors Creek DS – ASTP-DP [5]											
	Min	<2	3.2	7.3	5.7	**0.02**	8	0.01	**0.4**	**0.05**	78	<1
	20th percentile	-	3.2	-	-	**0.02**	8	0.01	**0.4**	**0.05**	-	<1
	Median	<2	4.2	7.3	7	**0.035**	**2150**	**0.065**	**0.48**	**0.06**	100	<1
	80th percentile	-	6	-	-	**0.06**	**3200**	**0.08**	**0.88**	**0.13**	-	<1
	Max	5.6	6	7.5	7.9	**0.06**	**3200**	**0.08**	**0.88**	**0.13**	**130**	<1

1 MDGV refers to moderately disturbed guideline values. Where a concertation is <LOR for the purpose of statistical analysis the results is treated as half of the LOR

2 Exceedances against MDGV's are in bold

3 One Faecal coliform concentration (31/10/2018) was >10,000, as per above, this result has been assumed to be 15,000 for the purpose of statistical results

4 One Faecal coliform concentration (31/10/2018) was >10,000, as per above, this result has been assumed to be 15,000 for the purpose of statistical results

5 Limited sampling has occurred to date for ASTP-DP with three or four sampling events, where there are only three parameter results percentiles have not been calculated

Table 7-2: Summary of Surface Water Characteristics collected by GHD Monthly (24/09/2018 – 20/3/2019, seven events) [1]

	Site/Statistic [1]	Suspended Solids	pH	Dissolved Oxygen	Free Chlorine	Faecal coliform	Ammonia	Total Nitrogen	Total Phosphorous	Electrical Conductivity
	Units	mg/L	pH units	%Sat	mg/L	CFU/100mL	mg/L	mg/L	mg/L	µS/cm
	MDGV's [2]	**8**	**6.0 - 8.0**	**-**	**0.003**	**10**	**0.01**	**0.34**	**0.025**	**106**
CONTROL SITES	**Mazlin Creek ASTP-US1**									
	Min	<5	7.03	61.1	<0.02	**60**	<0.005	0.3	<0.02	65.2
	20th percentile	<5	7.054	61.58	<0.02	**96**	0.008	**0.46**	<0.02	75.7
	Median	<5	7.28	97.7	<0.02	**420**	**0.04**	**1**	**0.04**	101.6
	80th percentile	14	7.708	107.5	<0.1	**1700**	**0.088**	**1.18**	**0.07**	**119**
	Max	**26**	7.84	110.3	<0.1	**2300**	**0.13**	**1.3**	**0.1**	**121.8**
	Priors Creek ASTP-US2 [3]									
	Min	<5	6.76	71.5	<0.02	**190**	>0.005	0.3	<0.02	48.4
	20th percentile	<5	7.078	72.88	<0.02	**190**	**0.0136**	0.3	<0.02	59.14
	Median	<5	7.37	98.8	<0.02	**1,100**	**0.03**	**0.4**	0.02	72.4
	80th percentile	16.4	7.958	118	<0.1	**5,080**	**0.054**	**0.75**	**0.054**	88.54
	Max	**29**	**8.09**	139.2	<0.1	**7,300**	**0.06**	**0.8**	**0.09**	102.7
RECEIVING SITES	**Mazlin Creek ASTP-DS1**									
	Min	<5	6.78	71.1	<0.02	6	<0.005	0.3	<0.02	79.6
	20th percentile	<5	6.93	71.65	<0.02	**56.4**	**0.012**	**0.54**	<0.02	82.42
	Median	6	7.23	80.2	<0.02	**690**	**0.04**	**0.74**	**0.06**	90.2
	80th percentile	64.2	7.75	113.6	<0.1	**1960**	**0.064**	**1.2**	**0.12**	105.9
	Max	**147**	7.81	125.5	<0.1	**2500**	**0.07**	**1.5**	**0.17**	**125.5**
	Mazlin Creek ASTP-DS2									
	Min	<5	6.77	61.6	<0.02	**34**	<0.005	0.3	<0.02	75.3
	20th percentile	<5	6.836	65.5	<0.02	**73.6**	0.007	**0.48**	<0.02	75.42
	Median	8	7.28	78.4	<0.02	**580**	**0.05**	**0.8**	**0.06**	84.1
	80th percentile	26.8	7.752	144.3	<0.1	**3300**	**0.08**	**1.04**	**0.112**	104.3
	Max	**46**	7.8	149.4	<0.1	**5700**	**0.08**	**1.1**	**0.16**	**124.6**

	Site/Statistic [1]	Suspended Solids	pH	Dissolved Oxygen	Free Chlorine	Faecal coliform	Ammonia	Total Nitrogen	Total Phosphorous	Electrical Conductivity
	Units	mg/L	pH units	%Sat	mg/L	CFU/100mL	mg/L	mg/L	mg/L	µS/cm
	MDGV's [2]	**8**	**6.0 - 8.0**	**-**	**0.003**	**10**	**0.01**	**0.34**	**0.025**	**106**
	Priors Creek DS – ASTP-DP [3, 4]									
	Min	5	7.26	75	<0.1	730	**0.02**	**0.5**	<0.02	77.7
	Median	31	7.71	95.8	<0.1	810	**0.022**	**0.79**	**0.0.5**	**299.9**
	Max	47	8.35	99.4	<0.1	>2,400	**0.088**	**2.3**	**0.39**	**347.4**

1 MDGV refers to moderately disturbed guideline values. Where a concertation is <LOR for the purpose of statistical analysis the results is treated as half of the LOR

2 Exceedances against MDGV's are in bold

3 One Faecal coliform concentration (20/03/2019) was >2,400, as per above, this result has been assumed to be 3,600 for the purpose of statistical results

4 Limited sampling has occurred to date for ASTP-DP (with only three monthly samples collected during the wet season Jan – March 2019) therefore percentiles are not practical at this stage

7.1.2 Biological Oxygen Demand

The 5-day biological oxygen demand (BOD) was <2 mg/L (the LOR) for the long-term 80th percentiles at all sites sampled by TRC operators. Table 7-3 provides the dates and results for BOD where concentrations where reported above the LOR.

Table 7-3: BOD Concentrations above LOR

	Mazlin Cr US1 (mg/L)	Priors Cr US2 (mg/L)	Mazlin Cr DS2 (mg/L)
8/11/2016	<2.0	**2.2**	**3.2**
16/01/2017	**7.2**	<2.0	<2.0
13/06/2017	<2.0	<2.0	**2.1**
24/07/2017	<2.0	<2.0	**2.3**
1/08/2017	<2.0	**6.5**	**6.1**
3/10/2017	<2.0	**2.5**	**2.6**
31/10/2017	<2.0	**2.7**	**3.4**
14/11/2017	**3**	<2.0	<2.0
31/07/2018	<2.0	<2.0	**2.8**
22/11/2018	<2.0	<2.0	**2.2**

Exceedance Events

BOD concentrations were part of the EE notice from DES for:

a. 7 August 2017.

The BOD concentrations within surface water where <2 mg/L until 3 October 2017, 2 months after the event. Based on this it is considered that if effluent discharge occurred it did not have a measured impact on the downstream environment (dilution may have occurred).

7.1.3 Free Chlorine

Free chlorine has been sampled and monitored by TRC operators. The results are summarised as follows:

- Upstream concentrations:
  - Mazlin Creek free chlorine ranged from 0.01 mg/L (08/03/3017, 26/04/2017 and 03/05/2017) to 1.2 mg/L (16/01/2017) and an average of 0.06 mg/L
    - The 1.2 mg/L concentration for Mazlin Cr US1 (16/01/2017) is considered likely an anomaly, as it is not related to any other concentrations of this magnitude. Where the result is treated as an outlier and discounted from statistics the maximum result is 0.08 mg/L (23/10/2018 and 22/11/2018) and an average of 0.03 mg/L
    - We have discounted this anomaly from further discussion
  - Priors Creek free chlorine ranged from 0.01 mg/L (08/03/3017, 26/04/2017 and 03/05/2017) to 0.1 mg/L (22/11/2018) and an average of 0.03 mg/L
- Downstream:
  - Maziln Creek (DS2) free chlorine ranged from 0.01 mg/L (five events) to 0.09 mg/L (31/10/2017) and an average of 0.03 mg/L.

Figure 13 displays the results in a time series (excluding the outlier). Note the MDGV is for tropical aquaculture as an aquatic ecosystem value has not been determined.

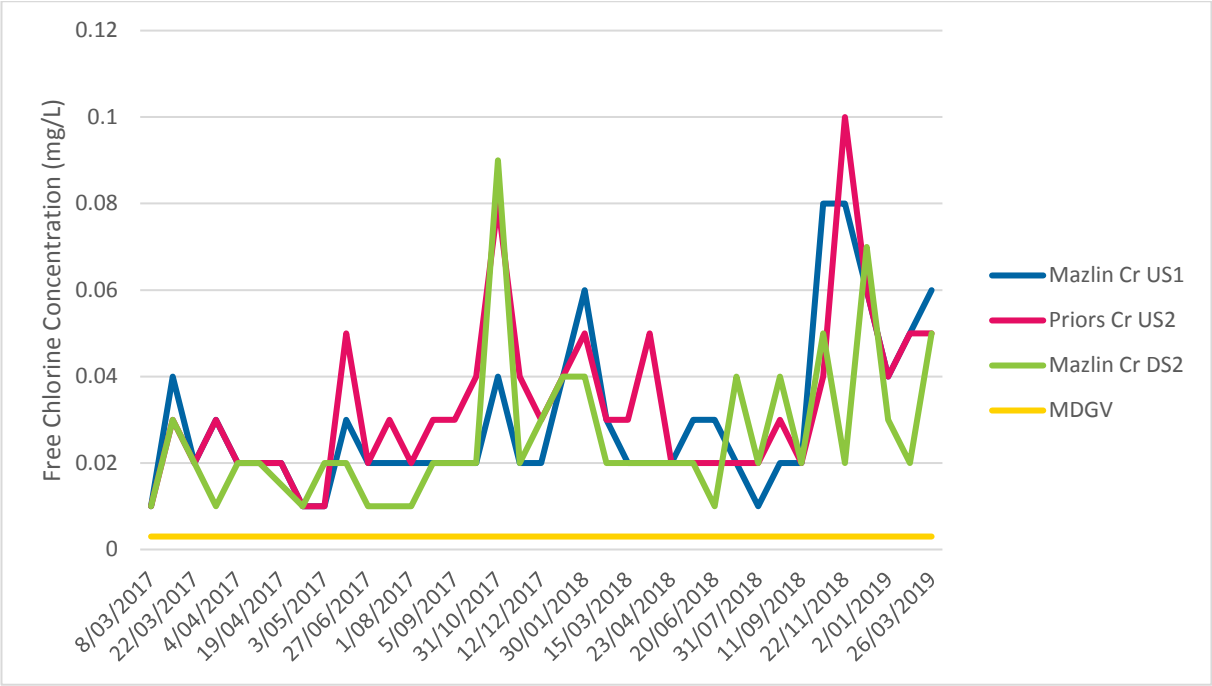


Figure 13: Free Chlorine Concentrations – Time Series

Exceedance Events

Free chlorine concentrations were part of the EE notice from DES for:

a. 21 April 2017.

The free chlorine concentrations within surface waters where <0.03 mg/L for the two months following the event. Based on this it is considered that if effluent discharge occurred it did not have a measured impact on the downstream environment (dilution may have occurred).

Spatial – Upstream and Downstream

The box and whisker plot, Figure 14, shows similar concentrations upstream and downstream.

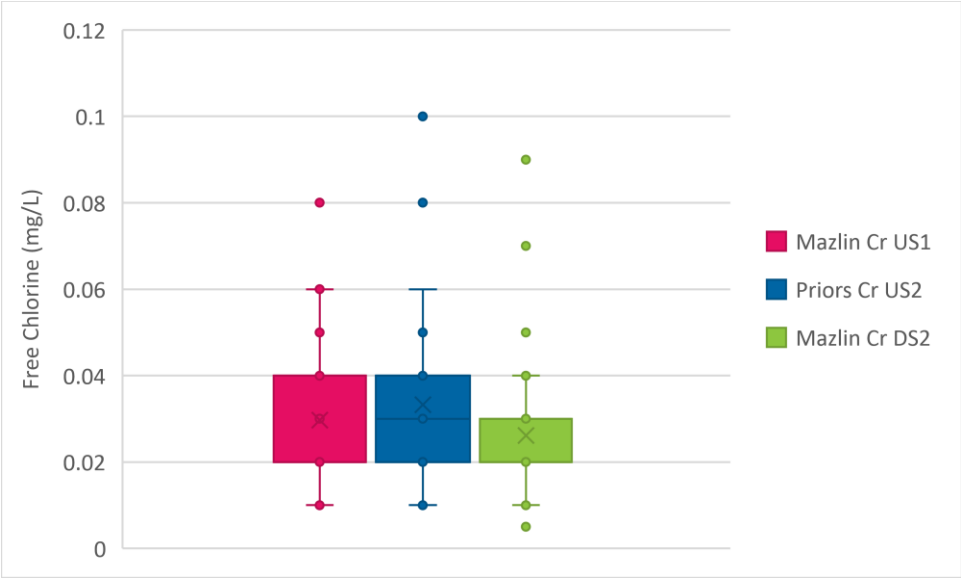


Figure 14: Free Chlorine Concentrations – Box and Whisker Plot

Effect of Atherton STP

In consideration of the information available (i.e. the one downstream site) the Atherton STP is unlikely to be affecting free chlorine in Mazlin Creek (after downstream point 2).

7.1.4 Total Suspended Solids

Total suspended solids (TSS) results are summarised as follows:

- Upstream concentrations:
  - Mazlin Creek TSS ranged from 0.5 mg/L (05/06/2017) to 86 mg/L (16/01/2017) and an average of 6.80 mg/L
  - Priors Creek TSS ranged from 1.5 mg/L (28/08/2017) to 80 mg/L (27/03/2017) and an average of 6.67 mg/L
- Downstream:
  - Mazlin Creek (DS1) TSS ranged from 2.5 mg/L (24/09/2018 and 17/10/2018) to 147 mg/L (15/12/2018) and an average of 25.43 mg/L
  - Maziln Creek (DS2) TSS ranged from 0.5 mg/L (04/04/2017) to 98 mg/L (27/03/2018) and an average of 9.73 mg/L
  - Priors Creek (DP) TSS ranged from 3.2 mg/L (22/11/2018) to 47 mg/L (21/03/2019) and an average of 14.37 mg/L.

Note that Mazlin Cr DS1 and Priors Cr DP both have seven sampling events only.

Figure 15 displays a box and whisker plot of the TSS concentrations. The results indicate outliers at four sites. A time series plot of the TSS concentrations is available in Appendix D 1.

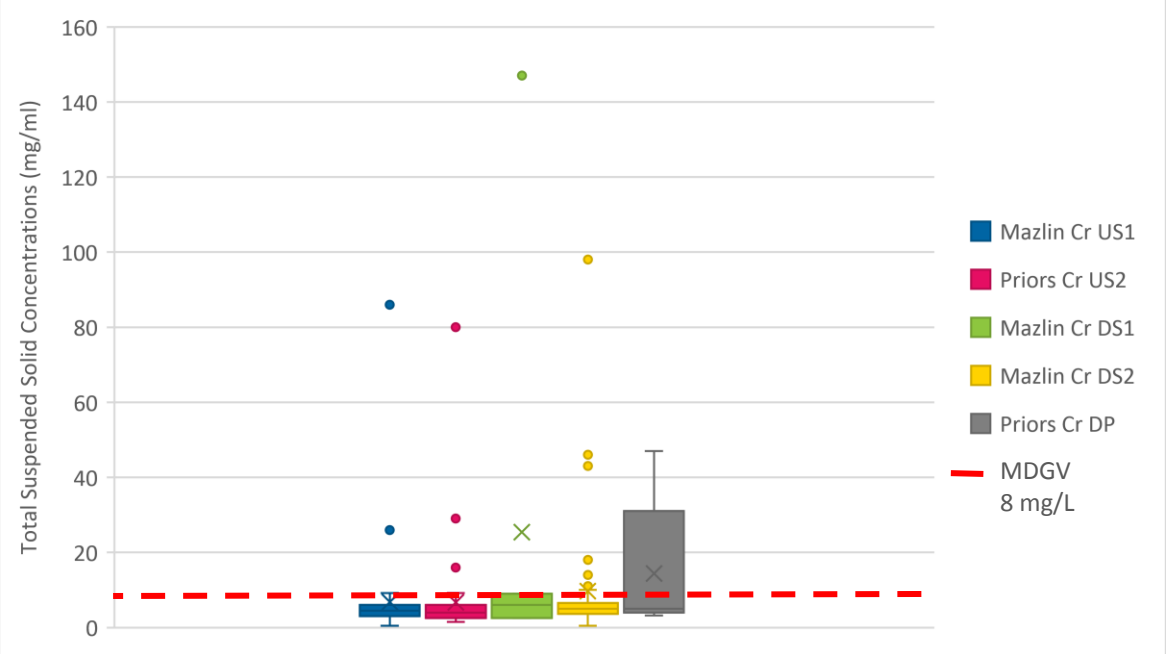


Figure 15: Total Suspended Solids – Box and Whisker Plot

Exceedance Events

TSS was not a parameter identified by DES in the EE notice. At the time of the exceedance events (plus one month), TSS concentrations upstream and downstream were at or below the MDGV of 8 mg/L.

Spatial – Upstream and Downstream

Both upstream and downstream sampling locations experience elevated TSS events (86 mg/L and 80 mg/L upstream, and 147 mg/L and 98 mg/L downstream).

The box and whisker plot identifies that downstream concentrations (average of 12.2 mg/L) are elevated when compared to upstream (average of 6.7 mg/L)

Seasonal

Appendix D 1 indicates that elevated TSS is more common during the wet season.

Effect of Atherton STP

As identified previously, the upstream and downstream catchments of Priors and Mazlin Creeks are impacted by agricultural use with evidence of erosive soils. While the average upstream concentration of TSS is below the guideline value (8 mg/L), there are a number of exceedences that occur throughout the year.

The results indicate that the discharge of effluent likely contributes to a localised increase in TSS due to physical flow of the discharge as the long term 80th percentile of effluent is 6.4 mg/L, compared to the 80th percentile for Priors Cr DP or 37.4 mg/L. The sampling of the Priors Creek discharge point is a new practice, having only been sampled since November 2018, similarly with Mazlin Cr DS1. Further data would be of benefit in determining the actual impact of the discharge on Priors and Mazlin Creek and the associated mixing zone of influence.

7.1.5 Faecal Coliform Counts

Faecal coliform results are summarised as follows:

- Upstream counts:
  - Mazlin Creek faecal coliform counts ranged from 60 CFU/100mL (24/09/2018) to 3,400 CFU/100mL (28/08/2018) and an average of 1,503 CFU/100mL
  - Priors Creek faecal coliform counts ranged from 190 CFU/100mL (13/11/2018) to 16,000 CFU/100mL (14/02/2017) and an average of 2,283 CFU/100mL.
- Downstream:
  - Mazlin Creek (DS1) faecal coliform counts ranged from 6 CFU/100mL (17/10/2018) to 2,500 CFU/100mL (15/12/2018) and an average of 835 CFU/100mL
  - Maziln Creek (DS2) faecal coliform counts ranged from 34 CFU/100mL (17/10/2018) to 20,000 CFU/100mL (14/02/2017) and an average of 2,176 CFU/100mL
  - Priors Creek (DP) faecal coliform counts ranged from 8 CFU/100mL (18/12/2017) to >2,400 CFU/100mL (19/02/2019) and an average of 1,807 CFU/100mL.

Note that Mazlin Cr DS1 and Priors Cr DP both have seven sampling events only.

Figure 16 displays a box and whisker plot of the faecal coliform counts. The results indicate outliers at four sites. A time series plot of the faecal coliform counts is available in Appendix D 2.

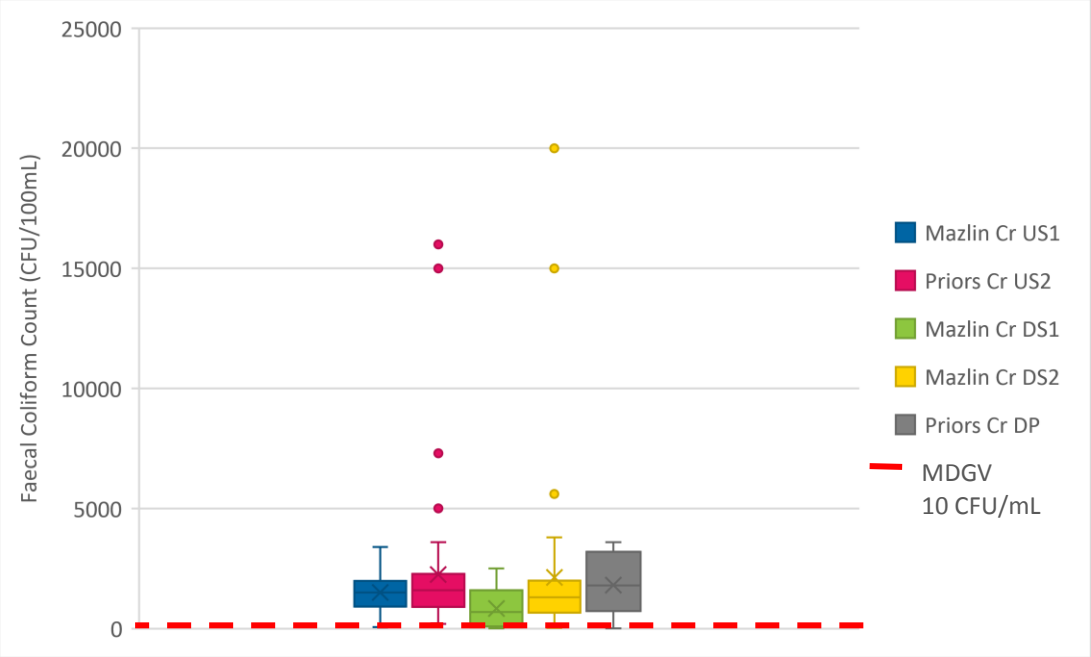


Figure 16: Faecal Coliform Counts – Box and Whisker Plot

Exceedance Events

Faecal coliforms was not a parameter identified by DES in the EE notice. At the time of the exceedance events (plus one month), Faecal coliform counts upstream and downstream were at or below average Faecal coliform counts (approximately 2,000 CFU/100mL)

Spatial – Upstream and Downstream

Both upstream and downstream sampling locations experience elevated faecal coliform events (3,400 CFU/100mL and 16,000 CFU/100mL upstream, and 20,000 CFU/100mL and 3,600 CFU/100mL downstream).

The box and whisker plot identifies that downstream counts (average of 2,025 CFU/100mL) are slightly elevated when compared to upstream (average of 1,902 CFU/100mL)

Seasonal

Appendix D 2 indicates that there is not a clear correlation between faecal coliform and rainfall, however the outliers (elevated events) are more likely to occur during the wet season.

Effect of Atherton STP

The counts of faecal coliforms are comparable and elevated both upstream and downstream. This is likely due to surrounding land use, cattle with cattle having direct access to the creek, and native fauna use of the area.

The adopted guideline value of 10 CFU/mL is for raw human food crops and 100 CFU/mL would be relevant for stock watering. The upstream and downstream faecal coliform counts are regularly above these values indicating that the guideline may not be appropriate to assess the discharge receiving environmental impact.

7.1.6 Ammonia Nitrogen Concentrations

Ammonia results are summarised as follows:

- Upstream concentrations:

- Mazlin Creek Ammonia ranged from <0.02 mg/L (TRC sampling events) or <0.005 mg/L (GHD sampling events) to 0.130 mg/L (15/12/2018) and an average of 0.021 mg/L
- Priors Creek Ammonia ranged from <0.02 mg/L (TRC sampling events) or <0.005 mg/L (GHD sampling events) to 0.060 mg/L (16/01/2019) and an average of 0.017 mg/L

- Downstream:
  - Mazlin Creek (DS1) Ammonia ranged from 0.019 mg/L (19/02/2019) to 0.70 mg/L (16/01/2019) and an average of 0.050 mg/L
  - Maziln Creek (DS2) Ammonia ranged from <0.02 mg/L (TRC sampling events) or <0.005 mg/L (GHD sampling events) to 1.8 mg/L (01/08/2017) and an average of 0.105 mg/L
    - Refer to Appendix D 3 and D 4, the 1.8 mg/L concentration for Mazlin Cr DS2 (01/08/2017) is considered likely an anomaly, as it is not related to any other exceedances of this magnitude. Where the result is treated as an outlier and discounted from statistics the maximum result is 0.330 mg/L (24/07/2017) and an average of 0.66 mg/L
    - We have discounted this anomaly from further discussion
  - Priors Creek (DP) Ammonia ranged from <0.02 mg/L (9/04/2019) to 0.088 mg/L (21/03/2019) and an average of 0.041 mg/L.

Note that Mazlin Cr DS1 and Priors Cr DP both have seven sampling events only.

Figure 17 displays a box and whisker plot of the Ammonia concentrations. The results indicate outliers at four sites. A time series plot of the Ammonia concentrations is available in Appendix D 3 and D 4.

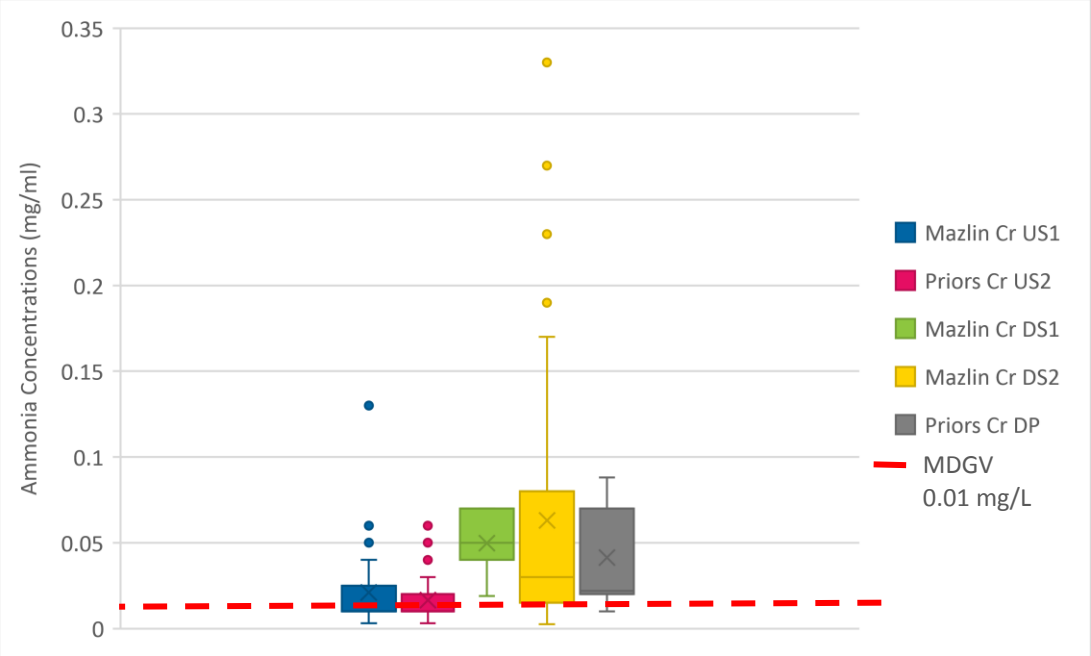


Figure 17: Ammonia Concentration – Box and Whisker Plot

Exceedance Events

Ammonia concentrations were part of the EE notice from DES for:

b. 7 August 2017

c. 5 January 2018

During these periods monitoring was being undertaken by TRC operators. The results recorded for two months following the events is provided in Table 7-4, it is noted that specific monitoring of the receiving environment for the exceedance was not undertaken. The results that are above the LOR are in bold.

The results from the two month period are within the range of other monitoring at the three sites, in particular Mazlin Cr DS2 (which is routinely elevated). Indicating a medium to long term impact from the event is unlikely. Due to the timing of the sampling short term impacts are not able to be determined. At the three month mark there is an elevated ammonia concentration downstream (Mazlin Cr DS2), due to the timing and water flow that occurs it is unlikely to be a result of the specific exceedance event.

Table 7-4: Ammonia Concentrations after the Exceedance Events

Date		Mazlin US1 (mg/L)	Prior US2 (mg/L)	Mazlin DS2 (mg/L)
14/08/2017	3 months after event b	<0.02	<0.02	**0.09**
22/08/2017		<0.02	<0.02	**0.04**
5/09/2017		<0.02	<0.02	<0.02
3/10/2017		**0.04**	**0.020**	**0.08**
31/10/2017		<0.02	<0.02	**0.04**
30/01/2018	3 months after event c	<0.02	0.020	<0.02
27/02/2018		<0.02	<0.02	**0.02**
15/03/2018		**0.02**	**0.020**	**0.15**
27/03/2018		Not analysed	<0.02	**0.04**

Note that the results discounted from this discussion (Mazlin Cr DS2 (01/08/2017)) occurred prior to exceedance event b (7 August).

Spatial – Upstream and Downstream

Both upstream and downstream sampling locations experience elevated ammonia events, with Appendix D 4 indicating elevated results are more common at Mazlin Cr DS2.

The box and whisker plot identifies that downstream concentrations (average of 0.019 mg/L and long term 80th percentile of 0.21 mg/L) elevated when compared to upstream (average of 0.061 mg/L and long term 80th percentile of 0.082 mg/L). Ammonia concentrations are on average three times higher downstream than upstream.

Seasonal

Appendix D indicates that there is not a clear correlation between ammonia concentrations and rainfall, however elevated events may be more common during the dry season.

Effect of Atherton STP

The environmental assessment has identified that upstream ammonia concentrations in both creeks (average of 0.019 mg/L) are elevated above the adopted guideline value of 0.01 mg/L, however the downstream sampling sites present a higher ammonia concentration, on average 0.04 mg/L higher than downstream concentrations.

The elevated ammonia concentrations in the receiving environment indicate that effluent discharge is likely to influence ammonia concentrations within the creeks.

The sampling of the Priors Creek discharge point is a new practice, having only been sampled since November 2018, similarly with Mazlin Cr DS1. Further data would be of benefit in

determining the actual impact of the discharge on Priors and Mazlin Creek and the associated mixing zone of influence.

7.1.7 Total Nitrogen Concentrations

Total nitrogen results are summarised as follows:

- Upstream concentrations:
  - Mazlin Creek total nitrogen ranged from <0.30 mg/L (16/01/2019) to 1.30 mg/L (15/12/2018) and an average of 0.76 mg/L
  - Priors Creek total nitrogen ranged from <0.27 mg/L (22/03/2017) to 1.00 mg/L (27/06/2017) and an average of 0.46 mg/L
- Downstream:
  - Mazlin Creek (DS1) total nitrogen ranged from 0.30 mg/L (16/01/2019) to 1.50 mg/L (15/12/2018) and an average of 0.81 mg/L
  - Maziln Creek (DS2) total nitrogen ranged from 0.05 mg/L (19/04/2017) to 3.6 mg/L (01/08/2017) and an average of 0.82 mg/L
  - Priors Creek (DP) total nitrogen ranged from 0.40 mg/L (22/11/2018) to 2.3 mg/L (21/03/2019) and an average of 0.831 mg/L.

Note that Mazlin Cr DS1 and Priors Cr DP both have seven sampling events only.

Figure 18 displays a box and whisker plot of the total nitrogen concentrations. The results indicate outliers at all sites. A time series plot of the total nitrogen concentrations is available in Appendix D 5.

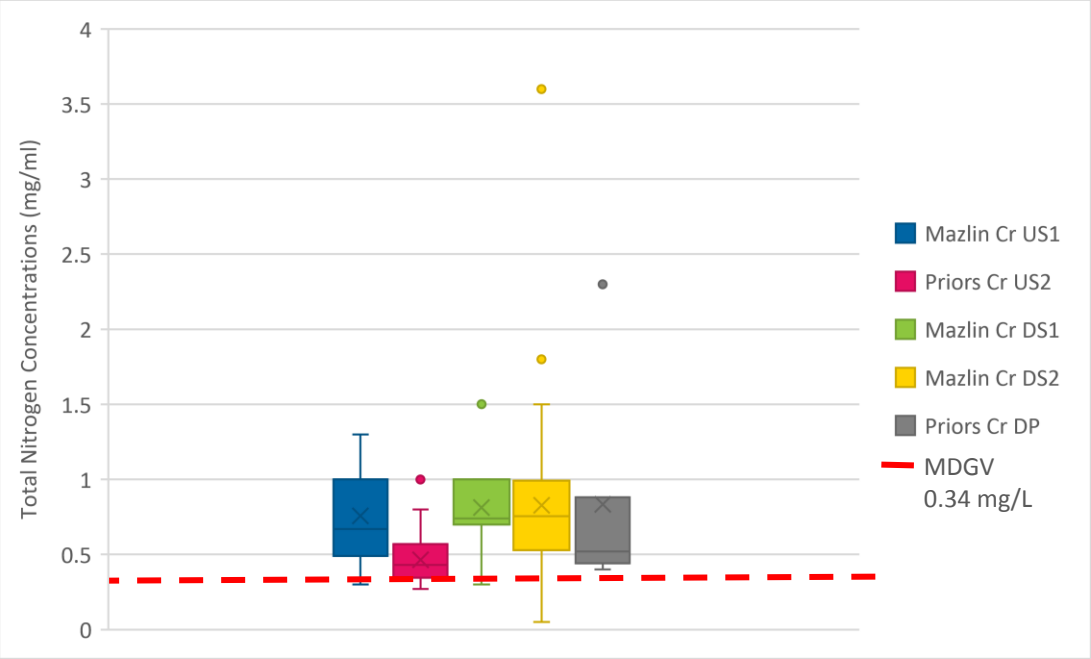


Figure 18: Total Nitrogen Concentration – Box and Whisker Plot

Exceedance Events

Total concentrations were part of the EE notice from DES for:

c. 5 January 2018.

During this period surface water monitoring was being undertaken by TRC operators. The results recorded for three months following the event are provided in Table 7-4, it is noted that specific monitoring of the receiving environment for the exceedance was not undertaken.

The results from the three month period are within the range of other monitoring at the three sites, in particular Mazlin Cr DS2. Indicating a medium to long term impact from the event is unlikely. Due to the timing of the sampling short term impacts are not able to be determined.

Table 7-5: Total Nitrogen Concentrations after the Exceedance Event

Date		Mazlin Cr US1 (mg/L)	Prior Cr US2 (mg/L)	Mazlin Cr DS2 (mg/L)
30/01/2018	2 months after event c	0.65	0.41	0.51
27/02/2018		0.44	0.43	0.45
15/03/2018		0.50	0.51	0.62
27/03/2018		Not analysed	0.46	0.86
Average		*0.53*	*0.45*	*0.61*

Spatial – Upstream and Downstream

Both upstream and downstream sampling locations experience elevated total nitrogen events. Figure 18 indicates that outliers (elevated events) for total nitrogen is less common than with other parameters.

The box and whisker plot identifies that downstream concentrations (average of 0.83 mg/L) are elevated by an average of 0.2 mg/L when compared to upstream (average of 0.0.60 mg/L). Figure 18 shows the difference is attributable to Priors Creek.

Seasonal

Appendix D 5 indicates that there is correlation between total nitrogen concentrations and rainfall, where total nitrogen concentrations are typically elevated during the dry season.

Effect of Atherton STP

The environmental assessment has identified that upstream and downstream total nitrogen concentrations within Mazlin Creek are comparable (averages within 0.05 mg/L) and indicate limited influence from the effluent discharge.

Of interest is Priors Creek where upstream total nitrogen concentrations are on average 0.3 mg/L lower than Mazlin Creek. The position of the effluent discharge point is in proximity to the confluence of Priors and Mazlin, therefore the potential impacts of the total nitrogen are not significant, but there may be a localised impact. Continued sampling of the Priors Creek discharge point will assist in determine if there is an effect on Priors Creek.

With regards to the WQO for total nitrogen, 0.34 mg/L, all sites, including Priors Creek upstream are above this value.

7.1.8 Total Phosphorus Concentrations

Total phosphorus results are summarised as follows:

- Upstream concentrations:
  - Mazlin Creek total phosphorus ranged from <0.02 mg/L (TRC and GHD sampling events) to 0.16 mg/L (16/01/2017) and an average of 0.05 mg/L
  - Priors Creek total phosphorus ranged from <0.02 mg/L (TRC and GHD sampling events) to 0.40 mg/L (28/08/2018 and an average of 0.05 mg/L

- Downstream:
  - Mazlin Creek (DS1) total phosphorus ranged from <0.02 mg/L (19/02/2019 and 20/03/2019) to 0.17 mg/L (15/12/2018) and an average of 0.06 mg/L
  - Maziln Creek (DS2) total phosphorus ranged from <0.02 mg/L (TRC and GHD sampling events) to 0.20 mg/L (24/07/2017) and an average of 0.09 mg/L
  - Priors Creek (DP) total phosphorus ranged from <0.02 mg/L (19/02/2019) to 0.39 mg/L (12/03/2019) and an average of 0.11 mg/L.

Note that Mazlin Cr DS1 and Priors Cr DP both have seven sampling events only.

Figure 19 displays a box and whisker plot of the total phosphorus concentrations. The results indicate outliers at three sites. A time series plot of the total nitrogen concentrations is available in Appendix D 6.

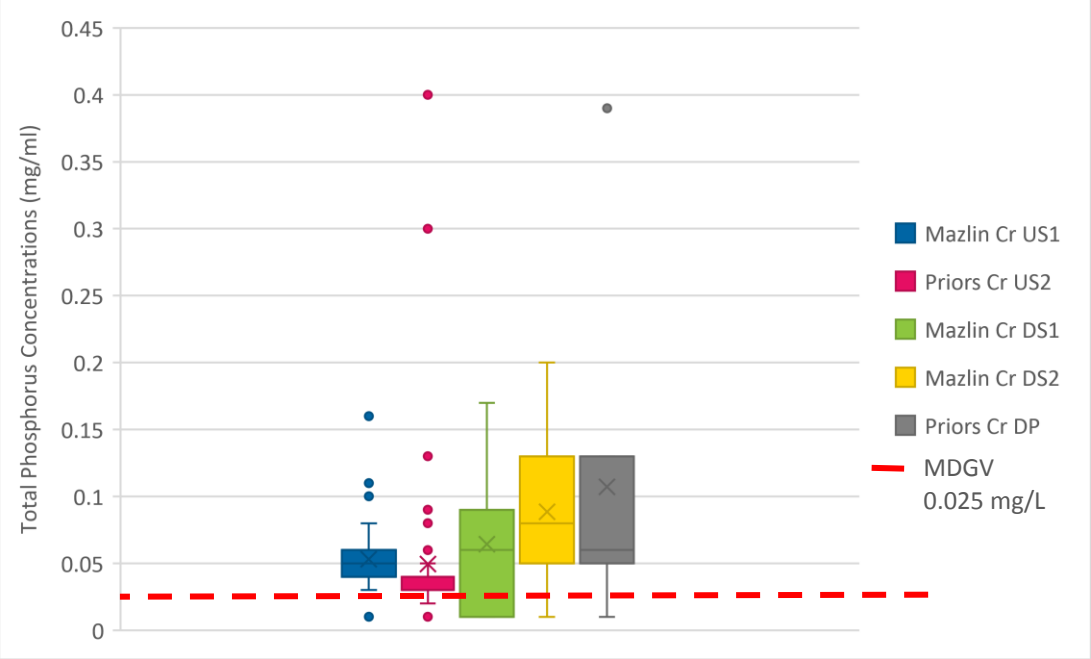


Figure 19: Total Phosphorus Concentration – Box and Whisker Plot

Exceedance Events

Total phosphorus was not a parameter identified by DES in the EE notice.

Spatial – Upstream and Downstream

Both upstream and downstream sampling locations experience elevated total phosphorus events.

The box and whisker plot identifies that downstream concentrations (average of 0.087 mg/L) are elevated by an average of 0.03 mg/L when compared to upstream (average of 0.050 mg/L).

Seasonal

Appendix D 5 indicates that there is no distinct correlation between total phosphorus concentrations and rainfall.

Effect of Atherton STP

The environmental assessment has identified that upstream total phosphorus concentrations in both creeks (average of 0.050 mg/L) are elevated above the adopted guideline value of 0.034 mg/L, however the downstream sampling sites present a higher total phosphorus

concentration, on average 0.03 mg/L higher than upstream concentrations. The plots of the results indicate that total phosphorus is lower at the first downstream site than the second, indicating there may be another influencing factor.

The elevated total phosphorus concentrations in the receiving environment indicate that effluent discharge may influence total phosphorus concentrations within the creeks.

The sampling of the Priors Creek discharge point is a new practice, having only been sampled since November 2018, similarly with Mazlin Cr DS1. Further data would be of benefit in determining the actual impact of the discharge on Priors and Mazlin Creek and the associated mixing zone of influence.

7.2 Sediment Quality Results

Particle size distribution (PSD) data for stream sediments collected is shown in Figure 20. The relative proportion of silt/clay in the sediment between the control/upstream sites ASTP/Mazlin Cr-US1 (22%) and ASTP/Priors Cr-US2 (19%), and the receiving sites ASTP/Mazlin Cr-DS1 (20%) and ASTP/Mazlin Cr-DS2 (10%). This data indicates that the STP appears to have minimal influence on the receiving environments sediment characteristics.

Stream sediment quality data show chromium and nickel exceedances of the ANZECC 2000 ISQG-Low were observed in both the control and receiving environments. The largest exceedance for these parameters were observed within the -63 µm fraction.

The concentrations at the receiving sites were comparable to those at control sites, indicating that the STP release was not a contributing factor. The ANZECC 2000 ISQG-High guidelines were not exceeded at the Atherton EIMP monitoring sites.

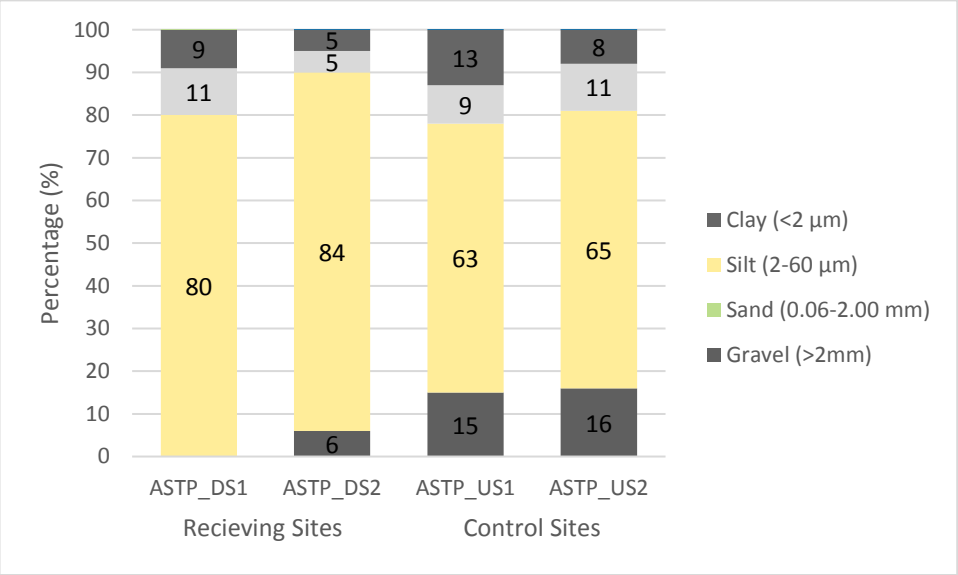


Figure 20: Particle size distribution of stream sediments at Atherton STP

7.3 Aquatic Communities Results

7.3.1 June 2017 to June 2018 (NRA)

Historical sampling of macroinvertebrate assemblages by NRA (2018) illustrate the following key observations:

- Mean abundance is comparable between receiving and control sites
- The mean SIGNAL2 score for the receiving site ASTP-DS1 (Mazlin Creek) is slightly lower compared to control sites. PET taxa richness is comparable between control and receiving sites
- The relative abundance of pollution sensitive and pollution tolerant taxa at receiving sites is comparable with control sites

Overall, NRA (2018) found that aquatic macroinvertebrate assemblages at the Atherton sites are not indicative of significant impacts and that habitat variability between control and receiving sites may play a larger role in the influence of macroinvertebrate assemblages than water quality.

7.3.2 September 2018 to Current (GHD)

Late dry season aquatic sampling in 2018 occurred prior to any major rainfall event marking the commencement of the wet season in 2018/2019. Base flow conditions had been observed in the lead up to the sampling event.

Late wet season aquatic sampling occurred after the peak of major rainfall events, however substantial rainfall occurred in the fortnight prior to sampling. Prior Creek control and receiving sites where sampled late March, however due to a significant flow event that evening, Mazlin Creek control and receiving sites where postponed until early April when river heights had receded. A visual difference in water quality was observed during late wet season sampling with an increase in turbidity and a change in the water colour from relatively clear to a grey/brown colour. Sediment shifts and deposition were also observed at both control sites and scour occurring at ASTP-DS2 (Mazlin Creek).

Riparian and Aquatic Habitat

The key aquatic habitat characteristics identified at each site are outlined in Table 7-6. There are key habitat attributes that differ between control and between receiving sites with shallower, narrower channels with flowing sections exhibited at upstream sites and deeper, wider pools at downstream sites. The two sites upstream of the discharge (ASTP-US1 (Mazlin Creek) and ASTP-US2 (Priors Creek)) are similar in regards to the amounts of large woody debris, overhanging vegetation and algae observed. The substrate at ASTP-US1 (Mazlin Creek) was generally coarser with some boulder and cobble observed while the substrate at ASTP-US2 (Priors Creek) contains a greater proportion of sand.

There are also some differences in habitat between the two receiving sites, with bedrock and cobble observed at ASTP-DS2 (Mazlin Creek) compared to the finer sediments at ASTP-DP (Priors Creek). As ASTP-US2 and ASTP-DP are on Priors Creek while ASTP-US1 and ASTP-DS2 are on Mazlin Creek, some differences in habitat are expected between sites.

Table 7-6: Atherton STP - key aquatic habitat attributes observed

Site Code	ASTP-US1 (Mazlin Cr US1)			ASTP-US2 (Priors Cr US2)			ASTP-DP (Prior Creek DP)			ASTP-DS2 (Mazlin DS2)		
Habitat sampled, replicate	Edge 1	Edge 2	Edge 3	Edge 1	Edge 2	Edge 3	Edge 1	Edge 2	Edge 3	Edge 1	Edge 2	Edge 3
Stream width: Max (m)	5	5	5	5	6	6	10	10	8	12	12	8
Stream width: Min (m)	2	2	2	2	2	2	7	7	6	8	8	4
Stream width: Mode (m)	3	3	3	3.5	4	4	8	8	7	10	10	6
Adjacent landuse	Industrial estate, pasture			STP, pasture, main road			STP, rural residential, agriculture			Rural residential, estate, pasture		
% Bedrock	0	0	0	0	0	0	0	0	0	50	25	60
% Boulder (>soccer ball)	0	15	10	0	0	0	0	0	0	0	0	0
% Cobble (tennis ball - soccer ball)	10	15	15	0	0	0	0	0	0	10	15	15
% Pebble (marble - tennis ball)	15	15	15	10	10	10	10	10	10	10	10	10
% Gravel (2 – 4 mm)	20	25	15	15	15	15	15	15	15	10	15	5
% Sand (0.005 – 2 mm)	30	20	25	35	35	35	35	35	35	15	25	5
% Silt/Clay (<0.005 mm)	25	10	20	40	40	40	40	40	40	5	10	5
% Detritus (leaves/twigs)	50	40	50	50	40	50	50	40	50	40	20	30
% Sticks (< 2 cm)	20	10	20	5	5	10	5	5	10	15	5	10
% Branches	20	10	10	10	15	15	10	15	15	0	30	30
% Logs (> 15 cm)	0	20	30	15	30	20	15	30	20	10	15	0
% Algae	20	35	30	20	30	20	20	30	20	40	40	60
% Macrophytes	15	0	0	0	0	0	0	0	0	0	0	0
% Overhanging habitat	60	70	60	40	50	60	40	50	60	30	25	40
% Blanketing silt	60	60	60	50	50	50	80	80	80	50	50	50
% Shading	30	40	50	50	40	80	70	80	70	30	30	40

Macroinvertebrate Monitoring Results

Atherton STP is located within the Barron River Basin, for which no macroinvertebrate objectives have been determined. Given the differences in habitat between Mazlin and Priors Creeks, it is best to assess the macroinvertebrate metrics separately for each creek system.

Metrics calculated for samples collected in the late wet 2019 season have been compared with results from GHD's late dry 2018 survey, and NRA results from 2017. Table 7-7 displays the dates and types of sampling conducted during this period. For samples collected by GHD, a mean metric was calculated for each site from the replicate samples collected during each season. However, samples collected and preserved as bulk samples in 2019 were only used in the calculation of abundance while other metrics (e.g. taxa richness) were calculated from live-picked samples only. Raw data were not available for samples collected by NRA in 2017 and, consequently mean metrics have been estimated from graphs displayed NRA (2018).

Table 7-7: Macroinvertebrate sampling 2017-2019

Samples	ASTP-US1 (Mazlin Creek)	ASTP-US2 (Priors Creek)	ASTP-DP (Priors Creek)	ASTP-DS1 (Mazlin Creek)	ASTP-DS2 (Mazlin Creek)
2019	2 live-pick, 1 bulk 11/4/2019	2 live-pick, 1 bulk 28/3/2019	2 live-pick, 1 bulk 28/3/2019	Not sampled. Replaced with ASTP-DP.	2 live-pick, 1 bulk 11/4/2019
2018	3 live-pick 17/10/18, 3 live-pick 30/10/18	3 live-pick 17/10/18, 3 live-pick 29/10/18	3 live-pick 29/11/18		3 live-pick 17/10/18, 3 live-pick 30/10/18
2017	3 live-pick samples by NRA December 2017	3 live-pick samples by NRA December 2017	Not sampled	3 live-pick samples by NRA December 2017	3 live-pick samples by NRA December 2017

Mean taxa richness in late wet 2019 was similar between Priors Creek sites ASTP-US2 (mean richness = 14.5) and ASTP-DP (mean richness = 13) but considerably lower at Mazlin Creek receiving site ASTP-DS2 (mean richness = 7.5) when compared to control site ASTP-US1 (mean richness = 12). In 2017, mean richness was higher at sites downstream of the Atherton STP discharge while in late dry 2018, mean richness was similar between sites, with no observable difference between control and receiving sites (Figure 21). In late wet 2019, mean taxa richness was lower than in late dry 2018, probably due to the scouring influence of wet season flows.

The reduced mean richness observed at ASTP-DS2 may indicate an impact of the STP discharge or differences in habitat. As was noted in section 7.3, scour was observed at ASTP-DS2 in late wet 2019 sampling which is attributed to the high flows observed in March 2019. Further, habitat was improved at upstream sites on both Mazlin and Priors Creeks with variable flow, depths and substrate observed.

Mean PET richness in 2019 was highest at ASTP-US2, while in 2018, mean PET richness results were similarly high at ASTP-US1, ASTP-US2 and ASTP-DP (Figure 22). Although mean PET richness at ASTP-DP in 2019 was lower than at ASTP-US2, the error bars indicate that the mean PET richness at ASTP-DP was within the range observed at ASTP-US2, across the two replicates. Mean PET richness results in both 2019 and 2018 were lowest at ASTP-DS2 and have decreased over time since 2017, when the highest mean PET richness result was observed at ASTP-DS2. Conversely, mean PET richness at ASTP-US1 and ASTP-US2 was higher in 2018 and 2019 compared to in 2017.

The declining pattern in average PET richness at ASTP-DS2 (Figure 22) is suggestive of a decline in macroinvertebrate health between 2017 and 2019. However, in 2019, higher PET richness was observed at ASTP-DP, closer to the Atherton STP discharge point, which suggests that the poor health of the macroinvertebrate community at ASTP-DS2 is likely due to differences in habitat (as discussed previously), rather than water quality impacts from the Atherton STP discharge.

SIGNAL-2 scores at all sites were highest in 2019 compared to results of previous sampling events, although the differences were only slight in some cases. In 2019, the highest SIGNAL-2 score was observed at ASTP-US2, however, SIGNAL-2 scores were between 4.00 and 5.00 at all sites. In 2018 and 2017, SIGNAL-2 was highest at receiving sites ASTP-DP and ASTP-DS2, respectively.

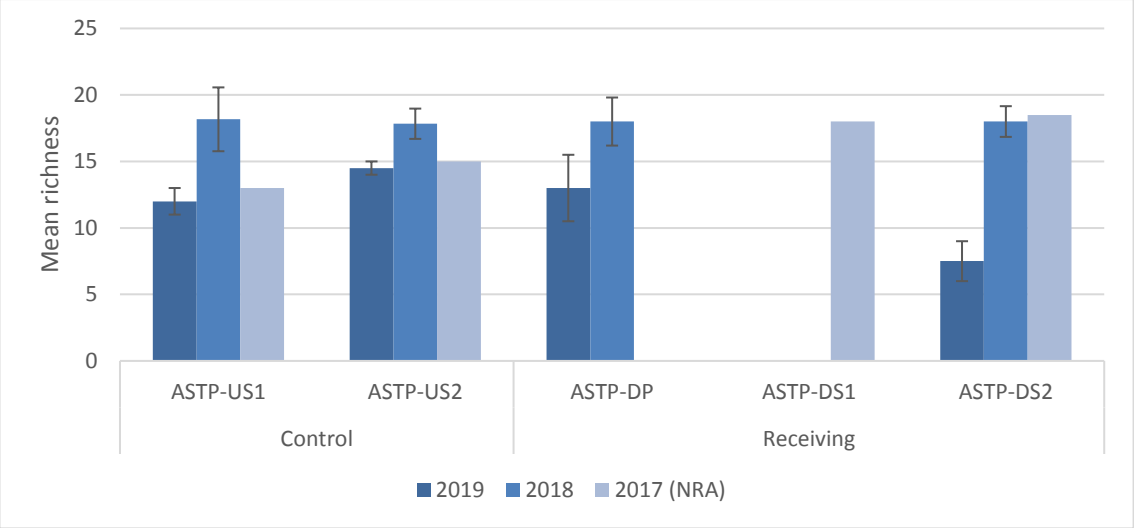


Figure 21: Mean richness in Atherton STP samples, 2017-2018

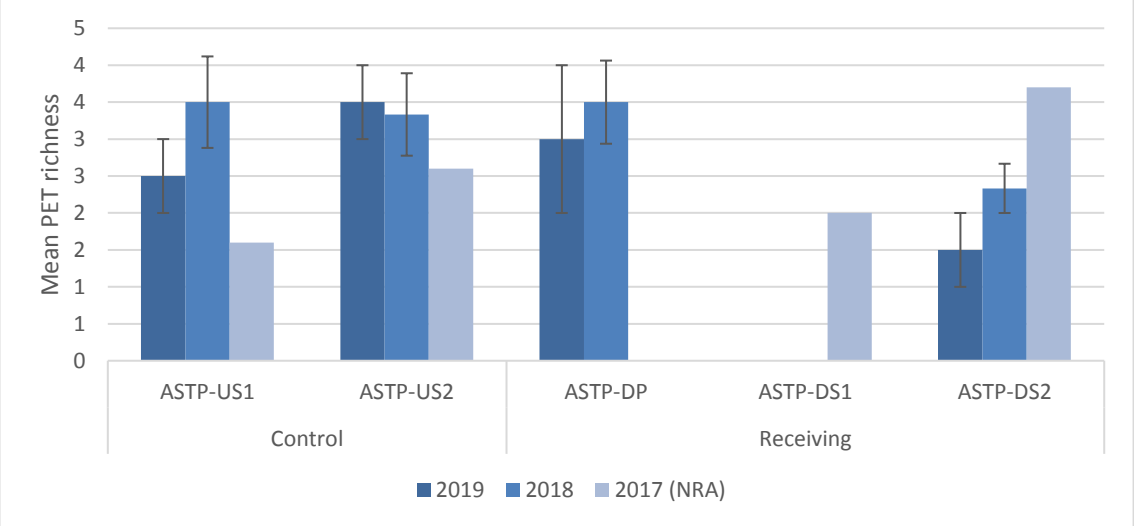


Figure 22: Mean PET richness in Atherton STP samples, 2017-2018

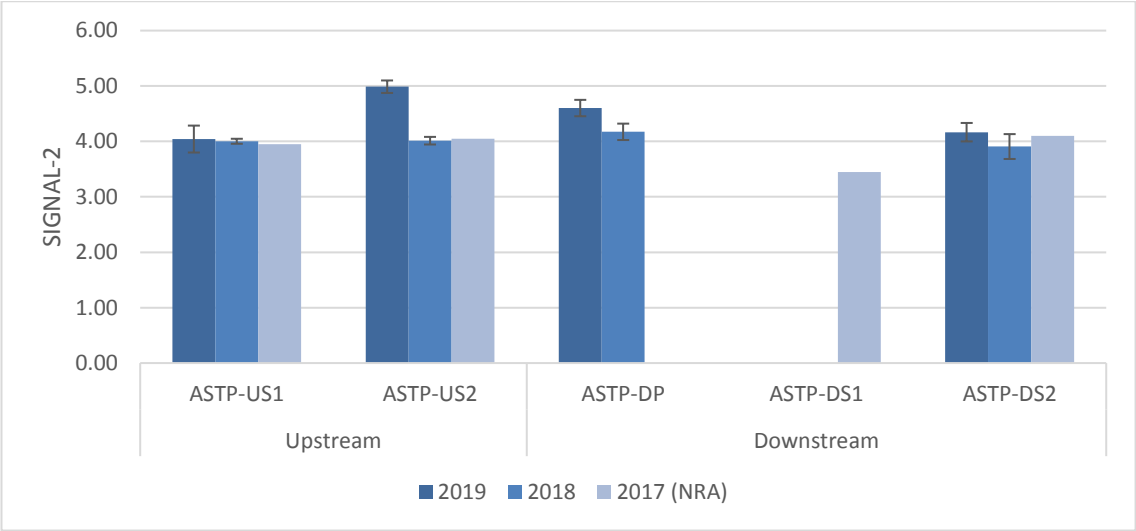


Figure 23: SIGNAL-2 scores in Atherton STP samples

The mean proportion of sensitive taxa has been highest at Priors Creek sites ASTP-US2 and ASTP-DP throughout the monitoring period (Figure 24). The proportion of sensitive taxa at these two sites was highest in 2019 compared with previous sampling events, while no sensitive taxa were collected in any replicate sample at either Mazlin Creek site (ASTP-US1 or ASTP-DS2) in 2019.

In 2019, a larger proportion of tolerant taxa were collected from ASTP-DP compared to ASTP-US2 and at ASTP-DS2 compared to ASTP-US1 (Figure 25). The proportion of tolerant taxa at control sites has reduced over time while the proportion of tolerant taxa at receiving sites has been relatively consistent. The greater consistency downstream of the Atherton STP discharge point is likely due to the consistency of water availability and quality provided by the permanent discharge. The control sites would experience more variable water levels, flow velocity and water quality in accordance with environmental conditions.

Relative abundance, that is, the estimated (based on the 10% sub-sort) total number of individuals collected in the bulk samples in 2019, is displayed in Figure 26:. Abundance results were highest at ASTP-DP, while results at all other sites were similar, and were approximately one-third of the abundance recorded at ASTP-DP. This higher abundance is largely comprised of a greater abundance of Diptera Chironominae which often become prolific in high nutrient environments, such as those observed downstream of STPs.

The community composition (number of individuals in each of the major orders) was similar between ASTP-US1, ASTP-US2 and ASTP-DP with the greatest difference observed at ASTP-DS2 (Figure 27). At ASTP-DS2 there was a higher proportion of crustacea and a smaller proportion of diptera compared to other sites. Hydrazoa were only collected from Priors Creek sites, with a higher proportion observed at ASTP-DP.

Overall, the results indicate that the macoinvertebrate community at Priors Creek site ASTP-US2 was in the best condition, particularly in 2019, with the highest values of most metrics observed at this site. In the late wet 2019 survey, relative abundance was higher at ASTP-DP and mean taxa richness, PET richness, SIGNAL-2 and the proportion of sensitive taxa was lower compared to ASTP-US2. These results suggest a mild influence of the discharge from Atherton STP on the macroinvertebrate community of Priors Creek, immediately downstream of the discharge point. However, the poor macroinvertebrate health (lowest richness, PET richness, SIGNAL-2 score and proportion of sensitive taxa at all sites) observed at Mazlin Creek site ASTP-DS2 is not attributed to the Atherton STP. The poor background water quality in Mazlin Creek, homogenous habitat and scouring effects of the early 2019 high flows are likely the major cause of the poor macroinvertebrate community condition at ASTP-DS2.

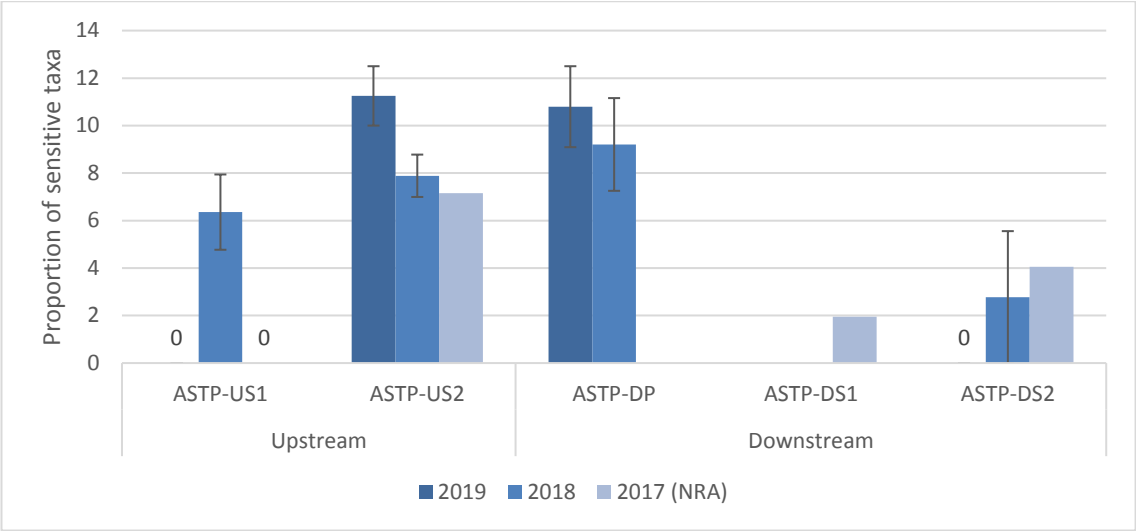


Figure 24: Proportion of sensitive taxa in Atherton STP samples

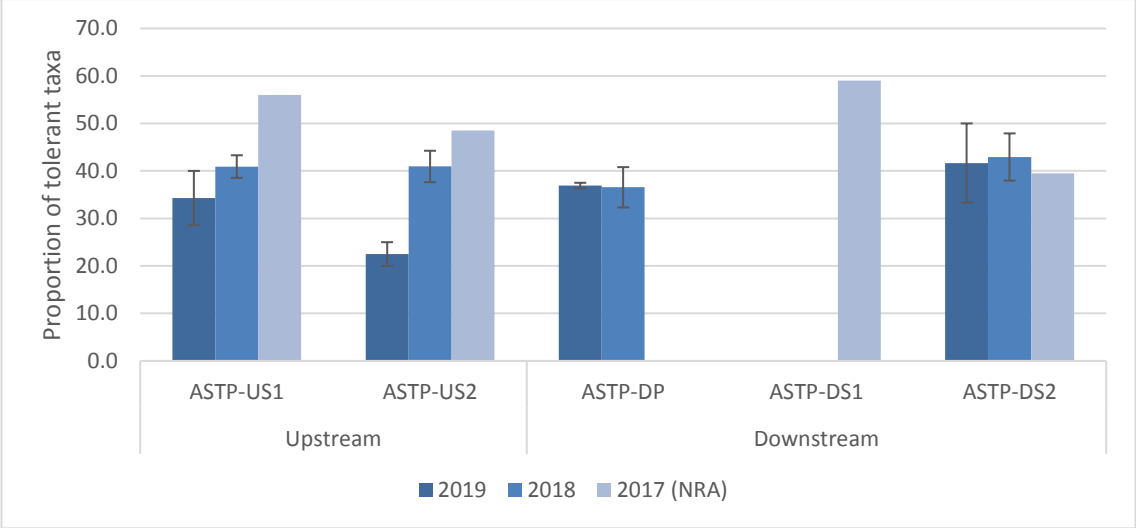


Figure 25: Proportion of tolerant taxa in Atherton STP samples

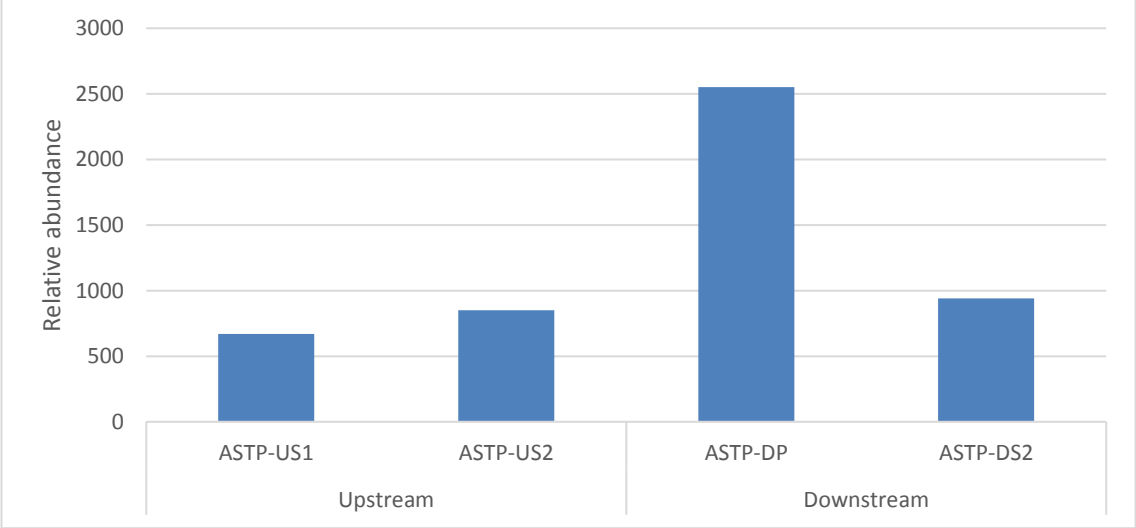


Figure 26: Relative abundance in Atherton STP samples in 2019

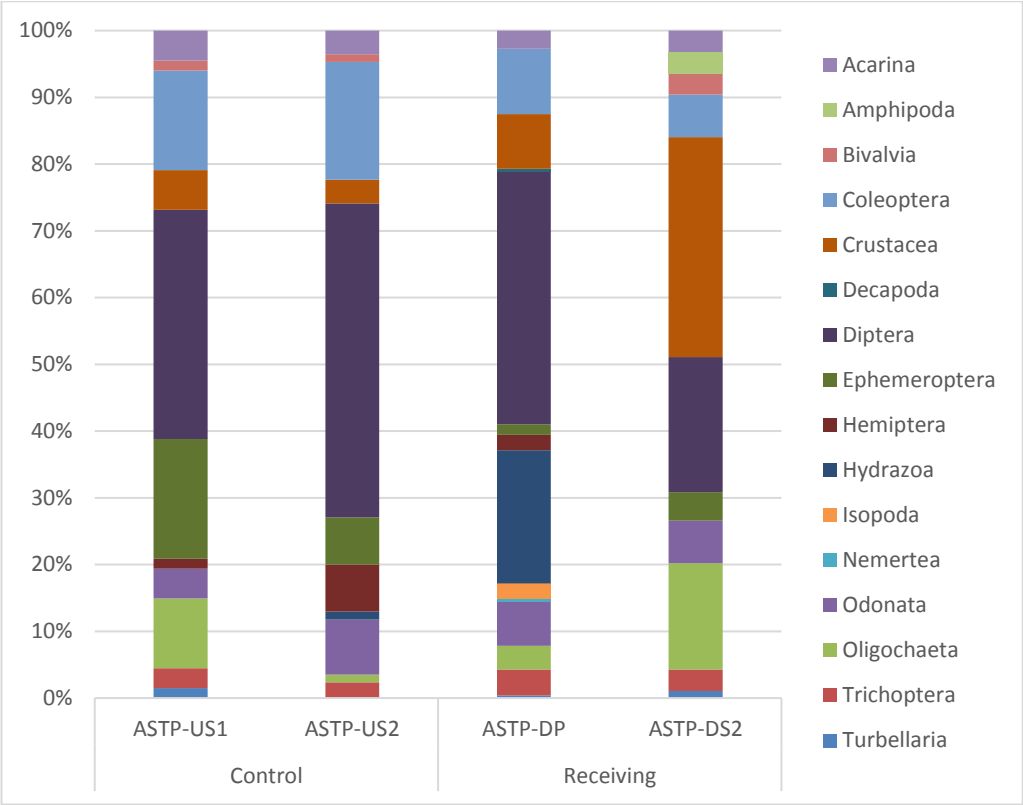


Figure 27: Community composition in Atherton STP samples in 2019

8. Environmental Harm – Discussion

8.1 Overview

STP's are considered to be a significant point source for nutrients transported to the Great Barrier Reef (GBR) although STP sources contribute only a small fraction of the total nutrient budget (Hateley, 2014). Past studies of the upper Barron River Catchment (Cogle *et al.* 2000) have pointed towards the Atherton STP as a 'hot spot' with high concentrations of nutrients attributed to the point source discharge, with acknowledgement by the former Atherton Shire Council (ASC) (1996) that the STP did not regularly meet licence requirements. Since this time, a number of improvements have been made to the facility to improve operational efficiency including the construction of the irrigation dam for use as a balancing storage where effluent can be reused for irrigation, this has also allowed TRC to reduce substantially the amount of discharge occurring during the dry season when risks to local environmental values is the highest.

Over recent years the Atherton STP has been largely compliant with its release quality characteristic limits outlined under WT3-5 of the EA (refer to the Planning Report for a discussion). The summary illustrates maximum values have exceeded limits for BOD5, free chlorine, ammonia, total nitrogen, total phosphorous on occasion. Faecal coliforms have also exceeded both the median and 80th percentile limits. These exceedences tend to be of short term duration and random frequency. The larger values of Faecal coliform recorded also appear to attributed to large rainfall events with more frequent exceedance occurring during the wet season (Dec – April).

8.2 Exceedance Events

An assessment of the available receiving environment data (sourced from TRC operators) indicates that there was unlikely to be a significant impact from the three exceedences reported by DES. This is because the water quality at Mazlin Cr DS2 was within the typical range after approximately one month (results immediately following the events were not available). At the time of the events the discharge point and the closer downstream location where not part of the monitoring program, therefore localised impacts are unable to be quantified.

Given the extent of information available from the exceedance event time, retrospective dilution assessments were not possible due to lack of definitive information.

8.3 Impact of the Atherton STP Discharge on the Receiving Waters

8.3.1 Water Quality Objectives

Flow and water quality appears to be highly variable with water quality declining after significant rain events with high creek flows and higher wet weather discharges from Atherton STP. The existing data set for assessing background levels is limited and variable, however indicative water quality can be ascertained to understand key issues and stressors impacting the local environmental values.

The following summarises key results from the surface water sampling and their applicability to an assessment of harm on the receiving environment:

- BOD is regularly below the LOR upstream and downstream.
- Free chlorine concentrations where comparable at both upstream and downstream sites indicating the discharge is unlikely affecting Mazlin Creek.

- Total suspended solid concentrations downstream concentrations (average of 12.2 mg/L) are elevated when compared to upstream (average of 6.7 mg/L), and both downstream and upstream sites experience periods of elevation. The adopted guideline value is 8 mg/L.
- Total suspended solid concentrations where highest at the discharge point / mixing zone (average of 25.43 mg/L) compared to the adopted guideline of 8 mg/L. The result indicates that the discharge is influencing the receiving water quality at the discharge point with results appearing to fall towards upstream concentrations by Mazlin Cr DS2.
- Faecal coliform downstream counts (average of 2,025 CFU/100mL) are only slightly elevated when compared to upstream (average of 1,902 CFU/100mL). Both downstream and upstream are above the adopted guideline value of 10 CFU/mL (where the guideline value is for raw human food crops).
- Ammonia downstream concentrations (average of 0.019 mg/L) are elevated when compared to upstream (average of 0.061 mg/L). Ammonia concentrations are on average three times higher downstream than upstream. Both downstream and upstream concentration are higher than the adopted guideline value of 0.01 mg/L. The elevated ammonia concentrations in the receiving environment indicate that effluent discharge is likely to influence ammonia concentrations within the creeks.
- Total nitrogen concentrations are above the adopted guideline value of 0.34 mg/L both upstream and downstream. Within Mazlin Creek upstream and downstream concentrations are comparable, however Priors Creek upstream concentrations are on average 0.2 mg/L lower than Mazlin Creek, indicating there may be localised impact from the discharge upon Priors Creek.
- Total phosphorus downstream concentrations (average of 0.087 mg/L) are elevated by an average of 0.03 mg/L when compared to upstream (average of 0.050 mg/L). Both downstream and upstream are above the adopted guideline value of 0.025 mg/L. The elevated total phosphorus concentrations in the receiving environment indicate that effluent discharge may influence total phosphorus concentrations within the creeks.

In the EIMP Annual Report (NRA, 2018) an assessment of potential influences was undertaken. Landuse mapping by Reef Plan 2015 illustrate intensive agriculture and urban influences which may contribute to the findings. Elevated ammonia sources may be attributed to the application of nitrogen based fertilisers, as they can increase nutrient levels. Faecal coliforms may be human or animal sourced, noting cattle have been observed to have direct access to Mazlin Creek and there are several ponds upstream on Priors Creek with well-established water fowl populations that are popular with tourists and locals for feeding and bird watching. These findings are also applicable for this current assessment.

Diffuse sources of pollution within the catchments are likely to be limiting the ability of water quality objectives to be achieved for the Mazlin Creek catchment at background levels prior to discharge of the Atherton STP.

Upon commissioning for this report a review was undertaken to determine is dilution modelling was able to be undertaken. It was determined that due to the limited stream flow data (refer to Section 2.4), actual effluent discharge flow rates (refer to Section 2.3.1) and data at the discharge point / likely mixing zone dilution modelling was not practical. If undertaken it is considered that the model result would not provide an adequate assessment of the situation.

The very preliminary data from Priors Cr DP outline a mild influence of the STP on Priors Creek prior to the mixing with Mazlin creek and represents primary mixing zone of influence however water quality appears to progressively fall back to upstream levels further downstream at Mazlin Cr DS2.

From assessment of the data available to date and presented in this report, the parameters that are of concern to the receiving environment, i.e. elevated concentrations downstream, are:

- Total suspended solids
- Ammonia
- Total phosphorus.

Total suspended solids have been identified as a potential parameter of concern at the discharge point and within the mixing zone. The discharge is into a semi-open/pooled area of Priors Creek (refer to Table 6-2) which is likely to influence total suspended solids. The long term 80th percentile of effluent total suspended solids is 6.4 mg/L, below the adopted guideline value of 8 mg/L, and below the Priors Cr DP 80th percentile concentration of 37.4 mg/L. This indicates that the location or the method of discharge (i.e. flow velocity) is likely to influence total suspended solids in Priors Creek. As the monitoring at this location has only been undertaken since November 2018 it is considered that further assessment of water quality will assist in determining any affects.

As identified by DES, high ammonia (nitrogen) concentrations in freshwater is known to be toxic and can lead to nutrient enrichment of water; this can subsequently lead to changes in biotic community structure (AWQG, 2018). The maximum concentrations in both upstream/control and downstream/receiving sites indicates that ammonia nitrogen concentrations within Mazlin Creek can be up to an order of magnitude above the adopted guideline value of 0.01 mg/L. The results available to date indicate that ammonia concentrations are on average three times higher downstream than upstream, however an increase in ammonia concentration between Mazlin Cr DS1 (ASTP-DS1) and Mazlin Cr DS2 (ASTP-DS2) indicates other diffuse sources are likely in the catchment. The elevated ammonia concentrations in the receiving environment indicate that effluent discharge is likely to influence ammonia concentrations within the creeks. It is considered that continual monitoring at Priors Cr DP (ASTP-DP) and Mazlin Cr DS1 (ASTP-D1) will assist in developing a data set to determine the level of impact the discharge has with regards to ammonia nitrogen.

Total phosphorous concentrations within the creek are variable with long term 20th percentiles, averages and long-term 80th percentiles above the adopted guideline value of 0.025 mg/L. This is likely attributable to the agricultural land uses in the catchments. However, of relevant to this report is downstream concentrations being higher than upstream, on average 0.03 mg/L higher than upstream/control. The trends with total phosphorus are comparable with ammonia, in that Mazlin Cr DS1 concentrations are lower than Mazlin Cr DS2, however the limited dataset limits the reliability of the review (i.e. that there are diffuse sources along Mazlin Creek). The elevated total phosphorus concentrations in the receiving environment indicate that effluent discharge may influence total phosphorus concentrations within the creeks.

8.3.2 Sediment

Stream sediment exceeded guideline values for chromium and nickel at both control and receiving sites. The stream sediment particle size distribution consisted of higher proportions of silt at control sites, indicating the STP appears to have minimal influencing on stream sediments in the receiving environment.

8.3.3 Aquatic Communities

The macroinvertebrate community at the sampled sites were impaired to some degree, which is to be expected given that all sites were moderately to heavily disturbed by historic clearing, vegetation modification, urbanisation and/or agricultural activity. There is a potential mild influence of the Atherton STP discharge on the macroinvertebrate community of Priors Creek

immediately downstream of the discharge point, however any impact is spatially limited with improved macroinvertebrate community condition in Mazlin Creek, approximately 700 metres downstream from the discharge point.

8.4 Management Options to Meet Targets

8.4.1 Release/Discharge Management

There are a number of release quality management options available that TRC could consider that aim to reduce future risks of non-compliances, ensure continual improvements towards best practice management approaches and actions that may create additional benefits to receiving waters. These approaches are proposed within the Planning Report, these include actions such as reviewing irrigation opportunities to reduce discharge requirements, especially during the dry season when flows, and hence dilution, are lower.

8.4.2 EA Amendment

The Planning Report outlines the EA amendments that will be of benefit to the Atherton STP, these include short-medium term amendments (such as long term 80%ile compliance, defining short and long term %ile limits and effluent re-use), and long term licence (such as a mass based licence) that would apply when the Atherton STP is upgraded.

8.4.3 EIMP and Site-Specific Guideline Values

It is clear from the surface water quality analysed that there are already elevated background levels of many contaminants sourced from the broader catchment. The existing Licence and the Barron River basin WQO's for moderately disturbed waters are relatively stringent and typical of STPs discharging directly to Great Barrier Reef catchments, and do not appear to factor in the length of the catchment or the impact of Tinaroo Dam.

The EIMP monitoring will be required to be continued as per the EA. It is proposed that continued monitoring of Priors Creek DP (ASTP-DP) and Mazlin Cr DS1 (ASTP-DS1) will build the dataset with regards to localised influences (particularly ammonia and total phosphorus) of the discharge and the mixing/dilution zones. During the sampling for this report and the EIMP (2018/2019) it was determined that some sites where unsafe, therefore revision of monitoring locations may be required. This would be addressed within the appropriate EIMP Annual Reporting.

In addition to meeting EA requirements, continual monitoring will also enhance the understanding of the two catchments. As noted within this assessment a number of the parameters of concern are above the adopted guideline values within the upstream or control sites. Where the guidelines have been sourced as 'moderately disturbed waters just the one water type is suitable, all developed freshwaters. This water type applies to the full catchment, therefore it may not be appropriate for agricultural catchments (and in consideration of Tinaroo Dam). There are methods and pathways available to establish SSGV's, however data to date is not suitable for the purpose without making many assumptions. Building the dataset with reliable data will assist in developing SSGV's in the future.

8.4.4 Stream Flow Monitoring

As identified the closest streamflow gauge is approximately 7.8 km downstream from the Atherton STP, with no upstream gauges available. Stream flow data is useful for assessing impacts of discharges as dilution modelling can be undertaken to quantify the impacts. This would be of key relevance to the long term Atherton STP significant upgrade. Undertaking modelling of discharges in the planning stage will assist with amending the EA and

understanding the catchments. In the short to medium term the stream flow data may also be of relevance as a risk management approach (e.g. assessing impact, or prioritising releases in higher flows).

8.4.5 Point Source Water Quality Offsets

The data presented in this report identify that there are diffuse sources of pollutant/nutrients to the catchments (such as agricultural use and gully erosion). Therefore, a holistic approach to catchment environmental values improvement, including total nutrient loads delivered to the Great Barrier Reef, is of benefit. This includes the point source nutrients from the STP, but also other sources, which are a higher impact upon environmental values (as evidences by upstream concentrations. It is recognised that any actions must be cost effective, practical, flexible and acceptable to the TRC community.

One such option is the consideration of Point Source Water Quality Offsets that allows for the implementation of catchment-based offset solutions allowing Council to meet their point source water emission discharge requirements while achieving improved water quality in the receiving environment. The Point Source Water Quality Offsets Policy (by DES) is currently in draft format and yet to be implemented (an existing Policy exists, however it is understood that the use is limited). It is considered that an approach under the Offsets Policy could be appropriate in the long term (e.g. upon seeking a major EA amendment for the significant Atherton STP upgrade).

Upon examination of catchment values, pressures and observed impacts, it is recommended that TRC consider measures that provide improved outcomes for environmental values in the catchment. Such offsets may include commitment to activities such as riparian restoration, streambank and erosion prevention and stabilisation, and or the establishment of wetlands. In order for the regulator to accept a water quality offset, the offsets proposed must create an additional benefit to receiving waters on top of demonstrating that the STP is already applying contemporary best management in its operations (DES, 2019).

9. Conclusion

The Atherton STP is operated under an EA and under the provisions of the EP Act, DES issued a Notice to conduct or commission an environmental Evaluation (21 June 2018). The investigation presented in this report presents part of the environmental evaluation required under the notice. Specifically the investigation reviewed the extent of environmental harm to Mazlin Creek.

In using data collected by TRC (October 2016 to March 2019), NRA (2017 to 2018 and GHD (September 2018 to current) an assessment of potential environmental harm from effluent discharges form the Atherton STP has been undertaken. It was determined that water quality within the catchments of Priors Creek and Mazlin Creek was highly variable (both upstream and downstream). Specifically the upstream water quality frequently exceeded the adopted receiving environment water quality objectives.

The key parameters of concern with regards to effluent discharges were determined to be:

- Biological oxygen demand
- Free chlorine
- Total suspended solids
- Faecal coliforms
- Ammonia nitrogen
- Total nitrogen
- Total phosphorus.

With regards to environmental harm upon Mazlin Creek Catchment, an assessment of the available data determined the following parameters of potential concern:

- Total suspended solids, there is evidence of localised increases associated with the discharge, however concentrations return to natural levels downstream from the discharge
- Ammonia, the catchments are likely already under stress with regards to ammonia from other land uses (due to the upstream sites being above guideline values). There is evidence from the sampling conducted that the Atherton STP effluent discharges influence ammonia within creeks and downstream catchment. However, it is considered likely that this impact is localised only (due to macroinvertebrate health). Further monitoring and enhancement of the data set will assist in quantifying impacts.
- Total phosphorous, concentrations are elevated downstream from the Atherton STP discharge, this may present an impact from the STP or from other land uses. Similar to ammonia, macroinvertebrate health indicates that the impacts specific to the discharge are likely to be localised. Further monitoring and enhancement of the data set will assist in quantifying impacts.
- Other parameters, including biological oxygen demand, free chlorine, faecal coliforms and total nitrogen were comparable between upstream and downstream sites. This indicated that the creeks are not suffering harm due to the discharge associated with these parameters. Ongoing monitoring and review will be required.

10. References

Brodie J., and Mitchell A. (2006). *Sediments and nutrients in north Queensland tropical streams: changes with agricultural development and pristine condition status*. CRC Reef Research Centre Technical Report No. 62, CRC Reef Research Centre, Townsville, Qld.

Cook, P.G., Herczeg, A.L. and McEwan, K.L. (2001) *Groundwater Recharge and Stream Baseflow: Atherton Tablelands, Queensland*. Technical Report 08/01, CSIRO Land and Water, Canberra.

Hately, L. (2014) *Modelling reductions of pollutant loads due to improved management practices in the Great Barrier Reef catchments*. Wet Tropics NRM Region Technical Report Volume 3, Department of Natural Resource and Mines, Cairns.

Mitchell, A., Brodie, J., Lewis, S., Devlin, M., Bainbridge, Z., Bulsink, D. and Furnas, M. (2006). *Water quality issues in the Barron WQIP area*. ACTFR Report 08/06. Australian Centre for Tropical Freshwater Research, James Cook University, Townsville.

Mitchell A., Reghenzani J., Faithful J., Furnas M., Brodie J. (2009) Relationships between land use and nutrient concentrations in streams draining a 'wet-tropics' catchment in northern Australia. *Marine and Freshwater Research* 60, 1097-1108.

NRA (2017), *Sewage Treatment Plant Environmental Impact Monitoring Program Design Report*, Prepared by NRA Environmental Consultants for Tablelands Regional Council, 11 October 2017

NRA (2018), *Sewage Treatment Plant Environmental Impact Monitoring Program Annual 2017-2018 Report*, Prepared by NRA Environmental Consultants for Tablelands Regional Council, 11 October 2018

Appendices

Appendix A – Environmental Authority

Queensland Government

Department of
Environment and Heritage Protection

To: Tablelands Regional Council
PO Box 573
ATHERTON QLD 4883

Email: info@trc.qld.gov.au

Your reference: EPPR00584813
Our reference: 242450

Amendment of an environmental authority to correct a clerical error

1. Environmental authority details

Environmental authority number EPPR00584813.

Land description: Yungaburra Sewage Treatment Plant – Lot 550 on Plan NR7572 Mulgrave Road, YUNGABURRA QLD 4872, Atherton Sewage Treatment Plant – Lot 1 on Plan RP889324 Grove Street, ATHERTON QLD 4883, Tinaroo Sewage Treatment Plant - Lot 3 on Plan RP836158 Tinaroo Falls Road, TINAROO QLD 4883, Ravenshoe Sewage Treatment – Lot 255 on Plan CWL1731 Aschem Road, RAVENSHOE QLD 4872, Millaa Millaa Sewage Treatment Plant – Lot 601 on Plan CP840989 Main Street, MILLAA MILLAA QLD 4886, Malanda Sewage Treatment Plant - Lot 2 on Plan RP735188, Lot 41 on Plan NR4169 (irrigational area), Lot 11 Plan SP241954 (irrigational area) and Lot 10 Plan SP241954 (Same lot as the Malanda Refuse Tip), Topaz Refuse Tip – Lot 82 on Plan NR808386 (Reserve 2128) Topaz Road, TOPAZ QLD 4885, Millaa Millaa Tip – Lot 510 on Plan NR7893 (Reserve 2064) Theresa Creek Road, MILLAA MILLAA QLD 4886, Malanda Refuse Tip – Lot 10 SP241954 English Road, MALANDA QLD 4885, Yungaburra Refuse Tip – Lot 550 on Plan NR7572 (Reserve 2063) Mulgrave Road, YUNGABURRA QLD 4872, Peeramon Waste Disposal – Lot 56 on Plan NR1118 (Reserve 511) Wharton Street, PEERAMON QLD 4885, Atherton Landfill – Lot 100 SP252409 Herberton Road, CARRINGTON QLD 4883, Alcatraz Landfill – Lot 41 on Plan SP158034 Kennedy Highway, INNOT HOT SPRINGS QLD 4872, Ravenshoe Landfill – Lot 308 on Plan CWL2530 Kennedy Highway, HERBERTON QLD 4872, Herberton Sanitary Depot – Lot 1 on Plan CP818023 Atherton – Herberton Road, HERBERTON QLD 4872, Herberton Landfill – Lot 250 on Plan CWL840900 Syme Road, HERBERTON QLD 4872, Atherton Quarry – Lot 851 NR6413 Carrington Falls Road, CARRINGTON QLD 4883, Allen Deco Pit – Lot 438 on Plan FTY1917 Allen Road, RAVENSHOE QLD 4872, Allen Maintenance Pit – Lot 438 on Plan FTY1917 Allen Road, RAVENSHOE QLD 4872, Running Creek Pit – Lot 623 on Plan SP148822 Kennedy Highway, RAVENSHOE QLD 4872, Penna Pit – Lot 1 on Plan AP17369 Silver Valley Road, SILVER VALLEY QLD 4872, Mobile and Temporary activity - EPPR00584813.

Amanda Gray
Heritage, Utilities and Government Organisations Assessment
Department of Environment and Heritage Protection
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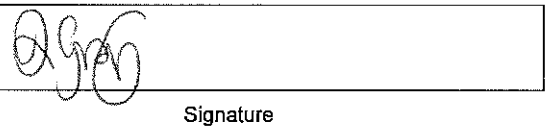
2. Amendment

The administering authority has become aware that there are clerical errors on the environmental authority that require correction.

The amended environmental authority is enclosed with this notice.

Should you have any further enquiries, please contact Amanda Gray on telephone 1300 130 372.

Yours sincerely

	27/9/17
Signature	Date

Amanda Gray
Department of Environment and Heritage Protection
Delegate of the administering authority
Environmental Protection Act 1994

Enclosed

Permit - environmental authority (reference EPPR00584813)

Permit[1]

Environmental Protection Act 1994

EPPR00584813

Environmental authority

This environmental authority is issued by the administering authority under Chapter 5 of the Environmental Protection Act 1994.

Permit[1] number: EPPR00584813

Environmental authority takes effect upon signing by the Delegate

The anniversary date of this environmental authority remains **1 August** each year. An annual return and the payment of the annual fee will be due each year on this day.

Environmental authority holder(s)

Name	Principal address
Tablelands Regional Council	45 Mabel Street ATHERTON QLD 4883

Environmentally relevant activity and location details

Environmentally relevant activities	Locations
ERA 63(1b)(i) Sewage Treatment >100 but <1500EP with treated effluent discharged to an infiltration trench or irrigation scheme	Yungaburra Sewage Treatment Plant – Lot 550 on Plan NR7572 Mulgrave Road, YUNGABURRA QLD 4872
ERA 63(1d) Sewage Treatment >4000 but <10000EP ERA 58 – Regulated Waste Treatment (operating a facility for the receiving and treating regulated waste	Atherton Sewage Treatment Plant – Lot 1 on Plan RP889324 Grove Street, ATHERTON QLD 4883
ERA 63(1b)(ii) Sewage Treatment >100 but <1500EP with treated effluent discharged other than as in 2(b)i	Tinaroo Sewage Treatment Plant - Lot 3 on Plan RP836158 Tinaroo Falls Road, TINAROO QLD 4883
ERA 63(1b)(ii) Sewage Treatment >100 but <1500EP with treated effluent discharged other than as in 2(b)i ERA 63(1d) Sewage Treatment >4000 but <10000EP	Ravenshoe Sewage Treatment – Lot 255 on Plan CWL1731 Aschem Road, RAVENSHOE QLD 4872
ERA 63(1a)(i) Sewage Treatment >21 but <100EP with treated effluent discharged to an infiltration trench or irrigation scheme	Millaa Millaa Sewage Treatment Plant – Lot 601 on Plan CP840989 Main Street, MILLAA MILLAA QLD 4886

[1] Permit includes licences, approvals, permits, authorisations, certificates, sanctions or equivalent/similar as required by legislation

ERA 63(1c) Sewage Treatment >1500 but <4000EP	Malanda Sewage Treatment Plant - Lot 2 on Plan RP735188, Lot 41 on Plan NR4169 (irrigational area), Lot 11 Plan SP241954 (irrigational area) and Lot 10 Plan SP241954 (Same lot as the Malanda Refuse Tip).
ERA 60(2a) Waste Disposal Facility (any combination of general waste and no more than 10% limited regulated waste): >50t but <2000t per year	Topaz Refuse Tip – Lot 82 on Plan NR808386 (Reserve 2128) Topaz Road, TOPAZ QLD 4885
ERA 60(2b) Waste Disposal Facility (any combination of general waste and no more than 10% limited regulated waste): >2000t but <5000t per year	Millaa Millaa Tip – Lot 510 on Plan NR7893 (Reserve 2064) Theresa Creek Road, MILLAA MILLAA QLD 4886
ERA 60(2c) Waste Disposal Facility (any combination of general waste and no more than 10% limited regulated waste): >5000t but <10000t per year	Malanda Refuse Tip – Lot 10 SP241954 English Road, MALANDA QLD 4885
ERA 60(2c) Waste Disposal Facility (any combination of general waste and no more than 10% limited regulated waste): >5000t but <10000t per year	Yungaburra Refuse Tip – Lot 550 on Plan NR7572 (Reserve 2063) Mulgrave Road, YUNGABURRA QLD 4872
ERA 60(1a) Waste Disposal Facility (any combination of regulated waste, general waste and limited regulated waste – and <5t untreated clinical wastes if in a scheduled are): <50000t per year	Peeramon Waste Disposal – Lot 56 on Plan NR1118 (Reserve 511) Wharton Street, PEERAMON QLD 4885
ERA 60(1a) Waste Disposal Facility (any combination of regulated waste, general waste and limited regulated waste – and <5t untreated clinical wastes if in a scheduled are): <50000t per year ERA 60(2c) Waste Disposal Facility (any combination of general waste and no more than 10% limited regulated waste): >5000t but <10000t per year ERA 56 Receiving and Storing Regulated Waste	Atherton Landfill – Lot 100 SP252409 Herberton Road, CARRINGTON QLD 4883
ERA 60(2b) Waste Disposal Facility (any combination of general waste and no more than 10% limited regulated waste): >2000t but <5000t per year	Alcatraz Landfill – Lot 41 on Plan SP158034 Kennedy Highway, INNOT HOT SPRINGS QLD 4872
ERA 60(2a) Waste Disposal Facility (any combination of general waste and no more than 10% limited regulated waste): >50t but <2000t per year	Ravenshoe Landfill – Lot 308 on Plan CWL2530 Kennedy Highway, HERBERTON QLD 4872
ERA 60(1a) Waste Disposal Facility (any combination of regulated waste, general waste and limited regulated waste – and <5t untreated clinical wastes if in a scheduled are): <50000t per year	Herberton Sanitary Depot – Lot 1 on Plan CP818023 Atherton – Herberton Road, HERBERTON QLD 4872
ERA 60(2c) Waste Disposal Facility (any combination of general waste and no more than 10% limited regulated waste): >5000t but <10000t per year	Herberton Landfill – Lot 250 on Plan CWL840900 Syme Road, HERBERTON QLD 4872
ERA 16(2a) Extracting rock or other material: 5000-100000t per year	Atherton Quarry – Lot 851 NR6413 Carrington Falls Road, CARRINGTON QLD 4883
ERA 16(2a) Extracting rock or other material: 5000-100000t per year	Allen Deco Pit – Lot 438 on Plan FTY1917 Allen Road, RAVENSHOE QLD 4872

ERA 16(3a) Screening rock or other material: 5000-100000t per year	
ERA 16(2a) Extracting rock or other material: 5000-100000t per year ERA 16(3a) Screening rock or other material: 5000-100000t per year	Allen Maintenance Pit – Lot 438 on Plan FTY1917 Allen Road, RAVENSHOE QLD 4872
ERA 16(2a) Extracting rock or other material: 5000-100000t per year ERA 16(3a) Screening rock or other material: 5000-100000t per year	Running Creek Pit – Lot 623 on Plan SP148822 Kennedy Highway, RAVENSHOE QLD 4872
ERA 16(2a) Extracting rock or other material: 5000-100000t per year ERA 16(3a) Screening rock or other material: 5000-100000t per year	Penna Pit – Lot 1 on Plan AP17369 Silver Valley Road, SILVER VALLEY QLD 4872
ERA 57(2b) Regulated Waste Transport (other than tyres) in 6 – 35 vehicles	Mobile and Temporary activity

Additional information for applicants

Environmentally relevant activities

The description of any environmentally relevant activity (ERA) for which an environmental authority is issued is a restatement of the ERA as defined by legislation at the time the approval is issued. Where there is any inconsistency between that description of an ERA and the conditions stated by an environmental authority as to the scale, intensity or manner of carrying out an ERA, then the conditions prevail to the extent of the inconsistency.

An environmental authority authorises the carrying out of an ERA and does not authorise any environmental harm unless a condition stated by the authority specifically authorises environmental harm.

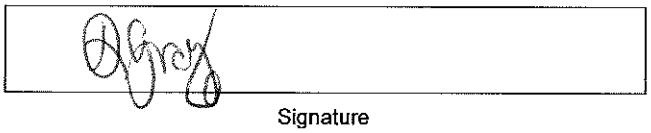
A person carrying out an ERA must also be a registered suitable operator under the *Environmental Protection Act 1994* (EP Act).

Contaminated land

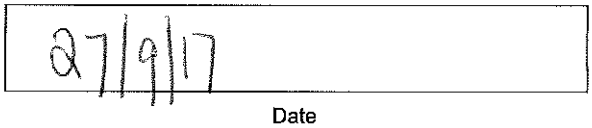
It is a requirement of the EP Act that an owner or occupier of land give written notice to the chief executive if they become aware of the following:

- a notifiable activity (as defined in Schedule 3) that is being, or has been, carried out on the land (notice must be given within 20 business days)
- an event involving a hazardous contaminant on the land, or a change in the condition of the contaminated land, that is causing, or is reasonably likely to cause, serious or material environmental harm (notice must be given within 24 hours).

For further information, including the form for giving written notice, refer to the Queensland Government website http://www.qld.gov.au/ (using the search term 'managing contaminated land').



Signature



Date

Amanda Gray
Department of Environment and Heritage Protection
Delegate of the administering authority
Environmental Protection Act 1994

Enquiries:
Department of Environment and Heritage Protection
GPO Box 2454
BRISBANE QLD 4001
Phone: 1300 130 372
Fax: 07 3330 6037
palm@ehp.qld.gov.au

Obligations under the *Environmental Protection Act 1994*

In addition to the requirements found in the conditions of this environmental authority, the holder must also meet their obligations under the EP Act, and the regulations made under the EP Act. For example, the holder must comply with the following provisions of the Act:

- general environmental duty (section 319)
- duty to notify environmental harm (section 320-320G)
- offence of causing serious or material environmental harm (sections 437-439)
- offence of causing environmental nuisance (section 440)
- offence of depositing prescribed water contaminants in waters and related matters (section 440ZG)
- offence to place contaminant where environmental harm or nuisance may be caused (section 443)

Conditions of environmental authority

Part 1 - General Conditions for all Sites

Environmentally relevant activities	Locations
ERA 63(1b)(i) Sewage Treatment >100 but <1500EP with treated effluent discharged to an infiltration trench or irrigation scheme	Yungaburra Sewage Treatment Plant – Lot 550 on Plan NR7572 Mulgrave Road, YUNGABURRA QLD 4872
ERA 63(1d) Sewage Treatment >4000 but <10000EP ERA 58 – Regulated Waste Treatment (operating a facility for the receiving and treating regulated waste	Atherton Sewage Treatment Plant – Lot 1 on Plan RP889324 Grove Street, ATHERTON QLD 4883
ERA 63(1b)(ii) Sewage Treatment >100 but <1500EP with treated effluent discharged other than as in 2(b)i	Tinaroo Sewage Treatment Plant - Lot 3 on Plan RP836158 Tinaroo Falls Road, TINAROO QLD 4883
ERA 63(1b)(ii) Sewage Treatment >100 but <1500EP with treated effluent discharged other than as in 2(b)i ERA 63(1d) Sewage Treatment >4000 but <10000EP	Ravenshoe Sewage Treatment – Lot 255 on Plan CWL1731 Aschem Road, RAVENSHOE QLD 4872
ERA 63(1a)(i) Sewage Treatment >21 but <100EP with treated effluent discharged to an infiltration trench or irrigation scheme	Millaa Millaa Sewage Treatment Plant – Lot 601 on Plan CP840989 Main Street, MILLAA MILLAA QLD 4886
ERA 63(1c) Sewage Treatment >1500 but <4000EP	Malanda Sewage Treatment Plant - Lot 2 on Plan RP735188, Lot 41 on Plan NR4169 (irrigational area), Lot 11 Plan SP241954 (irrigational area) and Lot 10 Plan SP241954 (Same lot as the Malanda Refuse Tip).
ERA 60(2a) Waste Disposal Facility (any combination of general waste and no more than 10% limited regulated waste): >50t but <2000t per year	Topaz Refuse Tip – Lot 82 on Plan NR808386 (Reserve 2128) Topaz Road, TOPAZ QLD 4885

ERA 60(2b) Waste Disposal Facility (any combination of general waste and no more than 10% limited regulated waste): >2000t but <5000t per year	Millaa Millaa Tip – Lot 510 on Plan NR7893 (Reserve 2064) Theresa Creek Road, MILLAA MILLAA QLD 4886
ERA 60(2c) Waste Disposal Facility (any combination of general waste and no more than 10% limited regulated waste): >5000t but <10000t per year	Malanda Refuse Tip – Lot 10 SP241954 English Road, MALANDA QLD 4885
ERA 60(2c) Waste Disposal Facility (any combination of general waste and no more than 10% limited regulated waste): >5000t but <10000t per year	Yungaburra Refuse Tip – Lot 550 on Plan NR7572 (Reserve 2063) Mulgrave Road, YUNGABURRA QLD 4872
ERA 60(1a) Waste Disposal Facility (any combination of regulated waste, general waste and limited regulated waste – and <5t untreated clinical wastes if in a scheduled are): <50000t per year	Peeramon Waste Disposal – Lot 56 on Plan NR1118 (Reserve 511) Wharton Street, PEERAMON QLD 4885
ERA 60(1a) Waste Disposal Facility (any combination of regulated waste, general waste and limited regulated waste – and <5t untreated clinical wastes if in a scheduled are): <50000t per year ERA 60(2c) Waste Disposal Facility (any combination of general waste and no more than 10% limited regulated waste): >5000t but <10000t per year ERA 56 Receiving and Storing Regulated Waste	Atherton Landfill – Lot 100 SP252409 Herberton Road, CARRINGTON QLD 4883
ERA 60(2b) Waste Disposal Facility (any combination of general waste and no more than 10% limited regulated waste): >2000t but <5000t per year	Alcatraz Landfill – Lot 41 on Plan SP158034 Kennedy Highway, INNOT HOT SPRINGS QLD 4872
ERA 60(2a) Waste Disposal Facility (any combination of general waste and no more than 10% limited regulated waste): >50t but <2000t per year	Ravenshoe Landfill – Lot 308 on Plan CWL2530 Kennedy Highway, HERBERTON QLD 4872
ERA 60(1a) Waste Disposal Facility (any combination of regulated waste, general waste and limited regulated waste – and <5t untreated clinical wastes if in a scheduled are): <50000t per year	Herberton Sanitary Depot – Lot 1 on Plan CP818023 Atherton – Herberton Road, HERBERTON QLD 4872
ERA 60(2c) Waste Disposal Facility (any combination of general waste and no more than 10% limited regulated waste): >5000t but <10000t per year	Herberton Landfill – Lot 250 on Plan CWL840900 Syme Road, HERBERTON QLD 4872
ERA 16(2a) Extracting rock or other material: 5000-100000t per year	Atherton Quarry – Lot 851 NR6413 Carrington Falls Road, CARRINGTON QLD 4883
ERA 16(2a) Extracting rock or other material: 5000-100000t per year ERA 16(3a) Screening rock or other material: 5000-100000t per year	Allen Deco Pit – Lot 438 on Plan FTY1917 Allen Road, RAVENSHOE QLD 4872
ERA 16(2a) Extracting rock or other material: 5000-100000t per year ERA 16(3a) Screening rock or other material: 5000-100000t per year	Allen Maintenance Pit – Lot 438 on Plan FTY1917 Allen Road, RAVENSHOE QLD 4872
ERA 16(2a) Extracting rock or other material: 5000-100000t per year	Running Creek Pit – Lot 623 on Plan SP148822 Kennedy Highway, RAVENSHOE QLD 4872

ERA 16(3a) Screening rock or other material: 5000-100000t per year	
ERA 16(2a) Extracting rock or other material: 5000-100000t per year ERA 16(3a) Screening rock or other material: 5000-100000t per year	Penna Pit – Lot 1 on Plan AP17369 Silver Valley Road, SILVER VALLEY QLD 4872
ERA 57(2b) Regulated Waste Transport (other than tyres) in 6 – 35 vehicles	Mobile and Temporary activity

The environmentally relevant activities conducted at the locations as described above must be conducted in accordance with the following general conditions of approval.

Agency interest: General	
Condition number	**Condition**
G1-1	All reasonable and practicable **measures** must be taken to prevent the likelihood of environmental harm being caused.
G1-2	Where the holder of this environmental authority has not given notification to the administering authority under section 320 of the Environmental Protection Act, as soon as practicable after becoming aware of any emergency or incident which results in the release of contaminants not in accordance, or reasonably expected to be not in accordance with the conditions of this environmental authority, the holder of this environmental authority must notify the administering authority of the release by telephone or facsimile or submission of a program notice in accordance with Section 350 of the Act. **Note:** The notification of emergencies and incidents required under this condition must also include any of the following events - sewage pump failures, sewage pump station overflows or any other incident resulting in the release of raw sewage to the environment.

G1-3	Where the holder of this environmental authority has not given notification to the administering authority under section 320 of the Environmental Protection Act, the notification of emergencies or incidents as required by condition G1-2 must, unless a program notice in accordance with Section 350 of the Act is submitted, include but not be limited to the following: (a) the holder of this environmental authority; (b) the location of the emergency or incident; (c) the number of the environmental authority; (d) the name and telephone number of the designated contact person; (e) the time of the release; (f) the time the holder of this environmental authority became aware of the release; (g) the suspected cause of the release; (h) the environmental harm and or environmental nuisance caused, threatened, or to be caused by the release; and (i) actions taken to prevent any further release and mitigate any environmental harm and or environmental nuisance caused by the release.
G1-4	Where the holder of this environmental authority has not given notification to the administering authority under section 320 of the Environmental Protection Act, not more than fourteen (14) days following the initial notification of an emergency or incident, the holder of this environmental authority must provide written advice of the information supplied in accordance with condition number G1-3 in addition to: (a) proposed actions to prevent a recurrence of the emergency or incident; (b) outcomes of actions taken at the time to prevent or minimise environmental harm and or environmental nuisance.
G1-5	If a program notice has been submitted under Section 350 of the Act, condition G1-4 will have been complied with if the required information is submitted by the date specified in a Section 352 notice requiring submission of a draft Environmental Management Program.
G1-6	The holder of this environmental authority must, unless a program notice in accordance with Section 350 of the Act is submitted, notify the administering authority in writing of any monitoring result which indicates an exceedance of any environmental authority limit within twenty-eight (28) days of completion of analysis.
G1-7	The written notification required by condition G1-6 above must include: (a) the full analysis results; (b) details of investigation or corrective actions taken; and (c) results of any subsequent analysis carried out to verify the success of any corrective actions taken.
G1-8	If a program notice has been submitted under Section 350 of the Act, condition G1-7 will have been complied with if the required information is submitted by the date specified in a Section 352 notice requiring submission of a draft Environmental Management Program.

G1-9	Other than as permitted by this environmental authority, the **release of a contaminant into the environment** must not occur.
G1-10	All information and records required by the conditions of this environmental authority must be kept for a minimum of five years with the exception of environmental monitoring results which must be kept until surrender of this environmental authority. All information and records required by the conditions of this environmental authority must be provided to the **administering authority** upon request and in the format requested.
G1-11	An **appropriately qualified person(s)** must monitor, record and interpret all parameters that are required to be monitored by this environmental authority and in the manner specified by this environmental authority.
G1-12	All analyses required under this environmental authority must be carried out by a laboratory that has National Association of Testing Authorities (NATA) certification, or an equivalent certification, for such analyses.
G1-13	An annual monitoring report must be prepared and submitted to the **administering authority** by 30 November each year, for the preceding financial year.
G1-14	**You** must record the following details for all environmental **complaints** received: a) date and time complaint was received b) name and contact details of the complainant c) nature of the complaint d) investigations undertaken e) conclusions formed f) actions taken.
G1-15	When required by the **administering authority**, monitoring must be undertaken in the manner prescribed by the **administering authority**, to investigate a **complaint** not considered by the **administering authority** to be frivolous or vexatious, of **environmental nuisance** arising from the **activity**. The monitoring results must be provided to the **administering authority** upon request.
G1-16	The **activity** must be undertaken in accordance with written procedures that: 1. identify potential risks to the environment from the **activity** during routine operations, closure and an emergency 2. establish and maintain control **measures** that minimise the potential for environmental harm 3. ensure plant, equipment and **measures** are maintained in a proper and effective condition 4. ensure plant, equipment and **measures** are operated in a proper and effective manner 5. ensure that staff are trained in and aware of their obligations under the *Environmental Protection Act 1994* 6. ensure that reviews of environmental performance are undertaken at least annually.
G1-17	Chemicals and fuels in containers of greater than 15 litres must be stored within a **secondary containment system.**

G1-18	Sampling must be in accordance with the Water Quality Sampling Manual and all monitoring devices must be effectively calibrated and maintained.
Agency interest: Waste	
Condition number	**Condition**
W1-1	All waste generated in carrying out the **activity** must be lawfully reused, recycled or removed to a facility that can lawfully accept the waste.
W1-2	The holder of this environmental authority must not: (a) burn waste at or on any licensed place covered by this environmental authority unless otherwise authorised by the administering authority; nor (b) allow waste to burn or be burnt at or on any licensed place covered by this environmental authority unless otherwise authorised by the administering authority; nor (c) remove waste from any licensed place covered by this environmental authority and burn such waste elsewhere except in accordance with the requirements of the Environmental Protection Act 1994.

Part 3 - Site Specific Conditions

Environmentally relevant activity	Location
ERA 63(1d) Sewage Treatment >4000 but <10000EP ERA 58 – Regulated Waste Treatment (operating a facility for the receiving and treating regulated waste)	Atherton Sewage Treatment Plant – Lot 1 on Plan RP889324 Grove Street, ATHERTON QLD 4883

The environmentally relevant activity conducted at the location as described above must be conducted in accordance with the following site specific conditions of approval.

Agency interest: Water	
Condition number	**Condition**
WT3-1	The **activity** must be undertaken in accordance with written procedures that: 1. address the monitoring requirements of the appropriate parts of this environmental authority and also the following issues: (a) monitoring of metals and other parameters likely to be found in the effluent (based on the type of wastes going to sewer in accordance with trade waste agreements in the catchment for the sewage treatment plant); and (b) monitoring of metals (eg. boron and cadmium) and other parameters which are generally found in sewage effluent and have a potential to cause harm to irrigated plants or the biodiversity of receiving waters; and (c) frequency of sampling to ensure the suitability of the effluent for irrigation and/or discharge to receiving waters; and (d) carrying out an annual review of the monitoring program against the trade waste agreements in effect for the sewage treatment plant to ensure that the parameters being monitored are appropriate for the types of contaminants being discharged to the sewer; and (e) monitoring of bacteria from sewage effluent in receiving waters to ensure that the standards appropriate to the uses of those receiving waters are being maintained
WT3-2	An Environmental Impact Monitoring Program must be developed and implemented which will effectively and appropriately monitor the impact of the activities carried out at the licensed place on receiving waters likely to be significantly affected and addresses at least the following issues: 1. defining and monitoring of potential effects on the environment including effects on: a. flora and fauna communities (such as aquatic plants and aquatic vertebrates); and b. ambient environmental quality in receiving waters; and 2. the relationship between the effluent discharge and environmental quality indicators, including biodiversity.

WT3-3

Sewage or treated sewage effluent must not be directly or indirectly released from any source on the licensed place to any waters other than:

(a) overflows from the sewage reticulation system in accordance with the requirements of this environmental authority; and

(b) the discharge of treated effluent from Release Point W1 to Mazlin Creek as shown in Schedule 2.

WT3-4

The total quantity of contaminants released from Release Point W1 during any dry weather day must not exceed 2,200 cubic metres.

WT3-5

The release of contaminants to waters from Release Point W1 must comply, at the sampling and in situ monitoring point specified with each of the limits specified in Table 1 - Release Quality Characteristic Limits for each quality characteristic.

Table 1 - Release Quality Characteristic Limits

QUALITY CHARACTERISTICS	RELEASE LIMIT	LIMIT TYPE
5-Day Biochemical Oxygen Demand (mg/l)	5 10 20	80th percentile (long term) 80th percentile (short term) maximum
Suspended Solids (mg/l)	7 15 30	80th percentile (long term) 80th percentile (short term) maximum
pH (pH Units)	6.5 to 8.5	range
Dissolved Oxygen (mg/l)	2	minimum
Free Residual Chlorine (mg/l)	0.7(1)	maximum
Ammonia Nitrogen (mg/l) (2)	2 4	80th percentile (long term) maximum
Total Nitrogen (mg/l)	5 10	50th percentile maximum
Total Phosphorus as P (mg/l)	1 2	50th percentile maximum
Oil and Grease (mg/1)	10	maximum
Faecal Coliforms (Organisms /100 ml)	150(3) 600	median(4) 80th percentile(5)

Notes:

1. Measured at the chlorine contact tank after a minimum twenty (20) minutes detention period.
2. The holder of this environmental authority must further dilute the effluent whenever necessary to ensure that the measured ammonia concentration in water at Mazlin Creek does not exceed 1 mg/litre.
3. ANZECC standards for primary contact recreation (swimming, bathing and other direct water-contact sports).
4. Median for this quality characteristic must be based on the results of at least five samples, with individual samples being collected at intervals of not less than thirty (30) minutes.
5. "80th percentile" for this quality characteristic means that the measured values of the quality characteristic must not be greater than the release limit for any more than one out of five

WT3-6	The release to **waters** must not produce any slick or other visible evidence of oil or grease, nor contain visible floating oil, grease, scum, litter or other visually objectionable matter.
WT3-7	The holder of this environmental authority is responsible for the making of determinations and keeping of records of the quality of the effluent released from the sewage treatment plant for the quality characteristics and not less frequently than the frequency specified in Table 2 - Monitoring Frequency.
WT3-8	Determinations of the quality of effluent released to waters to check conformity with the release quality characteristics specified in Table 1 of this environmental authority must be undertaken on samples collected at the exit from the sewage treatment plant.

Table 2 - Monitoring Frequency

QUALITY CHARACTERISTIC DETERMINATION	FREQUENCY
5-Day Biochemical Oxygen Demand	fortnightly
Suspended Solids	fortnightly
pH	weekly
Specific Conductance	weekly
Dissolved Oxygen	weekly
Temperature - Celsius degrees	weekly
Ammonia Nitrogen	fortnightly
Free Residual Chlorine	fortnightly
Oil and Grease	fortnightly
Faecal Coliforms (Organisms/100 ml)	fortnightly

Agency interest: Noise

Condition number	Condition
N3-1	In the event of a complaint about noise that the administering authority considers is reasonable, then the emission of noise from the activity must not result in levels greater than those specified in Table 3 - Noise Limits until the circumstances which gave rise to the complaint are resolved.

Table 3 - Noise Limits

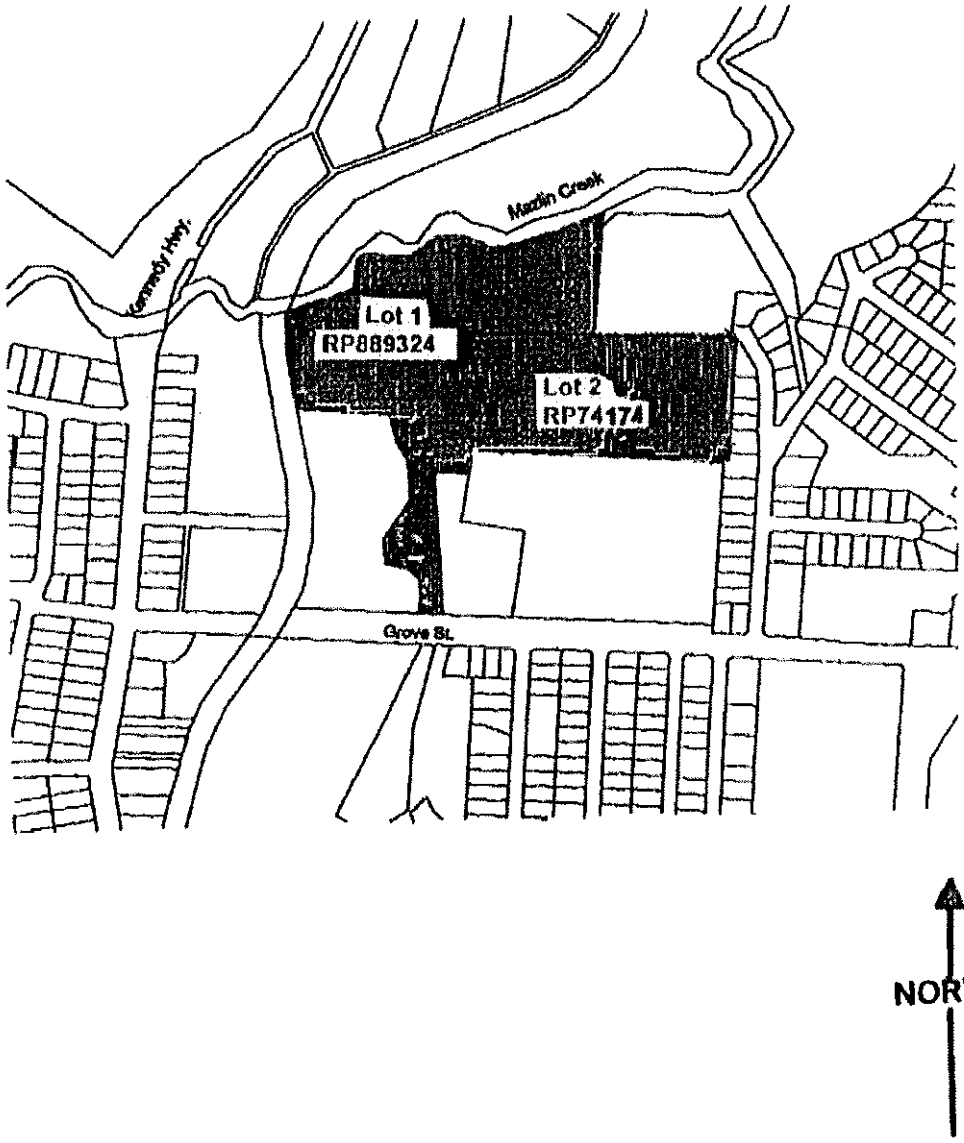
Noise Level at a Noise Sensitive Place Measured as the Adjusted Maximum Sound Pressure Level $L_{Amax\ adj,T}$	Period
Background noise level plus 5dB(A)	7 am - 6 pm
Background noise level plus 5dB(A)	6 pm - 10 pm
Background noise level plus 3dB(A)	10 pm - 7 am
Noise Limits at a Commercial Place Measured as the Adjusted Maximum Sound Pressure Level $L_{Amax\ adj,T}$	**Period**
Background noise level plus 10dB(A)	7 am - 6 pm
Background noise level plus 10dB(A)	6 pm - 10 pm
Background noise level plus 8dB(A)	10 pm - 7 am

Agency interest: Land	
Condition number	**Condition**
L3-1	The defined contaminant release area is described as part of Lot 2 RP741754 and is shown in Schedule 2 as the irrigation area.
L3-2	Treated effluent released to land must be done in accordance with documentation that ensures: (a) drainage to groundwater and subsurface flows of contaminants to surface waters are prevented (b) surface pondage and run-off of effluent is prevented (c) degradation of soil structure is minimised (d) soil sodicity and the build-up of nutrients and heavy metals in the soil and subsoil are minimised (e) spray drift or overspray does not carry beyond effluent disposal areas (f) effluent disposal areas are maintained with an appropriate crop in a viable state for transpiration and nutrient uptake (g) sufficient buffer zones are maintained between irrigation sites and sensitive environmental receptors.
L3-3	Treated sewage effluent may be removed from the site and used for an alternate purpose, with the written consent of any third party involved.

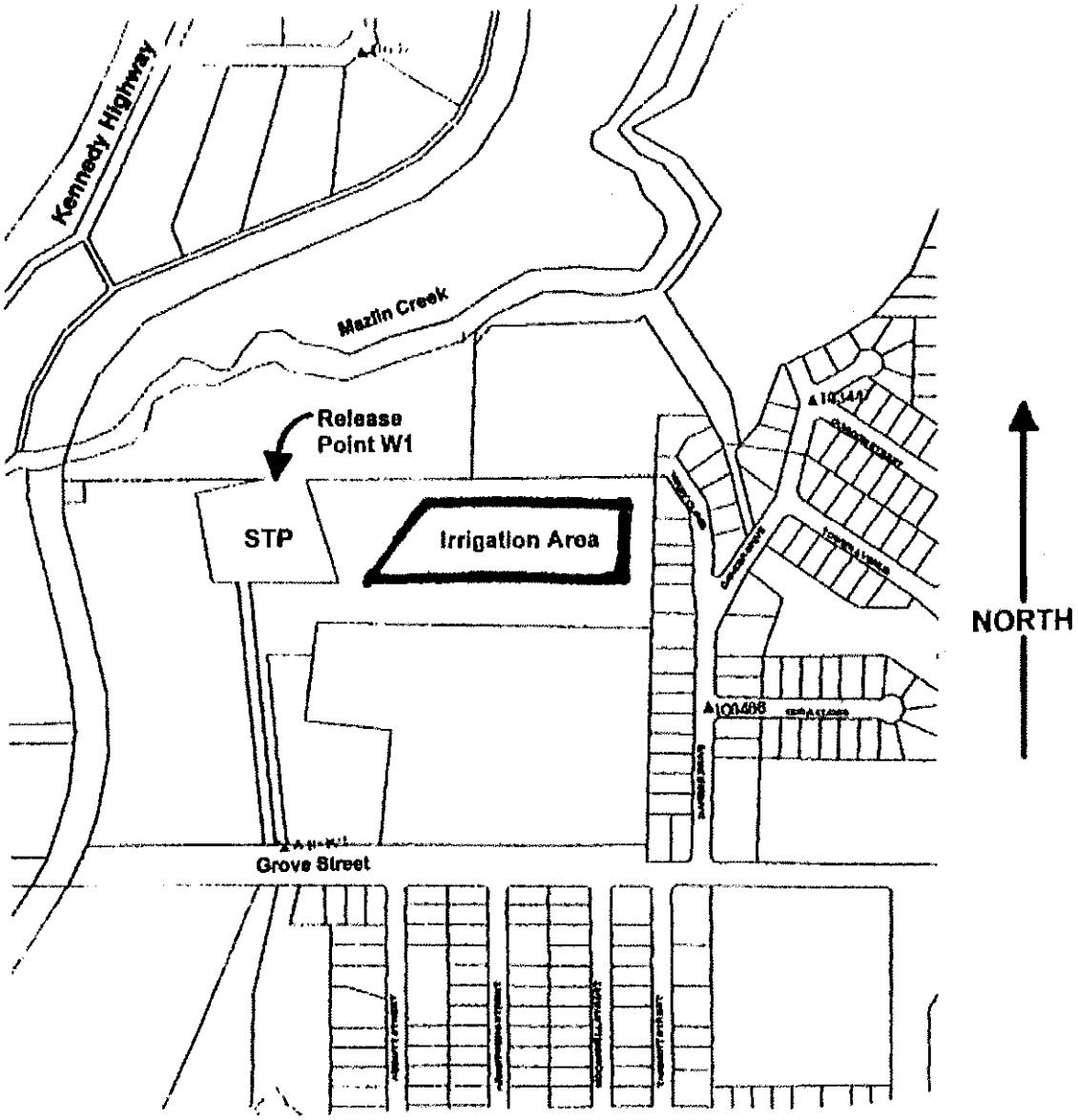
Agency interest: Waste	
Condition number	**Condition**
W3-1	The holder of this environmental authority may only accept regulated waste into the sewerage system serving the licensed place either commingled with normal domestic sewage or in accordance with Tableland Regional Council's Trade Waste Policy.

W3-2	A composite sample, of the sludge generated from the licensed place since the previous sample was taken, must be taken at least once in each three (3) years and analysed for the concentrations of the following parameters: (a) total zinc; (b) total copper; (c) total aluminium; (d) total chromium; (e) total cadmium; and (f) organochlorine pesticides

SCHEDULE 1 - Atherton Sewage Treatment Plant - Location



SCHEDULE 2 - Atherton Sewage Treatment Plant - Release Point W1



Appendix B – EE Notice Final

Notice

Environmental Protection Act 1994

Environmental Evaluation

Notice to conduct or commission an environmental evaluation

This notice to conduct or commission an environmental evaluation is issued by the administering authority pursuant to section 326B of the Environmental Protection Act 1994.

Tablelands Regional Council
45 Mabel Street
ATHERTON QLD 4883

Your reference: EPPR00584813

Our reference: 101/0009070; STAT1279

21 June 2018

Take notice: that under the *Environmental Protection Act 1994* (the Act) a notice to conduct or commission an environmental investigation is issued to Tablelands Regional Council (you) by the administering authority. The administering authority is the Chief Executive of the Department of Environment and Science, formerly the Department of Environment and Heritage Protection (the department).

The notice to conduct or commission an environmental investigation is issued in respect of the activities of Tablelands Regional Council at Atherton Sewage Treatment Plant on land described as Lot 1 on RP889324 situated at Grove Street, ATHERTON (the premises).

A. Grounds

The department considers it appropriate to require you to conduct or commission an environmental investigation under section 326B of the *Environmental Protection Act 1994* (the Act) on the following grounds:

1. An activity or proposed activity is causing, or is likely to cause environmental harm.

The facts and circumstances forming the basis for these grounds are:

1. You operate the Atherton Sewage Treatment Plant (Atherton STP) and hold Environmental Authority EPPR00584813 issued on 27 September 2017 (the EA), authorising the following environmentally relevant activities (ERAs) for the premises:
   a. 63(1)(d) – Sewage Treatment >4000EP to <10000EP; and
   b. 58 – Regulated Waste Treatment.
2. The EA authorises the release of contaminants to the waters of Mazlin Creek and prescribes release limits for multiple quality characteristics (the EA, Table 1 – Release Quality Characteristic limits). Those limits have been assessed and approved by the administering authority in order to protect identified environmental values and authorise an appropriate level of environmental harm.

3. Over the last fifteen months, the STP has been non-compliant with prescribed release limits in the EA. Exceedance notifications of the release limits for contaminants were provided as follows:
    a. 21 April 2017 - for Free Residual Chlorine;
    b. 7 August 2017 - for Ammonia Nitrogen and 5-Day Biological Oxygen Demand;
    c. 5 January 2018 - for Ammonia Nitrogen and Total Nitrogen.
4. Environmental harm is defined in section 14 of the Act as follows:

    (1) Environmental harm is any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an environmental value, and includes environmental nuisance.

    (2) Environmental harm may be caused by an activity—

    (a) whether the harm is a direct or indirect result of the activity; or

    (b) whether the harm results from the activity alone or from the combined effects of the activity and other activities or factors.
5. Environmental value is defined in section 9 of the Act as follows:

    a. *A quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or*

    b. *Another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation.*
6. Under the *Environmental Protection (Water) Policy 2009* (Water EPP), all Queensland waters including groundwater and surface waters have prescribed Environmental Values (EVs) and Water Quality Objectives (WQOs).
7. Barron River Basin, including all waters of the basin and adjacent coastal waters is listed in Schedule 1 of the *Environmental Protection (Water) Policy 2009* (see https://www.ehp.qld.gov.au/water/policy/pdf/plans/barron-evs-wqos.pdf).
8. Mazlin Creek is part of the Atherton Division of the Barron River Basin.
9. Prescribed EVs for Mazlin Creek surface waters include aquatic ecosystems, irrigation, farm supply, stock watering, human consumption, visual appreciation and cultural and spiritual values.
10. Relevant prescribed water quality objectives for the developed fresh waters of Mazlin Creek to protect aquatic ecosystems include <10µg/L for ammonia and <340µg/L for total nitrogen.
11. High concentrations of ammonia nitrogen in freshwater is known to be toxic and can lead to nutrient enrichment of water and lead to changes in biotic community structure (page 49, Australian and New Zealand guidelines for fresh and marine water quality. Volume 2, Aquatic ecosystems / Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand).
12. Limited receiving environment monitoring in Mazlin Creek, undertaken by you, indicates that the water quality objectives for Mazlin Creek are not being achieved.
13. The department considers that the activity conducted by you on the premises (sewage treatment) is likely to cause environmental harm due the concentrations of ammonia and total nitrogen measured in some treated effluent and the water quality monitoring undertaken in Mazlin Creek.
14. Given the above, the department is satisfied that it is appropriate and reasonable to require you to conduct and environmental investigation relating to the sewage treatment activity.

B. Requirements

The report on the environmental investigation must address the following relevant matters:

1. By 1 November 2018 you must engage an **appropriately qualified person** to complete an investigation to determine the source, cause and extent of environmental harm to Mazlin Creek from the activities of the Atherton STP. The investigation must consider:
    a. the environmental values, water quality objectives and management goals of the waters as specified in Schedule 1 of the *Environmental Protection (Water) Policy 2009* "Barron River Basin, Environmental Values and Water Quality Objectives Basin 110 and adjacent coastal waters"; and
    b. the limits in the EA EPPR00584813; and
    c. the measured water quality, sediment quality and key communities in the creek both upstream and downstream of the activity, at the mixing zone, during the wet season, during the dry season and during intermittent high flow events; and
    d. any relevant reports prepared by other governmental or professional research organisations that relate to the receiving environment.
2. By 28 June 2019 you must provide an investigation report prepared by the **appropriately qualified person** that describes the:
    a. potentially affected receiving waters; and
    b. measured impact of the Atherton STP discharge on the receiving waters; and
    c. water and sediment quality targets within the receiving environment to be achieved including clarification of contaminant concentrations or levels indicating adverse environmental impacts on the receiving environment.
3. By 28 June 2019 you must provide a final report prepared by an **appropriately qualified person** that considers the investigation report and:
    a. reviews and assesses the influent flow characteristics to the Atherton STP based on all available and relevant current and historical data; and
    b. reviews and assesses the current and likely future service demand needs of the plant in accordance with the Planning Guidelines for Water Supply and Sewerage April 2010 including amendments dated March 2014 (the guidelines); and
    c. determines the current plants' capacity and performance to meet the defined service needs; and
    d. identifies all feasible short term and long term asset and non-asset service improvements and efficiencies to both the sewage treatment and treated effluent management processes required to protect the environmental values, meet the water quality objectives and achieve the management goal of maintaining and improving the waters of Mazlin Creek; and
    e. includes an options analysis to determine a corrective program of improvements to the sewage treatment activity that balances financial, social and environmental risk; and
    f. identifies a reasonable implementation program for any improvements, efficiencies and/or measures required to protect all environmental values of Mazlin Creek.

The environmental investigation must be carried out, and the environmental report prepared, by an appropriately qualified person. An **appropriately qualified person** is defined as a person who has qualifications and experience relevant to performing the function

Both reports must be submitted to the department on or before:

- **28 June 2019**

As the recipient of this notice, you are also required to provide a statutory declaration in the form attached, to accompany the environmental report submitted to the department.

The appropriately qualified person(s) who prepares the environmental report must also provide a statutory declaration in the form attached to accompany the environmental report submitted to the department.

You can view an electronic version of the statutory declaration for a recipient using the following search term (ESR/2016/1997).[1]

An electronic version of the statutory declaration for a suitably qualified person form is available using the search term (ESR/2016/2266).

Take notice:

- the requirements of the notice to conduct or commission an environmental investigation take effect immediately upon service of this notice;
- this notice remains in force until further notice from the department; and
- you are responsible for meeting the costs of conducting or commissioning the environmental evaluation, preparing the environmental report and providing any further information as requested by the department.

C. Reviews and appeals

The provisions regarding reviews of decisions and appeals are found in sections 519 to 539 of the Act.

A person who is dissatisfied with certain decisions of the department, may be able to apply to have the department review that original decision.

Generally, a request to have a decision reviewed must be made:

- within 10 business days of the decision being notified to the person;
- be supported by enough information to enable the department to decide the application for review; and
- be made using the application for review of an original decision form (ESR/2015/1573).

Where an application has been made for a decision to be reviewed, the applicant may also apply to the relevant court for a stay of the decision to secure the effectiveness of the review.

Once the original decision has been reviewed, a person who is dissatisfied with the review decision may be able to appeal against that decision to the relevant court within 22 business days after receiving notice of the review decision.

[1] This is the publication number. The publication number can be used as a search term to find the latest version of a publication at <www.ehp.qld.gov.au>.

A person whose interests are or would be adversely affected by a decision of the department may also be able to request a statement of reasons for a decision or a statutory order review under the *Judicial Review Act 1991*.

For further information about reviews and appeals see the:

- Information sheet - internal review and appeal to the Planning and Environment Court (ESR/2015/1572).
- Information sheet - internal review and appeal to the Land Court (ESR/2015/1742).

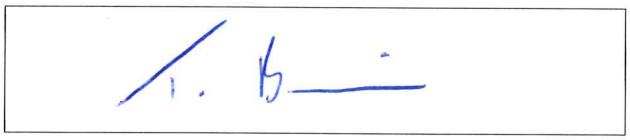
You may have other legal rights or obligations and should seek your own legal advice.

D. Penalty

Failure to comply with a notice to conduct or commission an environmental evaluation is an offence.

- The maximum penalty for an individual is 300 penalty units, totalling $37,845.
- The maximum penalty for a corporation is 1500 penalty units, totalling $189,225

Should you have any queries in relation to this notice, please contact Kirstie Treloar of the department on telephone number (07) 4222 5212.



Signature



Date

Tim Brain

Manager (Compliance)

Delegate of the Chief Executive

Department of Environment and Science

Environmental Protection Act 1994

Enquiries:

Level 3, 5B Sheridan Street, CAIRNS

Ph: (07) 4222 5212

Email: kirstie.treloar@des.qld.gov.au

Appendix C – EPP Policy Sch 1 Basin 110

Environmental Protection (Water) Policy 2009

Barron River Basin
Environmental Values and Water Quality Objectives

Basin No. 110 and adjacent coastal waters

Great state. Great opportunity.
And a plan for the future.
Queensland Government

Prepared by: Environmental Policy and Planning Division, Department of Environment and Heritage Protection

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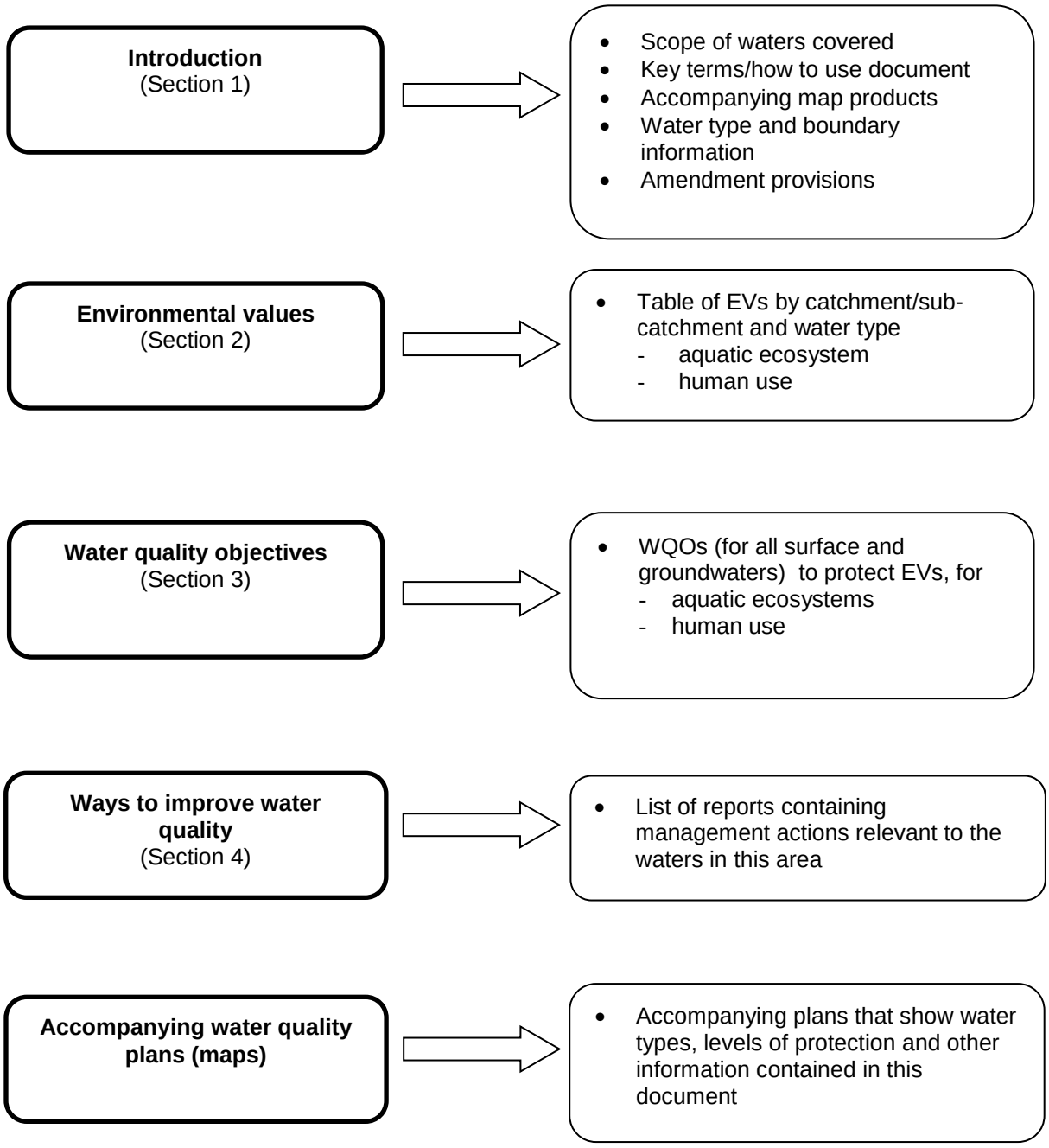
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November 2014

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Introduction and guidance on using this document

1 Introduction

This document is made under the provisions of the Environmental Protection (Water) Policy 2009 (EPP Water), which is subordinate legislation under the *Environmental Protection Act 1994* (EP Act).

The EPP Water and the EP Act provide a framework for:

- establishing environmental values (EVs) and management goals for Queensland waters, and deciding the water quality objectives (WQOs) to protect or enhance those EVs
- listing the identified EVs, management goals and WQOs under Schedule 1 of the EPP (Water).

This document contains the EVs, management goals, WQOs and map products for the waters of the Barron River basin (110)[1] and the adjacent coastal waters, to the limit of Queensland waters.

The document is listed under Column 2 of Schedule 1 of the EPP Water for the Column 1 entry of the Barron River basin (110) and adjacent coastal waters.

1.1 Purpose

The purpose of this document is to identify locally relevant environmental values and water quality objectives for the region, based on local historical data and in close consultation with the local community. These water quality objectives are used to help set development conditions, influence local government planning schemes and underpin report card grades for ecosystem health monitoring programs. These water quality objectives have been refined from national and state water quality guidelines and present a truer picture of the values and water quality of local waterways. This ensures the values the community holds for its waterways can be maintained and improved into the future, without imposing unrealistic standards from national guidelines that may be inappropriate for local conditions.

1.2 Waters to which this document applies-project waters

This document applies to all surface waters and groundwaters of the Barron River basin and adjacent coastal waters, as indicated in the accompanying maps WQ1101—surface waters, WQ1082—coastal waters and WQ1083—groundwaters.

The surface waters and groundwaters include:

- Upper Barron Division – Upper Barron, Poona, Morans, Gwynne, Peterson, Mobo and Robson Creeks
- Atherton Division – Rocky, Tolga, Mazlin Creeks and Barron R below Tinaroo
- Mareeba Division – Granite Creek, Tinaroo Creek, Emerald, Shanty, Pukanja, Blackwater, Oaky, Brindle Creeks and Barron River
- Kuranda zones – Davies, Reid, Groves, Thirty Three Creek, One Mile, Dismal, Kennedy, Tichum, Clohesy, Haren, Kauri, Jumrum, Mona, Big Rooty, Track, Kambul, Pearce, Flaggy, Rainy, Stony, Surprise, Shoteel and Myola Creeks and Barron Falls
- Cairns Zone –Clohesy River and Freshwater Creek
- Lower Barron River zone – Stratford, Thomatis, Moores Creek and Yorkeys Knob harbour

[1] Queensland Drainage Division number and river basin names are published at Geoscience Australia's website www.ga.gov.au.

- lakes, drinking water storages and wetlands; including Lakes Tinaroo, Eacham and Morris, Copperlode Falls Dam, Hasties Swamp, Nardellos Lagoon and Cattana wetlands
- Barron River basin groundwaters
- Barron enclosed coastal waters and open coastal waters to the limit of Queensland waters.

The geographical extent of waters shown in the accompanying maps is:

- north to the Mossman River basin (109)
- west to the Mitchell River basin (919)
- south to the Johnstone River basin (112)
- east to the Mulgrave and Russell rivers basin (111)
- north-east via the Lower Barron River zone to the jurisdictional limit of Queensland waters.

1.3 Guidance on using this document

1.3.1 List of acronyms and terms

ADWG means the Australian Drinking Water Guidelines (2011)-updated December 2013, prepared by the National Health and Medical Research Council (NHMRC)[2].

AWQG or ANZECC guidelines means the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (October 2000) prepared by the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ)[3].

Aquatic ecosystem means the animals, plants and micro-organisms that live in water, and the physical and chemical environment and climatic regime in which they interact. The physical components (e.g. light, temperature) and chemical components (e.g. oxygen, nutrients), and to a lesser extent biological interactions, determine what lives and breeds in the aquatic ecosystem and the food web structure.

Basin means hydrologic drainage basin. Refer to the Geoscience Australia website www.ga.gov.au.

Catchment means the land area draining into a watercourse. The limits of a catchment are the heights of land (watershed) separating it from neighbouring catchments.

Developed fresh waters (or waters in developed areas) are waters in areas impacted through some form of development e.g. urban, industrial, rural residential or agricultural development and land uses. These waters are generally assigned the Moderately Disturbed (MD) level of protection.

Ecological health or condition of an aquatic ecosystem means the ability to maintain key ecological processes and organisms so that their species compositions, diversity and functional organisations are as comparable as possible to those occurring in natural habitats. There are four levels of aquatic ecosystems protection—High Ecological Value (HEV), Slightly Disturbed (SD), Moderately Disturbed (MD) and Highly Disturbed (HD). See **Management intent** for waters under the EPP Water (section 14).

Environmental values means the EVs at Section 2. EVs for waters are the qualities of water that make it suitable for supporting aquatic ecosystems and human uses. EVs under the EPP Water shown below.

[2] The Australian Drinking Water Guidelines are available on the National Health and Medical Research Council website www.nhmrc.gov.au.

[3] The ANZECC guidelines are available on the Australian Government's National Water Quality Management Strategy website.

Environmental values (EVs)	Potentially applicable to:	
	Tidal waters	Fresh (non-tidal) waters, including ground water
Aquatic ecosystem EV		
Environmental values may be stated for four levels of aquatic ecosystems protection	✓	✓
• high ecological value waters (effectively unmodified)		
• slightly disturbed waters (slightly modified)		
• moderately disturbed waters (adversely affected to a relatively small but measurable degree)		
• highly disturbed waters (measurably degraded).		
Human use EVs		
Suitability of the water for agricultural use (e.g. crop irrigation, stock watering, farm use)		✓
Suitability of the water for aquaculture (e.g. prawns, barramundi)	✓	✓
Suitability of the water for producing aquatic foods (e.g. fish, crustaceans) for human consumption	✓	✓
Suitability of the water for supply as drinking water (i.e. raw water, before treatment)		✓
Suitability of the water for industrial use (e.g. mining, minerals refining/processing)		✓
Suitability of the water for recreation:		
• primary contact (e.g. swimming)	✓	✓
• secondary contact recreation (e.g. boating)	✓	✓
• visual (no contact) recreation	✓	✓
The cultural and spiritual values of the water	✓	✓

GBRMPA guidelines means the Water Quality Guidelines for the Great Barrier Reef Marine Park, Great Barrier Reef Marine Park Authority 2010, published at the GBRMPA website.

Management goals means the goals stated in Section 2.2 of this document. Management goals are used to assess whether the corresponding environmental value is being maintained. They reflect the desired levels of protection for the aquatic system and any relevant environmental problems.

Management intent for waters—see Section 2.2.

Monitoring and Sampling Manual 2009 means the protocol document under the EP Act published on the department's website at www.ehp.qld.gov.au.

Queensland waters means waters within the state (i.e. headwaters to the three nautical mile jurisdiction limit).

QWQG means the Queensland Water Quality Guidelines, published at www.ehp.qld.gov.au.

Soil degradation, for the purposes of the objective for irrigation water in section 2.2.3, means reduced permeability and soil structure breakdown caused by the level of sodium in the irrigation water, assessed using the sodium adsorption ratio.

Undeveloped fresh waters (or waters in undeveloped areas) are waters within protected areas such as National Park, Regional Park and forest reserves or in other undisturbed states. These waters are given High Ecological Value (HEV) or Slightly Disturbed (SD) levels of protection.

Water quality indicator for an environmental value, under the EPP Water, means a physical, chemical, biological or other property that can be measured or decided in a quantitative way. For example:

- the concentration of nutrients and pH value are examples of chemical indicators
- Secchi disc water clarity measure is an example of a physical indicator
- seagrass depth range, macro-invertebrate family richness are examples of biological indicators.

Water quality guidelines under the EPP Water means the quantitative measures (expressed as contaminant concentrations, loads or narrative statements) for indicators which protect a stated EV. For a particular water, the indicators and water quality guidelines for an EV are decided using the following documents (in order of priority):

- site specific documents for the water
- the QWQG
- the AWQG
- other relevant documents published by a recognised entity.

Water quality guidelines may be modified by economic and social impact assessments of protecting the EVs for waters.

Water quality objectives (WQOs) means the WQOs at Section 3 which protect the EVs at Section 2.

WQOs are the quantitative measures of the various water quality indicators that protect receiving waters aquatic ecosystem and human use EVs. WQOs are:

- numerical concentration levels, sustainable loads measures or narrative statements of indicators
- based on water quality guidelines, but may be modified by economic and social inputs
- receiving water quality objectives— not individual point source objectives or emission standards
- long-term goals for water quality management.

WQOs compliance assessment means the compliance assessment at Appendix D of the QWQG.

Water type means the grouping of waters within which water quality is sufficiently consistent that a single guideline value can be applied to all waters within each group (or water type). See section 1.5.

1.2.2 Use of this document

Section 1 – Introduction and guidance on using the document.

Section 2 – lists the identified EVs for protection for particular waters.

Section 3 – lists the WQOs to protect the corresponding aquatic ecosystems and human use EVs for each water type, including both surface waters and groundwaters.

This document refers to a number of water quality guidelines, codes and other reference sources. In particular, the QWQG provide detailed information on water types, water quality indicators, derivation of local water quality guidelines, monitoring and assessing compliance. ANZECC guidelines contain national water quality guidelines, for example water quality guidelines for toxicants.

Section 4 – lists documents relevant to the improvement of water quality in the Barron River basin.

1.4 Information about mapped areas and boundaries

The boundaries in the accompanying pdf plans are indicative only. The corresponding GIS datasets are available as part of the Wet Tropics Environmental Values Schedule 1 Geodatabase November 2014— held at the department's offices at Level 10, 400 George Street Brisbane.

The GIS datasets may be downloaded free of charge from the Queensland Spatial Catalogue (QSpatial) at http://qldspatial.information.qld.gov.au/catalogue/custom/index.page

For further information, please email the department at epa.ev@ehp.qld.gov.au

1.5 Water types and basis for boundaries

1.5.1 **Water types**

Water types in this document are identified in Section 3 and the accompanying plans. Water types include (see the QWQG and GBRMPA guidelines):

- upland fresh waters—smaller upper catchments freshwater streams, above 150 metres altitude, moderate to fast flowing with steeper gradients than lowland fresh waters, downstream limit—lowland fresh waters
- lowland fresh waters—larger slow moving freshwater streams and rivers, below 150 metres altitude, downstream limit – upper estuary
- freshwater lakes/reservoirs—deep water habitat situated in dammed river channels
- upper/mid estuary waters:
    - upstream tidal limit—determined from EHP wetland mapping, declared downstream freshwater limit, mean high water springs or limiting structure
    - downstream limit—lower estuary
- enclosed coastal/lower estuary waters—occur at the downstream end of estuaries and include shallow coastal waters (<6m depth) in enclosed bays (GBRMPA 2014)
- open coastal waters—extend from the seaward limit of the enclosed coastal water body to the jurisdictional limit of Queensland waters[4]
- groundwaters—sub-artesian waters that occur in an aquifer
- wetlands—palustrine, lacustrine and estuarine – see EHP mapping at Wetlandsinfo website.
- marinas, boat harbours, tidal canals and constructed estuaries

1.5.2 **Water type boundaries**

The boundaries of different water types are mapped in the accompanying plans using the following attributes, see QWQG for definitions, including:

- altitude (from Australian Height Datum, Geoscience Australia)
- catchment or sub catchment boundaries
- coastline mapping
- downstream or tidal limit—structure (limiting), declared downstream limit or mean high water springs
- enclosed coastal waters (GBRMPA 2014)
- geographic coordinates
- highest/lowest astronomical tide
- jurisdiction or defined coastal waters limits
- maritime mapping conventions
- plume line—seaward limit of detection of terrestrial impact—chlorophyll-a mapping (GBRMPA 2014)
- surveyed terrestrial and maritime boundaries.

[4] Beyond the jurisdictional limit of Queensland waters, mid-shelf marine waters extend from the limit of open coastal waters to 24 km offshore and offshore marine waters extend from the limit of mid-shelf waters to 170 km offshore. See GBRMPA guidelines.

1.6 Matters for amendment

Under section 12 (2) (b) of the EPP (Water), amendments of the following type may be made to this schedule 1 document for the purposes of a replacement document:

- changes to EVs
- changes to management goals
- changes to WQOs
- changes to management intent (level of protection) categories
- changes to water type boundaries/descriptions
- updates to information/data sources, websites and email contact details, agency/departmental names, other institutional names, references.

Environmental values for waters of the Barron River basin and adjacent coastal waters

2 Environmental values

2.1 Environmental values

The EVs for the surface waters and groundwaters of the Barron River basin and adjacent coastal waters are listed at table 1 and mapped in the accompanying plans and the GIS datasets.

The EVs were established during stakeholder consultation undertaken by the department and Terrain NRM – see Consultation Report: Environmental Values for Wet Tropics Basins, (Terrain NRM, September 2012).

2.2 Management goals

2.2.1 **Management intent for waters – under the EPP Water**

It is the management intent for waters that the decision to release waste water or contaminants to the waters must ensure the following:

- for high ecological value (HEV) waters—the measures for the indicators for all EVs are maintained
- for slightly disturbed (SD) waters—the measures for the slightly modified physical or chemical indicators are progressively improved to achieve the WQOs for HEV waters
- for moderately disturbed (MD) waters:
    - if the measures for indicators of the EVs achieve the water quality objectives for the water—the measures for the indicators are maintained at levels that achieve the WQOs for the water, or
    - if the measures for indicators of the EVs do not achieve the water quality objectives for the water—the measures for indicators of the EVs are improved to achieve the WQOs for the water
- for highly disturbed (HD) waters—the measures for the indicators of all environmental values are progressively improved to achieve the water quality objectives for the water.

The mapping of HEV waters, SD waters and HD waters in the accompanying plans (or GIS datasets) informs the determination of Management Intent for particular waters.

Note 1 – All other waters in the accompanying plans are moderately disturbed (MD).

Note 2 – See the Environmental Protection Regulation 2008, section 51.

Note 3 – See the Environmental Protection (Water) Policy 2009, section 14.

2.2.2 **Raw water for treatment for human consumption**

- Minimise the risk that the quality of raw water taken for treatment for human consumption results in adverse human health effects.
- Maintain the palatability rating of water taken for treatment for human consumption at the level of good, as set out in the Australian Drinking Water Guidelines (ADWG).
- Minimise the risk that the quality of raw water taken for treatment for human consumption results in the odour of drinking water being offensive to consumers.

2.2.3 **Irrigation water**

The management goal for irrigation water is that the quality of surface water, when used in accordance with the best irrigation and crop management practices and principles of ecologically sustainable development, does not result in crop yield loss or soil degradation.

2.2.4 **Recreational water quality**

The management goal for recreational water quality is to achieve a low risk to human health from water quality threats posed by exposure through ingestion or contact during recreational use of water resources.

Table 1 Environmental values for the waters of the Barron River basin (110) and adjacent coastal waters

Barron River basin (110)	Environmental values											
	Aquatic ecosystems	Irrigation	Farm Supply	Stock Watering	Aquaculture	Human Consumption	Primary Recreation	Secondary recreation	Visual Appreciation	Drinking Water	Industrial Use	Cultural and Spiritual
												
Surface fresh waters (rivers, creeks, streams) in developed areas (e.g. urban, industrial, rural residential, agriculture, farmlands)												
Barron River main channel from Mareeba downstream through Shanty and Pukanja Creeks sub-catchments	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓
Barron River main channel from Shanty and Pukanja Creeks sub-catchments to weir at Koah	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Barron River main channel between weir at Koah and Barron Falls	✓					✓	✓	✓	✓		✓	✓
Barron River main between Barron Falls and the estuarine limit at Kamerunga bridge.	✓			✓		✓	✓	✓	✓			✓
Oaky, Kambul, Track, Big Rooty and Flaggy Creeks	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓
Pearce Creek	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓
Rainy and Myola Creeks	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓

Barron River basin (110)	Environmental values											
	Aquatic ecosystems	Irrigation	Farm Supply	Stock Watering	Aquaculture	Human Consumption	Primary Recreation	Secondary recreation	Visual Appreciation	Drinking Water	Industrial Use	Cultural and Spiritual
												
Granite Creek	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Shanty and Pukanja Creeks	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓
Kauri, Groves, Thirty Three Mile, Blackwater, One Mile, Mona, JumRum, Haren and Dismal Creeks	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Surprise Creek	✓	✓			✓				✓			✓
Barron Falls	✓	✓							✓			✓
Stony Creek	✓					✓	✓	✓	✓			✓
Thomatis and Stratford Creeks	✓					✓	✓	✓	✓			✓
Tichum Creek	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kennedy fresh waters	✓			✓		✓	✓	✓	✓	✓		✓
Bridle Creek	✓			✓				✓	✓	✓		✓
Reid Creek	✓			✓				✓	✓	✓		✓

Barron River basin (110)	Environmental values											
	Aquatic ecosystems	Irrigation	Farm Supply	Stock Watering	Aquaculture	Human Consumption	Primary Recreation	Secondary recreation	Visual Appreciation	Drinking Water	Industrial Use	Cultural and Spiritual
												
Freshwater Creek	✓			✓		✓	✓	✓	✓	✓	✓	✓
Lake Morris (Copperlode Dam)	✓			✓					✓	✓		✓
Tinaroo Creek	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Emerald Creek	✓	✓	✓	✓		✓	✓	✓	✓			✓
Brindle Creek	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓
Davies Creek	✓	✓	✓	✓			✓	✓	✓	✓		✓
Rocky Creek	✓	✓		✓		✓	✓		✓	✓		✓
Tolga	✓	✓	✓	✓		✓	✓			✓		✓
Lake Tinaroo	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Mobo and Robson Creeks	✓			✓		✓	✓	✓	✓			✓
Mazlin Creek	✓	✓	✓	✓		✓			✓			✓
Morans, Poona and Carington Creeks	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓

Barron River basin (110)	Environmental values											
	Aquatic ecosystems	Irrigation	Farm Supply	Stock Watering	Aquaculture	Human Consumption	Primary Recreation	Secondary recreation	Visual Appreciation	Drinking Water	Industrial Use	Cultural and Spiritual
												
Gwynne Creek	✓	✓	✓	✓		✓	✓			✓		✓
Peterson Creek	✓	✓	✓	✓		✓	✓	✓	✓			✓
Upper Barron River	✓	✓	✓	✓			✓	✓		✓		✓
Surface fresh waters in undeveloped areas (e.g. National Parks, forest reserves)												
Oaky, Kambul, Track, Big Rooty and Flaggy Creeks	✓			✓		✓	✓	✓	✓	✓		✓
Pearce Creek	✓			✓		✓	✓	✓	✓			✓
Rainy and Myola Creeks	✓			✓		✓	✓	✓		✓		✓
Granite Creek	✓			✓								✓
Shanty and Pukanja Creeks	✓			✓								✓
Kauri, Groves, Thirty Three Mile, Blackwater, One Mile, Mona, JumRum, Haren and Dismal Creeks	✓			✓		✓	✓	✓		✓		✓
Surprise Creek	✓			✓		✓	✓	✓	✓	✓		✓

Barron River basin (110)	Environmental values											
	Aquatic ecosystems	Irrigation	Farm Supply	Stock Watering	Aquaculture	Human Consumption	Primary Recreation	Secondary recreation	Visual Appreciation	Drinking Water	Industrial Use	Cultural and Spiritual
												
Barron Falls	✓			✓		✓	✓	✓	✓	✓		✓
Stony Creek	✓			✓		✓	✓	✓	✓	✓		✓
Thomatis and Stratford Creeks	✓					✓	✓	✓	✓	✓		✓
Tichum Creek	✓			✓		✓	✓	✓	✓	✓		✓
Kennedy fresh waters	✓			✓		✓	✓	✓	✓	✓		✓
Shoteel Creek	✓					✓	✓	✓	✓	✓		✓
Bridle Creek	✓			✓		✓	✓	✓	✓	✓		✓
Reid Creek	✓					✓	✓	✓	✓	✓		✓
Freshwater Creek	✓	✓	✓	✓	✓	✓	✓					✓
Tinaroo Creek	✓			✓		✓	✓	✓	✓	✓		✓
Emerald Creek	✓			✓		✓	✓	✓	✓	✓		✓
Brindle Creek	✓			✓		✓	✓	✓	✓	✓		✓

Barron River basin (110)	Environmental values											
	Aquatic ecosystems	Irrigation	Farm Supply	Stock Watering	Aquaculture	Human Consumption	Primary Recreation	Secondary recreation	Visual Appreciation	Drinking Water	Industrial Use	Cultural and Spiritual
												
Davies Creek	✓			✓		✓	✓	✓	✓	✓		✓
Varch Creek	✓			✓		✓	✓	✓	✓	✓		✓
Rocky Creek	✓			✓								✓
Tolga	✓			✓		✓	✓	✓	✓	✓		✓
Mobo and Robson Creeks	✓					✓	✓	✓	✓			✓
Mazlin Creek	✓			✓		✓	✓	✓	✓	✓		✓
Morans, Poona and Carington Creeks	✓			✓		✓	✓	✓	✓	✓		✓
Gwynne Creek	✓					✓	✓		✓			✓
Peterson Creek – including Lake Eacham	✓	✓					✓	✓	✓	✓		✓
Upper Barron River	✓			✓		✓	✓	✓	✓	✓		✓
Groundwaters	✓	✓	✓	✓						✓	✓	✓

Barron River basin (110)	Environmental values											
	Aquatic ecosystems	Irrigation	Farm Supply	Stock Watering	Aquaculture	Human Consumption	Primary Recreation	Secondary recreation	Visual Appreciation	Drinking Water	Industrial Use	Cultural and Spiritual
												
Estuaries/bays, coastal and marine waters												
Estuarine waters	✓				✓	✓		✓	✓			✓
Barron coastal waters	✓					✓	✓	✓	✓		✓	✓

Notes:

1. ✓ means the EV is selected for protection.
2. Refer to the accompanying plans for the spatial locations of the EVs.
3. Blank indicates that the EV is not chosen for protection.
4. The selection of recreational EVs for waters does not mean that these waters are free of dangerous aquatic organisms, for example venomous organisms (e.g. marine stingers including box jellyfish, irukandji jellyfish), crocodiles, and sharks. Direct contact with dangerous aquatic organisms should be avoided. Refer to EHP CrocWatch, council, www.health.qld.gov.au, www.beachsafe.org.au, www.marinestingers.com.au and other information sources for further details on swimming safety and information on specific waters.

Water quality objectives to protect environmental values

3 Water quality objectives to protect environmental values

This section provides WQOs to protect the EVs for the waters at Section 2.

- Section 3.1 information for reference to the State Planning Policy: state interest – water quality.
- Section 3.2 states the surface waters WQOs to protect the aquatic ecosystem EV.
- Section 3.3 states the surface waters WQOs to protect the human use EVs.
- Section 3.4 states the groundwater WQOs to protect the groundwater EVs.

3.1 State planning policy: state interest – water quality

The State Planning Policy (SPP) defines the Queensland Government's policies about matters of state interest in land use planning and development. (A state interest is defined under the *Sustainable Planning Act 2009.*)

Water quality is a state interest. The SPP (state interest – water quality) seeks to ensure that 'the environmental values and quality of Queensland waters are protected and enhanced'. It includes provisions relating to planning schemes, acid sulfate soils and water supply buffer areas.

The provisions of the SPP are operationalised through the SPP code – water quality (Appendix 3 of the SPP). The purpose of the code is to 'ensure development is planned, designed, constructed and operated to manage stormwater and wastewater in ways that support the protection of environmental values identified in the Environmental Protection (Water) Policy 2009'. The code contains detailed performance objectives for planning schemes, development and land use activities to implement the code's purpose. These include stormwater management design objectives by climatic region (construction and post-construction phases).

The SPP (state interest – water quality) is supported by the State Planning Policy—state interest guideline – water quality. The SPP (including SPP code) and supporting guideline are available from the DSDIP website.

3.2 Water quality objectives to protect aquatic ecosystems and human use environmental values

This section lists the WQOs for the various water types at the stated levels of protection to protect the aquatic ecosystems environmental values for the surface waters of the Barron River basin and adjacent coastal waters at Section 2.

Procedures for the application of WQOs for aquatic ecosystem protection, and compliance assessment protocols can be found in Section 5 and Appendix D of the QWQG. For the comparison of test site monitoring data against WQOs, the median water quality value (e.g. concentration) of a number (preferably five or more) of independent samples at a particular monitoring ('test') site should be compared against the water quality objective of the same indicator, water type and level of aquatic ecosystem protection, as listed in table 2 below. For WQOs based on GBRMPA data, where single value WQOs are given for specified indicators (e.g. particulate N, Secchi depth), these should be compared to annual mean (rather than median) values. Relevant seasonal adjustments can be referenced in GBRMPA (2010) Water quality guidelines for the Great Barrier Reef Marine Park 2010. Also refer to notes after the tables.

WQOs for metals and other toxicants in sediments, in all cases reference is made to the ANZECC guidelines.

WQOs for metals and other toxicants in waters, where not stated in this document, are referred to the ANZECC guidelines. In the case of aluminium, reference is made to a recent peer reviewed study of toxicity of aluminium in marine waters by Golding et al. (2014). This study used ANZECC protocols to derive a marine guideline value of 24 µg/L of aluminium (that applies to the measured concentration in seawater that passes through an 0.45 µm filter) to protect 95% of species that applies to slightly to moderately disturbed waters, and 2.1 µg/L to protect 99% of species which applies to HEV waters. This supersedes the existing low reliability guideline of 0.5 µg/L that was derived using conservative safety margins from limited data.

- Golding, L.A., Angel, B.M., Batley, G.E., Apte, S.C., Krassoi, R. and Doyle, C.J. 2014. Derivation of a water quality guideline for aluminium in marine waters. Environmental Toxicology and Chemistry (Accepted) (DOI: 10.1002/etc.2771).

Water quality objectives for surface waters to protect the aquatic ecosystem environmental values

3.2.1 Surface water quality objectives

Tables 2.1 to 2.4 include the following information for the surface waters of the various catchments and adjacent coastal waters:

- Water quality objectives for physico-chemical, nutrient, algal and water clarity indicators under baseflow conditions—Table 2.1.
- Water quality objectives for nutrients and suspended solids during high flow periods—Table 2.2.
- Water quality objectives for specific pesticides and biocides—Table 2.3.
- Water quality objectives for other ions, metals and chemical indicators in surface waters—Table 2.4

Note: Event flow WQOs are provided in table 2.2. Unless otherwise stated all other WQOs provided are for application only during baseflow conditions.

Table 2.1 Water quality objectives for physico-chemical, nutrient, algal and water clarity indicators to protect the aquatic ecosystems EVs under baseflow conditions

Level of protection	Water type	Water quality objectives													
		Physico-chemical		Nutrients								Algal growth	Water clarity		
		DO	pH	Ammonia N	Oxidised N	Particulate N	Organic N	Total N	FRP	Particulate P	Total P	Chl-a	Turbidity	Secchi	TSS
		% Saturation		µg/L									NTU	m	mg/L
Table Notes		**Water Quality Objectives** shown as 20th, 50th and 80th percentiles (i.e. 3-4-5) or as a single value of median or 80th percentile (i.e. 15). DO and pH may be shown as a range of 20th and 80th percentiles (i.e. 85-105). **Seagrass:** Local seagrass distribution and composition is maintained as measured by extent of seagrass, species diversity and depth limit. Minimum light requirement for seagrass is a PAR two week moving average of greater than 6 mol m^{-2} day^{-1}. This is minimum requirement only for seagrass health and is generally below average harbour conditions. It does not include potential impacts on benthic microalgae and phytoplankton at this light level. Objective based on Chartrand et al. *(2012) Development of a Light-Based Seagrass Management Approach for the Gladstone Western Basin Dredging Program.* **Mangroves:** Objective of no net loss of mangrove area. The Queensland Herbarium conducts biennial mapping of mangrove cover and this could be used as an assessment tool. Mapping is available from EHP. **Wetlands:** for high impact earthworks within Great Barrier Reef wetland protection areas, refer to the guideline 'Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments', and the Queensland wetland buffer planning guideline, available from the department's website. Also refer to Section 3.2.3.													
High ecological value waters/ slightly disturbed waters	Undeveloped upland fresh water (HEV3021)	90-95-100[1]	6-6.5-7.5[1]	3-4-6[1]	10-15-30[1]	nd	75-100-125[1]	90-120-150[1]	3-4-5[1]	nd	5-7-10[1]	<0.5[1]	<1-2-5[1]	nd	2[3]
	Undeveloped lowland fresh water (HEV3021/ SD3021)	85-120[1]	6.0-8.0[1]	10[1]	30[1]	nd	200[1]	240[1]	4[1]	nd	10[1]	1.5[1]	15[1]	nd	2[3]
	Freshwater lakes/ reservoirs (HEV3021/ SD3021)	90-120[1]	6.0-8.0[1]	10[1]	10[1]	nd	330[1]	350[1]	5[1]	nd	10[1]	3[1]	2-200[1]	nd	nd
	Wetlands (HEV3021/ SD3021)	90-120[1]	6.0-8.0[1]	10[1]	10[1]	nd	330-1180[1]	350-1200[1]	5-25[1]	nd	10-50[1]	10[1]	2-200[1]	nd	nd
	Mid estuarine and tidal canals, constructed estuaries, marinas and boat harbours (SD3021)	80-85-105[1]	6.5-7.3-8.4[1]	5-10-15[1]	2-15-30[1]	nd	100-100-200[1]	110-130-250[1]	2-3-5[1]	nd	10-15-20[1]	1-2-3[1]	2-5-10[1]	1-1.5-2[1]	nd

Level of protection	Water type	Water quality objectives													
		Physico-chemical		Nutrients								Algal growth	Water clarity		
		DO	pH	Ammonia N	Oxidised N	Particulate N	Organic N	Total N	FRP	Particulate P	Total P	Chl-a	Turbidity	Secchi	TSS
		% Saturation		µg/L									NTU	m	mg/L
High ecological value waters/ slightly disturbed waters	Enclosed coastal/lower estuary (SD3021/ SD3121)	85-105[1]	7.5-8.4[1]	15[1]	10[1]	nd	135[1]	160[1]	5[1]	nd	20[1]	2.0[1]	10[1]	1[1]	nd
	Open coastal[2] (HEV3121/ SD3121)	95-100-105[2]	8.1-8.3-8.4[2]	1-3-7[2]	0-0-1[2]	≤20[2] (annual mean)	nd	75-105-140[2]	0-2-3[2]	≤2.8[2] (annual mean)	8-14-20[2]	<0.45[2] (annual mean)	0.6-0.9-1.8[2]	≥10[2] (annual mean)	≤2[2] (annual mean)
		Total dissolved N: 55-80-110 µg/L **Total dissolved P**: 4-8-18 µg/L **Silicate**: 90-165-260 µg/L **Temperature**: <1°C increase above long term (20 year) average maximum													
	Offshore waters[2] (HEV3122)	95-105[2]	8.1-8.3-8.4[2]	1-4-10[2]	0-1-2[2]	10-13-17[2]	nd	70-95-120[2]	0-1-3[2]	1.2-1.9-2.5[2]	4-6-10[2]	0.2-0.3-0.5[2]	<1[2]	10-13-16[2]	0.3-0.6-1.0[2]
		Total dissolved N: 55-75-95 µg/L **Total dissolved P**: 2-4-8 µg/L **Silicate**: 30-50-105 µg/L **Temperature**: <1°C increase above long term (20 year) average maximum													
Moderately disturbed waters	All developed fresh waters	85-120[1]	6.0-8.0[1]	<10[3]	<50[3]	nd	nd	<340[3]	<8[3]	nd	<25[3]	<1.5[1]	<15[1]	nd	<8[3]
	Freshwater lakes/ reservoirs	90-120[1]	6.0-8.0[1]	<10[1]	<10[1]	nd	<330[1]	<350[1]	<5[1]	nd	<10[1]	<3[1]	2-200[1]	nd	nd
	Wetlands	90-120[1]	6.0-8.0[1]	<10[1]	<10[1]	nd	330-1180[1]	350-1200[1]	5-25[1]	nd	10-50[1]	<10[1]	2-200[1]	nd	nd
	Mid estuarine and tidal canals, constructed estuaries, marinas and boat harbours	80-105[1]	6.5-8.4[1]	<15[1]	<30[1]	nd	<200[1]	<250[1]	<5[1]	nd	<20[1]	<3[1]	<10[1]	>1[1]	nd[1]
	Enclosed coastal/lower estuary	85-105[1]	6.5-8.4[1]	<15[1]	<10[1]	nd	<135[1]	<160[1]	<5[1]	nd	<20[1]	<2[1]	<10[1]	>1[1]	nd[1]

Level of protection	Water type	Water quality objectives													
		Physico-chemical		Nutrients								Algal growth	Water clarity		
		DO	pH	Ammonia N	Oxidised N	Particulate N	Organic N	Total N	FRP	Particulate P	Total P	Chl-a	Turbidity	Secchi	TSS
		% Saturation		µg/L									NTU	m	mg/L
Slightly – moderately disturbed waters	Open coastal[2]	95-105[2]	8.1-8.4[2]	≤3[2]	≤1[2]	≤20[2] (annual mean)	nd	≤105[2]	≤2[2]	≤2.8[2] (annual mean)	≤14[2]	≤0.45[2] (annual mean)	≤1[2]	≥10[2] (annual mean)	≤2[2] (annual mean)
		Total dissolved N: ≤80 µg/L **Total dissolved P**: ≤8 µg/L **Silicate**: ≥165 µg/L **Temperature**: <1°C increase above long term (20 year) average maximum													
Highly disturbed waters (long term objectives)		Assess existing water quality at the highly disturbed test site. Initial objective is to ensure no deterioration from this. Long-term objective is to attain the moderately disturbed objective value. Intermediate objectives can be set based on (a) 95%ile of reference values from a slightly disturbed reference site or (b) on references values from another site that is highly disturbed but that is nevertheless in measurably better condition than the test site[1].													
	Developed fresh water (HD3021)	85-120[1]	>6.0[1]	10[3]	50[3]	nd	nd	340[3]	8[3]	nd	25[3]	1.5[1]	15[1]	nd	8[3]
	Mid estuarine and tidal canals, constructed estuaries, marinas and boat harbours (HD3021)	80-105[1]	>6.5[1]	15[1]	30[1]	nd	200[1]	250[1]	5[1]	nd	20[1]	3[1]	10[1]	1[1]	nd

Notes:

- DO: dissolved oxygen, FRP: filterable reactive phosphorus, Chl-a: chlorophyll-a, TSS: total suspended solids. nd: no (or insufficient) data.
- Units % saturation: percent saturation, µg/L: micrograms per litre, NTU: nephelometric turbidity units, m: metres, mg/L: milligrams per litre.

Sources:

1. Queensland Water Quality Guidelines 2009.
2. GBRMPA analysis of Reef Rescue Marine Monitoring Program and/or Long Term Monitoring Program datasets.
3. Analysis of DSITIA water quality monitoring data and Great Barrier Reef Catchment Loads Monitoring Program.

Table 2.2 Water quality objectives for nutrients and suspended solids to protect aquatic ecosystem EVs during high flow periods

Water quality objectives	Ammonia N	Oxidised N	Particulate N	DON	TN	FRP	Particulate P	DOP	TP	TSS
Units	**µg/L**									**mg/L**
	WQOs apply to all fresh waters during high flow periods where discharge is above local baseflow.									
20^{th}-50^{th}-80^{th} percentiles	4-8-13	5-66-101	50-153-384	72-106-148	229-370-668	1-3-4	5-10-45	5-5-10	10-20-70	4-20-52

Notes:

1. High flow WQOs are based on measured data from high flow periods at a reference site on the Tully River in Tully Gorge National Park (gauging station 113015A).
2. DON: dissolved organic nitrogen, TN: total nitrogen, FRP: filterable reactive phosphorous, DOP: dissolved organic phosphorous, TP: total phosphorous, TSS: total suspended solids.

Source:

Orr, D., Turner, R.D.R., Huggins, R., Vardy, S., Warne, M. St. J. 2014. Wet Tropics water quality statistics for high and base flow conditions. Great Barrier Reef Catchment Loads Monitoring Program, Department of Science, Information Technology, Innovation and the Arts, Brisbane.

Table 2.3 Water quality objectives for specific pesticides and biocides to protect aquatic ecosystem EVs

Level of aquatic ecosystems protection	Water quality objectives												
	Water type	Pesticides											Biocide
		Diuron	Atrazine	Chlor-pyrifos	Endo-sulfan	Ametryn	Simazine	Hexa-zinone	2,4-D	Tebu-thiuron	MEMC	Diazinon	Tributlyltin (as Sn)
		µg/l											
High ecological value waters	All (HEV3021/ HEV3121/ HEV3122)	No detection of anthropogenic toxicants											
Slightly disturbed waters	Undeveloped fresh water (SD3021)	nd	0.7	0.00004	0.03	nd	0.2	75	140	0.2	nd	0.00003	nd
	Freshwater lakes/reservoirs	nd	0.7	0.00004	0.03	nd	0.2	75	140	0.2	nd	0.00003	nd
	Wetlands (SD3021)	nd	0.7	0.00004	0.03	nd	0.2	75	140	0.2	nd	0.00003	nd
	Mid estuarine and tidal canals, constructed estuaries, marinas and boat harbours (SD3021)	nd	0.7	0.00004	0.03	nd	0.2	75	140	0.2	nd	0.00003	nd
	Enclosed coastal/lower estuary (SD3021/ SD3121)	0.9	0.6	0.0005	0.005	0.5	0.2	1.2	0.8	0.02	0.002	0.00003	0.0004
	Open coastal (SD3121)	0.9	0.6	0.0005	0.005	0.5	0.2	1.2	0.8	0.02	0.002	0.00003	0.0004

Level of aquatic ecosystems protection	Water quality objectives												
	Water type	Pesticides											Biocide
		Diuron	Atrazine	Chlor-pyrifos	Endo-sulfan	Ametryn	Simazine	Hexa-zinone	2,4-D	Tebu-thiuron	MEMC	Diazinon	Tributlyltin (as Sn)
		µg/l											
Moderately disturbed and highly disturbed waters	Developed fresh water (HD3021)	nd	13	0.01	0.03	nd	3.2	75	280	2.2	nd	0.01	nd
	Freshwater lakes/reservoirs	nd	13	0.01	0.03	nd	3.2	75	280	2.2	nd	0.01	nd
	Wetlands	nd	13	0.010	0.03	nd	3.2	75	280	2.2	nd	0.01	nd
	Mid estuarine and tidal canals, constructed estuaries, marinas and boat harbours (HD3021)	nd	13	0.01	0.03	nd	3.2	75	280	2.2	nd	0.01	nd
	Enclosed coastal/lower estuary	1.6	1.4	0.009	0.005	1.0	3.2	1.2	30.8	2	0.002	0.01	0.006
	Open coastal	1.6	1.4	0.009	0.005	1.0	3.2	1.2	30.8	2	0.002	0.01	0.006

Notes:

1. nd = no data
2. For all other contaminants in waters, including **metals**—see ANZECC guidelines. For aluminium, refer to: Golding, L.A., Angel, B.M., Batley, G.E., Apte, S.C., Krassoi, R. and Doyle, C.J. 2014. Derivation of a water quality guideline for aluminium in marine waters. Environmental Toxicology and Chemistry (Accepted) (DOI: 10.1002/etc.2771).
3. Comply with the Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance, ANZECC (Re Tributyltin and Dibutyltin)

Source:

Freshwater and Mid estuarine WQOs derived from ANZECC (2000). Enclosed coastal/Lower estuary and Open coastal WQOs derived from GBRMPA (2010).

Table 2.4 Water quality objectives for other ions, metals and chemical indicators in surface waters

Percentile	Na		Ca		Mg		HCO_3		Cl		SO_4		EC	Hardness ($mg \cdot L^{-1}$)	Alkalinity ($mg \cdot L^{-1}$)	SiO_2 ($mg \cdot L^{-1}$)	F ($mg \cdot L^{-1}$)	Fe ($mg \cdot L^{-1}$)	Mn ($mg \cdot L^{-1}$)	Zn ($mg \cdot L^{-1}$)	Cu ($mg \cdot L^{-1}$)	SAR
	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$\mu S \cdot cm^{-1}$									
20th	5	40	2	16	1	17	14	47	6	28	1	2	47	8	11	10.1	0.010	0.010	0.000	0.000	0.00	0.60
50th	7	51	3	22	2	26	25	59	9	36	1	3	72	17	20	14.1	0.060	0.050	0.000	0.010	0.01	0.70
80th	11	66	5	28	4	34	40	68	14	48	2	6	106	29	33	21.1	0.110	0.200	0.010	0.020	0.03	0.95

Note:

1. These values are based on local data collected across the Wet Tropics region. ANZECC guidelines apply for some elements, however these locally observed data are below the guideline values and should be maintained.
2. EC = electrical conductivity; SAR = sodium adsorption ratio.

Source:

Queensland Wet Tropics and Black and Ross catchments: Regional chemistry of the groundwater. Queensland Government (Raymond, M. A. A. and V. H. McNeil, 2013).

3.2.2 Riparian and groundcover water quality objectives

The clearing of native vegetation in Queensland is regulated by the *Vegetation Management Act 1999* the *Sustainable Planning Act 2009* and associated policies and codes. This includes the regulation of clearing in water and drainage lines.

For vegetation management relating to waterways, reference should be made to:

- State Development Assessment Provisions (SDAP) Module 8: Native vegetation clearing. This module includes performance requirements relating to clearing of native vegetation and a table relating to watercourse buffer areas and stream order. To review the SDAP Modules, contact the Department of State Development, Infrastructure and Planning website.
- SDAP Module 11: Wetland protection area.
- relevant self-assessable codes under the *Vegetation Management Act 1999*. These codes are activity based, some applying to different regions, and include performance requirements relating to watercourses and wetlands, aimed at maintaining water quality, bank stability, aquatic and terrestrial habitat. Codes include vegetation clearing controls that vary according to stream order. To review the latest applicable self-assessable code (and other explanatory information), contact the Department of Natural Resources and Mines website.

To review the current vegetation management laws contact the Queensland Government website or Department of Natural Resources and Mines website.

To review the SDAP Modules, contact the Department of State Development, Infrastructure and Planning website.

Local Government Planning schemes under the *Sustainable Planning Act 2009* may also specify riparian buffers (for example under catchment protection or waterway codes). Contact the Department of State Development, Infrastructure and Planning website and local government websites for further information about planning schemes.

The **riparian vegetation** target up to 2018 in the Reef Water Quality Protection Plan (Reef Plan) 2013 is that “The extent of riparian vegetation is increased” and the **groundcover target** is for a “Minimum 70 per cent late dry season groundcover on grazing lands”.

3.2.3 Wetlands water quality objectives

The Environmental Protection Regulation section 81A defines Environmental values for wetlands.

The State assesses impacts from earth works that may have impacts on freshwater wetlands of High Ecological Significance in Great Barrier Reef Catchments against State Development Assessment Provisions (SDAP) Module 11: Wetland protection area.

This module includes performance requirements to ensure:

- adverse effects on hydrology, water quality and ecological processes of a wetland are avoided or minimised
- any significant adverse impacts on matters of state environmental significance and on riparian areas or wildlife corridors in strategic environmental areas are avoided.

Note: refer to the guideline 'Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments', and the Queensland wetland buffer planning guideline, available from the department’s website.

Water quality objectives to protect the human use environmental values

3.3 Water quality objectives for human use environmental values

This section outlines the WQOs to protect human use EVs, e.g. recreation, stock watering, aquaculture and crop irrigation. Tables 3.1 to 3.10 list the WQOs to protect the human use EVs for the waters of the Barron River basin and adjacent coastal waters.

The WQOs in these tables are based on national water quality guidelines, including ANZECC (2000), the National Health and Medical Research Council Guidelines for managing risks in recreational water, the Food Standards Australia New Zealand and the Australian Drinking Water Guidelines[5].

Where national guidelines are the source for the stated WQOs, reference is necessary to obtain comprehensive listings of all indicators, corresponding WQOs and up-to-date information.

Table 3.1 Water quality objectives to protect human use environmental values

Environmental value	Water type—refer attached pdf mapping or GIS datasets	Water quality objectives to protect the stated EV
Suitability for raw drinking water supply (before treatment)	Fresh waters and groundwaters	WQOs for drinking water supply are at table 3.2. Note: For water quality after treatment or at point of use refer to legislation and guidelines, including: • *Public Health Act 2005* and Regulations • *Water Supply (Safety and Reliability) Act 2008*, including any approved drinking water quality management plan under the Act • Australian Drinking Water Guidelines 2011—updated December 2013
Protection of the human consumer (oysters, fish crustaceans)	All fresh, estuarine and coastal waters	WQOs as per ANZECC guidelines and Australia New Zealand Food Standards Code[6], Food Standards Australia New Zealand, 2007 and updates.
Protection of cultural and spiritual values	All waters	Protect or restore indigenous and non-indigenous cultural heritage consistent with any relevant policies and plans.
Suitability for industrial use (includes mining, minerals processing, chemical process industries etc.)	Fresh waters, estuarine and coastal waters	No WQOs are stated for industrial uses of water. Water quality requirements for industry vary within and between industries. Where there are specific intake water quality requirements e.g. power station cooling water, the EV is protected by WQOs for other EVs, such as the aquatic ecosystem requirements.

[5] The AWQG are available on the National Water Quality Management Strategy website.
The ADWG are available on the NHMRC website.

[6] The Australia New Zealand Food Standards Code is available on the Food Standards Australia and New Zealand website.

Environmental value	Water type—refer attached pdf mapping or GIS datasets	Water quality objectives to protect the stated EV
Suitability for aquaculture	Fresh waters, estuarine and coastal waters	WQOs as per: • tables 3.3 to 3.5 • ANZECC guidelines and Australia New Zealand Food Standards Code, Food Standards Australia New Zealand, 2007 and updates.
Suitability for irrigation	Fresh waters and groundwaters	WQOs for pathogens and metals are provided in tables 3.6 and 3.7. For other indicators, such as salinity, sodicity and herbicides, see ANZECC guidelines
Suitability for stock watering	Fresh waters and groundwaters	WQOs as per ANZECC guidelines, including median faecal coliforms <100 organisms per 100 mL. WQOs for total dissolved solids and metals are provided in tables 10 and 11. For other objectives, such as cyanobacteria and pathogens, see ANZECC guidelines.
Suitability for farm supply/use	All fresh waters including groundwaters	WQOs as per ANZECC guidelines
Suitability for primary contact recreation	Fresh waters, estuarine and coastal waters	Objectives as per NHMRC (2008)[7], including: • water free of physical (floating and submerged) hazards • temperature range: 16–34°C • pH range: 6.5–8.5 • DO: >80% • faecal contamination: designated recreational waters are protected against direct contamination with fresh faecal material, particularly of human or domesticated animal origin. Two principal components are required for assessing faecal contamination: − assessment of evidence for the likely influence of faecal material − counts of suitable faecal indicator bacteria (usually *enterococci*) These two components are combined to produce an overall microbial classification of the recreational water body. • intestinal enterococci: 95th percentile ≤40 organisms per 100mL (for healthy adults) (NHMRC, 2008; table 5.7) • direct contact with venomous or dangerous aquatic organisms should be avoided. Recreational water bodies should be reasonably free of, or protected from, venomous organisms (e.g. box jellyfish and bluebottles) • waters contaminated with chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreational purposes.

[7] Guidelines for Managing Risks in Recreational Water are available on the NHMRC website.

Environmental value	Water type—refer attached pdf mapping or GIS datasets	Water quality objectives to protect the stated EV
Suitability for primary contact recreation – continued	Fresh waters	• cyanobacteria / algae: Recreational water bodies should not contain: – level 1[1]: ≥10 µg/L total microcystins; or ≥50 000 cells/mL toxic *Microcystis aeruginosa*; or biovolume equivalent of ≥4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume or – level 2[1]: ≥10 mm^3/L for total biovolume of all cyanobacterial material where known toxins are not present or – cyanobacterial scums consistently present. Further details are contained in NHMRC (2008) and table 3.10.
	Estuarine, coastal waters	cyanobacteria / algae: Recreational water bodies should not contain ≥ 10 cells/mL *Karenia brevis* and/or have *Lyngbya majuscula* and/or *Pfiesteria* present in high numbers[2]. Further details are contained in NHMRC (2008) and table 3.10.
Suitability for secondary contact recreation	Fresh waters, estuarine and coastal waters	Objectives as per NHMRC (2008), including: • intestinal enterococci: 95th percentile ≤ 40 organisms per 100mL (for healthy adults) (NHMRC, 2008; table 5.7) • cyanobacteria / algae—refer objectives for primary recreation, NHMRC (2008) and table 3.10.
Suitability for visual recreation	Fresh waters, estuarine and coastal waters	Objectives as per NHMRC (2008), including: • recreational water bodies should be aesthetically acceptable to recreational users. The water should be free from visible materials that may settle to form objectionable deposits; floating debris, oil, scum and other matter; substances producing objectionable colour, odour, taste or turbidity; and substances and conditions that produce undesirable aquatic life. • Cyanobacteria / algae—refer objectives for primary recreation, NHMRC (2008) and table 3.10

Notes:

1. Level 1 recognises the probability of adverse health effects from ingestion of known toxins, in this case based on the toxicity of microcystins. Level 2 covers circumstances in which there are very high cell densities of cyanobacterial material, irrespective of the presence of toxicity or known toxins. Increased cyanobacterial densities increase the likelihood of non-specific adverse health outcomes, principally respiratory, irritation and allergy symptoms. (NHMRC, 2008; 8).
2. The NHMRC states that its guidelines are concerned 'only with risks that may be associated with recreational activities in or near coastal and estuarine waters. This includes exposure through dermal contact, inhalation of sea-spray aerosols and possible ingestion of water or algal scums, but does not include dietary exposure to marine algal toxins.' (NHMRC, 2008; 121).

Sources:

The WQOs were determined from:

- Australian Drinking Water Guidelines (NHMRC, 2011)
- Australia New Zealand Food Standards Code (Australian Government)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000)
- Guidelines for Managing Risks in Recreational Water (NHMRC, 2008).

Table 3.2 Drinking water EV – Water quality objectives for raw drinking water supply in the vicinity of off-takes, including groundwater, before treatment

WQOs for drinking water **before treatment** are derived from the Office of the Water Supply Regulator (Department of Energy and Water Supply) and Queensland Health.

Note: For water quality after treatment or at the point of use, refer to relevant legislation and guidelines, including *Public Health Act 2005* and Regulations, *Water Supply (Safety and Reliability) Act 2008*, including any approved drinking water management plan under the Act, *Water Fluoridation Act 2008*, and the Australian Drinking Water Guidelines (ADWG (2011), 2013 update).

Indicator	Water quality objective
Giardia	0 cysts (Office of Water Supply Regulator) If *Giardia* is detected in drinking water then the health authorities should be notified immediately and an investigation of the likely source of contamination undertaken (ADWG).
Cryptosporidium	0 cysts (Office of Water Supply Regulator) If *Cryptosporidium* is detected in drinking water then the health authorities should be notified immediately and an investigation of the likely source of contamination undertaken (ADWG).
E. coli	<50 cfu/100mL Treatment plants with effective barriers and disinfection are designed to address faecal contamination. *E. coli* or thermotolerant coliforms should not be present in any 100 mL sample of (treated) drinking water (ADWG).
Blue-green algae (cyanobacteria)	<100 cells/mL
Algal toxin	<1 µg/L Microcystin
pH	5.5–8
Total dissolved solids	<600mg/L The concentration of total dissolved solids in treated drinking water should not exceed 600 mg/L (ADWG 2011, based on taste considerations).
Sodium	<180mg/L The concentration of sodium in reticulated drinking water supplies should not exceed 180 mg/L (ADWG, based on threshold at which taste becomes appreciable).
Sulfate	<250mg/L The concentration of sulfate in drinking water should not exceed 250 mg/L (ADWG 2011, based on taste/aesthetic considerations). ADWG 2011 health guideline: <500mg/L
Dissolved oxygen	5.5–7 mg/L

Indicator	Water quality objective
Pesticides	Raw supplies: Below detectable limits. Treated drinking water: Refer to ADWG.
Other indicators (including physico-chemical indicators)	Refer to ADWG.

Table 3.3 Aquaculture EV – Water quality objectives for tropical aquaculture

Water parameter	Recommended range		Water parameter	Recommended range
	Fresh water	Marine		General aquatic
Dissolved oxygen	>4 mg/L	>4 mg/L	**Arsenic**	<0.05 mg/L
Temperature ˚C	21–32	24–33	**Cadmium**	<0.003 mg/L
pH	6.8–9.5	7–9.0	**Calcium/Magnesium**	10–160 mg/L
Ammonia (TAN, total ammonia-nitrogen)	<1.0 mg/L	<1.0 mg/L	**Chromium**	<0.1 mg/L
Ammonia (NH_3, un-ionised form)	<0.1 mg/L	<0.1 mg/L	**Copper**	<0.006 mg/L in soft water
Nitrate (NO_3)	1–100 mg/L	1–100 mg/L	**Cyanide**	<0.005 mg/L
Nitrite (NO_2)	<0.1 mg/L	<1.0 mg/L	**Iron**	<0.5 mg/L
Salinity	0–5 ppt	15–35 ppt	**Lead**	<0.03 mg/L
Hardness	20–450 mg/L		**Manganese**	<0.01 mg/L
Alkalinity	20–400 mg/L	>100mg/L	**Mercury**	<0.00005 mg/L
Turbidity	<80 NTU		**Nickel**	<0.01 mg/L in soft water <0.04 mg/L in hard water
Chlorine	<0.003 mg/L		**Tin**	<0.001 mg/L
Hydrogen sulphide	<0.002 mg/L		**Zinc**	0.03–0.06 mg/L in soft water 1–2 mg/L in hard water

Source: Department of Primary Industries and Fisheries: Water Quality in Aquaculture—DPI Notes April 2004.

Table 3.4 Aquaculture EV – Water quality objectives for optimal growth of freshwater species

Water parameter	Barramundi	Eel	Silver perch	Jade perch	Sleepy cod	Redclaw
Dissolved oxygen	4–9 mg/L	>3 mg/L	>4 mg/L	>3 mg/L	>4.0 mg/L	>4.0 mg/L
Temperature ˚C	26–32	23–28	23–28	23–28	22–31	23–31
pH	7.5–8.5	7.0–8.5	6.5–9	6.5–9	7.0–8.5	7.0–8.5
Ammonia (TAN, Total ammonia-nitrogen)		<1.0 mg/L			<1.0 mg/L	<1.0 mg/L
Ammonia (NH_3, un-ionised form)*pH dependent.	<0.46 mg/L	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L
Nitrate (NO_3)			<100 mg/L			
Nitrite (NO_2)	<1.5 mg/L	<1.0 mg/L	<0.1 mg/L		<1.0 mg/L	<1.0 mg/L
Salinity (extended periods)	0–35 ppt		<5 ppt	<5 ppt		<4 ppt
Salinity bath	0–35 ppt		5–10 ppt for 1 hour		max. 20 ppt for one hour	
Hardness ($CaCO_3$)			>50 mg/L	>50 mg/L	>40 mg/L	>40 mg/L
Alkalinity	>20 mg/L		100–400 ppm	100–400 ppm	>40 mg/L	>40 mg/L
Chlorine	<0.04 mg/L				<0.04 mg/L	
Hydrogen sulphide	0–0.3 mg/L				0–0.3 mg/L	
Iron	<0.1 mg/L		<0.5 mg/L	<0.5 mg/L	<0.1 mg/L	<0.1 mg/L
Spawning temperature ˚C	Marine		23–28	23–28	>24 for more than three days	

Source: Department of Primary Industries and Fisheries: Water Quality in Aquaculture—DPI Notes April 2004.

Table 3.5 Aquaculture EV – Water quality objectives for optimal growth of particular marine species

Water parameter	Barramundi		Tiger prawn		Kuruma prawn
	Hatchery	Grow out	Hatchery	Grow out	Grow out
Dissolved oxygen	Saturation	>4 mg/L	>4 mg/L	>3.5 mg/L	>4 mg/L
Temperature ˚C	28–30 optimum 25–31 range	28–30 optimum		26–32	24
pH	~8	~8	~8	7.5–8.5	7.5–8.5
Ammonia (TAN, total ammonia-nitrogen)		0.1–0.5 mg/L			
Ammonia (NH_3, un-ionised form)	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L
Nitrate (NO_3)	<1.0 mg/L	<1.0 mg/L	<1.0 mg/L	<1.0 mg/L	<1.0 mg/L
Nitrite (NO_2)	<0.2 mg/L	<1.0 mg/L	<0.2 mg/L	<0.2 mg/L	<0.2 mg/L
Salinity	28–31 ppt	0–35 ppt		10–25 ppt optimum	30–35 ppt optimum
Alkalinity		105–125 mg/L $CaCO_3$			
Clarity				30–40 cm Secchi disk	30–40 cm Secchi disk
Hydrogen sulphide		<0.3 mg/L			
Iron		<0.02 mg/L		<1.0 mg/L	
Spawning temperature ˚C		28–32		27–32	

Source: Department of Primary Industries and Fisheries—Water Quality in Aquaculture—DPI Notes April 2004 (as amended).

Table 3.6 Irrigation EV – Water quality objectives for thermotolerant (faecal) coliforms in irrigation water used for food and non-food crops[1]

Intended use	Median values of thermotolerant coliforms (colony forming units—cfu)[2]
Raw human food crops in direct contact with irrigation water (e.g. via sprays, irrigation of salad vegetables)	<10 cfu/100 mL
Raw human food crops not in direct contact with irrigation water (edible product separated from contact with water, e.g. by peel, use of trickle irrigation); or crops sold to consumers cooked or processed	<1000 cfu/100 mL
Pasture and fodder for dairy animals (without withholding period)	<100 cfu/100 mL
Pasture and fodder for dairy animals (with withholding period of five days)	<1000 cfu/100 mL
Pasture and fodder (for grazing animals except pigs and dairy animals, i.e. cattle, sheep and goats)	<1000 cfu/100 mL
Silviculture, turf, cotton, etc. (restricted public access)	<10 000 cfu/100 mL

Notes:

1. Adapted from ARMCANZ, ANZECC and NHMRC (1999).
2. Refer to Australian Drinking Water Guidelines 2000 (AWQG), Volume 1, Section 4.2.3.3 for advice on testing protocols.

Source: AWQG, Volume 1, Section 4.2.3.3, table 4.2.2.

Table 3.7 Irrigation EV – Water quality objectives for heavy metals and metalloids in agricultural irrigation water[1] – long term trigger value (LTV), short-term trigger value (STV) and soil cumulative contamination loading limit (CCL)

Element	Soil cumulative contaminant loading limit (CCL) (kg/ha)[2]	Long-term trigger value (LTV) in irrigation water (up to 100 years) (mg/L)	Short-term trigger value (STV) in irrigation water (up to 20 years) (mg/L)
Aluminium	ND	5	20
Arsenic	20	0.1	2.0
Beryllium	ND	0.1	0.5
Boron	ND	0.5	Refer to AWQG, Vol 3, table 9.2.18
Cadmium	2	0.01	0.05
Chromium	ND	0.1	1
Cobalt	ND	0.05	0.1
Copper	140	0.2	5
Fluoride	ND	1	2
Iron	ND	0.2	10
Lead	260	2	5
Lithium	ND	2.5 (0.075 for citrus crops)	2.5 (0.075 for citrus crops)
Manganese	ND	0.2	10
Mercury	2	0.002	0.002
Molybdenum	ND	0.01	0.05
Nickel	85	0.2	2
Selenium	10	0.02	0.05
Uranium	ND	0.01	0.1
Vanadium	ND	0.1	0.5
Zinc	300	2	5

Notes:

1. Concentrations in irrigation water should be less than the trigger values. Trigger values should only be used in conjunction with information on each individual element and the potential for off-site transport of contaminants.
2. ND = Not determined; insufficient background data to calculate CCL.

Source: AWQG, Volume 1, Section 4.2.6, table 4.2.10.

Table 3.8 Stock watering EV – Water quality objectives for tolerances of livestock to total dissolved solids (salinity) in drinking water[1]

Livestock	Total dissolved solids (TDS) (mg/L)		
	No adverse effects on animals expected.	Animals may have initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production	Loss of production and decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually
Beef cattle	0–4000	4000–5000	5000–10 000
Dairy cattle	0–2500	2500–4000	4000–7000
Sheep	0–5000	5000–10 000	10 000–13 000[2]
Horses	0–4000	4000–6000	6000–7000
Pigs	0–4000	4000–6000	6000–8000
Poultry	0–2000	2000–3000	3000–4000

Notes:

1. From ANZECC (1992), adapted to incorporate more recent information.
2. Sheep on lush green feed may tolerate up to 13 000 mg/L TDS without loss of condition or production.

Source: AWQG, Volume 1, Section 4.3.3.5, table 4.3.1.

Table 3.9 Stock watering EV – Water quality objectives (low risk trigger values) for heavy metals and metalloids in livestock drinking water

Metal or metalloid	Trigger value (low risk)[1,2] (mg/L)
Aluminium	5
Arsenic	0.5 (up to 5[3])
Beryllium	ND
Boron	5
Cadmium	0.01
Chromium	1
Cobalt	1
Copper	0.4 (sheep), 1 (cattle), 5 (pigs), 5 (poultry)
Fluoride	2
Iron	not sufficiently toxic
Lead	0.1
Manganese	not sufficiently toxic
Mercury	0.002
Molybdenum	0.15
Nickel	1
Selenium	0.02
Uranium	0.2
Vanadium	ND
Zinc	20

Notes:

1. Higher concentrations may be tolerated in some situations (further details provided in AWQG, Volume 3, Section 9.3.5).
2. ND = not determined, insufficient background data to calculate.
3. May be tolerated if not provided as a food additive and natural level in the diet are low.

Source: AWQG, Volume 1, Section 4.3.4, table 4.3.2.

Table 3.10 Recreational waters – Alert levels and corresponding actions for management of cyanobacteria

The water quality objectives for water used for recreational purposes are that the values for cyanobacteria cell counts or biovolume meet the guideline values set out in Chapter 6 of the Guidelines for Managing Risks in Recreational Water.

When cyanobacteria are present in large numbers they can present a significant hazard, particularly to primary contact users of waters. Monitoring/action requirements relative to cyanobacteria 'alert' levels are summarised below the table, and are explained more fully in the Guidelines for Managing Risks in Recreational Water (NHMRC, 2008).

Further details on the process to determine suitability of waters for recreation, relative to historical cyanobacterial levels and susceptibility to cyanobacterial contamination, are contained in sections 6 and 7 of the NHMRC guidelines.

Green level surveillance mode[1]	Amber level alert mode[1]	Red level action mode[1]
Fresh waters		
≥500 to <5000 cells/mL *M. aeruginosa* or biovolume equivalent of >0.04 to <0.4 mm^3/L for the combined total of all cyanobacteria.	≥5000 to <50 000 cells/mL *M. aeruginosa* or biovolume equivalent of ≥0.4 to <4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume[2]. or[3] ≥0.4 to <10 mm^3/L for the combined total of all cyanobacteria where known toxin producers are not present.	Level 1 guideline[4]: ≥10 µg/L total microcystins or ≥50 000 cells/mL toxic *M. aeruginosa* or biovolume equivalent of ≥4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume. or[3] Level 2 guideline[4]: ≥10 mm^3/L for total biovolume of all cyanobacterial material where known toxins are not present. or cyanobacterial scums are consistently present[5].
Coastal and estuarine waters		
Karenia brevis		
≤1 cell/mL	>1– <10 cells/mL	≥10 cells/mL
Lyngbya majuscula, Pfiesteria spp.		
History but no current presence of organism	Present in low numbers	Present in high numbers. (For *Lyngbya majuscula* this involves the relatively widespread visible presence of dislodged algal filaments in the water and washed up onto the beach)
Nodularia spumigena: See NHMRC, Chapter 6 (Cyanobacteria and algae in fresh water) for details.		

Notes:

1. Recommended actions at different alert levels are outlined below (based on NHMRC, 2008, table 6.6—fresh waters. Similar actions are outlined for coastal/estuarine waters in NHMRC table 7.6):

   Green: Regular monitoring. Weekly sampling and cell counts at representative locations in the water body where known toxigenic species are present (i.e. *Microcystis aeruginosa, Anabaena circinalis, Cylindrospermopsis raciborskii, Aphanizomenon ovalisporum, Nodularia spumigena*); or fortnightly for other types including regular visual inspection of water surface for scums.

Amber: Notify agencies as appropriate. Increase sampling frequency to twice weekly at representative locations in the water body where toxigenic species (above) are dominant within the alert level definition (i.e. total biovolume) to establish population growth and spatial variability in the water body. Monitor weekly or fortnightly where other types are dominant. Make regular visual inspections of water surface for scums. Decide on requirement for toxicity assessment or toxin monitoring.
Red: Continue monitoring as for (amber) alert mode. Immediately notify health authorities for advice on health risk. ('In action mode the local authority and health authorities warn the public of the existence of potential health risks; for example, through the media and the erection of signs by the local authority.' NHMRC, 2008; 114). Make toxicity assessment or toxin measurement of water if this has not already been done. Health authorities warn of risk to public health (i.e. the authorities make a health risk assessment considering toxin monitoring data, sample type and variability).

2. The definition of 'dominant' is where the known toxin producer comprises 75 per cent or more of the total biovolume of cyanobacteria in a representative sample.
3. This applies where high cell densities or scums of 'non toxic' cyanobacteria are present i.e. where the cyanobacterial population has been tested and shown not to contain known toxins (mycrocystins, nodularian, cylindrospermopsin or saxitoxin).
4. Health risks and levels: Level 1 is developed to protect against short-term health effects of exposure to cyanobacterial toxins ingested during recreational activity, whereas the Level 2 applies to the circumstance where there is a probability of increased likelihood of non-specific adverse health outcomes, principally respiratory, irritation and allergy symptoms, from exposure to very high cell densities of cyanobacterial material irrespective of the presence of toxicity or known toxins (NHMRC, 2008;114).
5. This refers to the situation where scums occur at the recreation site each day when conditions are calm, particularly in the morning. Note that it is not likely that scums are always present and visible when there is a high population as the cells may mix down with wind and turbulence and then reform later when conditions become stable.

Source: Based on NHMRC (2008) Guideline for Managing Risks in Recreational Water (tables 6.2, 6.6, 7.3).

Water quality objectives to protect groundwater environmental values

3.4 Water quality objectives to protect groundwater environmental values

This section lists WQOs for the various groundwater types to protect the aquatic ecosystems environmental values stated for the groundwaters of the Barron River basin at Section 2.

WQOs are provided according to their chemistry zone and depth category in tables 4.1 to 4.9.

Where groundwaters interact with surface waters, groundwater quality should not compromise identified EVs and WQOs for those waters.

The AWQG recommends that the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value.

Where groundwaters are in good condition the intent is to maintain existing water quality (20th, 50th and 80th percentiles).

3.4.1 **Wet Tropics groundwater chemistry groups**

The groundwater chemistry zones in the Barron River basin are shown in Plan WQ1083. This plan shows the EVs of groundwater chosen for protection. Groundwater chemistry zones on the plan are labelled with the relevant identification number outlined in the list below.

The major groups include:

Wet tropical alluvial:

- ID No. 17 – East Mareeba Dimbula Irrigation area (Table 4.1)
- ID No. 18 – Barron Mulgrave Johnstone metamorphics (Table 4.2)
- ID No. 19 – Daintree Nth Barron uplands and slopes (Table 4.3)
- ID No. 23 – Basalt uplands and slopes (Table 4.4).

Sodic:

- ID No. 10 – Granitic uplands and slopes (Table 4.5).

Coastal and floodplain:

- ID No. 9 – Low salinity coastal floodplains (Table 4.6).

High salinity alluvial deposits:

- ID No. 3 – Ellie (Table 4.7)
- ID No. 7 – Clohesy (Table 4.8).

High sulphate:

- ID No. 26 – NE Caravonica (Table 4.9).

Table 4.1 Water quality objectives to protect aquatic ecosystem EVs for Groundwater Chemistry Group (refer Plan WQ1083) – Wet Tropical Alluvial – 17 East Mareeba Dimbula Irrigation area

Depth	Percentile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hardness ($mg \cdot L^{-1}$)	pH	Alkalinity ($mg \cdot L^{-1}$)	SiO_2 ($mg \cdot L^{-1}$)	F ($mg \cdot L^{-1}$)	Fe ($mg \cdot L^{-1}$)	Mn ($mg \cdot L^{-1}$)	Zn ($mg \cdot L^{-1}$)	Cu ($mg \cdot L^{-1}$)	SAR	RAH ($meq L^{-1}$)	eH (mV)
		$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$\mu S \cdot cm^{-1}$												
shallow	20th	27	52	5	2	4	5	141	38	24	19	-	-	-	-	262	28	6.8	71	38.4	0.404	0.000	0.010	0.000	0.00	1.70	0.89	-
	50th	150	75	8	9	13	15	283	67	34	37	-	-	0	0	816	65	7.6	228	70.0	0.580	0.075	0.080	0.000	0.00	5.35	3.49	-
	80th	788	91	23	15	47	30	853	82	844	67	1	2	1	0	3,776	245	8.2	683	95.3	1.523	0.643	2.427	0.000	0.00	22.66	7.55	-
moderate	20th	44	30	11	17	15	14	160	41	38	17	-	-	-	-	370	89	7.2	132	45.6	0.183	0.000	0.000	0.000	0.00	1.48	0.69	-
	50th	87	56	34	22	22	22	365	69	65	27	2	1	0	0	710	191	8.0	313	65.0	0.200	0.005	0.000	0.000	0.00	3.50	0.98	-
	80th	171	69	44	24	50	46	459	83	177	57	9	2	3	1	1,199	296	8.2	382	69.7	0.370	0.020	0.550	0.000	0.00	4.70	3.35	-
deep	20th	38	36	25	26	14	26	183	56	30	21	0	0	-	-	397	121	7.2	151	43.1	0.310	0.000	0.003	0.000	0.00	1.47	0.58	-
	50th	41	41	27	30	15	28	196	75	36	24	2	0	-	-	422	129	7.6	161	64.0	0.460	0.000	0.060	0.010	0.00	1.60	0.78	-
	80th	105	48	62	32	45	34	377	78	133	40	4	1	8	2	990	342	8.2	318	67.3	0.530	0.030	0.087	0.020	0.00	2.56	2.59	-

Table 4.2 Water quality objectives to protect aquatic ecosystem EVs for Groundwater Chemistry Group (refer Plan WQ1083) – Wet Tropical Alluvial – 18 Barron Mulgrave Johnstone metamorphics

Depth	Percentile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hardness ($mg{\cdot}L^{-1}$)	pH	Alkalinity ($mg{\cdot}L^{-1}$)	SiO_2 ($mg{\cdot}L^{-1}$)	F ($mg{\cdot}L^{-1}$)	Fe ($mg{\cdot}L^{-1}$)	Mn ($mg{\cdot}L^{-1}$)	Zn ($mg{\cdot}L^{-1}$)	Cu ($mg{\cdot}L^{-1}$)	SAR	RAH ($meqL^{-1}$)	eH (mV)
		$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$\mu S{\cdot}cm^{-1}$												
shallow	20th	8	45	2	12	1	11	23	41	5	19	-	-	-	-	66	8	6.4	19	12.0	0.003	0.000	0.000	0.000	0.00	0.80	0.10	-
	50th	10	59	4	24	2	13	32	68	7	25	-	-	2	2	105	18	6.7	26	18.0	0.100	0.010	0.020	0.015	0.01	0.90	0.22	-
	80th	13	75	9	35	3	21	55	75	19	44	2	3	7	13	144	34	7.1	45	36.0	0.119	1.026	0.401	0.030	0.01	1.59	0.32	-
moderate	20th	8	40	3	12	1	9	18	34	6	13	-	-	-	-	90	12	6.5	16	14.9	0.043	0.000	0.000	0.000	0.00	0.80	0.00	-
	50th	13	56	6	19	3	21	52	62	9	25	2	2	2	2	143	28	7.3	47	24.0	0.200	0.000	0.000	0.000	0.00	1.10	0.33	-
	80th	97	76	25	35	13	29	173	78	61	51	6	6	7	12	570	115	7.9	151	40.1	0.500	0.020	0.030	0.010	0.01	2.98	1.36	-
deep	20th	8	47	1	8	1	11	16	38	5	12	-	-	-	-	71	6	6.5	13	17.0	0.010	0.000	0.000	0.000	0.00	0.81	0.12	-
	50th	13	57	3	16	3	26	42	66	7	26	1	1	1	0	110	20	7.0	35	23.0	0.110	0.000	0.000	0.008	0.00	1.35	0.30	-
	80th	38	82	8	24	8	31	106	85	25	45	3	3	4	9	305	51	7.7	88	33.9	0.362	0.049	0.181	0.024	0.02	2.39	0.70	-
very deep	20th	15	77	2	8	1	9	22	38	11	25	0	0	0	0	98	9	6.4	18	22.0	0.524	0.000	0.000	0.000	0.00	2.20	0.10	-
	50th	17	80	2	10	1	10	35	57	12	32	1	4	5	4	119	10	7.2	29	22.5	0.620	0.015	0.000	0.000	0.00	2.25	0.33	-
	80th	20	84	8	12	4	11	50	63	17	34	4	9	15	22	166	37	7.8	41	24.8	0.695	0.700	0.063	0.000	0.00	2.40	0.40	-

Table 4.3 Water quality objectives to protect aquatic ecosystem EVs for Groundwater Chemistry Group (refer Plan WQ1083) – Wet Tropical Alluvial – 19 Daintree-Nth Barron uplands and slopes

Depth	Percentile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hardness	pH	Alkalinity	SiO_2	F	Fe	Mn	Zn	Cu	SAR	RAH	eH
		$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$\mu S{\cdot}cm^{-1}$	$(mg{\cdot}L^{-1})$		$(mg{\cdot}L^{-1})$	$(mg{\cdot}L^{-1})$	$(mg{\cdot}L^{-1})$	$(mg{\cdot}L^{-1})$	$(mg{\cdot}L^{-1})$	$(mg{\cdot}L^{-1})$	$(mg{\cdot}L^{-1})$		$meqL^{-1}$	
shallow	20th	7	56	1	5	1	13	10	17	10	39	-	-	-	-	64	9	6.0	10	13.0	0.000	0.000	0.000	0.010	0.01	1.33	0.00	-
	50th	16	66	2	9	3	22	20	32	20	57	-	0	3	4	115	17	6.7	16	18.0	0.080	0.000	0.000	0.050	0.01	1.60	0.00	-
	80th	28	77	4	24	5	27	41	52	31	71	3	6	10	13	167	26	7.3	34	33.5	0.263	0.019	0.010	0.080	0.02	2.40	0.19	-
moderate	20th	15	57	2	8	3	17	18	25	18	38	-	-	-	-	120	17	6.4	14	19.0	0.100	0.000	0.000	0.011	0.00	1.41	0.00	-
	50th	19	64	4	14	4	22	35	39	28	57	0	0	1	1	145	26	7.1	29	27.0	0.195	0.000	0.000	0.030	0.00	1.80	0.05	-
	80th	25	69	6	24	5	25	49	55	34	64	2	4	3	5	189	34	7.6	40	37.5	0.356	0.010	0.000	0.048	0.01	1.90	0.57	-
deep	20th	8	41	4	27	3	14	31	52	13	16	2	2	-	-	95	23	6.9	25	14.4	0.130	0.000	0.000	0.030	0.00	0.73	0.08	-
	50th	29	46	7	32	4	17	53	61	15	30	4	4	-	-	225	31	7.4	43	46.0	0.200	0.000	0.000	0.030	0.01	1.10	0.29	-
	80th	33	51	36	44	8	24	178	79	37	38	5	7	1	1	341	120	7.6	147	51.6	0.990	0.015	0.075	0.030	0.02	1.57	0.85	-
v deep		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-												
artesian	20th	20	60	2	9	4	22	24	29	31	52	-	-	-	-	153	23	6.3	20	8.8	0.000	-	-	0.000	0.00	1.63	-	-
	50th	22	65	3	11	4	24	27	32	33	67	-	-	-	-	160	24	6.6	22	13.5	0.150	-	-	0.000	0.00	1.80	-	-
	80th	23	69	4	12	6	29	51	47	34	70	-	-	-	-	195	32	7.3	42	23.1	0.720	-	-	0.000	0.00	2.04	-	-

Table 4.4 Water quality objectives to protect aquatic ecosystem EVs for Groundwater Chemistry Group (refer Plan WQ1083) – Wet Tropical Alluvial – 19 Basalt uplands and slopes

Depth	Percentile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hardness ($mg \cdot L^{-1}$)	pH	Alkalinity ($mg \cdot L^{-1}$)	SiO_2 ($mg \cdot L^{-1}$)	F ($mg \cdot L^{-1}$)	Fe ($mg \cdot L^{-1}$)	Mn ($mg \cdot L^{-1}$)	Zn ($mg \cdot L^{-1}$)	Cu ($mg \cdot L^{-1}$)	SAR	RAH ($meq L^{-1}$)	eH (mV)
		$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$\mu S \cdot cm^{-1}$												
shallow	20th	4	32	1	10	2	22	11	39	6	20	-	-	1	1	58	9	5.9	10	10.0	0.000	0.000	0.000	0.000	0.00	0.50	0.00	466.3
	50th	9	43	3	23	3	30	29	55	11	32	1	1	5	8	75	18	6.6	28	32.0	0.020	0.005	0.000	0.010	0.01	0.85	0.11	566.5
	80th	16	64	11	29	9	40	89	76	17	47	2	3	9	18	202	61	7.5	74	54.5	0.256	0.030	0.019	0.021	0.02	1.60	0.84	575.7
moderate	20th	6	26	3	17	3	29	16	49	7	15	-	-	-	0	79	18	6.2	15	16.0	0.000	0.000	0.000	0.010	0.00	0.50	0.00	425.5
	50th	9	36	7	26	5	37	54	74	10	22	-	-	2	2	128	38	6.8	50	37.5	0.000	0.000	0.000	0.020	0.01	0.60	0.12	526
	80th	14	50	13	32	10	43	100	81	14	39	2	3	5	10	200	73	7.5	85	51.1	0.100	0.010	0.010	0.060	0.02	0.80	0.33	564.3
deep	20th	7	25	3	18	3	26	30	62	7	11	-	-	0	0	97	20	6.4	26	22.3	0.000	0.000	0.000	0.000	0.00	0.50	0.00	397.8
	50th	9	31	8	28	7	39	69	76	10	20	-	-	2	2	159	48	7.0	59	41.5	0.010	0.000	0.000	0.010	0.01	0.60	0.08	519.5
	80th	16	53	17	32	11	45	137	86	14	30	2	3	5	6	257	89	7.6	114	53.0	0.100	0.010	0.010	0.050	0.01	0.90	0.38	549
very deep	20th	10	24	6	23	4	29	56	70	8	12	-	-	-	-	136	35	6.7	47	30.5	0.000	0.000	0.000	0.000	0.00	0.50	0.07	332.3
	50th	11	30	12	30	9	40	91	80	11	16	-	-	3	2	196	69	7.3	79	46.0	0.000	0.000	0.000	0.020	0.01	0.60	0.16	449
	80th	17	45	16	33	11	44	123	85	14	23	4	4	6	5	257	80	8.0	107	52.0	0.070	0.021	0.000	0.050	0.02	1.00	0.44	532.1

Table 4.5 Water quality objectives to protect aquatic ecosystem EVs for Groundwater Chemistry Group (refer Plan WQ1083) – Sodic – 10 Granitic uplands and slopes

Depth	Percentile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hardness ($mg \cdot L^{-1}$)	pH	Alkalinity ($mg \cdot L^{-1}$)	SiO_2 ($mg \cdot L^{-1}$)	F ($mg \cdot L^{-1}$)	Fe ($mg \cdot L^{-1}$)	Mn ($mg \cdot L^{-1}$)	Zn ($mg \cdot L^{-1}$)	Cu ($mg \cdot L^{-1}$)	SAR	RAH ($meq L^{-1}$)	eH (mV)
		$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$\mu S \cdot cm^{-1}$												
shallow	20th	16	46	10	9	3	8	68	33	13	26	1	1	0	0	158	38	6.9	56	30.6	0.100	0.000	0.000	0.010	0.00	1.10	0.13	-
	50th	109	55	16	21	7	15	194	45	125	52	5	2	2	0	800	72	7.6	161	70.0	0.200	0.020	0.010	0.030	0.02	3.15	1.07	-
	80th	168	84	45	33	21	24	254	66	175	59	12	8	7	7	997	195	7.9	208	101.1	0.550	0.422	0.037	0.054	0.02	8.47	2.04	-
moderate	20th	64	46	9	8	5	7	135	33	47	27	2	1	0	0	440	46	7.3	113	82.0	0.270	0.000	0.000	0.005	0.01	2.00	0.30	-
	50th	102	63	21	20	10	17	200	50	103	41	4	1	1	0	772	95	7.7	165	96.0	0.375	0.010	0.010	0.020	0.05	4.25	1.67	-
	80th	160	85	46	30	24	23	280	67	210	62	12	3	3	1	1,003	210	8.2	230	110.0	0.500	0.020	0.020	0.023	0.05	8.40	2.70	-
deep	20th	27	41	12	16	5	13	118	66	20	20	1	1	-	0	257	53	6.7	97	79.0	0.280	0.003	0.004	0.007	0.01	1.30	0.43	-
	50th	32	49	18	31	7	20	147	74	26	23	2	1	0	0	300	76	7.0	120	93.0	0.360	0.020	0.010	0.020	0.05	1.60	0.72	-
	80th	113	72	24	35	10	24	219	79	54	31	16	5	1	0	572	99	7.8	182	107.0	0.600	0.100	0.050	0.050	0.05	5.81	2.16	-

Table 4.6 Water quality objectives to protect aquatic ecosystem EVs for Groundwater Chemistry Group (refer Plan WQ1083) – Coastal and Floodplain – 9 Low salinity coastal floodplains

Depth	Percentile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hardness ($mg{\cdot}L^{-1}$)	pH	Alkalinity ($mg{\cdot}L^{-1}$)	SiO_2 ($mg{\cdot}L^{-1}$)	F ($mg{\cdot}L^{-1}$)	Fe ($mg{\cdot}L^{-1}$)	Mn ($mg{\cdot}L^{-1}$)	Zn ($mg{\cdot}L^{-1}$)	Cu ($mg{\cdot}L^{-1}$)	SAR	RAH ($meqL^{-1}$)	eH (mV)
		$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$\mu S{\cdot}cm^{-1}$												
shallow	20th	6	57	1	6	1	10	7	18	8	39	-	-	-	-	51	7	5.8	6	9.0	0.000	0.000	0.000	0.010	0.00	1.00	0.00	-
	50th	13	67	2	11	2	18	18	32	17	54	2	4	1	2	96	14	6.6	15	19.5	0.050	0.008	0.018	0.020	0.01	1.50	0.02	-
	80th	24	81	5	21	4	27	41	52	28	70	6	11	4	8	156	26	7.3	34	30.0	0.150	0.040	0.094	0.075	0.02	2.90	0.28	-
moderate	20th	6	50	1	6	1	14	6	12	8	32	-	-	1	0	64	8	6.0	5	11.1	0.000	0.000	0.000	0.010	0.00	0.70	0.00	-
	50th	10	67	2	12	2	21	14	27	12	46	1	2	7	12	85	15	6.5	12	18.0	0.020	0.000	0.010	0.020	0.01	1.20	0.00	-
	80th	25	75	7	22	4	28	62	50	28	64	5	10	13	29	199	34	7.2	52	27.0	0.200	0.020	0.040	0.039	0.02	2.10	0.22	-
deep	20th	6	53	1	8	1	12	6	19	8	22	-	-	-	0	59	6	5.5	5	11.0	0.000	0.000	0.000	0.005	0.00	0.90	0.00	-
	50th	9	65	2	14	2	18	16	35	10	43	1	2	3	5	82	12	6.5	14	17.0	0.050	0.002	0.010	0.010	0.01	1.30	0.10	-
	80th	18	76	6	25	3	24	64	68	15	65	4	5	9	22	163	34	7.2	52	35.0	0.180	0.030	0.060	0.030	0.02	1.65	0.49	-
very deep	20th	7	54	1	10	1	10	13	21	7	20	1	2	1	0	64	9	6.1	11	16.0	0.010	0.000	0.000	0.000	0.00	0.70	0.00	-
	50th	9	59	3	15	3	16	29	46	9	39	1	4	4	9	95	19	6.9	24	23.0	0.100	0.005	0.005	0.010	0.02	1.30	0.13	-
	80th	78	74	18	26	8	25	103	65	65	60	16	8	8	16	511	67	7.5	85	43.7	0.610	0.020	0.020	0.030	0.02	5.25	1.47	-

Table 4.7 Water quality objectives to protect aquatic ecosystem EVs for Groundwater Chemistry Group (refer Plan WQ1083) – High salinity alluvial deposits – 3 Ellie

Depth	Percentile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hardness ($mg{\cdot}L^{-1}$)	pH	Alkalinity ($mg{\cdot}L^{-1}$)	SiO_2 ($mg{\cdot}L^{-1}$)	F ($mg{\cdot}L^{-1}$)	Fe ($mg{\cdot}L^{-1}$)	Mn ($mg{\cdot}L^{-1}$)	Zn ($mg{\cdot}L^{-1}$)	Cu ($mg{\cdot}L^{-1}$)	SAR	RAH ($meqL^{-1}$)	eH (mV)
		$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$mg{\cdot}L^{-1}$	%	$\mu S{\cdot}cm^{-1}$												
shallow	20th	7	49	4	5	2	14	37	2	3	9	1	1	1	0	83	20	7.0	30	16.9	0.037	0.003	0.000	0.000	0.00	0.70	0.00	
	50th	23	56	11	29	4	18	50	45	21	30	9	11	2	1	238	39	7.3	41	20.5	0.200	0.070	0.030	0.020	0.11	1.50	0.13	
	80th	4,635	76	286	37	583	20	256	73	8,115	87	1,498	16	9	16	22,450	3,113	7.6	211	27.0	0.557	0.728	1.007	0.040	0.22	36.06	0.28	
moderate	20th	132	72	19	5	12	12	28	1	201	81	19	4	-	-	357	103	6.6	23	24.0	0.155	0.000	0.105	0.019	0.01	6.35	0.00	
	50th	703	77	80	8	103	16	113	4	1,632	90	234	8	-	0	3,680	830	7.2	93	28.0	0.270	0.010	0.590	0.080	0.02	14.30	0.00	
	80th	6,326	79	431	14	921	18	259	15	12,142	90	1,569	11	4	0	28,585	5,281	7.5	214	49.0	0.405	0.100	2.260	0.243	0.07	40.10	0.00	
deep	20th	28	67	5	4	6	14	29	1	53	77	10	6	-	-	204	30	6.6	24	24.0	0.127	0.000	0.051	0.030	0.11	2.18	0.00	
	50th	4,650	76	314	5	498	18	190	1	8,050	89	1,195	9	4	0	17,650	3,222	7.3	158	26.0	0.300	0.030	1.545	0.045	0.13	37.50	0.00	
	80th	10,509	79	546	9	1,336	24	236	18	18,542	90	2,568	12	16	2	44,557	6,848	7.7	197	32.5	0.412	1.645	2.320	0.060	0.14	55.85	0.40	
very deep	20th	28	55	8	6	6	18	43	1	29	46	2	1	-	-	280	43	6.7	35	12.5	0.100	0.000	0.000	0.053	0.01	1.83	0.00	
	50th	281	72	37	9	34	19	91	10	493	86	16	6	2	0	1,830	214	7.0	75	31.0	0.175	0.000	0.090	0.060	0.07	9.10	0.00	
	80th	5,625	75	504	21	777	23	206	30	10,708	90	1,390	9	6	1	27,800	4,399	7.3	170	36.8	0.254	0.628	2.432	0.123	0.11	36.84	0.10	
artesian	20th	54	59	20	14	9	11	46	2	48	31	7	3	-	-	640	85	6.9	38	54.0	0.160	0.050	0.130	0.130	0.00	2.60	0.00	
	50th	339	67	61	19	28	14	108	33	616	61	73	6	-	-	2,070	268	7.1	89	54.5	0.630	0.055	0.510	0.195	0.01	7.70	0.55	
	80th	624	76	102	24	48	17	171	64	1,185	90	138	8	-	-	3,500	450	7.2	140	55.0	1.100	0.060	0.890	0.260	0.01	12.80	1.09	

Table 4.8 Water quality objectives to protect aquatic ecosystem EVs for Groundwater Chemistry Group (refer Plan WQ1083) – High salinity alluvial deposits – 7 Clohesy

Depth	Percentile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hardness ($mg \cdot L^{-1}$)	pH	Alkalinity ($mg \cdot L^{-1}$)	SiO_2 ($mg \cdot L^{-1}$)	F ($mg \cdot L^{-1}$)	Fe ($mg \cdot L^{-1}$)	Mn ($mg \cdot L^{-1}$)	Zn ($mg \cdot L^{-1}$)	Cu ($mg \cdot L^{-1}$)	SAR	RAH ($meq L^{-1}$)	eH (mV)
		$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$\mu S \cdot cm^{-1}$												
moderate	20th	110	61	19	14	10	10	168	23	152	66	3	1	-	-	784	90	6.9	96	32.8	0.295	0.000	0.015	0.000	0.00	4.17	0.34	-
	50th	190	70	34	16	15	14	205	25	270	74	8	2	-	-	1,100	145	7.8	157	53.5	0.500	0.010	0.080	0.013	0.03	6.20	1.00	-
	80th	242	74	53	17	31	22	262	35	422	81	10	2	1	3	1,625	257	8.0	209	56.9	0.639	0.496	0.165	0.025	0.05	7.18	1.66	-
deep		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-												

Table 4.9 Water quality objectives to protect aquatic ecosystem EVs for Groundwater Chemistry Group (refer Plan WQ1083) – High sulphate – 26 NE Caravonica

Depth	Percentile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hardness ($mg \cdot L^{-1}$)	pH	Alkalinity ($mg \cdot L^{-1}$)	SiO_2 ($mg \cdot L^{-1}$)	F ($mg \cdot L^{-1}$)	Fe ($mg \cdot L^{-1}$)	Mn ($mg \cdot L^{-1}$)	Zn ($mg \cdot L^{-1}$)	Cu ($mg \cdot L^{-1}$)	SAR	RAH ($meq L^{-1}$)	eH (mV)
		$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$mg \cdot L^{-1}$	%	$\mu S \cdot cm^{-1}$												
shallow	20th	7	39	6	15	2	18	3	4	9	24	19	15	0	0	126	28	3.9	28		0.015	0.070	0.110	-	-	0.62	0.00	-
	50th	18	53	7	27	4	23	34	38	16	29	36	44	0	0	218	34	5.8	38		0.075	0.700	0.200	-	-	1.35	0.00	-
	80th	32	61	12	38	7	26	56	51	37	46	53	68	1	1	320	58	7.2	48		0.107	6.640	0.209	-	-	1.80	0.00	-
moderate	20th	21	60	6	3	4	7	35	24	23	42	11	3	0	1	196	29	6.2	29	27.0	0.055	0.192	0.000	-	-	1.44	0.00	-
	50th	80	75	6	9	8	16	62	45	105	46	17	7	3	3	570	47	7.0	52	27.0	0.100	1.200	0.290	-	-	4.50	2.18	-
	80th	188	89	9	20	9	21	297	52	144	61	31	14	17	3	1,002	59	8.2	244	27.0	0.190	2.100	0.580	-	-	11.88	4.36	-
deep	20th	13	34	8	14	6	18	49	15	14	21	19	6	1	0	205	51	6.7	40	25.7	0.106	0.000	0.024	-	-	0.74	0.00	-
	50th	24	53	14	19	7	24	58	41	18	28	34	24	3	2	237	61	6.9	48	32.0	0.120	0.005	0.135	-	-	1.45	0.00	-
	80th	1,413	67	219	42	169	28	348	54	2,809	73	128	35	5	4	6,685	1,238	7.5	288	35.6	0.127	0.010	6.553	-	-	15.11	0.00	-

Notes:

1. Refer to Plan WQ1083 to locate relevant groundwater chemistry zones.
2. Within each chemistry zone, groundwater quality values are provided for different depths (Shallow: <15m, Moderate: 15–40m, Deep: 40–65m, Very deep: >65m, Artesian: all artesian).
3. The management intent is to maintain 20th, 50th and 80th percentile values. Values are provided for each of these percentiles.
4. Abbreviations: EC: Electrical conductivity, $CaCO_3$: Calcium carbonate, Ca: Calcium, Mg: Magnesium, Na: Sodium, Cl: Chloride, SO_4: Sulfate, HCO_3: Bicarbonate, NO_3: Nitrate, SiO_2: Silica, F: Fluoride, Fe: Iron, Mn: Manganese, Zn: Zinc, Cu: Copper, SAR: Sodium adsorption ratio, RAH: Residual alkali hazard, EH: Redox (oxidation/reduction) potential, '-': insufficient data to perform statistical summaries, or the parameter was not tested.

Source: Queensland Wet Tropics and Black and Ross catchments: Regional chemistry of the groundwater. Queensland Government (Raymond, M. A. A. and V. H. McNeil, 2013).

Ways to improve water quality

4 Ways to improve water quality

The following documents are relevant in considering ways to improve water quality in the Barron River basin.

Regional plans

- Wet Tropics Water Quality Improvement Plan, Terrain NRM 2015, in publication. See Terrain website.

Queensland and Australian Government plans

- Reef Water Quality Protection Plan 2013
- Reef 2050 Long-Term Sustainability Plan
- Reef Program–The Australian Government Reef Program will be delivered as a component of the National Landcare Program and will build on the success of the first phase of Reef Rescue. More about the Australian Government Reef Program

Appendix D – Water Quality Results Graphs

Appendix D 1: Total Suspended Solids Concentrations - Time Series

Appendix D 2: Faecal Coliform Counts - Time Series

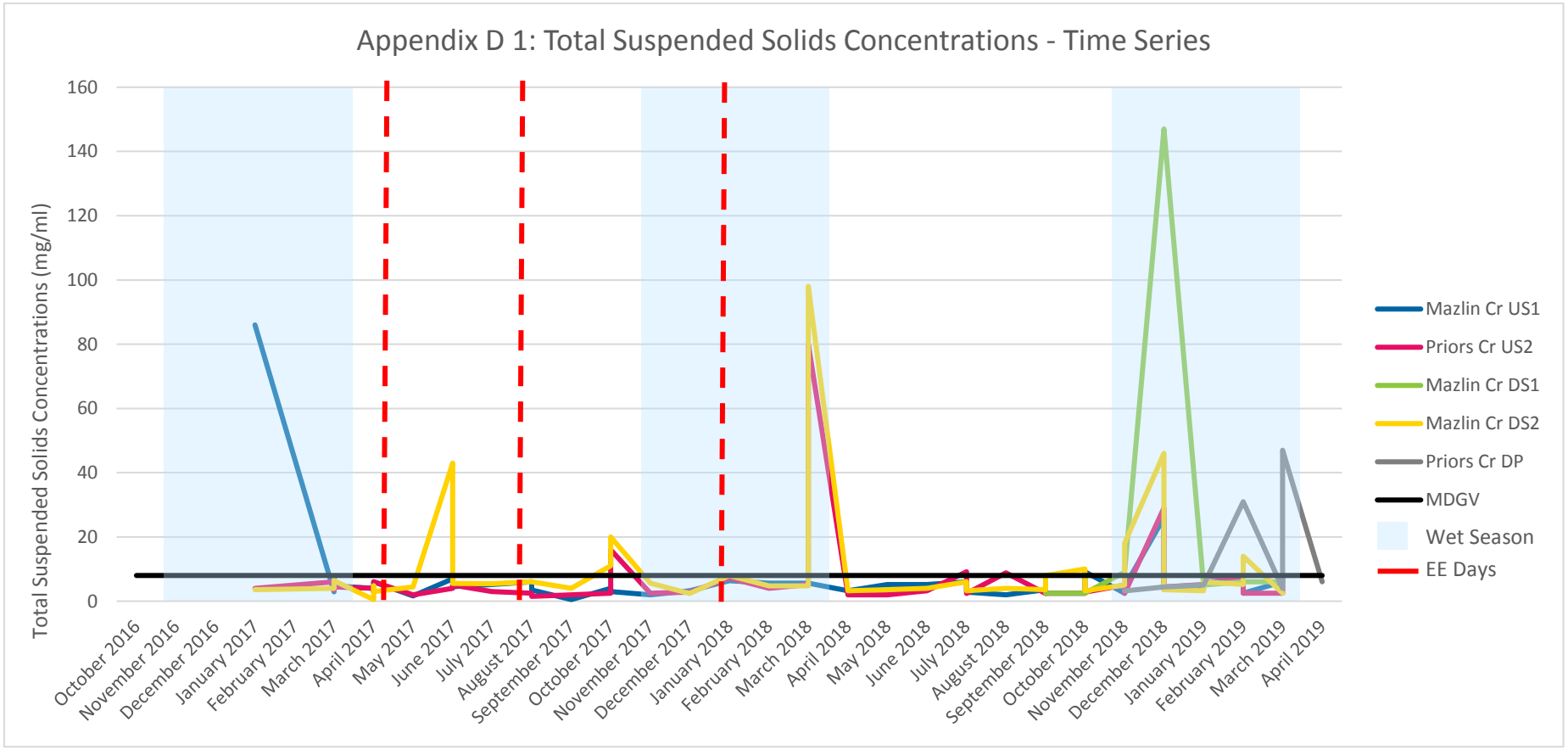
Appendix D 3: Ammonia Concentrations - Time Series

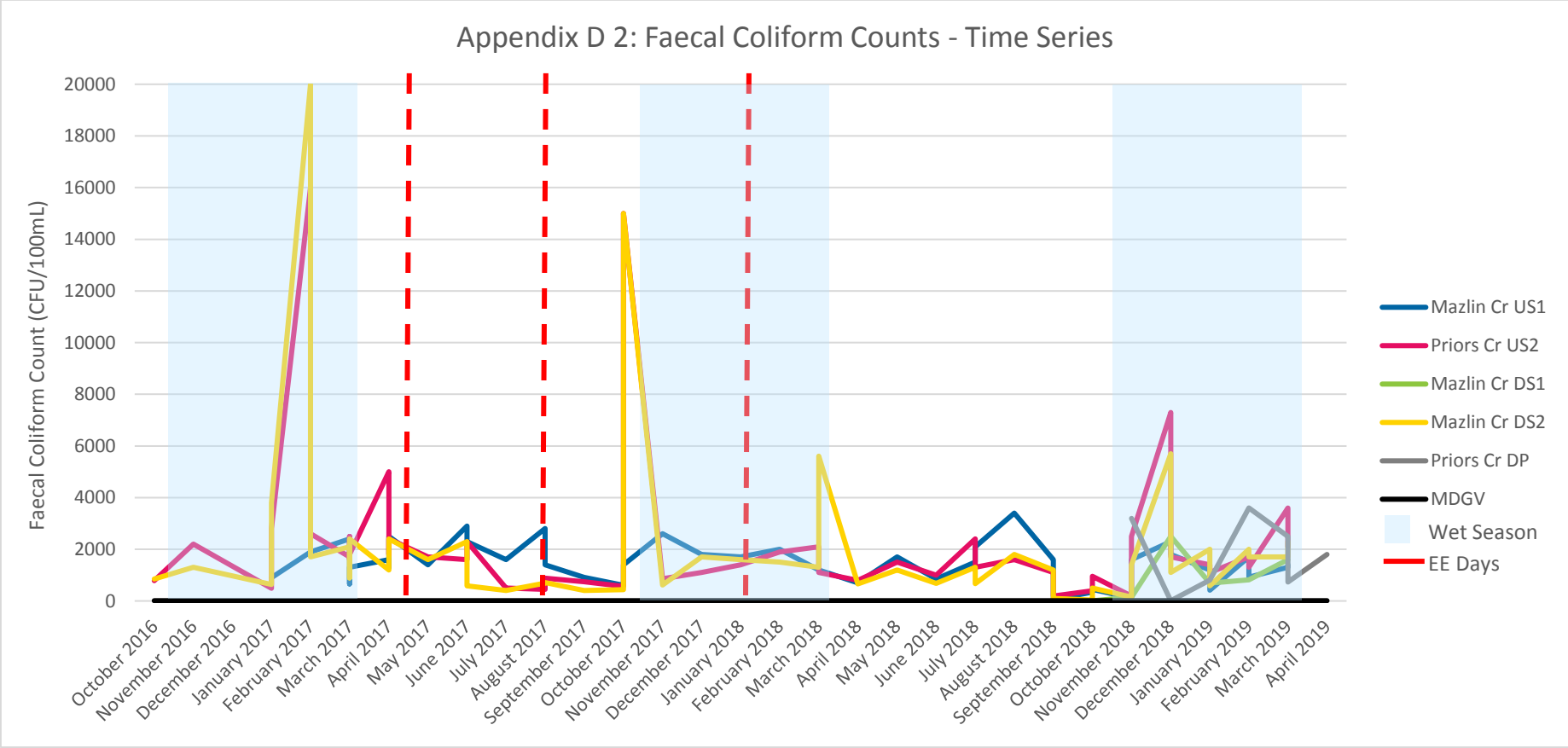
Appendix D 4: Ammonia Concentrations - Time Series
excluding Mazlin Cr DS2 1/08/2017 outlier (1.8 mg/L)

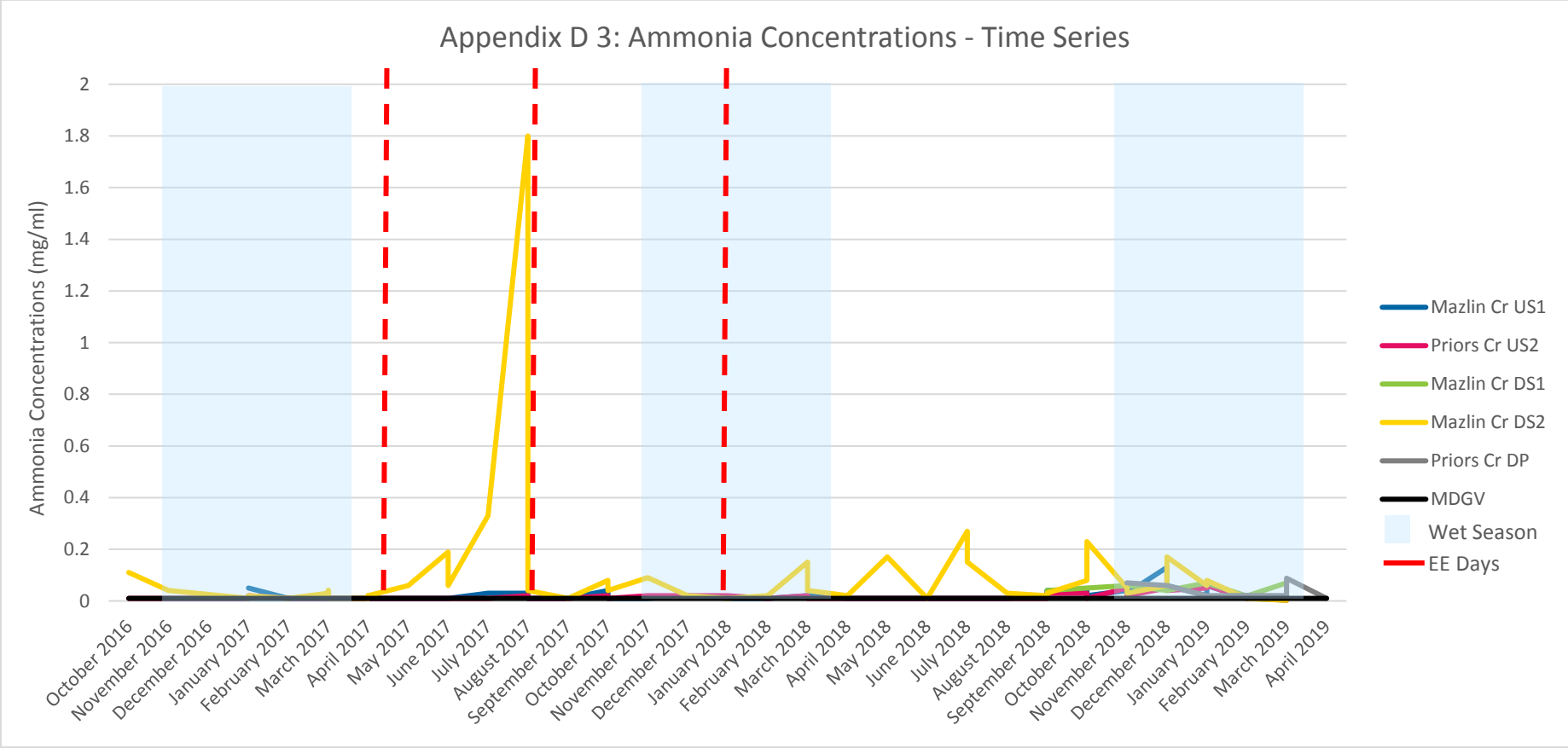
Appendix D 5: Total Suspended Solids Concentrations - Time Series

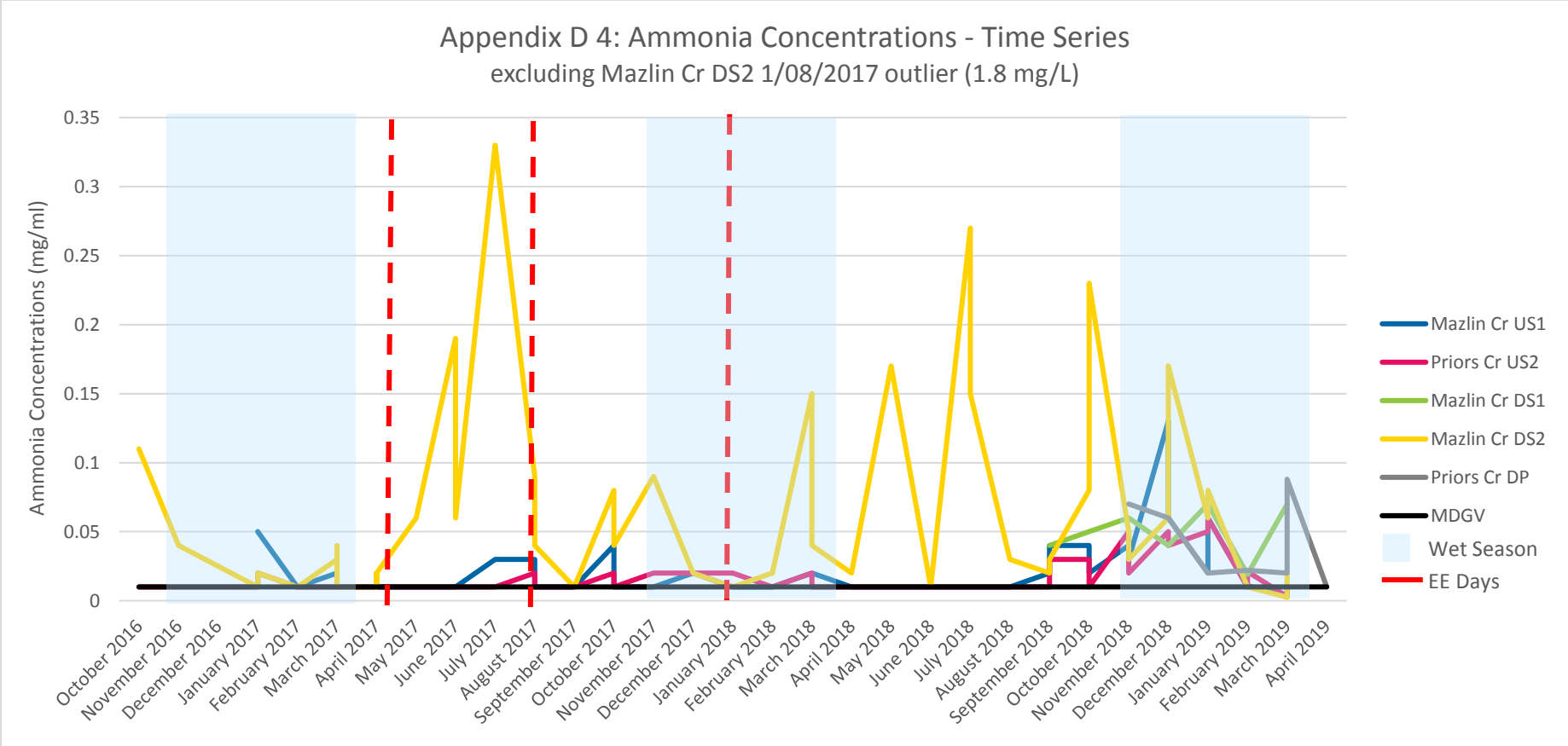
Appendix D 6: Total Nitrogen - Time Series

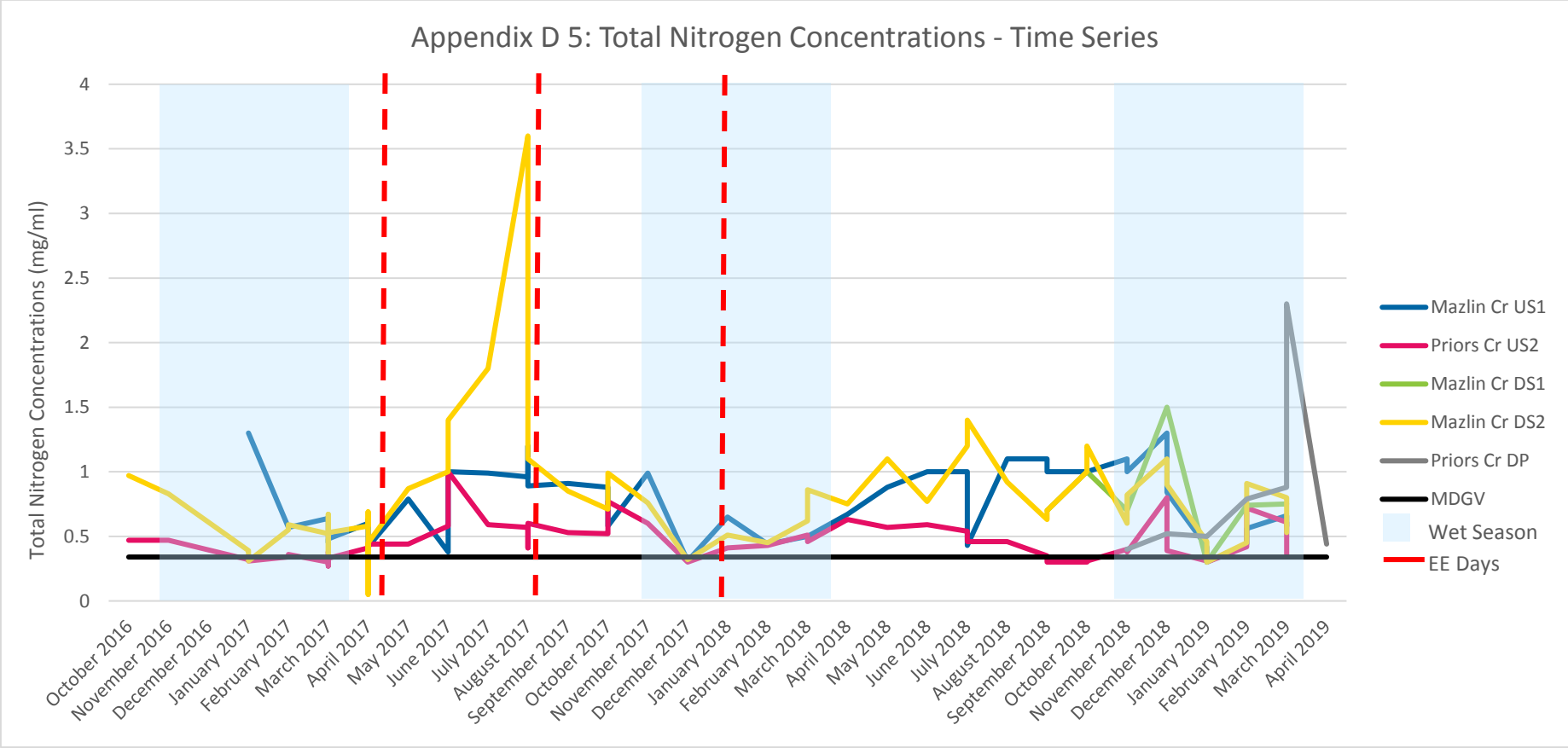
Appendix D 7: Total Phosphorus- Time Series

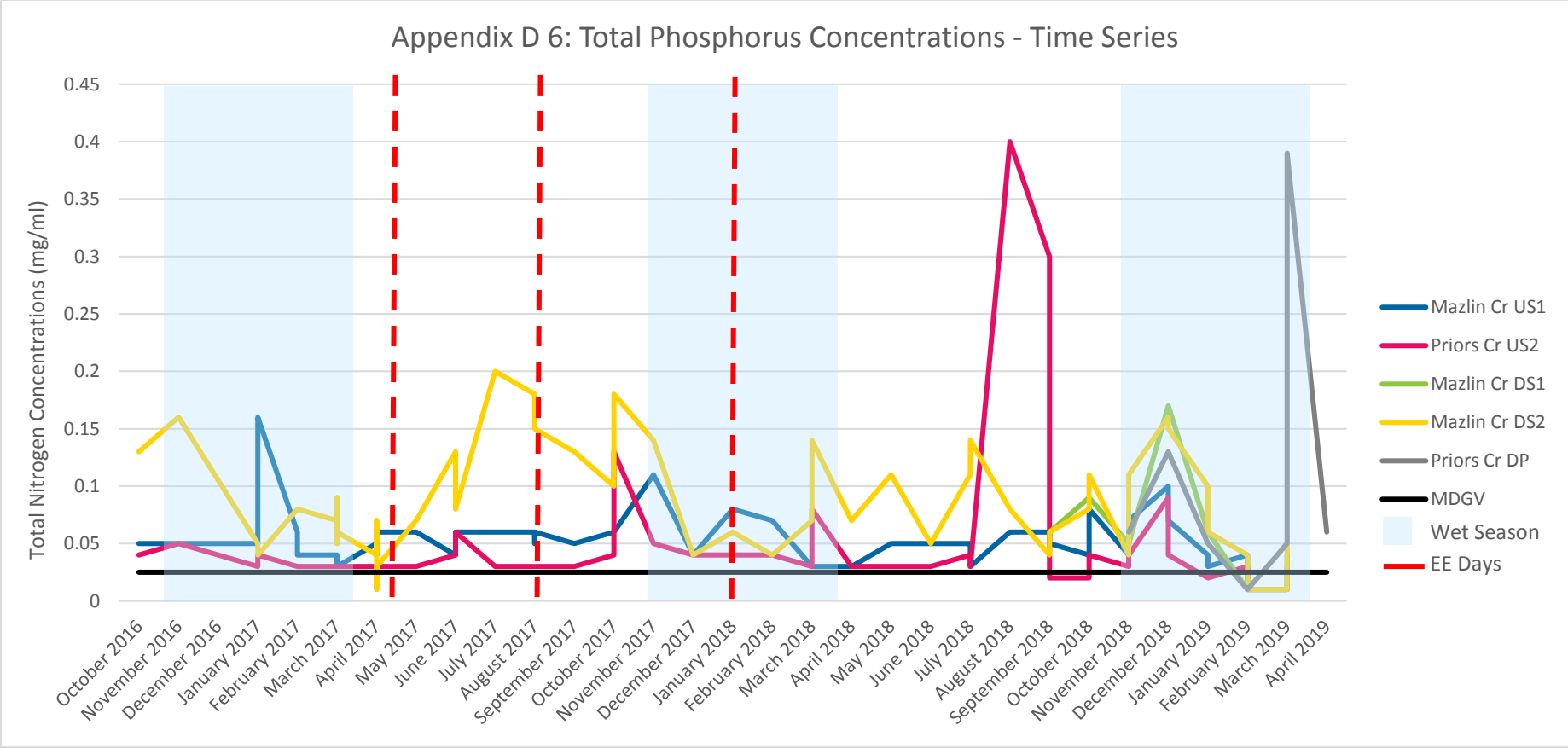

Appendix D 1: Total Suspended Solids Concentrations - Time Series
Total Suspended Solids Concentrations (mg/ml)
160
140
120
100
80
60
40
20
0
October 2016
November 2016
December 2016
January 2017
February 2017
March 2017
April 2017
May 2017
June 2017
July 2017
August 2017
September 2017
October 2017
November 2017
December 2017
January 2018
February 2018
March 2018
April 2018
May 2018
June 2018
July 2018
August 2018
September 2018
October 2018
November 2018
December 2018
January 2019
February 2019
March 2019
April 2019
Mazlin Cr US1
Priors Cr US2
Mazlin Cr DS1
Mazlin Cr DS2
Priors Cr DP
MDGV
Wet Season
EE Days


Appendix D 2: Faecal Coliform Counts - Time Series
Faecal Coliform Count (CFU/100mL)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
October 2016
November 2016
December 2016
January 2017
February 2017
March 2017
April 2017
May 2017
June 2017
July 2017
August 2017
September 2017
October 2017
November 2017
December 2017
January 2018
February 2018
March 2018
April 2018
May 2018
June 2018
July 2018
August 2018
September 2018
October 2018
November 2018
December 2018
January 2019
February 2019
March 2019
April 2019
Mazlin Cr US1
Priors Cr US2
Mazlin Cr DS1
Mazlin Cr DS2
Priors Cr DP
MDGV
Wet Season
EE Days


Appendix D 3: Ammonia Concentrations - Time Series
Ammonia Concentrations (mg/ml)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
October 2016
November 2016
December 2016
January 2017
February 2017
March 2017
April 2017
May 2017
June 2017
July 2017
August 2017
September 2017
October 2017
November 2017
December 2017
January 2018
February 2018
March 2018
April 2018
May 2018
June 2018
July 2018
August 2018
September 2018
October 2018
November 2018
December 2018
January 2019
February 2019
March 2019
April 2019
Mazlin Cr US1
Priors Cr US2
Mazlin Cr DS1
Mazlin Cr DS2
Priors Cr DP
MDGV
Wet Season
EE Days


Appendix D 4: Ammonia Concentrations - Time Series
excluding Mazlin Cr DS2 1/08/2017 outlier (1.8 mg/L)
Ammonia Concentrations (mg/ml)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
October 2016
November 2016
December 2016
January 2017
February 2017
March 2017
April 2017
May 2017
June 2017
July 2017
August 2017
September 2017
October 2017
November 2017
December 2017
January 2018
February 2018
March 2018
April 2018
May 2018
June 2018
July 2018
August 2018
September 2018
October 2018
November 2018
December 2018
January 2019
February 2019
March 2019
April 2019
Mazlin Cr US1
Priors Cr US2
Mazlin Cr DS1
Mazlin Cr DS2
Priors Cr DP
MDGV
Wet Season
EE Days


Appendix D 5: Total Nitrogen Concentrations - Time Series
Total Nitrogen Concentrations (mg/ml)
4
3.5
3
2.5
2
1.5
1
0.5
0
October 2016
November 2016
December 2016
January 2017
February 2017
March 2017
April 2017
May 2017
June 2017
July 2017
August 2017
September 2017
October 2017
November 2017
December 2017
January 2018
February 2018
March 2018
April 2018
May 2018
June 2018
July 2018
August 2018
September 2018
October 2018
November 2018
December 2018
January 2019
February 2019
March 2019
April 2019
Mazlin Cr US1
Priors Cr US2
Mazlin Cr DS1
Mazlin Cr DS2
Priors Cr DP
MDGV
Wet Season
EE Days


Appendix D 6: Total Phosphorus Concentrations - Time Series
Total Nitrogen Concentrations (mg/ml)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
October 2016
November 2016
December 2016
January 2017
February 2017
March 2017
April 2017
May 2017
June 2017
July 2017
August 2017
September 2017
October 2017
November 2017
December 2017
January 2018
February 2018
March 2018
April 2018
May 2018
June 2018
July 2018
August 2018
September 2018
October 2018
November 2018
December 2018
January 2019
February 2019
March 2019
April 2019
Mazlin Cr US1
Priors Cr US2
Mazlin Cr DS1
Mazlin Cr DS2
Priors Cr DP
MDGV
Wet Season
EE Days

Appendix E – Macroinvertebrate QA

Sample ID	Number of taxa	% identification correct
113ASTP-DS2P2	20	100%

Appendix F – Raw macroinvertebrate counts

Macroinvertebrate 2018 Data Analysis - Raw Counts

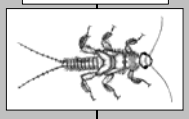
Class/Order	Family/Sub-family	Lowest Taxon	SIGNAL 2 Order	SIGNAL 2 Family	ASTP-US1 - Edge 1	ASTP-US1 - Edge 2	ASTP-US1 - Edge 3	ASTP-US1 - Edge 1	ASTP-US1 - Edge 2	ASTP-US1 - Edge 3	ASTP-US1 - 2018 average	ASTP-US1 - 2018 SE		ASTP-US2 - Edge 1	ASTP-US2 - Edge 2	ASTP-US2 - Edge 3	ASTP-US2 - Edge 1	ASTP-US2 - Edge 2	ASTP-US2 - Edge 3
Acarina	Acarina sp.	Acarina sp.	6		5	7	2	5	13	1				4	1	6	8	7	14
Bivalvia	Sphaeriidae	Sphaeriidae	3	5	1														
Coleoptera	Dytiscidae	Dytiscidae	5	2			1								1				
Coleoptera	Elmidae	Elmidae	5	7	2		4								2	1			3
Coleoptera	Gyrinidae	Gyrinidae	5	4			1												
Coleoptera	Hydrochidae	Hydrochidae	5	4				1											
Coleoptera	Hydrophilidae	Hydrophilidae	5	2		1	2	2										1	
Coleoptera	Psephenidae	Psephenidae	5	6			1												
Coleoptera	Scirtidae	Scirtidae	5	6														1	
Crustacea	Cladocera sp.	Cladocera sp.						1	1									1	
Crustacea	Copepoda sp.	Copepoda sp.				1	1	1	2	1				1					2
Crustacea	Ostracoda sp.	Ostracoda sp.			1				3	1									
Decapoda	Palaemonidae	Palaemonidae	4	4															
Diptera	Ceratopogonidae	Ceratopogonidae	3	4					1						1	1			
Diptera	Chironominae	Chironominae	3	3	15	14	6	7	10	2				11	9	9	2	10	8
Diptera	Culicidae	Culicidae	3	1										1		2			1
Diptera	Muscidae	Muscidae	3	1			1												
Diptera	Orthocladiinae	Orthocladiinae	3	4											2				
Diptera	Stratiomyidae	Stratiomyidae	3	2		2													
Diptera	Tanypodinae	Tanypodinae	3	4	2		4	1	1						1	2		1	6
Diptera	Tipulidae	Tipulidae	3	5					1										
Ephemeroptera	Baetidae	Baetidae	9	5					2	1				1		2			1
Ephemeroptera	Caenidae	Caenidae	9	4		1	2		4	6						1			
Ephemeroptera	Leptophlebiidae	Leptophlebiidae	9	8		1	4	3	6	4				4	4	4	1	1	4
Gastropoda	Ancylidae	Ancylidae	1	4										5	1	1			
Gastropoda	Lymnaeidae	Lymnaeidae	1	1					1										
Gastropoda	Planorbidae	Planorbidae	1	2															
Hemiptera	Corixidae	Corixidae	2	2															
Hemiptera	Gelastocoridae	Gelastocoridae	2	5			1									2			
Hemiptera	Gerridae	Gerridae	2	4		1	2		1	4				1	2	2		2	
Hemiptera	Hydrometridae	Hydrometridae	2	3						1				1					
Hemiptera	Micronectidae (Corixidae)	Micronectidae (Corixidae)	2		7	17	11	37	24	39				4	28	10	22	19	37
Hemiptera	Notonectidae	Notonectidae	2	1	1		6		1					2	1		2	4	1
Hemiptera	Veliidae	Veliidae	2	3	2		3	1	1					1		7	2		1
Hydrazoa	Clavidae	Clavidae	1	3															1
Hydrazoa	Hydridae	Hydridae	1	2						1									
Megaloptera	Corydalidae	Corydalidae	8	7			1								2				
Odonata: Epiprocta	Austrocorduliidae	Austrocorduliidae	3	10															
Odonata: Epiprocta	Cordulephyidae	Cordulephyidae	3	5												3	1		
Odonata: Epiprocta	Corduliidae	Corduliidae	3	5										1			1		
Odonata: Epiprocta	Gomphidae	Gomphidae	3	5		1	5			1							1		
Odonata: Epiprocta	Libellulidae	Libellulidae	3	4		3	3	2	6	1				1		5	2		3
Odonata: Epiprocta	Synthemistidae	Synthemistidae	3	2											1				1
Odonata: Zygoptera	Coenagrionidae	Coenagrionidae	3	2			4		1	1				1	1	5	1	10	4
Odonata: Zygoptera	Isostictidae	Isostictidae	3	3	2	1	2	4	3					1	1	1	2	6	2
Odonata: Zygoptera	Platycnemidae	Platycnemidae	3	4					5	5				1			1	1	2
Odonata: Zygoptera	Zygoptera sp.	Zygoptera sp.	3													1			
Oligochaeta	Oligochaeta sp.	Oligochaeta sp.	2		2		1	4	2	1				1				1	
Trichoptera	Calamoceratidae	Calamoceratidae	8	7					1										

Class/Order	Family/Sub-family	Lowest Taxon	SIGNAL 2 Order	SIGNAL 2 Family	ASTP-US1 - Edge 1	ASTP-US1 - Edge 2	ASTP-US1 - Edge 3	ASTP-US1 - Edge 1	ASTP-US1 - Edge 2	ASTP-US1 - Edge 3	ASTP-US1 - 2018 average	ASTP-US1 - 2018 SE		ASTP-US2 - Edge 1	ASTP-US2 - Edge 2	ASTP-US2 - Edge 3	ASTP-US2 - Edge 1	ASTP-US2 - Edge 2	ASTP-US2 - Edge 3
Trichoptera	Dipseudopsidae	Dipseudopsidae	8	9										1					
Trichoptera	Ecnomidae	Ecnomidae	8	4	1		1		1					1		4		1	
Trichoptera	Leptoceridae	Leptoceridae	8	6	9	7	9	10	29	10				4	3	8	16	28	60
Turbellaria	Dugesiidae	Dugesiidae	2	2			2	1	1										
				Richness	13	13	26	15	25	17	**18.2**	**2.4**		21	17	21	14	16	18
				PET	2	3	4	2	6	4	**3.5**	**0.6**		5	2	5	2	3	3
				SIGNAL-2	4.00	4.10	3.95	3.90	3.89	4.17	**4.0**	**0.0**		4.06	4.07	4.22	4.08	3.92	3.73
				Proportion of tolerant taxa	44.4	40.0	40.9	50.0	36.8	33.3	**40.9**	**2.4**		41.2	40.0	27.8	41.7	41.7	53.3
				Proportion of sensitive taxa	0.0	10.0	4.5	10.0	5.3	8.3	**6.4**	**1.6**		11.8	6.7	5.6	8.3	8.3	6.7

Class/Order	Family/Sub-family	ASTP-US2 - 2018 average	ASTP-US2 - 2018 SE		ASTP-DS2 - Edge 1	ASTP-DS2 - Edge 2	ASTP-DS2 - Edge 3	ASTP-DS2 - Edge 1	ASTP-DS2 - Edge 2	ASTP-DS2 - Edge 3	ASTP-DS2 - 2018 average	ASTP-DS2 - 2018 SE		ASTP-Discharge - Edge 1	ASTP-Discharge - Edge 2	ASTP-Discharge - Edge 3	ASTP-DP - 2018 average	ASTP-DP - 2018 SE
Acarina	Acarina sp.				1		3	17	10					21	9	27		
Bivalvia	Sphaeriidae																	
Coleoptera	Dytiscidae				1											1		
Coleoptera	Elmidae				1	1			2					1		1		
Coleoptera	Gyrinidae																	
Coleoptera	Hydrochidae																	
Coleoptera	Hydrophilidae									1					2			
Coleoptera	Psephenidae																	
Coleoptera	Scirtidae									1					1			
Crustacea	Cladocera sp.				1			5		1				1	1	3		
Crustacea	Copepoda sp.				1		1	4	2	1						2		
Crustacea	Ostracoda sp.					1			15	18				10	4	17		
Decapoda	Palaemonidae							1										
Diptera	Ceratopogonidae																	
Diptera	Chironominae				2	18	5	10	12	8				11	22	5		
Diptera	Culicidae														2			
Diptera	Muscidae																	
Diptera	Orthocladiinae																	
Diptera	Stratiomyidae								1									
Diptera	Tanypodinae				1	3	1		1	1					2	1		
Diptera	Tipulidae																	
Ephemeroptera	Baetidae																	
Ephemeroptera	Caenidae					3			3	4					1			
Ephemeroptera	Leptophlebiidae				1	4	3	5	11	2						1		
Gastropoda	Ancylidae					3	2			1								
Gastropoda	Lymnaeidae									1								
Gastropoda	Planorbidae								1									
Hemiptera	Corixidae								1									
Hemiptera	Gelastocoridae									1								
Hemiptera	Gerridae				5	2	4	1	2							2		
Hemiptera	Hydrometridae									1					1			
Hemiptera	Micronectidae (Corixidae)				12	14	7	23	25	7				36	24	34		
Hemiptera	Notonectidae				2	1	2		2	1				1				
Hemiptera	Veliidae				1	1			1						3			
Hydrazoa	Clavidae																	
Hydrazoa	Hydridae																	
Megaloptera	Corydalidae						1											
Odonata: Epiprocta	Austrocorduliidae						1											
Odonata: Epiprocta	Cordulephyidae					1				1				1				
Odonata: Epiprocta	Corduliidae													1				
Odonata: Epiprocta	Gomphidae							1							1	1		
Odonata: Epiprocta	Libellulidae					1		1	1	1					1	1		
Odonata: Epiprocta	Synthemistidae						1											
Odonata: Zygoptera	Coenagrionidae				9	3		2	2	5				3	2	2		
Odonata: Zygoptera	Isostictidae							1	4					13	11	25		
Odonata: Zygoptera	Platycnemidae						2	4	2					1		2		
Odonata: Zygoptera	Zygoptera sp.														1			
Oligochaeta	Oligochaeta sp.					2		6	2	5				1	1	1		
Trichoptera	Calamoceratidae								4	6								

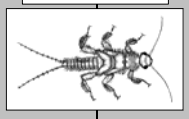
Class/Order	Family/Sub-family	ASTP-US2 - 2018 average	ASTP-US2 - 2018 SE		ASTP-DS2 - Edge 1	ASTP-DS2 - Edge 2	ASTP-DS2 - Edge 3	ASTP-DS2 - Edge 1	ASTP-DS2 - Edge 2	ASTP-DS2 - Edge 3	ASTP-DS2 - 2018 average	ASTP-DS2 - 2018 SE		ASTP-Discharge - Edge 1	ASTP-Discharge - Edge 2	ASTP-Discharge - Edge 3	ASTP-DP - 2018 average	ASTP-DP - 2018 SE
Trichoptera	Dipseudopsidae																	
Trichoptera	Ecnomidae					2		1	1	3				1	9			
Trichoptera	Leptoceridae				9	7	5	2	29	23				12	9	24		
Turbellaria	Dugesiidae								14	11				1				
		17.8	**1.1**		14	17	14	16	24	23	**18.0**	**1.8**		16	20	18	**18.0**	**1.2**
		3.3	**0.6**		2	4	2	3	5	5	**3.5**	**0.6**		2	3	2	**2.3**	**0.3**
		4.0	**0.1**		4.00	4.21	4.82	4.27	3.79	3.94	**4.2**	**0.1**		3.82	3.57	4.33	**3.9**	**0.2**
		40.9	**3.3**		50.0	28.6	27.3	27.3	47.4	38.9	**36.6**	**4.2**		45.5	50.0	33.3	**42.9**	**5.0**
		7.9	**0.9**		10.0	7.1	18.2	9.1	5.3	5.6	**9.2**	**2.0**		0.0	0.0	8.3	**2.8**	**2.8**

TAXA Count Macro



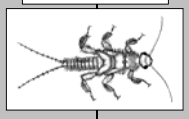
Taxa Code	Class/Order	Family/Sub-family	Lowest Taxon	SIGNAL 2 Order	SIGNAL2_Family	ASTP-US1 - Live Pick 1	ASTP-US1 - Live Pick 2	ASTP-US1 - Bulk	ASTP-US2 - Live Pick 1	ASTP-US2 - Live Pick 2	ASTP-US2 - Bulk	ASTP-DP - Live Pick 1	ASTP-DP - Live Pick 2	ASTP-DP - Bulk	ASTP-DS2 - Live Pick 1	ASTP-DS2 - Live Pick 2	ASTP-DS2 - Bulk
MM999999	Acarina	Acarina sp.	Acarina sp.	6		14	11	3	14	18	3	10	9	7		2	3
OP019999	Amphipoda	Talitridae	Talitridae	3	3												
OP029999	Amphipoda	Chiltoniidae	Chiltoniidae	3	2												
OP039999	Amphipoda	Eusiridae	Eusiridae	3	7												
OP049999	Amphipoda	Paracalliopidae	Paracalliopidae	3	3												
OP059999	Amphipoda	Corophiidae	Corophiidae	3	4												3
OP069999	Amphipoda	Paramelitidae	Paramelitidae	3	4												
OP079999	Amphipoda	Neoniphargidae	Neoniphargidae	3	4												
OP089999	Amphipoda	Perthiidae	Perthiidae	3	4												
OP099999	Amphipoda	Melitidae	Melitidae	3	7												
OD029999	Anostraca	Branchiopodidae	Branchipodidae	1	1												
KP019999	Bivalvia	Hyriidae	Hyriidae	3	5												
KP029999	Bivalvia	Cyrenidae	Cyrenidae	3	4												
KP039999	Bivalvia	Sphaeriidae	Sphaeriidae	3	5			1			1						3
	Bivalvia		Bivalvia Immature														
QC039999	Coleoptera	Microsporidae	Microsporidae	5	7												
QC059999	Coleoptera	Carabidae	Carabidae	5	3												
QC069999	Coleoptera	Haliplidae	Haliplidae	5	2												
QC079999	Coleoptera	Hygrobiidae	Hygrobiidae	5	1												
QC089999	Coleoptera	Noteridae	Noteridae	5	4												
QC099999	Coleoptera	Dytiscidae	Dytiscidae	5	2												
QC109999	Coleoptera	Gyrinidae	Gyrinidae	5	4												
QC119999	Coleoptera	Hydrophilidae	Hydrophilidae	5	2	1											
QC139999	Coleoptera	Hydraenidae	Hydraenidae	5	3							1	1				2
QC189999	Coleoptera	Staphylinidae	Staphylinidae	5	3												
QC209999	Coleoptera	Scirtidae	Scirtidae	5	6												
QC349999	Coleoptera	Elmidae	Elmidae	5	7			10	1	2	15	1	2	25			4
QC359999	Coleoptera	Limnichidae	Limnichidae	5	4												
QC369999	Coleoptera	Heteroceridae	Heteroceridae	5	1												
QC379999	Coleoptera	Psephenidae	Psephenidae	5	6												
QC399999	Coleoptera	Ptilodactylidae	Ptilodactylidae	5	10												
QCAH9999	Coleoptera	Chrysomelidae	Chrysomelidae	5	2												
QCAM9999	Coleoptera	Brentidae	Brentidae	5	3												
QCAN9999	Coleoptera	Curculionidae	Curculionidae	5	2												
QCAO9999	Coleoptera	Hydrochidae	Hydrochidae	5	4												
QCZZ9999	Coleoptera	Coleoptera sp.	Coleoptera sp.	5													
	Coleoptera	Spercheidae	Spercheidae	5	2												
OF999999	Crustacea	Conchostraca sp.	Conchostraca sp.	1													
OG999999	Crustacea	Cladocera sp.	Cladocera sp.							2				3			4
OH999999	Crustacea	Ostracoda sp.	Ostracoda sp.				1	2		2	3		6	11	3	7	24
OJ999999	Crustacea	Copepoda sp.	Copepoda sp.					2	1	2			2	7			3
OK999999	Crustacea	Branchiura sp.	Branchiura sp.	1													
OZ999999	Crustacea	Crustacea sp.	Crustacea sp.														
OT019999	Decapoda	Atyidae	Atyidae	4	3									1	1		
OT029999	Decapoda	Palaemonidae	Palaemonidae	4	4												
OV019999	Decapoda	Parastacidae	Parastacidae	4	4												
OX019999	Decapoda	Hymenostomatidae	Hymenosomatidae	4	3												
OX519999	Decapoda	Parathelphusidae	Parathelphusidae	4	3												
OX619999	Decapoda	Grapsidae	Grapsidae	4	7												
	Decapoda	Trogloplacidae	Trogloplacidae	4													
QD019999	Diptera	Tipulidae	Tipulidae	3	5												
QD039999	Diptera	Tanyderidae	Tanyderidae	3	6												
QD049999	Diptera	Blephariceridae (Larva)	Blephariceridae	3	10												
QD059999	Diptera	Chaoboridae	Chaoboridae	3	2												
QD069999	Diptera	Dixidae	Dixidae	3	7												
QD079999	Diptera	Culicidae	Culicidae	3	1												
QD099999	Diptera	Ceratopogonidae	Ceratopogonidae	3	4									4			1
QD109999	Diptera	Simuliidae	Simuliidae	3	5			4	1								
QD119999	Diptera	Thaumaleidae	Thaumaleidae	3	7												
QD129999	Diptera	Psychodidae	Psychodidae	3	3												1
QD209999	Diptera	Pelecorhynchidae	Pelecorhynchidae	3	10												
QD229999	Diptera	Athericidae	Athericidae	3	8												
QD239999	Diptera	Tabanidae	Tabanidae	3	3												
QD249999	Diptera	Stratiomyidae	Stratiomyidae	3	2												1
QD359999	Diptera	Empididae	Empididae	3	5						2						
QD369999	Diptera	Dolichopodidae	Dolichopodidae	3	3												
QD439999	Diptera	Syrphidae	Syrphidae	3	2												
QD459999	Diptera	Sciomyzidae	Sciomyzidae	3	2												
QD789999	Diptera	Ephydridae	Ephydridae	3	2												
QD899999	Diptera	Muscidae	Muscidae	3	1												
QDAA9999	Diptera	Aphroteniinae	Aphroteniinae	3	8												
QDAB9999	Diptera	Diamesinae	Diamesinae	3	6												
QDAD9999	Diptera	Podonominae	Podonominae	3	6												
QDAE9999	Diptera	Tanypodinae	Tanypodinae	3	4			5			5		1	6			3
QDAF9999	Diptera	Orthocladiinae	Orthocladiinae	3	4		1	3	1		5			1			
QDAJ9999	Diptera	Chironominae	Chironominae	3	3	2	2	11	2	3	28	3	5	86	2	1	13
QDAZ9999	Diptera	Chironomidae sp. (Larva)	Chironomidae sp.	3	3												
QDZZ9999	Diptera	Diptera sp. (Larva)	Diptera sp.	3													
QE019999	Ephemeroptera	Siphlonuridae	Siphlonuridae	9	10												
QE029999	Ephemeroptera	Baetidae	Baetidae	9	5	1		4			1						
QE039999	Ephemeroptera	Oniscigastridae	Oniscigastridae	9	8												
QE049999	Ephemeroptera	Ameletopsidae	Ameletopsidae	9	7												
QE059999	Ephemeroptera	Coloburiscidae	Coloburiscidae	9	8												
QE069999	Ephemeroptera	Leptophlebiidae	Leptophlebiidae	9	8				2	3	3	5	9	2			1
QE079999	Ephemeroptera	Teloganodidae	Teloganodidae	9	9												
QE089999	Ephemeroptera	Caenidae	Caenidae	9	4	1		8		1	2		2	2	1		3
QE099999	Ephemeroptera	Prosopistomatidae	Prosopistomatidae	9	4												
QE999999	Ephemeroptera	Ephemeroptera sp.	Ephemeroptera sp.	9													
KG019999	Gastropoda	Viviparidae	Viviparidae	1	4												
KG029999	Gastropoda	Hydrobiidae	Hydrobiidae	1	4												

TAXA Count Macro



Taxa Code	Class/Order	Family/Sub-family	Lowest Taxon	SIGNAL 2 Order	SIGNAL2_Family	ASTP-US1 - Live Pick 1	ASTP-US1 - Live Pick 2	ASTP-US1 - Bulk	ASTP-US2 - Live Pick 1	ASTP-US2 - Live Pick 2	ASTP-US2 - Bulk	ASTP-DP - Live Pick 1	ASTP-DP - Live Pick 2	ASTP-DP - Bulk	ASTP-DS2 - Live Pick 1	ASTP-DS2 - Live Pick 2	ASTP-DS2 - Bulk
KG039999	Gastropoda	Bithyniidae	Bithyniidae	1	3												
KG049999	Gastropoda	Thiaridae	Thiaridae	1	4												
KG059999	Gastropoda	Lymnaeidae	Lymnaeidae	1	1												
KG069999	Gastropoda	Ancylidae	Ancylidae	1	4												
KG069999	Gastropoda	Ancylidae (Planorbidae)	Ancylidae (Planorbidae	1	4												
KG079999	Gastropoda	Planorbidae	Planorbidae	1	2												
KG089999	Gastropoda	Physidae	Physidae	1	1												
KG999999	Gastropoda	Gastropoda sp.	Gastropoda sp.	1													
QH529999	Hemiptera	Mesoveliidae	Mesoveliidae	2	2												
QH539999	Hemiptera	Hebridae	Hebridae	2	3												
QH549999	Hemiptera	Hydrometridae	Hydrometridae	2	3												
QH569999	Hemiptera	Veliidae	Veliidae	2	3	1		1	6	1	5		2	1	1		
QH579999	Hemiptera	Gerridae	Gerridae	2	4	3											
QH589999	Hemiptera	Leptopodidae	Leptopodidae	2													
QH609999	Hemiptera	Saldidae	Saldidae	2	1												
QH619999	Hemiptera	Nepidae	Nepidae	2	3												
QH629999	Hemiptera	Belostomatidae	Belostomatidae	2	1												
QH639999	Hemiptera	Ochteridae	Ochteridae	2	2												
QH649999	Hemiptera	Gelastocoridae	Gelastocoridae	2	5	1											
QH659999	Hemiptera	Corixidae	Corixidae	2	2												
QH669999	Hemiptera	Naucoridae	Naucoridae	2	2												
QH679999	Hemiptera	Notonectidae	Notonectidae	2	1												
QH689999	Hemiptera	Pleidae	Pleidae	2	2												
QHZZ9999	Hemiptera	Hemiptera sp.	Hemiptera sp.	2													
	Hemiptera	Micronectidae (Corixidae)	Micronectidae (Corixid	2		8	13		2	19	1	16	20	5	1		
LH999999	Hirudinea	Hirudinea sp.	Hirudinea sp.	1	1												
LH049999	Hirudinea: Arhynchobdellida	Ornithobdellidae	Ornithobdellidae	1	1												
LH059999	Hirudinea: Arhynchobdellida	Erpobdellidae	Erpobdellidae	1	1												
	Hirudinea: Arhynchobdellida	Hirudinidae	Hirudinidae	1	4												
LH019999	Hirudinea: Rhynchobdellida	Glossiphoniidae	Glossiphoniidae	1	1		1										
LH029999	Hirudinea: Rhynchobdellida	Ozobranchidae	Ozobranchidae	1													
IB019999	Hydrazoa	Hydridae	Hydridae	1	2							2		51			
IB029999	Hydrazoa	Clavidae	Clavidae	1	3						1						
OR019999	Isopoda	Amphisopodidae	Amphisopidae	2	1												
OR029999	Isopoda	Mesamphisopodidae	Mesamphisopidae	2	3												
OR039999	Isopoda	Phreatoicopsidae	Phreatoicopsidae	2	2												
OR059999	Isopoda	Phreatoicidae	Phreatoicidae	2	4												
OR129999	Isopoda	Corallanidae	Corallanidae	2	2												
OR139999	Isopoda	Sphaeromatidae	Sphaeromatidae	2	1									6			
OR189999	Isopoda	Janiridae	Janiridae	2	3												
OR259999	Isopoda	Oniscidae	Oniscidae	2	2												
OR999999	Isopoda	Isopoda sp.	Isopoda sp.	2													
QL019999	Lepidoptera	Crambidae	Crambidae	2	3												
QK019999	Mecoptera	Nannochoristidae	Nannochoristidae	10	9												
QM019999	Megaloptera	Corydalidae	Corydalidae	8	7												
QM029999	Megaloptera	Sialidae	Sialidae	8	5										1		
II999999	Nematoda	Nematoda sp.	Nematoda sp.	3													
IJ019999	Nematomorpha	Gordiidae	Gordiidae	6	5												
IH019999	Nemertea	Tetrastemmatidae	Tetrastemmatidae	3	7									1			
QN039999	Neuroptera	Osmylidae	Osmylidae	6	7												
QN049999	Neuroptera	Neurorthidae	Neurorthidae	6	9												
QN059999	Neuroptera	Sisyridae	Sisyridae	6	3												
QN999999	Neuroptera	Neuroptera sp.	Neuroptera sp.	6													
OE019999	Notostraca	Triopsidae	Triopsidae	1	1												
QO129999	Odonata: Epiprocta	Aeshnidae	Aeshnidae	3	4												
QO139999	Odonata: Epiprocta	Gomphidae	Gomphidae	3	5		1		1			1					
QO169999	Odonata: Epiprocta	Corduliidae	Corduliidae	3	5												
QO179999	Odonata: Epiprocta	Libellulidae	Libellulidae	3	4	1	2		6	6		3	1			1	
QO219999	Odonata: Epiprocta	Telephlebiidae	Telephlebiidae	3	9												
QO229999	Odonata: Epiprocta	Lindeniidae	Lindeniidae	3	3												
QO239999	Odonata: Epiprocta	Synthemistidae	Synthemistidae	3	2	1											
QO249999	Odonata: Epiprocta	Gomphomacromiidae	Gomphomacromiidae	3													
QO269999	Odonata: Epiprocta	Macromiidae	Macromiidae	3	8												
QO279999	Odonata: Epiprocta	Austrocorduliidae	Austrocorduliidae	3	10												
QO289999	Odonata: Epiprocta	Cordulephyidae	Cordulephyidae	3	5												
QO999998	Odonata: Epiprocta	Epiprocta sp.	Epiprocta sp.	3							1			5			
QO999998	Odonata: Epiprocta	Brachytronidae	Brachytronidae	3													
QO029999	Odonata: Zygoptera	Coenagrionidae	Coenagrionidae	3	2												
QO039999	Odonata: Zygoptera	Isostictidae	Isostictidae	3	3								1				
QO049999	Odonata: Zygoptera	Platycnemidae	Platycnemidae	3	4												
QO059999	Odonata: Zygoptera	Lestidae	Lestidae	3	1												
QO069999	Odonata: Zygoptera	Hypolestidae	Hypolestidae	3	9												
QO079999	Odonata: Zygoptera	Argiolestidae	Argiolestidae	3	5												
QO089999	Odonata: Zygoptera	Synlestidae	Synlestidae	3	7												
QO099999	Odonata: Zygoptera	Diphlebiidae	Diphlebiidae	3	6												
QO189999	Odonata: Zygoptera	Chorismagrionidae	Chorismagrionidae	3													
QO999997	Odonata: Zygoptera	Zygoptera sp.	Zygoptera sp.	3		3	3	3	1	1	6	4	5	12	2	4	6
LO039999	Oligochaeta	Phreodrilidae	Phreodrilidae	2	2												
LO049999	Oligochaeta	Tubificidae	Tubificidae	2	2												
LO059999	Oligochaeta	Naididae	Naididae	2	2												
LO069999	Oligochaeta	Lumbriculidae	Lumbriculidae	2	1												
LO089999	Oligochaeta	Enchytraeidae	Enchytraeidae	2	4												
LO999999	Oligochaeta	Oligochaeta sp.	Oligochaeta sp.	2				7	1		1			9			15
QP019999	Plecoptera	Eustheniidae	Eustheniidae	10	10												
QP029999	Plecoptera	Austroperlidae	Austroperlidae	10	10												
QP039999	Plecoptera	Gripopterygidae	Gripopterygidae	10	8												
QP049999	Plecoptera	Notonemouridae	Notonemouridae	10	6												
IA019999	Porifera	Spongillidae	Spongillidae	4	3												
JZ999999	Rotifera	Rotifera sp.	Rotifera sp.														
ON029999	Syncarida	Koonungidae	Koonungidae	6	1												
QT019999	Trichoptera	Hydrobiosidae	Hydrobiosidae	8	8												
QT029999	Trichoptera	Glossosomatidae	Glossosomatidae	8	9												
QT039999	Trichoptera	Hydroptilidae	Hydroptilidae	8	4									1			
QT049999	Trichoptera	Philopotamidae	Philopotamidae	8	8												

TAXA Count Macro



Taxa Code	Class/Order	Family/Sub-family	Lowest Taxon	SIGNAL 2 Order	SIGNAL2_Family	ASTP-US1 - Live Pick 1	ASTP-US1 - Live Pick 2	ASTP-US1 - Bulk	ASTP-US2 - Live Pick 1	ASTP-US2 - Live Pick 2	ASTP-US2 - Bulk	ASTP-DP - Live Pick 1	ASTP-DP - Live Pick 2	ASTP-DP - Bulk	ASTP-DS2 - Live Pick 1	ASTP-DS2 - Live Pick 2	ASTP-DS2 - Bulk
QT069999	Trichoptera	Hydropsychidae	Hydropsychidae	8	6				2								
QT079999	Trichoptera	Polycentropodidae	Polycentropodidae	8	7												
QT089999	Trichoptera	Ecnomidae	Ecnomidae	8	4					2	1		1	1			1
QT099999	Trichoptera	Psychomyiidae	Psychomyiidae	8													
QT109999	Trichoptera	Limnephilidae	Limnephilidae	8	8												
QT129999	Trichoptera	Oeconesidae	Oeconesidae	8	8												
QT139999	Trichoptera	Tasimiidae	Tasimiidae	8	8												
QT159999	Trichoptera	Conoesucidae	Conoesucidae	8	7												
QT169999	Trichoptera	Antipodoecidae	Antipodoeciidae	8	8												
QT179999	Trichoptera	Helicopsychidae	Helicopsychidae	8	8												
QT189999	Trichoptera	Calocidae	Calocidae	8	9												
QT199999	Trichoptera	Helicophidae	Helicophidae	8	10												
QT209999	Trichoptera	Kokiriidae	Kokiriidae	8	3												
QT219999	Trichoptera	Philorheithridae	Philorheithridae	8	8												
QT229999	Trichoptera	Odontoceridae	Odontoceridae	8	7												
QT239999	Trichoptera	Atriplectididae	Atriplectididae	8	7												
QT249999	Trichoptera	Calamoceratidae	Calamoceratidae	8	7		1										
QT259999	Trichoptera	Leptoceridae	Leptoceridae	8	6	14	25	2	20	22	1	53	32	8	10	7	2
QT269999	Trichoptera	Dipseudopsidae	Dipseudopsidae	8	9												
QT999999	Trichoptera	Trichoptera sp.	Trichoptera sp.	8													
IF419999	Turbellaria	Temnocephalidae	Temnocephalidae	2	5												
IF619999	Turbellaria	Dugesiidae	Dugesiidae	2	2			1						1			1
					Total	51	61	67	61	84	85	99	99	256	22	22	94
					# Families	13	11	16	15	14	19	11	16	24	9	6	20

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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	B. Hodges	A.Smedley	*A.Smedley**	T.Boland	*T.Boland**	26/06/2019

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