Katherine Wastewater Treatment Plant
Waste Discharge Licence 151-07
Monitoring Report 2020 - 2021

October 2021

PowerWater

Document History and Status

Document Title: Waste Discharge Licence 151-07
Katherine Wastewater Treatment Plant– 2020- 2021 Monitoring Report

CM No: D2021/435478

Drafts	CM No. (Revision No X.)	Date Prepared	Preparer	Reviewer	Date Issued
0.1	D2021/435478	11/10/2021	Michael Gallagher	Tahlia Kemp, Jason Tomes, Wayne Sharp	
Version	**TRIM No. (Revision No. X)**	**Date Issued**	**Issuer**	**Approver**	**Date Approved**
1	D2021/435478	11/10/2021	Michael Gallagher	Tahlia Kemp	
Replaces WDL151-07 Monitoring Report Version 2020 1.0 Issued 30/09/2020					
1.0	D2020/332363		Jason Tomes	DEPWS	30/10/2020

Cover photograph aerial view of Katherine Wastewater Treatment Plant 2016 by Eric Vanweydeveld

Executive Summary

Power and Water operates the Katherine Wastewater Treatment Plant (KWwTP) to treat the wastewater produced by the Katherine community. Waste Discharge Licence (WDL) 151-07 specifies conditions under which the excess treated effluent produced by the KWwTP is authorised to be discharged to the Katherine River.

WDL151-07 specifies that 'discharges must only occur when Katherine River at Gauging Station G8140001 is at a minimum flow of 66.7 kL/s. These conditions were met on a number of occasions during the 2020-2021 period however discharges into the Katherine River were limited to two events, the first commencing on 27/01/2021 for 5 days resulting in a discharge of 58524 kL, the second beginning on the 17/2/2021 for 13 days resulting in a discharge of 133058kL. The combined total discharge into the Katherine River for these two events was 191582kL. The flow rates of the Katherine River at the time of these discharges were significantly in excess of 66.7 cumecs ensuring high dilution of potential contaminants.

Analysis of discharge water quality at authorised outlet SKa0001 during these discharge events indicated that whilst some tested parameters were slightly higher than the ANZECC guidelines for 95% freshwater species protection, most parameters were significantly below this guideline. None of the analytes were above the ANZECC acute toxicity levels. Of those that were above the guideline level, these would be immediately diluted to much lower concentrations in the high flows of the Katherine River. The low discharge concentrations at the outlet combined with dilution from large flows in the river, result in a low risk of environmental harm from the waste discharge from KWwTP.

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1 Background

Power and Water Corporation operate the Katherine Wastewater Treatment Plant (KWwTP) to treat and evaporate the wastewater created by the Katherine Community. The plant is located approximately 8 kilometres from town on the banks of the Katherine River (Figure 1).

Figure 1: Katherine Waste Stabilisation and evaporation Ponds (Google Image, 2019)

Discharges from the plant are regulated under conditions specified in WDL151-07, which is granted under provisions of the *Water Act 1992*. WDL151-07 was granted on 7th May 2020, the Waste Discharge Licence authorises discharge from the KWWTP to the Katherine River under specified conditions:

Condition 22 states 'All discharges events at the authorised discharge point must take place when Katherine River at Gauging Station G814-0001, is at a minimum flow of 66.78 kL/s.'

Monitoring of discharges from the Katherine Waste WSP is conducted as per Appendix 2: Discharge Monitoring Plan of WDL151-07 Katherine Waste Discharge Licence.

Condition 38 of WDL151-07 requires the Licensee to provide to the Administering Agency by 31 October for each year of the licence, a monitoring report. The monitoring report must include

- Is prepared in accordance with the requirements of the Administering Agency 'Guideline for Reporting on Environmental Monitoring';

- A tabulation of all monitoring data as a condition of this licence, including river height and flow telemetry at GS 8140001WDL151-06;
- Volumes of waste water and nutrient loads discharged to Katherine river;
- The current version of the conceptual site model;
- Long term trend analysis of monitoring data to demonstrate any environmental impact associated with the activity over an minimum period of three years (where the data is available);
- An environmental assessment of environmental impact from the activity as informed by the monitoring results; and
- Include recommendation as informed by the monitoring results for the implementation in the following licencing period.

This report is provided to fulfil the obligations of Condition 38 of WDL151-07.

2 Conceptual Site Model

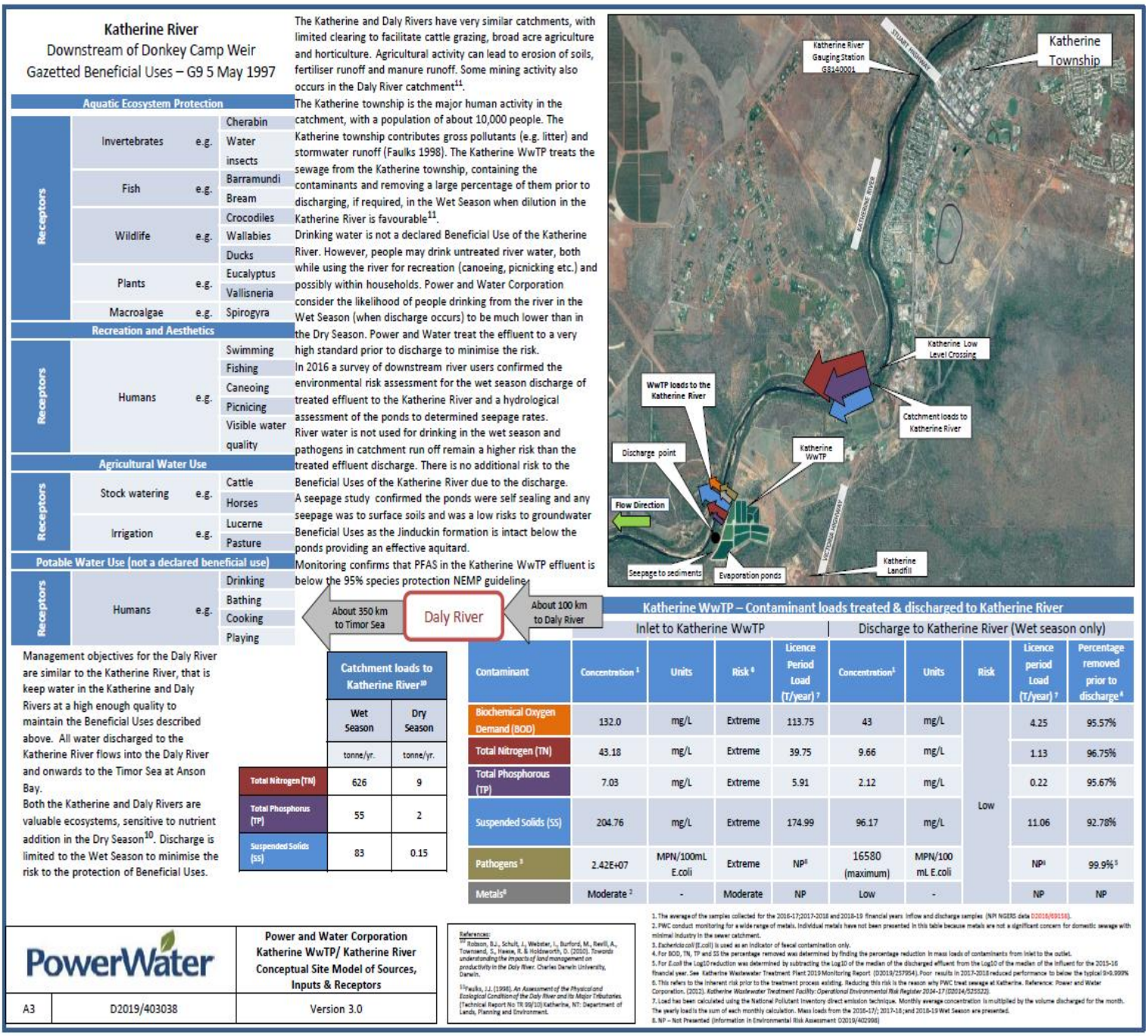


Figure 2: Katherine Waste Stabilisation Ponds Conceptual Site Model

3 Discharge Regime

The discharge of treated wastewater is only authorised when the flow rate of the Katherine River is 66.7 cubic meters per second (cumec) or greater. Discharges are strongly influenced by catchment runoff following rain. The rainfall in the 2020-2021 period was above the median for the period from 2011-2020.

There were 2 discharges in the reporting period, the first on 27th of Jan for 5 days and the second on the 17th of Feb for 13 days. The total discharge from these two events was 191582kL. During these discharges the Katherine River flow was in excess of 66.78kL/s as per condition 22 of the waste discharge licence. The Katherine River flow data is included in Appendix 2 of this report.

Table 1 displays the KWwTP discharges from 2017 to the 2021 wet season.

Table 1: Discharges from Katherine Waste Stabilisation Ponds Licence Period 2017 – to date

Discharge started	Discharge ceased	Total days	Discharge volume (KL)
24/01/2017	30/01/2017	7	57753
13/02/2017	16/2/2017	4	35214
13/03/2017	14/3/2017	2	13997
19/03/2017	26/3/2017	8	72291
28/03/2017	28/3/2017	1	1090
29/03/2017	29/01/2018	0	0
2017 total		**22**	**181345**
30/01/2018	02/02/2018	4	33 177.6
17/02/2018	25/02/2018	9	87 782.4
2018 total		**13**	**120960**
25/02/2018	**30/09/2019**	**0**	**0**
2019 Total		**0**	**0**
2020 Total		**0**	**0**
27/01/2021	01/02/2021	5	58524
17/2/2021	01/03/2021	13	133058
2021 to date		**18**	**191582**

Table 2 indicates the inflow volume in 2020-2021 was above average in the 60th percentile, corresponding to total rainfall for the year which was also above average and in the 60th percentile. Discharge into the Katherine River was higher than any year since 2011 at 191582kL. These observations can be explained by noting that the bulk of the rainfall in and around the catchment for the Katherine River occurred in a few concentrated events in late January into February.

Table 2: KWWTP Financial Year inflow; Outflow and Rainfall 2011-2012 to current

Financial Year	Inflow to Katherine WWTP (kL)	Discharge to Katherine River (kL)	Rainfall (mm)
2020-2021	860638	191582	1207.3
2019-2020	680559	0	461.8
2018-2019	938674	0	713.5
2017-2018	817941	120960	1067.4
2016-2017	890563	181345	1364.3
2015-2016	845299	21531	1222.1
2014-2015	840358	102352	845.2
2013-2014	861393	136200	1069.8

2012-2013	821491	101158	1013.6
2011-2012	840292	115275	947.3
Statistical Assessment			
10th percentile	804202.8	0	688.33
Median	842828.5	108813.5	1040.5
60th percentile	851434.6	117549	1068.36
75th percentile	867227	145229	1210.26
80th percentile	861204.3	145229	1210.26
90th percentile	895374.1	182368.7	1236.32
95th percentile	917024.1	186975.4	1300.31

Figure 3 displays discharge volumes from Katherine WwTP for 2011 – 2021. Figure 4 compares the rainfall, inflow to treatment plant and discharge of treated wastewater and displays the increase in wastewater discharge into the Katherine River in the 2020-2021 period. The high flow rates for the Katherine River during late January and February at the times of waste discharges into the river are displayed in figure 5. The higher discharge volumes for the year are offset by the very high flow rates at the time resulting in these discharges being highly diluted.

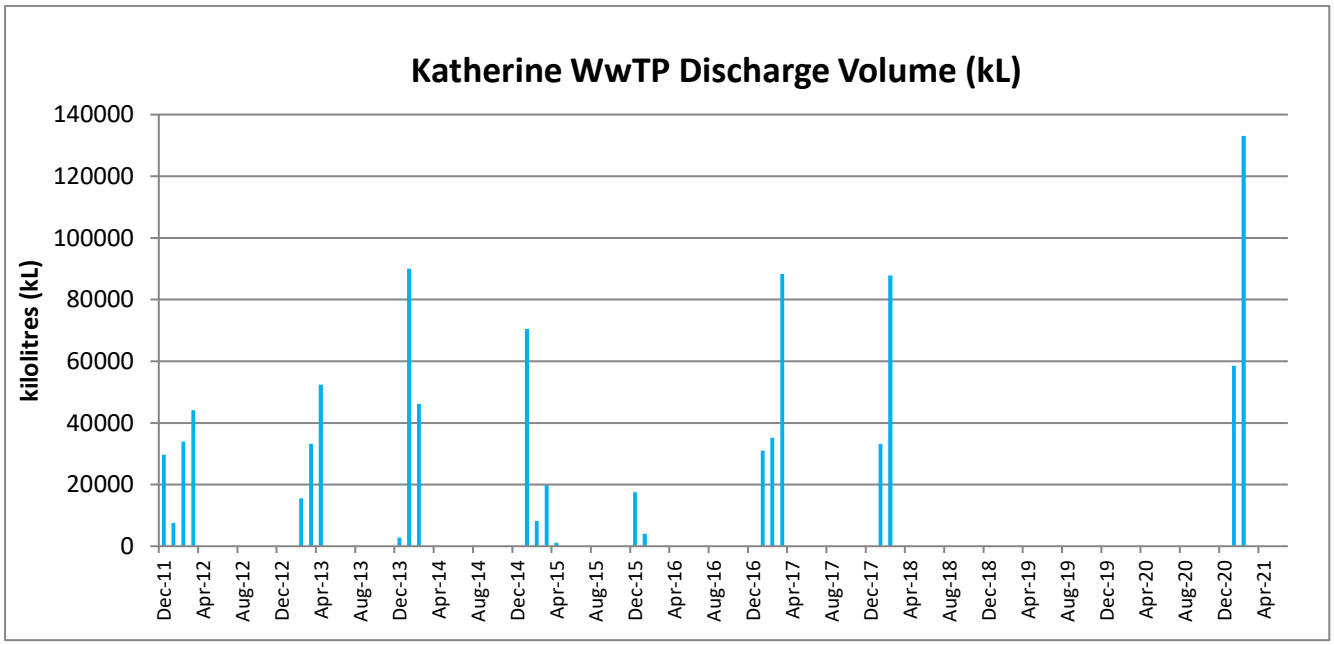


Figure 3: Katherine WWTP monthly discharge record to Katherine River since 2012 to 2021

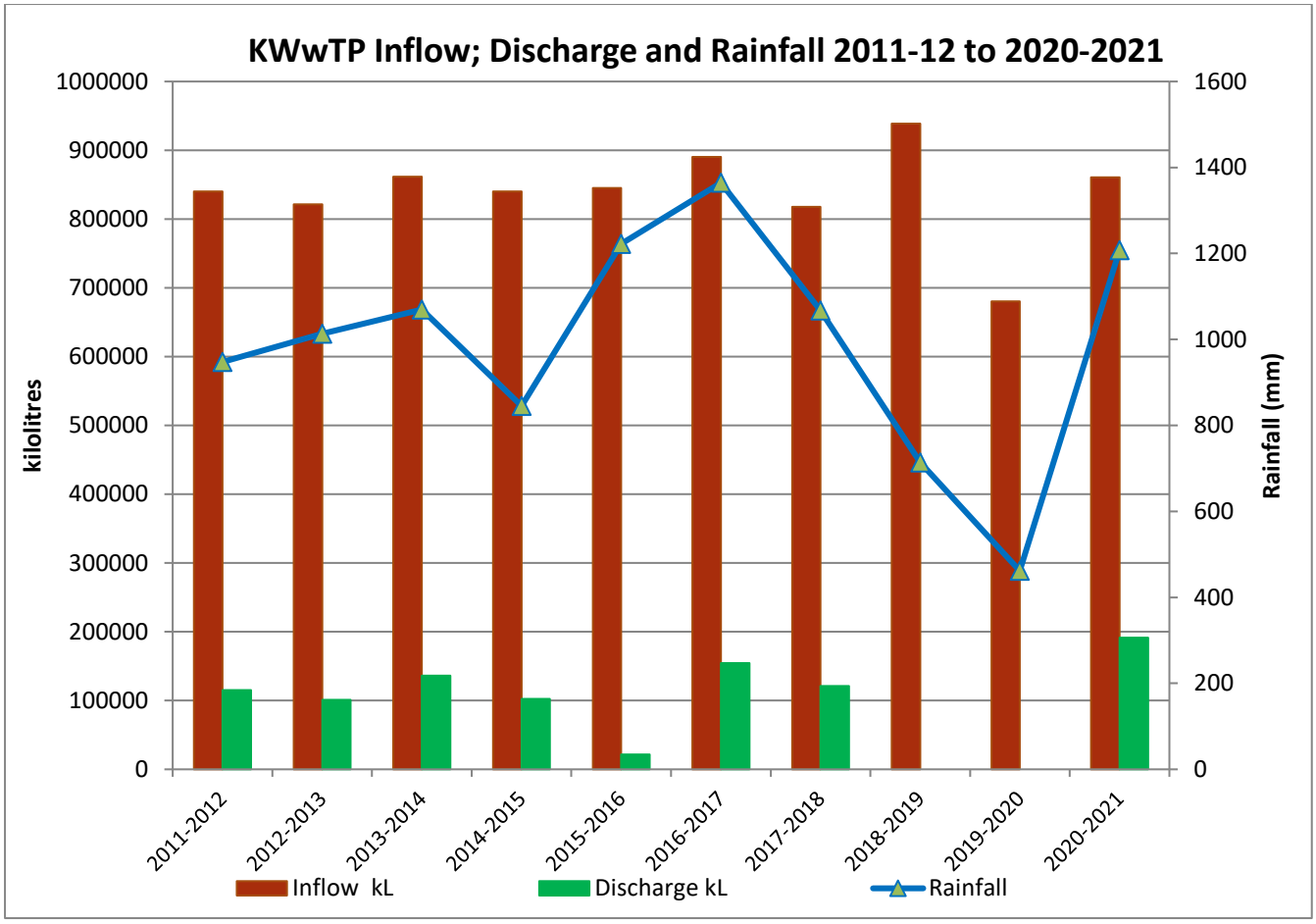


Figure 4: Katherine WWTP inflow and annual discharge record for financial years since 2011-2012 to 2020 - 2021

Condition 22 of the licence specifies that discharges only occur when the river flow is greater than 66.7 kL/sec which is a river height of approximately 1.7 metres. Power and Water have an established procedure under which discharges only occur when the Katherine River at the railway bridge (gauging station G8140001) is greater than 3 metres and the river level is rising. The decision to cease a discharge is based on the ability to safely access the site to manually close the discharge flume and an assessment of the pond levels returning to a sustainable capacity or the river level drops to 3 metres. Figure 5 and data in Appendix 2 confirm that during the licence period conditions were met for any discharges to be compliant with Condition 22 of WDL151-07.

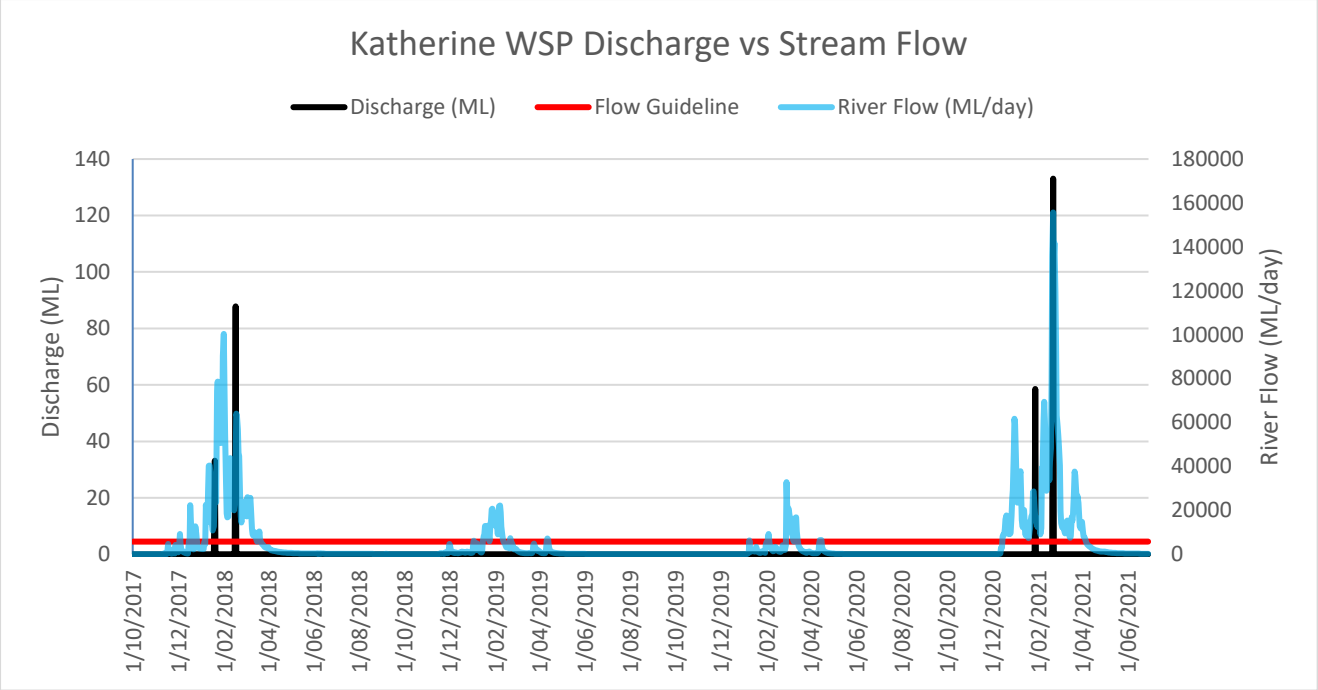


Figure 5: Katherine Wastewater Treatment Plant discharges (ML) to the Katherine River 1 July 2017 to 30 June 2021 and Katherine River flows (ML/day)

3.1 Discharge Loads

For the 2020-2021 period there were two discharges into the Katherine River resulting in a total of 191582kL. These discharges resulted in no significant load increases from previous discharge years for any measured parameters. Table 20 and Table 21 in Appendix 4 include the historical annual inlet and discharge loads for KWwTP and the contaminant reductions resulting from the treatment covering the period 2011-2012 to 2020-2021.

4 Discharge Monitoring

4.1 Discharge Quality

Power and Water conducts an extensive monitoring program for influent and effluent wastewater quality (Fakes and Riach, 2018), the monitoring is more extensive than the WDL requirements providing data to support pond performance assessments; however the monitoring of the effluent as discharged is limited by the fact that samples can only be collected from this site during an active discharge. As discharges have reduced in frequency the number of samples collected annually has also decreased. This limits the quality statistical assessment for compliance with ANZECC at the point of discharge, noting that the ANZECC Triggers are not designed as effluent quality triggers but rather as triggers for protection of ecosystem from chronic exposure within the receiving environment. Contaminant concentrations at levels that are for chronic exposure are lower than the concentrations that result in acute toxicity or acute impacts. The Katherine discharge is intermittent and into high flow conditions (>1:575 dilution) meaning that chronic exposure is not likely to occur and therefore compliance with these assessment triggers demonstrates low risk.

During the period of WDL151-07 PWC has continued to conduct discharge water quality monitoring as required by Condition 16 of the licence where and when discharges occur. The data collected continues to expand PWC's understanding of the water quality characteristics of the treated effluent discharged to the Katherine River. The only site required to be monitored under conditions of the WDL is site Ska100 (the effluent).

For the two discharge events in this reporting period, the required sampling was conducted at Ska100 for all of the parameters outlined in WDL151-07. Analysis of discharge quality for these events indicated no significant changes to the trends of previous years. Some analyte concentrations were above ANZECC 95% species protections but no concentrations exceeded ANZECC acute toxicity guidelines. Accounting for dilution, no analytes were present at concentrations that would pose a risk to the receiving waters.

Table 3 includes the statistical assessment of all the water quality monitoring data required to be collected as a condition of the WDL; the assessment period is from 1 July 2011 to 30 June 2021. Table 3 shows field measurements and laboratory results for water quality sampling conducted at the KWWTP discharge point (Ska100). Table 3 summarises discharge water quality and effluent loads for the periods where discharges occurred.

Long term trends of historic discharges are provided in section 5. The discharge trends are provided in order to characterise previous water quality discharged from KWwTP.

5 Long Term Discharge Monitoring Trends

5.1 Long Term Discharge Quality

Long term discharge water quality data is included in Appendix 3 of this report, with a summary included as Table 3 below. Table 3 shows field measurements and laboratory results for water quality sampling conducted at the KWWTP discharge point (Ska100). Table 3 summarises discharge water quality and effluent loads for the periods where discharges occurred.

The minimum dilution ratio that can be achieved when discharging in compliance with WDL 151-07 is 1:575 effluent to river water. Where possible Power and Water choose to maintain a regime of a river height of three metres at Katherine River gauging station G8140001, which is equivalent to a flow rate of 138 cumecs (m^3/sec= kL/sec). At this river height, the minimum dilution achievable is 1:1,190 between treatment effluent and river water. The high dilution and short-term and seasonal nature of the discharges suggest that the discharge load is the more appropriate criteria in assessing potential impacts associated with the discharge, as the water quality of the effluent is immediately diluted by a factor of 1:575 at the lowest authorised discharge.

Table 3: WDL151-07 discharge monitoring results 2011 to current

Parameter	Units	Detection Limits	ANZECC Guideline	Median	80th percentile	95th percentile
pH	pH	0.01	6.0-8.0	9.2	9.6	9.8
EC	µScm^2	0.1	250	387	435	457
DO	%sat	0.01	80-110	91	113.64	149.3
Temp	◦C	0.01	-	28.85	30.844	33.786
FRP	mg/L	0.05	0.004	0.895	1.36	2.10
TP	mg/L	0.05	0.01	2.25	2.68	3.79
NH3-N Total	mg/L	0.1	0.01	0.45	0.8	2.91
NO2	mg/L	0.1	-	0.1	0.1	0.20
NO3	mg/L	0.1	-	0.1	0.1	0.13
NOx	mg/L	0.1	0.005	0.05	0.05	0.34
TN	mg/L	0.1	0.2	12.4	17.22	22.12
E coli	org/100ml	10	200*	10	1644	18386
Enterococci	org/100ml	10	41-200	1664	6734	24564
As	µg/L	0.5	13	0.5	1.3	1.68
Cd	µg/L	0.2	370	0.2	0.2	0.2
Cr	µg/L	5	0.2	2.6	5	5
Cu	µg/L	10	1.4	7.455	10	10
Pb	µg/L	1	3.4	1	1	1.018
Hg	µg/L	0.1	0.06	0.06	0.1	0.2
Ni	µg/L	2	11	1.755	2	2
Zn	µg/L	10	8	0.5	1.3	1.68
BOD	mg/L	2	-	50	71.8	108.95
COD	mg/L	2	-	200	300	397.5
SS	mg/L	1	15	110.5	147.4	216.1
VSS	mg/L	1	-	101.5	134.8	205.6
Hardness (CaCO3)	mg/L	1	-	71.5	84.46	198.05

ANZECC 2000 Guideline values relevant to 95% Species protection in Tropical Lowland Rivers.
Note: Red results below limits of detection.
*change in limits of detection over 7-year assessment period

5.2 Water Quality Trends

5.2.1 Field Characteristics

Table 4: WDL151-07 discharge monitoring results 2020-2021: Field Characteristics

Sample and sample site parameters				WDL151-07 Sample Dates		
KWWT Plant Outfall Ska100		**Location**	**KWWTP outlet**	**01/02/21**	**23/02/21**	**2020-2021**
Location GDA94, Zone 53		**Site Code**	**Ska100**			
		Easting	**707738**			
		Northing	**8633020**			
	Abbreviation	Units	Frequency			
Annual Discharge Volume						191582
pH	pH	pH units	M	9.41	9.19	
Electrical conductivity	EC	µS/cm	M	0.387	0.266	
Dissolved Oxygen	DO	% saturation	M	53.2	128.1	
Temperature	T	°C	M	29.93	28.41	

M: Monthly at least once per any 30 day period during which a discharge has occurred.
A: Annually at least once per year in which a discharge has occurred

5.2.1.1 Water Quality Tends Assessment: Field Parameters

pH of Katherine WWTP Effluent 2011 to 2021

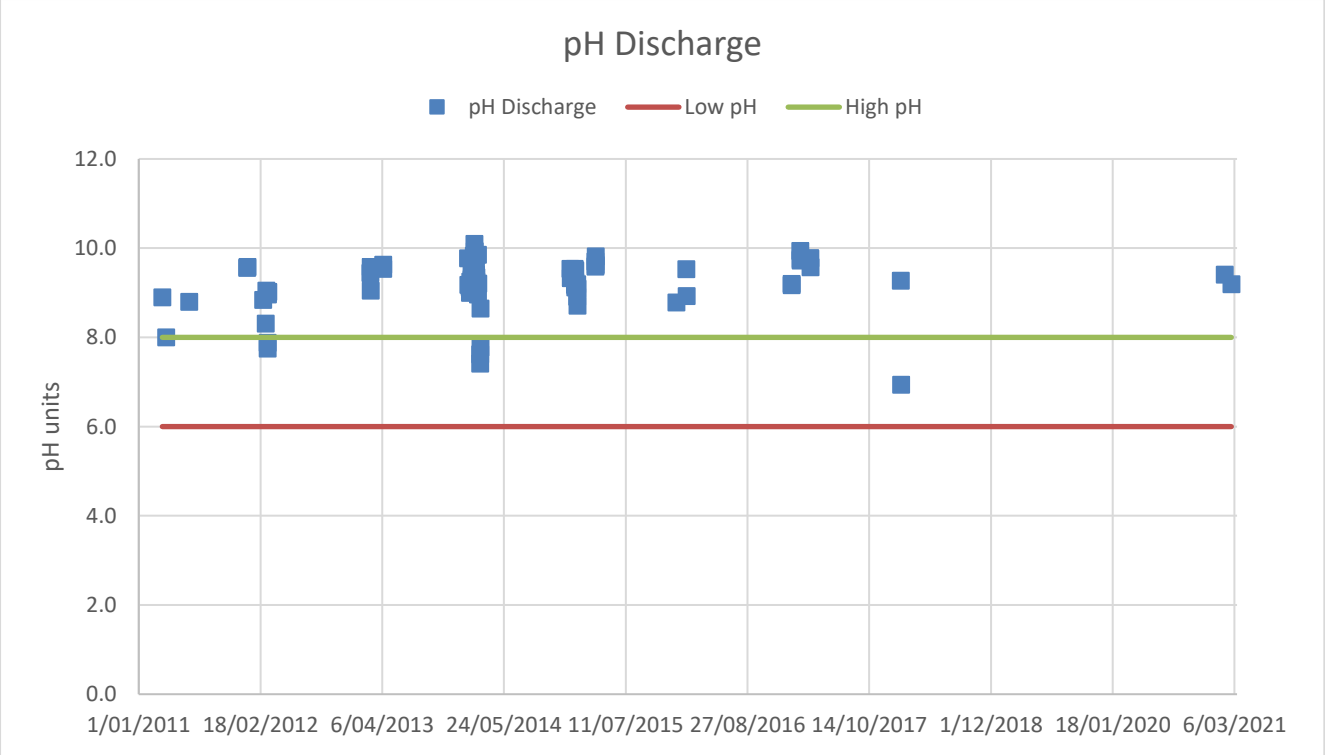


Figure 6: pH of Katherine Wastewater Treatment Plant Effluent since 2011 to 2020

Electrical Conductivity (EC) of KWwTP Effluent 2011 to 2021

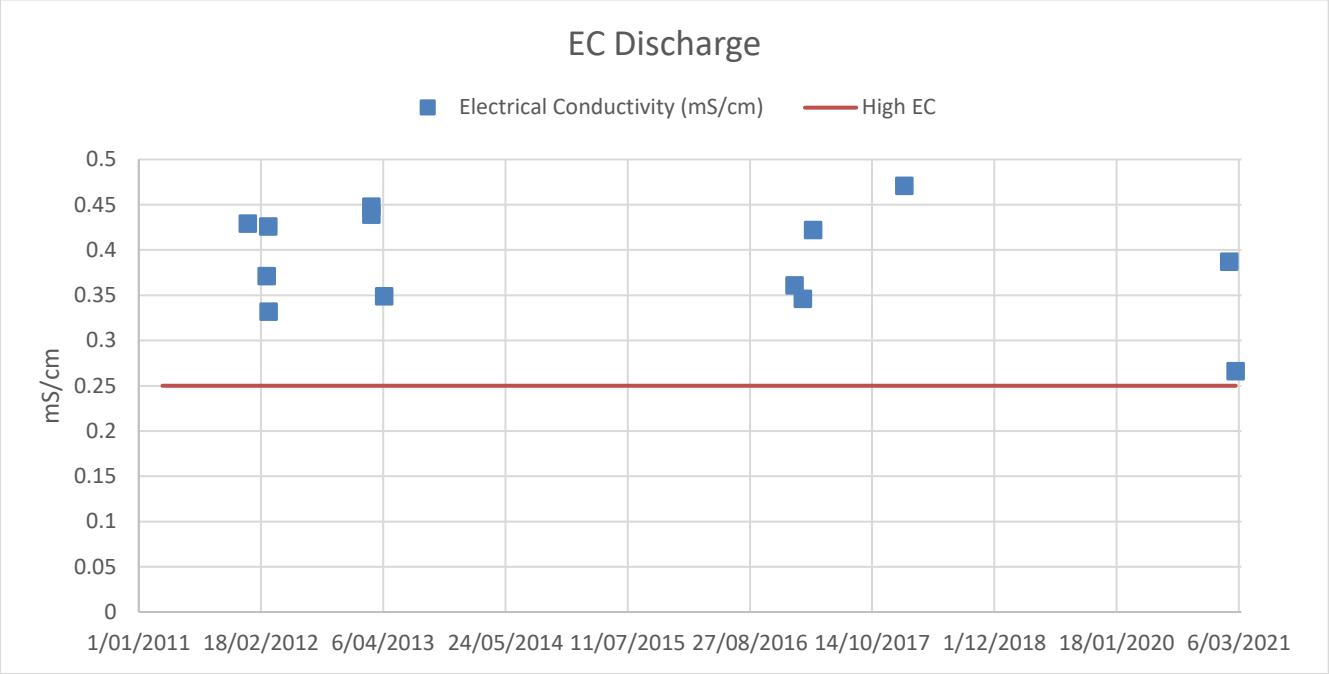


Figure 7: EC of Katherine Wastewater Treatment Plant Effluent 2011 to current

Dissolved Oxygen (DO) KWwTP Effluent 2011 to 2021

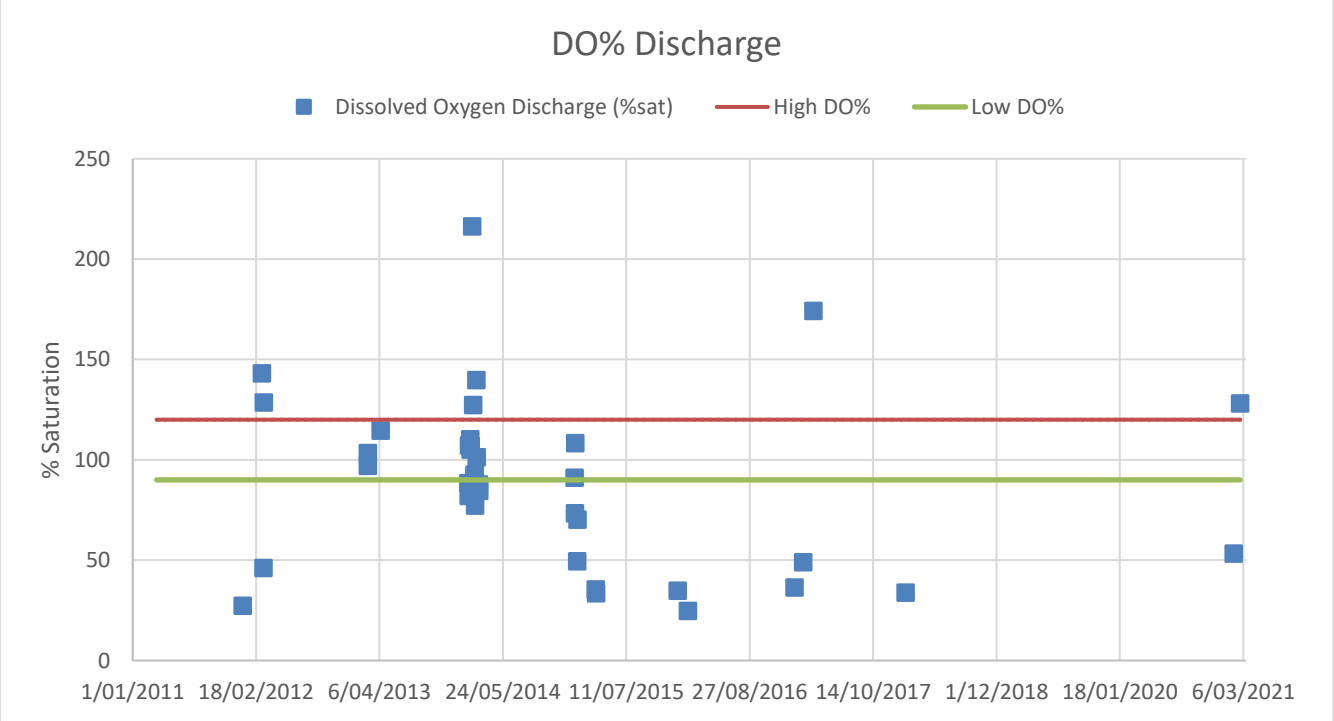


Figure 8: DO% saturation of Katherine Wastewater Treatment Plant Effluent 2011 to current

Temperature of KWwTP Effluent 2011 to 2021

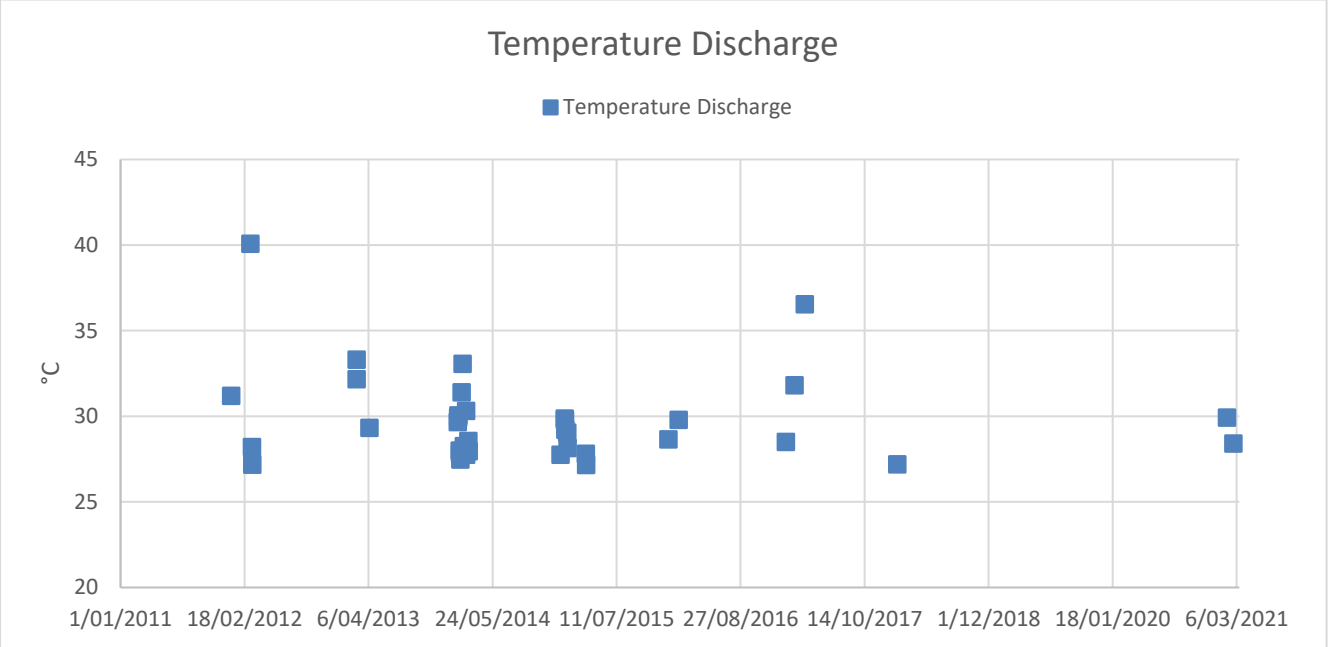


Figure 9: Temperature of Katherine Wastewater Treatment Plant Effluent since 2011 to current

The pH, EC and DO% saturation of the discharge from the Katherine Waste Stabilisation Ponds (Ska100) is consistently outside the trigger range recommended by the ANZECC Guidelines for Fresh and Marine Water Quality (ANZECC 2000) with DO% saturation both above and below the range recommended for the protection of the beneficial uses of the Katherine River, however the discharge of a small volume of treated effluent into high flow river conditions, with an immediate minimum dilution ration of 1:575 indicate that the elevated pH will not compromise the protection of the declared beneficial uses of the surface waters of the Katherine River.

5.2.2 Nutrients

Table 5: WDL151-07 discharge monitoring results 2020-2021: Nutrients

Sample and sample site parameters				**WDL151-07 Sample Dates**		
KWWT Plant Outfall Ska100		**Location**	**KWWTP outlet**	**01/02/21**	**23/02/21**	**2020-2021**
Location GDA94, Zone 53		**Site Code**	**Ska100**			
		Easting	**707738**			
		Northing	**8633020**			
	Abbreviation	Units	Frequency			
Annual Discharge Volume						191582
Filterable Reactive Phosphorus	FRP	mg/L	M	1.6	0.7	
Total Phosphate	TP	mg/L	M	4.2	2.3	
Total Ammonia	NH_3-N	mg/L	M	0.4	0.9	
Nitrate	NO_3	mg/L	M	< 0.1	< 0.1	
Nitrite	NO_2	mg/L	M	< 0.1	< 0.1	
Oxides of Nitrogen	NOx	mg/L	M	< 0.1	< 0.1	
Total Nitrogen	TN	mg/L	M	25.5	9.5	

M: Monthly at least once per any 30 day period during which a discharge has occurred.
A: Annually at least once per year in which a discharge has occurred

5.2.2.1 Water Quality Tends Assessment: Nutrients

Filterable Reactive Phosphorus (FRP) KWwTP Effluent 2011 to 2021

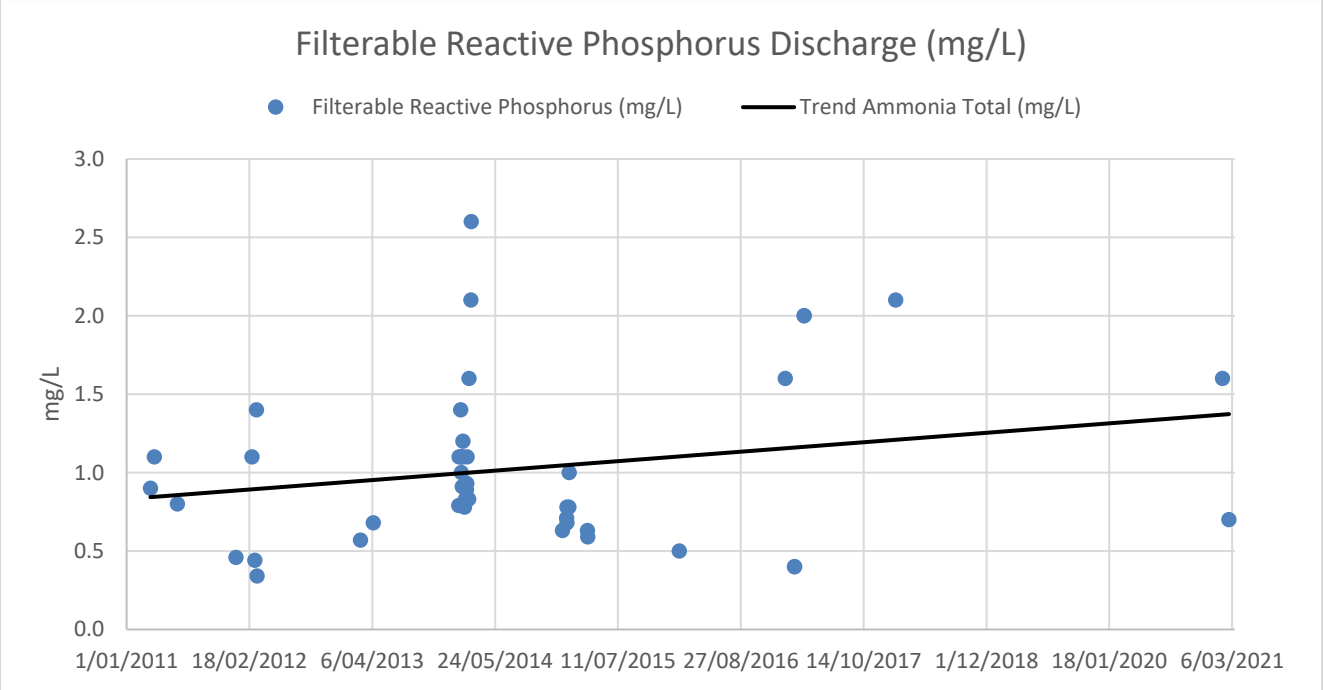


Figure 10: FRP in Katherine Wastewater Treatment Plant Effluent 2011 to current

Total Phosphorus (TP) KWwTP Effluent 2011 to 2021

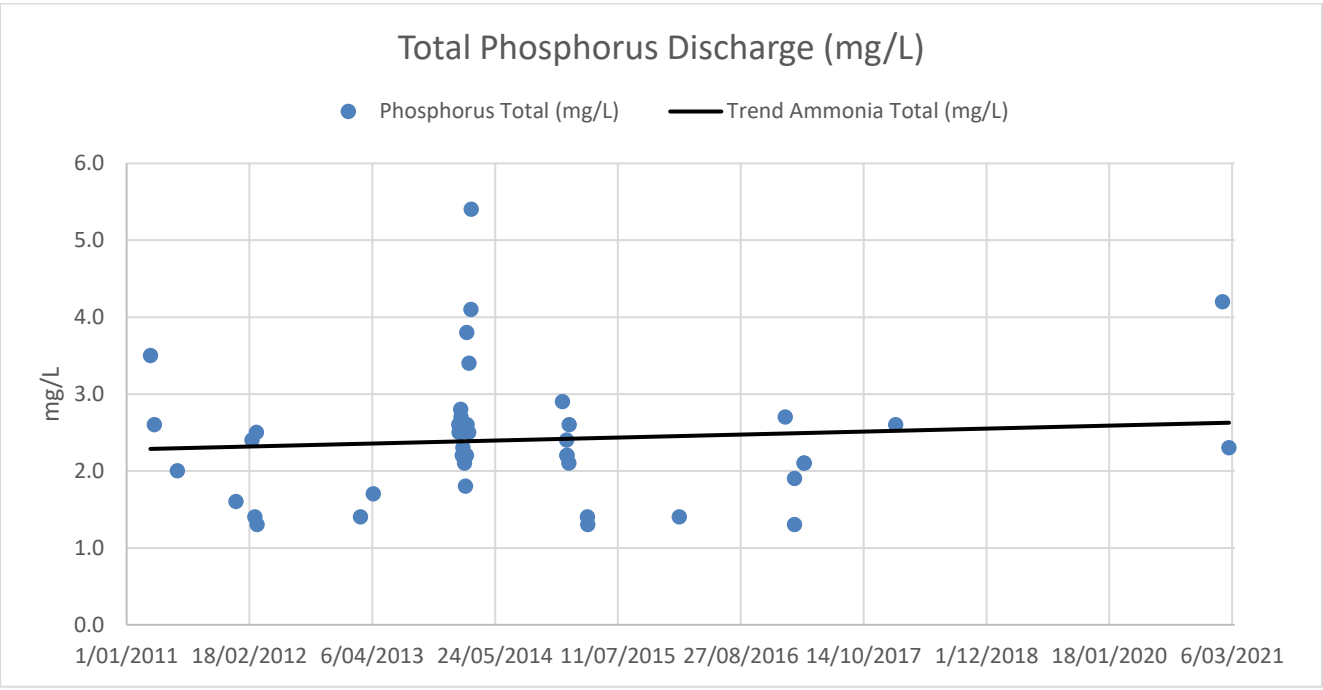


Figure 11: TP in Katherine Wastewater Treatment Plant Effluent 2011 to current

Nutrient indicators reactive and total phosphorus in the effluent is consistently above the range recommended by the ANZECC Guidelines for Fresh and Marine Waters. The guidelines

are designed to protect the environment from algal blooms resulting from excess phosphorus in the river. The discharge of small loads of nutrients into the river under high flow conditions (immediate discharge greater than 1:575) is considered to be a low risk to the protection of the declared beneficial uses and this is confirmed by the absence of algal blooms in the Katherine River downstream of the discharge.

Total Ammoniain KWwTP Effluent 2011 to 2021

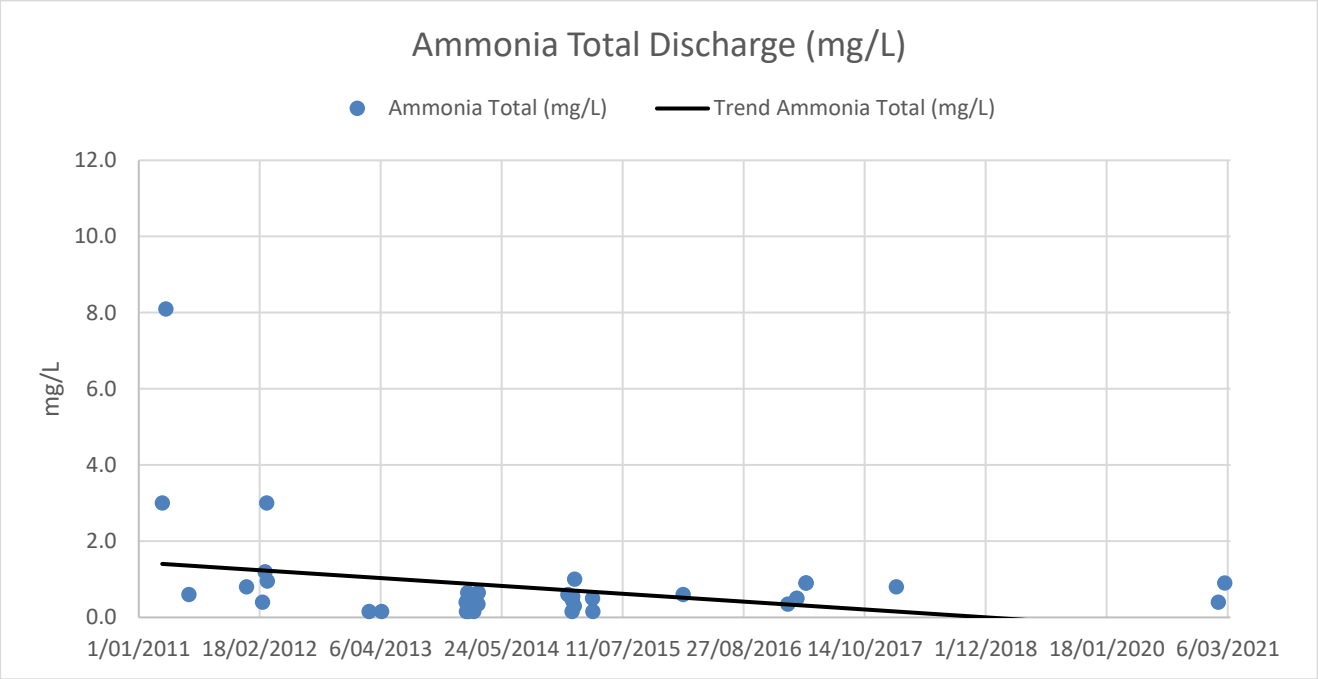


Figure 12: NH3-N in Katherine Wastewater Treatment Plant Effluent 2011 to current

Oxides of Nitrogen (NO2/NO3) in KWwTP Effluent 2011 to 2021

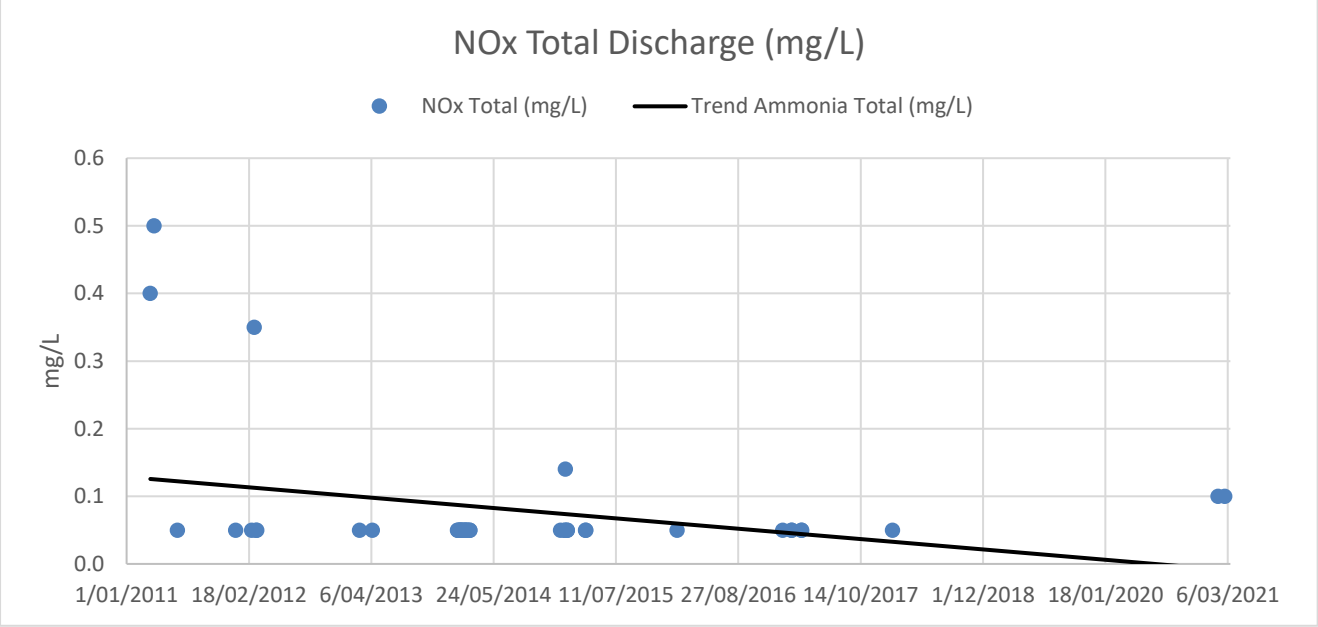


Figure 13: Oxides of Nitrogen in Katherine Wastewater Treatment Plant Effluent 2011 to current

Total Nitrogen (TN) in KWwTP Effluent 2011 to 2021

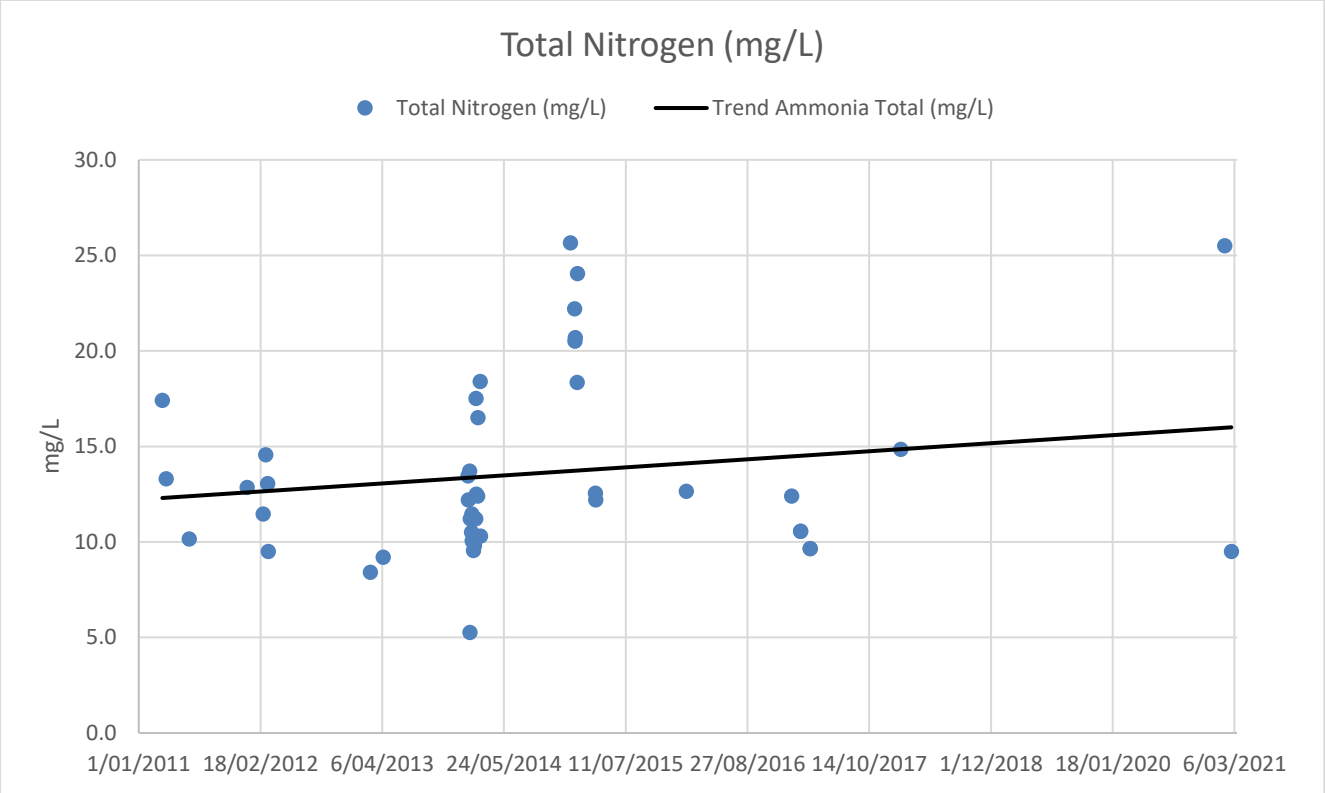


Figure 24: TN in Katherine Wastewater Treatment Plant Effluent 2011 to current

Nutrient indicators ammonia, oxides of nitrogen (NO2; NO3 and total NOx) and total nitrogen in the influent and effluent are consistently above the range recommended by the ANZECC Guidelines for Fresh and Marine Waters. The guidelines are designed to protect the environment from algal blooms resulting from excess nutrients in the river. The discharge of small loads of nutrients into the river under high flow conditions (immediate discharge greater than 1:575) is considered to be a low risk to the protection of the declared beneficial uses and this is confirmed by the absence of algal blooms in the Katherine River downstream of the discharger.

In addition to being a nutrient ammonia is also a potential toxicant, at the median pH of the effluent (9.2) the chronic toxicity value for ammonia is 0.180 mg/L. (Table) in Appendix 3 shows that the majority of the total ammonia measured in the treated effluent is organic ammonia in the form of proteins and other similar biological material. It is the free ammonia that is the potent toxicant and the 95th percentile free ammonia measured in the effluent is 0.450 mg/L indicating that exposure to the undiluted effluent may pose a risk to the protection of the declared beneficial uses of the Katherine River however the circumstances of all discharges are that there is an immediate dilution of a minimum of 1:575 indicating that the discharge of the treated effluent poses a low risk to the protection of the declared beneficial uses of the waters of the Katherine River.

5.2.3 Bacteriological Indicators: *E.coli* and Enterococci

Table 6: WDL151-07 discharge monitoring results 2020-2021: Bacteriological Indicators

Sample and sample site parameters				WDL151-07 Sample Dates		
KWWT Plant Outfall Ska100		Location	KWWTP outlet	01/02/21	23/02/21	2020-2021
Location GDA94, Zone 53		Site Code	Ska100			
		Easting	707738			
		Northing	8633020			
	Abbreviation	Units	Frequency			
Annual Discharge Volume						191582
Bacteriological Indicators						
Escherichia coli	*E. coli*	MPN/100 mL	M	< 100	< 100	
Enterococci		MPN/ 100 mL	M	< 10	86	

M: Monthly at least once per any 30 day period during which a discharge has occurred.
A: Annually at least once per year in which a discharge has occurred

5.2.3.1 Bacteriological Indicator trends 2011-12 to 2020-2021

Table 7: Bacteriological indicator monitoring from the 2011-12 to 2020-2021 financial years

		E.coli		Enterococci	
Period	Assessment Statistic	Inlet Sewer	Discharge	Inlet Sewer	Discharge
2020-2021	Median	24,196,000	10.0	987,000	1,553.0
	90th percentile	24,196,000	18057.35	2,394,000	24503
	Log10	7.3837	3.1883	5.9943	3.7846
	Samples	11		11	
	Log Reduction		4.1504		2.2097
2019-2020	Median	24,196,000	No discharge	965,100	No discharge
	90th percentile	24,196,000	No discharge	1,966,500	No discharge
	Log10	7.3837	No discharge	5.9846	No discharge
	Samples	12	0	12	0
	Log Reduction		No discharge		No discharge
2018-2019	Median	24196000	No discharge	939900	No discharge
	90th percentile	24196001	No discharge	1926400	No discharge
	Log10	7.3837	No discharge	6.2847	No discharge
	Samples	15	0	15	0
	Log Reduction		No discharge		No discharge
2017-2018	Median	22029500	16580	1046200	2690
	90th percentile	24196001	16580	1689580	2690
	Log10	7.3837	4.2196	6.2278	3.4298
	Samples	13	1	13	1
	Log Reduction		3.1641		2.798
2016-2017	Median	19863000	5	410600	295
	90th percentile	24196001	41	2218400	563
	Log10	7.3837	1.6123	6.3460	2.7505
	Samples	12	3	12	3
	Log Reduction		5.771		3.5955
2015-2016	Median	1600500	8	33650	242
	90th percentile	23762700	10	1033660	394
	Log10	7.3759	1.0000	6.0144	2.5955
	Samples	15	2	15	2
	Log Reduction		6.3759		3.4189
2014-2015	Median	19863000	5	770100	424
	90th percentile	24196001	16	1413600	1732
	Log10	7.3837	1.2041	6.1503	3.2385

	Samples	14	8	14	8
	Log Reduction		6.1796		2.9145
2013-2014	Median	17329000	5	980400	1723
	90th percentile	19863000	73	1986300	15449
	Log10	7.2980	1.8633	6.2980	4.1889
	Samples	11	21	11	21
	Log Reduction		5.4347		2.1091
2012-2013	Median	19863000	10	980400	24197
	90th percentile	24196000	176	1732900	129087
	Log10	7.3837	2.2456	6.2383	5.1109
	Samples	11	6	11	6
	Log Reduction		5.1381		1.1274
2011-2012	Median	15531000	1905	1326850	4138
	90th percentile	24196000	14827	2419601	9578
	Log10	7.3837	4.1711	6.3837	3.9813
	Samples	11	12	11	12
	Log Reduction		3.2126		2.4024

Analysis of discharge into Katherine River for 2020-2021 indicate that the lowest log reduction in the bacteriological indicators *E. coli* and enterococci were greater than 3.18 for *E.coli* and greater than 2.201 for enterococci which is similar to previous years in which there were discharges. This represents a reduction of greater than 99.9% for *E.coli* and greater than 99% for enterococci. The effluent from the KWwTP under conditions required by the licence result in an immediate minimum 1:575 dilution resulting in a low risk of pathogen impacts on the protection of the declared beneficial uses of the waters of the Katherine River.

5.2.4 Metals and Metalloids

Table 8: WDL151-07 discharge monitoring results 2021: Metals and Metalloids

Sample and sample site parameters				WDL151-07 Sample Dates		
KWWT Plant Outfall Ska100		Location	KWWTP outlet	01/02/21	23/02/21	2020-2021
Location GDA94, Zone 53		Site Code	Ska100			
		Easting	707738			
		Northing	8633020			
	Abbreviation	Units	Frequency			
Annual Discharge Volume						191582
Metals						
Arsenic	As	µg/L	A	< 0.5	< 0.5	
Cadmium	Cd	µg/L	A	< 0.2	< 0.2	
Chromium	Cr	µg/L	A	< 5.0	< 5.0	
Copper	Cu	µg/L	A	20	10	
Lead	Pb	µg/L	A	2	1	
Mercury	Hg	µg/L	A	0.8	0.1	
Nickel	Ni	µg/L	A	2	2	
Zinc	Zn	µg/L	A	20	10	

M: Monthly at least once per any 30 day period during which a discharge has occurred.
A: Annually at least once per year in which a discharge has occurred

5.2.5 Water Quality Trends Assessment: Metals and Metalloids

Arsenic (As) in KWwTP Effluent 2011 to 2021

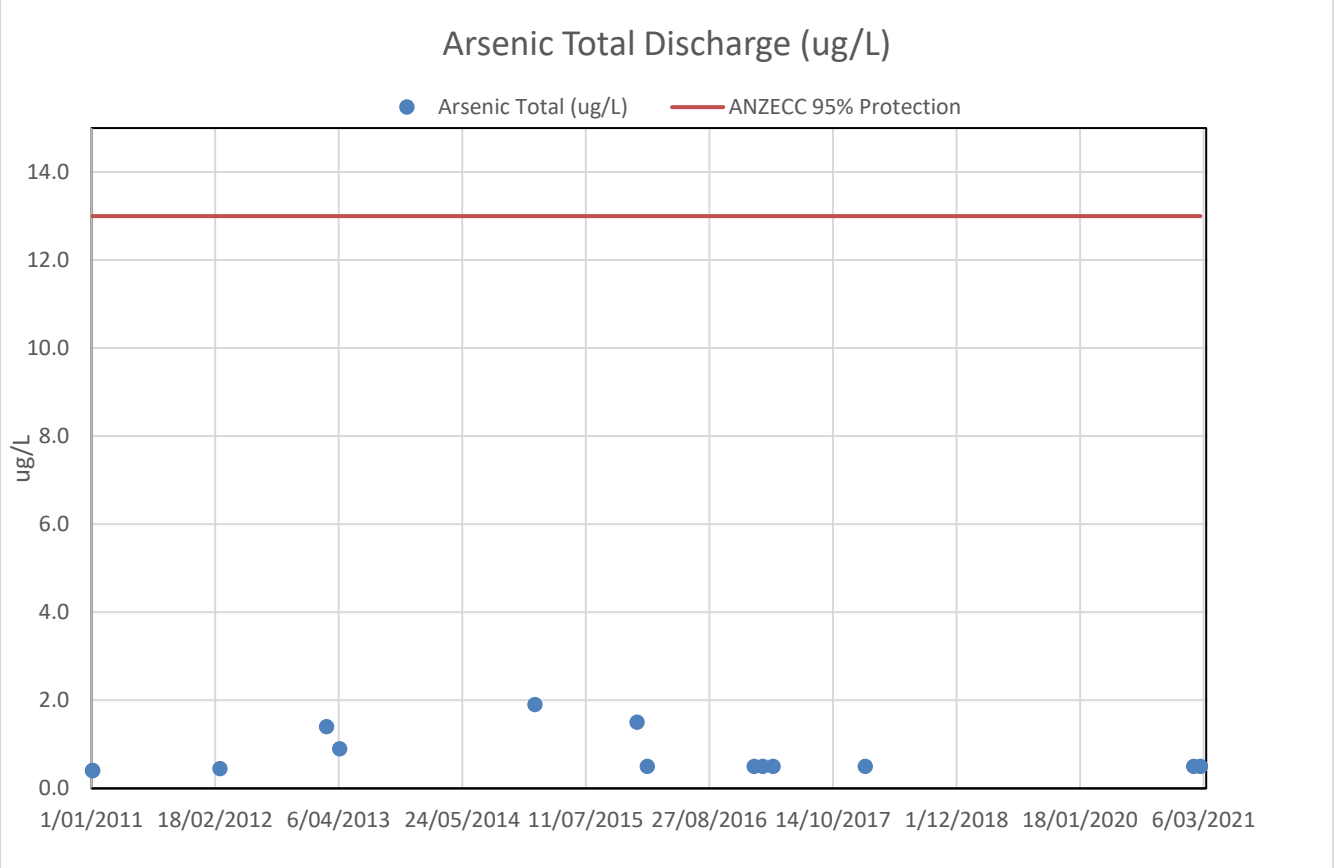


Figure 15: Arsenic (Total) in Katherine Wastewater Treatment Plant Influent and Effluent 2011 to current

Cadmium (Cd) in KWwTP Effluent 2011 to 2021

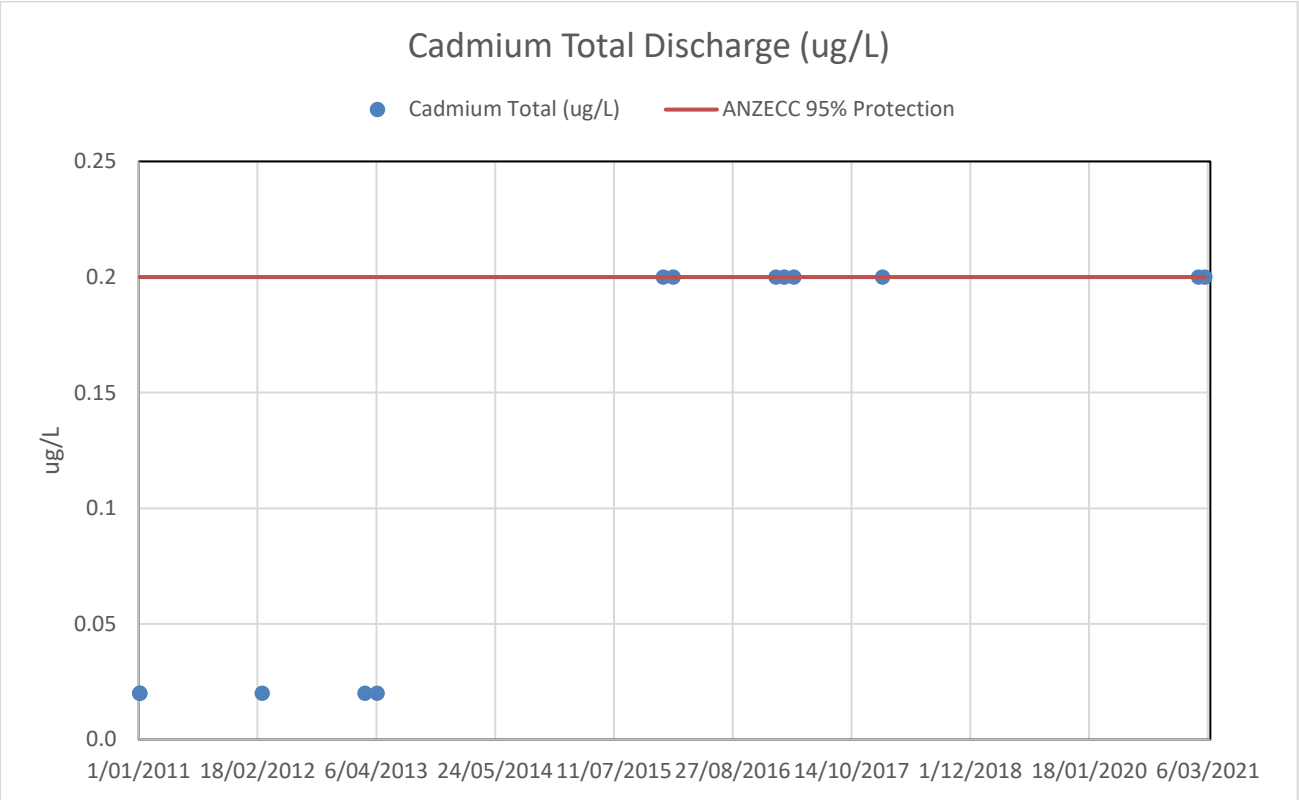


Figure 16: Cadmium (Total) in Katherine Wastewater Treatment Plant Effluent 2011 to current

Chromium (Cr) in KWwTP Effluent 2011 to 2021

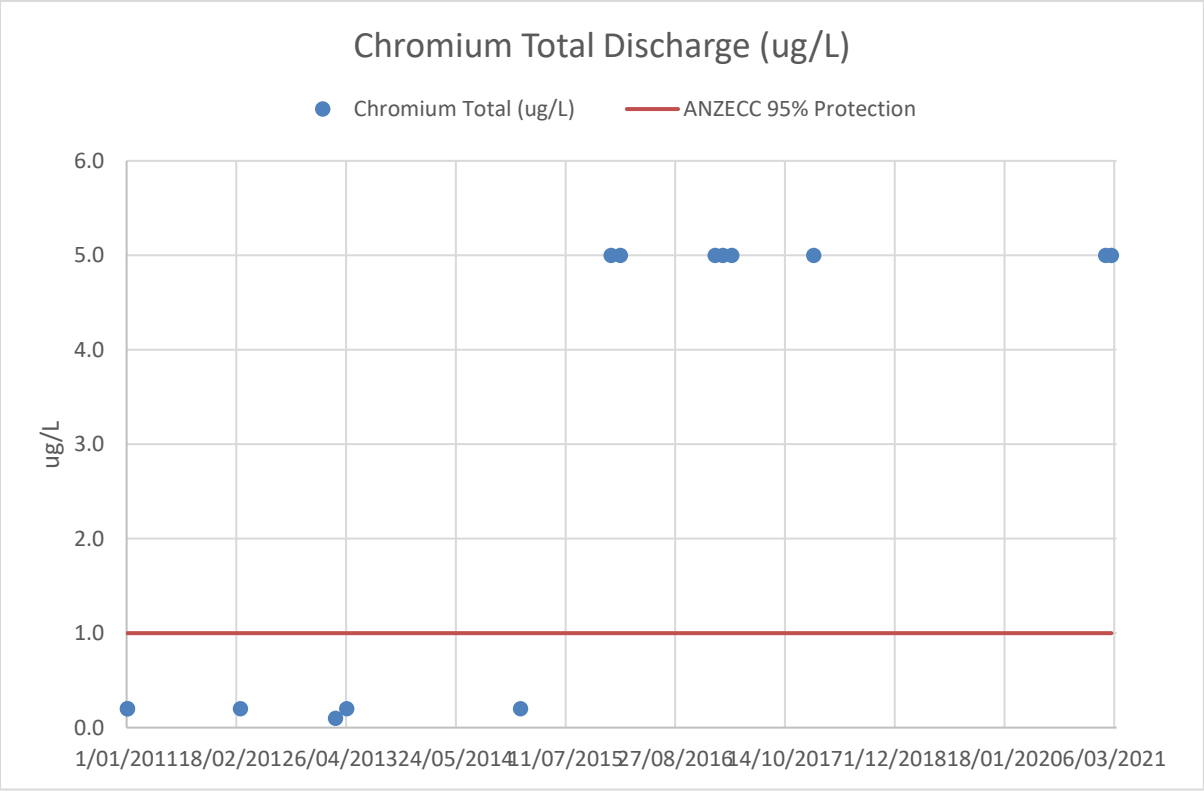


Figure 17: Chromium (Total) in Katherine Wastewater Treatment Plant Effluent 2011 to current

Copper (Cu) in KWwTP Effluent 2011 to 2021

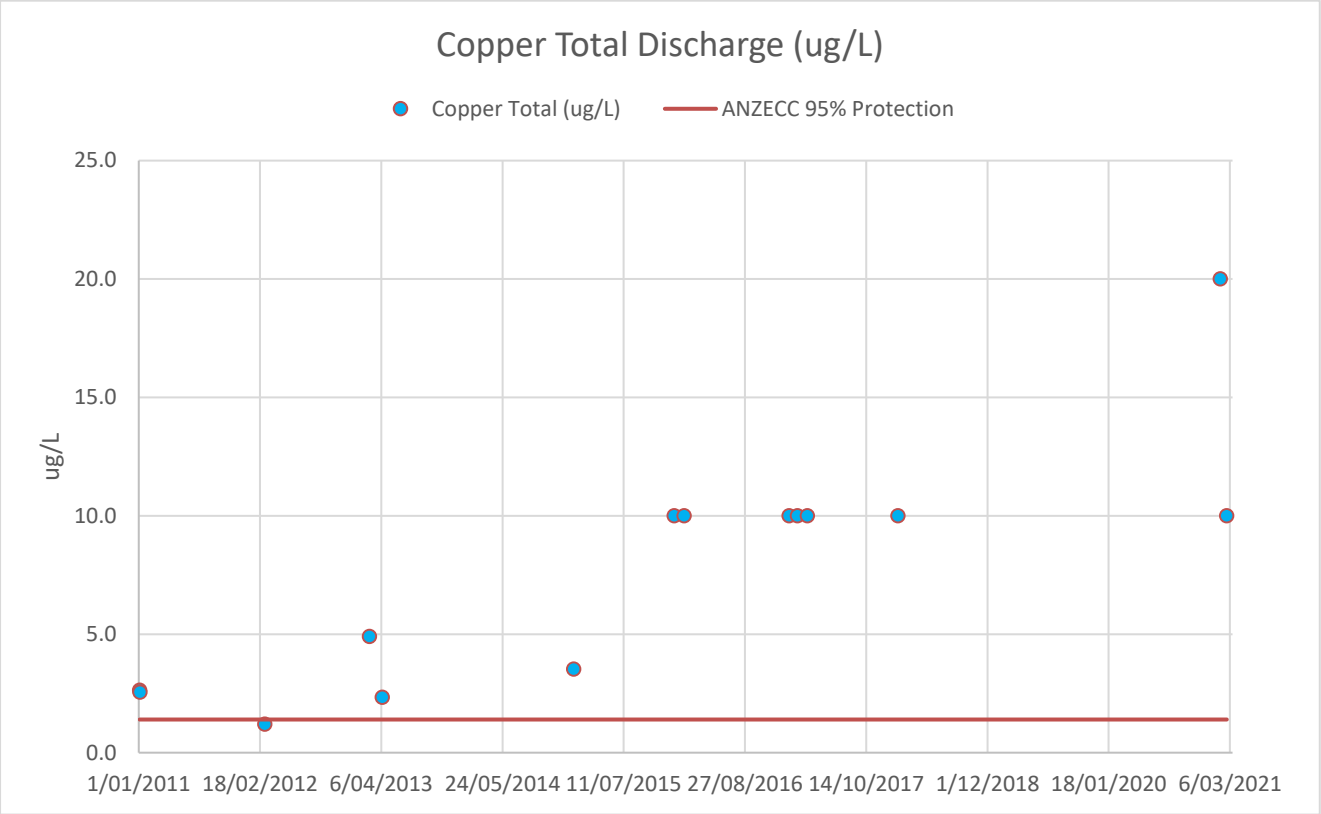


Figure 18: Copper (Total) in Katherine Wastewater Treatment Plant Effluent 2011 to current

Mercury (Hg) in KWwTP Effluent 2011 to 2021

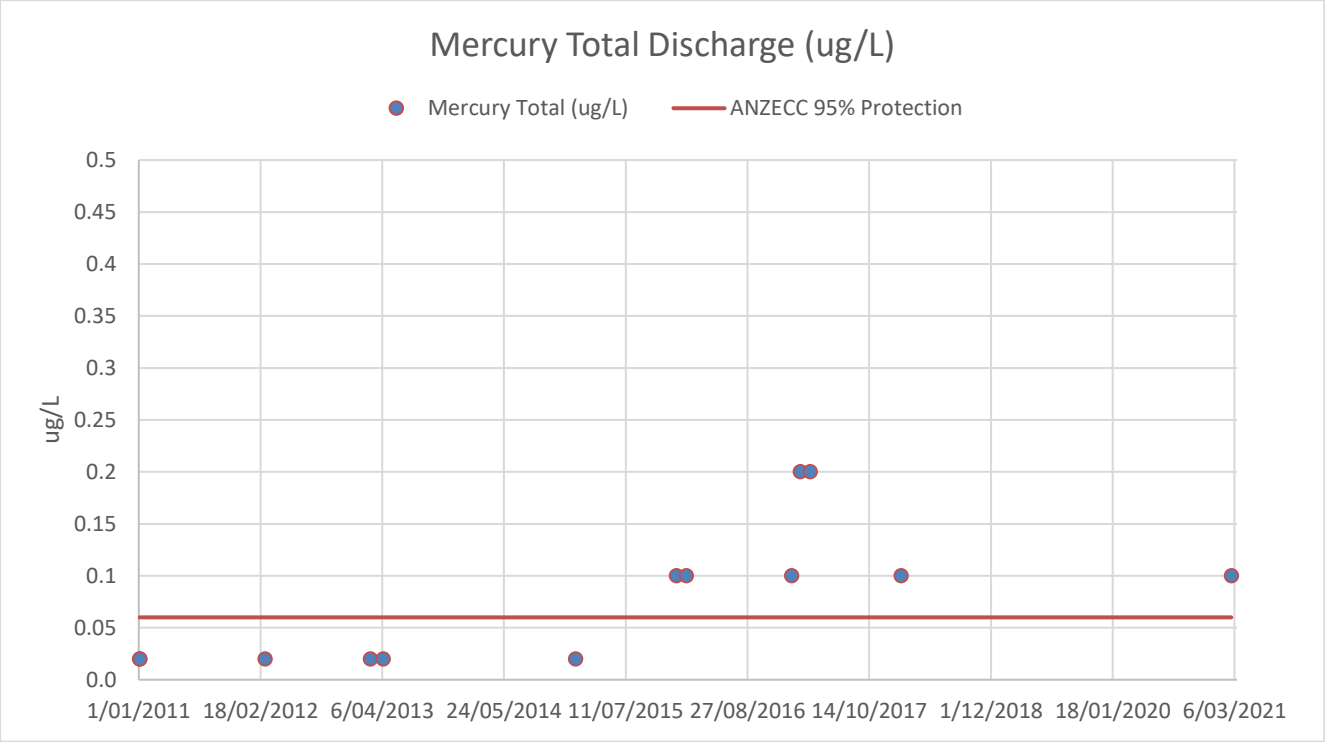


Figure 19: Mercury (Total) in Katherine Wastewater Treatment Plant Effluent 2011 to current

Lead (Pb) in KWWTP Effluent 2011 to 2021

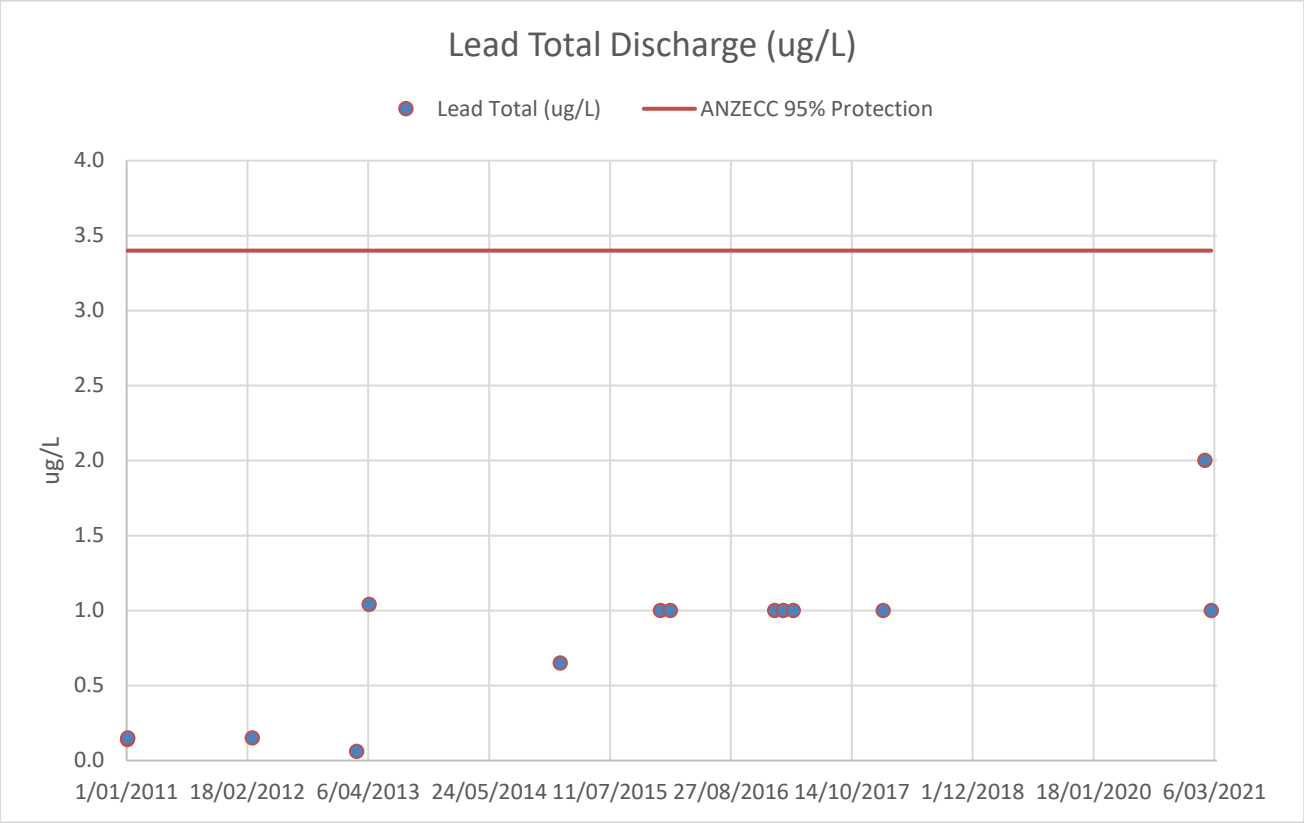


Figure 20: Lead (Total) in Katherine Wastewater Treatment Plant Effluent 2011 to current

Nickel (Ni) in KWwTP Effluent 2011 to 2021

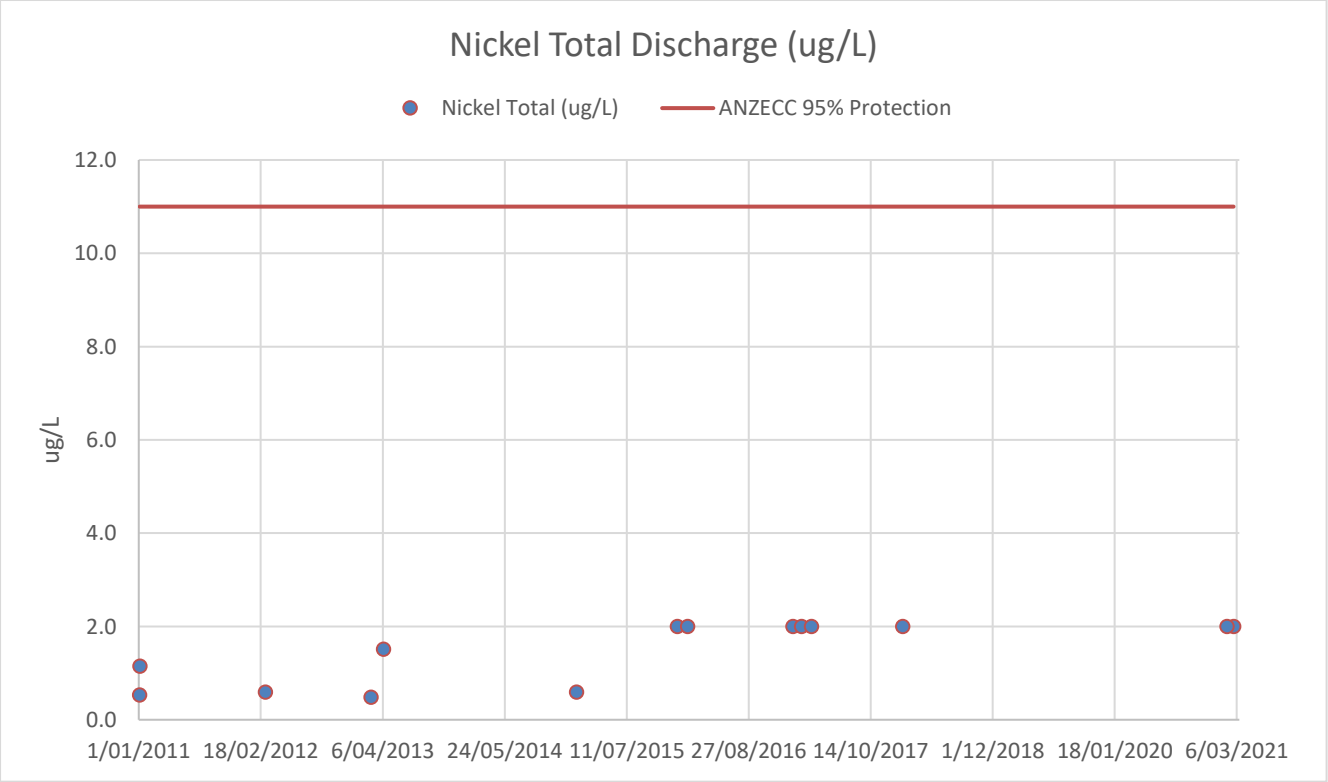


Figure 21: Nickel (Total) in Katherine Wastewater Treatment Plant Effluent 2011 to current

Zinc (Zn) in KWwTP Effluent 2011 to 2021

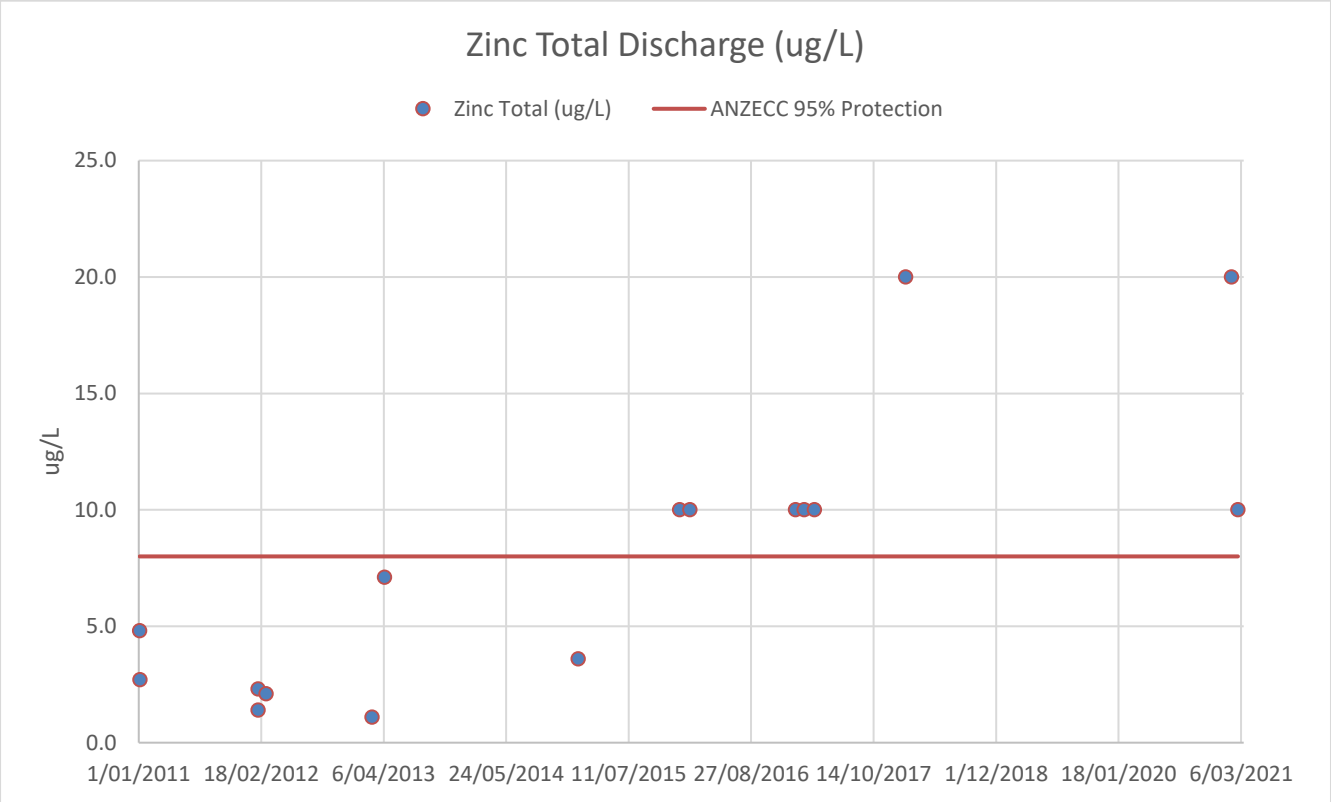


Figure 22: Zinc (Total) in Katherine Wastewater Treatment Plant Effluent 2011 to current

For the 2020-2021 reporting period:

- All discharge samples were below the ANZECC 95% species protection triggers for Arsenic; Cadmium; Mercury; Lead and Nickel;
- The discharge results from 2020-2021 were above the ANZECC 95% Species Protection trigger for Zinc, Copper and Chromium
- The ANZECC 99% Species Protection trigger is applied for Mercury due to the risk of bioaccumulation.
- All trigger values apply to long term or chronic exposure to a toxicant, typically the acute toxicity trigger is an order of magnitude greater.
- No results exceeded acute exposure triggers.

The discharge of treated effluent from the KWWPT under conditions required by the licence result in an immediate 1:575 dilution resulting in a low risk of toxic impacts on the protection of the declared beneficial uses of the waters of the Katherine River.

5.2.6 Environmental Indicators

Table 9: WDL151-07 discharge monitoring results 2021: Environmental Indicators

Sample and sample site parameters				WDL151-07 Sample Dates		
KWWT Plant Outfall Ska100		Location	KWWTP outlet	01/02/21	23/02/21	2020-2021
Location GDA94, Zone 53		Site Code	Ska100			
		Easting	707738			
		Northing	8633020			
	Abbreviation	Units	Frequency			
Annual Discharge Volume						191582
Environmental Indicators						
Biochemical Oxygen Demand	BOD	mg/L	M	47	14	
Chemical Oxygen Demand	COD	mg/L	M	210	140	
Suspended Solids	SS	mg/L	M	98	90	
Volatile Suspended Solids	VSS	mg/L	M	92	86	
Hardness as $CaCO_3$		mg/L	M	10	10	

M: Monthly at least once per any 30 day period during which a discharge has occurred.
A: Annually at least once per year in which a discharge has occurred

5.2.6.1 Water Quality Trends Assessment: Environmental Indicators

Biological Oxygen Demanding Substances (BOD) KWwTP Effluent 2011 to 2021

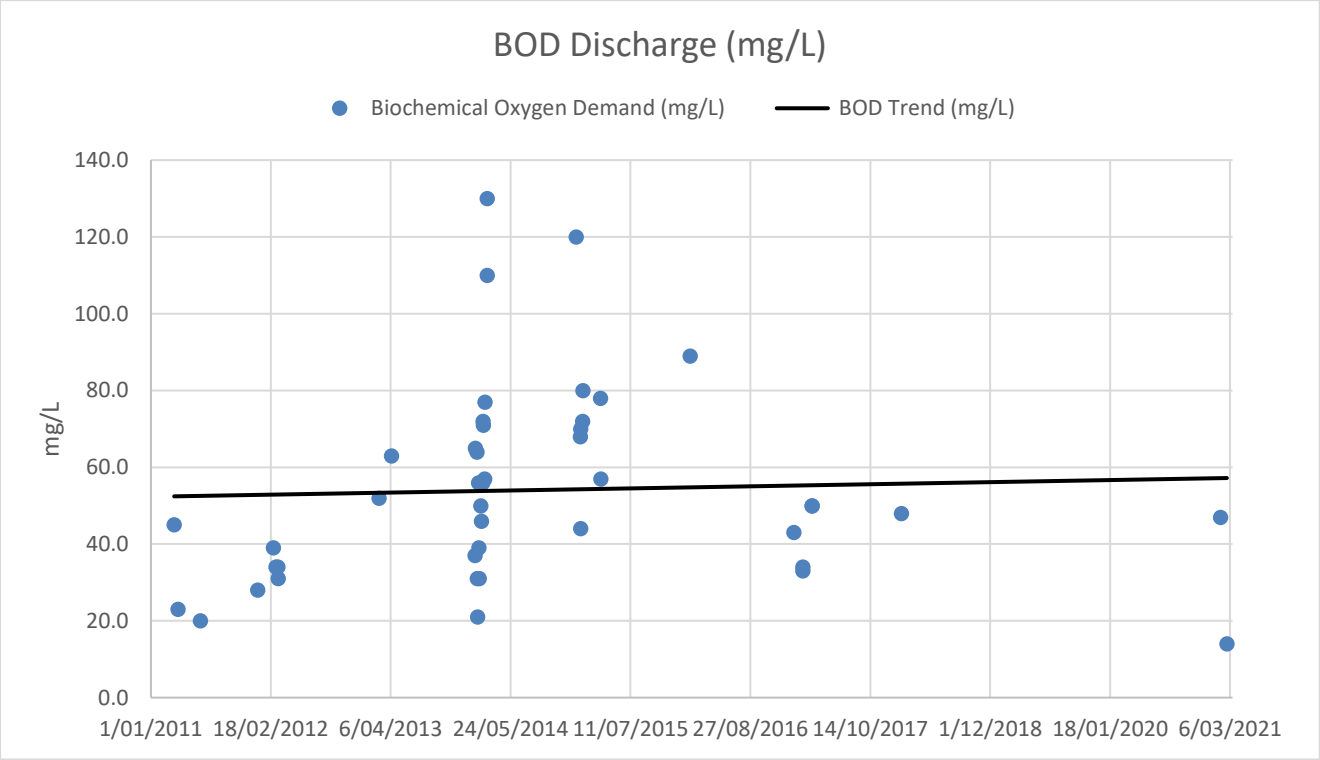


Figure 23: BOD in Katherine Wastewater Treatment Plant Effluent 2011 to current

Chemical Oxygen Demand (COD) KWwTP Effluent 2011 to 2021

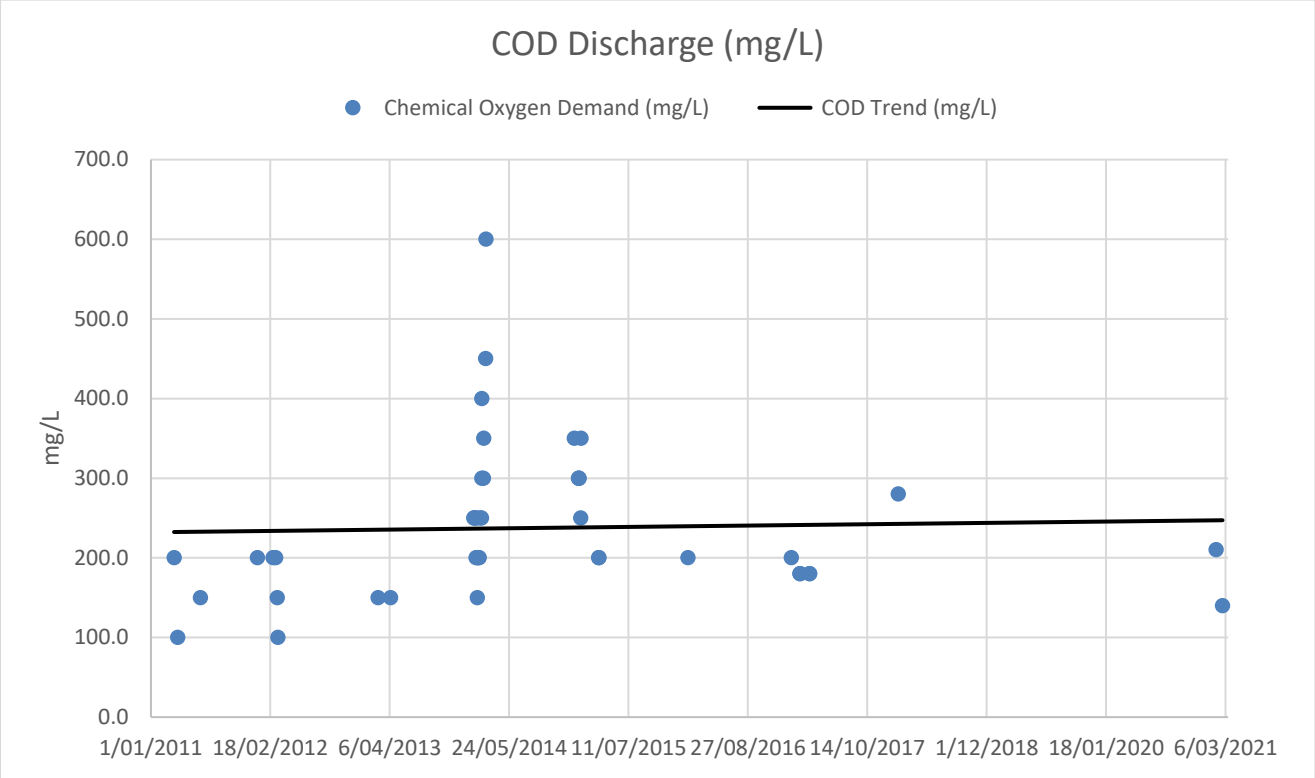


Figure 24: COD in Katherine Wastewater Treatment Plant Effluent 2011 to current

Total Suspended Solids (TSS) in KWwTP Effluent 2011 to 2021

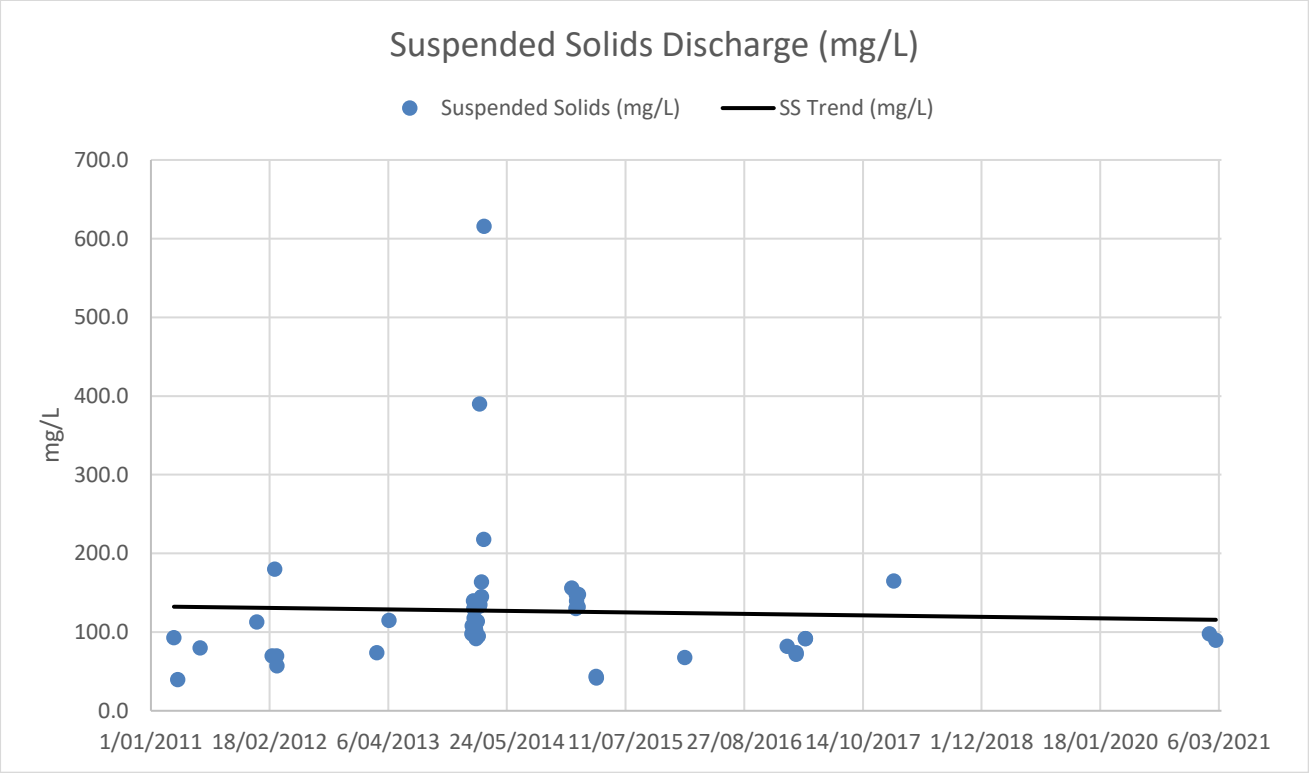


Figure 25: TSS in Katherine Wastewater Treatment Plant Effluent 2011 to current

Volatile Suspended Solids (VSS) KWwTP Effluent 2011 to 2021

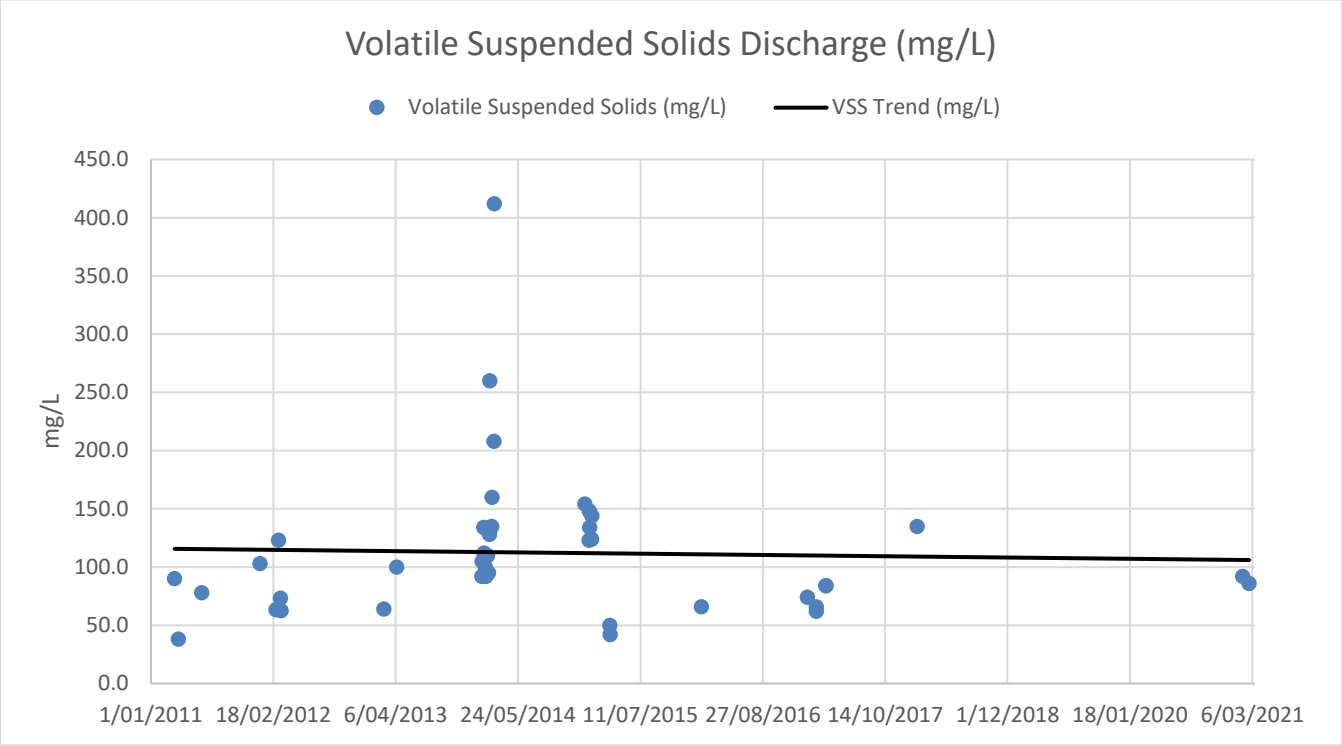


Figure 26: VSS in Katherine Wastewater Treatment Plant Effluent 2011 to current

Hardness (as CaCO3) in KWwTP Effluent 2011 to 2021

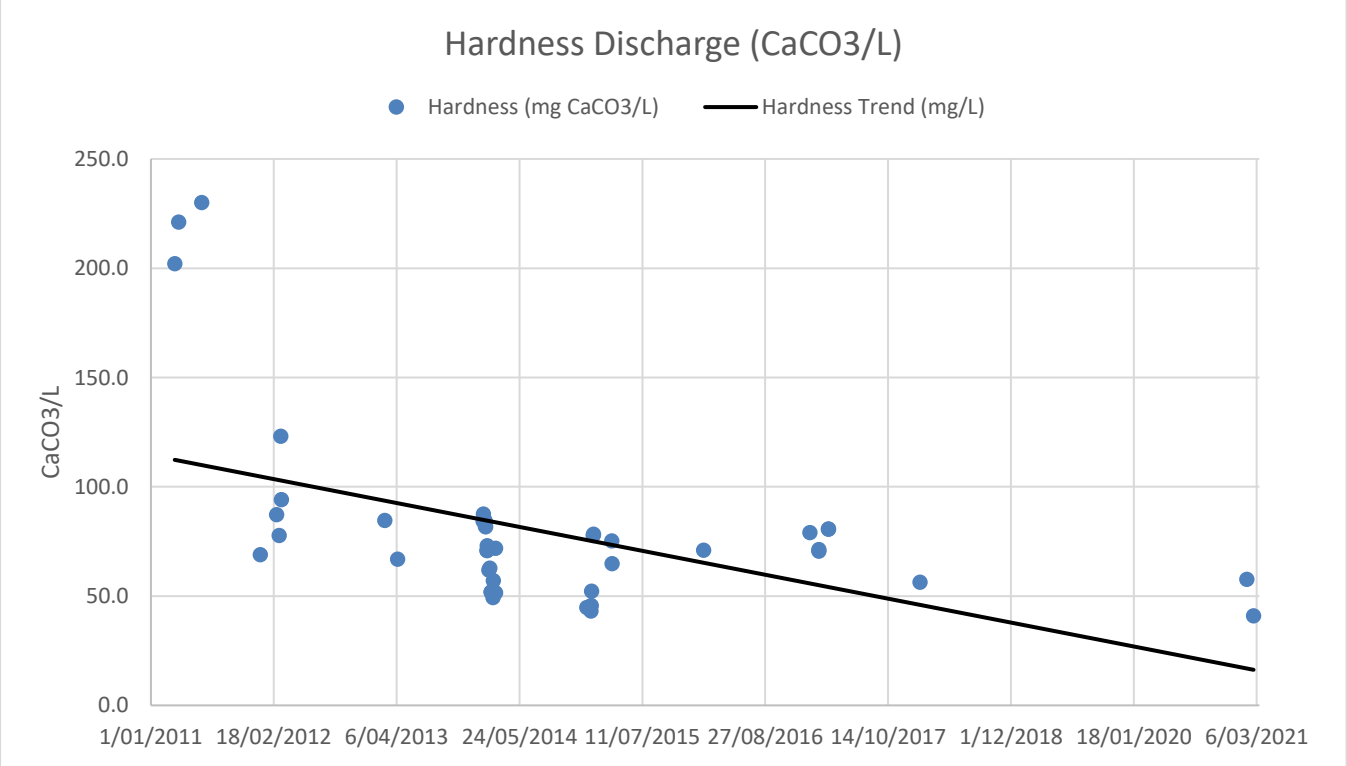


Figure 27: Hardness (as CaCO3) in Katherine Wastewater Treatment Plant Effluent 2011 to current

All environmental indicators specified in the licence are significantly reduced through the treatment process, the concentration of these indicators in the effluent is assessed as posing a low risk to the protection of the declared beneficial uses of the waters of the Katherine River due to the significant dilution and dispersal experienced when discharge to the river under high flow conditions.

5.3 Assessment of Environmental impact

Monitoring results from the discharge events for this reporting period suggest a low risk of environmental harm to the receiving environment. No significant changes in discharges from previous years, where there have been discharges into the river, have been observed. No reports or indications of algal blooms have been received or observed. PWC has undertaken to discharge when the Katherine River is above a height of 3m, which results in flows higher than the required 66.7 cumecs stated in the discharge licence. This results in high dilution of the discharge in the receiving waters and concentrations of all analytes well below ANZECC freshwater 95% species guidelines. Hence the licence activity was determined to have not had an impact on the declared beneficial uses, nor adversely impacted on the environmental values of the receiving waterway of the Katherine River.

5.4 Performance Improvement Plan

Subject to resource constraints implementation of the Performance Improvement Plan commenced in January 2018 with most actions substantially on track for delivery within the licence period. The re-evaluation of biosolids management (Action 2.3) is the exception with the task delayed due to delays in finalising the NT biosolids guideline which is currently in draft and awaiting acceptance by DEPaWS/NT EPA.

Table 11: Performance Improvement Implementation 2018

Action Area	Action	Timeframe	Action Status	On Track Y/N
1: Improved Hydraulic Performance	**Objective: To optimise hydraulic performance of ponds**			
1.1	Survey and document evaporation pond wall levels to identify impediments to optimum hydraulic performance	Q1 2018	Completed	Completed
1.2	Review and document the operational philosophy for the KWWTP.	Q1 2018	Completed	Completed
1.3	Develop an operational maintenance and management (OMM) plan for the KWWTP with a focus on optimising the hydraulic and treatment performance of the ponds	Q3 2020	Complete	Completed
1.4	Within budgetary constraints assess and where reasonable and practicable implement measures to improve the hydraulic performance of the ponds.	2020-2021 financial year	Improvement options scoped. Awaiting wet season to trial	Trial scheduled for wet season 2020/2021
1.5	Review wastewater quality data to track changes in water quality within ponds and in the discharge associated with changes in the hydraulic performance of the KWWTPs	Ongoing and following 1.4	Ongoing	Trial scheduled for wet season 2020/2021
1.6	Review off site risks to the protection of declared Beneficial Uses associated with changes in the hydraulic management of hydraulic performance of the KWWTP	Timing depends on item 1.4 implementation	No discharge so not possible to assess	Trial scheduled for wet season 2020/2021
2: Improved Treatment Performance	**Objective: To ensure effluent retention is maximised to improve treatment performance**			
2.1	Review research relating to the efficacy of treatment in removing contaminants from wastewater e.g. PFAS	Q1: 2018	Ongoing review and assessment	Ongoing
2.2	Review biosolid sludge management contaminant data to determine storage and reuse options	Q3: 2018	Reviewed, risk low due to storage design. Ongoing assessment	Ongoing
2.3	Review biosolids sludge storage management procedures	Q4: 2018	Awaiting finalisation (NT Biosolids CoP or Guideline)	Delayed awaiting DENR finalisation and NT EPA approval

Action Area	Action	Timeframe	Action Status	On Track Y/N
3: Improved Asset Management	**Objective: Document site specific asset management requirements to maintain facility as low risk**			
3.1	Review and document progress against Ashworth 2010 recommendations pp 95 -97 and p 209	Q1 2018	Actions reviewed and progress documented	On track
3.2	Prioritise outstanding actions from Ashworth 2010 review for re-evaluation or implementation	Q1 2018	All actions prioritised; inlet works not on priority plan	On track
3.3	Document discharge decision procedure	Q1 2018	New operational procedure to be trialled and evaluated	On track and under review for testing in next discharge
3.4	Document asset management plan for KWWTP	Q1 2018	Ongoing review and update	Completed and annual review process developed
3.5	Review and where necessary, implement reasonable and practicable measures to prevent off site migration of contaminants in sewage sludge	Q2 2019	Onsite measures return leachate to ponds for treatment	Sludge movement reviewed no action required. Completed
3.6	Develop a KWWTP contingency and emergency incident response plan to effectively manage emergency incidents impacting the KWWTPs	Q3 2018	Draft prepared awaiting finalisation alongside the facility Operational Management plan	Environmental Management Plan, including Incident and Emergency Response Plan completed June 2019
3.7	Update and install advisory signage relating to the KWWTP	Q1 2018	Signs prepared and approved Sign printing in progress, awaiting installation	Installed January 2019

5.5 Conclusion

Condition 38 of WDL 151-07 requires that a monitoring report must be submitted to the Administering Agency prior to 31 October for each year of the licence. Condition 39 of WDL 151-07 requires the Monitoring Report to include:

39.1.1 is prepared in accordance with the requirements of the Administering Agency 'Guideline for Reporting on Environmental Monitoring';

39.1.2 includes a tabulation of all monitoring data required as a condition of this licence, including river height and flow telemetry at GS814-0001;

39.1.3 includes volume of waste water and nutrient load discharged to Katherine River;

39.1.4 includes the current version of the conceptual site model;

39.1.5 includes long term trend analysis of monitoring data to demonstrate any environmental impact associated with the activity over a minimum period of three years (where the data is available);

39.1.6 includes an assessment of environmental impact from the activity as informed by the monitoring results; and

39.1.7 includes recommendations as informed by the monitoring results for implementation in the following licence period.

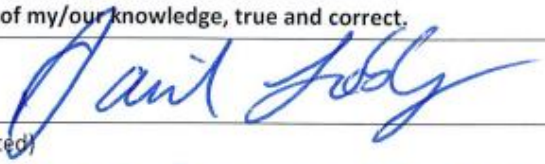
The purpose of this monitoring report was to demonstrate that during the licence period:

- All monitoring required by Condition 23 of the licence has been undertaken and confirms that no discharges occurred during the reporting period. Therefore all discharges were conducted in accordance with the licence.
- That implementation of the Performance Improvement Plan has progressed in accordance with the plan.

Based upon the contents of this report Power and Water considers that the requirements of Condition 39 of WDL151-07 have been met.

6 Signature and Certification

6 Signature and Certification

I/We hereby declare that the information provided in this Annual Return and accompanying documents is to the best of my/our knowledge, true and correct.
Signature 
Name (printed) DANIEL LOBLEY
Position SENIOR MANAGER PERFORMANCE REPORTING & IMPROVEMENT
Date 29 OCTOBER 2021

References

Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand 2000, *National Water Quality Management Strategy – Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Volume 1, The Guidelines, ANZECC and ARCANZ.

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PWC 2017, Waste Discharge Licence 151-06: Katherine Waste Stabilisation Ponds 2017 Monitoring Report, PWC Water Services Water Quality September 2017 D2017/388595

PWC2018, Waste Discharge Licence 151-06: Katherine Wastewater Treatment Plant 2018 Monitoring Report, PWC Water Services Water Quality October 2018 D2018/455711

PWC 2019a, Discharge Loads D2018/472329

PWC 2019b, Water Quality Assessment Data D2019/418842

PWC 2019c, Katherine River Flow Data to 2019: D2019/410869 Data Sourced from, https://nt.gov.au/environment/water/water-information-systems/water-data-portal/data_warehouse_rivers/814-Daly River/G8140001 Katherine River Railway Bridge

Moriarty, E, Nourozi, F, Robson, B, Wood, D, & Gilpin, B 2008, 'Evidence for Growth of Enterococci in Municipal Oxidation Ponds, Obtained Using Antibiotic Resistance Analysis', Applied and Environmental Microbiology, Vol 74(23), pp. 7204–7210.

Appendix 1– Abbreviations and Glossary

Table 12: Shortened Forms; Initialisms and Acronyms

Term	Explanation
AA	Administering Agency (Department of Natural Resources and Environment)
ANZECC	Australia and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AS	Australian Standard
BOD	Biochemical Oxygen Demand
BPEM	Best Practice Environmental Management
Cfu	Colony Forming Units
COD	Chemical oxygen demand
SOC	Site of Conservation Significance
Controller	Controller as specified in the Waste Discharge Licence. In this case, DENR
DAF	Dissolved Air Flotation – A process for treating effluent, in which particulate matter (solids such as algae) is removed from the wastewater through movement of particles attached to small bubbles of air. The bubbles and particles float to the surface where they can be physically removed.
DEWHA	Department of Environment, Water, Heritage and the Arts (DEWHA) (Cwth)
DENR	Department of Environment and Natural Resources (NT)
DO	Dissolved oxygen, a property of water usually expressed as per cent saturation (%sat) or in milligrams per litre of fluid. Temperature dependent parameter
EC	Electrical conductivity, a measure of the salinity of a substance, expressed as milli-Siemens or micro-Siemens per cubic centimetre of fluid (mS/cm^{-1} or $\mu S/cm^{-1}$)
Effluent	Treated Wastewater
EMP	Environmental Management Plan
EP	Equivalent Persons
EPBC Act	*Environment Protection and Biodiversity Conservation Act* 1999
ES	Environmental Services
ESO	Essential Service Officer
FRP	Filterable reactive phosphorous – a measure of bioavailable inorganic orthophosphate
Licence	Waste Discharge Licence 159 Issued under the *Water Act*
MEB	Medical Entomology Branch
MPN	Most probable number (expressed per unit of a specified volume of sample)
N/A	Not applicable
NEPC	National Environment Protection Council
NHMRC	National Health and Medical Research Council
NH3-N	Ammonia
NOHSC	National Occupational Health and Safety Commission
NOX-N	Oxides of nitrogen
NRMMC	Natural Resource Management Ministerial Council
NT	Northern Territory
PIR	Performance Improvement Report
PPE	Personal Protective Equipment
PWC	Power and Water Corporation
SI	International System of Units
SS / TSS	Suspended solids / total suspended solids. Solids refer to matter suspended in water or wastewater. "Total solids" is the term applied to the material residue left in a vessel after evaporation of known volume of a sample and its subsequent drying in an oven at a defined temperature. Total solids include "total suspended solids," the portion of total solids retained by a 2.0 micron filter
TSS	Total Suspended Solids (see above)
TN	Total nitrogen
TP	Total phosphorous
VSS	Volatile Suspended Solids

Term	Explanation
WDL	Waste Discharge Licence
WIMS	Work Information Management System
WM	Weeds Management
WMPC Act	*Waste Management and Pollution Control Act* (NT)
WQO	Water Quality Objectives
WRP	Water Reclamation Plant
WSP	Waste Stabilisation Pond
WWTP	Wastewater Treatment Plant

Table 13: Prefixes for SI units

Prefix	Symbol	Factor	Extended form
milli	m	10^{-3}	0.001
micro	µ	10^{-6}	0.000 001
kilo	k	10^{3}	1 000
mega	M	10^{6}	1 000 000

Table 14: Prefixes for base units

Quantity	Unit name	Unit symbol
length	metre	m
mass	kilogram	kg
mass	milligram	mg
time	second	s
flow rate	cubic metre per second	m^3/s
mass	tonne	t
volume	litre	L
temperature	degree Celsius	°C

Appendix 2 – Katherine River flow data

Table 15: Katherine River height and discharge data GS814-0001 (Katherine Rail Bridge)

Time	Golf Club	G8140001	G8140001	G8140001	G8140001	G8140001	G8140001	Discharge
Date	Rainfall (mm)	Level (m)	Level (m)	Level (m)	Discharge (Cumecs)	Discharge (Cumecs)	Discharge (Cumecs)	To River
	Total	Mean	Min	Max	Mean	Min	Max	kL
3/1/2017	WDL151-06 commences. No discharge until 24/01/2017							
24/1/2017	13.5	11.418	9.319	11.936	954.547	644.055	1041.652	
25/1/2017	6.5	12.029	11.676	12.201	1056.236	994.309	1091.103	
26/1/2017	0	11.324	10.472	12.062	935.922	804.119	1064.945	
27/1/2017	5.5	9.733	9.064	10.502	696.716	611.06	808.515	57753
28/1/2017	0	7.83	6.232	9.064	472.489	325.503	611.06	
29/1/2017	0	5.539	5.19	6.232	276.427	253.456	325.503	
30/1/2017	0	4.776	4.21	5.198	230.06	198.997	253.915	
No discharge between 01/02/2017 and 13/02/2017								
13/02/2017	6.5	14.333	13.566	14.881	1536.246	1365.527	1665.656	
14/02/2017	0	13.012	12.216	13.746	1251.946	1093.866	1404.1	35214
15/02/2017	0	11.098	9.715	12.216	905.183	697.05	1093.866	
16/02/2017	0.5	8.398	7.512	9.715	532.939	433.829	697.05	
No discharge between 17/02/1017 and 12/03/2017								
13/03/2017	3	4.169	3.778	5.34	196.993	176.222	263.353	13997
14/03/2017	79	6.749	5.329	7.418	366.818	262.612	424.656	
No discharge between 15/03/2017 and 18/03/2017								
19/03/2017	56.5	2.555	2.312	3.818	113.716	101.427	178.312	
20/03/2017	1.5	4.897	3.818	5.045	236.875	178.312	245.165	
21/03/2017	41	5.264	4.92	5.94	259.441	238.061	304.701	
22/03/2017	0.5	6.581	5.94	6.88	351.115	304.701	373.789	73321
23/03/2017	6	6.936	6.88	6.983	378.965	373.789	383.316	
24/03/2017	0	6.206	5.195	6.904	324.35	253.742	376.004	
25/03/2017	3	4.547	4.191	5.195	217.411	198.003	253.742	
26/03/2017	16.5	4.563	4.191	4.798	218.166	197.986	231.171	
No discharge 27/03/2017								
28/03/2017	0	3.966	3.639	4.348	186.131	169.016	206.382	1090
No discharge between 29/03/2017 and 29/01/2018								
30/01/2018	16.5	11.946	10.6	12.81	1048.333	822.957	1209.428	
31/01/2018	2	12.596	11.94	12.91	1167.822	1042.389	1229.484	33177.6
1/02/2018	0	11.048	10.19	11.95	893.542	763.371	1044.234	
2/02/2018	0	9.304	8.32	10.19	643.923	519.419	763.371	
No discharge between 03/02/2018 and 16/02/2018								
17/02/2018	0.5	10.061	9.55	10.17	745.157	674.735	760.52	
18/02/2018	15	9.984	9.86	10.14	734.313	717.001	756.254	
19/02/2018	4	9.431	8.62	10	660.165	555.473	736.499	
20/02/2018	16.5	8.454	8.24	8.87	535.578	510.004	586.42	
21/02/2018	0.5	8.277	6.968	8.94	518.623	381.923	595.232	87782.4
22/02/2018	0	5.787	4.861	6.968	295.243	234.721	381.923	
23/02/2018	0	4.261	3.806	4.861	201.864	177.697	234.721	
24/02/2018	0	3.63	3.493	3.993	168.565	161.456	187.5	
25/02/2018	8	4.794	3.988	5.313	231.179	187.236	261.536	
No discharge 26/02/2019 to 04/09/2020								
27/01/2021	2	5.0	4.1	5.8	244.0	190.7	297.4	
28/01/2021	33	4.0	3.9	4.2	190.0	181.9	199.0	58524
29/01/2021	0	4.1	3.6	4.4	192.0	165.9	209.9	
30/01/2021	0.5	3.5	3.3	3.6	159.5	153.5	165.9	

31/01/2021	0.5	3.1	3.0	3.3	143.6	135.1	153.9	
1/02/2021	0	4.0	3.0	4.4	188.5	135.3	208.1	
17/02/2021	16.5	8.00	7.37	8.79	486.65	420.43	576.31	
18/02/2021	34	8.63	7.56	9.38	558.63	438.66	651.81	
19/02/2021	23.5	11.09	9.38	12.71	908.27	651.81	1189.87	
20/02/2021	87	14.45	12.71	15.40	1574.78	1189.87	1812.26	
21/02/2021	14.5	15.36	15.00	15.65	1801.90	1698.07	1886.61	
22/02/2021	16.5	14.43	13.91	15.00	1557.40	1440.45	1698.07	
23/02/2021	4.5	14.77	13.93	15.12	1640.45	1444.18	1733.37	133058
24/02/2021	4	13.65	13.01	14.60	1385.88	1249.58	1596.45	
25/02/2021	3.5	12.23	10.92	13.02	1101.12	870.84	1252.43	
26/02/2021	0	9.95	9.48	10.92	730.63	665.21	870.84	
27/02/2021	0	9.53	9.46	9.58	672.23	663.07	679.05	
28/02/2021	0	9.17	8.91	9.46	624.88	590.99	663.18	
01/03/2021	0	8.73	8.55	8.92	569.55	546.36	592.24	

Appendix 3– Water quality monitoring data

Table 16: Previous discharge monitoring results 2014-20

Sample Collection Date																
Katherine Wastewater Treatment Plant Outfall Ska100		**Location**	**WWTP outlet**	5/3/2014	21/01/2015	27/01/2015	30/12/2015	02/02/2016	24/1/2017	22/2//2017	28/3/2017	30/01/2018	2019	2020	1/2/2021	23/2/21
Location GDA94, Zone 53		**Site Code**	**Ska100**													
		Easting	**707738**													
		Northing	**8633020**													
	Abbreviation	*Units*	*Frequency*													
Field Characteristics																
pH	pH	pH units	M	8.65	9.5	8.91	8.78	8.93	9.2	9.75	9.77	9.27	No discharge	No discharge	9.41	9.19
Electrical conductivity	EC	µS/cm	M	4048	470	466	7221	5702	358	320	340	370	No discharge	No discharge	387	266
Dissolved Oxygen	DO	% saturation	M	84.5	108.3	49.5	34.8	24.7	36.4	49	174.1	33.8	No discharge	No discharge	3.93	13.55
Temperature	T	°C	M	27.96	29.22	29.05	28.65	29.79	28.5	31.81	36.54	27.2	No discharge	No discharge	29.93	28.41
Nutrient Indicators																
Filterable Reactive Phosphorus	FRP	mg/L	M	2.6	0.68	0.78	NA*	0.5	1.6	0.4	2.0	2.1	No discharge	No discharge	1.6	0.7
Total Phosphate	TP	mg/L	M	5.4	2.2	2.1	NA*	1.4	2.7	1.9	2.3	2.6	No discharge	No discharge	4.2	2.3
Total Ammonia	NH_3-N	mg/L	M	0.65	0.35	18.30	NA*	12.6	10.35*	9.6*	9.6*	14.8	No discharge	No discharge	0.4	0.9
Nitrate	NO_3	mg/L	M	10.3	<0.1	<0.1	NA*	<0.1	<0.1	<0.1	<0.1	<0.1	No discharge	No discharge	<0.1	<0.1
Nitrite	NO_2	mg/L	M	<0.1	<0.1	<0.10	NA*	<0.1	<0.1	<0.1	<0.1	<0.1	No discharge	No discharge	<0.1	<0.1
Oxides of Nitrogen	NOx	mg/L	M	<0.10	0.14	<0.1	NA*	<0.1	<0.1	<0.1	<0.1	<0.1	No discharge	No discharge	<0.1	<0.1
Total Nitrogen	TN	mg/L	M	<0.10	20.69	18.35	NA*	12.65	12.4	10.55	9.65	14.9	No discharge	No discharge	25.5	9.5

Sample Collection Date																
Katherine Wastewater Treatment Plant Outfall Ska100		**Location**	**WWTP outlet**	5/3/2014	21/01/2015	27/01/2015	30/12/2015	02/02/2016	24/1/2017	22/2//2017	28/3/2017	30/01/2018	2019	2020	1/2/2021	23/2/21
Bacteriological Indicators																
Escherichia coli	*E. coli*	MPN/100 mL	M	10	<10	30	10	<10	<10	<100	<10	16580	No discharge	No discharge	<10	<100
Enterococci		MPN/100 mL	M	7701	256	3654	432	52	295	630	<10	2690	No discharge	No discharge	86	<100
Metals and Metalloids Indicators																
Arsenic	As	µg/L	A	0.65	1.9	NA	1.5	0.5	<0.5	<0.5	<0.5	<0.5	No discharge	No discharge	<0.5	<0.5
Cadmium	Cd	µg/L	A	<0.02	NA	NA	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	No discharge	No discharge	<0.2	<0.2
Chromium	Cr	µg/L	A	0.10	0.2	NA	<5	<5	<0.5	<0.5	<0.5	<5	No discharge	No discharge	<5	<5
Copper	Cu	µg/L	A	1.30	3.52	NA	<10	<10	<10	<10	<10	<10	No discharge	No discharge	20	10
Lead	Pb	µg/L	A	0.54	0.65	NA	<1	<1	<1	<1	<1	<1	No discharge	No discharge	2	1
Mercury	Hg	µg/L	A	0.11	<0.02	NA	<0.1	<0.1	<0.1	<0.2	<0.2	<0.1	No discharge	No discharge	0.8	0.1
Nickel	Ni	µg/L	A	4.3	0.59	NA	<2	<2	<2	<2	<2	<2	No discharge	No discharge	2	2
Zinc	Zn	µg/L	A	<0.02	3.6	NA	<10	<10	<10	<10	<10	20	No discharge	No discharge	20	10
Environmental Indicators																
Biochemical Oxygen Demand	BOD	mg/L	M	130	44	72	NA*	89	43	33	50	48	No discharge	No discharge	47	14
Chemical Oxygen Demand	COD	mg/L	M	600	300	250	NA*	200	200	180	180	280	No discharge	No discharge	210	140
Suspended Solids	SS	mg/L	M	616	140	132	NA*	68	82	72	92	165	No discharge	No discharge	98	90
Volatile Suspended Solids	VSS	mg/L	M	412	134	124	NA*	66	74	62	84	135	No discharge	No discharge	92	86
Hardness as $CaCO_3$		mg/L	M	71.8	52.2	77.6	NA*	70.9	79	70.5	80.6	56.3	No discharge	No discharge	57.6	40.9

Table 17: Dissolved oxygen in KWwTP discharge results 2012 to 2021 for site Ska100.

Sample Date	Dissolved Oxygen (% Saturation)
2011-2012	
04/01/2012	27.2
08/03/2012	143.1
13/03/2012	46.1
2012-2013	
25/02/2013	97.0
09/04/2013	114.5
2013-2014	
28/01/2014	88.3
05/02/2014	106.9
24/02/2014	139.7
05/03/2014	84.5
2014 -2015	
05/01/2015	N/A Field instrument not working
19/01/2015	91.0
20/01/2015	73.4
21/01/2015	108.3
27/01/2015	49.5
28/01/2015	70.1
30/03/2015	35.4
31/03/2015	33.4
2015-2016	
30/12/2015	34.8
02/02/2016	24.7
2016-2017	
24/1/2017	36.4
22/02/2017	49
28/3/2017	174.1
2017-2018	
30/01/2018	33.8
2018-2019	
No discharge	No Data
2019-2020	
No discharge	No Data
2020-2021	
01/02/2021	53.2
23/02/2021	128.1

Table 18: E.coli and Enterococci in KWwTP discharge 2012 to 2020 site Ska100

Sample Date	E. coli	Enterococci
2011-2012		
04/01/2012	10	11199
08/03/2012	3076	2481
13/03/2012	19863	5794
2012-2013		
25/02/2013	<10	>24196
09/04/2013	218	155310
2013-2014		
28/01/2014	10	24810
05/02/2014	10	2247
24/02/2014	<10	95
05/03/2014	10	7701
2014 -2015		
05/01/2015	<10	<10
19/01/2015	<10	591
20/01/2015	<10	908
21/01/2015	<10	749
27/01/2015	30	3654
28/01/2015	<10	256
30/03/2015	10	10
31/03/2015	<10	31
2015-2016		
30/12/2015	10	432
02/02/2016	<10	52
2016-2017		
24/1/2017	<10	295
22/2//2017	<100	630
28/3/2017	<10	<10
2017-2018		
30/01/2018	16580	2690
2018-2019		
No discharge	NA	NA
2019-2020		
No discharge	NA	NA
2020-2021		
01/02/2021	<10	<100
23/02/2021	<100	<100

Table19: Water Chemistry Field Parameters; Nutrients; and Environmental Indicators Field Data Monitoring summary Katherine WWTP Influent and Effluent (discharge) 2011-12 to 2020-21 financial years

	Asset Description	Year	BOD (mg/L)	COD (mg/L)	NH3-N Free (mg/L)	NH3-N Organic (mg/L)	NH3-N Total (mg/L)	NOX - N (mg/L)	Total N (Calc) (mg/L)	P_Reactive High (mg/L)	P_Total High Level (mg/L)	SS (mg/L)	VSS (mg/L)	Hardness (mg/L)	EC (µS/cm)	pH	Dissolved Oxygen % sat
Influent																	
	Average	2020-2021	189	596.92	36.19	13.01	49.2	0.11	49.3	5.75	8.37	271.08	245.08	65.11	798.46	7.48	63.1
	95th percentile		310	972	42.4	19.6	61	0.55	61.1	9.1	11.52	533.6	479.2	77.98	1000	8.13	101.8
	Number of samples		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
151 Katherine inflow sewer - SKA001	Average	2019-2020	185.4	571.6	36.4	14.4	36.4	0.1	36.4	5.1	7.2	296.0	255.7	87.9	714.1	7.4	49.8
	95th percentile		368.0	1280.0	49.6	31.4	49.6	0.1	49.7	8.0	10.9	816.0	696.0	121.6	836.0	7.9	103.9
	Number of samples		12													12	12
	Average	2018 -2019	187	630	25.3	18.3	43.7	0.1	43.7	5.8	9.3	342	312	64	860	7.61	41.38
	95th percentile		245	843	44.9	23.3	62.0	0.1	62.1	9.6	10.1	500	465	66	955	7.69	84.78
	Number of samples		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
	Average	2017-2018	132	439	37.2	9.9	47.2	0.06	47.2	5.4	6.4	191	171	66	691	7.53	44.63
	95th percentile		184	612	45.2	13.4	58.2	0.10	58.3	7.6	8.7	288	260	77	824	7.72	70.38
	Number of samples		13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
	Average	2016-2017	140	517	37.0	8.8	42.3	0.30	42.3	6.3	7.7	213	190	60	640	7.35	42.71
	95th percentile		175	791	45.9	11.0	55.8	0.30	56.2	10.2	12.3	372	334	77	748	7.72	68.85
	Number of samples		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	Average	2015-2016	100	309	30.6	9.3	39.9	0.05	39.9	3.2	5.5	154	134	110	676	7.59	35.05
	95th percentile		165	522	42.4	15.3	52.0	0.07	52.1	5.5	6.9	254	227	122	768	7.97	63.00
	Number of samples		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	Average	2014-2015	124	362	30.8	12.5	43.3	0.05	43.4	3.1	4.7	197	173	110	673	7.66	59.04
	95th percentile		289	840	51.8	26.4	74.2	0.05	74.2	5.8	8.5	440	385	142	798	8.46	110.56
	Number of samples		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	Average	2013-2014	199	568	41.3	16.7	57.9	0.05	58.0	5.2	7.2	219	274	90	713	7.52	94.81
	95th percentile		275	850	49.5	27.0	68.5	0.05	68.6	6.4	8.9	544	443	107	790	7.72	166.00
	Number of samples		11	11	11	11	11		11	11	11	11	11	11	11	11	11
	Average	2012-2013	251	759	40.8	20.9	56.6	0.12	56.7	5.3	9.2	454	378	94	737	7.48	42.30
	95th percentile		505	1500	53.5	42.0	81.9	0.44	82.0	7.2	12.5	1060	844	115	812	7.81	87.10
	Number of samples		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	Average	2011-12	306	885	37.9	18.6	56.5	0.05	56.5	5.7	7.9	485	418	106	764	7.51	38.28
	95th percentile		640	1780	48.7	34.0	80.5	0.05	80.6	6.9	10.4	9.84	838	162	868	7.64	75.90
	Number of samples		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Effluent																	
	Average	2020-2021	50	200	0.45	12	0.45	0.05	12.4	0.895	2.3	106	100	71.05	387	9.2	91
	95th percentile		106.85	300	2.73	22.9	2.73	0.32	23.77	2.09	4.06	212.3	200.8	190.15	457	9.8	149.3
	Number of samples		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Discharge to Katherine River - SKA100	Average	2019-2020	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	Nr
	95th percentile		nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	Nr
	Number of samples		0	0	0	0			0	0	0	0	0				
	Average	2018-2019	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	Nr
	95th percentile		nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	Nr
	Number of samples		0	0	0	0			0	0	0	0	0				
	Average	2017-2018	48	280	0.80	114.0	14.80	0.05	14.85	2.10	2.60	165	135	56.3	370	9.27	33.8
	95th percentile		48	280	0.80	114.0	14.80	0.05	14.85	2.10	2.60	165	135	56.3	370	9.27	33.8
	Number of samples		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Average	2016-2017	42	184	0.63	9.58	10.51	0.05	10.56	1.28	2.02	82.4	74.0	76.4	336	9.64	86.50
	95th percentile		50	196	0.90	11.60	11.98	0.05	12.03	2.00	2.58	92.0	84.0	80.6	354	9.77	161.59
	Number of samples		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Average	2015-2016	89	200	0.60	12.00	6.30	0.05	12.65	0.50	1.40	68.0	66.0	70.9	342	9.53	77.83
	95th percentile		89	200	0.60	12.00	11.97	0.05	12.65	0.50	1.40	68.0	66.0	70.9	342	9.53	162.36
	Number of samples		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Average	2014-2015	73.63	281	0.46	19.00	19.46	0.06	19.52	0.73	2.14	117.5	114.9	60.2	478	9.42	65.87
	95th percentile		106	350	0.86	24.30	25.04	0.11	25.09	0.92	2.80	153.2	151.9	78	572	9.78	103.11
	Number of samples		8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
	Average	2013-2014	59.59	285	0.38	11.68	12.06	0.05	12.11	1.19	2.81	170.71	145.88	67.29	360.24	9.20	107.87
	95th percentile		114.00	480.00	0.65	17.20	17.63	0.05	17.68	2.20	4.36	435.20	290.40	85.10	493.60	9.84	162.68
	Number of samples		17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
	Average	2012-2013	57.50	150	0.15	8.60	5.83	0.05	5.87	0.63	1.55	94.50	82.9	75.65	384	9.49	104.93
	95th percentile		62.45	150	0.15	8.96	9.07	0.05	9.17	0.67	1.69	112.95	98.2	83.62	430	9.54	113.38
	Number of samples		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Average	2011-2012	31.75	162.50	2.26	10.34	12.59	0.19	12.78	0.82	2.16	87.94	78.89	137.96	486	8.66	86.23
	95th percentile		42.90	200	6.32	13.65	16.02	0.47	16.40	1.30	3.19	156.55	116.00	226.85	620	9.37	140.91
	Number of samples		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Appendix 4– Annual inflow and outflow loads data

Table20: Mass loads inflow and outflow (Nutrients and Environmental Indicator Chemicals) Katherine Wastewater Treatment Plant 2011-12 to 2020-2021 inclusive.

	Volume	Biochemical Oxygen Demand BOD)	Chemical Oxygen Demand (COD)	Nitrogen-ammonia Free (NH3-N Free)	Nitrogen-ammonia Organic (NH3-N Organic)	Nitrogen oxide (NOX – N)	Total Nitrogen (TN)	Phosphorus P_Reactive High (FRP)	Phosphorus P_Total High Level (TP)	Suspended Solids (SS)	Volatile Suspended Solids (VSS)	Financial Year	Annual rainfall
2020-2021	kL / year (yr)	Tonnes/yr.	Tonnes/yr.	Tonnes/yr.	Tonnes/yr.	Tonnes/yr.	Tonnes/yr.	Tonnes/yr.	Tonnes/yr.)	Tonnes/yr.	Tonnes/yr.		mm/fin. yr.
Inflow	860638.2	158.7	455.6	30.5	10.2	0.1	40.8	4.7	6.9	188.2	170.6	2020-2021	1207.3
Discharge to Katherine River	191582	*4.6*	*30.9*	*0.1*	*2.6*	*0.0*	*2.7*	*0.2*	*0.6*	*17.7*	*16.8*		
Mass removed prior to discharge		*74.7*	*196.9*	*15.1*	*2.5*	*0.0*	*17.6*	*2.2*	*2.9*	*76.4*	*68.5*		
Percentage removed before discharge		*97.1%*	*93.2%*	*99.5%*	*74.5%*	*83.5%*	*93.3%*	*96.0%*	*92.0%*	*90.6%*	*90.1%*		
2019-2020													
Inflow	680558.75	120.50	340.83	21.31	9.53	0.04	30.88	4.17	5.60	152.24	138.83	2019-2020	461.8
Discharge to Katherine River	0 (no discharge)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Mass removed prior to discharge		120.50	340.83	21.31	9.53	0.04	30.88	4.17	5.60	152.24	138.83		
Percentage removed before discharge		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%		
2018-2019													
Inflow	938674	139.45	472.01	36.41	9.79	0.05	46.26	5.09	6.29	216.33	196.63	2018-2019	713.5
Discharge to Katherine River	0 (no discharge)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Mass removed prior to discharge		139.45	472.01	36.41	9.79	0.05	46.26	5.09	6.29	216.33	196.63		
Percentage removed before discharge		100*	100*	100*	100*	100*	100*	100*	100*	100*	100*		
2017-2018													
Inflow	817941.11	109.89	380.34	30.26	7.13	0.07	37.47	5.09	6.12	157.84	141.65	2017-18	1067.4
Discharge to Katherine River	120960	5.81	33.87	0.109	1.706	0.01	1.78	0.25	0.33	19.97	16.34		
Mass removed prior to discharge		104.08	346.47	30.15	5.42	0.06	35.69	4.84	5.79	137.87	125.31		
Percentage removed before discharge		94.71%	91.09%	99.64%	76.07%	79.26	95.25%	95.01%	94.66%	87.35%	88.47%		
2016-2017													
Inflow	890563	91.91	314.27	27.12	8.34	0.05	35.51	2.97	5.33	150.6	131.7	2016-17	1364.3
Discharge to Katherine River	154645	6.93	28.46	0.11	1.49	0.01	1.61	0.24	0.33	13.2	12.0		
Mass Removed Prior to Discharge		84.98	285.81	27.01	6.85	0.04	33.90	2.73	5.00	137.4	119.7		
Percentage removed before discharge		92.00%	91.00%	100.00%	82.00%	84.00%	95.00%	92.00%	94.00%	91.00%	91.00%		
2015-2016													
Inflow	845299	98.99	291.98	24.90	10.19	0.04	35.13	2.12	3.58	160.9	141.6	2015-16	1222.1
Discharge to Katherine River	21531	1.92	4.31	0.01	0.26	0.00	0.27	0.01	0.03	1.5	1.4		
Mass Removed Prior to Discharge		97.07	287.67	24.89	9.93	0.04	34.86	2.11	3.55	159.4	140.2		
Percentage removed before discharge		98.06%	98.52%	99.95%	97.45%	97.50%	99.23%	99.48%	99.16%	99.07%	99.01%		
2014-2015													
Inflow	840358	165.90	473.84	34.08	14.15	0.04	48.27	4.28	5.87	269.6	230.2	2014-15	845.2
Discharge to Katherine River	102352	7.70	29.34	0.05	1.98	0.01	2.03	0.08	0.22	12.2	11.9		
Mass Removed Prior to Discharge		158.21	444.50	34.03	12.17	0.04	46.24	4.20	5.65	257.4	218.3		
Percentage removed before discharge		95.36%	93.81%	99.86%	86.01%	84.78%	95.78%	98.23%	96.21%	95.47%	94.81%		
2013-2014													
Inflow	861393	181.61	577.99	35.59	15.65	0.10	51.34	4.49	7.55	329.2	279.4	2013-14	1069.8
Discharge to Katherine River	136200	6.49	33.61	0.05	1.51	0.01	1.57	0.14	0.35	17.5	16.0		
Mass Removed Prior to Discharge		175.12	544.38	35.54	14.14	0.09	49.77	4.35	7.20	311.7	263.4		
Percentage removed before discharge		96%	94%	100%	90%	93%	97%	97%	95%	95%	94%		
2012-2013													
Inflow	821491	224.43	702.74	33.15	18.26	0.04	51.45	4.30	6.67	400.5	321.9	2012-13	1013.6
Discharge to Katherine River	101158	6.02	15.17	0.02	0.88	0.01	0.90	0.07	0.16	10.3	9.0		

Mass Removed Prior to Discharge		218.41	687.57	33.14	17.38	0.04	50.55	4.24	6.51	390.2	313.0		
Percentage removed before discharge		97%	98%	100%	95%	88%	98%	98%	98%	97%	97%		
2011-2012													
Inflow	840292	266.94	772.25	32.48	15.57	0.04	48.09	4.85	6.47	417.8	359.9	2011-12	947.3
Discharge to Katherine River	115275	3.98	20.36	0.12	1.26	0.01	1.39	0.10	0.23	10.6	9.2		
Mass Removed Prior to Discharge		262.96	751.89	32.35	14.31	0.03	46.69	4.76	6.25	407.2	350.7		
Percentage removed before discharge		99%	97%	100%	92%	73%	97%	98%	96%	97%	97%		

*No discharge; 100% retained within treatment plant

Table 21: Mass loads inflow and outflow (metals) Katherine Wastewater Treatment Plant 2013-14 to 2019-2020 current.

	Volume	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
2020-2021	kL/year	kg/year	kg/year	kg/year	kg/year	kg/year	kg/year	kg/year	kg/year
Inflow	430319	Not Analysed	Not Analysed	Not Analysed	Not Analysed	Not Analysed	Not Analysed	Not Analysed	Not Analysed
Discharge to Katherine River	191582	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mass removed prior to discharge	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Percentage removed prior to discharge	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2019-2020									
Inflow	Not Analysed	Not Analysed	Not Analysed	Not Analysed	Not Analysed	Not Analysed	Not Analysed	Not Analysed	Not Analysed
Discharge to Katherine River	(no discharge)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass removed prior to discharge	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Percentage removed prior to discharge	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2018-2019									
Inflow	938674	0.469	0.094	2.347	140.80	2.82	0.047	9.887	290.99
Discharge to Katherine River	(no discharge)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass removed prior to discharge		0.469	0.094	2.347	140.80	2.82	0.047	9.887	290.99
Percentage removed prior to discharge		100	100	100	100	100	100	100	100
2017-2018									
Inflow	817941.11	0.82	0.98	2.04	768.86	0.16	16.36	23.72	2,355.67
Discharge to Katherine River	120960	0.03	0.01	0.30	0.60	0.01	0.12	0.06	2.42
Mass removed prior to discharge		0.79	0.97	1.74	768.26	0.16	16.24	23.66	2,353.25
Percentage removed prior to discharge		96.30%	98.77%	85.21%	99.92%	96.30%	99.26%	99.75%	99.90%
2016-2017									
Inflow	890563	0.09	2.23	17.81	320.60	0.04	0.89	0.45	44.53
Discharge to Katherine River	154645	0.05	0.02	0.39	0.77	0.02	0.15	0.08	0.77
Mass removed prior to discharge		0.04	2.21	17.42	319.83	0.03	0.74	0.37	43.75
Percentage removed prior to discharge		42.12%	99.31%	97.83%	99.76%	59.48%	82.64%	82.64%	98.26%
2015-2016									
Inflow	845299	1.69	0.085	2.11	16.91	0.042	0.85	1.69	25.36
Discharge to Katherine River	21531	0.02	0.002	0.05	0.11	0.001	0.02	0.01	0.11
Mass removed prior to discharge		1.67	0.082	2.06	16.80	0.041	0.82	1.68	25.25
Percentage removed prior to discharge		98.73%	97.45%	97.45%	99.36%	97.45%	97.45%	99.36%	99.58%
2014-2015									
Inflow	840358	1.39		4.20	117.65	0.118	5.44	6.39	269.75
Discharge to Katherine River	102352	0.19		0.02	0.36	0.001	0.06	0.07	0.37
Mass removed prior to discharge		1.19		4.18	117.29	0.117	5.38	6.32	269.39
Percentage removed prior to discharge		85.98%		99.51%	99.69%	99.13%	98.89%	98.96%	99.86%
2013-2014									
Inflow	861393	1.08	0.190	2.33	65.21	0.241	4.06	3.82	161.94
Discharge to Katherine River	136200	0.12	0.001	0.02	0.32	0.001	0.21	0.14	0.97
Mass removed prior to discharge		0.95	0.188	2.31	64.89	0.240	3.85	3.68	160.97
Percentage removed prior to discharge		88.62%	99.28%	99.12%	99.51%	99.44%	94.93%	96.30%	99.40%

*No discharge; 100% retained within treatment plant