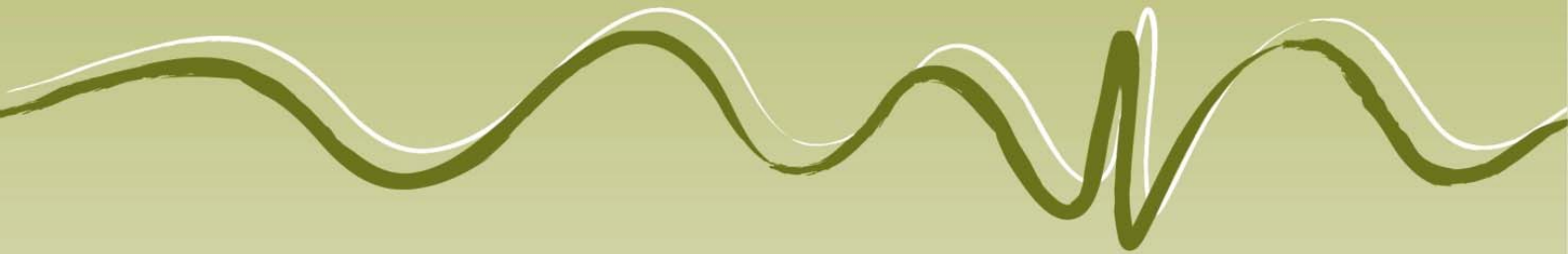


Salty Lagoon

Post Closure Monitoring

Project Management and Ecosystem Health Report

April 2019



AQUATIC SCIENCE AND MANAGEMENT

PO Box 119
Lennox Head NSW 2478
T 02 6687 7666

PO Box 1446
Coffs Harbour NSW 2450
T 02 6651 7666

info@geolink.net.au

Prepared for: Richmond Valley Council
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Table of Contents

1.	Introduction	1
1.1	Introduction	1
1.2	Guiding Values	1
2.	Methodology	2
2.1	Discrete Sampling	2
2.2	Fixed Point Photo Monitoring	2
2.3	Aquatic Weed Monitoring	2
2.4	Erosion Monitoring	3
2.5	Permanent Water Quality Monitoring Stations	3
3.	Results	6
3.1	Water Quality Samples	6
3.2	Permanent Water Quality Monitoring Stations	6
3.3	Aquatic Weed Monitoring	10
3.4	Erosion Monitoring Stations	10
4.	Discussion	11
4.1	Water Quality	11
4.2	Other Observations	12
5.	Key Points	13

Illustrations

Illustration 2.1	Water Quality and Erosion Monitoring Site Locations	5
Illustration 3.1	Salty Lagoon Rainfall and Water Quality Monitoring Station Data 1 March 2019 to 30 April 2019	8
Illustration 3.2	Salty Creek Rainfall and Water Quality Monitoring Station Data 1 March 2019 to 30 April 2019	9

Tables

Table 2.1	Locations of Water Quality Sample Sites in Salty Lagoon and Salty Creek (WGS84)	2
Table 2.2	Type and Locations (WGS84) of Erosion Monitoring Sites	3
Table 2.3	YSI sonde Status on 8 May 2019	4
Table 3.1	Results of Discrete Samples Collected 8 May 2019	7
Table 3.2	Erosion monitoring results from 8 May 2019	10



1. Introduction

1.1 Introduction

This document comprises the fifth bi-monthly monitoring report for year 7 of Salty Lagoon Post-Closure monitoring year's 6-10 program (GeoLINK 2017). The monitoring program is as described in *Final Evaluation Report - Salty Lagoon Monitoring: Pre-Post Closure of Artificial Channel – Project Finalisation Report*, which forms an extension of the monitoring undertaken as part of the *Salty Lagoon Ecosystem Recovery Monitoring Program; Pre-Post Closure of Artificial Channel* (MPPC) (Hydrosphere Consulting 2010).

This report is for the monitoring period 1 March 2019 until 30 April 2019.

1.2 Guiding Values

Guiding values were developed for Salty Lagoon and Salty Creek as part of the MPPC program (GeoLINK 2012) to assist with the contextualisation of monthly water monitoring results, rather than as a measure of the health of the waterway. These values are used as part of the current post-closure monitoring and provide a yardstick around which the adaptive management of Salty Lagoon can be discussed.

2. Methodology

2.1 Discrete Sampling

This was the fifth bi-monthly site visit for year 7 post-closure monitoring at Salty Lagoon. It included routine maintenance of permanent water quality monitoring stations and discrete water quality sampling. The site visit was undertaken on 8 May 2019. Water quality samples were collected between the hours of 7:30 am and 11:00 am on that day. A high tide of 1.43 metres was forecast for 10.42 am.

Discrete water quality samples were taken from surface water (approximately 0.2 metre depth) at three sites in Salty Lagoon and a single site (S5) in Salty Creek. An additional quality assurance (QA) replicate sample was collected at S1. The specific locations of all sites sampled are presented in **Table 2.1** and **Illustration 2.1**. They are the same sites previously used for the MPPC (GeoLINK 2017).

Table 2.1 Locations of Water Quality Sample Sites in Salty Lagoon and Salty Creek (WGS84)

Site	S 1	S 2	S 3	S 4	S 5
Eastings	0542064	0541799	0542037	0541738	0542187
Northings	6782801	6782669	6783013	6783033	6783665
Site Description	Lagoon monitoring station	SE of Drainage Channel	NE area of lagoon	NW area of lagoon	Creek monitoring station

Physico-chemical water quality parameters were measured with a calibrated HORIBA U-52 hand held water quality meter. Samples were collected from the surface, and at depth intervals of one metre where water levels allowed.

Samples were collected in jars for analysis of chemical and biological parameters at the Coffs Harbour Laboratory (CHL). Sterile jars were used for collection of samples for bacteriological analysis and brown glass jars were used for collection of samples for analysis of chlorophyll-a and blue green algal (BGA) content. Samples were placed upon ice in an esky and delivered to CHL on the following day.

2.2 Fixed Point Photo Monitoring

In addition to water quality samples, photos were taken showing the environment to the north, east, south and west of each water quality sample site. An additional photo monitoring site is located on the in-filled artificial channel.

2.3 Aquatic Weed Monitoring

Aquatic weed monitoring occurs three times each year; once in each of the summer, autumn and spring seasons. Maps of the monitoring meander and detailed data are provided in the annual reports. Aquatic weed monitoring for the autumn 2019 season was undertaken during the site inspection for the previous reporting period on 11 March 2019.

2.4 Erosion Monitoring

A series of stations have been set up around the active head cut to the east of the infilled channel and some nearby control sites to assess the progression of erosion between Salty Lagoon and Salty Creek. The specific locations of all sites sampled are presented in **Table 2.2** and **Illustration 2.1**.

The stations were set up in July 2017 at the head cut (Stations 4, 5 and 6), with control sites at points where lateral tributaries from Salty Creek lead towards Salty Lagoon (Stations 1, 2 and 3). At each site the monitoring involves a fixed-point photo and a measurement from a fixed peg to the nearest point of the head cut.

Table 2.2 Type and Locations (WGS84) of Erosion Monitoring Sites

Site	Control/Impact	Peg Location	
		Easting	Northing
ER1	Control	541961	6783356
ER2	Control	541934	6783355
ER3	Control	541978	6783342
ER4	Impact	542112	6783277
ER5	Impact	542129	6783262
ER6	Impact	542121	6783272

2.5 Permanent Water Quality Monitoring Stations

There are two permanent water quality monitoring stations (PWQMS) in place with YSI EXO3 series water quality sondes measuring temperature, pH, conductivity, turbidity and dissolved oxygen (DO) concentrations at 30-minute intervals. One PWQMS is located in Salty Lagoon at S1 and one in Salty Creek at S5. The data from these sites is downloaded at bi-monthly intervals for reporting purposes.

HOBO U20 water level loggers were installed in the water at each PWQMS and a third HOBO was installed above the water at S1 to collect barometric pressure data for offsetting atmospheric variability.

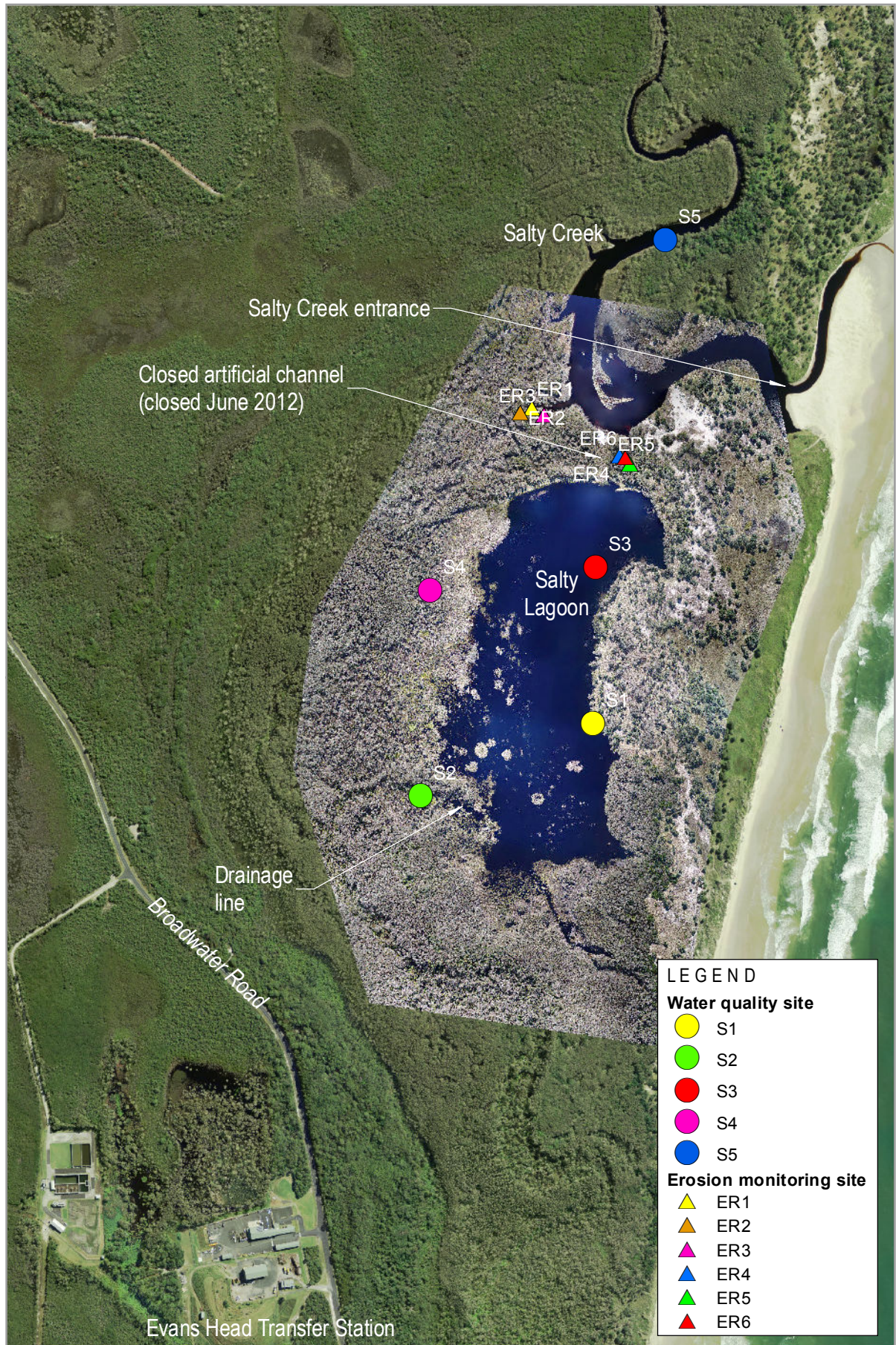
The temperature, pH, conductivity, turbidity and DO sensors on the EXO3 sonde installed at the Salty Lagoon PWQMS were removed on 8 May 2019 and replaced by a serviced and calibrated set.

The status of the two YSI EXO3 sondes on 8 May 2019 is displayed in **Table 2.3**. In response to a problem with the sonde at the Salty Lagoon PWQMS, detected on 11 March 2019, a spare sonde with serviced, calibrated probes was deployed on 27 March 2019. The removed sonde was sent to authorised service agents for repairs and has since been returned. There is a subsequent gap in the data collected from the Salty Lagoon PWQMS between 19 January 2019 and 27 March 2019.

Table 2.3 YSI sonde Status on 8 May 2019

Sonde	SN17F104100	SN 17H104488	Spare Probes
pH (cap life expectancy 18 months)	EXO pH 17H105047 Manufactured 08/2017 New cap 05/2019	EXO pH 17H105048 Manufactured 08/2017 New cap 03/2019	EXO pH 17H105049 Manufactured 08/2017 New cap 03/2019
Temp/ cond (life expectancy 7-10 years)	EXO Wiped CT 17F102047 Manufactured 06/2017	EXO Wiped CT 17F103252 Manufactured 06/2017	EXO Wiped CT 17F102685 Manufactured 06/2017
DO (cap life expectancy 18 months)	EXO Optical DO 17H103493 Manufactured 08/2017 New cap 05/2019	EXO Optical DO 17H103495 Manufactured 08/2017 New cap 03/2019	EXO Optical DO 17H103494 Manufactured 08/2017 New cap 03/2019
Turbidity (life expectancy 7-10 years)	YSI EXO Turbidity 17H101465 Manufactured 08/2017	YSI EXO Turbidity 17H101468 Manufactured 08/2017	YSI EXO Turbidity 17H103513 Manufactured 08/2017
Wiper	YSI Exo Wiper 17G101952	YSI Exo Wiper 17G101954	No Spare Wiper
Status	Serviced probes installed in Salty Lagoon 08/05/2019 Sonde repaired under warranty 04/2019 Batteries installed 08/05/2019	Serviced probes installed in Salty Creek 11/03/2019 Batteries installed 08/05/2019	Deployed in Salty Lagoon 27/03/2019 Removed from Salty Lagoon 08/05/2019
Notes	- 187 days estimated battery life - Memory cleared – 50045.3 days logging available	- 199 days estimated battery life - Memory cleared – 50045.3 days logging available	- Probes Removed from Salty Lagoon 08/05/2019

Climate information was sourced from the Evans Head bombing range weather station on the Bureau of Meteorology website (BoM 2019). Evans Head Sewage Treatment Plant (STP) facility routine sampling information was provided by Richmond Valley Council (RVC).



0 200

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Water Quality and Erosion Monitoring Site Locations

Salty Lagoon Project Management & Ecosystem Health Report - Feb 2019
1731-1297

Illustration 2.1



3. Results

3.1 Water Quality Samples

Results of the water quality monitoring undertaken on 8 May 2019 are reported in **Table 3.1**.

3.2 Permanent Water Quality Monitoring Stations

The data collected at the PWQMS, and rainfall data correlating to the reporting period are presented in **Illustration 3.1** and **Illustration 3.2**.

Table 3.1 Results of Discrete Samples Collected 8 May 2019

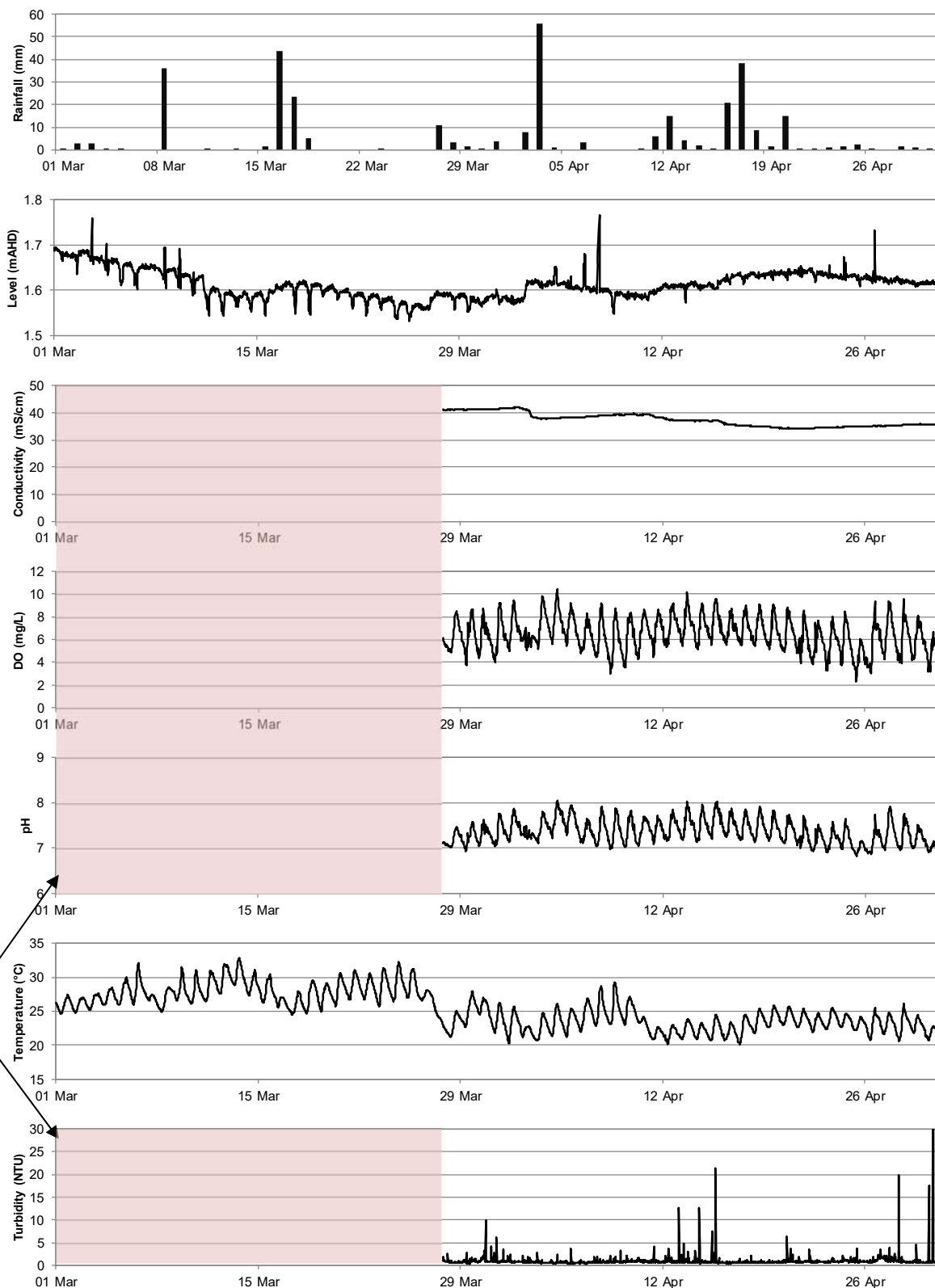
Parameter	Salty Lagoon								Salty Creek		S5
	Guiding Value	S1	S1 (1m)	S1* (QA)	S2	S3	S3 (1m)	S4	Guiding Value	S5	
Blue Green Algae ID (cells/mL)	0	Nil	ns	Nil	Nil	Nil	ns	Nil	0	Mixed <100	ns
Nitrite Nitrogen (mg/L)	0.01	<0.010	ns	<0.010	<0.010	<0.010	ns	<0.010	0.01	<0.010	ns
Nitrate Nitrogen (mg/L)	0.01	<0.010	ns	<0.010	<0.010	<0.010	ns	<0.010	0.01	<0.010	ns
Oxidized Nitrogen (mg/L)	-	<0.010	ns	<0.010	<0.010	<0.010	ns	<0.010	-	<0.010	ns
Ammonia Nitrogen (mg/L)	0.05	0.043	ns	0.037	0.022	0.021	ns	<0.010	0.11	0.02	ns
Total Kjeldahl Nitrogen (mg/L)	1.6	0.91	ns	0.9	1.04	0.89	ns	1.64	1.63	0.53	ns
Total Nitrogen (mg/L)	1.6	0.91	ns	0.9	1.04	0.89	ns	1.64	1.63	0.53	ns
Total Phosphorus(mg/L)	0.14	<0.03	ns	<0.03	0.04	<0.03	ns	0.05	0.04	<0.03	ns
Orthophosphate (mg/L)	0.11	<0.010	ns	<0.010	<0.010	<0.010	ns	<0.010	0.01	<0.010	ns
Chlorophyll-a (µg/L)	5	<1	ns	<1	7	<1	ns	12	3	<1	ns
Enterococcus (CFU/100mL)	170	10	ns	50	30	0	ns	98	40	0	ns
Faecal Coliforms (CFU/100mL)	135	36	ns	39	188	8	ns	18	150	6	ns
Temp (°C)	25.9	17.35	17.33	ns	15.24	17.72	17.75	16.11	13.1 - 28.8	19.86	19.53
pH	6.9	7.1	7.11	ns	6.66	7.14	7.15	6.19	4.3 - 6.8	6.97	7.01
ORP (mV)	-	119	122	ns	166	160	158	174	-	153	152
Cond (mS/cm)	8.0	35.6	35.6	ns	35.1	35.4	35.4	12.8	0.3 - 21.5	46.6	46.7
Turbidity (NTU)	13	0	0	ns	0	2.1	0.9	5	11	0	0
DO (mg/L)	4.09	4.59	4.53	ns	1.92	5.71	5.53	3.72	5.52	4.12	3.9
DO (% sat)	-	56.1	55.4	ns	22.4	70.4	68.2	40.6	-	55.5	52.3
TDS (mg/L)	-	21.7	21.7	ns	21.4	21.6	21.6	7.91	-	28.4	28.5
Sal (ppt)	-	22.3	22.3	ns	21.9	22.2	22.2	7.3	-	30.2	30.2
Depth (m)	-	Surface	0.6m	Surface	Surface	Surface	0.6m	Surface	-	Surface	1m

Note: * = randomly selected quality assurance sample.

red text = not compliant with MPPC guiding values (see GeoLINK 2012).

levels below detection limits will be incorporated into databases as 0 for the purpose of statistical analyses

TNTC = too numerous to count



Missing data due to a technical problem

Illustration 3.1 Salty Lagoon Rainfall and Water Quality Monitoring Station Data 1 March 2019 to 30 April 2019

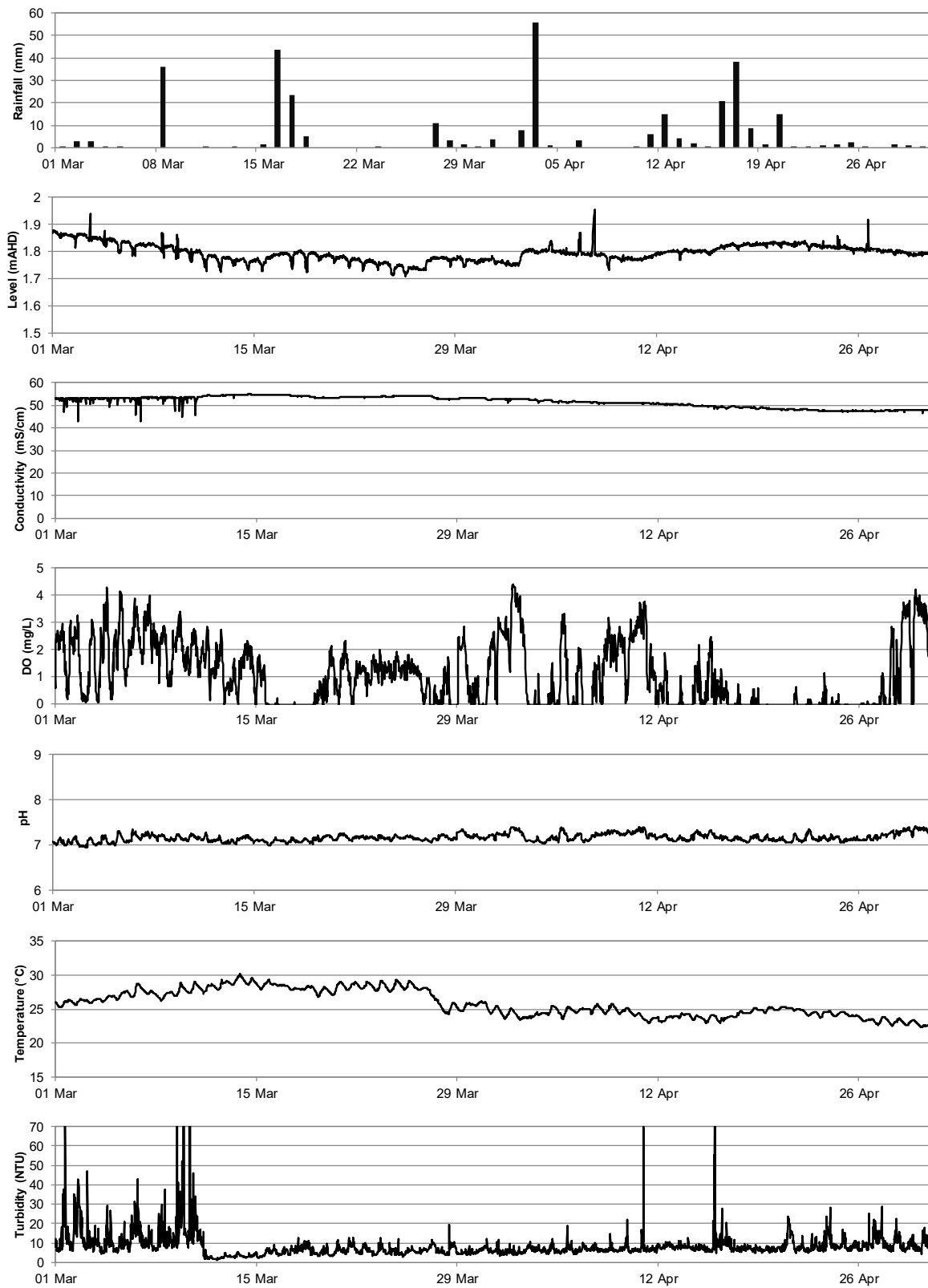


Illustration 3.2 Salty Creek Rainfall and Water Quality Monitoring Station Data 1 March 2019 to 30 April 2019

3.3 Aquatic Weed Monitoring

No aquatic weeds monitoring undertaken during this reporting period.

3.4 Erosion Monitoring Stations

The data collected at the erosion monitoring stations is presented in **Table 3.2**. There was no significant advance of the head cuts at the three impact stations in relation to the previous measurements on 11 March 2019. The head cut has advanced at least 9.90 m towards Salty Lagoon since the monitoring began in July 2017.

Table 3.2 Erosion monitoring results from 8 May 2019

Station	Control/Impact	Distance 25 July 2017 (m)	Distance 8 May 2019 (m)	Cut Movement (m)
ER1	Control	7.55	7.55	0.00
ER2	Control	10.20	10.15	0.05
ER3	Control	9.95	9.90	0.05
ER4	Impact	8.35	6.05	2.30
ER5	Impact	12.35	2.45	9.90
ER6	Impact	10.40	8.60	1.80



4. Discussion

4.1 Water Quality

Rainfall was approximately 10 per cent below average for this reporting period. There were several small and medium events, relatively evenly spaced throughout the two months. The conductivity and level data from the Salty Creek PWQMS indicate that the entrance to Salty Creek remained closed for the entire reporting period. It also shows that the water level in Salty Creek remained stable for most of the reporting period and that rainfall runoff failed to significantly reduce the high conductivity measurements. At the time of the site inspection on 8 May 2019, the entrance to Salty Creek was still closed. The water level in Salty Lagoon also remained relatively stable throughout this monitoring period, with small increases in response to rainfall and small decreases in response to evaporation. The conductivity measured at the Salty Lagoon PWQMS reduced in response to rainfall but conductivity was still very high at the end of this reporting period. The conductivity measurements collected on 8 May 2019 were higher than the guiding values at all sites. For the first time since November 2018 there was water to sample at site S4.

Erosion monitoring indicated that the head cut did not advance significantly during this reporting period. There has been little or no measured advance of the head cuts at the three control sites. This indicates that, for the third consecutive bi-monthly period, there was little flow from Salty Lagoon to Salty Creek.

The DO concentrations in discrete samples collected on 8 May 2019 were relatively low at all sites and did not comply with guiding values at site S2, S4 or S5. Low DO concentrations are naturally prevalent at the sites to the west of Salty Lagoon (sites S2 and S4) and in Salty Creek when brackish and saline conditions persist. The available measurements from the Salty Lagoon PWQMS indicate that the diurnal fluctuations in light availability were the major source of variation during the current reporting period. The measurements from the Salty Creek PWQMS indicate that the DO concentration also fluctuated mostly in response to light availability but that there were several daily cycles, during times of rainfall, where DO remained very low.

With the exception of the TN concentrations from S4 all of the nutrient concentrations from samples collected on 8 May 2019 complied with guiding values. The key factor resulting in low nutrient concentrations was the seawater ingress described in the previous report. Bioavailable nitrogen and bioavailable phosphorus concentrations were low at all sites. In keeping with this, the chlorophyll-a concentrations were relatively low at all sites and complied with guiding values at all sites except S2 and S4. There were no blue-green algae detected in any samples, except at S5, where a low concentration of mixed blue green algal cells was noted. Ammonia, at low concentrations, was detected at most sites in Salty Lagoon. This could be an indication that the extended presence of saline water may be starting to negatively impact upon some of the aquatic vegetation and lead to rotting organic matter.

Other results that did not comply with guiding values included the pH measurements from all sites except S2 and S4; and faecal coliform at S2. All other measurements complied with guiding values. High pH measurements are associated with seawater ingress. Seawater has a pH of approximately 8.3 and strong pH buffering capacity. The high faecal indicator organism concentrations at S2 are likely to be associated with waterbird use of that area.



4.2 Other Observations

The entrance to Salty Creek was closed on 8 May 2019. A variety of birds were observed incidentally during the site inspection including Pacific Black Duck, Pelican, Black Swan, Little Pied Cormorant, and Masked Lapwing. Large fish, including Sea Mullet and Longfin Eel were also observed in the lagoon.



5. Key Points

1. Water levels and conductivity remained stable in Salty Lagoon during this reporting period after saline water flow in from Salty Creek increased levels and conductivity in the previous reporting period. Site S4 had sufficient water to sample during the site visit on 8 May 2019 for the first time since November 2018.
2. A small number of results did not comply with the guiding values.
3. Total nutrient concentrations were mostly low in Salty Lagoon and Salty Creek and chlorophyll-a concentrations were low in the open water of Salty Lagoon.
4. The erosive headcut to the east of the old channel between Salty Lagoon and Salty Creek did not advance significantly during this reporting period.
5. The risk rating for the Salty Lagoon Response Protocol is uncertain, due to the potential ongoing impacts of saline water in Salty Lagoon. Persistent saline conditions are likely to have a negative impact on some of the flora around the lagoon.



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