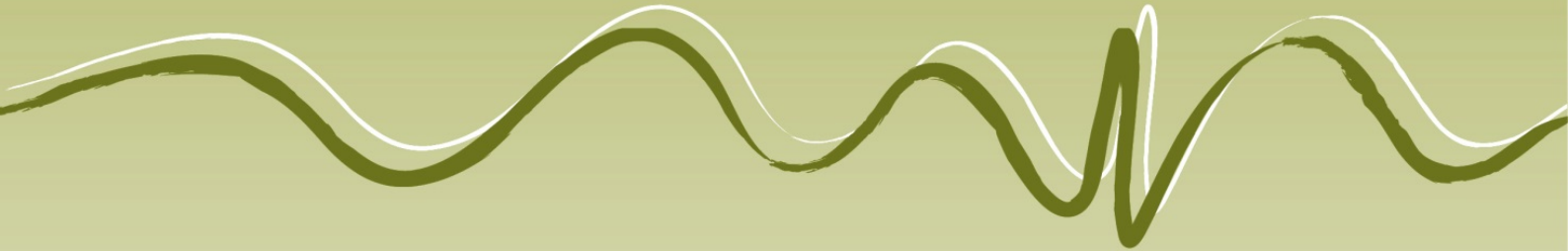


Salty Lagoon

Post Closure Monitoring

Project Management and Ecosystem Health Report

December 2017



AQUATIC SCIENCE AND MANAGEMENT

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1. Introduction

1.1 Introduction

This document comprises the second bi-monthly monitoring report for the Salty Lagoon Post-Closure monitoring years 6-10 (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 26 October 2017 until 31 December 2017.

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 second of the bi-monthly site visits for 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 11 January 2018 after a failed trip on 20 December 2017. Water quality samples were collected between the hours of 8:00 am and 11:30 am on that day. A low tide of 0.67 metres was forecast for 11.33 am.

Discrete water quality samples were taken from surface water (approximately 0.2 metre depth) at four 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 same 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 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

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

2.4 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 will be downloaded at bi-monthly intervals for reporting purposes.

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

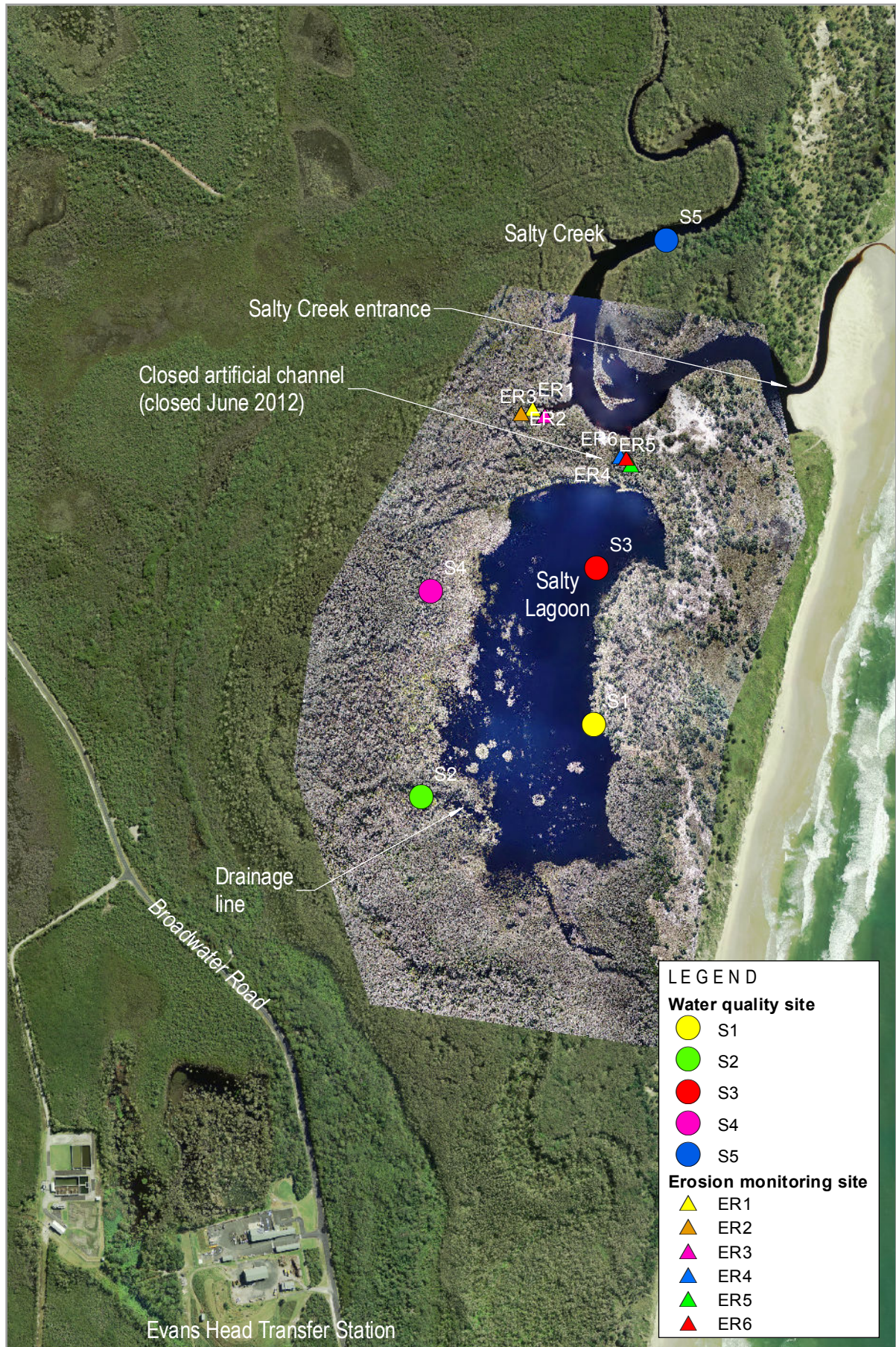
The temperature, pH, conductivity, turbidity and DO sensors on the EXO3 sondes installed at the Salty Lagoon PWQMS were removed and replaced by a calibrated set.

The status of the two YSI EXO3 sondes on 11 January 2018 is displayed in **Table 2.3**.

Table 2.3 YSI sonde Status on 11 January 2018

Sonde	SN17F104100	SN 17H104488	Spare Probes
pH (cap life expectancy 18 months)	YSI EXO pH 17H105047 Manufactured 08/2017	EXO pH 17H105049 Manufactured 08/2017	EXO pH 17H105048 Manufactured 08/2017
Temp/ cond (life expectancy 7-10 years)	EXO Wiped CT 17F102047 Manufactured 06/2017	EXO Wiped CT 17F102685 Manufactured 06/2017	EXO Wiped CT 17F103252 Manufactured 06/2017
DO (cap life expectancy 18 months)	EXO Optical DO 17H103493 Manufactured 08/2017	EXO Optical DO 17H103494 Manufactured 08/2017	EXO Optical DO 17H103495 Manufactured 08/2017
Turbidity (life expectancy 7-10 years)	YSI EXO Turbidity 17H101465 Manufactured 08/2017	YSI EXO Turbidity 17H103513 Manufactured 08/2017	YSI EXO Turbidity 17H101468 Manufactured 08/2017
Wiper	YSI Exo Wiper 17G101952	YSI Exo Wiper 17G101954	No Spare wiper
Status	New probes installed in Salty Lagoon 11/01/2018	New probes installed in Salty Creek 25/10/2017	Probes being calibrated for redeployment
Notes	<ul style="list-style-type: none"> - First deployment of probes - Probes manufacture calibrated - Estimated sonde battery life 131.8 days - Memory 50085.3 days logging 	<ul style="list-style-type: none"> - First deployment. - Probes manufacture calibrated - Estimated sonde battery life 156.3 days - Memory 50085.3 days logging. 	<ul style="list-style-type: none"> - Removed 11/01/2018

Climate information was sourced from the Evans Head bombing range weather station on the Bureau of Meteorology website (BoM 2017). Evans Head Sewage Treatment Plant (STP) facility routine sampling information was provided by Richmond Valley Council (RVC).



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Water Quality and Erosion Monitoring Site Locations

Salty Lagoon Project Management & Ecosystem Health Report, December 2017
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Illustration 2.1



3. Results

3.1 Water Quality Samples

Results of the water quality monitoring undertaken on 11 January 2018 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**. There is no level data presented because the HOBO loggers now collecting level data were only successfully installed on 11 January 2018.

Table 3.1 Results of Discrete Samples Collected 25 October 2017

Parameter	Salty Lagoon								Salty Creek	
	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	Nil
Nitrite Nitrogen (mg/L)	0.01	<0.010	ns	<0.010	<0.010	<0.010	ns	<0.010	0.01	<0.010
Nitrate Nitrogen (mg/L)	0.01	0.011	ns	0.013	<0.010	<0.010	ns	<0.010	0.01	<0.010
Oxidized Nitrogen (mg/L)	-	0.011	ns	0.013	<0.010	<0.010	ns	<0.010	-	<0.010
Ammonia Nitrogen (mg/L)	0.05	0.084	ns	0.086	0.011	0.09	ns	0.013	0.11	0.018
Total Kjeldahl Nitrogen (mg/L)	1.6	1.27	ns	1	1.45	1.42	ns	1.52	1.63	1.05
Total Nitrogen (mg/L)	1.6	1.28	ns	1.01	1.45	1.42	ns	1.52	1.63	1.05
Total Phosphorus(mg/L)	0.14	0.1	ns	0.08	0.06	0.11	ns	0.03	0.04	<0.03
Orthophosphate (mg/L)	0.11	0.012	ns	0.022	0.026	0.024	ns	<0.010	0.01	<0.010
Chlorophyll-a (µg/L)	5	12	ns	12	8	9	ns	14	3	<1
Enterococcus (CFU/100mL)	170	15	ns	5	225	5	ns	5	40	65
Faecal Coliforms (CFU/100mL)	135	52	ns	36	34	22	ns	6	150	900
Temp (°C)	25.9	25.73	25.71	ns	24.45	25.64	25.56	25.95	13.1 - 28.8	27.04
pH	6.9	7.02	7.04	ns	6.33	7.21	7.22	5.98	4.3 - 6.8	7.11
ORP (mV)	-	214	214	ns	219	191	201	193	-	288
Cond (mS/cm)	8.0	5.64	5.68	ns	1.49	6.17	6.19	0.944	0.3 - 21.5	21.1
Turbidity (NTU)	13	7.4	8.3	ns	1	4.8	6.2	1.6	11	0.8
DO (mg/L)	4.09	6.14	5.66	ns	2.42	7.33	7.1	2.86	5.52	4.33
DO (% sat)	-	74	71.1	ns	30.2	90.9	89.2	30.2	-	65.7
TDS (mg/L)	-	3.62	3.65	ns	0.998	3.76	3.77	0.839	-	13.7
Sal (ppt)	-	3.7	3.7	ns	1	4	4	0.6	-	12.6
Depth (m)	-	Surface	1m	Surface	Surface	Surface	1m	Surface	-	Surface

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

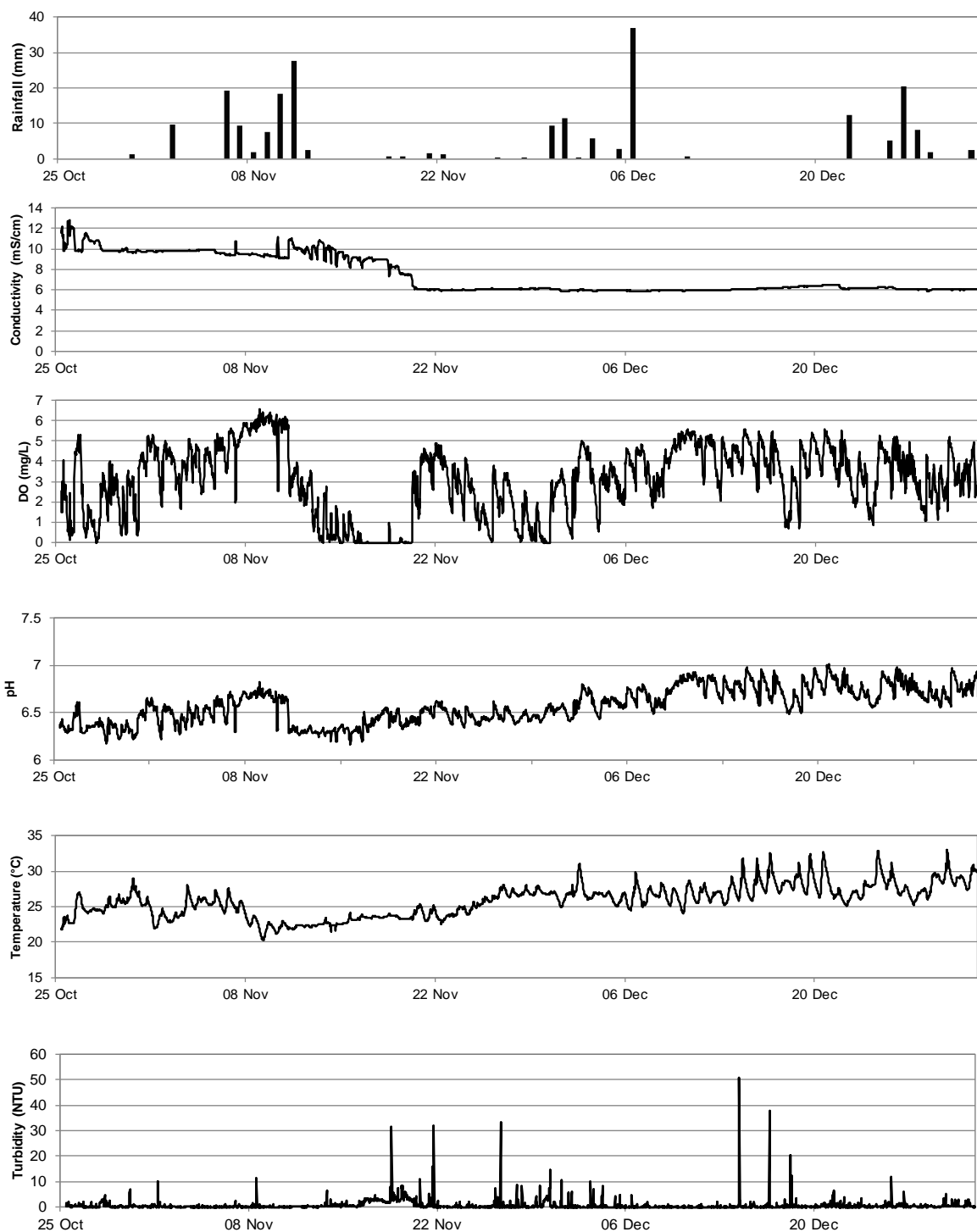


Illustration 3.1 Salty Lagoon Rainfall and Water Quality Monitoring Station Data 25 October 2017 to 31 December 2017

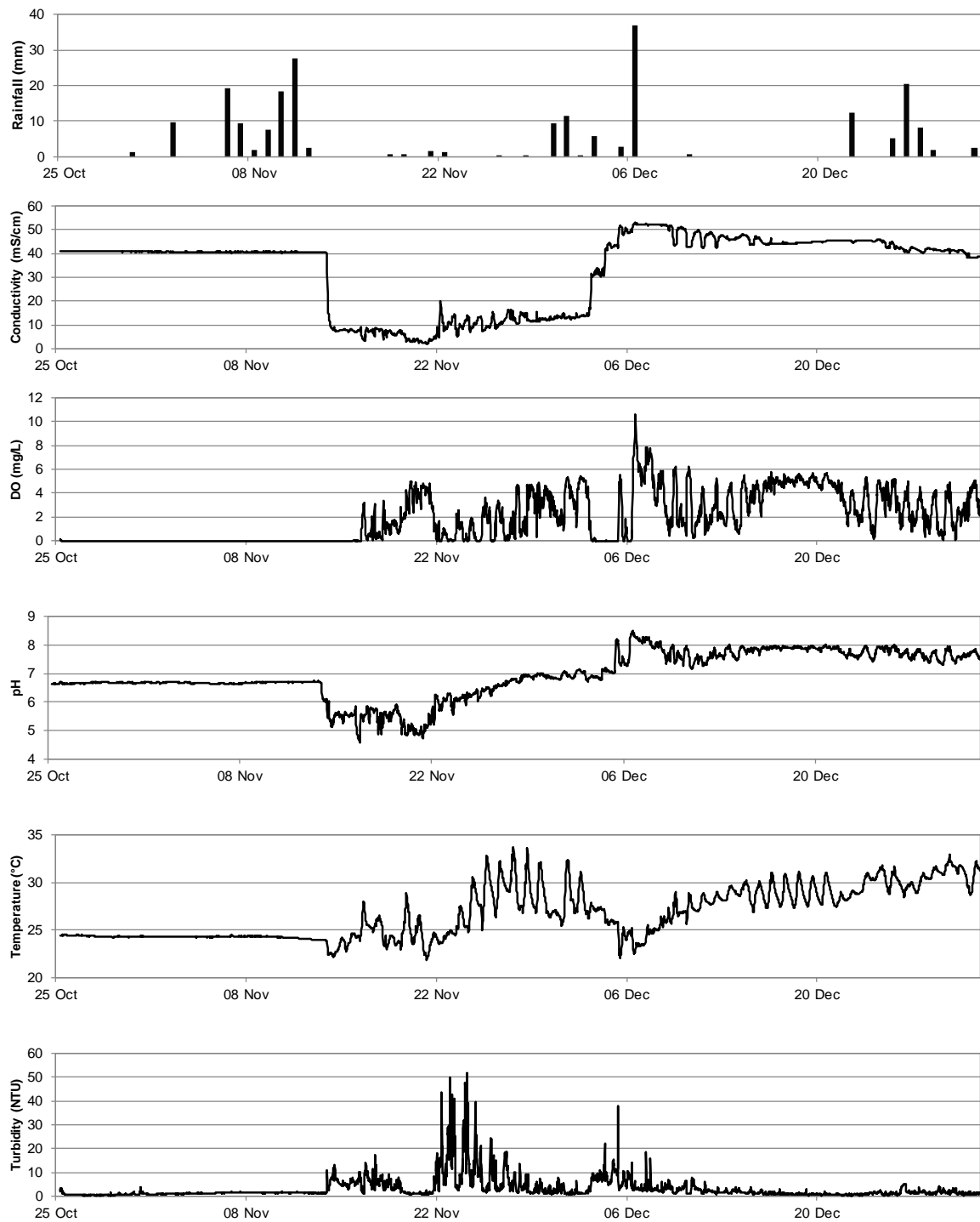


Illustration 3.2 Salty Creek Rainfall and Water Quality Monitoring Station Data 25 October 2017 to 31 December 2017

3.3 Erosion Monitoring Stations

The data collected at the erosion monitoring stations is presented in **Table 3.2**. There was a clear advance of the head cut at the three impact stations in relation to the previous measurements in October 2017.

Table 3.2 Erosion monitoring results from 11 January 2018

<i>Station</i>	<i>Control/Impact</i>	<i>Distance 25 July 2017 (m)</i>	<i>Distance 11 January 2018 (m)</i>	<i>Cut Movement (m)</i>
ER1	Control	7.55	7.55	0.00
ER2	Control	10.20	10.20	0.00
ER3	Control	9.95	9.90	0.05
ER4	Impact	8.35	7.80	0.55
ER5	Impact	12.35	11.65	0.70
ER6	Impact	10.40	9.70	0.70



4. Discussion

4.1 Water Quality

There were three distinct periods of moderate to heavy rainfall during this reporting period. The conductivity data from the Salty Creek PWQMS indicates that the entrance to Salty Creek opened in response to rainfall on 14 November 2017 and that a period of freshwater dominance lasted until 3 December 2017 when the entrance opened and successive seawater ingress events filled Salty Creek with saline water. The conductivity data from the Salty Lagoon PWQMS indicates that the saline water present in Salty Lagoon at the end of the previous reporting period was diluted by the first rainfall event prior to stabilising for the last 6 weeks of this reporting period. At the time of the site inspection the entrance to Salty Creek was closed.

Erosion monitoring indicated that the head cut advanced between 0.55 and 0.7 m since 25 October 2017 in three distinct locations, probably as a result of water draining out of Salty Lagoon. There was little or no advancement of the head cuts at the control sites.

Conductivity measurements from the PWQMS show the impact of rainfall and subsequent seawater ingress on Salty Creek and the impact of dilution from rainfall runoff on Salty Lagoon. At the time of the site inspection the conductivity measurements in Salty Lagoon were still higher than normal, but did not exceed guiding values. The water column was well mixed at all sites.

The DO concentrations in discrete samples collected on 11 January 2018 were typical at all sites. The DO concentrations complied with guiding values in the open water sites of Salty Lagoon but not at the two westernmost sites in Salty Lagoon, which are usually oxygen poor, or at the Salty Creek site.

Most of the nutrient concentrations complied with guiding values this month with the exception of the nitrate concentrations from S1 and the ammonia concentrations from S1 and S3. The chlorophyll-a concentrations did not comply with the guiding value at any of the Salty Lagoon sites. The results suggest an algal bloom of minor proportions. There were no blue-green algae detected in any samples. There is an emerging pattern of high chlorophyll-a concentrations in the warmer months in samples from Salty Lagoon. A key influence upon this is rainfall in the period immediately prior to sampling with heavy rainfall events leading to lower chlorophyll-a concentrations for a short time afterwards.

Other results that did not comply with guiding values included the pH measurements from S1, S3 and S5, the temperature measurement from S4, the enterococcus concentrations from S2 and S5 and the faecal coliform concentration from S5. All other measurements complied with guiding values. The high pH measurements from S1, S3 and S5 are likely to be associated with the continued presence of saline water. The high faecal indicator organism concentrations at S2 and S5 are likely to be associated with waterbird use of those areas. Waterbirds are often disturbed from those two sites during site inspections. The high temperature measurement from S4 results from a combination of seasonal conditions and low water levels.

4.2 Other Observations

The entrance to Salty Creek was closed on 11 January 2018. A variety of birds were observed incidentally during the site inspection including Pacific Black Duck, Eurasian Coot, Pelican, Intermediate Egret, Little Black Cormorant and Little Pied Cormorant.



Plate 4.1 The Headcut to the east of the old channel on 11 January 2018



Plate 4.2 The Headcut to the east of the old channel on 21 June 2017



5. Key Points

1. Rainfall diluted the saline water in Salty Lagoon and opened the entrance to Salty Creek.
2. Most results complied with the guiding values.
3. Total nutrient concentrations were low but there were high concentrations of bioavailable nutrients at the open water sites in Salty Lagoon.
4. Chlorophyll-a concentrations did not comply with guiding values at any of the Salty Lagoon sites, indicating an algal bloom of minor proportions.
5. The erosive headcut to the east of the old channel between Salty Lagoon and Salty Creek advanced approximately 0.55 – 0.7m in this reporting period.



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