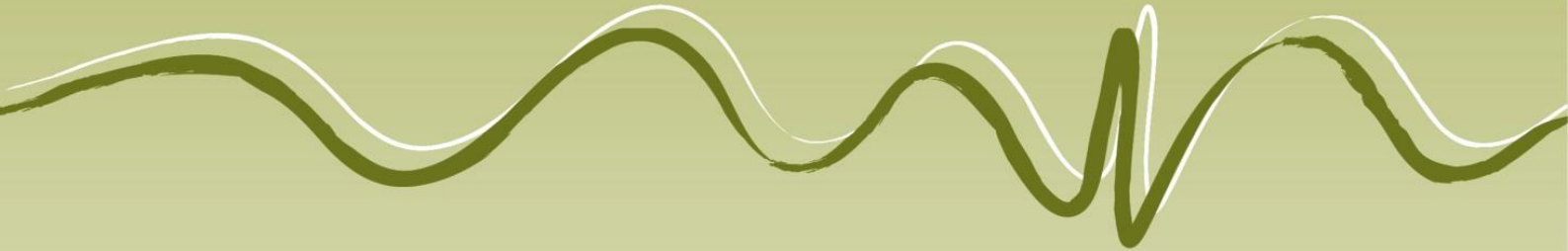


Salty Lagoon

Post Closure Monitoring

Project Management and Ecosystem Health Report

June 2022



AQUATIC SCIENCE AND MANAGEMENT

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1. Introduction

1.1 Introduction

This document comprises the final bi-monthly monitoring report for year 10 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 May 2022 until 30 June 2022.

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 final bi-monthly site visit for year 10 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 6 July 2022. Water quality samples were collected between the hours of 7:30 am and 11:30 am on that day. A low tide of 0.53 metres was forecast for 7.13 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	S1	S2	S3	S4	S5
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 Aquatic Weed Monitoring

Aquatic weed monitoring occurs three times each year; once in each of the summer, autumn and spring seasons. The autumn aquatic weed survey was undertaken during the site inspection on 9 May 2022.

2.4 Erosion Monitoring

A series of reference stations have been set up around the 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**. Repairs to the control structure installed by NSW National Parks and Wildlife Service (NPWS) in late 2020 were undertaken in June and July 2021. The repairs were noted to have failed following flooding that occurred in early 2022. Erosion monitoring is continuing to determine if the headcut has stabilised.

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. In March 2020 site ER5 had to be extended because the fixed peg was overtaken by the erosion. A new site, ER5A was created but allows erosion progression to be measured from the same initial reference point as ER5.

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

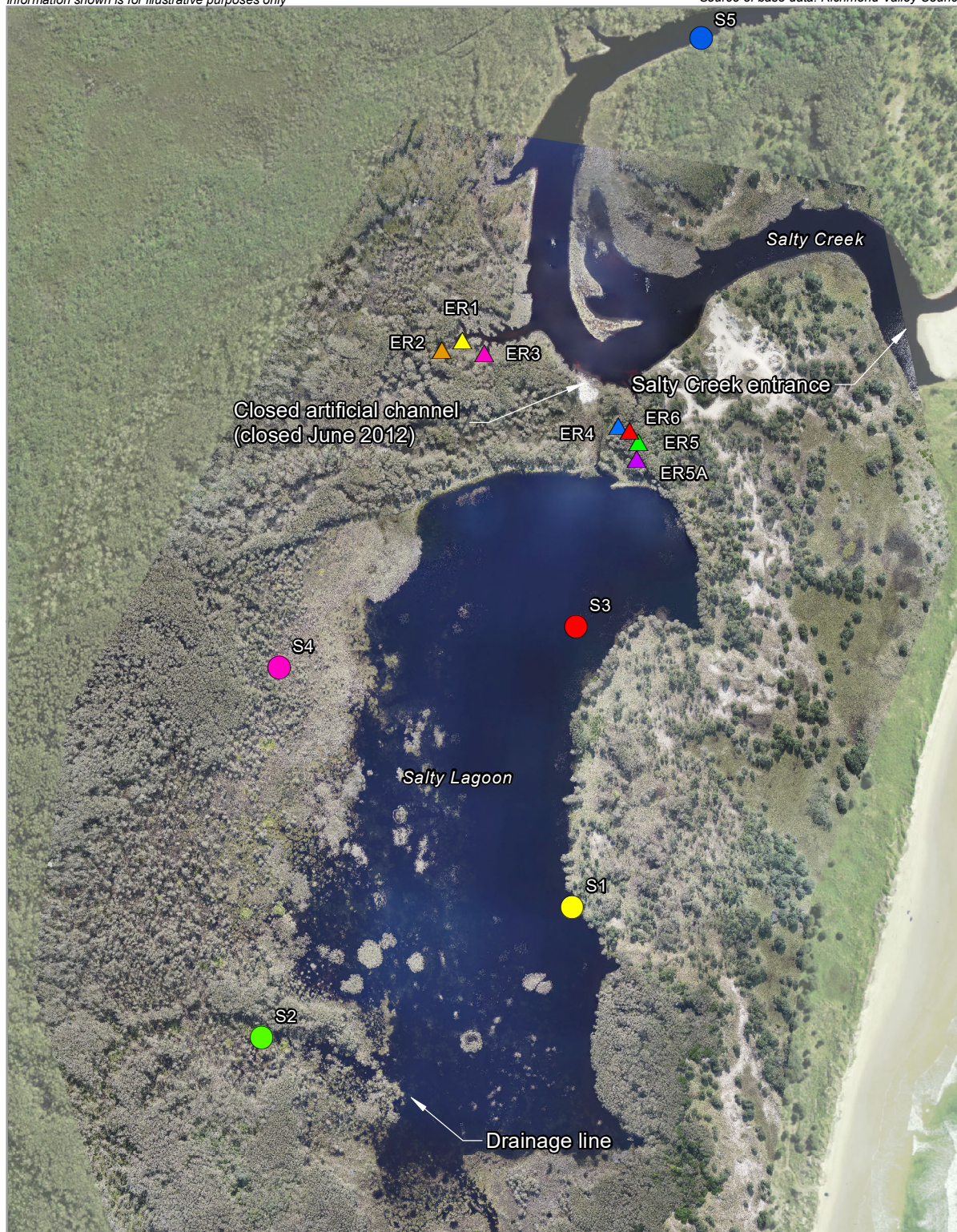
<i>Site</i>	<i>Control/ Impact</i>	<i>Peg Location</i>	
		<i>Easting</i>	<i>Northing</i>
ER1	Control	541961	6783356
ER2	Control	541934	6783355
ER3	Control	541978	6783342
ER4	Impact	542112	6783277
ER5	Impact	542129	6783262
ER5A	Impact	542128	6783245
ER6	Impact	542121	6783272

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.

HOB0 U20 water level loggers were installed in the water at each PWQMS and a third HOB0 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 sondes installed at the Salty Lagoon and Salty Creek PWQMS were not removed during this site inspection.



LEGEND

Water Quality Site

- S1
- S2
- S3
- S4
- S5

Erosion Monitoring Site

- ▲ ER1
- ▲ ER2
- ▲ ER3
- ▲ ER4
- ▲ ER5
- ▲ ER5A
- ▲ ER6

0 120



Location of Water Quality and Erosion Monitoring Sites



3. Results

3.1 Water Quality Samples

Results of the water quality monitoring undertaken on 6 July 2022 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 6 July 2022

Parameter	Salty Lagoon								Salty Creek		
	Guiding Value	S1	S1 (1m)	S1 (QA)*	S2	S3	S3 (1m)	S4	Guiding Value	S5	S5 (1m)
Blue Green Algae ID (cells/mL)	0	<100	ns	<100	<100	<100	<100	<100	0	nil	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	0.018	ns	0.018	0.01	0.025	ns	<0.010	0.01	<0.010	ns
Oxidized Nitrogen (mg/L)	-	0.019	ns	0.019	0.01	0.026	ns	<0.010	-	<0.010	ns
Ammonia Nitrogen (mg/L)	0.05	<0.010	ns	<0.010	<0.010	<0.010	ns	<0.010	0.11	<0.010	ns
Total Kjeldahl Nitrogen (mg/L)	1.6	1.01	ns	1	0.91	1.03	ns	1.16	1.63	0.93	ns
Total Nitrogen (mg/L)	1.6	1.03	ns	1.02	0.92	1.06	ns	1.16	1.63	0.93	ns
Total Phosphorus(mg/L)	0.14	<0.03	ns	0.03	0.04	0.05	ns	<0.03	0.04	<0.03	ns
Orthophosphate (mg/L)	0.11	<0.010	ns	<0.010	0.019	<0.010	ns	<0.010	0.01	<0.010	ns
Chlorophyll-a (µg/L)	5	1	ns	2	<1	1	ns	<1	3	1	ns
Enterococcus (CFU/100mL)	170	30	ns	5	80	115	ns	70	40	120	ns
Faecal Coliforms (CFU/100mL)	135	15	ns	23	45	6	ns	30	150	580	ns
Temp (°C)	25.9	13.17	13.16	ns	13.9	13.47	13.45	14.14	13.1 - 28.8	14.16	16.77
pH	6.9	6.94	6.69	ns	6.16	6.81	6.68	5.42	4.3 - 6.8	5.44	6.36
ORP (mV)	-	205	221	ns	230	201	212	230	-	263	95
Cond (mS/cm)	8.0	0.455	0.464	ns	0.276	0.441	0.44	1.23	0.3 - 21.5	3.26	47.1
Turbidity (NTU)	13	2.3	1.9	ns	3.3	2.1	2.6	5.3	11	2.9	4.4
DO (mg/L)	4.09	7.86	7.67	ns	1.82	9.04	8.92	3.08	5.52	4.99	0.1
DO (% sat)	-	77.5	75.6	ns	18.2	89.7	88.4	31.1	-	50.6	1.3
TDS (mg/L)	-	0.296	0.302	ns	0.179	0.287	0.286	0.787	-	2.08	28.7
Sal (ppt)	-	0.2	0.2	ns	0.1	0.2	0.2	0.6	-	1.7	30.3
Depth (m)	-	Surface	1	Surface	Surface	Surface	1	Surface	-	Surface	1

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

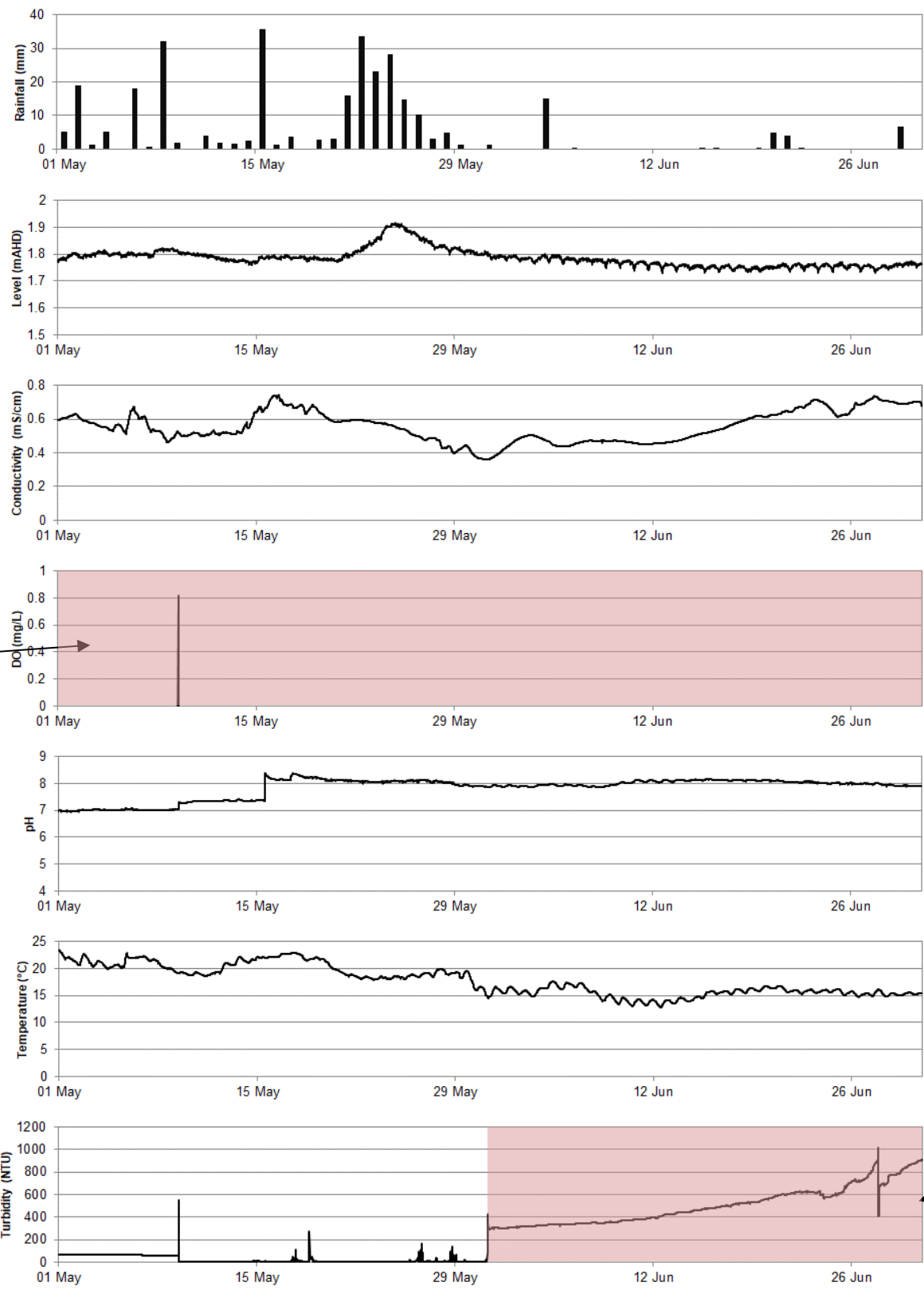


Illustration 3.1 Salty Lagoon Rainfall and Water Quality Monitoring Station Data 1 May 2022 to 30 June 2022

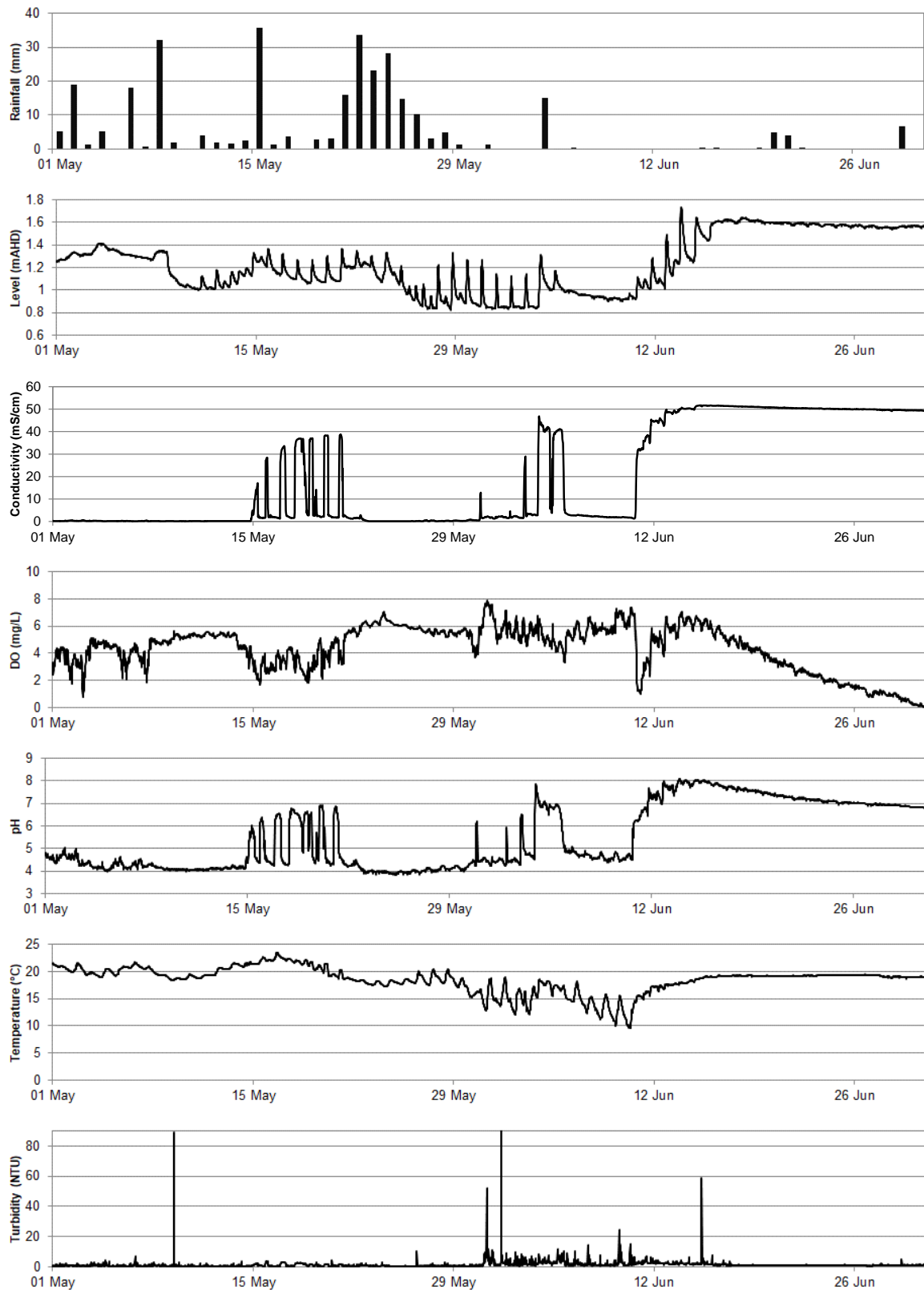


Illustration 3.2 Salty Creek Rainfall and Water Quality Monitoring Station Data 1 May 2022 to 30 June 2022

3.3 Erosion Monitoring Stations

The data collected at the erosion monitoring stations is presented in **Table 3.2** and **Illustration 3.3**. There was no significant advance of the head cut at ER5 in relation to the previous measurements on 9 May 2022. The head cut has advanced more than 50 m towards Salty Lagoon since the monitoring began in July 2017.

Table 3.2 Erosion Monitoring Results from 6 July 2022

Station	Control/ Impact	Distance 25 July 2017 (m)	Distance 6 July 2022 (m)	Cut Movement (m)
ER1	Control	7.55	7.35	0.20
ER2	Control	10.20	7.15	3.05
ER3	Control	9.95	9.80	0.15
ER4	Impact	8.35	-5.75	14.10
ER5	Impact	12.35	-39.9	52.25
ER6	Impact	10.40	6.15	4.25

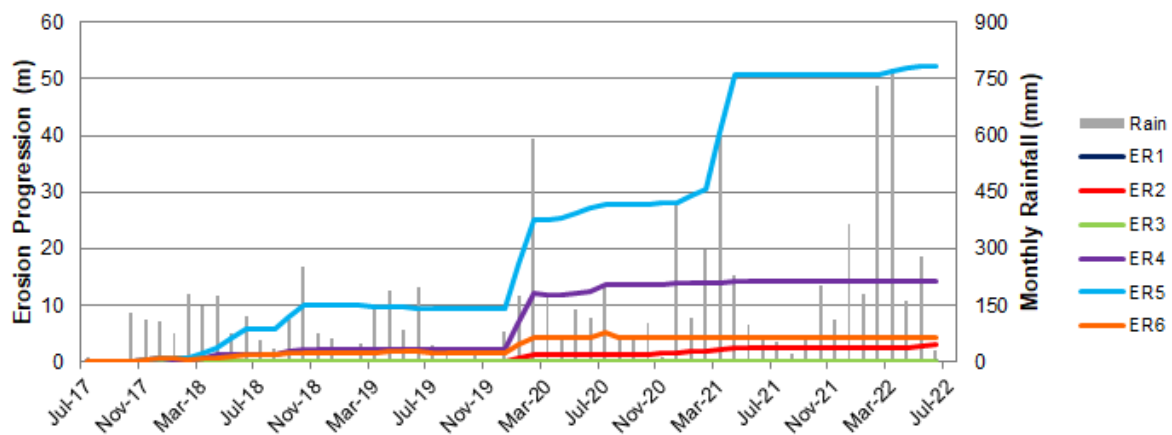


Illustration 3.3 Erosion Progression Plotted against Monthly Rainfall since July 2017



4. Discussion

4.1 Water Quality

There was heavy rainfall during the first month of this reporting period, followed by a relatively dry second month. The rainfall included several large events and a number of small events. The total rainfall for this reporting period was more than 30 percent greater than the average amount. This is the fifth consecutive bi-monthly reporting period where rainfall exceeded the average amount.

The water level at the Salty Creek PWQMS was particularly dynamic again during this reporting period, in response to rainfall runoff, seawater ingress, the entrance opening and tidal movements. The data indicates that the entrance to Salty Creek was open for most of the reporting period, and operating tidally for more than half of it. Water levels in Salty Lagoon remained high for the majority of the reporting period, with an increase to approximately 1.9 mAHd in response to sustained heavy rainfall around 24 May 2022. Water would have flowed from Salty Lagoon into Salty Creek for the entire reporting period. This flow led to an advance of the eroding head cut (**Illustration 3.3**) although most of the advance was westwards rather than southwards towards Salty Lagoon (**Plate 4.3**).

The conductivity measured at the Salty Lagoon PWQMS remained very low during this reporting period in response to consistent rainfall runoff. Small fluctuations detected at the Salty Lagoon PWQMS occurred in response to the variable influences of rainfall or evaporation. The conductivity measurements from the Salty Creek PWQMS varied between freshwater conditions or almost marine conditions in response to either rainfall runoff or tidal movements. At the end of the reporting period (and at the time of the site inspection on 6 July 2022) the water in Salty Lagoon was fresh and the water in Salty Creek was stratified into a brackish top layer and a highly saline bottom layer. The conductivity measurements collected on 6 July 2022 complied with guiding values at all sites except S5, where the result from deeper water was above the upper guideline limit as a result of the very strong influence from earlier tidal movements.

Erosion monitoring showed a small movement of the primary head cut towards Salty Lagoon since the previous measurements taken on 9 May 2022. Although the southward advance towards Salty Lagoon was approximately 0.2 m during this reporting period, the eroding channel extended approximately 1.5 - 2 m in a westward direction (**Plate 4.3**).

The DO concentrations in discrete samples collected on 6 July 2022 were below the guiding values at the two western sites in Salty Lagoon and at the Salty Creek site. Low DO concentrations are naturally prevalent at the sites to the west of Salty Lagoon. Logged data from the Salty Lagoon PWQMS indicates that the DO probe was faulty for the extent of this reporting period. Logged data from the Salty Creek PWQMS indicates that the DO concentration at the bottom of the water column in Salty Creek improved when freshwater conditions prevailed but was still variable in response to light availability.

Most of the nutrient concentrations from samples collected on 6 July 2022 complied with guiding values. Only the nitrate concentrations from S1 and S3 exceeded guiding values and generally the nutrient concentrations were very low. Low nutrient concentrations are often observed in Salty Lagoon after very heavy rainfall, an indication that the historical pollution is a stronger source of elevated nutrient concentrations than rainfall runoff. The chlorophyll-a concentrations from all sites complied with the guiding values. Blue-green algae were recorded from all sites in Salty Lagoon, but

in very low numbers. The blue-green algae detected were from the genera *Planktolyngbya*, *Synechococcus*, *Anabeana*, *Aphanocapsa* and *Geitlerinema*.

All other results complied with guiding values with the exception of the faecal coliform and enterococcus concentrations at S5 and the pH value from S1. Elevated faecal indicator organisms are also often associated with rainfall, as animal faeces are washed in from the wider catchment. There were no indications of impacts from the Evans Head sewage treatment plant.

4.2 Other Observations

The entrance to Salty Creek was open and flowing on 6 July 2022 (**Plate 4.1**). Few birds were observed incidentally during the site inspection. The species observed were Pacific Black Duck, White-eyed Duck, Little Pied Cormorant and Black Swan. A native aquatic plant, hornwort (*Ceratophyllum demersum*), was observed throughout Salty Lagoon in unusually high densities.



Plate 4.1 The open entrance to Salty Creek on 6 July 2022



Plate 4.2 The erosion control structure has been outflanked and is collapsing.



Plate 4.3 The position of the headcut on 6 July 2022 showing a westwards advance



Plate 4.4 The position of the headcut on 9 May 2022



5. Key Points

1. Water levels in Salty Lagoon were relatively high during this reporting period in response to above average rainfall.
2. A small number of results from a variety of parameters did not comply with the guiding values.
3. Nutrient and chlorophyll-a concentrations were very low.
4. Blue-green algae were detected for the tenth consecutive reporting period, but at very low levels.
5. The erosion control structure has been outflanked, is damaged and is no longer functional.
6. In accordance with the project Environmental Response Protocol (GeoLINK 2017b), the risk rating from the Salty Lagoon Response Protocol is uncertain. This is due to the potential for a new permanent channel to form between Salty Lagoon and Salty Creek. Adaptive management site visits are recommended for periods of potential head cut progression, with the following triggers:
 - >50 mm of rainfall with 24 hrs.
 - >200 mm of rainfall within a week.
 - Other high risk events, for example >100 mm of rainfall within 72 hours, significant storm surge, atypically large tides, etc. Due consideration would be given to rainfall intensity and volume, and the Salty Creek entrance status when known as appropriate.



References

Bureau of Meteorology (2022). <http://www.bom.gov.au/>. Accessed 11/07/2022.

Entwistle, T., Sonneman, J. and Lewis, S. (1997) *Freshwater Algae in Australia*.

GeoLINK (2012). *Salty Lagoon Monitoring: Pre-Post Closure of Artificial Channel – Project Management and Ecosystem Health Monthly Report – September 2012*. Report to Richmond Valley Council.

GeoLINK (2017). *Final Evaluation Report - Salty Lagoon Monitoring: Pre-Post Closure of Artificial Channel – Project Finalisation Report*. Report to Richmond Valley Council.

Hydrosphere (2010). *Salty Lagoon Monitoring Program Pre/Post Closure of the Artificial Channel*. Unpublished report to Richmond Valley Council. Hydrosphere Consulting, Ballina.



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