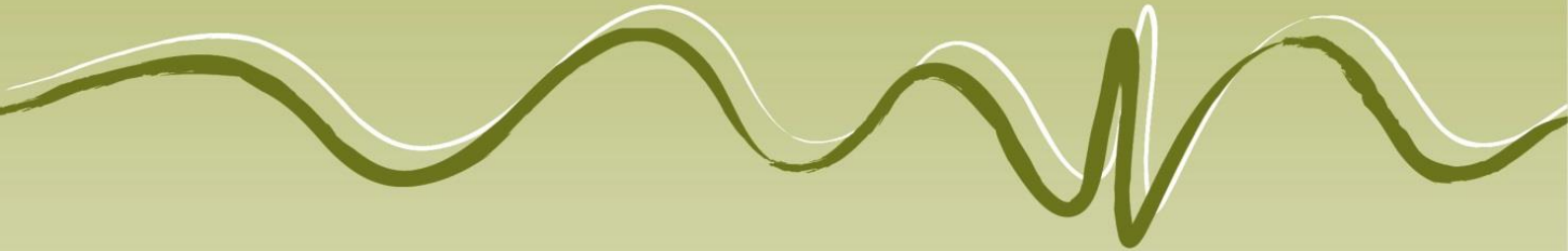


# **Salty Lagoon**

## **Post Closure Monitoring**

### **Project Management and Ecosystem Health Report**

**April 2021**



**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](mailto:info@geolink.net.au)

Prepared for: Richmond Valley Council  
© GeoLINK, 2021

<b><i>UPR</i></b>	<b><i>Description</i></b>	<b><i>Date Issued</i></b>	<b><i>Issued By</i></b>
1731-1339	First issue	15/06/2021	David Andrighetto



## Table of Contents

<b>1.</b>	<b>Introduction</b>	<b>1</b>
1.1	Introduction	1
1.2	Guiding Values	1
<b>2.</b>	<b>Methodology</b>	<b>2</b>
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
<b>3.</b>	<b>Results</b>	<b>6</b>
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
<b>4.</b>	<b>Discussion</b>	<b>11</b>
4.1	Water Quality	11
4.2	Other Observations	12
<b>5.</b>	<b>Key Points</b>	<b>13</b>

## 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 2021 to 30 April 2021 .....	8
Illustration 3.2	Salty Creek Rainfall and Water Quality Monitoring Station Data 1 March 2021 to 30 April 2021 .....	9
Illustration 3.3	Erosion Progression Plotted against Monthly Rainfall since July 2017 .....	10

## Plates

Plate 4.1	The open entrance to Salty Creek on 30 April 2021	12
Plate 4.2	The head cut continues to move towards Salty Lagoon.	12
Plate 5.1	The scour spillway on 2 March 2021	13
Plate 5.2	Evidence of a reduction in the level of the scour spillway on 30 April 2021.	13



## Tables

<u>Table 2.1</u>	<u>Locations of Water Quality Sample Sites in Salty Lagoon and Salty Creek (WGS84) .....</u>	<u>2</u>
<u>Table 2.2</u>	<u>Type and Locations (WGS84) of Erosion Monitoring Sites .....</u>	<u>3</u>
<u>Table 2.3</u>	<u>YSI Sonde Status on 30 April 2021 .....</u>	<u>4</u>
<u>Table 3.1</u>	<u>Results of Discrete Samples Collected 30 April 2021 .....</u>	<u>7</u>
<u>Table 3.2</u>	<u>Erosion Monitoring Results from 30 April 2021 .....</u>	<u>10</u>



# 1. Introduction

## 1.1 Introduction

This document comprises the fifth bi-monthly monitoring report for year 9 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 2021 until 30 April 2021.

## 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 9 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 30 April 2021. Water quality samples were collected between the hours of 7:00 am and 12:30 pm on that day. A high tide of 1.49 metres was forecast for 10.54 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 S2. 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 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. The autumn 2021 aquatic weed monitoring was undertaken during the site inspection on 30 April 2021.

## 2.4 Erosion Monitoring

A series of 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**. Remediation of the headcut was undertaken by NSW National Parks and Wildlife Service (NPWS) in late 2020 through creation of a rock, geofabric and sand spillway at the outlet. Erosion monitoring is continuing to confirm 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**

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
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.

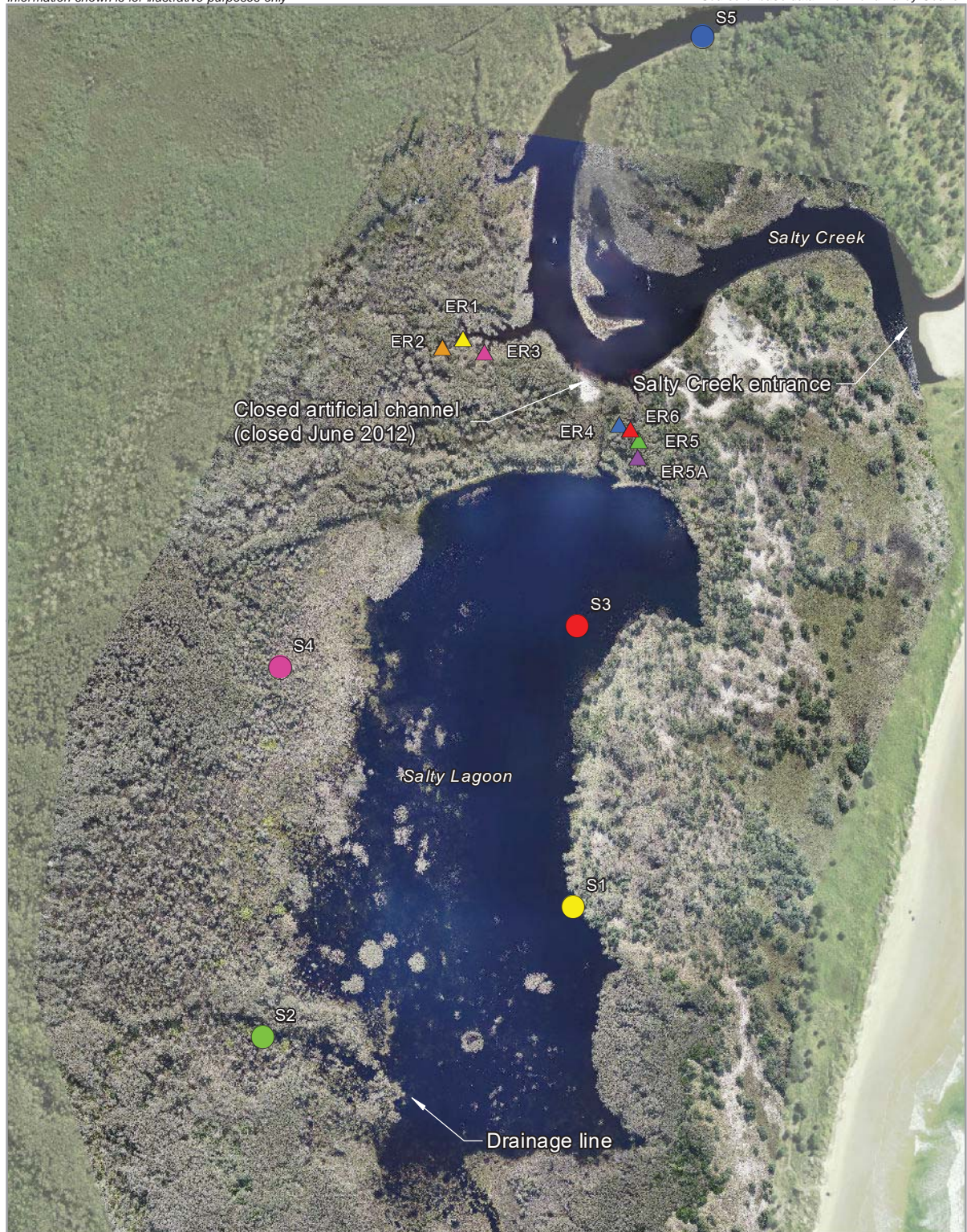
The temperature, pH, conductivity, turbidity and DO sensors on the EXO3 sonde installed at the Salty Lagoon PWQMS were removed on 2 March 2021 and replaced by a serviced and calibrated set.

The status of the two deployed YSI EXO3 sondes on 30 April 2021 is displayed in **Table 2.3**.

**Table 2.3 YSI Sonde Status on 30 April 2021**

<b>Sonde</b>	<b>SN17F104100</b>	<b>SN 17H104488</b>	<b>Spare Probes</b>
pH (cap life expectancy 18 months)	EXO pH 17H105049 Manufactured 08/2017 New cap 02/2021	EXO pH 17H105048 Manufactured 08/2017 New cap 10/2020	EXO pH 17H105047 Manufactured 08/2017 New cap 01/2021
Temp/ cond (life expectancy 7-10 years)	EXO Wiped CT 17F103252 Manufactured 06/2017	EXO Wiped CT 17F102685 Manufactured 06/2017	EXO Wiped CT 17F102047 Manufactured 06/2017
DO (cap life expectancy 24 months)	EXO Optical DO 17H103495 Manufactured 08/2017 New cap 03/2021	EXO Optical DO 17H103494 Manufactured 08/2017 New cap 04/2021	EXO Optical DO 17H103493 Manufactured 08/2017 New cap 05/2019
Turbidity (life expectancy 7-10 years)	YSI EXO Turbidity 17H101468 Manufactured 08/2017	YSI EXO Turbidity 17H103513 Manufactured 08/2017	YSI EXO Turbidity 17H101465 Manufactured 08/2017
Wiper	YSI Exo Wiper 17G101952 New wiper brush installed 07/2020	YSI Exo Wiper 17G101954 New wiper brush installed 03/2020	No Spare Wiper
Status	<ul style="list-style-type: none"> <li>- Serviced probes installed in Salty Lagoon 2/03/2021</li> <li>- New batteries installed 30/04/2021</li> </ul>	<ul style="list-style-type: none"> <li>- Serviced probes installed in Salty Creek 30/04/2021</li> <li>- New Batteries installed 30/04/2021</li> </ul>	<ul style="list-style-type: none"> <li>- Awaiting service and calibration.</li> <li>- Probes Removed from Salty Creek 30/04/2021</li> </ul>
Notes	<ul style="list-style-type: none"> <li>- 218 days estimated battery life</li> <li>- Memory cleared – 47861 days logging available</li> </ul>	<ul style="list-style-type: none"> <li>- 218 days estimated battery life</li> <li>- Memory cleared – 50045.3 days logging available</li> </ul>	<ul style="list-style-type: none"> <li>- New DO cap required</li> </ul>

Climate information was sourced from the Evans Head bombing range weather station on the Bureau of Meteorology website (BOM 2020). Evans Head Sewage Treatment Plant (STP) facility routine sampling information was provided by Richmond Valley Council (RVC).



## 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



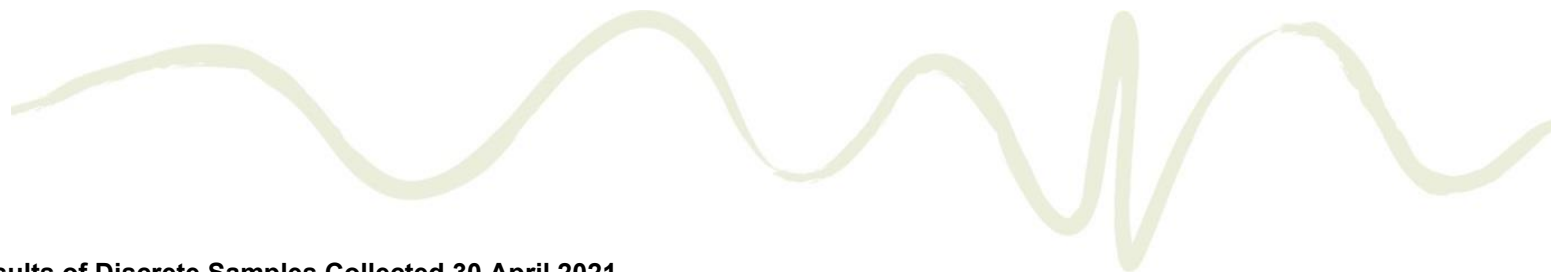
## 3. Results

### 3.1 Water Quality Samples

Results of the water quality monitoring undertaken on 30 April 2021 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**.



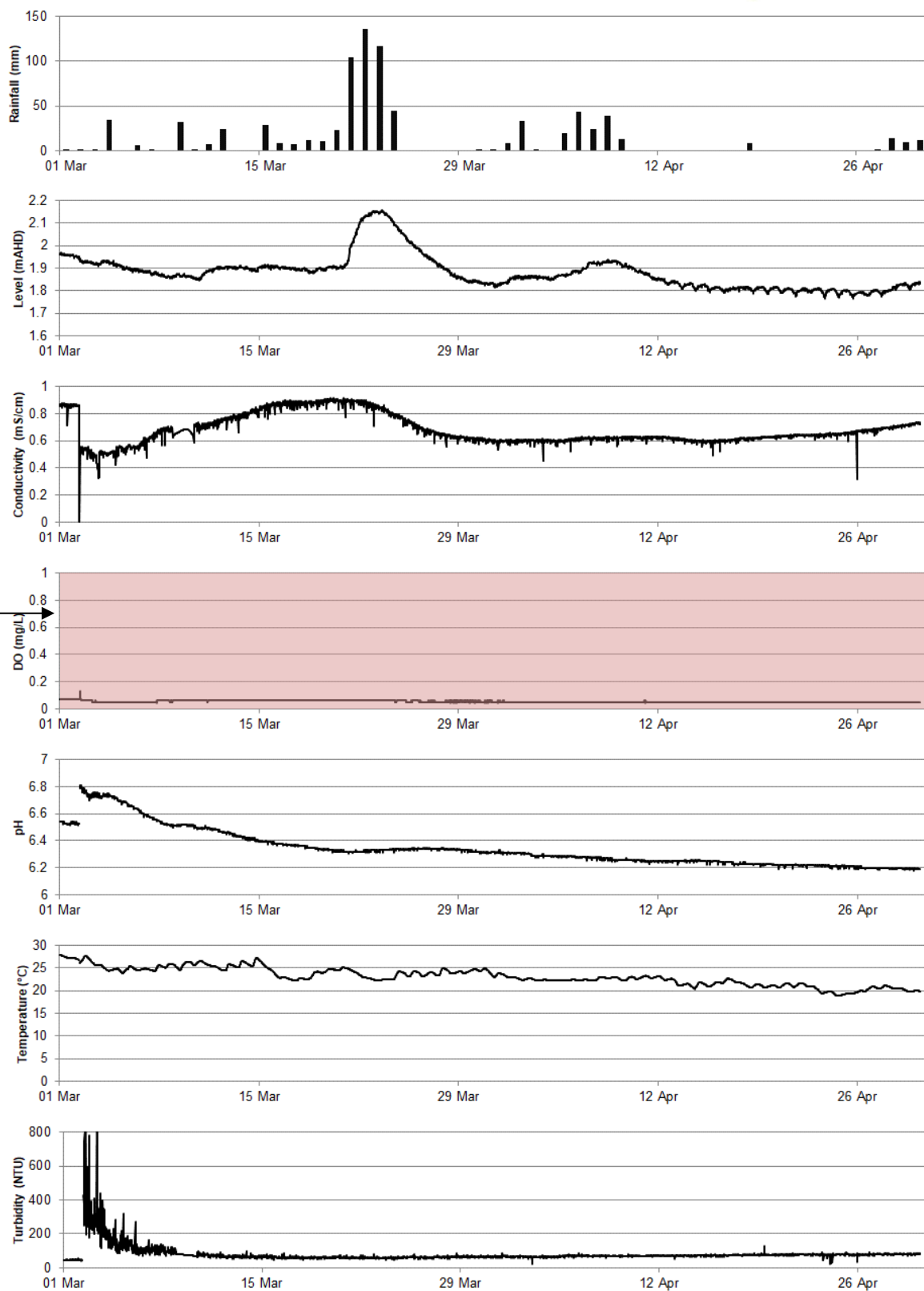
**Table 3.1 Results of Discrete Samples Collected 30 April 2021**

Parameter	Salty Lagoon								Salty Creek	
	Guiding Value	S1	S1 (1m)	S2	S2 (QA)*	S3	S3 (1m)	S4	Guiding Value	S5
Blue Green Algae ID (cells/mL)	0	nil	ns	<1000	<100	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	0.035	ns	<0.010	<0.010	0.042	ns	<0.010	0.01	<0.010
Oxidized Nitrogen (mg/L)	-	0.042	ns	<0.010	<0.010	0.049	ns	<0.010	-	<0.010
Ammonia Nitrogen (mg/L)	0.05	0.023	ns	<0.010	<0.010	0.016	ns	0.017	0.11	<0.010
Total Kjeldahl Nitrogen (mg/L)	1.6	1.44	ns	1.29	1.28	1.43	ns	1.64	1.63	1.12
Total Nitrogen (mg/L)	1.6	1.48	ns	1.29	1.28	1.48	ns	1.64	1.63	1.12
Total Phosphorus(mg/L)	0.14	0.05	ns	0.05	0.05	0.05	ns	<0.03	0.04	<0.03
Orthophosphate (mg/L)	0.11	0.049	ns	0.058	0.057	0.048	ns	<0.010	0.01	<0.010
Chlorophyll-a (µg/L)	5	<1	ns	<1	<1	5	ns	<1	3	<1
Enterococcus (CFU/100mL)	170	22	ns	49	26	38	ns	18	40	28
Faecal Coliforms (CFU/100mL)	135	58	ns	10	90	90	ns	70	150	390
Temp (°C)	25.9	18.43	18.09	16.69	ns	19.02	19.03	16.67	13.1 - 28.8	19.53
pH	6.9	6.31	6.18	5.77	ns	6.12	6.2	4.85	4.3 - 6.8	4.5
ORP (mV)	-	192	199	209	ns	214	209	243	-	283
Cond (mS/cm)	8.0	0.464	0.457	0.326	ns	0.457	0.457	1.02	0.3 - 21.5	2.03
Turbidity (NTU)	13	2.3	3.3	0.4	ns	1.5	1.5	0.6	11	0
DO (mg/L)	4.09	6.61	6.81	0.46	ns	8.1	8.07	1.84	5.52	6.54
DO (% sat)	-	72.7	74.3	4.9	ns	90	89.7	19.6	-	73.7
TDS (mg/L)	-	0.302	0.297	0.212	ns	0.297	0.297	0.653	-	1.3
Sal (ppt)	-	0.2	0.2	0.2	ns	0.2	0.2	0.5	-	1
Depth (m)	-	Surface	1	Surface	1	Surface	1	Surface	-	Surface

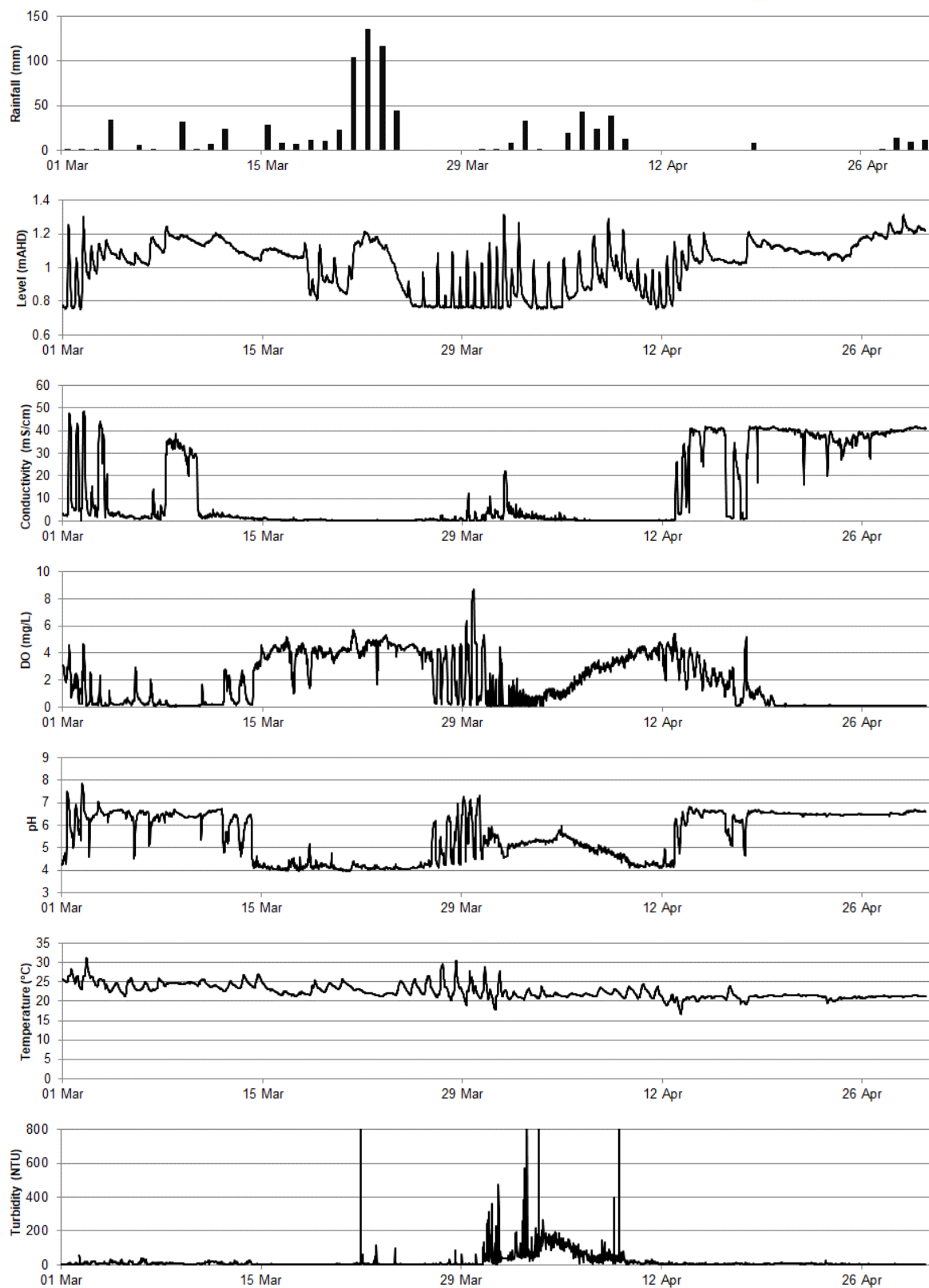
Note: \* = randomly selected quality assurance sample.

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 1**  
**March 2021 to 30 April 2021**



**Illustration 3.2 Salty Creek Rainfall and Water Quality Monitoring Station Data 1 March 2021 to 30 April 2021**

### 3.3 Aquatic Weed Monitoring

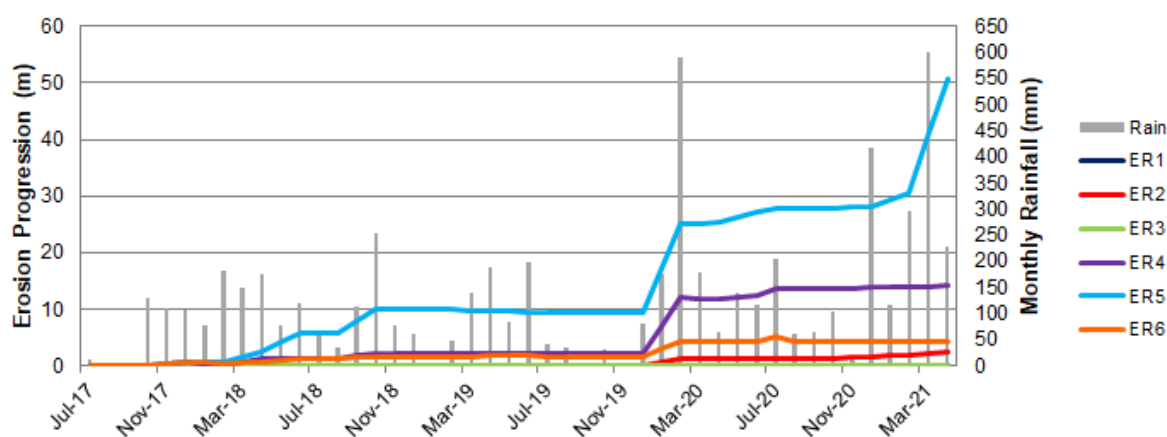
No significant aquatic weeds were identified during the aquatic weed survey on 30 April 2021. The next survey is due in October 2021.

### 3.4 Erosion Monitoring Stations

The data collected at the erosion monitoring stations is presented in **Table 3.2** and **Illustration 3.3**. There was only a very large advance of the head cut at impact station ER5 in relation to the previous measurements on 2 March 2021. The head cut has advanced at least 50 m towards Salty Lagoon since the monitoring began in July 2017.

**Table 3.2 Erosion Monitoring Results from 30 April 2021**

Station	Control/ Impact	Distance 25 July 2017 (m)	Distance 30 April 2021 (m)	Cut Movement (m)
ER1	Control	7.55	7.50	0.05
ER2	Control	10.20	7.75	2.45
ER3	Control	9.95	9.90	0.05
ER4	Impact	8.35	-5.75	14.10
ER5	Impact	12.35	-38.30	50.65
ER6	Impact	10.40	6.20	4.20



**Illustration 3.3 Erosion Progression Plotted against Monthly Rainfall since July 2017**



## 4. Discussion

### 4.1 Water Quality

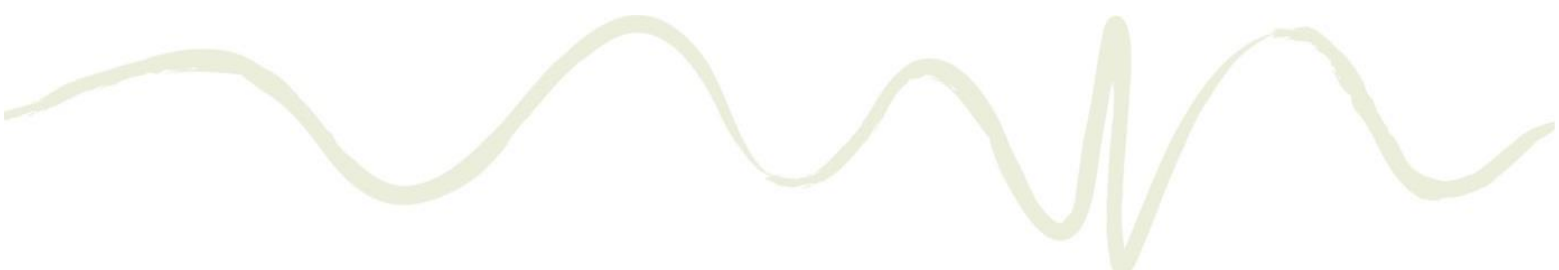
Total rainfall for this reporting period comprised of several medium to very large events interspersed with several small rainfall events. Rainfall for both months of this reporting period was much greater than average. Total rainfall for the two months was approximately 120 percent greater than the average amount. Rainfall runoff was a very significant factor in terms of water quality for this monitoring period.

The water level data from the Salty Creek PWQMS indicates that the entrance to Salty Creek was particularly dynamic during this reporting period. The entrance was tidal at the beginning of the reporting period before partially closing in early March. After ten days of rain starting on 15 March 2021 the entrance to Salty Creek opened again and remained tidal for an unusually long period of approximately 3 weeks before closing partially on 15 April 2021. At the time of the site inspection on 30 April 2021, the entrance to Salty Creek was slightly open and flowing out (**Plate 4.1**), with evidence of small tidal movements. The water level in Salty Lagoon remained high throughout this monitoring period with very high levels recorded on 23 March in response to heavy rainfall. The water levels from the Salty Lagoon PWQMS indicate that water from Salty Lagoon would have flowed into Salty Creek for the duration of the monitoring period.

The conductivity measured at the Salty Lagoon PWQMS was stable during this reporting period, remaining low in response to continued rainfall runoff. The conductivity measurements from the Salty Creek PWQMS show that the water quality in Salty Creek fluctuated dynamically in response to rainfall runoff and tidal movements and that the two partial closures of the entrance to Salty Creek were accompanied by seawater ingress. At the time of the site inspection on 30 April 2021 the water in Salty Lagoon was well mixed and fresh and the water in Salty Creek was stratified into a slightly brackish surface layer and a strongly saline, heavier bottom layer. The conductivity measurements collected on 30 April 2021 complied with guiding values at all sites.

Erosion monitoring indicated that the head cut advanced significantly during this reporting period. The level information indicates that runoff from Salty Lagoon into Salty Creek occurred for the majority of the reporting period and that flow would have been particularly strong for the week starting on 23 March 2021. At the control sites there was only a small advance of the head cut at one site. The head cut remains approximately 6 m from the current banks of Salty Lagoon. The recent works undertaken to reduce erosive pressure on the head cut slumped during this monitoring period, increasing the erosive potential of the water stored in Salty Lagoon.

The DO concentrations in discrete samples collected on 30 April 2021 were below the guiding values at the two western sites in Salty Lagoon. Low DO concentrations are naturally prevalent at the sites to the west of Salty Lagoon (sites S2 and S4). The data from the Salty Lagoon PWQMS indicates that the DO concentrations at the bottom of the water column in Salty Lagoon were at very low levels for the entire reporting period. However, the contradicting data from the discrete DO measurements collected at S1 and S3 indicate that the DO probe at the Salty Lagoon PWQMS may have been faulty. The data from the Salty Creek PWQMS indicate that DO concentrations were fluctuating in response to shifts in the salinity of the water for the entire monitoring period with high concentrations measured at times of freshwater dominance. This a common pattern in Salty Creek.



Almost all of the nutrient concentrations from samples collected on 30 April 2021 complied with guiding values. The exceptions were the TN concentration from S4 and the nitrate concentrations from S1 and S3. Dilution from continued heavy rainfall during the reporting period would have contributed to low nutrient concentrations. The chlorophyll-a concentration at S3 did not comply with guiding values and indicated an algal bloom of small proportions. Blue-green algae were recorded from S2, but in very low concentrations. The blue-green algae detected were from the genera *Planktolyngbya* and *Psuedanabaena*. Both are common in freshwater environments.

All other results complied with guiding values with the exception of the faecal coliform measurement from Salty Creek. It is likely to have been associated with waterbird use of the area or faecal material from terrestrial animals washed in with rainfall runoff.

## 4.2 Other Observations

The entrance to Salty Creek was open and tidal on 30 April 2021. A variety of birds were observed incidentally during the site inspection including Pacific Black Duck, Black Swan, Pelican, Little Pied Cormorant, Great Cormorant and Pied Cormorant.



**Plate 4.1** The open entrance to Salty Creek on 30 April 2021



**Plate 4.2** The head cut continues to move towards Salty Lagoon.

## 5. Key Points

1. Water levels remained high in Salty Lagoon throughout the current monitoring period. Water levels in and Salty Creek were highly variable in response to entrance conditions and rainfall.
2. A small number of results did not comply with the guiding values.
3. Nutrient and chlorophyll-a concentrations were improved in comparison with the previous report.
4. Blue-green algae were detected for the fourth consecutive month but at reduced concentrations and a lower number of sites.
5. The erosive headcut to the east of the old channel between Salty Lagoon and Salty Creek advanced significantly during this reporting period in response to heavy rainfall. The scour spillway installed appears to have slumped somewhat during this reporting period (**Plates 5.1** and **5.2**).
6. The risk rating for the Salty Lagoon Response Protocol is unknown due to the advance of the headcut. NPWS are currently investigating remediation options and the timing of this work will affect the risk rating.



**Plate 5.1** The scour spillway on 2 March 2021



**Plate 5.2** Evidence of a reduction in the level of the scour spillway on 30 April 2021.



## References

Bureau of Meteorology (2021). <http://www.bom.gov.au/>. Accessed 02/06/2021.

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.



# Copyright and Usage

©GeoLINK, 2021

This document, including associated illustrations and drawings, was prepared for the exclusive use of Richmond Valley Council. It is not to be used for any other purpose or by any other person, corporation or organisation without the prior consent of GeoLINK. GeoLINK accepts no responsibility for any loss or damage suffered howsoever arising to any person or corporation who may use or rely on this document for a purpose other than that described above.

This document, including associated illustrations and drawings, may not be reproduced, stored, or transmitted in any form without the prior consent of GeoLINK. This includes extracts of texts or parts of illustrations and drawings.