Australian Government
Department of Agriculture, Water and the Environment

Gulungul Creek Monitoring data: 2021-2022

Supervising Scientist

Cataloguing data

This publication (and any material sourced from it) should be attributed as: DAWE 2022, *Magela Creek monitoring Data*, Department of Agriculture, Water and the Environment, Canberra, March.

This publication is available at https://www.awe.gov.au/science-research/supervising-scientist/publications#monitoringdata

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Acknowledgements

The authors thank Jabiru Field station staff for the collection of water chemistry data that contributes to the results presented in this report.

Acknowledgement of Country

We acknowledge the Traditional Custodians of Australia and their continuing connection to land and sea, waters, environment and community. We pay our respects to the Traditional Custodians of the lands we live and work on, their culture, and their Elders past and present.

Contents

Summary ..... **iv**
Introduction **5**
1 Electrical conductivity in Gulungul Creek **7**
2 Turbidity in Gulungul Creek **8**
3 Magnesium in Gulungul Creek **9**
4 Uranium in Gulungul Creek **10**
5 Manganese in Gulungul Creek **11**
6 Total Ammonia Nitrogen in Gulungul Creek **12**
7 Radium-226 in Gulungul Creek **13**

Tables

Table 1 Monthly and median monthly rainfall at Jabiru Airport (data from BOM) 6

Figures

Figure 1 Continuous electrical conductivity and stage height (water level) in Gulungul Ck 7
Figure 2 Continuous turbidity in Gulungul Creek 8
Figure 3 Magnesium (mg/L) in Gulungul Creek 9
Figure 4 Uranium (µg/L) in Gulungul Creek 10
Figure 5 Manganese (µg/L) in Gulungul Creek 11
Figure 6 Total Ammonia Nitrogen (mg/L) in Gulungul Creek 12

Summary

The *Environmental Requirements of the Commonwealth of Australia for the Operation of the Ranger Uranium Mine* (ERs) provide objectives to protect the environmental and cultural values of Kakadu National Park. These ERs include Water Quality Objectives (WQOs) that must be met by the mine operator Energy Resources of Australia (ERA) to minimise the environmental impacts of the mine. The Supervising Scientist is required to report on performance against water quality criteria (key water quality parameters and contaminants of potential concern).

Monitoring is undertaken at off-site locations upstream and downstream of the mine in Magela Creek (to the east of the mine lease) and Gulungul Creek (to the west of the mine lease). Water quality monitoring data collected by the Supervising Scientist shows all Water Quality Objectives have been met thus far in Gulungul Creek for the 2021-2022 wet season.

Introduction

The charts below compare measurements of key chemical indicators, collected during the **2021-2022** wet season, to the Water Quality Objectives (WQOs) for Gulungul Creek. The WQOs present a hierarchical set of trigger values for each indicator, enabling a tiered approach to the oversight and management of water quality in Gulungul Creek. The Focus and Action Trigger Values are used by ERA to manage surface water quality during mine activities. The Guideline and/or Limit Values are used to monitor compliance and ensure the protection of the downstream environment.

Focus Trigger Value - Values that are higher than the Focus level but lower than the Action level will result in a watching brief. A watching brief involves precautionary ongoing data assessment to verify whether a trend away from background is occurring, possibly including further sampling if required.

Action Trigger Value - Values that are higher than the Action level but lower than the Guideline/Limit will result in a data assessment. Where assessment of the data shows the value represents a trend away from background the company must undertake:

- An investigation into the cause of the exceedance; and
- Correction of the cause if it is deemed to be mining related.

Guideline Value - The company shall treat values that exceed the Guideline the same as a Limit exceedance except:

- When there is a corresponding increase at the upstream site; and
- For the Mn limit when the flow is less than five cumecs.

When one or more of the above exceptions occurs, a Guideline exceedance will be treated the same as an Action exceedance.

Limit Trigger Value - Values that are higher than the Limit will result in a full investigation, including:

- Determining the cause(s) of the exceedance
- Collecting further samples and data
- Undertaking immediate correction of the cause if it is deemed to be mining related.

The chemical and physical indicators are:

- Electrical Conductivity in Gulungul Creek
- Magnesium in Gulungul Creek
- Uranium in Gulungul Creek

- Manganese in Gulungul Creek
- Total Ammonia Nitrogen in Gulungul Creek
- Turbidity in Gulungul Creek
- Radium-226 in Gulungul Creek

The indicators listed above are interpreted in the context of rainfall and rainfall events. Flow commenced in Gulungul Creek on 21st December 2021. Total rainfall at Jabiru Airport (BOM) over the period of October 2021 to March 2022, was 1162 mm. Measured monthly rainfall and a comparison to the median for each month (calculated based on data from 1971-current) are listed in Table 1.

Table 1 Monthly and median monthly rainfall at Jabiru Airport (data from BOM)

Month	Rainfall	Median
Oct	26.4	25.6
Nov	142.2	120.1
Dec	415.2	200.4
Jan	196.0	329.6
Feb	302.8	316.5
March	79.4	277.4
Total	**1162.0**	**1269.6**

1 Electrical conductivity in Gulungul Creek

A set of Electrical Conductivity (EC) Trigger Values has been derived to indicate when magnesium (Mg) concentrations might be approaching levels that exceed the Mg Trigger Values. The EC Trigger Values are essentially the same as the Mg Trigger Values, converted to EC using a long-term EC-Mg relationship established for Magela Creek. An additional *Investigation Trigger* was derived for EC which prompts an assessment of estimated Mg concentrations using the long-term Mg/EC relationship or an event-specific relationship. The EC *Investigation Trigger* applies if conductivity exceeds 42 µS/cm for more than 6 hours, to prevent unnecessary action for short duration (<6 hours) pulses that go above 42 µS/cm but do not approach the Mg Guideline value.

Electrical conductivity in Gulungul Creek has remained below the *Investigation Trigger*. The magnitude of difference between the upstream and downstream sites (maximum of 18 µS/cm) has sometimes been observed over previous seasons and can be a result of the many channels and sources of input contributing solutes to the creek between the downstream and upstream site. The patchy, localised rain that has occurred this season could result in inputs to the creeks from different areas. There were two spikes above the Action level in January, and one just below the Action level in March, which corresponded with such rainfall events.

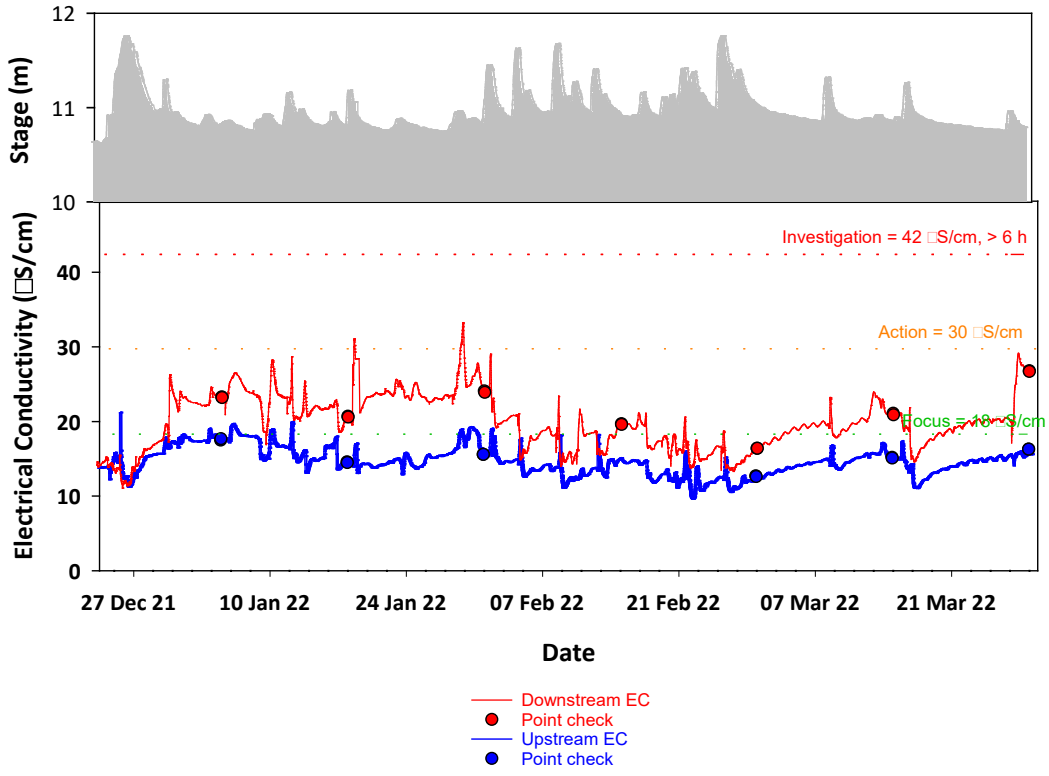

Figure 1 Continuous electrical conductivity and stage height (water level) in Gulungul Ck

2 Turbidity in Gulungul Creek

The turbidity Guideline Value of 26 NTU was determined statistically from continuous data collected from the upstream reference site between 2005-2015. This guideline may be exceeded occasionally due to natural events but should not be exceeded due to mining activities.

Turbidity at the Gulungul Creek downstream site has remained below the Guideline Value for December-March with four exceptions; 30 December 2021, 20th and 25th February and 27th March 2022. The first spike (31 NTU) was measured at the downstream monitoring site for a period of 30 minutes. Turbidity then decreased to <26 NTU over the next three hours. The three spikes over Feb-March which exceeded the Guideline Value (and were 39, 36 and 40 NTU, respectively) had a duration of less than 5 minutes. The peaks corresponded with localised rainfall which may have resulted in sediment run-off from a vehicle track that runs along the southern boundary of the mine lease. While not exceeding the Guideline Value, several short-term turbidity spikes were observed only at the downstream site. These spikes corresponded with localised rainfall and may be associated with runoff from a small erosion gully that has formed on the bank, near the downstream monitoring site. The cause of the Guideline Value exceedances and other elevated turbidity results over this period are being investigated by ERA.

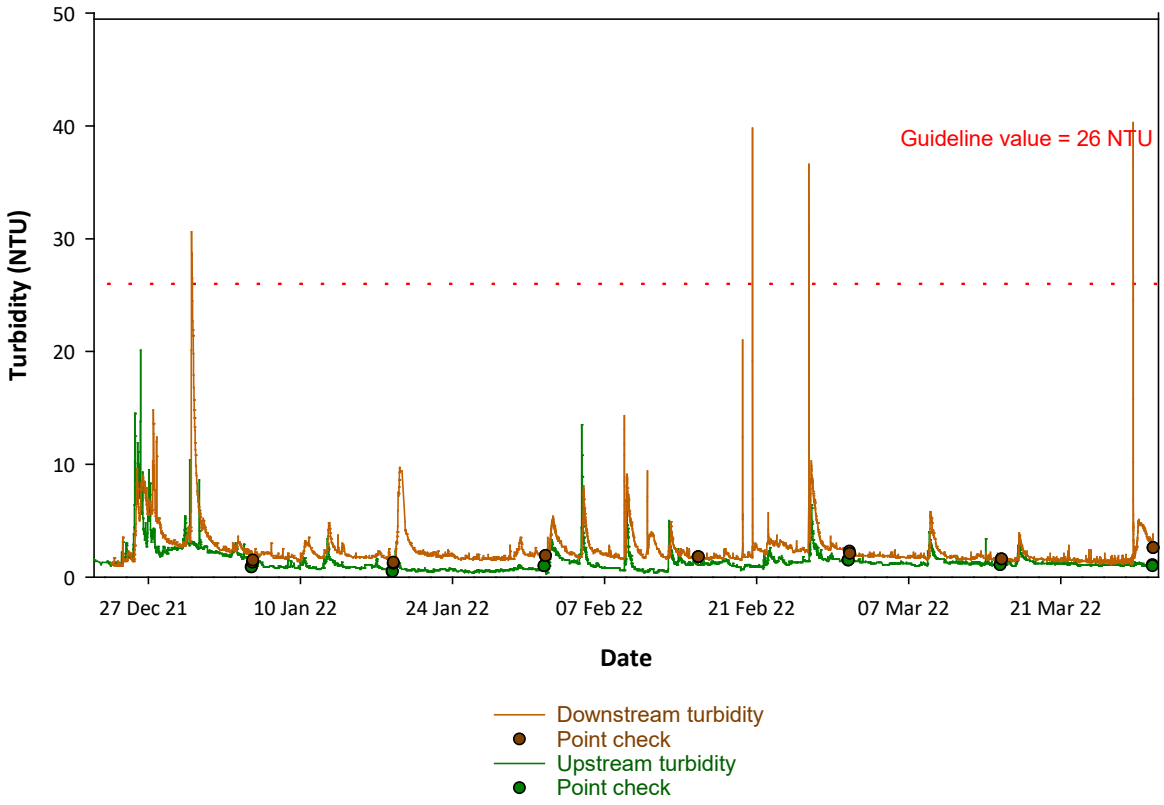

Figure 2 Continuous turbidity in Gulungul Creek

3 Magnesium in Gulungul Creek

The magnesium *Chronic Exposure Limit* of 3 mg/L has been derived using local ecotoxicological data and applies to exposures greater than 72 hours in duration. Based on the electrical conductivity (EC)-magnesium relationship developed for Magela Creek, this equates to an EC investigation trigger of 42 µS/cm for > 6 hours. The Supervising Scientist has also developed an interpretative framework for Mg exposures of less than 72 hours, which integrates the magnitude and the duration of any given pulse exposure. Details can be found in the Revised Ranger Mine Water Quality Objectives for Magela creek and Gulungul creek.

The EC trace thus far for the 2021-22 wet season (shown below) remains below the investigation trigger (42 µS/cm for > 6 h). Discrete samples collected from the downstream site in Gulungul Creek also demonstrate minimal increase in magnesium due to mining activity, with dissolved magnesium concentrations (< 0.45 µm filtered fraction) below the chronic exposure limit (green dashed line). Continuous EC data is shown for reference.

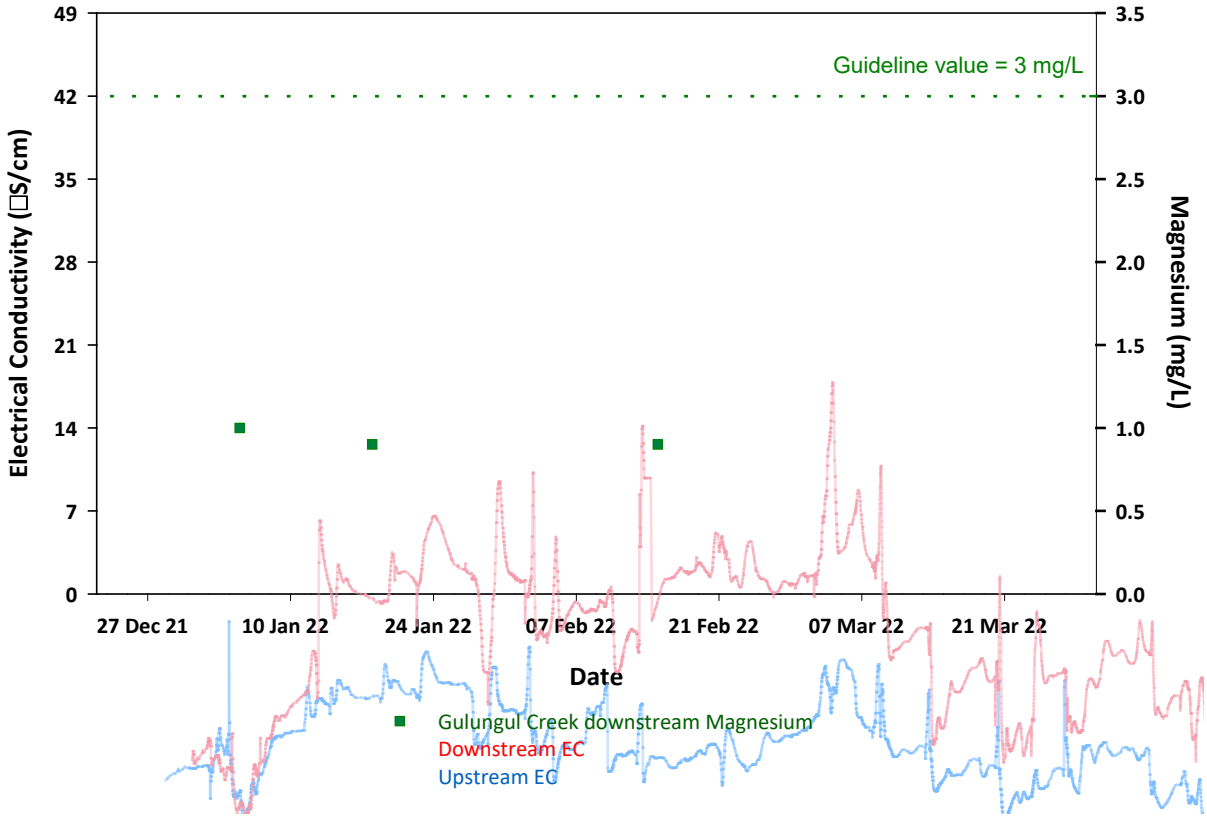

Figure 3 Magnesium (mg/L) in Gulungul Creek

4 Uranium in Gulungul Creek

The site-specific guideline value for uranium of 2.8 µg/L has been derived using local ecotoxicological data in accordance with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018)[1] to protect 99% of the species present.

Dissolved uranium concentrations (< 0.45 µm filtered fraction) in samples collected from the Gulungul Creek downstream site have remained below the guideline value. Continuous EC data is shown for reference.

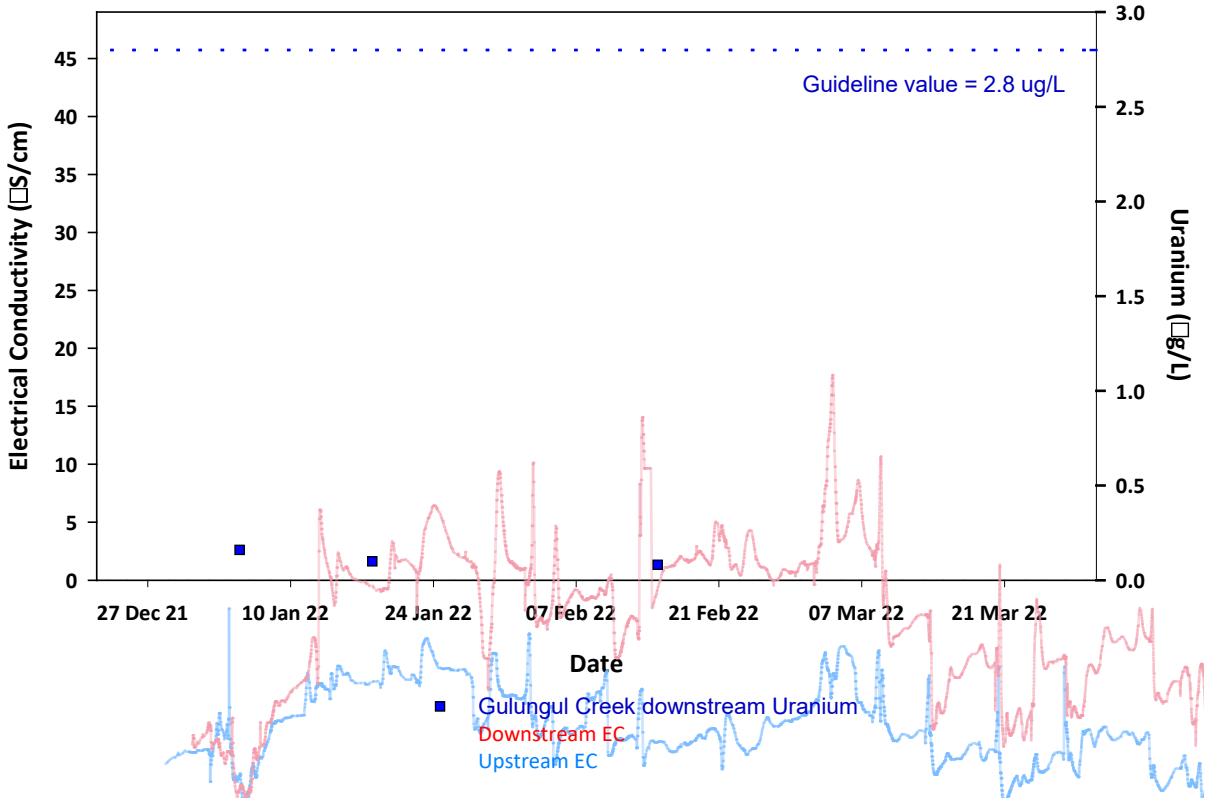

Figure 4 Uranium (µg/L) in Gulungul Creek

[1] www.waterquality.gov.au/anz-guidelines

5 Manganese in Gulungul Creek

The site-specific guideline value for manganese of 75 µg/L has been derived using local ecotoxicological data and applies to creek flows greater than 5 cumecs. Elevated manganese occurring in flows of less than 5 cumecs, is indicative of groundwater-dominated inputs, which are likely to be higher in manganese. This guideline may be exceeded occasionally due to natural events but should not be exceeded due to mining activities.

Dissolved manganese concentrations (< 0.45 µm filtered fraction) in samples collected at the Gulungul Creek downstream site have remained below the guideline value (continuous EC data shown for reference).

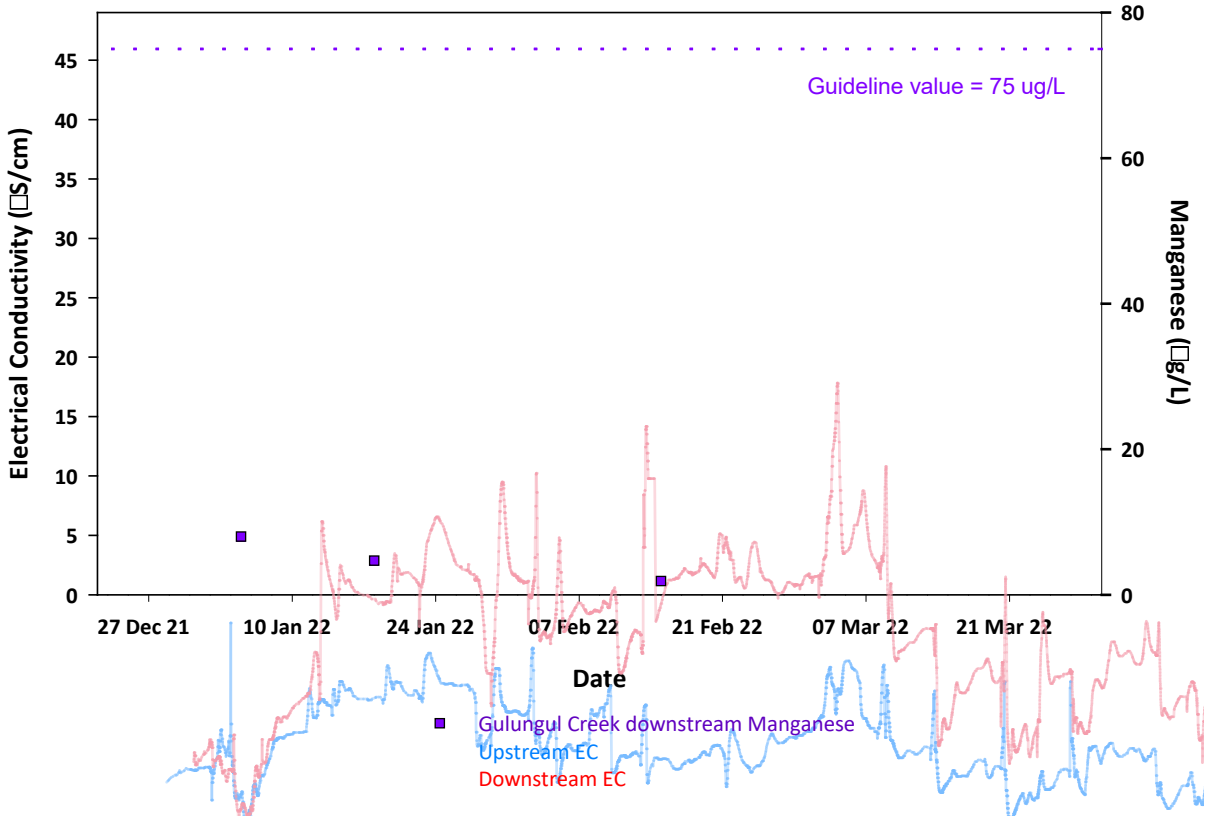

Figure 5 Manganese (µg/L) in Gulungul Creek

6 Total Ammonia Nitrogen in Gulungul Creek

The site-specific guideline value for total ammonia nitrogen of 0.4 mg/L has been derived using local ecotoxicological data in accordance with national guidance, to protect 99% of the species present.

Dissolved total ammonia nitrogen concentrations (< 0.45 µm filtered fraction) in samples collected at the Gulungul Creek downstream site have remained below the guideline value (continuous EC data shown for reference).

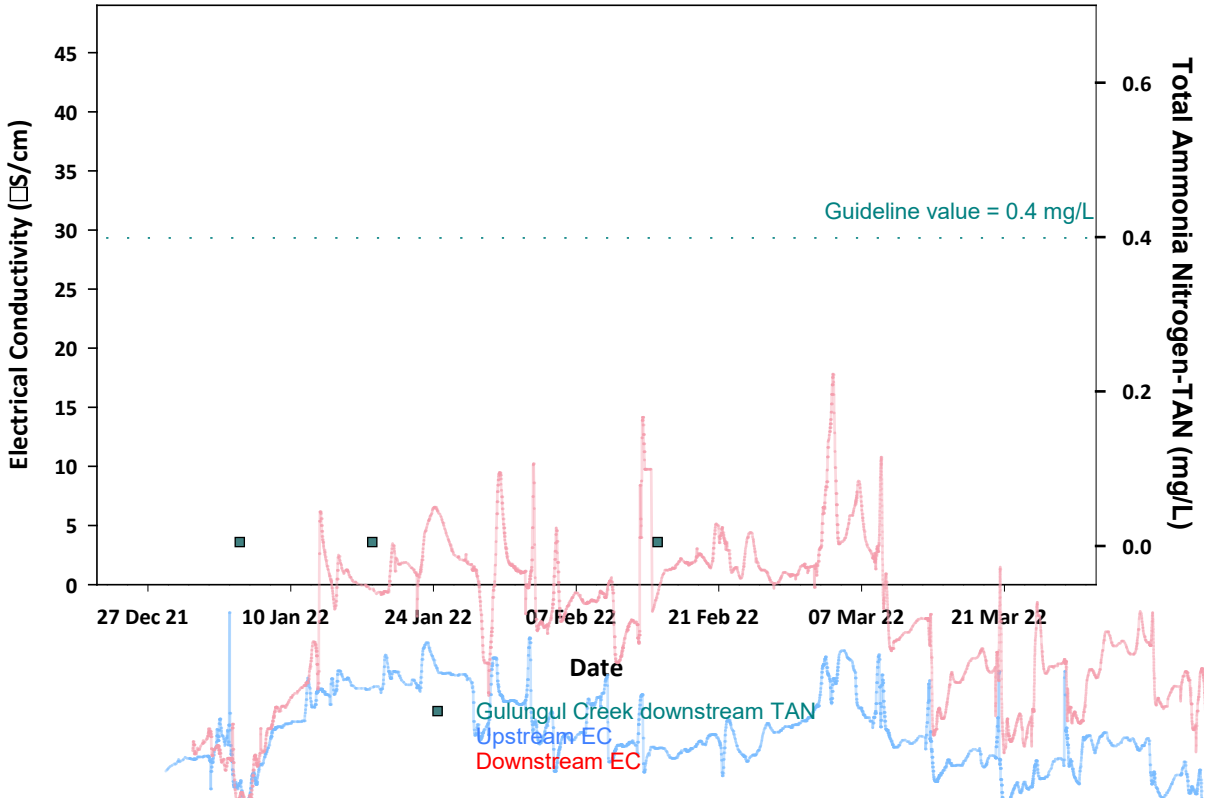

Figure 6 Total Ammonia Nitrogen (mg/L) in Gulungul Creek

7 Radium-226 in Gulungul Creek

The activity concentration limit for radium-226 was developed to ensure the radiation dose received by people who consume mussels from downstream waterways remains safe. The radium-226 *Limit Trigger Value* of less than 3 mBq/L is calculated as the geometric mean difference between the upstream and downstream values for the entire wet season.

For the three radium-226 samples collected this season, the activity of the upstream site was higher than the downstream site by 4.0, 5.9 and 3.5 mBq/L, respectively. The total activity of the samples has been within the historical range for both the upstream and downstream sites; 4-23 mBq/L and 3-12 mBq/L, respectively. A complete evaluation, including a graphical representation of the whole-of-season mean difference between the upstream and downstream site, will be provided at the end of the season.