



Gulungul Creek monitoring data 2018-2019

The Supervising Scientist's water chemistry monitoring program has been developed using continuous monitoring of physico-chemical parameters coupled with automatic event-based collection of water samples. Chemistry samples are collected when an electrical conductivity (EC) trigger is reached, indicating the potential for high concentrations of contaminants to be present in the creek, and also during routine monthly quality assurance sampling. No event-based samples were collected during this reporting period due to the low electrical conductivity.

Details regarding the development and operation of the monitoring program can be found in the [Surface water chemistry monitoring protocol to assess impacts from Ranger Mine](#).

The charts below compare measurements of key chemical indicators, collected up to the end of May for the **2018-2019** 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.

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 or not 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.

The Focus and Action Trigger Values are used by the company to manage surface water quality during mine activities. These are not displayed on the charts below.

Guideline Trigger Value - The company shall treat values in excess of the Guideline the same as a Limit exceedance except:

- When there is a corresponding increase at the upstream (background) site; and
- For the Mn limit when the flow is less than one cumec.

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; and
- Undertaking immediate correction of the cause, if it is deemed to be mining-related.

The Guideline and/or Limit Values are used to monitor compliance and ensure the protection of the downstream environment.

Flow was recorded in Gulungul Creek for 139 days over the 2018-2019 wet season. Flow commenced on 12 January 2019 and ceased on 31 May 2019. Rainfall for the 2018-2019 wet season, as recorded at Jabiru Airport, was below average totaling 1237mm. The last rainfall recorded at Jabiru Airport was on 20 May 2019, and was 1.2mm.

Water quality monitoring data collected by the SSB showed that all Water Quality Objectives were met in Gulungul Creek for the 2018-2019 wet season, indicating that operations at Ranger mine have not resulted in harm to downstream environments.

Chemical Indicators

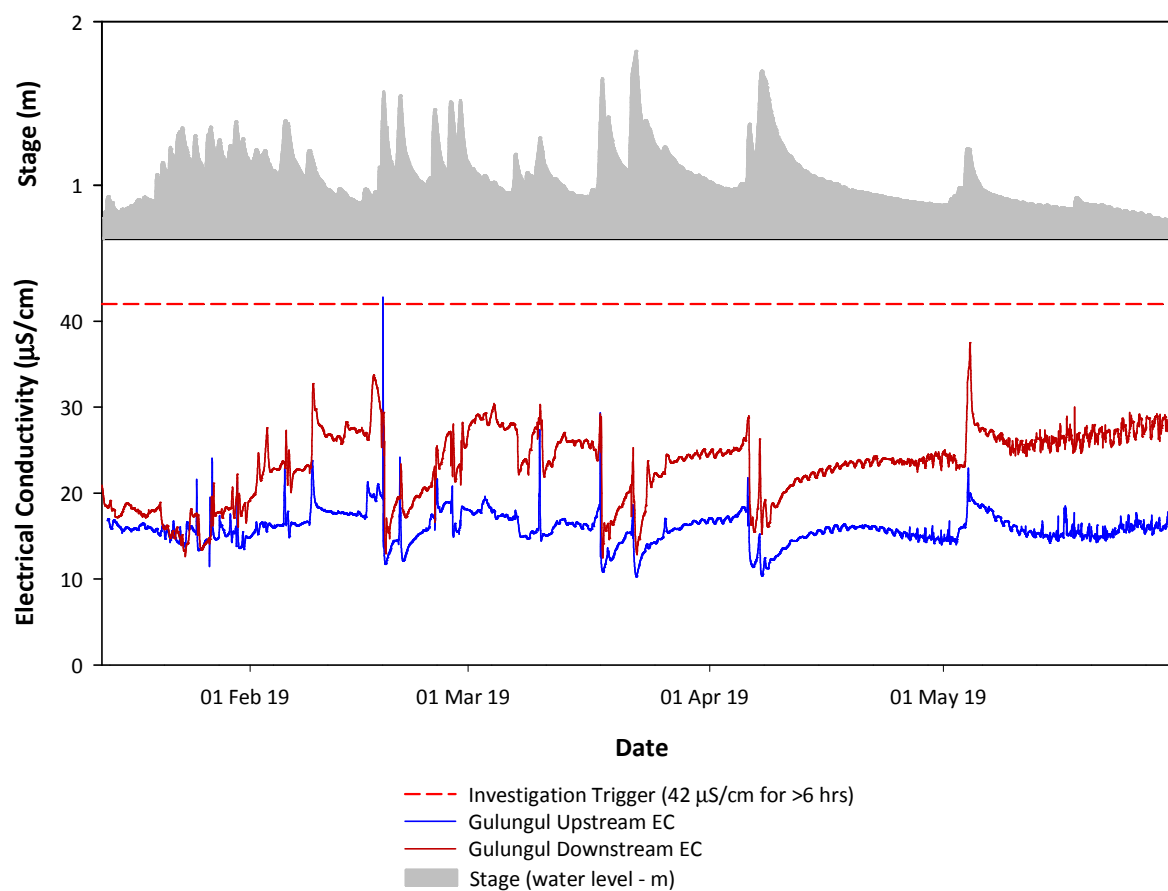
- Conductivity in Gulungul Creek
- Magnesium in Gulungul Creek
- Uranium in Gulungul Creek
- Manganese in Gulungul Creek
- Total Ammonia Nitrogen (TAN) in Gulungul Creek
- Turbidity in Gulungul Creek
- Radium-226 in Gulungul Creek



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 have been derived using the long-term EC-Mg relationship 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 $\mu\text{S}/\text{cm}$ for more than 6 hours to prevent unnecessary action for short duration (< 6 hours) pulses that go above 42 $\mu\text{S}/\text{cm}$ but do not approach the Mg Guideline value.

Throughout the 2018-2019 wet season, the conductivity in Gulungul Creek remained below the Investigation trigger value with the exception of an event on 18 February where the EC reached 42.8 $\mu\text{S}/\text{cm}$ at the Gulungul upstream monitoring site. The EC spike was brief and was attributed to a heavy rainfall event which occurred in the upper catchment, mobilising higher EC water and sediments (see also turbidity plot below) into the Gulungul stream. The pulse of high EC water was diluted by the time it reached the downstream monitoring site with maximum EC of 29.4 $\mu\text{S}/\text{cm}$ recorded.



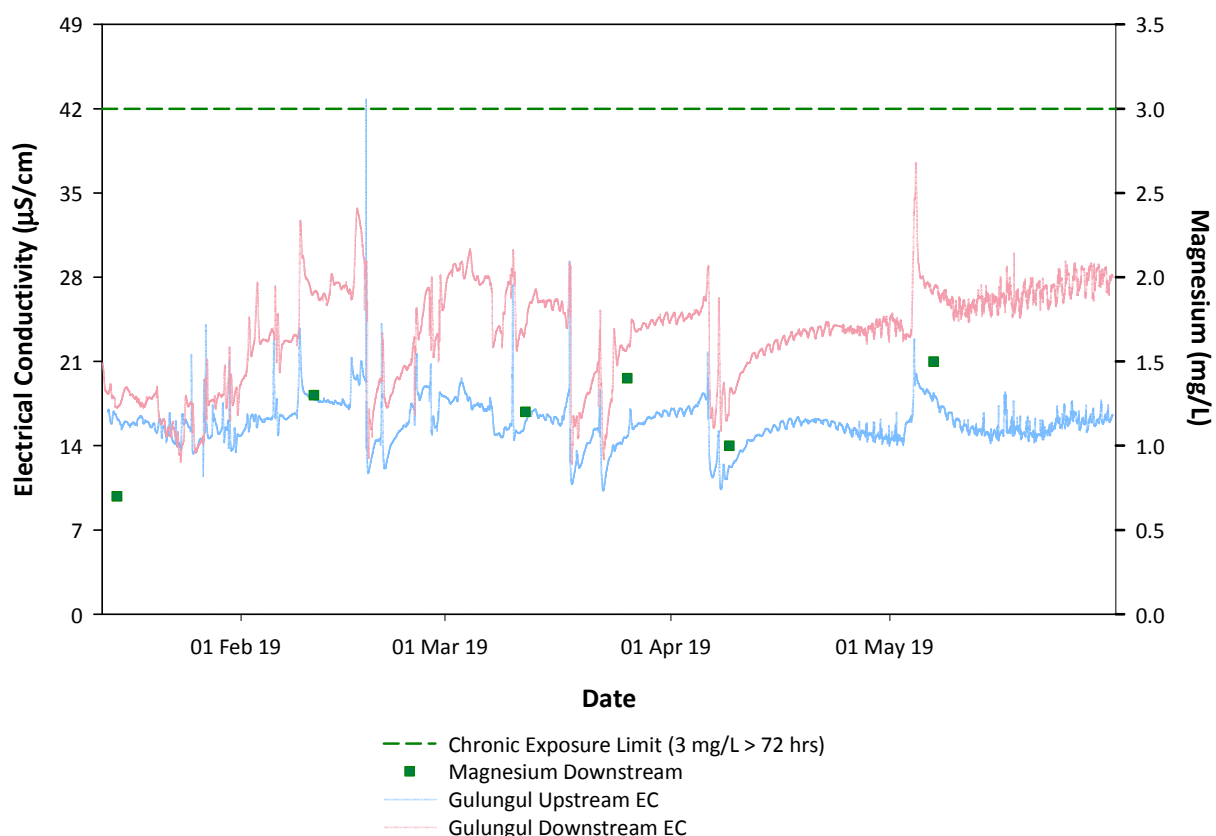
Gulungul Creek continuous conductivity monitoring data for the 2018-2019 season



Magnesium in Gulungul Creek

The magnesium (Mg) *Chronic Exposure Limit* of 3 mg/L has been derived using local ecotoxicological data and applies to exposures greater than 72 hours in duration. The Supervising Scientist has also developed an interpretative framework for Mg pulse exposures of less than 72 hours, which integrates the magnitude and the duration of any given pulse exposure. Details can be found on the [Ecotoxicology Electrical Conductivity-Magnesium Pulse Framework](#) page.

The EC trace indicates that magnesium was below the Chronic Exposure Limit throughout the season. Discrete samples collected from downstream Gulungul confirmed this interpretation with a magnesium concentration well below the limit during the 2018-2019 season.



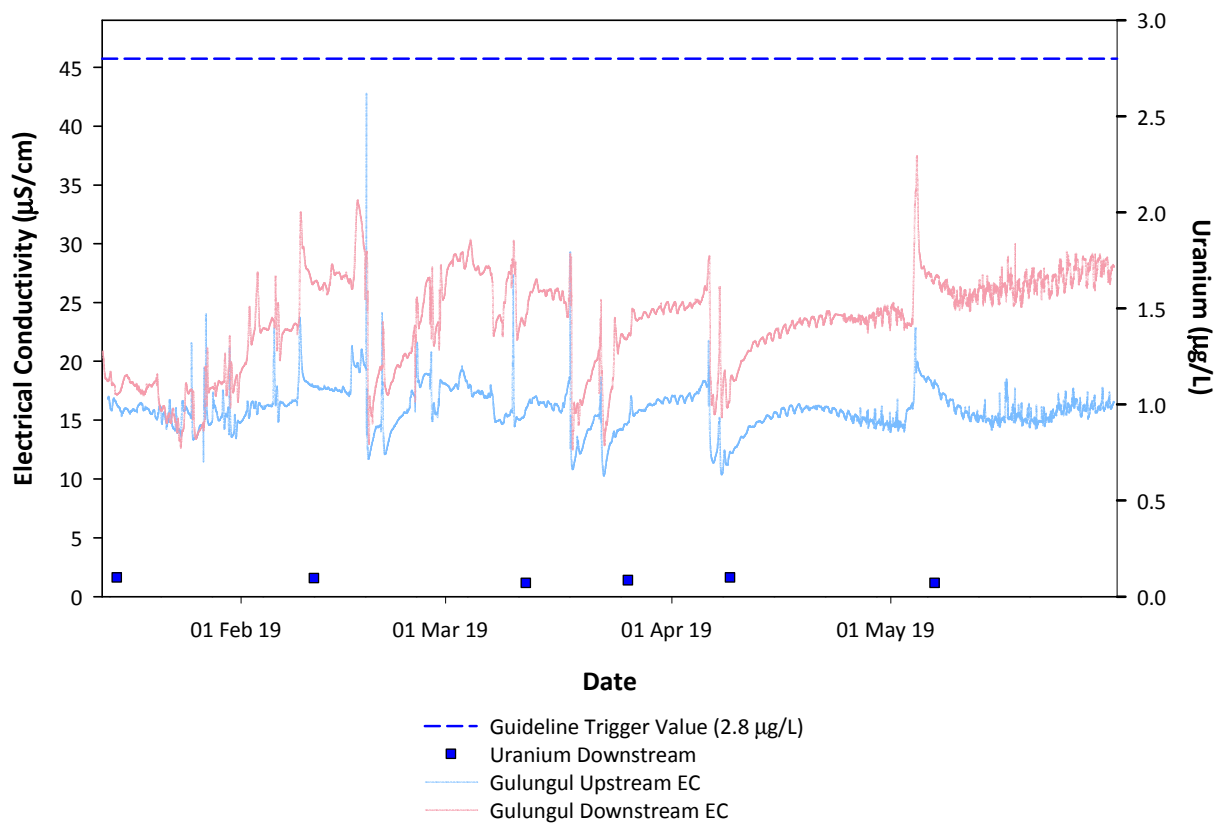
Gulungul Creek magnesium data for the 2018-2019 season



Uranium in Gulungul Creek

The uranium *Limit Trigger Value* of 2.8 µg/L has been derived using local ecotoxicological data in accordance with the Australian Water Quality Guidelines to protect 99% of the species present.

The uranium concentrations in samples during the 2018-2019 wet season were low and well below the trigger value at the Gulungul Creek downstream site.



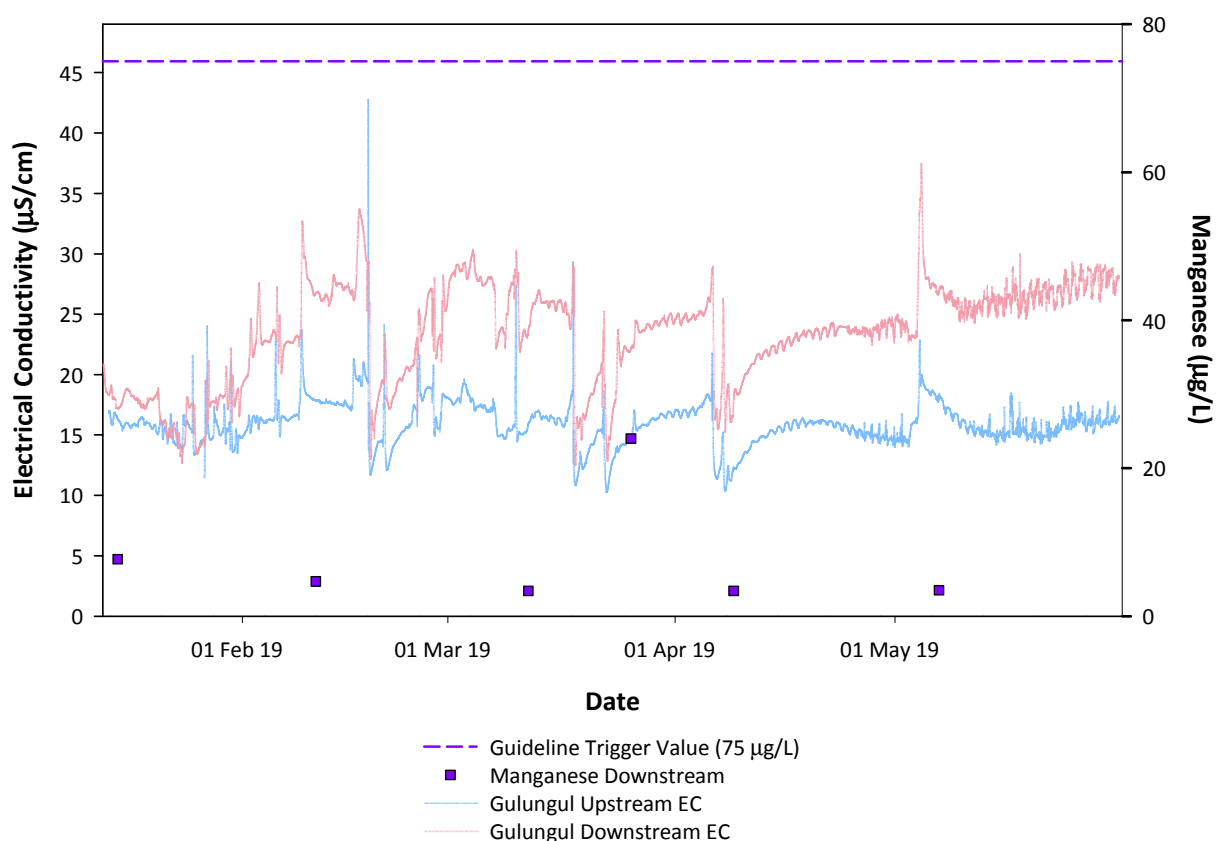
Gulungul Creek uranium data for the 2018-2019 season



Manganese in Gulungul Creek

The manganese *Limit Trigger Value* of 75 µg/L has been derived using local ecotoxicological data and applies only when creek flows are greater than 1 cumec. Flows less than 1 cumec are 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.

The manganese concentrations in samples collected during the 2018-2019 wet season were low and were below the trigger value at the Gulungul Creek downstream site.



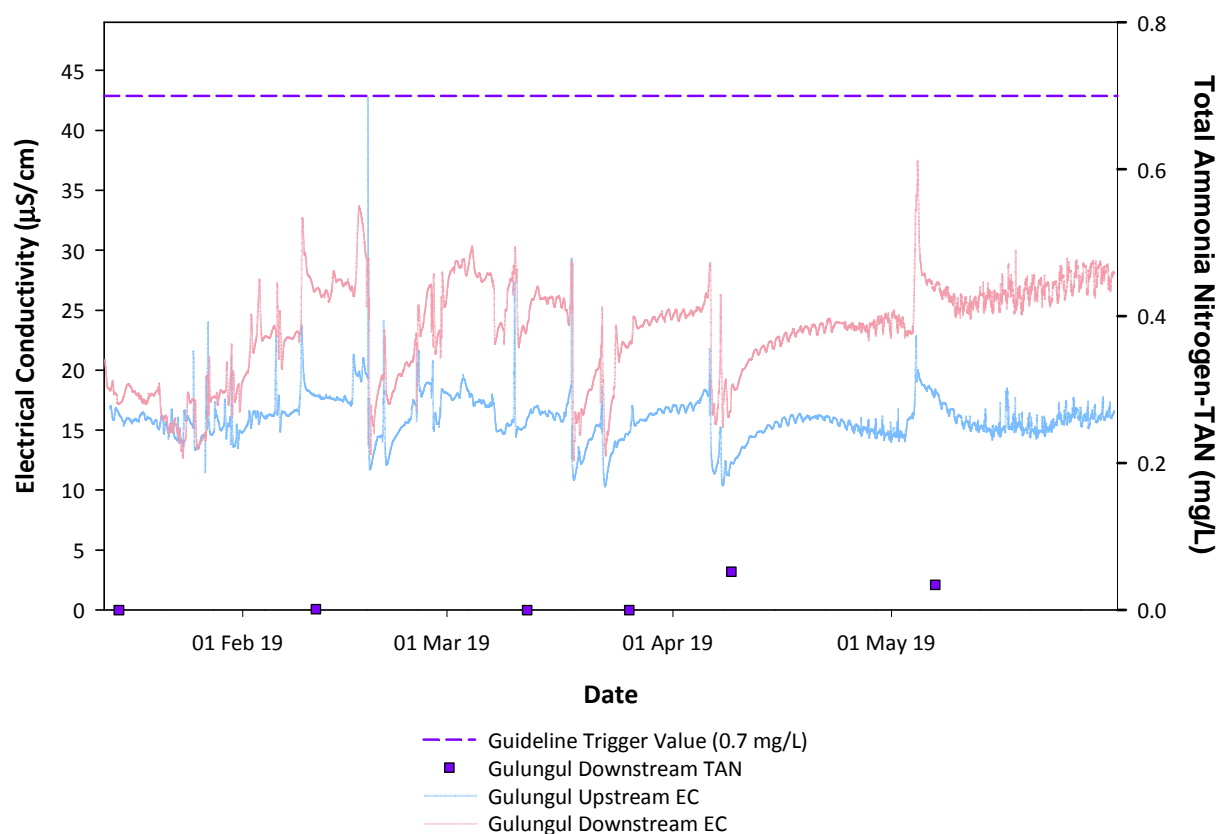
Gulungul Creek manganese data for the 2018-2019 wet season



Total Ammonia Nitrogen (TAN) in Gulungul Creek

The interim total ammonia nitrogen (TAN) *Guideline Trigger Value* of 0.7 mg/L was derived using international ecotoxicity data. In accordance with the Australian Water Quality Guidelines, the Supervising Scientist is currently developing site-specific trigger values, based on ecotoxicity data using local aquatic species.

The TAN concentrations in discrete samples collected during the 2018-2019 wet season were below detection limits or well below the trigger value at the Gulungul Creek downstream site.



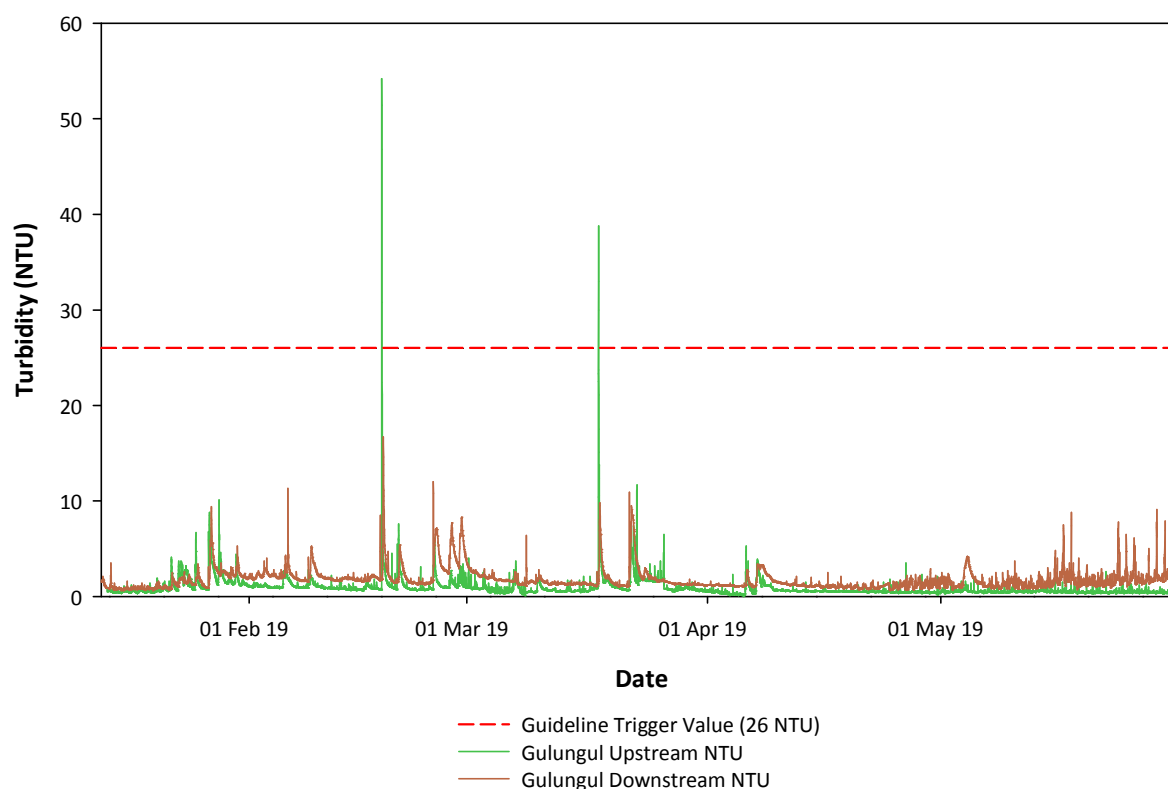
Gulungul Creek total ammonia nitrogen (TAN) data to the end of May 2019



Turbidity in Gulungul Creek

The turbidity *Guideline Trigger Value* of 26 NTU has been derived statistically from historical weekly grab sampling data at reference sites. This guideline may be exceeded occasionally due to natural events but should not be exceeded due to mining activities.

The turbidity values recorded in Gulungul Creek were below the guideline value for the 2018-2019 wet season except for two occasions. These were due in part to localised storms in Gulungul catchment on 18 February, and 18 March. Turbidity reached 54 NTU and 35 NTU respectively, with both events occurring at the upstream monitoring site. Peaks in turbidity are associated with sediments mobilised by rainfall events and do not reflect a trend of increased turbidity at the downstream site, or mining-related effects.



Gulungul Creek continuous turbidity monitoring data for the 2018-2019 wet season



Radium-226 in Gulungul Creek

The activity concentration limit for ^{226}Ra was developed to ensure the radiation dose received by people who consume mussels from downstream waterways remains below safe levels. The radium-226 *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.

Radium samples collected and reported during the wet season to date are similar to previous seasons at both the upstream and downstream sites. The final samples for the 2017-18 wet season are still undergoing analysis and the geometric mean will be reported as soon as these data are available.

