Australian Government
Department of Agriculture, Water and the Environment
Supervising Scientist

Turbidity in Surface Water — Rehabilitation Standard for the Ranger uranium mine

Water and sediment theme

Preface

The Supervising Scientist developed this Rehabilitation Standard to describe the requirements to protect aquatic ecosystems outside of the Ranger Project Area in the Alligator Rivers Region of the Northern Territory from the effects of suspended sediments in surface water.

This document is part of a series of Rehabilitation Standards for the Ranger uranium mine. It may be updated as additional relevant knowledge becomes available.

This Standard should be cited as follows:

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1. General elements

Scope

1.1 The Rehabilitation Standards for the Ranger uranium mine have been developed in accordance with section 5c of the *Environment Protection (Alligator Rivers Region) Act 1978* and are advisory only.

1.2 The *Environmental requirements of the Commonwealth of Australia for the operation of the Ranger uranium mine* (Environmental Requirements) (Australian Government 1999) specify the environmental objectives for the rehabilitation of the Ranger uranium mine.

1.3 The Supervising Scientist's Rehabilitation Standards quantify the rehabilitation objectives and recommend specific values based on the best available science that will ensure a high level of environmental protection. These values can be used to assess the achievement of, or progress towards, the rehabilitation objectives, some of which may not be reached for a significant period of time.

1.4 Until it can be determined that the rehabilitation objectives have or will be reached, there will be an ongoing need to ensure environmental protection during and after rehabilitation, through continued water quality monitoring, including the comparison of water quality data with relevant water quality limits.

Objective

1.5 There is currently no agreed acceptable level of effect to the environment surrounding the Ranger Project Area. In the absence of agreement, the Rehabilitation Standard for turbidity in surface water aims to protect the biodiversity and health of aquatic ecosystems outside of the Ranger Project Area. This includes ecosystems upstream of the mine given that poor water quality within the Ranger Project Area could form a barrier to the movement of aquatic organisms. If an acceptable level of effect is agreed, this standard will be updated accordingly.

Application

1.6 This Rehabilitation Standard should be applied in Magela and Gulungul creeks at the boundary of the Ranger Project Area, downstream from the Ranger uranium mine.

1.7 This Standard should be applied after the decommissioning phase (which includes landform construction and stabilisation of the final landform) i.e. once all active erosion and sediment control measures have ceased and associated structures removed.

1.8 Turbidity recorded continuously in receiving waters is used as an indicator for any fine suspended sediment reaching the offsite environment. Wherever turbidity exceeds natural background (defined in Section 4.4), this increase is attributed to erosion from the rehabilitated minesite.

1.9 Any net turbidity increase downstream of the Ranger minesite, over historical values unaffected by mining, is measured and assessed using the methodology described in the ‘scientific basis’ below.

2. Relevant requirements

Environmental Requirements

2.1 The primary environmental objectives in the Environmental Requirements require that surface waters or groundwater arising from the Ranger uranium mine do not result in any detrimental change to biodiversity or impairment of ecosystem health outside of the Ranger Project Area, including during or following rehabilitation. This Rehabilitation Standard is relevant to the Environmental Requirements listed in Box 1.

Aspirations of Traditional Owners

2.2 The Mirarr Traditional Owners desire that operations at the Ranger uranium mine should not result in any change to the natural water quality of surface waters outside of the Ranger Project Area (Iles 2004). Specifically, as stated in Garde (2013):

> …the waters contained within all riparian corridors, (i.e. rivers and billabongs), must be of a quality that is commensurate with non-affected riverine systems

and health standards. The principle of 'as low as reasonably achievable' should not apply to these areas. Instead, the standard of rehabilitation must be as high as is technically possible and level of contamination must be as low as technically possible.

Box 1: Ranger Environmental Requirements relevant to the Turbidity and Sedimentation Rehabilitation Standard

1 Environmental protection

1.1 The company must ensure that operations at Ranger are undertaken in such a way as to be consistent with the following primary environmental objectives:

(a) maintain the attributes for which Kakadu National Park was inscribed on the World Heritage list

(b) maintain the ecosystem health of the wetlands listed under the Ramsar Convention on Wetlands (i.e. the wetlands within Stages I and II of Kakadu National Park)

(d) maintain the natural biological diversity of aquatic and terrestrial ecosystems of the Alligator Rivers Region, including ecological processes.

1.2 In particular, the company must ensure that operations at Ranger do not result in:

(a) damage to the attributes for which Kakadu National Park was inscribed on the World Heritage list

(b) damage to the ecosystem health of the wetlands listed under the Ramsar Convention on Wetlands (i.e. the wetlands within Stages I and II of Kakadu National Park)

(d) change to biodiversity, or impairment of ecosystem health, outside of the Ranger Project Area. Such change is to be different and detrimental from that expected from natural biophysical or biological processes operating in the Alligator Rivers Region.

3 Water quality

3.1 The company must not allow either surface or ground waters arising or discharged from the Ranger Project Area during its operation, or during or following rehabilitation, to compromise the achievement of the primary environmental objectives.

3. Recommended values for turbidity

3.1 To protect aquatic ecosystems outside the Ranger Project Area in accordance with the rehabilitation objectives, turbidity in receiving waters at the boundary of the Ranger Project Area, should not deviate from natural background turbidity values, as defined in Table 1.

Table 1 Rehabilitation Standard for turbidity in surface water

Parameter	Location	Rehabilitation Standard
Turbidity (NTU)	In Magela and Gulungul creeks at the boundary of the Ranger Project Area, downstream of the Ranger uranium mine	For each of Magela and Gulungul Creeks, the difference in net annual turbidity between sites located upstream of the mine-site and downstream at the boundary of the Ranger Project Area, is similar to background values.

4. Scientific basis

Guidelines and standards used to develop the recommended values

4.1 The key national guidance authority for water quality (ANZG 2018) states that the most stringent guideline applicable to a given water body should be applied to ensure all indicators of water quality and community values are protected.

4.2 The most conservative guideline was selected after considering the following candidate guideline values:

4.2.1. Protection of aquatic ecosystems typically defers to turbidity guideline values that protect aquatic organisms, and site-specific, biological-effects-based guidelines are preferred. For waterbodies in the Alligator Rivers Region, aquatic organisms can tolerate sustained (i.e. 96-h) exposures of between 30 to 70 NTU (see Sections 4.7 and 4.8).

4.2.2. The National Health and Medical Research Council's (NHMRC) guidelines for risks in recreational water (NHMRC 2008) state that:

> "Recreational water bodies should be aesthetically acceptable to recreational users. The water should be free from visible materials that may settle to form objectionable deposits; floating debris, oil, scum and other matter; substances producing objectionable colour, odour, taste or turbidity; and substances and conditions that produce undesirable aquatic life" (NHMRC 2008).

These guidelines are interpreted to mean no change to natural background turbidity values.

4.2.3. The National Health and Medical Research Council's national drinking water standards (NHMRC, NRMMC 2011) for turbidity, based on aesthetics, is 5 NTU.

4.2.4. Whilst not part of the suite of community values considered by ANZG (2018), the intent of relevant Environmental Requirements stipulated for Ranger is that following decommissioning, erosion and sediment transport to receiving waters from the rehabilitated site should not be measurably different from that of comparable landforms in surrounding undisturbed areas.

4.3 The drinking water guideline for turbidity (from Section 4.2.3 above) is not implementable for Magela and Gulungul creeks because turbidity commonly and naturally exceeds 5 NTU. Conversely, a site-specific guideline value for turbidity derived for protection of aquatic organisms (from Section 4.2.1 above) is much less conservative than recreation and landform stability-based guidelines (Sections 4.2.2 and 4.2.4 respectively). The objectives of guidelines for recreational waters and landform stability are equivalent, i.e. following decommissioning there should be no changes to turbidity above natural background; the rehabilitation standard for turbidity will be assessed on this basis.

4.4 'Natural background' in turbidity refers to turbidity measures derived for those years to date where no significant mine-related movement of suspended sediment to receiving waters has been detected (– as described in the separate Landform stability

Rehabilitation Standard (Supervising Scientist 2021)). It is calculated as the difference in net annual turbidity between sites located upstream of the mine-site and downstream at the boundary of the Ranger Project Area, for each of Magela and Gulungul creeks. Any changes and trends (including return to natural background) will be assessed on the basis of the comparison of net annual turbidity (measured in the same manner) to natural background values for each of Magela and Gulungul creeks – as described in Supervising Scientist (2021).

4.5 The Supervising Scientist Branch has derived a site-specific operational guideline value for turbidity in Magela and Gulungul creeks of 26 NTU. This value is derived from the 99.7th percentile for turbidity at the upstream Magela Creek site using continuous turbidity data collected since 2005 (Turner et al. 2016). Continuously monitored measurements of turbidity are assessed against the guideline value and are used to invoke management actions unless accompanying levels at the relevant upstream control site are similar. The operational turbidity guideline value will continue to apply during the decommissioning phase of the mine. The operational guideline value, invoked on the basis of instantaneous turbidity values, is much more conservative than biological-effects-based guidelines for protecting aquatic ecosystems (from Section 4.2.1).

4.6 Following from Section 4.5, the Supervising Scientist will develop guidelines and measurement methods to assess whether mine-derived erosion products cause sedimentation above natural deposition rates in receiving-water billabongs. Sedimentation risks are greatest during the decommissioning phase of the mine for onsite billabongs. Providing the turbidity standard is met, the risks of sedimentation in offsite billabongs following decommissioning are assumed to be negligible.

Scientific evidence summary for biological effects of turbidity

4.7 Data are available on the thresholds for biological effects of high and sustained turbidity in the Alligator Rivers Region. Surface chlorophyll-*a* and turbidity data were collected from Georgetown Billabong during the dry season and were used to determine that turbidity values between 50-70 NTU inhibited phytoplankton biomass (Buckle et al. 2010, George and Humphrey 2013).

4.8 The effects of elevated turbidity on the macroinvertebrate assemblage in upland flowing portions of Jim Jim Creek were examined over the 1996 dry season. Adverse effects were evident after turbidity had reached sustained values of 30 NTU (Stowar 1997, George and Humphrey 2013).

Recommendations for the turbidity rehabilitation standard

4.10 No mine-related change to turbidity in Magela and Gulungul creeks over natural background values based on net annual turbidity measures following decommissioning, as described in the Landform stability Rehabilitation Standard (Supervising Scientist 2021).

5. Future knowledge needs

5.1 Rehabilitation planning can only be based on the best available information at a given time, but this should not preclude the continual improvement of the knowledge base and its subsequent application where possible.

5.2 The Supervising Scientist, through its Key Knowledge Needs, has identified the knowledge required to ensure appropriate management of the key risks to the environment from the rehabilitation of the Ranger uranium mine. For suspended sediment, these knowledge needs are shown in Table 3.

Table 3 Key Knowledge Needs for turbidity and sedimentation in surface water

ER Link	Key Knowledge Need	Questions
Biodiversity and human health	WS3. Predicting transport of contaminants in surface water	WS3F. What are the predicted concentrations of suspended sediment and contaminants (including nutrients) bound to suspended sediments in surface waters over time? WS3H. Where and when will suspended sediments and associated contaminants accumulate downstream?
Erosion	LAN1. Determining baseline erosion and sediment transport characteristics in areas surrounding the RPA LAN3. Predicting erosion of the rehabilitated landform	LAN1B. What is the baseline rate of bedload movement and deposition in creeks and billabongs? LAN3E. How much suspended sediment will be transported from the rehabilitated site (including land application areas) by surface water?

6. References

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Turner K, Tayler K & Tyrrell JWR 2016. Revised Ranger mine water quality objectives for Magela Creek and Gulungul Creek. Internal Report 659, April, Supervising Scientist, Darwin.