

Evaluation program report

Evaluating the environmental condition of Weeli Wolli Creek

Summary

This evaluation project focused on the theme of 'the on-ground environmental outcomes that are achieved after implementation of proposals'.

The question that the Environmental Protection Authority (EPA) wanted this project to answer is:

'Is Weeli Wolli Creek responding as was predicted through the EPA's Environmental Impact Assessment (EIA), from mining that has occurred in the catchment?'

From this evaluation, the EPA has concluded that the EIA process has been effective in predicting impacts to this stage of mining development and management measures appear to have been effective. Overall, the Weeli Wolli Creek system has largely responded as predicted.

The EPA has undertaken an evaluation of Weeli Wolli Creek to confirm that environmental outcomes have been achieved since mining began.

Why did the EPA choose Weeli Wolli Creek to evaluate?

Environmental value

The Weeli Wolli Creek system in the central Hamersley Range area of the East Pilbara (Figure 1) has high environmental value.

A key feature is Weeli Wolli Spring (Figure 2), created by a geological barrier where high permeability rock units meet low permeability rock units, forcing groundwater to rise to the ground surface.

Under natural conditions, Weeli Wolli Spring supported permanent pools and perennial (permanent) flow downstream of the spring.

Due to the permanent flow and pools and the diverse topography of the area, a unique vegetation community of high biodiversity value has established over time. The wetland community of the spring and creek is listed as a Priority 1 Ecological Community by the Department of Biodiversity, Conservation and Attractions. The creek and spring also have cultural and heritage significance and the area's permanent pools and large trees are valued by its Traditional Owners, the Banyjima people and Nyiyaparli people.

Weeli Wolli Creek drains into Fortescue Marsh, a nationally important wetland.

These environmental values were identified in the EPA's reports on its assessments of the proposals for the operating mines in the Weeli Wolli Creek catchment (Figure 2).

Increasing pressures on the creek system

The Weeli Wolli Creek catchment contains extensive iron ore deposits and increasing numbers of mining proposals in various stages of development (Figure 1). Activities from operating mines place pressure on the creek and have the potential to cause cumulative impacts.

Availability of information

The first mine in the catchment that the EPA assessed began operating in 1991 and most of the other mines were operating by the mid-2000s. The proponents (mining companies) and government agencies have accumulated a substantial amount of scientific information about the area.

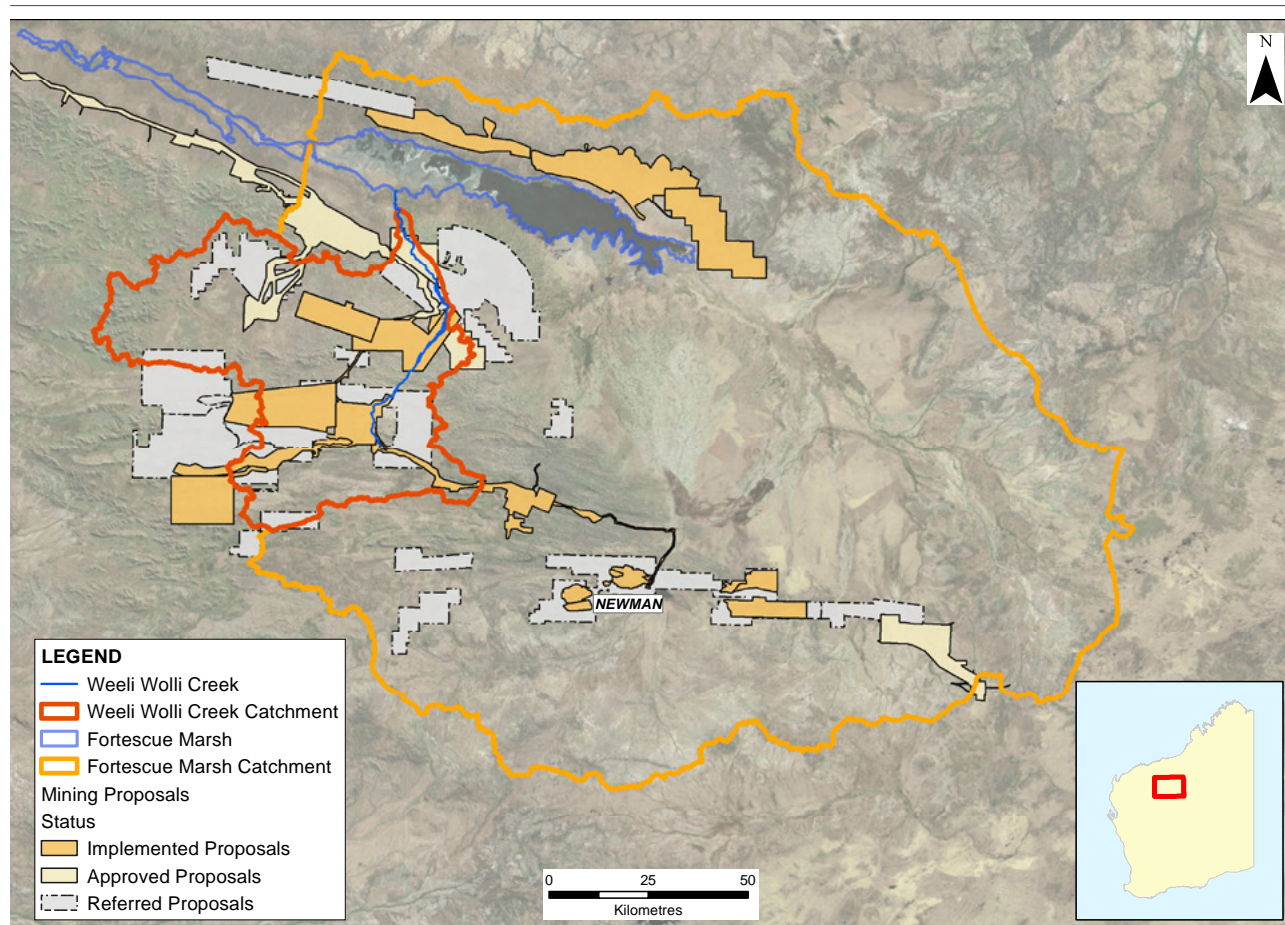


Figure 1: Regional location

What did the EPA want to find out?

The question the EPA wanted this evaluation project to answer is:

'Is Weeli Wolli Creek responding as was predicted through the EPA's EIA, from mining that has occurred in the catchment?'

The specific objectives of this project that the EPA evaluated to answer this question were:

- 1 Whether the environmental values and condition of Weeli Wolli Creek changed during the time the mines have been operating.
- 2 To what extent any changes in environmental values and condition are attributable to impacts of mining proposals assessed by the EPA.
- 3 Whether the changes were consistent with the impacts that were predicted through the EPA's EIA process.

The EPA assesses and reports on individual mining proposals, but considers cumulative impacts as part of its assessment. The EPA also wanted to better understand the cumulative impacts on the creek from multiple mining proposals.

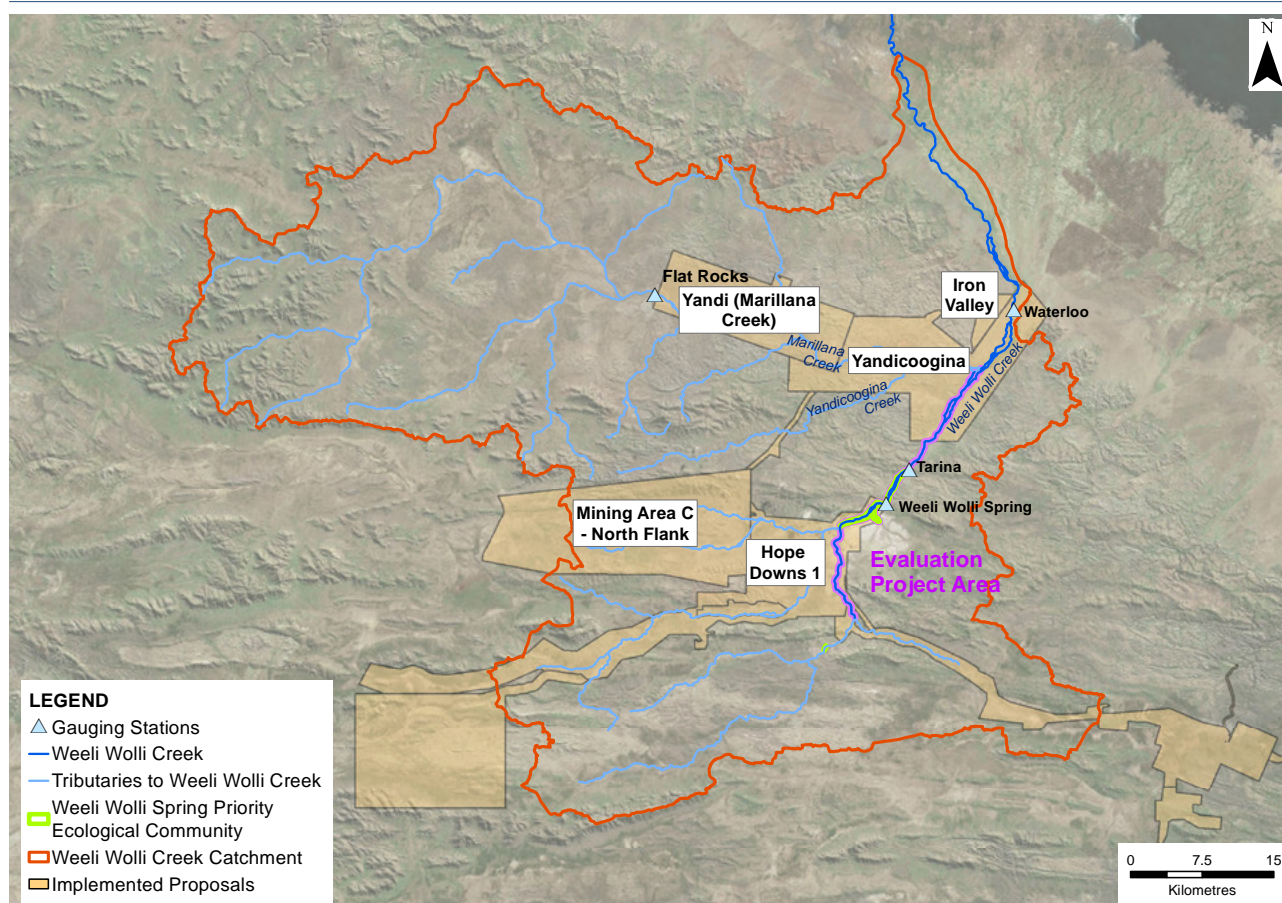


Figure 2: Evaluation project area

Methodology

What was the extent of the evaluation?

The starting point for the scope of the evaluation was the Weeli Wolli Catchment, which contains five operating mines (Figure 2). Due to the large area of the catchment and the amount of information available, the scope was limited to:

- The creek system (creek bed, banks, adjacent land and floodplain):
 - 35 km length of Weeli Wolli Creek, from upstream of Weeli Wolli Spring to the confluence of Weeli Wolli and Marillana creeks (Figure 2).
- Two of the EPA's environmental factors that relate to the creek system:
 - Hydrological Processes: focusing on groundwater, and creek flow
 - Flora and Vegetation: focusing on vegetation, including trees, in and along the creek.

What information did the EPA consider?

The EPA reviewed and analysed a range of information, including from:

- Site visits for this evaluation.
- EPA reports on the assessment of proposals in the Weeli Wolli catchment.
- Implementation conditions for approved proposals (Ministerial Statements).
- Mining company documents (EIA documents, survey reports, monitoring data, papers and consultant reports).
- Department of Water and Environmental Regulation surface and groundwater data and Bureau of Meteorology climate data.

What approach did the EPA use?

The EPA set out to understand:

- Pre-mining environmental values and condition.
- The changes and impacts predicted by mining companies and the measures they proposed to mitigate the impacts.
- Whether the mitigation measures were conditioned as part of the proposal approval and whether these were successfully implemented.
- How the approved mining proposals changed over time and how this has contributed to the change in environmental values and condition.
- The current environmental condition.
- Whether the EIA process (including mitigation measures and conditions) has been effective and whether environmental outcomes were as predicted.

Evaluation of the environmental condition

The Pilbara climate is semi-arid, with very hot summers, mild winters and low and highly variable rainfall. Rainfall events are localised and intense, occurring mostly in summer. Evaporation is high due to high temperatures. Most rivers in the Pilbara are ephemeral, remaining dry for most of the year and flowing only after large rainfall events.

The Weeli Wolli Creek system is highly dynamic due to extreme natural variability from drought, floods and fire, creating a disturbance ecology. This includes changes to creek morphology (shape of the creek channel), with the creation of pools and bars, and changes to creek vegetation.

The EPA evaluated the environmental condition in different reaches along the creek (Figure 3) in the Evaluation Project Area, as there are differences in groundwater, creek flow and vegetation along them.

Pre-mining environmental condition

Groundwater

Before mining, groundwater flowed to the north east, towards the spring. Groundwater levels measured in 1998 were deeper in the upper catchment (at least 50 m below ground level), becoming shallower towards the creek, and then rising to the surface at the spring. Immediately downstream of the spring, groundwater levels were shallow along the creek (less than 6 m below ground level) (Figure 3).

Creek flow

Before mining, most of Weeli Wolli Creek (except for the spring and the 2 km section downstream of it) behaved like a typical Pilbara creek, flowing only after large rainfall events, with some years of no flow. Peak flows of up to 62 GL/day (equivalent to filling Subiaco Oval 62 times) were recorded at the Tarina gauging station. These huge flows naturally changed the creek bed and the distribution and extent of permanent pools and streams, and their associated vegetation.

There was a permanent flow component from groundwater rising to the surface at the spring, which extended approximately 2 km downstream. Peak flows dominated the system and peak flows recorded at the spring were similar to those recorded 5 km downstream at Tarina.

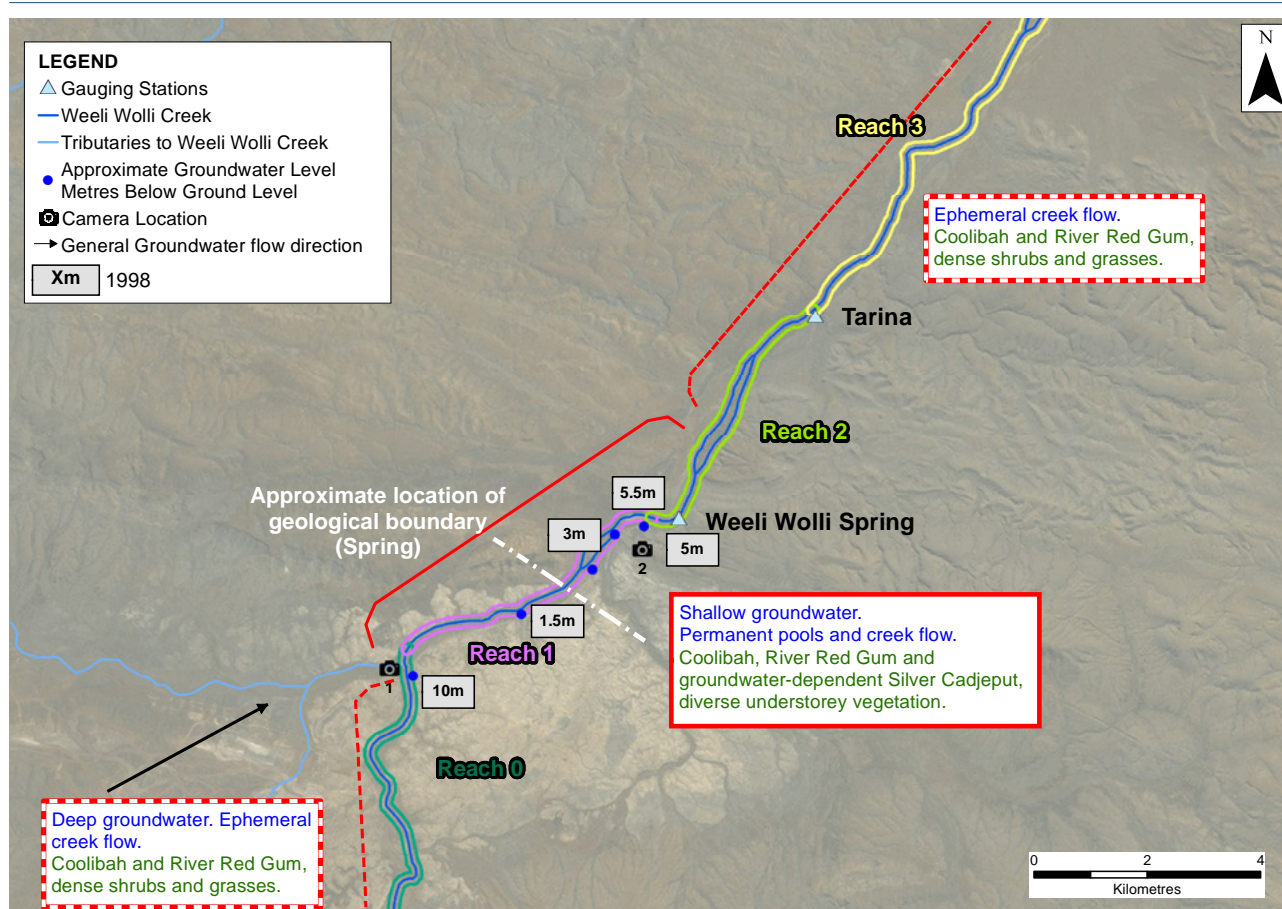


Figure 3: Pre-mining environmental condition summary

Vegetation

The types of vegetation found in the different reaches varied due to differences in the plants' access to water (Figure 3). Groundwater became more accessible to trees closer to the spring. In summary, there was the following relationship between water and vegetation:

- 1 **Areas of deeper groundwater and ephemeral flow:** Coolibah (*Eucalyptus victrix*) and River Red Gum (*Eucalyptus camaldulensis*) trees were dominant with an understorey of shrubs and grasses. These trees can access groundwater when available, but do not necessarily rely on it for survival.
- 2 **Areas of shallow groundwater, permanent pools and permanent flow:** Coolibah and River Red Gum trees were dominant along with areas dominated by the groundwater-dependent Silver Cadjeput (*Melaleuca argentea*) trees. These areas have a diverse understorey of vegetation, especially around permanent pools and flow. This section of the spring and creek is classified as a Priority Ecological Community.

Predicted changes and impacts

The EPA assessed the original proposals for the five operating mines in Weeli Wolli Creek catchment between 1988 and 2013. The EPA assessed revisions of three of the approved proposals in 2005 and 2016. The EPA has also assessed many changes to proposals and changes to conditions since the original proposals were approved. All EPA assessment reports specifically referring to Weeli Wolli Creek were reviewed as part of the evaluation. Only some of them predicted changes and impacts within the Evaluation Project Area (Figure 2).

Predicted pressures, changes and impacts

The key mining activities identified that had the potential to cause changes and significant impacts to Weeli Wolli Creek and its environmental values were **dewatering and discharge**.

Pre-mining creek and vegetation condition



Upstream of spring at creek crossing (2006)



Pool downstream of springs (2006)

Source: Rio Tinto Iron Ore

Dewatering of the aquifer is required to access iron ore below the water table. Dewatering of the orebody involves the abstraction of groundwater to lower the table. The main change related to Hydrological Processes and Flora and Vegetation predicted by the mining companies was:

- Lowering of groundwater levels (groundwater drawdown), causing the following impacts:
 - change in direction of groundwater flow
 - ceasing of spring flow
 - loss of permanent creek flow and permanent pools
 - reduced access to water by vegetation, resulting in some tree deaths.

Discharge of surplus dewater to creeks was the other key activity identified. Where more water is generated from dewatering than the mine can use for its operations, one option is to discharge to creeks. The main change predicted by mining companies was:

- Increased flow to the creek in the area downstream of the spring, causing the following impacts:
 - extending the distance of permanent flow in the creek
 - potential over-supply of water to vegetation, resulting in a change of vegetation types.

An important observation is that the pressures from dewatering and discharge change over time and space, depending on factors such as the nature of the aquifer, mining schedules and expansions to mining operations.

EPA assessment of predicted impacts

All of the EPA assessment reports included mining companies' estimates of dewatering and surplus dewater discharge. Most reports quantified predicted impacts from dewatering (such as decrease in groundwater levels from drawdown, extent of drawdown and timing of impacts). One assessment report explicitly discussed the uncertainty of dewatering predictions. Most reports quantified the predicted impact from discharge (such as how far down the creek permanent flow would extend).

Dewatering and discharge from four of the mines was predicted to affect Weeli Wolli Creek in the Evaluation Project Area. This includes one mine where dewatering was approved in December 2016.

Impacts on vegetation from dewatering were considered in all assessment reports, one of which quantified the predicted impacts to vegetation from dewatering. Some recent reports have included specific discussion on the interaction between groundwater drawdown and vegetation (e.g. how certain decreases in groundwater levels would affect particular species). Reports predicting surplus dewater discussed impacts from discharge on creek vegetation. This discussion was general and focused on impacts to trees, rather than understorey vegetation.

Once mining started, some companies reported that dewatering (and discharge) requirements were higher than predicted during the EPA's assessment. Some companies have also expanded or extended their mining operations. The approved annual dewatering and discharge for all operating mines in the Weeli Wolli catchment as at 2016 was more than 15 times what was approved with the first mine in 1988 (Figure 4).

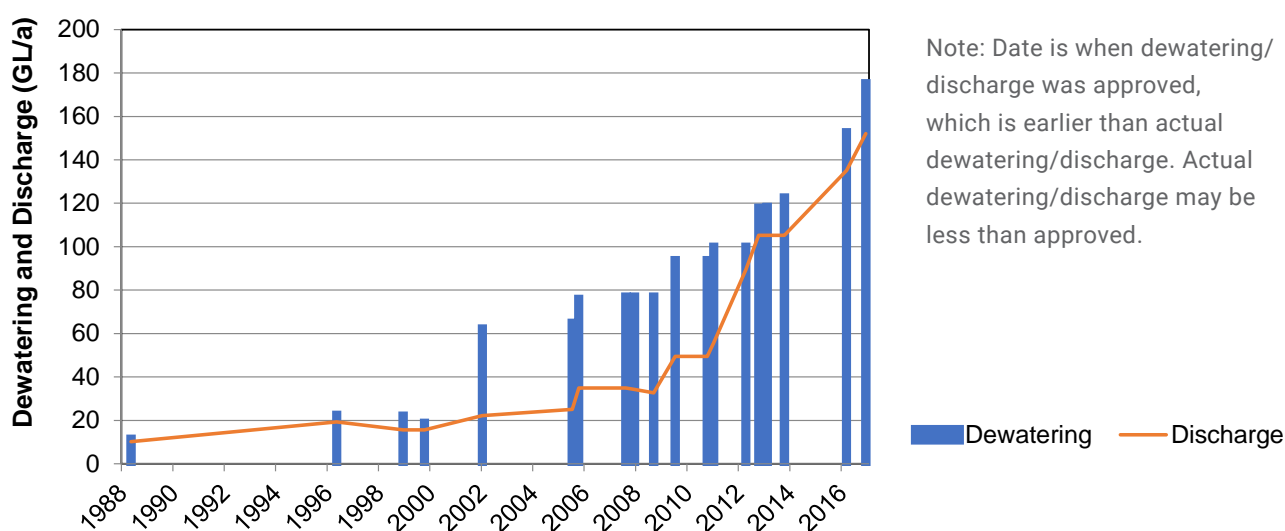


Figure 4: Approved dewatering and discharge

The EPA notes that predictions of dewatering and discharge requirements increased over time for some mining operations, but the increase in impacts on Weeli Wolli Creek was predicted to be either no change or negligible. All of the assessment reports from 1996 onwards raised cumulative impacts as an issue. Some assessment reports, particularly recent reports, explicitly stated that groundwater modelling included impacts from other proposals.

The EPA generally accepted mining companies' predictions but concluded that unmitigated impacts could be significant and were therefore unacceptable, particularly impacts to the spring. Mitigation measures proposed by mining companies included:

- monitoring effects of dewatering and discharge on creek vegetation to inform management
- maintaining spring flow and pool water levels with surplus mine dewater
- irrigating areas affected by dewatering with surplus mine dewater (i.e. dispersed discharge), to minimise impacts to creek vegetation.

The EPA notes that the irrigation system was planned as a mitigation measure to manage the lowering of groundwater levels and loss of spring flow. However, it can also cause an impact where it results in too much water.

The EPA generally accepted the mining companies' mitigation measures and in some reports explicitly discussed the importance of having contingencies. For all assessments, the EPA recommended conditions to enforce the measures that the EPA accepted and in some cases recommended additional measures.

Mine closure was not specifically addressed as part of this evaluation, which has focused on changes to date, rather than potential changes. However, the EPA notes that most of the assessment reports raised the issue of potential impacts following mine closure, when dewatering and discharge stops.

For all assessments, post-mining management was a key consideration for environmental acceptability and was included in the EPA's recommended conditions.

Until 2005, the EPA usually recommended a condition that required mining companies to implement commitments (including mitigation measures) made during the EIA process. After 2005, the EPA recommended conditions relating to specific issues and environmental factors, rather than referring to mining company commitments. For most proposals, these conditions required environmental management plans to address the environmental issues.

Current environmental condition

Groundwater

An analysis of recent and pre-mining groundwater information and data confirmed as predicted, that the following changes occurred as a result of dewatering:

- Groundwater levels have decreased, with the greatest change upstream of the spring, and the least change immediately downstream of the geological boundary.
- **Groundwater flow** upstream of the spring groundwater is now towards the mine, rather than to the north east. This confirms the presence of a geological barrier and groundwater divide, as flow is still to the north east downstream of the spring.
- **Reduced access to groundwater by vegetation.** The area of greatest change is upstream of the spring where groundwater levels have fallen below the root zone of trees.

There appears to be enough distance between the dewatering bore networks so that there are no obvious spatial or temporal cumulative effects. This was as predicted through the EIA process.

Creek flow

An analysis of recent and pre-mining flow information confirmed as predicted, that the following changes occurred as a result of dewatering and discharge:

- Spring flow has ceased.
- Permanent flow extends further downstream beyond the spring almost to the confluence of Marillana and Weeli Wolli creeks (approximately 19 km compared to the pre-mining extent of approximately 2 km).

To counteract the potential impacts from a decrease in groundwater levels, surplus dewater has been discharged to irrigate the area of the spring to sustain the surface expression of water at the spring and sustain pools. Water levels, not spring flow, have been maintained.

Further downstream, there is a cumulative effect from the discharge of dewater from multiple mining operations, which have extended the distance of permanent flow. This is as predicted.

Current creek condition



Irrigation at the spring (2015)



Permanent flow downstream of the spring (2015)

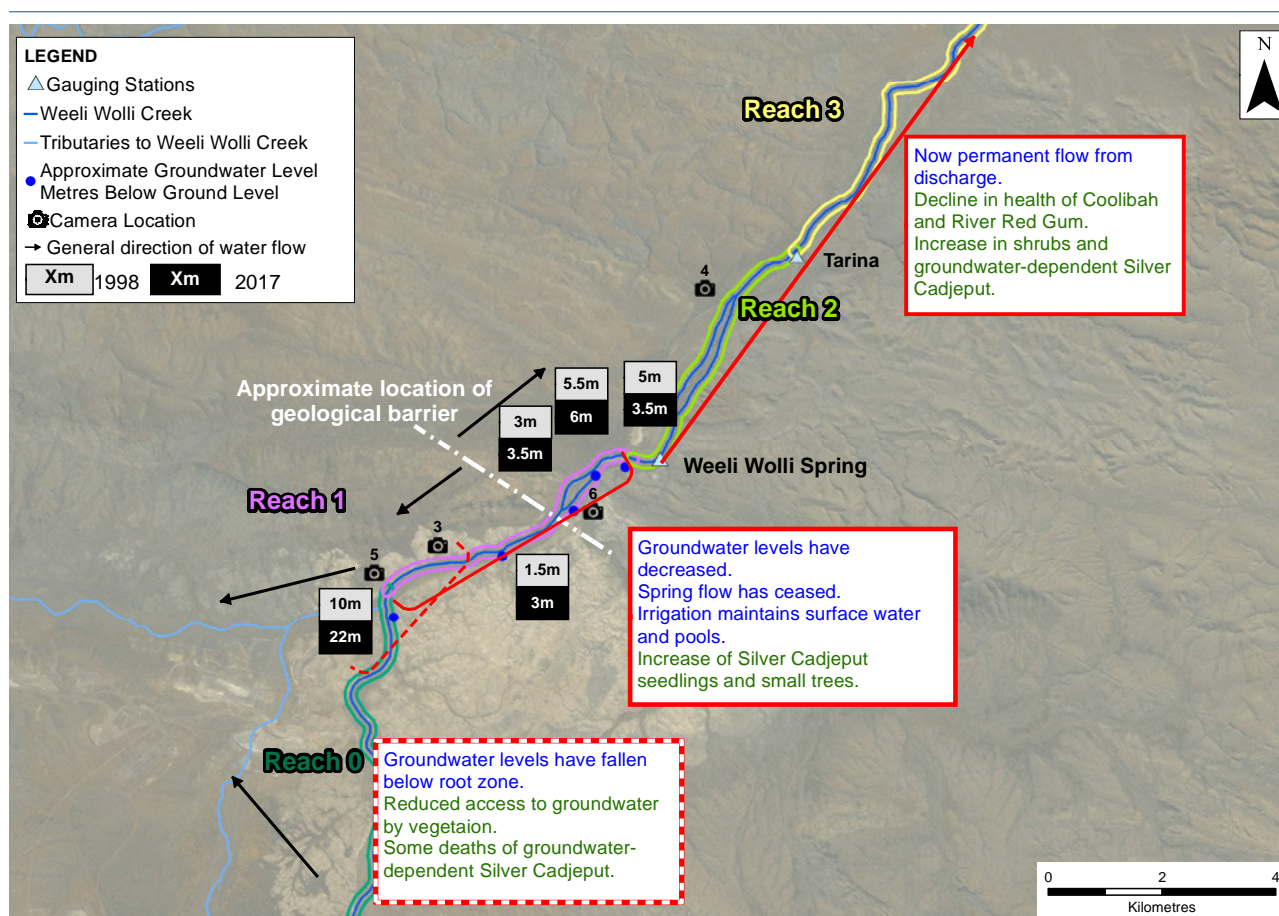


Figure 5: Current environmental condition summary

Vegetation

A suite of monitoring programs is in place to understand the impacts of the changes in groundwater and creek flow on the vegetation of Weeli Wolli Spring. It is difficult to determine the causes of changes to vegetation due to the high variability of the system across seasons and years. This is further complicated by multiple changes to the system at the same time (e.g. vegetation could be affected by drought and/or lowering of groundwater levels due to dewatering).

Monitoring has focussed on the health of the three dominant tree species (Coolibah, River Red Gum and Silver Cadjeput), with only one program monitoring the understorey vegetation. The information from the single program is not sufficiently robust to determine trends in species distribution and extent. The ecosystem of the spring is still functioning.

Monitoring of the trees has indicated that changes as a result of dewatering and discharge are mostly as predicted:

Area of reduced access to groundwater by vegetation, where groundwater levels have fallen below the root zone of trees:

- There has been some decline in the health of Silver Cadjeput trees and some deaths. It was originally predicted that irrigation would maintain groundwater levels beneath the creek and prevent this impact. The mitigation didn't work as predicted, and this impact is now being managed through direct irrigation of the affected areas and there appears to be some improvement.
- After an initial decline, River Red Gum and Coolibah trees appear to have adapted better than predicted to no access to groundwater, when surface water availability is maintained.

Area downstream of the spring:

- Silver Cadjeput seedlings and small trees in some areas have increased due to permanent water availability. An increase in opportunistic species was predicted.

- Downstream of discharge points where there is now permanent flow in what was previously an ephemeral section of creek, there appears to have been a decline in the health of River Red Gum and Coolibah trees. This was not predicted and the cause is unclear

Summary

As expected, some hydrological processes have changed due to dewatering and discharge of surplus dewater to the creek. There have been impacts to tree health with some tree deaths (Silver Cadjeput upstream of the spring) and declines in tree health (River Red Gum and Coolibah in the areas of greatest permanent flow increase). It is not clear if there are changes in the understorey vegetation. Tree health appears to be sufficiently managed through irrigation and adaptive management and the ecosystem appears to be functioning.

Current vegetation condition



Decline in health of Silver Cadjeput upstream of spring (2015)



Increase in Silver Cadjeput seedlings downstream of spring (2015)

Discussion and conclusion

What did the EPA find?

The answer to the question that the EPA wanted the evaluation project to answer – ‘Is Weeli Wolli Creek responding as was predicted through the EPA’s EIA, from mining that has occurred in the catchment?’ is **Yes**.

In answering the question, the EPA evaluated the following in relation to the theme area of ‘the on-ground environmental outcomes that are achieved after implementation of proposals’:

- 1 **Whether the environmental values and condition of Weeli Wolli Creek changed during the time the mines have been operating.**

The environmental condition has changed due to the naturally dynamic ecosystem and due to mining activities, particularly dewatering and discharge. There have been changes to the environmental values, e.g. spring flow has ceased, the extent of permanent creek flow has increased and there have been changes to the health and distribution of trees.

- 2 **To what extent any changes in environmental values and condition are attributable to impacts of mining proposals assessed by the EPA.**

Some of the changes to groundwater and creek flow (e.g. decrease in groundwater levels, ceasing of spring flow and extent of permanent flow) appear to be directly attributable to mining proposals as we can identify and quantify changes from dewatering and discharge.

It is more difficult to evaluate the extent to which changes to vegetation are attributable to mining proposals. In addition to the changes from dewatering and discharge, the creek system is dynamic due to large seasonal changes, large storm events and other factors such as fires. These result in large natural variations in vegetation condition and distribution. These changes to the system can also occur at the same time.

While we can conclude that some impacts are attributable to mining proposals, it was not possible to quantify the degree of change attributable to each cause, or the resilience of the system in response to these changes.

- 3 **Whether the changes were consistent with the impacts that were predicted through the EPA’s EIA process.**

Most of the changes were predicted through the EIA, except for the impacts to trees from cumulative discharge and the resilience of some trees in response to reduced access to groundwater.

In relation to the evaluation project objectives, the EPA found that:

- 1 The creek ecosystem is broadly functioning.
- 2 Changes in groundwater and creek flow can be directly attributable to mining proposals; however, it is more difficult to attribute changes in vegetation to mining proposals.
- 3 The current environmental condition is close to what was predicted through EIA (for this stage of mining development, i.e. during operations).

Other important findings were:

- 4 Conditions imposed on the approved mining proposals have helped achieve the predicted environmental outcomes.
- 5 Adaptive management has been important where mitigation measures did not work as predicted.
- 6 A key gap is in the robustness of floral monitoring and reporting, as there is a lack of understanding of understory floral diversity.
- 7 There do not appear to be cumulative impacts on the key environmental values from dewatering to date. There are cumulative impacts from discharges from multiple mines.

What did the EPA confirm?

The findings from the evaluation project have reinforced the following in relation to the EPA's EIA process, its assessment of mining proposals and provision of advice:

- 1 **Baseline and reference data:** It is important to have good baseline data (i.e. data before the start of activities that cause impacts) for evaluating changes to groundwater and creek flow. For vegetation, reference sites (i.e. sites that aren't impacted by the mining proposals) are important, because the system is so variable. Without this, evaluations will be more qualitative than quantitative.
- 2 **Predictions:** It is important to recognise uncertainties in predictions in the assessment stage (e.g. the extent of groundwater drawdown, response of vegetation), quantify predictions and have viable alternative mitigation measures and contingencies (i.e. mining companies need to demonstrate that they can adapt their management). It is also important to regularly update conceptual hydrological models as more information becomes available.
- 3 **Monitoring:** It is important to tailor monitoring to answer key questions in relation to ecosystem health, considering how environmental values/factors are inter-related. Monitoring should be sufficient to trigger the early initiation of contingency actions in the event of a decline in vegetation health.
- 4 **Management:** Results from monitoring reinforce the importance of adaptive management. It is also important for the EPA to assess proposed management (through Environmental Management Plans) during the assessment stage to make sure monitoring is tailored and mitigation measures are feasible and relevant.
- 5 **Recommended conditions:** It is important to consider factors such as existing variability in the system, whether monitoring will answer questions and whether mitigation measures are feasible.
- 6 **Cumulative impacts and future mine development:** It is important to consider how future mining proposals may impact environmental values and interact with existing impacts to avoid risk to the ecosystem. For example, since the EPA began this evaluation project, two expansions to existing mines in the Weeli Wolli Creek catchment have been approved. The EPA is currently assessing another large-scale expansion and a strategic proposal.
- 7 **Mine closure:** The key potential risk to the environment is mine closure. An important consideration is how impacts will be managed when dewatering and discharge stops (e.g. feasibility in returning spring flow; how vegetation that is now dependent on permanent flow will respond). This reinforces the need for closure to be considered at the early stages of the EIA process, to increase the likelihood of successful closure (i.e. so that impacts at closure are as predicted).

Conclusion

The EIA process has generally been effective in predicting impacts to this stage of mining development and management measures appear to have been implemented effectively. Overall, the Weeli Wolli Creek system has largely responded as predicted. The EPA will consider how it can apply the findings identified from the evaluation, to improve its EIA process.

More information

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