POWER AND WATER AUTHORITY
REPORT 97/1988

RUM JUNGLE MINE
REHABILITATION PROJECT

WHITES OPEN CUT AND INTERMEDIATE
OPEN CUT WATER QUALITY
1986-87

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SYNOPSIS


Based on the information obtained, and questions still unanswered, a more detailed sampling programme is proposed for the 1987-88 wet season and following dry season.
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1. INTRODUCTION

The treatment of the water in Whites and Intermediate Open Cuts and the subsequent rediversion of the East Branch of the Finniss River has been documented in previous reports (References 1 and 2).

The main reason for rediverting the East Branch of the Finniss River to flow through the Open Cuts was to ensure annual flushing. It was anticipated that the design would ensure that at least the top few metres of water in the Open Cuts would be flushed on an annual basis. The re-routed river is shown in Figure 1.

The Open Cuts were studied in detail prior to treatment, and closely monitored during the treatment process. After treatment was completed a sampling programme was initiated to monitor the seasonal and annual variation of water quality in both Open Cuts. Reference 1 is a record of the water quality in the Open Cuts on five occasions from November 1985 to August 1986. It was concluded that the water treatment was a success and the strategy of rediversion was also successful, resulting in improved water quality on an annual basis. It was anticipated that water quality would continue to improve with further flushing during successive wet seasons. The influence of inflow water was initially thought to be around 5 metres depth in both Open Cuts (Reference 3). It has later been shown to be greater; of the order of 15 metres depth (Reference 1).

This report is a record and discussion of monitoring from August 1986 to November 1987.
FIGURE 1

REDIVERSION OF THE EAST BRANCH OF THE FINNISS RIVER

[Diagram showing the redirection of the East Branch of the Finniss River through culverts, weirs, and diversion channels.]
2. WHITES OPEN CUT

The pH, specific conductance, copper, manganese, zinc and sulphate concentrations for six sampling profiles from 27 August 1986 to 9 November 1987 are shown in Appendix B Figures 2(a) to 2(f). The data are in Appendix P, Table 2. The following observations are made:

The 1986-87 wet season flush caused an increase in pH above approximately AHD 30m. pH decreased as the 1987 dry season progressed. Generally for a given profile, pH was fairly consistent to 45m AHD, and then decreased over approximately the next 12m to approximately pH 3.0, which is the pH of the untreated water.

For a given profile the specific conductance was fairly consistent from the surface to 44-46m AHD, then increased to about 8000 uS/cm, at about 30m AHD which is the specific conductance of the untreated water. Specific conductance decreased during the 1986-87 wet season because of the flushing by river water. The specific conductance of water above 45m AHD in November 1987 was approximately 700 uS/cm, which was a considerable improvement on the water quality of November 1986 when the specific conductance was 1400 uS/cm.

The specific conductance results mainly from alkaline earth sulphates. Thus the sulphate profiles were similar to those for specific conductance.

Comparison of the copper, manganese and zinc profiles with the corresponding pH profiles show that metal concentrations increase as the water becomes more acidic. The lowest concentrations of metals measured in the treated water were after the wet season flush. Concentrations increased during the dry season as the water became more acidic.
3. INTERMEDIATE OPEN CUT

Seven profiles were measured from 26 August 1986 to 9 November 1987. The pH, specific conductance, copper, manganese, zinc and sulphate profiles are shown in Appendix B Figures 3(a) to 3(f). The data is in Appendix A Table 3. The following observations are made:

The pH profiles generally showed several highs and lows. The most notable and consistent feature was increased pH at 27m AHD. This is most probably the residual of treated water. Above this is the fresh water input. Below this layer there is more acidic water with higher concentrations of metals.

Pf decreased steadily during the dry season over the interval from the surface to approximately 38m AHD. The surface waters are poorly buffered typical of the wet season river water flow.

The specific conductance profiles show that water quality above 37m AHD was markedly affected by inflow water. The 1986-87 wet season was the second time that the Open Cuts were flushed by flow from the East Finniss River. This resulted in a further decrease in the specific conductance of the water in the Intermediate Open Cut. Specific conductance increased during the 1987 dry season.

As with Whites Open Cut the specific conductance was largely a result of sulphate salts. The sulphate profiles were similar to those of specific conductance.

Comparison of the copper, manganese and zinc profiles with the pH profiles showed that lower metal concentrations were evident at 27m AHD where a layer of relatively high pH water exists. Below 27m AHD metal concentrations steadily increased. This maybe the result of polluted groundwater inflow or pyritic oxidation, and redissolution of metal hydroxides residual from the in-situ water treatment. There were some anomalous profiles which could not be explained; these include the profile for manganese of November 1986.
4. DISCUSSION AND CONCLUSIONS

The 1986-87 East Finniss River and Finniss River monitoring report suggested that the Open Cuts were a greater source of pollutants to the East Finniss River than previously suspected (Reference 2). It was suggested that high flow conditions into Whites Open Cut flushed polluted water from depths greater than 15m.

This report recommended that the Open Cut monitoring be increased. This report refers to the monitoring prior to the adoption of the more detailed 1987-88 programme.

The 1987-88 programme of sampling should result in less ambiguous data. Questions which arise from the 1986-87 reports and which require resolution are:

What is the depth to which Whites Open Cut is affected by flushing and what are the implications for pollution of the East Finniss River?

The data in this report suggests that flushing occurs to a depth of at least 30m AHD, where untreated water was encountered. The depth of flushing would depend primarily on the energy of the inflow water, and would presumably be more extensive if the water density was lowered because of previous flushing. To date the Open Cuts, and in fact the entire rehabilitation works have been tested only by well below average flow years.

How stable are the bottom waters in the Intermediate Open Cut?

The data suggest that metal concentrations increased in 1987 below 27m AHD. The decrease in pH could result from oxidation of a pyrite surface or input from an acidic groundwater. Both of these mechanisms combined with the dissolution of residual sludge would lead to an increase in metal contamination.

What is the origin and stability of the higher pH water at 27m AHD in the Intermediate Open Cut?

This water is a buffer between the bottom and top waters. The water is thought to be the residual of the initial treated water.
What is the mechanism by which polluted concentrations in the upper water levels increased during the dry season?

The mechanism previously proposed was thermal density differences, energy from winds and diffusion across concentration boundaries. However, the profiling was not sufficiently detailed to prove that mixing was the predominant mechanism, and the possibility of polluted groundwater inflow was not precluded.

Successful prediction requires a greater knowledge of the Open Cuts' hydrology. This report is confined to a record of the water quality in the Open Cuts over the study period (Appendix A). As expected, the overall quality of the water subject to annual flushing in the Intermediate Open Cut is inferior to that in Whites Open Cut. The overall quality of the water subject to annual flushing is a major improvement on the quality of water before treatment (References 1 and 3).
5. REFERENCES


6. ACKNOWLEDGEMENTS

The study was funded by the Commonwealth and Northern Territory Governments as part of their contribution to the monitoring of the rehabilitation project. The monitoring was carried out by staff of the East Point Laboratory.
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**INTERMEDIATE OPEN CUT WATER QUALITY**
**AUGUST 1986 - NOVEMBER 1987**

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Appendix B
FIGURE 2 (a)

1986–87 WHITES OPEN CUT pH PROFILES

- 27/8/86
- 1/10/86
- 18/11/86
- 12/2/87
- 25/5/87
- 9/11/87

AHD METRES
FIGURE 2.(c)

1986-87 WHITES OPEN CUT COPPER PROFILES

COPPER CONCENTRATION (mg/L)

20 30 40 50 60

AHD METRES

27/6/86
1/10/86
18/11/86
12/2/87
25/5/87
9/11/87
FIGURE 2.(d)

1986–87 WHITES OPEN CUT MANGANESE PROFILES

MANGANESE CONCENTRATION mg/L

AHD METRES

- 27/8/86
- 1/10/86
- 18/11/86
- 12/2/87
- 25/5/87
- 9/11/87
FIGURE 2.(e)

1986-87 WHITES OPEN CUT ZINC PROFILES

ZINC CONCENTRATION mg/L

27/8/86
1/10/86
10/11/86
12/2/87
25/5/87
9/11/87

AHD METRES
FIGURE 2.(f)

1986–87 WHITES OPEN CUT SULPHATE PROFILES

SULPHATE CONCENTRATION mg/L

AHD METRES

- 27/8/86
- 1/10/86
- 18/11/86
- 12/2/87
- 25/5/87
- 9/11/87
FIGURE 3.(a)

1986–87 INTERMEDIATE OPEN CUT pH PROFILES

26/8/86
1/10/86
18/11/86
12/2/87
26/5/87
15/9/87
9/11/87

AHD METRES
FIGURE 3.(b)

1986-87 INTERMEDIATE OPEN CUT SPECIFIC CONDUCTANCE PROFILES

SPECIFIC CONDUCTANCE µS/cm

- - - - 26/8/86
- - - - 1/10/86
- - - - 18/11/86
- - - - 12/2/87
- - - - 26/5/87
- - - - 15/9/87
- - - - 9/11/87

AHD METRES
FIGURE 3.(c)

1986–87 INTERMEDIATE OPEN CUT COPPER PROFILES

COPPER CONCENTRATION mg/L vs AHD METRES

- 26/8/86
- 1/10/86
- 18/11/86
- 12/2/87
- 26/5/87
- 15/9/87
- 9/11/87
FIGURE 3.(d)

1986-87 INTERMEDIATE OPEN CUT MANGANESE PROFILES

MANGANESE CONCENTRATION mg/L

0 10 20 30 40 50 60
AHD METRES

26/8/86
1/10/86
18/11/86
12/2/87
26/5/87
15/9/87
9/11/87
FIGURE 3.(e)

1986–87 INTERMEDIATE OPEN CUT ZINC PROFILES

ZINC CONCENTRATION mg/L

26/8/86
1/10/86
13/11/86
12/2/87
26/5/87
15/9/87
9/11/87

AHD METRES
FIGURE 3.(f)

1986–87 INTERMEDIATE OPEN CUT SULPHATE PROFILES

SULPHATE CONCENTRATION mg/L

AHD METRES

26/8/86
1/10/86
18/11/86
12/2/87
26/5/87
15/9/87
9/11/87

AHD METRES

2000
4000
600
800
1000
1200
1400
1600
1800
200
400
600
800
1000