AUSTRALIA

Technical Memorandum 5

Flocculation of Retention Pond Water

B.T. Hart and R.J. McGregor

Supervising Scientist for
the Alligator Rivers Region

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CONTENTS

SUMMARY

Hart, B.T. and McGregor, R.J. (1982). Flocculation of retention pond water. Supervising Scientist for the Alligator Rivers Region, Tech. Mem. 5.

Alum treatment of turbid water from Ranger's retention pond No 4 resulted in a significant increase in clarity. A concentration of 30 mg/L alum reduced turbidity from an initial 340 NTU to less than 30 NTU in four hours.

1 INTRODUCTION

An integral part of the water management strategy proposed by Ranger Uranium Mining Pty. Ltd. involves the collection of runoff water in a series of retention ponds. This water will subsequently be used in the uranium milling plant or released to Magela Creek. During the 1979-80 wet season, runoff water was collected for the first time at Ranger. Significantly, this water was very turbid and caused a section of Magela creek to become turbid when it was released. The eroded material causing the turbidity was very highly dispersed and showed little tendency to sediment out in the retention ponds.

Concern has been expressed about the release of this turbid water because of potential direct adverse effects on the biota downstream and because the suspended material can provide an efficient medium for transporting contaminants through the system. For this reason it may be necessary to place restrictions upon the levels of turbidity or suspended solids in retention pond water released to Magela Creek.

There are a number of methods potentially capable of being used for the treatment of retention pond water. In this report we present the results of a preliminary study to determine the feasibility of clarifying retention pond water by flocculation with alum.

2 METHODS

2.1 Flocculation Experiments

Alum ($Al_2(SO_4)_3.18H_2O$) was added to the natural water sampled from retention pond No. 4 taken at 0940 h on 24 April 1980. Three experiments were undertaken with initial alum concentrations of 30, 22.5 and 15 mg/L. After initial mixing, the solutions were allowed to stand and samples taken at intervals of up to five hours for turbidity measurements. There was no adjustment of the solution pH.

With the addition of 30 mg/L alum, the solution pH was reduced by approximately 1 pH unit after five hours; the initial pH was 6.7 and the final was 5.8.

2.1.1 General Analysis of Retention Pond Water

The water sample was analysed for conductivity, filterable residue (using 0.45 μm Sartorious membranes), suspended solids and pH.

2.1.2 Particle Size Analysis

A HIAC particle size analyser (Model PC-320) was used to determine the particle size distribution in the range 1.8 μm to 60 μm on two untreated samples of retention pond water and on one sample that had been sonicated for 60 minutes.

2.1.3 Trace Metal Levels in Suspended Solids

A sample of suspended solids was separated from the retention pond water by centrifuging at 3000 rpm for 10 minutes. This was then digested using 5 mL H_2O_2 and 5 mL concentrated HNO_3 (0.4 g sample) and the trace metal concentrations were determined using flame AAS with background correction.

3 RESULTS

The quality of the retention pond water sample is shown by the results in Table 1. The most outstanding characteristic was the very high turbidity and suspended solids levels. The latter was over 30 times higher than the mean level recorded in Magela Creek during the wet season (13.3 mg/L (n = 41)). The conductivity was also higher being around double that recorded for Magela Creek during the wet season (15.0 µS/cm (n = 39)).

TABLE 1 ANALYSIS OF RETENTION POND WATER

Parameter		
Conductivity	(µS/cm)	36
pH		6 .7
Filterable residue	(mg/L)	12
Suspended solids	(mg/L)	407
Turbidity	(NTU)	340
Trace metal in suspended solids (µg/g):	Fe	37 900
	Mn	90
	Cu	51
	Zn	52
	Cr	51
	Pb	22

NTU = Nephelometric Turbidity Units

The particle size distribution of the suspended material was investigated to provide information on settleability of the suspended matter. Two methods were used. Firstly, the size distribution in the range 1.8 to 60 µm was obtained using a HIAC particle size analyser. Unfortunately this instrument does not measure below particle sizes of 1.8 µm. Results in Figure 1 show that only a very small proportion of the suspended particles are greater than 10 µm in size and explain why this material will settle out only with difficulty. Conversion of the total particle volume into mass by assuming a specific gravity of 1.5 g/mL gave a value of 37 mg/L for particulate matter in the size range 1.8 to 60 µm. If this is compared with the value of 407 mg/L for suspended solids collected on a 0.45 µm Sartorious filter, it is seen that 370 mg/L of suspended matter is in the size range 0.45 - 2 µm.

Sonication reduced the particle volume in the lower size ranges measured. One interpretation of this result is that many of the particles in the mean size range 2.5-7.5 µm are aggregates that can be broken up into smaller particles by sonication.

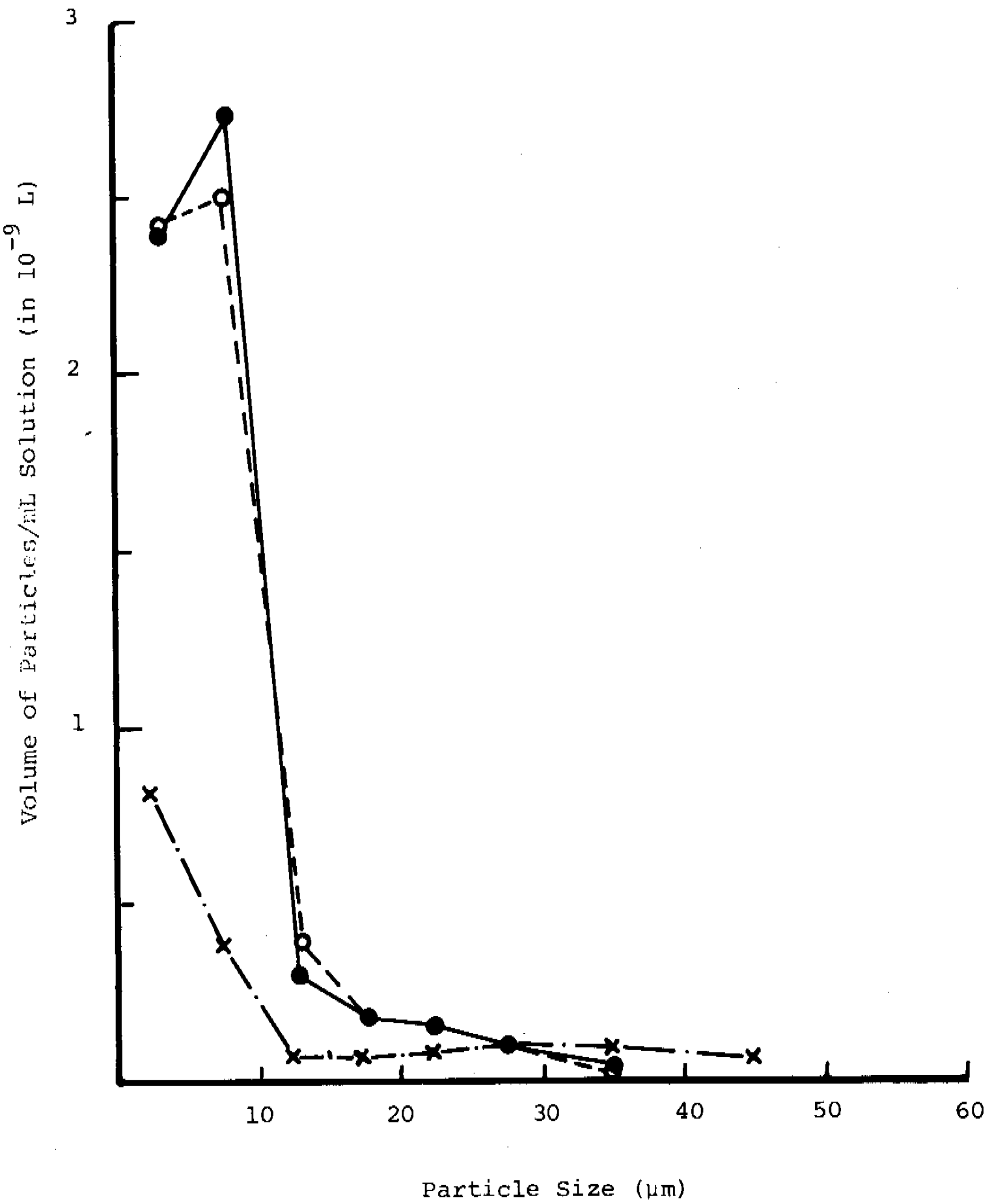

FIG. 1 PARTICLE SIZE DISTRIBUTION IN THREE SAMPLES OF WATER FROM RETENTION POND NO. 4

● and O, untreated samples; x sonicated sample

(Samples provided by Mr John Paul, Environmental Section, Northern Territory Department of Transport and Works.)

The second means of obtaining information on particle size distribution was to use a range of different size membrane filters. Aliquots of the retention pond water were filtered through Nuclepore filters with nominal pore sizes of 3, 2 and 0.4 μm; the amounts of suspended solids retained were 360, 390 and 390 mg/L respectively. These results indicate a quite different size distribution from that obtained using the HIAC analyser. The filter results suggest that the bulk of the suspended material is in excess of 3 μm in size, with 30 mg/L between 2-3 μm and very little less than 2 μm. A possible reason for the finer material being retained by the 3 µm filter may be that the pores are rapidly filled with larger particles, causing a significant reduction in the actual pore size and allowing the filter to retain material much smaller than the nominal pore size. This hypothesis is supported by the fact that the 0.1 µm filter only retained 280 mg/L of suspended matter.

Table 1 also contains results for the trace metal levels in the particulate matter. Comparison of these levels with those obtained from the 20 µm fraction in billabong sediments suggests that the levels in the particulate matter may be slightly higher for copper, zinc and lead.

Figure 2 contains the results of the flocculation experiments. Addition of 30 mg/L alum gave the best results, turbidity being reduced from 340 NTU to 50 NTU in two hours with further reduction to 25 NTU after four hours sedimentation. The solution pH was reduced by approximately 1 unit (6.7-5.8) after five hours. No attempt was made to determine the optimum pH for flocculation.

These results indicate that it would certainly be technically feasible to reduce the turbidity of retention pond waters by flocculation with alum.

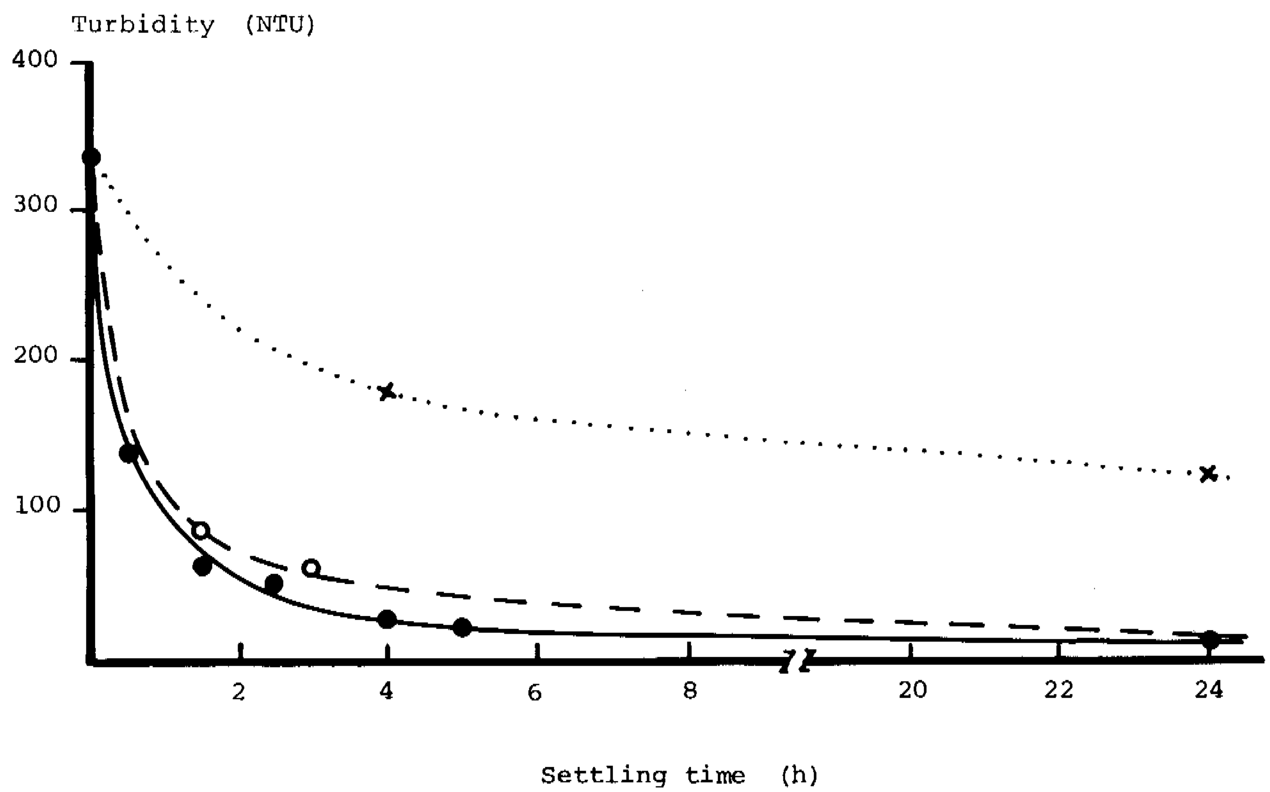

FIG. 2 REDUCTION IN TURBIDITY WITH TIME WHEN ALUM IS ADDED TO WATER FROM RETENTION POND NO. 4

● 30 mg/L O 22.5 mg/L x 15 mg/L

(Samples provided by Mr John Paul, Environmental Section, Northern Territory Department of Transport and Works.)

SUPERVISING SCIENTIST FOR THE ALLIGATOR RIVERS REGION

RESEARCH PUBLICATIONS

Research Reports (RR) and Technical Memoranda (TM)

TM 1	Transport of trace metals in the Magela Creek system, Northern Territory. I. Concentrations and loads of iron, manganese, cadmium, copper, lead and zinc during flood periods in the 1978-1979 wet season. December 1981 (26 pp)	Hart, B.T., Davies, S.H.R. & Thomas, P.A.
TM 2	Transport of trace metals in the Magela Creek system, Northern Territory. II. Trace metals in the Magela Creek billabongs at the end of the 1978 dry season. December 1981 (23 pp)	Davies, S.H.R. & Hart, B.T.
TM 3	Transport of trace metals in the Magela Creek system, Northern Territory. III. Billabong sediments. December 1981 (23 pp)	Thomas, P.A. Davies, S.H.R. & Hart, B.T.
TM 4	The foraging behaviour of herons and egrets on the Magela Creek flood plain, Northern Territory. March 1982 (20 pp)	Recher, H.F. & Holmes, R.T.
RR 1	The macroinvertebrates of Magela Creek, Northern Territory. April 1982 (46 pp)	Marchant, R.