MINERAL RESOURCES TASMANIA

STORYS CREEK
ACID DRAINAGE REMEDIATION

JIG TAILINGS RELOCATION
DESIGN REPORT

JULY 2000

John Miedecke and Partners Pty Ltd • July 2000

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1.0 INTRODUCTION

The Storys Creek/Rossarden remediation project is a cooperative project between Mineral Resources Tasmania (MRT), the Department of the Primary Industry Water and Environment (DPIWE) and the Commonwealth Department of the Environment. The aim is to design and implement a remediation strategy for the Storys Creek and Rossarden abandoned mine sites to reduce acid and heavy metal discharge into the South Esk River system.

Mineral Resources Tasmania is supervising the acid drainage remediation works at the old abandoned mine workings at Storys Creek and Rossarden. This report into the relocation of jig tailings is being funded by the State Government though the Rehabilitation of Mining Lands Trust.

A large quantity of Jig Tailings have also been deposited on the banks of Storys Creek near the old mine workings by past mining and processing operations. Figure 1 shows the location of the materials. Photographs shows the creek and the tailings materials.

Leachate from rainfall falling on the Jig tailings was identified as one of the major sources of heavy metal contamination to the creek in a study commissioned by Mineral Resources Tasmania in 1998 (John Miedecke and Partners Pty Ltd (JMP) 1998, 1999, 2000a).

As part of the remediation works, the removal and encapsulation of the jig tailings is being considered to remove the source of contamination and improve water quality in Storys Creek.

In 1999-2000, the "Precipitate" Dam, which contained tailings and acid drainage precipitate materials, was relocated from an existing tailings dam close to Storys Creek, to a new site further to the east. This new disposal site has been formed as a mound with the clay cap to minimise infiltration, and approximately one half of the dump has been left uncapped, to provide for the future disposal of Jig tailings. A small trial removal and disposal was also carried out. (JMP 2000b).

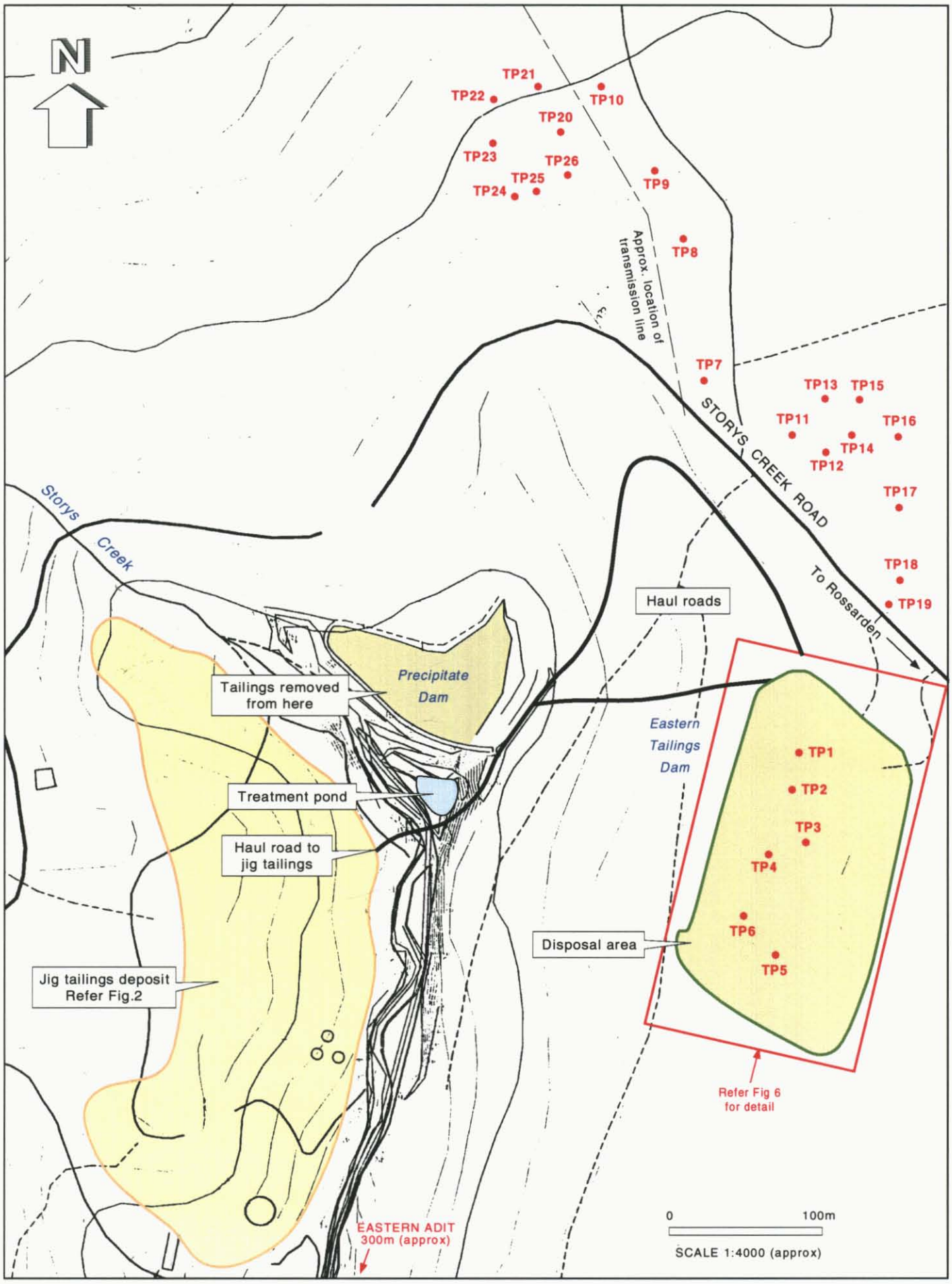
This report details a design and costing for the proposed relocation and encapsulation work. It also provides an estimate of costs for the completion of the clay capping and revegetation of the dump, if it is decided not to proceed with the Jig Tailings relocation.

2.0 MATERIAL CHARACTERISTICS

2.1 Physical

The jig tailings are the by- product of the processing of the Storys Creek ore. The heavier minerals were separated and the lighter jig tailings discarded. They are principally a coarse sand with some finer materials as the result of weathering and fracture. These materials are free flowing and highly erodible.

Large piles of tailings were deposited on the steep slopes adjoining the creek and cover an area of approximately 14 ha. As a result, tailings have been eroded into Storys Creek and form substantial riverine deposits between the mine site and Rossarden.



● TP1 Approximate location of test pit

5 cm

(June 2000)

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Storys Creek Remediation
Storys Creek Area Plan

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FIG 1

Laboratory infiltration tests indicate a permeability of 10^{-4} cm/ sec for jig tails. This is high and indicates that nearly 300% of annual rainfall will infiltrate the jig tails (based on an annual rainfall of 960mm) and that all rainfall could be expected to leach from the tails in a short time frame.

2.2 Geochemical

The total element analyses of the tailings materials is shown in Table 1.

A sample containing jig tailings was analysed for pH, electrical conductivity and acidity (on a 1 part sample to 2 parts deionised water); and total sulphur, acid neutralising capacity (ANC) and the net acid generation (NAG) test. The results are presented in Table 2.

Table 1 Metal Element Analyses

Element	As	Al	Cd	Cu	Fe	Mn	Ni	Pb	Zn
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
ANZECC* F	**500**		**100**	**5000**		**7500**	**3000**	**1500**	**35000**
Jig Tails	150	13500	<10	100	15800	250	<10	220	80

* ANZECC Commercial/ Industrial

A sample containing jig tailings was analysed for pH, electrical conductivity and acidity (on a 1 part sample to 2 parts deionised water); and total sulphur, acid neutralising capacity (ANC) and the net acid generation (NAG) test. The results are presented in Table 2.

Table 2: Acid Forming Characteristics of Storys Creek Jig Tailings

Sample	pH 1:2	EC 1:2 dS/m	Acidity 1:2 $mgCaCO_3/L$	Sulphur %S	ANC	NAPP	NAGpH
Oxidised	4.2	0.237	218	0.08	2	3	4.7

ANC, NAPP in kgH_2SO_4/t

Table 2 shows that the tailings have only a low S content (less than 0.1%S) but also have negligible ANC. The NAGpH values is greater than 4 which indicates that the sample was non-acid forming. However, since the tailings are essentially devoid of ANC, the pH of material represented by these samples would be expected to decrease to about 4 to 4.5. Because of these low pH conditions, metal solubility were expected to be relatively high.

The results suggested that improving the buffering capacity of the tailings by the additional of crushed limestone, would significantly reduce the metal release rate from the tailings. It was therefore recommended that trials be conducted to evaluate the feasibility of raising the buffering capacity of the tailings by laboratory and field trials. These were carried to give confidence that the addition of crushed limestone would be effective.

These trials consisted of the application of crushed limestone and monitoring

pore water and runoff chemistry through time in a laboratory and in field large scale lysimiter trials. The results are discussed in detail in the Final report (JMP(2000).

The laboratory trials were very successful for the jig tailings. The tailings mixed at a rate of 10kg/tonne with crushed limestone, had leachates with a pH of over 7, low acidity and very low concentrations of metals.

The lysimeters installed in the jig tailing heap trials has shown that the leachates from the untreated Jig Tailings are of very poor quality, with low pH, and very high metal concentrations. The treated tailings showed a significant improvement with reductions in the order of 50%. However, the alkalinity added to the jig tails was at a rate of 5kg/tonne (less than the design 10kg/tonne).

It was concluded that the addition of crushed limestone at a rate of 10kg/tonne would be sufficient to improve the buffering capacity of the tailings and reduce significantly the metal release rate from the tailings.

Therefore, the placement of limestone in direct contact with oxidising materials has been demonstrated to provide immediate neutralisation and precipitation of any released metals at the source. An increase in pH will further reduce the oxidation rate. However, the complete mixing of limestone with all the oxidising material will not be possible - as the jig tailings deposits themselves are quite deep and it would only be possible to add limestone to the near surface zone.

Therefore, the only feasible method of reducing the leachates is to relocate the tailings materials to a secure site, mix the limestone with the tailings, and provide a cap to reduce infiltration and leachate volumes.

3.0 TAILINGS, RELOCATION, TREATMENT AND ENCAPSULATION

3.1 Quantities

A survey of the tailings deposits was carried out by G J. Walkem and Co. The plan of the jig tails deposits is shown in Figure 2.

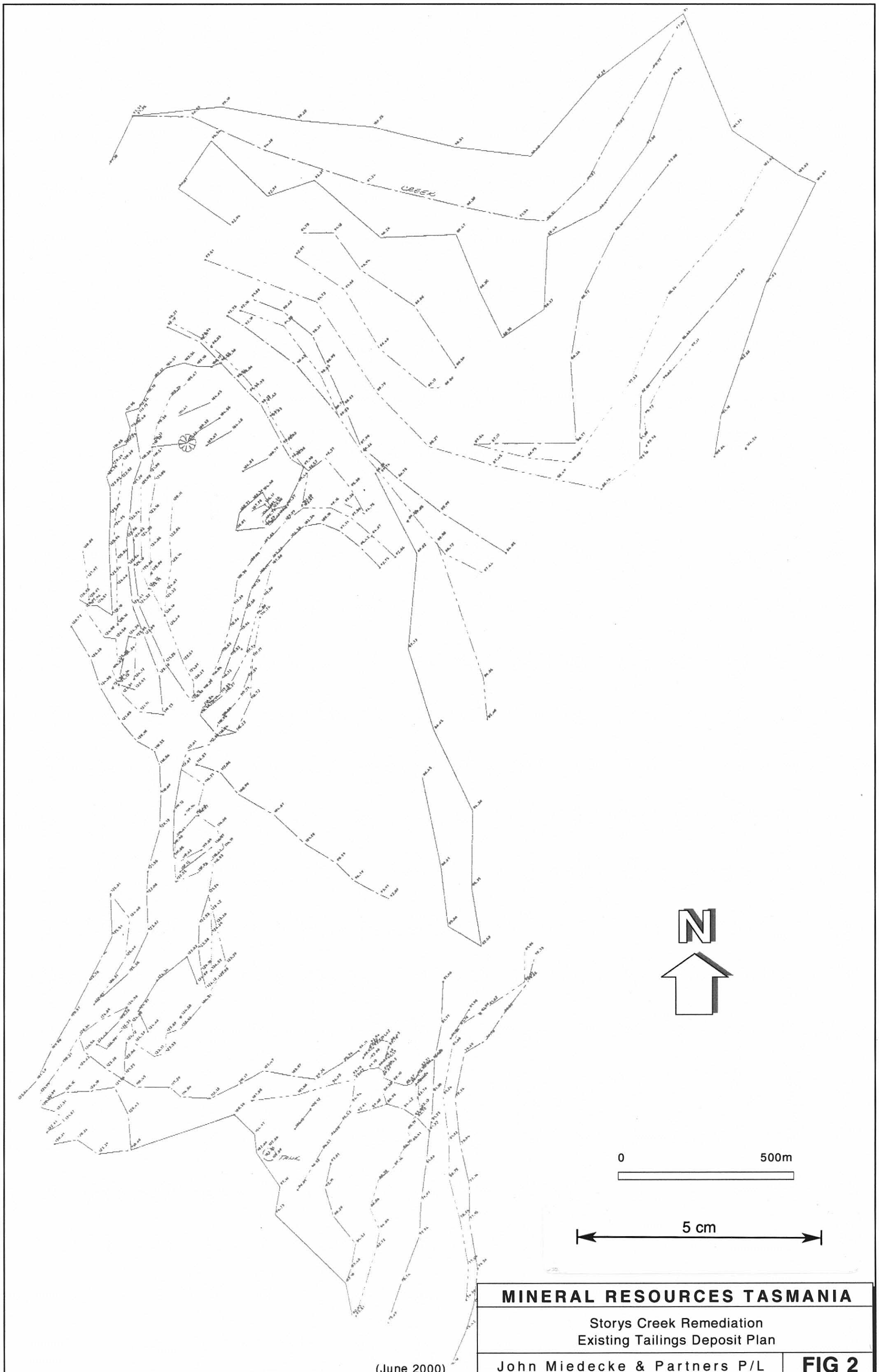
The estimate of jig tailings volumes was calculated at 43,800 m3. However, this has an accuracy of only +/- 20% as the underlying topography was difficult to establish and there was no pre-existing topographic survey information.

For earthmoving and contract purposes, volumes would need to be surveyed insitu at the disposal site to provide an accurate estimate of quantities relocated.

3.2 Trial Relocation

As a variation of the Precipitate Dam relocation contract, the Contractor (Becketts Heavy Plant Hire Pty Ltd) was engaged to remove approximately 2000m3 from the existing jig tailings dump on the western side of Storys Creek (see Figure 1) to the new tailings disposal area as a trial. This material was then spread over the surface of the Precipitate Dam materials.

A haul road and access was constructed over the creek.



(June 2000)

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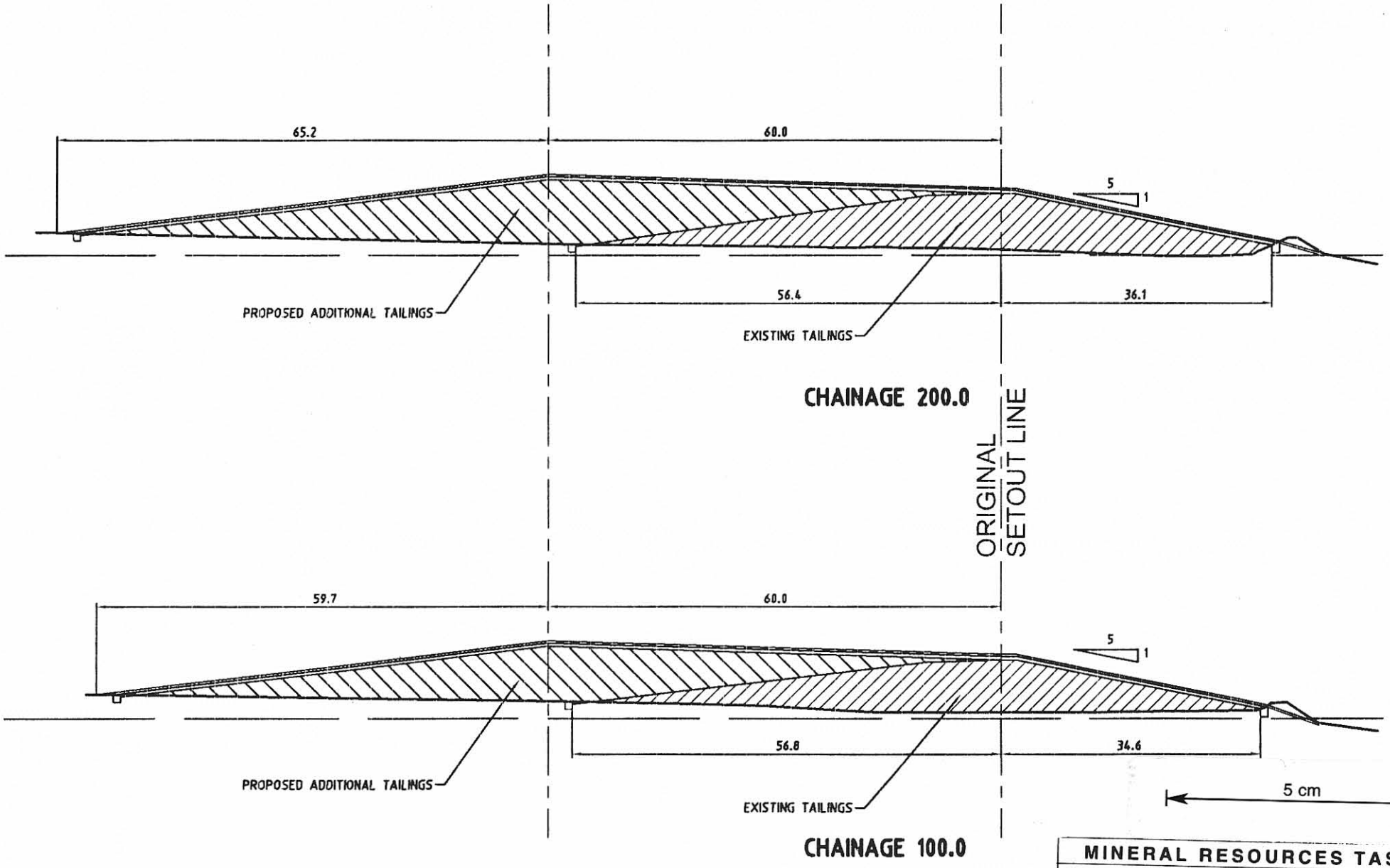
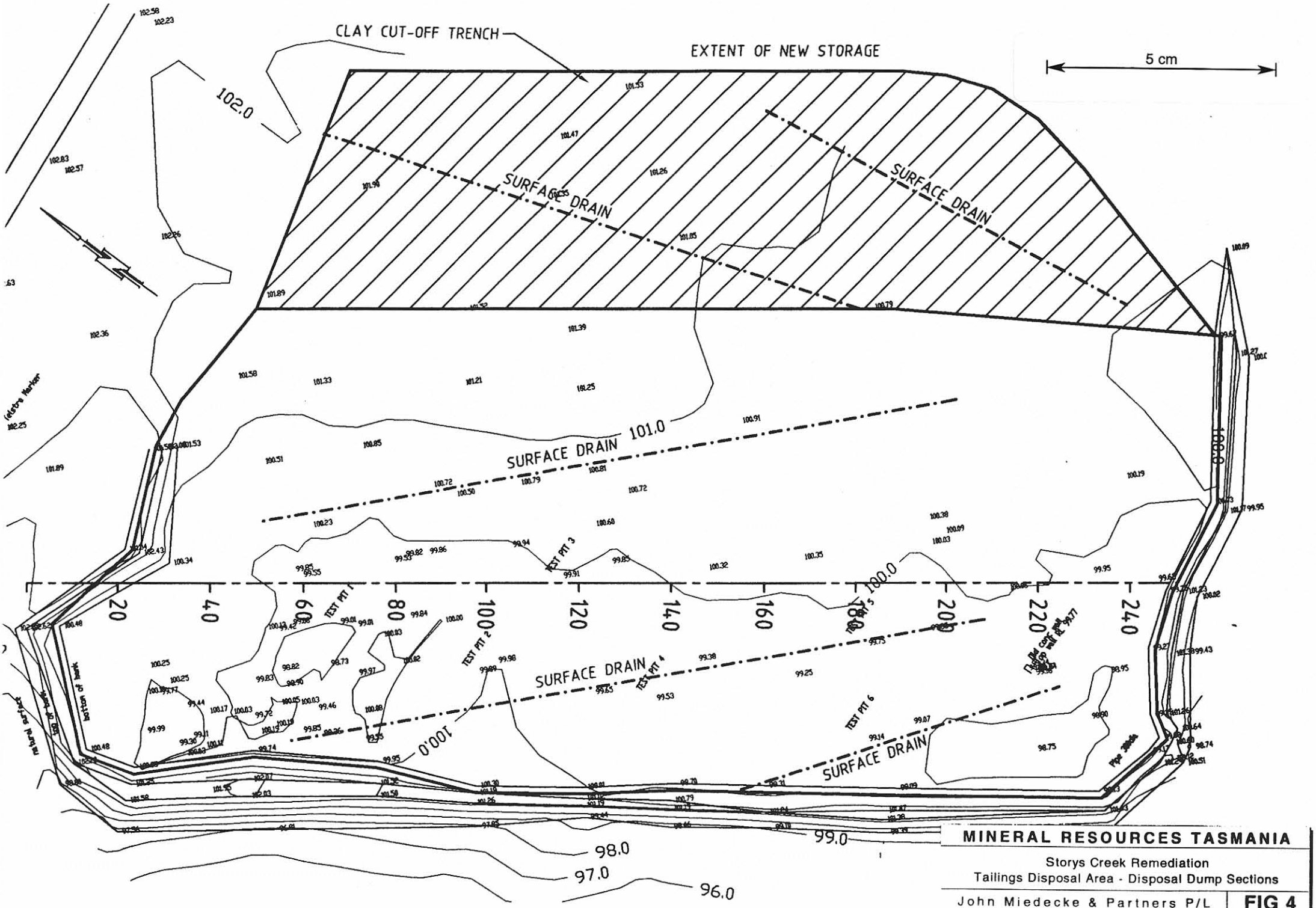
Storys Creek Remediation
Existing Tailings Deposit Plan

John Miedecke & Partners P/L

FIG 2



MINERAL RESOURCES TASMANIA	
Storys Creek Remediation Tailings Disposal Area - Disposal Dump Plan	
John Miedecke & Partners P/L	FIG 3



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Storys Creek Remediation
Tailings Disposal Area - Disposal Dump Sections

John Miedecke & Partners P/L | **FIG 4**

This trial was successful and there were no problems with the excavation, transport and dumping of the materials. The work was carried out with a 40t excavator and 30 tonne capacity Caterpillar dump trucks.

The jig tails were removed at the base of the slope and it was noted that the material slumped to almost the top of the dump.

3.3 Relocation Method

The trial showed that the majority of the material can be won by excavating the tails from the base (probably with a rubber tyred front end loader) and the majority of the tails will slump from the top of the dumps. The tailings can then be transported via the existing haul road network to the existing disposal site using dump trucks.

The remaining tails, including those in the Side Creek area, can either be removed by excavator and truck from the top of the dump via the public road, and/or rehandled to the base of the slope. This could be done with a small dozer.

The final clean up with tailings to be removed from isolated crevices and pockets, plus in areas surrounding significant heritage items is liable to be time consuming and difficult for a contractor to price adequately. It is therefore recommended that the final clean up should be done on an hourly basis at a schedule of rates and supervised.

Final clean up can be achieved by the construction of small settling ponds at the base of the slope to contain materials that will progressively be eroded in rainfall periods. These can then be periodically removed and disposed of to the dump site.

3.4 Disposal Site

3.4.1 General Arrangement

The tailings can be deposited at the rear of the existing dump, which has been used for the relocation of the Precipitate Dam tailings materials. This dump can be extended to the east and the top of dump extended to form a plateau, with the existing side slope batters maintained.

Only the western side of the dump has had the clay cap placed.

Figures 3 and 4 show the plan and sections of the proposed dump extension.

Small areas to the east will require clearing to provide the required area and the existing stockpiles of vegetation, topsoil and clay will need to be relocated. Side slopes will consist of between 1:4 and 1:6 side slopes to a maximum height of 10 metres which covers an additional "footprint area" of approximately XX hectares. It is proposed that provision would also be made for additional jig tailings placement in the future (for example from creek bank deposits).

3.4.2 Site Preparation

The majority of the site is already cleared and covered with the Precipitate Dam tailings materials. The required area to the east will be cleared of all vegetation (after recovery of any recoverable timber) and topsoils stripped

and stockpiled. The clay cutoff trench will be extended around the edge of the new dump.

3.4.3 Construction

Jig Tailings placement

As the permeability of the Jig tailings is high and that of the existing precipitate dam materials is low (similar to the clay cap) it is proposed that a 1metre deep layer of the existing tailings will be removed and then used to cap the jig tailings, with a final clay cap.

The Precipitate dam materials will be removed and stockpiled on the dump surface, with the Jig tailings placed in layers, track rolled and leveled.

Each layer will be treated with agricultural lime at a rate of 5kg/tonne.

After the final surface profile is achieved, the Jig Tailings will be covered with the replaced Precipitate Dam tailings to a depth of 1m, and compacted in layers, after a trial compaction (see next section). Figure 5 shows the proposed cap construction.

Alkalinity Addition

The geochemical testwork has shown that the addition of crushed limestone at the rate of 10kg/tonne would be sufficient to improve the buffering capacity of the tailings and eliminate almost all the metal release rate from the tailings in leachate.

Based on an estimate volume of 52,000m3, and a SG of 1.5 a total of 80,000 tonnes will require buffering. Therefore, a total of 800 tonnes of crushed limestone will be required to totally buffer the residual acidity. Based on a cost of $25 per tonne delivered, this would equate to a total of $24,000.

However, the jig tailings materials will be encapsulated and not directly exposed to rainfall with much lower infiltration rates and the application at this rate is believed to be too conservative. Therefore, it is recommended that the tailings should be treated at a rate of 25% of the above.

A total of 200 tonnes should be spread over the tailings in two or three applications prior to encapsulation. Any rainfall infiltrating the cap would therefore contain significant alkalinity

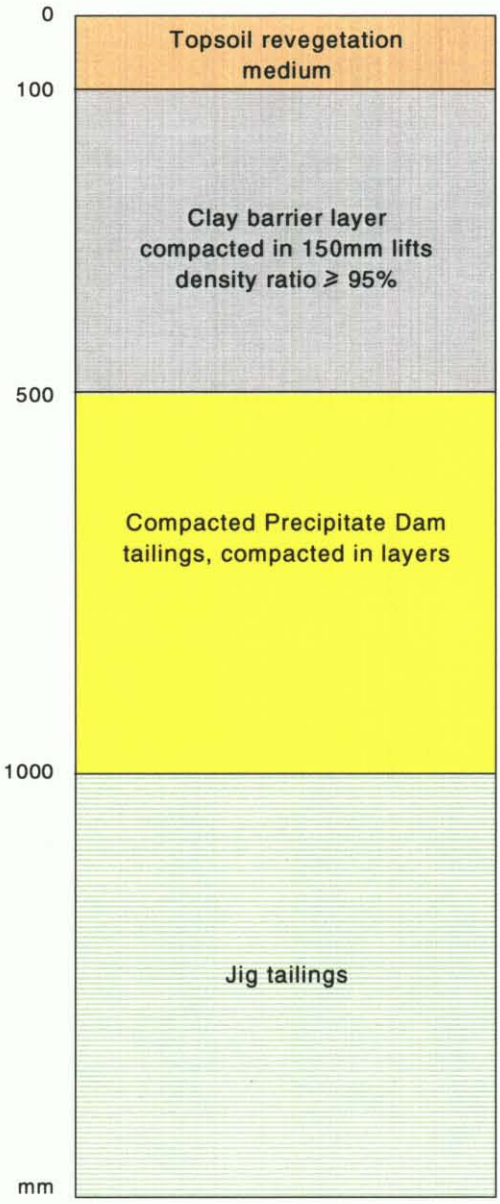
Capping

Laboratory permeability testing of the existing precipitate dam tailings materials have shown that they have a permeability of 2.2 $x10^{-9}$ m/sec (see Appendix A).

This is less permeable than the designed cap specifications used for the cover of the precipitate dam tailings materials of $< 5x10^{-9}$ m/sec. Therefore, the precipitate dam materials are recommended to be used as a additional clay cap for the Jig Tailings to further reduce infiltration. A test panel would need to be track rolled to determine the required number of passes to achieve the desired compaction.

The clay capping would then be placed in layers to a minimum 95% compaction and keyed into the cutoff trench at the edges.

The specification for the clay cap is set out in Table 3.



MINERAL RESOURCES TASMANIA	
Storys Creek Remediation Jig Tailings Relocation - Capping Design	
John Miedecke & Partners P/L	**FIG 5**

(June 2000)

3.4.4 Clay and Topsoil Sources

The previous construction activities have stockpiled clay on the eastern side of the storage area. It is anticipated that there will be sufficient clay within the extended surface area to provide the required quantities for the cover.

The existing stockpiles and overlying subsoils/topsoils will also be sufficient for revegetation purposes.

TABLE 3: Barrier Clay Material Specification

Test	Properties
Particle Size	
Percent Passing 75µm Sieve	> 40
Atterberg Limits	
LL	> 30
PI/(LL-20)	> 0.73
Permeability (m/sec)*	$< 5x10^{-9}$
Emerson Class Number	3, 4 or 5
Organic Content	< 1%

Permeability tests to be on samples compacted to a Dry Density Ratio of 95% Standard, at a moisture content in the range (OMC - 0.25)% to (OMC + 0.25)%.

3.5 Environmental Management

3.5.1 Water Quality and Leachates

A crossing will be constructed across Storys Creek with culverts for a low level crossing. The contract will require the crossing edges to be bunded. In addition, work adjoining Storys Creek will require the construction of bunds adjoining the creek.

3.5.2 Heritage

There are structures and equipment, including adit entrances, which have significant heritage values. These will need to be identified and boundaries marked with tape prior to removal of jig tailings in the area. Final clean -up will require close supervision in proximity. Any items uncovered will need to be salvaged

3.6 Rehabilitation

3.6.1 Dump Area

After placement, compaction of the tailings and clay capping, the surface will be contoured and the surface covered with stockpiled A2 horizon and topsoils.

Contour drainage bank(s) will be mounded at the required intervals.

Drainage will be directed to the natural surface from the contour bank(s).

Revegetation will consist of planted Poa grasses, and seeded with native species.

3.6.2 Existing Dump Area

It is likely that all materials underlying the tailings will be contaminated and final clean up will expose mostly bare rock. Rehabilitation options are to leave the rock exposed (the most practical and recommended option) or to introduce a revegetation medium. This has not been costed.

In either case it is proposed that the area be topdressed with crushed limestone (50t), using a truck based spreader. Sediment traps will be constructed at the base of the slope to contain eroded tailings materials from the slopes.

4.0 ESTIMATE OF COSTS

The estimate of costs is set out in Table 4. The costs of completing the capping and revegetating the site if the Jig Tailings relocation does not proceed, is set out in Table 5.

TABLE 4 ESTIMATE OF COSTS TO RELOCATE JIG TAILINGS

ESTIMATE FOR CONSULTANTS FEES
AND
THE RELOCATION OF JIG TAILINGS AND ASSOCIATED WORKS
AT
STORYS CREEK

27 JULY 2000

ESTIMATE FOR CONSULTANTS FEES

REF	DESCRIPTION OF THE WORK	AMOUNT $
1.0	DESIGN, TENDER AND CONSTRUCTION DOCUMENTS	7,000-00
2.0	TENDERING PROCESS AND RECOMMENDATIONS	2,500-00
3.0	CONSTRUCTION MANAGEMENT	16,000-00
4.0	SURVEY	4,000-00
5.0	PROJECT REPORT	2,500-00
6.0	**SUB TOTAL**	**32,000-00**
7.0	GST 10%	3,200-00
8.0	**TOTAL**	**35,200-00**

ESTIMATE INCLUDES TRAVELLING AND OUT OF POCKET EXPENSES

ESTIMATE FOR RELOCATION OF JIG TAILINGS AND ASSOCIATED WORKS

REF	ITEM	QUANTITY	UNIT	RATE $	AMOUNT $
1.0	SITE ESTABLISHMENT		ITEM	-	14,500-00
2.0	CARE OF THE WORKS		ITEM	-	5,000-00
3.0	PREPARE DAM SITE	9,000	M^2	0-46	4,140-00
4.0	CREEK CROSSING		ITEM	-	3,000-00
5.0	STOCKPILE TAILINGS	10,000	M^3	0-55	5,500-00
6.0	SPREAD TAILINGS	10,000	M^3	0-55	5,500-00
7.0	RELOCATE TAILINGS	52,000	M^3	3-50	182,000-00
8.0	FINAL CLEAN JT SITE	PC	ITEM	-	15,000-00
9.0	COLLECTION DAMS		ITEM	-	4,000-00
10.0	LIME DOSING JT'S	200	TONNE	35-00	7,000-00
11.0	LIME TO JT SITE	50	TONNE	35-00	1,750-00
12.0	CLAY CAPPING	9,506	M^3	4-80	46,440-00
13.0	CLAY CAPPING TOE	240	M^3	8-50	2,040-00
14.0	TESTING CLAY		ITEM	-	4,000-00
15.0	TOP SOIL LAYER	2,150	M^3	4-00	8,600 -00
16.0	REVEG	21,500	M^2	0-60	12,900-00
17.0	DEMOBILISE SITE		ITEM	-	5,500-00
18.0	CONTINGENCY		ITEM		10,000-00
19.0	**SUB TOTAL**				**336,870-00**
20.0	GST 10%				33,687-00
21.0	**TOTAL**				**370,557-00**

JOHN MIEDCKE AND PARTNERS PTY LTD
JOHN W WILSON PROJECT MANAGER

MPA WILLIAMS AND ASSOCIATES
MICHAEL HUNN CIVIL ENGINEER

TABLE 5 ESTIMATE OF COSTS TO COMPLETE CLAY CAPPING AND REHABILITATE THE SITE.

ESTIMATE FOR CONSULTANTS FEES
AND
COMPLETING THE CLAY CAPPING AND ASSOCIATED WORKS
IF NEGOTIATED WITH BECKETTS HEAVY PLANT HIRE
AT
STORYS CREEK

10 AUGUST 2000

ESTIMATE FOR CONSULTANTS FEES

REF	DESCRIPTION OF THE WORK	AMOUNT $
1.0	NEGOTIATE WITH BECKETTS	500-00
3.0	CONSTRUCTION MANAGEMENT	3,000-00
4.0	SURVEY	1,000-00
5.0	PROJECT REPORT	1,000-00
6.0	**SUB TOTAL**	**5,500-00**
7.0	GST 10%	550-00
8.0	**TOTAL**	**6,050-00**

ESTIMATE INCLUDES TRAVELLING AND OUT OF POCKET EXPENSES

ESTIMATE FOR COMPLETING THE CLAY CAPPING AND ASSOCIATED WORKS

REF	ITEM	QUANTITY	UNIT	RATE $	AMOUNT $
1.0	SITE ESTABLISHMENT		ITEM	-	4,000-00
2.0	CARE OF THE WORKS		ITEM	-	1,000-00
3.0	LIME DOSING TAILINGS	50	TONNE	35-00	1,750-00
4.0	CLAY CAPPING/ROADS		ITEM		25,950-00
5.0	TESTING CLAY		ITEM	-	2,000-00
6.0	TOP SOIL LAYER	1,100	M^3	3-20	3,520-00
7.0	REVEG	15,000	M^2	0-60	9,000-00
8.0	DEMOBILISE SITE		ITEM	-	4,000-00
9.0	CONTINGENCY		ITEM		2,000-00
10.0	**SUB TOTAL**				**53,220-0**
11.0	GST 10%				5,322-00
12.0	**TOTAL**				**58,542-00**

NOTE:
THE COST OF REVEGETATING THE HAUL ROADS IN THE ABOVE IS $9,350-00

References

Miedecke 1998. Storys Creek/Rossarden Acid Drainage Remediation Study – Preliminary Report . John Miedecke and Partners, March 1998.

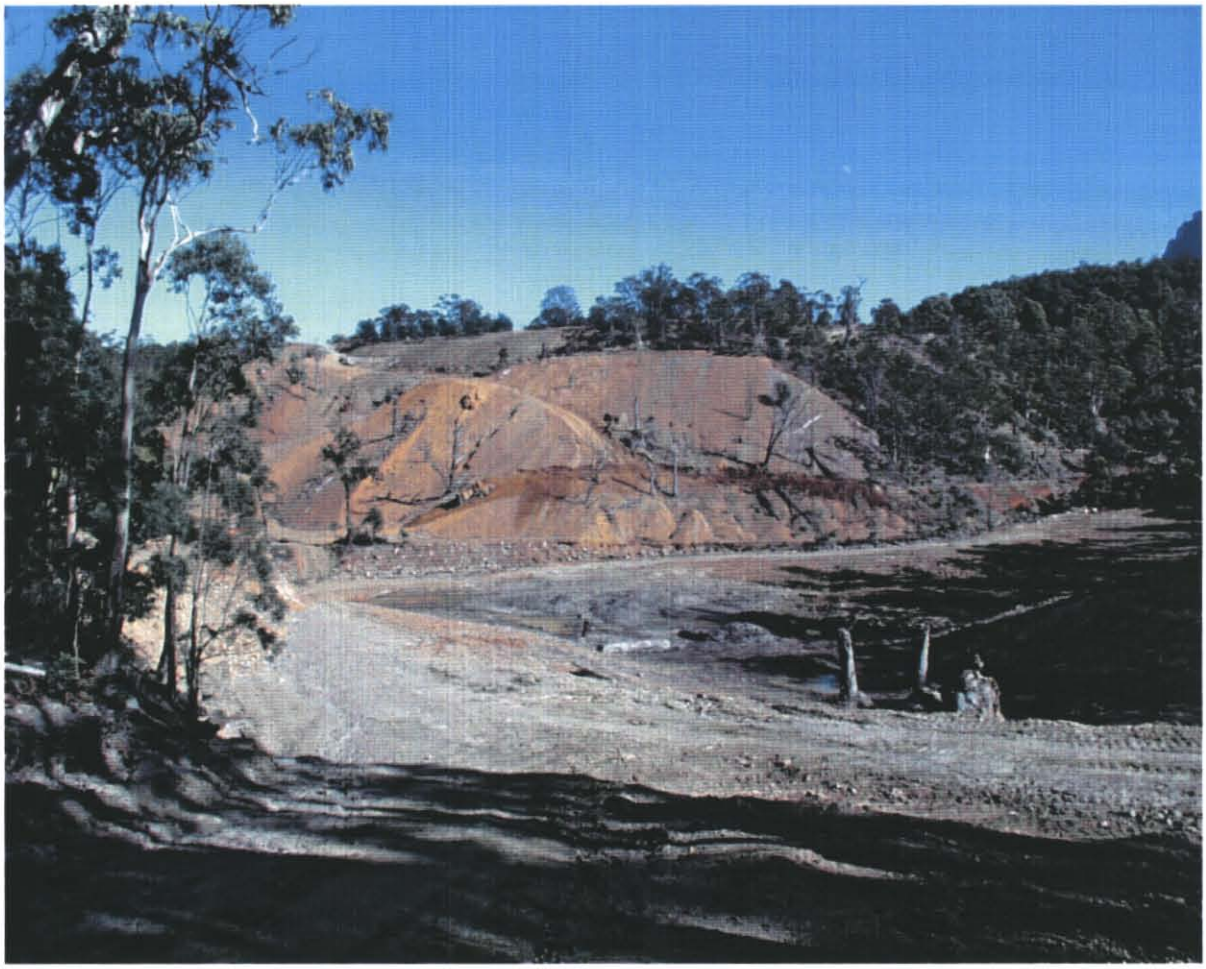
Miedecke 1999. Storys Creek/Rossarden Acid Drainage Remediation Study – Precipitate Dam Relocation Design Report. John Miedecke and Partners, 1997 March 1999.

Miedecke 2000a. Storys Creek/Rossarden Acid Drainage Remediation Study – Final Report John Miedecke and Partners, June 2000.

Miedecke 2000b. Storys Creek Remediation . Precipitate Dam Relocation Construction Report John Miedecke and Partners, July 2000.

APPENDICES

Appendix A BFP Permeability testing results



Jig Tailings deposits viewed from the east

Jig Tailings deposits viewed from the north near Storys Creek

Jig Tailings deposits viewed from the east. Showing creek banks and old equipment.

Adit entrance in jig tailings dumps

Crushed limestone addition to jig tailings on disposal area

Dozer flattening jig tailings for limestone addition