MINERAL RESOURCES TASMANIA

STORYS CREEK

PRECIPITATE DAM RELOCATION DESIGN REPORT

John Miedecke and Partners Pty Ltd • March 1999

JOHN MIEDECKE
AND
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Mineral Resources Tasmania

STORYS CREEK

PRECIPITATE DAM RELOCATION DESIGN REPORT

MARCH 1999

TABLE of CONTENTS

LIST OF FIGURE AND TABLES

APPENDICES

1.0 INTRODUCTION

The "Precipitate Dam" is located near the abandoned workings of the mine, at Storys Creek. The dam, which is believed to have been operated from the 1960's to the early 1980's, has been constructed on the eastern bank of the creek. The dam has had incidences of overtopping and spillage during flood events.

In 1994 the dam was capped with clay and attempts made to revegetate the surface.

Monitoring of groundwater levels at two standing piezometers have subsequently shown that the capping has been ineffective in reducing infiltration and that water levels in the dam remain high and respond to seasonal influences. While monitoring data on flows is not sufficient to make a comparison, it is also believed that leakage from the dam has continued at a similar rate and that the seepage remains a major point source load of metals to Storys Creek.

The location of the dam close to the Creek, with subsequent continued risk from flooding and possible erosion of the embankments, and the lack of room for any effective treatment of the leachates, has lead to the further consideration of relocation of the dam and contents.

As a result, MRT and River Works have funded a program of site investigations and design for the relocation of the dam to an existing disturbed site some 200m further away from the Creek.

This report documents the results of these investigations and a design for the new disposal area.

It also details the results of site investigations and the location of a concrete plug to block the Eastern Adit, which contributed acid drainage and metals to Storys Creek.

2.0 SITE INVESTIGATIONS

2.1 DRILLING PROGRAM

A drilling program was conducted over the surface of the Precipitate Dam to quantify the contents. The results of this program are set out in the report dated 29 September 1998. This report is attached as Appendix A.

2.2 DISPOSAL SITE AND CLAY BORROW AREA SITE INVESTIGATIONS

MPA Williams and Associates Pty Ltd, Consulting Geotechnical Engineers completed a program of test pitting and materials testing in December 1998. Their complete report is produced as Appendix B to this report (also refer Figure 1) .

2.3 DISPOSAL SITE TOPOGRAPHIC SURVEY

The general area of the existing eastern tailings dam has been detail surveyed by a licensed surveyor and the data digitised and used for the design of the disposal area.

2.4 GEOCHEMICAL TESTWORK.

Samples of wet sediment, comprising in situ tailings were submitted for geochemical testing by EGi in Sydney.

Their report and results are attached in Appendix C.

Basically the materials are not highly acidic. Rates for the application of hydrated lime to the tailings to maintain an alkaline pH and to waters to maintain a pH of approx 8.5 have been calculated at:

- tailings 56gms of lime per tonne of tailings
- waters 210 mg of lime per tonne of tailings

2.5 EASTERN ADIT SITE INVESTIGATIONS

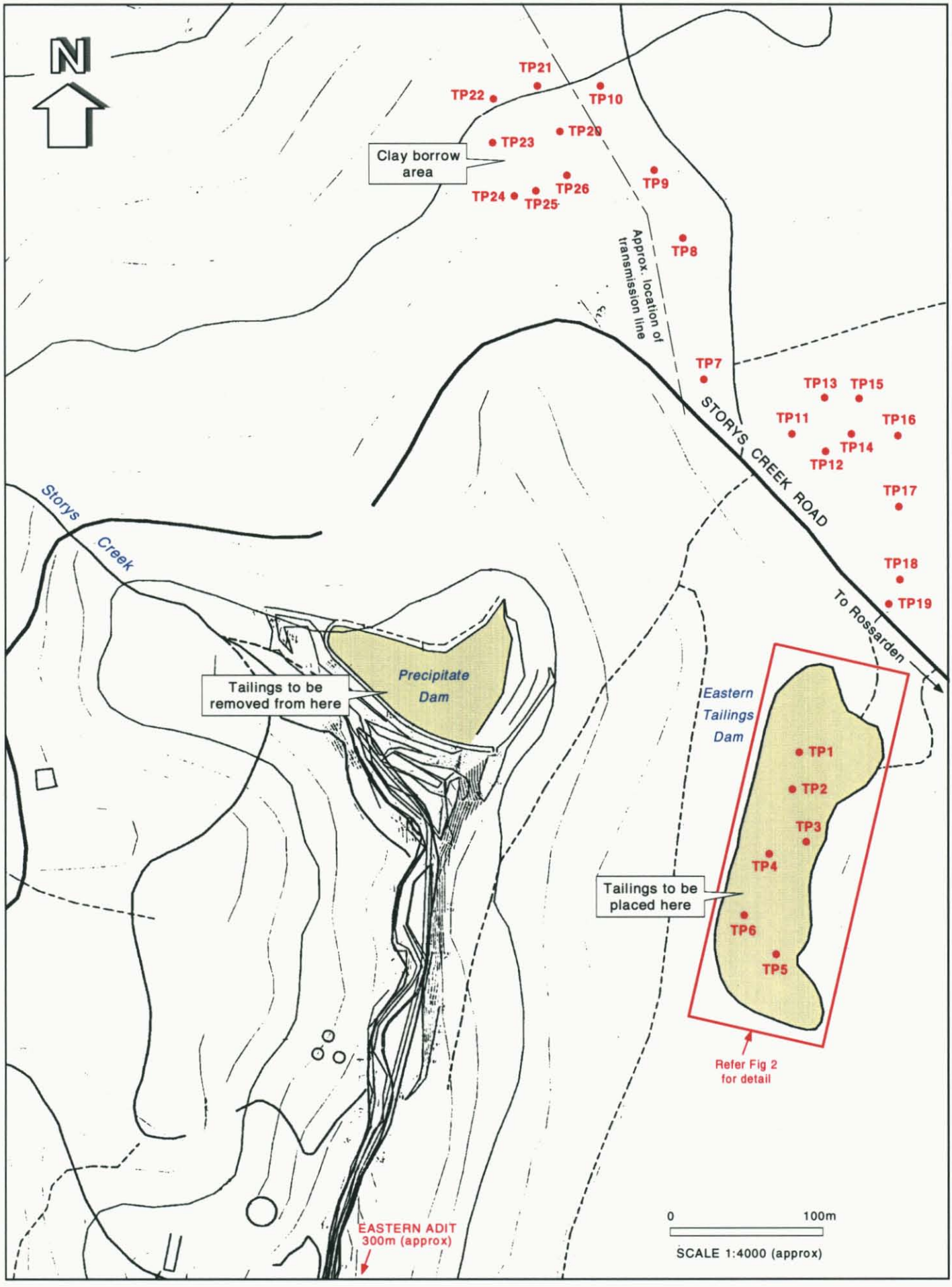
Mr David Wilson from the Hydro Electric Corporation Water Resources Section conducted an engineering geology investigation of the eastern adit and identified a suitable site for a concrete plug. This report of the investigations is attached as Appendix D.

3.0 DISPOSAL SITE AND DESIGN

3.1 DISPOSAL SITE DESCRIPTION

The area selected for the relocated tailings, is an existing disturbed area adjoining the Storys Creek road and known as the Eastern tailings dam (Figure 1) . This was the site of the proposed new tailings dam for the mine in the 1970's before the decision was made to cart ore to the Rossarden Plant and cease on-site processing.

This site has been identified, investigated and detail surveyed (refer Figure 2). It occupies an area of approximately 2.3 ha . The area has been previously stripped and has part of the site covered with tailings to a depth of between 0.1 to approximately 1m. It is accessible to wheeled and tracked machinery. The topsoil and subsoil has been previously removed and forms an embankment around the site. These materials are suitable for return and reuse as a growth medium.



● TP1 Approximate location of test pit

5 cm

(March 1999)

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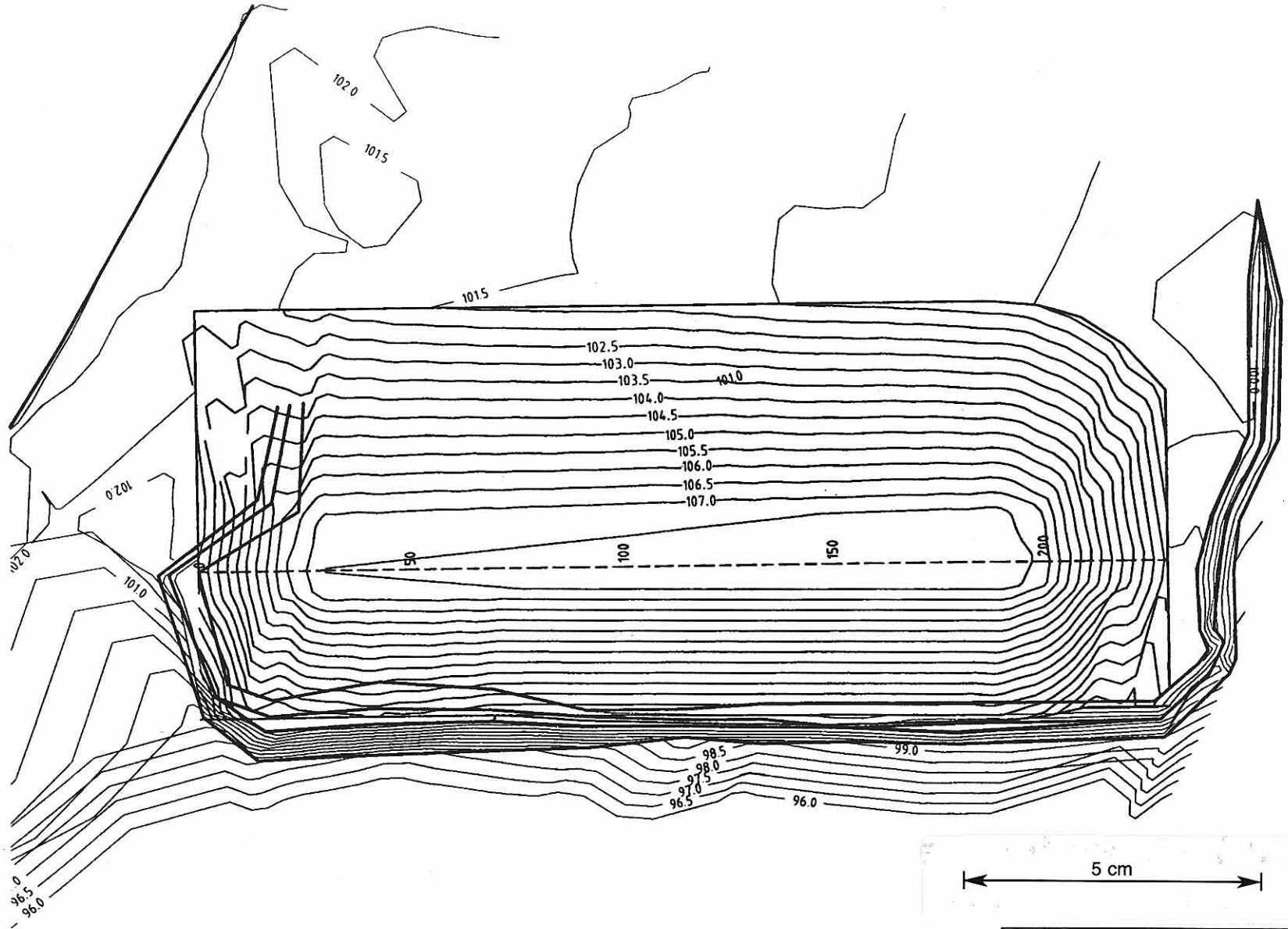
Storys Creek & Rossarden AD Remediation Projects
Precipitate Dam Area - Location

John Miedecke & Partners P/L | **FIG 1**



Scale as shown

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Storys Creek & Rossarden AD Remediation Projects
Precipitate Dam Relocation - Proposed Site Plan

(March 1999) | John Miedecke & Partners P/L | **FIG 2**

3.2 DESIGN

3.2.1 General Arrangement

The tailings will be deposited in a mound, generally within the existing disturbed area and at the northern end of the existing tailings dam. Figures 2 and 3 show the plan and sections of the proposed storage. Small areas to the east will require clearing to provide the required area. Side slopes will consist of between 1:4 and 1:6 side slopes to a maximum depth of 10 metres which covers an area of approximately 2.3 hectares. The slopes will grade into the base of the existing embankment which will be graded over the final surface.

The balance of the Eastern tailings dam site will be regraded and covered with the wall materials and revegetated.

3.2.2 Site Preparation

The majority of the site is clear and is located on a variable depth of tailings. The remainder of the area will be cleared of all vegetation (after recovery of any recoverable timber) and topsoils stripped and stockpiled.

The edges of the storage will be excavated through any tailings materials to basement materials and filled with clay

3.2.3 Construction

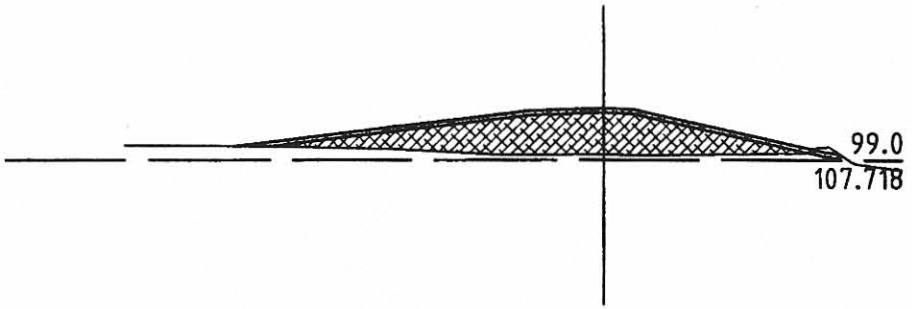
The Precipitate dam materials will be excavated from the existing dam and placed in layers and track rolled at the new disposal site. Each layer will be treated with lime in accordance with the geochemical report recommendations.

The clay capping would be constructed in layers to a minimum 95% compaction and keyed into bedrock through the underlying tailings materials. The surficial drainage layer would be track rolled and the final topsoil layer placed on the surface, tined and drainage berms established. The final surface would be revegetated by revegetation with a cover crop and native grass, shrub and tree species.

3.2.4 Encapsulation

MPA Williams have prepared a cover design for the capping and located a suitable clay source (Figure 4).

The cover design has been completed and infiltration modelled using the HELP program. The cover consists of 150mm of topsoil/ growth medium, 150mm of sands/gravel drainage layer and 450m of compacted clay over 200mm of gravel/sands (from the precipitate dam) track rolled as a cover of the tailings which will be placed in layers. The cover will be keyed into bedrock on all sides.



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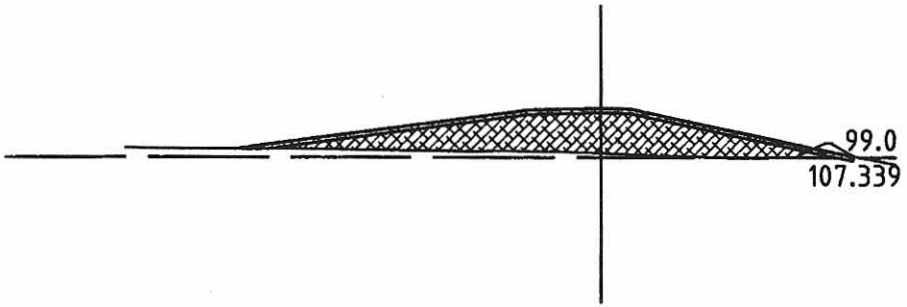

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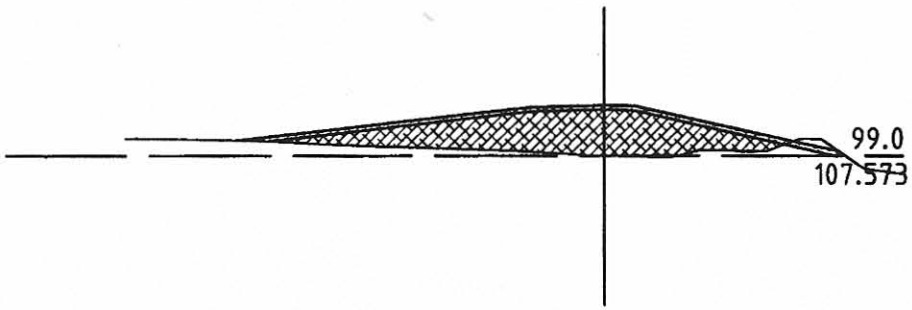
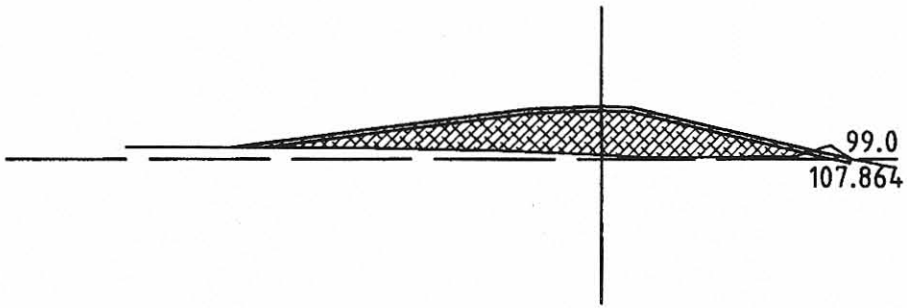


50.0



150.0

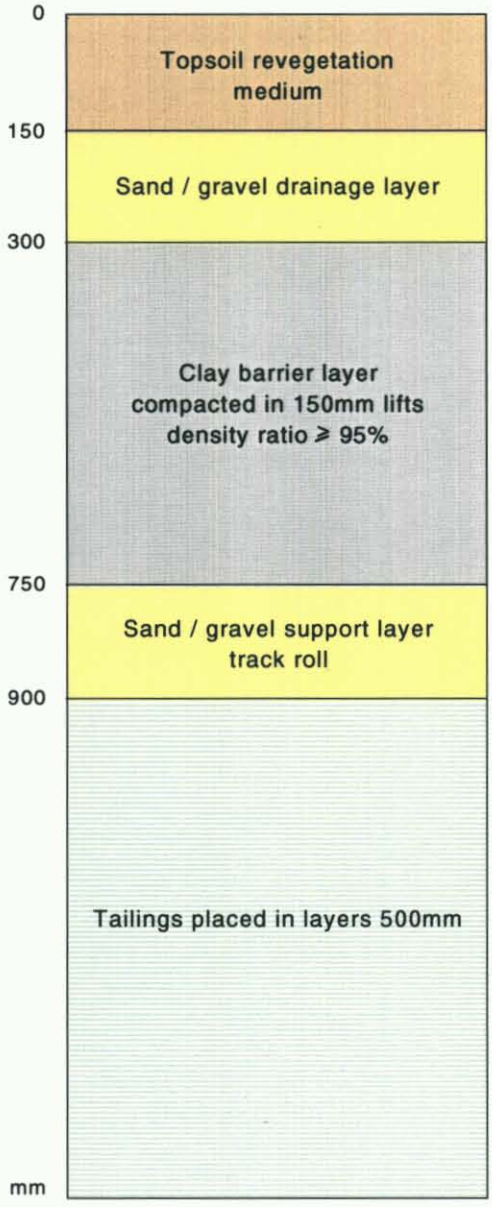
5 cm

Scale as shown

MINERAL RESOURCES TASMANIA

Storys Creek & Rossarden AD Remediation Projects
Precipitate Dam Relocation - Sections

(March 1999) John Miedecke & Partners P/L **FIG 3**



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Storys Creek & Rossarden AD Remediation Projects
Precipitate Dam Relocation - Cover Design

(March 1999)

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

3.2.5 Clay Source

Site investigations have identified a suitable clay source adjoining the transmission line, adjacent to the previous borrow area (see Figure 1). Geotechnical testing has been carried out and suitable clays have been identified which are highly impermeable (permeability of 10^{-9}m/sec). Clays can be sourced from this area, with overlying subsoils/topsoils also suitable for revegetation purposes.

3.2.6 Other Materials

Topsoil will be recovered from the clay borrow area and from the existing windrowed materials. The drainage gravel/sands will either be recovered from the coarser sandy precipitate dam materials (subject to geochemical suitability) or sourced from the Rossarden jig tailings.

3.2.7 Environmental Management

Waters enclosed within the existing precipitate dam are acid and with elevated metals . They will require temporary storage and treatment with lime to raise the ph to pH 8 prior to release. It is expected that two small dams (say 50m3) will be constructed immediately below the existing embankment where all drainage will be directed . Lime will be added to the stored water with a settling period (minimum of 4 hrs) prior to discharge to Storys Creek. Records are to be kept of volumes treated and lime additions.

The tailings will be treated with lime during placement (see Section 3.2.3)

3.2.8 Rehabilitation

Existing Precipitate Dam Site

The existing clay cover on the dam (approximately 300mm thick) will be retrieved and stockpiled for later replacement on the floor of the storage after the tailings materials are removed. The soils will be limed and then fertilised and revegetated with planted Poa grasses, trees and shrubs, and seeded with native species.

The original creek will be realigned.

A remnant of the existing wall will be left for historical purposes.

New Site

All vegetation will be removed from areas to be disturbed and topsoils/subsoils stockpiled.

After placement, compaction of the tailings and clay capping the surface will be contoured. The existing wall materials will be pushed over the placed tailings and topsoils placed over the surface with contour drainage banks mounded at the required intervals.

Drainage will be directed to the natural surface from the contour banks.

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

4.0 BLOCKING OF EASTERN ADIT

The adit will be blocked with a concrete plug 2 m in length (approx 4m3). A location some 30m from the entrance. The walls and base will need to be scaled, high pressure washed and treated with slush cement prior to pouring the plug.

5.0 ESTIMATE OF COSTS

The estimate of costs is set out in Table 1. These are based on estimated contract prices.

TABLE 1 ESTIMATE OF COSTS.

Item	Quantity m3 and m2	Rate $	Total $
Establish	item		4000
prepare dam site	item		3500
Load and cart tails m3	65000	3.2	208000
Load and place clay m3	10235	5	51175
Cart and place gravel m3	3410	4.5	15345
Cart and place topsoil m2	3415	5	17075
Clean up replace soil	item		3000
Lime and treat water	item		1000
Add lime to tails	item		1500
Rehab both sites m2	30000	0.5	15000
Place 6m3 plug in adit	item		5000
Engin design, superv, survey	item		36000
			360595

APPENDICES

Appendix 1 Tailings Dam Investigation Report

Appendix 2 MPA Williams Investigation Report

Appendix 3 EGi Geochemistry Report

Appendix 5 HECEC Eastern Adit Geological Assessment

Appendix 1 Tailings Dam Investigation Report

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Mineral Resources Tasmania

STORYS CREEK

PRECIPITATE DAM DRILLING REPORT

29 September 1998

1.0 INTRODUCTION

The Precipitate Dam is located near the abandoned workings of the mine, at Storys Creek. The dam, which is believed to have been operated from the 1960's to the early 1980's, has been constructed on the eastern bank of the creek. The dam has had incidences of overtopping and spillage during flood events.

In 1994 the dam was capped with clay and attempts made to revegetate the surface.

Monitoring of groundwater levels at two standing piezometers have subsequently shown that the capping has been ineffective in reducing infiltration and that water levels in the dam remain high, and respond to seasonal influences. While monitoring data on flows is not sufficient to make a comparison, it is also believed that leakage from the dam has continued at a similar rate and that the seepage remains a major point source load of metals to Storys Creek.

The location of the dam close to the Creek, with subsequent continued risk from flooding and possible erosion of the embankments, and the lack of room for any effective treatment of the leachates, has lead to the further consideration of relocation of the dam and contents.

As a result, MRT have funded a program of drilling , geological logging, geochemical testing and survey of the dam .

This report documents the results of these investigations.

2.0 DRILLING PROGRAM

A total of seven holes were drilled using a Stacpoole Drilling Mobile B40 drilling rig with hollow flight augers. A rock road way was constructed onto the dam surface and a road reconstructed from the main Story's Creek road.

The location of the seven holes are illustrated on Figure 1 and the reduced level (to an arbitrary datum) surveyed. Each hole was logged and the results are shown in Table 1. The bottom of each hole was noted for quantity survey purposes. Composite samples were taken of representative materials throughout the profile for geochemical testwork.

The drill logs are consistent with a typical tailings dam with a mixture of coarser (sand size) and fine (slimes) tailings materials. This is attributed to the spiggotting

Date 23/9/98	Scale 1 : 1000	Datum..... Arbitrary 0.5 interval	Ref: MIED01 CP02

SHAPE AS SURVEYED

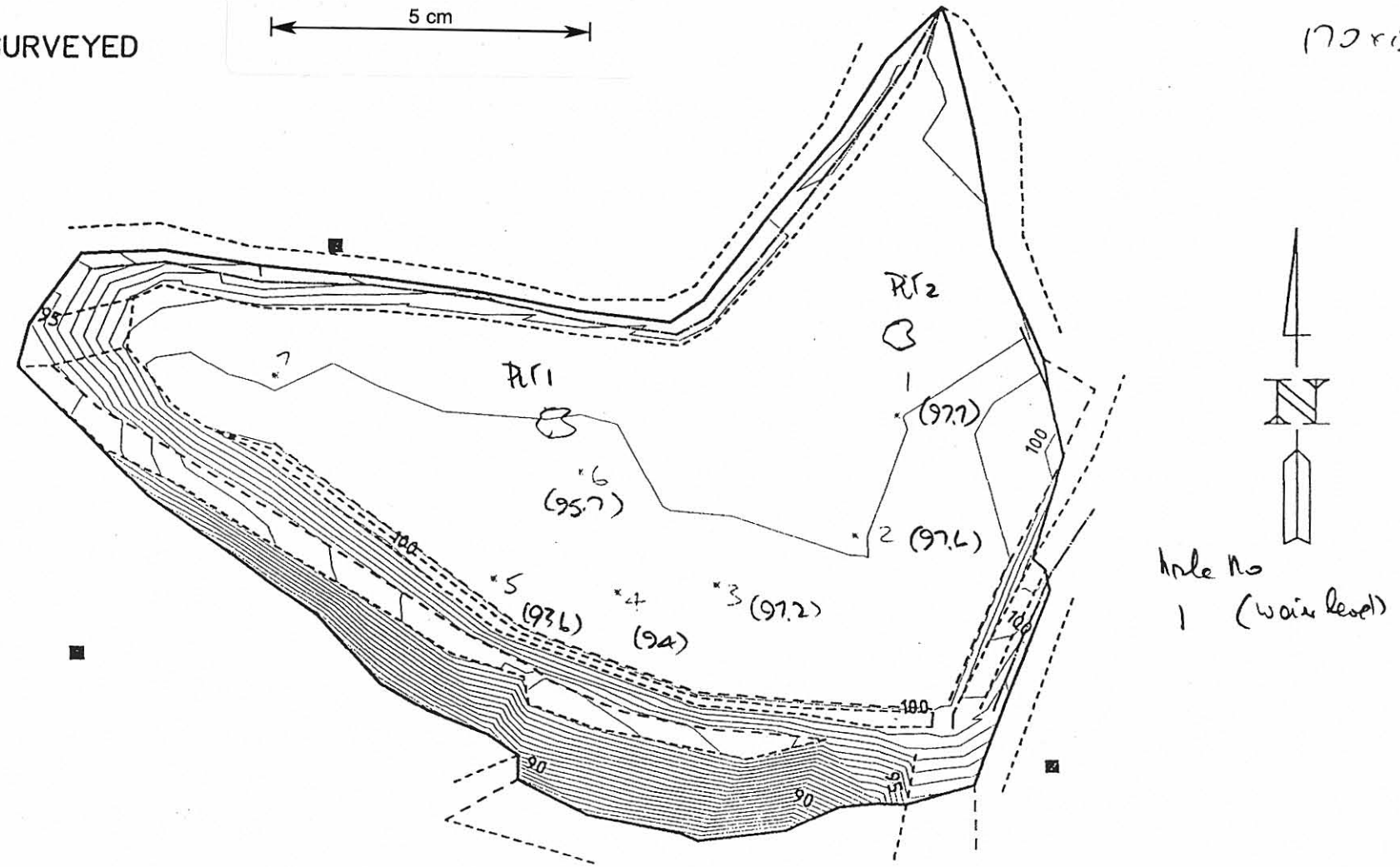

Figure 1

Storys Creek Precipitate Dam
Auger Drilling Location Plan

john miedecke and partners pty ltd.

Table 1 Story Creek Precipitate Dam
Auger Drilling

Hole No	
1	
Depth	
0 -0.6	Clay cap
0.6 -1.5	soft brown grey sludge
1.5 - 3	brown sludge sandy water sat
3.0 - 4	sand
4.0 - 5	sand
5.0 -6	sand soft grey sludge
6.0 -7.10	sand
7	end of hole
2	
Depth	Description
0 -0.7	Clay cap
0.7 -1.5	soft brown grey sludge
1.5 - 3	grey sludge ext soft gravel bands
3.0 - 4.5	grey sludge ext soft gravel bands
4.5 - 6	grey sludge ext soft gravel bands
6.0 -7.0	grey sludge ext soft
7	end of hole soil and vegn
3	
Depth	Description
0 -0.6	Clay cap
0.6 -1.5	grey brown silt/clay firm
1.5 - 3	grey sludge soft
3.0 - 4.5	grey sludge soft sandy
4.5 - 6	grey sludge ex soft sandy
6.0 -7.5	grey sand, some grey sludge
7.5 - 12.2	grey sand, some grey sludge
12	end of hole
4	
Depth	Description
0 -0.7	Clay cap
0.7 -1.5	firm brown clays and silts, gritty
1.5 - 3	grey sludge and bron clay soft
3.0 - 7.5	grey sludge ex soft sandy
9 - 10.5	grey sand
11	end of hole
5	
Depth	Description
0 -0.7	Clay cap
0.7 -1.5	yellow and brown soft sludge
1.5 - 3	yellow soft sludge
3.0 - 7.5	grey sandy sludge mod wet
7.5 - 10	grey sandy sludge
10	end of hole
6	
Depth	Description
0 -0.66	Clay cap
0.66 -1.5	yellow sludge ex soft
1.5 - 3	grey sand dry
3.0 - 4.5	grey sand moist
4.5 - 10	grey sandy sludge mod wet
10	end of hole
7	
Depth	Description
0 -0.7	Clay cap
0.7 -1.5	yellow and grey sludge ex soft
1.5 - 3	grey sludge ex soft
3.0 - 4.5	grey sandy sludge mod wet
3.0 - 7	grey sandy mod wet
7	end of hole

of tailings from various locations around the embankment which is believed to be the method of construction. These tailings materials are capped with a shallow (approx 0.7m) layer of fine residue which is believed to be from the caustic soda neutralisation of the Story Creek mine waters and the recently placed approx. 0.5m clay cap.

The water table within the storage was monitored by measuring the standing level in the boreholes (water levels are noted in Figure 1). This indicates that the tailings dam phreatic level is quite deep near the embankment, but rises sharply away from it. This is consistent with a dam constructed by spigotting tailings from the embankment. Water movements are expected to be through the storage, and expressed as the leakage at the base of the dam wall.

3.0 EXCAVATOR PITS

Two pits were excavated by a 30 tonne excavator at the locations shown in Figure 1.

Pit 1 was to a maximum depth of approximately 6 metres, the depth of the excavator boom, and Pit 2 to a depth of approximately 3.5metres when natural surface was reached.

Pit 1 was comprised of sand sized tailing particles, with damp materials (presumably the water table) nearly at the bottom of the pit. A this layer of clay was underlain by a 300mm layer of fine residue (caustic soda precipitate) . Underneath this material was a consistent coarse tailing material. Photograph 1 shows the pit.

Pit 2 consisted of a similar upper horizons, but with finer tailings saturated materials at depth, with subsequent wall failure (Photograph 3).

A water sample was taken from this pit and the results of the analyses are shown in Table 2, with the leachate water quality. Water quality is poor with high metal concentrations.

4.0 GEOCHEMICAL TESTWORK.

49 samples of wet sediment, comprising in situ tailings and applied capping material, were obtained from the site by seven shallow percussion drill holes (DH 1-9) and two excavation pits (EP 1-2) (Figure 1).
The field samples were logged and classified into 3 material types from which 10

composite samples were produced for analytical work by EGi to determine their acid generating characteristics.
The composite samples were grouped so that the acid generating capacity of the site could be evaluated in segments.
The ten composite samples taken from the drill holes, were submitted for geochemical testing by EGi Sydney.

Their report and results are attached in Appendix A.

Basically the materials are not highly acidic and addition of agricultural lime and a simple cover would be adequate for relocation.

5.0 QUANTITY SURVEY

Cromer and Associates, surveyors, prepared a plan of surface and assumed bottom contours. They have estimated a volume of 64,000m3. Their plan is attached as Appendix B.

6.0 CONCLUSIONS

The Precipitate Dam is composed approximately 95% of spiggotted tailings from the original processing of the ore. Only a shallow layer of acid water neutralisation precipitates caps these materials, which in turn is capped by clay.

The volume of the dam has been estimated at 64,000m3, which includes the outer wall and the enclosed materials. The tailings are free digging, but the rear of the storage will contain saturated materials which will contain significant quantities of waters which will have elevated metal concentrations. These materials should ideally be left to drain and blended with drier materials for cartage.

Geochemical testwork has shown that the tailings materials are not acid generating and therefore the source of the acid leachate is uncertain. It is possible that the waste rock placed as a buttress to the wall is the source, or some other materials which were not sampled within the storage.

Relocation and disposal will not therefore require a sophisticated cover.

Water quality of the contained waters are poor and will require neutralisation to raise the pH and precipitate metals prior to release to Storys Creek.

Appendix A EGi Report

EGi
ENVIRONMENTAL GEOCHEMISTRY INTERNATIONAL
Stuart D Miller
MANAGING DIRECTOR

TO	:	John Miedecke and Partners
ATTENTION	:	John Miedecke
FROM	:	Stuart Miller/Theresa Donohue
SUBJECT	:	Storys Creek Tailings Dam Sampling
DATE	:	30th September, 1998
PAGES (including this page)	:	3

John,

Ten composite samples were provided to EGi on 3rd September, 1998 for pH, electrical conductivity and acidity. The purpose of this test work is to determine the immediate lime requirement to neutralise existing acidity and precipitate any metals prior to relocation of the tailings to the new storage facility. The results of these analyses are provided below.

Analyses

The samples were analysed in their 'as received' condition. pH and electrical conductivity (EC) was measured on a 1:2 (sample: deionised water) extract left to equilibrate for at least 12 hours. This provides an indication of the inherent acidity and salinity of each sample. The water extract was then filtered and a 50 ml aliquot of the liquor titrated initially to pH 7 and then to pH 8.3 to determine the existing acidity of the tailings materials. This acidity result determines the amount of alkali required to bring the sample to pH 7 and pH 8.3.

Results

Table 1 gives the results of the testwork carried out as well as a description of the composite tailings samples. The 'as received' moisture content of each sample has been provided for your information.

The results show that all samples had pH results between 6.6 and 6.8. These results indicate that the samples have a near neutral pH. Electrical conductivity ranged from 0.28 to 0.51 dS/m which shows that the tailings materials are moderately saline. Determinations on the tailings samples indicated an acidity of nil to pH 7 and between 8 to 70 mg $CaCO_3$/kg to pH 8.3.

FAXED

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ACN 003 793 486

Precipitate Dam water quality results on pit water sampling carried out by K.C. Morrison Pty Ltd on 19th August 1998 confirm the measured pH and EC results and indicate that sulphate is the major anion with Ca, Zn and Mg the major cations. The data provided also indicates a high Cd solubility. The reported acidity for the pit water was 158 mg $CaCO_3$/L which is most likely due to the dissolved zinc.

The pit water quality results also show that the pH of leachate flowing out of the base of the tailings dam wall is acidic. As the tailings samples collected were near pH neutral, it is probable that the material contained in the dam wall embankment zone has developed acid conditions and is the source of the acid drainage.

Based on the 10 composite tailings samples analysed, there is no lime requirement to elevate the samples to pH neutral (*i.e.* pH 7). However, lime will be required to raise the pH of the material to near pH 8.3 in order to precipitate the Zn and Cd. To effect immediate precipitation of the metals a readily available alkali source such as lime (CaO, $Ca(OH)_2$) or caustic soda (NaOH) will be required. Agricultural lime ($CaCO_3$) is unlikely to be immediately effective but would provide longer term buffering.

Please call to discuss the implications of these findings for tailings relocation and management.

Regards

Stuart Miller

Table 1: Results of Testwork Performed on Old Tailings Dam Samples - Storys Creek Project

EGi Sample Code	Composite Sample Code	Composite Sample Description	Composite Sample Composition	pH#	E.C. (dS/m)#	Acidity * to pH 8.3 (mg CaCO3/kg dry weight)	Moisture Content % (dry weight)
SC/12061	1	Surficial brown-orange silty sludge (from caustic soda treatment of acid mine water)	DH-1, -2, -3	6.6	0.42	70	37
12062	2		EP-1, DH-4, -5, -6, -7	6.7	0.51	18	26
12063	3	Coarse sandy wet and dry tails (typical tailings)	EP-2, DH-1	6.7	0.28	19	14
12064	4		DH-2, -3	6.7	0.35	20	18
12065	5		EP-1, DH-6, -7	6.8	0.41	13	8
12066	6		DH-4, -5	6.8	0.38	19	15
12067	7	Fine wet slime tails	DH-1, -2	6.8	0.37	14	30
12068	8		DH-2, -3	6.8	0.35	8	42
12069	9		DH-6, -7	6.6	0.32	33	28
12070	10		DH-4, -5	6.6	0.41	18	29

#pH and EC on 1:2 (sample:deionised water)

Appendix B Survey and Quantities

Cromer & Associates

Registered Consulting Surveyors

PO Box 1240 Rosny Park, 7018

Phone 62 447275 Fax. 62 450899

Rear dam slope assumed to be same as cut batter

Rear dam slope extended to intercept dam depth

as per depths provided by client at bore holes.

Dam base is estimated per the above and likely

shape pre-construction

Plan of Contours

VOLUME ESTIMATED TO BE 64,000 m3

Datum..... Arbitrary
0.5 interval

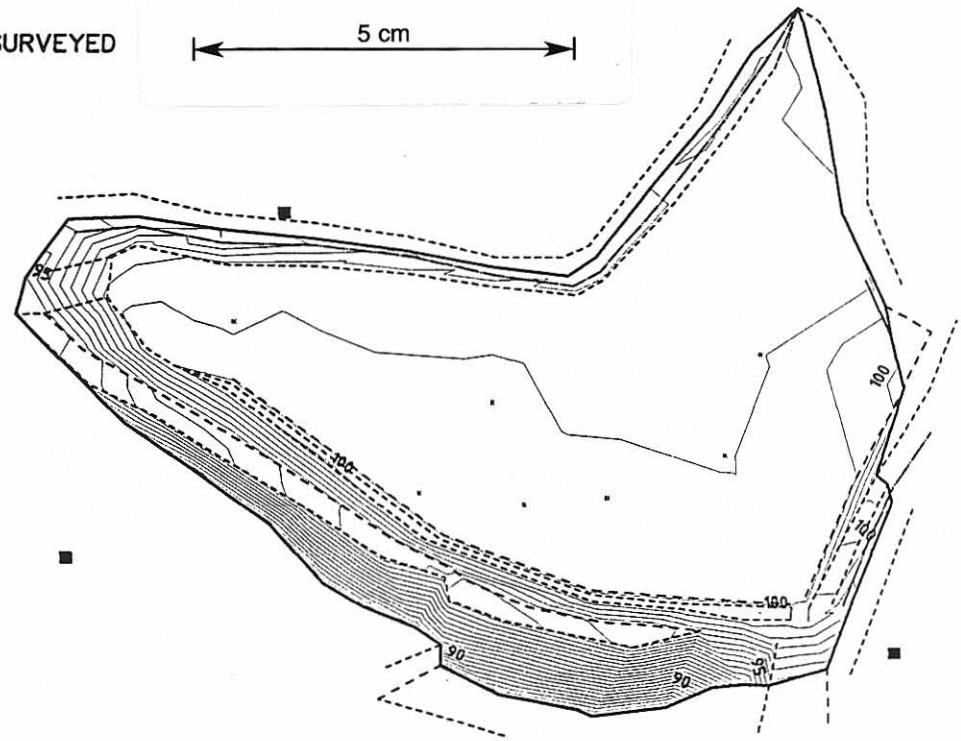
Ref: MIED01 CP02

Date 23/9/98

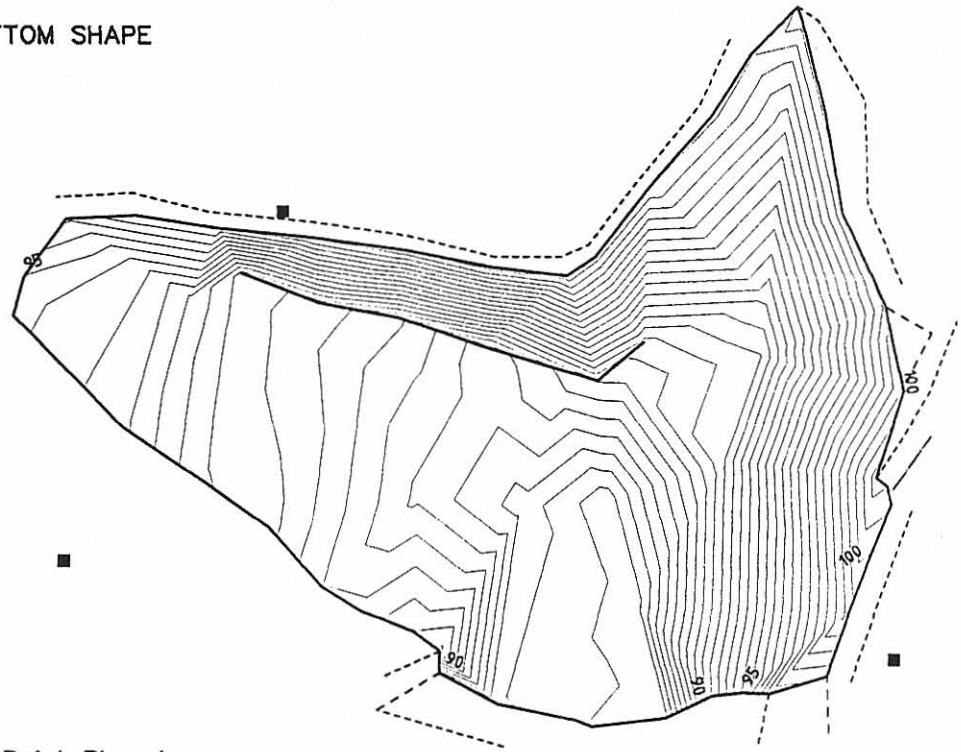
Scale 1 : 1000

SHAPE AS SURVEYED

5 cm



ASSUMED BOTTOM SHAPE



■ Reference Point Placed

Appendix 2 MPA Williams Investigation Report

MPA Williams and Associates

Consulting Geotechnical Engineers

Prop. M.P.A. Williams & AssociatesPty.Ltd.
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533-535 Nepean Highway
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Email: mel@mpaw.com.au

J. MIEDECKE & PARTNERS P/L

GEOTECHNICAL INVESTIGATION FOR ASPECTS OF STORYS CREEK MINE REHABILITATION

STORYS CREEK, TASMANIA

98037

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DECEMBER, 1998

CONDITIONS OF INVESTIGATION

1. Geotechnical site investigation necessarily involves the investigation of the subsurface conditions at a site at a few isolated locations, and the interpretation and extrapolation of those conditions to elsewhere on the site not so investigated. This procedure has been adopted at the site that is the subject of this report and due care and skill has been applied in carrying out and reporting on the work. Thus the findings, conclusions and comments contained in this report represent professional estimates and opinions and are not to be read as facts unless the context makes it clear to the contrary. In general, statements of fact are confined to statements as to what was done and/or what was observed. Other statements have been based on professional judgement.

2. The scope of the work has been planned in the absence of any fore-knowledge of the site other than that stated in the report. Unless otherwise stated we consider that the number of locations investigated and the depths to which they have been investigated are reasonable bearing in mind the scale and nature of the project, and the defined purpose for which the investigation was undertaken.

3. We do not accept any responsibility for any variance between the interpreted and extrapolated conditions and those that are revealed by any means subsequently. Specific warning is also given that many factors, either natural or artificial, may render ground conditions different from those which pertained at the time of the investigation. Should there be revealed during the construction or at any other time any apparent difference from subsurface conditions described or assessed in this report, it is strongly recommended that such differences be brought to our attention so that its significance may be assessed and appropriate advice given.

4. This report is prepared solely for the use of the person or company to whom it is addressed, and must not be reproduced in whole or in part or included in any other document without our express permission in writing. No responsibility or liability to any third party is accepted for any damages howsoever arising out of the use of this report by any third party.

Paul Williams B.Sc., FIEAust., M.I.C.E., F.Aus IMM
Keith Seddon B.E., M.Sc., MIEAust., M.AustIMM., M.I.A.H.
Trevor Osborne MIEAust.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

This report details the results of a geotechnical investigation for components of the rehabilitation of the Storys Creek mine site.

The work was carried out at the request of Mr J Miedecke in accordance with an M.P.A. Williams and Associates Pty Ltd proposal dated 25 September 1998.

It is understood that old tailings are to be removed from an area known as the Precipitate Dam and placed over existing tailings in an area known as the Eastern Tailings Dam. The stockpiled tailings will cover an area of approximately 1 ha, they will have a maximum thickness of the order of 10 m and will have batter slopes of the order of 1:4 to 1:5 (vertical to horizontal). The stockpiled tailings are to be covered with a clayey capping material to limit the production of acid leachate.

The scope of the investigation comprised:-

- geotechnical investigation of resources of clayey capping material suitable to cover old mine tailings
- input into the design and specification of the cover material, including running the computer program HELP (Hydrologic Evaluation of Landfill Performance) and preparation of draft specification clauses for selection and placement of the cover material

The investigation comprised the excavation of 26 test pits in the field, testing of typical samples in the laboratory, followed by detailed analysis and reporting.

It was originally proposed that geotechnical design input for the blocking of an old adit be provided. This was not required as the work was carried out by others.

2 SITE DESCRIPTION

The site of the old mine is some 5 km north of the township of Rossanden and is to the south of the Ben Lomond National Park.

Part of the old mine site is shown on a Site Plan, **Figure 1** attached. The plan shows the Precipitate Dam from which the old mine tailings are to be removed, the Tailings Dam where it is proposed to place the old mine tailings and areas where test pits were excavated to investigate potential sources of borrow material.

Further description of the Tailings Dam and the borrow areas is given below in **Section 5**.

3 GEOLOGY

The general geological units in the area, as indicated by the 1:250,000 scale Tasmanian Geological Survey sheets, comprise basic intrusive rocks in the Ben Lomond area of Tertiary Age, granitic rock of Devonian Age to the west of the Rossanden township, and micaceous quartzwacke turbiditic sequences

and mudstone sequences (Mathinna Group) of Silurian Age in the area of the mine and the Rossanden township.

4 SITE INVESTIGATION

4.1 Field Work Methods

The field work comprised 26 test pits excavated to depths of between 0.2 m and 2.0 m.

The test pits were excavated by a Komatsu PC40-6 excavator.

Disturbed samples were taken at regular intervals during the work and selected bulk samples were also taken.

The test pits were located by a GPS (Global Positioning System) unit, however, the resolution of the positioning was poor with the locations varying by as much as ± 20 m. Hence the test pit positions shown on the Site Plan are approximate only.

The work was carried out on 4 November, 1998. The weather during this time was fine.

The work was supervised full time by an experienced geotechnical engineer who logged the ground strata revealed in accordance with the M.P.A. Williams and Associates Pty Ltd soil description, classification and abbreviations system.

4.2 Laboratory Testing

Laboratory testing was carried out on selected samples in the M.P.A. Williams and Associates NATA registered laboratory. All tests except for specialist in-house tests were carried out in accordance with AS1289. The following tests were carried out:-

Field Moisture Content	4 No.
Atterberg Limits and Unified Classification	4 No.
Percent passing 75 μm sieve	4 No.
Standard Compaction	1 No.
Falling Head Permeability	1 No.

Detailed results of the tests are given on the test certificates attached as **Appendix B**.

The test results are summarised on **Table 1**.

TABLE 1 - SUMMARY OF LABORATORY TESTS

Test Pit No.	Depth Range (1m)	Description	Field MC (%)	LL (%)	PL (%)	PI (%)	PSD <75 μm (%)	Standard Compaction MDD (%)	Standard Compaction OMC (t/m³)	Permeability (k) (m/sec)
10	0.5	Sandy CLAY (CI)	25.4	42	19	23	70			
12	0.3-0.9	Clayey SAND (SC)	18.9	41	20	21	43			
20	0.5-1.0	CLAY (CH)	25.6	54	23	31	90	1.66	21.0	$8.8x10^{-10}$
25	0.1-1.0	Clayey SAND (SC)	18.3	29	17	12	42			

4.3 Field Work Results

Detailed logs of the test pits are given in **Appendix A**. The logs should be read in conjunction with notes on soil description, classification and abbreviations used on logs which are also given in **Appendix A**.

5 SUBSURFACE CONDITIONS

5.1 Eastern Tailings Dam Area (TP's 1 to 6)

Test pits 1 to 6 were excavated in the area of the Eastern Tailings Dam to investigate the existing tailings in this area and the natural ground conditions beneath the tailings.

The tailings comprised pale grey fine grained material (fine sand and silt possibly with some clay) interbedded with coarser, yellow and orange brown material (medium grained sand material). The tailings varied in thickness from 0.2 m to 1.6 m. The average thickness of the tailings based on the six test pits excavated was 0.75 m.

The tailings were underlain by a weathered shale type material. The material had a rock structure with thin (<1 mm) clay seams. The excavator met virtual refusal on the shale and was only able to penetrate it by 0.4 m. The shale appeared to be tight and relatively impermeable.

In test pit 1 only, residual clayey gravel/gravelly clay material was found overlying the shale.

5.2 Borrow Area (TP's 7 to 10)

Test pits 7 to 10 were excavated parallel to a road and in the easement of an electricity transmission line. The area was approximately 50 m wide and 300 m long parallel to the road and had been previously disturbed. It became apparent during the excavation of TP's 7 to 9 that the area had been used as a source for borrow material in the past and only remnant clayey material existed. The area had been cross ripped by a bulldozer to allow for revegetation. TP10 was positioned in an area that had not been disturbed by previous excavation. It revealed topsoil to a depth of 0.20 m overlying sandy clay extending to 1.2 m. Virtual refusal of the excavator was encountered at 1.2 m depth.

The area of TP10 and areas extending to the north-west in the electricity transmission line easement potentially contain approximately 1 m depth of good quality borrow clay.

The rock in the area appeared to be shale.

5.3 Borrow Area (TP's 11 to 19)

Test pits 11 to 19 were excavated in an area to the north of the Eastern Tailings Dam as shown on the Site Plan, **Figure** 1 attached.

The test pits typically revealed topsoil to depths of between 0.15 m to 0.30 m. Silty sand/sandy silt materials (TP's 14 to 19) were revealed to depths of between 0.4 m and 0.6 m. Clayey Sand/sandy clay/clayey gravel/gravelly clay type materials were revealed extending to the full depth explored and virtual refusal on rock at depths of between 0.5 m and 1.2 m.

The average depth to virtual refusal on rock (shale) was 0.78 m, and the average depth to the upper contact level of the clayey material was 0.43 m. Hence the average thickness of the clayey potential borrow material is only about 0.34 m in this area.

5.4 Borrow Area (TP's 20 to 26)

Good quality clay, 1 m thick was revealed at TP20. The clay was very similar to that found at TP10. The clay was overlain by 0.50 m of topsoil and extended to 1.5 m and rock (shale). However, TP's 21 and 22 revealed very little clay. TP23 revealed similar good quality clay 0.60 m thick, overlain by 0.60 m of topsoil. TP's 24 and 25 each revealed approximately a 1 m thickness of dark brown and orange brown clayey sand/sandy clay material. This material is believed to have a different geological origin to the clays from TP20 and TP10. However, the material contains of the order of 40% clay (TP25, 42% <75μm) and would be suitable as a cover material.

TP26 was excavated in a stockpile of excavated clay similar to TP20. This material would be suitable as a cover material.

6 DISCUSSION

6.1 Sources of Cover Material

It is suggested that good quality medium to high plasticity clay suitable as a cover material could be won from:-

- the area of TP10 and areas to the north and west
- the area of TP20, the stockpile of TP26 and possibly from areas to the west and south of the stockpile.

Good quality clayey sand material suitable as a cover material could be won from:-

- the area of TP24 and TP25 and areas to the west.

Classification tests were carried out on samples from TP10 and TP20 and indicated that the materials classified as CI and CH respectively. Where CI is a clay of intermediate (medium) plasticity and CH a clay of high plasticity. Classification tests carried out on a sample from TP25 indicated that the material classified as SC - a clayey sand.

A permeability test was carried out on a sample of the clay from TP20. It revealed a permeability value (k) of 8.8×10^{-10} m/sec. The permeability is less than 1×10^{-9} m/sec which is the figure often quoted as being suitable for clays used as liners. It is suggested that the clayey sand material revealed in TP's 24 and 25 would have a slightly higher permeability. If it is considered that both materials are required to be used to make up the required volume of borrow material, it is recommended that they be mixed to provide a cover of uniform quality. Alternatively alternate layers of clay and clayey sand could be placed.

6.2 Cover Modelling and Design

The capping of the tailings with a cover of compacted clay and other layers was modelled using the computer program HELP, the Hydrologic Evaluation of Landfill Performance. The model uses site rainfall, temperature and other climatic data along with details of the capping layers to compute the seepage into the tailings from the base of the capping layers.

The climate data from an automatic weather station at Storys Creek was obtained from the Bureau of Meteorology. The weather station operated from about 1987 to 1997, however, the recorded data was not complete. Nevertheless a complete block of five years of data was able to be used in the model. The block of data was checked against other climatic records for Tasmania and dry year data selectively replaced with more average data where applicable.

The years adopted were 1986 to 1989 inclusive and 1991. The total rainfall for the five years was 6655 mm with an average of 1331 mm. The data from 1990 was excluded since it was below average (1036 mm). The rainfall data for Beaconsfield was also examined and it to had a below average rainfall in 1990. It appeared that 1990 may have generally been a dry year for north-east of Tasmania. Since the usable climatic data from the site was limited, and the 1990 record was below average, the data was omitted so that the model could run on more average or possibly conservative rainfall data.

For the purposes of the model the capping material comprised the following layers:-

Layer Thickness (mm)	Description	Role in Model
150 - 225	topsoil silty sand	Vertical Percolation Layer
75 - 150	sands, gravels	Lateral Drainage Layer
450 - 1000	compacted clay	Barrier Layer

To assess the efficiency of the cover material the amount of rainfall excluded by the barrier was expressed as a percentage of total incident rainfall.

The results of the analysis are sensitive to the permeability adopted for the compacted clay liner. The calculated efficiences for various permeabilities of the compacted clay liner are as follows:-

Permeability (k) m/sec	Indicated Efficiency (%)
1×10^{-9}	98
5×10^{-9}	90
1×10^{-8}	88

The actual thickness of the liner (i.e. 400 mm, 600 mm, 800 mm, 1000 mm) has little effect on the overall efficiency. However, this does not mean that a thin liner is suitable in the field. The liner in the field needs to be designed so that a minimum critical thickness of the total liner maintains its "as constructed" compaction and permeability throughout the life of the cover.

It should be noted that the permeabiility of the sample tested was 8.8×10^{-10} m/sec, and this material would have a higher efficiency than the $k = 1 \times 10^{-9}$ m/sec value of 98%. However, some variation of clay quality can be expected over the borrow areas and consequently lower efficiencies may apply in practice.

A suggested cover design is attached as **Figure 2**.

The model adopted a cross slope of 20% (equivalent to a batter of 1:5) and a slope length of 35 m, which is about half of the proposed width. The model assumed 100% runoff from the stockpile.

The suggested thickness of the compacted clay barrier layer is 450 mm. It is suggested that this layer be made up of sub-layers with a maximum thickness of 150 mm. Depending on the machinery available, better compaction may be achieved using multiple thin layers. These layers need to be compacted to a dry density ratio of at least 95% of the standard maximum dry density at a moisture content equal to or up to 3% wet of the optimum moisture content (OMC) for standard compaction, i.e. moisture content range OMC to (OMC + 3)%.

To enable the clay barrier layers to be adequately compacted a support layer comprising clays, sands or gravels may need to be placed over the tailings. The suggested thickness is 150 mm. This thickness should be adequate provided that the tailings are not wet and soft and otherwise have low strength. If the tailings are wet and soft and/or have low strength two options are available. One, allow the tailings to free drain and to slowly increase in strength, or two, provide a much thicker support layer. Analysis of the above is complex and is beyond the scope of this report. It has therefore been assumed that the stockpiled tailings have adequate strength and the placement of the cover layers with standard equipment is possible. It is recommended that the tailings be selectively placed so that any wet and soft tailings are well covered by drier tailings with higher strength. The support layer can be mixtures of gravels, sands or clays. More readily compactable granular materials such as gravelly sands or sandy gravels with small percentages of clays are preferred. High standards of compaction are not required, however, the layer

should provide a uniform degree of support throughout for placement of the overlying barrier layers. If the tailings are placed such that the outer surface is of sufficient strength to allow direct placement of the compacted clay barrier layer then the support layer can be omitted.

The compacted clay barrier layers should be placed and compacted as described above. The critical item for the placement of the barrier layers is the close control of the moisture content. The limited laboratory tests carried out indicated that the borrow clay at the time of the testing was too wet. The field moisture content of the clay in TP20 was 25.6% and the OMC was 21.0%. That is, the field moisture content was 4.6% above the OMC. It should be noted that the investigation was carried out at the end of a period of wet weather and the moisture content of the clay may be lower depending on the timing of the work. Further testing should be carried out by the contractor to check the moisture contents of the proposed borrow clays.

Two protection layers are suggested over the barrier clay layer. These are described from the top down.

The surface layer should comprise topsoil, sands, or low plasticity clay and should support vegetation, allow controlled surface water runoff, be resistant to erosion and allow vertical and horizontal percolation. The layer should not be compacted. It is suggested that the layer be tyned or ploughed along the contour on the batters of the stockpile to limit surface water flow and erosion. The performance of the layer will be dependant on establishing a good vegetative cover. Heavy rain before the establishment of a good vegetative cover could result in damage or loss of the layer. Material suitable for construction of the layer is available throughout the borrow areas.

The second protection layer should comprise fine to medium grained sand with little or no silt and clay obtained from site, or coarse sand to fine gravel which may need to be imported materials.

Increasing the thickness of the horizontal drainage layer increases the horizontal flow through the layer and reduces surface flow but very thick (and unpractical) layers are required to prevent all surface runoff, particularly during longer storm events. Such storm events will always (in any practical system) result in surface runoff.

It is suggested that a 150 mm topsoil and a 150 mm horizontal percolation layer be placed over the compacted clay. These thicknesses are suggested because they should have a reasonable capacity for horizontal percolation and they are the practical minimum thicknesses to protect the compacted clay layers from drying out due to wind and solar drying.

The model has assumed that a 150 mm thickness of fine to medium grained sand with little or no silt and clay, can be obtained from on site and used in the horizontal percolation layer. If fine to medium grained sand with little or no silt and clay is unable to be found on site then it is suggested that a free draining coarse sand to fine gravel material be imported. If a coarse sand to fine grained material is imported, the thickness of the horizontal percolation layer can be halved to 75 mm. This thickness of the topsoil layer however, should increase to 225 mm so that the overall cover over the compacted clay barrier layer is maintained at 300 mm.

The overall thickness of the suggested cover is 900 mm. Only half of the total thickness is good quality clay or clayey sand compacted to a high standard to provide a barrier layer. The remaining thickness comprises topsoils, sands, gravels and clays to provide support or protection to the barrier layer.

6.3 Draft Specification Clauses

Draft specification clauses for the selection and placement of the cover material are given under a separate cover.

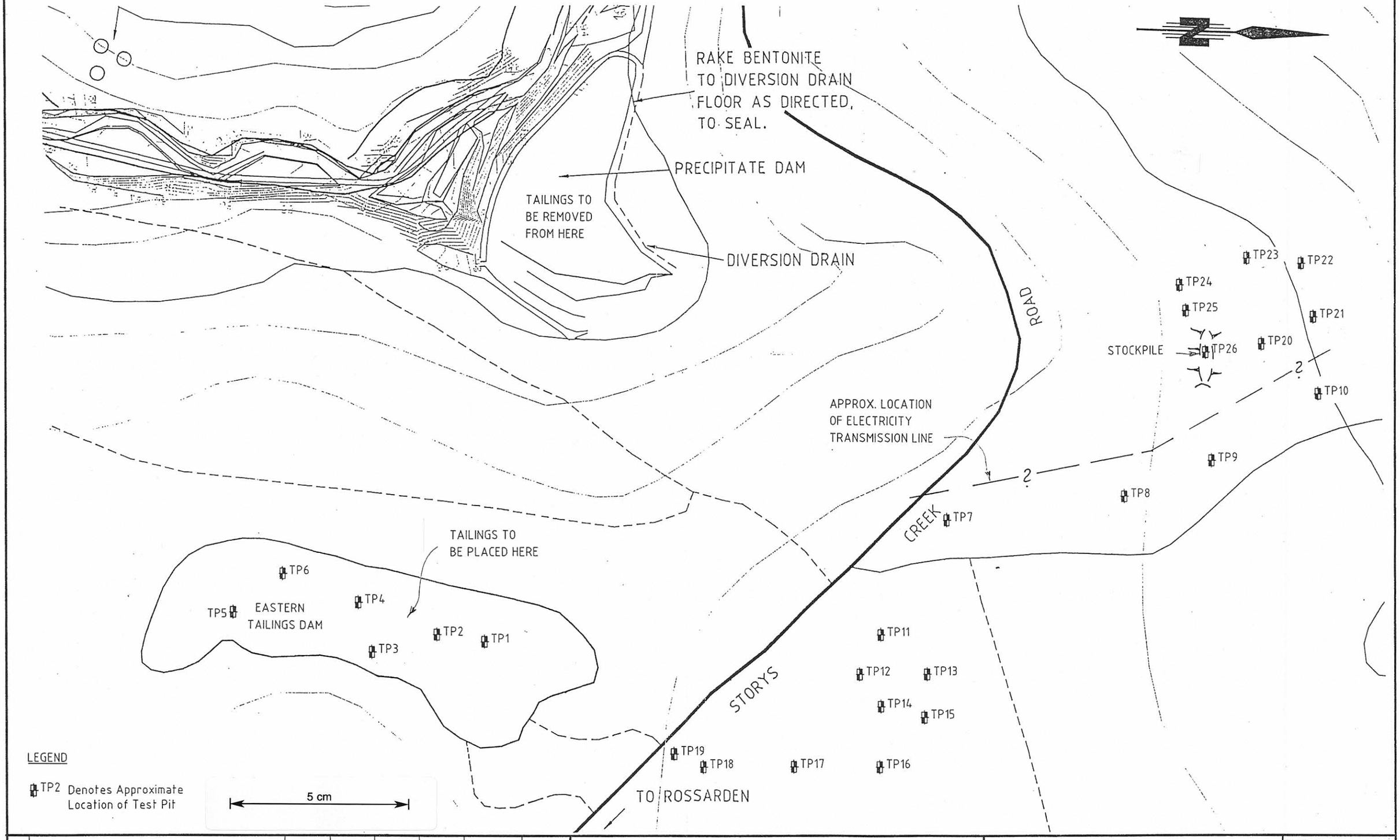
7 CLOSURE

Your attention is drawn to the "Conditions of Investigation" which appear on the Title page of this report.

M.P.A. WILLIAMS & ASSOCIATES PTY LTD

P.M. REID

FIGURES



No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D

JOB No.	98037
DATE	4.11.98
DESIGN	PMR
DRAWN	HGE
CHECKED	PMR
APPROVED	

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SITE PLAN

STORYS CREEK MINE REHABILITATION

DWG. No. FIGURE 1

SCALE 1:2000 Approx

CAD No. C:/../98037/figure 1

REV. No. 0 | SHT SIZE A3

SHEET 1 OF 1

CAD No. C:/../98037/FIGURE2

COVER SECTION

THICKNESS	MATERIAL	PURPOSE OF LAYER	COMPACTION STANDARD
150	TOPSOIL / SAND / LOW PLASTICITY CLAY	PROTECTION LAYER, SUPPORT VEGETATION, EROSION PROTECTION, ALLOW CONTROLLED SURFACE RUNOFF. VERTICAL AND HORIZONTAL PERCOLATION.	NO COMPACTION
150	GRAVEL, SAND	PROTECTION LAYER & HORIZONTAL PERCOLATION LAYER	NO COMPACTION
450	CLAY AND CLAYEY SAND SUB LAYER ≤ 150mm COMPACTED	BARRIER LAYER	DENSITY RATIO ≥ 95% STD. MAX. DRY DENSITY MOISTURE CONTENT BETWEEN OMC AND (OMC + 3) %
150 (MIN)	CLAY, SAND, GRAVEL	SUPPORT LAYER OVER TAILINGS FOR THE BARRIER LAYERS	TRACK ROLL
	TAILINGS		

Total thickness: 900

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STORYS CREEK MINE SITE REHABILITATION

TAILINGS COVER DESIGN

JOB No. :	98037
DATE :	25.11.98
DESIGN	PMR
DRAWN	HGE
CHECKED	PMR
DWG. No.	FIGURE 2
SCALE	NOT TO SCALE
SHT SIZE	A4
REV. No.	0
SHEET	1 OF 1

APPENDICES

APPENDIX A

SOIL DESCRIPTION AND CLASSIFICATION NOTES AND ABBREVIATIONS USED ON LOGS

FIGURE A1

IDENTIFICATION AND CLASSIFICATION

GW	Well graded gravels, gravel sand mixtures, less than 5% fines.
GP	Poorly graded gravels, gravel sand mixtures less than 5% fines.
GM	Silty gravels, gravel sand silt mixtures, 12 - 50 % non-plastic fines.
GC	Clayey gravels, gravel sand clay mixtures, 12 - 50% plastic fines.
SW	Well graded sands, gravelly sands, less than 5% fines.
SP	Poorly graded sands, gravelly sands, less than 5% fines.
SM	Silty sand, sand silt mixtures, 12 - 50 % non-plastic fines.
SC	Clayey sand, sand clay mixtures, 12 - 50% plastic fines.
ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands.
CL - ML CL CI	Inorganic clays of low to medium plasticity, gravelly, sandy or silty clays, lean clays.
OL	Organic silts and silty clays of low plasticity.
MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, plastic silts.
CH	Inorganic clays of high plasticity, fat clays.
OH	Organic clays of medium to high plasticity.
Pt	Peat, highly organic soils.

PARTICLE SIZE

Clay	Silt	Sand	Gravel	Cobbles	Boulders
0.002	0.06	2	60	200	

Particle size (mm)

NOTE : 0.06 mm is about the smallest particle size visable to the naked eye. The 0.075 mm sieve is used to represent this size in the laboratory.

CONSISTENCY OF COHESIVE SOILS

Classification	Undrained shear strength (kPa)
Very soft	Less than 12.5
Soft	12.5 - 25
Firm	25 - 50
Stiff	50 - 100
Very stiff	100 - 200
Hard	More than 200

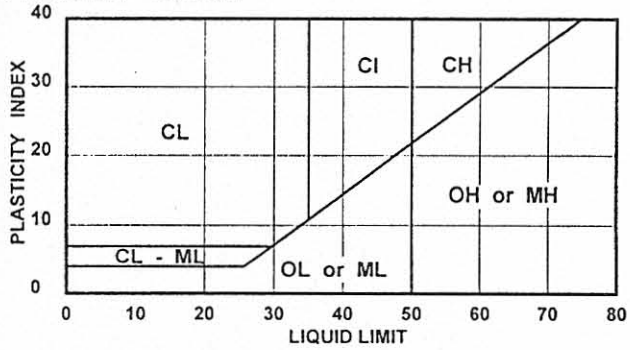
CONSISTENCY OF COHESIONLESS SOILS

Classification	Relative density (%)
Very loose	Less than 15
Loose	15 - 35
Medium dense	35 - 65
Dense	65 - 85
Very dense	More than 85

MOISTURE CONDITION OF COHESIVE SOILS

Symbol	Description
w	Field moisture content
w_p	Plastic limit

PLASTICITY CHART



NOTE : If in-situ tests and/or laboratory tests are not shown on the borelogs, classifications and descriptions are based on field identification procedures (AS 1726, Appendix A) including the use of pocket penetrometer for the fine grained soils, and on the ease and stability of drill holes or excavations in coarse grained soils.

NOTES AND ABBREVIATIONS

Sample Type	AS	Auger sample taken from the auger bit after withdrawl of the auger string, not from the auger flights at the surface.
	BS	Bulk sample from excavation eg. Test pit.
	SPT	Standard Penetration Test sample. Open split tube, 51mm outside diameter.
	TO	Open tube sample.
	NMLC	Core from a triple tube barrel, 52mm diameter.
	RC	Rock core.
Field Tests	SPT	N = the number of blows of a 63.5 kg. hammer dropping 760mm required to drive the spilt tube sampler 300mm. If less than 300mm can be driven the blows and penetration achieved are noted.
	SDP	Scala Dynamic Probe. A 19mm pointed rod driven into the ground by a 9 kg hammer falling 508mm. The number of blows per 50mm penetration is recorded.
Sample Condition		Undisturbed
		Disturbed
		Sample lost. (For core runs it may not be clear where the loss occurred in the run. In these cases the total loss is shown at the bottom of the run.)
Groundwater		Observed groundwater level. Groundwater not observed means that the natural standing groundwater level was not or could not be measured, possibly due to a caving hole or to the use of wash water during the drilling operations. Groundwater not encountered means that the hole was dry after drilling.

test pit location : Refer Site Plan, Figure 1	TEST PIT No. 1	FIGURE A2
surface elevation : —— Datum : ——		
date excavated : 04.11.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : NO FREE GROUNDWATER OBSERVED		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
							w	w_L	w_p	I_p	% finer than 75 μm	linear shrinkage	SMDD / OMC	
							natural moisture	liquid limit	plastic limit	plasticity index				Blows /100mm 2 4 6 8
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition **Rock:** type, weathering, colour, fabric, estimated strength, structure/bedding														
FILL Tailings, orange brown		0.20												
Gravelly CLAY (CH) / Clayey GRAVEL (GC) Very soft to hard, high plasticity clay, angular coarse gravel (weathered siltstone / sandstone) orange brown with silt, w > wp		0.50	D											
SHALE (HW) mottled brown and grey, highly weathered		1.0 1.10												
TEST PIT 1 TERMINATED AT 1.1 ml Virtual backhoe refusal														

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test pit location : Refer Site Plan, Figure 1	TEST PIT No. 2	FIGURE A3
surface elevation : —— Datum : ——		
date excavated : 04.11.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : NO FREE GROUNDWATER OBSERVED		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
							w natural moisture	w_L liquid limit	w_p plastic limit	I_p plasticity index	% finer than 75 μm	linear shrinkage	SMDD / OMC	Blows /100mm 2 4 6 8
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition **Rock:** type, weathering, colour, fabric, estimated strength, structure/bedding														
FILL Tailings, interbedded pale grey, fine grained and yellow brown, coarse grained, moist to wet			D											
SHALE (HW) dark grey, highly weathered, tightly jointed with clay in joints		1.60	D											
TEST PIT 2 TERMINATED AT 2.0 ml Virtual backhoe refusal		2.0												

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test pit location : Refer Site Plan, Figure 1	**TEST PIT No. 3**	**FIGURE A4**
surface elevation : —— Datum : ——		
date excavated : 04.11.98 logged by : P.M.R..	**PROJECT** **STORYS CREEK** **TAILINGS REHABILITATION**	**JOB No. 98037**
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : NO FREE GROUNDWATER OBSERVED		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS: natural moisture (w)	liquid limit (w_L)	plastic limit (w_p)	plasticity index (I_p)	% finer than 75μm	linear shrinkage	SMDD / OMC	dynamic penetrometer results (Blows /100mm, 2 4 6 8)
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition **Rock:** type, weathering, colour, fabric, estimated strength, structure/bedding														
FILL Tailings, interbedded orange brown and grey, moist to wet		0.60												
SHALE (HW) highly weathered, dark grey and orange brown		0.70												
TEST PIT 2 TERMINATED AT 0.7 ml Virtual excavator refusal														

MPA Williams & Associates

test pit location : Refer Site Plan, Figure 1	**TEST PIT No. 4**	**FIGURE A5**
surface elevation : —— Datum : ——		
date excavated : 04.11.98 logged by : P.M.R..	**PROJECT** STORYS CREEK TAILINGS REHABILITATION	**JOB No. 98037**
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : NO FREE GROUNDWATER OBSERVED		Sheet 1 of 1

Material Description :

Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition

Rock: type, weathering, colour, fabric, estimated strength, structure/bedding

Material Description	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS: natural moisture (w)	liquid limit (w_L)	plastic limit (w_p)	plasticity index (I_p)	% finer than 75μm	linear shrinkage	SMDD / OMC	dynamic penetrometer results (Blows /100mm, 2 4 6 8)
FILL Tailings, interbedded dark grey and orange brown, moist to wet														
SHALE (HW) highly weathered, dark grey and brown		1.10												
TEST PIT 2 TERMINATED AT 1.2 m Virtual excavator refusal		1.20												

MPA Williams & Associates

test pit location : Refer Site Plan, Figure 1	TEST PIT No. 5	FIGURE A6
surface elevation : —— Datum : ——		
date excavated : 04.11.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		Sheet 1 of 1
groundwater : NO FREE GROUNDWATER OBSERVED		

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
							w natural moisture	w_L liquid limit	w_p plastic limit	I_p plasticity index	% finer than 75μm	linear shrinkage	SMDD / OMC	Blows /100mm 2 4 6 8
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition **Rock:** type, weathering, colour, fabric, estimated strength, structure/bedding														
FILL / Clayey GRAVEL fine to coarse, angular, red - orange brown, moist														
		0.50	D											
SHALE (HW) highly weathered, dark grey and orange		0.60												
TEST PIT 5 TERMINATED AT 0.6 m Virtual refusal on shale														

test pit location : Refer Site Plan, Figure 1	TEST PIT No. 6	FIGURE A7
surface elevation : —— Datum : ——		
date excavated : 04.11.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : NO FREE GROUNDWATER OBSERVED		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components. moisture condition Rock: type, weathering, colour, fabric, estimated strength, structure/bedding							w natural moisture	w_L liquid limit	w_p plastic limit	I_p plasticity index	% finer than 75μm	linear shrinkage	SMDD / OMC	Blows /100mm 2 4 6 8
FILL Tailings, clayey silt, brown, moist														
		0.50												
SHALE (HW) highly weathered, dark grey and brown		0.60												
TEST PIT 5 TERMINATED AT 0.6 m Virtual excavator refusal														

MPA Williams & Associates

test pit location : Refer Site Plan, Figure 1	TEST PIT No. 7	FIGURE A8
surface elevation : —— Datum : ——		
date excavated : 04.11.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : NO FREE GROUNDWATER OBSERVED		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
							w natural moisture	w_L liquid limit	w_P plastic limit	I_P plasticity index	% finer than 75 μm	linear shrinkage	SMDD / OMC	Blows /100mm 2 4 6 8
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition **Rock:** type, weathering, colour, fabric, estimated strength, structure/bedding														
Clayey GRAVEL (GC) orange brown and pale grey, fine to coarse, subangular gravel, moist		0.20												
TEST PIT 7 TERMINATED AT 0.2 m Virtual refusal on rock														

MPA Williams & Associates

test pit location : Refer Site Plan, Figure 1	TEST PIT No. 8	FIGURE A9
surface elevation : —— Datum : ——		
date excavated : 04.11.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : NO FREE GROUNDWATER OBSERVED		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
							w natural moisture	w_L liquid limit	w_p plastic limit	I_p plasticity index	% finer than 75 μm	linear shrinkage	SMDD / OMC	Blows /100mm 2 4 6 8
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition **Rock:** type, weathering, colour, fabric, estimated strength, structure/bedding														
Gravelly CLAY (CL) low to medium plasticity, thinly interbedded orange brown and pale grey, containing gravel			D											
TEST PIT 8 TERMINATED AT 0.5 m Virtual refusal on rock		0.50												

test pit location : Refer Site Plan, Figure 1	TEST PIT No. 9	FIGURE A10
surface elevation : —— Datum : ——		
date excavated : 04.11.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : NO FREE GROUNDWATER OBSERVED		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS: w (natural moisture)	w_L (liquid limit)	w_p (plastic limit)	I_p (plasticity index)	% finer than 75 μm	linear shrinkage	SMDD / OMC	dynamic penetrometer results (Blows /100mm: 2 4 6 8)
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition **Rock:** type, weathering, colour, fabric, estimated strength, structure/bedding														
Gravelly CLAY (CL) grey and orange brown														
TEST PIT 9 TERMINATED AT 0.25 m Virtual refusal on rock		0.25												

test pit location : Refer Site Plan, Figure 1	TEST PIT No. 10	FIGURE A11
surface elevation : —— Datum : ——		
date excavated : 29.10.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : NO FREE GROUNDWATER OBSERVED		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
							w	w_L	w_p	I_p	% finer than 75 μm	linear shrinkage	SMDD / OMC	Blows /100mm 2 4 6 8
							natural moisture	liquid limit	plastic limit	plasticity index				
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition														
Rock: type, weathering, colour, fabric, estimated strength, structure/bedding														
TOPSOIL dark grey, silty sand, moist														
Sandy CLAY (CI) medium plasticity, fine to medium grained, orange brown, w > wp containing boulders and some layers of shale		0.20	D				25.4	42	19	23	70			
TEST PIT 10 TERMINATED AT 1.2 m Virtual refusal on shale		1.20												

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test pit location : Refer Site Plan, Figure 1	TEST PIT No. 11	FIGURE A12
surface elevation : —— Datum : ——		
date excavated : 29.10.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : FREE GROUNDWATER SEEPAGE OVER ROCK		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
							w natural moisture	w_L liquid limit	w_p plastic limit	I_p plasticity index	% finer than 75 μm	linear shrinkage	SMDD / OMC	Blows /100mm 2 4 6 8
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition **Rock:** type, weathering, colour, fabric, estimated strength, structure/bedding														
TOPSOIL pale grey, silty sand, wet														
Clayey SAND (SC) pale grey and orange brown, moist		0.30												
TEST PIT 11 TERMINATED AT 0.6 m Virtual refusal on rock		0.60												

MPA Williams & Associates

test pit location : Refer Site Plan, Figure 1	**TEST PIT No. 12**	**FIGURE A13**
surface elevation : —— Datum : ——		
date excavated : 29.10.98 logged by : P.M.R..	**PROJECT** STORYS CREEK TAILINGS REHABILITATION	**JOB No. 98037**
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : FREE GROUNDWATER SEEPAGE OVER ROCK		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
							w	w_L	w_p	I_p				
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition							natural moisture	liquid limit	plastic limit	plasticity index	% finer than 75 μm	linear shrinkage	SMDD / OMC	Blows /100mm 2 4 6 8
Rock: type, weathering, colour, fabric, estimated strength, structure/bedding														
TOPSOIL silty sand, grey. moist														
Clayey SAND (SC) fine to medium grained, orange brown, w > wp		0.30	D			Bulk	18.9	41	20	21	43			
TEST PIT 12 TERMINATED AT 0.9 m Virtual refusal on rock		0.90												

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test pit location : Refer Site Plan, Figure 1	TEST PIT No. 13	FIGURE A14
surface elevation : —— Datum : ——		
date excavated : 29.10.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : FREE GROUNDWATER SEEPAGE OVER ROCK		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
							w natural moisture	w_L liquid limit	w_p plastic limit	I_p plasticity index	% finer than 75 μm	linear shrinkage	SMDD / OMC	Blows /100mm 2 4 6 8
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition **Rock:** type, weathering, colour, fabric, estimated strength, structure/bedding														
TOPSOIL silty sand, dark grey. wet														
Sandy CLAY (CL) / Clayey SAND (SC) orange brown and pale grey, w>wp		0.30												
TEST PIT 13 TERMINATED AT 0.5 m Virtual refusal on rock		0.50												

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test pit location : Refer Site Plan, Figure 1	TEST PIT No. 14	FIGURE A15
surface elevation : —— Datum : ——		
date excavated : 29.10.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : FREE GROUNDWATER SEEPAGE OVER ROCK		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
							w natural moisture	w_L liquid limit	w_p plastic limit	I_p plasticity index	% finer than 75 μm	linear shrinkage	SMDD / OMC	Blows /100mm 2 4 6 8
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition														
Rock: type, weathering, colour, fabric, estimated strength, structure/bedding														
TOPSOIL dark grey, silty sand, wet														
Sandy SILT (ML) pale grey, wet		0.20												
Clayey SAND (SC) fine to medium grained, orange brown to pale grey w > wp		0.40	D											
TEST PIT 14 TERMINATED AT 0.8 m Virtual refusal on rock		0.80												

MPA Williams & Associates

test pit location : Refer Site Plan, Figure 1	**TEST PIT No. 15**	**FIGURE A16**
surface elevation : —— Datum : ——		
date excavated : 29.10.98 logged by : P.M.R..	**PROJECT** STORYS CREEK TAILINGS REHABILITATION	**JOB No. 98037**
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : FREE GROUNDWATER SEEPAGE OVER ROCK		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS: natural moisture (w)	liquid limit (w_L)	plastic limit (w_p)	plasticity index (I_p)	% finer than 75 μm	linear shrinkage	SMDD / OMC	dynamic penetrometer results (Blows /100mm, 2 4 6 8)
TOPSOIL silty sand, dark brown														
Sandy SILT (SM) pale grey, wet		0.20												
Clayey SAND (SC) fine to medium, pale grey and orange brown, moist		0.40												
TEST PIT 15 TERMINATED AT 0.7 m Virtual refusal on rock		0.70												

Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition

Rock: type, weathering, colour, fabric, estimated strength, structure/bedding

MPA Williams & Associates

test pit location : Refer Site Plan, Figure 1	TEST PIT No. 16	FIGURE A17
surface elevation : —— Datum : ——		
date excavated : 29.10.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : FREE GROUNDWATER SEEPAGE OVER ROCK		Sheet 1 of 1

Material Description :

Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition

Rock: type, weathering, colour, fabric, estimated strength, structure/bedding

TOPSOIL silty sand, dark grey, moist	0.30
Sandy SILT (ML) pale grey, wet	0.60
Clayey GRAVEL (GC) fine to coarse, orange brown, wet, rounded gravel and cobble	0.90
TEST PIT 16 TERMINATED AT 0.9 m Virtual refusal on rock	

graphic log | depth (m) | sample type | sample lost | sample disturbed | REMARKS

LAB. TEST RESULTS: w | w_L | w_p | I_p | % finer than 75 μm | linear shrinkage | SMDD / OMC

dynamic penetrometer results — Blows /100mm — 2 4 6 8

test pit location : Refer Site Plan, Figure 1	**TEST PIT No. 17**	**FIGURE A18**
surface elevation : —— Datum : ——		
date excavated : 29.10.98 logged by : P.M.R..	**PROJECT** STORYS CREEK TAILINGS REHABILITATION	**JOB No. 98037**
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : FREE GROUNDWATER SEEPAGE OVER ROCK		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
							w	w_L	w_p	I_p	% finer than 75μm	linear shrinkage	SMDD / OMC	
							natural moisture	liquid limit	plastic limit	plasticity index				Blows /100mm 2 4 6 8
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition														
Rock: type, weathering, colour, fabric, estimated strength, structure/bedding														
TOPSOIL dark grey, silty sand		0.15												
CLAY (CL) orange brown, sandy, w > wp														
TEST PIT 17 TERMINATED AT 0.5 m Virtual refusal on rock		0.50												

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test pit location : Refer Site Plan, Figure 1	**TEST PIT No. 18**	**FIGURE A19**
surface elevation : —— Datum : ——		
date excavated : 29.10.98 logged by : P.M.R..	**PROJECT** STORYS CREEK TAILINGS REHABILITATION	**JOB No. 98037**
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : FREE GROUNDWATER SEEPAGE OVER ROCK		Sheet 1 of 1

Material Description :

Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition

Rock: type, weathering, colour, fabric, estimated strength, structure/bedding

graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
						w natural moisture	w_L liquid limit	w_P plastic limit	I_P plasticity index	% finer than 75μm	linear shrinkage	SMDD / OMC	Blows /100mm 2 4 6 8
	0.15												
	0.50	D											
	1.20												

TOPSOIL
dark grey, silty sand, moist

Silty SAND (SM)
pale grey, wet

Gravelly CLAY (CL) / clayey SAND (SC)
orange brown and pale grey, containing rounded cobbles

TEST PIT 18 TERMINATED AT 1.2 m
Virtual refusal on rock

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test pit location : Refer Site Plan, Figure 1	TEST PIT No. 19	FIGURE A20
surface elevation : —— Datum : ——		
date excavated : 29.10.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : FREE GROUNDWATER SEEPAGE OVER ROCK		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
							w	w_L	w_p	I_p	% finer than 75 μm	linear shrinkage	SMDD / OMC	
							natural moisture	liquid limit	plastic limit	plasticity index				Blows /100mm 2 4 6 8
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition **Rock:** type, weathering, colour, fabric, estimated strength, structure/bedding														
TOPSOIL dark grey, silty sand, moist														
Silty SAND (SM) pale grey, wet		0.15												
Clayey GRAVEL (GC) orange brown with cobbles		0.60												
TEST PIT 19 TERMINATED AT 0.9 m Virtual refusal on rock		0.90												

MPA Williams & Associates

test pit location : Refer Site Plan, Figure 1	TEST PIT No. 20	FIGURE A21
surface elevation : —— Datum : ——		
date excavated : 29.10.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : NO FREE GROUNDWATER OBSERVED		Sheet 1 of 1

Material Description :

Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition

Rock: type, weathering, colour, fabric, estimated strength, structure/bedding

Material Description	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS: natural moisture (w)	liquid limit (w_L)	plastic limit (w_p)	plasticity index (I_p)	% finer than 75 μm	linear shrinkage	SMDD / OMC	dynamic penetrometer results (Blows /100mm; 2 4 6 8)
DISTURBED GROUND / TOPSOIL dark grey, moist														
CLAY (CH) hard, medium to high plasticity, pale grey and orange brown, with silt, w > wp		0.50	D				25.6	54	23	31	90		1.66/21.0	
TEST PIT 20 TERMINATED AT 1.5 m Virtual refusal on rock		1.50												

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test pit location : Refer Site Plan, Figure 1	TEST PIT No. 21	FIGURE A22
surface elevation : —— Datum : ——		
date excavated : 29.10.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : NO FREE GROUNDWATER OBSERVED		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS: natural moisture (w)	liquid limit (w_L)	plastic limit (w_p)	plasticity index (I_p)	% finer than 75 μm	linear shrinkage	SMDD / OMC	dynamic penetrometer results (Blows /100mm, 2 4 6 8)
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition **Rock:** type, weathering, colour, fabric, estimated strength, structure/bedding														
TOPSOIL dark grey, silty sand, moist														
Silty SAND (SM) pale grey, wet		0.20												
CLAY (Cl) medium plasticity, orange brown, w > wp		0.40												
TEST PIT 21 TERMINATED AT 0.5 m Virtual refusal on rock		0.50												

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test pit location : Refer Site Plan, Figure 1	**TEST PIT No. 22**	**FIGURE A23**
surface elevation : —— Datum : ——		
date excavated : 29.10.98 logged by : P.M.R..	**PROJECT** STORYS CREEK TAILINGS REHABILITATION	**JOB No. 98037**
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : NO FREE GROUNDWATER OBSERVED		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
							w natural moisture	w_L liquid limit	w_p plastic limit	I_p plasticity index	% finer than 75 μm	linear shrinkage	SMDD / OMC	Blows /100mm 2 4 6 8
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition														
Rock: type, weathering, colour, fabric, estimated strength, structure/bedding														
TOPSOIL brown, sandy, containing cobbles and boulders, moist														
TEST PIT 22 TERMINATED AT 0.7 m Virtual refusal on slate		0.70												

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test pit location : Refer Site Plan, Figure 1	TEST PIT No. 23	FIGURE A24
surface elevation : —— Datum : ——		
date excavated : 29.10.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : NO FREE GROUNDWATER OBSERVED		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition **Rock:** type, weathering, colour, fabric, estimated strength, structure/bedding							w natural moisture	w_L liquid limit	w_p plastic limit	I_p plasticity index	% finer than 75μm	linear shrinkage	SMDD / OMC	Blows /100mm 2 4 6 8
TOPSOIL dark brown, silty sand with boulders														
Sandy CLAY (CL) orange brown and pale grey, with gravel and cobbles, w > wp less gravel and cobble with depth		0.60	D											
TEST PIT 23 TERMINATED AT 1.2 m Virtual refusal on siltstone		1.20												

MPA Williams & Associates

test pit location : Refer Site Plan, Figure 1	**TEST PIT No. 24**	**FIGURE A25**
surface elevation : —— Datum : ——		
date excavated : 29.10.98 logged by : P.M.R..	**PROJECT** STORYS CREEK TAILINGS REHABILITATION	**JOB No. 98037**
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : NO FREE GROUNDWATER OBSERVED		Sheet 1 of 1

Material Description :

Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition

Rock: type, weathering, colour, fabric, estimated strength, structure/bedding

graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS: natural moisture (w)	liquid limit (w_L)	plastic limit (w_p)	plasticity index (I_p)	% finer than 75 μm	linear shrinkage	SMDD / OMC	dynamic penetrometer results (Blows /100mm: 2 4 6 8)

TOPSOIL
silty sand, dark brown, moist

0.30

Sandy CLAY (CL) / clayey SAND (SC)
dark brown to 1.0 m
becoming orange brown and pale grey
w > wp

1.20

TEST PIT 24 TERMINATED AT 1.2 m
Virtual refusal on rock

test pit location : Refer Site Plan, Figure 1	**TEST PIT No. 25**	**FIGURE A26**
surface elevation : —— Datum : ——		
date excavated : 29.10.98 logged by : P.M.R..	**PROJECT** STORYS CREEK TAILINGS REHABILITATION	**JOB No. 98037**
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : NO FREE GROUNDWATER OBSERVED		Sheet 1 of 1

Material Description :	graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
							w	w_L	w_p	I_p				
							natural moisture	liquid limit	plastic limit	plasticity index	% finer than 75 μm	linear shrinkage	SMDD / OMC	Blows /100mm 2 4 6 8
Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition														
Rock: type, weathering, colour, fabric, estimated strength, structure/bedding														
TOPSOIL dark brown, silty sand		0.10												
Clayey SAND (SC) fine to medium grainedl, brown and orange brown, with gravel w > wp						Bulk	18.3	29	17	12	42			
TEST PIT 25 TERMINATED AT 1.1 m Virtual refusal on rock		1.10												

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test pit location : Refer Site Plan, Figure 1	TEST PIT No. 26	FIGURE A27
surface elevation : —— Datum : ——		
date excavated : 04.11.98 logged by : P.M.R..	PROJECT STORYS CREEK TAILINGS REHABILITATION	JOB No. 98037
excavation method : KOMATSU PC40 - 6 EXCAVATOR		
groundwater : NO FREE GROUNDWATER OBSERVED		Sheet 1 of 1

Material Description :

Soil : type, USCS symbol, strength, plasticity or particle size, colour, secondary components, moisture condition

Rock: type, weathering, colour, fabric, estimated strength, structure/bedding

graphic log	depth (m)	sample type	sample lost	sample disturbed	REMARKS	LAB. TEST RESULTS							dynamic penetrometer results
						w natural moisture	w_L liquid limit	w_p plastic limit	I_p plasticity index	% finer than 75 μm	linear shrinkage	SMDD / OMC	Blows /100mm 2 4 6 8
					STOCK PILE								
	1.90												

Gravelly CLAY (CI)
medium to high plasticity, orange brown and pale grey with silt w>wp

TEST PIT 26 TERMINATED AT 1.9 m
Virtual refusal on rock

MPA Williams & Associates

APPENDIX B

CLASSIFICATION TEST RESULTS	NATA REPORT No. R12898
	JOB No. 98037
CLIENT : John Miedecke & Partners	
PROJECT : Mine Site Rehabilitation	LOCATION : Storys Creek , Tas.

REGISTER NUMBER	BOREHOLE (BH) TEST PIT (TP)	SAMPLE NUMBER	DEPTH (m)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	LINEAR SHRINKAGE (%)
37198	TP 20	-	0.5 - 1.0	54	23	31	-
37298	TP 25	-	0.1 - 1.0	29	17	12	-
37398	TP 12	-	0.3 - 0.9	41	20	21	-
37498	TP 10	-	0.5	42	19	23	-

TEST METHODS :

LIQUID LIMIT	☐	AS 1289. 3.1.1 - 1995	(Standard method)
	☒	AS 1289. 3.1.2 - 1995	(Subsidary method)
PLASTIC LIMIT		AS 1289. 3.2.1 - 1995	
PLASTICITY INDEX		AS 1289. 3.3.1 - 1995	
LINEAR SHRINKAGE		AS 1289. 3.4.1 - 1995	

SAMPLE PREPARATION :

☐ Natural Moisture	☒ Air Dried	☐ Oven Dried	☐ Unknown
☐ Wet Sieved	☒ Dry Sieved	☐ Unsieved	

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Authorised Signatory ..... Date 8.12.98

MOISTURE CONTENT AND % PASSING 75 µm TEST RESULTS AS 1289.2.1.1 - 1992 AS 1289.3.6.1 - 1995 (PART)	NATA REPORT No. R12998 JOB No. 98037
CLIENT : John Miedecke & Partners	
PROJECT : Mine Site Rehabilitation	LOCATION : Storys Creek, Tasmania

REGISTER NUMBER	BOREHOLE (BH) TEST PIT (TP)	SAMPLE NUMBER	DEPTH (m)	% PASSING 75 µm	MOISTURE CONTENT (%)
37198	TP 20	-	0.5 - 1.0	90	25.6
37298	TP 25	-	0.1 - 1.0	42	18.3
37398	TP 12	-	0.3 - 0.9	43	18.9
37498	TP 10	-	0.5	70	25.4

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COMPACTION TEST RESULTS
COMPACTION CURVE

AS 1289.5.1.1 (STANDARD) ☑
AS 1289.5.2.1 (MODIFIED) ☐

NATA
REPORT No. : R12798
JOB No. : 98037
REGISTER No. : 37198

CLIENT: John Miedecke & Partners

PROJECT: Minesite Rehabilitation

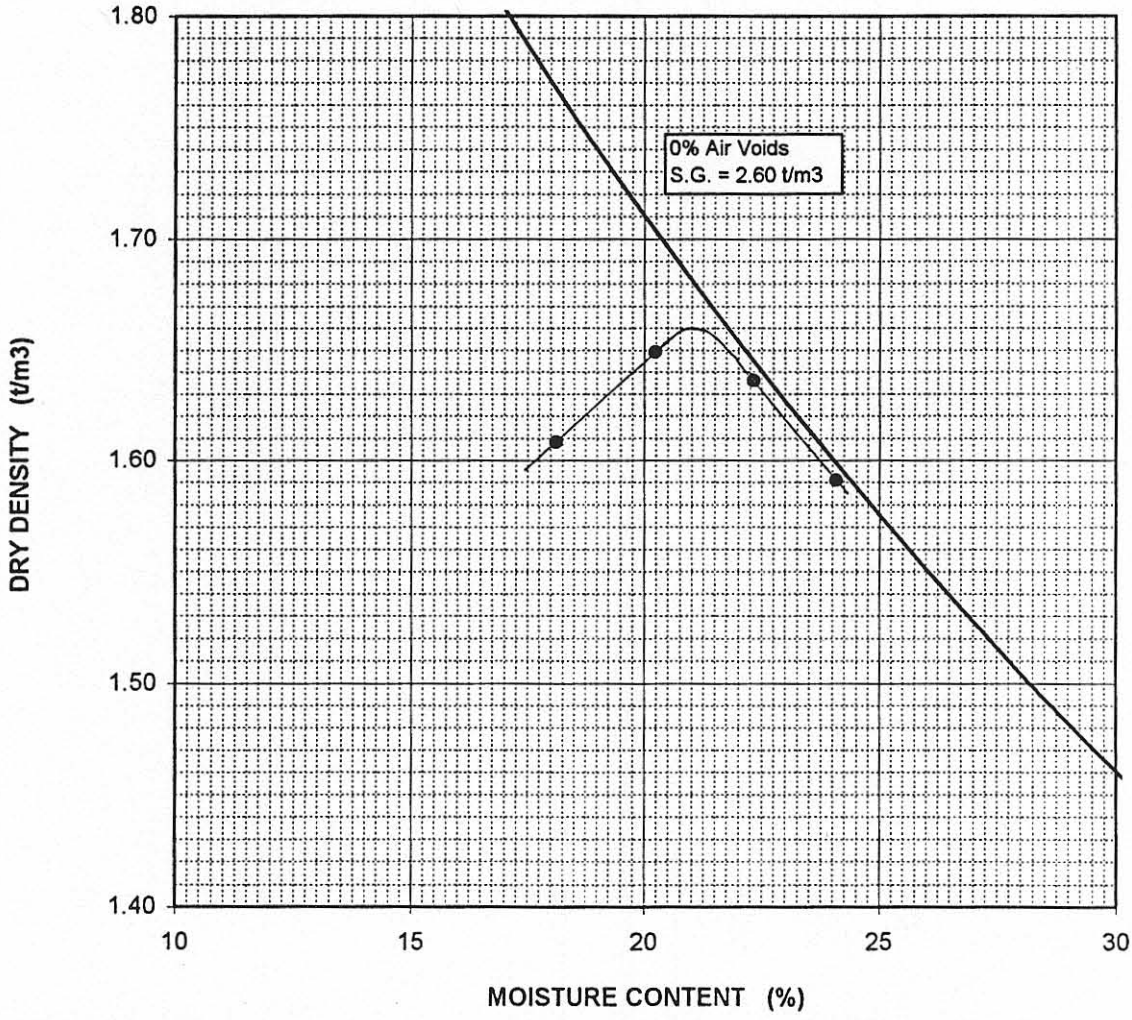
LOCATION: Storys Creek, Tasmania

SAMPLE DESCRIPTION : Sandy CLAY (CH)

BOREHOLE ☐ TEST PIT ☑
No. : 20
DEPTH : 0.5 - 1.0 m

MAXIMUM DRY DENSITY 1.66 (t/m3)

OPTIMUM MOISTURE CONTENT 21.0 (%)



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Authorised Signatory ..... Date 8.12.98

FALLING HEAD PERMEABILITY TEST

JOB No. :	98037
DATE. :	30 / 11 / 98

CLIENT : JOHN MIEDECKE & PARTNERS

PROJECT : STORY S CREEK REHAB' | LOCATION :

SAMPLE REGISTER No.	37198		
BOREHOLE (BH) TEST PIT (TP)	TP 20 B		
SAMPLE DEPTH (m)	0.5 - 1.0		
SAMPLE DESCRIPTION	SANDY - CLAY (CH)		

SAMPLE AS PREPARED

DRY DENSITY @ 95 % MMD (t/m^3)	1.577		
MOISTURE CONTENT (%)	24.0		
OVERSIZE (>19 mm) DISCARDED (%)	0.0		

TEST CONDITIONS

SURCHARGE (Kpa)	20		
WATER USED	Melb' Tap		
CONDUCTIVITY OF WATER (μS/cm)	70		

TEST RESULTS

PERMEABILITY @ 20°C (m/s)	8.77×10^{-10}		
FINAL MOISTURE CONTENT (%)	26.07		

ADDITIONAL NOTES :			

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Appendix 3 EGi Geochemistry Report

MEMORANDUM

EGi
ENVIRONMENTAL GEOCHEMISTRY INTERNATIONAL
Stuart D Miller
MANAGING DIRECTOR

TO: John Miedecke and Partners
ATTENTION: John Miedecke
COPY:
FROM: Stuart Miller
DATE: 8 December 1998
SUBJECT: Storys Creek Tailings Dam

John

Attached is a copy of our memorandum to you dated 30 September, 1998 which presents the results of the acidity testing of the 10 samples collected by Ken Morrison and supplied to us.

John Jeffery and I have looked over these results and the results of other solids and tailings water testing and discussed possible treatment requirements . Our comments and suggestions are presented below:

1. The tailings have a circum-neutral pH and the bulk of the tailings do not appear to be acid generating. However, sections of the tailings dam wall are acid generating.

1. Although the tailings samples tested have only a low sulphur content and are classified as non-acid forming, they are devoid of acid neutralising capacity and are prone to oxidation and release of soluble metals, in particular Zn and Cd with some Cu and Mn. The concentrations of these metals in the tailings pore water is relatively high (a few to 10's of mg/L) even at the existing pH values which range from 6.1 to 6.8.

1. The purpose of treatment will be to precipitate and immobilise the soluble metals so that the risk of leaching from the new storage area is minimal and that any water released during the relocation works does not adversely affect Story's Creek.

- The acidity in the tailings is due to the dissolved metals and in particular the dissolved Zn. Acidity measurements have been conducted on the solids and on samples of tailings pore water. The results indicate that a pH of at least 8.5 will be required to effectively precipitate Zn and Cu and most of the Cd and Mn.

- The acidity of the solids ranges from about 8 to 70 gms $CaCO_3$/t (average 25 gms $CaCO_3$/t) and the acidity of the pore water ranges from about 160 to 280 mg $CaCO_3$/L.

- Since the pH is currently near neutral, it will be necessary to use a soluble alkali such as lime (CaO) or hydrated lime ($Ca(OH)_2$) to raise the pH for effective precipitation of the metals[1]. The $CaCO_3$ equivalent neutralisation rates for CaO and $Ca(OH)_2$ are as follows:

  1 tonne CaO = 1.79 tonnes $CaCO_3$

  1 tonne $Ca(OH)_2$ = 1.35 tonnes $CaCO_3$

- Assuming an average liming rate of 25 gms $CaCO_3$/t for the solids and applying a safety factor of 3 to account for treatment inefficiency, a rate of 75 gms $CaCO_3$ equivalent/tonne of solids is recommended. Assuming a total of 100,000 tonnes of tailings requires treatment, the equivalent of 7.5 tonnes of $CaCO_3$ (5.6 tonnes of $Ca(OH)_2$) will be required.

- For the tailings water, it is recommended that the pH is raised to between 8.5 and 9 and the data suggests that the dosing rate will range from about 160 to 280 mg $CaCO_3$ equivalent / litre. The treatment efficiency will be much greater for the water than for the solids and a safety factor is not necessary. However, pH monitoring during treatment is required for operational control to prevent overdosing.

I hope these comments and suggested treatment rates help. Please call to discuss.

Regards

Stuart Miller

[1] Note: $CaCO_3$ will not significantly increase the pH but will provide buffering against any further lowering of the pH and could be incorporated into the tailings during placement in the new storage area to supplement the long term control provided by the compacted clay cover layer.

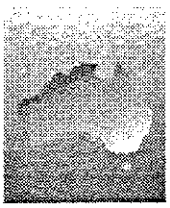
Appendix 5 HECEC Eastern Adit Geological Assessment

Storys Creek / Rossarden Acid Mine Drainage Remediation Study

EASTERN ADIT
GEOLOGICAL ASSESSMENT

December 1998

Prepared By: D Wilson



HECEC Australia Pty Ltd
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Telephone (61 3) 6231 2099 Fax (61 3) 6231 2389
ACN 074 518 077

REPORT No. 001-0681-CR-002

Introduction

This report presents the results of a brief geological inspection of Eastern Adit, an abandoned tunnel driven beneath Eastern Hill at Storys Creek Mine. The aim of the inspection was to determine the suitability of the tunnel for sealing to reduce the flow of acid mine drainage from the adit and to recommend a suitable location for the sealing plug. Eastern Adit is located on the left bank of Storys Creek approximately 100m downstream from Side Creek confluence, the tunnel invert being only a few metres above the bed of Storys Creek. The tunnel runs horizontally and directly into the hillside for some 230m at a bearing of approximately 070°. A mass concrete plug was the preferred method of sealing.

The geological inspection was made on 29 October, 1998. Access into the tunnel was initially difficult due to accumulations of silt and sludge to depths of 0.5 m. An initial inspection was made to determine the overall structure and safety of the tunnel and determine the general area for a plug location. The tunnel roof, walls and floor were then washed down by hosing with a portable fire fighting pump and hose to facilitate geological logging and the sludge from the selected section to the tunnel entrance was sluiced out.

Orientation of discontinuities in this report are expressed as Dip and Dip Direction fore example 30/270 for a discontinuity 30° dip due west.

Discussion

Eastern Adit was geologically logged from the entrance to a distance of 45 m. The adit log is attached to this report as drawing number 001-0681-001. The tunnel sides and roof are viewed as from the outside looking into the tunnel. The cross sectional area of the adit varies somewhat due to over break or slight collapse in places but the general dimensions are 1m wide by 2 m high. The rock condition is generally sound and not requiring support although a few sections have suffered minor collapse and were originally supported by timber, now rotted. The rock into which the tunnel is driven belongs to the Mathinna Beds of Silurian to early Devonian age. The sections of tunnel inspected comprise massively bedded metamorphosed siliceous sandstone with interbeds of slaty siltstone. A typical description of the rock mass is:

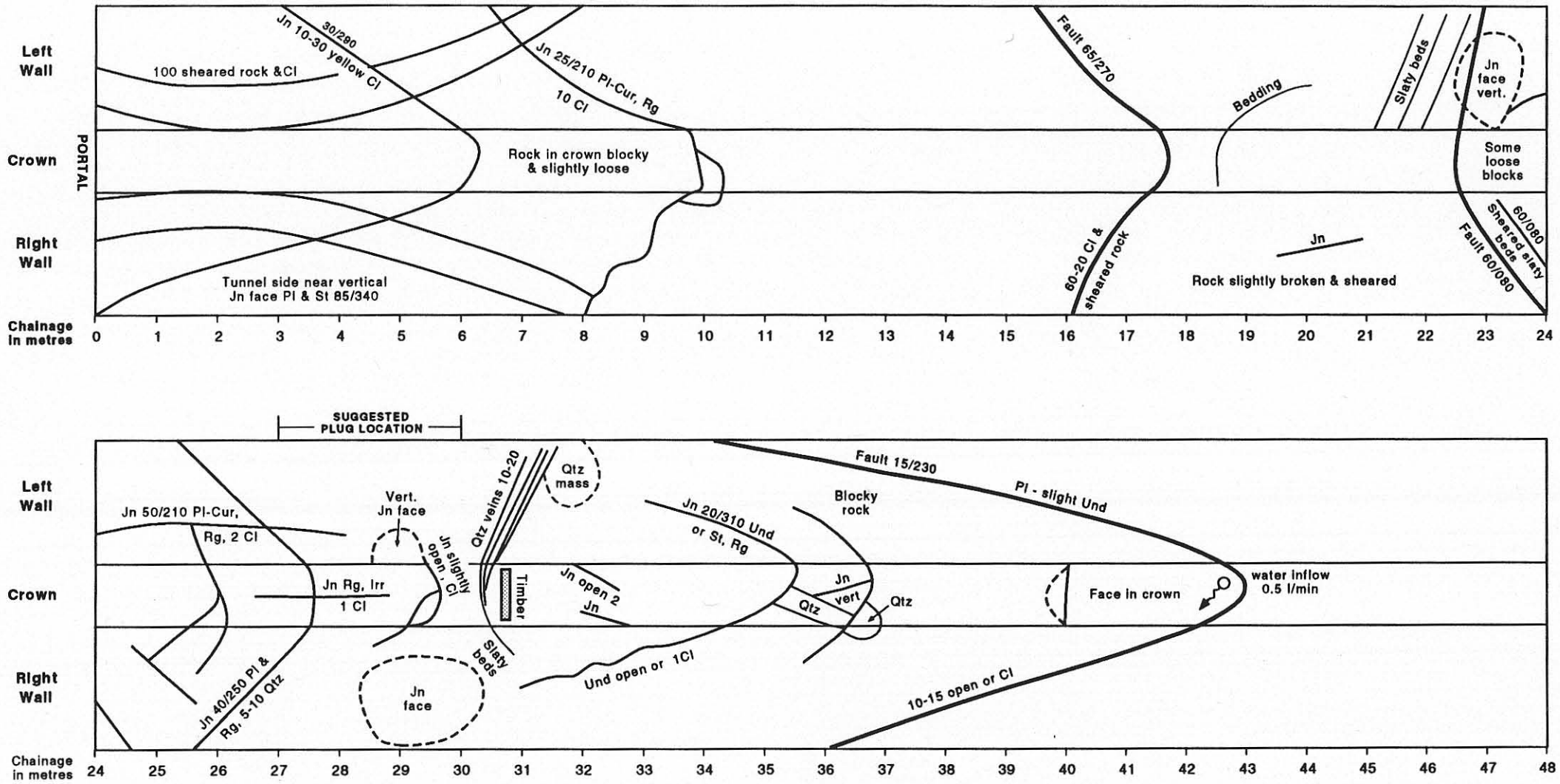
Rock type	Sandstone and siltstone
Colour:	Dark grey
Grainsize:	Fine medium
Strength:	Medium to High Strength
Weathering:	Fresh to Slightly Weathered
Fabric:	Bedded
Discontinuities:	Mainly planar to undulating and rough

The more prominent joints had 1 to 5mm of low plasticity clay but the remainder were generally tight. Most joints were iron-stained and some contained secondary quartz filling. Three faults with grater than 10mm clay and sheared rock were mapped. Some minor roof collapse was associated with each of these faults. The choice of plug location was largely controlled by these faults. A fault dipping 65° towards the entrance at 17.5 m chainage contained 20 to 60mm clay and sheared rock and voids. Between this fault and the entrance the rock was generally more open jointed indicating the transmission of water through the rock mass around the plug may be a problem. The plug should be located away from and further into the hill from this fault. At chainage 42.5m a fault dips shallowly (15/230) towards the entrance. Water is flowing from this fault at the roof line with an approximate flow rate of 0.5 l/min, therefore to intercept this flow the plug should be located away from the fault and towards the entrance. A final suggested plug location was determined by the best tunnel shape and general rock mass quality at a location between chainage 27 and 30m from the entrance. The suggested location may be found relative to a piece of flagging tape attached to a roof timber at chainage 30.6m.

Treatment

The suggested location is a 3m length of the tunnel. The plug need not necessarily be the whole of this length to gain the required sealing. The tunnel floor over the whole of this section should be thoroughly cleared or rubble and iron deposits. The roof and walls should be scaled by hand to remove any loose rock blocks and the area, including the floor, washed down with high-pressure hose to provide a final clean. Any rock protruding markedly into the tunnel should be removed to provide a fairly even tunnel surface. A final inspection of the rock mass should be made once cleaning has been completed to check for open or clay filled joints that may present sealing problems. It is recommended that the area be covered with a slush cement grout to coat the rock surface and fill in any minor joints or depressions prior to pouring the concrete plug.

Grouting of the rock surrounding the tunnel will probably not be required as only a low water head is anticipated.



N

5 cm

Jn	Joint (measurements in mm)		
50/210	Dip & direction of discontinuity		
Pl	Planar		
Und	Undulating		
Cur	Curved	Cl	Low plasticity clay
St	Stepped	Qtz	Quartz
Irr	Irregular		
Rg	Rough		Water inflow

Date: 12.11.98

HECEC Australia Pty Ltd

Rossarden / Storeys Creek Mine Remediation

Eastern Adit - Geological Log

Geology by D.R.Wilson | Drawing No.: 001-0681-001