822001

**ANDREW SHIRLEY & ASSOCIATES PTY. LIMITED**

CONSULTING GEOTECHNICAL ENGINEERS

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PH. 47 2853

**AMG REFERENCE POINTS ADDED**

# GEOTECHNICAL ASSESSMENT OF TIN MINING OPERATIONS AT PIONEER, TASMANIA.

95-3699

ML 38m/71

CLIENT:

Amdex Mining Limited,
119 York Street,
SYDNEY. N.S.W. 2000.

OUR REFERENCE:

Report No. 7878/1
Job No. E-078
28th July, 1978.

95-3699.

PIONEER TIN MINE - PIONEER, TASMANIA. 822002

GEOTECHNICAL ASSESSMENT.

TABLE OF CONTENTS

## INTRODUCTION.

At the request of the Acting Manager for Amdex Mining Limited, this firm undertook a Geotechnical Assessment of the Company's Tin Mining operations at Pioneer, Tasmania. The purposes of the assessment were to comment on the Geotechnical/Civil Engineering aspects of the Mine, with particular reference to:

* The causes of pit slope instability, and possible methods of control.

* The influence of the Bradshaw's Creek diversion dam upon the pit slope stability.

* Methods of tailings and slimes disposal.

* The scope, and extent of future Engineering studies necessary to place the mine on a technically sound operating basis.

The work was undertaken consequent to doubts about the technical and economic viability of the mine.

In view of the nature of the site problems, the Acting Manager requested that the work be completed within two (2) weeks, and include a general report which included guidelines for future action. This report is therefore limited in extent, and is substantially a summary of opinions formed during our site inspection, and subsequent consideration of the various site problems in our offices.

## WORK UNDERTAKEN.

The mine and adjoining area was inspected by our Mr. A.F. Shirley, B.E., M.I.E. Aust., on 18th, 19th and 20th July, 1978; subsequently, the information obtained during the course of this inspection was further considered and analysed at our offices in Hornsby, N.S.W. Analytical work has included:

* Rainfall and run-off calculations.

* Consultations with Surveyors and Photogrammetry experts.

* Consideration of various methods of mining the overburden and ore materials.

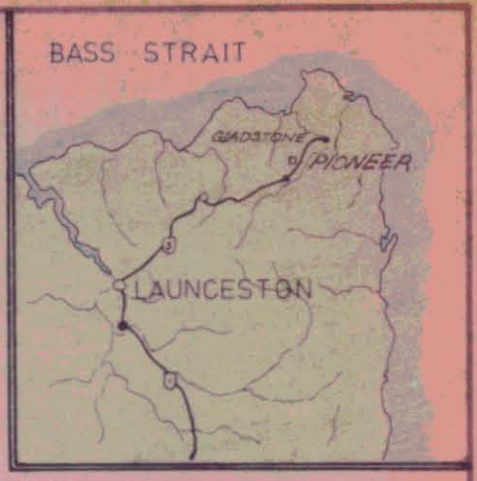
* Documentation of field notes.

In view of the time allowed for the work, the majority of the above studies were only 'outline' investigations, and not of a detailed nature.

822003

## LEGEND

- Qa. river alluvium
- Dbapc granite
- Ts graval, sand, clay & mud
- location of Pioneer tin mine.
- Tb basalt

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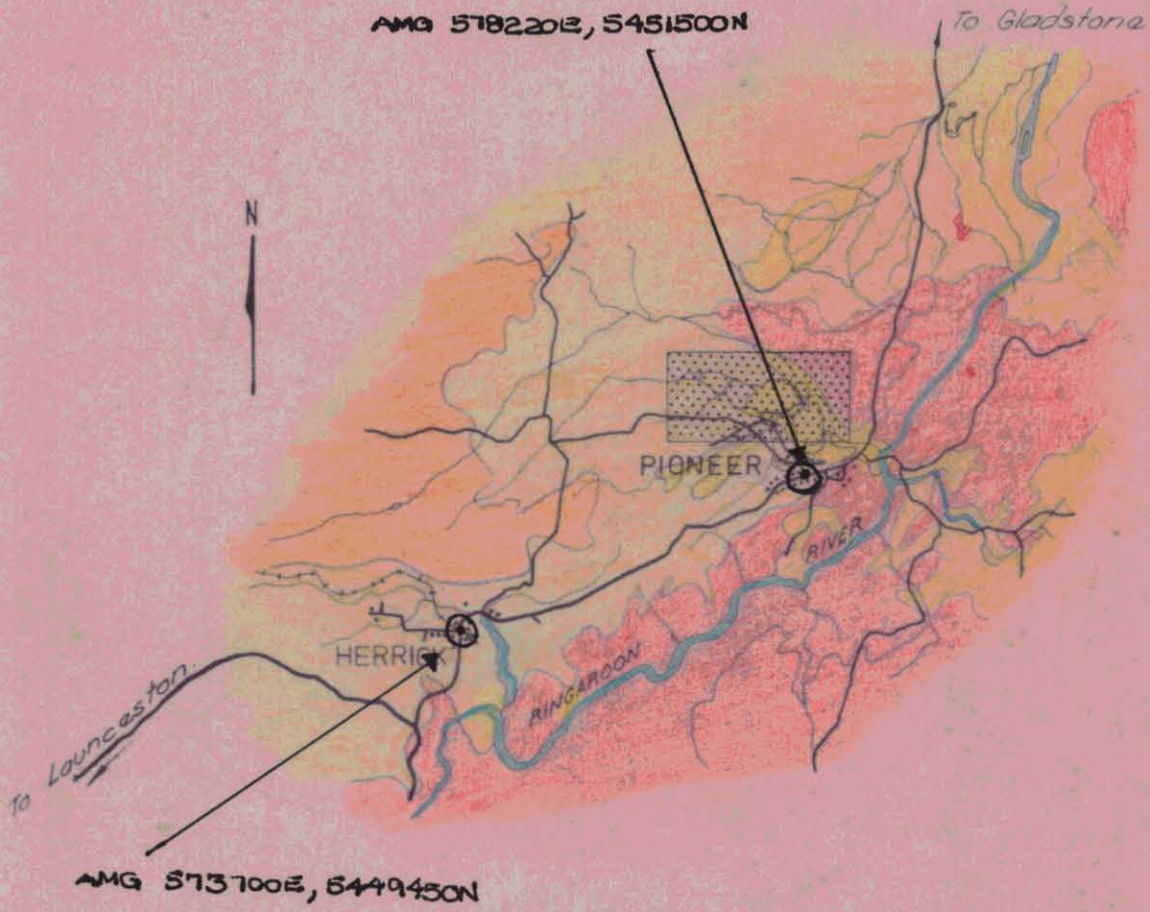


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SITE LOCATION & GEOLOGY
PIONEER MINE . TASMANIA .

AMDEX MINING Ltd.

| Date | Scale | Drawing Number |
|---|---|---|
| July 78 | N.T.S. | E-078 / G1 |

822004

CONCLUSIONS.

During the course of this assessment, it became clear that the Pioneer Mine had a number of problems which have been attributed to a lack of mine planning based on established engineering practice. The magnitude of the problems being encountered preclude their immediate solution, and therefore it recommended that a comprehensive, detailed feasibility study of the Mining, Civil and Geotechnical aspects of the mining operations should be carried out as soon as possible.

There is a great deal of survey/planning work which could be undertaken at once, that will result in a considerable improvement of mine productivity and safety; this work is referred to as 'Initial Studies', in the subsequent sections of the report, and includes:

* Topographic survey of mine area.

* Detailed survey and planning of the slimes dam area, and diversion channels.

* Constructing proper stormwater drainage around the pit.

This initial work should be followed by the detailed feasibility study, which is considered an essential pre-requisite to any economic analysis of the mining operations.

Based upon our site observations, and subsequent consideration of the specific matters raised by you, we have concluded that:

1. Overburden Removal.

a) Present Problems

The present problems (both technical and economic) associated with overburden removal appear to be primarily related to:

* The difficulty of excavating the Tertiary Alluvial (or partially cemented) materials with conventional earthmoving equipment.

* The failure to clearly differentiate between overburden removal, and the winning of ore-bearing alluvium.

* The saturated ground conditions.

b) Excavation Method

The selection of the appropriate excavation method will depend upon the results of the proposed feasibility studies; however, no particular technical problems are envisaged with the use of scrapers or hydraulic methods, provided that the work is undertaken in accordance with a proper plan that includes:

* Maximum bench height of 8 metres.

* Bench face slope angles of approximately 45 degrees.

* Effective control of stormwater in overburden stripping areas.

2. Site and Pit Drainage.

As the mine is located at the centroid of an extensive catchment area, proper control of stormwater is an essential pre-requisite to economic earthworks. The uncontrolled nature of the site stormwater and subsurface seepage is therefore having an extremely adverse effect upon the mining operation. The provision of adequate stormwater drainage periferal to the mine, is therefore a matter of high priority.

3. Bradshaw's Creek Diversion Dam.

The influence of this storage reservoir on the pit excavation is minor at present. However, as the pit excavation advances towards the toe of the dam, its effect will gradually increase. In addition, because the long term stability of the dam is suspect, the presence of a large quantity of stored water above the pit represents a possible threat (by flooding) to the pit area.

4. Tailings and Slimes Disposal.

Site observations and measurements have indicated that:

* The present method of tailings disposal is aggravating both effluent, and pit dewatering, problems.

* The newly constructed slimes disposal dam could fail upon filling; consequently the use of this dam should be avoided until it is stabilised, and/or partly reconstructed.

* The present diversion of Gilham Creek around the proposed slimes disposal dam is unsatisfactory, and could erode its banks so that it will break into the old erosion gully leading into the pit area. Flooding of the mine workings would result from such an event.

RECOMMENDATIONS.

In view of the scope and magnitude of the site problems, it is recommended that:

a) survey and Engineering Design work be commenced immediately to provide proper plans for the future development at the mine. (Refer 'Initial Studies' in Recommended Engineering Studies).

b) A proper plan for mine development be prepared on the basis of a detailed Engineering Study.

c) Immediate action be taken to reduce the potentially dangerous situation of the Gilham/Bradshaw's Creeks diversion channels, near the north-east corner of the mine.

d) The newly constructed slimes disposal dam remain empty until it is suitably stabilised, and/or reconstructed.

e) The present mine practice of hydraulic removal of both overburden and ore (with face heights exceeding 10 metres), be discontinued immediately.

f) Stormwater be adequately controlled in the area adjacent to the pit top.

g) Overburden stripping, in advance of the mine face, be accelerated so that a clear distance of at least 50 metres is achieved between the top of the pit and the stripped area.

h) A clear distance of at least 150 metres is maintained between the pit top, and the downstream toe of the Bradshaw's Creek Diversion Dam.

ANDREW SHIRLEY & ASSOCIATES PTY. LIMITED,

A. E. SHIRLEY, B.E., M.I.E.Aust.

RECOMMENDED ENGINEERING STUDIES.

Our site observations, and subsequent consideration of the problems at the mine, have indicated that there are a considerable number of problems which should be resolved at an early date.

An outline programme of the necessary Engineering and Survey activities (Drawing No. E-078/G2), has been prepared and is summarised below. The activities have been grouped together in order of undertaking the work.

1. Initial Studies (August-September, 1978).

To improve the safety, and productive capacity of the mine as soon as possible, Survey and Civil Engineering design/construction activities should commence immediately. The activities considered necessary at this time include:

a) The preparation of a 1:5000 (with 5 metre contours) general area map, using 1976 Tasmanian Lands Department aerial photography.

b) The establishment of a grid system of survey control at the site, to enable 1:1000 pit area mapping to proceed by ground survey techniques.

c) The carrying out of detailed topographic and geotechnical (1:1000) surveys of the Slimes Disposal Dam, Slimes Pond Area, and Diversion Channels for Bradshaw's Creek and Gilham Creek.

d) Prepare detailed Civil Engineering plans for the partial reconstruction of the slimes disposal dam, and diversion channels.

e) Institute a water sampling programme of nearby creeks and mine effluent, and commence laboratory studies of water treatment methods.

f) Immediately speed up the ore exploration drilling programme (possibly by the addition of a second rig), to enable the future extent of the mine to be ascertained.

It is to be noted that if instructions in the above were received by 9th August, 1978, then Items (a) to (d), could be completed by 24th September, 1978. Reconstruction of the Slimes Dam/Diversion Channels could therefore be undertaken in October, 1978. The approximate costs of this work would be:

| | |
|---|---|
| * Air Photo (1:5000) Plan | $4,000 |
| * Ground Survey (1:1000) | |
| - Control Survey | 5,000 |
| - Detail Mapping | 5,000 |
| * Design of diversion channels, dam reconstruction, approx. location of stormwater channels around pit. | 10,000 |
| TOTAL | $24,000 |

The above estimate however excludes airfares, and site accommodation, expenses.

Subsequently, the various Engineering works referred to above should be constructed under Engineering Supervision.

2. Immediate Studies (September-November, 1978).

To provide a proper basis for an objective assessment of the mine's economic viability, detailed Civil/Geotechnical Engineering Studies are necessary. A pre-requisite to such studies are the surveys, designs, etc., referred to in (1) above, and these additional studies should include:

* Investigation of various methods of overburden removal, and likely costs.

* Methods of treatment of mine waste water, tailings and slimes.

* Outline investigation, and design, of various stormwater and related drainage works.

* Investigation and design of suitable pit slopes.

* Preliminary design of overburden stripping operations.

* An assessment of the location of new creek diversion structures, races, and stormwater channels.

If instructions in this matter were given by mid-September, 1978, then this part of the work could be completed by end of November, 1978. The approximate cost of this work would be $36,000, an amount which includes $3,000 for laboratory testing of water samples.

3. Long-Term Studies (Subsequent to December, 1978).

On the basis that the Mine is shown to be economically viable, then it will be necessary to progressively investigate, design and construct the various major Civil Engineering Structures (e.g. stormwater channels, dams, etc.), required to maintain and extend the mine. These operations should be treated on an individual 'project' basis, and could include such items as:

* Construction of a new diversion dam at Bradshaw's Creek.

* Reconstruction of the Old Water Race for Gilham Creek.

* General Pit Stripping and Overburden removal planning.

* Design of new slimes disposal areas (e.g. on the old tailings dumps).

* Development of improved methods of tailings disposal.

To assist in the implementation of the above, Drawing No. E-078/G2, has been prepared, and is included to facilitate discussion of the site problems.

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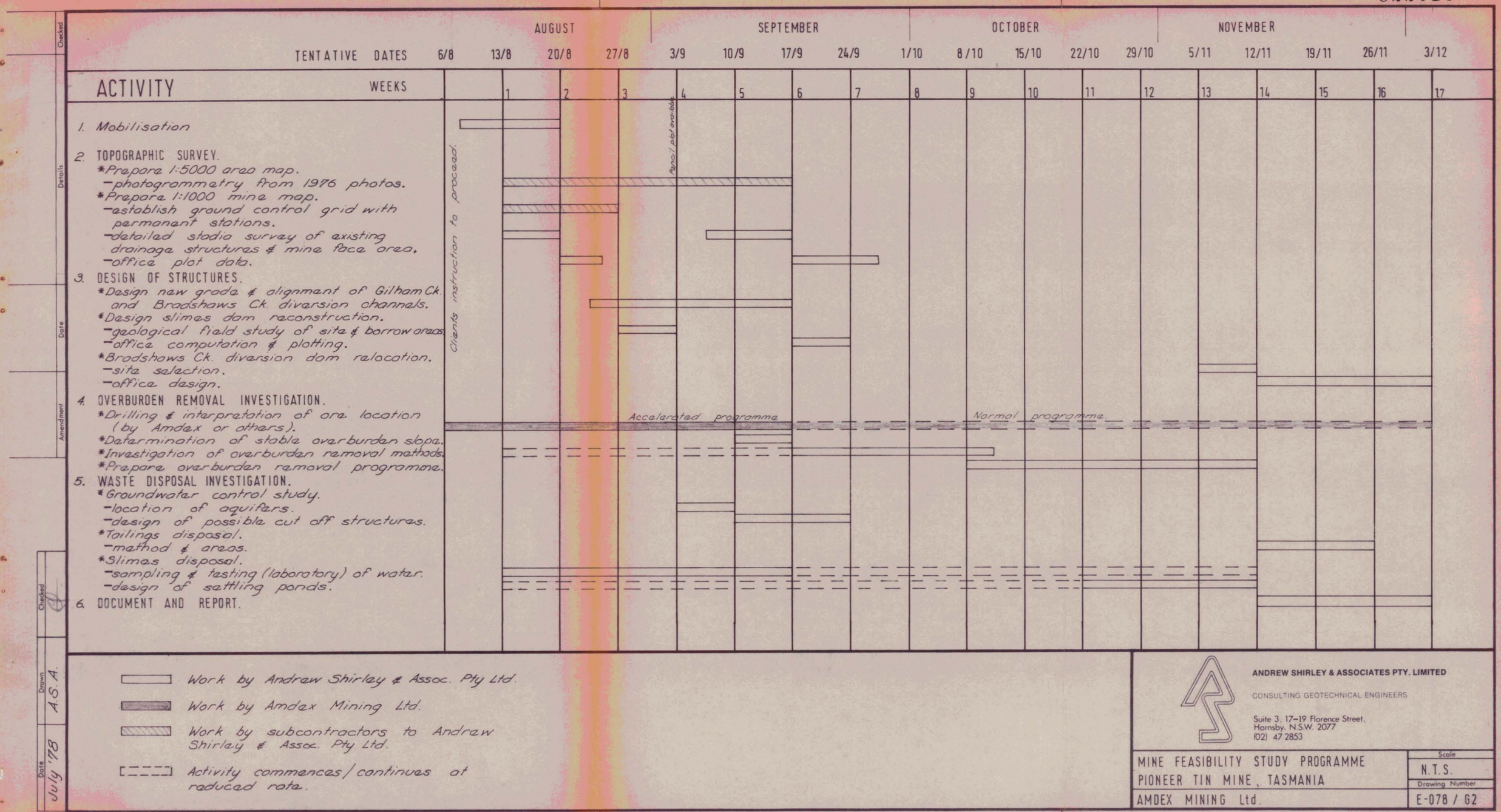


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Date July '78


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MINE FEASIBILITY STUDY PROGRAMME
PIONEER TIN MINE, TASMANIA
AMDEX MINING Ltd.

Scale N.T.S.
Drawing Number E-078 / G2

DISCUSSION OF MINE PROBLEMS.

1. Location and Extent of Ore Body.

Before any proper planning of site operations can be undertaken, it is clearly essential to know the direction(s) in which it is proposed to extend the mine. Whilst in general terms it is apparent that the main 'Wyniford' ore lead extends under the diversion dam, the detailed extent of the proposed pit is apparently not known. Consequently, it is suggested that:

* The ore reserve programme drilling rig be speeded up, (possibly by the establishment of a second drilling rig at the site).

* Plans showing the possible extent of the pit be prepared as soon as possible.

It would also be of considerable assistance if the exploration drill holes were logged by an Engineering Geologist during drilling, in a manner suitable for Geotechnical interpretation.

In addition, the regional geology indicates that the dip of the ore strata is such that it may be preferable to mine the ore in a different direction, to that being presently undertaken. This, and other related matters, are more fully discussed in paragraphs 3 and 4 of this Discussion.

2. Mining Operations and Planning.

The almost total absence of proper plans for development of the mine, excavation methods, and waste treatment is considered to be the prime cause of the present difficulties. It is considered most unwise to undertake excavations of the planned magnitude (about 1 to 1.5 million cubic metres per annum), without a proper plan. Further our experience in matters of this type indicates that the lack of such essential survey and planning data inevitably leads to uneconomic, and sometimes dangerous, mining methods.

For example:

The location of the new slimes disposal dam near the top of the old pit, and the diversion of Gilham Creek through a right angled bend around the dam, is regarded as potentially dangerous. During the course of our inspection, the water flowing through the diversion channel was eroding the base and sides of the channel; further, calculations have indicated that the channel could flood the pit areas. (See graphs in Appendix). The consequences of such pit flooding could include:

* Personal Injury.

* Loss of Production.

* Destruction of Mining Equipment.

Proper planning of the diversion channel, and dam, would have eliminated the above risks.

In the light of the above comments, it is considered that the obtaining of suitable site survey, and related geotechnical data, is a matter of the highest priority. Immediately afterwards, plans for the reconstruction of the dangerous structures should be prepared and appropriate construction activities commenced. After these priority works are undertaken, then it will be possible to develop proper plans for future mining at the site.

3. Pit Slope Stability.

Site observations and measurements have indicated that:

* The instability in the pit slopes is primarily caused by excavating the site materials in benches too high for the strength of the in-situ materials.

* Partial failure of the newly excavated slopes can be expected at any time; such failures could occur without warning.

* The present method of mining the overburden is unsatisfactory, and the prime cause of pit slope instability.

Provided that a proper planned method of excavating both overburden and ore is developed, technically acceptable and safe slopes should be able to be achieved in this mine. However, to achieve and maintain safe slopes it will be necessary to:

* Carry out mining in accordance with a properly thought out plan.

* Control stormwater and groundwater.

* Mine overburden and ore separately.

Drawing No. E-078/G4 has been prepared to illustrate a possible general arrangement of the mine working face, which would provide much greater stability of the mine area. In respect of this proposed method of excavating both the overburden and ore, it is to be noted that:

* Near surface pit slopes in overburden are shown at a slope angle of 38 degrees, so that stability can be maintained for several months (possibly up to 9 months).

* The majority of the overburden is excavated with a working face of approximately 45 degrees; a slope angle which site measurements indicate should maintain stability for several weeks (possibly up to 3 months).

* The working face in the ore-bearing alluvium is restricted to a height of 8 metres, a height at which the site materials should be able to stand temporarily, and fail in a planned manner. It is our opinion that face heights greater than 9 metres are, theoretically, immediately unstable.

It is also our view that a considerable amount of work can be done, which will significantly improve the safety and economic operations of the pit, almost immediately (i.e. in the next 6 to 12 weeks). A pre-requisite to such work, would however be the immediate carrying out of site survey (both from Aerial Photography and Ground Survey), and the preparation of appropriate Engineering Designs for the various works to be constructed.

4. Overburden Removal Methods.

It is paramount to the viability of the mining operation at Pioneer that the most economic method of overburden removal be implemented, and that the method adopted be compatible with the range of ground conditions likely to be experienced during the operation of the mine. Previous mining of the lead has revealed an overburden with horizons which have varying engineering properties, and which could require special treatment. For example, it used to be common practice to use explosives to loosen the hard claypan horizon which occurs in the upper levels of the overburden. Consequently, during the course of exploration drilling, it is important that the engineering properties of the overburden material be accurately logged.

To enable the most economic method of removing the overburden to be developed, it is recommended that:

a) A detailed study be made of past methods of removing the overburden.

b) Extensive investigation be made in to various present day methods of removing the materials.

Item (b) would naturally include a study of all possible methods and combinations of methods, which could include the basic components of scraper, dozer, conveying, dragline, shovel, and hydraulic methods of overburden removal.

It may well be that the final recommendation of such a study would require different techniques or combination of techniques of overburden removal depending upon the ground conditions revealed by the exploration drilling.

5. Stormwater Control in Mine Area.

It is our view that the majority of the overburden excavation problems are being caused by the totally inadequate methods of site stormwater, and groundwater, control. It is therefore critically important to re-establish proper drainage in the area as soon as possible.

It is also to be noted that, the Pioneer Mine is located at the centroid of a substantial catchment area, into which three (3) creeks flow (viz. Racecourse Creek, Bradshaw's Creek and Gilham Creek). Reference to Drawing No. E-078/G5, will show how vulnerable the mine area is to flooding from these creeks; the plan also indicates the measures taken a number of years ago to prevent such flooding (ref. the 'Old Water Race' from Gilham Creek). It would appear that the reconstruction of such water races would materially reduce the vulnerability of the mine to stormwater flows, and flooding.

Calculations upon the capacity of the new Diversion Channel for the combined Gilham and Bradshaw's Creeks, (*Ref. Figures A1, A2 and A3 in the Appendix*), have indicated that:

* The portion of the channel with a bed slope of 10%, has streamflow velocities of approximately 4.0m/sec.

* In those parts of the channel with a bed slope of 3%, streamflow velocities of approximately 2.5m/sec. can be expected.

It is established Engineering practice to limit flow velocity in earth channels of this type to a maximum value of 1.5m/sec, to reduce channel erosion to an acceptable level. Consequently, it is anticipated that severe erosion of both the channel bed and sides will occur in those section of the Diversion which have a grade of greater than 1% (water velocity approximately 1.5m/sec.).

It is also recommended that any new open channels should generally be constructed with trapezoidal sections having side slopes not exceeding $1\frac{1}{2}$:1 horizontal to vertical; also the invert of the drain should be excavated into the Tertiary Alluvial (hardpan) material where possible.

In addition, the outcrop of the contact between the Basalt flows and the Granite rocks in the upper catchment areas, is a source of considerable underground waterflow, which comes to the surface as 'Springs'. In effect, the Basalt rock acts as a collector for these underground aquifers, and so the catchment areas for the various creeks are much larger than the topographic conditions would indicate.

6. In Pit Mine Water Control.

The regional geology of the area (refer Tasmanian Department of Mines Geological Survey Bulletin No. 35, 1925), shows the Wynifford River Lead at Pioneer to be an old river course which flowed into the Ringarooma River, which in turn was formerly located to the north-west of Pioneer. In the absence of ground movements since the ore-bearing deposits were laid down, it is reasonable to assume the alluvial tin deposit will dip to the north-west. This, coupled with the slope of the natural ground surface in the area to the east, presents an unfavourable situation for the disposal of in-pit mine water.

It is therefore considered essential that as part of the overall drilling and mine planning phase, that careful attention be paid to slope of the bedrock at the base of the deposit with a view to the ultimate disposal of mine water.

Our site observations also indicated that the majority of the sub-surface water was emanating immediately above the ore-bearing alluvial material. This subsurface water comes into the pit in localised areas, often as a concentrated stream, and therefore causes considerable problems to the mining operation. The suggested method of working the mine face would also permit the installation of subsurface drains to enable the control of these waters. The subsurface drains could probably utilise the old Tailings materials as a filter material, and as such could be constructed relatively cheaply.

7. Slimes and Effluent Treatment.

It would appear that the slimes and effluent treatment needs careful consideration and planning before further construction work can be carried out. A critical factor in the treatment of the slimes is the length of time required for sufficient settling of the clay to permit decanting of the 'clean' water. Some sampling, testing and analysis of the water from the mine is therefore a matter of considerable priority.

It is also our view that any settling ponds should be operated on a 'cyclic' basis, with at least two pond areas. In this way the effluent can be completely arrested, and the maximum effect obtained from 'gravity' settling.

8. Bradshaw's Creek Diversion Dam.

It is our opinion that the Bradshaw's Creek Diversion Dam is presently having only a minor effect upon the pit slope stability; however, as the pit advances towards the dam, the detrimental effect will significantly increase.

The stability of the embankment structure itself is however suspect, as muddy water was observed near the outlet of the scour pipe. It is understood that this pipe was accidentally damaged by a bulldozer some time ago, and this damage may be now giving rise to internal erosion and piping within the dam.

The diversion channel for Bradshaw's Creek around the northern side of the mine is similarly only having a minor effect on the pit stability. However, the 'Viaduct' section of the Race could be permitting small quantities of seepage to pass into the overburden adjacent to the mine, and consequently make overburden stripping operations much more difficult.

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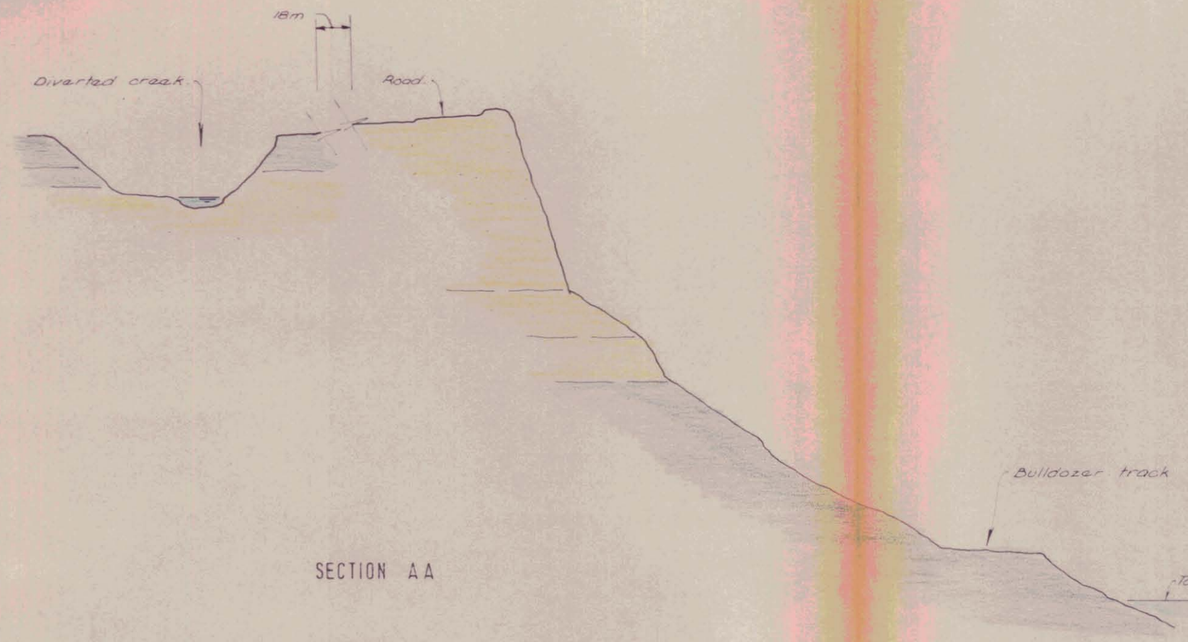
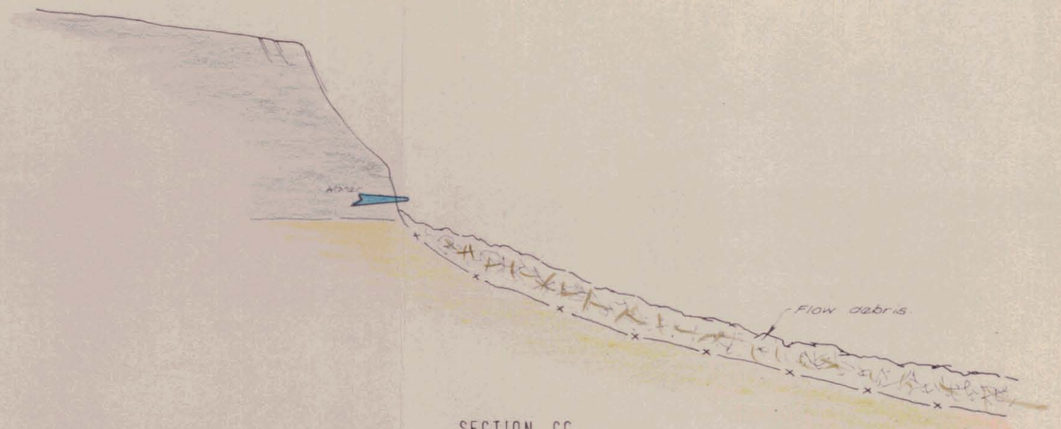



SECTION AA


SECTION BB




SECTION CC


SECTION DD

# SECTIONS THROUGH ACTIVE MINE AREA

# SECTIONS THROUGH OLD PIT

5 cm

NOTES:

1. For description of exposed material refer to drawing No. E-078/
2. Sections EE, FF & GG are documented separately.

| Drawn | Date |
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| A.S.A. | July '78 |


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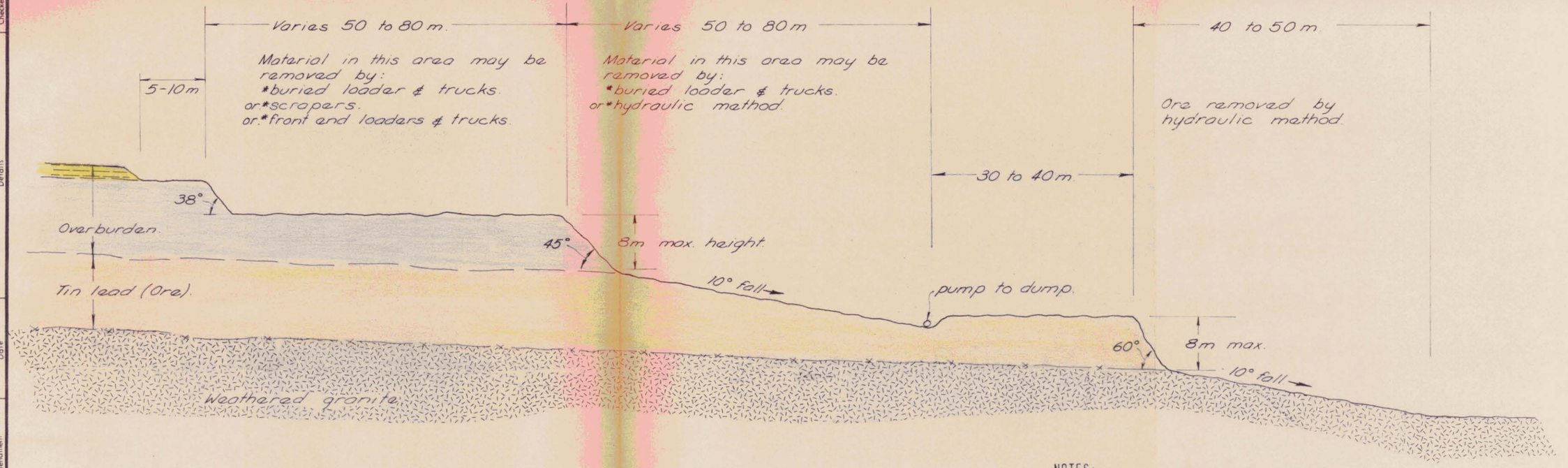
| | |
|---|---|
| SECTIONS THROUGH PIT<br>PIONEER TIN MINE . TASMANIA | Scale<br>1: 250 |
| AMDEX MINING Ltd | Drawing Number<br>E-078/G3 |

822018




## LEGEND

| | | |
|---|---|---|
| Quaternary | | Alluvial material (Topsoil, grey sand, silt, etc.). |
| Tertiary | | Partially cemented light grey silty sand with bands of clay (to 1m) and silt. |
| | | Partially cemented grey & yellow brown clayey silt with bands of silty clay and localised layers of ferricrete. |
| | | Highly weathered, fresh granite. |

NOTES:

1. This drawing depicts a general arrangement of the mine working face which would achieve greater stability of the mine area.
2. The actual arrangement adopted should be varied in accordance with a detailed mine plan which takes into account lead dimensions and orientation, overburden characteristics and the mining method adopted.

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Details
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WORKING FACE ARRANGEMENT
PIONEER TIN MINE . TASMANIA

AMDEX MINING Ltd

Scale N.T.S.

Drawing Number E-078 /G4

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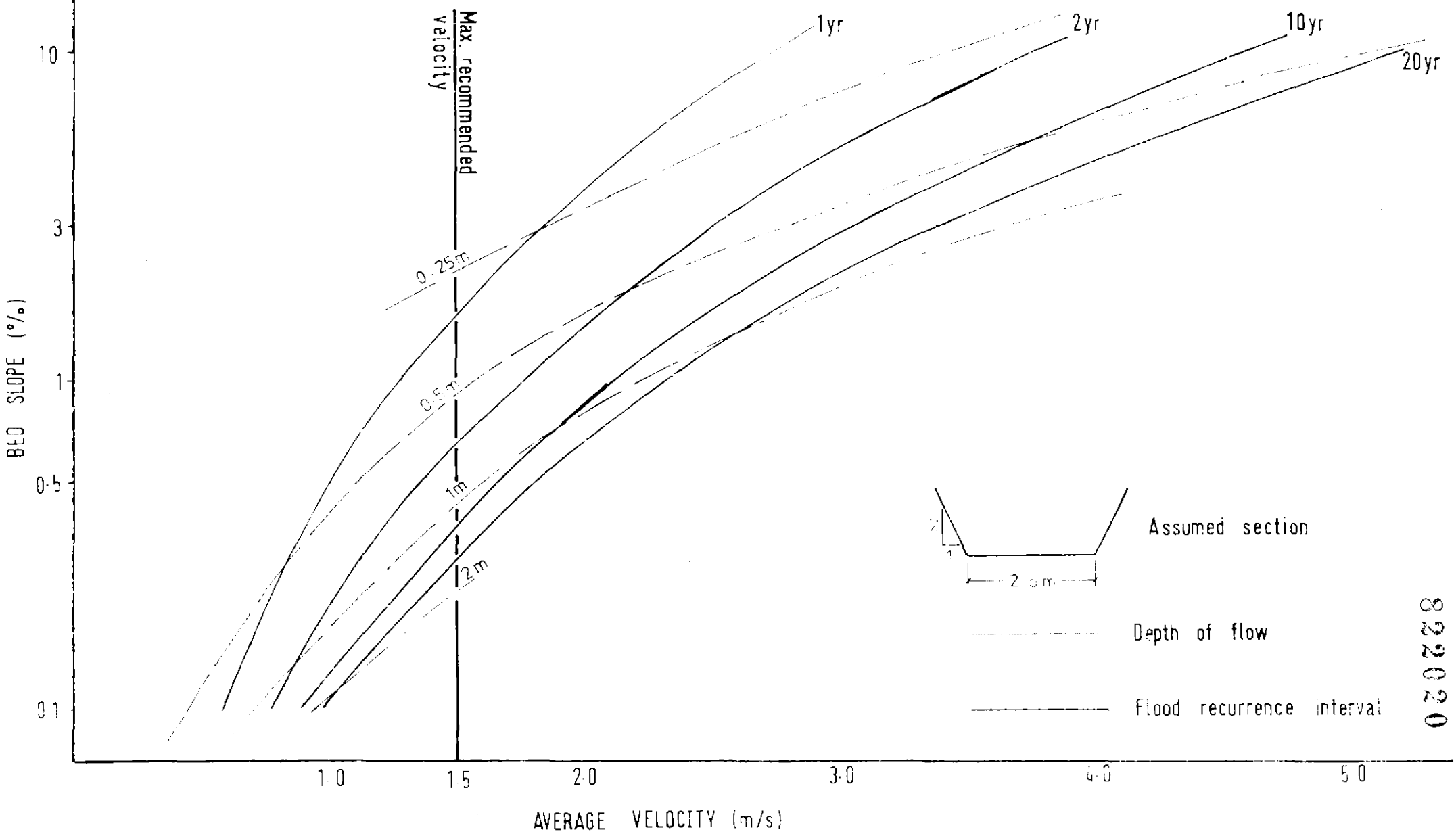
# APPENDIX 'A'

## TECHNICAL DATA

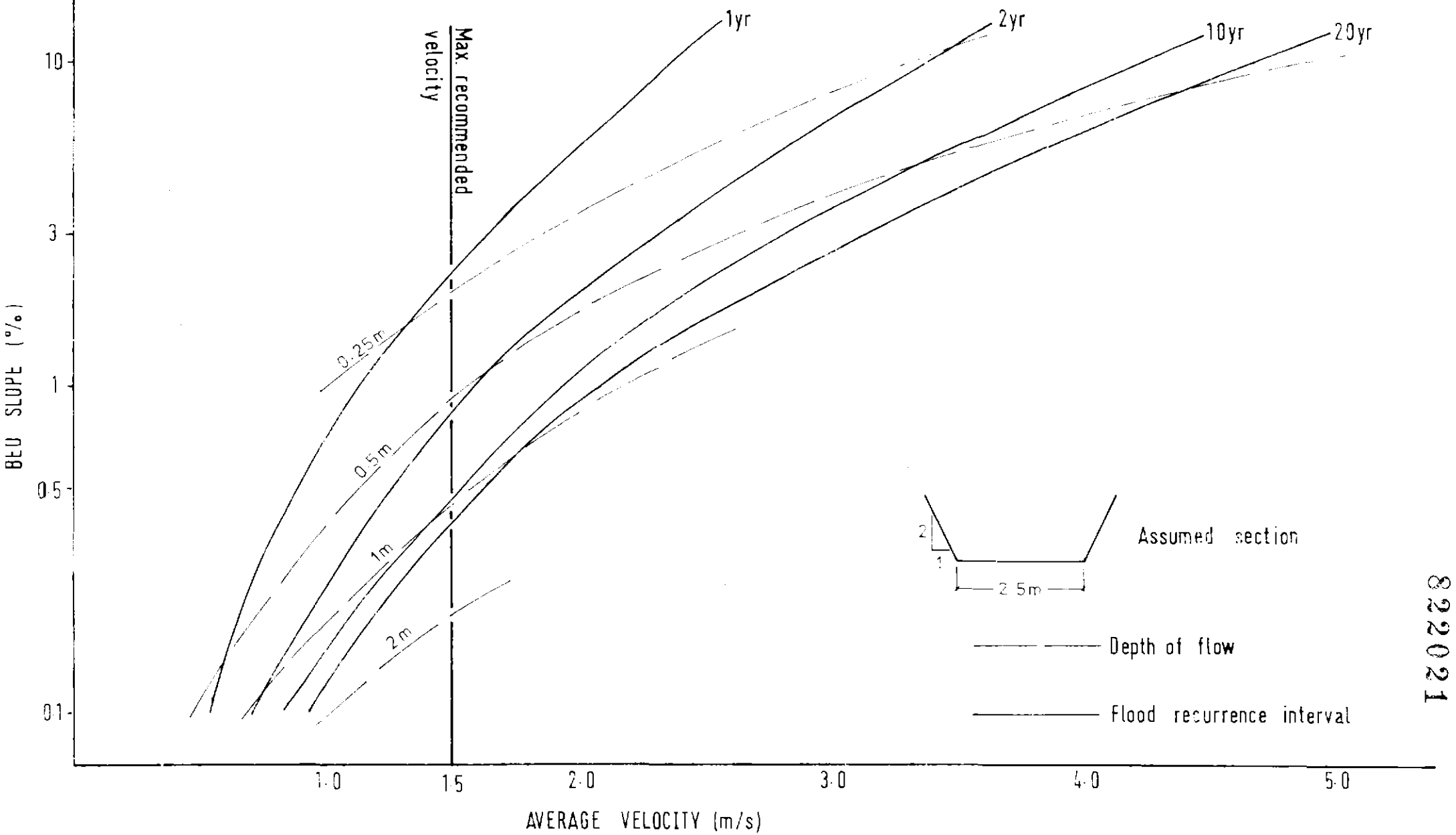
# COMBINED DIVERSION CHANNEL Fig A1

## Bed slope Vs Average velocity



# BRADSHAWS CREEK Fig A2

## Bed slope Vs Average velocity

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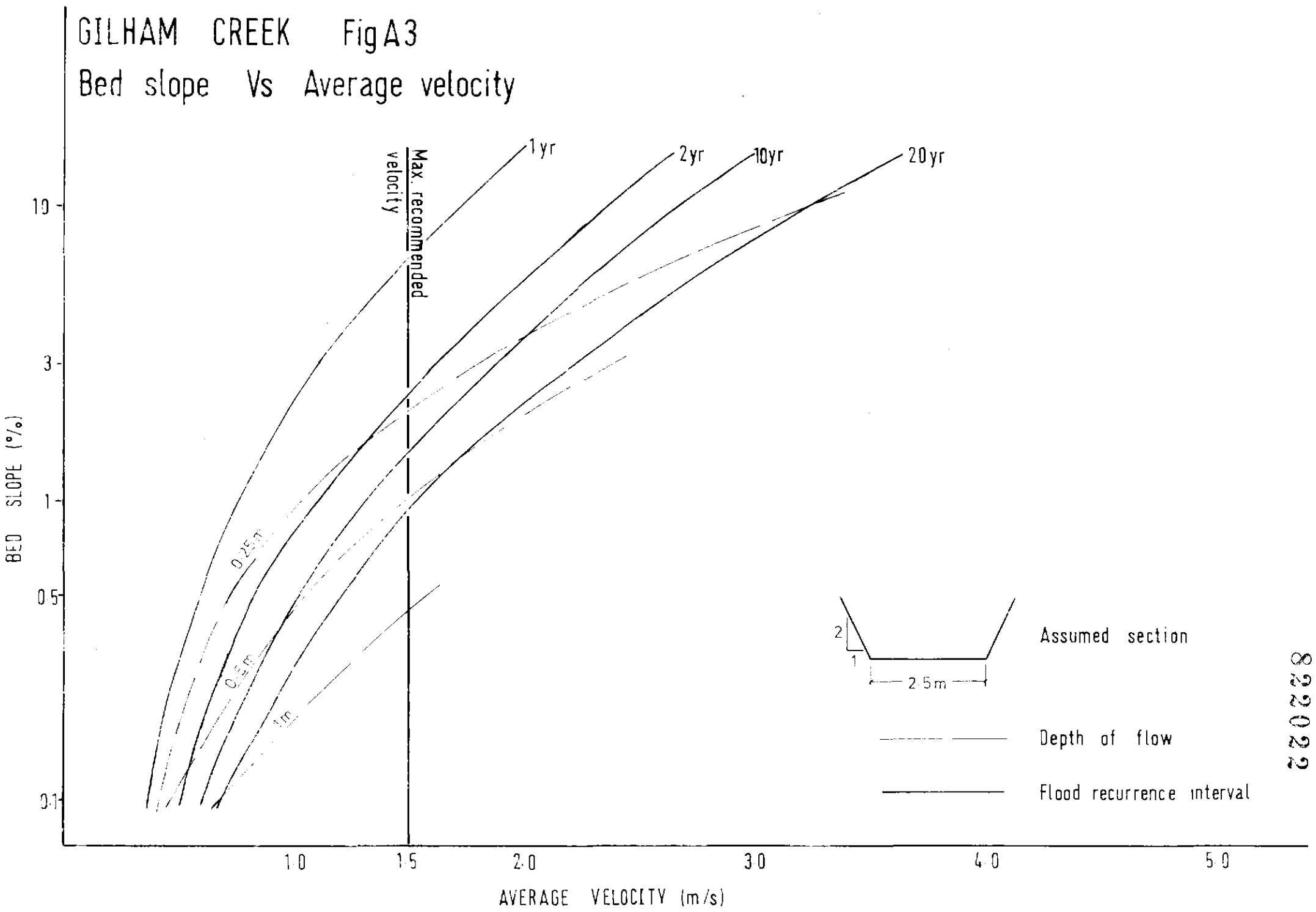
# GILHAM CREEK Fig A3

## Bed slope Vs Average velocity



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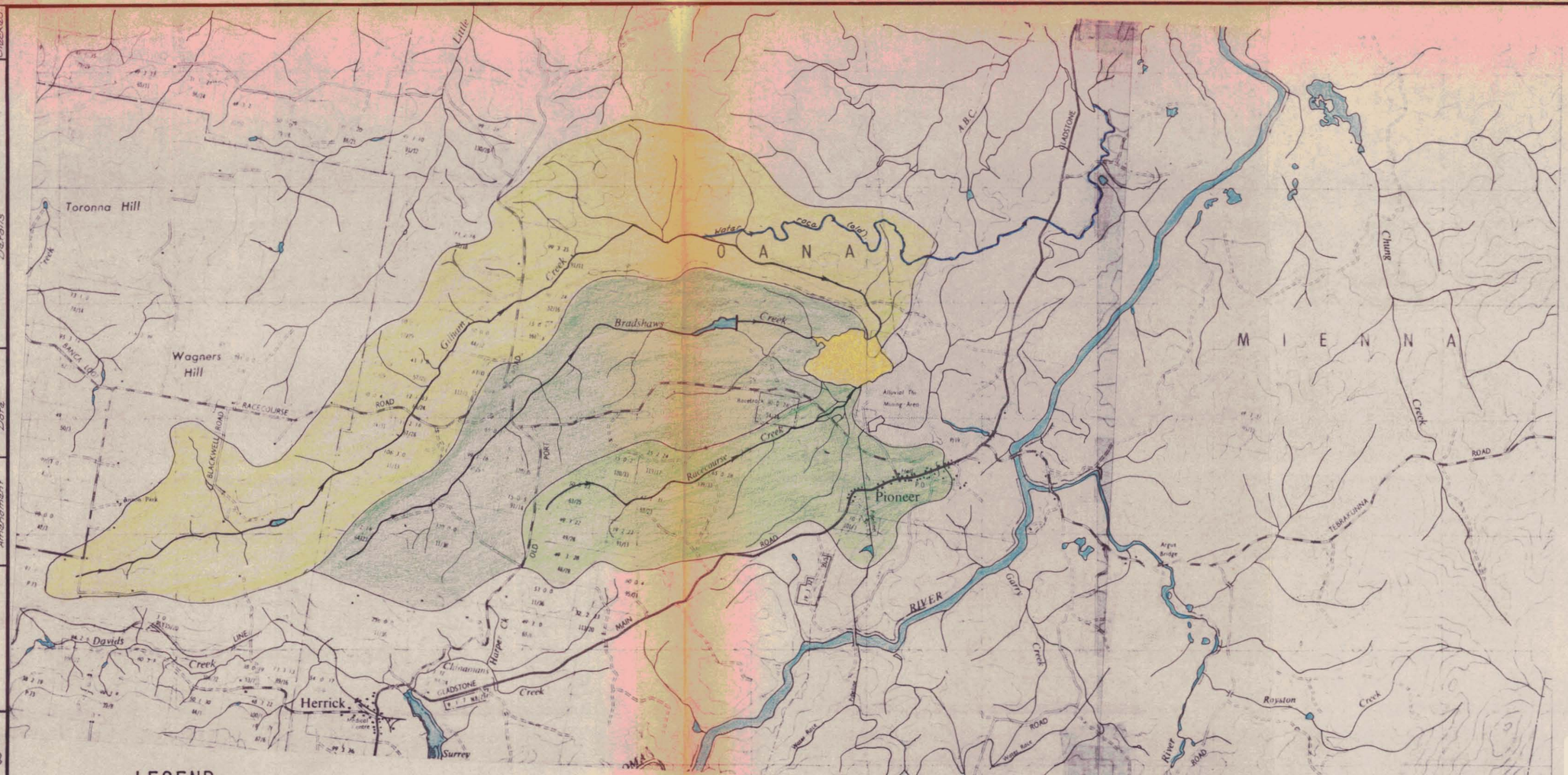


## LEGEND

- Gilham creek catchment area.
- Bradshaws creek catchment area.
- Racecourse creek catchment area.
- Location of Pioneer tin mine.
- Old water race.

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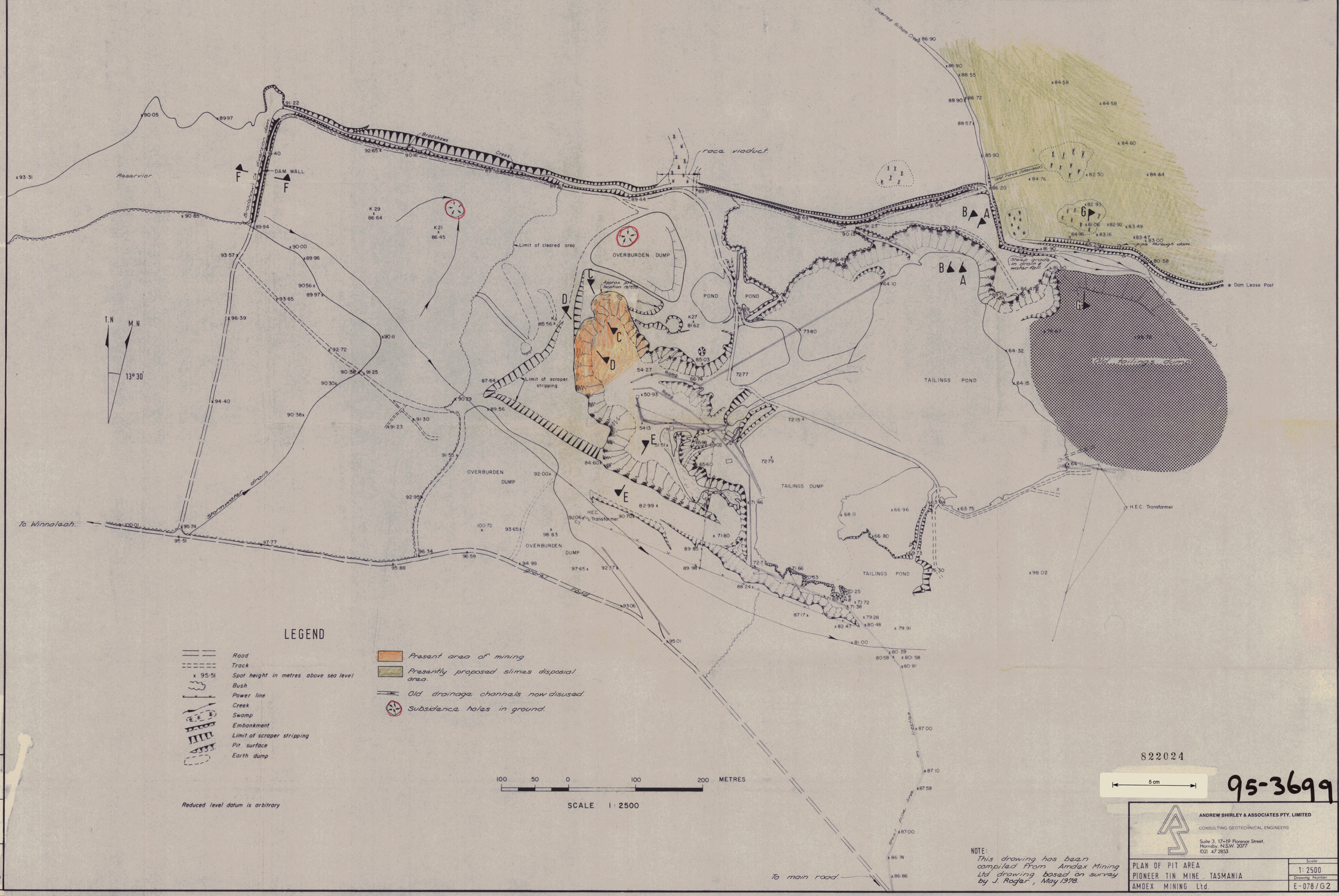
CATCHMENT AREAS & DRAINAGE
PIONEER TIN MINE . TASMANIA
AMDEX MINING Ltd

Scale: 1: 13,680

Drawing Number: E-078 / G5


Diverted Gilham Creek
Bradshaws Creek
race viduct
Reservior
DAM WALL
Embankment of diversion dam
Limit of cleared area
OVERBURDEN DUMP
POND
POND
Approx. pit location 1978
Limit of scraper stripping
Ramp
Ramp
TAILINGS POND
TAILINGS DUMP
TAILINGS POND
OVERBURDEN DUMP
OVERBURDEN DUMP
HEC Transformer
H.E.C. Transformer
old race (abandoned)
Steep grade in drain & water fall
pipe through dam
Dam Lease Post
Old race (no use)
Stormwater drain
To Winnaleah
To main road
T.N
M.N
13° 30'
LEGEND
Road
Track
Spot height in metres above sea level
Bush
Power line
Creek
Swamp
Embankment
Limit of scraper stripping
Pit surface
Earth dump
Present area of mining
Presently proposed slimes disposal area.
Old drainage channels now disused.
Subsidence holes in ground.
Reduced level datum is arbitrary
100 50 0 100 200 METRES
SCALE 1:2500
822024
5 cm
95-3699
NOTE:
This drawing has been compiled from Amdex Mining Ltd drawing based on survey by J. Roger, May 1978.
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PLAN OF PIT AREA
PIONEER TIN MINE. TASMANIA
AMDEX MINING Ltd.
Scale 1:2500
Drawing Number E-078/G2
Date July '78
Drawn A.S.A.
Checked A.J.