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REPORT ON

MICROFILMED
FICHE No. 015200 -

CONCEPTUAL DRAINAGE DESIGN
CREST MAGNESITE PROJECT

DRAFT

Submitted to :

Hatch Australia Pty Ltd
PO Box 7638, Cloisters Square
PERTH WA 6850

AMG REFERENCE POINTS ADDED

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Report on Conceptual Drainage Design - Crest
Magnesium Project
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1. INTRODUCTION

Hatch Australia Pty Ltd (Hatch) is undertaking design studies for the proposed Crest Magnesite Project, the mine for which would be located in north western Tasmania. Golder Associates Pty Ltd (Golder) has been engaged to carry out preliminary dewatering studies, to be reported separately from this document, and drainage design.

This report presents the results of the initial drainage design, which has been prepared as a desk study in Golder's Perth office. Hatch requested that the drainage design be developed to a level appropriate to support applications for environmental permitting for the project rather than for engineering design.

2. BACKGROUND

2.1 Site Description and Proposed Project Layout

Detailed site descriptions will be provided in numerous other documents prepared for the project. This description is intended to provide a sufficient background for understanding the drainage designs which are presented and discussed in this report.

The site proposed for the Crest Magnesite mine is located approximately 50 km south west of Burnie in Tasmania. It is close to the confluence of the Keith River and the Arthur River, the former of which forms the boundary of the Tarkine Wilderness area.

Both rivers are understood to be perennial, the Keith being reportedly "pristine". The Arthur drains a mixed catchment but is understood to be generally in good condition.

The site slopes towards both rivers and is crossed by several small, ephemeral drainage lines, indicated on Figure 1. It is understood to be covered with regrowth vegetation, dominated by *Melaleuca* species and underlain at surface mostly by alluvium. The geology is believed not to be well understood in detail beyond knowledge of the occurrence of economic magnesite and its broad setting.

It is proposed that the site will accommodate:

- An open pit mine

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- A waste dump
- A load out area with stockpiles and both rail and road access from the opposite bank of the Arthur River
- Drainage management facilities such as bunds and sediment control ponds.

These facilities are shown indicatively on Figure 1.

2.2 Climate

The area has a cool, wet climate with an annual rainfall of 1896 mm and Class A pan evaporation of about 1100 mm (Bureau of Meteorology, 1988). Rainfall statistics are summarised in Table 1.

Table 1 : Rainfall Statistics (1926 – 1967)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Rainfall (mm)	83	97	102	150	187	204	251	231	182	167	131	112	1896
Average No. Wet Days	13	13	16	18	21	20	23	22	20	20	18	16	219

(Data supplied by Bureau of Meteorology)

3. SCOPE OF WORK

The scope of work for this study included:

- preparation of conceptual designs for mine dewatering pump and pipework systems, the capacity of which should allow for removal of both groundwater and surface water from the mine
- assessment of the most appropriate storm duration and recurrence interval to use for the dewatering design
- provision of design advice for the retention ponds, which are required to reduce the suspended solids load and turbidity of the dewatering discharge, prior to its release to the

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Arthur River, including assessing likely turbidity objectives, retention time in the ponds, discharge structures for the Arthur River outfall and general design comments

- assistance with briefing and discussion meetings in Perth regarding the environmental approvals process.

Information was gleaned from various sources regarding the likely constraints on discharge water quality as necessary background to assessing the likely water quality management requirements and providing enough understanding to discuss any limitations inherent in the simple settlement pond approach.

4. CONSTRAINTS ON DISCHARGE OF WATER FROM THE SITE

Runoff to the Keith and Arthur Rivers from the site will be generated both offsite (uphill) and from areas on the site which have been affected by the project development.

In general, runoff from undisturbed vegetation is already discharging to the rivers, and if isolated from the project facilities, should remain acceptable in quality. Runoff from the parts of the site which are to be affected by the project components is likely to be contaminated by suspended solids and maybe dissolved constituents.

Discharges of water from the site are constrained by three main legislative requirements. These are:

- that the discharge must be approved and licensed
- that the discharge must occur in accordance with any conditions imposed in the operating licence and must not result in environmental harm which is greater than that allowed under the environmental licence
- that the discharge must not have the effect of contravening state environmental policies which aim to promote sustainable resource development or protection of particular species, ecosystems or geographic area.

Detailed statutory requirements are described in relevant state and Commonwealth Acts, and in related subordinate legislation. A list of State legislation which may constrain or influence discharge of water from the site is provided in Table 2.

DRAFT**Table 2 : Regulations Potentially Impacting on Water Discharges**

Title of Act
Environmental Management and Pollution Control Act 1994
Groundwater Act 1985
Land Use Planning and Approval Act 1993
Mineral Resources Act 1995
National Parks and Wildlife Act 1970
Resource Management and Planning Appeal Tribunal Act 1993
State Policies and Projects Act 1993
Water Act 1957
State Policy on Water Quality Management 1997

Water discharges from the site will require an environmental approval, normally in the form of a discharge licence if the project is classified as a "Schedule 2" activity.¹ The discharge licence will typically impose conditions that may limit:

- the concentration of dissolved or suspended substances in the water discharged
- the mass of dissolved or suspended substances discharged over a specified time period or duration
- the concentration of dissolved or suspended substances that will occur in the receiving water as a result of discharges from the site (superimposed on any existing dissolved or suspended substances).

¹ A more rigorous level of scrutiny and approval may be applied if the project is deemed to constitute an activity "of State significance under the State Policies and Projects Act 1993". Such a classification is possible (but not certain), given the proximity of the project to the Tarkine Wilderness area.

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More than one of these conditions may be imposed, with the most stringent discharge control normally taking precedence.

Table 3 provides a summary of the maximum contaminant concentrations likely to be allowed in water discharged to the Arthur River (or other surface waters). The values listed in the table are summarised from the Environment Protection Act 1973, which has been superceded by the Environmental Management and Pollution Control Act 1994. On the basis of discussions with the Tasmanian Department of Primary Industries, Water and Environment, we understand that these values are still being used as guidelines for general environmental licensing purposes.

**Table 3 : Maximum Allowable Contaminant Concentrations
in Water Discharged To Surface Waters in Tasmania**

Parameter	Concentration, mg/L
Arsenic	0.1
Cadmium	0.03
Chlorides and sulphates (combined)	600
Copper	1.0
Chromium (VI)	0.05
Chromium (III)	0.5
Cyanide	0.2
Fluoride	3.0
Iron and manganese (combined, dissolved)	5.0
Lead	0.2
Mercury	0.01
Zinc	5.0
BOD5	20 – 40*
Suspended solids (non-filtrable residue)	30 – 60*
Oil and grease	10
Faecal coliforms	200 / 100 mL
Aesthetic requirement	"Visually free of grease, oil, solids and unnatural discolouration"

* Depending upon flow rate in the receiving water.

Limitations on mass discharges to the environment have not yet been defined in Tasmanian regulations. However, based upon our discussions with representatives of the Department of Primary Industries, Water and Environment, current policy development is considering this approach as an additional regulatory control on industrial discharges.

It is almost certain that any application involving discharges to surface waters will be required to estimate the impact of the discharges on the receiving water quality. The assessment of impact may be made by comparing the predicted water quality in the river to a standard set of water quality criteria (such as the *ANZECC Water Quality Guidelines for Fresh and Marine Waters*). However in areas considered to have a high environmental value (such as upper reaches of the Arthur and Keith Rivers), it would be more usual to compare the altered river condition (after receiving mine discharges) to the original, or "typical" river condition in the absence of any discharges.

Although mixing zones may be allowed (i.e. zones in which river water is demonstrably different to the normal river water chemistry as a result of the release of water from the mine site), the magnitude of the allowable deviation from "usual" river chemistry is likely to be small – in the order of 50% deviation or less. This may present a serious constraint to the disposal of water from dewatering and stormwater diversion activities, particularly in connection with the requirement to manage levels of suspended solids and iron in the water discharged from the mine site.

At present, there appears to be insufficient information to characterise "usual" conditions in the Arthur River, against which to compare the estimated concentrations of contaminants in water which may need to be discharged from the site. Further work will therefore be required both to characterise the Arthur River and to describe the physico-chemical properties of any water (including suspended or dissolved solids) proposed to be discharged from the site. This is well beyond the scope of Golder Associates' engagement and is the responsibility of other consultants working on the project.

5. ESTIMATION OF RUNOFF QUANTITIES AND RATES

5.1 General

The area was divided into three broad categories for the purposes of this part of the study, the mine itself, the waste dump/loadout area and the naturally vegetated areas. As discussed elsewhere, it is anticipated that natural vegetation would be disrupted minimally outside the area

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of the main facilities and therefore that runoff from those areas would remain suitable for natural discharge to the rivers.

5.2 Rainfall Analysis

A dewatering requirement stipulated by the project mining engineer is that runoff from the incident rainfall be pumped out of the pit within 24 hours. Regional rainfall data were analysed by Pitt and Sherry to calculate storm intensity-duration-return period curves, which were provided to Golder Associates. Consideration of these curves suggested that annual return intervals of 2 and 5 years for storms of 24 hour duration would be appropriate for the preliminary calculations of runoff. The rainfall associated with these events are shown in Table 4.

Table 4 : Rainfall Intensity Data

Return Interval	Storm duration and intensity (mm/hr)			
	1 hour	2hour	6 hour	24 hour
2 Year	18.1	12.67	7.09	3.29
5 Year	22.71	15.67	8.56	3.86

This information allows the calculation of the rate of generation of runoff and of the volume of water which would need to be pumped from the pit. The selection of the 24 hour duration storm is due entirely to the requirement that the water be removed within 24 hours, since this duration storm gives the largest volume of runoff in that time. The small difference between 2 Year and 5 Year return interval storms suggests a consistent rainfall pattern from year to year. The 5 Year return interval was selected for design purposes, although the difference between this and a slightly longer or shorter interval would not much affect the design.

5.3 Mine Groundwater Inflows

The mine will be developed below the water table and, as a consequence, groundwater will flow into it unless intercepted by a system of bores outside the pit. The need for such a system is not anticipated at this stage.

The preliminary, predicted inflow rate for groundwater to the mine is 196 L/s at full pit development. These estimates are currently being finalised by Golder Associates as part of a separate commission and may change slightly.

5.4 Mine Drainage Requirements

It is anticipated that mine drainage will be achieved by sumping, for both groundwater and surface water. As shown in section 5.4.1, most of the peak flows will be generated from runoff within the pit area, although the base flow will be provided by the groundwater inflow.

For this initial design phase, Golder Associates have been requested to design pump and pipework for the pit floor sump to a capacity which would ensure that most storm runoff would be removed from the pit floor within 24 hours for the fully developed Stage 3 mine.

5.4.1 Mine Drainage Volumes and Rates

The runoff volume once the mine has been developed to its final slopes at the surface is estimated to be approximately 23 200 m³, using the 1 in 5 Year return interval for an event duration of 24 hours. It has been assumed that 100% of the rain would run off, given the climate and the development of the mine below the water table.

Based on this volume, the pumping rate required to empty the pit within 24 hours is approximately 270 L/s. An additional 200 L/s would enter the pit at its final depth as groundwater inflow, giving a design requirement for pumping and water quality management systems of 470 L/s (41,000 m³/day).

5.5 Runoff from Loadout Area and Waste Dump

5.5.1 Loadout Area Runoff

The loadout area incorporates the rail line, the access road and the stockpiles (see Figure 1). This area would produce a volume of 12 500 m³ of runoff for a 24 hour storm event with a 5 year recurrence interval. This is a conservative estimate as a runoff factor of 90% has been used.

5.5.2 Waste Dump Area Runoff

Rainfall runoff from the waste dump from the 1 in 5 year 24-hour storm event is estimated to be approximately 29 000m³. This is also a conservative estimate as a runoff coefficient of 90% has been used.

5.5.3 Combined Runoff Rates From Loadout Area and Waste Dump

The combined runoff volume for both areas is estimated to be 41,500 m³ for a 24 hour storm event with a 5 year recurrence interval. This represents an instantaneous rate of 480 L/s averaged over the duration of the storm, which is almost identical to the runoff rate predicted for the pit drainage. Since a runoff coefficient of 90% has been used, this estimate may appear to overestimate somewhat the actual runoff rate but, given the local climate, it is possible that antecedent conditions could result in the design storm occurring when the catchment has been thoroughly wetted.

6. PUMPING AND PIPEWORK FOR MINE DRAINAGE

It is anticipated that the mine drainage will be achieved using a floating pumpset in a pit floor sump. These pumps would discharge into a rising main which would be carried up the pit walls, eventually discharging into the mine water settlement pond. Detailed design is beyond the scope of this work: it may be, for example, that staged pumping up the pit wall would be required but this is not known at this stage.

A floating pumpset would allow for occasional flooding of the pit, which is expected given the climate and predicted storm event recurrences.

The pumps would remove both groundwater and surface water. It is expected that suspended solids contents will be variable, increasing during and after storms and depending upon the extent of intersections of clayey infill material when cavities in the magnesite are mined through.

A preliminary selection of pumps has been made, using four sets each of two Weir High Head Dirty Water Pumps in series. These might discharge via 2 HDPE pipes of 450 mm diameter. The pumping head is estimated to be about 180 m (static head) with an additional 40 m head to allow for the specific gravity of the dirty water and the friction losses along the delivery pipeline to the mine water settlement pond.

The power consumption for this pump system when pumping the runoff from the design storm has been estimated by Weir Engineering to be 2 MW. Since more than half the discharge rate for the design storm is provided by runoff, this peak power demand could be reduced by accepting a longer period of flooding of the pit floor.

7. COLLECTION AND TREATMENT OF RUNOFF OUTSIDE THE MINE

7.1 Surface Drainage Overview

It is proposed that the surface drainage from the mine site to the adjacent rivers would be partitioned and managed as follows:

- mine drainage (groundwater plus runoff) would be discharged to the Arthur River via a settlement pond
- waste dump and load out area runoff would be discharged to the Arthur River via a settlement pond
- drainage from the rising ground to the east of the site facilities would be discharged directly to both Arthur and Keith Rivers if minimum disturbance of the catchments is possible. Otherwise, this drainage would be directed to the loadout area.

7.2 Management of Natural Drainage

The catchment to the east drains to the Arthur River via two stream channels which coalesce near the waste dump. The small catchment area which drains to these streams from the direction of the pit and waste dump will be reduced in size and runoff from the waste dump will be isolated from the natural runoff by means of a toe drain, which will discharge to the settlement pond.

In order to prevent interference with the natural drainage from the east to the stream channel the discharge pipeline from the mine to the settlement pond will either be buried or elevated.

The drainage from the undisturbed area immediately east of the mine will be diverted into a lined channel, located between the mine and the boundary of the mining lease, discharging to the Keith River.

The small area between the mine and the loadout area will be kept undisturbed and drained via a lined channel to the Keith River. In the event that this area is disturbed, it would be drained via the loadout area using a sump and pump.

By careful attention to maintenance of existing vegetation it is anticipated that these two drainages will not become turbid. As a consequence, it is anticipated that no settlement ponds would be necessary and that direct discharge to the rivers will be acceptable.

7.3 Isolation of Runoff to and from Mine Facilities

It is understood that the mine would be protected from runoff entering from the hills to the east by a bund.

The waste dump should be isolated from adjacent areas with a catchdrain so that its runoff and shallow seepage would be collected and taken to its settlement pond.

7.4 Design Approach for Settlement Ponds

7.4.1 General

Settlement ponds are required to collect suspended solids which will inevitably be entrained in the runoff streams from all site facilities.

The approach adopted for this initial design study was to allow for settling as much fine suspended material as practicable, given the size of the site. Calculating likely settling times led to the conclusion that a pond designed to settle particles sized 0.01mm and should have a flowing depth of 1 m or more and a retention time of 6 hours or more. A particle size of 0.01mm is a medium-grained silt.

7.4.2 Mine Drainage

For the mine drainage requirement (up to 470 L/s) this 6-hour retention criterion would require a pond with an area of approximately 10,000 m² with an actively moving water depth of approximately 1m. The pond water depth would be 1.5 m to 2 m and 0.5 m freeboard would be a prudent allowance.

Given that no allowance has been made at this conceptual stage for factors such as wind effects or turbulence, the presence of mica from schistose materials etc, a sizing factor of two has been allowed, resulting in a preliminary size for the mine water retention pond of 20,000 m².

The detailed design will require a very slow velocity across a wide cross sectional area in order to allow the sedimentation of suspended solids. It is desired to have the runoff flowing through a diffusion system at the inlet to the settlement ponds to distribute the flow across the whole width of the pond. A broad-crested weir at the outflow will minimise acceleration of the flow near the discharge end of the settlement pond.

7.4.3 Drainage of Loadout and Waste Dump Areas

For the drainage from waste dump and loadout areas, the combined runoff for the 24-hour, 1 in 5 year event is estimated to be 41,500 m³. For convenience, runoff from these areas could be combined in a single settlement pond between the waste dump and the Arthur River.

To allow settling time comparable with that provided for the mine drainage, which is appropriate, a settlement pond of similar size to that allowed for mine drainage would be required, i.e. 20,000 m². However, the mine provides effectively unlimited storage for rare, larger events whereas there is no storage inherently available for the loadout and waste dump areas.

For this reason a buffering storage is required upstream from the settlement pond, to route storm flow into the settlement pond so that its capacity to manage suspended solids is not overwhelmed by a large enough storm for the design residence time not to be achieved. Such an event could result in an unacceptably turbid discharge from the settlement pond. A storage of another 15,000 m³ is envisaged as being suitable for this purpose, with a spillway which would be designed to limit discharge into the settlement pond to a rate of 480 L/s.

7.4.4 Mine Water Settlement Pond

It is anticipated that the mine water settlement pond will be a cut and fill structure with a compacted base and compacted walls (Figure 2). Seepage through the base of the structure is likely to be acceptable but, for stability reasons, the embankments should be constructed to a standard which prevents this. The compaction of the base of the pond is intended to allow access by machinery to remove sediments when required, for disposal in the waste dump.

Flow into the pond will be diffused to spread flow over the whole width of the pond. At the outlet a level spillway will collect water over a sufficient width to minimise deep flow through the pond and to direct water into a concrete channel leading to the Arthur River. Where the water enters the river, it is anticipated that a method of dispersing its energy may be necessary. This

could be achieved by installing an outlet structure and laying a rock bed at its base to act as an energy dissipator.

The settlement pond for the mine drainage has been located conceptually in a gently sloping area near the Arthur River and avoiding the footprint of the potential second pit (Figure 1). It is at a higher elevation than the estimated 1 in 100 Year flood level of approximately 145 m AHD.

7.4.5 Waste Dump and Loadout Area Settlement Pond

It is anticipated that the settlement pond for the loadout area and waste dump will be a cut and fill structure with a compacted base and compacted walls, similar to that for the mine drainage.

The settlement pond for the mine drainage has been located conceptually between the Arthur River and the waste dump, downstream from the flow control structure (Figure 1). It is at a higher elevation than the estimated 1 in 100 Year flood level of approximately 145 m.

8. DISCUSSION

8.1 Storage and Treatment of Drainage Water on Site

The areas available for storage and treatment appear to be large enough for the construction of settlement ponds, based on removal by sedimentation alone of suspended solids larger than 0.01 mm. To remove finer material by sedimentation would require substantially larger ponds which may not be practicable. In any case, longer settlement times are not expected to remove extremely fine silt and colloids and the larger ponds would introduce further difficulties as they would harvest significant amounts of incident rainfall. As a consequence, it is possible that discharges from the settlement ponds could have concentrations of fine suspended solids in the range of hundreds to thousands of parts per million at times of heavy rainfall. It is for this reason that Golder Associates has pursued the matter of environmental requirements as part of the design study.

It is possible that dilution with clean runoff may assist in reducing concentrations of suspended solids before discharge to the Arthur River, for example by discharging via the stream to the east of the waste dump. This has not been included in the conceptual design because the catchment of this stream may itself be disrupted in the future and it would be premature to base a discharge design on its long term good quality runoff. Similarly, dilution with clean groundwater may assist, for example if mine dewatering were achieved largely with production bores. Since bores

would be more expensive in both capital and operating costs than sumping it is presumed that they would only be considered in the event that the volume of dirty water were a sufficiently large issue to warrant the expense.

No assessment has been made of other treatment methods, such as filtration, flocculation etc. at this stage. These methods may need more investigation, depending upon Tasmanian regulators' requirements. Similarly, the option of disposing by infiltration has not been investigated, although this may be feasible later in the project life if mine planning resulted in a completed pit which might be used to infiltrate waste water.

8.2 Catchment Management and Sub-division

Management of the site runoff and its quality will be optimised by minimising disturbance of land outside the areas which are being mined, used for waste dumping etc. This report has allowed for maintenance of undisturbed areas which can drain directly to the rivers down their existing stream channels.

8.3 Management During Construction

It will be critical to control of the quality of runoff that the issue of land disturbance during construction is addressed thoroughly and that the construction schedule is designed with this issue in mind.

8.4 Water Quality Issues

The settlement pond designs which have been developed do not address some issues of water quality for discharges from the site. These issues may require further assessment in the context of Tasmanian environmental protection requirements. These issues are:

- turbidity resulting from suspended solids (including colloids) which are too fine to settle by gravity alone in a reasonable time
- dissolved constituents, such as iron and other metals, and various salts
- potential contamination from sources such as accidental fuel spills from trucks, oils and (other by-products) of the transport process.

For suspended solids (perhaps the major issue) discussions with Ms Lois Koehnken (Technical Advice on Water) suggested that the regulators may consider assessment on the basis of suspended solids at the edge of a (yet undefined) mixing zone within the Arthur River. It may be that levels in the order of tens to a few hundreds of parts per million within the mixing zone would be acceptable for short periods and that limits at the edge of the mixing zone may be more likely tens of parts per million.

9. RECOMMENDATIONS

It is recommended that this report be used to guide clarification of environmental discharge requirements for the project. Once the issue have been clarified, it will be possible to revise and refine the storage and treatment requirements.

10. IMPORTANT INFORMATION

Your attention is drawn to the document - "Important Information About Your Geotechnical Engineering Report", included in Appendix A. This document has been prepared by the ASFE (Professional Firms Practising in the Geosciences), of which Golder Associates Pty Ltd is a member. The statements presented in this document are intended to advise you of what your realistic expectations of this report, and to present you with recommendations on how to minimise the risks associated with the groundworks for this project. The document is not intended to reduce the level of responsibility accepted by Golder Associates Pty Ltd, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

We would be pleased to answer any questions about this important information from the reader of this report.

GOLDER ASSOCIATES PTY LTD

L Chandler
Manager Environmental Services

J D Waterhouse
Manager Hydrogeological Services

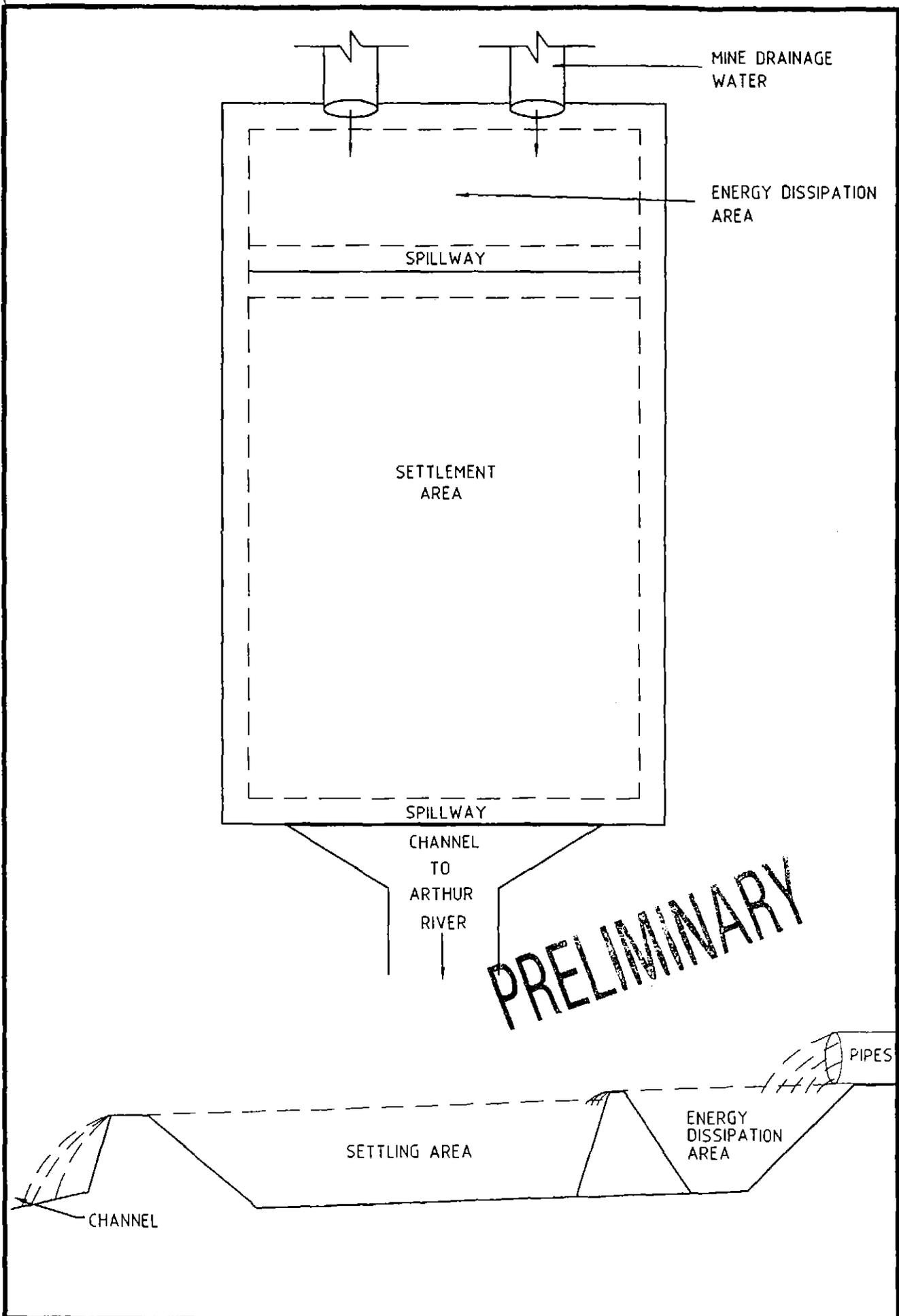
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ACKNOWLEDGEMENTS

Golder Associates gratefully acknowledge assistance and advice provided by staff of Pitt and Sherry and Ms Lois Koehnken regarding environmental issues associated with water discharges from the site.

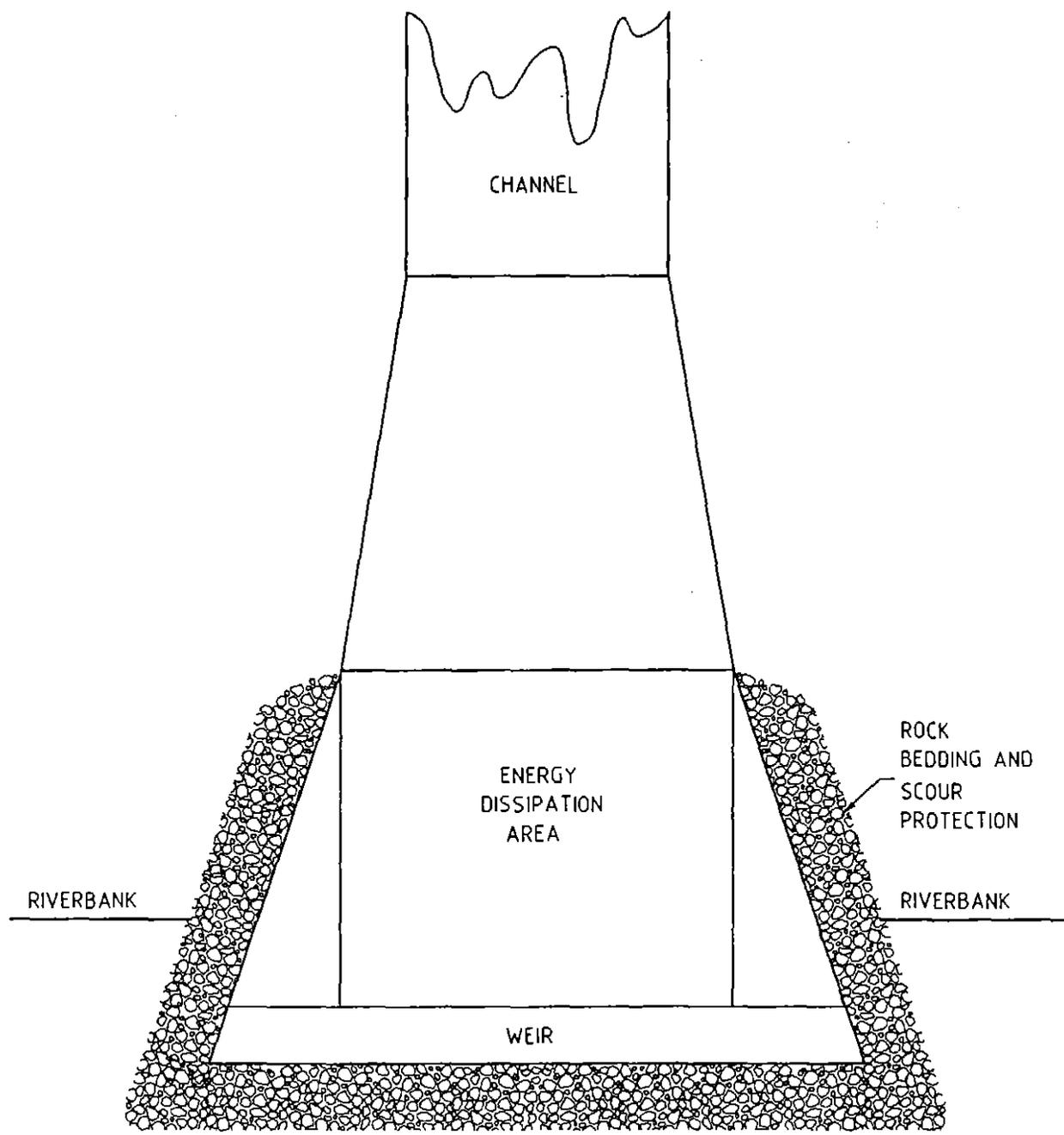


PRELIMINARY

	CLIENT Hatch (Australia) Pty Ltd		PROJECT Crest Magnesite	
	DRAWN TJP/IK	DATE May 99	TITLE CONCEPTUAL DESIGN SKETCH FOR SETTLEMENT POND	
	CHECKED	DATE		
	SCALE NTS	A4	PROJECT NO 99640120	FIGURE 2

502021

DISCHARGE FROM
SETTLEMENT POND



ARTHUR
RIVER →

PRELIMINARY

0 APPROXIMATE SCALE 5
METRES



CLIENT Hatch (Australia) Pty Ltd		PROJECT Crest Magnesite	
DRAWN TJP/IK	DATE May 99	TITLE CONCEPTUAL DESIGN SKETCH FOR RIVERBANK DISCHARGE STRUCTURE	
CHECKED	DATE		
SCALE NTS	A4	PROJECT No 99640120	FIGURE 3

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Appendix A

Important Information About Your Geotechnical Engineering Report

Important Information About Your

Geotechnical Engineering Report

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Subsurface problems are a principal cause of construction delays, cost overruns, claims and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfil the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. *No one except you* should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you –* should apply the report for any purpose or project except the one originally contemplated.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include : the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, *do not rely on a geotechnical engineering report that was :*

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical change that can erode the reliability of an existing geotechnical engineering report include those that affect :

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *Geotechnical Engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by : the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions *only* at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgement to render an *opinion* about subsurface conditions throughout the site. Actual subsurface conditions may differ – sometimes significantly – from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgement and opinion. Geotechnical engineers can finalise their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for*

the report's recommendations if that engineer does not perform construction observation.

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. *Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.*

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognise that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time to perform additional study. Only*

then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognise that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce such risks, geotechnical engineers commonly include a variety of explanatory provisions in *their reports. Sometimes labelled "limitations", many of these provisions indicate where geotechnical engineers responsibilities begin and end, to help others recognise their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.*

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures. If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. Do not rely on an environmental report prepared for someone else.*

Rely on Your Geotechnical Engineer for Additional Assistance

Membership in ASFE exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE member geotechnical engineer for more information.

ASFE PROFESSIONAL
FIRMS PRACTICING
IN THE GEOSCIENCES

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FACSIMILE TRANSMISSION

DATE : 23/4/99 JOB No: 99612011/011
 TO : Hatch Engineering
 ATTENTION : Rob Astell
 FAX No. : 08 9486 4455
 FROM : Robin Friday
 SUBJECT : **GROUNDWATER INFLOW TO PIT**
 PRELIMINARY ESTIMATE



MELBOURNE, AUSTRALIA

Golder Associates Pty Ltd
 ACN 006 107 857

25 Burwood Road
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Tel : (03) 9819 4044
 Fax : (03) 9818 7990
 Email : rfriday@golder.com.au

Total number of pages (including this cover page): 4 Original to be sent by mail: N Courier N

Please advise immediately if any pages not received.

Rob,

These estimates of groundwater inflow were obtained from our initial groundwater model for this site. The model has been approximately matched to groundwater levels before the pump test. Next week we will adjust it further to match observations made during the pump test. This will change the model. We should also get from you more detail on the planned rate of deepening in different parts of the pit floor.

Please contact us if you have any questions on these results.

Robin Friday
 Principal

011w011f.doc

Copies to:	John Pitt	6334 4651
	Ian Woodward	6223 1299
	John Waterhouse	Perth

BW



CREST MULTIPLEX MAGNESITE PIT

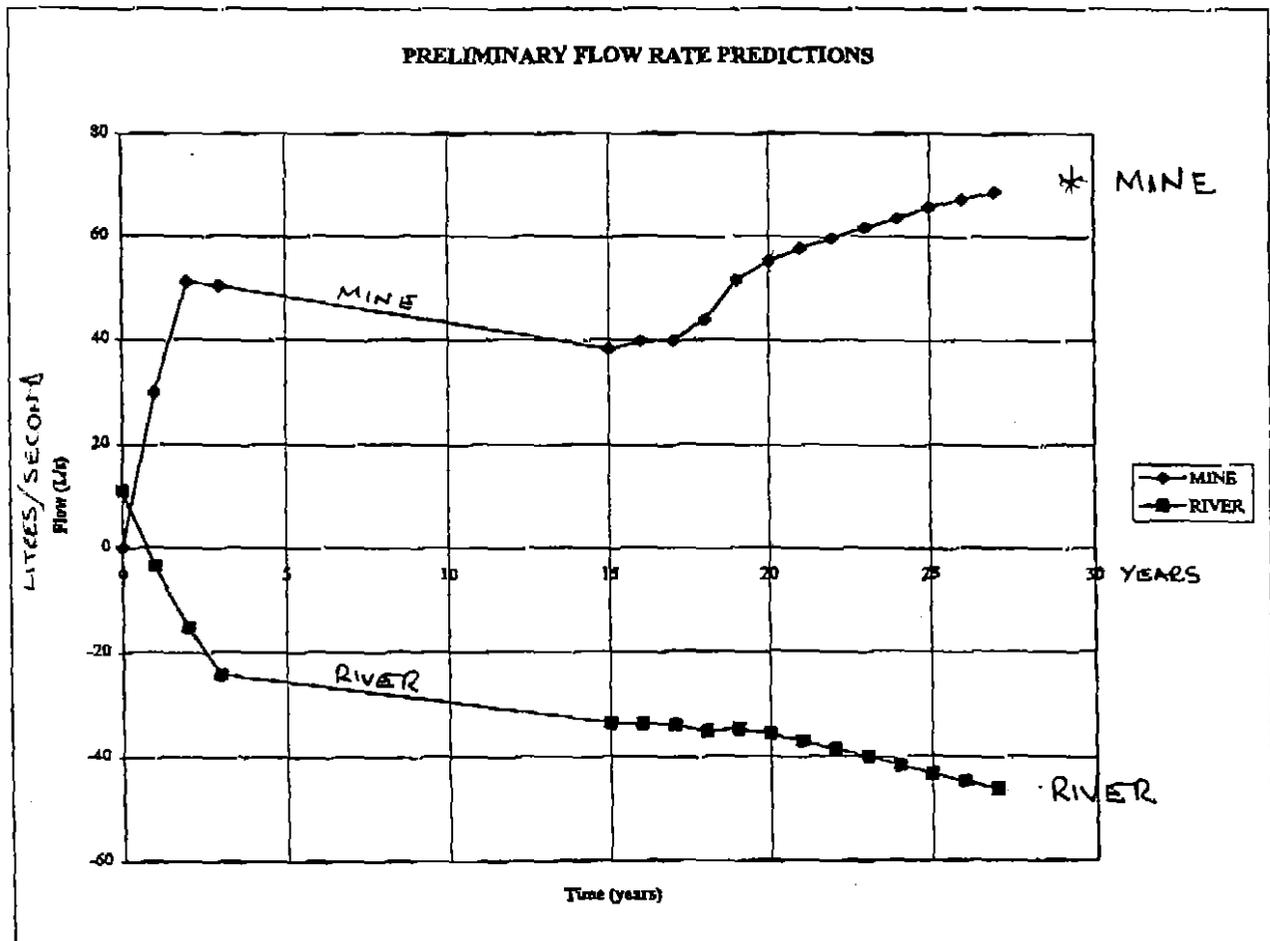
TIME years	MINE L/s	KEITH RIVER L/s	PIT FLOOR RL m
0	0	11	144
1	30	-3	116
2	51	-15	88
3	50	-24	60
15	38	-34	60
16	40	-34	60
17	40	-34	62
18	44	-35	57
19	52	-35	51
20	55	-36	46
21	58	-37	41
22	60	-39	36
23	62	-40	31
24	63	-42	26
25	66	-43	20
26	67	-45	15
27	69	-46	10

MINE
START

Assumed pit deepening to RL 60 m alongside Keith River in first 3 years
Flow from groundwater to Keith River initially positive, becomes negative.

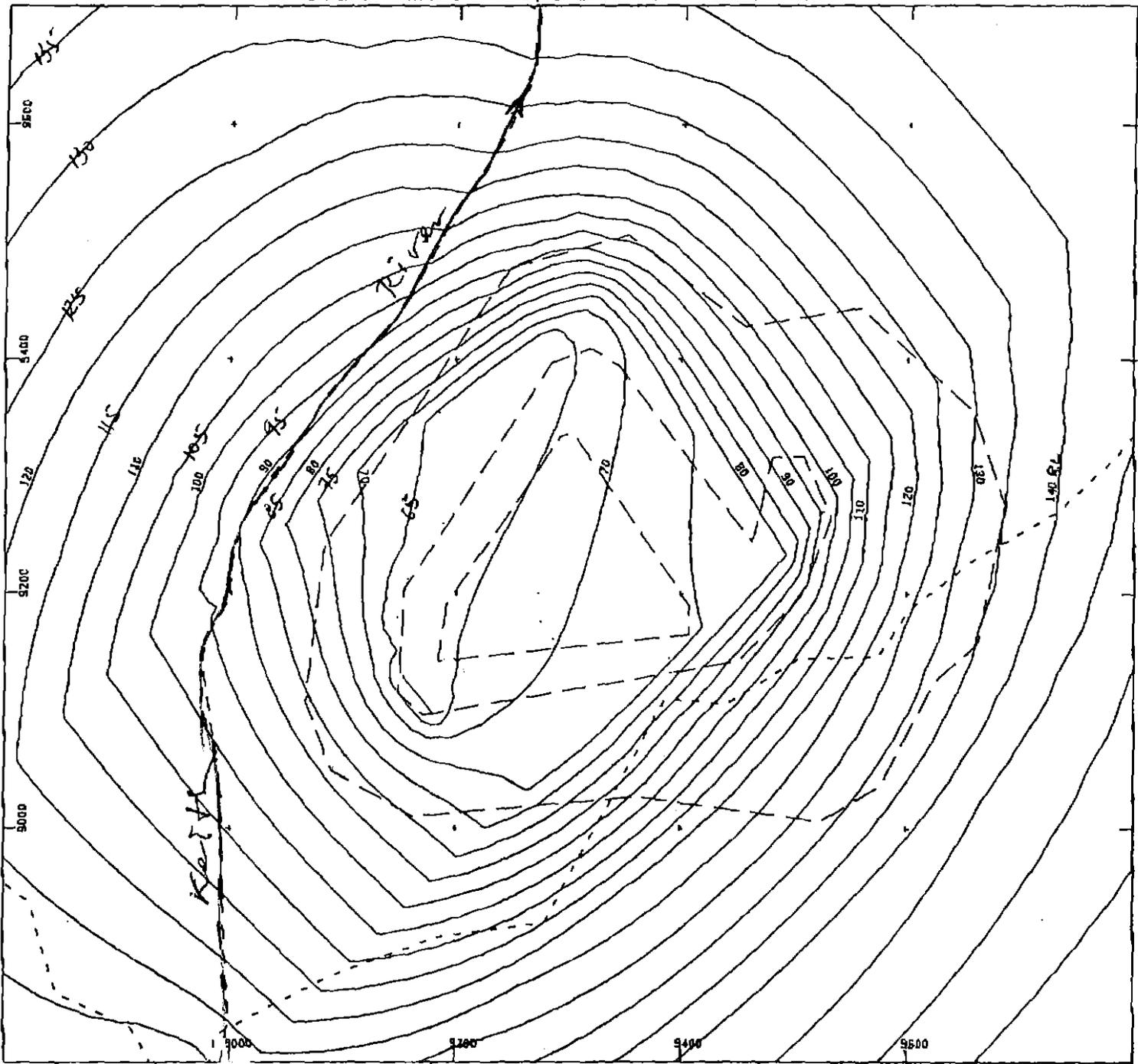
MINE
FINISH

PRELIMINARY



Files: 011ML01.TPI 011AF02.OUT of time 1095.0
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APP4 - RUN DATE/TIME: 04/23/99 14:13:38

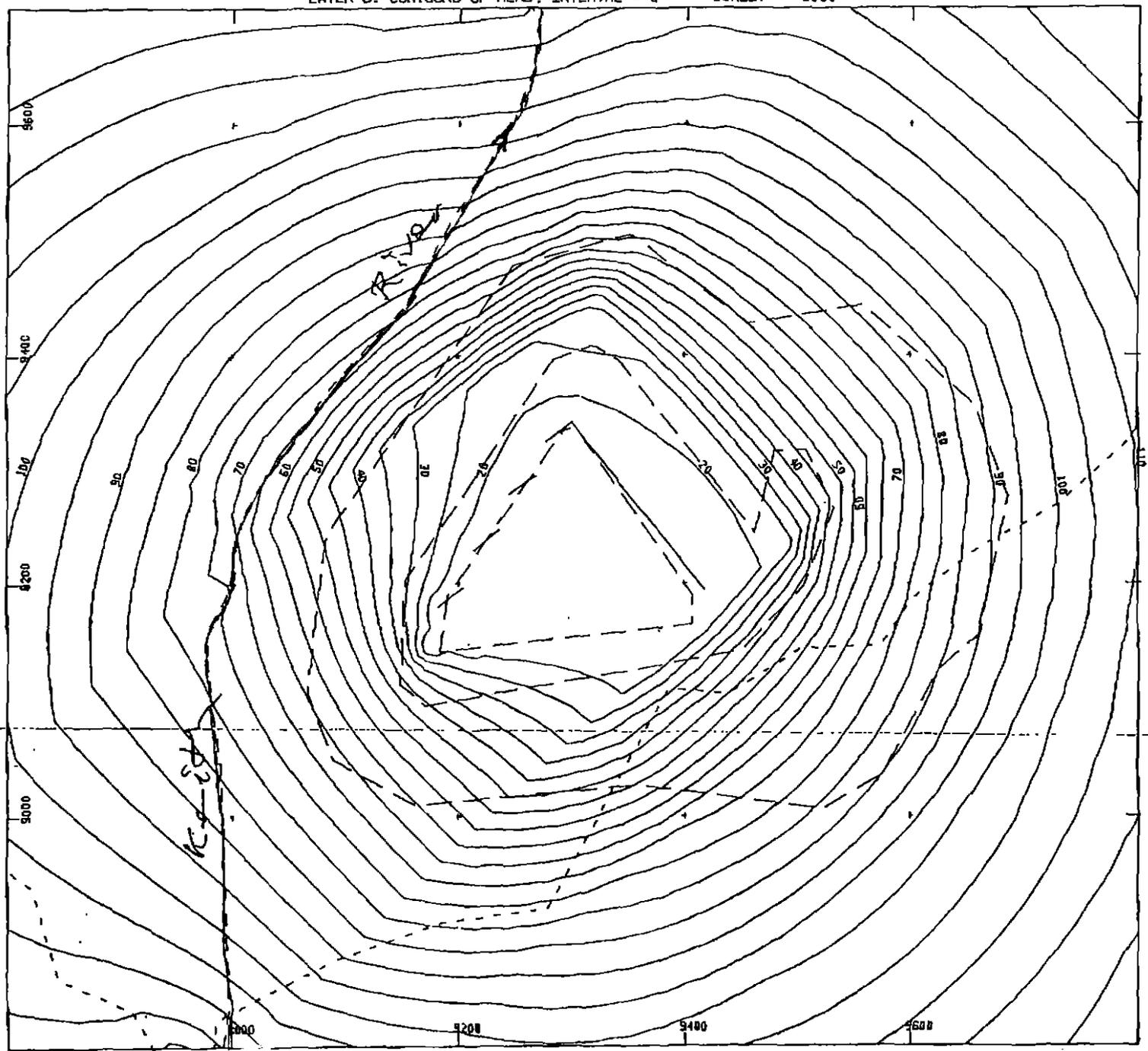


Groundwater
levels after
3 years

PRELIMINARY

Files: 011A01.TPI 011A02.OUT at time 9490.0
LAYER B: CONTOURS OF HEAD, INTERVAL = 5 SCALE: 5000

ATPM - RUN DATE/TIME: 04/23/99 14:33:38



Groundwater
levels after
27 years

PRELIMINARY

502029