

**NATIONAL
MINERAL SANDS PTY. LTD.**

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NARACOOPA PROJECT
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**PEKO-WALLSEND OPERATIONS LTD
NATIONAL MINERAL SANDS PTY LTD
JOINT VENTURE**

**NARACOOPA PROJECT
FEASIBILITY STUDY**

93-3429 1/2

AUGUST 1989

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NARACOOPA PROJECT

FEASIBILITY STUDY

Heavy mineral sand mining occurred on King Island, a 1090 km² island at the western entry to Bass Strait, between 1969 and 1977 involving operation firstly by Naracoopa Rutile Ltd and subsequently by Kibuka Mines Pty Ltd.

The accompanying study into the resurrection of this industry represents over 18 months work with input from more than 40 consultants and sub-consultants.

OPEN FILE

DAVID GILLET
PROJECT MANAGER

NARACOOPA PROJECT

FEASIBILITY STUDY

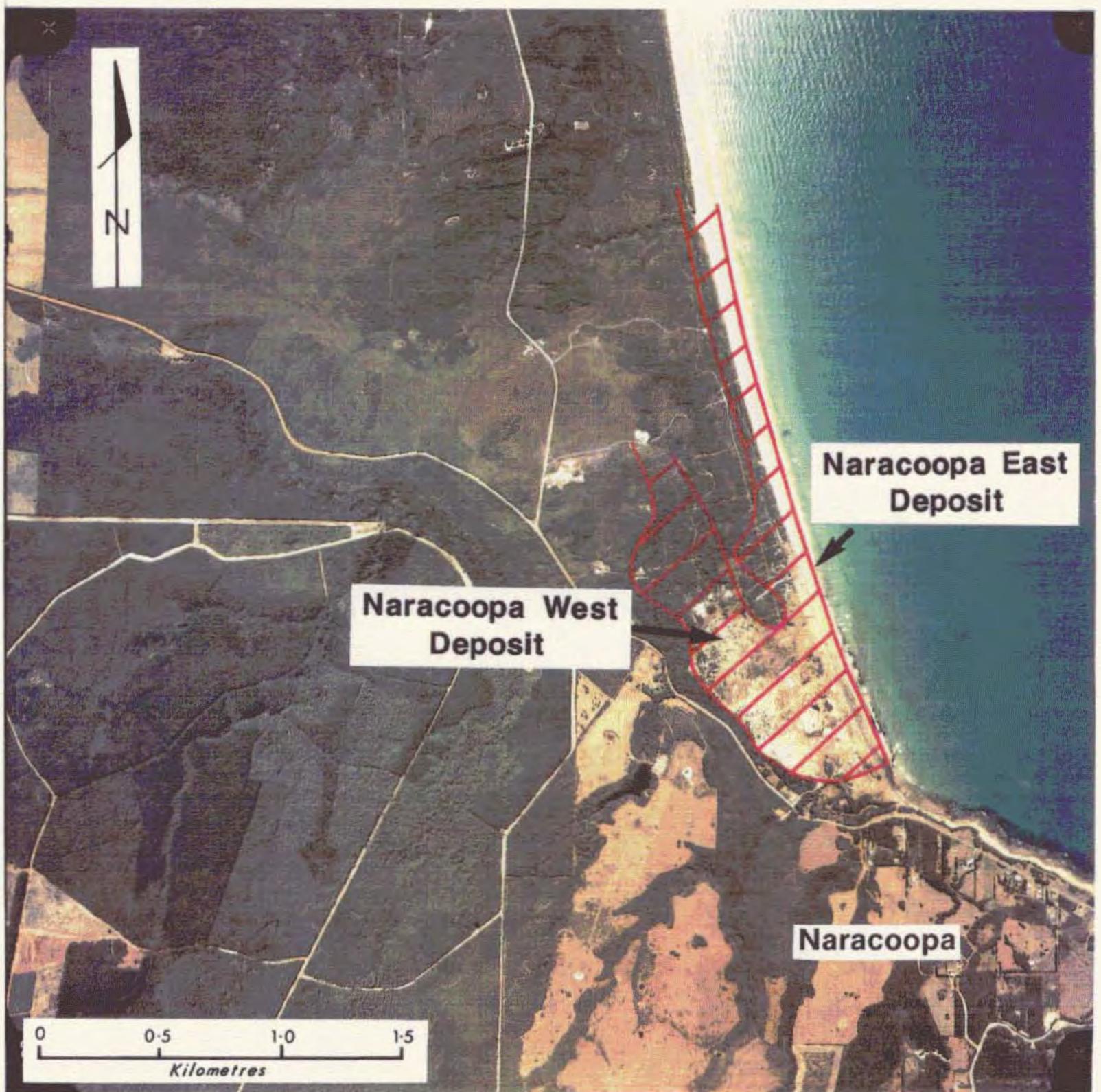
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Aerial view of Mineral Sands Mining Operation at Naracoopa in the 1970's.

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Aerial photograph of the Naracoopa deposits in EL 28/85, showing old mined area, Naracoopa West deposit and Naracoopa East deposit.

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Aerial photograph of Cowper Point deposits in EL 41/88 showing Cowper Point East deposit and Cowper Point West deposit.

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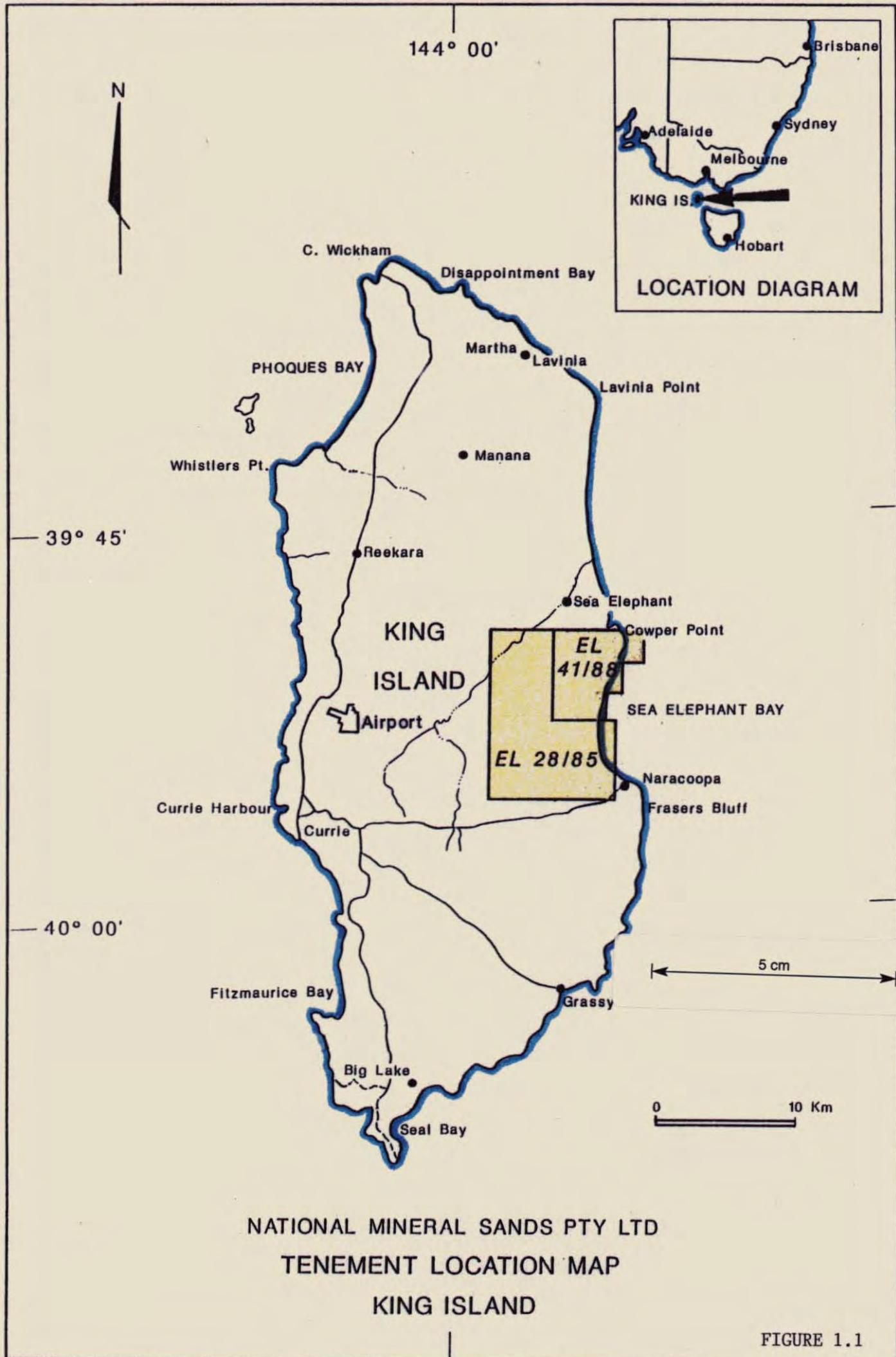


FIGURE 1.1



NATIONAL MINERAL SANDS PTY LTD
 NARACOOPA PROJECT
 EL's 28/85, 41/88.
 SCALE 1:100000

FIGURE 1.2

SECTION 1.0

SUMMARY

- 1.1 INTRODUCTION
- 1.2 STUDY STRUCTURE AND PROCEDURE
- 1.3 PROJECT DESCRIPTION
- 1.4 PROJECT STATUS
- 1.5 CONCLUSIONS & RECOMMENDATIONS

SECTION 1.0 - SUMMARY

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1.1 INTRODUCTION

PROJECT OVERVIEW

The Naracoopa Project is a 50:50 Joint Venture between National Mineral Sands Pty Ltd, the operator and manager of the feasibility study stage and Peko Wallsend Operations Ltd.

The project is located on the central east coast of King Island which is situated at the western entry of Bass Strait, 80 km south of Cape Otway on the Victorian coast and 100 km N.W. of West Point, N.W. Tasmania. Refer to Figure 1.1 and 1.2 for project location.

The Joint Venture has conducted a feasibility study which has defined a geological and mineable resource and has examined mining, metallurgical, geotechnical, engineering, environmental and economic aspects in detail.

The Naracoopa Project is a proposal

- . To mine in stages, over a period of 6 years, the four separate heavy mineral sand deposits located on the coast between 2 and 9 km north of the village of Naracoopa.

The deposits are known as

Naracoopa East (Milford/Sea Beach)
Naracoopa West (Lanherne Beach)
Cowper Point East (High Dune)
Cowper Point West (Back Beach)

Stage I - Mining will begin at Naracoopa

Stage II - Mining will move to Cowper Point at the beginning of Year 3.

Mining will be based on a floating dredge and concentrator to produce a heavy mineral concentrate. Supplementary dry mining will be necessary in Years 1 and 2.

- . To process the heavy mineral concentrate in a dry plant located on King Island at the intersection of Fraser Road and Sea Elephant Road.

SECTION 1.0 - SUMMARY

This study addresses dry plant products as

BASE CASE Rutile and Zircon
ALTERNATIVE - Rutile, Zircon, Leucoxene

- . To transport these products by road to receival storage and loading facilities at Grassy Wharf where small (up to 4000 t dwt) bulk carriers will be loaded for direct shipment to export markets.

TENEMENTS

The project area comes under two exploration licences held by the Joint Venturers:

EL 28/85 (Naracoopa) issued Jan. 1987
over an area of 78 km²

EL 41/88 (Cowper Point) issued Oct. 1988
over an area of 30 km²

These licences are under the jurisdiction of the Tasmanian Department of Mines.

The Director of Mines excised 30 km² from the original application for EL 28/85 because of an objection by the promoters of the Kings Paradise leisure village development.

Subsequently EL 41/88 was granted to the Joint Venturers after the Kings Paradise failed to show material development.

The land tenure over the project area and a proposed Mine Lease Application area within these exploration licences is shown in Figure 1.3

DEVELOPMENT APPROVALS

Development of the Naracoopa Project is subject to the requirements of Tasmanian and Commonwealth Acts and Regulations. The main ones are

- . Mining Act 1929 and Amendments
and Regulations (Tas)
- . Mines Inspection Act 1968 and Amendments
and Regulations (Tas)
- . Environmental Protection Act 1923
and Amendments and Regulations (Tas)

SECTION 1.0 - SUMMARY

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Tasmanian requirements are implemented through a three-way approval system.

- i) The Mine Lease - administered by the Tasmanian Department of Mines.
- ii) The Planning Permit - administered by the King Island Council.
- iii) The Licence To Operate - administered by the Tasmanian Department of Environment.

Commonwealth requirements are implemented through the Export Licence which is administered by the Minister for Resources. Commonwealth environmental assessment will be satisfied, under an informal management agreement with the Tasmanian government, by the requirements of the Licence to Operate.

The Mine Lease and Planning Permit must be granted prior to the issue of a Licence to Operate. Refer to Figure 1.4 - Approval Network.

MINERALOGY

The Naracoopa deposits average 10.1% H.M. at 1.5% cut-off grade.

The heavy mineral has an average 28% non-magnetic content.

The rutile (SG 4.2) content of heavy mineral is an average 5.7% and the zircon (SG 4.68) content of heavy mineral is an average of 6.4%.

There is a high incidence of "light heavy" minerals with up to 57% of H.M. being tourmaline and alumino-silicates (SG 3 to 3.75).

The Cowper Point East deposit averages 4.1% H.M. at 2.5% cut-off.

The rutile content of H.M. is an average 6.1% and the zircon content an average 7.5%.

The Cowper Point West deposit averages 5.1% H.M. at 1.5% cut-off.

The rutile content is an average 7.5% and the zircon content an average 11.8%.

The ilmenite has a high Cr_2O_3 content and has been measured as 1.5% and higher. The maximum desirable for pigment production is 0.1%.

SECTION 1.0 - SUMMARY

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RESERVES SUMMARY

Refer to figure 1.5 for a summary of project mineral resources and probable ore reserves.

PRODUCTION SCHEDULE

A summary of the BASE CASE sand mined and saleable products is as follows:

YEAR	1	2	3	4	5	6	TOTAL
Sand Mt	2.65	2.65	1.92	3.3	3.3	2.9	16.7
H.M. t	255000	255000	106000	127000	127000	112000	1000000
Rutile t	10300	10700	6700	6700	6700	5900	47000
Zircon t	12000	12000	10800	8200	8200	7200	58400

Refer to Figure 1.6 for a tabulated mining and metallurgical production schedule.

CAPITAL COST ESTIMATE

The BASE CASE initial investment required will be \$13.5 million with a further \$600,000 required in Year 2 for relocation and \$385,000 in Year 4 for concentrator capacity increase. Refer to Figure 1.7 for a capital cost summary for the Naracoopa Project Cost estimates are to an accuracy of +15 per cent.

OPERATING COST ESTIMATE

Total operating costs per tonne of rutile and zircon will be as follows:

YEAR	1	2	3	4	5	6
\$/t R&Z	262.1	257.4	269.3	326.5	326.5	357.7

These operating costs are on a F.O.B. Grassy basis for bulk rutile and zircon. Bagging and/or containerisation will add significantly to costs and will require specific marketing back-up for further action.

Freight cost for bulk delivery to S.E. Asian markets will be approximately \$60 per tonne compared with \$10-30 per tonne available in large parcels out of major Australian ports. Actual freight costs will depend on the shipping situation prevailing at the time of shipment.

Algas
AL

$$\frac{1}{16.7} \times 100 = 6\%$$

SECTION 1.0 - SUMMARY

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Project manning requirements will be a total of 45 persons for a 4 shift operation with 27 persons on day shift.

Refer to Figure 1.8 for an operating cost summary of the Naracoopa Project. Figure 1.9 is a project manning schedule.

FINANCIAL EVALUATION

The BASE CASE DCF ROR is 17.6 % and the payback period is 3.2 years compared with a project life of 6 years. The evaluation is based on all equity funding, straight line depreciation and no escalation. A salvage value of \$2.3 million is included. Marginal cost analysis does not justify leucoxene recovery for the initial project. The operating profit to sales margin averages 24% which is at the low end in comparison to existing Australian producers.

Refer to Figure 1.10 for the BASE CASE discounted cash flow analysis.

1.2 STUDY STRUCTURE AND PROCEDURE**DESCRIPTION**

National Mineral Sands Pty Ltd, as manager and operator for the Joint Venture, has undertaken a feasibility study for the development of the Naracoopa Project. Work commenced in the first quarter of 1988 with the Project Manager located in NMS Head Office in Perth. In November, 1988, the Project Manager relocated to Sydney and a new project office.

Over the course of the study specialised consultants were engaged to work out of their own office accommodation.

The study organisation chart is shown on Figure 1.11 and a list of consultants used for the study is shown in Appendix I.

STUDY METHODOLOGY

As manager and operator NMS developed work programmes and budgets. These were submitted to the Joint Venture Technical Committee for review and approval and subsequent overall approval by the Joint Venture Management Committee.

SECTION 1.0 - SUMMARY

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The Naracoopa deposits have a considerable history of both exploration and mining activity. There is a considerable body of exploration data which was used as a basis for the development of the exploration programmes undertaken by the Joint Venture. Other historical data was noted and used as a guide but this study relies on data specifically generated over the study period.

The project design criteria were generated progressively and concurrently and included geological resource estimates, mineable resource, mine plans, process flowsheet, equipment identification and infrastructure requirements.

A bidders list was prepared and budget quotations solicited based on a duty specification for most items of equipment.

Estimates of construction man hours and construction scheduling were prepared by experience and reference to Vendors and Contractors as necessary.

NMS has prepared the overall development concept and carried out sufficient process and engineering design for the preparation of capital and operating cost.

A project development schedule has been prepared and addresses the statutory approval process, and the engineering, procurement, construction and commissioning of the total project.

The capital cost estimate is based on

- . Duty specifications and budget quotes
- . Detailed equipment list
- . Quantity take-off and factoring for civil structural, building, piping and electrical

- . Man-hour cost allowing as necessary for King Island conditions

The operating cost estimate has been prepared in detail and based on a manning chart and confirmed prices for operating supplies.

Labour rates are in accordance with the current King Island Scheelite Award because of the anticipated close operational ties between the Naracoopa Project and K.I.S.

The original Study Terms of Reference are included for completeness - refer Appendix II.

SECTION 1.0 - SUMMARY

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1.3 PROJECT DESCRIPTION

GENERAL

The project has been developed in two stages.

Stage I (project Year 1 and 2) mining at Naracoopa produces in total 21000 t rutile, 24000 t zircon and if desired, 4400 t leucoxene.

Stage II (project Year 3 to 6) mining at Cowper Point produces in total 26000 t rutile, 34000 t zircon and if desired 10600 leucoxene. Equipment and facilities have been provided as follows.

- . A 600kW diesel powered dredge fitted with High Speed Cutter wheel and suction pump.
- . Floating wet concentrator designed for 450 t/h sand extraction rate.
- . Dry Separation Plant capable of processing the maximum heavy mineral concentrate production.
- . Product receival storage and loadout facilities are designed to store and load a 3000 t parcel.
- . Power generation will be supplied from diesel-generator sets. One, a 1015 kVA set, will be dedicated to (and mounted on board) the floating wet concentrator. The other a 644 kVA set, will be dedicated to and located adjacent to the dry plant.
- . A process water supply will be provided from two spear point batteries. One will be developed at Cowper Point and the other at Naracoopa. Each will supply approximately 1 Ml/day. The total process water required is approximately 1.8 Ml/day. The vacuum and transfer pumps will be diesel driven.
- . Support facilities at the dry plant include workshop, laboratory, administration office, ablution block, crib facilities and a nursery area.
- . Light vehicles for mine use including an RC drill rig.
- . Refurbishment of housing at Grassy for mine personnel. Houses currently owned by King Island Scheelite.

SECTION 1.0 - SUMMARY

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1.4 PROJECT STATUS

With the issuance of this document the project status can be summarised as follows:

TECHNICAL OVERVIEW

- . A mineable resource to "indicated" status has been defined. Potential for identifying further resources within the EL's is low.
- . Metallurgical testwork has been conducted on Narcoopa West raw sand only.
- . Process development is based on this metallurgical testwork.
- . Capital and operating cost estimates to $\pm 15\%$ accuracy have been developed.
- . Project evaluation is based on Rutile and Zircon production as the Base Case.

An alternative to the Base Case which includes production of leucoxene (shown to be a significant resource) is also addressed.

- . Magnetic tailings from the old Kibuka operations have been proved a significant and recoverable resource of rutile and zircon.
- . Rutile and zircon product analysis indicate that both could be considered at least the equivalent of East Coast standard grade and possibly premium grade. Ilmenite has a high chromite content, and is considered unsaleable, for this study.
- . The Narcoopa West and Cowper Point West resources are heavily indurated and the mining and treatment costs used in the evaluation reflect this condition.
- . Geotechnical investigations have identified an underground water resource at both Narcoopa and Cowper Point suitable for a process water supply for both Stage I and Stage II mining.
- . Power supply will be derived from diesel generator sets located at the wet plant and the dry plant.

SECTION 1.0 - SUMMARY

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- . Storage and loading facilities will be established at Grassy Wharf. The King Island Marine Board has given approval in principle however, a detailed agreement for use of the wharf is not yet secured.
- . Transportation of products on the island and from the island to market has been investigated.
- . Roadworks will be necessary on the "Council road" section of the proposed product cartage route.
- . Physical constraints of Grassy Harbour dictate that small, highly manoeuvrable, bulk vessels (max. 4000t dwt approx.) up to 90 m long and 6.1 m draught will be required for transportation product to market. This will tend to limit project markets to the S.E. Asian region.

DEVELOPMENT OVERVIEW

ENVIRONMENTAL

- . Baseline surveys for flora, soil, fauna, archaeology and noise have been completed.
- . A broad annual rehabilitation programme has been developed.
- . The environmental issues have been identified however a detailed Environmental Management Plan has not yet been prepared.
- . Discussions have been held with the Department of Environment, Department of Land, Parks & Wildlife and Department of Mines with particular reference to the Orange-bellied Parrot and the interface between the northern boundary of EL 41/88 and the Lavinia Nature Reserve.
- . Guidelines with regard to the OBP were issued by the Department of Land, Parks and Wildlife and particular requirements will be included as part of the Licence to Operate and/or Mine Lease conditions.
- . The Department of Environment has advised draft guidelines for the preparation of a detailed EMP. Refer to Appendix III.

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- . The Department of Environment has advised that the Commonwealth environmental assessment requirement, prior to the grant of an export licence, will be satisfied by their approval process.
- . The Department of Environment has advised that there are no constraints to the project such as no mining of the modern beach. The project will be evaluated on its merits.

PROPOSED MINE LEASE APPLICATION

- . The Department of Mines has indicated a recommended Mine Lease application area. Refer to Figure 1.3.
- . Initially the MLA will consist of 14 separate applications of 100 ha and 1 application of 40 ha.
- . After approval these will be consolidated into 1 Mine Lease.
- . Compensation agreements (not relating to minerals) with the landowner/occupier should accompany the Mine Lease Application and in any case not later than 12 months after the date of marking out.
- . A draft compensation agreement has been compiled but no agreements secured.
- . Mining on private land will not occur until the beginning of Year 3.

OWNERSHIP OF MINERAL

- . There is no privately held mineral in the project area.

LAND STATUS/OWNERSHIP

- . The total area of privately held land within the proposed MLA is 911.6 ha of which 544 ha is held by the Kings Paradise interest. The remainder is Crown Land or Crown Reserve.
- . All the Crown Land comes under the Mining Act.
- . There are 14 individual landowners covering the 911.6 ha and all are absentee. Refer Appendix IV for listing of landowners.
- . Based on data from the Valuer General the total value of privately held land is \$367,000 or \$400 per hectare. A 47.8 ha parcel of bushland in the Naracoopa region is currently for sale at \$20,000 or \$418 per hectare.

PLANNING APPROVAL

- . Constant contact has been maintained with the King Island Council over the duration of this study.

A full disclosure of the detail of the project has not yet occurred, however, a document to be used for this purpose is currently in preparation.
- . The King Island Council has shown interest and enthusiasm for this project to proceed. Council representatives have indicated that they would not like to see the project founder due to the burden of roadworks. The project is in a position to negotiate over roadworks.
- . Planning approval on King Island is governed by an Interim Order which is due to expire in October, 1989. A draft new planning instrument has been sent to the Council from the Town & Country Planning Commissioner. While this new instrument could be operating by January 1990 this study assumes that the planning approval will be assessed under the Interim Order.
- . Zoning under the Interim Order is "Rural - with extractive industry a permitted use." This applies to the whole proposed MLA area except the land associated with the Kings Paradise development. This area is zoned "Village - with extractive industry a prohibited use." However, the Council can issue a absolute/ conditional/ temporary dispensation to allow mining to proceed.

In summary, the planning permit would be approved at the discretion of the Council.

THE LICENCE TO OPERATE

- . A detailed Draft EMP and a fee of \$26,000 will be necessary for the formal application for Licence to Operate.
- . Grant of a MLA and a Planning Permit must precede the issue of a Licence to Operate.
- . The Department of Environment has issued draft guidelines for the EMP. Refer Appendix III.

1.5 CONCLUSIONS AND RECOMMENDATIONS

The objectives of the exploration programme and subsequent feasibility study were

- a) to define a geological resource of heavy mineral sands in the Sea Elephant Bay area.
- b) to conduct mining, metallurgical, engineering, environmental and marketing investigations into the establishment of a project to exploit that geological resource.
- c) to estimate capital and operating costs of the project to an accuracy of $\pm 15\%$.
- d) to perform a financial evaluation as the basis for a decision to proceed to mine development.

and these objectives have been met.

If this study is adopted as the basis for proceeding to mine development then recommendations relating to further confirmatory technical investigations, and strategy for project implementation, are as follows.

FURTHER TECHNICAL INVESTIGATIONS

SERVICES

Water Supply

Undertake long term pumping test at both Naracoopa and Cowper Point to prove the long term yield capacity of both aquifers and the suitability of the groundwater interception method.

Roadworks

Initiate a civil engineer's report on the condition of the Council roads affected by the project. This report to be used as basis for negotiating some funding assistance with road works.

GEOLOGY

- . Undertake a close-spaced drilling programme in the area to be mined first.
- . Undertake a drilling programme to define the limits and volume of the magnetic tailings dump.

SECTION 1.0 - SUMMARY

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- . Undertake a drilling programme using closer spaced grid lines to define the resource limits to the north and south of line 1000N in better detail.

MINING

- . Attempt to quantify the degree of induration in the Lanherne and Back Beach deposits - see metallurgy.
- . Make a 3D model of the Dune deposit to illustrate the "before" and "after" landform.

METALLURGY

- . Carry out mineralogical studies on wet plant flow streams to optimise gravity separation stages.
- . Quantify the degree of attritioning and caustic addition required.
- . Perform limited testwork on material from other deposits - to prove suitability of flowsheet based on Lanherne material.
- . Quantify the degree of induration and the mineralogy of the indurated material.
- . Perform some check mineralogical analyses on samples used in the 3t bulk sample testwork - to account for the differences in rutile and zircon content used in the resource estimate compared with those found in the 3t bulk sample.
- . Perform flotation test using Naracoopa water.
- . Test suitability of ilmenite for upgrading to lower Cr_2O_3 content.

ENGINEERING

- . Test geotechnical conditions at the Dry Plant site for footing design.

STRATEGY FOR PROJECT IMPLEMENTATION

The major factor which will increase the return on investment for this project is the ability to sell product at the current historically high prices. This means that speed of project implementation is all important.

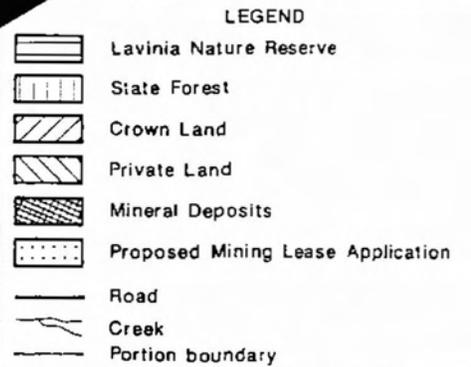
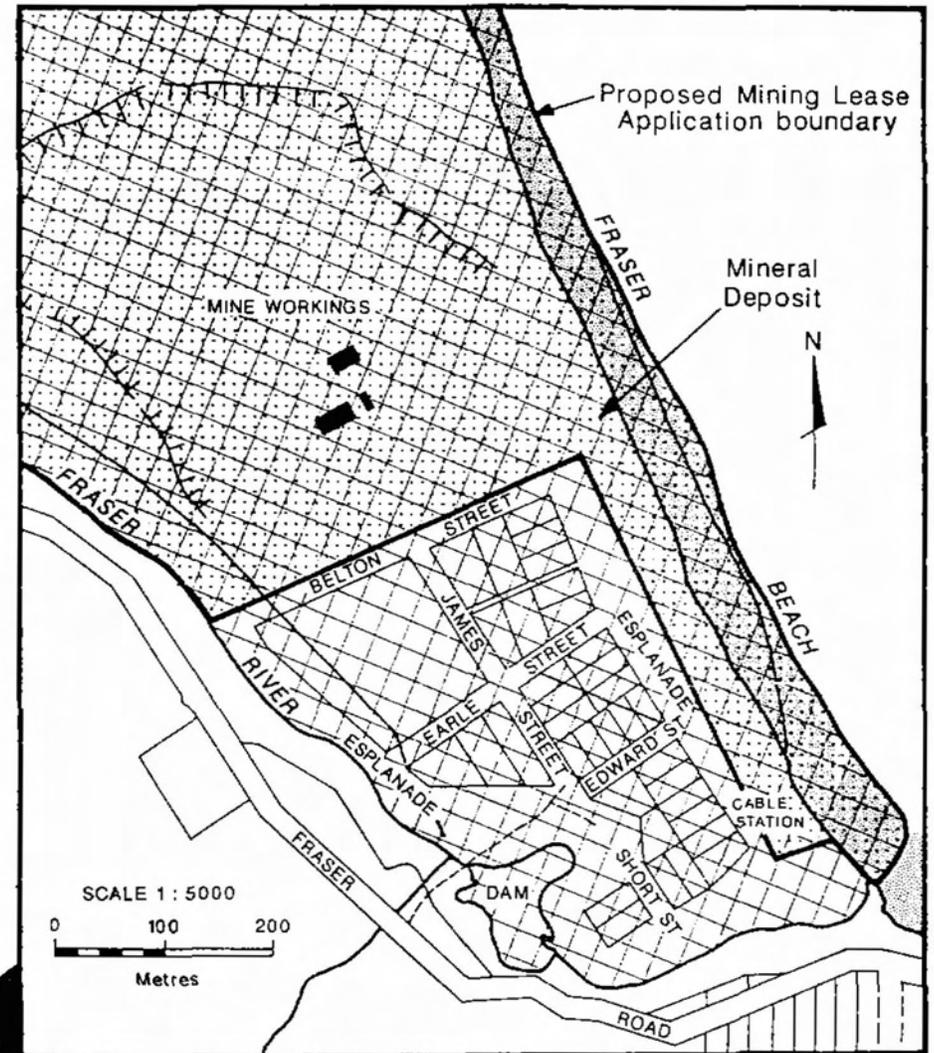
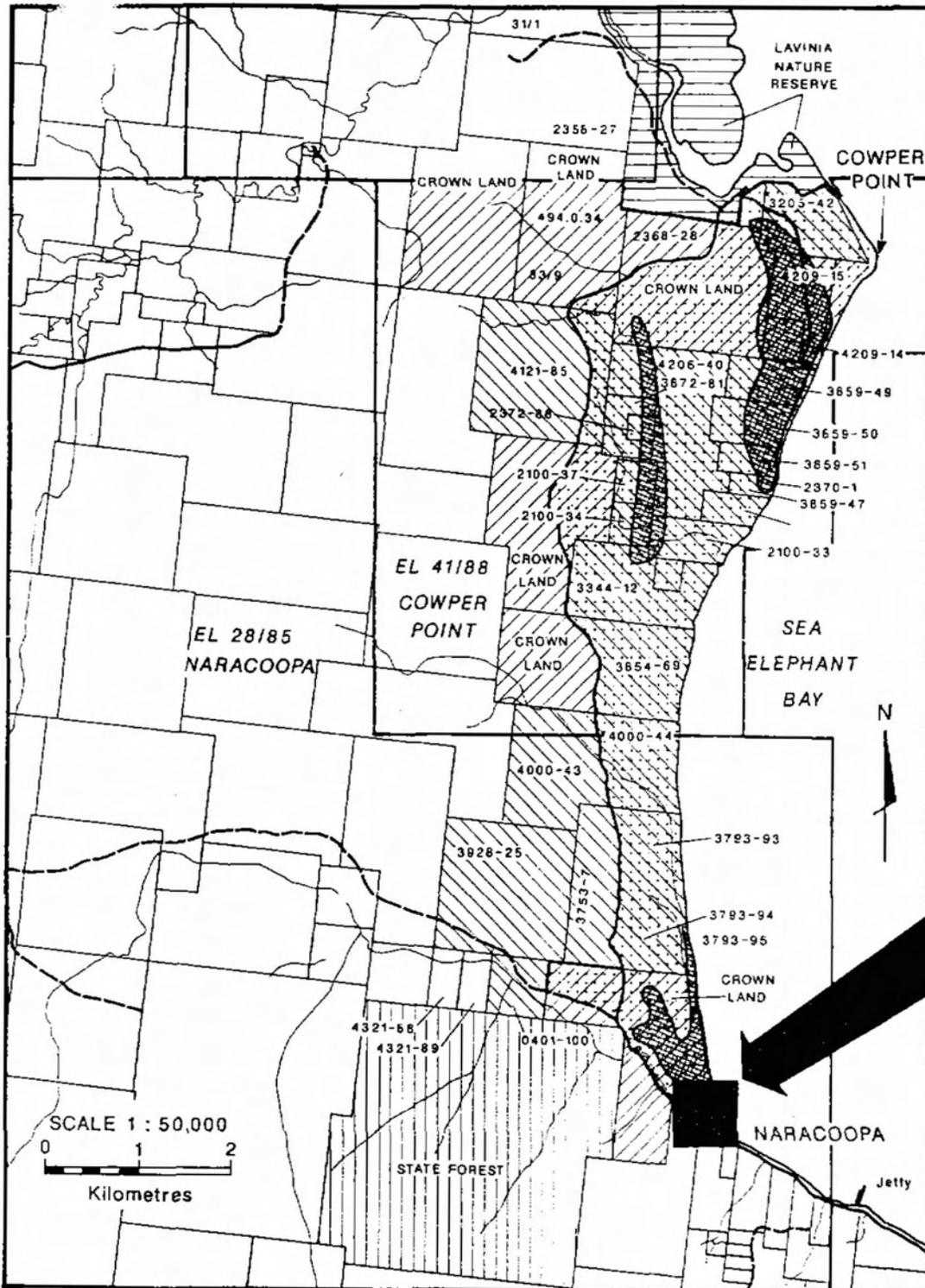
Having due regard for the matters raised in Further Technical Investigations, the Joint Venturers should set December, 1989 as the target date by which

- . all governmental approvals are secured
- . engineering and procurement documentation are sufficiently advanced to place long lead equipment orders.

This may give some chance of forward selling rutile and zircon product in the annual period of contractual negotiations. If construction begins in January, 1990, then product could be shipped in the last quarter of 1990.

To do this the Joint Venture will as a matter of priority

- 1) engage an Environmental Consultant to assemble the Development Proposal and Environmental Management Plan.
- 2) complete compensation agreements with landowners/occupiers.
- 3) begin a major "sell-the-project" campaign to the various authorities and the King Islanders.
- 4) select an engineer-constructor and progress design and documentation to allow an early start.
- 5) recruit the Operations Manager and Metallurgist so that they can be involved in project implementation from the beginning.
- 6) Vigorously pursue rutile and zircon buyers.
- 7) Examine value added activities (eg. micronising) very closely. While the first priority would be to establish the operation as a conventional rutile and zircon concentrate producer value-added activities should be examined at the first opportunity



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 LAND TENURE PLAN

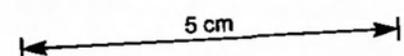
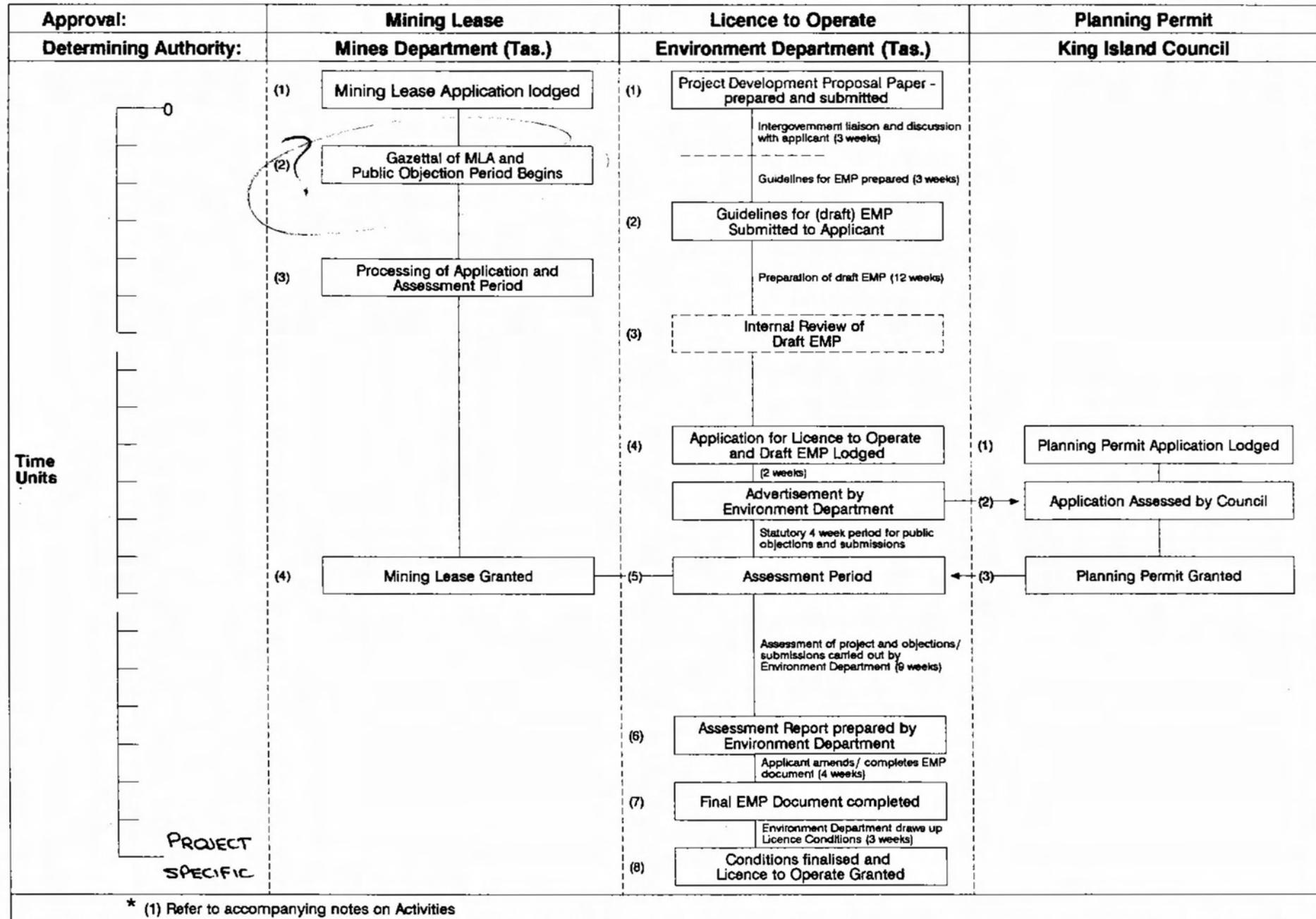


FIGURE 1-3

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FIGURE 1.4 PROJECT APPROVAL NETWORK



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TABLE 2.1

RESOURCE SUMMARY

REVISED MAY 1989

RESOURCES STATED AS INDICATED EXCEPT FOR *BURIED HEAVY TAILINGS
AT 1.5% HEAVY MINERAL CUT-OFF

CATEGORY	IN-SITU CONTENT			TONNES				
	% H.M.	% R	% Z	SAND	H.M.	R	Z	Leu
<u>RAW SAND</u>								
LANHERNE BEACH	5.1	0.38	0.46	2,980,000	153,000	11,200	13,800	7,100
MILFORD BEACH	11.3	1.17	1.14	320,000	37,000	3,740	3,640	740
SEA BEACH	17.5	1.32	1.35	195,000	34,000	2,570	2,640	510
<u>SAND TAILINGS</u>	7.9	0.41	0.46	2,710,000	213,000	11,200	12,500	8,200
<u>HEAVY TAILINGS</u>								
ABOVE SURFACE	82.90	3.31	4.13	139,000	115,000	4,600	5,800	1,200
BURIED*	47.30	1.90	1.90	245,000*	116,000*	4,600*	4,600*	2,300*
TOTAL				6,589,000	668,000	37,910	42,980	20,050
ROUNDED TONNES				6,600,000	670,000	38,000	43,000	20,000

Σ 3deps

70,500 86,000 47.9

- * Less certain that quantities stated are reliable since lateral extent is not known. Further drilling would be required to quantify this resource. This resource is stated as INFERRED.
- . It is possible that part of this resource is replaced by an equivalent quantity of sand tailings of an untested heavy mineral grade.

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FIGURE 1.5
SUMMARY
RESOURCES AND PROBABLE RESERVES

DEPOSIT	MINERAL RESOURCES @ 1.5% H.M. COG					MINERAL RESOURCES @ 2.5% H.M. COG					PROBABLE RESERVES				
	SAND	HM	R	Z	L	SAND	HM	R	Z	L	SAND	HM	R	Z	L
Naracoopa East	515,000	71,000	6,310	6,280	1,250	342,000	63,000	5,600	5,600		498,100	59,650	4,530	4,790	7,130
Naracoopa West *	5,935,000	482,000	27,000	30,900	17,600	4,845,000	459,000	25,000	28,700		4,667,000	335,800	18,880	21,540	5,190
Surf Mag Tailings	139,000	115,000	4,600	5,800	1,200	139,000	115,000	4,600	5,800		135,000	114,560	4,590	5,670	
Sub TOTAL	6,589,000	668,000	37,910	42,980	20,050	5,326,000	537,000	35,200	40,100		5,300,000	<u>510,000</u>	28,000	32,000	12,320
Cowper Point East (Corrected) #	15,000,000	510,000	32,000	39,000	31,000	8,800,000	350,000	22,000	27,000	21,000	9,500,000	386,000	23,900	29,200	22,900
Cowper Point East	2,200,000	110,000	8,200	13,000	4,700	1,200,000	87,000	6,800	10,000	3,800	2,000,000	117,000	8,600	13,800	5,000
Sub TOTAL (Corrected)	18,200,000	620,000	40,200	52,000	35,700	10,000,000	447,000	28,800	37,000	24,800	11,500,000	<u>503,000</u>	32,000	43,000	27,900
TOTAL (Corrected)	24,789,000	1,288,000	78,110	94,980	55,750	15,326,000	1,084,000	64,000	77,100	24,800	16,800,000	1,013,000	60,500	75,000	40,400

NOTES: * Includes buried magnetic tailings.
Corrected for topography; includes "Inferred" Resources.

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FIGURE 1.6

PRODUCTION SCHEDULE

The following production schedule is based on a maximum dredge throughput of 450 T.P.H.; Years 1 to 3 inclusive assume a mining recovery of 90% of all heavy minerals; Years 4, 5 & 6 assume a mining recovery of 95%.

PRODUCTION SCHEDULE

Production Period	Sand Mined	H.M. Contained	Rutile to Wet Plant	Rutile (1) % Recovery	Tonnes Rutile Recovered	Zircon to Wet Plant	Zircon (1) % Recovery	Tonnes Zircon Recovered	Leuc Cox to Wet Plant	Leuc Cox(2) % Recovery	Tonnes Leuc Cox Recovered
<u>Year 1</u>											
Yr Total	2650000	255000	12600	81.5	10300	14664	81.5	11952	6421	35	2275
<u>Year 2</u>											
Yr Total	2650000	255000	12600	85	10710	14136	85	12016	5317	40	2127
Total - Naracoopa	5300000	510000	25200	83	21000	28800	83	24000	11738	37.5	4402
<u>Year 3</u>											
45 weeks	1917760	117162	7766	85	6601	12426	85	10562	4586	40	1834
Canal Move	150000	3000	180	75	135	310	75	233	104	30	31
Yr Total	2067760	120162	7946	85	6736	12736	85	10795	4690	40	1865
Year 4	3.3MT	134095	7886	85	6703	9636	85	8191	7556	40	3022
Yr Total											
Year 5	3.3MT	134095	7886	85	6703	9636	85	8191	7556	40	3022
Yr Total											
Year 6	2.9MT	117808	6931	85	5891	8456	85	7196	6542	40	2657
Yr Total											
Total-Cowper Point	11567760	506162	30649	85	26033	40474	85	34373	26444	40	10566
TOTAL -	16.8MT	1000000	55850	84	46900	69200	84	58100	38182	39	14968

(1) Recovery figures are based on Metallurgical Test Report Recommendations.
 (2) Recovery is conservatively estimated from industry experience.

FIG. 1.7

CAPITAL COST SUMMARY

ITEM	PRODUCTION		
	<u>RZL</u>	<u>RZ</u>	
1. DREDGE	1295000	1295000	
2. WET PLANT	4460000	4002000	
3. DRY PLANT	5388000	4657000	
4. PRODUCT STORAGE & LOADING	580000	580000	
5. WATER SUPPLY/ COMMUNICATIONS/ VEHICLES/ WORKSHOP EQUIPMENT	957000	957000	
6. ADMIN./ AMENITIES	260000	260000	
7. HOUSING	150000	150000	
8. EPCM & Contingency	1412000	1265000	+600,000
9. WORKING CAPITAL <i>loadwork</i>	340000	340000	+160,000
		<i>+ 246,000</i>	
TOTAL	14,842,000	13,506,000	+1,000,000

NOTES

1. ROADWORKS \$500,000 approx.
2. SALVAGE VALUE \$2.3 million
3. WET PLANT EQUIPMENT
PURCHASE DEFERRED
TO YEAR 4 \$382,000
4. WORKING CAPITAL
INCLUDES INITIAL SPARES

FIGURE 1.8
OPERATING COST \$

COMPONENT

SUMMARY		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
1.	Mining	1412084	1412084	876709	821709	821709	817709
2.	Rehabilitation	98000	98000	98000	98000	98000	98000
3.	Wet Plant	1156000	1156000	906000	1049200	1049200	979800
4.	Dry Plant	RZ 1465000	1465000	1163300	1198000	1198000	1148800
		RZL 1544000	1544000	1219300	1263000	1263000	1205800
5.	Maintenance	190000	190000	190000	190000	190000	190000
6.	Operating Staff	294000	294000	294000	294000	294000	294000
7.	Administration	418000	418000	418000	418000	418000	418000
8.	Utilities	332000	328000	325000	322000	322000	319000
9.	Transportation	RZ 398350	400150	378000	419000	419000	368000
	(Grassy)	RZL 462200	485000	461404	521326	521326	458019
10.	Wharfage	RZ 81250	82700	63800	54400	54400	47800
		RZL 89200	905004	70407	65035	65035	57151
TOTAL		RZ 5844684	5843939	4712946	4864537	4864537	4691098
		RZL 5995484	6015584	4858820	5042270	5042270	4837479
TONNES		RZ 22300	22700	17500	14900	14900	13100
COST	\$/t, RZ	262.1	257.4	269.3	326.50	326.50	358
(F.O.B. GRASSY)							
TONNES	RZL	24547	24831	19396	17916	17916	15744
COST	\$/t, RZL	244.2	242.3	250.5	281.4	281.40	307.30

FIG. 1.9
MANNING SCHEDULE

		Shifts/day	No./Shift	TOTAL
1.	MINING			
	Dredge Operator	4	1	4
	Grade Control	1	1	1
2.	REHABILITATION			
	Operators	1	2	2
3.	WET PLANT			
	Operators	4	2	8
	Day Gang	1	2	2
4.	DRY PLANT			
	Operators	4	2	8
	Day Gang	1	2	2
5.	MAINTENANCE			
	Tradesmen	1	5	5
6.	STAFF			
	Foreman	1	1	1
	Shift Boss	4	1	4
	Metallurgist	1	1	1
	Mining Superintendent	1	1	1
7.	ADMINISTRATION			
	General Manager	1	1	1
	Accountant	1	1	1
	Office Staff	1	2	2
8.	UTILITIES			
	Storeman	1	1	1
	Lab. Analyst	1	1	1
TOTAL				45

		-2	-1	1	2	3	4	5	6	7	8	TOTAL
Mineable Reserves												
Sand	tonnes		2,650,000	2,650,000	1,918,000	3,300,000	3,300,000	2,900,000				16,718,000
HM	tonnes		255,000	255,000	120,000	134,000	134,000	117,808				1,015,808
Rutile	tonnes		14,000	14,000	8,829	8,302	8,302	7,296				60,729
Zircon	tonnes		16,294	15,700	14,152	10,144	10,144	8,912				75,346
Leucoxene	tonnes											
Recovered Total												
HM	tonnes		230,000	230,000	108,145	127,391	127,391	111,917				934,844
Rutile	tonnes		10,300	10,700	6,736	6,703	6,703	5,891				47,033
Zircon	tonnes		11,952	12,000	10,795	8,191	8,191	7,196				58,325
Leucoxene	tonnes											
PRICES												
Rutile	A\$/tonne	600	600	600	600	600	600	600	600	600	600	
Zircon	A\$/tonne	500	500	500	500	500	500	500	500	500	500	
Leucoxene	A\$/tonne											
Recovered Total												
Rutile	tonnes		10,300	10,700	6,736	6,703	6,703	5,891				47,033
Zircon	tonnes		11,952	12,000	10,795	8,191	8,191	7,196				58,325
Leucoxene	tonnes											
REVENUE												
Rutile	A\$		6,180,000	6,420,000	4,041,600	4,021,800	4,021,800	3,534,600				28,219,800
Zircon	A\$		5,976,000	6,000,000	5,397,500	4,095,500	4,095,500	3,598,000				29,162,500
Leucoxene	A\$											
less Royalty			350,292	358,114	224,929	191,092	191,092	167,912				1,483,431
Total			11,805,708	12,061,886	9,214,171	7,926,208	7,926,208	6,964,688				55,898,869
OPERATING COSTS												
Mining			1,412,084	1,412,084	876,709	821,709	821,709	817,709				6,162,004
Rehabilitation			98,000	98,000	98,000	98,000	98,000	98,000				588,000
Wet Plant			1,156,000	1,156,000	906,000	1,049,200	1,049,200	979,800				6,296,200
Dry Plant			1,465,000	1,465,000	1,163,300	1,198,000	1,198,000	1,148,800				7,638,100
Maintenance			190,000	190,000	190,000	190,000	190,000	190,000				1,140,000
Operating Staff			294,000	294,000	294,000	294,000	294,000	294,000				1,764,000
Administration			418,000	418,000	418,000	418,000	418,000	418,000				2,508,000
Utilities			332,000	328,000	325,000	322,000	322,000	319,000				1,948,000
Transportation			398,350	400,150	378,299	419,563	419,563	368,638				2,384,563
Warfare	2.5%		81,250	82,705	63,638	54,065	54,065	47,500				383,223
Marketing												
Total			5,844,684	5,843,939	4,712,946	4,864,537	4,864,537	4,681,447				30,812,090
	A\$/t sand		2.21	2.21	2.46	1.47	1.47	1.61				1.84
	A\$/t HM		22.92	22.92	39.27	36.30	36.30	39.74				30.33
	A\$/t HM rec		25.41	25.41	43.58	38.19	38.19	41.83				32.96
	A\$/t R+Z		262.1	257.4	269.3	326.5	326.5	357.7				

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FIGURE 1.10

		-2	-1	1	2	3	4	5	6	7	8	TOTAL
Sales			11,805,708	12,061,886	9,214,171	7,926,208	7,926,208	6,964,688				55,898,869
Salvage value (fully depreciated plant)									2,300,000			2,300,000
Operating cost			5,844,684	5,843,939	4,712,946	4,864,537	4,864,537	4,681,447				30,812,090
			5,961,024	6,217,947	4,501,225	3,061,671	3,061,671	2,283,241	2,300,000			27,386,779
Depreciation			2,194,358	2,314,358	2,314,358	2,442,692	2,442,692	2,442,692				14,151,150
Loss carried fwd									159,450			
Operating profit/(loss)			3,766,666	3,903,588	2,186,867	618,980	618,980	(159,450)	2,140,550			
Tax payable	39.0%		1,469,000	1,522,399	852,878	241,402	241,402		834,814			5,161,895
Tax paid				1,469,000	1,522,399	852,878	241,402	241,402			834,814	5,161,895
After tax profit/(loss)			3,766,666	2,434,589	664,467	(233,898)	377,578	(400,852)	2,140,550	(834,814)		
C A P I T A L												
Dredge	AS		1,295,000									1,295,000
Wet Plant			4,002,150				385,000					4,387,150
Dry Plant			4,657,000									4,657,000
Product Storage & Loading			580,000									580,000
Water Suppl/Comm./Vehicles			957,000									957,000
Admin/Amenities			260,000									260,000
Housing			150,000									150,000
Relocation				600,000								600,000
E.P.C.M./Contingency			1,265,000									1,265,000
Sub-total			13,166,150	600,000			385,000					14,151,150
Working capital			340,000						(340,000)			
Total			13,506,150	600,000			385,000		(340,000)			14,151,150
CASH FLOW												
Cumulative		(13,506,150)	5,961,024	4,148,947	2,978,825	1,823,793	2,820,269	2,381,839	2,300,000	(834,814)	8,073,734	8,073,734
		(13,506,150)	(7,545,126)	(3,396,179)	(417,353)	1,406,440	4,226,709	6,608,548	8,908,548	8,073,734		

		TOTAL PROJ
		A\$000
NPV @	10.0%	2,465
	15.0%	730
	20.0%	(563)
IRR	17.64%	

FIGURE 1.10

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NARACOOPA FEASIBILITY STUDY
FUNCTION CHART

D. Gillett
21.11.88

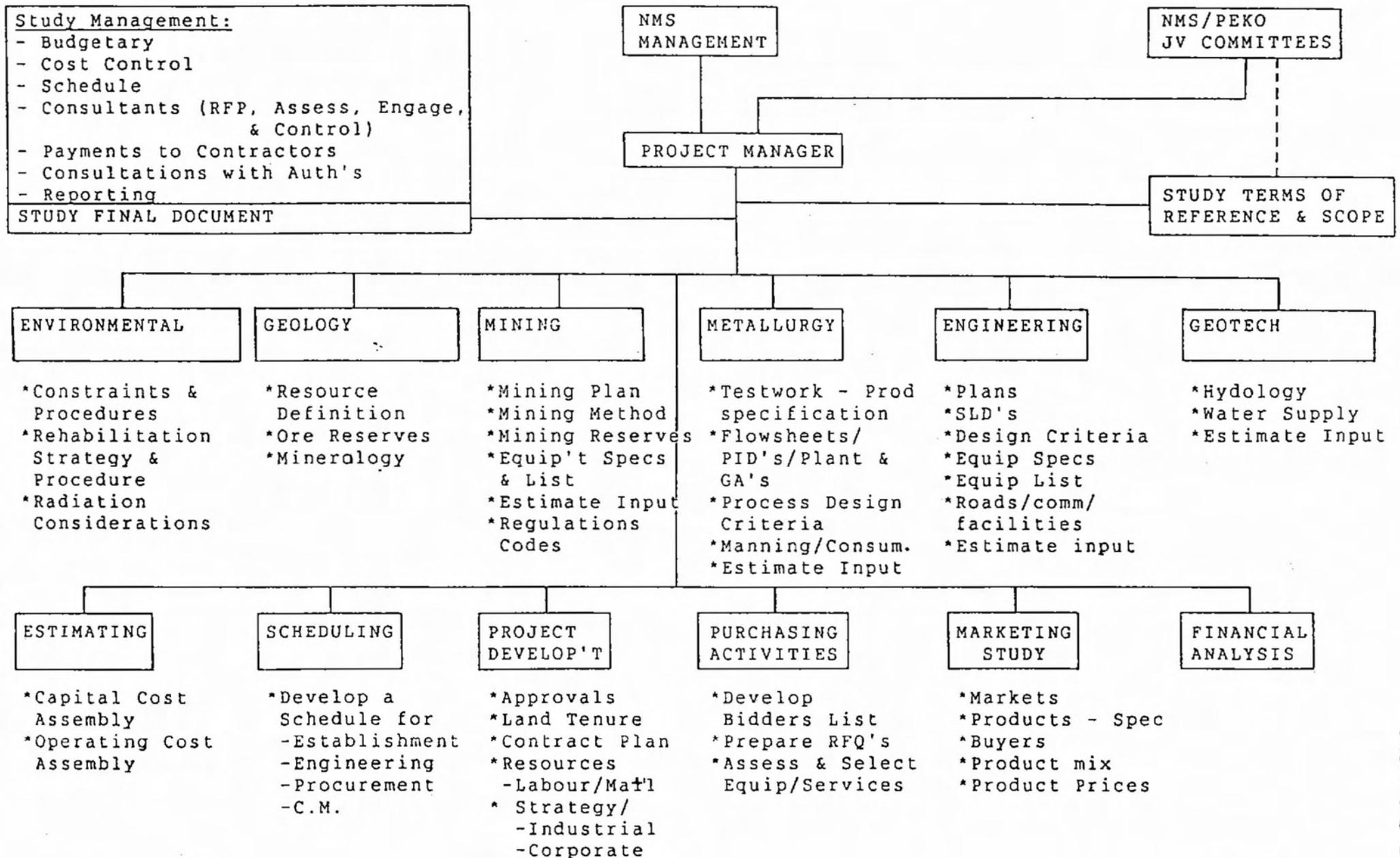


FIGURE 1.11

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S E C T I O N 2.0

GEOLOGY AND MINERAL RESOURCE ESTIMATE

- 2.1 BRIEF REVIEW OF GEOLOGY
- 2.2 SURVEY AND MAPPING
- 2.3 DRILLING
- 2.4 LABORATORY TESTING
- 2.5 RESOURCE ESTIMATES
AT 1.5% HEAVY MINERAL CUT OFF
- 2.6 RESERVE ESTIMATES
AT 2.5% HEAVY MINERAL CUT OFF
- 2.7 ADDITIONAL RESOURCES
- 2.8 HYDROGEOLOGY
- 2.9 TERMINOLOGY

2.1 BRIEF REVIEW OF GEOLOGY

GENERAL GEOLOGY

The basement rocks of King Island consist of Pre-Cambrian Metamorphics and Palaeozoic sediments and volcanics. Granitic rocks of two ages have intruded the above sequences - Devonian potassic granites confined to the west coast of the island and Carboniferous granodiorites and adamellites confined mainly to the east coast of the island.

The majority of the basement, however, is covered by Tertiary sediments, Pleistocene and Recent superficial deposits.

The Tertiary sequence is part of the western margin of the Bass Basin and underlies the recent sand deposits at Cowper Point. In this area it is represented by a marine sandstone composed mostly of carbonate fragments with localised quartz rich sand and granule deposits.

Pleistocene & Recent sand deposits have been formed by coastal processes at Naracoopa & Cowper Point. It is these deposits which contain the heavy mineral concentration which form the subject of this study.

FORMATION OF MINERAL SAND DEPOSITS

NARACOOPA

Lanherne Beach is considered to be an accumulation of beaches with at least three (3) vertically stacked beaches visible on the eastern scarp as evidenced by pebble and cobble horizons. Milford Beach is considered to be the accreting storm barrier to the present day Sea Beach. Large timbers from the nearby Naracoopa wharf which were deposited by a storm on Milford Beach attest this fact.

The heavy minerals were distributed by means of ocean tides and currents after being carried in suspension by the rivers to the seas from a point or points inland. They were subsequently deposited by wave action on the beach.

After the deposition of the highest Lanherne Beach level and subsequent lowerings of sea level, the resulting downcutting of the Frazer River reworked some of the initial deposits. The reworking contributed to the high grade Milford Beach and Sea Beach deposits.

COWPER POINT

In the Cowper Point area the Back Beach Deposit is the oldest mineralised beach sand occurrence. This deposit is the northerly time equivalent to the Lanherne deposit at Naracoopa.

The Back Beach deposit overlies a Tertiary calcareous sandstone, similar to that outcropping at the mouth of Blowhole Creek. In some areas, particularly along the western flank of the Back Beach deposit, a dark grey carbonaceous clay underlies the sands and overlies the Tertiary sandstone. This clay unit thins towards the east.

Traversing in an easterly direction from the Back Beach is a series of beach strandline deposits resting directly on the Tertiary sandstone. These beach deposits typically fine upwards and often contain a basal gravel and/or coarse shell layer. Along the eastern side aeolian dune sands overlie these strandline deposits.

The High Dune deposit occurs near the modern coastline at Cowper Point. It comprises a sequence of mineralised beach deposits capped with mineralised aeolian dunes. Beach sequences typically commence with a poorly sorted shelly sand, sometimes with carbonaceous silt resting directly on the Tertiary sandstone. The sequence fines upwards to a well sorted sometimes richly mineralised beach deposit. Aeolian dune deposits range upwards to in excess of 30m. thick. To the south of Cowper Point the mineralised beach and aeolian dune deposits extend to the modern coastline, while to the north of Cowper Point a younger, non-mineralised sequence of beach and dune deposits has built up on the coastal side of the High Dune deposit.

High Dune mineral deposition is structurally controlled by a high in the Tertiary calcareous sandstone basement. The structural contour map for the base of the sand body (Figure 2.1) shows the highest area is in the vicinity of drill traverse line 3150N. The basement high appears to have caused heavy mineral concentration to the north, principally between lines 3150N and 4050N.

The higher concentration of heavy mineral most likely occurred due to an altered energy regime in the shallow beach environment caused by the structural high. This caused the deposition and accumulation of the higher density heavy minerals.

NATURE OF THE DEPOSITS

NARACOOPA

The Sea and Milford Beach deposits consist of fresh sand that is free from iron staining and organic coatings. Wave action is actively regenerating these deposits and concentration of rich mineral sand is still taking place. After storms have stripped back the Sea Beach, older indurated sands are exposed on parts of the beach. These are probably of similar age to the Lanherne deposits.

The Lanherne deposit was formed by strong wave action, as is evident by cross bedding and the well stratified nature of the deposit. It is most probably a Pleistocene interglacial beach deposit. The significant feature of the Lanherne Beach deposit is that the sand is partially indurated with iron and /or organic deposits. Occurring within this semi-consolidated sand are compact cemented bands of iron and organic rich material. Old soil horizons and pebble layers are observed in both natural and artificial exposures, indicating a vertical accumulation of beaches. It is the plant growth on the soil horizons which has contributed most of the organic cementing material and caused mobilisation of iron.

COWPER POINT

The Back Beach deposit comprises a moderately well sorted sand with a coarse basal deposit particularly along the western flank. Also along the western margin some very high heavy mineral grades have been encountered in the near surface sands. For the most part the deposit is indurated with accumulated organic cement, similar to Lanherne Beach at Naracoopa. Blowhole Creek forms the western limit to this deposit.

The High Dune deposit comprises a moderately well sorted beach sequence overlain by a well sorted aeolian dune. For the most part the sand is very clean with little matrix. Shell content is variable. Pebbles and shells with coarse sand occur near the base in places. The western part of the High Dunes overlies organically cemented sands similar to those of Back Beach.

2.2 SURVEY AND MAPPING

PREAMBLE

A survey was carried out to establish a baseline and to provide photogrammetric control for an orthophoto mapping programme by Geospectrum (Aust) Pty Ltd. The area covered extended from Naracoopa to Cowper Point approximately 12kms

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north, and generally inland to include the Sea Elephant Road.

The survey was established from existing Tasmanian landmarks, with the co-ordinates being related horizontally to Australian Map Grid (AMG) and vertically to mean sea level. The survey programme was carried out using Wild T2 single second theodolites, AGA Model 16 electronic distance measuring equipment and Fuji-Koh precise level.

PHOTO-CONTROL SURVEY

Photogrammetric survey control was established at 12 targeted locations within the mapping area. A closed survey traverse was undertaken based on survey marks found at Naracoopa and Cowper Point with azimuth checks on to Councillor Island Light and Counsel Hill Trig Station. All elevations were established by trigonometrical heighting. From the survey information and aerial photography, eight (8) orthophoto map sheets covering the area from Naracoopa to Cowper Point were produced.

BASELINE SURVEYS**NARACOOPA**

The baseline was commenced from the original point (0E 0N) a few metres to the east of the old mine entrance gate, and pegged at 100 metre intervals from 0N to 2000N. The baseline is oriented to run generally parallel to the coastline.

A permanent Bench Mark (BM) was established at the old mine site. The BM is a white painted sawn off bolt on a disused concrete footing.

Along Traverse Lines 100N, 300N, 500N, 600N, 700N, 1000N, 1200N, 1400N, holes were pegged every 20 metres by tape and range pole to low water mark in the east and the Frazer River or swamp in the west.

COWPER POINT

A project grid was established using an existing north-south straight trafficable track along the axis of the Back Beach deposit as a base line. This line was given an eastings designation of 1000E. It formed the base line for the 1967 McMahon grid. At the northern end the 1000E line swings in a north-westerly direction and has been designated 1000NE.

Drill hole positions were established on east-west traverse lines. Traverse lines were established at right angles to the 1000E line and mostly spaced at 300m intervals, in order to be spaced half way between McMahons 1967 traverse lines

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and provide greater information density.

Three exploratory drill traverse lines extended west of Back Beach. These lines were located to coincide with existing cut lines and do not intersect the 1000E line at right angles. In these cases the line has been given a designated northing at the point of intersection with the 1000E line.

All survey of locations prior to drilling was by tape compass and range pole. In the case of the Back Beach and intermediate strandlines between Back Beach and High Dunes, this survey method is considered to be sufficiently accurate for resource estimation purposes, since there was good line of sight along cleared lines with minimal topographic relief.

In the High Dune deposit topographic relief caused problems with survey. Furthermore many drill holes had to be relocated to sites accessible by the drill rig which were offset from the original pegged location. In the extreme cases offsets approaching 30m. were made, requiring a rig drilled hole on the offset location and a hand bored hole on the original site. When offsetting hole locations, a balance was made, where possible, to ensure a consistent sampling of the topographic relief i.e. some holes were offset upslope and some downslope, rather than all offsets downslope. Upon completion of the drilling in the High Dunes drill hole collars were surveyed by Mr R.Cleeland, a registered surveyor.

2.3 DRILLING

Drilling operations were carried out using both hand augering/cased sludging and reverse circulation techniques. Holes spaced at either 40m or 20m apart were drilled on east-west traverse lines.

HAND DRILLING

Hand augering was carried out by Moina Mining Industries in areas inaccessible for the drilling rig. Holes were hand augered to water table using 50mm diameter hand auger. When water table was reached, 50mm casing was inserted into the hole and was advanced by sludging using a whistle top sludger on aluminium extension rods.

REVERSE CIRCULATION DRILLING

Reverse circulation drilling was carried out, using a drilling rig mounted on a Toyota Landcruiser. The hole size was BQ (56mm diameter), and the drill rod lengths were 6 metres. The advantage of this type of drilling, compared to hand augering, is greater depth penetration and clay and gravel layers can also be penetrated. It does however tend to down-grade contained heavy mineral

SECTION 2.0 - GEOLOGY & MINERAL RESOURCE ESTIMATE

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grades when compared to results obtained from hand drilling, as was demonstrated at Naracoopa, Reference 1.001.

The reverse circulation drillhole samples were subject to a weight check as a means of establishing reliability of sampling.

2.4 LABORATORY TESTING

HEAVY MINERAL DETERMINATION PROCEDURE

All samples were treated by R.H.F. Laboratories, Smithton, using the procedure outlined below:

1. Dry sample as received
2. Weigh and record dry weight.
3. Screen on a 2 mm coarse sieve to break up lumps.
4. Riffle split approximately 100 gm working sample.
5. Re-pack balance of sample.
6. Weigh working sample.
7. Screen on 1000 micron sieve and weigh plus 1000 micron fraction.
8. Caustic wash using a 2 percent NaOH solution, agitate and allow sand to settle.
- 8.1 Decant NaOH solution, wash and decant with clean water in repeated steps until all NaOH is removed.
- 8.2 Dry washed sample.
- 8.3 Weigh washed and dried sample and calculate percentage lost as slimes during washing.
9. Using TBE, separate heavy minerals.
10. Dry and weigh heavy minerals.
11. Calculate heavy minerals as a percentage of the sample weighed in step 6 above.
12. Package heavy minerals for despatch.
13. Records results for:

- * dry weight of sample as received
- * weight % of + 1mm & + 2mm material
- * weight % of slimes
- * weight % heavy minerals

BULK DENSITY DETERMINATIONS

Bulk density was determined for a range of heavy mineral contents. Samples used were from Naracoopa drill hole 80W, 500N; 0 - 7.5m which contained a range of heavy mineral from high to low. The raw dry sand samples were lightly tamped down prior to measuring volume and weight.

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Results are:

Hole	Sample Interval	Heavy Mineral %	Bulk Density g/cm ³
80W, 500N	0 - 1.5	86.76	2.38
	1.5 - 3.5	97.64	2.55
	3.5 - 5.5	50.16	1.96
	5.5 - 7.5	1.79	1.67

MINERALOGICAL INVESTIGATION

Mineralogical studies were carried out on bulk composites of heavy mineral. Composites were prepared by combining intervals both vertically and horizontally for a number of adjoining drill holes for areas containing plus 1.5% heavy mineral.

For most composites all magnetic fractions were subject to point count, while a few selected samples had only the 1.2 amp non magnetic fraction point counted. The method adopted for mineralogical study was:

1. Magnetically separate the heavy concentrate into:
 - * hand magnetics
 - * 0.5 amp Frantz magnetics
 - * 1.0 amp Frantz magnetics
 - * 1.2 amp Frantz non-magnetics

Using a Frantz magnetic separator with forward slope of 25 degrees and side tilt of 18 degrees.

2. Weigh each magnetic fraction.
3. Optically identify mineral grains and point count a minimum 500 points for the relevant magnetic fractions.

Mineralogical examinations were carried out by Applied Petrographic Services, Sydney.

Mineralogical results, as reported are weight percent for magnetic fractions and volume percent for the optically identified point counted grains. The total percentage for the whole sample is a combination of weight and volume, as reported by Applied Petrographic Services.

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A typical heavy mineral suite from these deposits contains the following mineralogy:

<u>MINERAL</u>	<u>RANGE %</u>
Rutile	5 - 9
Zircon	6 - 14
Leucoxene	3 - 7
Ilmenite	18 - 28
Leucoxenised Ilmenite	8 - 13
Magnetite	<1 - 1
Garnet	5 - 10
Tourmaline	16 - 25
Alumino Silicate	1 - 4
Other Silicates	1 - 6
Epidote	2 - 6
Staurolite	4 - 6
Chromite	<1 - 1
Kyanite	<1 - 1
Monazite	<1 - 1
Corundum	<1
Iron Oxides	<1
Quartz	<1 - 2

2.5 RESOURCE ESTIMATES AT 1.5% HEAVY MINERAL CUT-OFF PREAMBLE

Estimates of contained resources have been made on the basis of data obtained from the drilling, testing and mineralogical work programmes. These resource estimates have been prepared in accordance with the Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves.

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Resource estimates have been calculated initially at 1.5% heavy mineral cut-off. A 1.5% heavy mineral cut-off was selected as being near the lower end of the ultimately selected economic cut-off limit and would provide a first approximation to the extent of the economically viable deposit. This decision was made prior to detailed mineralogical results in order that samples for mineralogical determination would relate more closely to the finally selected cut-off limit. It was also realised that later revision of cut-off grades may be required after actual operating costs were available.

The method of calculation was:

- i) Calculate average heavy mineral grade for each drill hole down to 1.5% cut-off.
- 11) Determine cross-sectional area of influence for each drill hole. Each drill hole represents a block extending half way to the adjoining drillhole i.e. 10m either side of the drill hole for Naracoopa & Back Beach and 20m either side of the drill hole for the High Dunes
- 111) Calculate cross-sectional area and average grade for each mineralised block.
- IV) Calculate contained volumes on the basis that each cross-section has an area of influence half way to next cross-section line.

The following have also been used:

- * Tonnage conversion factor 1.6 t/m^3 based on bulk density determination of 1.67 t/m^3 for sand containing 1.79% heavy mineral, at Naracoopa.
- * All resources are considered as "Indicated" and totals have been rounded to 2 significant figures as set out on tables 2.1 to 2.8.

NARACOOPA

Resource estimates for Lanherne Beach raw sand, Milford Beach, Sea Beach and sand tailings have been determined in accordance with the above procedure. Heavy mineral tailings have been treated differently as discussed later. A resource summary for Naracoopa is shown in Table 2.1.

LANHERNE BEACH RAW SAND

The Lanherne Beach represents a stacked accumulation of old beaches. Mining has previously been carried out on the area south of approximately 800N, although not all the available resource has been mined. Sand tailings from the previously mined area have been considered separately.

Typically the Lanherne Beach sand has a higher slimes content and layers of coarse sand with gravel. Organic and minor iron-rich induration is common although rarely did it prevent drill penetration and then only when hand drilling. The heavy mineral suite shows a greater variation than for any other feed type with rutile 6 - 10% and zircon 6 - 15%. Leucoxene is higher, ranging from 4 - 8%.

To the north of approximately 800N the Lanherne Beach mineralisation splits into two separate bodies. Drilling completed previously by Kibuka also showed this split. Kibuka called the two bodies "Lanherne Beach Northern Extension" and "Minor Eastern Lens." Results obtained from the current study shows that the equivalent to the Minor Eastern lens contains a higher content of rutile (10%), zircon (15%) and leucoxene (8%) than does the main body of mineralisation. Although the thickness of mineralisation is shallow and total tonnage of contained mineral is not great, the increased content of economically recoverable mineral may make this area attractive.

Resources of Lanherne Beach raw sand are set out in Table 2.2. The 3.0 million tonnes of raw sand represents 45% of the Naracoopa resource at 1.5% mineral cut-off. Contained heavy mineral is 153,000 tonnes which is 23% of the resource outlined to date.

MILFORD BEACH

Milford Beach is the barrier inland from Sea Beach. It represents a narrow strip approximately 30m. wide, but tends to be wider to the north. The southern end of Milford Beach appears to have been previously worked. In the vicinity of the 600N line old sand tailings cover Milford Beach.

The sand is typically clean with low slimes content. The heavy mineral suite contains higher rutile and zircon values (each 9 - 11%) than does Sea Beach. Leucoxene is low.

Resources are set out in Table 2.3. The raw sand at 320,000 tonnes represents 5% of the Naracoopa resource at 1.5% mineral cut-off. Contained heavy mineral is 37,000 tonnes which is 6% of the resource outlined.

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SEA BEACH

Sea Beach is the present day beach which contains visible concentrations of heavy mineral, some of which is high grade. The beach represents a narrow strip approximately 30m. wide. Since this is an active beach, it is a resource which has potential to replenish with time.

The sand is typically clean, being low in slimes. The heavy mineral suite contains 7 - 8% rutile and 6 - 9% zircon. Leucoxene at 1 - 2% is lower than for the other parts of the deposit.

Resources are set out in Table 2.4. The raw sand at 195,000 tonnes represents 3% of the deposit at 1.5% mineral cut-off. Contained heavy mineral is 34,000 tonnes which is 5% of the resource outlined to date.

SAND TAILINGS

Sand tailings from the operations of Naracoopa Rutile and Kibuka have been placed on the southern half of Lanherne Beach. For the most part this material is tailings from the richer parts of the deposit which was worked by Kibuka. Although this material is tailings it does contain a significant heavy mineral content including rutile and zircon. In some areas it overlies previously unmined sand with appreciable mineral contents, which for simplicity have been included as tailings.

Typically sand tailings have lower slimes and oversize content. The heavy mineral suite consistently contains approximately 5 - 6% each of rutile and zircon and does not show the variations that the raw sand does.

Resources of sand tailings are set out in Table 2.5. The 2.71 million tonnes of sand tailings represents 41% of the deposit at 1.5% mineral cut-off. Contained heavy mineral is 213,000 tonnes which is 32% of the resource outlined to date.

HEAVY MINERAL TAILINGS

Heavy mineral tailings occur as two (2) separate bodies, buried heavy mineral tailings and above (natural) surface tailings. In the case of the buried heavy mineral tailings, resource calculations have been made using the projection of cross-sectional area method applied to all other types of mineralisation. A bulk density of 1.9 t/m³ has been applied. It is likely that the resource estimates quoted are not very reliable and may be higher than those resulting from further follow-up information.

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They have therefore been categorised as Inferred Resources. If these estimates are high, then they will be at the expense of sand tailings, with the net result of an overall reduction in total contained mineral. An estimate of 245,000 tonnes of buried heavy tailings, containing 116,000 tonnes of heavy mineral is inferred from data presently to hand.

For heavy mineral tailings above surface, resources have been estimated from measurement of volume within the contours on the orthophoto map. Additionally grades determined from drill holes have been utilised along with a bulk density of 2.3 t/m³. Estimates for the above surface heavy tailings are considered to be reliable. An estimate of 139,000 tonnes containing 115,000 tonnes of heavy mineral, is indicated.

The heavy mineral tailings for the most part comprise magnetic heavy mineral (ilmenite + others) but includes rutile (4%), zircon (4-5%) and leucoxene (1-2%). They comprise 6% of the raw sand feed and 35% of the total heavy mineral.

COWPER POINT**HIGH DUNE**

The High Dune deposit contains both strandline and aeolian dune concentrations of mineralisation. The area considered which is bounded in the north by McMahon's 160N traverse line and in the south by a line half way between McMahon's 90N and N.M.S. 1900N traverse lines i.e. 1960N on the N.M.S. grid. The western boundary for the most part is the junction between back barrier swamps and aeolian dunes which is marked by a distinct break in slope.

McMahon's (1967) results as well as the recent results of N.M.S. have been included in the resource calculations. The McMahon results have been demonstrated to be reliable (see reference 1.004). Subsequent work has further reinforced the reliability of McMahon's results with respect to:

- * extent of High Dune mineralisation
- * overall grade trends

In calculating resource estimates McMahon's results for heavy mineral content have been given equal weight with those of N.M.S. thereby increasing density of available data throughout the mineralised body. In the north of the High Dune deposit the 160N, 150N, 140N and 130N traverse lines of McMahon and the 4650N, 4350N and 4050N traverse lines of N.M.S. cross each other. In this area triangular resource blocks are generated with a bisector separating the McMahon and N.M.S. traverse lines into blocks. This creates a variable north-south extension and so each drillhole has been treated as a separate sub-block with an extension to the edge of the resource block.

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At the apex of each triangular resource block preference has been given to N.M.S. drill hole data.

Table 2.6 sets out the resource estimates block by block for the High Dune area. Only mineralogy due to National Mineral Sands has been included in this Table. While partial mineralogy is available from McMahon's results it does not contain leucoxene data; it shows similar zircon contents but rutile on average is 2.5% higher than N.M.S. data. Furthermore the overall trends exhibited by the N.M.S. mineralogy data are considered to be sufficiently reliable to allow a prediction of the mineralogy on the McMahon lines to be made for resource calculation purposes.

The plus 2mm material was determined to be 0.24 per cent. However, this figure was not applied as a correction to the resource estimates since it does not alter the rounded figures.

Within the High Dune resource there is a higher grade resource. This resource has been defined as the High Dune area where drillholes contain greater than 3.0% heavy mineral average grade.

Estimates were also made, for comparative purposes, using only N.M.S. and only McMahon data, at 1.5% cut off within basically the same limits used elsewhere. Results are:

	Raw Sand t	Heavy Mineral t	Av Grade %
N.M.S.	18,000,000	560,000	3.1
McMahon	14,000,000	440,000	3.2
N.M.S. & McMahon	16,000,000	510,000	3.1

The above results show:

- * very similar average grades
- * significantly higher tonnage estimates for N.M.S. only data

The higher N.M.S. tonnage estimates are due to greater depth penetration of drill holes; and greater sampling of topographically higher ground by the N.M.S. grid compared to the McMahon grid.

BACK BEACH

The Back Beach deposit is an accumulation of beach deposited strandlines. The area considered which is bounded to the north by traverse line 3750NW and to the west by Blowhole Creek and to the south also by Blowhole Creek where it turns and flows in an easterly direction. For resource estimation purposes, the southern boundary has been taken as a line equivalent to the project grid 1175N. The eastern extent is determined by heavy mineral grade.

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McMahon's (1967) results as well as the recent results of N.M.S. have been included in the resource calculations. The McMahon results have been previously demonstrated to be reliable and recent work has further reinforced the reliability with respect to:

- * Overall extent of mineralisation
- * Overall grade trends

In calculating resource estimates McMahon's results have been given equal weight with those of N.M.S., thereby increasing the density of available data throughout the mineralisation.

Table 2.7 sets out the resource estimates block by block for the Back Beach area.

The plus 2mm material was determined to be 1.96 per cent. Applying 1.96% as an oversize correction factor will slightly alter the results which are shown in Table 2.7 as "Total Rounded Tonnes After Oversize Correction."

Within the Back Beach resource there is a high grade mineral concentration which probably represents a single storm event. This high grade resource is also shown and defined as the area encompassing drill holes with greater than 5.0% heavy mineral average grade.

Estimates were also made for comparative purposes using only N.M.S. and only McMahon data, at 1.5% cut off within basically the same limits used elsewhere. Results are:

	Raw Sand t	Heavy Mineral t	Av Grade %
N.M.S.	2,800,000	140,000	5.2
McMahon	1,400,000	79,000	5.5
N.M.S. & McMahon	2,200,000	110,000	5.1

The above results show:

- * very similar average grades
- * significantly higher tonnage estimates for N.M.S. only data

The higher N.M.S. tonnage estimates are due in part to greater drill hole depth penetration, but probably of greater importance is the better definition of mineralisation achieved as a result of the N.M.S. drilling and testing utilising the McMahon data as a basis for planning.

COWPER POINT - HIGH DUNE

RESOURCE ESTIMATION BY SURPAC MINING SYSTEM

During the investigation it was realised that the irregular topography in the High Dune deposit area could have a significant influence on the volume of mineralised sand. The most expedient means of accounting for topography was to utilise the digitised photogrammetry.

Resource estimates were calculated by Geopeko using the Surpac Mining System, taking account of topography and drill hole data. A cut-off grade of 1.5% only was considered. Results are recorded in Table 2.8, a comparison made with manually calculated results is also given in the right hand column.

The resource estimates determined fall into two categories:

- . Indicated topographically corrected.
- . Inferred resources below McMahon's resource blocks.

The indicated resource was calculated for both the National Mineral Sands and the McMahon resource blocks and takes into account the topography present within each resource block, based on cross-sections spaced 10m apart. The average grades shown are the same as those calculated manually (see reference 1.006). The figures obtained from a more rigorous topographic consideration, using the Surpac System have shown the raw sand to increase by 1,000,000 tonnes and the heavy mineral by 34,000 tonnes over the figures obtained from manual calculations. These increased figures are entirely due to topography.

The inferred resource takes into account mineralised sand not included in the McMahon resource blocks. McMahon's drilling did not penetrate the full depth of the mineralised body, principally due to the hand drilling technique employed. This resource has been classified "Inferred" as an accurate grade figure cannot be readily determined from the data available. The average grades calculated separately for both McMahon's and N.M.S. data are very similar and suggest that this Inferred resource will not differ greatly from the average 3.1% heavy mineral at 1.5% cut-off grade. Over all, 1.7 million tonnes of sand containing 54,000 tonnes of heavy mineral are shown to occur within this Inferred resource.

It is pointed out that determination of this Inferred resource depends to some extent on the evaluation correction adopted to make McMahon's drill hole collar elevations consistent with the photogrammetry.

Over-all, there is an increase of 2.7 million tonnes of sand and 87,000 tonnes of heavy mineral when comparing the Surpac generated estimates with the manually calculated estimates.

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In summary, resource estimates made using the Surpac System both Indicated and Inferred, are 19 million tonnes of sand containing 600,000 tonnes of heavy mineral and compare with manually calculated Indicated resource estimates of 16 million tonnes of sand containing 514,000 tonnes of heavy mineral. It is interesting to note that, when considering the National Mineral Sands data only, separate from McMahon's, an estimated 18 million tonnes of raw sand containing 560,000 tonnes of heavy mineral is obtained. This is a very similar estimate to that generated from the Surpac System.

2.6 RESOURCE ESTIMATES AT 2.5% HEAVY MINERAL CUT OFF

PREAMBLE

Upon completion of initial mining, metallurgical and associated production cost studies, a re-assessment of the resource estimate was made, taking into account production operating cost estimates.

DETERMINATION OF CUT OFF GRADE

An average operating cost exclusive of any capital repayments was initially determined to be \$1.62/tonne of sand mined. For the purpose of determining cut off grade, it was assumed that rutile and zircon were the only minerals contributing to revenue.

On the basis of contained rutile valued at \$600/tonne and zircon valued at \$500/tonne a heavy mineral cut off grade equivalent to a value of \$1.62 was applied to each resource block in each of the deposits. The determined grades for each deposit are:

Naracoopa	=	2.2% heavy mineral
Cowper Point, High Dunes	=	2.4% heavy mineral
Cowper Point, Back Beach	=	1.5% heavy mineral

The operating cost estimates were further revised and again by comparing resource block average values the above cut-off grade estimate was confirmed.

Indicated Resource estimates are set out in Tables 2.9 to 2.11 respectively for Naracoopa, Cowper Point (High Dunes) and Cowper Point (Back Beach).

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SUMMARY OF INDICATED RESOURCES

Indicated Resources at 2.5% heavy mineral cut off grade are:

DEPOSIT	RAW SAND(t)	H.M.(t)	RUTILE(t)	ZIRCON(t)
Naracoopa	5,300,000*	640,000*	35,000*	40,000*
Cowper Point (High Dunes)	8,800,000	360,000	22,000	27,000
Cowper Point (Back Beach)	<u>1,200,000</u>	<u>87,000</u>	<u>6,800</u>	<u>10,000</u>
TOTAL	15,300,000	1,087,000	63,800	77,000
ROUNDED	15,000,000	1,100,000	64,000	77,000

* Includes Buried Heavy Tailings as an INFERRED RESOURCE.

Within each of the mineralised areas there are higher grade areas which could be selectively mined.

The resource estimates stated in this report have an Indicated status and therefore must be considered as having a reliability of probably $\pm 20\%$. In broad terms, this encompasses the ranges shown in Section 2.5 by considering the McMahon and N.M.S. data separately.

2.7 ADDITIONAL RESOURCES

Exploration drilling completed as the basis of this feasibility study has concentrated on outlining resources in the vicinity of Naracoopa and Cowper Point. In addition to the resources outlined in 2.5, there is potential in areas which required further investigation. These areas are listed below:

- Naracoopa: Sea Beach has potential for replenishment of heavy minerals
- Naracoopa: north end of Sea Beach and Milford Beach, have potential for small quantities of mineral to the north of drill traverse 2000N
- Cowper Point: west of Blowhole Creek

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- Cowper Point:
Back Beach Some encouraging heavy mineral grades (+5%) were encountered in this area particularly on the 1638N line, however the shallow depth of sand (generally less than 2.0m) overlying the Tertiary calcareous sandstone would increase mining and rehabilitation costs.
- Cowper Point:
Back Beach Closer spaced drilling at 10m centres of the high grade Back Beach area would assist in delineating this resource and is likely to lead to an increase in estimated resource. Extension of some McMahon traverse lines is also required.
- Cowper Point:
High Dune Along the eastern flank of this area the full thickness of the sand body has not been sampled. Strandline concentrations may occur which could lift the overall grade to near the cut off grade.
- Sea Elephant Road: To the east of Sea Elephant Road between Naracoopa & Cowper Point. No exploration has been carried out to determine if heavy mineral concentrations occur.
- Mt Counsel: Exploration to date has encountered heavy mineral concentrations on four drill traverse line. Results to date infer a resource of approximate size:
Sand 3 million t.
Rutile 4 000 t.
Zircon 10,000 t.

Overall the potential additional resources are small.

2.8 HYDROGEOLOGY

Hydrogeological studies were carried out over two separate campaigns. A preliminary study was conducted at Naracoopa in June, 1988 and a further study covering both Naracoopa and Cowper Point was conducted in April, 1989.

The hydrogeological study involved the drilling of 23 holes 18 of which were converted to regional observation bores which were incorporated with the 10 water level monitoring points established in the 1988 campaign. In addition, two production bores and three production spearpoints were constructed and test pumped. Water levels were measured

in additional observation piezometers around the groundwater discharge facility to assess aquifer hydrologic characteristics. On-site chemical analyses were carried out at most observation piezometers, and surface water and groundwater samples sent to a private laboratory for inorganic chemical analysis. Computer modelling assessed the likely quantity of groundwater available from the sand aquifers and regional effects of such withdrawals on the environment.

NARACOOPA

The Naracoopa sand deposit consists of a frontal beach, a Recent interdunal system and extensive beach and aeolian sediments of Pleistocene age. The saturated thickness of aquifer in the Pleistocene sand is variable with an average of 7m. This deposit contains diagenetic, carbonaceous cement horizons and peat layers which significantly reduce the permeability of the sand aquifer. Perched systems above the peat are present. Clay bedrock occurs beneath the sand and dips eastwards, being RL 20m near Sea Elephant Road, RL 2m beneath the interdunal system and RL 0m on the beach. The limit of the Naracoopa sand deposit is taken as: Eldorado Creek to the north; Sea Elephant Road to the west and Fraser River to the south. Transmissivity values for the Pleistocene sand range from 0.4 to 6m²/day, and a value of 36m²/day was derived for the interdunal system. This indicates the low permeability of the carbonaceous sand and the more transmissive characteristics in the Recent deposit. The quantity of water in aquifer storage is estimated as 1120 Ml with annual groundwater discharge being 730 Ml of which 630 Ml/year is drainage to Sea Elephant Bay. The groundwater yield needed for mining purposes is 1 Ml/day, which is about 60% of discharge to the ocean and 33% of aquifer storage.

The preferred area for groundwater withdrawal is the more permeable interdunal system at the base of the Pleistocene deposit. The potentiometric surface at this location is shallow. The most appropriate method of groundwater is a spearpoint battery along the interdunal sand deposit to intercept the natural base flow drainage to the ocean.

The salinity of the groundwater is less than 1000uS/cm except in the southern area where higher salinity is assessed as being due to the use of sea water and caustic soda during previous mining operations. The low salinity water is acidic, highly coloured, occasionally contains excessive iron, and hydrogen sulphide gas is present. The water quality indicates that the groundwater in the Naracoopa sands is unsuitable for domestic purposes. Potable water should be obtained from surface water sources.

Mining close to the Fraser River will have little environmental effect on the watercourse. Salt water encroachment from Sea Elephant Bay due to pumping close to the beach is unlikely to occur due to the geometry of the aquifer system. The use of sea water for mining purposes is not recommended due to the subsequent increase in salinity in the sand aquifer around the mining pond and the deleterious effect on surface rehabilitation.

Due to the presence of the indurated carbonaceous cement throughout the Pleistocene sand, the aquifer does not form an ideal groundwater supply system. The apparent marginally better hydrologic characteristics of the Recent interdunal sand and shallow potentiometric surface, indicate that a spearpoint battery should extract 1 Ml/day. A length of 2.5 km will be required. The spearpoints are expected to yield 20m³/day and should be spaced 50m apart. Due to the shallow saturated sand thickness along the north-south orientated interdunal system it is assumed that the groundwater quantity required will largely be withdrawn by induced drainage from the Pleistocene sand system. It is further assumed that the saturated sand is hydrologically continuous over the length of extraction. Before an extensive spearpoint battery is installed it is recommended that a trial 250m length of spearpoints be installed between 1600N to 1850N and pumped over a period of one month to assess the suitability of the withdrawal/interception system. An effective water management scheme is required and re-use of mine waste water will be maximised to reduce the demand on the groundwater withdrawal facility.

Additional water should be available from the Frazer River during the wet periods of the year.

COWPER POINT

The High Dune system extends from the calcareous sandstone at the confluence of Blowhole Creek and Sea Elephant Bay to Cowper Point. The multidune system rises sharply to RL 44m with interdunal areas of RL 5 to 8m. Carbonaceous cement is present in about 50% of the High Dune deposit; the remainder consists of clean, shelly, fine to coarse sand. Bedrock consists of a calcareous sandstone platform located at RL 1 to -2m. The saturated thickness of the unconfined aquifer varies from 0.9 to 7.9 m, the average being around 4m. The transmissivity of the High Dune sand aquifer varies from 78 to 739 m²/day (average of 300 m²/day) indicating a clean, transmissive, coarse grained sand unit. Based on the examination of drilled samples, the transmissivity of the carbonaceous cemented sand is assumed to be slightly higher than that at Naracoopa.

The quantity of water in storage in the High Dune sand

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aquifer is estimated as 400 Ml with annual rainfall recharge to the aquifer system of 593 Ml. The mine supply of 1 Ml/day is 60% of rainfall recharge and 90% of groundwater in storage. A 50 spearpoint battery system established over a 1.25 km length of the interdunal clean sand area between the dunes should extract the mine water supply. The spearpoints will be spaced 25m apart and are expected to yield 20 m³/day. The water salinity is less than 1000uS/cm over the central part of the High Dune deposit with increase in salinity to 1760 S/cm along the flow path. The Na:Cl type water is enriched in calcium and bicarbonate ions due to the dissolution of shells within the aquifer, the pH is neutral, the water is colourless to light brown and has a low iron content. The inorganic chemical analysis indicates that the water may be suitable as a potable water supply. No bacteriological analysis was carried out.

It is assessed that if the northern extent of the spearpoint battery is restricted to drill line 4650N there will be no effect on the Sea Elephant River due to groundwater withdrawal activity. Salt water intrusion into the High Dune aquifer is not anticipated from Sea Elephant Bay. The use of sea water in this low salinity, permeable aquifer is not recommended.

The clean sand beneath the High Dunes appears to have good hydrologic characteristics but the lack of saturated sand thickness due to shallow bedrock and carbonaceous cement to the west restricts the groundwater yielding potential of this aquifer. It is unlikely that groundwater yields in excess of 1 Ml/day could be extracted over a length of 1.25 km within the interdunal system. It is recommended that initially a 500m length of spearpoint battery, each spear 25m apart, be initially established and pumped for 1 month with water level monitoring in surrounding piezometers. Additional spearpoints could be added after this trial to increase groundwater extraction rate.

The Back Beach deposit occurs as a slightly elevated beach sand deposit west of the High Dunes. It is of limited aquifer thickness and contains carbonaceous cement throughout. No test pumping was carried out in this deposit.

SURFACE WATER

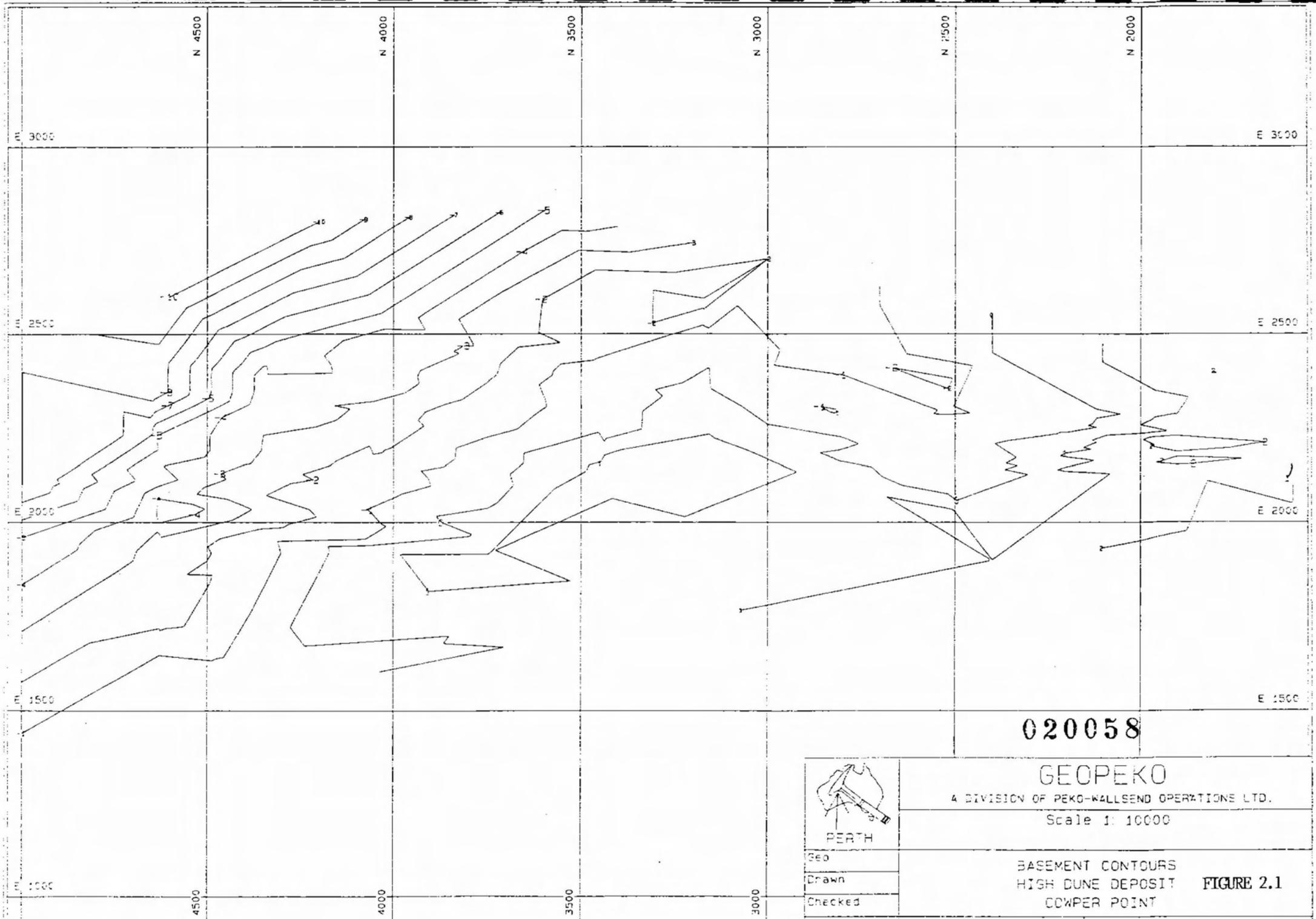
The quality of groundwater from the surface swamp is similar to the groundwater system to which it is hydrologically connected. The Na:Cl dominant swamp water at Naracoopa is acidic, highly coloured, of low salinity and the bicarbonate ion is absent. The chemistry of swamp water at Cowper Point is significantly different to that at Naracoopa being of neutral pH, colourless to light brown and with a high bicarbonate content. Water samples from

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the mouth of Blowhole Creek and the Frazer River indicate hydrologic connection to Sea Elephant Bay.

Refer to Appendix VII for the locations of surface water and groundwater tests and laboratory analysis of samples taken from those sites.



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BASEMENT CONTOURS
 HIGH DUNE DEPOSIT
 COWPER POINT

FIGURE 2.1

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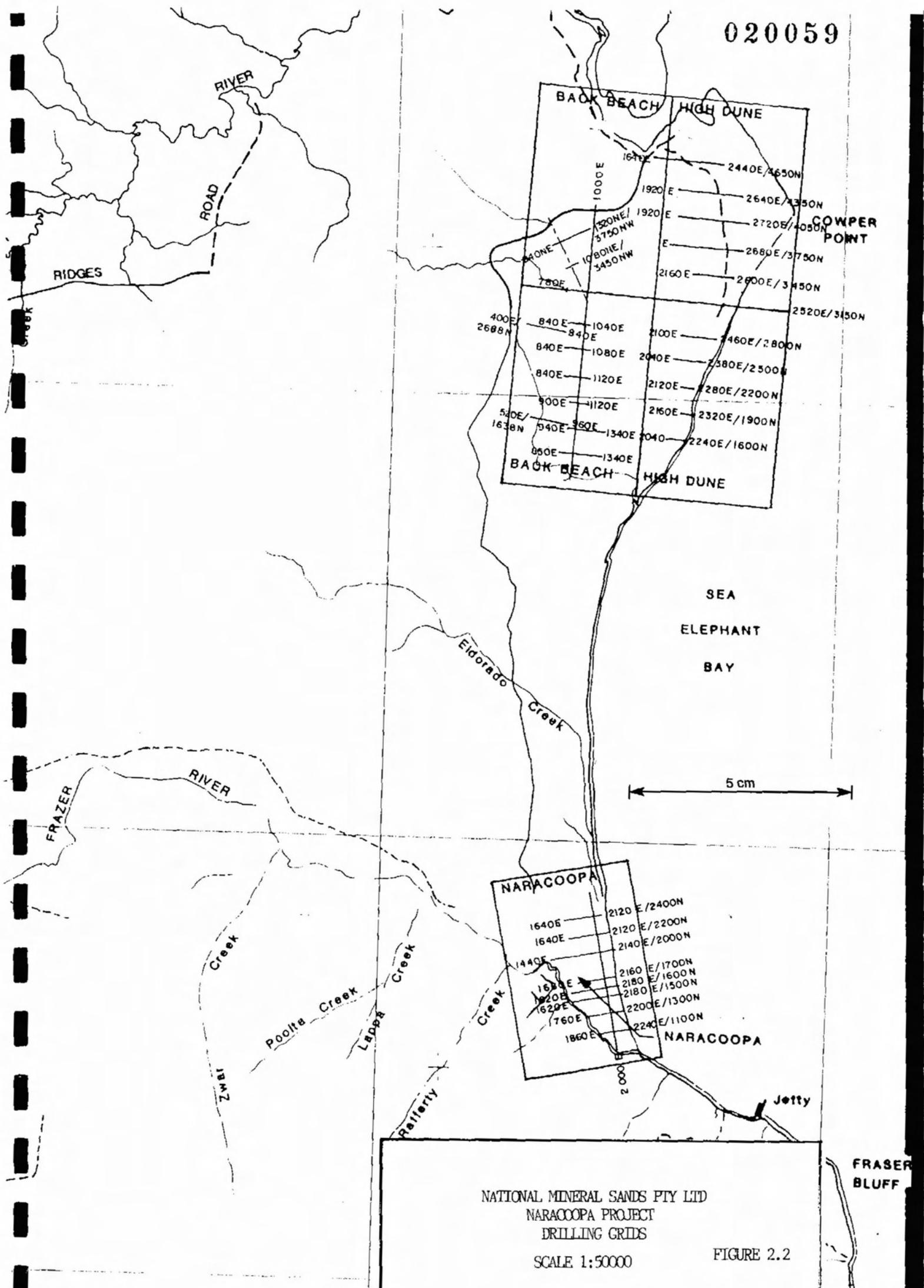


TABLE 2.1

RESOURCE SUMMARY

REVISED MAY 1989

RESOURCES STATED AS INDICATED EXCEPT FOR *BURIED HEAVY TAILINGS
AT 1.5% HEAVY MINERAL CUT-OFF

CATEGORY	IN-SITU CONTENT			TONNES				
	% H.M.	% R	% Z	SAND	H.M.	R	Z	Leu
<u>RAW SAND</u>								
LANHERNE BEACH	5.1	0.38	0.46	2,980,000	153,000	11,200	13,800	7,100
MILFORD BEACH	11.3	1.17	1.14	320,000	37,000	3,740	3,640	740
SEA BEACH	17.5	1.32	1.35	195,000	34,000	2,570	2,640	510
<u>SAND TAILINGS</u>	7.9	0.41	0.46	2,710,000	213,000	11,200	12,500	8,200
<u>HEAVY TAILINGS</u>								
ABOVE SURFACE	82.90	3.31	4.13	139,000	115,000	4,600	5,800	1,200
BURIED*	47.30	1.90	1.90	245,000*	116,000*	4,600*	4,600*	2,300*
TOTAL				6,589,000	668,000	37,910	42,980	20,050
ROUNDED TONNES				6,600,000	670,000	38,000	43,000	20,000

- * . Less certain that quantities stated are reliable since lateral extent is not known. Further drilling would be required to quantify this resource. This resource is stated as INFERRED.
- . It is possible that part of this resource is replaced by an equivalent quantity of sand tailings of an untested heavy mineral grade.

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TABLE 2.2

Revised May, 1989

RAW SAND - LANHERNE BEACH INDICATED RESOURCES AT 1.5% CUT-OFF

LINE	EXTENSION			t/m EXTENSION		% H.M.	MINERALOGY %			TONNES				
	North (m)	South (m)	Total (m)	Raw Sand	H.M.		Rutile	Zircon	Leucoxene	Sand	H.M.	Rutile	Zircon	Leucoxene
100N (180E-20E)	100	100	200	1,948	119	6.1	8	10	4	389,600	23,800	1,900	2,380	950
300N (140E-60W)	100	100	200	1,723	62	3.6	9	12	4	344,600	12,400	1,120	1,490	500
500N (120E-120W)	50	100	150	2,752	162	5.9	5.7	9.7	4	412,800	24,300	1,390	2,360	970
600N	-	-	-											
700N (120E-60E)	150	50	200	784	125	16.0	6	6	2	156,800	25,000	1,500	1,500	500
1000N (160W-540W) (60E-120W)	100	150	250	2,363 832	109 22	4.6 2.6	7 10	7 15	6 8	590,750 208,000	27,250 5,500	1,910 550	1,910 830	1,640 440
1200N (180W-340W)	100	100	200	1,392	61	4.4	8	9	5	287,400	12,200	980	1,100	610
1400N (240W-360W)	50	100	200	1,744	73	4.2	9	12	7	348,800	14,600	1,310	1,750	1,020
TIP ROAD (TR28-TR 50)	50	50	100	2,408	83	3.4	6	6	6	240,800	8,300	498	498	498
						5.1%	TOTAL TONNES			2,979,550	153,350	11,158	13,818	7,128
							TOTAL ROUNDED TONNES			2,980,000	153,000	11,200	13,800	7,100

020061

TABLE 2.3

MILFORD BEACH INDICATED RESOURCES AT 1.5% CUT-OFF

REVISED MAY 1989

LINE	EXTENSION			t/m EXTENSION		% H.M.	MINERALOGY %				TONNES					
	North (m)	South (m)	Total (m)	Raw Sand	H.M.		Rutile	Zircon	Leucoxene	Ilmenite	Sand	H.M.	Rutile	Zircon	Leucoxene	Ilmenite
100N	100	100	200	76.8	29.8	38.8	9	11	2	37	15,360	5,690	536	626	114	2,105
300N	100	100	200	73.6	23.6	32.1	9	11	2	37	14,720	4,720	425	519	94	1,746
500N	50	100	150	89.6	24.7	27.5	9	11	2	37	13,440	3,705	333	408	74	1,371
600N	-	-	-													
700N	-	-	-													
1000N	100	150	250	250	44.2	17.8	11	9	2	38	62,500	11,050	1,215	995	221	4,774
1200N	100	100	200	278	22.2	8.0	11	9	2	38	55,600	4,440	488	400	89	1,687
1400N	100	100	200	171	7.8	4.5	11	9	2	38	34,200	1,560	172	140	31	593
1600N	100	100	200	253	14.2	5.6	-	-	-	-	50,600	2,840	-	-	-	-
1800N	100	100	200	180	5.5	3.1	-	-	-	-	36,000	1,100	-	-	-	-
2000N	100	100	200	210	8.4	4.0	-	-	-	-	42,000	1,680	-	-	-	-
											324,420	36,785				
						11.3	TOTAL TONNES				320,000	37,000				
							TOTAL ROUNDED TONNES									

020062

TABLE 2.4

SEA BEACH INDICATED RESOURCES AT 1.5% CUT-OFF

REVISED MAY 1989

LINE	EXTENSION			t/m EXTENSION		% H.M.	MINERALOGY %				TONNES					
	North (m)	South (m)	Total (m)	Raw Sand	H.M.		Rutile	Zircon	Leucoxene	Ilmenite	Sand	H.M.	Rutile	Zircon	Leucoxene	Ilmenite
100N	100	100	200	93.6	46.7	49.9	8	8	1	33	18,700	9,340	747	747	93	3,080
300N	100	100	200	176.0	33.6	19.1	8	8	1	33	35,200	6,720	538	538	67	2,220
500N	50	100	150	92.8	22.2	23.9	7	6	2	32	13,900	3,330	233	200	66	1,070
600N	50	50	100	48.0	7.8	16.3	7	6	2	32	4,800	780	55	47	16	250
700N	150	50	200	94.4	20.7	21.9	7	6	2	32	18,900	4,140	290	248	82	1,320
1000N	100	150	250	70.4	13.6	19.4	7	9	2	29	17,600	3,400	238	306	68	990
1200N	100	100	200	70.4	10.8	15.3	7	9	2	29	14,100	1,980	139	178	40	570
1400N	100	100	200	112.0	12.2	10.9	7	9	2	29	22,400	2,440	171	220	49	710
1600N	100	100	200	122.0	5.6	4.6	-	-	-	-	24,400	1,120	-	-	-	-
1800N	100	100	200	64.0	2.3	3.5	-	-	-	-	12,800	460	-	-	-	-
2000N	100	100	200	64.0	2.4	3.7	-	-	-	-	12,800	480	-	-	-	-
						17.5	TOTAL TONNES				195,600	34,190				
							TOTAL ROUNDED TONNES				195,000	34,000				

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TABLE 2.5

SAND TAILINGS LANHERNE BEACH INDICATES RESOURCES AT 1.5% CUT-OFF

REVISED MAY 1989

LINE	EXTENSION			t/m EXTENSION		% H.M.	MINERALOGY %			TONNES				
	North (m)	South (m)	Total (m)	Raw Sand	H.M.		Rutile	Zircon	Leucoxene	Sand	H.M.	Rutile	Zircon	Leucoxene
100N (000-140W)	100	100	200	1,630	106	6.5	6	6	3	326,000	21,200	1,270	1,270	640
300N (80W-240W)	100	100	200	2,824	277	9.8	5	6	3	564,800	55,400	2,770	3,320	1,660
500N (220W-380W)	50	100	150	2,544	221	8.7	4.5	5	5	381,600	33,150	1,490	1,660	1,660
600N (140E-380W)	50	50	100	7,678	618	8.1	5.2	6	3.5	767,800	61,800	3,210	3,710	2,160
700N (80W-360W)	150	50	200	3,362	208	6.2	6	6	5	672,400	41,600	2,500	2,500	2,080
1000N														
1200N														
1400N														
TIP ROAD														
						7.9	TOTAL TONNES			2,712,600	213,150	11,240	12,460	8,200
							TOTAL ROUNDED TONNES			2,710,000	213,000	11,200	12,500	8,200

TABLE 2.6

HIGH DUNE - INDICATED RESOURCES AT 1.5% CUT-OFF.

McMAHON (1967)	N.M.S. (1989)	EXTENSION (m)			t/m	EXTENSION		H.M. %	MINERALOGY			TONNES				
		Nth	Sth	Total		Raw Sand	H.M.		Rutile	Zircon	Leu.	Sand	H.M.	Rutile	Zircon	Leu.
160N		VARIABLE						2.28	(5)	(5)	(5)	192 528	4 390	220	220	220
	4650N	VARIABLE						2.56	5	5	5	1 535 488	39 308	1 965	1 965	1 965
150N		VARIABLE						2.32	(5)	(5)	(5)	306 248	7 105	355	355	355
	4350N	VARIABLE						2.95	4.5	5	5	1 226 240	36 174	1 628	1 809	1 809
140N		VARIABLE						3.33	(5.5)	(6)	(5)	559 864	18 643	1 025	1 119	932
	4050N	VARIABLE						3.41	6.5	7.5	5	1 726 741	58 882	3 827	4 416	2 944
130N		VARIABLE						3.25	(6.5)	(7.5)	(5.5)	1 191 672	38 729	2 517	2 905	2 130
120NC		90	58	148	5 500	178		3.23	(6.5)	(7.5)	(5.5)	814 000	26 292	1 709	1 972	1 446
	3750N	58	90	148	11 875	445		3.74	6.5	8	6	1 757 500	65 731	4 273	5 258	3 944
120NB		90	65	155	8 602	310		3.60	7	10	6	1 333 310	47 999	3 360	4 800	2 880
	3450N	65	90	155	5 660	213		3.76	6.5	8.5	6.5	877 300	32 986	2 144	2 804	2 144
120NA		90	58	148	4 267	162		3.80	(6.5)	(8)	(7)	631 516	23 998	1 560	1 920	1 680
	3150N	58	100	158	6 611	182		2.76	6.5	8	7.5	1 044 538	28 829	1 874	2 306	2 162
120N		100	75	175	5 467	164		3.00	5	8	9	956 725	28 702	1 435	2 296	2 583
	2800N	75	75	150	5 066	127		2.51	7	8	7	759 900	19 073	1 335	1 524	1 335
110N		75	75	150	3 317	90		2.70	(7.5)	(9)	(6)	497 550	13 434	1 008	1 209	806
	2500N	75	80	155	2 899	81		2.78	8	10	5	449 345	12 492	999	1 249	625
100N		80	70	150	1 800	36		2.00	(6.5)	(7.5)	(5.5)	270 000	5 400	351	405	297
	2200N	70	88	158	984	20		2.00	5	5	6	155 472	3 109	155	155	187
90N		88	65	153	758	17		2.30	(5)	(5)	(6)	115 974	2 667	133	133	160
		Average Grade:			3.1				TOTAL TONNES			16 401 911	513 943	31 873	38 820	30 604
									TOTAL ROUNDED TONNES			16 000 000	510 000	32 000	39 000	31 000

(6.5) Assumed Mineralogy on the Basis of Adjacent N.M.S. Mineralogy.

TABLE 2.7

BACK BEACH - INDICATED RESOURCES AT 1.5% CUT-OFF.

McMAHON (1967)	N.M.S. (1989)	EXTENSION (m)			t/m EXTENSION		H.M. %	MINERALOGY			TONNES				
		Nth	Sth	Total	Raw Sand	H.M.		Rutile	Zircon	Leu.	Sand	H.M.	Rutile	Zircon	Leu.
	3750NW	-	150	150	728	23	3.20	2	2	2	109 200	3 494	70	70	70
	3450NW	150	122	272	352	9	2.43	8	12	4	95 744	2 327	186	279	93
	3150N	122	98	220	552	23	4.10	6	10	4	121 440	4 979	299	498	199
120N		98	80	178	202	5	2.67	8	12	12	35 956	960	77	115	115
	2800N	80	70	150	680	60	8.84	7	10	2	102 000	9 017	631	902	180
110N		70	85	155	754	31	4.09	(6.5)	(9.5)	(2.5)	116 870	4 780	311	454	120
	2500N	85	75	160	582	35	6.05	6	9	3	93 120	5 634	338	507	169
100N		75	78	153	595	26	4.42	(6.5)	(10)	(3.5)	91 035	4 024	262	402	141
	2200N	78	78	156	2 272	141	6.20	7.5	11	4	354 432	21 975	1 648	2 417	879
90N		78	75	153	154	20	13.34	(7.5)	(11)	(4)	23 562	3 143	236	346	126
	1900N	75	75	150	1 296	86	6.60	8	11	4	194 400	12 830	1 026	1 411	513
80N		75	70	145	906	91	10.00	10	14	8	131 370	13 137	1 314	1 839	1 051
	1600N	70	78	148	1 430	47	3.32	9	16	5	211 640	7 026	632	1 124	351
70N		78	65	143	943	35	3.74	(8.5)	(17)	(5)	134 849	5 043	429	857	252
	1325N	65	150	215	1 565	53	3.41	8	18	5	336 475	11 474	918	2 065	573
Average Grade							5.1	TOTAL TONNES			2 152 093	109 843	8 377	13 286	4 832
TOTAL ROUNDED TONNES AFTER OVERSIZE CORRECTION											2 200 000	110 000	8 200	13 000	4 700

(6.5) Assumed Mineralogy on the Basis of Adjacent N.M.S. Mineralogy.

TABLE 2.3
HIGH DUNE RESOURCE ESTIMATES AT 1.5% CUT-OFF

Block	GEOPEKO COMPUTER CALCULATED RESOURCE ESTIMATE							MANUAL CALCULATION Report 11/89	
	Indicated Resources Within NMS & McMahon Drilled Sections Topographically Corrected			Inferred Resources Below McMahon's Resource Blocks		Total		Indicated NMS & McMahon Data	
	Tonnes of Sand	Grade	Tonnes of H.M.	Tonnes of Sand	Tonnes of H.M.	Sand Tonnes	H.M. Tonnes	Sand Tonnes	H.M. Tonnes
90N	60,557	2.30	1,393	62,520	1,438	123,077	2,831	115,974	2,667
2200N	172,520	2.00	3,450			172,520	3,450	155,472	3,109
100N	325,115	2.00	6,502	0 (-57,042)	0 (-1,141)	325,115	6,502	270,000	5,400
2500N	405,859	2.78	11,283			405,859	11,283	449,345	12,492
110N	531,914	2.70	14,362	0 (-42,650)	0 (-1,152)	531,914	14,362	497,550	13,434
2800N	865,712	2.51	21,729			865,712	21,729	759,900	19,073
120N	809,491	2.75	22,261	198,181	5,450	1,007,672	27,711	956,725	28,702
3150N	1,268,986	2.76	35,024			1,268,986	35,024	1,044,538	28,829
120NA	827,763	3.80	31,455	56,178	2,135	883,941	33,590	631,516	23,998
3450N	1,051,742	3.76	39,546			1,051,742	39,546	877,300	32,986
120NB	1,315,534	3.60	47,359	196,803	7,085	1,512,337	54,444	1,333,310	47,999
3750N	1,715,584	3.74	64,163			1,715,584	64,163	1,757,400	65,731
120NC	1,066,211	3.23	34,439	0 (-146,278)	0 (-4,725)	1,066,211	34,439	814,000	26,292
130N	998,062	3.25	32,437	464,242	15,088	1,462,304	47,525	1,191,672	38,729
4050N	2,106,739	3.41	71,840			2,106,739	71,840	1,726,741	58,882
140N	647,794	3.33	21,572	366,424	12,202	1,014,218	33,774	559,864	18,643
4350N	1,438,011	2.95	42,421			1,438,011	42,421	1,226,240	36,174
150N	252,093	3.32	5,849	229,291	7,612	481,384	13,461	306,248	7,105
4650N	1,395,930	2.56	35,736			1,395,930	35,736	1,535,488	39,308
160N	198,112	2.28	4,517	118,206	2,695	316,318	7,212	192,529	4,390
Total	17,454,000	3.14	547,337	1,691,845 (1,445,875)	53,705 (46,687)	19,145,845 (18,899,875)	601,062 (594,024)	16,401,911	513,943

(-47,042) - negative values generated by using Surpac Mining System

TABLE 2.9

NARACOOPA - INDICATED RESERVES AT 2.5% CUT-OFF

CATEGORY	IN-SITU CONTENT	TONNES			
	% HM	SAND	H.M.	RUTILE	ZIRCON
RAW SAND					
LANHERNE BEACH	6.6	2 000 000	131 000	9 400	11 600
MILFORD BEACH	15.9	196 000	31 000	3 200	3 100
SEA BEACH	22.10	146 000	32 000	2 400	2 500
SAND TAILINGS	8.2	2 600 000	212 000	11 000	12 500
HEAVY TAILINGS					
ABOVE SURFACE	82.90	139 000	115 000	4 600	5 800
BURIED*	47.30	245 000*	116 000*	4 600*	4 600*
TOTAL		5 326 000	637 000	35 300	40 000
ROUNDED TOTAL		5 300 000	640 000	35 000	40 000

* . Less certain that quantities stated are reliable since lateral extent is not known. Further drilling would be required to quantify this reserve. This reserve is stated as Inferred.

. It is possible that part of this reserve is replaced by an equivalent quantity of sand tailings of an untested heavy mineral grade.

TABLE 2.10

HIGH DUNE - INDICATED RESOURCES AT 2.5% CUT-OFF.

McMAHON (1967)	N.M.S. (1989)	EXTENSION (m)			t/m	EXTENSION Raw Sand	H.M. H.M.	H.M. %	MINERALOGY			TONNES				
		Nth	Stn	Total					Rutile	Zircon	Leu.	Sand	H.M.	Rutile	Zircon	Leu.
160N		VARIABLE						3.58	(5)	(5)	(5)	47 160	1 688	84	84	84
	4650N	VARIABLE						2.81	5	5	5	934 720	26 266	1 313	1 313	1 313
150N		VARIABLE						2.80	(5)	(5)	(5)	47 520	1 331	67	67	67
	4350N	VARIABLE						3.30	4.5	5	5	870 240	28 716	1 292	1 436	1 436
140N		VARIABLE						3.77	(5.5)	(6)	(5)	430 152	16 217	891	973	811
	4050N	VARIABLE						4.81	6.5	7.5	5	959 840	46 168	3 001	3 463	2 308
130N		VARIABLE						4.39	(6.5)	(7.5)	(5.5)	627 216	27 535	1 790	2 065	1 514
120NC		90	58	148	2 688	134		4.99	(6.5)	(7.5)	(5.5)	397 824	19 832	1 289	1 487	1 091
	3750N	58	90	148	7 456	361		4.93	6.5	8	6	1 103 488	53 428	3 473	4 274	3 205
120NB		90	65	155	5 040	232		4.60	7	10	6	781 200	35 960	2 475	3 596	2 122
	3450N	65	90	155	3 472	163		4.70	6.5	8.5	6.5	538 160	25 265	1 642	2 148	1 642
120NA		90	58	148	3 581	150		4.19	(6.5)	(8)	(7)	529 988	22 200	1 443	1 776	1 554
	3150N	58	100	158	2 688	99		3.68	6.5	8	7.5	424 704	15 642	1 017	1 251	1 173
120N		100	75	175	2 630	95		3.61	5	8	9	460 250	16 625	831	1 330	1 496
	2800N	75	75	150	704	20		2.84	7	8	7	105 600	3 000	210	240	210
110N		75	75	150	1 498	61		4.07	(7.5)	(9)	(6)	224 700	9 150	686	824	549
	2500N	75	80	155	960	33		3.44	8	10	5	148 800	5 115	409	512	256
100N		80	70	150	513	17		3.31	(6.5)	(7.5)	(5.5)	76 950	2 550	166	191	140
	2200N	70	88	158	432	12		2.78	5	5	6	68 256	1 896	95	95	114
90N		88	65	153	216	7		3.24	(5)	(5)	(6)	33 048	1 071	54	54	64
Average Grade:								4.08	TOTAL TONNES			8 809 816	359 657	22 228	27 179	21 149
									TOTAL ROUNDED TONNES			8 800 000	360 000	22 000	27 000	21 000

(6.5) Assumed Mineralogy on the Basis of Adjacent N.M.S. Mineralogy.

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TABLE 2.11

BACK BEACH - INDICATED RESOURCES AT 2.5% CUT-OFF.

McMAHON (1967)	N.M.S. (1989)	EXTENSION (m)			t/m	EXTENSION	H.M. %	MINERALOGY			TONNES					
		Nth	Sth	Total	Raw Sand	H.M.		Rutile	Zircon	Leu.	Sand	H.M.	Rutile	Zircon	Leu.	
	3750NW	-	150	150	272	11	4.04	2	2	2	40 800	1 650	33	33	33	
	3450NW	150	122	272	144	5	3.47	8	12	4	39 168	1 360	109	163	54	
	3150N	122	98	220	384	20	5.21	6	10	4	84 480	4 400	264	440	176	
120N		98	80	178	130	4	3.08	8	12	12	23 140	712	57	85	85	
	2800N	80	70	150	440	55	12.50	7	10	2	66 000	8 250	578	825	165	
110N		70	85	155	235	22	9.36	(6.5)	(9.5)	(2.5)	36 425	3 410	222	324	85	
	2500N	85	75	160	248	28	11.29	6	9	3	39 680	4 480	269	403	134	
100N		75	78	153	317	21	6.62	(6.5)	(10)	(3.5)	48 501	3 213	209	321	112	
	2200N	78	78	156	2 272	141	6.20	7.5	11	4	354 432	21 996	1 650	2 420	880	
90N		78	75	153	154	20	13.00	(7.5)	(11)	(4)	23 562	3 060	230	337	122	
	1900N	75	75	150	704	75	10.65	8	11	4	105 600	11 250	900	1 238	450	
80N		75	70	145	504	75	14.88	10	14	8	73 080	10 875	1 088	1 523	870	
	1600N	70	78	148	473	26	5.50	9	16	5	70 004	3 848	346	616	192	
70N		78	65	143	324	13	4.01	(8.5)	(17)	(5)	46 332	1 859	158	316	93	
	1325N	65	150	215	970	41	4.23	8	18	5	208 550	8 815	705	1 587	441	
		Average Grade			7.08	TOTAL TONNES			1 259 754	89 175	6 818	10 628	3 892			
		TOTAL ROUNDED TONNES			AFTER OVERSIZE CORRECTION			1 200 000	87 000	6 800	10 000	3 800				

(6.5) Assumed Mineralogy on the Basis of Adjacent N.M.S. Mineralogy.

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SECTION 3.0

MINING

- 3.1 PRODUCTION PARAMETERS
- 3.2 PRODUCTION PROGRAMME
- 3.3 MINING METHOD
- 3.4 SURFACE PREPARATION AND REHABILITATION
- 3.5 SUPPLEMENTARY MINING OPERATIONS
- 3.6 ASSOCIATED WORKS
- 3.7 MINING EQUIPMENT
- 3.8 MINE PLANNING
- 3.9 ANCILLARY AND MAINTENANCE EQUIPMENT

SECTION 3.0 - MINING

1

3.1 PRODUCTION PARAMETERS

The Heavy Mineral Sand resources are located at two areas, Naracoopa and Cowper Point, which are approximately 11 km apart. Precise geographical locations are given elsewhere.

NARACOOPA DEPOSITS

NARACOOPA WEST

The Naracoopa West deposit consists of raw sand and gravity tailings from the previous mining operation. In the southern half these tailings overlay indurated raw sand unmined, while in the north end there is solely raw sand which consists of sand over laying and inter-layered with very hard severely indurated sand.

Also placed on and within the above mentioned tailings is a dump of Heavy Mineral (magnetic) tailings from the old Dry Mill.

NARACOOPA EAST

The Naracoopa East deposit consists of a frontal berm and tidal beach deposit of high grade, the berm part of which is on and within indurated material.

COWPER POINT DEPOSITS

At Cowper Point there are two distinct and different types of resource:

COWPER POINT WEST

The Cowper Point West deposit is a narrow strand deposit approximately 1.5 km inland. This deposit is shallow and generally consists of a top layer of clean sand overlaying extremely hard indurated sand.

COWPER POINT EAST

The Cowper Point East deposit is a free sand dune deposit which is lower grade than the other deposits but much larger. An area has been delineated in this deposit at a higher cutoff which upgrades it but reduces its size. A dredgeability study was made on the total deposit at the lower cutoff. It is reasonable to assume, by reference to plan and sections, that the reduced area of higher cutoff will be mineable.

SECTION 3.0 - MINING

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A summary of mineral resources and probable ore reserves is presented in Table 3.1.

MINING PLAN AND METHOD

A mining plan was developed commencing at a target production of from 20,000 t to 30,000 t of combined Rutile and Zircon per year. However the low VHM:HM ratio required optimisation of plant size and services required.

A rang of operational sizes were investigated with regard to mining method and sand extraction rates. The rates considered were

150tph 300tph 450tph and 600tph mining throughput rate.

The concept of a 450tph plant upgradable to 600tph in Cowper Point East was considered as the best practical combination.

The availability of make up water from groundwater sources is a major constraint to the scale of mining and processing.

The base unit of 450tph will be sustainable from local aquifers but the matter of upgrading to 600tph at Cowper Point East will to be deferred until later in the life of the operation after experience in the operating environment.

Therefore the mining production, programme is based on a maximum sand extraction rate of 450 tph and the probable ore reserves as shown in Table 3.1 .

3.2 PRODUCTION PROGRAMME

A production programme has been drawn up for the life of the operation using mining methods described later in this section.

The production schedule has been annualised and is shown in Table 3.2.

The production schedule is based on an optimised mining sequence.

For the Naracoopa deposits the dredge will mine in longitudinal runs in the Western deposit and its feed will be supplemented by mechanically excavated material from the Eastern deposit.

The heavy mineral stockpile centred on line 500N will be dispersed by spreading with a dozer north and south to lines 700N and 300N respectively.

TABLE 3.1
SUMMARY
RESOURCES AND PROBABLE RESERVES

DEPOSIT	MINERAL RESOURCES @ 1.5% H.M. COG					MINERAL RESOURCES @ 2.5% H.M. COG					PROBABLE RESERVES				
	SAND	HM	R	Z	L	SAND	HM	R	Z	L	SAND	HM	R	Z	L
Naracoopa East	515,000	71,000	6,310	6,280	1,250	342,000	63,000	5,600	5,600		498,100	59,650	4,530	4,790	7,130
Naracoopa West *	5,935,000	482,000	27,000	30,900	17,600	4,845,000	459,000	25,000	28,700		4,667,000	335,800	18,880	21,540	5,190
Surf Mag Tailings	139,000	115,000	4,600	5,800	1,200	139,000	115,000	4,600	5,800		135,000	114,560	4,590	5,670	
Sub TOTAL	6,589,000	668,000	37,910	42,980	20,050	5,326,000	637,000	35,200	40,100		5,300,000	510,000	28,000	32,000	12,300
Cowper Point East (Corrected) †	16,000,000	510,000	32,000	39,000	31,000	8,800,000	360,000	22,000	27,000	21,000	9,500,000	386,000	23,900	29,200	22,900
Cowper Point East	2,200,000	110,000	8,200	13,000	4,700	1,200,000	87,000	6,800	10,000	3,800	2,000,000	117,000	8,600	13,800	5,000
Sub TOTAL (Corrected)	18,200,000	620,000	40,200	52,000	35,700	10,000,000	447,000	28,800	37,000	24,800	11,500,000	503,000	32,000	43,000	27,900
TOTAL (Corrected)	24,789,000	1,288,000	78,110	94,980	55,750	15,326,000	1,084,000	64,000	77,100	24,800	16,800,000	1,013,000	60,500	75,000	40,400

NOTES: * Includes buried magnetic tailings.
† Corrected for topography; includes "Inferred" Resources.

TABLE 3.2

PRODUCTION OF MINERAL COMPONENTS TO WET CONCENTRATOR
 MAXIMUM DREDGE THROUGHPUT RATE OF 450 TPH - 7425Hr/Yr

	Sand mt Mined	HM mt In Grnd	HM mt 90% REC 95%y 4-6	RUT mt In Grnd	RUT mt 90% REC 95%y 4-6	ZIR mt In Grnd	ZIR mt 90% REC 95%y 4-6	LEU mt In Grnd	LEU mt 90% REC 95%y 4-6
YEAR 1 YR TOTAL	2650000	255000	230000	14000	12600	16294	14664	7135	6421
YEAR 2 YR TOTAL	2650000	255000	230000	14000	12600	15700	14130	5190	4671
NARACOOPA TOTAL	5300000	510000	459000	28000	25200	32000	28800	12300	11100
YEAR 3 YR TOTAL	1900000	117000	105500	8630	7770	13800	12400	5100	4600
YEAR 4 YR TOTAL	3300000	134100	127400	8300	7900	10150	9600	8000	7600
YEAR 5 YR TOTAL	3300000	134100	127400	8300	7900	10150	9600	8000	7600
YEAR 6 YR TOTAL	2900000	118000	112000	7300	6900	8900	6900	7000	6600
COWPER POINT TOTAL	11500000	503000	478000	32500	30600	43000	38900	28100	26400
GRAND TOTAL	16800000	1013000	937000	60500	55800	75000	69600	40400	37500

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The production life estimated for this operation is almost two years. Following the completion of this mining operation the plant will be partly dismantled and relocated to the Cowper Point West deposit, reassembled and recommissioned over a period of ten weeks.

The life of the operation in the Cowper Point West deposit will be approximately 45 weeks and it is proposed that the plant would dredge its way eastward by a minimal canal type of cut across the low heath to the Cowper Point east deposit and commence full production mining after approximately seven weeks.

The life of the operation in Cowper Point East is calculated to be 2.8 years.

3.3 MINING METHOD

The selection of a mining unit consisting of a dredge and floating concentrator resulted from the mining rate vs operating/capital cost comparison. The diesel powered dredge is designed to mine both free sand and indurated sand using a 300kw variable High Speed Cutter wheel. This system is proven in indurated heavy mineral sand deposits, however it is still under development with productivity improvements still being achieved. The dredge is a separate unit able to move independently by winch lines and spuds. The main pump proposed is a Warman 18/16 GG gravel pump. The apparent large sizing of the pump is due to the low pulp density (15-20% solids w/w) attained in indurated conditions. The dredge is fitted with a single main diesel engine with direct drive to the pump and hydraulic supply to the cutter.

The material mined by the dredge is pumped via a flexible 400mm sand mining hose on a 60 m articulated pontoon line to a floating wet gravity concentrator which is stationary in the dredge pond.

The wet concentrator will extract the heavy minerals and the tailings reject will be pumped off the rear of the concentrator thus providing infill of the dredged excavation as the dredging face advances.

The concentrate produced by the concentrator will be pumped ashore to a mobile stockpile dewatering facility from where it will be trucked to the Dry Mill for separation of the various mineral components.

The description of the mining operation also involves reference to a floating concentrator unit. The scope of this section does not involve metallurgical considerations so the two units floating in the pond should be referred to herein as a system and the operation of mining involves the

SECTION 3.0 - MINING

control and direction of both units together called the "Mining Plant."

The operation will also include the surface preparation prior to mining and the management of tailings placement, reshaping and consequent surface rehabilitation.

The dredge and floating concentrator combination has been selected as the most manageable and cost effective mining method. Minimal surface area environmental disturbance and the shortest time from topsoil stripping to replacement of topsoil and commencement of regrowth will be a result of its use.

The arrangement of the Mining Plant and its pond is shown in Figure No. 3.1. The diagram shows a general layout of the mining activities and although it indicates electrical cables the basis for this study is a diesel powered Mining Plant.

The concentrate will be pumped to a concentrate stockpile and dewatering unit. The concentrate will be trucked to the Dry Mill and excess water returned to the pond. Gravel roads will be constructed to provide access to these sites for haulage vehicles, maintenance vehicles and employees.

When spur roads are no longer needed the road base will be lifted and reused for further extensions as necessary.

As the Mining Plant progresses, the shore point of the line of articulated pontoons ("Plant Service Line") will be moved accordingly. This line carries the concentrate delivery line, clear make up water supply line and provides walk-on access for personnel.

The concentrator unit will be held in place by winch ropes connected to anchors on the bank and will be moved as required by progress of the dredge unit. The tailings from the concentrator unit will be discharged by boom mounted pipe lines which can be directed to left or right, up or down to facilitate the placement of the tailings and to minimise the spreading required after draining and before replacement of topsoil. Movement of the concentrator across the pond will be necessary to assist this process.

The mining operation will work on a continuous 7 day x 24 hour basis. The support services will work on a 5 day x 8 hour day shift basis.

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3.4 SURFACE PREPARATION AND REHABILITATION

The technical ecological details are discussed in Section 7.0 however the actual performance of mining operations includes the co-ordination of activities set down in the overall rehabilitation programme and are included here to show the activities as part of the mining operation.

The mining operation will commence with the clearing of the land surface by dozer and stripping the topsoil to a depth of approximately 250mm and stockpiling it at the side of the dredge path. As the dredge mines through the cleared and stripped area the dozer will be used to reshape the surface of the tailings after drainage and to spread the topsoil and vegetable material over the reshaped area.

After this, rehabilitation work will begin with activities such as fertilising, planting of hybrid cover crops, brush matting or fencing. Other activities on older areas will include planting out of young trees from nursery stock. The nursery, located at the Dry Plant, will be kept supplied with seed stock harvested from the area to be mined or neighbouring similar areas.

Pre-mining botanical surveys record species originally present and their density. Follow-up surveys will be made of the rehabilitated area to monitor the return of the various species and the rehabilitation crew will take remedial action as necessary. Follow-up is an on-going process of maintenance, repair and supplementation over a number of years.

Pre-mining topographical surveys will assist in reshaping the tailings to land forms similar to those originally existing prior to the return of the topsoil.

3.5 SUPPLEMENTARY MINING OPERATIONS

At Naracoopa East, the high grade material occurs as part of a frontal berm and also forms the tidal beach. This area is therefore subject to the hazards of the sea. There is a further complication in that the berm is held in place by induration and the mineralisation occurs on top of it and in pockets within it.

The mining of this zone will be carried out by mobile mechanical excavator and articulated dump trucks which will be suitably deployed on the site according to tide and weather conditions. The material will be transported in dump trucks to the Western deposit dredge path where it will form part of the feed to the Mining Plant.

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Tailings will be pumped to this area from the concentrator using an overland pipeline to a dewatering cyclone. Overflow water will be returned to the groundwater collection system.

Rehabilitation work will also be required on this area as previously described in 3.4 with possible modifications to stripping as conditions determine.

A 25 tonne track mounted hydraulic excavator is proposed for this operation with two 24 tonne ADT vehicles on a 5 day daylight basis.

3.6 ASSOCIATED WORKS

Works associated with the mining operation include provision of the three principal services as follows:

- . Haulage, access and service roads
- . Water supply management
- . Maintenance of the Mining Plant

The necessity for roads has been mentioned above under section 3.3. These roads should be of minimal construction but of sufficient width and pavement strength to carry tip trucks loaded with mineral to legal axle loading. Usually a width of 4 m and thickness of 250 mm compacted is satisfactory. Suitable turning and passing bays will be necessary at the concentrate loading sites. Spur roads will be required to service the planned operation which will involve parallel path mining. This will be discussed under Mine Planning. These roads will be constructed by simply tipping suitable gravel and spreading by dozer ahead on the pre-planned marked alignment. The construction of roads will be advanced by the distance to each Concentrate Stockpile site which will be approximately 450m.

Water supply management operations will include rerouting delivery lines and the facilities at the bank of the pond according to the advance of the Mining Plant. There may be water recovery bores in the tailings which require attendance and periodic relocation.

Maintenance of the Mining Plant will require careful planning to achieve high operating efficiency.

A comprehensive maintenance section will be required for this operation.

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3.7 MINING EQUIPMENT

The equipment employed in addition to the Mining Plant will comprise 1 x D8 size dozer servicing this mining plant for stripping, tailings reshaping and topsoil spreading. Other duties will include positioning the plant units and maintenance.

1 x Cat 926 (1.7m³ bucket) for loading concentrates from the stockpile and for use as a carrier of equipment and parts over sandy surfaces to the mining plant and other uses at the Dry Plant.

1 x Cat EL 240 Track mounted hydraulic excavator for the mining operation at Naracoopa East.

2 x Cat D250B Articulated Dump Trucks for transporting ore and tailings between Naracoopa East and West mining sites.

These will also be used for the transport of concentrates from the mine stockpile to the Dry.

This equipment will be taken on hire from a reliable Heavy Equipment operating firm and has been taken into the costs at calculated hire rates.

3.8 MINE PLANNING

The mine planning process begins with the derivation of a feasible production programme as described previously. It can become complicated when the scheduling of production is matched to the physical size of both the dredge pond and the ore bodies.

The first consideration is the starting and finishing points of the dredging of each orebody. The starting point at Naracoopa has been chosen because it is virtually a ready made dredge pond which will require virtually no pre-excavation except that a bund wall will have to be pushed up to the east of the embayment to complete a pond after construction. The site is shown on the Naracoopa Preliminary Plan and in the photographs "view North from 1200N" and "view south from 1300N."

The dredging sequence is also shown and it is important to minimise the number of turns. The width of the Naracoopa orebody is approximately three ponds wide except for the wider area in the vicinity of lines 500 and 600N. To accommodate this, the pattern has been aligned so as to allow 5 ponds to be fitted obliquely across it. The longer the runs the more stable is the operation. The general pond



VIEW SOUTH FROM 1300N



VIEW NORTH FROM 1200N

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layout drawing shows an approximate pond width of 80m. This can be varied gradually without too much of a mass balance problem with respect to tailings levels. Sharp turns create such problems and will be minimised.

The object of the Naracoopa plan is to finish at the north end to facilitate dismantling the plant prior to relocation to Cowper Point West. There will be a hole remaining at the final pond site and the pond should be gradually reduced to minimise this effect. It can be filled or partly filled by bringing tailings forward and using fill from the surrounding area. There will be a depression remaining of a magnitude depending on the forward planning during the operation.

During the operation, access roads will be brought to the pond at required intervals. These spur roads will be mined through eventually and will usually be lifted and the gravel reused. Examples of the spur road system are given on the Naracoopa plan. These roads will be placed over the unmined ground rather than cross rehabilitated tailings.

At Cowper Point West, the plan is to commence at the southern end of this deposit. Therefore the road will have to be constructed over its full length close to the ore body. As the ore body is narrow, there will be no need for spur roads. The digging of this hole will have to be planned to allow for the fact that there will be an excess of sand to be dispersed over the surrounding surface without creating a large unsightly mound. Careful placement ahead of the dredging will mitigate the effect, as the volume is reduced by extraction of high grade mineral and mass balance stability is reached after a few months operation.

At the northern end, it is planned to leave the orebody via a canal style relocation across the low swamp to the Cowper Point East ore body.

Figure 3.3 shows the Cowper Point mine plan concept.

Mining in the Cowper Point East area is planned to commence in the low area. This is the reason for commencing at the southern end of Cowper Point West and mining north a) to leave the area via the canal with no residual depression and b) to commence in the lowest part of Cowper Point East so as not to create an excess of sand on the swamp at a point of commencement in high ground. This approach will allow gradual alteration of the area mined.

The diagram shows a series of dredge paths and the direction of dredging required. This allows the plant to finish its operation in low ground after mining high ground which will provide a supply of sand for filling the dredge pond after removal of the equipment.

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Roads are also shown on the plan. This system will keep the operation isolated from the Sea Elephant River.

In the case of diesel powered plants, the logistics are essentially the same except that a mobile tank will deliver fuel to a filling point on the bank from where fuel is pumped aboard the concentrator or dredge. The fuel supplier delivers to storage tanks accessible to normal road tankers and the operator shuttles fuel to the bank daily on a unit towed by dozer. It should not be necessary to construct roads for the sole purpose of delivering fuel by road vehicle to the pond bank.

The mine planning involves technical input, layout work, control drilling, weekly surveying of mining progress and comparison of production against planning to enable accurate forecasting once the operation is established.

3.9 ANCILLARY AND MAINTENANCE EQUIPMENT

Ancillary mining equipment has been described under Mining Equipment 3.7.

Maintenance equipment will be required for

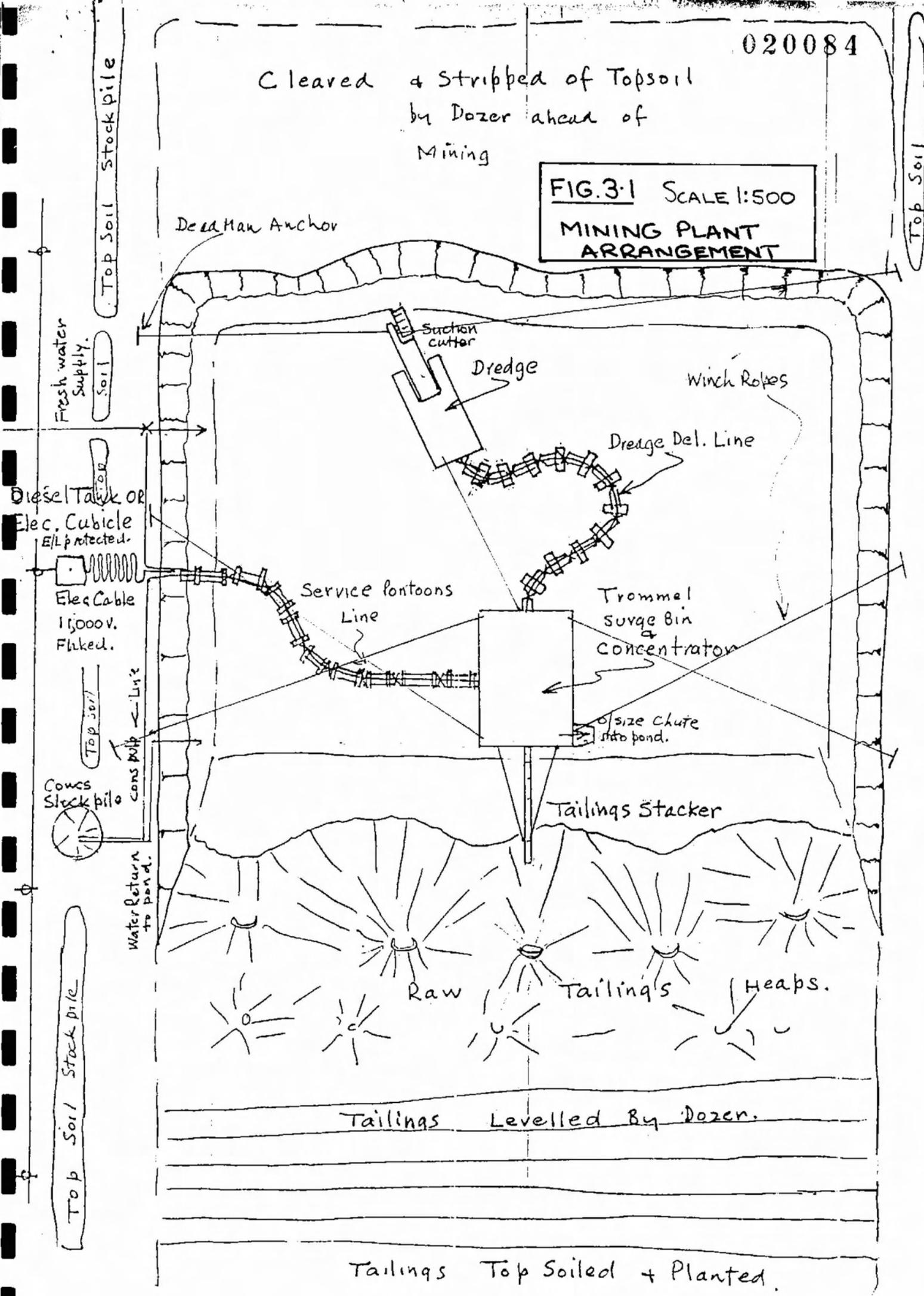
- * the replacement of adapters and teeth on the cutter wheel.
- * replacement of wearing parts of the Dredge pump.
- * repairs and fitting of heavy bearing assemblies.
- * high quality hydraulic repair work and replacement of high pressure hoses (the equipment powering the HSC cutter is very high pressure) and
- * general metal working maintenance welding, corrosion protection, surface coating and cleaning.

Heavy lift operations of components up to 3 tonnes on board and from plant to shore will be required.

This work will be handled by crawl beams and chain hoists. The use of a crane would be required to transfer these pieces ashore and vice versa. A track mounted crane or hydraulic excavator would be suitable. The dredge would have to be brought to the bank to allow a workable reach. In some cases the dozer will be required to cut a ramp down to a platform at water level for heavy lift transfers and maintenance work on the dredge cutter and ladder.

Cleared & Stripped of Topsoil
by Dozer ahead of
Mining

FIG. 3.1 SCALE 1:500
MINING PLANT
ARRANGEMENT



Dead Man Anchor

Suction cutter
Dredge

Winch Ropes

Dredge Del. Line

Diesel Tank OR
Elec. Cubicle
E/L protected.

Service pontoons
Line

Trommel
surge Bin
&
Concentrator

o/size chute
into pond.

Tailings Stacker

Raw

Tailings

Heaps.

Tailings Levelled By Dozer.

Tailings Top Soiled + Planted.

Top Soil Stockpile

Fresh water
Supply.
Soil

Soil

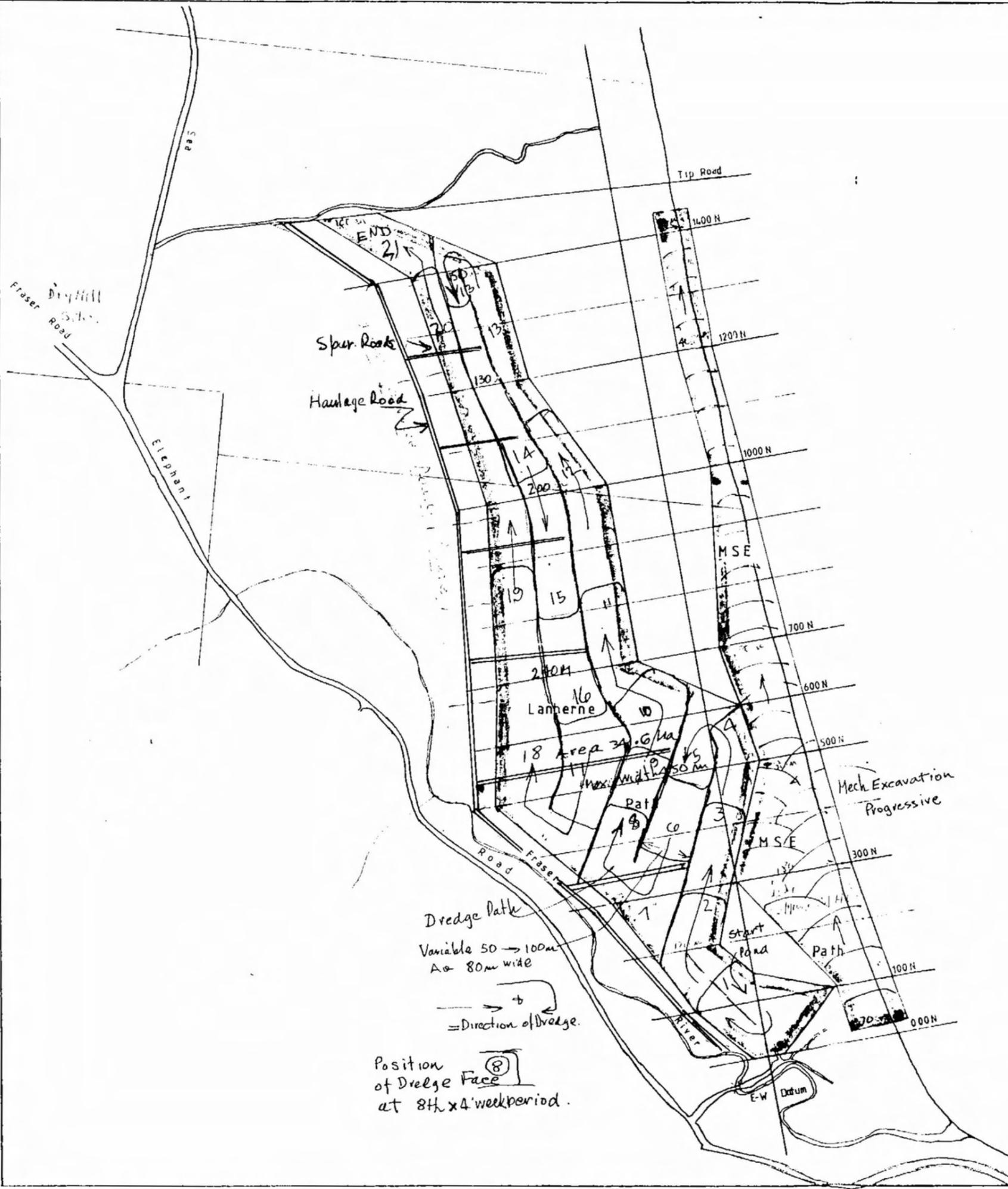
Top soil

Cows
Stockpile

Water Return
to pond.

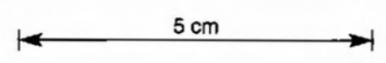
Top Soil Stockpile

Top Soil



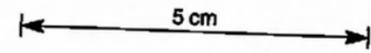
Bass

Strait



PRELIMINARY

ITEM	DESCRIPTION	REQ'D	MATERIAL	REMARKS	
NATIONAL MINERAL SANDS		SCALE		PASSED	DATE
		1:5000			
NARACOOPA	MINING PATHS	DRAWN	S K P	DRAWING NUMBER	
LANIERN	DREDGE SEQUENCE	TRACED		FIGURE 3.2	
		CHECKED			



57500mN
5587000mN
5586500mN
5586000mN

BACK BEACH

(Sea Elephant)
From Public Road
Access + haul road
to South end B beach
& to High dune

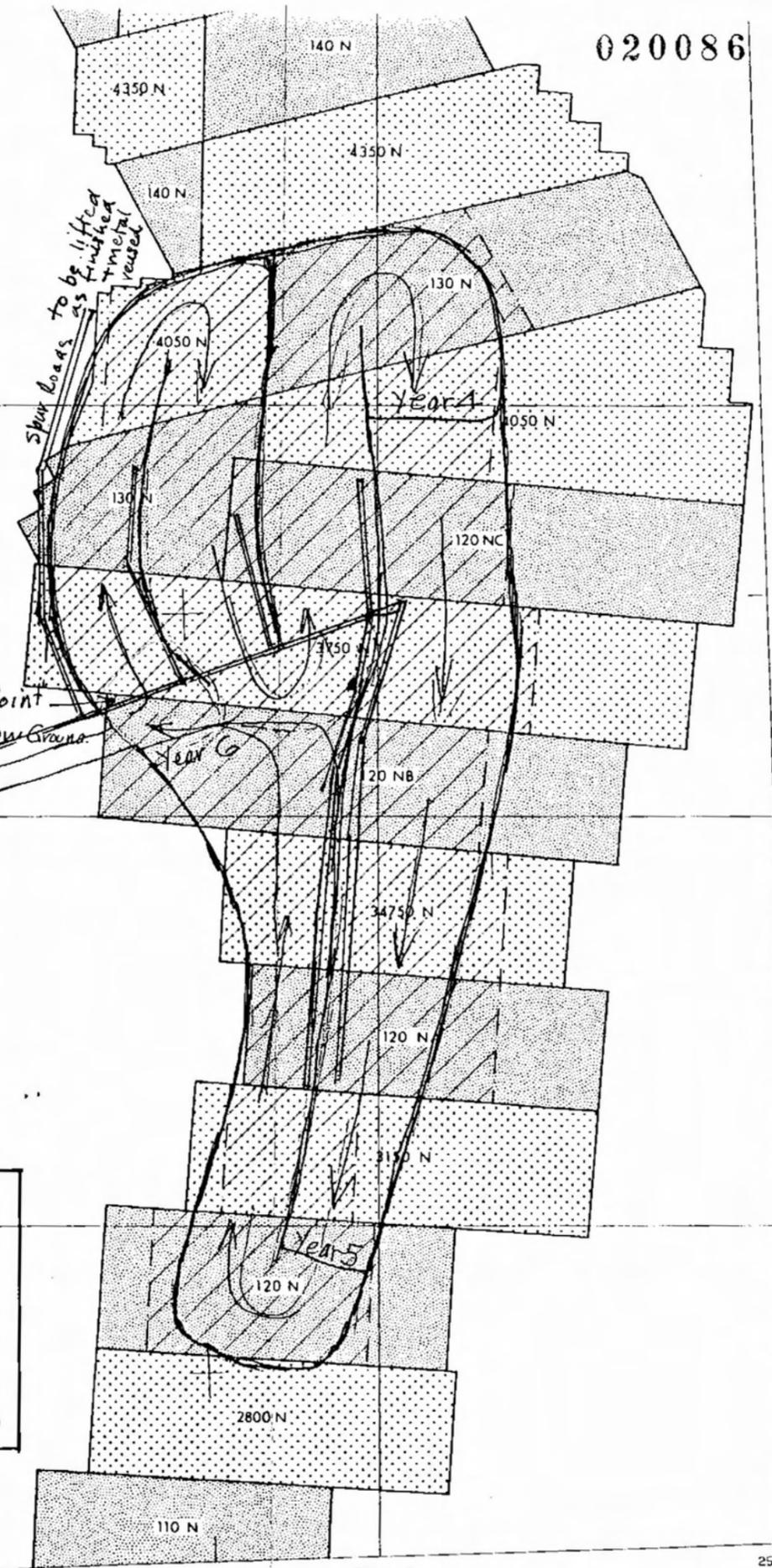
Assemble Plant at South End
of Back beach & mine Northward
& turn off into sand Mode.

Access & Haulage Road to High Dunes
C. an. al.

Year 3 path B beach
B' Beach
Access Road
Mine

Entry Point
& Exit into Ground

Spur leads to be lifted
as finished
& metal
reused



Mining SEQUENCE PLAN
COWPER POINT
1:5,000 (D.N.S.)
SAD Reduction
28/7/89
PRELIMINARY

FIGURE 3.3

251500mE

252500mE

253000mE

253500mE

254000mE

39°50'0"

39°50'30"

SECTION 4.0

METALLURGY

- 4.1 INTRODUCTION
- 4.2 MINERALOGY AND ORE DESCRIPTION
- 4.3 METALLURGICAL TESTWORK REVIEW
- 4.4 PROCESS DESIGN
- 4.5 PROCESS DESIGN CRITERIA
- 4.6 FACILITIES DESCRIPTION
- 4.7 INSTRUMENTATION AND PROCESS CONTROL

SECTION 4.0 - METALLURGY

1

4.1 INTRODUCTION

Two programmes of metallurgical testwork have been conducted on samples taken from the Naracoopa West deposit.

The initial programme was conducted at AMMTEC's laboratories in Perth on a 1400kg sample composited from drill hole material (see reference 3.001). This testwork established guide lines and identified problem areas ahead of a more comprehensive test campaign. It also examined the heavy mineral tailings left from previous workings.

The main test programme was carried out on a three tonne bulk sample from the 1400N line and assessed wet and dry separation techniques (see reference 3.004). The work included spiral concentration by AMMTEC to produce a heavy mineral concentrate which was subjected to wet high intensity magnetic separation at Readings facilities in Lismore. The non-magnetic fraction from the WHIMS was returned to AMMTEC for further test separations aimed to produce market quality products of rutile and zircon. These test operations included electrostatic and magnetic separation, attritioning, flotation and wet tabling. The final concentrates of rutile and zircon are regarded as standard grade products.

4.2 MINERALOGY AND ORE DESCRIPTION

The material tested consisted of sand containing 5.13% heavy mineral, 4.5% oversize (+2 mm) particles and 5.5% slimes.

The heavy mineral suite of a composite sample from the 1400N line was assessed by Applied Petrographic Services and found to have 30% ilmenite and altered ilmenites, 34% tourmaline and other alumino-silicates, 12% zircon, 9% rutile, 7% leucoxene, 4% garnet and 4% others (see Table 4.1).

Samples of the testwork feed and wet concentration products were examined by Analabs and found to have a composition of 28% ilmenite and altered ilmenites, 34% tourmaline and other alumino-silicates, 9% zircon, 12% rutile, 10% leucoxene, 3% garnet and 4% others (see Table 4.2).

Tourmaline reports as a heavy mineral but has a reasonably low specific gravity of 3.0 to 3.2 and its presence increases the circulating and "middlings" loads in a concentrating operation. It is a particular difficulty when leucoxene is also encountered and has a detrimental effect on leucoxene recovery.

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4.3 METALLURGICAL TESTWORK REVIEW

SPIRAL CONCENTRATION

The testwork flowsheet for primary gravity concentration consisted of roughing, cleaning, recleaning and middling/scavenging operations.

The spiral tests returned flat concentration curves reflecting the samples high proportion of "light"-heavy mineral i.e. tourmaline. During the testwork a high percentage weight cut to concentrate was taken to ensure a high recovery of heavy mineral and this resulted in low heavy mineral grades. The relationship between weight to concentrate and recovery of valuable heavy mineral (rutile and zircon) was not developed.

The final heavy mineral concentrate supplied for wet high intensity magnetic separation contained 81% heavy mineral. The wet plant recovery of rutile was calculated at 96.2% and that of zircon at 97.3%.

WET HIGH INTENSITY MAGNETIC SEPARATION

The objective of the WHIMS was to reject the maximum weight of material to magnetics consistent with low non-magnetics (i.e. rutile and zircon) losses in the magnetics.

A series of tests (Table 4.3) established operating parameters that were able to eliminate 29% of the WHIMS feed to magnetics with a non-magnetics entrainment of 0.4%. The WHIMS testwork also reported the non-magnetics fraction as containing up to 30% quartz. Further upgrading by gravity concentration to remove the bulk of this quartz was recommended ahead of dry plant testwork. Various flowsheets were examined including the possible inclusion of a second stage of WHIMS. The flowsheet adopted consisted of spirals and tables ahead of the dry plant.

DRY PLANT TESTWORK

Dry plant separation was designed to produce rutile and zircon to market grade. Initial testwork showed attritioning as being an important step in the process, this was confirmed in later testwork.

SECTION 4 - METALLURGY

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T A B L E 4.1

PETROGRAPHIC ANALYSIS OF HEAVY
MINERAL FROM NARACOOPA, KING ISLAND

(Data by Applied Petrographic Services)

Sample No. 28 (1,400W LINE)

	TOTAL	HAND MAGS	0.5A MAGS	0.9A MAGS	1.2A MAGS	1.2A NON MAGS
MAGNETITE	<1	100	-	-	-	-
ILMENITE	21	-	98	56	-	-
LEUCOX. ILMENITE	9	-	-	15	14	-
IRON OXIDES	<1	-	1	<1	-	-
CHROMITE	-	-	-	-	-	-
GARNET	4	-	1	13	-	-
TOURMALINE	27	-	-	11	71	2
STAUROLITE	4	-	-	2	12	-
EPIDOTE	1	-	-	3	2	-
ROCK FRAGMENTS	-	-	-	-	-	-
ALUMINO-SILICATES	3	-	-	-	-	9
OTHER SILICATES	-	-	-	-	-	-
RUTILE	9	-	-	-	<1	25
LEUCOXENE	7	-	-	-	-	18
ZIRCON	12	-	-	-	-	33
QUARTZ	1	-	-	-	-	2
PYRITE	2	-	-	-	1	5
CORUNDUM	<1	-	-	-	-	<1
SPINEL						
APATITE						
MONAZITE	<1					<1
SCHEELITE	<1					<1
CASSITERITE						
WEIGHT	11.1138g	0.0054g	0.5368g	3.2489g	3.2603g	4.0624g
%	100%	0.1%	4.8%	29.2%	29.3%	36.6%
NO. OF POINTS			516	504	568	668

SECTION 4.0 - METALLURGY

TABLE 4.2

Lanherne Concentration Products Modal Analysis of Heavy Mineral
(Data by Analab - R Townsend)

Mineral	Head	Conc. to RMS	Rougher Tail	Cleaner Tail	Re-Cleaner Tail	Wet Table Mid	Wet Table Tail
Ilmenite	2.6	3.4	-	0.3	-	0.3	-
Alt. Ilm	24.8	32.1	1.5	6.5	16.5	4.9	4.6
Leucoxene	9.9	11.3	13.7	8.0	9.5	8.4	8.2
Rutile	12.1	14.3	0.4	1.1	2.4	0.4	1.1
Limonite	0.7	0.2	2.4	1.7	1.5	-	0.7
Chromite	0.1	0.4	-	-	-	-	-
Zircon	8.5	11.9	0.3	0.7	1.5	-	-
Monazite	0.6	1.4	0.8	0.3	1.8	-	-
Staurolite	4.8	7.0	10.9	8.7	7.2	5.9	3.3
Tourmaline	25.7	4.4	28.4	42.5	45.4	66.1	72.7
Amphibole	-	5.4	23.8	12.6	4.7	-	-
Garnet	2.9	3.7	-	1.9	1.9	-	-
Corundum	-	1.5	0.4	-	-	-	-
Al. Sil	-	0.3	3.9	4.9	3.0	5.5	6.8
Others	0.4	0.6	3.1	1.6	2.3	5.1	2.2
Pyrite	3.4	2.1	4.2	8.5	0.5	3.4	0.4
Quartz	-	-	5.7	0.7	2.2	-	-
Kyanite	3.5	-	-	-	-	-	-

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The dry plant testwork attritioned the upgraded WHIMS non-magnetic fraction ahead of high tension separation. From H T separation the conductors were further cleaned by electrostatic and magnetic methods to produce a conducting non-magnetic portion. This material was wet tabled to remove cassiterite at the top and fine quartz at the tail, the remaining bulk was subjected to flotation to remove pyrite. The final rutile product was analysed and sized, this data is presented in Section 4.5.

The non-conductor fraction from high-tension separation was wet tabled to remove silica and cleaned by electrostatic and magnetic separation. Final product preparation required heavy liquid separation to remove alumina and quartz. The final zircon product was analysed and this information is detailed in Section 4.5.

VALUABLE HEAVY MINERAL RECOVERY

The total testwork flowsheets gave the following
Rutile and Zircon Balance:

Flowstream	% Rutile Recovery	% Zircon Recovery
Primary Wet Tailings	8.8	2.3
WHIMS Magnetics	0.5	0.6
Secondary Wet Tailings	3.5	2.1
Dry Plant Losses	0.1	0.1
Product & Circulating Loads	92.1	94.9

TABLE 4.3

METALLURGICAL ANALYSIS OF WHIMS MAGNETICS

Each of the Wet High Intensity Magnetic Separation
Magnetic Products was Assessed for Non-Mag Losses
using Readings "In-House" Analysis

Field Strength (AMPS)	Magnetics % Weight	% Non-Mags In Magnetics
70	12.23	0.57
80	15.85	0.55
90	20.58	0.47
100	24.76	0.37
110	26.73	0.44
120	29.07	0.41

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RADIOACTIVITY SURVEY

Thorium and uranium analyses were conducted on selected samples. The results, tabulated below, indicate that none of the products would be classed as a radioactive substance with the rutile fraction clean. The induced roll magnetics in which monazite would be concentrated, would require controlled blending back to the wet tailings stream. This operation would return the tailings to a radioactivity level similar to that of the unmined ore reserve.

TABLE 4.4

Radioactivity Survey of Selected Samples

Product	Parts per Million	
	Thorium	Uranium
Spiral Tailing	1.96	0.41
Ilmenite Concentrate	13.5	2.85
Rutile Concentrate	10.5	15.8
Nonconductor <u>IRM</u> Mags	765.0	52.8
Heavy Mineral Concentrate	139.0	17.7

MAGNETIC TAILINGS EVALUATION

A series of tests were conducted on samples representing the rejected magnetic tailings from an earlier processing operation. The testwork consisted of attritioning, magnetic separation, heavy liquid determination and mineralogical examination (see reference 3.003).

This programme established that of the sample supplied, 3.4% reported as non-magnetic rutile and 3.3% as non-magnetic zircon. The most likely cause for the presence of these valuable minerals would be by entrainment and due to the possible inefficient operation of the previous process equipment.

Considering the parameters used in the testwork the rutile and zircon mentioned above are essentially non-magnetic and recoverable.

CASSITERITE (TIN) PRODUCTION

Previous plant operations reported that tin in rutile was controlled by a wet tabling scheme with the top cut recovering cassiterite and the rutile proceeding on the circuit. The specific gravity variation between cassiterite

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and rutile (7.0 vs 4.2) confirms this process selection.

Accordingly wet tabling of the rutile concentrate was undertaken. Samples were taken from the first seven products from the top of the table and submitted for Sn O₂ analysis. Analytical results and Sn O₂ distribution in the table products are given in Table 4.5 (below). These results demonstrate an initial tin upgrading to the concentrate with a corresponding decrease in tin in the rutile product. However in order to produce a saleable cassiterite product at least one more (and possibly two) gravity upgrading step would be necessary. Further testwork would be required to develop this flow circuit.

TABLE 4.5

Cassiterite Distribution in Rutile Wet Table Products

Product	Weight %	Assay %	Sn O ₂ Dist. %	Cum. Dist. %
Conc. 1	1.8	2.41	32.1	32.1
Conc. 2	6.1	0.76	34.0	66.1
Conc. 3	11.3	0.16	12.7	78.8
Conc. 4	19.3	0.05	7.2	86.0
Conc. 5	19.5	0.04	5.4	91.4
Conc. 6	17.9	0.03	3.7	95.1
Conc. 7	24.1	0.03	4.9	100.0
TOTAL	100.0		100.0	

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4.4 PROCESS DESIGN

The main test programme resulted in the generation of proportional weight figures for the various separations comprising the flowsheets. Circulating loads were monitored and appropriate allowances made. This information formed the base for flowsheet construction

Whenever possible flowsheet design followed conventional practices for the industry. Process design has been directed at maximising the recoveries of valuable heavy minerals.

The study flowsheets and general arrangements are presented as rutile, zircon and leucoxene recovery circuits. However cost estimates have been generated for the base case rutile and zircon only recovery circuit by take out of equipment required for leucoxene recovery.

In the wet plant a significant middlings circuit has been included to maximise leucoxene recovery which occurs coincidentally with significant quantities of other 'light' heavy minerals.

In the dry plant the only part of the flowsheet that could be considered unusual would be the use of a relatively large number of shaking tables to process the middlings stream in the secondary wet plant. These tables are justified by the high proportion of 'light' heavy minerals (e.g. toumarline) in the mineral suite.

Process equipment has been chosen by approaching selected equipment vendors with specifications and duty requirements, this information was taken directly from the flowsheets. Vendor data on equipment capacity was used, in accordance with industry practice, to specify the number of equipment items required.

RECOVERY OF RUTILE AND ZIRCON ONLY

The decision to recover only rutile and zircon and not to recover leucoxene would lead to significant load variations with the flowsheet. Insufficient details of individual species recovery exists for a quantitative assessment, nevertheless projections could be made based on expected performance using the current testwork as a guide.

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The flowsheet modifications to disregard leucoxene recovery include:

1. Reduce the number of banks of middlings spirals in the wet plant from 7 to 3.
2. A reduction of 20% in the tonnage hauled from the wet plant to the dry plant.
3. Elimination of the 10 gravity tables from the wet circuit of the dry plant and their replacement with one spiral bank.
4. A reduction of 20% in the tonnes of heavy mineral concentrate requiring filtering and drying.
5. Reducing by 10% the tonnes of product requiring filtering and drying ahead of the zircon circuit.
6. The elimination of a cleaning step in both the electrostatic and magnetic separation circuits of the dry plant.

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4.5 PROCESS DESIGN CRITERIA

OPERATING SCHEDULE

Plant Availability	85%
Hours per day Operating	24
Days per week Operating	7
Weeks per year Operating	52
Total hours per year Available	7,425

by kinetic !!

WET PLANT

Design plant feedrate	450 tph
% oversize (+2mm) in feed	3.0
% undersize (-50um) in feed	5.0
Design feed to spirals	414 tph
Heavy Mineral in spiral feed	5.1%
Rougher spiral feed/start	1.7 tph
Rougher spiral feed density	40% by weight
Rougher spiral solids S.G.	2.7
Middlings spiral feed/start	1.7 tph
Middlings spiral feed density	39.5% by weight
Middlings spiral solids S.G.	3.0
Cleaner spiral feed/start	1.5 tph
Cleaner spiral feed density	35.0% by weight
Cleaner spiral solids S.G.	3.2
Recleaner spiral feed/start	1.5 tph
Recleaner spiral feed density	35.0% by weight
Recleaner spiral solids S.G.	3.4
Attrition cell feed density	80% by weight
Attrition cell power consumption	5 kwh/tonne
Attrition cell retention	15 minutes
Attrition cell caustic usage	1 kg/tonne
Wet mag.sep.feed rate design	25.7 tph
Wet mag.sep.feed density	25% by weight
Wet mag.sep.% mags rejected	34% of feed

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DRY PLANT

Primary spiral feed/start	1.5 tph
Primary spiral feed density	40% by weight
Primary spiral solids S.G.	3.8
Scavenging spiral feed/start	1.8 tph
Scavenging spiral feed density	20% by weight
Scavenging spiral solids S.G.	3.2
Middling table feed/table	1.1 tph
Middling table feed density	33% by weight
Middling table solids S.G.	3.5
H-M concentrate filtration rate	12 t/m ² /HR
H-M concentrate " feed rate	10 to 20 tph
H-M concentrate " feed density	50-80% by wt
H-M concentrate filter cake	5% moisture
H-M concentrate filter vacuum	5" Hg
H-M concentrate dryer feed temp	15°C
H-M concentrate dryer product temp	100°C
H-M concentrate fuel consumed	110kg/hr LPG
Thickener feed density	5% by weight
Thickener underflow density	34% by weight
Thickener feed solids S.G.	2.7
Thickener feed volume	60m ³ /HR
Thickener area requirement	0.4m ² /t/day
H-T roughing roll feed rate	16.6 tph
Rutile cleaning table feed/table	1.3 tph
Rutile cleaning table feed density	30% by weight
Rutile cleaning table solids S.G.	4.2
Rutile filtration rate	12t/m ² /HR
Rutile filtration feed rate	2.1 tph
Rutile filtration feed density	43% by weight
Rutile filtration filter cake	5% moisture
Rutile filtration filter vacuum	5" Hg
Rutile dryer feed temp	15°C
Rutile dryer product temp	100°C
Rutile dryer fuel consumed	12kg/Hr of LPG
Zircon filtration rate	12t/m ² /HR
Zircon filtration feed rate	8.1 tph
Zircon filtration feed density	70% by weight
Zircon filtration filter cake	5% moisture
Zircon filtration filter vacuum	5" Hg
Zircon dryer feed temp	15°C
Zircon dryer product temp	100°C
Zircon dryer fuel consumed	50kg/HR of LPG
Rutile product storage bin capacity	55 tonnes
Premium zircon " " "	35 tonnes
'B' Grade " " "	35 tonnes
Leucoxene " " "	35 tonnes
Rutile design production rate	2.1 tph
Premium Zircon design " "	1.2 tph
'B' Grade Zircon " " "	1.4 tph
Leucoxene design " " "	1.3 tph

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RUTILE PRODUCT ANALYSIS

CHEMICAL ANALYSIS

TiO ₂	96.4%
Fe ₂ O ₃	1.10
MnO	0.02
Cr ₂ O ₃	0.21
Nb ₂ O ₅	0.37
V ₂ O ₅	0.53
MgO	0.015
CaO	<0.01
ZrO ₂	0.22
SiO ₂	0.65
Al ₂ O ₃	0.37
Sn	0.08
S	0.025
U	40 ppm

PARTICLE SIZE DISTRIBUTION

APERTURE (Microns)	WEIGHT %	
	RETAINED	PASSING
+250	0.0	100.0
-250+180	1.3	98.7
-180+125	43.2	55.5
-125+90	51.6	3.9
-90+63	3.6	0.3
-63+45	0.3	0.0
-45	0.0	0.0

ZIRCON PRODUCT ANALYSIS

CHEMICAL ANALYSIS

ZrO ₂	66.2
TiO ₂	0.08
Fe ₂ O ₃	0.06
Al ₂ O ₃	0.19
Cr ₂ O ₃	0.02
P ₂ O ₅	0.163
S	0.06
CaO	0.02
MgO	0.01
U	0.027
Th	0.025

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PARTICLE SIZE DISTRIBUTION

APERTURE (Microns)	WEIGHT %	
	RETAINED	PASSING
+355	0.0	100.0
-355+250	0.6	99.4
-250+18-	3.0	96.4
-180+125	13.3	83.1
-125+90	64.9	18.2
-90+63	16.2	2.0
-53+45	1.9	0.1
-45	0.1	0.0

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4.6 PROCESS DESCRIPTION

PRIMARY WET PLANT -RUTILE AND ZIRCON RECOVERY ONLY

Mineral laden sand will be mined at up to 450t/h by a dredge and pumped to a floating pontoon supporting a 2.5m diam x 6m long, 45kw scrubber/trommel screen and a 90m³ constant density tank. The scrubber/trommel will break down indurated material and remove oversize trash, the constant density tank will allow most of the fine clay constituent of the feed to overflow the tank. Constant density tank underflow will be withdrawn at a constant rate to feed the primary wet plant.

A separate floating pontoon will contain the primary wet plant. Services and access to the plant will be by a floating walkway supported on small pontoons. Feed to this plant will be pumped to the spiral circuit for initial upgrading. In years 1 to 3 the dredge output will average 335t/h and years 4 to 6 450t/h. Therefore the spiral circuit will be upgraded in year 4. The rougher circuit initially will consist of 5 banks of 12 triple start spirals to be upgraded to 7 banks in year 4. The cleaner circuit initially will consist of 5 banks of 12 double start spirals to be upgraded to 6 banks in year 4. The recleaner circuit initially will consist of 2 banks of 12 double start spirals requiring no upgrading. The middlings circuit initially will consist of 2 banks of 12 triple start spirals to be upgraded to 3 banks in year 4. Spiral tail will be pumped to the rear of the dredge pond for stacking and replacement. Spiral concentrate will be attritioned in a caustic solution (1kg/t H.M. for years 1 to 3 and 0.25kg/t for years 4 to 6) in 4 x 1m³ cells, rubber lined, with 37kw per cell and arranged in series and then double washed through cyclones. Cleaned concentrate is pumped to a 16 pole x 120 amp rotor wet high intensity magnetic separator which removes most of the valueless highly magnetic minerals and these are returned with the spiral tailing. Non-magnetic concentrate is pumped to the shore where it is cycloned to remove excess water and stock-piled.

SECONDARY PROCESSING - DRY PLANT

Primary wet plant concentrate will be trucked to the secondary processing facility located at the junction of Fraser Road and Sea Elephant Road. At this operation the concentrate will be reslurried and pumped over a single deck 914mm wide x 2440mm long vibrating trash screen. The underflow will be collected in a 6.7m³ constant density tank and pumped to a single bank of 8 double start primary spirals. Concentrate will be pumped to a single triple start scavenger spiral. It will then filtered on a 2m² vacuum belt filter and dried in a 2.00m diameter fluid bed dryer. Water used in this process step will be recycled through a 6m diameter thickener. Dried concentrate will be

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conveyed to a 6m³ surge bin ahead of the high tension circuit which will separate the concentrate into conducting and non-conducting minerals. Conductors will be subjected to further magnetic separation with the cleaned concentrate proceeding to wet tables for the removal of cassiterite which will be stockpiled for further treatment. From the tables the concentrate will be pumped to a 2 x 0.5m³ flotation cell bank where sulphides will be floated off. Flotation tail will be dried in a 0.6m fluid bed dryer and conveyed to product storage as final rutile concentrate.

Non conductors from the high tension separation are elutriated to remove fine silica, filtered on a 0.5m² vacuum belt filter and redried in a 1.2m diameter fluid bed dryer prior to cleaning steps of electrostatic and magnetic separation. The final non conducting and non magnetic portion will be fed across 2, 1470mm x 2440mm air tables to remove kyanite with the final concentrates conveyed to storage as premium grade or foundry grade zircon.

Most of the various intermediate fractions generated within the dry plant will be returned as circulating loads. Final tailings from this facility will be trucked back to the dredge pond and blended in with the primary plant tailings.

Tailings from the wet circuit at the dry plant are pumped to a cyclone for dewatering. Cyclone underflow is rehandled to join dry plant tailings and cyclone overflow is combined with other wet circuit "dirty-water" products and pumped to a thickener for clarification. Thickener overflow is recycled as process water, thickener underflow joins the other tailings stream.

Plant final products of rutile, premium zircon and 'B' grade zircon will be stored in covered day bins situated over a truck loading facility.

PROCESSING MAGNETIC TAILINGS

During the processing of rejected magnetic tailings the head grade of heavy mineral to the wet plant increases to approximately 15%. The increased mineral load by nature of its origin comprises predominantly magnetic material and is felt primarily by the wet magnetic separator. Constraints imposed by this machine will limit production to 350 tph. Once the bulk of magnetic material is rejected by the wet magnetic separator then the heavy mineral concentrate tonnage is easily handled by the downstream circuit items.

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4.7 INSTRUMENTATION AND PROCESS CONTROL

Instrumentation throughout the wet and dry plants will be minimised to that necessary for a short term 'remote' operation.

The primary wet plant will have a mass flow measurement on the roughing spiral feed which is taken by monitoring flow and pulp density. Intermediate pumping duties will be controlled by simple float valves adding water to pump hoppers.

Feed to the secondary wet plant, at the head of the dry plant, will be controlled by a variable speed pump feeding the primary spirals, other pumps will be constant speed with water addition to pump hoppers controlled by float valves.

The concentrate filter and dryers will be interlocked by various vendor supplied controls to ensure correct operation in a 'fail safe' configuration.

Conveyors and elevators within the dry plant will be interlocked to shut down upstream items in the event of equipment failure.

Sampling and grade control will be by manual means taken by the shift operators.

P R O D U C T I O N S C H E D U L E

The following production schedule is based on a maximum dredge throughput of 450 T.P.H.; Years 1 to 3 inclusive assume a mining recovery of 90% of all heavy minerals; Years 4, 5 & 6 assume a mining recovery of 95%.

P R O D U C T I O N S C H E D U L E

Production Period	Sand Mined	H.M. Contained	Rutile to Wet Plant	Rutile (1) % Recovery	Tonnes Rutile Recovered	Zircon to Wet Plant	Zircon (1) % Recovery	Tonnes Zircon Recovered	Leucos to Wet Plant	Leucos(2) % Recovery	Tonnes Leucos Recovered
Year 1											
Yr Total	2650000	255000	12600	81.5	10300	14664	81.5	11952	6421	35	2275
Year 2											
Yr Total	2650000	255000	12600	85	10710	14136	85	12016	5317	40	2127
Total - Naracoopa	5300000	510000	25200	83	21000	28800	83	24000	11738	37.5	4402
Year 3											
45 weeks	1917760	117162	7766	85	6601	12426	85	10562	4586	40	1834
Canal Move	150000	3000	180	75	135	310	75	233	104	30	31
Yr Total	2067760	120162	7946	85	6736	12736	85	10795	4690	40	1865
Year 4	3.3MT	134096	7886	85	6703	9636	85	8191	7556	40	3022
Yr Total											
Year 5	3.3MT	134096	7886	85	6703	9636	85	8191	7556	40	3022
Yr Total											
Year 6	2.9MT	117808	6931	85	5891	8466	85	7196	6642	40	2657
Yr Total											
Total-Cowper Point	11567760	506162	30649	85	26033	40474	85	34373	26444	40	10566
TOTAL -	16.8MT	1000000	55850	84	46900	69200	84	58100	38182	39	14968

(1) Recovery figures are based on Metallurgical Test Report Recommendations.

(2) Recovery is conservatively estimated from industry experience.

S E C T I O N 5.0

ENGINEERING AND SERVICES

- 5.1 PROCESS WATER
- 5.2 POTABLE WATER
- 5.3 POWER
- 5.4 DRYER FUEL
- 5.5 SPARES AND CONSUMABLES
- 5.6 PLANT SERVICES
- 5.7 TRANSPORTATION, PRODUCT STORAGE/LOADOUT
AND SHIPPING
- 5.8 ROADWORKS

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5.1 PROCESS WATER

The water distribution diagram highlights the following:

- i) Make-up process water requirements are 1.8 ML/day and are generally associated with the wet plant circuit.
- ii) Make-up process water is supplied and pumped from two spear point batteries - one located at Naracoopa and one at Cowper Point.
- iii) Process water is available to the dry plant for breakdown, shut-down and start-up periods.
- iv) Water recovery is highly dependent on the water recovered from the stacked tailings. Tailings are expected to be placed at 86% w/w solids. The 90 percent water recovery indicated in the flowsheet reflects this. Water recovery is also influenced by the dredge pond/watertable relation.
- v) The process water system has three main elements and the equipment utilised is as follows:
 - a) Naracoopa Spearpoint Battery - 2.5 km length using Class 9 PVC - Constructed in the interdunal system between 1600N to 1800N.
 - . Vacuum pump (100 cfm, 40-50kPa, 12 l/sec), diesel generator, air tank
 - . 150mm diameter, Class 9 PVC, solvent weld -2500m x \$182.51/6m length
 - . Spearpoints - 50mm diameter PVC, 2m slots, 3m blank 50 x \$100
 - . T Header and isolator 50 x \$100
 - . Booster pump from air tank to area of use
 - . Fuel Tank

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b) Cowper Point Spearpoint Battery - 1.25 km length using Class PVC. Constructed in the interdunal area between 3400N to 4650N.

- . Vacuum Pump (100 cfm, 40-50 kPa - 12 l/sec), diesel generator, air tank
- . 150mm diameter, Class 9 PVC, solvent weld - 1250m x \$182.51/6m length
- . Spearpoints - 50mm diameter PVC, 2m slots, 3m blank -5 x \$100
- . T Header and isolator 50 x \$100
- . Booster pump from air tank to area of use
- . Fuel Tank

c) Distribution system

- . Cowper Pt to Naracoopa dredge pond and dry plant - 9000m of 160 O.D. Class 4.5 PVC pipe with 80 x 65 (10 kw) diesel driven transfer pump at Cowper Point and 100 x 65 (3 kw) diesel driven pump at Naracoopa.
- . Naracoopa to Cowper Point (for stage 2 mining only) - 7500m of 160 O.D. Class 4.5 PVC and an upgraded transfer pump.

5.2 POTABLE WATER

Run-off water from the roof of the dry plant is collected in a storage tank. A pressurised domestic pumping installation is used to reticulate this water to the amenities building and dry plant. Potable water requirements are based on 200 litres per man/day.

No potable water is necessary for process purposes.

SECTION 5.0 - ENGINEERING AND SERVICES

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5.3 POWER

POWER CONSUMPTION

The estimated power consumption for the life of the project is detailed in the table shown below.

The consumed figures are based on:-

- The use of a max. 80% of the installed power
- Constant power draw by the dredge
- Constant power draw by the dry circuit
- Tonnage related power draw by the wet plant
- Tonnage related power draw by the wet circuit at dry plant.

YEAR	MINED t/a	MINED t/h	POWER CONSUMED IN kW				
			DREDGE	WET PLANT	DRY PLANT	TOTAL	
1	2.5 M	335	600	505	145	311	961
2	2.56M	332	600	505	123	311	939
3	1.9 M	280	600	420	74	311	805
4	3.3 M	450	600	670	83	311	1064
5	3.3 M	450	600	670	83	311	1064
6	2.9 M	390	600	580	73	311	964

The basis for this study is as follows:

- i) Dredge - diesel powered cutter and pump.
- ii) Wet Plant - diesel/generator
- iii) Dry Plant - diesel/generator

Annual diesel consumption will be approximately 3.8×10^6 l and a 78m^3 storage tank will be provided at the dry plant site.

ELECTRICAL SUMMARY

The installation cost of the wet and dry plants includes all cables, trays, lights, GPO's, switchboards etc. required to make a complete installation but it excludes the power supply to the main switchboard.

The cost of connecting the plants to Grassy Power

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station includes all transformers, line regulators, overhead transmission lines and connection fees. It does not take into account any rent or maintenance costs that the H.E.C. may choose to impose. Negotiations will be required to determine the exact cost of the connection. It is also rumoured that the H.E.C. are considering connecting their high voltage grid to the Grassy Power Station, which would complicate matters further.

The cost of installing the generators includes fuel tanks.

The bore field transfer pump near the Northern deposit is diesel powered as the cost of cabling is prohibitive.

The Southern bore field transfer pump can be powered from the dry plant at an increased cost over diesel power but with the advantage of remote control and no fuel tank.

ELECTRICAL COST COMPARISON

A)	Installation cost of Wet Plant (excluding power supply)	\$133,829.
B)	Installation cost of Dry Plant (excluding power supply)	\$271,524.
C)	Cost of connecting plants to Grassy Power Station	\$502,600.
D)	Cost of installing generator to Wet Plant	\$166,300.
E)	Cost of installing generator to Dry Plant	\$ 95,800.
F)	Cost of power from Grassy	13 cents KWh
G)	Cost of power using generators including maintenance	11 cents KWh
H)	The calculations for power requirements are based on:	

Maximum demand at Dry Plant 525 KW
Maximum demand at Wet Plant 680 KW
Diesel powered dredge

Therefore by comparing C) with the total of D) and E), and by comparing F) with E) it can be seen that power from dedicated diesel generator sets has both capital and operating cost advantages over power supplied from Grassy Power Station.

SECTION 5.0 - ENGINEERING AND SERVICES

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5.4 DRYER FUEL

The estimated power consumption for the three (3) dryers is given in the table below.

TABLE: ESTIMATED POWER REQUIREMENTS ASSOCIATED WITH DRYING OF MINERAL SANDS.

DRYER	EQUIVALENT FUEL REQUIREMENTS			
	POWER MJ/HR	LPG KG/HR	DIESEL KG/HR	ELECTRICITY KW
CONCENTRATE	4800	95.1	108.1	1333
ZIRCON	2760	55.1	62.2	767
RUTILE	600	12	13.5	167
TOTAL	8160	163	184	2267

5.5 SPARES AND CONSUMABLES

Maintenance spare parts have been annualised at a value of 7% of the mechanical equipment capital cost for the wet plant, dry plant and borefield and 5% for the wharf area.

Caustic soda is added to the wet plant attrition cells at a rate of 1kg per tonne of heavy mineral for Years 1 to 3 and 0.25 kg/t for Year 4 to 6. Flotation collector (potassium amyl xanthate) is added to the dry plant rutile cleaning flotation cells at a rate of 0.1kg per tonne of rutile product.

Both reagents are delivered to site in 40 kg bags and require stock mixing on a regular, day-shift only basis. A specific annual allowance has been made for other consumables, this cost is detailed in the operating costs.

5.6 PLANT SERVICES

Apart from process water and power, the plant services at the wet plant and dredge are limited to hand held fire extinguishers.

At the dry plant process water, potable water, compressed air and power are reticulated. Hand-held fire extinguishers are provided and the entire site is secured by 3 metre fencing and a gate house. The dry plant site also includes an amenities building housing ablution facilities and a crib room. Major roads and

hardstanding within the dry plant are bitumenised.

Offices are located near the dry plant and consist of two 'Atco' type buildings housing the general manager, accountant, metallurgist, mining superintendent foreman and analyst. A 30 metre x 15 metre building serves as a workshop, attached to this building is a fenced hardstanding area 30 metres x 60 metres for laydown and storage.

5.7 TRANSPORTATION PRODUCT STORAGE LOAD OUT AND SHIPPING

a) TRANSPORTATION

All goods, services, heavy mineral concentrate and mineral products are transported in trucks on King Island.

All trucking operations will be provided by contractors.

Heavy mineral concentrate will be transported on the mining lease area in off-road 6WD Articulated dump trucks.

Mineral products will be transported to Grassy Wharf 31 km by road from the Dry Plant in a purpose-built enclosed tandem-tandem 20t trailer.

A summary of trucking movements is as follows:

Travel distances

- | | | | |
|----|-----------------------------|---|-------|
| 1) | Dry Plant to Grassy Wharf | - | 31km |
| 2) | Cowper Pt West to Dry Plant | - | 8km |
| 3) | Cowper Pt East to Dry Plant | - | 9km |
| 4) | Naracoopa West to Dry Plant | - | 1.5km |

Truck Capacity - 20t

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YEAR	1	2	3	4	5	6
H.M. Conc (t)						
RZ	199000	199000	93531	110176	110176	96793
RZL	249000	249000	116913	137720	137720	120991

Av. Daily Truck Return						
Trips	RZ					
	27	27	13	15	15	13
	RZL	34	34	16	19	17

PRODUCT (t)						
R	10300	10710	6600	6703	6703	5891
Z	11952	12016	10562	8191	8191	7196
L	<u>2275</u>	<u>2127</u>	<u>1834</u>	<u>3022</u>	<u>3022</u>	<u>2657</u>
TOTAL RZ	22300	22700	17531	14894	14894	13087
TOTAL RZL	24575	24827	19396	17916	17916	15744

Av. Daily Truck Return						
Trips	RZ					
	3	3	3	2	2	2
	RZL	4	4	3	3	3

Trucking will occur in daylight hours 7 days a week.

b) PRODUCT STORAGE AND LOAD OUT.

At Grassy Wharf a product receipt storage and load out facility will be built adjacent to the existing concrete apron and between the existing derrick crane and the sea wall.

The completely enclosed building is 20m x 35m in plan with 8m eave height. It is equipped with a concrete floor and tapering storage walls suitable for bulk storage of approximately 1500t rutile and 1500t zircon. Stacking and discharge is achieved using 800mm wide belt conveyors.

A covered mobile discharge conveyor 30m long loaded by F.E.L. will load, 4000t dwt bulk vessels in 1 day.

About 3000t is envisaged as the maximum size shipping parcel, however, the optimum will only be determined after actual markets are located and the shipping coordinated.

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The King Island Marine Board, which administers Grassy Harbour, has given approval in principle to the use of the wharf as described.

c) SHIPPING

Shipping constraints imposed by Grassy Harbour limit vessel size to approximately 90m overall length and draught 6.1m at low water mark. Bowthrusters are necessary for ships to have the manoeuvrability to berth unassisted.

Dutch owners of vessels meeting these requirements have indicated a freight rate to Korea/Japan from Grassy of \$US50/t. Mineral sands are already being transported to the China area from Australia in vessels of this size and at rates less than that quoted. While the project appears tied to rather specific shipping requirements, the range of small, modern, flexible (they carry general cargo, bulk, containers on the hatch covers) and manoeuvrable vessels now available suggest that the only real constraint is that it directs the project marketing effort to the South East Asian region.

5.8 ROADWORKS

King Island has a mixture of Council roads and DMR roads. The route from the Dry Plant to Grassy Wharf is

7.5 km	Fraser Road	(Council)
7.0 km	North Pegarah Rd	(Council)
16.0 km	Grassy Rd	(DMR)

Both Council roads are unsealed and the North Pegarah Rd has not been resurfaced for years. Both roads are in need of work with or without the project. As demonstrated in 5.7 the frequency of trucking is quite low. An estimate of the work required on the 15 km of unsealed road is approximately \$500,000.

The Council representatives have stated that they would not want the project to founder due to the extra burden of roadworks. We are in a position to negotiate over road work required (and this includes Sea Elephant Rd for H.M. conc. transport after Year 2) and it is for this reason that the capital estimate does not include a figure for road reconstruction.

020115



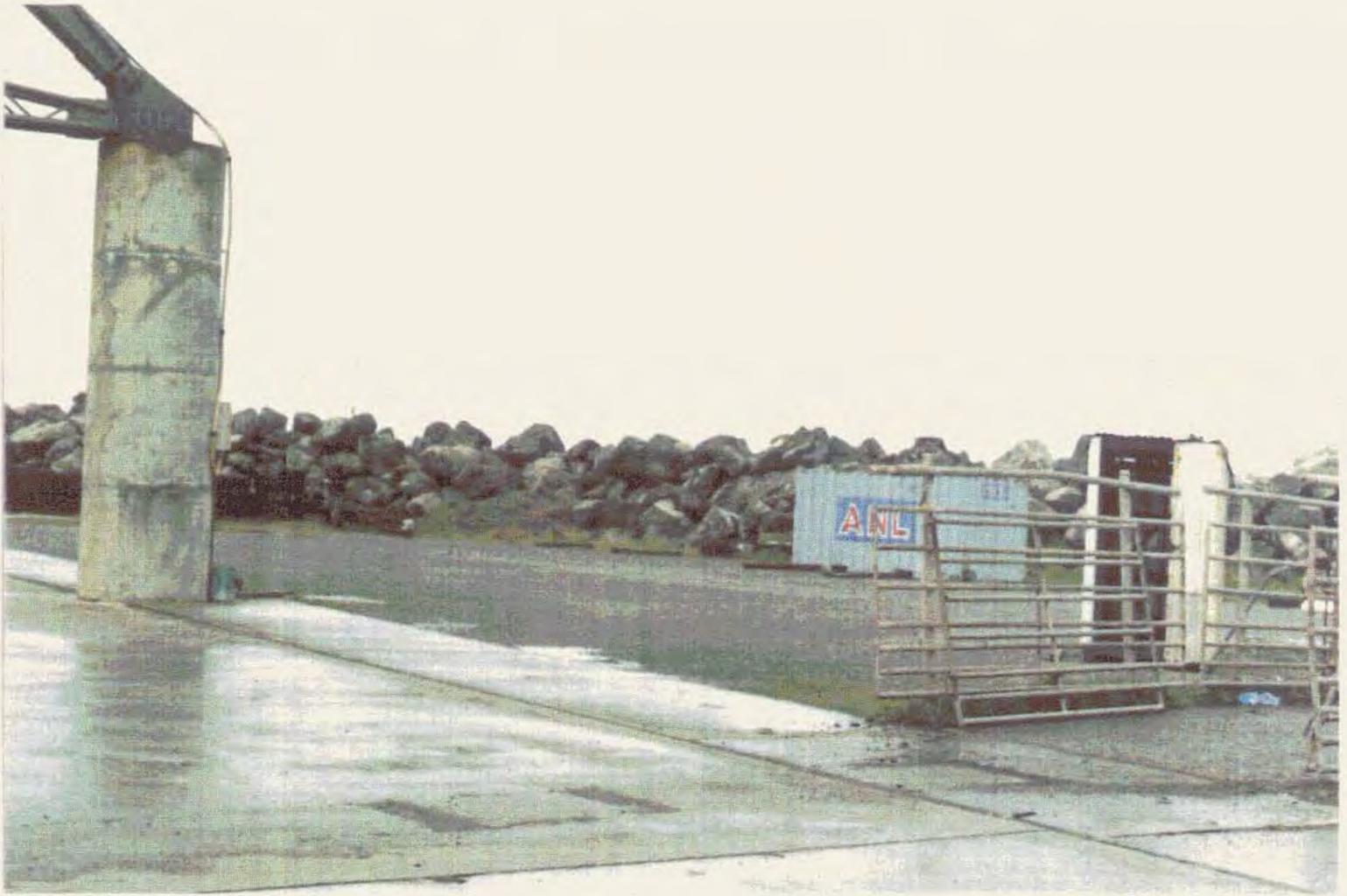
ENTRANCE TO DRY PLANT AREA - OPPOSITE TIP ROAD



VIEW OF GRASSY HARBOUR



VIEW OF GRASSY WHARF



PRODUCT STORAGE SITE - GRASSY WHARF



**DRY PLANT SITE - INTERSECTION OF
FRASER ROAD AND SEA ELEPHANT ROAD**

SECTION 6.0

ENVIRONMENTAL

- 6.1 TOPOGRAPHY
- 6.2 SURFACE WATER
- 6.3 GROUND WATER
- 6.4 REGIONAL AND LOCAL GEOLOGY
- 6.5 SOILS
- 6.6 METEOROLOGY AND MICROCLIMATE
- 6.7 NOISE LEVELS
- 6.8 ARCHAEOLOGICAL ASPECTS
- 6.9 ECOLOGY
- 6.10 LAND USE AND ZONING
- 6.11 VISUAL ASPECTS
- 6.12 TRANSPORTATION
- 6.13 FIRE MANAGEMENT

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6.1 TOPOGRAPHY

NARACOOPA DEPOSITS

The aeolian and beach sand dune sequence at Naracoopa rises steeply from the beach along the southern end of Sea Elephant Bay. There is a small frontal dune and a narrow interdunal area of Recent age and then a steep rise to the top of the main sand dune system, of Pleistocene age. The Pleistocene sand rises to 29m above the sea level at the Sea Elephant Road along drill line 1600N. The dunal system is undulating in nature. Vegetation consists of ti-tree and heath which are very thick in places and peaty swamps in the interdunal areas. The Fraser River forms the southern boundary of the sand deposit adjacent to hard rock outcrop. The intermittent Rocky Creek, Eldorado Creek and associated watercourses truncate the Pleistocene sand in the central and northern part of the project area. A large swamp is located in the western sections of drill lines 1200 to 1400N.

COWPER POINT DEPOSITS

The Cowper Point dune system extends from the calcareous sandstone outcrop at the mouth of Blowhole Creek north to the Sea Elephant River. Dune systems rise sharply to RL 44m (AHD) with interdunal areas around RL 5 to 8m. Topographically, there appears to be two dune systems, one adjacent to the coastline and a second, some 300 to 500m inland. Swampy areas occur to the west of the inner high dune system. The vegetation consists of low coastal shrubs.

The Cowper Point West deposit occurs in a slightly elevated area of distinct beach strand lines. In contrast to the coastal dunes the area is relatively flat, being only 1 to 2m above the surrounding area and is surrounded by interdunal lowlands. It is likely that some of this area would be waterlogged during wetter months of the year. Blowhole Creek and associated watercourses drain the Cowper Point West area in a southern and easterly direction to Sea Elephant Bay.

Each of the four deposits has a separate geomorphological setting and variation in geomorphology also provides variation in ecosystems and this has been documented in the baseline flora survey.

Orthophoto maps at 1:5000 for the project area are available - see reference 1.001 and 1.006.

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The draft EMP guidelines do indicate that changes in topography and drainage, as a result of the proposed mining, must be documented and addressed.

6.2 SURFACE WATER

The Project Area is bordered by the Sea Elephant River to the north and the Fraser River to the south. Two smaller drainage lines are the Blowhole Creek and Eldorado Creek which are, however, non-perennial and may recharge to the groundwaters of the sand dune systems.

The Sea Elephant River is the largest catchment on King Island and receives most of its inflow as groundwater base flow and interflow. It has a substantial wetland development, borders the Lavinia Nature Reserve to the north and has a high habitat and landscape value. The Sea Elephant estuary is wide and tidal and provides a natural barrier between the Lavinia Nature Reserve and areas of proposed mining.

Base flow of the Fraser River is provided from the beach system groundwaters - the brown water colour is derived from lignins and humic acid leached by groundwaters. Runoff from steeper Palaeozoic hills in the Fraser River catchment provides the larger component of flows above base flows. The habitat value of the Fraser River is less significant than that of the Sea Elephant River.

Neither of these river systems support water storage developments. The only major surface water developments on King Island are those developed by King Island Scheelite on the Grassy River.

The water supply capacity of the Sea Elephant River is likely to be large and relatively insensitive to any mining development of the Cowper Point deposits. However, due to its high ecological significance and the tidal nature of the estuary, it cannot be considered as a water supply. Groundwater studies predict no effects on the river estuary from groundwater withdrawal if spearpoints are restricted in a northerly direction.

The flow in the Fraser River, particularly base flow and its relationship to groundwater of the beach system has been assessed. The assessment indicates that the integrity of the base flow of Fraser River may not be deleteriously affected by the use of groundwater during mining. This case should be refined for presentation in the EMP.

Surface and groundwater monitoring has been carried out at 5 surface water sites, 2 groundwater production bores and a production spearpoint. The monitoring is to establish baseline water quality. Sampling was completed in February, 1989 and further sampling should be undertaken in winter.

Standards for water quality for emissions into inland waters, estuaries and coastal waters are specified in the Environmental Protection (Water Pollution) Regulations, No. 174 - Regulation 3. It is noteworthy that nothing in the regulations require an emission to have a concentration of substances lower than that occurring naturally in the receiving waters.

The mining activities are considered therefore unlikely to pose a water pollution hazard. The standards for water quality are achievable, bearing in mind the baseline water quality.

It is likely that the water monitoring programme will need to be continued throughout the project life.

A comprehensive water balance will be required for the EMP.

6.3 GROUNDWATER

Coffey & Partners, (see reference 4.002) have undertaken an assessment of groundwater in the vicinity of the deposits. These reports are considered adequate for assessment/presentation in the EMP, although stress testing of the aquifer, required to establish the integrity of supply is yet to be completed.

Groundwater quality at Cowper Point appears to be good and suitable for all uses. At Naracoopa there is some evidence of increased salt levels in the vicinity of the old tailings areas, which may be residual from use of salt (sea) water during Kibuka mining. Naracoopa groundwater is not of potable quality.

The groundwater supply identified within the project area was previously unknown. Allocation of the groundwater for mining will not be a problem as this will recharge and re-establish a groundwater equilibrium.

Responsibilities in respect of pollution/contamination of groundwater aquifers are shared between the Department of Mines and Department of Environment in consultation. To this end the integrity of the aquifer during mining against saline incursion will be scrutinised in the EMP. It is possible/likely that piezometers will be required to be installed seaward of the mining zone to monitor groundwater quality and flow.

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The use of sea water as a source of process water is viewed unfavourably due to the likely contamination of the aquifers and the likely deleterious effect on rehabilitation.

6.4 REGIONAL AND LOCAL GEOLOGY

The geological reports prepared for this study on exploration in the Project Area can be condensed for presentation in the EMP.

The geological description should be sufficient to define mineable reserves of heavy mineral sands and the geological setting of the deposits.

Geological features with specific environmental implications which will need to be addressed include:

- (i) the geochemistry of process wastes tailings and waste concentrates - as it relates to water quality.
- (ii) the radioactivity of process wastes. A baseline assessment of radioactivity levels has been undertaken. Radiation issues are addressed separately. Re-mining of the Kibuka tailings areas will constitute an environmental advantage considering the radioactive hotspots residual in these areas. Disposal procedures for radioactive monazite concentrate (the non-conductor mags) will be such that there is no monitored increase above existing elevated levels.
- (iii) description of the geological profile - noting the occurrence of hard pan coffee rock (aquicludes).

The following brief assessment of seismic risk has been incorporated for completeness. Seismic risk assessment has more bearing on design than any requirement for environmental assessment.

Seismic activity in Australia has been recorded and shown on a seismic zone map of Australia, in conjunction with Australian Standard AS 2121-1979, the Standards Association of Australia Earthquake Code. A section of this map, showing south eastern Australia and Tasmania, is shown on Figure 6.1. The map shows zones of seismic activity defined by boundaries according to ground-particle velocity (shaking) and expected return periods.

No seismic activity is shown to have occurred on King Island. An area of Zone A seismic activity is shown to the

east over the Furneaux Group of islands. Zone 1 seismic activity is shown to the north of Victoria. Seismic risk is considered low on King Island and poses no constraint to development.

6.5 SOILS

Two major soil types are found within the exploration area; Naracoopa sand and Lappa sand. Alternatively these are described as duplex soils and fall within the Eldorado Land system.

The Naracoopa sand extends north to south along the coastline and incorporates the Cowper Point East deposit as well as parts of the Naracoopa deposits. The coastal foredunes are undergoing a process of cutback by wave action.

The Lappa sand characterises the Old Shoreline System, and incorporates the Cowper Point West deposit and some parts of the Naracoopa West deposit. The Lappa sand is the most acid and infertile of the soils on King Island.

Soil profiles were inspected and sampled at five locations within the four mineral deposits. For each horizon a range of analyses were undertaken.

The soils are documented as strongly podsolized with a surface horizon consisting of grey to dark grey sand and containing substantial organic matter. The subsurface soil is very pale and almost devoid of organic matter.

The hardpan which comprises the B Horizon differs in thickness between the two major soil types. The Naracoopa hardpan forms an extremely hard, deep horizon, whereas that of the Lappa sand may form a horizon only a few centimetres deep.

Soils of the area have low fertility. This poses no constraint to project approval, but relates to operational procedures. It should be noted that much Australia-wide rehabilitation of mineral sand mining has proven successful on similarly infertile soils, using indigenous species.

The soil profiles identified indicate a depth varying from 10 to 30 cm of Ao/A1 topsoil is worthy of prestripping for rehabilitation purposes over the mining zones generally.

Disturbance of the hardpan horizon by mining will result in unavoidable implications to the pattern of revegetation possible.

The coastal landforms within the exploration area are currently stable with the exception of a large blow out on the frontal dune at Cowper Point and some portions of the active sea beach. Wind action (specifically gale force greater than 60 knots) is a major constraint to rehabilitation, requiring progressive programmes and specific control measures.

Water logging of soils in depressions and swales is also a major operational constraint to access within the exploration area during winter months.

6.6 METEOROLOGY AND MICROCLIMATE

An assessment of likely meteorological conditions will be incorporated in the EMP, as climatic variation has implications for mining techniques and rehabilitation success.

An assessment of meteorological conditions on King Island has been prepared - refer Appendix VII. Data has been acquired from the Bureau of Meteorology.

Meteorological conditions are summarised below:

RAINFALL

Mean annual rainfall at Currie is 906 mm and 963 mm at Grassy. Rainfall is persistent throughout the year. However, 70 per cent of rain falls during the period May to October. Maximum daily temperatures range from 12 degrees C in July to 21 degrees C in January.

Actual evaporation figures are not available for King Island, however, reference to Bureau of Meteorology, Climate Atlas of Australia, - Map Set 3 - Evaporation (May 1975) indicates annual evaporation of approximately 1200mm.

WIND

King Island is characterised by persistent winds. Available wind data for the west coast, at Currie, indicates that moderately strong winds (>30km/hr) persist with a frequency of 25 per cent of the time. Westerly and southwesterly winds predominate. Wind strengths above 30 km/hr may pose a nuisance level for operations.

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Strong to very strong winds (>50km/hr) can be expected at a frequency of 5 per cent throughout the year. Gale force winds (>60km/hr) occur with an average frequency of 2 days per month. Winds up to 100km/hr may be experienced. Wind strengths above 50km/hr are likely to pose a significant operational constraint requiring specific design/procedural safeguards to mineral sands mining.

It is likely that southwesterly wind strengths on the east coast are less than the west coast, although northeasterly wind strengths are likely to be greater on the east coast during summer.

Strong winds may have the following implications for minerals sands mining on King Island:

- . Tailings discharge via high stackers is affected resulting in uneven spread of discharge. The stackers may need to be reinforced.
- . Mineral concentrate stockpiles may blow and will need to be kept wet in summer via sprinklers.
- . The dry tailings become unstable in high winds and surface sands become windblown. Progressive and continual surfacing of the tailings is necessary by topsoil respreading, vegetation mulch covering and establishing wind protection fences (Nylex) on high dune areas.
- . Strong winds may crowd the wet plant up against the dredge affecting slurry pipe efficiency. Mooring and anchoring of the dredge and wet plant is critical lest damage be done against dredge pond banks.
- . Strong winds may effect the separation process of the wet plant requiring complete enclosure of the plant.
- . Strong winds on the east coast are predominantly from the northeast during summer. The summer has a drop in rainfall and the hazard of fire outbreak is high during periods of northerly wind and low relative humidity. The fire danger period extends from December to March.

6.7 NOISE LEVELS

The impact of noise from the mining and treatment plant on ambient background noise will be a constraint on operations in the vicinity of Naracoopa village and in the vicinity of Orange-bellied Parrot habitat at Cowper Point.

Background noise levels were measured at three locations in the vicinity of the Project Area, on June 26th and 27th, 1989. The results are presented in the Table 6.1. At the

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time of measurement, the sea was calm and wind was slight (<1m/s) with clear skies - relatively "quiet" meteorological conditions. Even so, the noise of surf on the beach provides a relatively high background noise level - 35 to 40 Leq dB(A). During more "average" meteorological conditions the surf and wind in trees would raise background noise by 5 dB(A), to 45 dB(A) Leq or more.

The Tasmanian Department of Environment have a standard noise criteria at residences in the vicinity of developments, as follows:

Daytime: 7 am to 7 pm - 45 dB(A) Leq
Night time: 7 pm to 7 am - 35 dB(A) Leq

At Naracoopa, it may be argued that due to the high background noise, these goals may be relaxed to 50 dB(A) Leq the daytime and 40 dB(A) Leq at night time.

It is possible that night time noise goals may be difficult to achieve at the residences on the northern perimeter of Naracoopa village. Two residences are within 200 m of the proposed mining along the modern sea beach. It is likely that mobile mining equipment will be restricted to day-light hours only. These noise impacts will be quantified in more detail in the EMP.

A detailed noise assessment will be a component of the EMP.

The potential increase in noise levels on proposed transport routes to Grassy, generated by increased heavy vehicle traffic, will also be a component of the noise assessment of the EMP. The proposed level of heavy vehicle use is unlikely to make a significant impact on the ambient noise levels along the transport route.

6.8 ARCHAEOLOGICAL ASPECTS

An archeological inventory of the Project Area is a requirement of the Department of Lands, Parks and Wildlife. The archaeological aspects to be addressed include both Aboriginal (Pre-European) and European settlement.

Archaeological survey work has been undertaken in February, 1989 by Ms Robyn Sim (Reference 6.003).

HISTORICAL SITES

The survey (and literature research) documents the occurrence of three historical sites:

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- 1) French Scientist expedition to the Antipodes, led by Baudin, established a campsite in 1802 at the mouth of the Fraser River. This site is well documented and is of great heritage significance.
- ii) An early sealer's camp thought to be in the vicinity of Cowper Point (Circa 1802) and possibly located at the sand blowout on the frontal dune. This is considered worthy of documentation.
- iii) The campsite of the Field Naturalists' Club Victoria located somewhere on Eldorado Creek. This is poorly documented and of little archaeological or heritage significance.

The proximity of these sites is illustrated on Figure 6.2.

The French Scientists Camp at Fraser River mouth will be preserved from the mining path of the Naracoopa East Deposit. The area recommended is:

"200 m of the foreshore of Fraser River mouth and 125 m inland from the highwater mark."

The actual area set aside will be determined for the EMP.

As a public relations exercise it is recommended that a commemorative plaque be prepared and positioned at the site.

The other two sites pose no constraint to the development. Mining of the frontal dune at Cowper Point is not proposed (possible sealer's camp). It is unlikely that remains of either camp will be identifiable.

ABORIGINAL PREHISTORY

It is thought that Aboriginal occupation ceased prior to 6,500 years ago. Recent depositional units since then are, therefore, sterile of archaeological artefacts, but these units may overlie archaeological artefacts. A predictive model for the occurrence of archaeological relics occurring within the subject area is therefore:

- i) artefacts would not be expected on the Naracoopa East and Cowper Point East deposits;
- ii) stone artefacts may occur on the surface of all other areas, more particularly on relict dune formations of Naracoopa West deposit rather than the Cowper Point West deposit;
- iii) there is likelihood of greater concentrations of artefacts near freshwater sources;

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- iv) the lack of suitable stone outcrops means dense artefact scatters are unlikely.

The survey located only one Aboriginal stone artefact, shown on Figure 6.2. An Aboriginal Site Recording Form for this find has been completed for later submission to the Archaeological Section of the Department of Lands Parks and Wildlife, Tasmania.

The report recommends that with the exception of the designated mineral deposit areas, mining and processing activity should be restricted to areas greater than 250 m from the major freshwater courses (Fraser and Sea Elephant Rivers, Eldorado and Blowhole Creeks) - see Figure 6.3.

Some further archaeological assessment may be required during the operational phases of the development, and this will be discussed with Ms Sim at the appropriate time.

The Senior Archaeologist with the Department of Lands Parks and Wildlife will be informed of any archaeological finds, including the one located during the survey to enable recording on the Tasmanian register.

The recommendations pose no constraint to mining of the mineral sand deposits as defined for the project, nor to the overall approval of the project development.

6.9 ECOLOGY

Discussions have been held with representatives of the King Island Council and the Tasmanian Government (specifically the Department of Lands, Parks and Wildlife) concerning the ecological issues on King Island.

Field surveys of flora and fauna within the Project Area have been undertaken during February, 1989, with species inventory lists and reports prepared.

FLORA

Ms Fiona Coates (Reference 6.005) identified and mapped the plant communities at a scale of 1:5 000 and a list of species occurring in the exploration licence area was prepared. The vegetation is broadly distributed according to geomorphology, distance from high tide mark, and drainage into floristic species associations. Fire history is also a factor in the pattern of plant communities.

No rare species were recorded during the course of the survey.

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No evidence of the cinnamon fungus, *Phytophthora cinnamoni* was found during the survey. The fungus was first recorded for King Island in 1960. It is considered the major threat to the survival of coastal heathland ecosystems in Tasmania. Although absent at the time of the survey, the composition of the vegetation indicates vulnerability to infection. The fungus is transmitted in wet conditions.

The following comments refer to conservation status:

- i) The area north of Naracoopa which has already been mined, is badly degraded and has no conservation value.
- ii) The Sea Elephant River flats have a high conservation value due to the population of *Sarcocornia quinqueflora* and *Sclerostegia arbuscula*, both species forming part of the diet of the Orange-bellied Parrot. In addition, the rare herb, *Calitriche sonderi* has been collected from this area.
- iii) The vegetation found within the Cowper Point East Deposit is probably reserved in the Lavinia Nature Reserve. It contains few weeds, but is subject to disturbance at present from both on- and off-road vehicles which have caused erosion around tracks, especially in the northern end. The majority of the deposit supports plant communities undisturbed other than by burning in the past. The foredunes have undergone partial invasion by Marram grass (*Ammophila arenaria*) and Sea Rocket (*Cakile* spp.) and as such are not considered to have high conservation priority botanically. The foredunes support species which form a part of the diet of the Orange-bellied Parrot (*Cakile* spp., *Acaena novae-zelandiae*).
- iv) The Old Shoreline System which contains all four sand deposits, as well as the potential areas of infrastructure, supports the *Banksia marginata* - *Leptospermum scoparium* heath community. The community is reserved in north western Tasmania and on Flinders Island, and is present in the Lavinia Nature Reserve. The community within the exploration licence is considered by local field naturalists as being the most intact of its kind on the island.

It is unlikely that rehabilitation after mining will fully restore plant communities and a decrease in species richness is likely due, probably, to altering the proximity of vegetation to the water table.

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Seed should be collected from the area prior to clearing works and indigenous species propagated under nursery conditions.

Further work should be undertaken to establish the exact presence of Phytopthera fungus.

Disturbance to vegetation should be kept at a minimum by restricting infrastructure sites and roads to defined areas. Undisturbed tracts of vegetation and corridors should be left where possible. This will minimise invasion by exotics, and weeds and the spread of fungus and provide a native seed source.

The ecological status of the proposed mining areas are such as not to warrant wholesale conservation. The communities are represented elsewhere on the island and no rare species are present. Ecological status is not a constraint to the development.

FAUNA

The species documented are all animals that would be expected in an area with the history of fire and disturbance that this area has had. The area is of no special ecological significance and is not unlike other areas of the island except that it has experienced less disturbance by grazing stock.

The species distribution, especially birds, is closely correlated to vegetation communities with species richness increasing with increased age or structural diversity.

Small animal trapping results (only one species caught - a ship rat) suggests overall low numbers in the area surveyed (Reference 6.004).

Evidence of feral cat tracks and scats in the area is noteworthy. Trapping of feral cats was previously attempted by Department of Lands, Parks and Wildlife to reduce numbers near the Orange-bellied Parrot (OBP) roosting areas.

The OBP is a rare and endangered species with a total population of 200 or less. A recovery plan has been endorsed by all States and the Commonwealth Government. A programme of captive breeding of the OBP as part of the recovery plan, has achieved encouraging results. The OBP is migratory and spends its summers in S.W. Tasmania and its winters along the coasts of Victoria and South Australia - arriving on King Island in mid-March and departs by June, with highest numbers in April. Some birds may remain on the island over winter. The migrants rarely stop again on their way back to Tasmania from South Australia and Victoria.

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Bird numbers reported to visit the Island vary greatly from 18 to 70. Birds numbers are globally stable with a total population of 200 or less.

The OBP has specific food requirements preferring the species of the tidal flat of the Sea Elephant River estuary. The birds also have a specific roosting habitat. The Lavinia Nature Reserve has been extended (in June, 1988) to provide a buffer area for the protection of the birds' habitat.

Two colonies of the short-tailed shearwaters (mutton birds) are located within the exploration area:

- i) Blowhole Creek - a colony of 7,600 burrows in an area of 2.5 ha (grid reference 528842);
- ii) Cowper Point - a similar number over an area of 2.5 ha (grid reference 540877).

Both colonies occur on or near the frontal dune. The season for taking mutton birds is generally the first two weeks in April each year with a bag limit of 50 birds per day. The birds are harvested mainly for local use, though some tourists may be involved. There are no commercial operations on the island. It is estimated that 25per cent of chicks are removed from the Blowhole rookery and less from Cowper Point due to poor access. All colonies are considered important and worthy of protection.

Direct disturbance of habitat in the mining path will have an unavoidable impact on fauna. This impact may be reduced by confining disturbance to the mineral deposit areas. The Lavinia and Reekara Nature Reserves hold representative populations of fauna but it would be preferable to leave tracts of undisturbed areas within the exploration licence area to act as reservoirs and corridors for animal movement. The following is recommended:

1. Mining proceed south to north from inside out. Mining activity in the north near the Lavinia Nature Reserve boundary should be planned to take account of migratory movements of OBP.
2. Disturbance should be confined to the mineral deposits as much as possible. The tall eucalypt community at the western edge of the Cowper Point West deposit should not be disturbed.
3. The known mutton bird colonies be excluded from any mining or related activity.

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4. That development not disturb the first line of sand dunes adjacent to the Cowper Point East deposit. These dunes will act as a buffer against strong northeast winds for protection of the rehabilitated areas.
5. That siting of infrastructure and processing plant(s) be carefully planned. Areas of tall vegetation communities should be avoided. The low heath community near the present rubbish tip would be a site of least disturbance to fauna.

The proximity of the OBP habitat within the Lavinia Nature Reserve to prospective mineral deposits is the most significant environmental constraint to the project.

Mr Peter Brown (Department of Lands, Parks and Wildlife) has supplied the following list of constraints to protect the OBP, in relation to mining activities at Cowper Point.

- i) Vehicle movements and access to the mining area and associated works should only be from the south. Car parks should be to the south of the operation.
- ii) Noise levels should be such that the operation is inaudible from the saltmarsh area used by the OBP.
- iii) Visual disturbance - plant, dredges, bulldozers, vehicles, etc. should not be visible from the Sea Elephant River Estuary.
- iv) Visual disturbance - lights will not be visible from, nor illuminate, the OBP saltmarsh area.
- v) Emissions - airborne emissions, will not affect OBP area.
- vi) Hydrology. Saltmarshes are fragile ecosystems very reliant upon specific hydrological conditions. The operation will not interfere with the hydrology of the Sea Elephant Estuary.
- vii) Introduced animals, plants and diseases. The operation should ensure that the risk of introduction is minimised. In particular no domestic animals should be brought into the area and dredges and other equipment should be cleaned prior to being brought into the area.
- viii) Fires should not be permitted and the operation should have a fire fighting capability to suppress any wild fires emanating from it.

6.10 LAND USE AND ZONING

The land within the proposed Mine Lease Application area consists of approx. 530 ha Crown Land and 911 ha freehold land.

Documentation of Landownership will be shown in the EMP.

Under the existing King Island Interim Planning order, the lands within the exploration area are zoned "rural," with the exception of the King's Paradise area which is zoned "village." Extractive industry mining is a permitted use in "rural" zoning but a prohibited use in "village" zoning. However, the Council can issue an absolute /conditional/temporary dispensation at its discretion.

The Commissioner for Town and Country Planning is (at the time of writing) preparing a new Planning Instrument for King Island. A presentation has been made to government representatives on the 8th December, 1988, specifically addressing the status of the art of rehabilitation following mineral sands mining. Various planning issues were canvassed at that meeting with the principal objective of having the mineral prospectivity of the exploration licence area recognised in any future Planning Instrument.

The area is currently under no existing landuse, and there are no other formal development proposals before the King Island Council (the vague King's Paradise proposed by Bloecker excepted).

6.11 VISUAL ASPECTS

In general, the mineral sands deposit between Naracoopa and Cowper Point are remote, with visual access limited.

The future mining path immediately north of Naracoopa will be visible from:

- i) Three holiday houses at the northern extremity of Naracoopa village;
- ii) The "Cleeland" residence and property;
- iii) The wharf at Naracoopa;
- iv) The air - distant views of the project area are possible from the Currie to Tasmania domestic air flight route.
- v) Distant views from a small section (200m long) of Pegarah Road, above Naracoopa.

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The dry plant facilities can be suitably screened behind existing vegetation from Sea Elephant Road.

6.12 TRANSPORTATION

Access to the mineral sand deposits between Naracoopa and Cowper Point is via the unsealed Sea Elephant Road. The Sea Elephant Road is wide, well formed and in a reasonable state of repair for light traffic.

Transport of wet concentrate by road to the dry plant poses no environmental impact for concern.

The proposed route for transport of mineral product from the dry plant at Naracoopa to Grassy Harbour is:

- Fraser Road, North Pegarah, (15.5 km, unsealed); Grassy Road (15 km, sealed) to Grassy Harbour.

The Fraser Road/North Pegarah Road is unsurfaced and needs re-surfacing. Council advise it has not been surfaced for at least 8 years, as it is situated midway from the Councils's northern and southern gravel sources.

There are 8 residences located within 100 m of the unsealed section of the transport route.

Traffic counts undertaken by King Island Council in July, 1988 are as follows:

Sea Elephant Road	-	4.45 AADT
North Pegarah Road	-	24.00 AADT
Fraser Road	-	57.4 AADT

There is little heavy vehicle use on these roads except for 6 movements per day by fuel tanker and occasional cattle tracks.

It is noteworthy that there is no provision for the King Island Council to obtain infrastructure or community contributions from developers by way of its Planning Permit. The possibility exists for a contribution to road use by way of back loading gravel from Council's southern pit in trucks returning from Grassy.

The product truck movements for the development involve 4 x 20t articulated truck, Naracoopa/Grassy return trips, per day.

There are no issues of environmental concern with respect to shipping of product from Grassy Harbour Wharf. Indeed the provision of extra shipping into Grassy may be considered advantageous to the community - by way of more frequent delivery of services to the Island.

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6.13 FIRE MANAGEMENT

The potential for outbreak of bushfire along the east coast of King Island is an issue that has been identified in discussions with both the King Island Council and the Department of Lands, Parks & Wildlife.

The dry summer period (December to March), when strong northeasterly winds persist, is a fire hazard period on King Island. Fire outbreak poses potentially serious consequences to the ecology of nature reserves and to settlement areas at Naracoopa.

Operational safeguards will need to be imposed and followed during the summer period, during both exploration and mining activity.

It may be argued that the availability of men, earthmoving equipment and access roads associated with the mining development will serve to provide improved fire management control on an area of the island previously inaccessible.

The possible provision for fire breaks and fire trails as a component of post mining rehabilitation objectives has received a positive response during preliminary discussion with the King Island Council and Department of Lands, Parks & Wildlife.

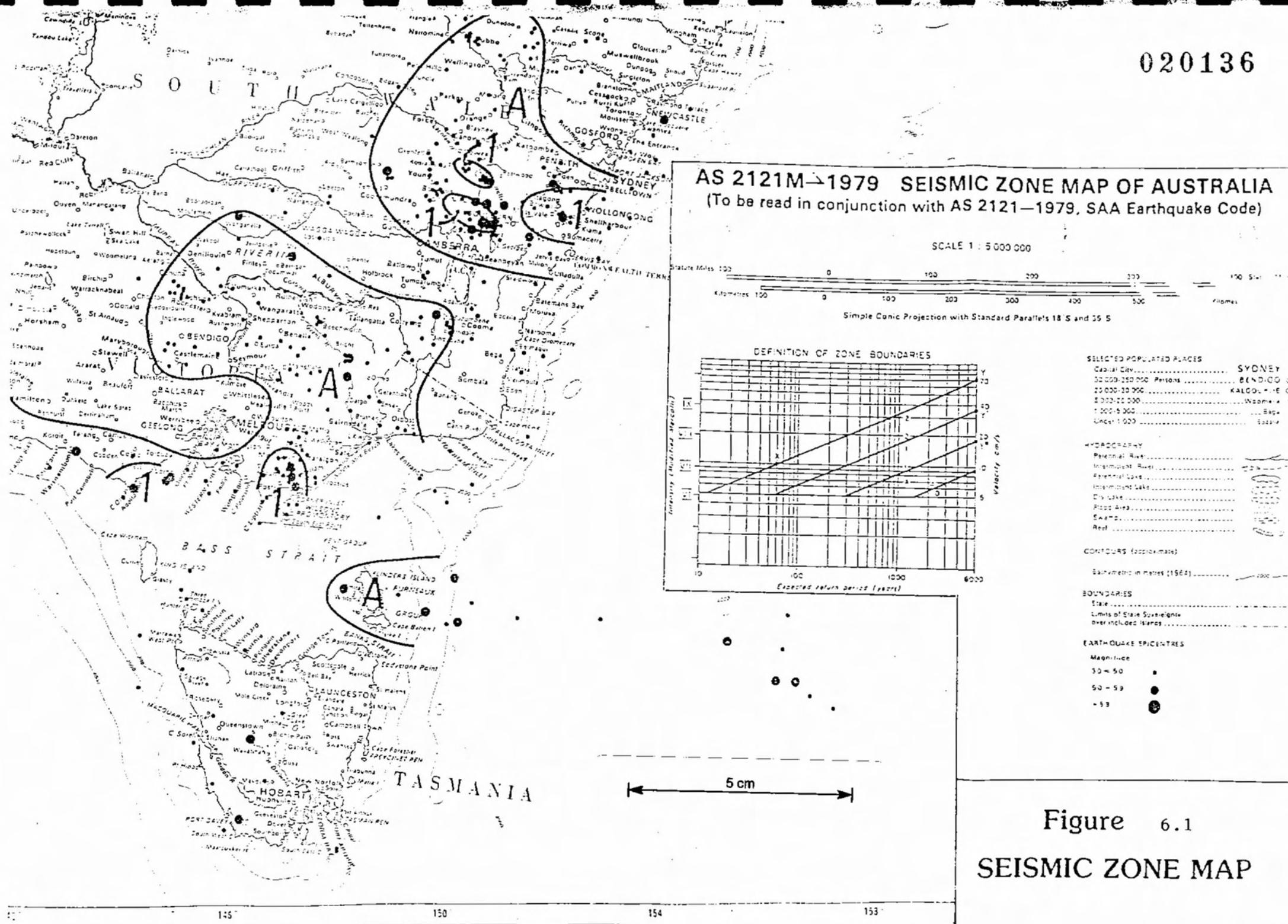


Figure 6.1
SEISMIC ZONE MAP

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- *1 - Sealers' camp area
- *2 - Snarers' campsite
- *3 - 1802 French Expedition Campsite

- #4 - Stone Tool Site

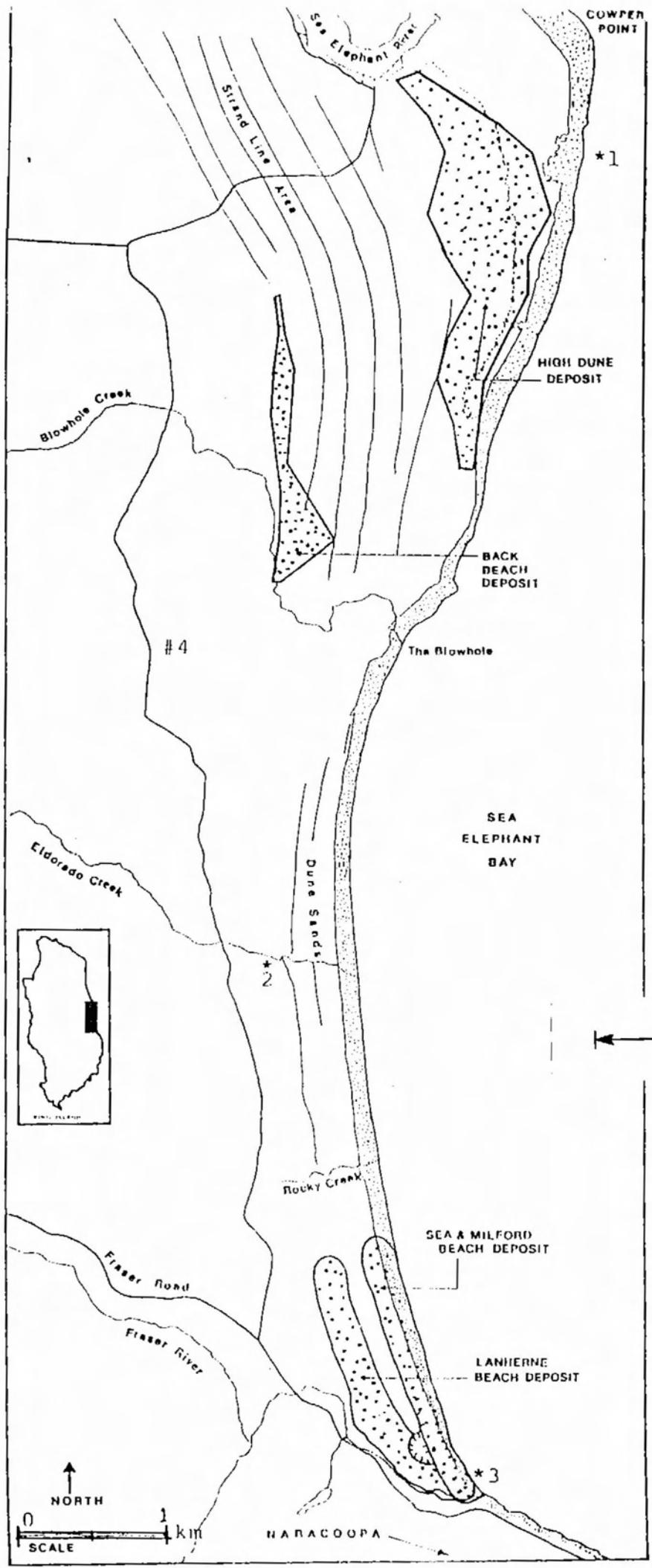


Fig. 6.2
Study Area
& Deposit
Locations

020138

Figure 6.3

Areas of prehistoric archaeological potential - areas recommended to be left undisturbed

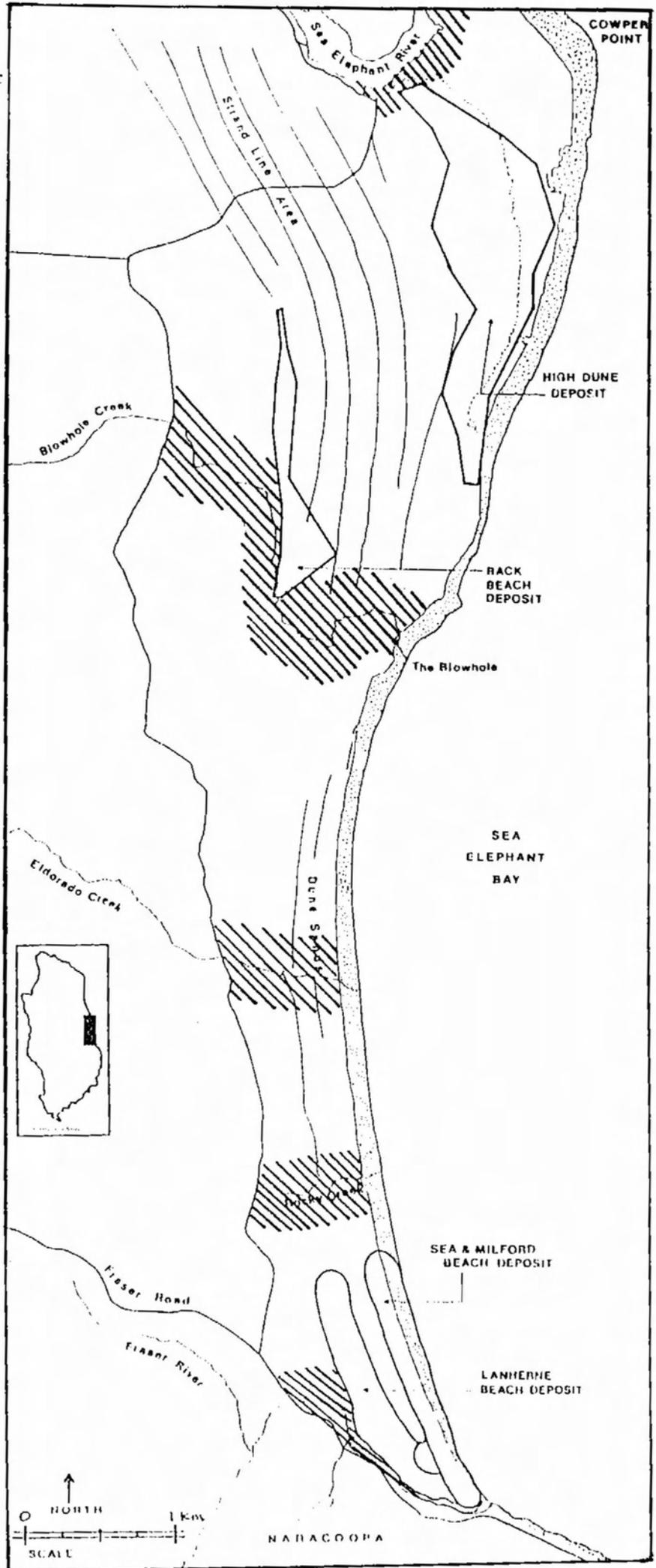


TABLE 6.1

Background Sound Level Measurements in the Vicinity of the Naracoopa Project site, King Island

Site No.*	Location	Late Afternoon			Night Time			Early Morning			Midday		
		L ₉₀ dB(A)	L _{eq} dB(A)	L ₁₀ dB(A)	L ₉₀ dB(A)	L _{eq} dB(A)	L ₁₀ dB(A)	L ₉₀ dB(A)	L _{eq} dB(A)	L ₁₀ dB(A)	L ₉₀ dB(A)	L _{eq} dB(A)	L ₁₀ dB(A)
N1	Naracoopa Picnic Ground	45	46 a,b	49	47	50 a,c	52	47	50 a,b	53	40	42 a,b,f	44
N2	Lease Boundary at Naracoopa	37	39 a,b	41	49	50 a,d	52	45	47 a,b,c	49	31	33 a,b,e,g	34
N3	OBP Roosting Area at Sea Elephant	36	38 a,b	40	39	40 a,b,e	43	47	48 a,b	50	29	32 a,b,d	34

	Date:	26th June 1989	26th June 1989	27th June 1989	27th June 1989
	Time:	4.30 - 5.30 pm	10.30 - 11.30 pm	7.30 - 8.30 am	12 noon to 1.00 pm
Field Conditions	Temp:	10° - 12°C	6° - 7°C	4° - 6°C	14°C
	Cloud Cover:	clear	clear	20% - 40%	clear
	Wind Speed:	still to 1 m/s	still to 1 m/s	still to 1 m/s	still to 1 m/s
	Wind Direction:	NE	SW	SW	NE

* See Figure for location

NOTE: L₉₀ = Sound level exceeded 90% of the sampling time.
 L_{eq} = Level of continuous noise which emits the same energy as a fluctuating sound over a fixed period
 L₁₀ = Sound level exceeded 10% of the sampling time

Noise Sources (given in order of audibility)

- | | |
|-------------------------|---------------------|
| (a) waves/surf on beach | (e) frogs |
| (b) bird calls | (f) distant traffic |
| (c) generator (distant) | (g) sheep |
| (d) wind in trees | |

S E C T I O N 7.0

R E H A B I L I T A T I O N

- 7.1 INTRODUCTION
- 7.2 GENERAL REHABILITATION OPERATIONS
- 7.3 NARACOOPA EAST
- 7.4 NARACOOPA WEST
- 7.5 COWPER POINT EAST
- 7.6 COWPER POINT WEST
- 7.7 POST MINING MAINTENANCE LIABILITY
- 7.8 DECOMMISSIONING

SECTION 7 - REHABILITATION

1

7.1 INTRODUCTION

. PURPOSE OF THE REHABILITATION PROGRAMME

It is proposed to mine the sand deposits near Naracoopa on King Island for heavy minerals. Experience obtained during the last 20 years in other parts of Australia has shown that coastal sands supporting native vegetation communities can be mined and the native vegetation re-established, provided careful attention is paid to implementing a range of proven rehabilitation techniques.

The volume of heavy minerals extracted by the mining process is small and the main landscape features can be restored with no apparent volume change. Topsoil is removed and conserved during mining, to be returned to the surface of the area after mining. This is a crucial aspect of the rehabilitation process, since the topsoil is the reservoir of plant nutrients, plant propagules (seeds, rhizomes etc.) and micro-organisms, and the organic matter enhances water retention in the soil.

Subsequent rehabilitation operations entail collection and planting of native seeds, the planting of seedlings raised in the nursery, the application of small amounts of fertilisers, erection of temporary windbreaks etc.

For the purpose of this study it is assumed that land will be rehabilitated to landforms and vegetation similar to that which prevails before mining commence.

The rehabilitation programme for each area is described in detail in this section. The detail is based on a flora survey and soil investigations conducted by F. Coates. See references 6.005 and 6.006.

. A BRIEF HISTORY OF THE DEVELOPMENT OF REHABILITATION TECHNIQUES IN THE HEAVY MINERAL SAND MINING INDUSTRY IN AUSTRALIA

Heavy mineral sand mining commenced in Australia in the 1930's, on the far north coast of New South Wales. In those days, horsedrawn scoops scraped up the concentrate from the beaches and bagged it for shipment overseas to be processed.

After World War II the uses for these minerals developed and demand increased. Small mining plants were built to dredge the beach deposits and remove the siliceous sand, before the heavy mineral concentrate was exported. Subsequently, the heavy mineral concentrate was dried and sorted into its component minerals before being exported.

SECTION 7 - REHABILITATION

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Rehabilitation initially was rudimentary or non-existent. For example, the east coast of North Stradbroke Island was mined in the 1950's and left as bare sand, because there were no rehabilitation provisions in the mining lease. (This area was re-mined during the 1970's and successfully rehabilitated). During the 1950's and 1960's the New South Wales Soil Conservation Service became increasingly involved in coastal mining rehabilitation. Stabilisation of the dunes was their principal objective and little attention was given to the return of native ecosystems.

When mining was confined to the frontal dunes, rehabilitation was fairly straightforward. The mined dunes were stabilised with brush matting (branches cut from standing vegetation, often on the mining path). Horsetail oaks, Coastal wattle and Beach spinifex were the principal species planted on the dune. The companies established nurseries to raise seedlings for the purpose.

The readily available beach deposits of heavy minerals were becoming exhausted by the late 1960's and the companies discovered concentrations of minerals in sand deposits further inland, usually supporting more complex ecosystems such as elevated heaths, forests, wet heaths and swamps. The mineral grades were often low, requiring large plants capable of mining the deposits economically.

By the early 1970's the industry was concentrated on the coast of New South Wales and Queensland and a number of companies were commencing mining operations in a variety of environmentally sensitive areas. There was also some mining on agricultural lands on the west coast, south of Perth.

Rehabilitation standards rose rapidly to meet the new demands of mining in these new areas. Many of the techniques that have since become standard practice in the industry were developed during this period.

It became standard practice to carry out a detailed topographical and vegetation survey of the area to be mined. The landforms and plant communities were mapped and plant species listed. A soil survey and description, and an assessment of the fauna of the area also became common features of the pre-mining environmental studies.

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This information provided the basis for planning the post-mining rehabilitation programme. Soil handling techniques, the collection of seeds of various species, wind reduction techniques, nursery seedling requirements and a fertilising programme could be planned.

Regular monitoring of the developing rehabilitation became standard practice. This is essential to ensure that all facets are developing as planned. Areas requiring attention can be quickly identified and appropriate remedial action taken, for example surface stabilisation, additional plantings, fertilising.

Monitoring should continue until the area has developed to a stage where it can be assessed as self-supporting and requiring no further inputs from man.

The areas proposed for mining at Naracoopa have tall shrubs as their major plant communities. There are smaller areas of open forest.

If the appropriate rehabilitation practices described in the following pages are carried out correctly, after a period of five years the shrubland and heath communities should be well-established, although still not mature communities. The forest communities should also be established in an immature condition after five years but will require a much longer period to approach a mature state.

The objective of the rehabilitation programme is to ensure the stability of the mined area and to re-establish the basic fundamentals of a plant community so that it can develop over time into a stable, self-regenerating system resembling the pre-mining condition.

7.2

GENERAL REHABILITATION OPERATIONS

. PRE-MINING OPERATIONS

The following standard operations should be carried out in advance of mining. They are normally planned as an integral part of the mining operation and are carried out in an orderly, sequential manner, after taking seasonality aspects into consideration.

The mining operation proposed is a continuous dredging operation, which gradually moves along a planned mining path. This method of operation allows a complete chain of events to be carried out, from pre-mining preparation of the land in advance of mining to the implementation of the rehabilitation programme behind the mining operation.

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Each activity will be carried out to a greater or lesser degree depending on the nature of the area. The appropriate recommendation for each area proposed for mining is described in detail in the later sections.

The use of supplementary dry mining techniques does not change these principles of rehabilitation.

Collection and storage of seeds of the major plant species.

These seeds are collected and stored for the following purposes:

- the production of seedlings in the nursery
- broadcasting on rehabilitation areas.

Native seeds collected in this way should be stored under dry cool conditions to prolong their life.

Removal of vegetation in advance of mining.

This may be removed in one or two layers, depending on the type of vegetation community.

Disposal of vegetation in advance of mining.

This may be by burning large plants infrequently on the mining path, by cutting branches for use as brush matting, harvesting by a machine called a tritter for use as a mulch on rehabilitated areas, or removal and incorporation in the soil stockpile. Where possible, in the areas of flatter topography, trees and large shrubs will be conserved and returned to the mined area to enhance faunal micro-habitats.

Stripping of topsoil

The topsoil is the organically enriched layer of sand near the surface. Its depth will depend on the nature of the plant community and the degree of soil development. A topsoil is sometimes removed in two layers.

Stockpiling of soil

Topsoil should be stored in long, low heaps beside the mining path to facilitate its return to the mined area. The heaps should be low to reduce the risk of erosion and to prevent heat build-up in the heaps through breakdown of organic matter, with consequent adverse effects on seeds.

SECTION 7 - REHABILITATION

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. POST-MINING OPERATIONS

Shaping of tailings

This is accomplished roughly by the boom stacker behind the mining plant and finished by the bulldozer. By these means it is possible to restore the heights and general topographical features that existed before mining. It is not possible to reconstitute micro-topographical features.

The return of tailings using a land line will be necessary in some areas.

Spreading of topsoil from the stockpiles

This is usually carried out by bulldozer. It is important to ensure that the soil is spread evenly over the mined tailings.

Planting of a temporary cover crop

This provides protection to the soil surface and to the emerging native plants. A range of plants may be used and cereal rye is commonly used under cooler conditions.

Broadcasting of native seeds

Seeds of the major plant species in each community should be broadcast when the cover crop is planted and the soil has been freshly cultivated.

Erection of temporary windbreak fences

Such fences are necessary when mined areas are exposed to strong prevailing winds. Nylex welded mesh has been found to be the best material and it can be taken down when no longer required and re-used on other areas. The spacing between fences will depend on the topography and the degree of exposure to prevailing winds.

Planting of native seeds

The seeds of some plants, especially Banksias, are difficult to obtain in large quantities and need to be planted individually.

Monitoring progress of rehabilitation

Regular inspections of the developing rehabilitation should be carried out and remedial action taken if necessary.

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Planting of native seedlings

Seedlings of the major species raised in the nursery should be planted out, to densities indicated by the monitoring programme. The seedling programme is intended to be a supplement to the seed broadcast programme. A site nursery should be established for this purpose before mining commences.

Monitoring of progress of rehabilitation

Regular monitoring is required to detect any losses of native plants or other setbacks in the rehabilitation programme.

Planting of additional seedlings as required

This will be indicated by the monitoring programme.

Continuation of regular monitoring

Regular monitoring should continue until the mining lease is relinquished.

7.3 **NARACOOPA EAST****. EXISTING CHARACTERISTICS****Typography**

Low foredune with some truncated hind dune, and subdued topography to the west.

Degree of exposure

Foredune subject to on-shore winds.

Soils

Naracoopa sand, typically

A₀ horizon 0-3 cm
A₁ horizon 3-60 cm

Vegetation communities

Most of this area has been previously mined. The area is covered principally with tall shrubland (11), disturbed foredunes (12), with open scrub (10, 19), closed heath on secondary foredunes (7) and pioneer herbfield on undeveloped foredune (5).

SECTION 7 - REHABILITATION

7

. PRE-MINING OPERATIONS

Collecting native seeds

Collect seeds of the following species: *Acacia mucronata*, *A. sophorae*, *A. verticillata*, *Melaleuca ericifolia*, *M. squarrosa*, *Eucalyptus ovata*, *Leptospermum laevigatum* and *Banksia marginata*.

Removing vegetation

Push and heap for burning any trees and large shrubs. Remaining vegetation should be stripped with the topsoil. Any burning would be carried out at infrequent intervals in accordance with local fire control regulations.

Stripping topsoil

Strip the 0-30 cm layer of topsoil and stockpile beside the mining path in long heaps, 1-2 m in height.

. POST-MINING OPERATIONS

Contouring tailings

Contour the mined sand to conform with pre-mining landforms as closely as possible. The pre-mining contours should be used as a guide.

Spreading topsoil

Spread topsoil from stockpiles evenly over tailings.

Cover crop

Plant temporary cover crop, e.g. cereal rye depending on the season. Use a low rate of high nitrogen/low phosphorus fertiliser.

Broadcasting native seeds

Broadcast seeds of *Acacia* spp., *Leptospermum* spp., *Melaleuca* spp. and *Eucalyptus* sp. on areas where these species occurred before mining, using vegetation map as a guide.

Planting marram grass

Plant marram grass as required on the foredune berm.

SECTION 7 - REHABILITATION

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Laying brush-matting

Lay brush-matting (cut from areas to be mined) on foredune slopes.

Planting native seeds

Plant seeds of *Banksia marginata* individually in areas where these occurred before mining.

Planting seedlings

Plant seedlings of *Acacia* sp., *Leptospermum* sp., *Melaleuca* sp., *Eucalyptus* sp. and *Banksia* sp. as determined by monitoring.

7.4

NARACOOPA WEST**. EXISTING CHARACTERISTICS****Topography**

The topography is subdued in nature.

Degree of exposure

The area is protected from prevailing westerly winds.

Soils

Naracoopa sand, typically

A₀ 0-1 cm
A₁ 1-6 cm

Vegetation communities

Much of the area has been previously mined. The principal vegetation comprises open scrub (10,18), tall shrubland (11), with some closed scrub (21) and low woodland - open forest (23).

. PRE-MINING OPERATIONS**Collecting native seeds**

Collect seeds of the following species: *Acacia mucronata*, *A. sophorae*, *Leptospermum scoparium*, *Eucalyptus ovata*, *E. viminalis*, *Banksia marginata*, *Melaleuca squarrosa* and *Allocasuarina monilifera*.

SECTION 7 - REHABILITATION

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Much of the area has been previously mined so the reservoir of native seeds in the area may be expected to be low. Adequate quantities of seeds of native plants should be collected for later use in rehabilitation and production of nursery stock.

Removing vegetation

Push and heap for burning on the mining path any trees and large shrubs. The remaining vegetation should be stripped with the topsoil. Any burning would be carried out at infrequent intervals in accordance with local fire control regulations.

Stripping topsoil

On the previously mined areas strip the surface 0-10 cm layer of topsoil and conserve. On other areas strip the 0-30 cm layer of topsoil and conserve. The soil should be stockpiled beside the mining path in long heaps 1-2 m high.

. POST-MINING OPERATIONS**Contouring tailings**

Contour the mined sand to conform with pre-mining landforms as closely as possible. The pre-mining contours should be used as a guide.

Spreading topsoil

Spread topsoil from the stockpiles evenly over the tailings.

Cover crop

Plant a temporary cover crop, e.g. cereal rye depending on the season. Use a low rate of a high nitrogen/low phosphorus fertiliser.

Broadcasting native seeds

Broadcast seeds of *Acacia mucronata*, *A. sophorae*, *Leptospermum scoparium*, *Eucalyptus ovata*, *E. viminalis*, *Melaleuca squarrosa* and *Allocasuarina monilifera*.

Planting native seeds

Plant seeds of *Banksia marginata* individually in areas where these plants occurred before mining.

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Planting native seedlings

Plant seedlings of *Acacia mucronata*, *A. sophorae*, *Leptospermum scoparium*, *Eucalyptus ovata*, *E. viminalis*, *Melaleuca squarrosa*, *Allocasuarina monilifera* and *Banksia marginata* as determined by mining monitoring.

7.5

COWPER POINT EAST**. EXISTING CHARACTERISTICS****Topography**

The area consists of dunes of medium height, rising to approximately 40 m above sea level. The holocene dunes are crisply defined, with protected swales between the dune ridges.

Degree of exposure

Because of its elevated situation, the area is exposed to prevailing westerly winds.

Soils

These consist of Naracoopa sand, typically A₁ 0-9 cm.

Vegetation communities

The principal community on the area is tall shrubland-heath (8), with some closed heath (7).

. PRE-MINING OPERATION**Collecting native seeds**

Collect the seeds of the following species: *Leptospermum laevigatum*, *L. scoparium*, *Acacia sophorae*, *A. mucronata*, and *Banksia marginata*.

Removing vegetation

Push and heap for burning on the mining path any large shrubs. Remaining vegetation should be stripped with the topsoil. Any burning would be carried out at infrequent intervals in accordance with local fire control regulations.

SECTION 7 - REHABILITATION

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Stripping topsoil

The 0-10 cm layer is a sharply defined zone of organically enriched sand and this should be carefully removed and stockpiled beside the mining path in long heaps 1-2 m high.

. **POST-MINING OPERATIONS****Contouring tailings**

Contour the mined sand to conform with pre-mining landforms as closely as possible. The pre-mining contours should be used as a guide.

Spreading topsoil

Spread topsoil from the stockpile evenly over the tailings.

Cover crop

Plant a temporary cover crop, e.g. cereal rye depending on the season. Use a low rate of a high nitrogen/low phosphorus fertiliser.

Broadcasting native seeds

Broadcast seeds of *Leptospermum laevigatum*, *L. scoparium*, *Acacia sophorae*, and *A. mucronata*.

Temporary fences

Erect temporary fences of Nylex weld mesh at right angles to the prevailing winds.

Planting native seeds

Plant seeds of *Banksia marginata* individually.

Planting native seedlings

Plant seedlings of *Leptospermum laevigatum*, *L. scoparium*, *Acacia sophorae*, *A. mucronata* and *Banksia marginata* as determined by monitoring.

7.6

COWPER POINT WEST. **EXISTING CHARACTERISTICS****Topography**

The area has a subdued topography.

SECTION 7 - REHABILITATION

12

Degree of exposure

The area has a low degree of exposure to prevailing westerly winds.

Soils

The soil on the area is Lappa sand, typically

A₀ 0-3 cm
A₁ 7.20 cm

Vegetation communities

The principal community on the area is open scrub (18), with tall shrubland (16), low open woodland-open forest (22) and open forest (25).

. PRE-MINING OPERATIONS**Collecting native seeds**

Collect seeds of the following species: *Banksia marginata*, *Eucalyptus viminalis*, *Melaleuca squarrosa*, *Leptospermum scoparium*, *Acacia mucronata* and *A. verticillata*.

Removing vegetation

Push and heap for burning on the mining path any trees and large scrubs. The remaining vegetation should be stripped with the topsoil. Any burning would be carried out at infrequent intervals in accordance with local fire control regulations.

Stripping topsoil

Strip the 0-20 cm layer of soil and stockpile beside the mining path in long heaps 1-2 m high.

. POST-MINING OPERATIONS**Contouring tailings**

Contour the mined sand to conform with pre-mining landforms as closely as possible. The pre-mining contours should be used as a guide.

Spreading topsoil

Spread topsoil from the stockpiles evenly over the tailings.

SECTION 7 - REHABILITATION

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Cover crop

Plant a cover crop, e.g. cereal rye depending on the season. Use a low amount of a high nitrogen/low phosphorus fertiliser.

Broadcast native seeds

Broadcast seeds of *Acacia mucronata*, *A. Verticillata*, *Eucalyptus ovata*, *E. Viminalis*, *Leptospermum scoparium*, and *Melaleuca squarrosa* on areas where these species occurred before sandmining, using vegetation map as a guide.

Planting native seeds

Plant seeds of *Banksia marginata* individually in areas where these occurred before mining.

Planting native seedlings

Plant seedlings of *Banksia marginata*, *Acacia mucronata*, *A. verticillata*, *Eucalyptus ovata*, *E. viminalis*, *Leptospermum scoparium*, and *Melaleuca squarrosa* as determined by monitoring.

7.7

POST-MINING MAINTENANCE LIABILITY

The post-mining maintenance liability is an area which will be dealt with in the detail of the Mine Lease conditions. It is to be expected that the Tasmanian Department of Mines will be guided by industry experience in other states and, based on this, the project can expect to provide a bond, in the form of a bank guarantee, which will only be released by the Department of Mines approval. The size of the bond would be in accordance with the degree of difficulty of the rehabilitation. This subject has not been raised with the Department of Mines because there should be some degree of negotiation open to the project at the time of application.

It should be noted that industry experience shows that, depending on the nature of the area mined, the post-mining maintenance liability can be around ten years. Generally this just reflects time taking its course and not a heavy annual commitment of money, men and materials. However, progress would be assessed annually after the end of the second year after rehabilitation and any further remedial work identified.

Post-mining maintenance liability depends on the land use ultimately decided upon - however, to reiterate, this study is based on rehabilitation to similar conditions to those existing before mining.

A Minimum
10,000 hectares
must be annually
renewed annually

S E C T I O N 8.0

M A R K E T I N G

- 8.1 INTRODUCTION
- 8.2 NARACOOPA PRODUCTS
- 8.3 PRODUCTION PRICING
- 8.4 MARKET STRATEGY

SECTION 8.0 MARKETING

1

8.1 INTRODUCTION

The main minerals of commercial interest in the Naracoopa sand are rutile and zircon. The ilmenite produced from Naracoopa is high in chrome content (over 1.5% Cr₂O₃) and hence will be of no interest to pigment producers who demand chrome values below 0.2% and preferably below 0.1%. The feasibility study base case is therefore based on the sale of rutile and zircon only.

There are considerable quantities of leucoxene (or altered ilmenite) present in the Naracoopa mineral suite and the only analysis available indicates a TiO₂ content of 75.7%. An alternative to the base case includes for the separation and recovery of leucoxene.

The dominant use for titania (TiO₂) minerals such as rutile, leucoxene and ilmenite is in the production of TiO₂ pigment. World demand for TiO₂ pigment is around 2,800,000 tonne per annum. The pigment is used in a variety of applications, including:

Paints and coatings	60%
Plastics	15%
Paper	15%
Other (rubber, ink, fibres, ceramics)	10%

The world pigment industry is dominated by a few large companies including Du Pont, SCM, the Tioxide Group and NL Industries. The titanium dioxide pigment industry is passing through a strong growth period at the present time and new pigment plants have been recently commissioned or planned in a number of countries, including Canada, US, Europe, Singapore, Australia, South Korea and Taiwan. Overall growth in pigment demand is projected to average 2-3% p.a. over the next five years.

There are a number of large new mineral sands projects and expansions of existing operations competing to supply the resultant increase in demand for TiO₂ raw materials. The major new projects/expansions which are scheduled to come on stream over the next 2-3 years include Cooljarloo (new), Cable Sands (expansion) and AMC (expansion) in Western Australia as well as Richards Bay (expansion) in South Africa and BHP's Rocky Point project in Queensland. In the longer term, a major new ilmenite project is being developed in Madagascar and BHP is reported to have discovered a major mineral sands resource in Western Australia. CRA has a major mineral sands resource near Horsham in Victoria. There are also a large number of smaller mineral sands projects being developed around the world.

The major markets for zircon are in foundry use and steelworks refractories. The other important use of zircon is in ceramics as an opacifier where zircon can replace the

SECTION 8.0 - MARKETING

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more expensive tin oxide in many cases. Growth in zircon demand in the ceramics areas has been particularly strong in recent years and this is expected to continue. Total world zircon demand is around 800,000 tonne per annum with growth projected at around 3-4% p.a.

It is generally recognised that there is currently a supply deficiency in the zircon market and this has resulted in extremely high prices being paid for small quantities of zircon (particularly for premium quality zircon suitable for ceramic applications). This supply deficiency is expected to disappear over the next few years as new mineral sands projects are developed.

Mineral sands companies are currently enjoying excellent profits following substantial rises in prices for rutile, zircon and ilmenite. Demand and supply for TiO_2 minerals is generally in balance. However, with the development of major new projects this situation could be reversed over the next few years. The buoyant profit position is attracting new participants to the industry and almost all existing mineral sands producers are now committed to expansions. The current price levels enjoyed by rutile and zircon are not necessarily indicative of future trends.

8.2 NARACOOPA PRODUCTS

Naracoopa will be a relatively small producer of mineral sands products, with an expected mine life of around six years. Annual rutile production of around 7-10,000 tpa represents less than 0.3% of world TiO_2 demand, whilst zircon production at 9-12,000 tpa represents around 1% of world zircon demand.

The quality of Naracoopa rutile produced in laboratory tests is compared in Table 4.1 with that of current major producers. It is seen that on the basis of this sample, Naracoopa rutile compares favourably with other rutile grades and hence should be readily marketable as a feed to pigment plants. Naracoopa rutile (see Table 4.2) is finer in size than RZM or AMC rutile, but somewhat coarser than CRL rutile. Again, no problems are seen with the marketability of this size distribution.

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COMPARISON RUTILE GRADES

%	NARACOOPA TAS	RZM NSW	CRL QLD	AMC WA	RBM STH AFRICA
TiO ₂	96-97	96.2	95.5	95.2	93.5
ZrO ₂	0.22	0.75	0.69	0.9	1.8
Fe ₂ O ₃	1.1	0.45	0.53	0.85	1.2
SiO ₂	0.65	0.70	0.72	0.7	2.0
Al ₂ O ₃	0.37	0.35	0.30	0.6	0.5
Cr ₂ O ₃	0.21	0.20	0.16	0.15	0.12
V ₂ O ₅	0.53	0.70	0.75	0.6	0.45
CaO	0.01	0.05	0.03	0.01	0.15
MgO	0.015	0.05	0.03	0.01	0.05

TABLE 8.2

RUTILE SIZE DISTRIBUTION

APERTURE um	% RETAINED (CUMULATIVE)			
	NARACOOPA	RZM	CRL	AMC
250	-	0.8	trace	3
180	1.3	15.5	1-3	50
125	44.5	74.5	21-25	94
90	96.1	98.0	89-91	99
63	99.7	99.9	97-98	100
45	100	100	100	100

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It is proposed to produce two grades of zircon. The proposed premium quality zircon as shown in Table 3 will be a readily acceptable material in all market conditions and compares favourably with other high quality zircon products (but is not as attractive in iron, alumina and phosphorus contents as Premium A RZM material). The B grade material will be at least comparable with generally accepted standard grade specifications for this material and although cannot be stated there is sufficient flexibility in the final zircon treatment to ensure this.

T A B L E 8.3
COMPARISON ZIRCON GRADES

%	Naracoopa (3t test) Premium	RZM		CRL	AMC	RBM
		A Grade	B Grade			
ZrO ₂	66.2	66.5	66.2	66.3	66.4	65.9
TiO ₂	0.08	0.09	0.25	0.12	0.23	1.14
Fe ₂ O ₃	0.06	0.025	0.04	0.05	0.07	0.08
Al ₂ O ₃	0.19	0.09	0.13	0.29	0.35	0.17
P ₂ O ₅	0.16	0.09	0.13	0.12	0.06	0.12
SiO ₂	33.2	33.2	33.2	33.0	32.5	32.0

The leucoxene analysis available to date is as follows:

TiO ₂	75.7%
Fe ₂ O ₃	11.5
FeO	1.3
ZrO ₂	0.1
Al ₂ O ₃	2.63
SiO ₂	2.50

This is essentially an "altered ilmenite" and would not command a significant premium over ilmenite.

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8.3 PRODUCTION PRICING

Average export prices for Australian rutile and zircon are shown in Table 4.4. Both commodities are currently trading at historically high price levels (in real terms).

The export price for bulk rutile averaged \$580 per mt in 1987 and 1988 but prices have improved to the \$600-\$700 per mt level in 1989. The twenty year average export price in real 1989 terms for rutile is \$550 per mt and with a firm market expected to continue for some time, a price of \$600 per mt (1989 \$) for rutile has been used in the base case of the feasibility study.

Zircon has been traditionally a by-product of the mineral sands industry and as such has suffered severe price fluctuations. During supply shortages in 1974-75, prices increased seven-fold to over \$200 per mt (equivalent to \$700 per mt in 1989 values) but subsequently prices fell back to below \$70 per mt. The average long term price for Australian export zircon is around \$250 per mt (1989 real terms). Zircon has been in severe shortage since late 1987 and has again experienced rapid price increases.

In the second half of 1987, the export prices averaged \$230 per mt and this had increased to \$450 per mt by the end of 1988. Bulk export prices are around \$500-\$600 per mt for 1989 delivery with spot prices much higher again. Small quantities of high quality zircon have sold for up to \$2,000 per mt during recent shortages.

It is difficult to forecast how long the current shortage of zircon will continue, but major producers such as AMC are planning to increase output in an attempt to stabilise prices. Much of the foundry market has already been lost and there is severe threat of substitution of zircon (from alumina etc) in the steelmaking refractory area. With little substitution threat in the ceramics area, a two-tiered pricing structure has emerged for zircon but this is expected to moderate once the supply/demand balance comes back into equilibrium.

It is unlikely that any substantial quantities of Naracoopa zircon will be available to the market before the first half of 1991 and the demand/supply imbalance for zircon may well have moderated by then. Zircon prices, however, are forecast to remain firm given reasonable economic conditions and hence a long term price of A\$500 per mt (1989 values) for good quality zircon has been used in the feasibility study. If the zircon shortage continues then there is considerable up-side on this price in the first year or two of production.

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Leucoxene pricing is difficult to evaluate due to the relatively small market so three prices have been chosen for analysis - \$100/t, \$200/t and \$300/t with the lower numbers the more likely prices achieved.

8.4 MARKET STRATEGY

The Naracoopa project is characterised by a number of features which will impact on an appropriate market strategy for the project, viz.

- . relatively small scale of production
- . limited life of reserves
- . production remote from major markets
- . difficult and limited size of shipping operations
- . construction during a period of record high mineral sands prices.

These features suggest the following broad market strategy:

- . early negotiation of base contracts (say 3-5 years) with major rutile and zircon consumers to reflect current high term opportunities
- . reliance on a substantial portion of "spot" sales rather than long term contracts in order to take advantage of short term opportunities
- . emphasis on higher valued end-use markets for zircon where premium quality zircon can command substantial price premiums in an under-supplied market
- . emphasis on the Asian market to minimise Naracoopa's freight disadvantages
- . examination of the potential for higher valued products (such as toll conversion to micronised zircon).

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TABLE 8.4

AUSTRALIAN MINERAL SANDS EXPORTS (BULK, FOB)

YEAR	RUTILE		ZIRCON	
	QUANTITY 000 t	AVE PRICE \$ per t	QUANTITY 000 t	AVE PRICE \$ per t
1969	299.1	85.22	315.9	39.10
1970	368.2	94.39	379.8	36.52
1971	330.6	108.33	366.0	36.30
1972	313.1	115.73	380.8	35.95
1973	335.2	118.98	428.8	36.97
1974	344.5	140.01	384.4	83.80
1975	319.0	188.23	299.3	194.42
1976	346.8	209.03	350.5	155.90
1977	246.7	216.84	327.8	110.27
1978	371.3	186.25	390.0	75.41
1979	317.7	218.21	479.4	69.07
1980	315.3	281.62	501.8	69.86
1981	216.0	296.62	444.1	83.28
1982	199.2	255.28	405.2	106.27
1983	217.6	247.88	379.9	117.76
1984	191.5	302.95	437.7	118.37
1985	211.7	394.26	495.8	128.82
1986	229.6	506.88	445.6	167.15
1987	256.8	583.00	465.0	233.00
1988	244.5	576.00	471.6	397.00

SECTION 9.0

PROJECT DEVELOPMENT

- 9.1 GENERAL
- 9.2 STATUTORY APPROVALS
- 9.3 MINERAL OWNERSHIP
- 9.4 MINING LEASE
- 9.5 ENVIRONMENTAL MANAGEMENT PLAN
- 9.6 PLANNING PERMIT
- 9.7 LAND STATUS AND OWNERSHIP
- 9.8 COMPENSATION AGREEMENTS
- 9.9 PROPOSED KINGS PARADISE DEVELOPMENT
- 9.10 SUMMARY OF COMPENSATION PAYMENTS, ROYALTIES
AND OTHER GOVERNMENT CHARGES
- 9.11 PROJECT ORGANISATION
- 9.12 DETAILED ENGINEERING DESIGN
- 9.13 PROJECT SCHEDULE
- 9.14 PROCUREMENT
- 9.15 FIELD CONSTRUCTION
- 9.16 CONTRACT PLAN
- 9.17 TEMPORARY CONSTRUCTION FACILITIES
- 9.18 COMMISSIONING

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9.1 GENERAL

This section details the Statutory Approvals needed for the project to proceed. It deals with such issues as: land status and ownership; mineral ownership; landowner compensation; rights of objection and appeal.

This section also outlines the basic method and programme proposed for the physical implementation of the project.

For this study it is assumed that the Naracoopa Project joint venturers will appoint an engineer-constructor organisation to carry out the engineering design, procurement, construction management and commissioning of the project facilities.

9.2 STATUTORY APPROVALS

INTRODUCTION

Mining development in Tasmania is subject to the requirements of numerous legislation. These requirements are implemented through a 3 way approval system consisting of

- i) The Mining Lease - administered by the Tasmanian Department of Mines.
- ii) The Licence to Operate - administered by the Tasmanian Department of Environment.
- iii) The Planning Permit - administered by the King Island Council.

There is little formal networking evident within the Tasmanian Government project approval system and the following information has been compiled to illustrate the approvals necessary for the project to reach development stage in a minimum time. Environmental assessment is specifically addressed.

The approvals schedule aims to run the processing of approvals concurrently to minimise delays while satisfying specific formal requirement.

The Environmental Management Plan (EMP) is prepared specifically in support of a Licence to Operate but is a key document for all approvals.

For the export of mineral sands the project will also require an Export Licence from the Commonwealth Government.

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The responsible minister is the Minister for Resources. This export licence system was instituted to prevent mineral sand mining on Moreton and Fraser Islands.

The Minister for Resources relies on advice from the Commonwealth Department of Environment. Advice from the Tasmanian Department of Environment says that the Commonwealth will rely on the State's environmental assessment procedures. If this undertaking, holds the Export Licence should follow as a matter of course once the 3 main approvals are secured. However, the project will be introduced to the Commonwealth authorities at the same time as the Tasmanian approvals are initiated.

APPROVAL PROCEDURE

The following "activity" numbers apply to Figure 9.1

a) MINING LEASE(S)

Activity 1

Mining Lease Application(s) should be accompanied by written compensation agreements with the landowners /occupiers.

Activity 2

Following gazettal/notification of the Mining Lease Application(s) is the statutory 28 day period for public objections.

Activity 3

After the period of public objection has expired, the application is processed through the Mines Department. Any objections are assessed and may be determined in a Mining Warden's Court.

Activity 4

The granting of the Mining Lease(s) would proceed sometime after Mines Department's assessment of the Draft EMP, and is pre-requisite to the granting of the Licence to Operate.

b) LICENCE TO OPERATE

Activity 1

Preparation and submission of a Development Proposal paper by the applicant to the Department of Environment is a precursor to formal discussions leading to an Application for Licence to Operate (scheduled premises).

This should be submitted at the same time as the Mining Lease Application(s) are lodged with the Mines Department.

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Activity 2

A (somewhat informal) network of intergovernment liaison is then established by the Tasmanian Department of Environment. Likely participant departments include:

- . Department of Mines
- . Department of Lands, Parks and Wildlife
- . River and Waters Department
- . Department of Tourism

The applicant is then formally advised of guidelines/requirements for the preparation of a Draft Environmental Management Plan (EMP) which is written to support the application. It should be noted that Draft Guidelines for the preparation of the EMP have already been presented to the project.

Activity 3

A Draft EMP is prepared comprising input from:

- i) environmental constraints inventory and environmental baseline studies;
- ii) geotechnical studies (hydrogeology, mining engineering, exploration geology);
- iii) detailed project development (mining method, site rehabilitation, transportation, ore treatment and infrastructure).

Activity 4

The Draft EMP is formally submitted to Tasmanian Department of Environment with the application for a Licence to Operate which is then publicly advertised/notified. For mining developments processing 10,000 to 100,000 tonnes per annum, an application fee of \$24,000.00 applies. An annual renewal fee of \$6 000.00 also applies. The document is circulated to key government departments and King Island Council for assessment/review. A statutory period of 30 days ensues where public objections may be lodged.

Activity 5

The Tasmanian Department of Environment reviews submissions and objections from the public (if any) and other key government departments, and prepares an assessment report.

Activity 6

Prerequisite to the granting of a Licence to Operate is the granting of the Mining Lease(s) from the Department of Mines and the Planning Permit from King Island Council. The Department of Environment prepares an assessment of the development and the EMP.

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Activity 7

The applicant then completes the final EMP document from feedback from the Department of Environment.

Activity 8

The Department of Environment then draws up the formal Licence to Operate and conditions. The Licence to Operate is then granted.

c) PLANNING PERMIT

Activity 1

Lodging of a Planning Permit Application with the King Island Council is considered straightforward.

Activity 2

The Council will assess the application and examine the Draft EMP. Hence, the completion and submission of the Draft EMP is critical to the assessment and granting of the Planning Permit. Processing of the Planning Permit Application takes approximately four weeks.

Activity 3

The Planning Permit is granted. A Planning Permit is a pre-requisite to the granting of a Licence to Operate.

APPEALS NETWORK IN THE APPROVAL PROCEDURE.

Figure 9.2 describes the avenues for appeals in the approval procedure.

APPROVAL SCHEDULE

Figure 9.3 describes a very conservative approval schedule and was constructed with advice from a consultant to the Tasmanian Industry Association for Environmental Control. However, it is apparent that considerable shortening of this procedure can be achieved by close liaison with all government departments involved.

9.3 MINERAL OWNERSHIP

The ownership of minerals in Tasmania is complex. Prior to 1890's the rights to coal and to metal minerals were generally conveyed to the owner with the grant of the land. From 1893 the Crown reserved the rights from grants and metal minerals remain the property of the Crown.

The precise form of words changed progressively until the 1910's. Consequently a landowners rights to mineral can only be determined by search of the original term of the grant.

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No. 5?

Such a search has been conducted by Australian Mining Title Services Pty Ltd and all mineral rights in the project area rest with the Crown.

9.4 MINING LEASE

Preliminary discussions have been held with the Tasmanian Department of Mines and figure 9.4 shows the recommended mining leases.

A total of 15 leases will need to be marked out and applied for. The 14 x 100 ha leases plus 1 x 40 ha lease will then be consolidated into one operating lease.

Mineral leases are limited to a maximum of 100 hectares in each lease although the number of such leases which may be held is not limited. Provision exists for consolidation where leases are contiguous and it can be shown that consolidation will provide greater facilities for working. Leases are marked out and applied for on the prescribed form and lodged with the Director or the Registrar.

Applications must be submitted within 3 days of marking out and all application fees and rent included.

Any person who claims an interest in any land comprised in an application may lodge an objection in the prescribed form with the Director at any time before the expiry of 28 days from the date of marking out.

A fee is payable for the lodgement of each objection and the objector is required to serve a copy of the objection on the applicant either personally or by post within 7 days after lodging the objection with the Director. Objections are heard by Warden of Mining. There is no requirement for advertisement of an application for Mining Lease.

Application fees amount to \$4500 and annual rent amount to \$14400.

The following points should be noted.

1. The Tasmanian Mining Act states that an applicant for a Mining Lease in respect of private land shall make payment of compensation to the owner and occupier.
2. The Mining Lease is not granted until the applicant has secured all compensation agreements and copies deposited with the Director of Mines.
3. An application for a Mining Lease lapses if it is not determined within 12 months after marking out - although the Minister has discretion over this.

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4. Compensation agreement does not relate to any allowance for minerals however the Naracoopa Project contains no private land with mineral rights.

9.5 ENVIRONMENTAL MANAGEMENT PLAN

This is a project specific document and the Department of Environment has advised Draft Guidelines to be used in the preparation of the Draft EMP.

Refer to Appendix III for these draft guidelines.

A consultant will be appointed to coordinate the production of this document and to liaise with Tasmanian government departments as necessary.

Timely production of the draft EMP is critical to further project progress.

A formal Application for Licence to Operate is submitted together with the Draft EMP and the application fee. The application will be advertised and the draft EMP made available for public examination during the statutory 30 day objection period. The Department of Environment then assesses the proposal, taking public comment and the other authorities into account and arrives at a licence decision.

The proponent or any valid objector may appeal against the licence decision to the Environment Protection Appeal Board. Any person may appeal against grant of the Licence provided that person had lodged an objection with the Department of Environment in respect of the application. Before a licence decision is made the project must secure a Mining Lease and Planning Approval.

Advice from the Department of Environment says that there are no pre-existing attitudes as to what areas may or may not be mined. This is with particular reference to the modern day beach.

The message from the Department of Environment is that they have an open mind on this development and will want to be convinced that the development is technically and environmentally sound.

9.6 PLANNING PERMIT

An interim planning order which expires in October 1989, provides the legal framework by which the King Island Council administers land use. A new planning scheme has been drafted by the Town and Country Planning Commissioner and at the time of writing the final draft is about to be issued to the King Island Council (KIC).

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If this final draft is accepted and adopted by the KIC then the TCP Commissioner will give provisional approval to the draft scheme to be followed by a 3 month public comment/objection period.

This illustrates that the planning for the Naracoopa Project should be based on the requirements of the Interim Order.

Under this Interim Order the project area, as defined by the proposed MLA area, is zoned Rural with extractive industry a permitted use. The exception is the land owned by the Kings Paradise interests which is zoned Village with extractive industry prohibited.

Explanations of the zoning categories follows:

- a) **Rural extractive industry a permitted use.** Under this zoning, the Council cannot refuse the application. Council can add conditions against which the applicant can appeal. However third party appeals cannot be lodged.
- b) **Village**
While extractive industry is prohibited under this zoning, under the interim order the Council can issue a special dispensation. This dispensation could be either temporary, absolute or conditional but no council has issued on absolute dispensation. The development is treated as a discretionary application which is then advertised using only local newspapers and a site notice. There is a 14 day period for public comment and any landowner/occupier related to the land in question can object. The Council reviews the objections and either grants or refuses the application. The applicant or the objectors have the right of appeal to the Planning Appeal Board.

So, in summary, the issue of the Planning Permit is very much at the discretion of the KIC. From direct contact with the KIC, it is apparent that they are keen to see this project eventuate.

9.7 LAND STATUS AND OWNERSHIP

The proposed MLA consists of a total area of 1440 ha. The total area of privately held land within the proposed MLA is 911.6 ha of which 544 ha. is held by the Kings Paradise development interest.

Refer to figure 9.5 for a map indicating the various land holdings within the proposed MLA.

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There are 14 individual landowners covering the 911.6 ha and all are absentee.

It has been confirmed by the Department of Mines and separate investigation that all the land within the project area comes under the Mining Act, including the modern beaches.

Appendix IV is a listing of the landowners within the proposed MLA area. This listing also gives the size of the parcel and its value as recorded at the Valuer General's 1985 revision.

9.8 COMPENSATION AGREEMENTS

The Mining Act requires written compensation agreements between landowner/occupier and the applicant to be lodged with the Director before the Lease can be granted.

The Act also says that mining may not take place within 100 metres of a house/garden/dam without the consent of the owner and occupier.

This will influence access to mineral on the modern beach adjacent to the old cable station although this material is not actually within the resource estimate.

It will also influence a small portion of the southern corner of Naracoopa West deposit.

It should be noted that all dwellings in this area appear to be occupied on part time basis only.

There are two approaches to the issue of compensation. One is to purchase all the private land in the project area and thereby remove the issue completely. The other is to seek compensation agreements.

It is a question of economics and strategy. As shown later, annual compensation payment will probably be a cheaper route than outright purchase. The land in question is not good agricultural land and is currently not put to any commercial use. Apart from the proposed Kings Paradise development there is no proposed alternative land use.

There are 3 main issues relating to compensation agreements:

- a) an estimate of the costs to the project for study financial analysis
- b) the actual draft form of the agreement and how compensation amount is to be determined.

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- c) the strategy the JV adopts to secure these compensation agreements with landowners.

Recent compensation paid by a sand mining operation on the North Coast of NSW for good agricultural land not under cultivation is \$300 per hectare or about 25% of the land value. It should be noted that most of the land for this NSW operation is covered by a compensation agreement - only one property was purchased outright due to the difficulties presented by a combination of Crown and private mineral rights.

Therefore annual compensation of \$100 per hectare for the Naracoopa Project area should represent an upper limit because this land is not agricultural land.

A 2 tier rate is necessary. One which applies for the land actually mined and one for the land where only right of access, including services corridors, is required. Say \$50 for the lower rate.

An assessment of compensation agreements costs for study use is as follows:

- a) Legal assistance for each agreement to a maximum of \$200 per agreement.
- b) Compensation payable annually of \$50 or \$100 per hectare.
- c) Compensation for excessive noise at \$200 per month - relating to dwellings close to the southern end of Naracoopa deposits.

The agreements are non-committal unless mining actually occurs.

Securing these agreements before commitment to the project has the advantage of lower landowner expectations. This is a particularly relevant point in relation to the Kings Paradise group.

Based on data from the Valuer General the total land value of privately held land in the Naracoopa Project area is \$367,000 and the Assessed Annual Value (used for Council rating purposed) is 4 percent of this i.e. \$14,680.

Council rates levied on this A.A.V. are \$2135 p.a. i.e. about 15%.

The average value of privately held land (based on the Valuer General Data) is \$400 per hectare or \$160 per acre.

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Current market values are indicated by a 118 acre parcel of bushland at Naracoopa adjacent to the mine area for sale at \$20,000 or \$170/acre.

9.9 PROPOSED KINGS PARADISE DEVELOPMENT

Figure 9.6 shows the parcel of land currently owned by the interest associated with the Kings Paradise development.

This area is zoned Village under the Interim Planning Order and extractive industry is a prohibited use. However, the Council has discretionary powers to override this.

Mr Hans Bloecker, the promoter of the Kings Paradise development has been to King Island recently (late May) and he has sent the King Island Council into a spin with his request that they confirm that his project is "an approved project" - which it is not.

The Council has written to all relevant government departments seeking advice on the matter.

Discussions were held with Bloecker (a German resident) on the phone while he was here in May.

He indicated that his development had some basic problems.

- a. The capital cost is now \$160M cf original \$40M.
- b. He is still chasing finance.
- c. Most of his partners do not want to proceed due to the size of the investment required now and he was suggesting tha he would buy them out but the asking price for the land is \$1M.

i.e. His partners will sell for \$1M / 394 ha = \$2,540/ha.

He did not indicate that there would be a problem in coming to an arrangement with the Naracoopa Project. However, his move on the Council maybe related to maximising any compensation.

So overall the strategy would be to

- a. secure agreement with one of two of the non-Bloeker block to set a precedent.
- b. negotiate with Bloecker and his associates individually.
- c. complete the outstanding agreements.

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9.10 SUMMARY OF COMPENSATION PAYMENTS, ROYALTIES AND OTHER GOVERNMENT CHARGES

. COMPENSATION PAYMENTS TO LANDOWNERS

As described in section 9.8 compensation to landowners will be based on a 2 tier rating system of \$100 per hectare per year for access to mine and \$50 per hectare per year for unrestricted access only.

For the project starting at Naracoopa the following annual sequence of compensation payment for affected land would apply.

YEAR	TOTAL COMP PAYMENT	C.T.	PRIVATE LAND MINED ha	PRIVATE LAND ACCESSED ha
1	\$45560		NIL	911.2
2	\$45560		NIL	911.2
3	\$59247	4206-40 3872-81 2372-88 2100-33 2100-34 2100-37	152.5 32.42 7.99 40.44 20.18 <u>20.20</u>	
	TOTAL		273.73	637.5
4	\$54680	2368-28 3205-42 2374-15 3859-49 3859-50 3859-51	9.32 74.21 2.53 35.86 40.32 <u>20.15</u>	
	TOTAL		182.39 ha	728.81
5	\$54680	Ditto		Ditto
6	\$54680	Ditto		Ditto

. ROYALTIES

The only claim for royalties is to the Crown as there are no private mineral rights to any land within the project area.

The royalty payable is calculated as the sum of:

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- a) an amount equal to 5 per cent of such portion of annual profits (if any) which does not exceed 20 per cent of annual net sales and;
- b) an amount equal to 10 per cent of such portion (if any) of annual profits as exceeds 20 per cent of annual net sales.

"Net Sales" mean the amount receivable (in Australian currency at the time of receipt) for the sale, reduced by the cost of cartage, transport, freight, handling and selling of the product and such other costs (if any) as may be approved by the Minister, either generally or in a particular case.

PAYROLL TAX

The payroll tax commitment is determined on a company's Australia-wide wage bill.

If the total wages exceed \$500,000 annually then the company is liable for Tasmanian payroll tax.

For a company with a wage bill of \$500,000 to \$5000,000 annually then the rate paid is 5 per cent of the wages paid in Tasmania.

WORKERS COMPENSATION

The annual premium for workers compensation insurance amounts to 3.585% of the gross wage bill.

KING ISLAND MARINE BOARD CHARGES

The charges levied by the King Island Marine Board for the passage and loading of mineral sands onto a vessel berthed at Grassy Wharf are tabled in the "Marine Board of King Island BY-Laws" Dec. 1987.

The detailed arrangements will only result from final negotiations with the Marine Board over the conditions for building, operating and eventually decommissioning the product storage facility.

For each visit of a vessel of approximately 4000 gross tonnes to Grassy Harbour the following charges apply

- a) Tonnage Rate - \$304.00 total for a day period.
- b) Outward Wharfage Rate - \$3.63 per tonne for bulk mineral or per cubic metre for containers.

So for example a 3500t bulk parcel would attract the following charge.

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	\$
Tonnage rate	304
Wharfage - 3500 x 3.63 \$/t.....	<u>12705</u>
	\$13009

In addition to these charges will be the cost of the "storage facility" rent at the wharf.

9.11 PROJECT ORGANISATION

All home office project functions will be carried out from an office in Sydney.

Initial work of design procurement and construction planning will be carried out in the home office.

When site construction commences, emphasis will move to site but with the home office continuing design and procurment activities as necessary.

Throughout the construction phase the home office will supply administration and documentation support services to reduce the site workload.

9.12 DETAILED ENGINEERING DESIGN

During this study, flowsheets have been fully developed and balanced.

A design criteria was developed for the production facilities and based on metallurgical testwork.

General arrangement drawings have been prepared based on equipment selected from specific vendor enquiry packages.

An equipment list has been prepared.

All engineering and drawings have been prepared such that a commitment to proceed can be readily implemented.

9.13 PROJECT SCHEDULE

Figure 9.7 shows the overall project schedule.

9.14 PROCUREMENT

The majority of equipment necessary for the project is Australian sourced. The consolidation and scheduling of freight to the construction site, whether it be King Island or a pre-fabricators yard, will be the engineer-constructors responsibility.

SECTION 9.0 - PROJECT DEVELOPMENT

14

Off-loading and storage at site will also be the engineer-constructors responsibility. Competent quality inspection services will be engaged as necessary.

9.15 FIELD CONSTRUCTION

The capital cost estimate for this study is based on a turn-key arrangement with the engineer-constructor. However, there will be price and time advantages in conducting the project engineering procurement and construction management on a schedule of rates basis with subcontractors engaged under lump sum contracts.

Construction equipment for the orderly completion of the project will be available on the island or supplemented as necessary.

9.16 CONTRACT PLAN

The following identifies the major construction packages within the project.

Earthworks

- Site clearing, dry plant roads and drainage

Civil Works

- Dry plant slab, bin footings thickener footings and product storage slab
- Water supply

Steelwork

- Wet Plant
- Thickener and product storage bin
- Product storage building

Mechanical

- Installation of equipment
- Installation of piping

Buildings

- Dry Plant
- Administration/laboratory
- Workshop & store
- Ablution

Services

- Spear point batteries
- Fencing

Electrical/Instrumentation

- Electrical/instrumentation distribution
- Motor control centres

SECTION 9.0 - PROJECT DEVELOPMENT

15

9.17 TEMPORARY CONSTRUCTION FACILITIES AND SERVICES

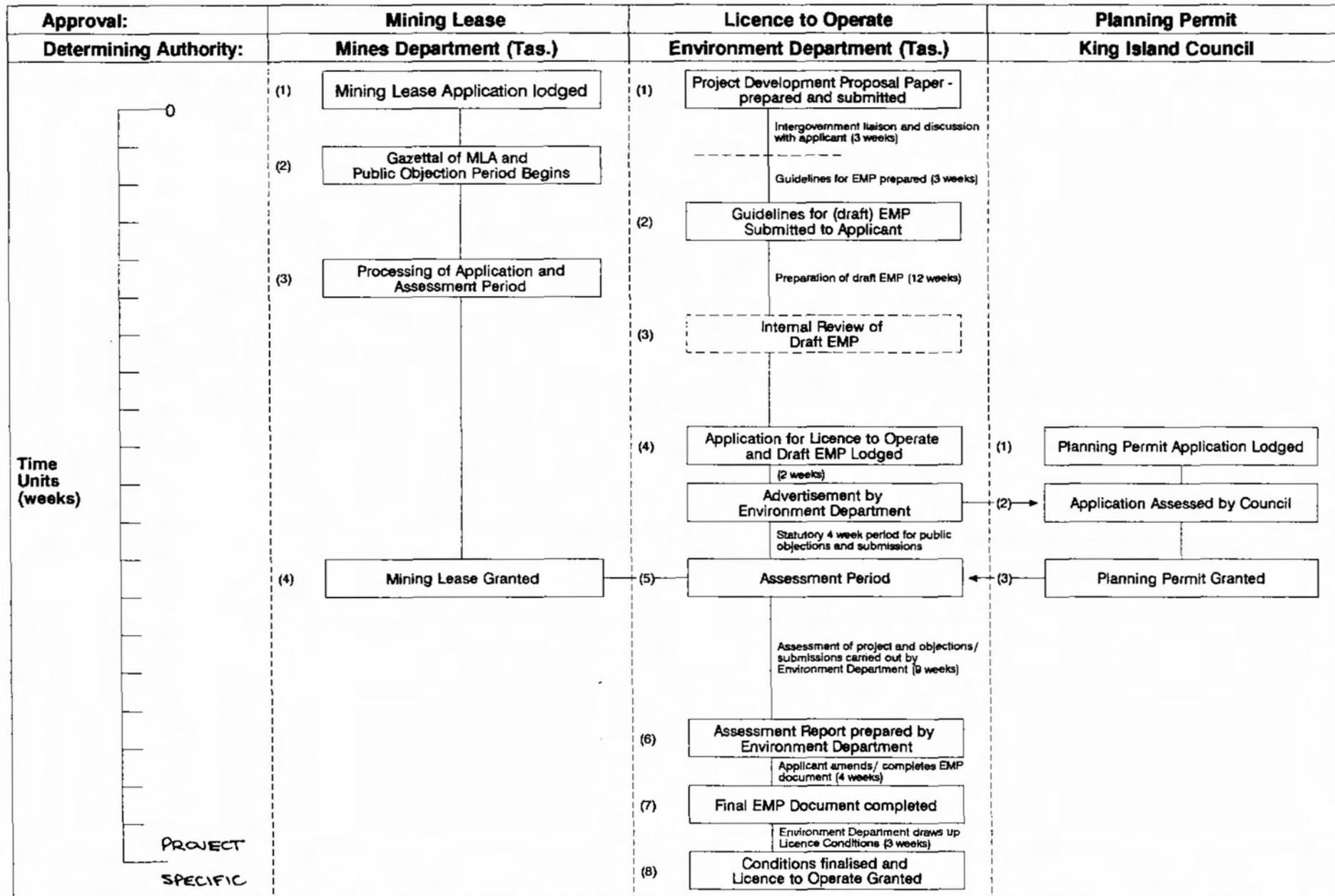
The Dry Plant administration and ablution blocks will be established first and used as the construction office.

9.18 COMMISSIONING

Mechanical commissioning will be the responsibility of the engineer - constructor but will be carried out under the supervision of the operating staff.

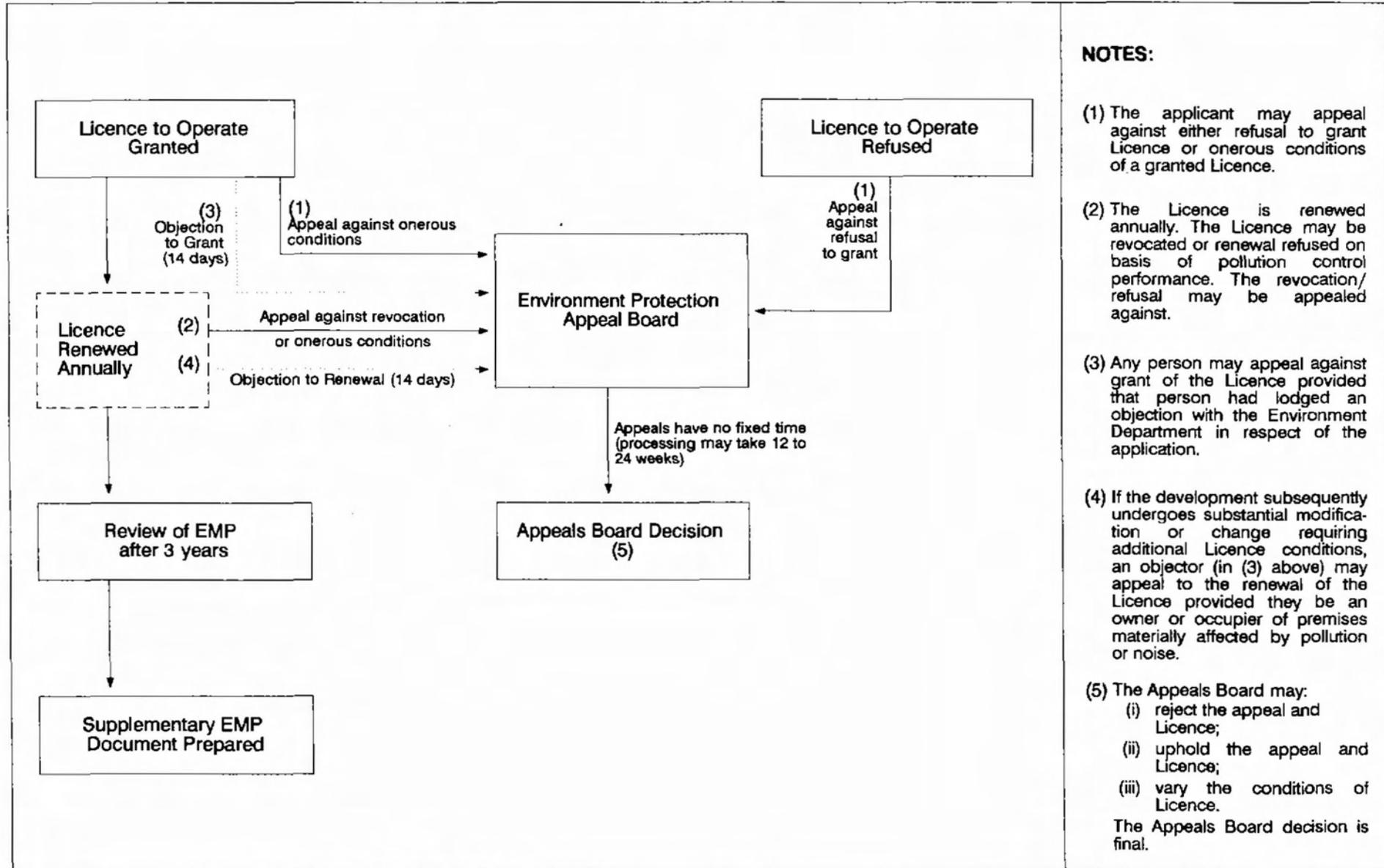
Operating staff will be engaged in the lead up to the mechanical commissioning phase to allow a training and induction period prior to wet commissioning.

FIGURE 9.1 PROJECT APPROVAL NETWORK



* (1) Refer to accompanying notes on Activities

FIGURE 9.2 PLANNING APPROVAL APPEAL NETWORK



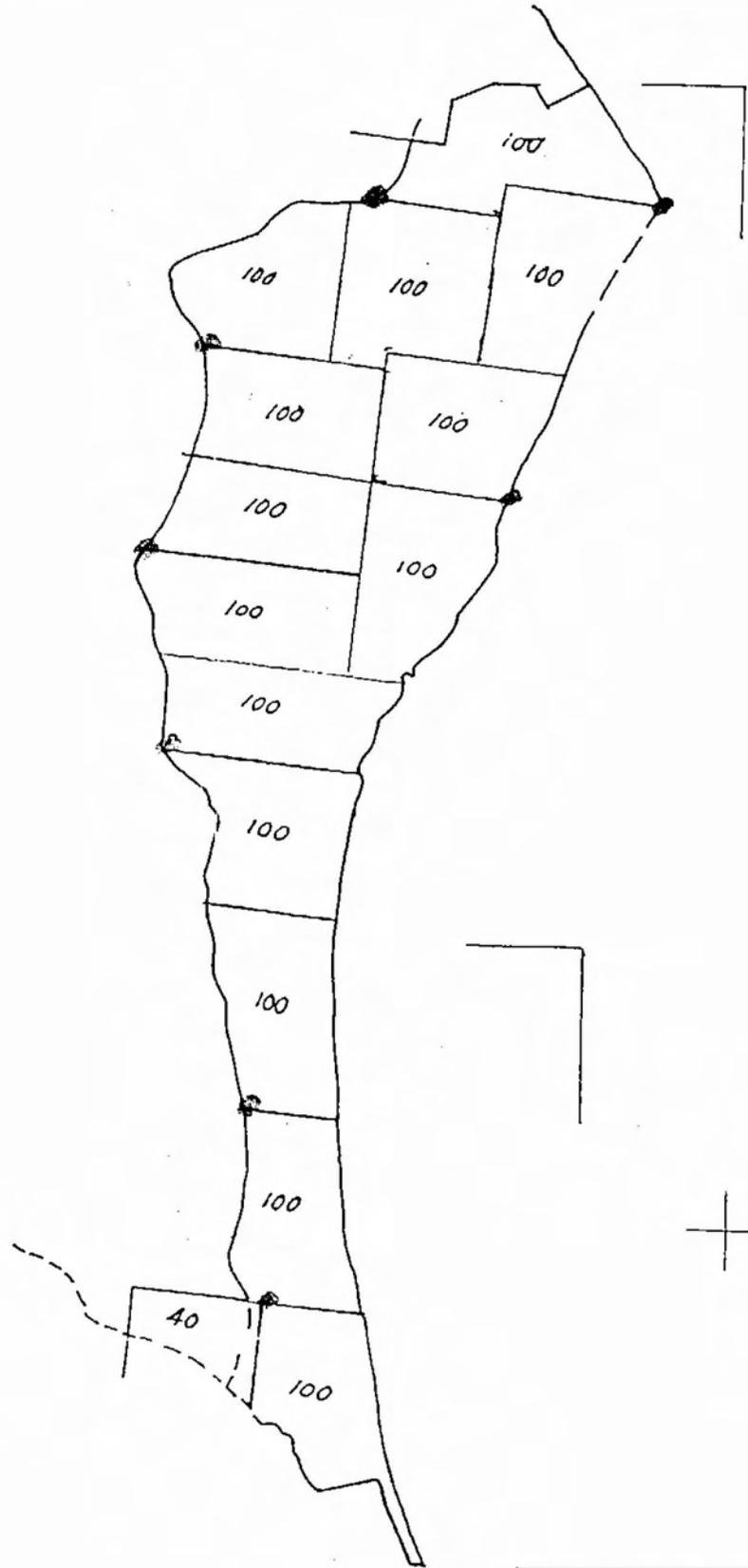
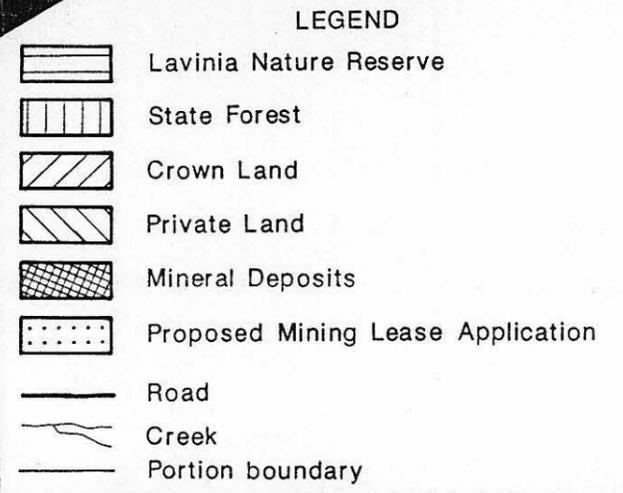
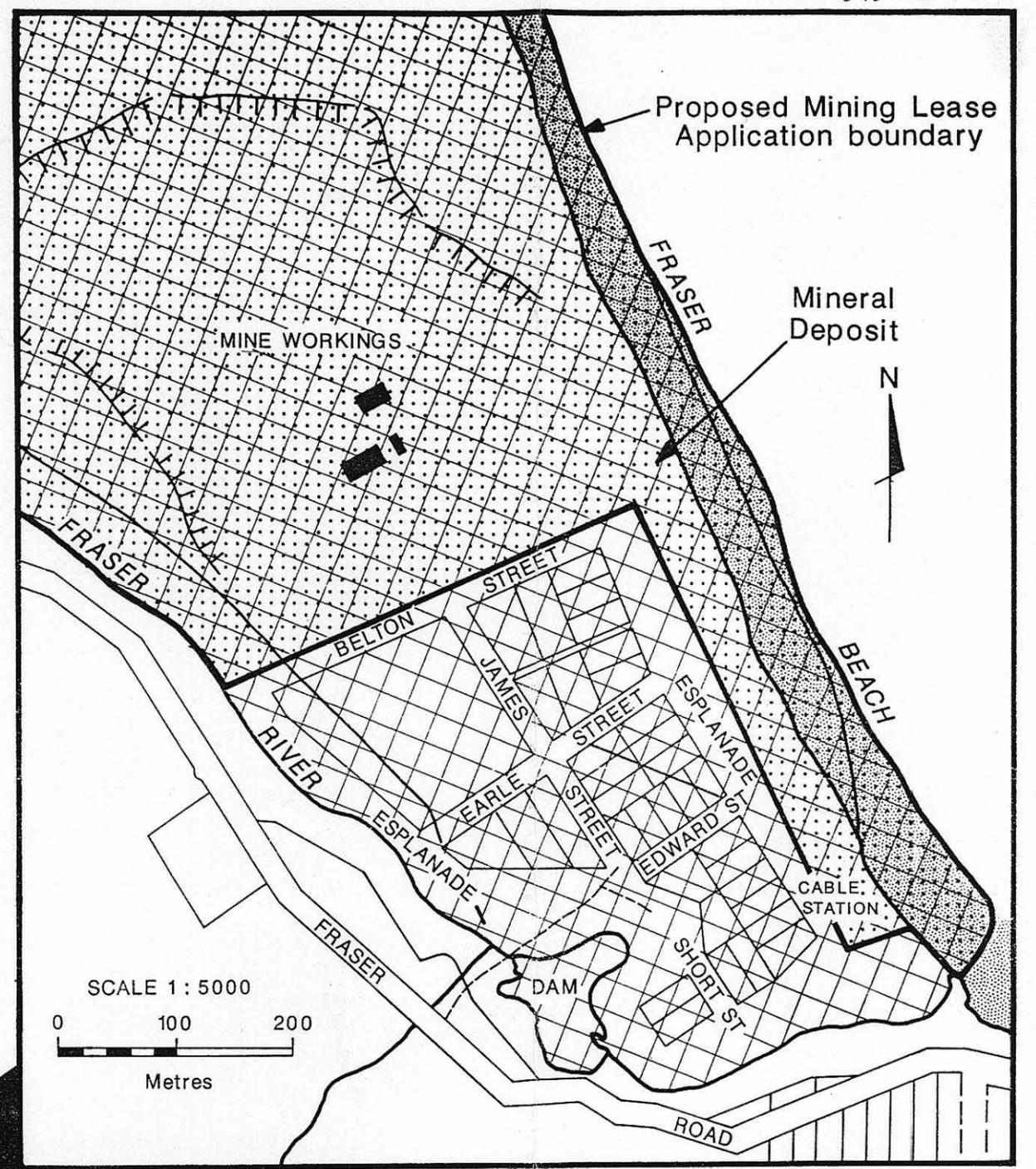
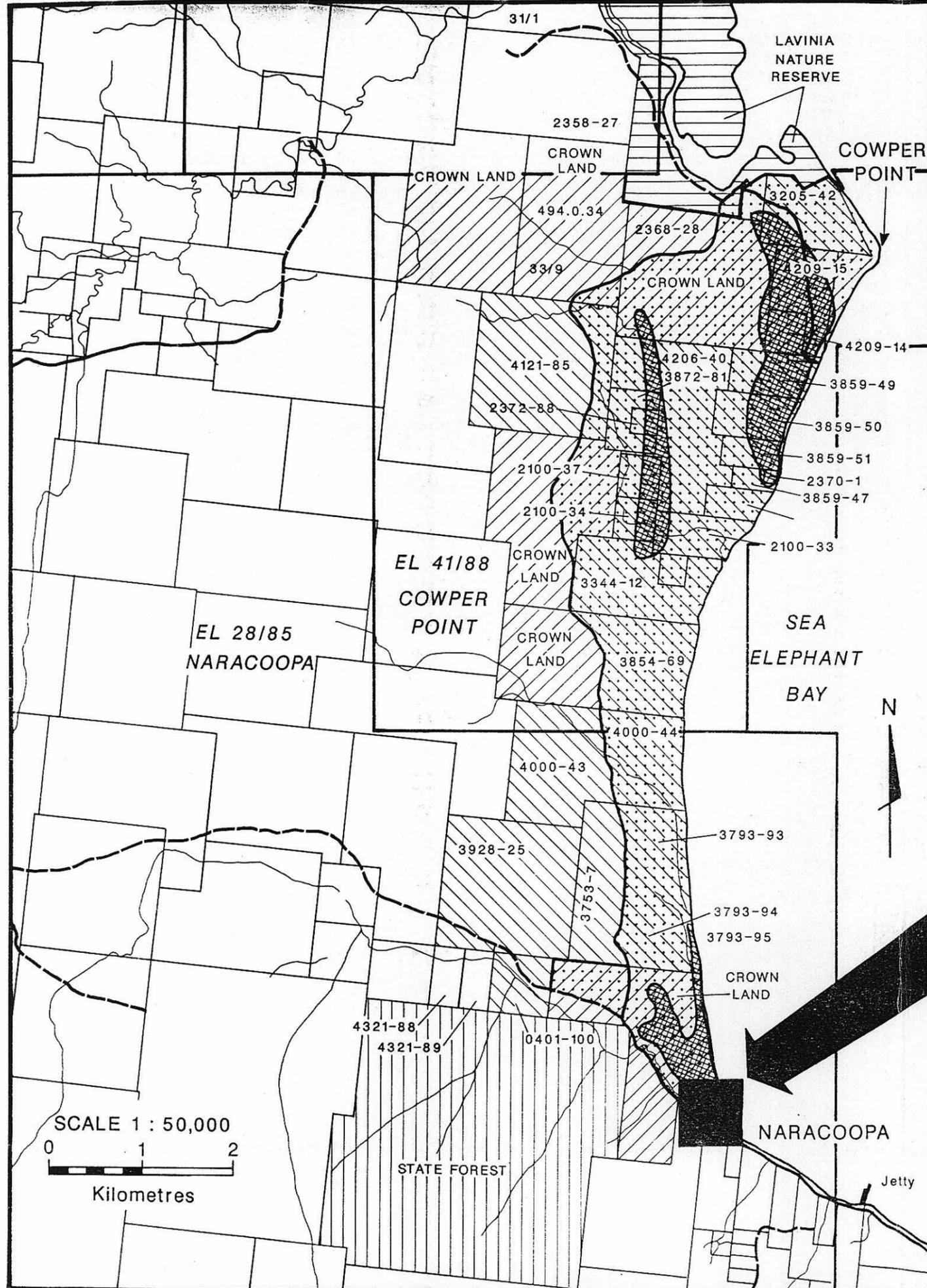


FIG. 9.4
PROPOSED
MINE
LEASE(S).



5 cm

NATIONAL MINERAL SANDS PTY LTD
LAND TENURE PLAN

FIGURE 9.5

FIGURE 9.7 NARACOOPA PROJECT
PROJECT SCHEDULE

ACTIVITY	1989	1990
	A . S . O . N . D	J . F . M . A . M . J . J . A . S . O . N . D
Licence to Operate		
Appoint Operations Manager & Metallurgist	-----	
Engineering	-----	-----
Procurement		-----
Construction - Wet Plant		-----
- Dry Plant		-----
- Wharf		-----
Commission		-----

S E C T I O N 10.0

S O C I A L E M P L O Y M E N T A N D E C O N O M I C

- 10.1 GENERAL COMMENTS
- 10.2 SOCIO-ECONOMIC FACTORS
- 10.3 KING ISLAND FACILITIES AND SERVICES
- 10.4 EMPLOYMENT
- 10.5 ECONOMIC ASPECTS

SECTION 10.0 - SOCIAL ECONOMIC & EMPLOYMENT ASPECTS

1

10.1 GENERAL COMMENTS

King Island has seen a severe contraction in its economic and social base over the 1980's.

The following figures extracted from the 1981 and 1986 Census of Population and Housing (Aust. Bureau of Statistics) illustrate the situation.

	POPULATION	LABOUR FORCE	Persons aged 20-54	
			MALES	FEMALES
1981	2592	1344	724	314
1986	1989	953	477	274

	PRIVATE DWELLINGS		Persons aged 0-16	
	TOTAL	No. UNOCCUPIED	TOTAL	
1981	886	114	833	
1986	893	196	582	

So it can be seen that King Island with its current housing stock and community assets has recently supported a population some 30 per cent larger than the current population.

King Island is a separate local government area with severe constraints on its ratings base. Rates income is less than \$500,000 per annum and the Council relies heavily on Grants Commission support. The rates income should be compared with \$100,000 required for forming and sealing 1 km of roadway. Most King Island roads are Council roads except for the Currie/Grassy and the North roads.

There is a policy of equipment sharing between the smaller Tasmanian LGA's, however, the transport problem makes a day's use of a traxcavator a \$10,000 exercise.

By regulation the Council via the Planning Permit is unable to tell a developer that contribution will be required to community capital assets or maintenance programmes as part of his development. However, it is clear that the King Island Council will be looking for some benefits outside of the increased employment and indirect economic activity the Naracoopa Project would bring to the island.

10.2 SOCIO-ECONOMIC FACTORS

The impacts of mining development on the socio-economic environment are not required to be addressed under the Tasmanian Government's draft guidelines. However, socio-economic issues will be addressed in the EMP. It is apparent that the mining development will have a significant and positive impact on the residents of King Island.

The following issues should be broadly addressed:

- i) **The provision of facilities and infrastructure.**
The King Island Council and residents will be anxious to see that the use of public facilities (Grassy Wharf, roads, power, housing) will not be adversely affected.
- ii) **The effect on tourism on the Island.**
Tourism is actively promoted on the Island and has developed in recent years to an industry based on 10,000 visitors per year. Naracoopa and the east coast has (perceived) climatic advantages for tourism relative to the west coast. The potential for loss of environmental amenity and loss of access to the Fraser Beach and Cowper Point due to the mining development should be addressed and dispelled in any EMP and reinforced by public awareness presentations by the joint venture.
- iii) **The economic stimulus.**
The justification of the mining development could be stated in terms of direct employment opportunities and project servicing, multiplier effect, State royalty and State/Federal tax revenue.

10.3 KING ISLAND FACILITIES AND SERVICES

SCHOOLS

The Primary school at Currie, with approximately 25 pupils, is near full capacity. There is a small Primary school at Reekara 20 km north of Currie.

The Primary school at Grassy has recently been upgraded and has capacity for approximately 120 pupils (30-40 now). There is a High school at Currie only and is at about 85% capacity. There are only 8 final year students at the High school this year.

MEDICAL

There are two doctors resident on King Island and they can easily absorb an increase in patient numbers. Currently 1 doctor visits Grassy 2 to 3 days per week.

The present dentist is leaving and the Council is confident of attracting a replacement for its clinic in Currie.

The hospital at Currie has 14 acute care beds but no maternity facility. There is much annoyance at the Tasmanian Government preference for flying expectant mothers off the island to other facilities.

POLICE

Currently there are 3 police on King Island and this is sufficient to allow 24 hour call at the Police Station. Otherwise it is inadequate and there is some concern for law and order should a large influx of construction crew eventuate. Similarly it is apparent that the community will be more comfortable with an operations work force based on family people rather than single men.

SPORTING CLUBS AND FACILITIES

The Council is of the opinion that this area is adequately catered for and no contributions are needed.

There are golf courses at both Currie and Grassy, squash courts, tennis courts, cricket, football, basketball, bowls, table-tennis and a swimming pool at Grassy.

There are clubs for: rifle and pistol shooting; sailing and boating; aero.

ACCOMMODATION

A new hotel with 12 unit accommodation is currently being built in Currie to be opened by December, 1989.

The Boomerang motel is to be upgraded with an increase in accommodation and a new 150 seat restaurant.

In Currie, accommodation is available at -

- . A-Frame Unit
- . Boomerang Motel
- . Bass Caravan Park
- . Daisy Flats

In Naracoopa, accommodation is available at

- . Naracoopa Lodge
- . Naracoopa Holiday Flats

In Grassy, the King Island Scheelite operation has detached housing available for 30 families and extensive single quarters accommodation. The KIS housing would need refurbishing.

TOURISM

Recent estimates put the number of tourist beds available at 100.

Tourism is a growing industry-from insignificant levels a few years ago to the current level of 10,000 visitors per year. Local operators have arranged packaged tours with K.I. accommodation to handle 20 per cent of the total visitor number.

The attractions are fishing, bushwalking, surfing and Nature Reserves.

10.4 EMPLOYMENT

OPERATIONS

Direct employment for the mining treatment and administrative functions will amount to 45 persons. It is intended that as far as is possible the workforce will be built by local recruitment. The local area includes King Island itself and the north west of Tasmania in general.

The King Island labour force is approximately 1020 persons and at the time of writing there are 52 jobseekers registered with the Commonwealth Employment Service. 39 of these are male between the ages of 18 and 45 years and about 2/3 would have factory or process work experience. Specific recruiting will be necessary for professional, administrative and trades positions.

King Island has an unemployment rate of 5.1% compared with the Tasmanian average of 9.1% and the Australian average of 6.3%.

It is intended to make use of the existing housing stock on King Island and mostly the workforce will be accommodated in the towns of Grassy and Currie. A bus service for employees from both centres will minimise the increase in private vehicle usage.

CONSTRUCTION

It is intended to maximise off-site pre-fabrication and so minimise the construction plant equipment and labour required on-site.

However, it is envisaged that a construction workforce of up to 45-50 persons will be required.

SECTION 10.0 - SOCIAL ECONOMIC & EMPLOYMENT ASPECTS

5

10.5 ECONOMIC ASPECTS

The project outlined in this document will require capital expenditure of approximately \$14 million.

The project will add approximately \$55,000,000 to Tasmania's value of exports over a project life of 6 years.

The annual payroll will amount to approximately \$1.5 million.

Annual royalties will average approximately \$250,000 for the life of the mine.

The annual production of 15,000 - 20,000t of combined product is 1 to 1.3 times the existing total annual tonnage exported through Grassy Harbour.

S E C T I O N 11.0

CAPITAL COST ESTIMATE

- 11.1 METHOD
- 11.2 BASE CASE AND ALTERNATIVE
- 11.3 ROADWORKS
- 11.4 SALVAGE VALUE
- 11.5 RELOCATION COST AND DEFERRED EQUIPMENT PURCHASE
- 11.6 WORKING CAPITAL
- 11.7 CAPITAL COST SUMMARY

SECTION 11.0 - CAPITAL COST ESTIMATE

1

11.1 METHOD

Flowsheets and General Arrangement drawings were developed.

Budget pricing for most equipment items was secured by enquiry to 2 or 3 different suppliers for each item. Enquiries were based on brief duty specifications which included the flowsheet process parameters as appropriate.

Quantities of steel, concrete and pipework were estimated and appropriate rates applied.

Estimates have been prepared to a accuracy of $\pm 15\%$ and include EPCM and contingency.

11.2 BASE CASE AND ALTERNATIVE

The base case is for the production of rutile and zircon. The alternative is for the production of rutile, zircon and leucoxene.

The flowsheets and general arrangements were originally generated for the alternative rutile zircon and leucoxene production.

To develop the base case, take out prices for equipment and associated works related to the production of leucoxene were generated to adjust the overall capital cost.

A summary of capital costs is presented in Section 11.7

11.3 ROADWORKS

A cost of around \$500,000 has been estimated for roadworks required to bring Council roads up to the required standard.

This cost has been isolated because in discussion with the Council representatives it has been indicated that they would not like to see the cost of roadworks as a barrier to the project proceeding.

The Joint Venture is in a position to negotiate with the Council and the Tasmanian Government over funding of roadworks.

11.4 SALVAGE VALUE

Over a project life of only 6 years it is essential to consider the probable salvage value of the plant and equipment which has all been included in this study as newly purchased.

SECTION 11.0 - CAPITAL COST ESTIMATE

2

Based on historical results of orderly sales of second hand mineral processing plant and equipment, the Joint Venture could expect to recover 35 to 40 per cent of the initial purchase price.

A summary of the equipment only purchases for the Naracoopa Project is as follows.

.	Dredge	1,285,000
.	Wet Plant	2,000,000
.	Dry Plant	<u>3,280,000</u>
	TOTAL	\$6.56 M.

At 35 per cent, salvage value is \$2.3M in 6 years time - say 7 by the time of liquidation. Recent experience suggests that the diesel powered dredge will retain a significant proportion of its purchase price.

Therefore the salvage value could be expected in the range \$2.3M to \$3.3M.

11.5 RELOCATION COST AND DEFERRED EQUIPMENT PURCHASE

At the end of year 2 the wet plant and dredge are dismantled, transported to Cowper Point West deposit reassembled and recommissioned. This work will occupy about 10 weeks and will cost \$600,000. A detailed cost estimate is given.

At the beginning of Year 4 the wet plant spiral circuits are expanded to accommodate the higher tonnage through-put.

11.6 WORKING CAPITAL

The working capital requirements for the project will depend on the marketing arrangement for the products - that is whether payment occurs on shipment or on delivery into storage or other.

An estimate as follows -

Wages	\$200,000
Stockpile	\$ 33,000
Consumables	\$ 20,000
Initial Spares	\$ 90,000
TOTAL say	\$340,000

SECTION 11.0 - CAPITAL COST ESTIMATE

3

11.7 CAPITAL COST SUMMARY

ITEM	PRODUCTION	
	<u>RZL</u>	<u>RZ</u>
1. DREDGE	1295000	1295000
2. WET PLANT	4460000	4002000
3. DRY PLANT	5388000	4657000
4. PRODUCT STORAGE & LOADING	580000	580000
5. WATER SUPPLY/ COMMUNICATIONS/ VEHICLES/WORKSHOP EQUIPMENT	957000	957000
6. ADMIN./AMENITIES	260000	260000
7. HOUSING	150000	150000
8. EPCM & Contingency	1412000	1265000
9. WORKING CAPITAL	340000	340000
TOTAL	14,842,000	13,506,000

NOTES

1. ROADWORKS \$500,000 approx.
2. SALVAGE VALUE \$2.3 million
3. WET PLANT EQUIPMENT
PURCHASE DEFERRED
TO YEAR 4 \$382,000
4. WORKING CAPITAL
INCLUDES INITIAL SPARES

SECTION 12.0

OPERATING COST ESTIMATE

- 12.1 METHOD
- 12.2 POWER COSTS
- 12.3 ROYALTIES
- 12.4 COMPENSATION AND MINE LEASE PAYMENTS
- 12.5 SHIPPING AGENT
- 12.6 MARKETING COSTS
- 12.7 WORKERS COMPENSATION AND INSURANCE
- 12.8 PAYROLL TAX
- 12.9 KING ISLAND MARINE BOARD CHARGES
- 12.10 PROJECT QUANTITIES

SECTION 12.0 - OPERATING COST ESTIMATE

1

12.1 METHOD

The cost estimates have been compiled using prices from potential suppliers of consumables and unit rates from potential equipment hire and transportation contractors. Labour rate burdens and conditions are based on the current King Island Scheelite award. A manning schedule is attached.

12.2 POWER COSTS

The basis for the study is diesel/generator supply for the wet and dry plant and a diesel powered dredge. Power from diesel/generator set is costed at 11 c/kW.hr which includes maintenance costs.

12.3 ROYALTIES

The rate of royalty payable is calculated as the sum of -

- (a) an amount equal to 5 per cent of such portion of annual profits (if any) as does not exceed 20 per cent of annual net sales.

and

- (b) an amount equal to 10 per cent of such portion (if any) of annual profit as exceeds 20 per cent of annual net sales.

Net sales mean the amount receivable (in Australian dollars or the equivalent at the time of receipt) for the sale reduced by the cost of cartage, transport, freight handling and selling of the product.

12.4 COMPENSATION AND MINE LEASE PAYMENTS

Landowner compensation and Mine Lease payments will amount to less than \$70,000 per annum.

This figure is based on a two tier landowner compensation payment system consisting of -

- (a) \$50 per ha. for the right of access, to run services and extract water
- (b) \$100 per ha for the right to mine.

Compensation agreements have not been secured but the above figures are based on logic prevailing in similar agreements recently negotiated in New South Wales.

Mine Lease payments amount to \$14,400 per annum.

SECTION 12.0 - OPERATING COST ESTIMATE

2

12.5 SHIPPING AGENT

It is intended that arrangements for shipping of the product would be handled by an agent.

The agent would, on a fee per voyage basis:

- . locate the ship
- . arrange charter party on voyage basis
- . complete the documentation
- . arrange insurance
- . pay freight (depending on marketing arrangements).

and the fee would be 2-3 per cent of the freight rate.

This fee is approximately \$3000 per voyage.

12.6 MARKETING COSTS

It is intended that the Naracoopa Project conducts its own marketing and cultivates close relationships with the end users. The cost incurred will relate to time and travel for employees of the Joint Venture.

An allowance of 50,000 dollars per annum is made for this activity.

12.7 WORKERS COMPENSATION AND INSURANCE

The annual premium for Workers Compensation insurance amounts to 3.585% of the gross wage bill or approximately \$54,000 per annum. Property Public Liability and Vehicle insurance premiums for the project amount to approximately \$31,000 per annum.

12.8 PAYROLL TAX

The payroll tax amounts to 5% per annum of the gross wage bill.

12.9 KING ISLAND MARINE BOARD CHARGES

A 3500 t bulk parcel would attract wharfage of \$13,000.

SECTION 12.0

3

12.10 PROJECT QUANTITIES

All the following are average annual consumptions:

Power	7560	MW.hr
Process Water	657	Ml
Caustic (@\$1100/t)	144	t
Collector (@\$1500/t)	0.7	t
Distillate (@.31c/kg)		
Mining	913000	
Drying	1141000	
Power gen.	<u>1816000</u>	3870000 l

Construction quantities:

Concrete - Dry Plant	378	
- Product Storage	<u>245</u>	<u>623m³</u>
Steel - Wet Plant	340	
- Dry Plant	257	
- Product Storage		<u>35</u> <u>632 t</u>

COMPONENT

OPERATING COST \$

SUMMARY		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
1. Mining		1412084	1412084	876709	821709	821709	817709
2. Rehabilitation		98000	98000	98000	98000	98000	98000
3. Wet Plant		1156000	1156000	906000	1049200	1049200	979800
4. Dry Plant	RZ	1465000	1465000	1163300	1198000	1198000	1148800
	RZL	1544000	1544000	1219300	1263000	1263000	1205800
5. Maintenance		190000	190000	190000	190000	190000	190000
6. Operating Staff		294000	294000	294000	294000	294000	294000
7. Administration		418000	418000	418000	418000	418000	418000
8. Utilities		332000	328000	325000	322000	322000	319000
9. Transportation	RZ	398350	400150	378000	419000	419000	368000
(Grassy)	RZL	462200	485000	461404	521326	521326	458019
10. Wharfage	RZ	81250	82700	63800	54400	54400	47800
	RZL	89200	905004	70407	65035	65035	57151
TOTAL	RZ	5844684	5843939	4712946	4864537	4864537	4691098
	RZL	5995484	6015584	4858820	5042270	5042270	4837479
TONNES	RZ	22300	22700	17500	14900	14900	13100
COST (F.O.B. GRASSY)	\$/t,RZ	262.1	257.4	269.3	326.50	326.50	358
TONNES	RZL	24547	24831	19396	17916	17916	15744
COST	\$/t,RZL	244.2	242.3	250.5	281.4	281.40	307.30

COMPONENT	UNIT COST	OPERATING COST \$					
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
1. MINING							
Operators (5x)	\$ 32,000/yr	160000	160000	160000	160000	160000	160000
Maintenance Materials		154000	154000	129000	74000	74000	74000
Power - 600 kW installed 450 kW average 123 l/h fuel cons.	.28 cents/l	256000	256000	256000	256000	256000	256000
Equipment Hire - D8 @56 HRS/WEEK	\$107/HR	311584	311584	311584	311584	311584	311584
Equipment Hire - Excavator @50 HRS/WEEK	\$ 58/HR	136000	136000				
Equipment Hire - Trucks @100 HRS/WEEK	\$ 70/HR	364000	364000				
Mine Access Roads	\$ 7/M	10500	10500	20125	20125	20125	20125
Tailings Return		20000	20000				
TOTAL		1412084	1412084	876709	821709	821709	817709

COMPONENT	UNIT COST	OPERATING COST \$					
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
2. REHABILITATION							
Operator (2 off)	\$29,000/YR	58000	58000	58000	58000	58000	58000
Consumables	\$40,000	40000	40000	40000	40000	40000	40000
TOTAL		98000	98000	98000	98000	98000	98000

COMPONENT	UNIT COST	OPERATING COST \$					
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
3. WET PLANT							
Operators-Shift (8off)	\$32,000/YR	256000	256000	256000	256000	256000	256000
Operators-Day (2 off)	\$29,000/YR	58000	58000	58000	58000	58000	58000
Power-kW:Tonnes	\$0.11/kWh	436000	436000	320000	547000	547000	482000
Reagents - 1 kg/t, Yr. 1,2,3 .25 kg/t, Yr. 4,5,6	\$1.10/Kg	253000	253000	119000	140000	140000	123000
Maintenance Materials	7% of capital \$1.89	133000	133000	133000	133000	133000	133000
Consumables	Allowance	20000	20000	20000	20000	20000	20000
TOTAL		1156000	1156000	906000	1049200	1049200	979800

COMPONENT	UNIT COST	OPERATING COST \$					
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
4. DRY PLANT							
Operators-Shift (8off)	\$32,000	256000	256000	256000	256000	256000	256000
Operators - Day (2off)	\$29,000	58000	58000	58000	58000	58000	58000
Power kW:Tonnes	\$0.11kWh	384000	384000	315300	326000	326000	317800
Reagents 0.02Kg/tonne	\$1.50/Kg	1000	1000	1000	1000	1000	1000
Maintenance Materials	7% of capital \$3.33	233000	233000	233000	233000	233000	233000
Consumables	Allowance	20000	20000	20000	20000	20000	20000
Drying Fuel (RZ L)	31 ^c /kg	592000	592000	336000	369000	369000	320000
(RZ)	31 ^c /kg	513000	513000	280000	304000	304000	263000
TOTAL	RZ L	1544000	1544000	1219300	1263000	1263000	1205800
	RZ	1465000	1465000	1163300	1198000	1198000	1148800

COMPONENT	UNIT COST	OPERATING COST \$					
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
5. MAINTENANCE							
Tradesmen (5 off)	\$38,000	190000	190000	190000	190000	190000	190000
TOTAL		190000	190000	190000	190000	190000	190000

COMPONENT	UNIT COST	OPERATING COST \$					
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
6. OPERATING STAFF							
Foreman (1 off)	\$42,000/YR	42000	42000	42000	42000	42000	42000
Shift Boss (4 off)	\$38,000/YR	152000	152000	152000	152000	152000	152000
Metallurgist (1 off)	\$50,000/YR	50000	50000	50000	50000	50000	50000
Mining Super (1 off)	\$50,000/YR	50000	50000	50000	50000	50000	50000
TOTAL		294000	294000	294000	294000	294000	294000

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COMPONENT	UNIT COST	OPERATING COST \$					
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
7. ADMINISTRATION							
Mine Manager	\$80,000/YR	80000	80000	80000	80000	80000	80000
Accountant	\$50,000/YR	50000	50000	50000	50000	50000	50000
Office Staff (2 off)	\$25,000/YR	50000	50000	50000	50000	50000	50000
Power Consumables	\$18,000/YR	18000	18000	18000	18000	18000	18000
Insurances, Workers Compensation	\$100,000/YR	100000	100000	100000	100000	100000	100000
Compensation, Mine Lease Payments	\$70,000/YR	70000	70000	70000	70000	70000	70000
Marketing	Allowance	50000	50000	50000	50000	50000	50000
TOTAL		418000	418000	418000	418000	418000	418000

COMPONENT	UNIT COST	OPERATING COST \$					
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
8. UTILITIES							
Storeman	\$32,000/YR	32000	32000	32000	32000	32000	32000
Wharf - Power	Allowance	10000	9000	8000	7500	7500	7000
Wharf - Maintenance	Allowance	22000	19000	17000	14500	14500	12000
Borefield - Fuel	Allowance	20000	20000	20000	20000	20000	20000
Borefield-Maintenance	Allowance	20000	20000	20000	20000	20000	20000
Laboratory Analyst	\$38,000/YR	38000	38000	38000	38000	38000	38000
Laboratory-Consumables	Allowance	30000	30000	30000	30000	30000	30000
Vehicles - Car (3 off)	\$10,000/YR	30000	30000	30000	30000	30000	30000
Vehicles - Ute (4 off)	\$10,000/YR	40000	40000	40000	40000	40000	40000
Vehicles-Truck (1 off)	\$20,000/YR	20000	20000	20000	20000	20000	20000
Vehicles - Mobile Crane	\$20,000/YR	20000	20000	20000	20000	20000	20000
RC Drill Rig	\$50,000/YR	50000	50000	50000	50000	50000	50000
TOTAL		332000	328000	325000	322000	322000	319000

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COMPONENT

UNIT COST

OPERATING COST \$

9. TRANSPORT

Year 1

Year 2

Year 3

Year 4

Year 5

Year 6

1. H.M. Conc. @ 90% w/w solids (Wet Plant to Dry Plant)	RZ t	Yr 1, 2 \$1.50	179000	179000	84178	99158	99158	87114
	90% w/w		199000	199000	93531	110176	110176	96793
	\$	274709	298000	298000	352563	352563	309738	
	RZL t	Yr 3, 6 \$3.20	224000	224000	105222	123948	123948	108892
90% w/w	249000		249000	116913	137720	137720	120991	
	\$		373000	373000	374122	440704	440704	387171
2. Product (Dry Plant to Grassy)	RZ t	\$4.50	22300	22700	17531	14894	14894	13087
	\$		100350	102150	79000	67000	67000	58900
	RZL t	\$4.50	24575	24827	19396	17916	17916	15744
	\$		110600	112000	87282	80622	80622	70848
3. Wharfage	RZ t	\$3.63	81250	82705	63638	54065	54065	57151
	\$							
	RZL t		89200	90500	70407	65035	65035	57151
	\$							
TOTAL								
RZ			398350	400150	378299	419563	419563	368638
RZL			462200	485000	461404	521326	521326	458019

020207

S E C T I O N 13.0

FINANCIAL EVALUATION

- 13.1 BASIS
- 13.2 METHOD
- 13.3 RESULTS
- 13.4 DISCUSSION

SECTION 13.0 - FINANCIAL EVALUATION

1

13.1 BASIS

Mining Recovery - (on mineable reserves)	Year 1 to 3	90 %
	Year 4 to 6	95 %
Cut-off grade	Naracoopa East	1.5%
	West	2.5%
	Cowper Point East	2.5%
	West	1.5%
Metallurgical Recovery	R&Z	85 %
	L	40 %
Product Pricing	Rutile	\$600/t.
	Zircon	\$500/t.
Depreciation -	Straight line	
Taxation	39%	
Funding -	all equity.	
Salvage Value -	35 per cent of equipment capital cost.	

Costs are all expressed in Australian dollars, July 1989
- no escalation

13.2 METHOD

The financial evaluation is based on a discounted cash flow analysis over the life of the project. All dollars are Australian July 1989. The evaluation is on all equity funding with no escalation.

The following alternatives have been considered:

- a) A base case with rutile and zircon production only. Product selling prices are \$600/t rutile and \$500/t zircon.
- b) The same as a) except the product selling prices, for year 1 only, are rutile \$700 and zircon \$850/t to illustrate how the current market prices could impact on the project.
- c) An alternative project producing rutile, zircon and leucoxene has also been evaluated. Leucoxene pricing has been taken over the increment \$100/\$200/\$300 per tonne.

SECTION 13.0 - FINANCIAL EVALUATION

2

The marginal capital expenditure required to produce leucoxene is \$1.34 Million over the project and the marginal operating cost over the project life is \$1.44 M. At the increasing selling prices the increase in sales revenue is \$1.5M/\$3.0M/\$4.5M.

13.3 RESULTS

The BASE CASE results in a DCFROR of 17.6 per cent.

The payback period for the BASE CASE is 3.2 years.

Using current product prices for Year 1 only results in a DCFROR of 28 per cent.

The ALTERNATIVE CASE results in DCFROR as follows

- a) At leucoxene \$100/t; 15 per cent
- b) At leucoxene \$200/t; 16.7 per cent
- c) At leucoxene \$300/t; 18.2 per cent

13.4 DISCUSSION

Analysis shows that the BASE CASE is the most efficient investment. The likely selling price of the leucoxene identified so far is in the \$100-200/t range.

		-2	-1	1	2	3	4	5	6	7	8	TOTAL
Mineable Reserves												
Sand	tonnes		2,650,000	2,650,000	1,918,000	3,300,000	3,300,000	2,900,000				16,718,000
HM	tonnes		255,000	255,000	120,000	134,000	134,000	117,808				1,015,808
Rutile	tonnes		14,000	14,000	8,829	8,302	8,302	7,296				60,729
Zircon	tonnes		16,294	15,700	14,152	10,144	10,144	8,912				75,346
Leucoxene	tonnes											
Recovered Total												
HM	tonnes		230,000	230,000	108,145	127,391	127,391	111,917				934,844
Rutile	tonnes		10,300	10,700	6,736	6,703	6,703	5,891				47,033
Zircon	tonnes		11,952	12,000	10,795	8,191	8,191	7,196				58,325
Leucoxene	tonnes											
PRICES												
Rutile	A\$/tonne	600	600	600	600	600	600	600	600	600	600	
Zircon	A\$/tonne	500	500	500	500	500	500	500	500	500	500	
Leucoxene	A\$/tonne											
Recovered Total												
Rutile	tonnes		10,300	10,700	6,736	6,703	6,703	5,891				47,033
Zircon	tonnes		11,952	12,000	10,795	8,191	8,191	7,196				58,325
Leucoxene	tonnes											
REVENUE												
Rutile	A\$		6,180,000	6,420,000	4,041,600	4,021,800	4,021,800	3,534,600				28,219,800
Zircon	A\$		5,976,000	6,000,000	5,397,500	4,095,500	4,095,500	3,598,000				29,162,500
Leucoxene	A\$											
less Royalty			350,292	358,114	224,929	191,092	191,092	167,912				1,483,431
Total			11,805,708	12,061,886	9,214,171	7,926,208	7,926,208	6,964,688				55,898,869
OPERATING COSTS												
Mining			1,412,084	1,412,084	876,709	821,709	821,709	817,709				6,162,004
Rehabilitation			98,000	98,000	98,000	98,000	98,000	98,000				588,000
Wet Plant			1,156,000	1,156,000	906,000	1,049,200	1,049,200	979,800				6,296,200
Dry Plant			1,465,000	1,465,000	1,163,300	1,198,000	1,198,000	1,148,800				7,638,100
Maintenance			190,000	190,000	190,000	190,000	190,000	190,000				1,140,000
Operating Staff			294,000	294,000	294,000	294,000	294,000	294,000				1,764,000
Administration			418,000	418,000	418,000	418,000	418,000	418,000				2,508,000
Utilities			332,000	328,000	325,000	322,000	322,000	319,000				1,948,000
Transportation			398,350	400,150	378,299	419,563	419,563	368,638				2,384,563
Warfare	2.5%		81,250	82,705	63,638	54,065	54,065	47,500				383,223
Marketing												
Total			5,844,684	5,843,939	4,712,946	4,864,537	4,864,537	4,681,447				30,812,090
	A\$/t sand		2.21	2.21	2.46	1.47	1.47	1.61				1.84
	A\$/t HM		22.92	22.92	39.27	36.30	36.30	39.74				30.33
	A\$/t HM rec		25.41	25.41	43.58	38.19	38.19	41.83				32.96
	A\$/t R+Z		262.1	257.4	269.3	326.5	326.5	357.7				

	-2	-1	1	2	3	4	5	6	7	8	TOTAL	
Sales			11,805,708	12,061,886	9,214,171	7,926,208	7,926,208	6,964,688			55,898,869	
Salvage value (fully depreciated plant)									2,300,000		2,300,000	
Operating cost			5,844,684	5,843,939	4,712,946	4,864,537	4,864,537	4,681,447			30,812,090	
			5,961,024	6,217,947	4,501,225	3,061,671	3,061,671	2,283,241	2,300,000		27,386,779	
Depreciation			2,194,358	2,314,358	2,314,358	2,442,692	2,442,692	2,442,692			14,151,150	
Loss carried fwd									159,450			
Operating profit/(loss)			3,766,666	3,903,588	2,186,867	618,980	618,980	(159,450)	2,140,550			
Tax payable	39.0%		1,469,000	1,522,399	852,878	241,402	241,402		834,814		5,161,895	
Tax paid				1,469,000	1,522,399	852,878	241,402	241,402		834,814	5,161,895	
After tax profit/(loss)			3,766,666	2,434,589	664,467	(233,898)	377,578	(400,852)	2,140,550	(834,814)		
C A P I T A L												
Dredge	AS		1,295,000								1,295,000	
Wet Plant			4,002,150			385,000					4,387,150	
Dry Plant			4,657,000								4,657,000	
Product Storage & Loading			580,000								580,000	
Water Suppl./Comm./Vehicles			957,000								957,000	
Admin/Amenities			260,000								260,000	
Housing			150,000								150,000	
Relocation				600,000							600,000	
E.P.C.M./Contingency			1,265,000								1,265,000	
Sub-total			13,166,150	600,000		385,000					14,151,150	
Working capital			340,000					(340,000)				
Total			13,506,150	600,000		385,000		(340,000)			14,151,150	
CASH FLOW												
			(13,506,150)	5,961,024	4,148,947	2,978,825	1,823,793	2,820,269	2,381,839	2,300,000	(834,814)	8,073,734
Cumulative			(13,506,150)	(7,545,126)	(3,396,179)	(417,353)	1,406,440	4,226,709	6,608,548	8,908,548	8,073,734	

	TOTAL PROJ	
	AS000	
NPV @	10.0%	2,465
	15.0%	730
	20.0%	(563)
IRR	17.64%	

	-2	-1	1	2	3	4	5	6	7	8	TOTAL
RUTILE REC			ZIRCON REC								
	+\$NPV @ 15% +\$IRR		+\$NPV @ 15% +\$IRR								
50%											
55%											
60%											
65%											
70%	NOT IMPLEMENTED										
75%											
80%											
85%											
90%											
95%											
RUTILE PRICE			ZIRCON PRICE								
	+\$NPV @ 15% +\$IRR		+\$NPV @ 15% +\$IRR								
-40%	(3,647)	2.1%	-40%	(3,771)	1.6%						
-30%	(2,452)	6.4%	-30%	(2,546)	6.0%						
-20%	(1,388)	10.1%	-20%	(1,446)	9.8%						
-10%	(321)	13.8%	-10%	(350)	13.7%						
	730	17.6%		730	17.6%						
10%	1,778	21.5%	10%	1,807	21.6%						
20%	2,824	25.4%	20%	2,861	25.5%						
30%	3,850	29.2%	30%	3,934	29.4%						
40%	4,895	33.1%	40%	5,007	33.4%						
OP COST			CAP COST								
	+\$NPV @ 15% +\$IRR		+\$NPV @ 15% +\$IRR								
-40%	5,290	34.1%	-40%	4,570	43.5%						
-30%	4,150	30.0%	-30%	3,611	34.1%						
-20%	3,011	25.9%	-20%	2,651	27.2%						
-10%	1,872	21.8%	-10%	1,692	21.9%						
	730	17.6%		730	17.6%						
10%	(417)	13.5%	10%	(233)	14.2%						
20%	(1,597)	9.3%	20%	(1,197)	11.4%						
30%	(2,894)	4.5%	30%	(2,171)	9.0%						
40%	(4,246)	[-ve]	40%	(3,157)	7.0%						

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		-2	-1	1	2	3	4	5	6	7	8	TOTAL
Mineable Reserves												
Sand	tonnes		2,650,000	2,650,000	1,918,000	3,300,000	3,300,000	2,900,000				16,718,000
HM	tonnes		255,000	255,000	120,000	134,000	134,000	117,808				1,015,808
Rutile	tonnes		14,000	14,000	8,829	8,302	8,302	7,296				60,729
Zircon	tonnes		16,294	15,700	14,152	10,144	10,144	8,912				75,346
Leucoxene	tonnes											
Recovered Total												
HM	tonnes		230,000	230,000	108,145	127,391	127,391	111,917				934,844
Rutile	tonnes		10,300	10,700	6,736	6,703	6,703	5,891				47,033
Zircon	tonnes		11,952	12,000	10,795	8,191	8,191	7,196				58,325
Leucoxene	tonnes											
P R I C E S												
Rutile	AS/tonne	600	600	700	600	600	600	600	600	600	600	
Zircon	AS/tonne	500	500	850	500	500	500	500	500	500	500	
Leucoxene	AS/tonne											
Recovered Total												
Rutile	tonnes		10,300	10,700	6,736	6,703	6,703	5,891				47,033
Zircon	tonnes		11,952	12,000	10,795	8,191	8,191	7,196				58,325
Leucoxene	tonnes											
R E V E N U E												
Rutile	AS		7,210,000	6,420,000	4,041,600	4,021,800	4,021,800	3,534,600				29,249,800
Zircon	AS		10,159,200	6,000,000	5,397,500	4,095,500	4,095,500	3,598,000				33,345,700
Leucoxene	AS											
less Royalty			591,136	358,114	224,929	191,092	191,092	167,912				1,724,275
Total			16,778,064	12,061,886	9,214,171	7,926,208	7,926,208	6,964,688				60,871,225
O P E R A T I N G C O S T S												
Mining			1,412,084	1,412,084	876,709	821,709	821,709	817,709				6,162,004
Rehabilitation			98,000	98,000	98,000	98,000	98,000	98,000				588,000
Wet Plant			1,156,000	1,156,000	906,000	1,049,200	1,049,200	979,800				6,296,200
Dry Plant			1,465,000	1,465,000	1,163,300	1,198,000	1,198,000	1,148,800				7,638,100
Maintenance			190,000	190,000	190,000	190,000	190,000	190,000				1,140,000
Operating Staff			294,000	294,000	294,000	294,000	294,000	294,000				1,764,000
Administration			418,000	418,000	418,000	418,000	418,000	418,000				2,508,000
Utilities			332,000	328,000	325,000	322,000	322,000	319,000				1,948,000
Transportation			398,350	400,150	378,299	419,563	419,563	368,638				2,384,563
Warfare	2.5%		81,250	82,705	63,638	54,065	54,065	47,500				383,223
Marketing												
Total			5,844,684	5,843,939	4,712,946	4,864,537	4,864,537	4,681,447				30,812,090
	AS/t sand		2.21	2.21	2.46	1.47	1.47	1.61				1.84
	AS/t HM		22.92	22.92	39.27	36.30	36.30	39.74				30.33
	AS/t HM rec		25.41	25.41	43.58	38.19	38.19	41.83				32.96
	AS/t R+Z											

	-2	-1	1	2	3	4	5	6	7	8	TOTAL
Sales		16,778,064	12,061,886	9,214,171	7,926,208	7,926,208	6,964,688				60,871,225
Salvage value (fully depreciated plant)								2,300,000			2,300,000
Operating cost		5,844,684	5,843,939	4,712,946	4,864,537	4,864,537	4,681,447				30,812,090
		10,933,380	6,217,947	4,501,225	3,061,671	3,061,671	2,283,241	2,300,000			32,359,135
Depreciation		2,194,358	2,314,358	2,314,358	2,442,692	2,442,692	2,442,692				14,151,150
Loss carried fwd								159,450			
Operating profit/(loss)		8,739,022	3,903,588	2,186,867	618,980	618,980	(159,450)	2,140,550			
Tax payable	39.0%	3,408,218	1,522,399	852,878	241,402	241,402		834,814			7,101,114
Tax paid			3,408,218	1,522,399	852,878	241,402	241,402			834,814	7,101,114
After tax profit/(loss)		8,739,022	495,370	664,467	(233,898)	377,578	(400,852)	2,140,550	(834,814)		
C A P I T A L											
Dredge	AS	1,295,000									1,295,000
Wet Plant		4,002,150				385,000					4,387,150
Dry Plant		4,657,000									4,657,000
Product Storage & Loading		580,000									580,000
Water Spray/Comm./Vehicles		957,000									957,000
Admin/Amenities		260,000									260,000
Housing		150,000									150,000
Relocation			600,000								600,000
E.P.C.M./Contingency		1,265,000									1,265,000
Sub-total		13,166,150	600,000			385,000					14,151,150
Working capital		340,000						(340,000)			
Total		13,506,150	600,000			385,000		(340,000)			14,151,150
CASH FLOW		(13,506,150)	10,933,380	2,209,728	2,978,825	1,823,793	2,820,269	2,381,839	2,300,000	(834,814)	11,106,871
Cumulative		(13,506,150)	(2,572,770)	(363,042)	2,615,784	4,439,577	7,259,846	9,641,686	11,941,686	11,106,871	

		TOTAL PROJ
		\$000
NPV @	10.0%	5,118
	15.0%	3,215
	20.0%	1,768
IRR	28.65%	

	-2	-1	1	2	3	4	5	6	7	8	TOTAL
RUTILE REC			ZIRCON REC								
	+\$NPV @ 15%		+\$IRR			+\$NPV @ 15%		+\$IRR			
50%					50%						
55%					55%						
60%					60%						
65%					65%						
70%	NOT IMPLEMENTED				70%	NOT IMPLEMENTED					
75%					75%						
80%					80%						
85%					85%						
90%					90%						
95%					95%						
RUTILE PRICE			ZIRCON PRICE								
	+\$NPV @ 15%		+\$IRR			+\$NPV @ 15%		+\$IRR			
-40%	(1,342)		9.4%		-40%	(2,079)		6.7%			
-30%	(100)		14.6%		-30%	(652)		12.4%			
-20%	1,001		19.2%		-20%	675		17.8%			
-10%	2,115		23.9%		-10%	1,935		23.1%			
	3,215		28.7%			3,215		28.7%			
10%	4,311		33.4%		10%	4,492		34.4%			
20%	5,405		38.3%		20%	5,747		40.1%			
30%	6,479		43.1%		30%	7,020		46.1%			
40%	7,572		48.0%		40%	8,293		52.2%			
OP COST			CAP COST								
	+\$NPV @ 15%		+\$IRR			+\$NPV @ 15%		+\$IRR			
-40%	7,774		47.6%		-40%	7,055		ERR			
-30%	6,635		42.9%		-30%	6,096		55.0%			
-20%	5,496		38.2%		-20%	5,136		43.6%			
-10%	4,357		33.4%		-10%	4,177		35.1%			
	3,215		28.7%			3,215		28.7%			
10%	2,068		23.8%		10%	2,251		23.5%			
20%	888		18.8%		20%	1,288		19.4%			
30%	(409)		13.2%		30%	314		16.0%			
40%	(1,762)		7.1%		40%	(672)		13.1%			

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S E C T I O N 14.0

RISK

SECTION 14.0 - RISK

1

<u>ITEM</u>	<u>RISK AREA</u>
ORE	<ul style="list-style-type: none"> - Accuracy of ore resource estimate - Accuracy of mineralogy - Limited potential resource increase
MINING	<ul style="list-style-type: none"> - Is induration an extreme impediment to dredging - Dust/noise/lighting/hours of operation - Rehabilitation programme procedure/effectiveness/time to prove effective/post mining liability - Effect on groundwater/can a dredge pond be maintained
METALLURGY-	<ul style="list-style-type: none"> Cowper Pt drillhole sample testing - High quantity of light heavies - Recoveries - Product quality and specification
GROUNDWATER	<ul style="list-style-type: none"> - Quantity and assurance of supply - Effect on aquifer - Sea water intrusion to aquifer - Effect on tidal flats, Sea Elephant River
ENVIRONMENTAL	<ul style="list-style-type: none"> - Effect of implementation of guidelines similar to those in NSW - i.e. no mining of foredunes/beaches/wetlands (advised that none apply) - Proximity to OBP feeding/roosting grounds - Mutton bird rookeries - Radiation question - background <ul style="list-style-type: none"> - post mining situation - operations - product handling - Rehabilitation on annual basis and postmining maintenance - "Clean Air," "Clean Water" requirements - Waste disposal - process <ul style="list-style-type: none"> - sewage and waste water - refuse (new Council tip required) - Traffic movement - Noise - Archaeological aspects - Dieback disease - initiation, spread

SECTION 14.0 - RISK

2

TRANSPORT - Reliance on small specialised foreign vessels for product transport in and out of Grassy Harbour

Freight rate of approximately \$60/t from Grassy to market compared with \$10-30/t from major city ports

OPERATIONS

- Where will labour force come from?
- Pay scales to be compatible with KIS - are they sufficient to attract new quality workforce

LIFE OF MINE - Approximately 5 - 7 years

POLITICAL RISKS

- Accord between Labour and Greens likely to lock out Mt Counsel, a potential project life increase
- Attitude of Labour and Greens to this project

PROJECT RISK - Payback period (Base Case) approximately 3.2 years
- Operating Profit Margin (Base Case) starts at 32 per cent finishes at 8 per cent.
Averages 24 per cent.

MARKET RISK - Other rutile/zircon properties coming on stream over next 2 to 5 years
- Current supply demand imbalance probably will continue, but close, over next 2 to 3 years

ECONOMIC RISK - Continued growth in rutile and zircon markets heavily dependent on continued growth in world economy.

**NATIONAL
MINERAL SANDS PTY. LTD.**

REFERS TO FILE
L10 - PART FILE TEMP
NARACOOPA PROJECT
JUNE 1989

A P P E N D I C E S

NARACOOPA FEASIBILITY STUDY

NO	TITLE
I	FEASIBILITY STUDY LIST OF CONSULTANTS
II	FEASIBILITY STUDY TERMS OF REFERENCE
III	DRAFT GUIDELINES FOR ENVIRONMENTAL MANAGEMENT PLAN
IV	LAND OWNERS WITHIN PROPOSED MLA AREA
V	CAPITAL COST BACKUP DATA
VI	KING ISLAND CLIMATIC DATA
VII	GROUNDWATER AND SURFACE WATER SAMPLING SITES AND ANALYSIS
VIII	EQUIPMENT LIST AND BIDDERS LIST
IX	DRAWINGS
X	REFERENCES

93-3429

2/2

MICROFILMED
FICHE No. 012923 -28

MINES	
File Ref. 410(7)	
27 FEB 1990	
Doc. Ref.	
Action Officer	Initials
LETTER	
14. 2. 90	
REFERS	
Resubmit to	Date

A P P E N D I C E S

NARACOOPA FEASIBILITY STUDY

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X	REFERENCES

OPEN FILE

I FEASIBILITY STUDY LIST OF CONSULTANTS

NARACOOPA PROJECT
CONSULTANT / ORGANISATION LISTING

1. R.W. CORKERY & CO PTY LTD
Suite 4
The Plaza
212 Anson St.
Orange, NSW
P.O.Box 80
Orange, NSW 2800

Tel: 063 - 62 54 11
Fax: 063 - 61 36 22

Contact: Mr Greg Summerhayes

2. COFFEY AND PARTNERS PTY LTD
12 Waterloo Rd
North Ryde
P.O.Box 125
North Ryde, NSW 2113

Tel: 02 - 888 7444
Fax: 02 - 888 9880

Contact: Dr Len Drury

3. PETER H. STITT AND ASSOC. PTY LTD
5th Floor
King York Building
32 York St.
Sydney, NSW 2000

Tel: 02 - 29 1403
Fax: 02 - 262 2395

Contact: Mr Graham Lee

4. AMMTEC
6 Macadam Place
Balcatta, WA 6021

Tel: 09 - 344 2416
Fax: 09 - 349 7688

Contact: Mr Graham Lloyd/ Mr Doug Moyses

5. RHF LABORATORIES
33 Nelson St
Smithton,
P.O.Box 5
Smithton, TAS 7330

Tel: 004 - 521 982

Contact: Mr Greg Dowson

6. STEWART K. PENNYCUICK
14 Loweana Crescent
Southport, QLD 4215

Tel: 075 - 311 033
Fax: 075 - 396 503

7. APPLIED PETROGRAPHIC SERVICES
2A Railway Ave
Stanmore, NSW 2048

P.O.Box 257
Strawberry Hills, NSW 2012

Tel: 02 - 516 4808

Contact: Janet McNulty

8. BUTLER MCINTYRE AND BUTLER
20 Murray St
Hobart City 7000

Tel: 002 - 236 321
Fax: 002 - 344 444

Contact: Mr Peter Joyce

9. KING ISLAND SCHEELITE
Post Office
Grassy
King Island 7256

Tel: 004 - 611 200
Fax: 004 - 611 114

Contact: Mr Michael Crow - Manager Operations

PEKO WALLSEND OPERATIONS LTD

25 Merriwa Street
GORDON NSW 2072

Tel: 02 - 498 4566

Fax: 02 - 499 2315

Contact: Mr Errol Lovett - Project Representative
Mr Norm Musgrove - Chief Metallurgist
Mr Rod Scotford - Marketing Manager

SANIDINE N.L.

15th Floor
50 Bridge Street
SYDNEY NSW 2000

Tel: 02 - 232 5155

Fax: 02 - 221 4662

Contact: Mr Paul Anthony

NATIONAL MINERAL SANDS PTY LTD

Suite 403
32 York Street
SYDNEY NSW 2000

PO BOX C262
Clarence Street
SYDNEY NSW 2000

Tel: 02 - 262 4360

Fax: 02 - 262 4368

Contact: Mr David Gillett - Project Manager

WARMAN INTERNATIONAL LTD

1 Marden Street
ARTARMON NSW 2064

Tel: 02 - 436 6789

Fax: 02 - 436 6701

44 Fisher Street
BELMONT WA

Tel: 09 - 277 4166

Fax: 09 - 478 2827

Contact: Mr Rod Watts - Project Metallurgist

LEWIS ENVIRONMENTAL CONSULTANTS

62 Cunningham Street
TARINGA QLD 4068

Tel: 07 - 371 9115

Fax: 07 - 371 9004

Contact: Dr J W Lewis

READINGS METALLURGICAL SERVICES

PO BOX 161
LISMORE NSW 2480

Tel: 066 - 217 451

Fax: 066 - 219 384

Contact: Mr David James/ Mr Eugene Dardengo

FIONA COATES

PO BOX 348
SANDY BAY TAS 7005

Tel: 002 - 349 202

STEWART BLACKHALL

PO BOX 32
WOODBIDGE TAS 7162

Tel: 002 - 674 378

ROBIN SIM

II FEASIBILITY STUDY TERMS OF REFERENCE

REV.	ISSUE
A.	REVIEW BY J.V.
B.	PROJECT USE.
C.	INTRODUCTION REVISED.

Rev : C
By : David Gillett
Date: 13/02/1989

**FEASIBILITY STUDY
NARACOOPA JOINT VENTURE**

Terms of Reference

INTRODUCTION

The Naracoopa Minerals Sand Project involves the investigation of heavy minerals sands known to occur at Naracoopa and Cowper Point on the east coast of King Island. The project comprises the Tasmanian Exploration Licences (EL's) No. 28/85 (Naracoopa) and No. 41/88 (Cowper Point).

Tenure to the Naracoopa sands was secured by Sanidine N.L. by application in September, 1985. The project concerns the development of a defined resource at Naracoopa in as timely a manner as possible and the exploration of additional mineral sands resources in the area. Peko's interest has been acquired as part of an existing and on-going programme with a series of tenements and brings a long history of involvement in the Australian mineral sands industry to the joint venture.

NMS is operator for the exploration of the tenement which includes this feasibility study, while Peko has the right to be operator once the decision to mine at Naracoopa has been taken. It is intended that this feasibility study will:

1. Establish ore reserves
2. Estimate capital and operating costs
3. Identify products and markets
4. Evaluate project financial viability

LOCATION AND TENURE

The subject area of the Naracoopa Mineral Sand Agreement extends from the township of Naracoopa northwards around Sea Elephant Bay to Cowper Point on the central east coast of the King Island, at the western end of Bass Strait.

- 2 -

Exploration is under the jurisdiction of the Government of Tasmania. The island is served by scheduled air services and small coastal freighters connecting with ports in north west Tasmania and Melbourne, Victoria. Shipping distance, Stanley in north west Tasmania is approximately 140 km and to Melbourne approximately 265 km.

Tenure of Tasmanian Exploration Licences extends for 10 years, with 50% relinquishment by the end of the 5th year. E1 28/85 was granted in January, 1987 and E1 41/88 in October, 1988.

Ref: DG2912

FEASIBILITY STUDY
NARACOOPA JOINT VENTURE

Terms of Reference

- 1) The Project will have a level of raw feed which will make approximately (15,000 t/a) of rutile available for sale. HOLD

Production of zircon and ilmenite (if it is considered a product) will alter to allow this level of rutile output to be maintained.

- 2) The project is to have a minimum 5 year operating life at the rate of (15000 t/a) of rutile together with production of zircon and ilmenite. HOLD

- 3) The project is to minimise expenditure consistent with sound operational, engineering, health and environmental standards.

- 4) The project is to keep capital expenditure to a minimum consistent with the establishment of a mining and processing operation with associated facilities to enable sale of (15000 t/a) of rutile and whatever rate of zircon and ilmenite is optimum. HOLD

- 5) Project evaluation is to centre on the exploitation of four discrete deposits, being:

- the Lanherne Beach deposit
- the Milford and Sea Beach deposit

which together are referred to as Naracoopa,

and

- the High Dune deposit
- the Back Beach deposit

which together are referred to as Cowper Point.

Also included is the reworking of the sand and Heavy Mineral tailings from the old Kibuka workings and are a part of the Naracoopa area.

- 6) The project is to optimise the sequence of mining of these deposits and project evaluation is to be based on the optimum production schedule. The optimum production schedule will maximise overall profitability.

The optimum production schedule will be based on ore reserves in the probable category only. The definition of this category is to be in accordance with AUS.IMM guidelines.

- 7) The project is to produce the following:

<u>Product</u>	<u>Form</u>	<u>Specification</u>
Rutile	Bulk Bagged	HOLD
Zircon	Bulk Bagged	HOLD
Ilmenite	Bulk	HOLD.

- 8) The study is to include a construction programme and construction budget.
- 9) The study is to be prepared on the basis that the project will comply with both Federal and State government requirements.
- 10) The study is to identify and confirm:
- the geological basis for the project;
 - the ore reserve estimates for the project;
 - the suitability of the mining method to be employed for the project;
 - the suitability of the metallurgical process to be employed for the project;
 - the suitability of product, product form and specification recognising market conditions and maximising project profitability.
- 11) The study is to develop project capital and operating costs to an accuracy of + - 15%.
- 12) Costs are to be expressed in 31st December 1988 Australian dollars. Base exchange rates to be used in the study are as indicated in Table I.

- 13) The study is to assume commencement of production from January 1990 with a minimum 5 year operating life.
- 14) The study is to produce a document to bankable standards.

To achieve this and the accuracy of cost estimation the following is the minimum level of documentation required:-

- Probable Ore Reserves;
- Optimum Production Schedule;
- Process Flowsheets with Mass and Energy Balances;
- Plot Plans and General Arrangement Drawings;
- Preliminary P.I.D.'s;
- Process and Engineering Design Criteria;
- Equipment List and Duty Specifications;
- Single Line Diagrams;
- Support Facilities, Utilities and Transport Definition;
- Operating Consumables
- Manning Schedule
- Capital Cost
- Operating Cost
- Marketing Study;
- Administration and Construction Facilities;
- Project Development Plan;
- Environmental Rehabilitation, and Occupational Health Considerations;
- Project Financial Evaluation.

- 15) Development Concept

The study will address the development of a heavy mineral sand mining and processing operation and it will assume that the project will be a staged development with the reserves at Naracoopa mined first - followed by mining of the reserves at Cowper Point.

Base Case - The study will assume that a full mining, heavy mineral concentrator, and dry plant operation, together with all associated utilities, maintenance, administrative, technical support, warehousing, product storage and load out requirements will be established at Naracoopa.

15) continued.....

Metallurgical testwork will be carried out to test the viability of the following alternatives.

Alternative A - Will determine a method for the mining and treatment of Heavy Mineral tailings. It will also determine how to incorporate this phase in the overall mining and production schedule of the Base Case and define its impact on all project parameters.

Alternative B - Will be the same as for the base case except that in an effort to minimise capital cost, a high value intermediate product (such as an R + Z concentrate) will be addressed.

Alternative C - Will determine whether ilmenite is to be a product for sale from the project. If it is shown to have market potential then Alt.C. will determine how to incorporate this phase in the overall mining and production schedule of the Base Case and define its impact on all project parameters.

Study analysis will include the following:

- wet or dry (or combination of both) mining techniques);
- maximise pre-fabricated construction;
- maximise extent of mobile/dismountable process plant to match requirement of staged operation and locating process plant as close as practicable to mining operation;
- use of material handling via slurry pipelines in an effort to eliminate intermediate trucking operations.

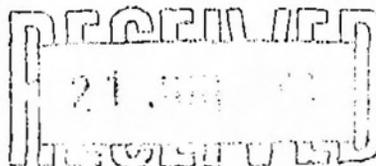
III DRAFT GUIDELINES FOR ENVIRONMENTAL
MANAGEMENT PLAN

ENVIRONMENT TASMANIA



Our Ref: 3/41/WGJ/DMW
 Your Ref:
 Contact: Warren Jones 30 6336

Mr David Gillett
 Project Manager
 National Mineral Sands Pty Ltd
 P O Box C262 Clarence Street
 SYDNEY NSW 2000



Dear Sir,

Further to your correspondence of 25 May 1989 please find attached draft guidelines for the preparation of a 'Development Proposal and Environmental Management Plan' (DP & EMP) for your proposal at Naracoopa, King Island.

The procedural steps to obtain a licence to operate scheduled premises from this point may be outlined as follows:

- * You should appoint a qualified consultant to prepare the DP & EMP in a professional manner. The consultant should make early contact with this Department to ensure that the level and nature of information he will provide will meet our requirements.
- * I have forwarded copies of the draft guidelines to the Mines Department, the Department of Lands Parks and Wildlife and the King Island Municipal Council for comment. It is conceivable that the guidelines will be modified following receipt of these comments, and I will forward you a copy of the final guidelines in due course.
- * A formal licence application should be submitted with the completed DP and EMP. Provided that the latter is of a satisfactory standard, the licence application will be advertised and the DP and EMP made available for public examination during the statutory 30-day objection period. Sufficient copies should be produced to allow for this, and the forwarding of copies to the authorities identified above for comment. A minimum of 8 copies should be provided to me.

..2/

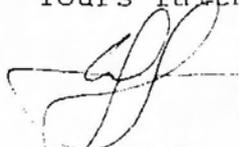
2.

- * At the end of the objection period I will assess the proposal taking into account comment from the public and other authorities and come to a licence decision.
- * Either yourself or any valid objector may appeal my decision to the Environment Protection Appeal Board.
- * Before I will make a licence decision you will need to have obtained
 - a legal right to work the site in the form of a sub-lease or sealed agreement acceptable to the Mines Department.
 - planning approval, if required, from the Municipality of King Island.

As per earlier discussions, please confirm whether or not a Commonwealth Export Licence is required for your product. If a Commonwealth licence is required it will be necessary for me to initiate discussions with the Commonwealth to ensure that the environmental assessment process proposed, and the guidelines issued to you, will also serve their requirements. I would appreciate your early advice on this matter.

If you have any queries regarding the guidelines or the procedure outlined above, please contact this office.

Yours faithfully,



Warren Jones
A/ASSISTANT DIRECTOR
DEVELOPMENT ASSESSMENT & CONTROL

C.C. The Council Clerk
Municipality of King Island.

The Director,
Department of Lands, Parks & Wildlife.

19 JUN. 1989



GUIDELINES FOR THE PREPARATION OF A
"DEVELOPMENT PROPOSAL AND ENVIRONMENTAL MANAGEMENT PLAN"
FOR A PROPOSAL TO MINE AND PROCESS MINERAL SANDS
AT NARACOOKA, KING ISLAND

1. INTRODUCTION

This should identify the proponent and provide relevant background to the proposal. The rationale/need for the development should be outlined, together with the broad economic implications for Tasmania and Australia. The time frame for the development should be given.

Other approvals required for the development to proceed (at Local, State, and Commonwealth level) should be identified, and the status of each approval given.

2. DEVELOPMENT PROPOSAL

2.1 Site description

This section must include:

- Information on land tenure and mining lease(s) for all land to be directly affected by the proposal.
- A locality map (1:25000) showing
 - * land tenure (private/public) of all land adjacent to the area to be mined, and the processing site.
 - * land zoning (Planning Scheme or Interim Order) of the area to be mined, the processing site, and all adjacent land.
 - * topography, watercourses etc.
 - * access and cartage routes (existing and proposed)
 - * boundaries of mining lease(s) over which the proponent has control.
 - * any existing or proposed (i.e. plans lodged with Council) houses in the vicinity of the development sites (1 km)
- Description of surrounding land use and ownership
- Description of vegetation and soils of the development site
- Description of geology and hydrology of the development site

- Outline of condition and use of roads to be affected by the development, and any upgrading required
- Description of the resource
- Relevant meteorological data

2.2 Development Description

This section should provide a full description of the development proposed, including any necessary associated infrastructure development.

The following must be included:

- Detailed plan(s) of the area to be mined at a scale of 1:5000 or better showing
 - * vegetation
 - * topography and watercourses/swamps
 - * the limits of the resource to be mined
 - * the sequence of mining, and mine paths
 - * the progressive locations of the wet processing plant within the mined area.
- A site plan (1:1000) of the dry processing plant site showing
 - * the location of all structures and items of equipment
 - * the location of stockpiles of raw material, product, and tailings
 - * landform modifications associated with the development of the site
 - * access roads etc.
 - * watercourses
- A description of the sand mining operation to be carried out, including the major items of equipment to be used, and method of operation.
- The quantities of sand to be mined, overburden shifted etc. on a daily/annual basis
- A description of the wet processing operation including the steps involved in processing, the equipment used, water consumption and source, the treatment and replacement of tailings and storage and transport of product.
- A description of the dry processing operation, including the steps involved, major items of equipment used, quantity and nature of wastes produced.

- All points of emissions - liquid, atmospheric, noise - must be identified for each phase of the operation.
- All points at which solid wastes are generated must be identified, and the means of disposal described.
- The timetable for each phase of the development, including the projected life of the mine.
- A description of any infrastructure development required (roadworks etc).
- The projected hours of operation (hours per day/days per week etc.) for the mining operation, wet processing plant and dry processing plant.

3. ENVIRONMENTAL MANAGEMENT PLAN

This should describe how the facilities will be developed and operated so as to meet satisfactory environmental performance standards. These may take the form of emission standards or requirements defined by the Environment Protection Act 1973, the legislative requirements of other agencies or authorities, or objectives agreed with the Department of the Environment Tasmania.

Each significant environmental issue should be identified, the environmental performance standard clearly defined, and the method of achieving the required standard demonstrated. This may be by the use of specific pollution control equipment, or management prescriptions. Unsupported assertion that the standard will be achieved will not be considered adequate.

The environmental issues addressed in the management plan must include the following

3.1 - Source of water for processing

The source(s) of water for processing must be identified, the quantities involved, and any potential environmental effects addressed.

3.2 - Wastewater emissions from

- * the wet processing plant
- * stormwater runoff from disturbed ground

In each instance the volumes involved, the quality before and after treatment, method of treatment, and the point of discharge to the receiving water should be identified. Standards for wastewater emissions are prescribed in the Environment Protection (Water Pollution) Regulations. Consideration must be given to the consequences of plausible equipment malfunction or breakdown.

3.3 - Atmospheric emissions

Dust emissions from the dry processing plant, and the control measures to be employed must be thoroughly reviewed. Any point source emissions must comply with the Environment Protection (Air Pollution Regulations) and visible dust must be contained within the area controlled by the company. Dust from roads and the loading of product onto ships must also be considered.

3.4 - Noise emissions

Consideration must be given to noise from road traffic movements as well as from the mine and dry processing plant. Predicted changes in the noise environment of residences nearest the dry processing plant must be provided, together with the predicted noise levels at the boundary of the land controlled by the proponent. The potential for noise from ship loading operations to cause nuisance should also be considered.

3.5 - Solid waste disposal

The quantities and nature of tailings from the wet and dry processing plants must be described. Special attention should be given to the disposal of concentrated radioactive materials naturally occurring in the raw materials.

3.6 - Hazardous materials

All potentially hazardous materials (including fuels) to be held at either the mine site or dry processing plant must be identified. The quantities of such materials must be given, the locations for storage, and the safeguards that will be taken to contain these materials.

3.7 - Visual Impact

The visual impact of both the active mine, previously mined areas, areas cleared ahead of mining, and the dry processing plant must be considered. Any significant vantage points from the point of view of tourism/residential use must be identified. The potential for night lighting at the mine site and processing facility should be reviewed.

3.8 - Rehabilitation

A comprehensive rehabilitation plan must be presented including:

- * the final end uses proposed for the mined areas
- * the changes in topography that will occur as a result of mining, and any resultant changes in drainage patterns
- * the method of replacing processed sands
- * the method of rehabilitation, including depth of topsoil to be replaced, the plant species to be used, origin of seed, fertiliser type and application rate
- * the timing of rehabilitation works relative to mining
- * measures to prevent the introduction of weed species
- * measures to rehabilitate the dry processing plant site
- * measures to limit sand drift from exposed areas prior to rehabilitation.

3.9 - Impact on flora and fauna

Clearly any possible impact of the proposal on the rare and endangered Orange-bellied Parrot must be carefully reviewed. The area utilised by the parrots for feeding and roosting must be identified, and the prime time of use of these areas by the parrot defined. The following possible impacts of the operation on the parrot must be reviewed and satisfactory management prescriptions described

- * direct disturbance of sites used by the parrot
- * indirect effects, such as alteration of the hydrology of the salt marsh feeding area
- * preventing or interrupting feeding by way of increased noise or movements visible from the feeding site

3.10 - Archeology

Disturbance to or destruction of archaeological sites is possible, and the Department of Lands, Parks and Wildlife should be contacted to determine what is known of this area, and whether an archaeological survey of the mining area is warranted.

3.11 - Fire

Any potential for the project to result in an increased risk of fire should be reviewed and, if necessary, a fire plan developed with the appropriate authorities.

3.12 - Social Impact

The socio-economic impact of the proposal should be reviewed, with details of the number of persons likely to be employed as a result of the proposal, the resultant population increase, the arrangements for housing workers, and the extra demands likely to be placed on community services.

3.13 - Monitoring and Review

A conceptual outline of a monitoring program to ensure compliance with the objectives and predictions of the EMP must be presented. This should include

- * monitoring of point source wastewater emissions
- * monitoring the progress of rehabilitation works
- * review of EMP after 12 months of operation, and at three yearly intervals thereafter.

IV LAND OWNERS WITHIN PROPOSED MLA AREA

N A R A C O O P A P R O J E C T

LANDOWNER LISTING

** AREA. (ha)

<u>CT VOL</u>	<u>FOLIO</u>	<u>OWNER</u>	<u>ADDRESS</u>	<u>*** LAND VALUE</u>
* 2100	33	40.44 Dittmar Ruffer	C/- Mr R Young, Jennings Elliott GPO Box 720G HOBART TAS 7001	} \$40000
* 2100	34	20.18 " "	"	
* 2100	37	20.20 " "	"	
4209	14	The Crown	<i>RECREATIONAL RESERVE</i>	
4209	15	The Crown		
2368	28	9.32 Leon Charles Jenkin Parnham	PO Box 91 MIDDLE BRIGHTON VIC 3186	\$5000
* 2372	88	7.99 Geoffrey William Griggs	3 Erina Place, SANDY BAY TAS 7005	\$2373
* 3859	48	20.23 " " "	"	\$12000
* 3872	81	32.42 " " "	"	\$9627
* 2374	15	2.53 Karel Bocek	C/- Mr R Young, Jennings Elliott GPO Box 720G HOBART TAS 7001	\$1280
* 3859	47	9.189 " "	"	\$4651
* 3859	51	20.15 " "	"	\$10200
* 3859	49	35.86 " "	"	\$18150
2401	100	George Anderson Macdonald Scott & Royce Ann Scott	The Masters Lodge, Queens College University of Melbourne PARKVILLE VIC 3005.	
3205	42	74.21 Herman Kat & Eileen Joan O'Malley	22 Adventage Road, HIGHETT VIC 3190	\$20000
* 3344	12	108.3 Premysl Pavlicek	C/- Mr Young, Jennings Elliott GPO Box 720G HOBART 7001	\$50000

020242

N A R A C O O P A P R O J E C T

LANDOWNER LISTING

** AREA (ha).

<u>CT</u> <u>VOL</u>	<u>FOLIO</u>	<u>OWNER</u>	<u>ADDRESS</u>	<u>*** LAND VALUE</u>
3753	7	Ingvard Pederson & Lina Pederson	Pegarah Road KING ISLAND TAS 7256	
3793	93	57.5 Cyril Bertram Gillespie	23 Action Street, WACOL QLD 4076	\$30000
3793	94	57.53 Queensland Steam Ship Co. Pty. Ltd.	C/- Mr Nick Logos PO Box 216 ANNERLEY QLD 4103	} \$30000
3793	95	168m ² "	"	
3854	69	94.29 Michael Van Stamm	C/- Mr B Leung, GPO Box 1117L HOBART TAS 7001	\$45000
* 3859	50	40.32 Wolfgang Peters	15 Regent Street WAVERLEY TAS 7250	\$24000
3928	25	Eileen Mary Hickey	333 Sheffield Road MONTROSE VIC 3765	
4000	43	Valerie Ruth James	C/- Layh, Hart & Room, 31 Smith Street SMITHTON TAS 7330	
4000	44	74.68 Ick Rudzki, Fejga Rudzki, Joseph Sallick & Ada Sallick	Carmel Framing Ent. 15 Jessamine Avenue, VIC 3101	\$22200
* 4121	84	32.32 Holger Ipsen, Eberhard Schmidt	Ipsen Woonbau GMBH & Co, Rohrer Home 44 D-7000 STUTTGART WEST GERMANY	\$5700
4121	85	Holger Ipsen, Eberhard Schmidt	Ipsen Woonbau GMBH & Co, Rohrer Home 44 D-7000 STUTTGART WEST GERMANY	

N A R A C O O P A P R O J E C T

LANDOWNER LISTING

AREA (ha)

CT VOL	** FOLIO	AREA (ha)	OWNER	ADDRESS	*** LAND VALUE
* 4206	40	152.5	Hans Herbert Bloecker	C/- Mr Young, Jennings Elliott GPO Box 720G HOBART TAS 7001	\$36000
* 2370	1	1.42	Elizabeth Tasmania Tolman, Edward Watson Tolman & Alfred Gibbs Tolman		\$719

* INDICATES LAND WITHIN THE PROPOSED KINGS PARADISE DEV'T.

** TOTAL AREA PRIVATELY OWNED LAND WITHIN PROPOSED M.L.A. IS 9.116 km².

*** LAND VALUE BASED ON VALUER GENERAL'S DATA WHICH IS THE BASIS FOR CALCULATING THE "ASSESSED ANNUAL VALUE" (AAV) WHERE THE CAPITAL VALUE = LAND VALUE THE A.A.V = 0.04 X LAND VALUE.
A.A.V. IS BASIS FOR LOCAL COUNCIL RATING PURPOSES.
TOTAL LAND VALUE IS \$366900

020244

V CAPITAL COST BACKUP DATA

CAPITAL COST ESTIMATE DREDGE

1.	JADEN HSC CUTTER WHEEL DREDGE	
	. 40 rpm cutter wheel	
	. Power to cutter wheel 300kW	
	. Warman 18/16 Gravel Pump 260kW	
	. Drive Engine-Caterpillar 3508TA diesel engine	
	. Travelling spud system	
		TOTAL COST \$1,097,000
2.	ANCILLARIES	
	. Includes pontoon line	
	and sand hose	94,415
3.	TRANSPORT	28,585
4.	ASSEMBLY/COMMISSIONING	30,000
5.	SPARE CUTTER WHEEL	<u>4,500</u>
		TOTAL 1,295,000

**CAPITAL COST ESTIMATE
RZ RECOVERY**

WET PLANT

1.	Pontoons (30m x 18m x 2m)	605,000
2.	Superstructure	1,019,370
3.	Equipment	1,895,570
4.	Process Pipework	242,000
5.	Tailings Stacking	213,360
6.	Sump	147,500
7.	Electrical	<u>261,200</u>
	TOTAL	\$4,384,000

\$382,000 of this is deferred to Year 4

CAPITAL COST ESTIMATE
RZ RECOVERY

DRY PLANT

1.	BUILDING	
	Steelwork	739,000
	Sheeting	138,000
	Concrete	116,400
		<u>993,400</u>
2.	EQUIPMENT	
	Wet Circuit	533,025
	Dry Circuit	2,496,545
	Control Room	30,000
	Contingency	83,360
		<u>3,142,930</u>
3.	PIPEWORK	190,000
4.	ELECTRICAL	330,000
	TOTAL	<u>\$4,656,330</u>

CAPITAL COST ESTIMATE
RZL RECOVERY

WET PLANT

1.	Pontoons (30m x 2.4m x 2m)	735,000
2.	Superstructure	1,019,370
3.	Equipment	2,133,570
4.	Process Pipework	242,000
5.	Tailings Stacking	213,360
6.	Sump	147,500
7.	Electrical	<u>261,200</u>
	TOTAL	\$4,842,000

\$382,000 of this is deferred to Year 4

CAPITAL COST ESTIMATE
RZL RECOVERY

DRY PLANT

1.	BUILDING	
	Steelwork	819,000
	Sheeting	158,000
	Concrete	215,400
		<u>1,192,400</u>
2.	EQUIPMENT	
	Wet Circuit	829,725
	Dry Circuit	2,696,545
	Control Room	30,000
	Contingency	83,360
		<u>3,639,630</u>
3.	PIPEWORK	190,000
4.	ELECTRICAL	366,500
	TOTAL	<u>\$5,388,130</u>

**CAPITAL COST ESTIMATE
WATER SUPPLY/ COMMUNICATIONS/ VEHICLES**

1.	WATER SUPPLY			
	Spearpoint Battery	132,000		
	(Naracoopa)			
	Spearpoint Batter	132,000		
	(Cowper Point)			
	Transfer Pumps	19,000		
	Pipework	304,000		
				<u>587,000</u>
2.	COMMUNICATION			
	Telecom - estension/fee	10,000		
	2 - way radios	15,000		
				<u>25,000</u>
3.	VEHICLES			
	3 Cars x 20,000	60,000		
	3 Utes (FWD) x 20,000	60,000		
	1 Truck x 30,000	30,000		
	1 Crane x 30,000	30,000		
	1 RC Drilling x 135,000	135,000		
				<u>315,000</u>
4.	WORKSHOP EQUIPMENT	30,000		
	TOTAL			\$957,000

CAPITAL COST ESTIMATE
PLANT RELOCATION
AT END OF YEAR 2

1.	DISMANTLE/ REMOVAL	
	Dismantle	132,500
	Craneage	47,000
	Transport	29,900
		<u>209,300</u>
2.	REASSEMBLY	
	Reassemble	219,420
	Crane & Equipment	82,800
	Miscellaneous	18,000
		<u>320,220</u>
3.	SUPERVISION	77,000
	TOTAL say	<u>\$600,000</u>

CAPITAL COST ESTIMATE
PRODUCT STORAGE/ LOADOUT

1.	BUILDING	150,000
	(40m x 15m x plan)	
2.	CONCRETE	184,200
	(incl. bunker walls)	
3.	OVERHEAD CONVEYOR	97,900
4.	LOADOUT CONVEYOR	<u>150,000</u>
	TOTAL .....	.\$580,000

CAPITAL COST ESTIMATE

ADMINISTRATION AND AMENITIES

1.	ADMIN. BLOCK	(transportable)	.....	50,000
2.	CRIB ROOM	(transportable)	.....	15,000
3.	ABLUTION BLOCK	(transportable)	.....	25,000
4.	LABORATORY			
		Building	.....	25,000
		Equipment	.....	20,000
5.	WATER TANKS	(2 x 20m ³)	.....	4,000
6.	WORKSHOP	(20m x 8m x 5m)	.....	<u>82,000</u>
	TOTAL		.....	\$260,000

VI KING ISLAND CLIMATIC DATA

SUMMARY OF METEOROLOGICAL CONDITIONS

A.2.1 SOURCE OF DATA

Meteorological data (temperature, rainfall, wind, fog) has been drawn from records at Currie Post Office, King Island (Meteorological Station 09 8001; lat., 39° 56'S, Long., 143° 52'E, Elevation 24 m).

Meteorological records for the east coast of King Island are limited to rainfall data only at Grassy Post Office for the period 1917 to 1969.

Data on evaporation rates on King Island have not been recorded, although it may be generally assumed that precipitation exceeds evaporation in all months of the year.

There is little difference in elevation at Currie, Naracoopa and Cowper Point, and conditions on the east coast are assumed to be similar to those recorded at Currie on the west coast. It is, however, generally believed that wind strengths are less on the east coast.

The high humidity, together with the insular nature of the place, accounts for moderate temperatures and makes the climate mild and moist.

A.2.2 RAINFALL

The available data on mean monthly rain fall at Currie and a Grassy are presented in Table A2.1. Highest rainfall is recorded in July and least in January. Rainfall during winter is high, (>100 mm per month), and fairly persistent rains may be experienced from May to October. Grassy receives higher average annual rainfall than Currie. Precipitation is predominantly associated with cold westerly winds. The average relative humidity is high (79 % at 9 am., 74 % at 3.00 pm).

TABLE A2.1

MEAN MONTHLY RAINFALL - KING ISLAND - mm

Month	J	F	M	A	M	J	J	A	S	O	N	D	Year
Currie													
Mean	35	39	49	69	98	103	125	114	84	76	61	53	906
Rain days per month	11	10	14	17	21	22	24	24	21	19	15	14	
Grassy													
Mean	24	35	50	61	101	122	167	121	86	84	64	48	963
Rain days per month	6	8	11	12	16	18	22	18	16	13	13	10	

A2.3 TEMPERATURE

Table A2.2 presents the average maximum and minimum daily temperatures recorded at Currie. January and February are the warmest months and July the coldest. Although the mean daily maximum temperature for January is 20.5°C, a maxima of 35°C has been recorded. Temperatures over 32°C are rare.

TABLE A2.2

MEAN DAILY TEMPERATURES - CURRIE POST OFFICE - °C

Month	J	F	M	A	M	J	J	A	S	O	N	D
Minimum	12.4	13.1	12.5	11.1	9.8	8.4	7.7	7.8	8.2	8.9	9.9	11.3
Maximum	20.2	20.5	19.5	17.1	15.1	13.4	12.8	13.2	14.2	15.6	17.0	18.6

An assessment of wind strength from any direction throughout the year has been undertaken and the frequency of occurrence of winds greater than 30 km/hr and 50 km/hr are presented in Table A2.4.

TABLE A2.4

ASSESSMENT OF WIND STRENGTH (from any direction)

Wind Strength	Summer	Autumn	Winter	Spring
>30 km/hr	26%	22%	27.5%	28%
>50 km/hr	6%	4%	7.5%	6%

Strong winds are most frequent during winter. Wind strengths above 30 km/hr may be considered to pose a nuisance level of constraint to operations. Wind strengths above 50 km/hr are likely to be a significant operational constraint requiring specific design/procedural safeguards to mineral sands mining.

Table A2.4 indicates that moderately strong winds (>30 km/hr) can be expected throughout the year at a frequency of approximately 25 per cent. Strong to very strong winds (>50 km/hr) can be expected at a frequency of approximately 5 per cent throughout the year. Gale force winds (>60 km/hr) occurs with a frequency average of 2 days per month and is most frequent in late winter and early spring.

It is noteworthy, however, that this wind data is relevant for the west coast of King Island (Currie). Some variation can be expected on the east coast. It is generally held view on King Island that wind strengths are less on the east coast, with the topography of the island affording some barrier to the predominant westerly and southwesterly wind. It is likely, however, that northeasterly wind strengths are higher on the east coast than the west coast during summer.

Most precipitation is predominantly associated with westerly winds. north easterly winds are often accompanied by warm and humid conditions.

A.2.4 TEMPERATURE INVERSIONS

Radiation inversions are the main type of temperature inversions likely to cause any noise to be enhanced. An indication of radiation inversions is obtained by examining fog frequencies as fogs are radiation inversions when water vapor is present. Table A2.3 presents the recorded fog frequencies at Currie.

Although Leavey dews are common, frosts are rare.

On average one fog is recorded in March each year, with a maximum of 4 recorded in March, 1982. The data indicates that the incidence of fog is relatively low. Noise enhancement by temperature inversion will be a rare constraint.

TABLE A2.3

FOG FREQUENCIES - CURRIE POST OFFICE

Month	J	F	M	A	M	J	J	A	S	O	N	D
Average No. per month	0	0	1	0	0	0	0	0	0	0	0	0
Max. No. recorded per month	2	3	4	2	2	2	1	1	1	3	3	2
Min. No. recorded per month	0	0	0	0	0	0	0	0	0	0	0	0

A.2.5 WIND

Figure A2.1 presents the wind roses prepared from data collected over a 29 year period at Currie on the west coast.

The wind roses show that moderate to strong winds are (relatively) frequent on King Island. Calm conditions occur less than 5 per cent of the time.

During summer both south, southwesterly and northeasterly winds predominate.

During autumn wind strengths are less but remain predominantly from the south and south west.

During winter wind strength increases and predominates from a westerly direction (southwest to northwest).

During spring strong wind predominates from the southwest.

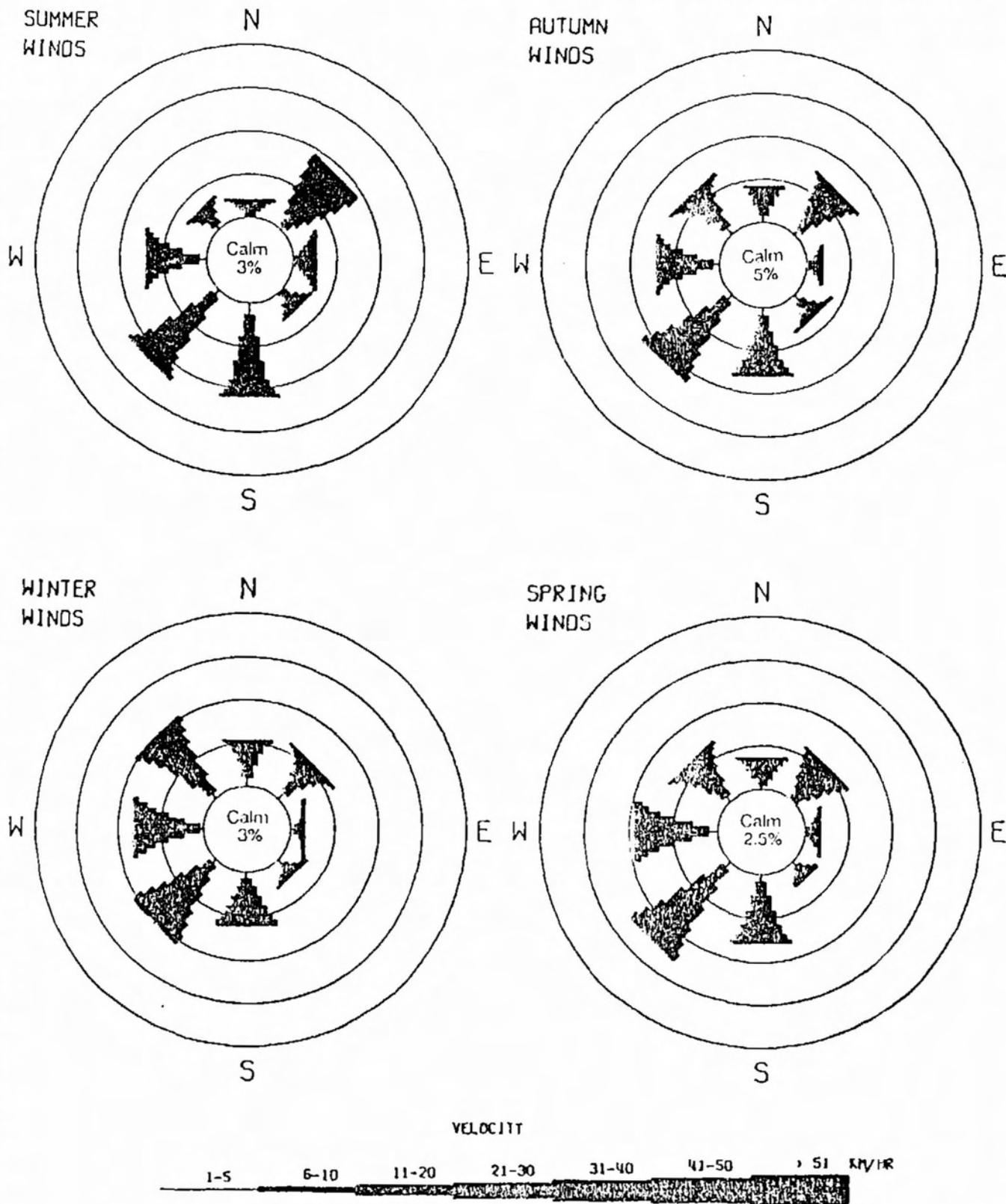
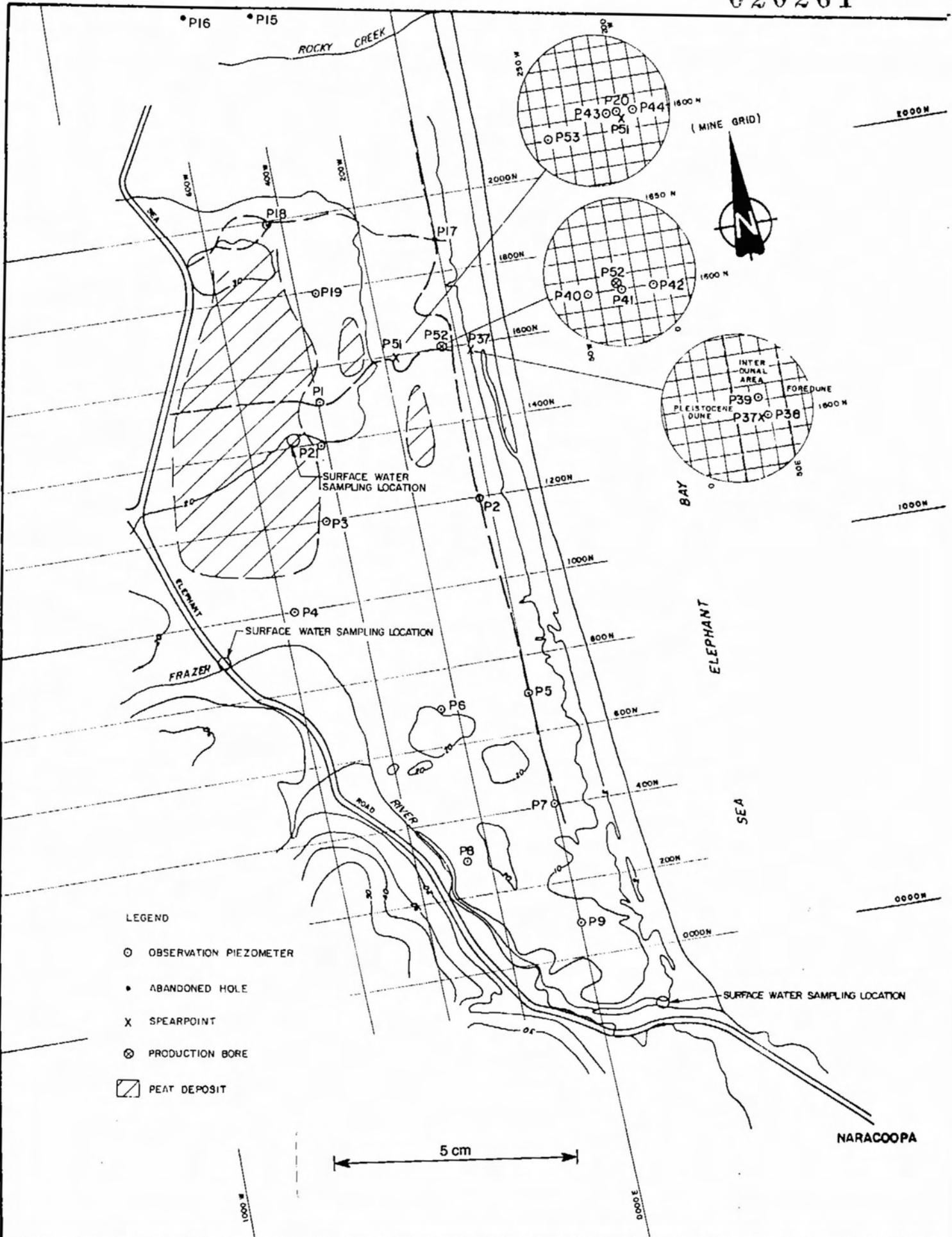


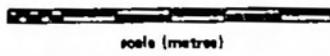
Figure A2.1

WIND SPEED AND DIRECTION FOR
CURRIE P.O., KING IS., TAS.

VII GROUNDWATER AND SURFACE WATER SAMPLING
SITES AND ANALYSIS



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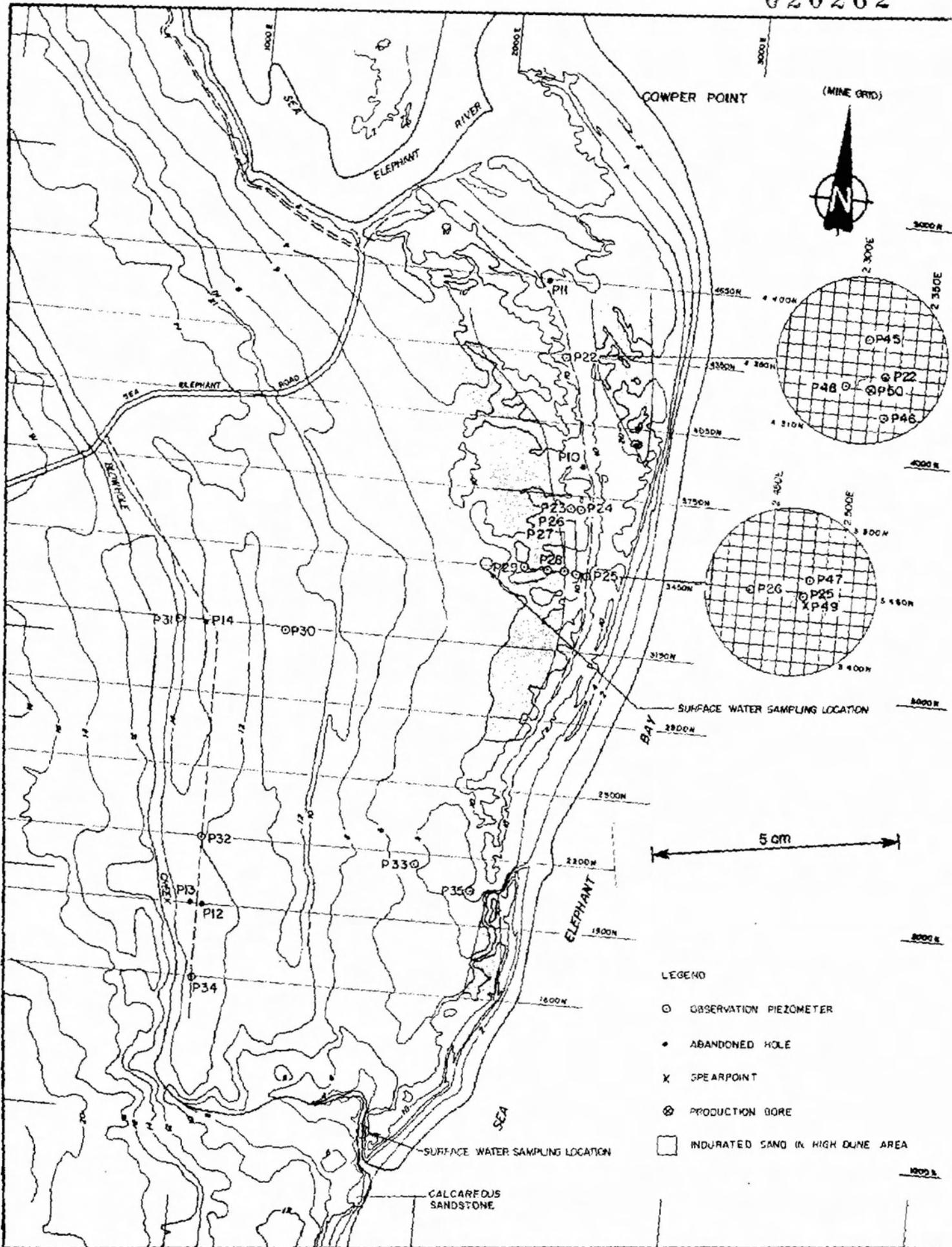
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checked	<i>[Signature]</i>
date	12/12/89

NATIONAL MINERAL SANDS
 KING ISLAND HEAVY MINERAL DEPOSITS
 LOCATION OF OBSERVATION PIEZOMETERS,
 SPEARPOINTS & PRODUCTION BORE



FIGURE 3

job no G85 / 3



- LEGEND
- OBSERVATION PIEZOMETER
 - ABANDONED HOLE
 - X SPEARPOINT
 - ⊗ PRODUCTION BORE
 - INDURATED SAND IN HIGH DUNE AREA

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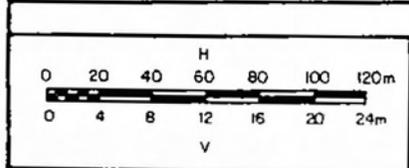
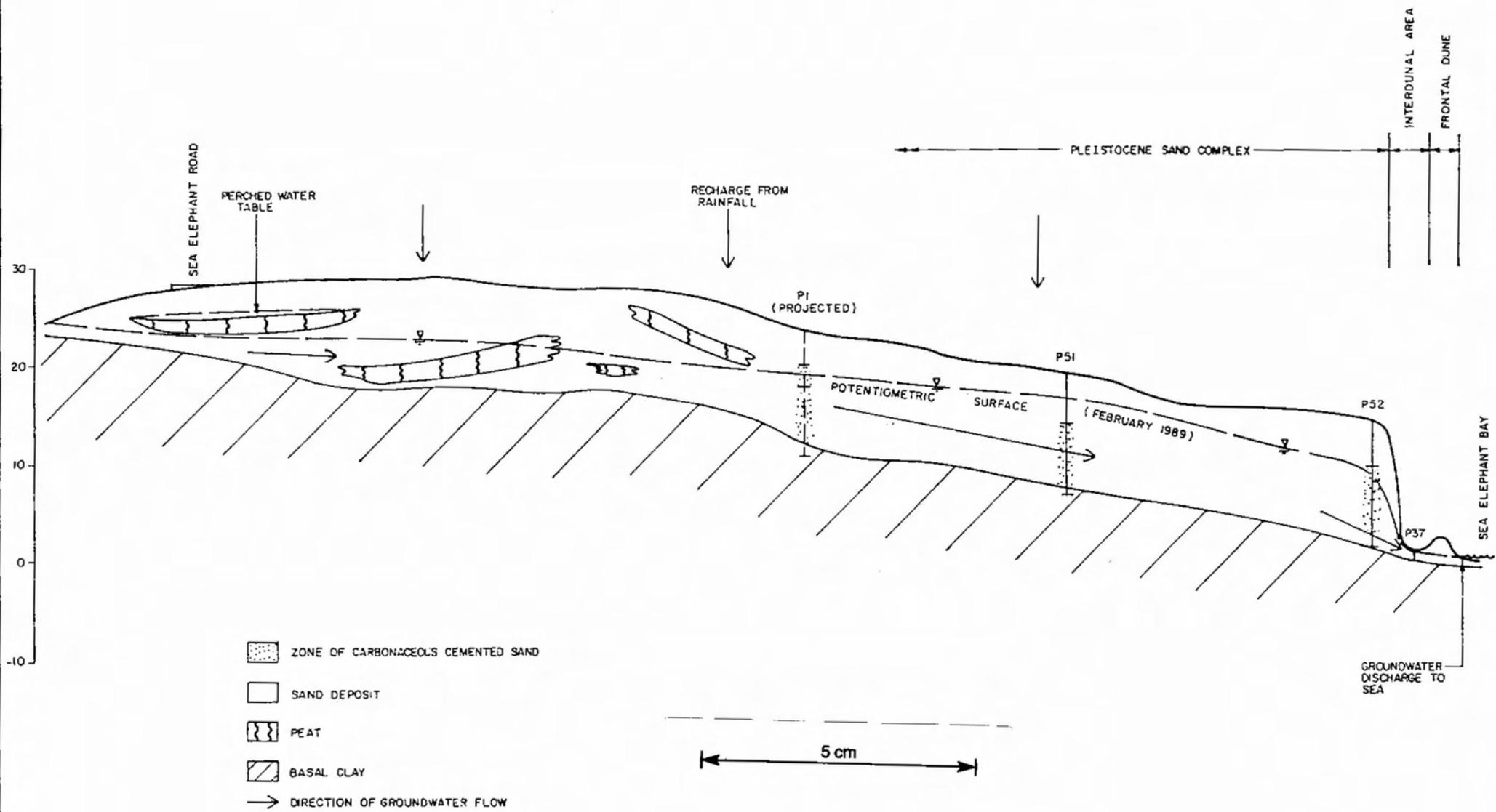
scale (metres)

drawn LWD/SW
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NATIONAL MINERAL SANDS
 KING ISLAND HEAVY MINERAL DEPOSITS
 LOCATION OF OBSERVATION PIEZOMETERS,
 SPEARPOINT & PRODUCTION BORE



FIGURE 4
 job no 065/3



revision	description	drawn	approved	date

drawn	LWD/AB
checked	<i>[Signature]</i>
date	12/4/89

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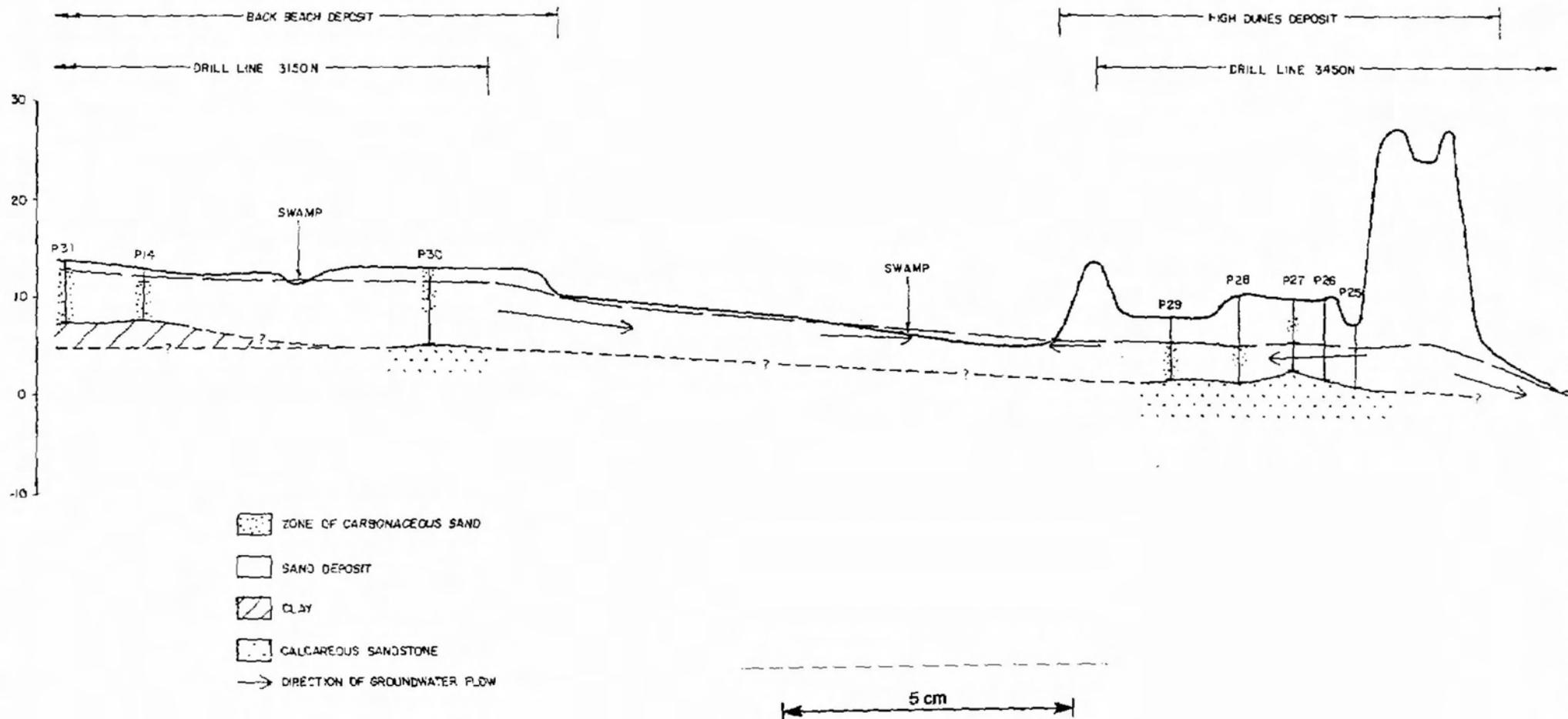
NATIONAL MINERAL SANDS
KING ISLAND HEAVY MINERAL DEPOSITS
HYDROGEOLOGICAL CROSS SECTION
DRILL LINE 1600N - NARACOOPA



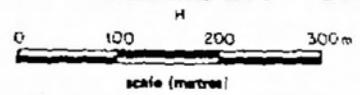
FIGURE 5

job no G65/3

020263



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revision	description	drawn	approved	date

drawn	LWD/AB
checked	<i>[Signature]</i>
date	2/4/89

NATIONAL MINERAL SANDS
 KING ISLAND HEAVY MINERAL DEPOSITS
 HYDROGEOLOGICAL CROSS SECTION
 ACROSS DRILL LINES 3150N & 3450N



FIGURE 6

job no G65 / 3

020264

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LABORATORY REPORT

No. 8902036 Page 1

Client: Coffey & Partners Pty. Ltd.,
P.O. Box 125,
NORTH RYDE N.S.W. 2113

Date Received: 14.2.89

Date of Collection: 14.2.89

Attention: Dr. L. Drury

Client Ref: Job No. G65/3

Description of Sample: Water samples from King Island Heavy Mineral Mine, as below:

<u>Reference Number:</u>	147	148	149	150
<u>Sample Origin:</u>	Mouth of Blowhole Ck.	Swamp Cowpers Pt. West of P25	Beach Spearpoint P37 Narracoopa	Production Bore P50 Cowpers Pt.
pH (Method 423*)	8.8	6.2	5.1	7.3
Biochemical Oxygen Demand, BOD ₅ , mg/L (Method 507*)	< 5	17	< 5	< 5
True Colour, Pt-Co units, (Method 204A* Modified - filtration)	29	500	220	26
Suspended solids, mg/L, (Method 209C*)	13	51	< 2	< 2
Specific conductance, at 25°C, microsiemens/cm, (Method 205*)	34 300	1 760	686	1 370
Calcium, Ca, mg/L, (Method 311A*)	500 (24.95)	58 (2.89)	10.3 (0.51)	127 (6.34)
Magnesium, Mg, mg/L, (Method 318A*)	880 (72.42)	36 (2.96)	14.1 (1.16)	21.0 (1.73)
Sodium, Na, mg/L, (Method 325A*)	5 800 (252.30)	225 (9.79)	95 (4.13)	138 (6.00)
Potassium, K, mg/L, (Method 322A*)	64 (1.64)	6.4 (0.16)	1.9 (0.05)	4.2 (0.11)
Nitrate, NO ₃ ⁻ , mg/L, (Method 418D*)	3.1 (0.05)	3.1 (0.05)	2.7 (0.04)	0.9 (0.01)
Bicarbonate, HCO ₃ ⁻ , mg/L, (Method 403*)	102 (1.67)	70 (1.15)	< 1 (<0.02)	247 (4.05)
Carbonate, CO ₃ ²⁻ , mg/L (Method 403*)	25 (0.83)	Nil	Nil	Nil

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LABORATORY REPORT

No. 8902036 Page 2

Client: Coffey & Partners Pty. Ltd.,
P.O. Box 125,
NORTH RYDE N.S.W. 2113

Date Received: 14.2.89

Date of Collection: 14.2.89

Attention: Dr. L. Drury

Client Ref: Job No. G65/3

Description of Sample: Water samples from King Island Heavy Mineral Mine, as below:

<u>Reference Number:</u>	147	148	149	150
<u>Sample Origin:</u>	Mouth of Blowhole	Swamp Ck. Cowpers Pt. West of P25	Beach Spearpoint P37 Narracoopa	Production Bore P50 Cowpers Pt.
Sulphate, $SO_4^{=}$, mg/L, (Method 426C*)	1 700 (35.39)	2 (0.04)	28 (0.58)	51 (1.06)
Chloride, Cl^{-} , mg/L, (Method 407C*)	11600 (327.24)	529 (14.92)	188 (5.30)	331 (9.34)
Total Arsenic, As, mg/L (Method 303E*)	0.003	< 0.002	0.002	< 0.002
Total Zinc, Zn, mg/L (Methods 302D*, 328A*)	< 0.01	< 0.01	0.06	0.02
Total Copper, Cu, mg/L (Methods 302D*, 304*)	< 0.01	< 0.01	< 0.01	< 0.01
Total Lead, Pb, mg/L (Methods 302D*, 304*)	< 0.01	< 0.01	< 0.01	< 0.01
Total Cadmium, Cd, mg/L (Methods 302D*, 304*)	0.004	0.002	< 0.001	< 0.001
Total Iron, Fe, mg/L, (Methods 302D*, 315A*)	0.06	0.65	2.16	0.34
Total Chromium, Cr, mg/L (Methods 302D*, 304*)	< 0.01	< 0.01	< 0.01	< 0.01
Total Manganese, Mn, mg/L, (Methods 302D*, 319A* or 304*)	< 0.01	0.07	0.04	0.04
Cations/Anions, %	96.2	97.8	98.7	98.0

* Standard Methods for the Examination of Water and Wastewater
16th Edition, 1985
A.P.H.A. - A.W.W.A. - W.P.C.F.

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LABORATORY REPORT

No. 8902036 Page 3

Client: Coffey & Partners Pty. Ltd.,
P.O. Box 125,
NORTH RYDE N.S.W. 2113

Date Received: 14.2.89

Date of Collection: 14.2.89

Attention: Dr. L. Drury

Client Ref: Job No. G65/3

Description of Sample: Water samples from King Island Heavy Mineral Mine, as below:

<u>Reference Number:</u>	151	152	153	154
<u>Sample Origin:</u>	Frazer River Mouth Narracoopa	Frazer River Bridge Narracoopa	Swamp 1400N 380W Narracoopa	Production Bore P52 Narracoopa
pH (Method 423*)	7.3	6.8	4.2	4.4
Biochemical Oxygen Demand, BOD ₅ , mg/L (Method 507*)	< 5	8	11	9
True Colour, Pt-Co units, (Method 204A* Modified - filtration)	55	300	260	24
Suspended solids, mg/L, (Method 209C*)	13	18	67	< 2
Specific conductance, at 25°C, microsiemens/cm, (Method 205*)	4 340	480	331	558
Calcium, Ca, mg/L, (Method 311A*)	160 (7.98)	16.6 (0.83)	4.3 (0.21)	5.2 (0.26)
Magnesium, Mg, mg/L, (Method 318A*)	98 (8.06)	12.9 (1.06)	5.4 (0.44)	11.4 (0.94)
Sodium, Na, mg/L, (Method 325A*)	740 (32.19)	61 (2.65)	44 (1.91)	76 (3.31)
Potassium, K, mg/L, (Method 322A*)	18.5 (0.47)	3.0 (0.08)	1.0 (0.03)	1.8 (0.05)
Nitrate, NO ₃ ⁻ , mg/L, (Method 418D*)	3.1 (0.05)	2.2 (0.04)	4.0 (0.06)	3.1 (0.05)
Bicarbonate, HCO ₃ ⁻ , mg/L, (Method 403*)	123 (2.02)	72 (1.18)	N11	N11
Carbonate, CO ₃ ²⁻ , mg/L (Method 403*)	N11	N11	N11	N11

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TELEX AA27466

LABORATORY REPORT

No. 8902036 Page 4

Client: Coffey & Partners Pty. Ltd.,
P.O. Box 125,
NORTH RYDE N.S.W. 2113

Date Received: 14.2.89

Date of Collection: 14.2.89

Attention: Dr. L. Drury

Client Ref: Job No. G65/3

Description of Sample: Water samples from King Island Heavy Mineral Mine, as below:

<u>Reference Number:</u>	151	152	153	154
<u>Sample Origin:</u>	Frazer River Mouth Narracoopa	Frazer River Bridge Narracoopa	Swamp 1400N 380W Narracoopa	Production Bore P52 Narracoopa
Sulphate, $SO_4^{=}$, mg/L, (Method 426C*)	68 (1.42)	< 1 (<0.02)	2 (0.04)	27 (0.56)
Chloride, Cl^{-} , mg/L, (Method 407C*)	1 580 (44.57)	118 (3.33)	84 (2.37)	138 (3.89)
Total Arsenic, As, mg/L (Method 303E*)	0.002	0.003	< 0.002	< 0.002
Total Zinc, Zn, mg/L (Methods 302D*, 328A*)	< 0.01	0.02	< 0.01	1.96
Total Copper, Cu, mg/L (Methods 302D*, 304*)	< 0.01	< 0.01	0.013	< 0.01
Total Lead, Pb, mg/L (Methods 302D*, 304*)	< 0.01	< 0.01	< 0.01	0.018
Total Cadmium, Cd, mg/L (Methods 302D*, 304*)	0.003	0.003	0.002	< 0.001
Total Iron, Fe, mg/L, (Methods 302D*, 315A*)	1.28	21.2	0.34	0.28
Total Chromium, Cr, mg/L (Methods 302D*, 304*)	< 0.01	< 0.01	< 0.01	< 0.01
Total Manganese, Mn, mg/L, (Methods 302D*, 319A* or 304*)	0.10	0.79	0.02	0.02

.../5

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TELEX 4477268

LABORATORY REPORT

No. 8902036 Page 5

Client: Coffey & Partners Pty. Ltd.,
P.O. Box 125,
NORTH RYDE N.S.W. 2113

Date Received: 14.2.89

Date of Collection: 14.2.89

Attention: Dr. L. Drury

Client Ref: Job No. G65/3

Description of Sample: Water samples from King Island Heavy Mineral Mine, as below:

<u>Reference Number:</u>	151	152	153	154
<u>Sample Origin:</u>	Frazer River Mouth Narracoopa	Frazer River Bridge Narracoopa	Swamp 1400N 380W Narracoopa	Production Bore P52 Narracoopa

Total Coliforms, organisms/100mL (Method 909A*)	-	-	-	TNTC
---	---	---	---	------

Faecal Coliforms, organisms/100mL (Method 909C*)	-	-	-	480
--	---	---	---	-----

Standard Plate Count, organisms/mL (Method 907 ⁺)	-	-	-	59 000
---	---	---	---	--------

Cations/Anions, %	101.4	101.7	105.0	101.0
-------------------	-------	-------	-------	-------

+ Standard Methods for the Examination of Water and Wastewater
15th Edition, 1980
A.P.H.A. - A.W.W.A. - W.P.C.F.

* Standard Methods for the Examination of Water and Wastewater
16th Edition, 1985
A.P.H.A. - A.W.W.A. - W.P.C.F.


J.D.C. ANDERSON

SAMPLE DESCRIPTION:

WATERS, ORDER NUMBER 25603

DATE RECEIVED:

MAY 4, 1988.

CLIENT SAMPLE REFERENCE:		P 6 X	P 6 Y	P 6 Z	P 9 X	P 9 Y	P 9 Z	
LABORATORY REFERENCE NO.:		QL6774/1	QL6774/2	QL6774/3	QL6774/4	QL6774/5	QL6774/6	SGS Quantum Method No.
pH		7.4	-	-	4.7	-	-	9.125
Conductivity	uS/cm	3050.	-	-	3830.	-	-	9.060
Total Dissolved Salts	mg/L	2160.	-	-	2110.	-	-	9.180
Colour	PCU	6700.	-	-	17000.	-	-	9.055
Turbidity	NTU	2400.	-	-	5000.	-	-	9.185
Calcium as Ca	mg/L	130.	-	-	20.	-	-	9.035
Magnesium as Mg	mg/L	95.	-	-	83.	-	-	9.095
Sodium as Na	mg/L	360.	-	-	630.	-	-	9.155
Potassium as K	mg/L	23.	-	-	23.	-	-	9.135
Alkalinity as CaCO3	mg/L	660.	-	-	16.	-	-	9.010
Sulphate as SO4	mg/L	350.	-	-	240.	-	-	9.165
Chloride as Cl	mg/L	540.	-	-	1100.	-	-	9.040
Sulphide as S	mg/L	-	-	< 1.	-	-	< 1.	9.170
Iron as Fe	mg/L	-	0.8	-	-	20.	-	9.085
Manganese as Mn	mg/L	-	3.6	-	-	3.4	-	9.100

020270

Coffey & Partners Pty. Ltd.,
P.O. Box 118,
EAST BRISBANE. QLD. 4169.



This Laboratory is registered by the National Association of Testing Authorities, Australia. The tests reported herein have been performed in accordance with its terms of registration. This document shall not be reproduced except in full.

Signed.....
Date.....

J. Anderson
18/5/88



Department of Health

RADIATION HEALTH SERVICES

Mr J Anderson
 Judall Platt Thomas & Associates
 168 Willoughby Rd
 CROWS NEST 2065 226

Joseph Street
 Lidcombe, N.S.W. 2141
 Address reply to
 P.O. Box 162 Lidcombe, N.S.W.
 2141 Australia

Telex: 72233
 Facs: (02) 646 0333

Our reference: GG:ia

Your reference:

7 April 1989

Phone: 646 0222

RE: WATER SAMPLES - RADIOACTIVITY

The results of gross alpha and gross beta analysis for water samples are as follows:-

Sample	Alpha Bq/l	Beta Bq/l
147	0.64 ± .95	6.56 ± 2.45
148	0.26 ± .83	.89 ± 2.1
149	0 ± 0.7	0.67 ± 2.08
150	0.14 ± .79	0 ± 1.99
151	0 ± .75	1.84 ± 2.6
152	0.13 ± 0.79	1.2 ± 2.12
153	0 ± 0.75	1.22 ± 2.12
154	0.00 ± 0.1	0 ± 0.21

Fifteen ml of each sample was evaporated on a planchette and counted for 50 minutes in a Canberra Law Level Alpha Beta System.

The results are quoted with an associated assessment of the error and from these results it is unlikely that there is any gross alpha or beta concentration in any sample to be of any concern.

Yours faithfully

GEORGE GANDY
 Scientific Officer
 Radiation Health Services

VIII EQUIPMENT LIST AND BIDDERS LIST

EQUIPMENT LIST

This equipment list is based on nominated duties obtained during preliminary investigations.

ITEM NO: 1 TROMMEL

Nominated Supplier : CMI Services Pty. Ltd.
 Diameter : 1.8m
 Length : 6.0m
 Capacity : 450 tph
 Screen type : Polyurethane
 Cut-Size : 2mm
 Motor : 10 kW
 Weight : 3 Tonnes

Alternative Suppliers:
 Warman International Ltd.
 Surescreen
 Mineral Deposits Ltd.

ITEM NO: 2 CONSTANT DENSITY TANK

Capacity : 90m³
 Material : Mild Steel
 Inclusions : Overflow Weir

ITEM NO: 3 ROUGHER SPIRAL FEED PUMP

Nominated Supplier : Warman International Ltd.
 Duty : 773m³/h at 11.8m TDH
 Type : 12/10 F-AH Rubber Lined
 Motor : 55 kW
 Weight : 4.9 Tonnes

ITEM NO: 4 ROUGHER SPIRALS

Nominated Supplier : M.E.T. Pty. Ltd.
 Model : MM7 Triplex
 No. of Banks : ~~8~~ 7
 Spirals/Bank : 3612
 Total No. of starts : ~~288~~ 240 (178 for years 1 to 3)

Alternative Suppliers:
 C.M.I. Services Pty. Ltd.
 Mineral Deposits Ltd.

ITEM NO: 5 MIDDLEINGS SUMP

Capacity : 23m³
 Material : Mild Steel

ITEM NO: 6 MIDLINGS SPIRAL FEED PUMP

Nominated Supplier : Warman International Ltd.
 Duty : 698m³/h at 15.6m TDH
 Type : 10/8 F-AH Rubber Lined
 Motor : 75 kW
 Weight : 4.3 Tonnes

ITEM NO: 7 MIDLINGS SPIRAL

Nominated Supplier : M.E.T. Pty. Ltd.
 Model : MM7 Triplex
 No. of Banks : ~~7~~ 6³
 Spirals/Bank : ~~36~~ 12¹²
 Total No. of Starts : ~~252~~ 108 - for RZ recovery

Alternative Suppliers:
 C.M.I. Services Pty. Ltd.
 Mineral Deposits Ltd.

216 - for RZL recovery.
 (80 - for RZ recovery)
 Years 1 to 3)

ITEM NO: 8 CLEANER SUMP

Capacity : 15m³
 Material : Mild Steel

ITEM NO: 9 CLEANER SPIRAL FEED PUMP

Nominated Supplier : Warman International Ltd.
 Duty : 463m³/h at 15.1m TDH
 Type : 10/8 F-AH Rubber Lined
 Motor : 45 kW
 Weight : 4.0 Tonnes

ITEM NO: 10 CLEANER SPIRALS

Nominated Supplier : M.E.T. Pty. Ltd.
 Model : HM-3 Duplex
 No. of Banks : ~~7~~ 6
 Spirals/Bank : ~~24~~ 12
 Total No. of Starts : ~~268~~ 144 (107 for years 1 to 3).

Alternative Suppliers:
 C.M.I. Services Pty. Ltd.
 Mineral Deposits Ltd.

ITEM NO: 11 RECLEANER SUMP

Capacity : 5m³
 Material : Mild Steel

ITEM NO: 12 RECLEANER SPIRAL FEED PUMP

Nominated Supplier : Warman International Ltd.
 Duty : 154m³/h at 17.7m TDH
 Type : 6/4 D-AH Rubber Lined
 Motor : 18.5 kW
 Weight : 1.0 Tonnes

ITEM NO: 13 RECLEANER SPIRALS

Nominated Supplier : M.E.T. Pty. Ltd.
 Model : HM-3 Duplex
 No. of Banks : ~~4~~ 2
 Spirals/Bank : ~~16~~ 12
 Total No. of Starts : ~~64~~ 48 (36 for years 1 to 3)

Alternative Suppliers:

C.M.I. Services Pty. Ltd.
 Mineral Deposits Ltd.

ITEM NO: 14 CONCENTRATE SUMP

Capacity : 2.5m³
 Material : Mild Steel

ITEM NO: 15 CONCENTRATE PUMPS

Nominated Supplier : Warman International Ltd.
 Duty : 76m³/h at 77.1m TDH
 Type : 3/2 C-AH Rubber Lined
 No. : 2 in series
 Motor : 22 kW each
 Weight : 1.0 Tonne Total

ITEM NO: 16 CONCENTRATE CYCLONE

Nominated Supplier : Warman International Ltd.
 Model : 15 CE
 Operating pressure : 100 kPa
 Inclusions : Underflow density controller

ITEM NO: 17 PROCESS WATER CIRCULATING PUMP

Nominated Supplier : Warman International Ltd.
 Duty : 500m³/h at 30m TDH
 Type : 8/6 DD-S
 Motor : 75 kW
 Weight : 1.1 Tonnes

ITEM NO: 18 TAILINGS SUMP

Capacity : 50m³
 Material : Mild Steel

ITEM NO: 19 TAILINGS PUMPS

Nominated Supplier : Warman International Ltd
 Duty : 808m³/h at 30m TDH each
 Type : 8/6 F-AH Rubber Lined
 No. : 2 in parallel
 Motor : 132 kW each
 Weight : 6.7 Tonnes Total

ITEM NO: 20 MAGNETIC SEPARATOR

Nominated Supplier : Serpent And Dove Pty. Ltd.
 Type : Eriez Double Drum
 Drum Diameter : 914mm
 Drum Length : 1220mm
 Motor : 4 kW

ITEM NO: 21 WET HIGH INTENSITY MAGNETIC SEPARATOR

Nominated Supplier : Serpent And Dove Pty. Ltd.
 Model : CF250
 Motor : 37 kW
 Weight : 22 Tonnes

Alternative Supplier:

Readings of Lismore Pty. Ltd.
 Boxmag-Rapid Limited

ITEM NO: 22 ATTRITION MACHINE

Nominated Supplier : Warman International Ltd.
 No. of Cells : 4
 Capacity : 4m³
 Motor : 148 kW (4x37kW)
 Weight : 8 Tonnes

ITEM NO: 23 BULK CONCENTRATE SUMP

Capacity : 2m³
 Material : Mild Steel

ITEM NO: 24 BULK CONCENTRATE TRANSFER PUMP

Nominated Supplier : Warman International Ltd.
 Duty : 67m³/h at 18m TDH
 Type : 4/3 C-AH Rubber Lined
 Motor : 11 kW
 Weight : 0.8 Tonnes

ITEM NO: 25 DESLIMING CYCLONE

Nominated Supplier : Warman International Ltd.
 Model : 15 CE
 Operating Pressure : 100kPa

ITEM NO: 26 BULK CONCENTRATE SUMP-B

Capacity : 2m³
Material : Mild Steel

ITEM NO: 27 BULK CONCENTRATE TRANSFER PUMP B

Nominated Supplier : Warman International Ltd.
Duty : 67m³/h at 18m TDH
Type : 4/3 C-AH Rubber Lined
Motor : 11 kW
Weight : 0.8 Tonnes

ITEM NO: 28 DESLIMING CYCLONE B

Nominated Supplier : Warman International Ltd.
Model : 15 CE
Operating Pressure : 100kPa

ITEM NO: 29 CAUSTIC SODA MIXING TANK

Working Volume : 2.6m³
Material : Mild Steel

ITEM NO: 30 CAUSTIC SODA MIXING AGITATOR

Nominated Supplier : Sardik Engineering
Model : To be nominated
Motor : 4 kW

Alternative Supplier:
Warman International Ltd.
Lighting Mixers Pty. Ltd.

ITEM NO: 31 CAUSTIC SODA PUMP

Nominated Supplier : Acromet
Model : 3001-F-025
Motor : 0.37 kW
Weight : 30 Kgs

Alternative Supplier:
Prominent.

ITEM NO: 51 WET CONCENTRATE FEED PUMP

Nominated Supplier : Warman International Ltd.
Duty : 24m³/h at 13.6 TDH
Type : 40 VC-GPS Sump Pump
Motor : 5.5 kW

ITEM NO: 52

TRASH SCREEN

Nominated Supplier : Vibramech (Aust.) Pty. Ltd.
 Screen Type : Horizontal Vibrating
 Selection : H1-24-9
 Motor : 2x1.1 kW
 Weight : 0.9 Tonnes

Alternative Suppliers:

Bryce Watson
 Honert Vibration Technic

ITEM NO: 53

CONSTANT DENSITY TANK

Capacity : 6.7m³
 Material : Mild Steel
 Inclusions : Overflow Weir

ITEM NO : 54

PRIMARY SPIRAL FEED PUMP

Nominated Supplier : Warman International Ltd.
 Duty : 41m³/h at 20.1 TDH
 Type : 3/2 C-AH Rubber Lined
 Motor : 7.5 kW
 Weight : 0.4 Tonnes

ITEM NO: 55

PRIMARY SPIRALS

Nominated Supplier : M.E.T. Pty. Ltd.
 Model : KM3 Duplex
 No. of Banks : 1
 No. of Spirals : 8
 No. of Starts : 16

Alternative Suppliers:

CMI Services Pty. Ltd.
 Mineral Deposits Ltd.

* ITEM NO: 56

GRAVITY TABLE

Nominated Supplier : Mineral Deposits Ltd
 Number : ~~4~~10
 Type : Diester Concenco Super
 Duty No. 6
 Motor : 3 kW Each

Alternative Supplier:

Clyde-Carruthers : Wilfley

ITEM NO: 57

SCAVENGER SPIRAL FEED SUMP

Capacity : 2m³
 Material : Mild Steel

* FOR RZ RECOVERY ITEM 56 IS SINGLE DUPLEX SPIRAL

ITEM NO: 58 SCAVENGER SPIRAL FEED PUMP

Nominated Supplier : Warman International Ltd.
 Duty : 24m³/h at 20m TDH
 Type : 2/1½ B-AH Rubber Lined
 Motor : 5.5 kW

ITEM NO: 59 SCAVENGER SPIRALS

Nominated Supplier : M.E.T. Pty. Ltd.
 Model : MMZ Triplex
 No. of Banks : 1
 No. of Spirals : 1
 No. of Starts : 3

Alternative Suppliers:

C.M.I. Services Pty. Ltd.
 Mineral Deposits Ltd.

ITEM NO: 60 SUMP PUMP

Nominated Supplier : Warman International Ltd.
 Duty : 16m³/h at 20m TDH
 Type : 40 PV-SPR Sump Pump
 Motor : 4 kW

ITEM NO: 61 CONCENTRATE DEWATERING FEED SUMP

Capacity : 1.5m³
 Material : Mild Steel

ITEM NO: 62 CONCENTRATE DEWATERING CYCLONE

Nominated Supplier : Warman International ltd.
 Type : 6 C
 Operating Pressure : 70 kPa

ITEM NO: 63 CONCENTRATE DEWATERING FEED PUMP

Nominated Supplier : Warman International Ltd.
 Duty : 18m³/h at 25.6m TDH
 Type : 1½/1 B-AH Rubber Lined
 Motor : 7.5 kW

ITEM NO: 64 CONCENTRATE DEWATERING FILTER

Nominated Supplier : Delkor Pty. Ltd.
 Type : Vacuum Belt Filter
 Filter Area : 2m²
 Motor : 0.75 kW
 Inclusions : Item No 65 Vaccum Fan 22 kW
 : Item No 66 Filtrate Receiver
 : Tank

ITEM NO: 67 FILTRATE PUMP

Nominated Supplier : Warman International Ltd.
 Type : Submerged Gland Sealed
 Selection : 1½/1 B-AH
 Motor : 3 kW

ITEM NO: 68 DRYER SCREW FEEDER

Nominated Supplier : Scott-Osmond
 Diameter : 300mm
 Length : 10m

ITEM NO: 69 CONCENTRATE DRYER

Nominated Supplier : Pyrotherm Pty. Ltd.
 Type : Fluidised Bed
 Diameter : ~~1.85m~~ 2.0m
 LGP Consumption : 110 kG/hr
 Weight : 7 Tonnes

Inclusions:

Item No. 70	Cyclone Extractor	
Item No. 71	Exhaust Fan	18.5 kW
Item No. 83	Main Fan	30 kW
	Booster Fan	15 kW

Alternative Supplier:

West's Process Engineering

ITEM NO: 72 THICKENER FEED TRANSFER HOPPER

Capacity : 1.5m³
 Material : Mild Steel

ITEM NO: 73 THICKENER FEED TRANSFER PUMP

Nominated Supplier : Warman International Ltd.
 Duty : 22m³/h at 10m TDH
 Type : 2/1½ B-S Solution Pump
 Motor : 2.2 kW

ITEM NO: 74 THICKENER

Nominated Supplier : Warman International Ltd.
 Diameter : 6m
 Type : Conventional
 Model : 38 T
 Motor : 1.5 kW Drive, 0.75 kW Lift.

ITEM NO: 75 PROCESS WATER TRANSFER HOPPER

Capacity : 5m³
 Material : Mild Steel

ITEM NO: 76

PROCESS WATER PUMP

Nominated Supplier : Ajax Pumps Pty. Ltd.
 Type : BPO Pump
 Model : 100x65 - 315
 Motor : 7.5 kW

Alternative Supplier:
 Warman International ltd.

ITEM NO: 77

THICKENER UNDERFLOW PUMP

Nominated Supplier : Warman International Ltd.
 Duty : 6.6m³/h at 15m TDH
 Type : 1½/1 B-AH Rubber Lined
 Motor : 2.2 kW

ITEM NO: 78

TAILINGS FEED HOPPER

Capacity : 2.5m³
 Material : Mild Steel

ITEM NO: 79

TAILINGS CYCLONE FEED PUMP

Nominated Supplier : Warman International Ltd.
 Duty : 29.4m³/h at 28m TDH
 Type : 2/1½ B-AH Rubber Lined
 Motor : 7.5 kW

ITEM NO: 80

TAILINGS DEWATERING CYCLONE

Nominated Supplier : Warman International Ltd.
 Type : 10 CE
 Operating Pressure : 50 kPa
 Inclusions : Underflow Density Controller

ITEM NO. 81

GUARD SCREEN

Nominated Supplier : Bryce Watson
 Screen Type : Horizontal Vibrating
 Selection : Jacques 1850x900
 Motor : 4 kW
 Cut-Size : 0.5mm

ITEM NO. 82

SURGE BIN

Capacity : 6m³
 Material : Mild Steel

ITEM NO. 104

ROUGHER ROLLS

Nominated Supplier : Readings of Lismore Pty. Ltd.
 Feed Rate : 16.6 TPH Nominal
 Type : Roll High Tension Separators
 Number/Selection : 3 off/2x2x1524x270
 Power : 5.5 kW Each
 Inclusions : Dust Enclosures
 A.C. Wipers
 100mA Rectifier/Controller
 45mA A.C. Wiper Power Unit

Alternative Suppliers:

Mineral Deposits Ltd.
 Serpent And Dove Pty. Ltd.

ITEM NO. 105

CONDUCTOR CLEANER ROLLS

Nominated Supplier : Readings of Lismore Pty. Ltd.
 Feed Rate : 6.3 TPH Nominal
 Type : Roll High Tension Separator
 Number/Selection : 1 off/2x2x1524x270
 Power : 5.5 kW
 Inclusions : Dust Enclosures
 A.C. Wipers
 50mA Rectifier/Controller
 30mA A.C. Wiper Power Unit

Alternative Suppliers:

Mineral Deposits Ltd.
 Serpent And Dove Pty. Ltd.

ITEM NO. 106

NON-CONDUCTOR CLEANER ROLLS

Nominated Supplier : Readings of Lismore Pty. Ltd.
 Feed Rate : 10.3 TPH Nominal
 Type : Roll High Tension Separators
 Number/Selection : 2 off/2x2x1524x270
 Power : 5.5 kW Each
 Inclusions : Dust Enclosures
 A.C. Wipers
 50mA Rectifier/Controller
 45mA A.C. Wiper Power Unit

Alternative Suppliers:

Mineral Deposits Ltd.
 Serpent And Dove Pty. ltd.

ITEM NO. 107

CONDUCTOR RECLENER ROLLS

Nominated Supplier : Readings of Lismore Pty. Ltd.
 Feed Rate : 5 TPH Nominal
 Type : Roll High Tension Separator
 Number/Selection : 1 off/2x2x1524x270
 Power : 5.5 kW
 Inclusions : Dust Enclosures
 A.C. Wipers
 50mA Rectifier/Controller
 30mA A.C. Wiper Power Unit

Alternative Suppliers:

Mineral Deposits Ltd.
 Serpent And Dove Pty. Ltd.

ITEM NO. 108

NON-CONDUCTOR RECLENER PLATE

Nominated Supplier : Readings of Lismore Pty. Ltd.
 Feed Rate : 3.5 TPH Nominal
 Type : Electrostatic Plate Separator
 Number/Selection : 2 off/2x5x1800
 Power : 1.1 kW Each
 Inclusions : Dust Enclosures
 A.C. Wipers
 12.5mA Rectifier/Controller

ITEM NO. 109

H.M. CONDUCTORS MAGNET

Nominated Supplier : Readings of Lismore Pty. Ltd.
 Feed Rate : 4.3 TPH Nominal
 Type : Induced Roll Magnetic
 Separators
 Number/Selection : 2 off/2x3x762
 Power : 6.5 kW (Max) Each
 Inclusions : Control Switchboard

Alternative Suppliers:

Hilring Pty. Ltd. (Carpco)
 Serpent And Dove Pty. Ltd.

ITEM NO. 110

RECLENER CONDUCTORS MAGNET

Nominated Supplier : Readings of Lismore Pty. Ltd.
 Feed Rate : 1.7 TPH Nominal
 Type : Induced Roll Magnetic
 Separator
 Number/Selection : 1 off/2x3x762
 Power : 6.5 kW
 Inclusions : Control Switchboard

Alternative Suppliers:

Hilring Pty. Ltd. (Carpco)
 Serpent And Dove Pty. Ltd.

ITEM NO. 111 NON-CONDUCTOR SCAVENGER PLATE

Nominated Supplier : Readings of Lismore Pty. Ltd.
 Feed Rate : 2.7 TPH Nominal
 Type : Electrostatic Plate Separator
 Number/Selection : 2 off/2x5x1800
 Power : 1.1 kW (Max) Each
 Inclusions : Control Switchboard
 Dust Enclosures
 12.5mA Rectifier/Controller

Alternative Supplier:
 Mineral Deposits Ltd.

ITEM NO. 112 NON-MAGS SCAVENGER MAGNET

Nominated Supplier : Readings of Lismore
 Feed Rate : 3.6 TPH Nominal
 Type : Induced Roll Magnet Separator
 Number/Selection : 2 off/2x2x762
 Power : 6.5 kW (Max) Each
 Inclusions : Control Switchboard

Alternative Suppliers:
 Hilring Pty. Ltd. (Carpco)
 Serpent And Dove Pty. Ltd.

ITEM NO. 113 NON-MAGNETICS CLEANER PLATES

Nominated Supplier : Readings of Lismore Pty. Ltd.
 Feed Rate : 4.2 TPH Nominal
 Type : Electrostatic Plate Separators
 Number/Selection : 2 off/2x5x1800
 Motors : 1.1 kW Each
 Inclusions : Dust Enclosures
 25mA Rectifier/Controller

Alternative Supplier:
 Mineral Deposits Ltd.

ITEM NO. 114 NON-CONDUCTOR SCAVENGER MAGNET

Nominated Supplier : Readings of Lismore Pty. Ltd.
 Feed Rate : 3.7 TPH Nominal
 Type : Induced Roll Magnetic Separator
 Number/Selection : 2 off/2x2x762
 Power : 6.5 kW (Max) Each
 Inclusions : Control Switchboard

Alternative Suppliers:
 Hirling Pty. Ltd. (Carpco)
 Serpent And Drove Pty. Ltd.

ITEM NO. 115 NON-MAGNETICS RECLENER PLATE

Nominated Supplier : Readings of Lismore Pty. Ltd.
 Feed Rate : 3 TPH Nominal
 Type : Electrostatic Plate Separator
 Number/Selection : 2 off/2x5x1800
 Motors : 1.1 kW Each
 Inclusions : Dust Enclosures
 12.5mA Rectifier/Controller
 Alternative Supplier:
 Mineral Deposits Ltd.

ITEM NO. 116 MAGNETICS CLEANER PLATES

Nominated Supplier : Readings of Lismore Pty. Ltd.
 Feed Rate : 1.4 TPH Nominal
 Type : Electrostatic Plate Separator
 Number/Selection : 1 off/2x5x1800
 Motors : 1.1 kW
 Inclusions : Dust Enclosures
 12.5mA Rectifier/Controller

ITEM NO. 117 TOURMALINE SCREEN

Nominated Supplier : Warman International Ltd.
 Type : Circular, Kason
 Model : K 48
 Motor : 0.75 kW

ITEM NO. 118 N.C. CLASSIFYING FEED SUMP

Capacity : 1m³
 Material : Mild Steel

ITEM NO. 119 N.C. CLASSIFYING FEED SUMP

Nominated Supplier : Warman International Ltd.
 Duty : 14m³/h at 24.3 TDH
 Type : 1½ B-AH Rubber Lined
 Motor : 5.5 kW

ITEM NO. 120 ZIRCON CLASSIFYING CYCLONE

Nominated Supplier : Warman International Ltd.
 Type : 3R
 Operating Pressure : 40 kPa

Alternative Supplier:
 Linatex (Australia) Pty. Ltd.

ITEM NO. 121 ZIRCON DEWATERING FILTER

Nominated Supplier : Delkor Pty. Ltd.
 Filter Area : 1m²
 Power : 0.5 kW
 Inclusions : Item No 127 Filtrate Receiver
 Item No 128 Vacuum Fan 15kW
 Item No 129 Filtrate Pump 1.1kW

ITEM NO. 133 ZIRCON CLEANER MAGNET

Nominated Supplier : Readings of Lismore Pty. Ltd.
 Feed Rate : 5.3 TPH Nominal
 Type : Induced Roll Magnetic Separator
 Number/Selection : 3 off/2x2x762 (2 off RZ only)
 Power : 6.5 kW Each (Max)
 Inclusions : Control Switchboard

Alternative Suppliers:
 Hirling Pty. Ltd. (Carpcoc)
 Serpent And Dove Pty. Ltd.

ITEM NO. 134 AIR TABLES

Nominated Supplier : Combustion Engineering
 Type : Oliver
 No/Model : 4 off/160 (2 off RZ only)
 Power : 30 kW Total

ITEM NO. 135 ZIRCON CLEANER PLATE

Nominated Supplier : Readings of Lismore Pty. Ltd.
 Feed Rate : 2 TPH Nominal
 Type : Electrostatic Plate Separator
 Number/Selection : 1 off/2x5x1800
 Motor : 1.1 kW
 Inclusions : Dust Enclosures
 12.5mA Rectifier/Controller

Alternative Supplier:
 Mineral Deposits Ltd.

ITEM NO. 136 RUTILE WET TABLE FEED HOPPER

Capacity : 0.5m³
 Material : Mild Steel

ITEM NO. 137 RUTILE WET TABLE FEED PUMP

Nominated Supplier : Warman International Ltd.
 Duty : 6.7m³/h at 11m TDH
 Type : 1½/1 B-AH Rubber Lined
 Motor : 1.1 kW

ITEM NO. 138 CASSITERITE REMOVAL TABLES

Nominated Supplier : Mineral Deposits Ltd.
 Type : Deister Concenco
 Number : 2
 Power : 3 kW Each

Alternative Supplier:
 Clyde-Carruthers : Wilfley

ITEM NO. 139 PYRITE REMOVAL FLOTATION CELLS

Nominated Supplier : Metquip Pty. Ltd.
 Model : OK - 0.5
 No. of Cells : 2
 Inclusions : Feed Box and Discharge Box
 Motor : 5.5 kW
 Air Requirements : 1m³/min at 10 kPa

ITEM NO. 140 RUTILE FILTER FEED PUMP

Nominated Supplier : Warman International Ltd.
 Duty : 3.3m³/h at 15m TDH
 Type : 1¼/1 B-AH Rubber Lined
 Motor : 1.1 kW

ITEM NO. 141 RUTILE DEWATERING FILTER

Nominated Supplier : Delkor Pty. Ltd.
 Filter Area : 1m²
 Power : 0.5 kW
 Inclusions : Item No 147 Filtrate Receiver
 Item No 148 Vacuum Fan 15kW
 Item No 149 Filtrate Pump 1.1kW

ITEM NO. 142 RUTILE DRYER SCREW FEEDER

Nominated Supplier : Scott-Osmond
 Diameter : T.B.A.
 Length : 4.5m
 Motor : T.B.A.

ITEM NO. 143 RUTILE DRYER

Nominated Supplier : Pyrotherm Ltd.
 Type : Fluidised Bed
 Diameter : 0.6m
 LPG Consumption : 12Kg/hr
 Inclusions : Item No 144 Dust Collector
 Item No 145 Exhaust Fan 5.5kW
 Item No 146 Main Fan 11kW

Alternative Supplier:
 Wests Process Engineering

ITEM NO. 150 SPRAY WATER PUMP

Nominated Supplier : Ajax
 Model : 65x40-250
 Motor : 2.2 kW

ITEM NO. 151 DRY PLANT TAILINGS HOPPER

Capacity : 1.5m³
 Material : Mild Steel

ITEM NO. 152 DRY PLANT TAILINGS TRANSFER PUMP

Nominated Supplier : Warman International Ltd.
Duty : 17m³/h at 8m TDH
Type : 2/1½ B-AH Rubber Lined
Motor : 1.5 kW

ITEM NO. 153 AIR BLOWER

Nominated Supplier : Fitzpatrick Engineering

ITEM NO. 154 PLANT AIR COMPRESSOR

Nominated Supplier : Champion Compressors



020290

Alex Fisher Drive, Burleigh Gardens Industrial Park, Gold Coast, Queensland, Australia 4220.

P.O. Box 54, Burleigh Heads, Qld. Aust. 4220.

Telephone: (075) 934 567

Facsimile: (075) 934 398

FACSIMILE MESSAGE

ATTENTION: DAVID GILLETT FAX NO: 02 2624368

COMPANY: NATIONAL MINERAL SANDS DATE: 2/8/89

FROM: DOUG McILWRAITH PAGE:(inc this page)1.

RE: DREDGE

QUOTATION

1 - 18 x 16 DREDGE AS PER PREVIOUS CORRESPONDENCE, BUT
 BEING DIESEL POWERED BY A 3508TA CATAPILLAR MARINE
 ENGINE FITTED WITH MARINE TRANSMISSION & 3 WAY
 HYDRAULIC DRIVE.

H.P. 855 CONTINUOUS CONSUMPTION 123 LITRES/HOUR.

PRICE \$1,097,000.00

REGARDS

DOUG McILWRAITH

Main Pump

Warman gravel pump 12/10 G.G.

Speed 625 R.P.M. driven by a 415V 185kw electric motor through and pulley drive using 65PC belts. Flow rate through 150m of 14" pipe would be 376 L/S.

Theoretical Production:

25%	Density	300	tons/hr
30%	Density	400	tons/hr
35%	Density	601	tons/hr.

Priming:

A Hydra - jet system is used for the priming of the dredge pump, plus having the advantage of eliminating cavitation and adding to the lifting capabilities of the dredge pump using a 6" x 5" Kelly & Lewis pump direct coupled to an electric motor is provided for priming the main pump via an inlet in front of the main pump. A foot valve and priming tank is provided to maintain the prime for the priming pump.

Control Cabin:

A fully insulated control cabin is provided for operating comfort and is situated so that the swing winches and machinery can be seen from the one point.



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MARINE - GENERAL & HYDRAULIC

ElectricsElectric Motors:

TECO TEFC Squirrel-Cage Induction Motors are designed, manufactured and tested to meet or exceed latest BS/AS and other international standards, suitable for all general applications, where dirt, dust, or moisture exists making the use of open machines unacceptable. TECO's unique design and versatile engineering background makes TECO Motors longer running and less costly.

Standards and Specifications:Performance:

Type AEEB-2 motors meet the requirements of BS5000 Part 99 also with BS4999 Parts 4,30,31,32,41,50,51,60,69 & 72 and with the equivalent Part of AS1359.

Enclosure:

The standard protection is IP44 but additional protection to IP55 to give protection against weather and dust can be supplied. These enclosures are to BS4999 and AS1359 Part 20.

Cooling:

These motors are all totally enclosed fan cooled IC0141 to BS4999 and AS1359 Part 21.

Mounting:

Type AEEB-2 motors can be provided in the following mounting forms to BS4999 and AS1359 Part 22.

- IM1001 - horizontal foot mounted.
- IM2001 - horizontal foot and flange mounted.
- IM3011 - vertical shaft flange mounted.



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Supply and Operating Conditions

Supply system:

415/440 volt 3 phase 50HZ.

Voltage variation:

Type AEEB-2 are suitable for continuous operation on +6% rated voltage, supplying rated output at approximately rated speed. Sustained operation on voltages exceeding +6% rated voltage will result in overheating. They are also suitable for supply voltages with 1% phase unbalance.

Frequency variation:

Type AEEB-2 are suitable for operation at full load on any frequency between 47.5 H and 51 H.

Ambient temperature:

Type AEEB-2 are designed for use in ambient temperatures varying from 0°C to 40°C. For nonstandard ambient please refer to TECO.

Altitude:

Standard motors are designed for operation at any altitude up to 1,000 metres above sea level. For higher altitudes please refer to TECO.

Duty, Rating and Characteristics

TECO type AEEB-2 motors have standard rated outputs given on the basis of maximum continuous rating (MCR). This indicates the load at which the motor will operate continuously, corresponding to duty type S1 of BS4999 and AS1359 Part 30. The rating plate indicates MCR or S1 and gives the appropriated KW output and current for the rated output and speed. Short time rated (STR) motors also duty type rating (DTR) can be supplied but full details must be referred to TECO.

General Characteristics:

Standard AEEB-2 motors comply with the requirements of BS4999 and AS1359 Part 41, design B. Other characteristics are available please refer to TECO.



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MARINE - GENERAL & HYDRAULIC

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Overload:

These motors are capable of withstanding for up to 15 seconds a gradually applied excess torque of 60%

Overspeed:

The robust construction of standard motors permits an overspeed of 120% full load speed.

Electrical Switch Gear

One (10 indoor dust tight cubicle approx. 2400 (L) x 2000 (H) x 800 deep housing -

- 1 800 AMP incoming circuit breaker with shunt trip and earth leakage protection.
- 1 150KW intermittent duty auto transformer starter.
- 1 220KW Ditto
- 1 55KW Ditto
- 1 320 AMP ACB W/- door interlock (150KW)
- 1 400 AMP ACB Ditto (220KW)
- 1 160 AMP ACB Ditto (55KW)
- 1 24 pole circuit breaker chassis space for circuit breakers, contactors and overloads for 5 x 15KW.
- 1 10ACB (control)
- 1 240/55-0-55 mining type control transformer
- 2 RSH fuse fittings
- 6 Pushbuttons
- 6 Indicating lights
- 3 960 ammeters
- 3 CT's to suit

Bucket Wheel

Diameter - 2100mm. Having 20 Buckets with an opening of 500mm wide 300mm high & being 350mm deep being made of 20mm plate and pressed to shape with a replaceable tooth on each corner of the buckets. The driving plate of the bucket wheel is cone shaped forcing the material towards the suction duct. The internal area of the wheel is separated in half by scraper plates limiting the amount of water entering and keeping the solid percentage up. The speed of the bucket wheel will be 0-18 R.P.M. and with a slewing speed of 36 metre per minute. The theoretical production should be 500 ton per hour at 75% availability.



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Bearing Assembly

The bucket wheel is supported on two Timken taper bearings having a radial loading of 860,000 LBS and A thrust of 244000 LBS in a counter levered housing being sealed by one duo-cone seal, oil filled from and header tank.

Hydraulic Motor

Hagglunds Marathon hydraulic industrial motors are of the radial-piston type with a rotating shaft and stationary housing. A cylinder block rotates in roller bearings fixed in the housing. An even number of pistons are radially located in bores in the cylinder block. Each piston is attached to a cam roller. The cam rollers push against the cam ring, which is rigidly connected to the housing, thereby producing torque. The roller bearings on the cam rollers transfer the reaction force to the associated guide plates, which are connected to the rotating cylinder block.

Motor output torque	=	77,825 NM (theoretical)
Operating pressure	=	275 BAL (4000 PSI)
Flow Rate	=	342 LPM
Cutter Speed	=	18.25 RPM
Input Power	=	185 KW

Hydraulic Pump:

The cutter motor is operated by a Rexroth A4VSO250CR2DN hydraulic pump. Variable cutter speed is achieved by a joystick control. the joystick consists of 2 pressure reducing valves, one valve controlling speed of the forward direction and the other the speed of the reverse rotation. Moving the joystick increases the pilot pressure to the control of the Rexroth A4VSO250 pump and simultaneously selects the forward or reverse direction on the directional control valve.

The pump includes a pressure shut off control. This control limits the operating pressure to a preset valve by reducing the pump displacement to almost zero whilst maintaining the flow across the main relief valve.

The Rexroth A4VSO250 pump includes a full flow boost pump, thru drive mounted onto its back end cover.

The boost pump pressurises the inlet part of the A4VSO250 pump insuring reliable operation during shock loads.



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All flow into the A4VSO250 pump is filtered to 10 micron providing long life of all components.

Winches:

Ladder raise and lower, main spud and auxiliary spud raise lower, spud carriage travel are all Jaden Series 10 Auto Lock Winches using Commercial M75 hydraulic motors.

The drive and brake systems are of a totally enclosed design which eliminates all external brake bands, brake drums and winch drum pawls. The only external moving part of the entire winch is the drum itself.

The automatic drum lock is a totally enclosed multiple disc, fail safe brae unit. Control of the brake is by means of pilot operation off the hydraulic circuit, and is completely automatic. For lowering, braking is controlled hydraulically. Winch operation is entirely controlled by one lever.

Swing Winches:

These winches feature automatic 'reel on - reel off' with single lever control for ease of operation. Individual winch control is also retained.

The winch motors are Rexroth Calzone MR2800N radial piston design. This configuration provides high starting torques to 90% of running torque.

The motors have a continuous pressure rating of 250 bar, intermittent duty rating of 300 bar with peak pressures to 420 bar.

This design of motors minimizes the number of moving parts with power transmission occurring via a high pressure column of oil without the aid of reciprocating pistons or connecting rods. The sealing of the chambers is achieved with spherical seats providing very high volumetric efficiency and low leakage.

Winch Performance:

Motor output torque	=	8500 NM
Motor speed	=	25 RPM
Low Rate	=	74 LPM
Operating pressure	=	191 bar (2782 PSI)



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Winch System:

The winch system is operated by a Rexroth A10V0100DFR load sensing pump. This type of pump provides flow and pressure as demanded by the system.

Sensitive speed control is achieved by a main flow control with pump flow regulated to the flow set on this valve. This results in an efficient system with energy wastage minimised.

The Rexroth A10V0100DFR pump has a continuous pressure rating of 250 bar with a peak pressure rating of 315 bar.

Spud Carriage System:

The main spud has a travel of 4 metres, and gives the operator a completely controllable depth of cut for the bucket wheel. When the dredge has advanced the 4 metres the auxiliary spud is lowered and the travelling spud returned to the starting end. The spuds are raised and lowered by means of a winch allowing the spud to be powered into the ground giving positive holding. The travel of the spud carriage is also by means of a winch

Spud Size: 16" diameter - 9m long

Swing Sheaves

Swing sheaves are positioned on the ladder in close proximity to the bucket wheel.

This gives positive swing control for the cutter ensuring proper feed to be achieved at all times.

These sheaves are also fitted with 'life-time' seals, oil lubricated and counter balanced to help eliminate rope wear. The rope grooves are also hardened to help prevent sheave wear.

Ladder:

A ladder 6 metres long is of heavy beam construction raising and lowering is effected by a hydraulic winch through an 'A' frame mounted on the side pontoons, using wire rope through sheaves.



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Paint

The entire dredge is sandblasted, inorganic zinc coated and epoxy painted twice.

Attached are spec sheets of Galvit EP100 which is the paint used for touching up the welding on the BHP, treated inorganic zinc plate.

The spec sheet on the Galvit ES400 is the paint used on all parts of the dredge which have been sandblasted to Australia Class 2 1/2 - 3.

The spec sheet on Epinamel High-Build 404 is the paint used for the two top coats, colour being light grey.

The spec sheet on Epithane Primer is the undercoat for the marine ply, on the cabin walls.

The spec sheets on Poly-U 200 is for the finish coat of the marine ply, colour being a light cream.

- ① Transport. 1 x Semi wide load (3.6m) 1 x Escort.
1 x Low loader with " " .
- ② Cutting Teeth 1 set included in price
cost adapters \$56-00 ea.
Teeth \$26-00 ea.



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MARINE - GENERAL & HYDRAULIC



**WATTYL
- SIGMA
COATINGS**

Poly-U 200

**Recoatable heavy duty
polyurethane coating**

C/SIB v5 5.01

020300

Description

Product Type	A two-pack recoatable polyurethane finish of outstanding quality.
Properties	Poly-U 200 is a two-pack product consisting of a base and hardener. It exhibits outstanding exterior durability particularly with regard to gloss and colour retention. It has good general chemical and solvent resistance and is resistant to Skydrol (hydraulic fluid), an important factor for the aircraft industry. The cured film is extremely tough and flexible and abrasion resistance is excellent.
Principal Uses	Poly-U 200 is an ideal product where decoration as well as protection is important. Typical applications include — road transport vehicles, concrete transit mixers, buses, aircraft, locomotives and rolling stock, caravans, superstructures of pleasure craft and shipping. Also particularly suitable in the petroleum, sugar, paper, food, mining and chemical industries.
Colour Range	Refer Colour Card.

Typical Specifications

Surface	Preparation	Suggested Coating Systems	Dry Film Thickness (microns)
Steel	Blast clean to AS 1627.4 Class 2 (Min)	Light Industrial: 1st Coat: Epithane Primer 2nd Coat: Poly-U 200 3rd Coat: Poly-U 200	35 30 30
Steel	Blast clean to AS 1627.4 Class 2½-3	Marine — Salt Water and Splash Zones 1st Coat: Galvil ES.200 2nd Coat: Epithane Primer (thinned 30% with Thinner L.703) 3rd Coat: Poly-U 200 4th Coat: Poly-U 200	75 20 30 30
Aluminium	Degrease with Killrust Degreasol. Rinse well with water and allow to dry	Light Industrial: 1st Coat: Perm-Etch Primer 2nd Coat: Epithane Primer 3rd Coat: Poly-U 200 4th Coat: Poly-U 200	7.5 35 30 30
Galvanised Iron	Degrease with Killrust Degreasol. Rinse well with water and allow to dry	Medium Industrial: 1st Coat: Perm-Etch Primer 2nd Coat: Epithane Primer 3rd Coat: Poly-U 200 4th Coat: Poly-U 200	7.5 35 30 30
Concrete	Acid etch, rinse with water, dry thoroughly	Light Industrial: 1st Coat: Colluriel WL Primer 2nd Coat: Poly-U 200 3rd Coat: Poly-U 200	25 30 30
	Refer to Wattyl-Sigma for more complete recommendations on surface preparation.	Note: For concrete surfaces that are porous, thin 1st coat with up to 20% Thinner 91-92	
		Refer to Wattyl-Sigma for further specifications.	



WATTYL
- SIGMA
COATINGS

Epithane Primer

Epoxy resin primer

CI/SIB
V.1
2.05

020301

Description

Product Type	Epithane Primer is a two-pack, polyamide cured, epoxy resin based anti-corrosive primer.
Properties	It has a very good chemical and solvent resistance. On curing, Epithane Primer forms an extremely tough and flexible film with excellent adhesion to steel and fibreglass. It has excellent resistance to fresh and salt water and is suitable for total immersion.
Principal Uses	Recommended for use in highly corrosive environments as a priming coat for high performance coatings such as Epinamels, Poly-U 200, and Permachlor. May also be used as a general purpose anti-corrosive primer for recoating with alkyds. Typical areas of use include oil refineries, food and beverage plants, canneries, chemical plants, abattoirs and paper mills, structural steelwork in marine and industrial environments.
Colour Range	Red and White.

Typical Specifications

Surface	Preparation	Suggested Coating Systems	Dry Film Thickness (microns)
Steel	Blast clean to AS 1627.4 Class 2-3	Medium Industrial: 1st Coat: Epithane Primer 2nd Coat: Epinamel 202 3rd Coat: Epinamel 202	35 35 35
Steel	Blast clean to AS 1627.4 Class 2½-3	Heavy Industrial: 1st Coat: Epithane Primer 2nd Coat: Epinamel High-Build 404 3rd Coat: Epinamel High-Build 404	35 135 135
Galvanised Iron	Degrease with Killrust Degreasol. Rinse well with water and allow to dry. Note: Best coating system performance will be obtained with the highest class of blast cleaning. Refer to Wattyl-Sigma for more complete recommendations on surface preparation.	Medium Industrial: 1st Coat: Perm-Etch Primer 2nd Coat: Epithane Primer 3rd Coat: Epinamel 202 4th Coat: Epinamel 202 Refer to Wattyl-Sigma for further specifications.	7.5 35 35 35



WATTYL
- SIGMA
COATINGS

CI/SIB
u1 6.05

Galvit EP. 100

020302

Cold galvanising epoxy primer — two-pack

Description

Product Type	A cold galvanising two-pack, polyamide cured epoxy zinc rich primer.
Properties	Galvit EP. 100 is a two-pack material consisting of a base and hardener. Galvit EP. 100 is pigmented with zinc dust and provides cathodic protection to steel. The high metal content of the cured film allows direct electrical contact with clean steel surfaces. Galvit EP. 100 on curing, forms an extremely hard but flexible film with outstanding adhesion to steel. It is particularly suitable for topcoating with high performance anti-corrosive coatings such as the Colluriel systems, Permatar, Tarcol, Epinamel, Poly-U 200 and Permachlor. Will protect steel against attack in marine and industrial environments.
Principal Uses	As a priming coat for structural steel, bulk tanks, pipelines, bridges, towers and machinery as well as bulk handling installations, oil refineries, power stations, mining equipment and steel structures in marine environments.
Colour Range	Grey.

Typical Specifications

Surface	Preparation	Suggested Coating Systems	Dry Film Thickness (microns)
Steel	Blast clean to AS 1627.4 Class 2½-3	Heavy Industrial: 1st Coat: Galvit EP. 100 2nd Coat: Epinamel High-Build 404 3rd Coat: Epinamel 202	50 135 35
Steel	Blast clean to AS 1627.4 Class 2½-3	Marine — Salt Water and Splash Zones 1st Coat: Galvit EP. 100 2nd Coat: Permachlor High-Build 3rd Coat: Permachlor High-Build	50 100 100
Steel	Blast clean to AS 1627.4 Class 2½-3	Severe Abrasion: 1st Coat: Galvit EP. 100 2nd Coat: Permatar High-Build Brown 3rd Coat: Permatar High-Build Black	50 200 200
	Refer to Wattyl-Sigma for more complete recommendations on surface preparation.	Refer to Wattyl-Sigma for further specifications.	



WATTYL
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COATINGS

CI/SIU

v1

- 6.08

Galvit ES. 400

020303

Inorganic zinc rich pre-weld primer — two-pack

Description

Product Type	A two-pack weldable zinc rich shop primer based on an ethyl silicate binder.
Properties	Galvit ES. 400 has been specifically designed as a pre-weld, pre-construction primer. Applied at a dry film thickness of between 12 and 20 microns, it will provide protection for abrasive blast cleaned steel for periods of from six to nine months. Steel plates coated with Galvit ES. 400 may be welded without adverse effect on weld strength or excessive burn-back. Because of the relatively low film build, zinc fumes are also kept to a minimum, however adequate forced ventilation should still be provided if welding in confined spaces.
Principal Uses	A single-coat, temporary protective primer for steelwork. Recommended as a pre-weld primer for blasted steel used in marine and industrial environments. Galvit ES. 400 dries to a hard, abrasion resistant coating and may be overcoated with high performance coatings such as Permatar, Epinamel, Poly-U 200 and Permachlor. Used extensively as a pre-construction primer for shipping.
Colour Range	Grey.

Typical Specifications

Surface	Preparation	Suggested Coating Systems	Dry Film Thickness (microns)
Steel	Blast clean to AS 1627.4 Class 2½-3	Heavy Industrial: 1st Coat: Galvit ES. 400 2nd Coat: Galvit EP. 100 3rd Coat: Permachlor High-Build 4th Coat: Permachlor High-Build 5th Coat: Permachlor	12.5 50 100 100 35
Steel	Blast clean to AS 1627.4 Class 2½-3	Marine — Salt Water Splash Zones: 1st Coat: Galvit ES. 400 2nd Coat: Galvit EP. 100 3rd Coat: Epinamel High-Build 404 4th Coat: Epinamel 202	12.5 50 135 35
Steel	Blast clean to AS 1627.4 Class 2½-3	Marine — Complete Immersion 1st Coat: Galvit ES. 400 2nd Coat: Permatar High-Build 3rd Coat: Permatar High-Build (Depending on the condition of the Galvit ES. 400, it may be necessary to thin the first coat of Permatar High-Build)	12.5 200 200
	Refer to Watty Sigma for more complete recommendations on surface preparation.	Refer to Watty Sigma for further specifications.	



WATTYL
- SIGMA
COATINGS

EpinameL High-Build 404

Heavy duty epoxy coating — two-pack

CI/51B

u1

2.15

020304

Description

Product Type	A two-pack, high-build polyamide cured, epoxy resin based coating.
Properties	EpinameL High-Build 404 is a two-pack material consisting of a base pack and hardener. A high performance, thixotropic, anti-corrosive protective coating designed to provide a thick, tough, highly impermeable barrier coating particularly suitable for highly aggressive environments. It has excellent resistance to alkali, salt and fresh water, mineral oils and solvents. Resistance to dilute acids is also quite good and abrasion resistance is excellent. Suitable for exterior or interior use. The coating has a tendency to chalk on exposure to sunlight, but this does not detract from its performance. Because of high-build characteristics, it can be used in an epoxy or polyurethane system, giving maximum build with a minimum number of coats.
Principal Uses	Suitable for protection of structures immersed in salt water or exposed to salt spray, including shipping, bridge and wharf installations. Particularly suitable in food processing plants, breweries, chemical manufacturing plants, paper and sugar mills. Other typical uses include chemical storage tanks, plating shops and for the protection of sewerage and water treatment plants. Recommended for use as an internal protective coating on potable water vessels.
Colour Range	White, Light Grey and Micaceous Iron Oxide.

Typical Specifications

Surface	Preparation	Suggested Coating Systems	Dry Film Thickness (microns)
Steel	Blast clean to AS 1627.4 Class 2½-3	Heavy Industrial: 1st Coat: Epithane Primer 2nd Coat: EpinameL High-Build 404 3rd Coat: EpinameL High-Build 404	35 135 135
Steel	Blast clean to AS 1627.4 Class 2½-3	Marine — Salt Water Splash Zones: 1st Coat: Galvit ES. 200 2nd Coat: EpinameL High-Build 404 (Thinned 40% with Thinner L.704) 3rd Coat: EpinameL 202	75 50 35
Galvanised Iron	Degrease with Killrust Degreasol. Rinse well with water and allow to dry	Heavy Industrial: 1st Coat: Perm-Etch Primer 2nd Coat: Epithane Primer 3rd Coat: EpinameL High-Build 404 4th Coat: EpinameL High-Build 404	7.5 35 135 135
Concrete	Acid etch, rinse with water, dry thoroughly	Industrial: 1st Coat: EpinameL 202 (Thinned 20% with Thinner L.703) 2nd Coat: EpinameL High-Build 404 3rd Coat: EpinameL 202	25 135 35
	Refer to Wattyl-Sigma for more complete recommendations on surface preparation.	Refer to Wattyl-Sigma for further specifications.	

BIDDERS LIST

NAME: WARMAN INTERNATIONAL LTD.

CONTACT: BOB STEEL/BRIAN ROGERS

PHONE: (02) 436-6789 N.S.W.

FAX: (02) 436-6701

SUPPLY: SLURRY PUMPS
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ATTRITION MACHINES
THICKENERS
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WET TABLES - DEISTER
H.T. ROLL SEPARATORS
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TROMMELS
WET DRUM MAGNETIC SEPARATORS (SALA)

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CONTACT: RON GOODMAN

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FAX: (03) 525-3020

SUPPLY: SPIRALS

NAME: PYROTHERM PTY. LTD.

CONTACT: GARY AFFLECK

PHONE: (09) 279-7500 W.A.

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SUPPLY: FLUIDISED BED DRYERS.

NAME: SERPENT AND DOVE PTY. LTD.
CONTACT: JAMES T. WYNNE
PHONE: (02) 450-2007 N.S.W.
FAX: (02) 450-2150
SUPPLY: WET DRUM MAGNETIC SEPARATORS (ERIEZ)
WHIMS (ERIEZ)
HT. SEPARATORS
INDUCED ROLL SEPARATORS

NAME: BRYCE WATSON PTY. LTD.
CONTACT: GRAHAM SMITH
PHONE: (002) 34-2544 TAS.
FAX: (002) 34-6145
SUPPLY: CONVEYORS
SCREENS - JACQUES

NAME: READINGS OF LISMORE PTY. LTD.
CONTACT: DOUG EDWARDS
PHONE: (066) 21-7451 N.S.W.
FAX: (066) 21-9384
SUPPLY: WET MAGNETIC SEPARATORS
CROSSBELT MAGNETIC SEPARATORS
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ELECTROSTATIC SEPARATORS

NAME: HILRING PTY. LTD.
CONTACT: TONY GRIFFITHS
PHONE: (043) 88-2495 N.S.W.
FAX: (043) 88-2531
SUPPLY: INDUCED ROLL MAGNETIC SEPARATORS (CARPO)

NAME: COMBUSTION ENGINEERING
CONTACT: JOHN WILKS
PHONE: (02) 819-7399 N.S.W.
FAX: (02) 819-7628
SUPPLY: AIR TABLES (OLIVER)

NAME: AJAX PUMPS PTY. LTD.
CONTACT: BETTY CAPSIS
PHONE: (02) 642-6311 N.S.W.
FAX: (02) 642-5645
SUPPLY: WATER PUMPS

NAME: DORR OLIVER
CONTACT: TREVOR LING
PHONE: (02) 412-1800 N.S.W.
FAX: (02) 412-1860
SUPPLY: FLOTATION CELLS
THICKENERS

NAME: METQUIP PTY. LTD.
CONTACT: NEVILLE DOWSON
PHONE: (02) 805-0311 N.S.W.
FAX: (02) 805-0316
SUPPLY: FLOTATION CELLS - OUTOKUMPU

NAME: DELKOR PTY. LTD.
CONTACT: PETER FLEMING
PHONE: (02) 387-6900 N.S.W.
FAX: (02) 387-7870
SUPPLY: HORIZONTAL VACUUM BELT FILTERS
LINEAR SCREENS

NAME: VIBRAMECH
CONTACT: DAVID SOUTHALL
PHONE: (02) 905-5833 N.S.W.
FAX: (02) 905-5810
SUPPLY: HORIZONTAL SCREENS
VIBRATING FEEDERS

NAME: PRO MINENT & FLUID CONTROLS PTY. LTD.
CONTACT: GUNILLA BURROWES
PHONE: (02) 958-1844 N.S.W.
FAX: (02) 958-6074
SUPPLY: METERING PUMPS

NAME: ACROMET (AUST.) PTY. LTD.
CONTACT: ROBERT FULTON
PHONE: (02) 662-1488 N.S.W.
FAX: (02) 682-4580
SUPPLY: METERING PUMPS

NAME: MALCO ENGINEERING PTY. LTD.
CONTACT: PHILIP BROWN
PHONE: (02) 560-8144 N.S.W.
FAX: (02) 569-7025
SUPPLY: VIBRATING SCREENS

NAME: C.M.I. PTY. LTD.
CONTACT: MIKE TRENCH
PHONE: (07) 265-4344 QLD.
FAX: (07) 265-2558
SUPPLY: TROMMELS
SPIRALS
CYCLONES

NAME: WESTS PROCESS ENGINEERING

CONTACT: GRAHAM MORGAN

PHONE: (02) 439-4177 N.S.W.

FAX: (02) 439-4639

SUPPLY: FLUIDISED BED DRYERS

NAME: LINATEX (AUSTRALIA) PTY. LTD.

CONTACT: ARTHUR THOMPSON

PHONE: (03) 791-1566 VIC

FAX: (03) 794-8359

SUPPLY: CYCLONES

NAME: SARDIK ENGINEERING

CONTACT: TONY DICKSON

PHONE: (02) 809-5515 N.S.W.

FAX: (02) 807-2793

SUPPLY: AGITATORS
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NAME: BOLIDEN - ALLIS

CONTACT: GRAHAM LOCKWOOD

PHONE: (02) 438-4799 N.S.W.

FAX: (02) 436-4404

SUPPLY: SCREENS
CYCLONES

NAME: SCOTT - OSMOND

CONTACT: KEN FOOT

PHONE: (02) 623-9722 N.S.W.

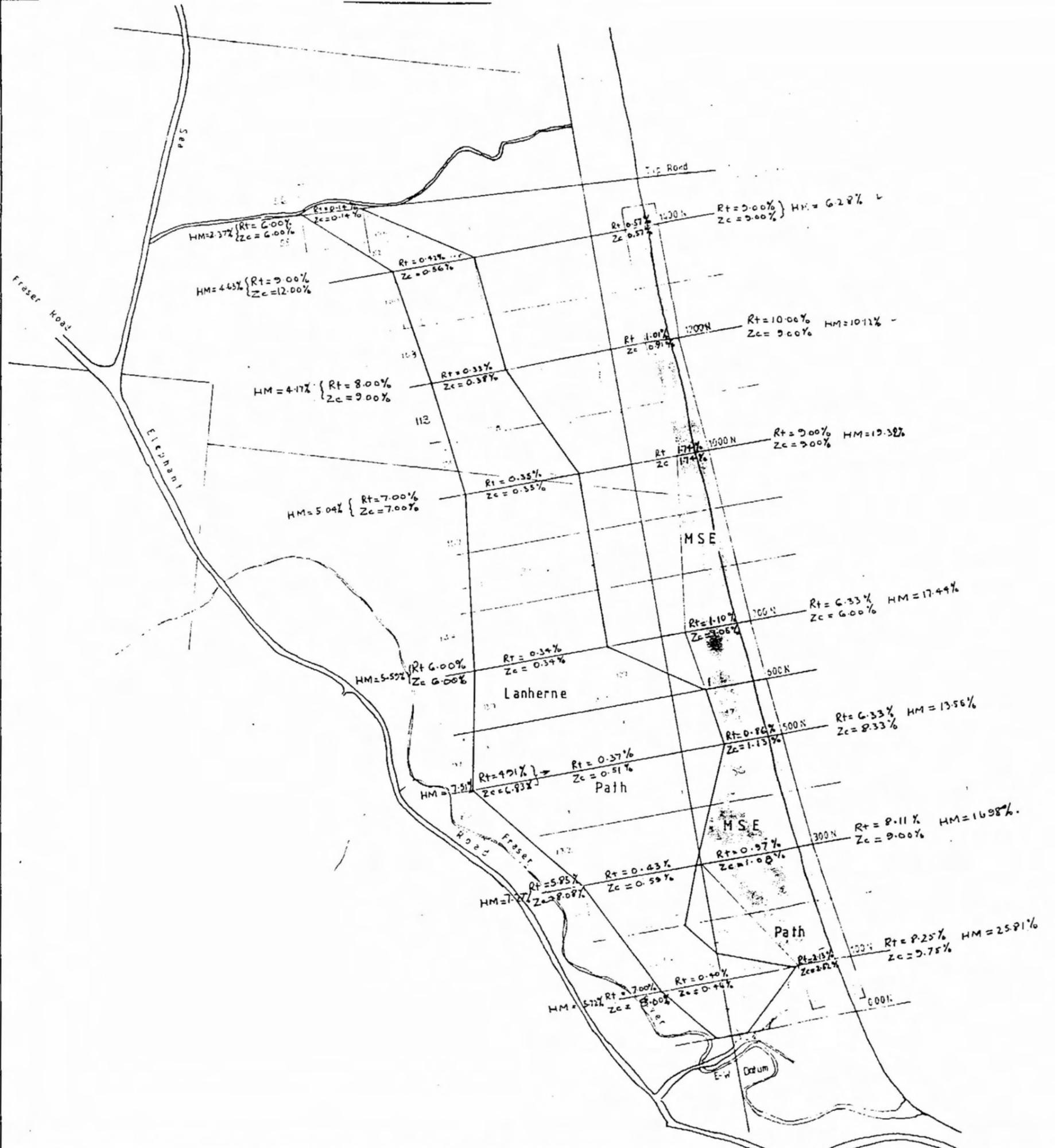
FAX: (02) 673-4910

SUPPLY: SCREW FEEDERS
BUCKET ELEVATORS

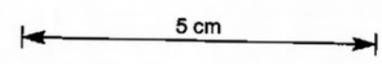
NAME: CLYDE - CARRUTHERS
CONTACT: ROD KIDD
PHONE: (02) 929-5311 N.S.W.
FAX: (02) 959-3578
SUPPLY: WIFLEY TABLES

NAME: BRYCE WATSON PTY. LTD.
CONTACT: MIKE COOPER
PHONE: (002) 34-2544 TAS.
FAX: (002) 34-6143
SUPPLY: CONVEYORS
SCREENS

IX DRAWINGS

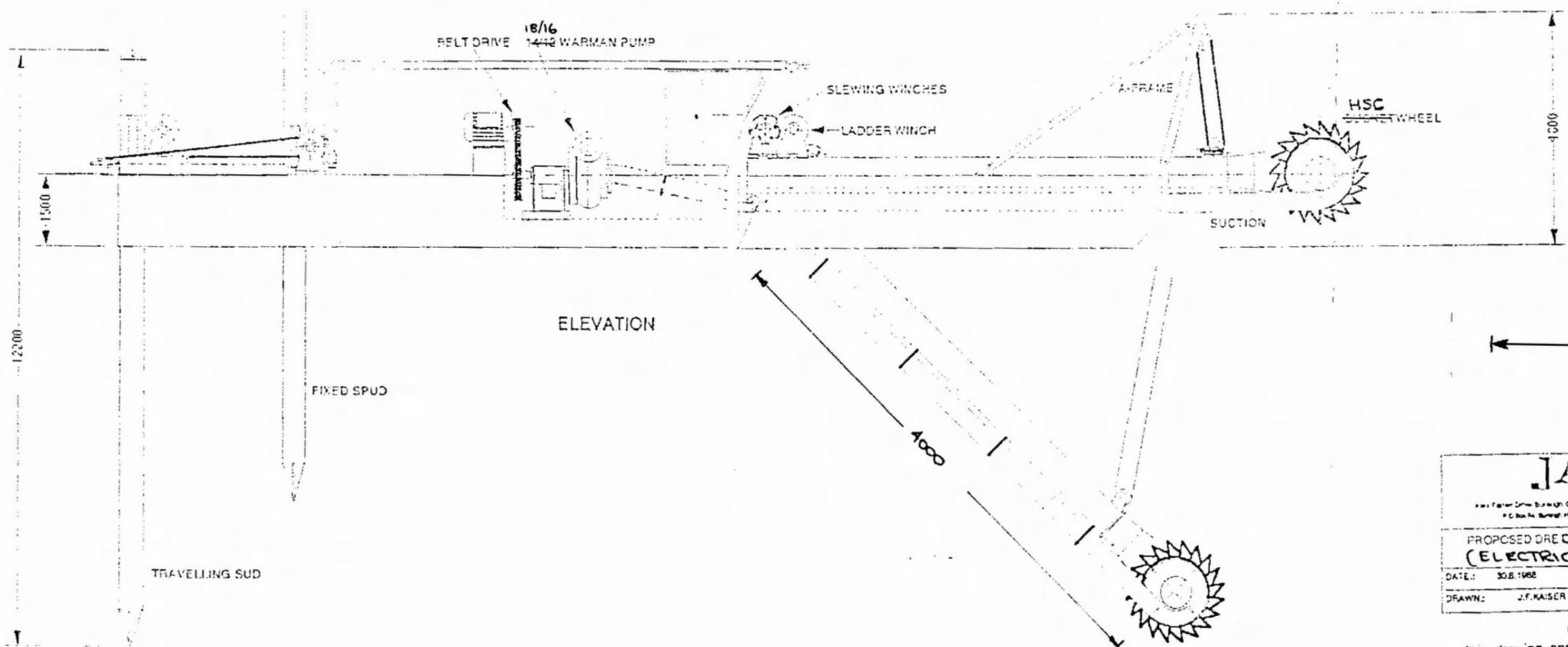
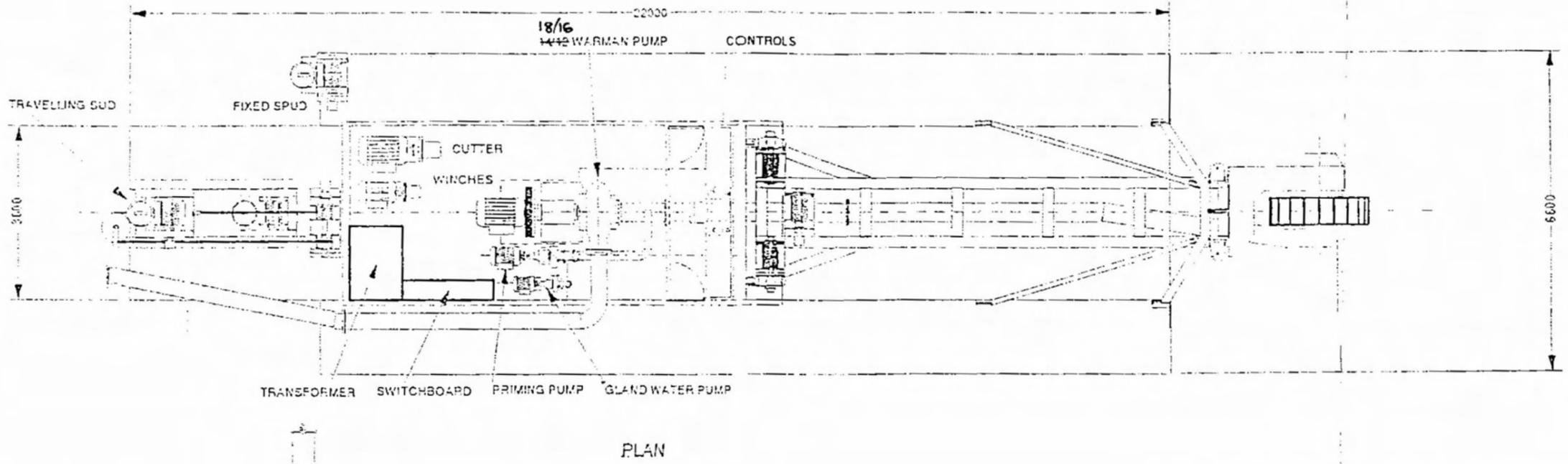


Bass
Strait



Area Lanherne 35Ha
MSE 15Ha.

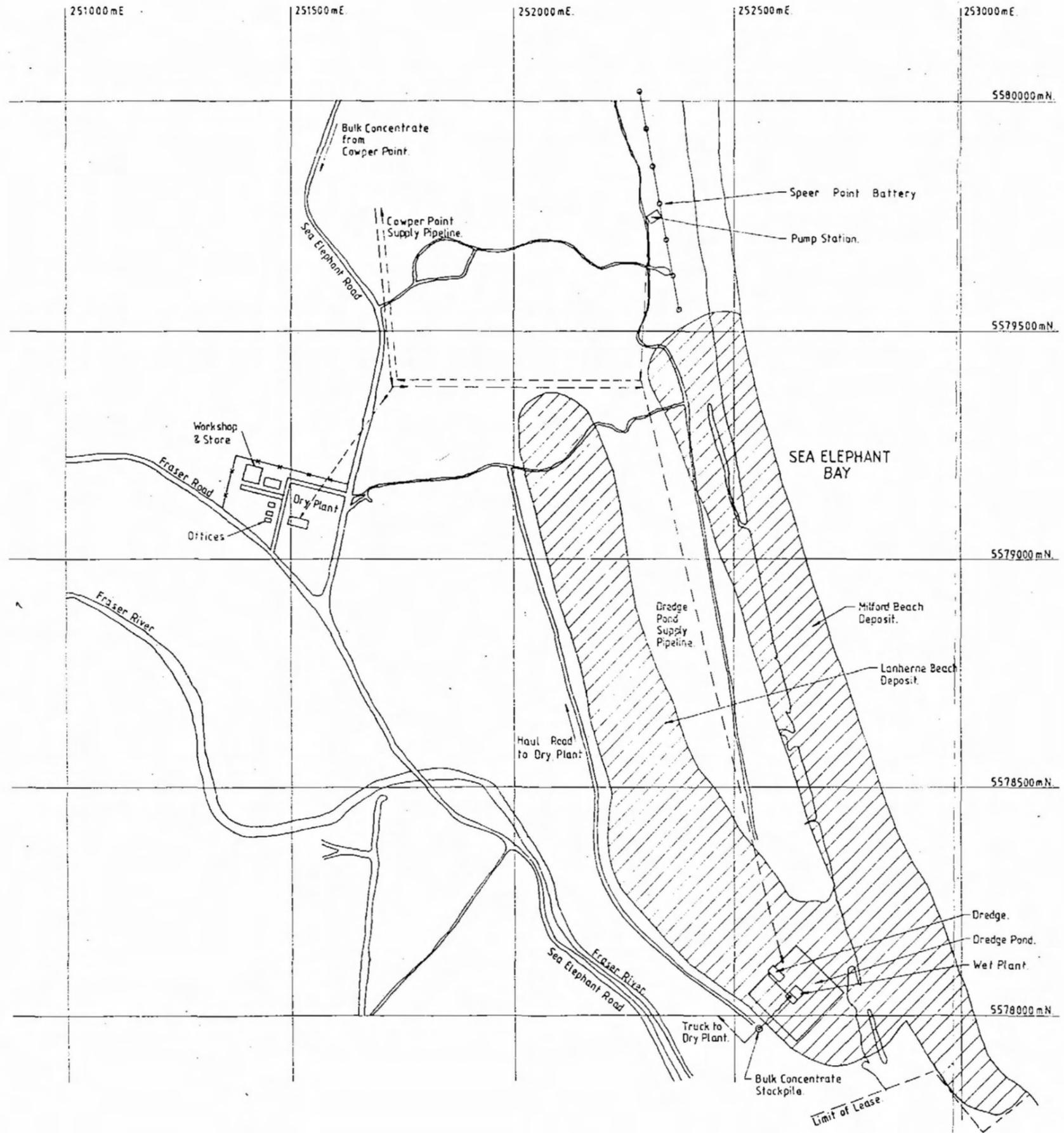
ITEM	DESCRIPTION	REQ'D	MATERIAL	REMARKS
NATIONAL MINERAL SANDS	SCALE	1:5000	PASSED	DATE
NARACOOPA MINING PATHS	DRAWN	S.K.P.	TRACED	DRAWING NUMBER
	CHECKED			20-001



5 cm

JADEN PTY. LTD.	
<small>2001 Fisher Drive, Burleigh Heads Industrial Park, Gold Coast, Qld 4220 P.O. Box 44, Burleigh Heads, Qld 4220. Telephone 67594967</small>	
PROPOSED DREDGE - DIESEL DRIVE (ELECTRIC DRIVE SHOWN)	
DATE: 30.8.1982	DWG NO: 20-006
DRAWN: J.F. KAISER	

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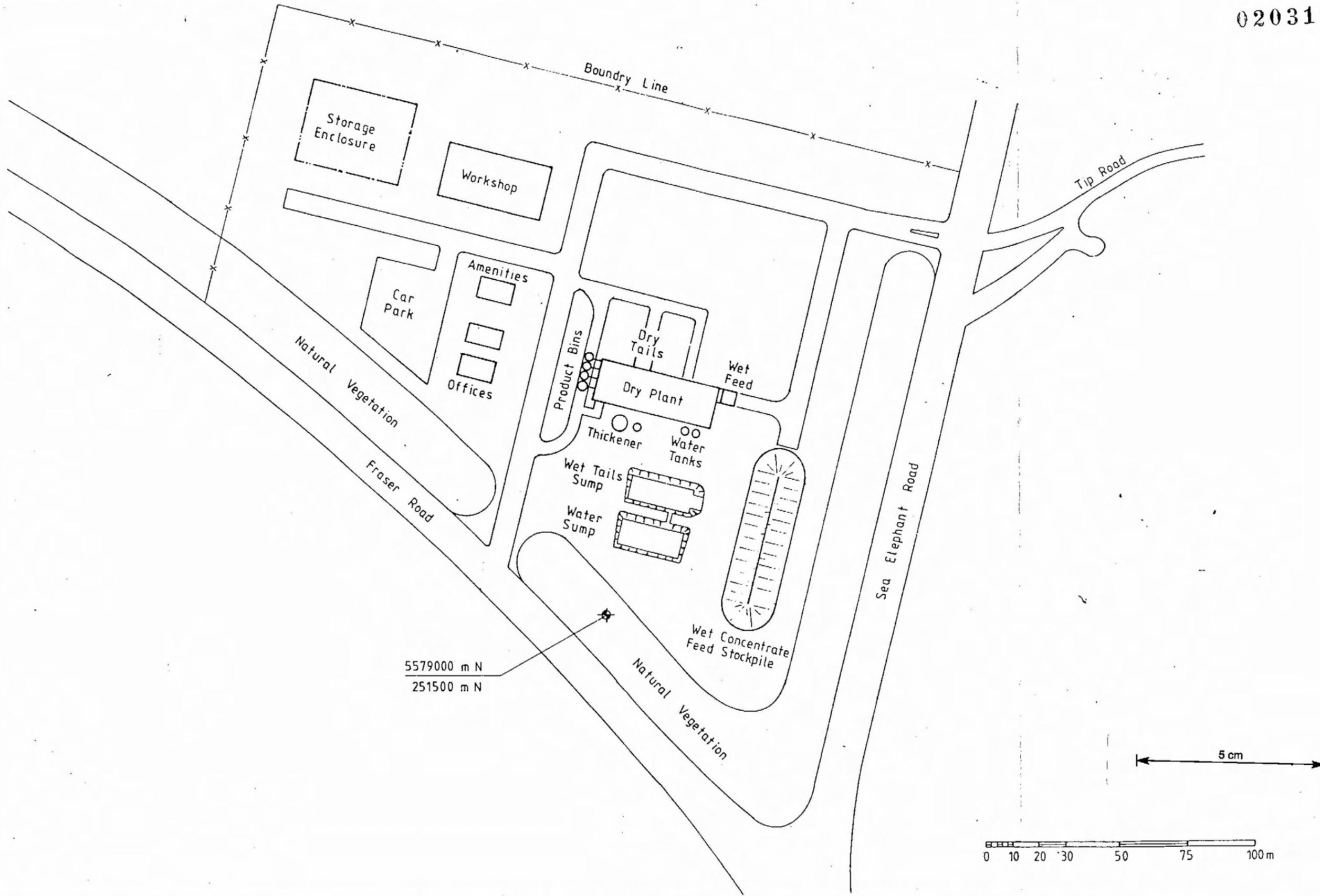


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NO.	DESCRIPTION	BY	DATE
1	DRY PLANT RELOCATED		
REVISIONS			

APP.	
CHECK	
DRN.	D.A.D.
DATE	25/5/89
SCALE	1:5000

NATIONAL MINERAL SANDS PTY. LTD. NARACOOPA MINERAL SANDS PLANT (KING ISLAND) PROPOSED SITE OPERATIONS	
WARMAN INTERNATIONAL LTD.	A1-1001-1-060
OFFICE OF ORIGIN:	SYDNEY



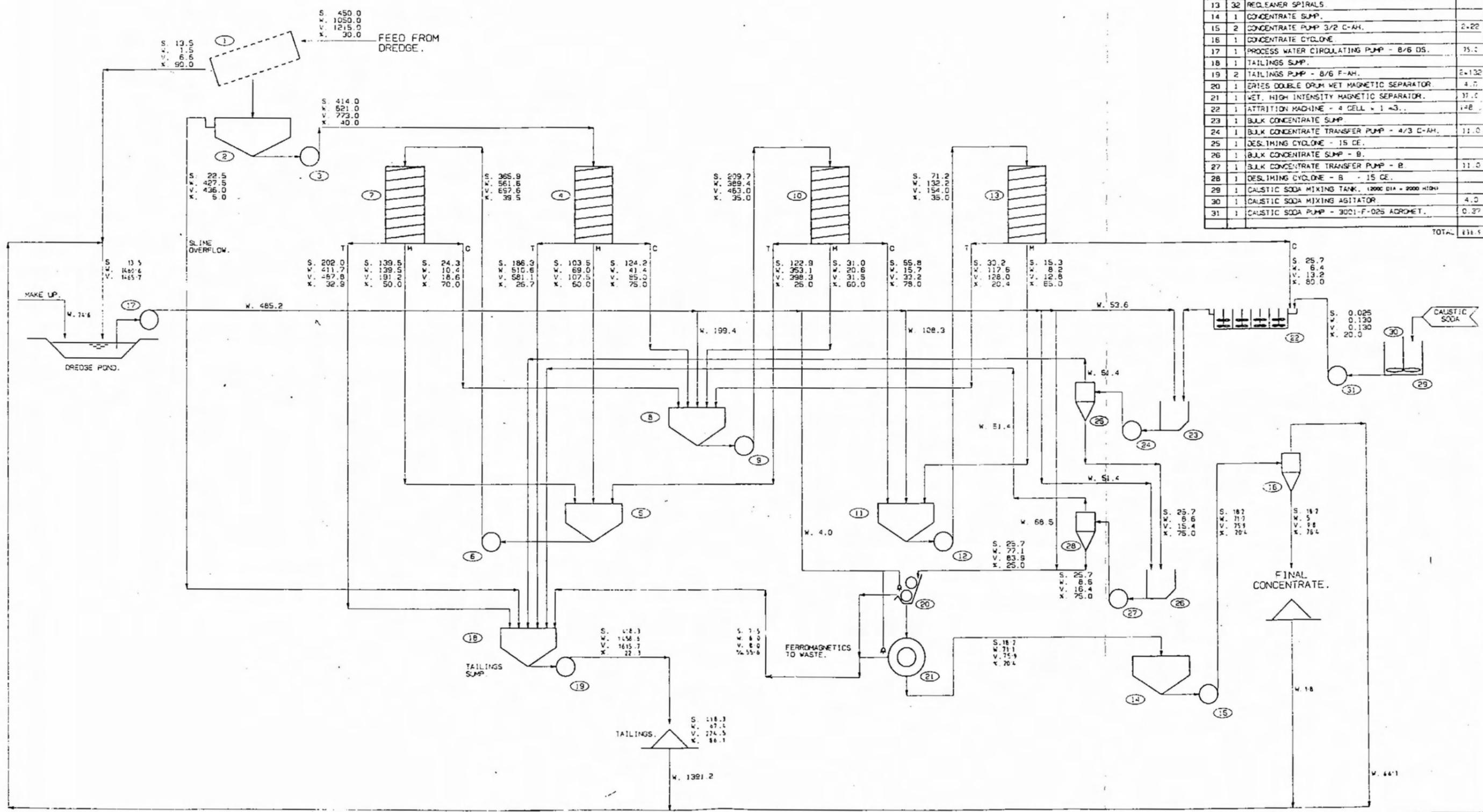
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No.	DESCRIPTION	BY	DATE
5			
4			
3			
2			
1			
REVISIONS			

APP.	
CHECK	
DRN.	R. T.
DATE	26.7.89
SCALE	1:1000

NATIONAL MINERAL SAND PTY. LTD.	
NARACOOPA MINERAL SANDS PLANT (KING ISLAND)	
PROPOSED SITE PLAN - DRY PLANT	
WARMAN INTERNATIONAL LTD.	A2-1001-1-069
OFFICE OF ORIGIN: SYDNEY	REV.

ITEM	QTY	DESCRIPTION	KW
1	1	TROMMEL	45.0
2	1	CONSTANT DENSITY TANK	
3	1	ROUGHER SPIRAL FEED PUMP - 12/10 F-AH.	55.0
4	96	ROUGHER SPIRALS - TRIPLEX.	
5	1	MIDDINGS SUMP.	
6	1	MIDDINGS SPIRAL FEED PUMP 10/8 F-AH.	75.0
7	84	MIDDINGS SPIRALS - TRIPLEX.	
8	1	CLEANER SUMP.	
9	1	CLEANER SPIRAL FEED PUMP - 10/8 F-AH.	45.0
10	84	CLEANER SPIRALS - DUPLEX.	
11	1	RECLEANER SUMP.	
12	1	RECLEANER SPIRAL FEED PUMP - 6/4 D-AH.	18.5
13	32	RECLEANER SPIRALS	
14	1	CONCENTRATE SUMP.	
15	2	CONCENTRATE PUMP 3/2 C-AH.	2.22
16	1	CONCENTRATE CYCLONE	
17	1	PROCESS WATER CIRCULATING PUMP - 8/6 DS.	15.0
18	1	TAILINGS SUMP.	
19	2	TAILINGS PUMP - 8/6 F-AH.	2x132
20	1	ERIES DOUBLE DRUM WET MAGNETIC SEPARATOR	4.0
21	1	WET, HIGH INTENSITY MAGNETIC SEPARATOR.	37.0
22	1	ATTRITION MACHINE - 4 CELL x 1 m3.	148.0
23	1	BULK CONCENTRATE SUMP	
24	1	BULK CONCENTRATE TRANSFER PUMP - 4/3 C-AH.	11.0
25	1	DESIMING CYCLONE - 15 CE.	
26	1	BULK CONCENTRATE SUMP - B.	
27	1	BULK CONCENTRATE TRANSFER PUMP - B.	11.0
28	1	DESIMING CYCLONE - B - 15 CE.	
29	1	CAUSTIC SODA MIXING TANK. (2000 DIA x 2000 HIGH)	
30	1	CAUSTIC SODA MIXING AGITATOR	4.0
31	1	CAUSTIC SODA PUMP - 3001-F-025 ACROMET.	0.37
TOTAL			818.5



LEGEND.
 S - SOLIDS FLOW - tonnes/hr.
 W - WATER FLOW - m³/hr.
 V - VOLUMETRIC FLOW - m³/hr.
 X - PULP DENSITY - x Solids.

REVISIONS				APP. D.S.F.		CHECK		DRAW. D.A.O.		DATE 18/5/89		SCALE		N.T.S.	
NO.	DESCRIPTION	BY	DATE												
B	MODIFIED.	DAO	23/6												
A	NEW EQUIPMENT ADDED & FLOWS MODIFIED.	DAO	20/6												

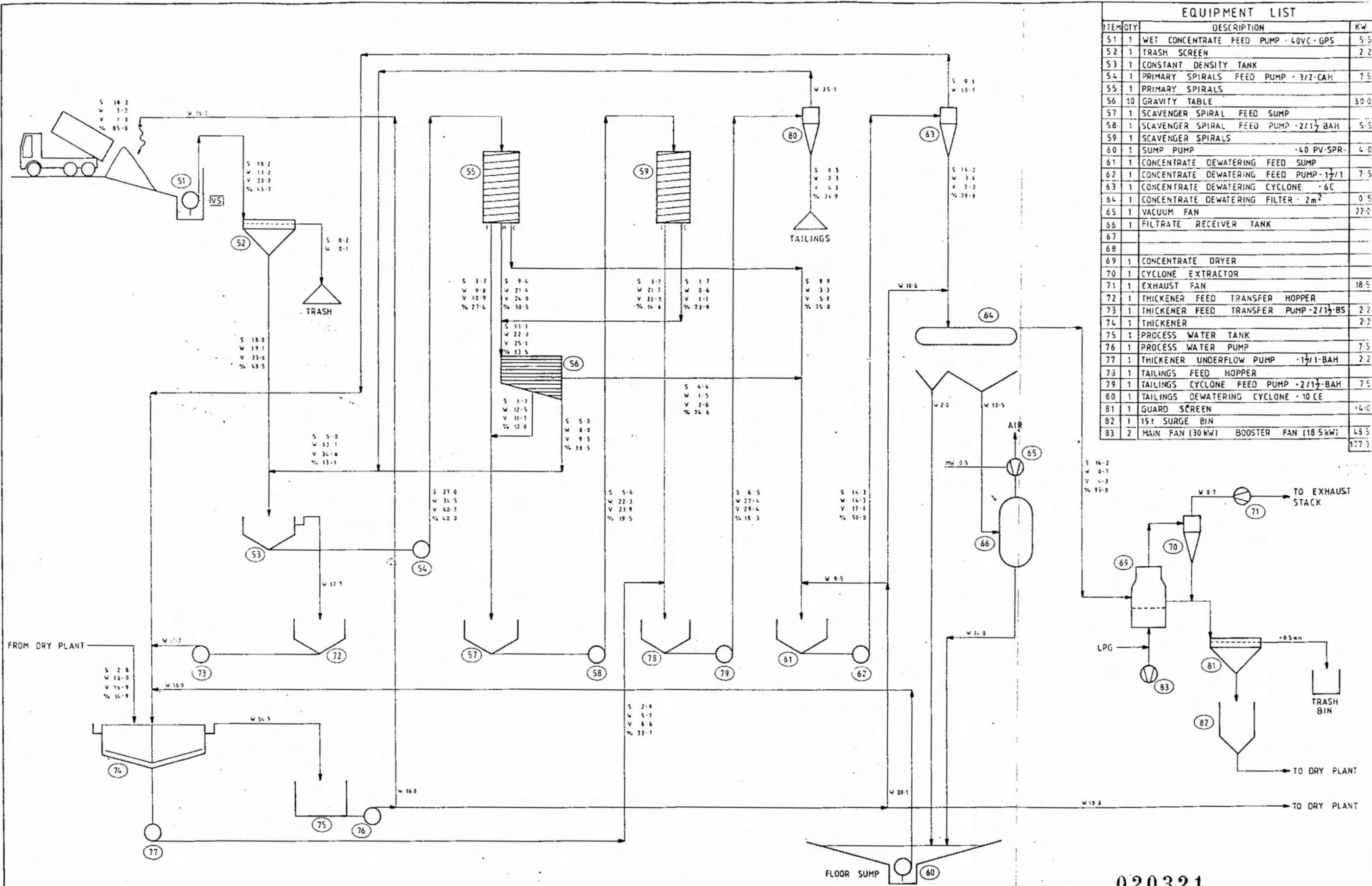
NATIONAL MINERAL SANDS PTY. LTD.
 NARACOOPA MINERAL SANDS PLANT (KING ISLAND)
 PROPOSED WET PLANT FLOWSHEET

WARMAN PROJECT
 ENGINEERING

OFFICE OF ORIGIN - SYDNEY C.A.D.

AI-1001-0-057 B

020320



EQUIPMENT LIST			
ITEM	QTY	DESCRIPTION	KW
51	1	WET CONCENTRATE FEED PUMP - 40VC - GPS	5.5
52	1	TRASH SCREEN	2.2
53	1	CONSTANT DENSITY TANK	
54	1	PRIMARY SPIRALS FEED PUMP - 3/2-CAH	7.5
55	1	PRIMARY SPIRALS	
56	10	GRAVITY TABLE	30.0
57	1	SCAVENGER SPIRAL FEED SUMP	
58	1	SCAVENGER SPIRAL FEED PUMP - 2/1-BAH	5.5
59	1	SCAVENGER SPIRALS	
60	1	SUMP PUMP - 40 PV-SPR	4.0
61	1	CONCENTRATE DEWATERING FEED SUMP	
62	1	CONCENTRATE DEWATERING FEED PUMP - 1-1/1	7.5
63	1	CONCENTRATE DEWATERING CYCLONE - 6C	
64	1	CONCENTRATE DEWATERING FILTER - 2m ²	0.5
65	1	VACUUM FAN	22.0
66	1	FILTRATE RECEIVER TANK	
67			
68			
69	1	CONCENTRATE DRYER	
70	1	CYCLONE EXTRACTOR	
71	1	EXHAUST FAN	18.5
72	1	THICKENER FEED TRANSFER HOPPER	
73	1	THICKENER FEED TRANSFER PUMP - 2/1-BS	2.2
74	1	THICKENER	2.2
75	1	PROCESS WATER TANK	
76	1	PROCESS WATER PUMP	7.5
77	1	THICKENER UNDERFLOW PUMP - 1-1/1-BAH	2.2
78	1	TAILINGS FEED HOPPER	
79	1	TAILINGS CYCLONE FEED PUMP - 2/1-BAH	7.5
80	1	TAILINGS DEWATERING CYCLONE - 10 CE	
81	1	GUARD SCREEN	14.0
82	1	15t SURGE BIN	
83	2	MAIN FAN (30 kW) BOOSTER FAN (18.5 kW)	48.5
			127.3

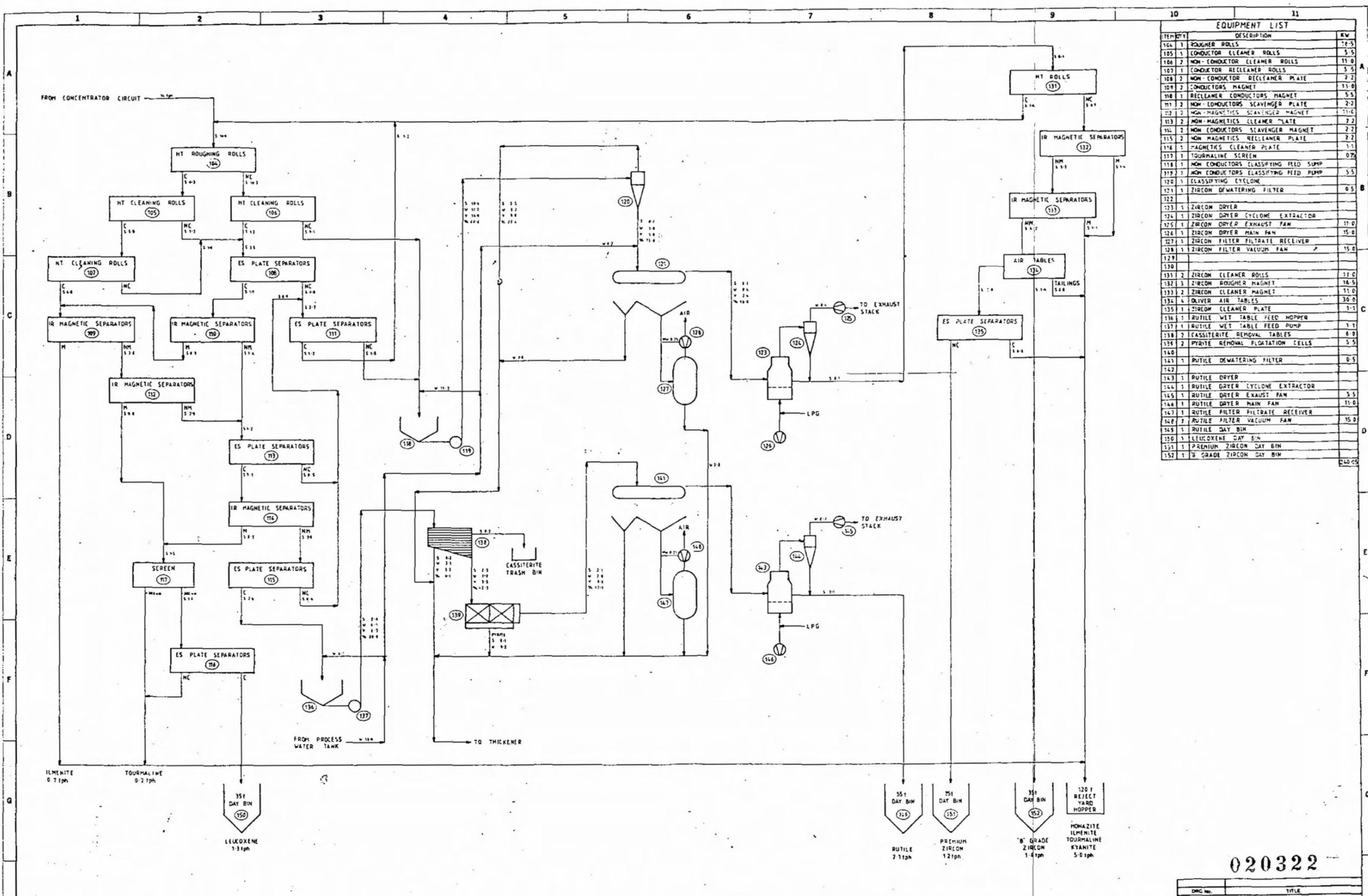
LEGEND
 S = SOLIDS FLOW - tonnes/hr
 W = WATER FLOW - m³/hr
 V = VOLUMETRIC FLOW - m³/hr
 % = PULP DENSITY - % SOLIDS
 MW = MAINS WATER FLOW - m³/hr

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No.	DESCRIPTION	BY	DATE
1	GENERAL REVISION	RT	13/7/89

APP. P.C.
 CHECK
 DRN. R.T.
 DATE 13-7-89
 SCALE
NATIONAL MINERAL SANDS PTY. LTD.
NARACOOPA MINERAL SANDS PLANT (KING ISLAND)
PROPOSED DRY PLANT WET CONCENTRATOR - FLOWSHEET
WARMAN INTERNATIONAL LTD. A1-1001-0-065
 REV. 1

020321

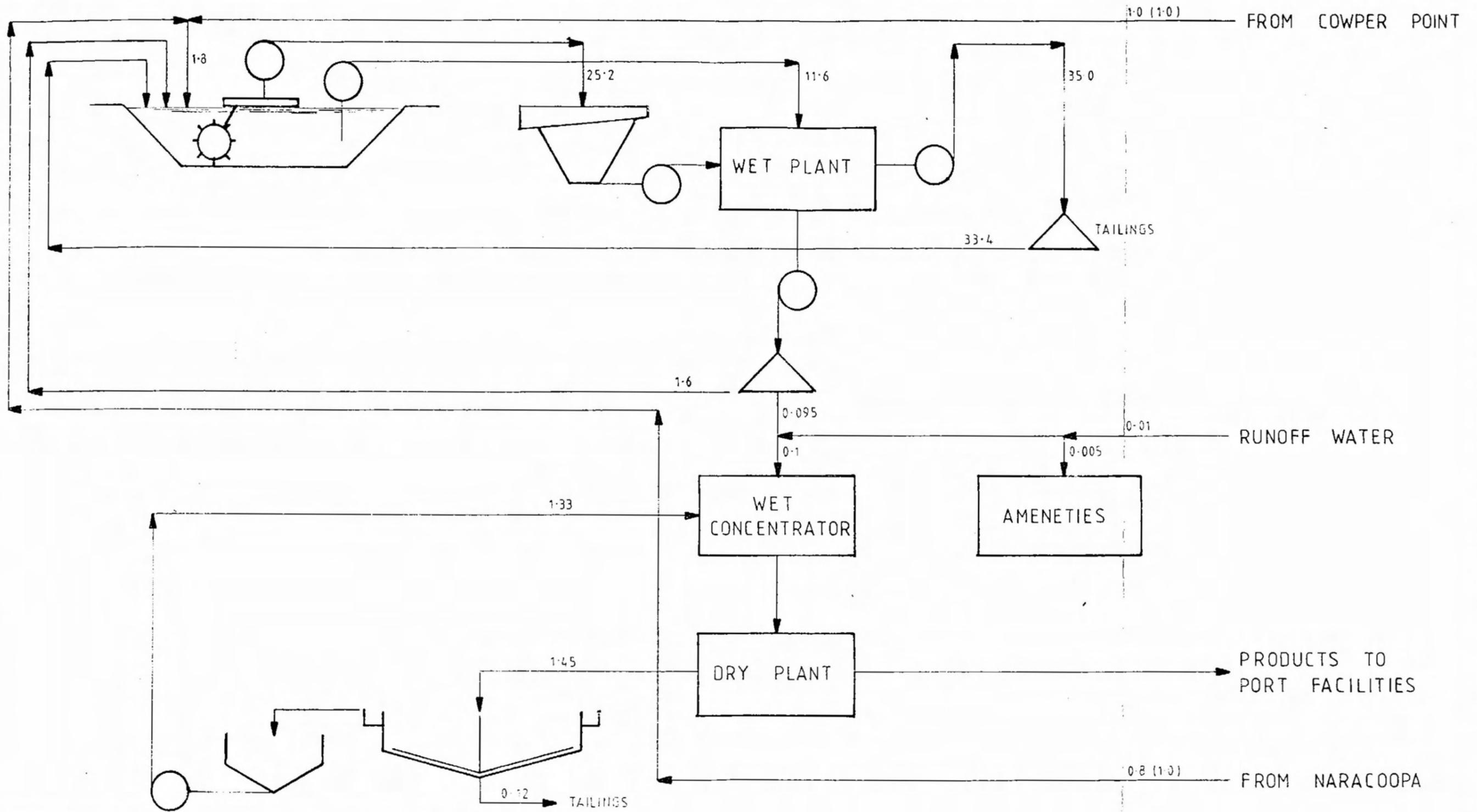


EQUIPMENT LIST		
ITEM NO.	DESCRIPTION	QTY
104	ROUGHING ROLLS	2x5
105	CONDUCTOR CLEANER ROLLS	5x5
106	NON-CONDUCTOR CLEANER ROLLS	11x0
107	CONDUCTOR RECLEANER ROLLS	3x5
108	NON-CONDUCTOR RECLEANER PLATE	2x2
109	CONDUCTORS MAGNET	11x0
110	RECLEANER CONDUCTORS MAGNET	3x5
111	NON-CONDUCTORS SCAVENGER PLATE	2x2
112	NON-MAGNETICS SCAVENGER MAGNET	11x0
113	NON-MAGNETICS CLEANER PLATE	2x2
114	NON-CONDUCTORS SCAVENGER MAGNET	2x2
115	NON-MAGNETICS RECLEANER PLATE	2x2
116	MAGNETICS CLEANER PLATE	1x1
117	TOURMALINE SCREEN	0x2
118	NON CONDUCTORS CLASSIFYING FEED SUMP	
119	NON CONDUCTORS CLASSIFYING FEED PUMP	5x5
120	CLASSIFYING CYCLONE	
121	ZIRCON DEWATERING FILTER	0x5
122		
123	ZIRCON DRYER	
124	ZIRCON DRYER CYCLONE EXTRACTOR	
125	ZIRCON DRYER EXHAUST FAN	11x0
126	ZIRCON DRYER MAIN FAN	15x0
127	ZIRCON FILTER FILTRATE RECEIVER	
128	ZIRCON FILTER VACUUM FAN	15x0
129		
130		
131	ZIRCON CLEANER ROLLS	11x0
132	ZIRCON ROUGHER MAGNET	10x5
133	ZIRCON CLEANER MAGNET	11x0
134	OLIVER AIR TABLES	30x0
135	ZIRCON CLEANER PLATE	1x1
136	RUTILE WET TABLE FEED HOPPER	
137	RUTILE WET TABLE FEED PUMP	1x1
138	CASSITERITE REMOVAL TABLES	6x0
139	PYRITE REMOVAL FLOTATION CELLS	5x5
140		
141	RUTILE DEWATERING FILTER	0x5
142		
143	RUTILE DRYER	
144	RUTILE DRYER CYCLONE EXTRACTOR	
145	RUTILE DRYER EXHAUST FAN	5x5
146	RUTILE DRYER MAIN FAN	11x0
147	RUTILE FILTER FILTRATE RECEIVER	
148	RUTILE FILTER VACUUM FAN	15x0
149	RUTILE DAY BIN	
150	LEUKOXENE DAY BIN	
151	PREMIUM ZIRCON DAY BIN	
152	'B' GRADE ZIRCON DAY BIN	0x0x5

LEGEND
 S = SOLIDS FLOW - tonnes/hr
 W = WATER FLOW - m³/hr
 V = VOLUMETRIC FLOW - m³/hr
 % = PULP DENSITY - % SOLIDS
 MW = MAINS WATER FLOW - m³/hr

020322

DRC No.		TITLE	
REFERENCE DRAWINGS			
NATIONAL MINERAL SANDS PTY. LTD. NARACOOPA MINERAL SANDS PLANT (KING ISLAND) PROPOSED DRY SEPARATION PLANT - FLOWSHEET			
WARMAN INTERNATIONAL LTD.		AQ-1001-0-066	
OFFICE OF OMDM SYDNEY			

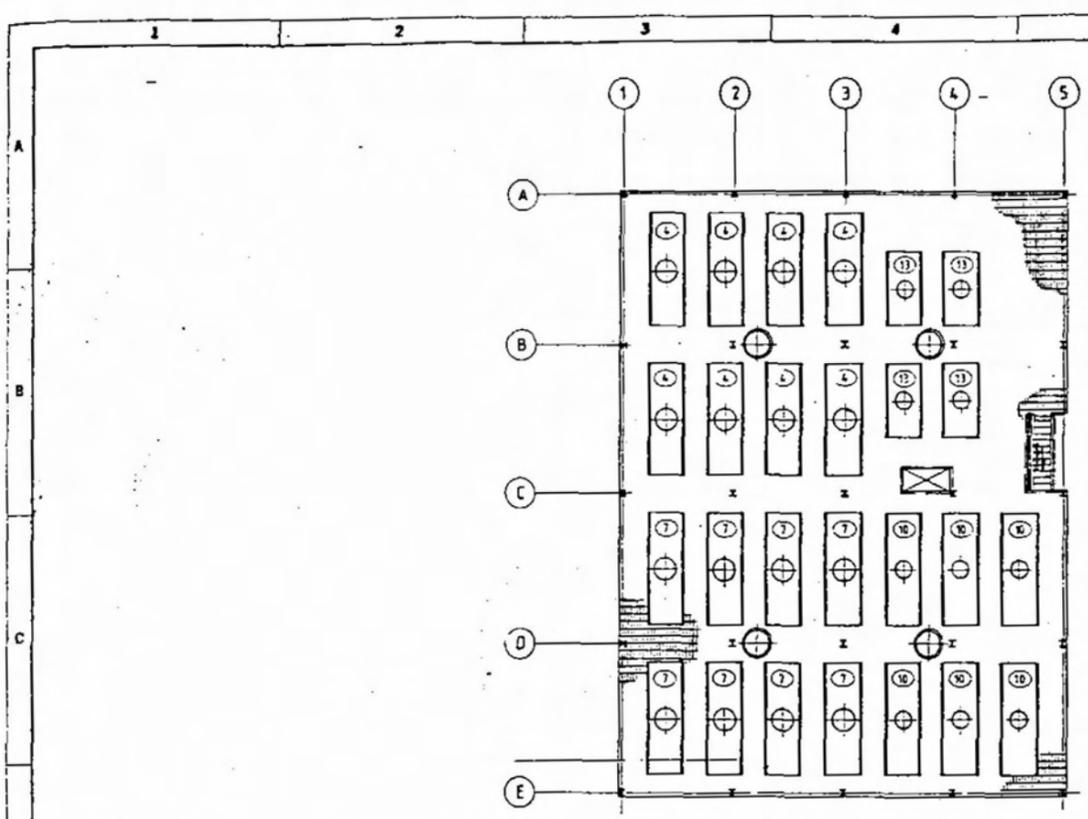


WATER FLOWS IN ML / DAY - NOMINAL (MAX AVAILABLE)

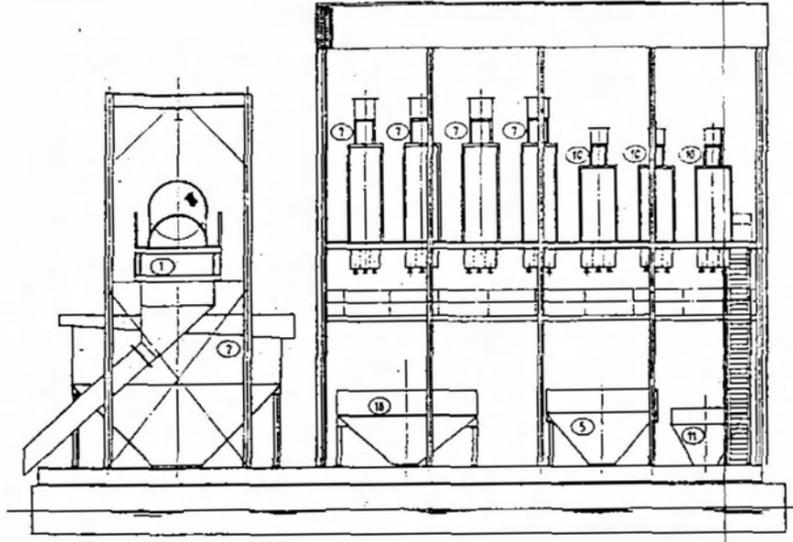
020323

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4				APP.		NATIONAL MINERAL SAND PTY. LTD. NARACOOPA MINERAL SANDS PLANT (KING ISLAND) PROPOSED WATER REQUIREMENTS - FLOWSHEET	WARMAN INTERNATIONAL LTD.	A3-1001-0-068	REV.
3			CHECK						
2			DRN.	R. T.					
1			DATE	24.7.89					
No.	DESCRIPTION	BY	DATE	SCALE	OFFICE OF ORIGIN: SYDNEY				
REVISIONS									

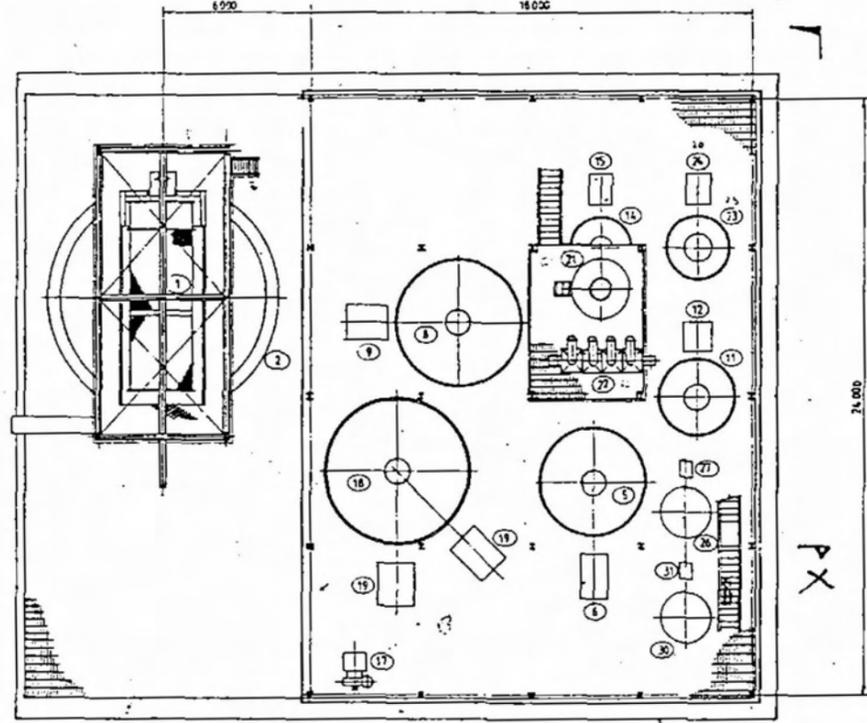


PLAN RL 9 000 T.O.G.

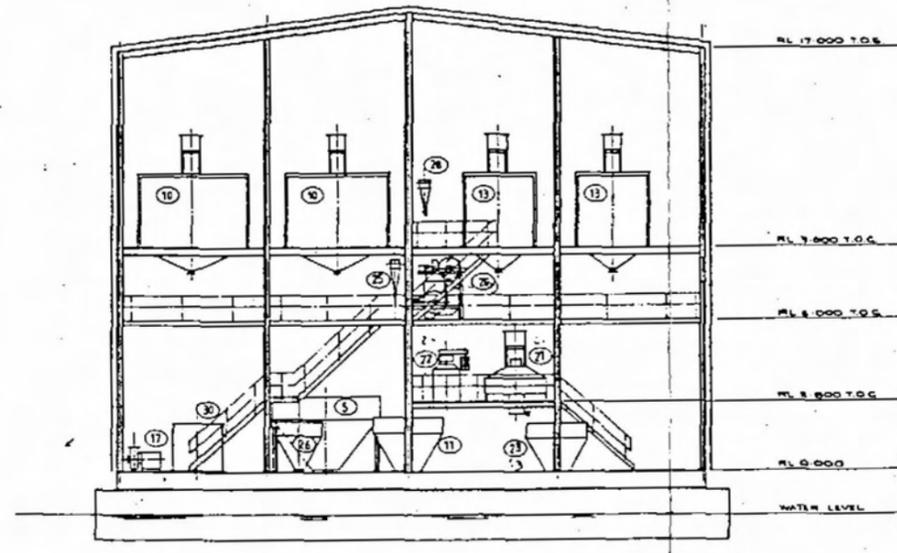


VIEW A

EQUIPMENT LIST		
ITEM NO.	DESCRIPTION	K.W.
1	TROMMEL	45.0
2	CONSTANT DENSITY BANK	
3	ROUGHER SPIRAL FEED PUMP - 12/10 F-AH	55.0
4	SPIRALS-TRIPLEX	
5	PRODDING SUMP	
6	SPIRAL FEED PUMP - 10/8 F-AH	75.0
7	SPIRALS-TRIPLEX	
8	CLEANER SUMP	
9	SPIRAL FEED PUMP - 6/8 F-AH	45.0
10	SPIRALS-DUPLEX	
11	RECLEANER SUMP	
12	SPIRAL FEED PUMP - 6/4 D-AH	18.5
13	SPIRALS	
14	CONCENTRATE SUMP	
15	PUMP - 3/2 C-AH	2422
16	CYCLONE	
17	PROCESS WATER CIRCULATING PUMP - 6/8 DS.	37.0
18	TAILINGS SUMP	
19	PUMP - 8/8 E-AH	24132
20	ERES DOUBLE DRUM WET MAGNETIC SEPARATOR	4.0
21	WET HIGH INTENSITY MAGNETIC SEPARATOR	34.0
22	ATTRITION MACHINE - 4 CELL 1.1M	148.0
23	BULK CONCENTRATE SUMP	
24	TRANSFER PUMP - 4/3 C-AH	11.0
25	DESLEPING CYCLONE - 15 CE	
26	BULK CONCENTRATE SUMP - B	
27	TRANSFER PUMP - B	11.0
28	DESLEPING CYCLONE - B - 15 CE	
29	CAUSTIC SODA MIXING TANK 4.2m x 2.4m HIGH	
30	AGITATOR	4.0
31	PUMP - 300% F-DS ACROMET	1.37



PLAN RL 0000 & 2-800 T.O.G.



VIEW B

5 cm

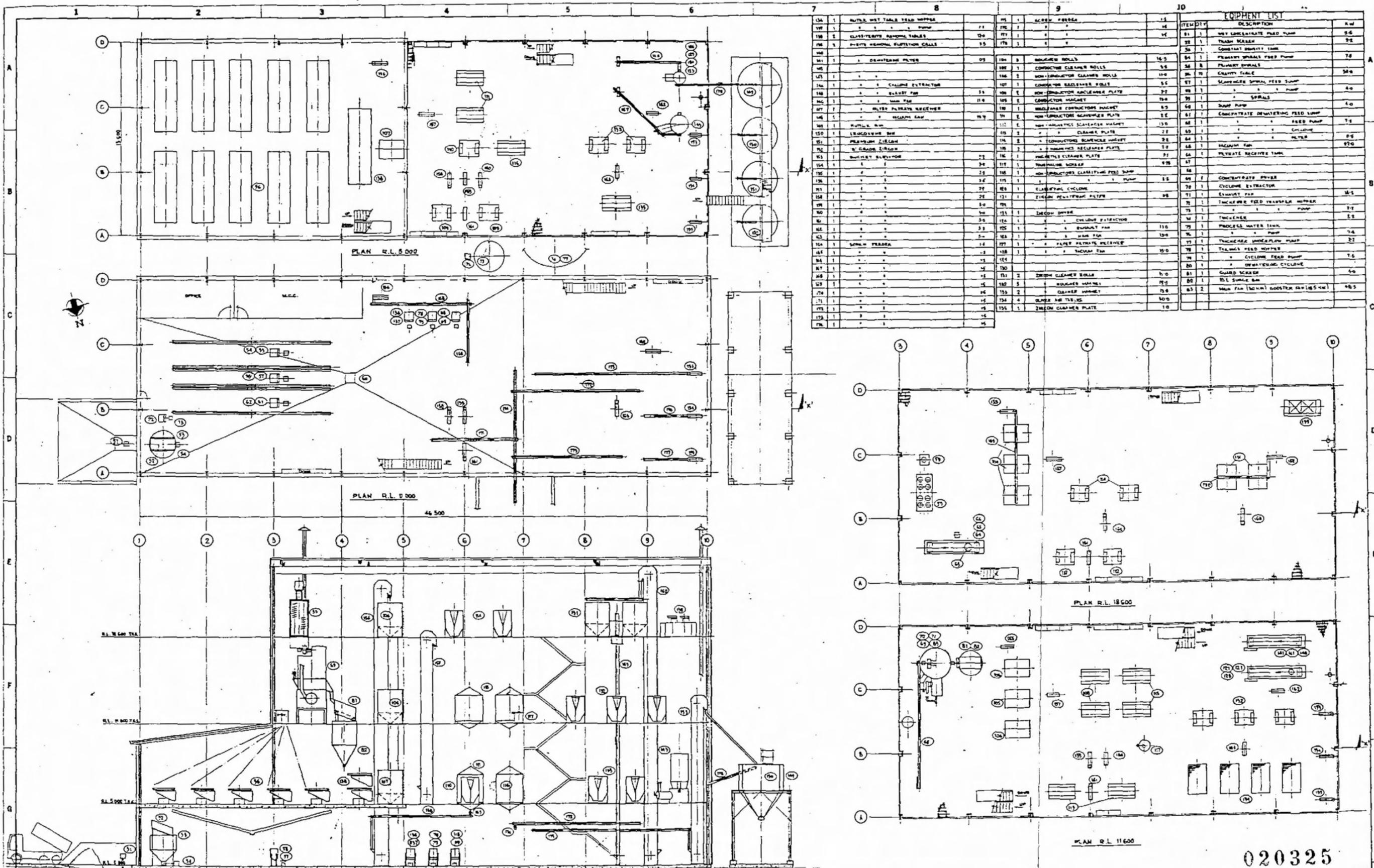
NOTES
 1) PLANT FOR RZL RECOVERY - AS DRAWN
 2) PLANT FOR RZ RECOVERY - REMOVE 1 BAY AS SHOWN 'X-X'

020324

REVISIONS		DESCRIPTION		BY	DATE
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					

NO.	DATE	PROPOSED WET PLANT FLOW-SHEET	TITLE
1			

NATIONAL MINERAL SANDS PTY LTD.	
NARACOOPA MINERAL SANDS PLANT (KING ISLAND)	
PRELIMINARY WET PLANT ARRANGEMENT	
WARMAN INTERNATIONAL LTD.	AO-1001-1-063



ITEM NO.	DESCRIPTION	QTY	UNIT	ITEM NO.	DESCRIPTION	QTY	UNIT
134	WATER WET TABLE FEED HOPPER	1	NO	105	SCREW FEEDER	1	NO
135	CLASSIFIER	1	NO	106	SCREW FEEDER	1	NO
136	CLASSIFIER RAMMING TABLES	120	NO	107	SCREW FEEDER	1	NO
137	WASTE REMOVAL FLUATION CALLS	15	NO	108	SCREW FEEDER	1	NO
138				109	SCREW FEEDER	1	NO
139				110	SCREW FEEDER	1	NO
140				111	SCREW FEEDER	1	NO
141	DEWATERING FILTER	05	NO	112	SCREW FEEDER	1	NO
142				113	SCREW FEEDER	1	NO
143				114	SCREW FEEDER	1	NO
144				115	SCREW FEEDER	1	NO
145				116	SCREW FEEDER	1	NO
146				117	SCREW FEEDER	1	NO
147				118	SCREW FEEDER	1	NO
148				119	SCREW FEEDER	1	NO
149				120	SCREW FEEDER	1	NO
150				121	SCREW FEEDER	1	NO
151				122	SCREW FEEDER	1	NO
152				123	SCREW FEEDER	1	NO
153				124	SCREW FEEDER	1	NO
154				125	SCREW FEEDER	1	NO
155				126	SCREW FEEDER	1	NO
156				127	SCREW FEEDER	1	NO
157				128	SCREW FEEDER	1	NO
158				129	SCREW FEEDER	1	NO
159				130	SCREW FEEDER	1	NO
160				131	SCREW FEEDER	1	NO
161				132	SCREW FEEDER	1	NO
162				133	SCREW FEEDER	1	NO
163				134	SCREW FEEDER	1	NO
164				135	SCREW FEEDER	1	NO
165				136	SCREW FEEDER	1	NO
166				137	SCREW FEEDER	1	NO
167				138	SCREW FEEDER	1	NO
168				139	SCREW FEEDER	1	NO
169				140	SCREW FEEDER	1	NO
170				141	SCREW FEEDER	1	NO
171				142	SCREW FEEDER	1	NO
172				143	SCREW FEEDER	1	NO
173				144	SCREW FEEDER	1	NO
174				145	SCREW FEEDER	1	NO
175				146	SCREW FEEDER	1	NO
176				147	SCREW FEEDER	1	NO
177				148	SCREW FEEDER	1	NO
178				149	SCREW FEEDER	1	NO
179				150	SCREW FEEDER	1	NO

ITEM NO.	DESCRIPTION	QTY	UNIT
151	WET SCREENING FEED PUMP	05	NO
152	WET SCREENING FEED PUMP	05	NO
153	WET SCREENING FEED PUMP	05	NO
154	WET SCREENING FEED PUMP	05	NO
155	WET SCREENING FEED PUMP	05	NO
156	WET SCREENING FEED PUMP	05	NO
157	WET SCREENING FEED PUMP	05	NO
158	WET SCREENING FEED PUMP	05	NO
159	WET SCREENING FEED PUMP	05	NO
160	WET SCREENING FEED PUMP	05	NO
161	WET SCREENING FEED PUMP	05	NO
162	WET SCREENING FEED PUMP	05	NO
163	WET SCREENING FEED PUMP	05	NO
164	WET SCREENING FEED PUMP	05	NO
165	WET SCREENING FEED PUMP	05	NO
166	WET SCREENING FEED PUMP	05	NO
167	WET SCREENING FEED PUMP	05	NO
168	WET SCREENING FEED PUMP	05	NO
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170	WET SCREENING FEED PUMP	05	NO
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174	WET SCREENING FEED PUMP	05	NO
175	WET SCREENING FEED PUMP	05	NO
176	WET SCREENING FEED PUMP	05	NO
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195	WET SCREENING FEED PUMP	05	NO
196	WET SCREENING FEED PUMP	05	NO
197	WET SCREENING FEED PUMP	05	NO
198	WET SCREENING FEED PUMP	05	NO
199	WET SCREENING FEED PUMP	05	NO
200	WET SCREENING FEED PUMP	05	NO

NOTES
 1) FOR RZL RECOVERY, PLANT AS DRAWN
 2) FOR RZ RECOVERY, DELETE COL. LINES ① & ② AND EQUIPMENT ITEM ⑤6

NO.	DESCRIPTION	DATE
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AS - 1001-1-001	PROPOSED SITE PLAN - DRY PLANT
AD - 1001-1-002	FLUORIDE WET PLANT (WET SEPARATION)
AE - 1001-1-003	WET CONC. CIRCUIT
AF - 1001-1-004	TITLE
AG - 1001-1-005	REFERENCE DRAWINGS

NATIONAL MINERAL SANDS PTY. LTD.
 NARACOOPA MINERAL SANDS PLANT (KING ISLAND)
 CONCEPTUAL GENERAL ARRANGEMENT - DRY PLANT
 WARMAN INTERNATIONAL LTD. AO-1001-1-067
 OFFICE OF ORIGIN: SYDNEY

X REFERENCES

FEASIBILITY STUDY

REFERENCES

CATEGORY	NUMBER	TITLE	AUTHOR
GEOLOGY	1.001	Evaluation of Mineral Sand Resources at Naracoopa King Island - VOL 1.	P.H.STITT & ASSOC.-Report No; 20/88 " "
	1.002	Ditto - VOL 2.	" "
	1.003	Ditto - VOL 3.	" "
	1.004	An investigation to verify the Reliability of MacMahon & Partners 1967 Drilling & Testing at Cowper Pt King Island.	P.H. STITT & ASSOC.-Report No; 31/88
	1.005	Addendum to report No. 20/88 Further investigation to the mineral sand resources at Naracoopa, King Island EL 28/85	P. H. Stitt & Assoc.-Report No. 7/89

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CATEGORY	NUMBER	TITLE	AUTHOR
	1.006	Evaluation of mineral sand Resources at Cowper Point, King Island EL 41/88 - VOL. 1	P. H. Stitt & Assoc.- Report No. 11/89
	1.007	Ditto - VOL. 2	" "
	1.008	Ditto - VOL. 3	" "
	1.009	Ditto - VOL. 4	" "
METALLURGY	3.001	Metallurgical Testing of a Heavy Mineral concentrate prepared from Lanherne Raw Sand Drill samples for Nat'l Mineral Sands Pty.Ltd	AMMTEC - April 1989
	3.002	Preliminary Budget estimate	Warman-30/5/89
	3.003	Metallurgical Testwork conducted upon the King Island magnetics stockpile for National Mineral Sands Pty Ltd	Amntec-June 1989
	3.004	Metallurgical Testwork Conducted Upon a 3t Bulk Sample from the Lanherne Deposit for National Mineral Sands Pty Ltd	Amntec - July 1989

CATEGORY	NUMBER	TITLE	AUTHOR
GROUND WATER	4.001	Prelim. Hydrogeological study for proposed H.M Sand Mine Milford Beach and Lenherne Beach -King Island.	COFFEY & PART. REPORT G65/1 - JUNE 1988.
	4.002	Hydrogeological Study for proposed H.M Sand Mines Naraccopa Project, King Island.	COFFEY & PART. REPORT G95/3-AB - APRIL 1989.

CATEGORY	NUMBER	TITLE	AUTHOR
ENVIR	6.001	Environmental Constraints and Procedure Report DRAFT	R.W.CORKERY & CO - REPORT 170/4 DEC. 1988.
	6.002	APPENDICES.	" "
	6.003	Archaeological survey between Naracoopa and Cowper Pt. King Island.	ROBIN SIM.- FEB 1989
	6.004	A survey of the Fauna in a selected area of King Island.	STEWART BLACKHALL
	6.005	The Vegetation and Flora of the sea Elephant Bay Area King Island.	FIONA COATES - MARCH 1989.
	6.006	The soils of the sea Elephant Ba area, King Island	FIONA COATES - MARCH 1989
	6.007	Approval Network 8 Flowsheet an Timechart for Environmental Assessment.	R.W. CORKERY & CO - REPORT 170/5.
	6.008	Rehabilitation Programme Naracoopa Project	Lewis Environmental Consultants, June 1989

CATEGORY	NUMBER	TITLE	AUTHOR
PROJEC DEV.	7.001	Rehabilitation followin Mineral Sands Mining	R.W. CORKERY & CO - REPORT 170/3 NOV 1988.
	7.002	Naracoopa Mineral Sand Project -Project summary - Dec. 1988.	N.M.S.

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