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PREFEASIBILITY STUDY

QUARTZITE AND DOLOMITE/MAGNESITE

EXTRACTION PLANTS

for

MINERAL HOLDINGS AUSTRALIA PTY. LTD.

Bechtel Australia Pty. Ltd.

September, 1986.

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Bechtel Australia Pty.Ltd.
Engineers — Constructors
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22 September, 1986

Mr N. Thomas
Mineral Holdings Australia Pty Ltd
2nd Floor, 100 Collins Street
MELBOURNE VIC 3000

Dear Sir

Subject: Prefeasibility Study Quartzite and Dolomite/Magnesite Extraction Plants

We are pleased to submit our Prefeasibility Study and Indicative Capital and Operating Costs for your proposed Quartzite and Dolomite/Magnesite mining and crushing and sizing projects in Tasmania.

As there is not any testwork data and site information the quartzite and dolomite/magnesite crushing and sizing flowsheets as proposed by Bechtel need to be further investigated to confirm type of plant, route selection and equipment sizing.

The proposed quartzite extraction plant can be developed in two stages as follows:

- Stage One - Material sizing greater than or less than 25 mm
- Stage Two - Is the further reduction of the fines material (< 25 mm) to (> 120 mesh ≤ 30 mesh) sizing.

It is anticipated that the proposed quartzite fines circuit (> 120 mesh ≤ 30 mesh) will experience excessive wear due to the high silica content of the quartzite. This circuit in particular requires extensive testwork so as to ensure optimum cost effectiveness and control of silica dust.

The Tasmanian Government authorities have indicated that strict controls will be applied to the quarrying and crushing and sizing of quartzite because of the silica dust problem.

The indicative costs developed are preliminary and based on a number of assumptions due to the lack of testwork data and site information.

A considerable amount of site investigation, crushing and screening test work, engineering and environmental studies are required before these projects can be committed.

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It is recommended that you instigate a further study comparing mobile crushing and screening plants with fixed permanent plants as outlined in our report.

We thank you for the opportunity of performing this study and we will be pleased to carry out any additional services as may be required.

Yours sincerely,
BECHTEL AUSTRALIA PTY. LTD.

Jerry R. Bell
Operations Manager & Director

JRB:AGB:sb
Attach.

PREFEASIBILITY

Quartzite and Dolomite/Magnesite Extraction Plants

FOR

MINERAL HOLDINGS AUSTRALIA PTY. LTD.

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1.0 INTRODUCTION

On the 15th August, 1986 Mineral Holdings Australia Proprietary Limited authorised Bechtel Australia Proprietary Limited to carry out a pre-feasibility study to determine indicative capital and operating costs for its proposed quartzite and dolomite/magnesite quarrying, crushing and screening operations in northern Tasmania.

The studies requested and project criteria supplied by Mineral Holdings are:

Quartzite: Mine, crush and size quartzite ore as follows:

Stage One — 100,00 tonnes per annum (> 25 mm ≤ 125 mm)
Material (< 25 mm) to separate stockpile

Stage Two — Is the further reduction of the fines material (< 25 mm) to (> 120 mesh ≤ 30 mesh) sizing

30 to 50,000 tonnes per annum (> 120 mesh ≤ 30 mesh)

(say 40,000 tonnes for study purposes)

The sizing tolerances on the fines product are:

99.5 percent of product < 30 mesh
95.0 percent of product > 120 mesh

Dolomite/Magnesite: Mine, crush and size dolomite/magnesite ores as follows:

Case (1) — 100,000 tonnes per annum (> 25 mm ≤ 125 mm)
Material (< 25 mm) to separate stockpile

Case (2) — 100,000 tonnes per annum (> 25 mm ≤ 50 mm)
Material (< 25 mm) to separate stockpile

For the purpose of the pre-feasibility study, the flowsheets, process and plant descriptions and preliminary design were developed by Bechtel and are shown in Section 2.0 of this Report.

2.0 PROJECT DESCRIPTION

2.1 QUARRY DEVELOPMENT AND OPERATION

The quarry will be developed and operated by a mining contractor who will be fully responsible for:

- site preparation including land clearing and grubbing,
- removal and placement of topsoil,
- drill and blasting,
- loading and hauling of product and waste materials,
- supply and storage of blasting explosives,
- repair and maintenance of all contractor equipment and facilities,
- contractor site office and amenities including cribroom,
- supply of all associated fuels, oils and lubricants,
- power supply and necessary lighting,
- security of contractors' equipment and facilities.

For the purpose of the study the quarry to plant haul distance was assumed at 750 metres one way.

The quarrying operation is similar for both quartzite and dolomite/magnesite operations.

2.2 CRUSHING AND SIZING PLANT

2.2.1 Quartzite Mining

The proposed quartzite crushing and sizing plant can be developed in two stages as follows:

- Stage One - Material sizing greater than or less than 25 mm
- Stage Two - Is the further reduction of the fines material (<25 mm) to (>120 mesh ≤ 30 mesh) sizing

A generalised flowsheet is shown at the end of this section of the report.

The combined production of 100,000 tonnes per annum of lump product sizing, (>25 mm ≤ 125 mm) and 40,000 tonnes per annum of fines product sizing, (>120 mesh ≤ 30 mesh) can be achieved by mining a proposed minimum of 140,000 to a proposed maximum of 200,000 tonnes per annum of quartzite ore.

The ratio of lump to fines (material > 25 mm sizing) was estimated from historical data and ranged from 2.5:1.0 to 1.0:1.0 for a 100 mm primary crusher jaw setting operating with a 25 mm opening.

The proposed dry crushing and sizing plant flowsheet was developed using the above sizing fractions. Prior to any further study work a detailed crushing and sizing testwork program needs to be instigated so as to establish pertinent grading curves which are essential for accurate plant sizing.

It is understood that trial sample mining is presently being undertaken. This work may well provide some basic data to assist in the design of the plant under consideration.

The proposed process route for the production of fines (> 120 mesh ≤30 mesh) while incurring a relatively lower initial capital cost will incur a higher operating maintenance cost when compared to ball milling due to the excessive wear of the crushing and sizing equipment items.

The crushing and sizing plant operation is scheduled for 5 days per week, 1 shift per day using a normal 40 hour work week.

Dump Pocket and Primary Crusher

Ore is discharged from quarry trucks into a 40 tonne surge hopper which feeds by a vibratory grizzly into the primary jaw crusher. The vibrating grizzly bypasses the undersized materials from the crusher. From there the material is coveyed to a double deck vibrating screen fully fitted with a fabricated dust tight enclosure. The dump pocket and primary crusher area is roof covered with open sides for the quartzite operation.

It has been assumed that the crushing and screening plant will be located on a flat site requiring no earthworks. No allowance has been included for any associated earthworks for the truck dump hopper and primary crusher installation.

Sizing and Screen House - Quartzite

The oversize material (> 125 mm) travels by conveyor belt to a stockpile located within 50 m of the Dump Pocket and Primary Crusher. The oversize material is transported to the dump pocket on an as required basis by the Quarry Contractor's front-end-loader.

The lump product (> 25 mm ≤ 125 mm) travels by conveyor belt and a mobile radial stacker to the product stockpile. Dust is controlled along these conveyor belts and at stockpile by water sprays.

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Sizing Circuit for Quartzite Fines Extraction

The fines product (< 25 mm) travels by chute via a flap gate into a 60 tonne storage bin prior to discharging by a vibratory feeder into an impact crusher.

The flap gate regulates the quantity of feed through the fines sizing circuit of the plant.

The unwanted excess fines product (< 25 mm), the quantity dependent on the lump to fines ratio split through the double deck screen travels from the flap gate chute by conveyor belt to a separate stock pile. Dust is controlled along this conveyor and at stockpile by water sprays.

The feed rate into the impact crusher, air swept classifier and cyclone sizing plant is limited to 20 to 30 tonnes per hour. No allowance has been provided for the removal of iron products from the fines produced during this operation. Iron contamination will occur from the crushing, screening and milling of the high silica quartzite ore.

The fines product from the air classifier and cyclone sizing plant travels to a 260 tonne storage bin.

The bin discharges by vibratory feeders into quartzite bagging plant the scope of which is not included in this study. Also the classification of the fines product is not included in this study.

The quartzite sizing and fines extraction building is enclosed with roof and wall cladding.

A dust collector is provided for the double deck screen, the fines sizing and extraction plant and the fines product storage bin facilities. The dust collector is a modular multi chambered filter unit type.

2.2.2 Dolomite/Magnesite Mining

The production of 100,000 tonnes per annum of lump product sizing, either (>25 mm ≤ 125 mm) or (>25mm ≤ 50 mm) can be achieved by mining a proposed minimum of 140,000 to a proposed maximum of 200,000 tonnes per annum of dolomite/magnesite ore.

Generalised flowsheets for dolomite/magnesite Cases (1) and (2) are shown at the end of this Section of the report.

The ratio of lump to fines (material > 25 mm sizing) was estimated from historical data and ranged from 2.5:1.0 to 1.0:1.0 for a 100 mm primary crusher jaw setting operating with a 25 mm opening.

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The proposed crushing and sizing plant flowsheets were developed using the above sizing fractions. Prior to the feasibility study a detailed crushing and sizing testwork program needs to be instigated so as to establish pertinent grading curves which are essential for accurate plant sizing.

The crushing and sizing plant operation is scheduled for 5 days per week, 1 shift per day using a normal 40 hour work week.

Dump Pocket and Primary Crusher

Ore is discharged from quarry trucks into a 40 tonne surge hopper which feeds by a vibratory grizzly into the primary jaw crusher. The vibrating grizzly bypasses the undersized material from the crusher. From there the material is conveyed to a double deck vibrating screen. The dump pocket and primary crusher area is not roof covered for the dolomite/magnesite operations.

It has been assummed that the crushing and screening plant will be located on a flat site requiring no earthworks. No allowance has been included for any associated earthworks for the truck dump hopper and primary crusher installation.

Sizing and Screening House - Dolomite/Magnesite

The fines product (< 25 mm) travels by conveyor belt from the double deck screen to a mobile radial stacker prior to placement on the product stockpile.

There are two lump products required from the double deck screen and are

Case (1) (> 25 mm $\leqslant 125$ mm) material sizing

Case (2) (> 25 mm $\leqslant 50$ mm) material sizing

The lump product whether it is either (> 25mm $\leqslant 125$ mm) or (> 25 mm $\leqslant 50$ mm) travels by conveyor belt from the double deck screen to a mobile stacker prior to placement on the products stockpile.

The oversized material from Case (1) will travel via a conveyor from the double deck screen to a stockpile located in the immediate vacinity of the dump pocket and primary crusher area.

The oversized material from Case (2) will travel to a secondary crusher then by conveyor to discharge on the primary crusher to double deck screen conveyor.

The sizing and screening building is not roof covered.

Dust is controlled at all transfer points by water sprays.

2.3 QUARRY SERVICE BUILDING

An allowance has been made for the Quarry Service Building including workshop, warehouse, office, cribroom, and laboratory. It has been assumed that the Quarry Service Building will be located on a flat site requiring no earthworks.

The pre-engineered fabricator design, supply and installed building is 450 square metres in area, is steel framed, wall clad and roof covered with heavy duty colourbond.

A fenced warehouse laydown area of 300 square metres has been allowed for.

The Quarry Service Building is similar for both the quartzite and dolomite/magnesite operations.

2.4 POWER SUPPLY

Power supply is provided by self contained fully housed diesel powered generating set located on a concrete slab. It has been assumed that the power supply generating set will be located on a flat site requring no earthworks.

The generating set includes an acoustic and weather proof canopy.

An allowance has been provided for underground cable runs from the generator to the Quarry Service Building and Crushing and Sizing Plant.

2.5 FUEL STORAGE

No allowance has been provided for fuel storage as from quotations received the diesel supplier will provide and install the storage tank complete with all fittings and attachments at their cost.

2.6 UTILITIES

An allowance for water supply gravity fed from a local river and sewage disposal has been included in the study.

2.7 EQUIPMENT LIST

An equipment list for each of the Quartzite and Dolomite/Magnesite studies is shown on Table 2.1 within this Section of the report.

TABLE 2-1

EQUIPMENT LIST

ITEM	DESCRIPTION	POWER	QUARTZITE		DOLOMITE/MAGNESITE	
			STAGE I	STAGE II	CASE (1)	CASE (2)
Vibrating Grizzly	Heavy Duty (1200 mm X 4000 mm)	35 kW	x	x	x	x
Primary Crusher . Single Toggle Jaw Crusher	42" by 30" Sized for Max Lump (300 - 600 mm)	110 kW	x	x	x	x
Feed Conveyor	50 metres by 600 mm	12 kW	x	x	x	x
2 Deck Screen (Heavy Duty)	1800 mm by 4900 mm	22 kW	x	x	x	x
Oversize Conveyor	100 metres by 600 mm	12 kW	x	x	x	
(>25 mm) Product Conveyor	50 metres by 600 mm	12 kW	x	x	x	x
Stacker Conveyor	50 metres by 600 mm	12 kW	x	x	x	x
(<25 mm) Product Conveyor	50 metres by 600 mm	12 kW	x		x	x
Stacker Conveyor	50 metres by 600 mm	12 kW	x		x	x
(<25 mm) Excess Product Conveyor	100 metres by 600 mm	8 kW		x		
Secondary Crusher	36 inch Cone	95 kW				x
(<50 mm) Feed Conveyor	10 metres by 600 mm	8 kW				x
Vibratory Feeder	750 mm by 400 mm	1 kW		x		
Air Swept Mill and Classifier	Complete Unit	580 kW		x		
Dust Collector	Modular, Multi Chambered Bag Unit	85 kW		x		
Vibrating Feeder	750 mm by 400 mm	1 kW		x		
Power Generator	1500 KVA Diesel Unit			x		
	625 KVA Diesel Unit		x		x	x
Fork Lift Truck	250 kgm, 3.5 m lift, diesel		x	x	x	x

Note: Power requirements for Quarry Service Building and anciallary workshop and laboratory equipment are not shown.

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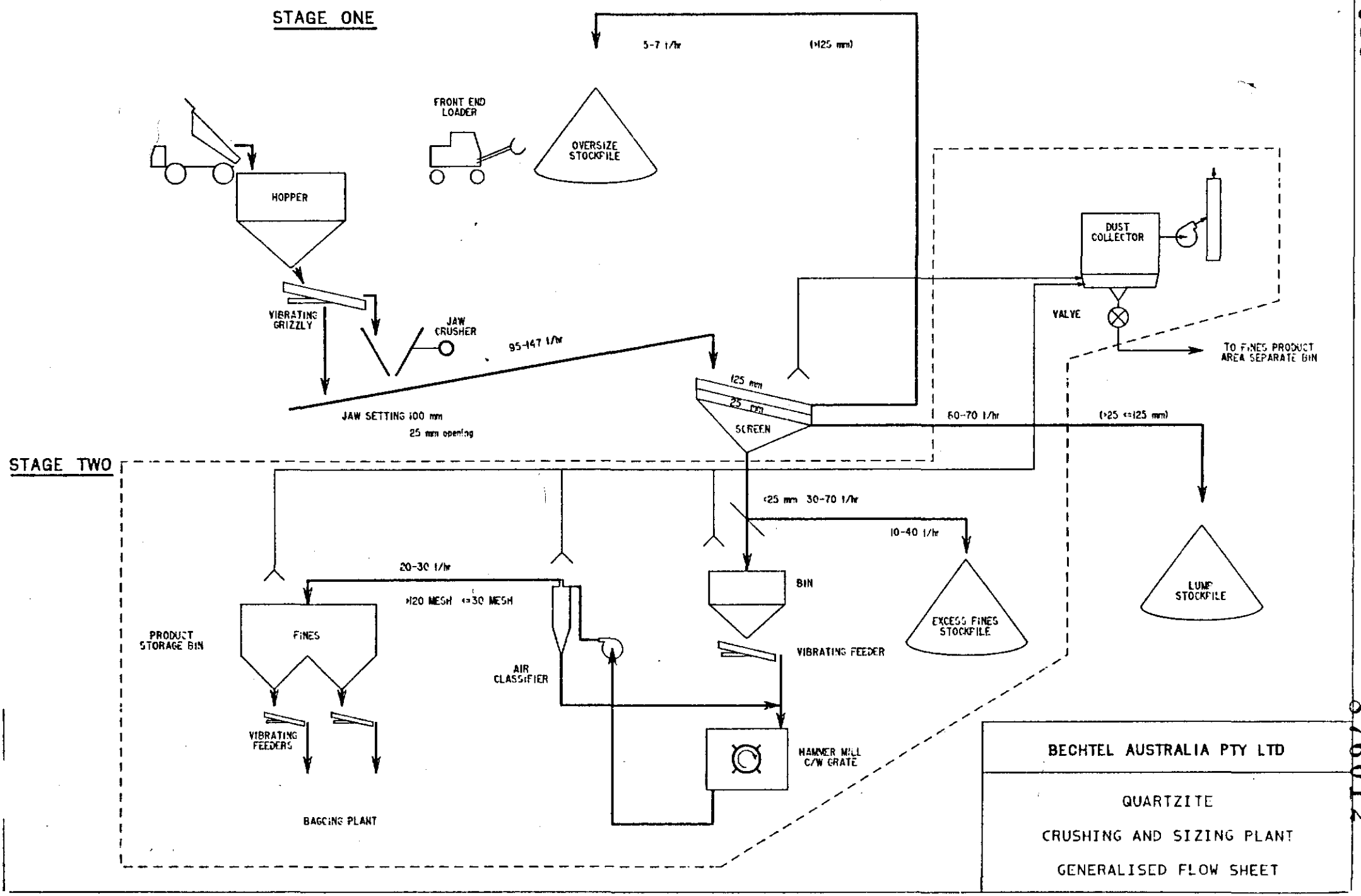

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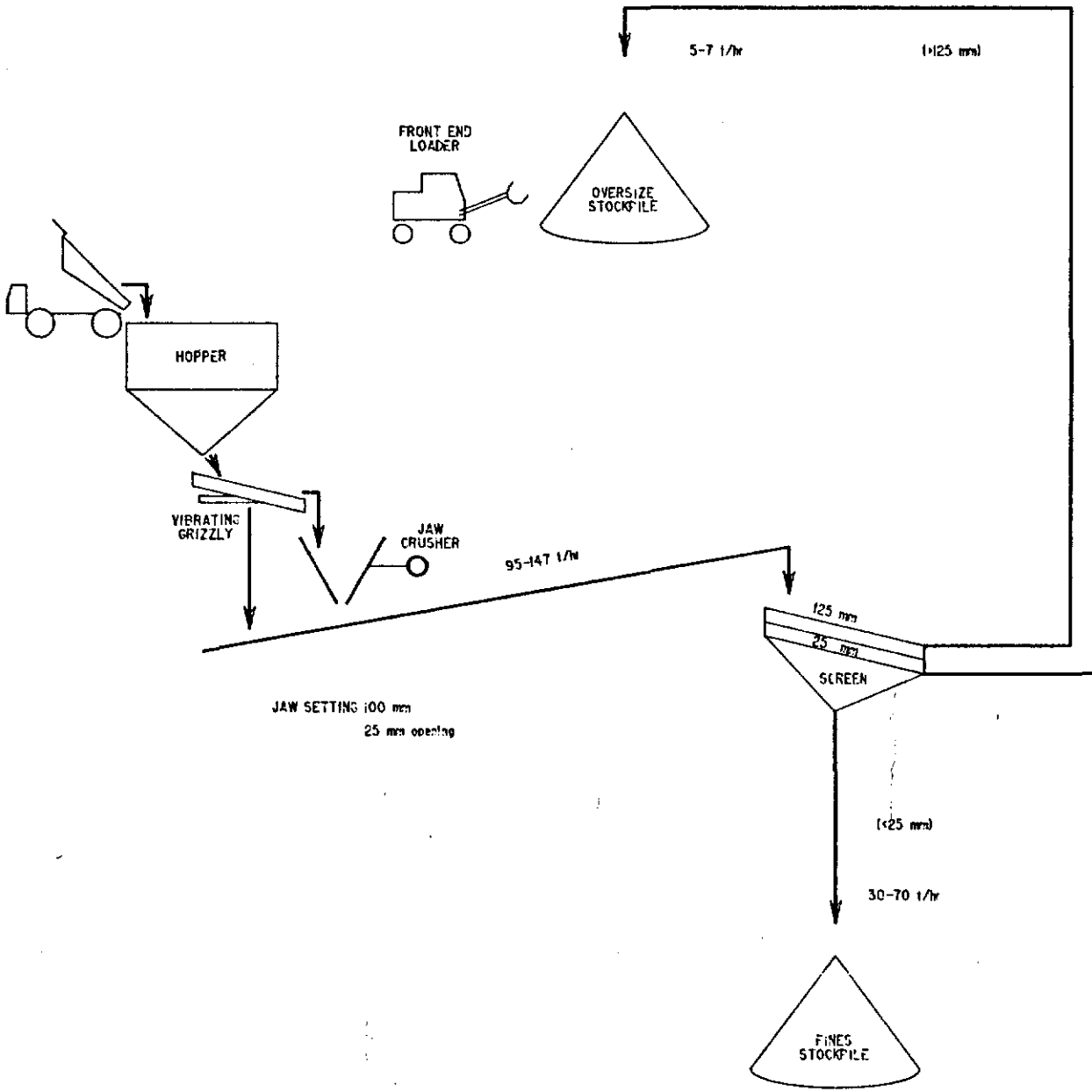
QUARTZITE

CRUSHING AND SIZING PLANT

GENERALISED FLOW SHEET



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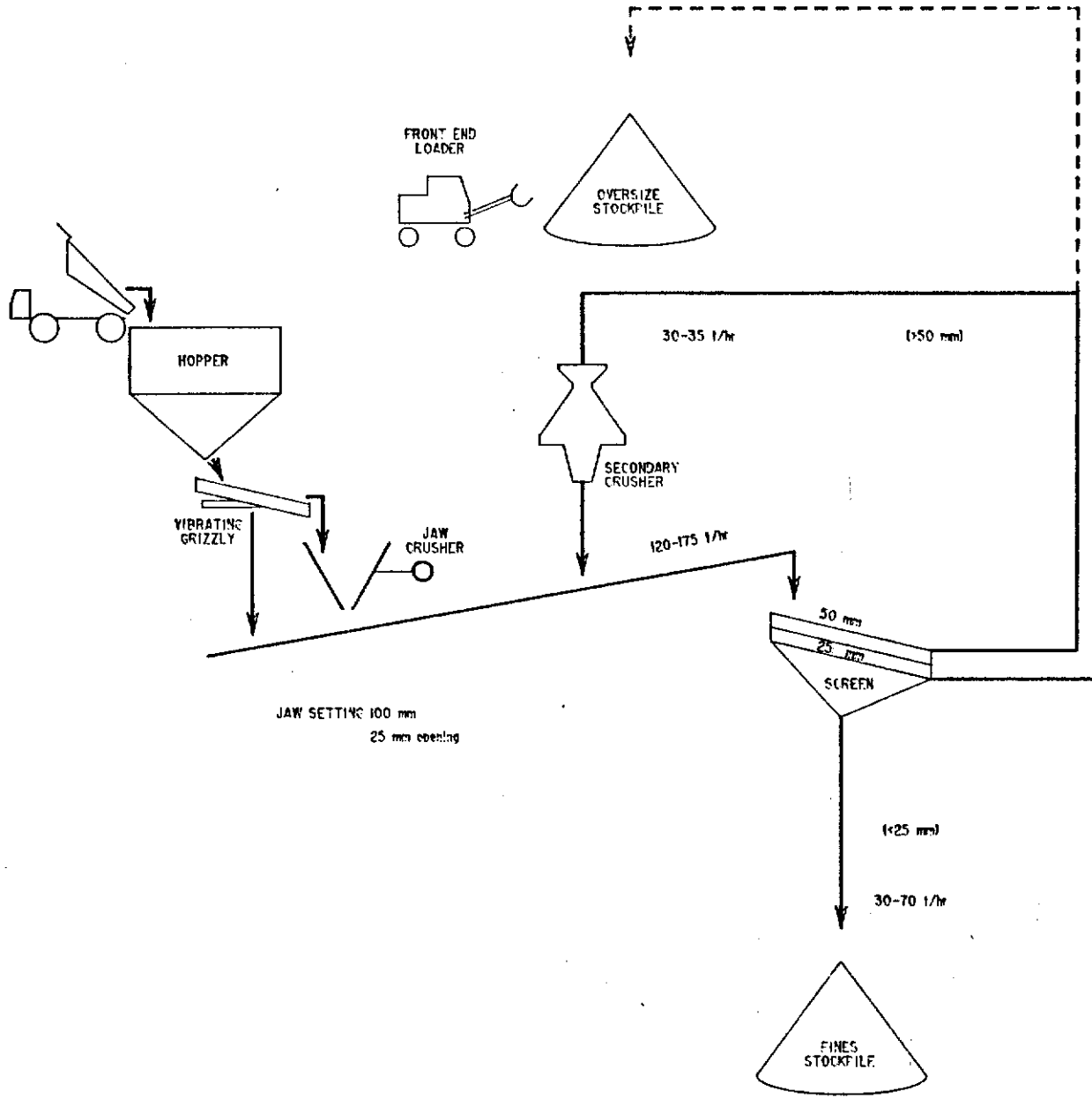
DOLOMITE/MAGNESITE

CRUSHING AND SIZING PLANT

GENERALISED FLOW SHEET - CASE I



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DOLOMITE/MAGNESITE

CRUSHING AND SIZING PLANT

GENERALISED FLOW SHEET - CASE II

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3.0 CAPITAL COSTS

3.1 SUMMARY OF CAPITAL COSTS

The indicative initial capital costs for the Quartzite and Dolomite/Magnesite Crushing and Sizing Plant operations have been estimated as follows:

(i) Quartzite

	Stage One A$,000	Stage Two A$,000	Total A$,000
Crushing and Sizing Plant	1,287	1,665	2,952
Utilities, Power/Water/ Sewerage	270	-	270
Incremental Power	-	320	320
Quarry Service Building	308	-	308
Contingency @ 15%	279	299	578
Total A$	2,144	2,284	4,428

(ii) Dolomite/Magnesite

	Case (1) A$,000	Case (2) A$,000
Crushing and Sizing Plant	1,156	1,198
Utilities, Power/Water/Sewerage	262	276
Quarry Service Building	308	308
Contingency @ 15%	259	267
Total A$	1,985	2,049

3.2 ESTIMATE BASIS

The capital cost estimates include the cost of the crushing and sizing plants, the quarry service building, power supply and utilities necessary to support a quarrying operation. The capital costs for the major equipment, mine service building and power supply generator for each of the flowsheets studied were developed from manufacturers listed prices and quotations as at August, 1986. Quotations for equipment e.g. USA have been converted at A$1.00 = US$ 0.60.

Bulk material pricings are based on current construction rates. It is assumed these items can be readily obtained in Tasmania.

The installation costs have been derived by using historical data for construction manual manhours and adjusting such hours for Tasmanian productivity and site conditions. The labour rate used is consistent with the construction industry, being based on a 48 hour work week.

Contractors distributable costs are based on historical and current experience. These costs cover mobilisation, demobilisation, temporary facilities, warehousing, maintenance of equipment, equipment rental, fuels, tools, consumables, supervision, head office overhead, insurance and profit.

No allowance has been made for site preparations and it is assumed that the ramp leading up to the hopper will be included in site preparation works.

3.3 ESTIMATE EXCLUSIONS

- Owners Costs
- Royalties to other land rights holders
- State and Federal Royalties (if any)
- Working capital
- Financing charges and interest during construction
- Land acquisition and right of way costs
- Environmental considerations other than those included in present designs
- Cost of training plant operating personnel
- Site investigation and crushing and sizing testwork programs
- On-going engineering study costs including geological definition of lease areas
- Permits, licences, and approvals required by authorities
- Project insurances
- Major Site preparation
- Environmental impact study costs
- Removal of iron contamination from silica sand product fines.
- Crushing and Sizing Plant Lighting
- Fuel storage

- Company vehicles
- Bagging and fines classification plant for quartzite fines extraction.
- Escalation costs

4.0 OPERATING COSTS

4.1 SUMMARY OF OPERATING COSTS

The indicative annual operating costs for the quarrying and crushing and sizing of Quartzite and Dolomite/Magnesite ores have been estimated for the following two assumed plant lump to fine recovery rates.

	Ratio	Lump (>25mm) Tonnes	Fines (<25mm) Tonnes	Total Plant Input Tonnage
Lump to Fines	2.5:1.0	100,000	40,000	140,000
Lump to Fines	1.0:1.0	100,000	100,000	200,000

The required annual lump and fines product tonnages are:

	Quartzite		Dolomite/Magnesite	
	Stage I	Stage II	Case (1)	Case (2)
Lump (>25mm ≤125mm)	100,000	100,000	100,000	---
(>25mm ≤50mm)	---	---	---	100,000
Fines (<25mm)	40,000	---	40,000	40,000
(>120mesh ≤30mesh)	---	40,000	---	---
Total Product Required Tonnages:	140,000	140,000	140,000	140,000

The operating costs have been estimated for a minimum annual plant throughput of 140,000 tonnes and a maximum annual plant throughput of 200,000 tonnes with both producing 140,000 tonnes of total annual product.

The indicative operating costs are:

Quartzite	Stage One	A$ 6.10	to	A$ 7.80/tonne
	Stage Two	A$ 8.70	to	A$ 10.50/tonne
Dolomite/ Magnesite	Case (1)	A$ 5.90	to	A$ 7.60/tonne
	Case (2)	A$ 6.00	to	A$ 7.80/tonne

4.2 SALARY SCHEDULE

	Salaries Per Annum		
	Quartzite		Dolomite/Magnesite
	Stage I	Stage II	
Quarry Manager	50,000	50,000	50,000
Crushing and Sizing Plant Foreman	32,000	32,000	32,000
Electrician/Fitter	30,000	30,000	30,000
Crushing and Sizing Plant Attendant	27,000	27,000	27,000
Crushing and Sizing Plant Attendant	-	27,000	-

The salaries do not include any fringe benefits, allowances and overtime payments.

4.3 BASIS OF OPERATING COST ESTIMATE

The general indicative annual operating cost estimate includes the quarrying operation by contractor and the crushing and sizing plant and power supply by owner.

The battery limits of operation covered by this operating cost estimate commence at the quarry and conclude for the quartzite study at the lump stockpile (material > 25 mm ≤ 125 mm), excess fines stockpile (material < 25 mm) and the outlet of the fines product bin (material > 120 mesh ≤ 30 mesh); and for the dolomite/magnesite studies at the lump and fine product stockpiles.

The estimated annual operating cost has been determined for a typical year at full production rate.

4.4. DETAILS OF OPERATING COSTS

4.4.1 Quarrying Contractor

The quarrying contractor operating costs are developed from quotations from Tasmanian earthmoving and quarrying contractors.

The costs include all areas of the quarrying operation as outlined in Section 2.1 of this report.

4.4.2 Manpower

Owner manpower requirements are based on a 5 day per week, 1 shift per day using a normal 40 hour work week for all personnel.

The salary schedule shown in Section 4.2 has been developed from current and inhouse information.

No allowance has been made for fringe benefits and other allowances.

4.4.3 Maintenance Materials and Services

The crushing and sizing plant annual maintenance materials have been estimated after considering equipment application, its wear life and unit replacement cost. The Maintenance Materials and Services costs do not include the initial spares cost.

4.4.4 Operating Supplies

The annual costs of consumable operating supplies and utilities have been assessed according to typical crushing and sizing requirements and prevailing unit prices delivered to site.

Local prices for diesel and lubricants were obtained from the major local suppliers.

4.4.5 Indirect Operating Costs

This item includes local office expenses for telephone, mail, travel, subscriptions and miscellaneous office supplies, estimated at 1% of the plant direct operating costs.

4.5 ESTIMATE EXCLUSIONS

- Waste Removal
- Company Vehicles
- Salary fringe benefits, allowances and overtime payments

5.0 RECOMMENDATIONS

5.1 QUARRYING, CRUSHING AND SIZING OF QUARTZITE ORE

It is recommended that Bechtel on behalf of Mineral Holdings Australia determines the Government's acceptable operating conditions for the quarrying, crushing and sizing of quartzite ore.

Quartzite is high in silica and as such is considered by the Mines Department and Department of Environment as hazardous material to work force and neighborhood health and as such the Owner will have to operate under strict controls.

Mineral Holdings Australia when applying for a licence to operate the quarry and crushing and sizing plant will have to satisfy the "Environmental Protection Act" and have gained approval of an Environmental Impact Statement prior to submittal.

The Environmental Act is not specific about silica dust emissions into the atmosphere and does not address dust levels acceptable to work force.

The Act does however throw the onus onto Mineral Holdings Australia to prove that the dust emission levels are acceptable to the work force and persons residing or working in the neighboring vacinity.

The National Occupational Health Guide issued by the National Health Board outlines acceptable threshold limit values for silica dust emissions and these should be addressed in the Environmental Impact Statement submission.

5.2 ALTERNATE PROCESSING OF QUARTZITE FINES PRODUCT

In order to determine the most suitable and cost efficient plant Bechtel recommend that additional engineering be undertaken to thoroughly evaluate the full implications of quartzite quarrying, crushing and sizing operations specifically those related to the production of fine products in the range of 120 mesh to 30 mesh sizing.

As alternatives to the proposed dry crushing and sizing of quartzite fines product the following process routes are recommended for further study. They are:

- Air swept ball mill with cyclone classifier
- Wet grinding and size classification.

5.3 CRUSHING AND SIZING TESTWORK

To accurately size a crushing and screening plant a detailed and controlled crushing and grading tests need to be completed for quartzite and dolomite/magnesite ores.

Also the quartzite dust emission levels, the degree of quartzite abrasiveness and iron contamination levels produced during a dry fines process circuit need to be established and quantified to assist in final process selection and design.

5.4 THE USE OF CONTRACTORS VERSUS OWNER'S PERSONNEL

Bechtel recommends that further cost studies be instigated to determine the relative costs of the following cases:

a) Owner purchased and operated fixed and mobile Crushing and Sizing Plants.

b) Owner purchased and contractor operated fixed and mobile Crushing and Sizing Plants.

c) Contractor owned and operated Crushing and Sizing Plant.

5.5 USED CRUSHING AND SIZING PLANT EQUIPMENT

To offset high initial equipment costs for a fixed plant it is recommended that Bechtel investigate the availability and suitability of used process equipment items.

5.6 ENVIRONMENTAL IMPACT STATEMENT

Bechtel recommends that environmental field studies and data collection studies be commenced. The scope of these programs should be developed to satisfy requirements of the Environmental Protection Act and the Environmental Impact Statement Report.

5.7 QUARRYING AND ENGINEERING STUDIES

If the results of this study are sufficiently encouraging to merit further study, an extensive program of field data collection and office study work is required. It is understood that the reserves cover a large area. Each area may have differing material chemical and physical properties which may suit specific markets.

It is recommended that Mineral Holdings Australia marketing plan and mining lease information be made available to Bechtel to assist in the ongoing crushing and sizing plant design, its location and the provision of infrastructure and services.