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ADDITIONAL PLANS:

CONVERSION OF GYPSUM TO AMMONIUM SULPHATE IN PLANTS BY POWER-GAS

DAVY-ASHMORE PTY. LTD.
G.P.O. BOX 4709
MELBOURNE

THE POWER-GAS CORPORATION LTD
MEMBER OF THE DAVY-ASHMORE GROUP
STOCKTON-ON-TEES ENGLAND

CONVERSION OF GYPSUM TO AMMONIUM SULPHATE IN PLANTS BY POWER-GAS

Natural gypsum, anhydrite or by-product gypsum from phosphoric acid manufacture can be profitably converted to pure ammonium sulphate liquor or crystals by treatment with ammonia and carbon dioxide in plants offered by The Power-Gas Corporation Limited, Stockton-on-Tees, England.

The ammonium sulphate produced can be used:

a) for sale as a straight N fertilizer

b) to make ammonium sulphate nitrate (ASN) for sale as a straight N fertilizer

c) as an internal sulphate recycle within a nitrophosphate process to produce highly concentrated NP/NPK fertilizers with more than 90% P_2O_5 in the water soluble form.

C O N T E N T S

DEVELOPMENT OF THE PROCESS AND COMMERCIAL PLANTS

The Process was originally developed separately by Österreichische Stickstoffwerke AG (OSAG) of Linz, Austria, and The Fertilisers and Chemicals, Travancore Limited (FACT) of Kerala, South India, but both have granted exclusive rights to Power-Gas. For some years FACT have operated a small industrial unit at Kerala using by-product gypsum produced in their own factory, and OSAG daily produce a large tonnage of ammonium sulphate from natural gypsum. Power-Gas and OSAG have already collaborated to design and supply a plant for ammonium sulphate from by-product gypsum in Germany, and now together with FACT are providing design, engineering, purchasing and commissioning services for a plant to produce 440 tonnes per day of ammonium sulphate from by-product gypsum.

Power-Gas' experience with the ammonium sulphate from gypsum process began in 1946 with the supply of 1000 tons/day natural gypsum sulphate plant at Sindri, India. Other natural gypsum plants with which Power-Gas has been associated include those for ANIC, Ravenna, Italy; WPIDC, Daudkhel, West Pakistan; Azot Sanayii, Kütahya, Turkey; BASF, Ludwigshafen, Germany; and OSAG, Linz, Austria.

Thus it is evident that Power-Gas has unique experience in the gypsum process (and particularly in dealing with by-product gypsum) through collaboration with the producing companies able to provide design data backed up by proven long term operation of commercial plants.

FEEDS AND UTILITIES CONSUMPTIONS PER TONNE OF $(NH_4)_2SO_4$

For 44.5 weight % ammonium sulphate liquor as product.

Gypsum:

$CaSO_4 2H_2O$	75.3%	
H_2O	19.6%	
Other	5.1%	
	100.0%	1.82 tonnes

Ammonia:

Anhydrous liquid	0.27 tonne

Carbon dioxide:

98% gaseous	0.34 tonne

Cooling water:

Supply 30°C

Return 43°C 13.8 cu. metres

Electric power:

(Excluding lighting, instruments and services) 40.0 kWH

For dry ammonium sulphate crystals as product:

Ammonium/sulphate liquor:

44.5 weight % at 75°C	2.24 tonnes

Sulphuric acid:

98% for neutralisation	0.06 tonne

Cooling Water:

Supply 30°C

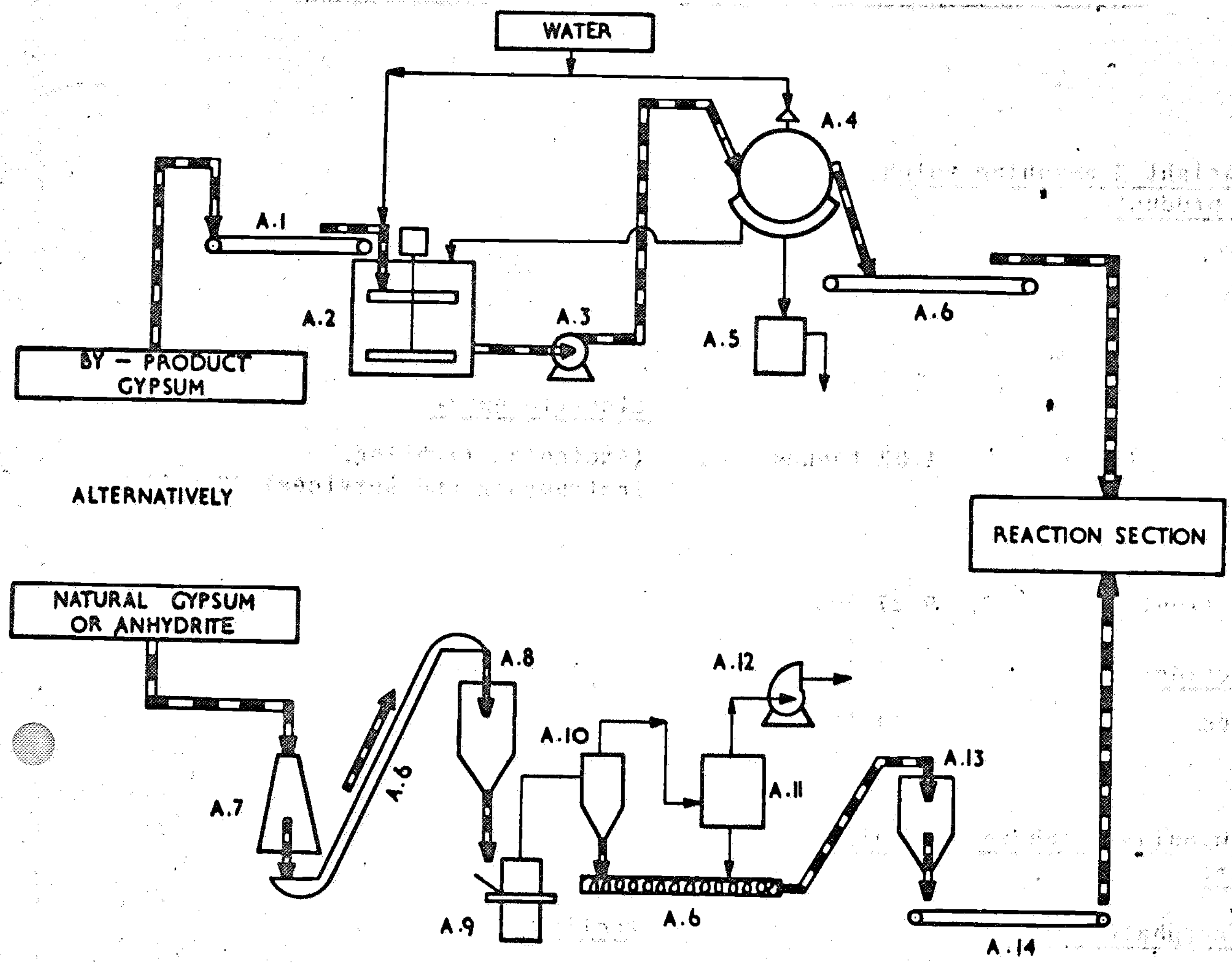
Return 43°C 21.0 cu. metres

Electric power:

(Excluding lighting, instruments and services) 20.0 kWH

Steam:

Supply 3 ata . . . 0.68 tonne



GYPSUM PREPARATION

A1	Gypsum Conveyor	A8	Mill Feed Hopper
A2	Slurry Tank	A9	Mill
A3	Filter Feed Pump	A10	Cyclone
A4	Gypsum Filter	A11	Bag Filters
A5	Filtrate Tank	A12	Exhaust Fan
A6	Gypsum Conveyor	A13	Ground Gypsum Storage
A7	Crusher	A14	Weigh Belt Feeder

PROCESS DESCRIPTION

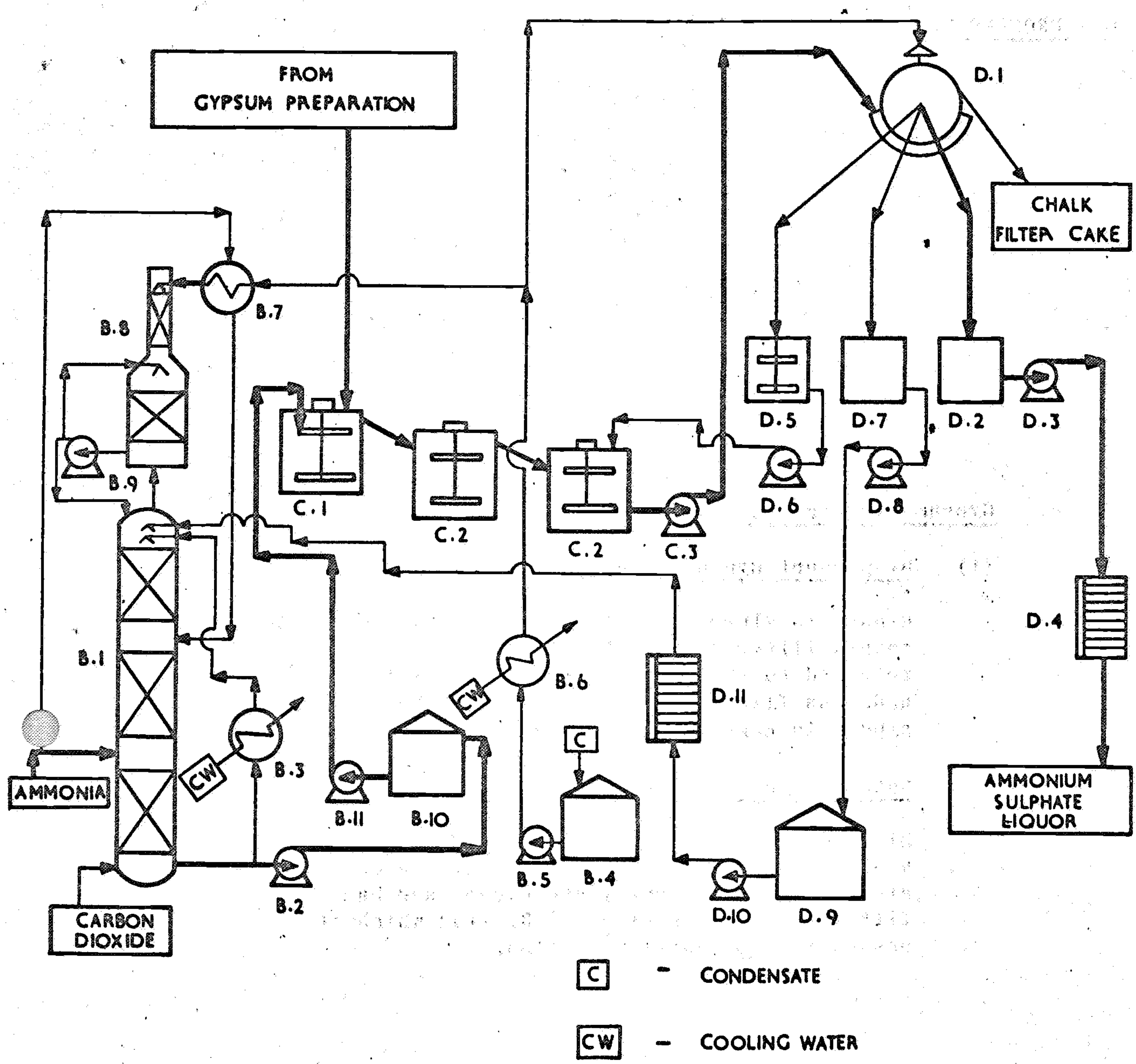
A. Gypsum preparation

(i) By-product Gypsum Feed

Gypsum is slurried in tank A.2 and passed to the rotary filter A.4. The muddy filtrate is returned to the slurry tank and the filtrate and wash filtrate sent to drain. The filtered gypsum is conveyed to the reaction section.

(ii) Natural Gypsum or Anhydrite Feed

Mined gypsum is reduced in the crusher A.7 to a size suitable for feed to the mill A.9. The ground gypsum is sent via cyclones and bag filters to storage silos A.13, from which it passes to the reaction section.



CARBONATION, REACTION AND CHALK FILTRATION

B1	Carbonation Tower
B2	Circulating Pump
B3	Carbonation Cooler
B4	Condensate Tank
B5	Condensate Pump
B6	Condensate Cooler
B7	Ammonia Evaporator
B8	Residual Gas Washer (R.G.W.)
B9	R.G.W. Circulating Pump
B10	Carbonate Tank
B11	Carbonate Pump
C1	Reaction Mix Tank
C2	Lye Tank
C3	Slurry Pump
D1	Chalk Filter
D2	Filtrate Tank
D3	Filtrate Pump
D4	Pressure Filter
D5	Muddy Filtrate Tank
D6	Muddy Filtrate Pump
D7	Wash Water Tank
D8	Wash Water Pump
D9	Buffer Tank
D10	Buffer Tank Pump
D11	Pressure Filter

PROCESS DESCRIPTION (Continued)

B. Ammonium carbonate preparation.

Ammonia and carbon dioxide are fed into the column B1 in which the ammonium carbonate liquor is circulated by the pump B2 through the coolers B3. The heat of reaction from the absorption of the CO_2 and NH_3 in the solution is removed from the system by the cooler B3.

Process water (which will be the condensate from the crystallisers if ammonium sulphate crystals are the final product) is collected in tank B4 from which it is pumped through a cooler B6 and an ammonia evaporator cooler B7 to the top of the residual gas washer B8. A temperature of $10^{o}C$ is used for the process water to the residual gas washer to minimise ammonia losses.

In the residual gas washer, the cooler condensate absorbs the ammonia and carbon dioxide from the waste gases leaving the carbonation tower. With the recirculation pump B9 part of the solution at the base of the residual gas washer is pumped to the top of the carbonation tower.

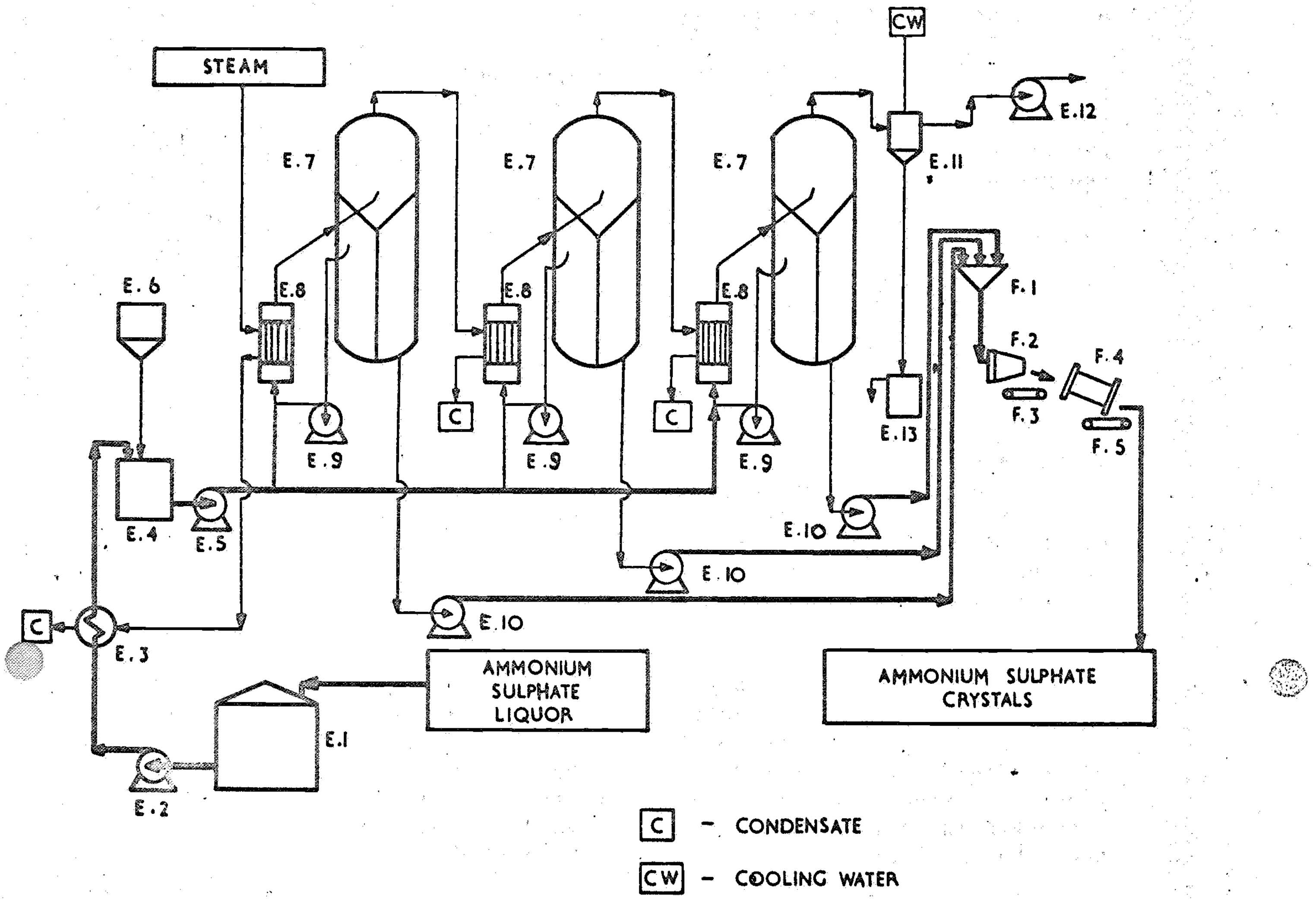
C. Reaction

Gypsum filter cake (or ground gypsum) and ammonium carbonate liquor are mixed in the reaction mix tank C1. A heating coil is fitted to the mix tank to allow the reaction temperature to be adjusted to the optimum. The gypsum/carbonate liquor reaction reaches completion in the lye tanks C2, which are connected in series. The slurry is pumped from the last lye tank, by the slurry pumps C3, to the chalk filters.

D. Chalk Filtration

The reaction section product liquor is filtered on rotary vacuum filters D1. The fresh ammonium sulphate liquor passes from the filters into the tank D2; from there it is pumped through the pressure filters D4 from which it is discharged into the buffer tank E1 or sent directly to NPK plant.

The filtrate initially obtained contains some $CaCO_3$ and is thus termed "muddy filtrate". This $CaCO_3$ is collected in the muddy filtrate tank D5 from which it is pumped back to the lye tanks. Before the filter cake is discharged from the filter it is washed in two stages, with the condensate from the cooler B6. The final wash filtrate is collected in tank D7 from which it is pumped to the filtrate buffer tank D9. Soluble $CaSO_4$ is removed from the filtrate in D9 by the addition of $(NH_4)_2CO_3$ solution. The $CaCO_3$ so formed is removed from the filtrate by settling, the filtrate then being pumped to the carbonation towers through the pressure filter D11.



NEUTRALISATION, CRYSTALLISATION, DEWATERING AND DRYING

E1	ASU* Feed Storage Tank	E10	Slurry Pump
E2	ASU* Feed Pump	E11	Condenser
E3	Feed Preheater	E12	Vacuum Pump
E4	Mother Liquor and Neutralisation Tank	E13	Condenser Seal Pot
E5	Crystallisers Feed Pump	F1	Prethickener
E6	Sulphuric Acid Head Tank	F2	Centrifuge
E7	Crystalliser	F3	Conveyor
E8	Calandria	F4	Drier
E9	Circulating Pump	F5	Product Conveyor

* Ammonium Sulphate

PROCESS DESCRIPTION (Continued)

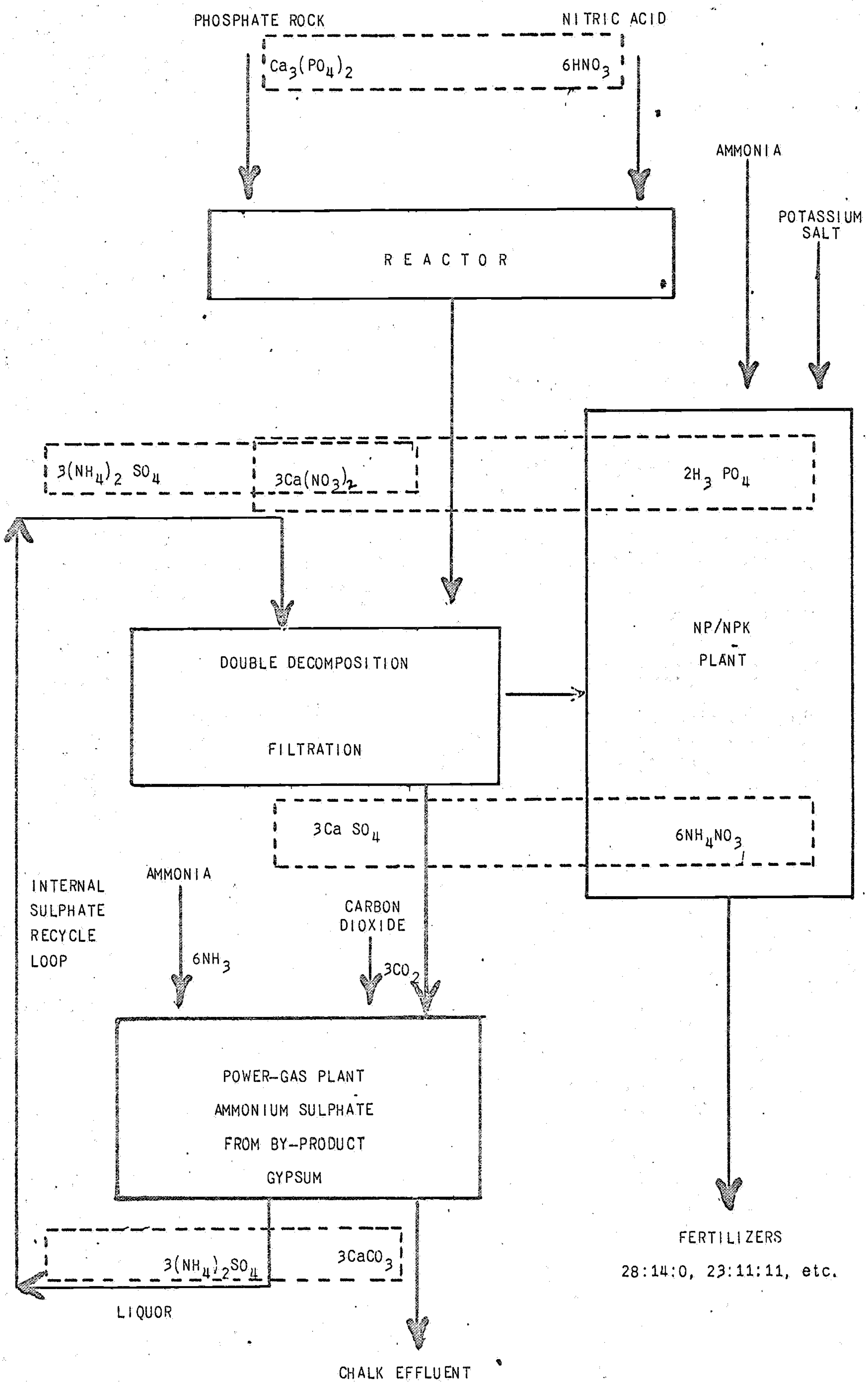
E. Neutralisation and Crystallisation

Sulphuric acid is fed to the neutralisation tank E4, where it is mixed with the ammonium sulphate liquor, which is pumped from the storage tank E1 through the feed preheater E3, where it is heated by the first effect calandria condensate. The neutralised liquor, together with the overflow mother liquor from the prethickener and centrifuge, is then fed in parallel feed to the triple effect evaporator crystalliser.

F. Dewatering and Drying

The ammonium sulphate slurry from each effect is pumped to the prethickener F1 and the overflow returned to the mother liquor tank E4. The thickened slurry passes to the centrifuge F2 and from there the dewatered crystals are conveyed to the drier F4.

BASIC NITRO-PHOSPHATE PROCESS EMPLOYING SULPHATE RECYCLE



USE OF THE AMMONIUM SULPHATE LIQUOR PRODUCT IN NITRO-PHOSPHATE PRODUCTION

The ammonium-sulphate-from-gypsum plant can be used to drive an internal sulphate recycle within a nitro-phosphate process.

Most nitro-phosphate processes today suffer from:

The need to separate calcium nitrate from the nitric acid/ phosphate rock reaction products;

OR The eventual conversion of phosphate in the initial reaction products to insoluble dicalcium phosphate; plus

The inclusion of the calcium in the final fertilizer with consequent dilution of the product and lowering of the NP/NPK analysis.

A NPK process using nitric acid acidulation of phosphate rock combined with an internal recycle of sulphate radical is illustrated in the sketch opposite together with the main basic reactions. The system's advantages, over conventional processes employing separate phosphoric acid production facilities based on sulphuric acid acidulation of phosphate rock, are:

The phosphate rock feed needs less grinding.

No sulphuric acid is needed other than as make-up to the by-product gypsum plant. This sulphate make-up can alternatively be met by the addition of gypsum (natural or by-product from other production facilities). Hence sulphuric acid costs are saved.

The nitric acid is used not only to acidulate the phosphate rock but also to provide the nitrate requirements. Separate production of phosphoric acid for use in a conventional NPK plant is not needed, with consequent savings.

Effluent problems are much reduced, since the solid effluent is predominantly chalk, instead of gypsum. This means a 35% saving in the weight of the calciferous effluent to be handled. Furthermore chalk, unlike gypsum dumped into say a river, will tend to flush away.

The products are high-analysis NP/NPK formulations containing more than 90% P_2O_5 in the water soluble form. Most authorities agree that fertilizers with a high water-soluble P_2O_5 content usually provide a quicker crop response and a greater total availability of P_2O_5 than do conventional nitro-phosphate fertilizers incorporating large percentages (approximately 50% of their P_2O_5) in the citrate soluble form.

COST SAVINGS IN COMPARISON WITH CONVENTIONAL NPK PROCESSES

In a comparison between the conventional route to NP/NPK fertilizers and the nitro-phosphate/sulphate recycle route, certain units are common to both. These are:

1) The ammonia plant
2) The nitric acid plant.

The capital costs of these plants are therefore common to both routes. Additionally, the respective NP/NPK plants (with granulation or prilling) required by the two routes would differ little in capital cost.

The difference between the two routes is mainly that the sulphuric acid and phosphoric acid plants required by the conventional route are replaced by an ammonium-sulphate-from-gypsum plant in the nitro-phosphate/sulphate recycle route. The overall capital cost is normally in favour of the latter process route.

In terms of running cost, a conventional NPK process with an annual fertilizer output of 100,000 tonnes of formulation 28: 14: 0 plus 100,000 tonnes of formulation 23: 11: 11, needs a total of approximately 70,000 tonnes of sulphuric acid to manufacture the necessary P_2O_5 as phosphoric acid. The cost of this sulphuric acid (taking a price per tonne of £14) is approximately £1 million per year, or £5 per tonne of NPK product, which in the U.K. is approximatley 15% of the selling price of the fertilizers in question.

Hence maximum cost savings resulting from use of the new route occur with compound fertilizer formulations such as 28: 14: 0 and 23: 11: 11 which have high N/P_2O_5 ratios. For low N/P_2O_5 ratios the need for separate phosphoric acid addition may arise but nevertheless the scale of this will usually be considerably less than that associated with a "conventional" NPK ferilizer plant employing only P_2O_5 derived from a wet phosphoric acid plant using sulphuric acid acidulation of the phosphate rock.

The rapidly expanding world demand for concentrated NP/NPK compound fertilizers, based on ammonium nitrate and ammonium phosphates (with or without the inclusion of potassium salts), together with the rising cost of sulphur(required for the production of sulphuric acid used in wet phosphoric acid manufacture) have combined to place Power-Gas ammonium-sulphate-from-by-product-gypsum plants in a most important role in the future world fertilizer industry. This is particularly the case where high analysis NP/NPK formulations with high P_2O_5 water-solubility are required.

LIST OF POWER-GAS PATENT APPLICATIONS

British Provisional Patent applications :

No. 25902/66
No. 26825/66
No. 30688/66

Others are in course of preparation

The following extract is taken from a United Nations report* dated June 21st., 1966

"".... the techniques of each section (of a nitro-phosphate installation incorporating an internal ammonium sulphate recycle) are well known and have been in large scale operation in separate plants for many years. Therefore, nitro-phosphate processes of this type are considered to have excellent future potential, particularly ..... where low cost ammonia is available and elemental sulphur is in restricted supply."

* United Nations, Department of Economic and Social Affairs, Centre for Industrial Development: "Reducing sulphur needs in fertilizer manufacture.""

COMMONWEALTH OF AUSTRALIA.

TELEPHONE: CANBERRA 7 0423.
TELEGRAMS:
SECTRADE, CANBERRA.
ASE ADDRESS REPLY TO THE "SECRETARY"
AND QUOTE 66/3369

DEPARTMENT OF TRADE AND INDUSTRY,
CANBERRA, A.C.T.
5th December, 1966.

Mr. S. B. Dickinson,
Clutha Development Pty. Limited,
4th Floor, Pearl Assurance House,
1 Castlereagh Street,
SYDNEY. N.S.W.

8 DEC 1966

Dear Mr. Dickinson,

You will recall your letter of the 22nd November, 1966 in which you raised the question of exporting gypsum to India. I have written the Trade Commissioner, Calcutta, asking him to carry out enquiries along the lines suggested in your letter.

However, information held in the Department, although slightly out of date, suggests that prospects of exporting gypsum to this market would be very small. At present all gypsum entering the country is imported from Pakistan under a Trade Arrangement which is basically a barter arrangement. The quantities being imported are to supplement local production, which although rising cannot match demand.

It has been estimated that total reserves of gypsum in India are in the vicinity of 476 million tons, with production running at approximately 1 million tons per year.

The Sindri Fertiliser Factory is the major consumer, using nearly 2000 tons per day in its production of ammonium sulphate. The carbonate sludge recovered in the process is supplied to Associated Cement Co. Ltd. for the manufacture of cement. Most of their Gypsum requirements are met from their own mines located at Kavas and Uttarlai in Rajasthan and from Bikaner Gypsums Ltd, Calcutta.

The Sindri factory uses Gypsum of the following specifications:-

	Grade I.	Grade II
$CaSO_4 2H_2O$ per cent by weight minimum	88.0	86.0
Silica & other insoluble matter per cent by weight maximum	6.5	8.5
Iron & Aluminium (as oxides)	1.5	1.5
Magnesium Oxide (MgO) maximum	1.0	1.0
Chlorides as NaCl maximum	0.01	0.01

A considerable rise in the production of fertilisers is visualised in India and a target of 1 million tons of nitrogenous fertilisers, in terms of nitrogen, has been indicated by the end of the Third Five Year Plan. With the expansion of existing fertiliser and cement plants, and the setting up of new ones, the demand for gypsum as a raw material will increase rapidly.

The question arises as to whether local production can increase sufficiently rapidly to meet this demand.

In any case, it would appear that a short fall in production would be met by imports from West Pakistan, where production is increasing and reserves are also high.

I trust the above information will be of some use to you, until such time as we receive the report from the Trade Commissioner Calcutta, which will be forwarded on to you.

Yours faithfully,

Neil Hope

(For Director.)
Asia Branch.
International Trade Relations Division.

INTER - OFFICE MEMORANDUM

TO : MR GEORGE O. JENNINGS

FROM : MR S. B. DICKINSON

SUBJECT : PROPOSED (GYPSUM AND COAL) CHEMICAL AND FERTILIZER PROJECT FOR NEWCASTLE

PREAMBLE :

≡ to 200,000 tons phosphoric acid per annum.

Newcastle has recently been selected by I.C.I. and C.R.A. as the setting for a nitrogenous and phosphatic fertilizer complex. Key elements of this complex are a 600 tons per day ammonia plant to be erected by I.C.I. and a 540 tons per day sulphuric acid plant which has recently been completed by C.R.A. I.C.I.'s main product will be ammonium nitrate whilst C.R.A.'s is superphosphate and enriched superphosphate. I.C.I.'s ammonia plant will use naptha initially as the feed stock, but is adaptable for natural gas in possibly two years time. C.R.A.'s sulphuric acid plant is geared to imported elemental sulphur. The total investment by both companies is of the order of $50,000,000 with the Government of New South Wales providing rail, road, wharf and other harbour facilities at a cost of $8,400,000. Power and fresh water are also available from Government instrumentalities.

These activities, on face value, can be supplemented by further chemical and fertilizer industries which are the subject of this proposal. The proposal now presented supercedes the proposals which have been the subject of earlier reports.

LOCATION :

"Walsh Island" - Newcastle, adjoining C.R.A.'s Greenleaf Fertilizers". (see plans) At the time of writing the areas shaded are available, namely :-

(1) 74 acres (unreclaimed) which has tentatively been set aside for a disposal area for the effluent of impure gypsum (150,000 tons per annum) from a phosphoric acid plant. This effluent could be taken further afield or, alternatively, used by one of the proposed new industries by arrangement with C.R.A.

(2) 21 acres and 25 acres adjoining, on the west, the 74 acres in (1) above. These areas are adjacent to existing and proposed roads and railway line and are 95% reclaimed.

(3) Further west of the 21 acre and 25 acre blocks there is virtually unlimited ground, partly reclaimed, but more distant from the berth and railway facilities adjacent to (1) and (2) above.

All r[illegible]med land referred to above is available with free[illegible] [illegible] at $7000 per acre or on lease at 8%. This pri[illegible] [illegible] [illegible]ate after December, 1966 as Government spending [illegible] improvements and services generally in the area progress.

SIDE WATER BERTHING :

The Maritime Services Board have established common bulk unloading facilities (see plan) for the I.C.I. and C.R.A. fertilizer industries and also for Alcan whose aluminium plant situated at Karri Karri, 35 miles distant by rail, will receive alumina from Gladstone at this berth. The Department of Public Works has stated that it is possible for other industries also to be serviced from this berth. The installation of a belt conveyor from the berth to the sites, (1) (2) and/or (3) referred to above, can be effected. The limiting depth of water at the berth will be 36 feet.

PROPOSED NEW INDUSTRIES :

The proposed new industries comprise the establishment of the following plants.

Stage 1

(a) Ammonia Synthesis Plant (100% capacity 300 tons NH_3/d - 98,000 tons NH_3/y).

(b) Ammonium Sulphate Plant (100% capacity 1200 tons/d - 383,333 tons/y).

(c) Cement (100% capacity 780 tons/d. - 266,000 tons/y).

CAPITAL COST :

The capital cost of this new chemical and fertilizer c[illegible]ples is, broadly, as follows :-

(a)	Ammonia Plant	$2,30[illegible]
(b)	Ammonium Sulphate Plant	4,900,[illegible]
(c)	Cement Plant	5,800,000
		$13,000,[illegible]

Hence the total capital cost for the complex as set [illegible] ready to operate, but excluding start up and working capital is $13,000,000.

RAW MATERIALS :

The chief raw materials for the complex comprise:-

Naptha or Natural Gas for Ammonia Manufacture.

Gypsum - 500,000 tons per annum approx.

Coal - 60,000 tons per annum.

OPERATING COSTS :

(a) Ammonia Plant 90,000 tons per annum Manufacturing Costs (M.C.)	Unit Cost $ Per Ton	Annual Cost $ per annum
Natural gas 34.00 MM at 40 c/MM Btu.	13.60	[illegible],224,[illegible]00

	Unit Cost $ Per Ton	Annual Cost $ per annum	
Process water (net) 580g. at 100c/1000g.	0.58	52,200	1800.
Cooling water 60,320 g. at 2c/1000g.	1.21	108,900	65,200
Electricity 794 kwh/t at 1.4c/kwh	11.12	1,000,800	618
Labour and Supervision	1.58	142,200	
Repairs and Maintenance at 4% of fixed cap.	1.02	92,000	
Property Taxes and Insurance at 1.5% of fixed cap.	0.37	33,500	
Manufacturing Cost (M.C.)	29.48	2,653,600	
Fixed Cost (F.C.)			
Depreciation (Straight line) at 7.7% of fixed capital	1.97	177,100	
Total Cost T.C. = M.C. + F.C.	$31.45	$2,830,700	

(b) Ammonium Sulphate Plant
345,000 tons per annum
Manufacturing Costs (M.C.)

			Gamanid
Ammonia 0.26t. at $37.00 p.t.	8.20	3,830,700	0.27T
Carbon Dioxide 0.34t			
Gypsum 1.34t. at $5.00 p.t.	6.70	2,311,500	1.37T
Sulphuric Acid 0.06t. at $20.00 p.t.	1.20	41[illegible],000	0.06T
Steam 2800 lb (1500) at 50c/1000lb.	1.40	483 000	0.75T
Cooling water 2340g. at 2c/1000g	0.07	24,[illegible]50	14,500gal
Electricity 102 kwh at 1.4c/kwh	1.43	493 350	53 kwh
Labour and Supervision	0.53	18[illegible] [illegible]50	
Repairs and Maintenance at 4% of fixed capital	0.57	196 [illegible]00	
Property Taxes and Insurance at [illegible]% of fixed capital	0.21	73,500	
Manufacturing Cost (M.C.)	$20.31	$7,009,050	
Fixed Cost (F.C.)			
Depreciation (Straight Line) at 7.[illegible]% of fixed capital	1.09	377,300	
Total Cost T.C. = M.C. + F.C.	$21.40	$7,386,350	

	Unit Cost $ Per Ton	Annual Cost $ Per Annum
(c) Cement Plant 230,000 tons per annum Manufacturing Costs (M.C.)		
Calcium Carbonate 1.[illegible]4 T. at $1.00/t. (from Ammonium Sulphate Plant)	1.14	262,200
Coal 0.25t. at $4.50/t.	1.13	259,900
Shale 0.25t. at $2.00/t	0.50	115,000
Gypsum 0.05T at $5.00/t	0.25	57,500
Electricity 79 kwh at 1.4c/kwh	1.11	255,300
Miscellaneous Materials including, Repairs and Maintenance	1.50	345,000
Labour and Supervision	2.01	462,300
Property Taxes and Insurance at 1.5% of fixed capital	0.38	87,000
Manufacturing Cost (M.C.)	$8.02	$1,844,200
Fixed Cost (F.C.)		
Depreciation (Straight Line) at 7.7% of fixed capital	1.94	446,600
Total Cost T.C. = M.C. + F.C.	$9.96	$2,290,800

Hence Total Manufacturing Costs per annum

Ammonium Sulphate	$7,386,3[illegible]0
Cement	2,290,800
	$9,677,150

Assume:

Selling price Ammonium Sulphate $35 per ton ex works
Cement $20 per ton ex works

Hence :

Sales Ammonium Sulphate	345,000 tons x 35	=	$11,072,000
Cement	230,000 tons x 20	=	4,600,000
			$15,672,000

Profit after Tax = 0.625 (15,672,000 - 9,667,150) = $3,753,030

Assume Working Capital = 3 months manufacturing costs less depreciation =

$$\frac{9,677,150 - 1,001,000}{4} = \frac{8,676,150}{4} = \$2,1[illegible],040$$

Hence return on total investment (after tax) =

$$\frac{3,753,030}{13,000,000 + 2,169,040} = \frac{3,753,030}{15,169,040} = 24.74\%$$

The following explanatory notes are submitted in amplification of the costing of the project:-

(a) The costing of the ammonia plant is based on estimates given by Voogd. J. and Tielrooy J. - Hydrocarbon Processing and Petroleum Refiner, 1963, 42, 3 p. 144.

(b) The costing of the ammonium sulphate plant is based on W. L. Hardy of Foster Snell (Ind. Eng. Chem. 49, 2 p.57A, 59A February 1957).

(c) The costing of the cement plant is based on information and advice received from Mr Bob Schroeder of the Adelaide Cement Coy. S.A.

(d) The gypsum price of $5.00 per ton is reasonable since it would cost about $1.50 to put it into ships at Lake MacDonnell S.A.

(e) A price of $4.50 per ton is reasonable for non-coking coal for the cement kiln from nearby Newcastle mines.

(f) Electricity is charged at 1.4 cents per kwh as presently quoted by the local County Council.

(g) Natural gas is taken as the feedstock material for the ammonia plant but naptha could be used initially as in the case of the I.C.I. plant. Natural gas is charged at 40c per 1000 c.ft. in keeping with anticipated price when available for industrial use in Newcastle.

(h) Prices ex works for cement at $20.00 per ton and for ammonium sulphate at $35.00 per ton are conservative.

(i) The lime effluent from the ammonium sulphate plant is in a physical form suitable for cement kiln use and is charged at $1.00 per ton to the cement plant. A lower electricity consumption is used to that for a natural limestone feed as little grinding is involved in the preparation of the chemical lime used.

(j) Initially it may be possible to buy ammonia from I.C.I. pending the erection of a separate ammonia plant. A bounty of $40.00 per ton is paid for ammonia produced in Australia.

FURTHER DEVELOPMENTS :

Following the establishment of Stage 1, it would seem logical to expand the complex as follows :-

1. Power Station for Synthesis Gas, Steam and Electricity for the common use of the complex and for sales to the adjoining I.C.I. and C.R.A. industries. The power station will provide a market for coal from the Company's Newcastle district properties. Coke ovens and the full utilization of coke oven gas might be an alternative.

2. The addition of a sulphuric acid plant to the compl[illegible] for an indigenous supply of H_2SO_4 with possible sal[illegible] to C.R.A. for phosphoric acid and superphosphate produ[illegible]ion in preference to higher cost acid from imported sul[illegible]ur. A bounty of $6.00 per ton of acid applies.

3. The establishment of an alkali chlorine complex, based on salt from South Australia and power from a Company power station.

4. An oil refinery to be established in close association with the Company's chemical complex.

RECOMMENDATION :

1. Land be optioned in the Newcastle District for the chemical complex including a refinery site.

2. Consultants be engaged to examine in detail these proposals in the light of latest developments and in collaboration with the Company's staff.

S.B. Dickinson

S. B. DICKINSON.

Capital Expenditure (A) $13,000,000

7.7% depreciation on $13,000,000	A. $1,001,000
Maintenance (including wages)	633,000
Wages and Overheads	981,350
Electricity at 1.4¢/kwh	1,,749,450
Steam at 50¢/1000 lbs	483,000
Process water at 100¢/1000 gal	52,200
Cooling water 2¢/1000 gal.	133,050
	A. $5,033,050

RAW MATERIALS :

Coal at $4.50/t.	A. $ 259,900
Gypsum at $5.00/t.	2,369,000
Sulphuric acid at $20.00/t.	414,000
Natural gas at 40¢/1000 cu.ft.	1,224,000
Shale at $2.00/t.	115,000
Calcium carbonate at $1.00/t.	262,200
	A. $4,644,100

SUMMARY :

Production cost	A. $5,033,050
Raw Material Cost	4,644,100
	A. $9,677,150
Working Capital 6% of $2,160,640	129,640
	A. $9,806,790

345,000 tons ammonium sulphate at $35.00	A. $11,072,000
230,000 tons cement at $20.00	4,600,000
Total Sales :	A. $15,672,000
Total Costs :	9,806,790
Difference :	A. $5,865,210

NOTE : Interest on Capital $13,000,000 not included.

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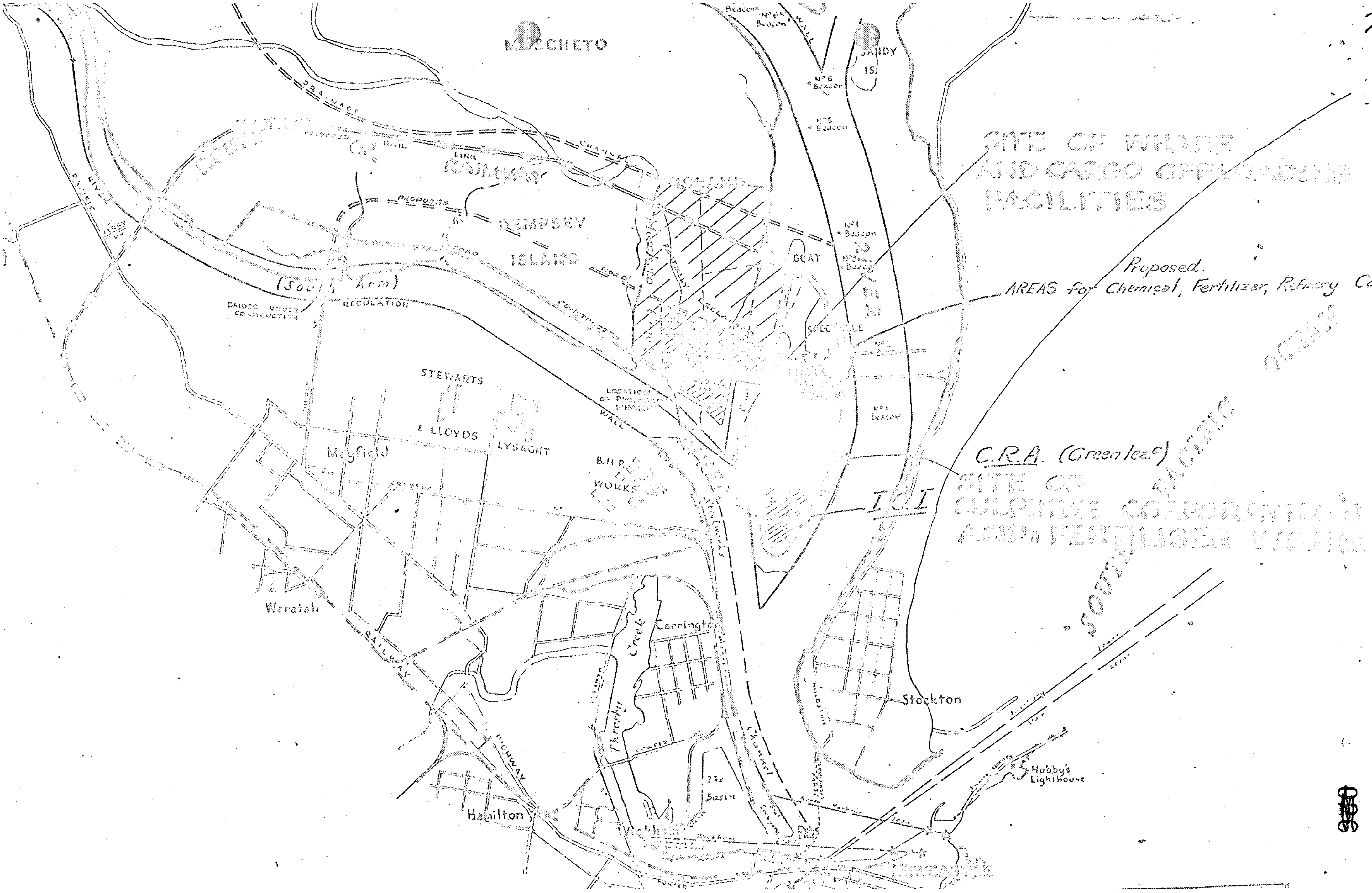
SANDY IS.
No 6 Beacon
No 5 Beacon
No 4 Beacon
No 3 Beacon
No 1 Beacon
SITE OF WHARF AND CARGO OFFLOADING FACILITIES
DRAINAGE CHANNEL
PROPOSED RAIL LINK
RAILWAY
DEMPSEY ISLAND
GOAT
Proposed.
AREAS for Chemical, Fertilizer, Refinery Comp
(South Arm)
BRIDGE UNDER CONSTRUCTION
REGULATION
SPECTACLE
STEWARTS & LLOYDS
LYSAGHT
LOCATION OF PROPOSED WHARF
WALL
C.R.A. (Greenleaf)
SITE OF SULPHIDE CORPORATION'S ACID & FERTILISER WORKS
I.C.I
B.H.P. WORKS
Mayfield
OCEAN
SOUTH PACIFIC
Waratah
RAILWAY
Carrington
Throsby Creek
Stockton
Channel
HIGHWAY
The Basin
Nobby's Lighthouse
Hamilton
Wickham
NEWCASTLE

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CASE G-1

GYPSUM TO ACID AND CEMENT

VOLUME FORECAST

For this case it will be assumed that production forecasts will be geared to the acid requirements of the fertilizer plant. The volumes assumed will be in favour of the economics of the gypsum/acid/cement plant.

Year	1971	1972	1973
Acid Required (tons 100%)	250,000	300,000	350,000
Cement produced (tons)	242,000	290,000	338,500

CASE G-1

GYPSUM TO ACID AND CEMENT

RAW MATERIAL SCHEDULE

It will be assumed that the plant efficiency will remain constant regardless of operating level. Raw material requirements and costs are as follows:-

Quantities

Item	Cost/ton	1971	1972	1973
Gypsum	$6.00 T delivered	518,000	621,000	724,000
Coal/Coke	$4.50/T "	165,000	198,000	230,000
Sand	$2.00/T "	47,000	57,000	66,000
Clay	$4.00/T "	47,000	57,000	66,000

Cost - $A 000's

Item	1971	1972	1973
Gypsum	3,108	3,726	4,344
Coal/Coke	743	891	1,035
Sand	94	114	132
Clay	188	228	264
Total	4,133	4,959	5,775

CASE G-1

GYPSUM TO ACID AND CEMENT

PRODUCT REALISATION

1. Cement Sales

It will be assumed that the total quantity of cement can be sold ex works at $20 per ton in bulk. This allows approximately $4.50 for freight, harbour dues (both Newcastle and Sydney), wharfage, unloading costs, spillage, downstream delivery if any, etc. and remains competitive with bulk cement as currently imported.

2. Sulphuric Acid Sales

Assuming a sulphur price of $A 45 per long ton delivered and knowing that there is no power credit available to the acid plant, cost of production at capacity may be summarized for a brimstone plant as follows:-

Raw Materials	
Sulphur ($45 x 0.353)	$ 15.90
Catalyst, Chemicals, etc.	0.25
Labour	
Process	0.20
Maintenance	0.15
Supervision	0.35
Utilities	
Fresh water	0.03
Salt water	0.06
Electricity	0.13
Sundry Materials	
Maintenance	0.20
Operating	0.05
Depreciation, Rent, Insurance, etc.	
Depreciation	1.17
Rent (on site)	0.06
Insurances	0.19
Overhead, Office costs, etc.	0.40
Total Cost	$ 18.74/long ton

As proposed producers of pyritic acid are offering acid for sale at $18.50 to $19.00 per ton delivered, it would not seem reasonable to allow any higher cost to the fertilizer plant than these prices. For calculation of a return on the gypsum to acid and cement plant, an acid realization of $19.00 per long ton will be used. Some difficulty would be experienced in obtaining this price because of the power credit available to a fertilizer plant from an acid plant generating power for internal use.

Product Realization - $A 000's

Item	1971	1972	1973
Acid	4,750	5,700	6,650
Cement	4,840	5,800	6,770
Totals	9,590	11,500	13,420

CASE G-1

GYPSUM TO ACID AND CEMENT

PLANT MANNING SCHEDULE

Manning Schedules for the various activities (cement production, acid production, maintenance, supervision, office and administration) may be set out as follows on an annual basis:-

A. Cement Production

Classification	Number	Annual Cost
Raw Materials Handling	4/shift	56,000
Raw Materials Grinding	1/shift	14,000
Kiln Operators	1/shift	16,000
Kiln Operator's Assistant	1/shift	12,000
Conveyor & Elevator Operators	2/shift	28,000
Cement Mill Operator	1/shift	14,000
Gas Cleaning Plant Operator	1/shift	14,000
Process Labourers	2/shift	24,000
Day Work Operators	2	24,000
Totals	54 men	202,000

B. Acid Production

Classification	Number	Annual Cost
Acid Plant Operators	1/shift	16,000
Operator's Assistant	1/shift	12,000
Day Work Operator	1	4,000
Totals	9 men	32,000

C. Maintenance Crew

Classification	Number	Annual Cost
Fitters	8	32,000
Welders	2	8,000
Turners	2	8,000
Electricians	4	16,000
Plumbers	1	4,000
Carpenters	2	7,000
Labourers	6	18,000
Storemen	2	6,000
Apprentices	3	5,000
Mechanics	1	3,000
Totals	31	107,000

D. Supervision

Classification	Number	Annual Cost
General Foremen	1	6,000
Cement Plant Foremen	4	20,000
Acid Plant Foremen	1	5,000
Maintenance Foremen	1	5,000
Acid Plant Superintendent	1	8,000
Cement Plant Superintendent	1	8,000
Totals	9	52,000

E. Office and Administration

Classification	Number	Annual Cost
Plant Manager	½ time	12,000
Assistant Plant Manager	½ time	8,000
Chief Accountant	1	8,000
Accountants	3	15,000
Clerks (Seniors)	3	9,000
Secretaries	4	8,000
Typists	3	5,000
Purchasing Officer	1	8,000
Purchasing Juniors	2	4,000
Paymaster	1	6,000
Pay Clerks	3	9,000
Sales Clerks	2	6,000
Janitors	2	4,000
First Aid Attendants	4	12,000
Chief Chemist	1	8,000
Senior Chemist	1	6,000
Shift Analysts	8	24,000
Trainees	4	10,000
Engineers (Mechanical)	2	10,000
Draughtsmen	2	8,000
Totals	48	180,000

N.B. Wages and salaries include 23% fringe benefits for superannuation, long service leave, sick leave, holiday pay, etc.

CASE G-1

GYPSUM TO ACID AND CEMENT

PLANT OPERATING COSTS

Item	1971	1972	1973
Operating Labour			
(a) Cement	$ 202,000	$ 202,000	$ 202,000
(b) Acid	32,000	32,000	32,000
(c) Maintenance	107,000	107,000	107,000
(d) Supervision	52,000	52,000	52,000
Operating Stores	10,000	12,000	15,000
Maintenance Stores	400,000	400,000	400,000
Laboratory Stores	35,000	45,000	55,000
Taxes, Insurance, etc.	60,000	60,000	60,000
Site Rental	8,000	8,000	8,000
Plant Start-up	100,000	-	-
Utilities			
(a) Cement (i) Power	469,000	562,000	656,000
(ii) Fuel Oil	15,000	18,000	21,000
(b) Acid (i) Power	107,000	128,000	149,000
(ii) Fresh Water	5,000	6,000	7,000
(iii) Cooling water	6,000	7,000	7,000
Factory Administration	180,000	180,000	180,000
Total Operating Costs	$ 1,788,000	$ 1,819,000	$ 1,951,000

CASE G-1

GYPSUM TO ACID AND CEMENT

REVENUE AND OPERATING EXPENSE

As there are no delivery costs, commissions, etc. associated with sales, the Product Realization amounts also become the Gross Revenue.

Item	1971	1972	1973
Gross Revenue			
as for Product Realization	9,590	11,500	13,420
Operating Expense			
Raw Materials	4,133	4,959	5,775
Plant Operation	1,788	1,819	1,951
*Selling Costs & Overhead	150	150	150
Total Operating Expense	6,071	6,928	7,876
Net Revenue	3,519	4,572	5,544

* Although selling costs and overhead are not ideally applicable here as only the cement will be sold and an administrative head office will be installed for the Fertilizer Operation, an assumption will be made as to the proportion of such costs to apply to the acid and cement operations.

CASE G-1

GYPSUM TO ACID AND CEMENT

INVESTMENT SCHEDULE

Item	1968	1969	1970
	A$ 000's		
Preliminary Eng.	100	250	-
Acid Plant	1,100	1,100	1,317
Cement Plant	1,400	7,000	11,651
Service Facilities	70	172	-
Totals	2,670	8,522	12,368

DEPRECIATION SCHEDULE

Assume 90% of each plant is depreciable (and so subject to Investment credit) and that the allowable rate as defined by the Taxation Commissioner will apply.

Item	Rate
Acid Plant	10% flat for 90% of Investment
Cement Plant	7½% flat for 90% of Investment
Service Facilities	10% flat for 40% of Investment

Schedule

Item	1970	1971/80	1981/85
	A$ 000's		
Preliminary Eng.	-	(Expensed)	-
Acid Plant	-	317	-
Cement Plant	-	1,313	1,313
Service Facilities	10	10	-
Totals	10	1,640	1,313

Investment Allowance

Item	Allowance Rate	Allowance $
Acid Plant	20% of 90%	733,000
Cement Plant	20% of 90%	3,501,000
Service Facilities	20% of 40%	19,000
Total		4,253,000

CASE G-1

GYPSUM TO ACID AND CEMENT

WORKING CAPITAL

For this preliminary evaluation the old formula for Working Capital will be used. It consists of total costs associated with one month's raw materials, one month's production at cost and one month's sales as accounts receivable.

It will be assumed that all plants close for one month each year for maintenance, so that the annual cost is spread (for raw materials and operation) over 11 months whereas sales are spread over 12 months.

Item	Cost $A 000's
Raw Materials	344
Production	
(a) Raw Materials	344
(b) Operating Costs	163
Accounts Receivable	799
Total	1,650

CASE G-1

GYPSUM TO ACID AND CEMENT

INVESTMENT REQUIREMENT

Assuming plant location is Walsh Island, Newcastle and site conditions are as already indicated for the fertilizer plant, an approximate investment estimate is as follows:-

A. Acid Plant

Item	Cost $A 000's
1,000 T.P.D. battery limits plant	2,500
Piling and foundations	100
Interplant piping and pumps	20
Acid storage (20,000 tons)	280
Workshop and store including equipment	98
Fences, roads, paving, etc.	40
Transformers, distribution, etc.	60
Cooling water system	190
Sub Total	3,288
Engineering and contingency at 10%	329
Total Acid Plant	3,617

B. Cement Plant

Item	Cost $A 000's
Basic cement plant including clinker storage and mills, raw materials mills and storage, ancillary services, etc.	17,000
Piling and foundations	300
Product storage bins and loading equipment	400
Workshop and store - addition to fertilizer plant workshop	70
Fences, roads, paving, etc.	40
Transformers, distribution, etc.	100
Sub Total	17,910
Contingency and engineering (10%)	1,791
Total Cement Plant	19,701

C. Service Facilities

Item	Cost $A 000's
Additional change rooms, showers, etc. for 150 men	75
2 laboratories - 1 acid and 1 cement with equipment, furniture, etc.	65
Extension of office planned for fertilizer complex	45
Office equipment, furniture, communication equipment, etc.	35
Sub Total	220
Contingency and engineering (10%)	22
Total Service Facilities	242

Total Investment

A. Acid Plant	3,617
B. Cement Plant	19,701
C. Service Facilities	242
Total	23,560

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CASE G-1

CAPITAL APPRAISAL SHEET

$A 000's

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	SALVAGE VALUE
Net Revenue	–	–	–	3519	4572	5544	5544	5544	5544	5544	5544	5544	5544	5544	5544	5544	5544	5544	
Engineering Exp.	(100)	(250)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
Tax Depreciation	–	–	10	1640	1640	1640	1640	1640	1640	1640	1640	1640	1640	1313	1313	1313	1313	1313	
Investment Credit	–	–	–	4253	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
Taxable Income	(100)	(350)	(350)	(2734)	198	3904	3904	3904	3904	3904	3904	3904	3904	4231	4231	4231	4231	4231	
Taxes at 42.5%	–	–	–	–	84	1660	1660	1660	1660	1660	1660	1660	1660	1798	1798	1798	1798	1798	
Cash Flow	(100)	(250)	–	3519	4488	3884	3884	3884	3884	3884	3884	3884	3884	3746	3746	3746	3746	3746	
Investment Schedule	2670	8522	12368	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(3000)
Working Capital	–	–	–	1650	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(1650)
NET CASH FLOW	(2770)	(8772)	(12368)	1869	4488	3884	3884	3884	3884	3884	3884	3884	3884	3746	3746	3746	3746	3746	4650

RATE OF RETURN = 11.8% D.C.F.

11% (20,716) ≅ 22,162

12% (20,461) ≅ 20,020

DJB:MMW

CHEMICO

Chemical Construction Corporation

(An Electric Bond and Share Company)

320 PARK AVENUE • NEW YORK, N. Y. 10022

TELEPHONE: PLAZA 1-3900 • CABLE ADDRESS: CHEMICONST, NEW YORK

December 15, 1966.

Mr. F.W. Bloecher
American Cyanamid Corporation
Wayne, New Jersey.

Dear Mr. Bloecher :

In response to your request, we are pleased to present preliminary information for a 300 STPD Ammonia Plant and a 1000 STPD Ammonium Sulfate Plant from natural gypsum. Natural gas is used as the feedstock for the Ammonia Plant.

Preliminary investment and operating data are presented on the attached table. These data include the battery limit plants and the boiler feedwater treating system, the natural gas compressor and the initial charge of catalyst for the Ammonia Plant. Investments are based on the Houston Gulf Coast area and do not include product storage, piling, premium time, fringe benefits or any local taxes.

We trust the information presented meets your immediate requirements. Please feel free to contact us if we may be of any further assistance.

Yours very truly,

CHEMICAL CONSTRUCTION CORPORATION

G.P. Tirauno

for Walter R. Smith
Account Manager

WRS/GPT/gf
Attachment

PRELIMINARY INVESTMENT AND OPERATING DATA

AMMONIA PLANT

CAPACITY 300 STPD

INVESTMENT $ 5,800,000

B. L. Plant & boiler feedwater treating system and natural gas compressor

(360 tpd CO_2)

OPERATING DATA

Natural gas MM Btu/T (LHV)	28.1 = 31.2 on (HHV) = 35.0 on LT NH_3, (1.2 tons/Ton)
Power KWH/T	618
Boiler Feedwater Make-up Gal/T	1800
Circulating Cooling Water Gal/T (Δ T=25°F)	65,200

AMMONIUM SULFATE PLANT

CAPACITY 1000 STPD (1000)

INVESTMENT $ 5,300,000

B. L. Plant

(about enough CO_2)

OPERATING DATA

Gypsum (100%)	Ton/Ton	1.37
Ammonia	Ton/Ton	0.27
Carbon Dioxide	Ton/Ton	0.37 — 370 tpd
Sulfuric Acid	Ton/Ton	0.06
Steam	Ton/Ton	0.75
Circulating Cooling Water	Gal/Ton	14,500
Power	KWH/Ton	53

CLUTHA DEVELOPMENT PTY. LIMITED

INTER-OFFICE MEMORANDUM

TO: MR. G. O. JENNINGS

FROM: MR. S. B. DICKINSON

SUBJECT: PROPOSED FERTILIZER PROJECT FOR NEWCASTLE, N.S.W.

1. Introduction

Further to my memorandum of October 18th, 1966 (copy attached), the following modified estimates are submitted as a result of further enquiries made regarding capital and operating costs of overseas ammonium sulphate plants using natural gypsum. The relevant correspondence is attached and comprises investment data for the Houston Gulf Area of the U.S.A. made available by Cyanamid (Far East) Limited which has expressed keen interest in the possibilities of obtaining low-cost gypsum from Australia for certain projected fertilizer operations. Additional data has been provided by Davey Ashmore Pty. Limited which has constructed a number of ammonium sulphate plants through its subsidiary, Power Gas Corporation Limited, Stockton-on-Tees, England. Power Gas Corporation Limited has considerable experience in the production of ammonium sulphate from natural gypsum, anhydrite, and by-product gypsum from phosphoric acid manufacture as may be seen in the summary data attached on the scope of its activities in this field.

This proposal concerns the production of ammonium sulphate from gypsum with lime effluent product being used for cement manufacture.

The ammonium sulphate produced can be used:-

(a) for sale as a straight Nitrogen (N) fertilizer

(b) to make ammonium sulphate nitrate (A.S.N.) for sale as a straight N fertilizer

(c) as an internal sulphate recycle within a nitrophosphate process to produce highly concentrated NP/NPK fertilizers with more than 90% P_2O_5 in the water soluble form.

The project can be integrated with the already established or about-to-be established industrial complexes of B.H.P., I.C.I. and C.R.A. to provide utilities such as steam and electricity as well as intermediate products, or alternatively be the recipient of same wholly or in part.

The establishment of this proposed ammonium sulphate, cement industry can be the forerunner of wide manufacturing interests for the Company and its associates in Australia. In particular there is clear evidence of this project creating stable and expanding markets for its shipping and coal mining activities in Australia.

This report is divided into three main sections, namely

(A) Estimates of Investment and Operating Costs

(B) Estimates of the Profitability in relation to known markets.

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2. Outline of Proposal

The proposal is designed to produce

330,000 tons of ammonium sulphate per annum, and
235,000 tons of cement per annum.

The proposed plant site is on "Walsh Island" Newcastle, adjacent to I.C.I. Nitrogenous fertilizer complex and C.R.A's "Greenleaf" phosphatic fertilizer complex and opposite the B.H.P. Company's Newcastle steel works.

Production costs are based on the use of naptha, initially for the ammonia requirement with the plant designed (as in the case of I.C.I's ammonia plant) for natural gas expected to be available in two years. Gypsum is supplied from Company-owned leases in South Australia and coal from the Company's northern mines. Electricity, water supply, port, road, rail and other services are available through Commonwealth and State Government instrumentalities.

The proposed location of the plant is shown on the accompanying plan. The common berth for shipping is limited to 36 feet of water which will limit the shipping to 50,000 tons dead weight.

3. Investment Costs

The summary for estimated capital costs is as follows:-

Ammonia Plant (98,000 tons p.a. at 100% capacity) (POWER GAS)	$ 3,870,000	
Ammonium Sulphate Plant (365,000 tons p.a.at 100% capacity) (CYANAMID)	4,550,000	
Cement (258,000 tons p.a. at 100% capacity) (DICKINSON)	5,580,000	
Erected Cost 3 plants Total	$14,000,000	$14,000,000
Storage facilities at 7% of Erected Cost	$ 980,000	
Boiler 1200 lb x 1000/24 at $4.00 per lb. per hr.	200,000	
Process Water System $\frac{650}{60} \times \frac{1000}{24}$ at $10.00 per g.p.m.	5,000	
Chilled Water $\frac{30,000}{60} \times \frac{1000}{24}$ at $10.00 per g.p.m.	208,000	
Electricity 325 x $\frac{1000}{24}$ at $15 per KWH purchased.	202,000	
Plant general at 10% of erected cost	1,400,000	
Supplementary Services Total	$2,995,000	
say	$3,000,000	$ 3,000,000
Total		$17,000,000
Add:- Contingencies not included above 5% of total		$ 850,000
Grand Total		$17,850,000

4. Operating Costs

The costs are estimated for a production at 90% of the plant capacity. Explanatory notes are given in the section of this report following these estimates.

The operating costs are expressed in terms of per long ton of ammonium sulphate and total costs per annum on a 90% capacity basis are also given.

RAW MATERIALS	Cost per ton	Cost per annum
Gypsum 1.405 T. at $6.00 per T.	$8.43	$2,782,000
Natural gas or equivalent from naptha 14.17 MM at 40¢ per MM B.T.U.	5.67	1,871,000
Sulphuric Acid 0.06 T. at $20.00 per T.	1.20	396,000
Shale 0.177 T. at $2.00 per T.	0.35	116,000
NH_3 catalyst	0.22	73,000
Total	$15.87	$5,238,000

UTILITIES		
Steam 1200 lb. at 50¢ per 1000 lb.	$0.60	$ 198,000
Process Water 650 g. at 30¢ per 1000 g.	0.20	66,000
Cooling Water 30,000 g. at 2¢ per 1000 g.	0.60	198,000
Electricity 325 KWH at 1.4¢ per KWH	4.55	1,502,000
Total	$5.95	$1,964,000

OTHER DIRECT OPERATING COSTS		
Direct Labour 108 men at $3000 per man yr.	$0.98	$ 324,000
Supervision & Overheads 100% Direct Labour	0.98	324,000
Maintenance 4% of Total Establishment Cost i.e. 4% of $19,550,000	2.37	782,000
Property Taxes & Insurance at 1.5% of Total Establishment Cost i.e. 1½% of $19,550,000	0.89	293,250
Total	$5.22	$1,723,000

Total Manufacturing Costs excluding all capital charges	$27.04	$8,925,250

/4...

5. Profitability

It is estimated that ammonium sulphate sales can be effected at $30.00 per ton and cement sales at $20.00 per ton.

Hence Capital Funds $17,850,000

Operating Costs

Depreciation on Sinking Fund Basis 15 years at 5% interest	$ 828,000
Interest at 6%	$1,071,000
Operating Cost	$8,925,000
Total	$10,824,000

Sales

330,000 tons of $(NH_4)_2SO_4$ ($30.00 p.t.)	$9,900,000
234,000 tons of cement ($20.00 p.t.)	$4,676,000
	$14,576,000

Profit $3,752,000

Return on Capital $\frac{3,752,000}{17,850,000} \times 100$

= 21% before taxes = 14% after taxes

Return of Capital in 5 years with surplus of $1,000,000 p.a.

$\frac{\$17,850,000}{5}$ = $3,570,000 per year

Sales	$14,576,000	Capital	$3,570,000
Costs	$ 8,925,000	Interest	$1,071,000
Gross	$ 5,651,000	Total	$4,641,000

Difference - Surplus $1,010,000 per annum.

Note:- The proposals above relate to a completely independent chemical operation. By obtaining ammonia from I.C.I. and some of the gypsum from C.R.A. (effluent from the phosphoric acid plant), the capital cost would be substantially reduced and a recast of the estimates would be necessary.

S B Dickinson

S. B. Dickinson
Projects Development Manager

6th February, 1967.

ENV 902

DAVY-ASHMORE

Received	Answered	
Date	Initials 046	Date

From	To	Copies
Company P.G.C.	D.A. Melbourne	Mr. R. Ludbrook (D.A.A.)
Location STOCKTON		Mr. R. Fowler - Dr. D.S. Ashburner, Dev
Reference PGC/GC/MM Tel.Ext. 309	Attention Mr. J.W. Gullock	Mr. H. Thirkell - Mr. F.A. Horner, Tech.
		Mr. G. Collins, Proc.Eng.
		Mr. L.F. Robinson
		Sir Douglas Bell (2)

SUBJECT CONOCO/CLUTHA DEVELOPMENT - YOUR REF.E.2214 SULPHURIC ACID FROM GYPSUM

Date 1st July, 1968

LETTER NO.2810

The evaluation report on this project by Mr. D.J. Batton of Conoco dated 7th March, 1968 has now been examined in more detail and our comments are given below.

1. The capital investment is some 20% too high. Our estimate based on U.K. conditions would be 17,665,000 Australian Dollars compared to 23,560,000 Australian Dollars given in the report.

2. The raw material cost is some 12% too high due to the consumptions being too great. Referring to the page headed "Revenue and Operating Expense" the figures for raw materials should read as below. (The original figures are shown in brackets).

1971	1972	1973
3,615 (4,133)	4,338 (4,959)	5,061 (5,775)

This makes the nett revenue figures

1971 - 4,037 (3,519)
1972 - 5,193 (4,572)
1973 - 6,258 (5,544)

3. The power cost appears to be on the high side but this could not be checked from the figures available in the report and has therefore not been adjusted. The other operating figures were of the right order.

Mr. J.W. Gullock 1.7.68.

Making the above adjustments and repeating the D.C.F. calculation as given on the page headed "Capital Appraisal" we arrive at a rate of return equals 16.3% D.C.F. This compares to the 11.8% given in the report and may change the picture as far as Clutha is concerned.

Referring now to the points made in Mr. Batton's letter the following comments are made.

Item 1.

Provided the market is available there is no reason why the rate of production should not be high initially and reach capacity in three years.

Item 2.

Our estimate of the capital is based on three kilns.

Item 3.

The contractor could meet 30 months without any difficulty. For instance 26 months to the end of commissioning from order would be reasonable, leaving 4 months for selection of contractor and contingency.

Item 4

Increases in power cost would give a sulphur burning plant to which credits were allowed, greater profitability but this is not the subject of this assessment.

Item 5.

Any loan would require servicing. Capitalising the working capital has already reduced the cash flow in this assessment.

Item 6.

An additional point against the scheme for Conoco but probably does not apply to Clutha.

Item 7.

The cement market must be assured, and this comment suggests Conoco have not done sufficient investigation.

Item 8.

Working capital is too high anyway because of the errors in material consumptions. The fertiliser plant should be treated the same as any other customer for accounting purposes. Otherwise some items in the working capital will be included twice, first on the cement/acid plant and then on the fertiliser plant.

Incidentally have Clutha checked whether anhydrite is available associated with the gypsum deposits, because this would reduce the fuel costs and the capital cost of the plant ?

Summarising the report gives a bias against the cement/acid plant because of mistaken assumptions for the capital and operating costs.

G. Collins
Senior Process Design Engineer
Process Engineering Department

DAVY-ASHMORE PTY. LTD.
G.P.O. BOX 4709
MELBOURNE

DK/AW
Tel.Ext.275.

30th December, 1965.

AMMONIUM SULPHATE - PHOSPHORIC ACID, GYPSUM PROCESS

INTRODUCTION:

The process description given below provides the basic information on the production of ammonium sulphate. It will be appreciated that without analysis of the raw materials and particulars of site conditions and site services we are unable to draw up a mass balance or do any detailed design work, but the scheme outlined is based broadly on data relating to a similar plant now under construction by The Power-Gas Corporation Limited.

Our flowsheets Nos.2021/6241/106/15 outline the scheme.

The only companies who have been manufacturing ammonium sulphate from natural gypsum for many years and who possess all the necessary 'know-how' are :-

Badische Anilin & Soda Fabrik, Ludwigshafen, Germany.

Imperial Chemical Industries Ltd., Billingham, England.

Oesterreichische Stickstoffwerke, Linz, Austria.

Etablissement Kuhlmann, Selzaete, Belgium.

Office National Industriel d'Azote, Toulouse, France.

Of these, B.A.S.F. OSAG and Kuhlmann use 'Krystal' apparatus of Power-Gas Corporation Limited's design.

These companies have collaborated with us in the supply of ammonium sulphate plant to others where natural rock gypsum was the raw material, and we have as a result supplied plant to :-

The Government of India Fertiliser Factory, Sindri, Bihar, India, in collaboration with Chemico and ICI.

A.N.I.C. Ravenna, Italy, in collaboration with Chemico and ICI.

Pakistan Industrial Development Corporation, in collaboration with U.C.B. and ONIA.

Government of Turkey in connection with B.A.S.F.

We have always made a practice of supplying engineers to start up plant, and in some of the above cases whether for the producers own works or where we have collaborated, we have been in touch with all sections of the gypsum process, so that over the years we have acquired considerable first-hand 'know-how'.

In the case where phosphoric acid gypsum is concerned, the 'know-how' is in the hands of very few people. In fact it is due to previous difficulties arising from its use, that it has not been used more extensively. The only producing companies who handle and have years of experience of phosphate gypsum are KUHLMANN, OSAG and F.A.C.T.

Because of their satisfaction with our apparatus in their own works at Linz, OSAG recommended us to Stickstoffwerke, Krefeld, where we, together with OSAG, supplied complete plant to produce ammonium sulphate from phosphoric acid gypsum. Subsequently we made an agreement with OSAG by which we have exclusive rights to their 'know-how' on the by-product gypsum process. Later we and OSAG jointly signed a contract with F.A.C.T. for a complete factory extension again using by-product gypsum. This was more recently sealed by a further agreement between us and F.A.C.T. whereby their 'know-how' also is available to us.

Thus it will be evident The Power-Gas Corporation Limited has unique experience in the gypsum process and particularly so in dealing with by-product gypsum through our collaboration with the producing companies able to back up proposals and technical data by proved long term commercial operation.

Through the collaboration with F.A.C.T./OSAG/and Power-Gas we offer a proved commercial process and we are able to guarantee liquor coming forward from the reaction section as feed to the evaporators at 40-42% $(NH_4)_2SO_4$, whereas comparative processes for rock gypsum give concentrations of no more than 36%. This point alone leads to considerable steam economy.

In the case of the 'Krystal' evaporator crystalliser, we have had licence rights since 1946, and in 1960 when Mr. Finn Jeremiassen died, we acquired all rights and now trade this equipment in all parts of the world. 'Krystal' evaporator crystallisers are used by all the foregoing companies, and all of these units were designed and supplied by us at Stockton-on-Tees.

PROCESS DESCRIPTION

A. GYPSUM HANDLING, DEWATERING AND PREPARATION SECTION

Gypsum from the phosphoric acid plant is made into a 10% slurry in the primary slurry tank, then transfereed by pump to hydroclones. The underflow from the hydroclones containing 30% solids is pumped to the secondary slurry tank. From this slurry tank the 30% slurry is pumped to the rotary gypsum filters.

Filtrate from the gypsum filters is sent to drain, and the filtered gypsum is conveyed to the reaction mix tank (C.1).

B. AMMONIUM CARBONATE PREPARATION SECTION

Ammonia and carbon dioxide are fed into the bases of the carbonate liquor columns (B.1) in which the ammonium carbonate liquor is circulated by the pumps (B.2) through the coolers (B.3). The heat of reaction due to the absorption of the CO_2 and NH_3 in the solution is removed from the system via the coolers (B.3).

The contaminated condensate from the crystallisation plant is collected in a stock tank (B.4) from which it is pumped (B.5) through a cooler (B.6) and an ammonia evaporator cooler (B.7) to the top of the residual gas washer (B.8). The temperature of the condensate is reduced to about $45^{o}C$ in the cooler by indirect water cooling, and further cooled to $10^{o}C$ in the evaporator cooler by the expansion of liquid ammonia. The low absorption temperature is required to reduce ammonia losses.

In the residual gas washer, the cooled condensate absorbs the ammonia and carbon dioxide from the waste gases leaving the carbonate liquor columns. The residual gas washer operates with two stages; in the upper stage the cooled contaminated condensate entering at the top of the column passes directly into the lower stage. In the lower stage solution is recirculated (B.9) from the base of the scrubber to the top of the lower bed of Raschig rings. With the same recirculation pump, a part of the solution at the base of the residual gas scrubber is pumped to the top of the absorption column.

C. REACTION SECTION

Gypsum filter cake and ammonium carbonate liquor are mixed in the reaction mixed tank (C.1). A heating jacket is supplied on the mixed tank to allow the reaction temperature to be adjusted to the optimum. The gypsum-carbonate liquor reaction reaches completion in the lye tanks (C.2) which are connected in series. The slurry is pumped from the last lye tank by the slurry pumps (C.3) to the chalk filters (1A & B).

A reaction vessel let-down pit (C.4) is provided in case of an emergency. A pump (C.5) is provided for emptying the let-down pit.

D. FILTRATION SECTION

The reaction section product liquor is filtered on rotary vacuum filters (1A & B). The fresh ammonium sulphate liquor passes from the filters into the fresh liquor clarifier (8) and from there pumped through the pressure filter (D.4), from which it is descharged into the buffer tanks (E.1).

The filtrate initially obtained contains some $CaCO_3$ and is thus termed muddy filtrate. This $CaCO_3$ collects in the clarifier from which it is pumped back to the lye tanks via pump (9). Before the filter cake is discharged from the filter, the cake is washed in two stages. Cold contaminated condensate from the condensate cooler (B.6) is sparyed on to the filter cake just prior to its discharge, and is collected in the wash liquor receiver. The wash liquor is then pumped (4A) to a small head tank from which it is distributed as a second wash to the chalk filter cake. This liquor after passing through the filter cake is them pumped from the filtrate receiver to the filtrate buffer tank (D.9). Soluble $CaSO_4$ is removed from the filtrate in (D.9) by the addition of $(NH_4)_2CO_3$ solution.

The $CaCO_3$ so formed is removed from the filtrate by settling, the filtrate then being pumped (D.10) to the carbonation towers (B.1) through the pressure filter (D.11).

E. NEUTRALISATION

Sulphuric acid from a 24 hour capacity sulphuric acid tank is fed by gravity to an agitated neutralisation tank. Fresh feed liquor from the buffer storage tanks (E.1) is pumped (E.2) through a feed preheater, to the neutralisation tank, from which it is pumped to the battery limits.

PRODUCTION OF 44.5% AMMONIUM SULPHATE LIQUOR

A. RAW MATERIALS per tonne $(NH_4)_2SO_4$

Gypsum

$CaSO_4.2H_2O$	75.3	
H_2O	19.6	1.82 tonnes
Other	5.1	
	100.0%	

Ammonia

Anhydrous Liquid — 0.27 tonnes

Carbon Dioxide

98% Gaseous — 0.34 tonnes

Sulphuric Acid

98% for neutralisation — 0.06 tonnes

B. UTILITIES per tonne $(NH_4)_2SO_4$

Cooling Water

Supply 30°C

Return 43.5°C — 13.8 cu. metres

Electric Power

excluding lighting, instruments and services — 44.3 KWH

C. PRODUCT

44.5% neutral ammonium sulphate solution at 75°C.

PRODUCTION OF AMMONIUM SULPHATE LIQUOR

Plant for the production of neutralised 44% $(NH_4)_2SO_4$ liquor from phosphoric acid plant by-product gypsum.

APPROXIMATE CAPITAL EQUIPMENT COSTS

The following prices are approximate on the basis of United Kingdom or European fabrication and supply f.o.b. British or Continental port. Supply would comprise one or more of each of the items shown on the flowsheet together with interconnecting pipework and valves.

Nominal Capacity Metric tons/day $(NH_4)_2SO_4$	Cost
250	£ 302,000
500	£ 450,000
1,000	£ 828,000
1,500	£1,165,000
2,000	£1,510,000

EXCLUSIONS

Electric motors, starters, lighting and wiring.

Civil Engineering work, Foundations and buildings.

Erection and supervision of operation.

Instrumentation.

Output tonnes/day $(NH_4)_2SO_4$	Cost
250	£ 530,000
500	£ 760,000
1,000	£ 1,410,000
1,500	£ 2,030,000
2,000	£ 2,650,000

The exclusions are:

Electric motors, starters, lighting and wiring
Civil Engineering work, Foundations and buildings
Erection and supervision of operation
Instrumentation
Product Storage and despatch equipment

Staff requirements depend on location and experience; we have assessed the requirement per shift for a 1,000 Tonne/day plant in two different locations as follows:

	India	Italy
Gypsum treatment and carbonation (including one analyst)	3	2
Reaction and filtration	3	2
Crystallisation and drying	3	2
Foremen	2	1
	11	7

This does not include management, maintenance or unskilled labour for loading operations. Chalk disposal may be tackled in various ways, if it is not to be reprocessed as Nitro-chalk or other product; for example, it may be re-slurried and pumped out to sea or to land reclamation areas.

TABLE I

PROCESS ROUTE	TEXACO PARTIAL OXIDATION OF NATURAL GAS USING OXYGEN ENRICHED AIR, H.T. SHIFT CONVERSION L.T. SHIFT CONVERSION; CO_2 REMOVAL; METHANATION; COMPRESSION; I.C.I. SYNTHESIS LOOP		
CAPACITY	350 MT/DAY ANHYDROUS LIQUID NH_3		
INVESTMENT	£2,250,000 (EXCLUDING STORAGE FACILITIES)		
UTILITY	RATE	UNIT COST	COST £/HOUR (8000 hrs/ annum)
DIRECT COSTS			
NATURAL GAS	585,000 NCFH	2.5 Sh /1000 NCF	73.0
POWER	14,000 KW	1d /KWh	58.5
COOLING WATER	200,000 Imp gph	4d /1000 Imp Gall	3.3
DEMIN. WATER	8,500 Imp gph	4s /1000 Imp Gall	1.7
EXPORT STEAM	28,600 lb/hr	5s /Ton Credit	- 3.2
SUB TOTAL			133.30
INDIRECT COSTS			
LABOUR	4 Men/Shift 4 Shifts		1.96
OVERHEADS	80% Labour		1.57
MAINTENANCE	2½% p.a. of Investment		7.07
CATALYST REPLACEMENT	Based of Expected Life		5.90
CAPIT[illegible]ES	Ba[illegible] a ca[illegible]al recovery factor o[illegible] 23.74[illegible] capital investment		67.00
SUB TOTAL			83.50
TOTAL			216.80

PENINSULA PROSPECTING AND MINING PROPRIETARY LTD. [redacted]

REPORT ON SPECIAL MINING LEASE (LAKE MACDONNELL S.A.) FOR PERIOD ENDING DECEMBER 14TH, 1968.

902
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The investigational work on the Special Mining Lease has been concerned during the period June 14th to December 14th, with studies relating to the production of sulphur, sulphuric acid and other chemicals from gypsum, a feasibility study on scale production operation for export gypsum and further marketing studies relating to the shipping interests of Clutha Development Pty Ltd.

It was agreed with the Government to pursue investigational work on two main lines of enquiry, namely:

(1) The study of the coastline adjacent to the deposits for a deep water harbour site.

(2) The investigation of the thermal processes for the recovery of sulphur from gypsum.

The work on item (1) is planned for the period January to June, 1969.

The studies relative to (2) have revealed that there are no technical difficulties relating to the recovery of sulphur from gypsum. However only one commercial plant has been built, namely that of Elcor in Texas, which is presently being commissioned. Details of the plant remain a well kept secret.

Indications point clearly to costs being satisfactory for an Australian operation which would have to be on the deposits to effect a low plant cost for gypsum, say of the order of 30-50 cents per ton for an annual requirement of 2,000,000 tons of gypsum, to produce 300,000 tons of sulphur per annum. The cost of fuel will be critical in the overall economics and needs careful investigation. Natural gas, fuel oil or coal would be suitable.

The AMDEL Laboratories are well advanced in their studies of the gypsum processes and a report is expected shortly from them as a result of work done locally and from comprehensive enquiries overseas.

The planning of a small scale production operation is proceeding, but the decision to establish same will largely depend on the findings relating to the major enquiries (1) and (2) above.

Direct expenditure during period:-

Salaries and Wages	$2,450.00
Payments to AMDEL	$ 813.00
Sundry Expenses	$ 65.00
Freight and Travelling Expenses	$ 938.00
	$4,266.00

AUST. FINANCIAL REVIEW 7.2.68

W.M.C. nickel plans key to W.A. chemicals

058

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By TREVOR DAWSON-GROVE

AS THE biggest single user of ammonia in Australia, Western Mining Corporation Ltd. could be expected to play a significant role in the future development of the Kwinana chemical complex in Western Australia.

In addition W.M.C. will have 150,000 tons of ammonium sulphate fertiliser worth more than $5 million available for export.

Geographical position suggests exports aimed at countries bordering the Indian Ocean.

The company's nickel refinery at Kwinana will probably use between 40,000 tons and 50,000 tons of ammonia annually, worth between $4-$5 million.

The amount of ammonia used will depend on the concentrate of ore delivered to the refinery.

The price paid will depend on the formula agreed on with the supplier because bulk ammonia is usually purchased on a sliding scale.

As it will be the largest single purchase so far made in Australia it could call for a new pricing formula.

As it is, Western Mining is considering several alternatives.

Western Mining has not given any indication of how much ammonia it expects to use or from where it will draw its supplies.

These would include obtaining the ammonia from the Kwinana complex, importing it from overseas or using natural gas.

It is understood that C.S.B.P. and Farmers Fertilisers would be prepared to supply Western Mining with its ammonia requirements.

But this could be of only a short-term nature.

C.S.B.P. should have no difficulty supplying Western Mining in the early stages because the C.S.B.P. nitrogen plant has been designed with expansion in nitrogenous demand very much in mind.

This, in turn, means that C.S.B.P. would have substantial unused capacity available at the outset.

But the gap will shrink rapidly with the lift in Australian demand.

Then Western Mining could have to look elsewhere for its supplies.

In view of the Western Australian Government's attitude towards State development it would seem highly likely that pressure would be put on Western Mining to obtain its supplies locally.

If Western Mining imported the ammonia from overseas it would stand to lose the Federal Government's current subsidy of $80 a ton on the nitrogen content in fertilisers.

A spokesman for Eastern Nitrogen (the I.C.I.A.N.Z.-C.R.A.-Mitsui complex at Newcastle) said yesterday the company would be keen to tender for the Western Mining ammonia contract.

But he pointed out that the high cost of freights from Newcastle, together with the difficulty of chartering ammonium tanker space for the infrequent shipments, would tend to work against a successful tender.

While Western Mining plans to use the Sherritt Gordon process it does not necessarily mean the same method of obtaining feedstock will be followed.

Sherritt Gordon makes its own ammonia by converting natural gas from Alberta natural gas.

But the company makes considerably more ammonia than it needs in its nickel processing because the fertiliser interests are more important than nickel.

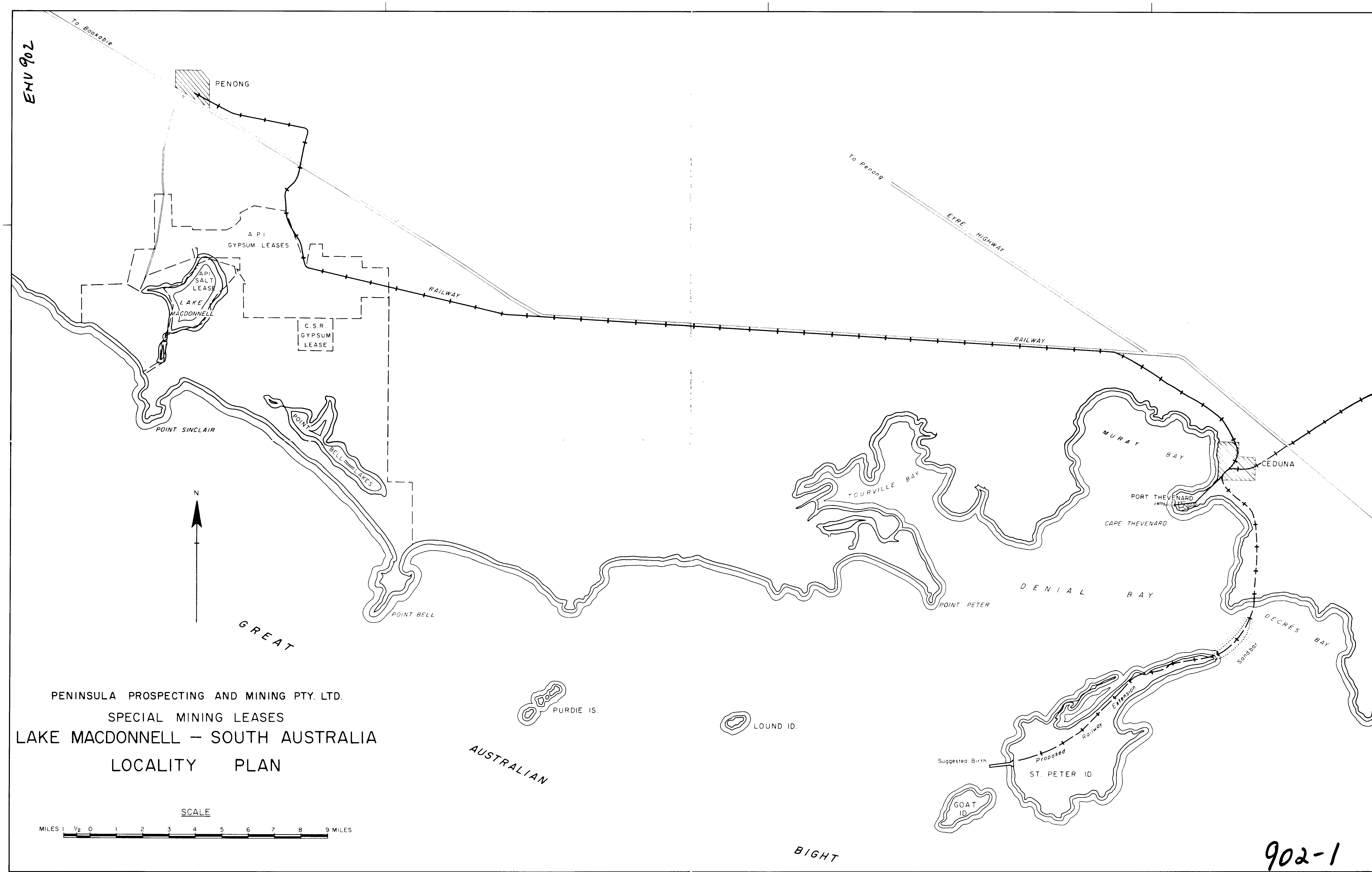
In Western Mining's case, the amount of natural gas required to produce the necessary ammonia and hydrogen would be about three million cu. ft. a day.

The biggest expanding market for ammonium sulphate is in the countries bordering the Indian Ocean.

Western Mining refinery would be ideally located to service this market.

India alone consumes in the region of one million tons of ammonium sulphate a year, more than six times the amount Western Mining expects to produce.

Currently, the main suppliers are located in the United States, particularly in the Carribbean area, and in Europe.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