THE ADDITIONAL EVALUATION STUDY
FOR
THE ASEAN ROCK SALT-SODA ASH PROJECT
IN
THE KINGDOM OF THAILAND

MARCH 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

The Government of Japan submitted to the Government of the Kingdom of Thailand an "Evaluation Study Report for ASEAN Rock Salt – Soda Ash Project in the Kingdom of Thailand" in March 1981.

Thereafter, the Government of Thailand decided to alter the site of the soda ash plant from Laem Chabang to either of two other candidate sites, and requested the Government of Japan to conduct a comparative study on technical and economic aspects of the two sites.

The Government of Japan decided to conduct the study and entrusted it to the Japan International Cooperation Agency (JICA).

The JICA sent to Thailand a team consisting of 5 experts headed by Mr. Yoshiyasu Mikami from November 19 to December 2, 1981. The team exchanged views with the officials concerned of the Government of Thailand and conducted a field survey in Rayong and Chonburi Provinces.

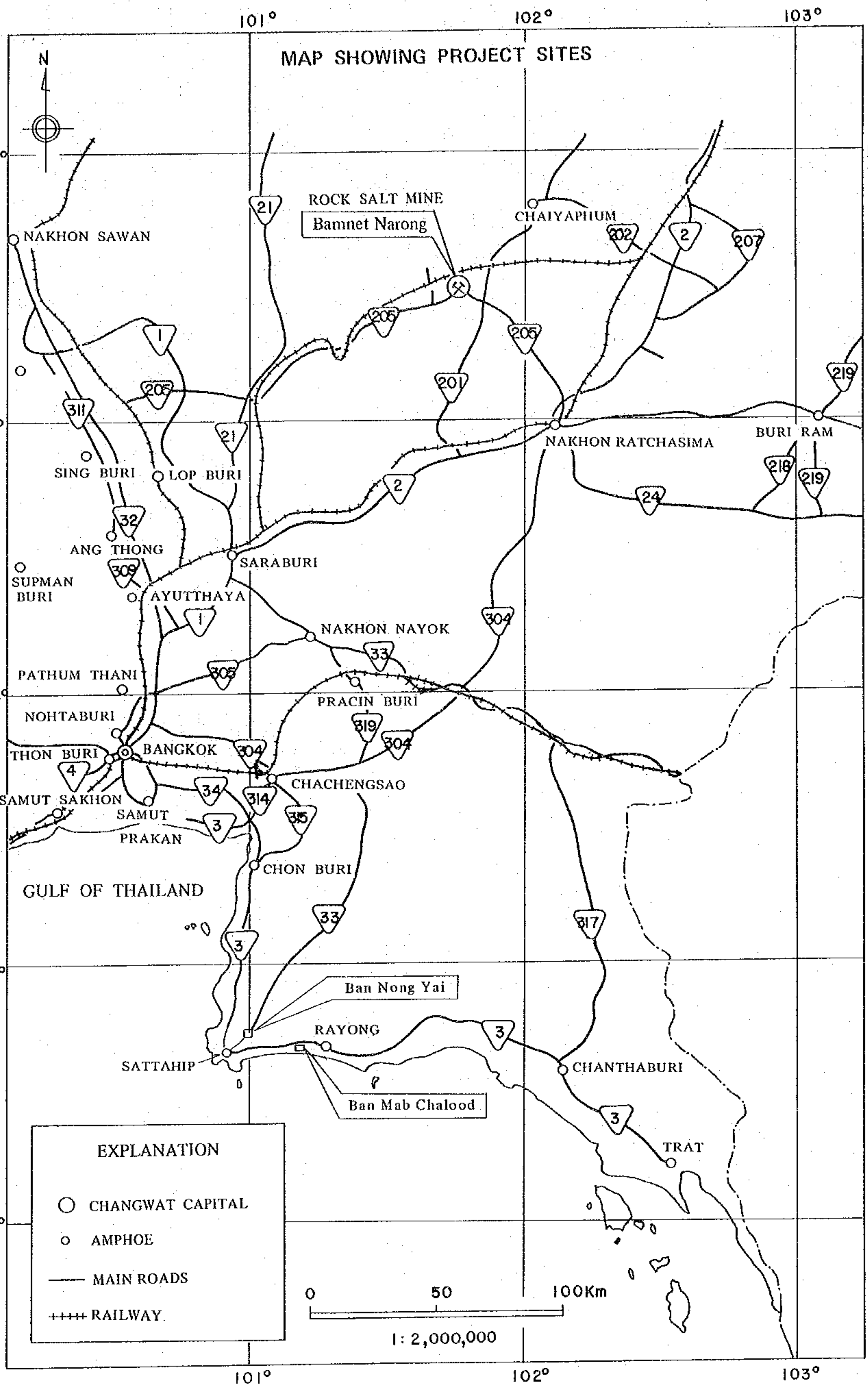
After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will prove to be useful for the development of the Project, thereby contributing to promoting intra-ASEAN cooperation and friendly and cooperative relations between Japan and the ASEAN member states.

I wish to express my deep appreciation to the officials concerned of the Government of Thailand for their close cooperation extended to the team.

March, 1982

Keisuke Arita
President
Japan International Cooperation Agency


MAP SHOWING PROJECT SITES
N
101°
102°
103°
16°
15°
14°
13°
12°
ROCK SALT MINE
Bamnet Narong
CHAIYAPHUM
NAKHON SAWAN
SING BURI
LOP BURI
ANG THONG
SARABURI
SUPMAN BURI
AYUTTHAYA
NAKHON NAYOK
PATHUM THANI
PRACIN BURI
NOHTABURI
THON BURI
BANGKOK
CHACHENGSAO
SAMUT SAKHON
SAMUT PRAKAN
CHON BURI
NAKHON RATCHASIMA
BURI RAM
GULF OF THAILAND
Ban Nong Yai
RAYONG
SATTAHIP
Ban Mab Chalood
CHANTHABURI
TRAT
EXPLANATION
CHANGWAT CAPITAL
AMPHOE
MAIN ROADS
RAILWAY
0
50
100Km
1: 2,000,000

ABBREVIATIONS ETC.

<u>General</u>

GOT	Government of Thailand
C & F	Cost & Freight
CIF	Cost, Insurance & Freight
FOB	Free on Board
IRR	Internal Rate of Return
B	Baht
MSL	Mean Sea Level

<u>Exchange Rate</u>

US$1 = B20.5 in 1980
US$1 = B23.5 in 1981

<u>Organizations</u>

EGAT	Energy Generation Authority of Thailand
IEAT	Industrial Estate Authority of Thailand
NEB	National Environment Board
PAT	Port Authority of Thailand
PEA	Provincial Electricity Authority
PTT	Petroleum Authority of Thailand
TSR	Thai State Railway

<u>Units</u>

KVA	Kilovolt-ampere
KW	Kilowatt
KWH	Kilowatt-hour
MW	Megawatt (Million Watt)
MMBTU	Million BTU (MM = million, M = thousand)
MSCFD	Thousand SCF per Day
MSCF	Thousand SCF
QUEN	1,500 kg
RAI	0.16 ha
SCF	Standard Cubic Feet, 1SCF = 0.0283 Nm^3
SCFD	Standard Cubic Feet per Day
M/T, t	Metric Ton
T/Y, t/y	Ton per Year

<u>Products</u>

AC	Ammonium Chloride
K	Potash
MSG	Monosodium Glutamate
N	Nitrogen
P	Phosphate

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PART VII

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

1. STUDY OBJECTIVE

1–1 Background

The Japan International Cooperation Agency (JICA) submitted its report "Evaluation Study Report for ASEAN Rock Salt – Soda Ash Project in the Kingdom of Thailand" to the Government of Thailand (GOT) in March, 1981. Thereafter, the GOT, at the recommendation of the Committee on the Development of Heavy Industries in the Eastern Seaboard, of which the Prime Minister was the Chairman, decided that either of the following two locations was to be selected as the location of the soda ash plant:

(1) Ban Mab Chalood* (Rayong Province)
(2) Ban Nong Yai (Chonburi Province)
* including Mab Ta Phud

Subsequently, the GOT requested the Government of Japan (GOJ) to undertake an additional study of technical and economic aspects of the two locations (September, 1981).

For this purpose, JICA dispatched the preliminary study mission to Thailand in order to confirm the reason why Thailand is unable to select one of two candidate sites to be the location for the soda ash plant and to determine the scope of the additional study, by which *the study is limited to assess the location study by direct factors such as technical* and economical points of views and not by indirect factors such as political and social impact factors. The Minutes of Meetings held with the Thai counterparts team were signed and JICA study team was dispatched to Thailand in November 1981.

The Minutes of Meetings and Interim Report submitted by the study team are provided hereunder as APPENDIX–I.

1–2 Objective and Scope of Study

The Minutes of Meetings indicates that the objective of the study is to be as follows.

(1) The study would comprise a technical and economic evaluation of the two locations, in order to obtain data which will be used by the GOT, in conjunction with other selection criteria, to select the location of the plant site.

(2) On the basis of the "Evaluation Study Report for ASEAN Rock Salt – Soda Ash Project in The Kingdom of Thailand" of March, 1981, investigation of the

following would be undertaken at the proposed plant sites, in order to evaluate the sites from the viewpoint of technical and economic feasibility of their use.

1) Locational conditions
2) Conceptual design of the plant and related facilities
3) Estimation of the required investment, and preparation of the financial plan
4) Financial and economic analysis
5) Comparison of the two sites

2. ASSUMPTIONS FOR THE STUDY

For studying the technical and economic aspects of the two potential sites, it is assumed that the GOT adopts the following four basic policies.

(1) Supply of utilities and related infrastructure is to be made by the GOT to each site in equal manner.

(2) Sattahip is to be used as the harbor in the cases of both potential sites, and the GOT will develop Sattahip as a Deep Sea Port by the time the soda ash plant begins operation.

(3) An adequate land area is to be available at Sattahip, for the warehouse, storage and material handling facilities required for the project. (Study was also made of the case wherein such land area is not available.)

(4) According to the Supplementary Agreement of the ASEAN Rock Salt – Soda Ash Project (Thailand) initialled at the 12th meeting of ASEAN Economic Ministers, the Thai Shareholders Entity will be responsible for off-taking the total amount of ammonium chloride produced from the soda ash plant and surplus rock salt produced at the rock salt mine based on three shift operation. The transfer price of the rock salt output of 1.8 million metric tons shall be to attain an Internal Rate of Return on Investment after tax of 12.7% for the Rock Salt Mine.

The selling price of ammonium chloride to be paid by the Thai Shareholders Entity shall be based on the import parity price of urea from the ASEAN Urea Projects of Indonesia and Malaysia multiplied by the proportional nitrogen contents.

3. FORMULATION OF THE ALTERNATIVE CASES FOR STUDY

In addition to the alternative choice of plant site location, there is a choice to be made regarding the source of supply of ammonia. The alternative cases for study have been defined as follows in view of this situation.

3–1 Ammonia Supply Source and Price

The soda ash plant will require about 130,000 T/Y of ammonia, as a raw material. There is no source of supply in Thailand, but at present the GOT is negotiating with a group of private firms of other countries for establishment of a joint venture for a fertilizer complex project which would utilize natural gas from the Gulf of Thailand and would include ammonia among its products.

Therefore, while ammonia may be imported possibly from a natural gas based fertilizer plant in Indonesia, it may be possible to obtain a supply of ammonia from this source.

For this Study, the following two alternatives were compared:

(1) Importation from Indonesia (or elsewhere)
(2) Supply from the proposed fertilizer complex

It should be noted that ammonia will be purchased at the price of US$235/ton(1985 price) whether imported or locally produced in accordance with the Supplementary Agreement.

3–2 Case Studies

The following matrix represents the combination of alternatives studied and their designations used in the study report.

Ammonia Source / Plant Site	Importation	Domestic (Fertilizer Project)
Ban Mab Chalood	BMCI	BMCD
Ban Nong Yai	BNYI	BNYD

4. PROJECT OUTLINE

4–1 Rock Salt Mine

(1) Proposed mine site: Bamnet Narong (225 km NE of Bangkok)

(2) Mining method: Room and pillar method

(3) Scale of mine production: 1.8 million T/Y (2,000 T/D per each 8-hour shift; working three shifts, 300 work days a year.)

(4) Utilities: Power to be supplied by EGAT/PEA, water to be supplied from a swamp in the general vicinity of the mine.

(5) Destination and method of shipments: 1.8 million T/Y is to be shipped by rail to the destinations as shown below.

Destination	Annual Quantity	Distance from Mine (km)
Soda Ash Plant	600,000	
Ban Mab Chalood		493.8
Ban Nong Yai		480.0
Exports	1,000,000	
Sattahip Port		485.5
Domestic Market	200,000	
Bangkok		291.5

(6) Others: According to the GOT's indication, the housing facilities shall be excluded from the scope of the rock salt mine portion of the Project.

4–2 Soda Ash Plant

(1) Proposed plant site: Ban Mab Chalood (Rayong Province) or Ban Nong Yai (Chonburi Province).

(2) Soda ash production process and scale of production: Full Ammonium Chloride Process; 400,000 T/Y of each of soda ash and ammonium chloride.

(3) Required raw materials and utilities supply:

Raw Material	Consumption per ton of soda ash produced	Required Annual Amount
Salt (100% NaCl)	1,371 kg	548,400 t
Ammonia	320 kg	128,000 t
Carbon dioxide gas	332 Nm^3	132,800 Nm^3
Quicklime	46 kg	18,400 t
Caustic soda (or soda ash)	42 kg (60 kg)	16,800 t (24,000 t)

Utilities		Consumption per ton of soda ash produced	Required Annual Amount
Power		496 KWH	198.4 MWH
Water		25.6 m^3	10.24 MMm^3
Fuel	Natural Gas	5.3 SCF	2.11 MMSCF
	(Fuel Oil)	(0.208 m^3)	(83.2 Mm^3)

(4) Raw materials and utilities, and their transportation and receiving method:

1) Rock salt: A rock salt storage yard is to be provided within the soda ash plant site, and hopper wagons are to be used to transport rock salt from the mine to the storage yard.

2) Carbon dioxide gas: To be supplied by a pipeline from the PTT gas processing plant in Mab Ta Phud to the soda ash plant, with both the compressor installed at the PTT end and the pipeline deemed to be part the present Project.

3) Ammonia: For this study, two alternatives are conceivable; importation of ammonia from Indonesia, and acquisition from a new fertilizer complex to be built in Thailand.

In the case of importation, ammonia receiving storage facilities are to be constructed at Sattahip Deep Sea Port and ammonia is to be unloaded by means of a pump aboard the ammonia tanker and an unloading arm installed as part of the port facilities provided within the scope of this Project. The ammonia is to be conveyed by a pipeline to the soda ash plant site at whichever location is selected.

In the case of domestic production, ammonia should be pumped from the fertilizer complex to the soda ash plant at the expense of the Project, but in the event that the soda ash plant is located at Ban Mab Chalood, use can be made of the latter's storage facilities and in the Ban Nong Yai case, it is not possible to use the fertilizer complex's storage, so a storage facility is to be constructed within the soda ash plant site. In either event, the buffer tank will be constructed within the soda ash plant site.

4) Quicklime: To be purchased from local producers.

5) Caustic soda (Soda ash): Soda ash produced in the plant is to be used. (Caustic soda shall be used at initial start-up.)

6) Power: PEA/EGAT will supply 230kv power to the boundary of the plant site.

7) Water: The Royal Irrigation Department (RID) will construct intake facilities at the reservoir at Dok Krai, and a pipeline from there to the Rayong area. Water will be supplied to each plant's boundary line from a storage pond in Rayong.

8) Natural gas: Natural gas will be supplied by a pipeline from the PTT to each plant site boundary.

(5) Products shipping facilities

The quantity and form of products to be shipped are as follows.

Product	Annual quantity	Form
Soda ash	400,000 t	Bulk Bagged
Ammonium chloride	400,000 t	Bagged (using large size bags to be returned after delivery)
Rock salt	1,000,000 t	Bulk

These products are to be shipped to domestic markets and to export markets.

For bulk products, rock salt and soda ash are transported by railway from the mine and the soda ash plant respectively to the storage facilities in the Sattahip Deep Sea Port. From there, they are transported by belt conveyors to the ship loader on the pier for loading.

For the shipment of bagged products to domestic market, they will be moved by belt conveyors from the storage points in the plant to trucks and/or freight cars. In the case of export, the bagged products are to be moved by trucks and/or freight cars to the storage facilities in the Port. Trucks will be used to transport bagged products to the pier, where the ship's derricks will be used for loading to the ship.

(6) Infrastructure

1) Railway:

Rock salt will be transported by rail from the mine to the soda ash plant, and the port of shipment, Sattahip. Soda ash produced at the plant will be transported by rail to Sattahip, from which it will be exported.

The following facilities are included in this Project.

1.	Rock salt mine railway spur	5.7 km
2.	Soda ash plant railway spur	
	Ban Mab Chalood	0.8 km
	Ban Nong Yai	5.0 km

The required number of locomotives and hopper wagons, to be supplied by the GOT, are as follows.

1.	Main locomotive	9 cars
2.	Marshaling locomotives	3 cars
3.	Hopper wagons for rock salt	184 cars
4.	Hopper wagons for sada ash	18 cars

The specifications for hopper wagons for rock salt and for soda ash are to be identical.

In addition to make use of existing railway lines, it will be necessary to make use of the following lines which are now either being constructed or planned.

1. Chachengsao – Sattahip (under construction; estimated date of completion, end of 1983).
2. Phu Ta Luang – Rayong (being planned; the GOT expects construction will be completed during 1985).

2) Port and harbor

Assuming that the Sattahip Deep Sea Port, which the GOT has decided to construct, is completed and ready for use by the time that this Project begins functioning, its facilities shall be used. Even in this event, the installation and construction of facilities for storage, bulk materials loading, belt conveyors and ship loaders are to be a part of the present Project.

(7) Implementation schedule of the Project

The commercial operation of the Project is assumed to be commenced by the middle of 1985.

5. LOCATIONAL CONDITIONS AT THE TWO PROPOSED SODA ASH PLANT SITES

5–1 Ban Mab Chalood

At Ban Mab Chalood, there are existing facilities in the form of the PTT Dew Point Control Unit, and it is planned that a PTT gas separation plant and a fertilizer complex will be constructed here in connection with Eastern Seaboard Development Plan through establishment of an industrial estate for heavy industry. This area is between the National Highway No. 3 and the shore line facing the Gulf of Thailand. It is 31 km from Sattahip (see Figure 1).

5–2 Ban Nong Yai

Ban Nong Yai is located adjacent to the National Highway No. 3 on the north side, 8 km from the Sattahip Deep Sea Port. The area is inland from the Gulf and in the military safety zone. Permission for the use of the land has been obtained from the Thai Navy. For disposal of waste effluents, the site is 5km by the shortest direct line to the Gulf, traversing the site of Navy installations (see Figure 1).

5–3 Physiographical and Geological Features at Each Site

Ban Mab Chalood is level land, with elevations varying by 5–6m from low to high points.

Ban Nong Yai is also level, fan-shaped and surrounded by hills of about 200m high.

Physiographically and geologically there is essentially no difference between the two sites. That is, the surface soil is about 0.3m thick and contains organic matter, below which there are alternating layers of sandy soil and sandy silt to about 30.0m below MSL, after which rock is encountered.

Therefore it is judged that it will not be necessary to drive piles for the plant foundation at either site.

6. CONCEPTUAL DESIGN OF PLANT FACILITIES AT THE ALTERNATE SITES

6–1 Introduction

The facilities required for the plant may be divided into the following three general categories.

(1) Process plant facilities
(2) Utilities facilities
(3) Off-site facilities

Details on requirements for process plant facilities and utilities facilities are provided in Table 1. Details for off-site facilities are provided in Table 2.

Requirements for process plant facilities and utilities facilities are identical to those determined by the Previous Report, and are the same for either site now under consideration.

6–2 Process Plant

The plant is to be designed for the Full Ammonium Chloride Process, and to have production capacity of 1,200 T/D of soda ash, and 1,200 T/D of ammonium chloride as a byproduct.

6–3 Utilities Facilities

The following are included as utilities facilities

(1) Water treatment facilities
(2) Power receiving facilities
(3) Cooling tower facilities
(4) Boiler facilities
(5) Instrumentation and plant air facilities
(6) Emergency power generating facilities
(7) Waste water treatment facilities

6–4 Off-Site Facilities

The common facilities and off-site buildings and structures as listed in item 3.2 and 3.3 in Table 1 are the same at whichever of the two site locations. However, raw materials and products handling facilities are different. Yet, the following export related facilities will be the same for both sites.

(1) Within the soda ash plant site

1) Soda ash storage facilities (4 silos of 4,000 tons each)
2) Soda ash hopper wagon loading facilities

(2) At Sattahip Deep Sea Port

1) Rock salt hopper wagon unloading facilities
2) Soda ash hopper wagon unloading facilities
3) Rock salt storage facilities (50,000 T capacity)
4) Soda ash storage facilities (5 silos of 4,000 tons each)
5) Rock salt belt conveyor
6) Soda ash belt conveyor
7) Ship loader

6–5 Conceptual Design of Off-Site Facilities for Each Location

As shown in Table 2, the items for which substantial differences exist are the following.

	Ban Mab Chalood (BMC)		Ban Nong Yai (BNY)	
	Ammonia imported	Ammonia domestically produced	Ammonia imported	Ammonia domestically produced
Length of carbon dioxide pipeline (m)	1,000	1,000	24,000	24,000
Ammonium storage capacity (ton)				
– Plant site	500	500	500	1,000
– Sattahip	5,000	–	5,000	–
Length of ammonia pipeline (m)	31,000	1,000	8,000	23,000
Length of waste water ditch (m)	1,000	1,000	5,000	5,000
Length of railway siding (m)	800	800	5,000	5,000

As is shown in the above table, in the event that ammonia is imported, ammonia storage capacity for 5,000 tons at the Sattahip Deep Sea Port would be required. In addition, there would be a difference in the length of ammonia pipeline required for different cases.

7. ESTIMATION OF CAPITAL REQUIREMENT

7–1 Difference in Capital Requirement for the Soda Ash Plant for Each Alternative

For the alternatives under consideration, the capital requirement for the rock salt mine remains the same. A difference exists only in regard to the soda ash plant, and in particular the off-site facilities. The differences among the alternatives, therefore, are as shown below (taking up only the soda ash plant).

Capital Requirement for The Soda Ash Plant in Each Alternative Plan
(Excluding interest during construction)

(Unit: US$1,000)

Case	Foreign Currency	Domestic Currency	Total
BMCD	222,693	82,207	304,900
BMCI	240,362	85,358	325,700
BNYD	229,226	90,129	319,355
BNYI	232,944	90,576	323,520

From the above, the capital requirement is lower in the case of acquiring ammonia from the proposed fertilizer plant as compared to importing the ammonia.

Regarding the difference between the two possible locations, in the event that a domestic supply of ammonia is used, siting the soda ash plant at Ban Mab Chalood requires less capital investment, whereas in the case of importation of ammonia, Ban Nong Yai siting requires less investment.

7–2 Total Capital Requirement for the Entire Project

The total capital requirement for the entire Project, including both the rock salt mine and the soda ash plant, has been calculated using three rates of interest, namely 4%, 5% and 6% per annum, with the results as shown in Table 3.

8. FINANCIAL ANALYSIS

8–1 Base Data for Financial Analysis

(1) Sales price: (1985 prices)

Soda ash	US$225/T (Ex-factory price to Thailand)*
Ammonium chloride	US$150/T (Ex-factory price to Thailand)*
Rock salt	US$11.42/T (Ex-mine price)**

Notes: * For soda ash to be exported to ASEAN countries (except Thailand), the prices as shown below (estimated on the basis of CIF competitive price in each destination) are used.

(US$/ton)

Destination	CIF Price	Ocean Freight
Thailand	225	–
Singapore	229	15
Malaysia	230	17
Indonesia	229	19
Philippines	225	23

** Ex-mine price calculated on the basis of the Supplementary Agreement for the ASEAN Rock Salt – Soda Ash Project (Thailand).

(2) Raw materials and utilities prices:

	1980 Prices	1985 Prices
Ammonia (imported or locally produced)	–	US$235/T
Carbon dioxide gas	–	0
Quicklime	US$20/T	US$ 28/T
Soda ash	–	US$225/T
Power	US$0.076/KWH*	US$0.092/KWH
Water	US$0.08/m³	US$0.108/m³
Natural gas	–	US$4.6/MMBTU (fuel oil equivalent, US$181.6/m³)

*Note: * 1981 price*

(3) Railway freight

	1981 Rate	1985 Rate
Rock Salt		
B.N.*–Sattahip	US$8.38/T	US$10.19/T
B.N.*–BMC	US$8.52/T	US$10.36/T
B.N.*–BNY	US$8.23/T	US$10.00/T
Soda Ash		
BMC–Sattahip / BNY–Sattahip	US$0.7/T	US$ 0.85/T

Note: * Bamnet Narong

(4) Assumptions

Corporate tax	: Waived for 8 years, thereafter 40% of taxable income
Import duty, business tax	: Waived
Depreciation and amortization	: Straight-line method for 15 years, with zero salvage value
Terms and conditions of loan	: Grace period, 3 years; repayment over the period of 15 years; interest rates: 4%, 5%, 6%

8–2 Rock Salt Mine

As per the Supplementary Agreement for the Project, the rock salt mine will have a production capacity of 1.8 million tons/year and the product rock salt shall be off-taken by the soda ash plant and the Thai Rock Salt – Soda Ash Shareholders Entity at the price set forth to attain Internal Rate of Return on Investment (IRROI) after tax of 12.7% of the rock salt mine.

This price is assessed through the sensitivity analysis of IRROI varying the sales price of rock salt to find followings:

Production Capacity of the Mine (t/y)	Sales Price at Ex-Mine (US$/ton)
1,800,000	11.42
1,200,000	15.72

8–3 Soda Ash Plant

The IRROI for each alternative are shown below.

Internal Rate of Return (IRR, %) for Each Alternative (Soda Ash Plant)

Case	Before Tax	After Tax
BMCD	10.01	8.97
BMCI	8.90	7.93
BNYD	9.30	8.31
BNYI	9.09	8.11

The difference in IRROI principally stems from differences in capital requirement. In the case of domestic production of ammonia siting the soda ash plant at Ban Mab Chalood provides a higher IRR, whereas in the case of importation of ammonia Ban Nong Yai siting gives higher IRROI.

8–4 Entire Project

The Internal Rate of Return for the entire Project, including the rock salt mine and the soda ash plant, are as follows,

Case	Internal Rate of Return (IRR, %) for Entire Project	
	Before Tax	After Tax
BMCD	10.02	8.94
BMCI	9.07	8.04
BNYD	9.42	8.37
BNYI	9.24	8.20

The results for the entire project demonstrate the same ranking as in the case of the soda ash plant alone, for the reason that the rock salt mine does not differ case to case.

For the alternative case of producing 1.2 million tons/year of rock salt, following results are obtained.

(1) Ex-mine price of rock salt: US$15.72/ton
(at IRROI after tax of the rock salt mine 12.7%)

(2) IRROI (%)

Case	Before Tax	After Tax
BMCD	9.45	8.37
BMCI	8.51	7.50
BNYD	8.86	7.82
BNYI	8.67	7.65

9. CONCLUSION

9–1 Comparison of Alternatives

(1) Ranking in order of capital requirements (excluding interest during construction) and internal rate of return is shown below.

Rank	Case	Capital Req't (US$1,000)	Internal Rate of Return After Tax (%)
1	BMCD	355,546	8.94
2	BNYD	370,001	8.37
3	BNYI	374,166	8.20
4	BMCI	376,366	8.04

The requirement for ammonia transport and storage costs would be lower in the case where ammonia is supplied from the proposed fertilizer complex. Consequently the IRROI for the said alternatives is higher than those where ammonia is imported.

From the above, it can be concluded that, in the case of importation of ammonia, siting of the soda ash plant at Ban Nong Yai is preferable, whereas in the case of ammonia supply from the proposed fertilizer plant, Ban Mab Chalood siting is preferable.

(2) In all cases, the IRROI after tax for the entire project is higher than the minimum 8% requirement for the ASEAN Industrial Projects set by the ASEAN Economic Ministers.

(3) In any case in order to be able to implement this Project, it is essential to install storage facilities for rock salt and soda ash at Sattahip Deep Sea Port.

In case that such facilities could not be provided at the Port, it is not possible to select Ban Mab Chalood as a soda ash plant site. Alternatively, however, Ban Nong Yai site could possibly be used, by installing one each belt conveyor for rock salt and soda ash for direct loading from the plant to ships berthed at the Sattahip Port.

In such a case construction cost for these belt conveyors, in 1985 price, is estimated as follows.

	(Unit: US$1,000)
Foreign currency	48,327
Domestic currency	10,020
Total	58,347

This increase in construction cost would substantially reduce the IRROI to an unacceptable level as follows:

	Base Case	Alternative Case
Case BNYD	8.37%	5.5%
Case BNYI	8.20%	5.4%

This indicates the necessity for the government to provide the rock salt and soda ash storage facilities at Sattahip Deep Sea Port. In view of the large amount of rock salt and soda ash to be exported to the ASEAN and the non-ASEAN countries, it is also imperative in all cases that the Sattahip Port be expanded.

(4) In view of the fact that water, power and natural gas will be supplied to the Plant by the GOT, the choice in siting the soda ash plant should take into account the differences in the delivery distances for these utilities as shown below:

Distances from the Main Utilities Systems to the Battery Limit of the Soda Ash Plant

	Ban Mab Chalood	Ban Nong Yai
Water pipeline (m)	3,000	3,000
Power cable (m)	2,000	24,000
Natural gas pipeline (m)	1,000	24,000

9–2 Evaluation of the project

Evaluation of the Project shows that the Project is technically and financially feasible, however, the GOT has to undertake followings:

(1) Sattahip Deep Sea Port expansion must be completed by the time this Project begins operations.

(2) The water and power supply projects must be implemented in parallel to construction work for this Project.

(3) Facilities for transport of rock salt and soda ash (locomotives, hopper wagons, extension of railway line) must be provided in time before the Project become operational.

(4) There must be a guarantee that carbon dioxide gas will be supplied from PTT gas separation plant free of charge.

(5) A source of supply of ammonia price according to the Supplemental Agreement of the ASEAN Rock Salt – Soda Ash Project (Thailand), must be assured before the Project is implemented.

(6) Low-priced supply of natural gas from PTT must be assured.

10. RECOMMENDATIONS

This project is extremely dependent on external factors. That is,

(1) Port and harbor facilities: It is dependent on completion of the Sattahip Deep Sea Port project.

(2) Fuel: Natural gas must be supplied by a pipeline from PTT facilities.

(3) Rock salt (and caustic soda) rail transport: In addition to relying on the use of locomotives and hopper wagons owned by the national railway, in the event that the plant site is at Ban Mab Chalood the Project must also rely on a new line laid between Phu Ta Luang and Rayong. (It is assumed that the line between Chachengsao and Sattahip, now under construction, is completed as planned.)

(4) Water: The Project must rely on water intake by RID and water supply by IEAT.

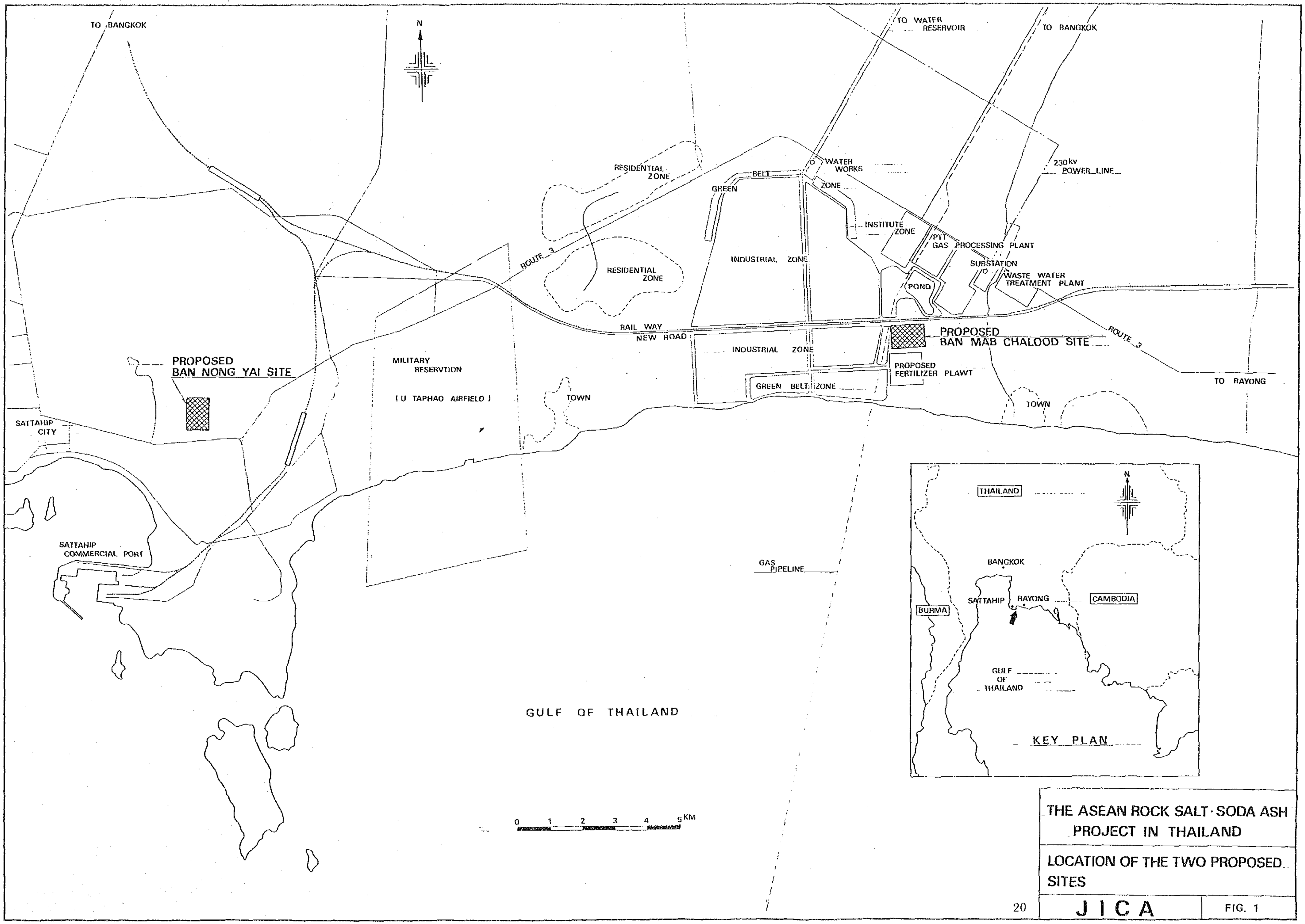
(5) Power: The Project must rely on power generation by EGAT/PEA and power supply by IEAT.

(6) Ammonia: The Project must rely on either importation or supply from the fertilizer complex now being planned.

As a consequence of this dependence on external factors,

(1) It is advisable that a project company be established as soon as to take over the Project from the Thai Shareholders Entity.

(2) Overall coordination with the proposed fertilizer project is necessary, not only because of the question of ammonia supply but also of the competitive relationship between the products of the two projects.

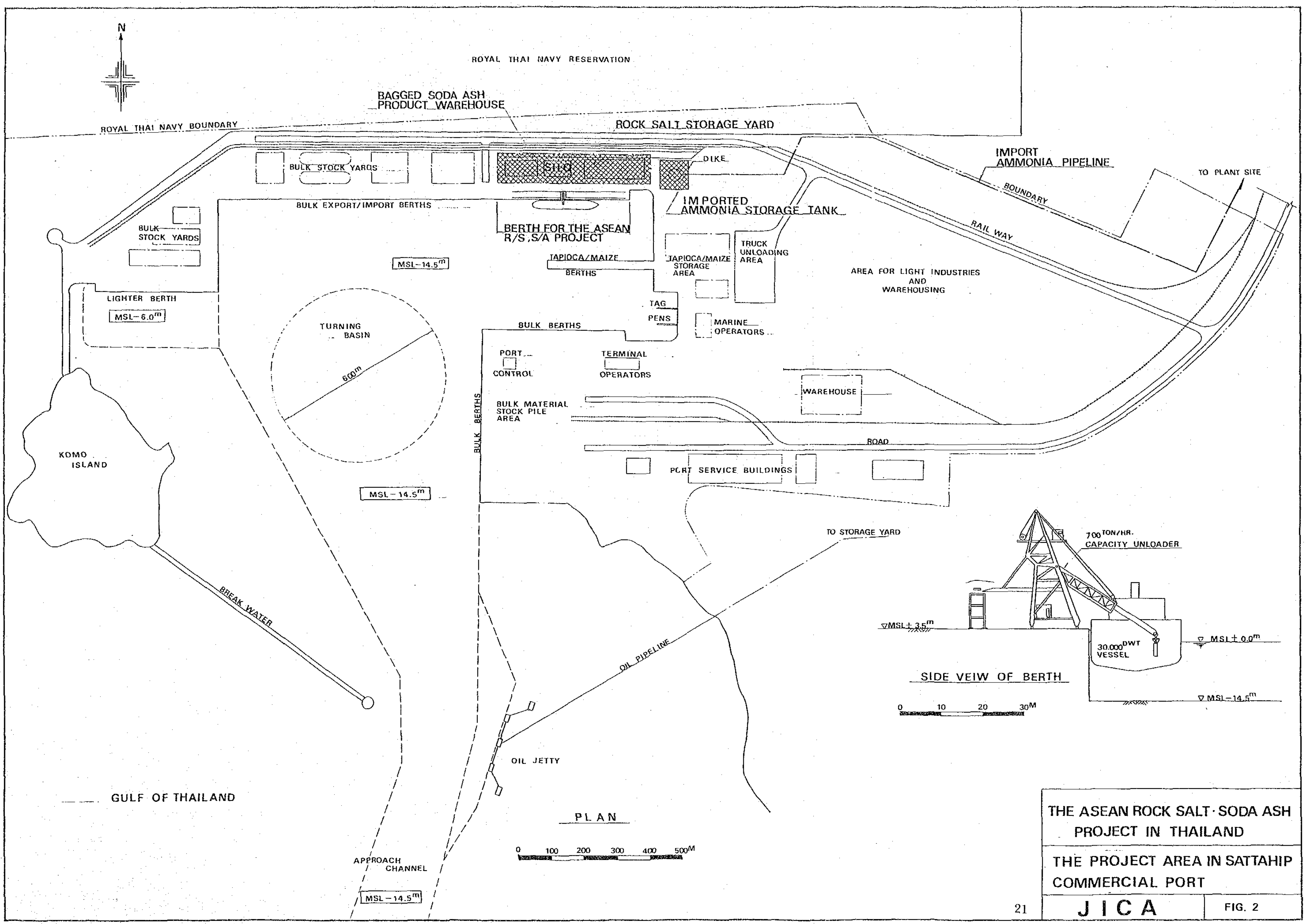


THE ASEAN ROCK SALT·SODA ASH PROJECT IN THAILAND

LOCATION OF THE TWO PROPOSED SITES

JICA

FIG. 1



THE ASEAN ROCK SALT·SODA ASH PROJECT IN THAILAND

THE PROJECT AREA IN SATTAHIP COMMERCIAL PORT

JICA

FIG. 2

FIG. 3 SENSITIVITY ANALYSIS (CASE: BMCD)

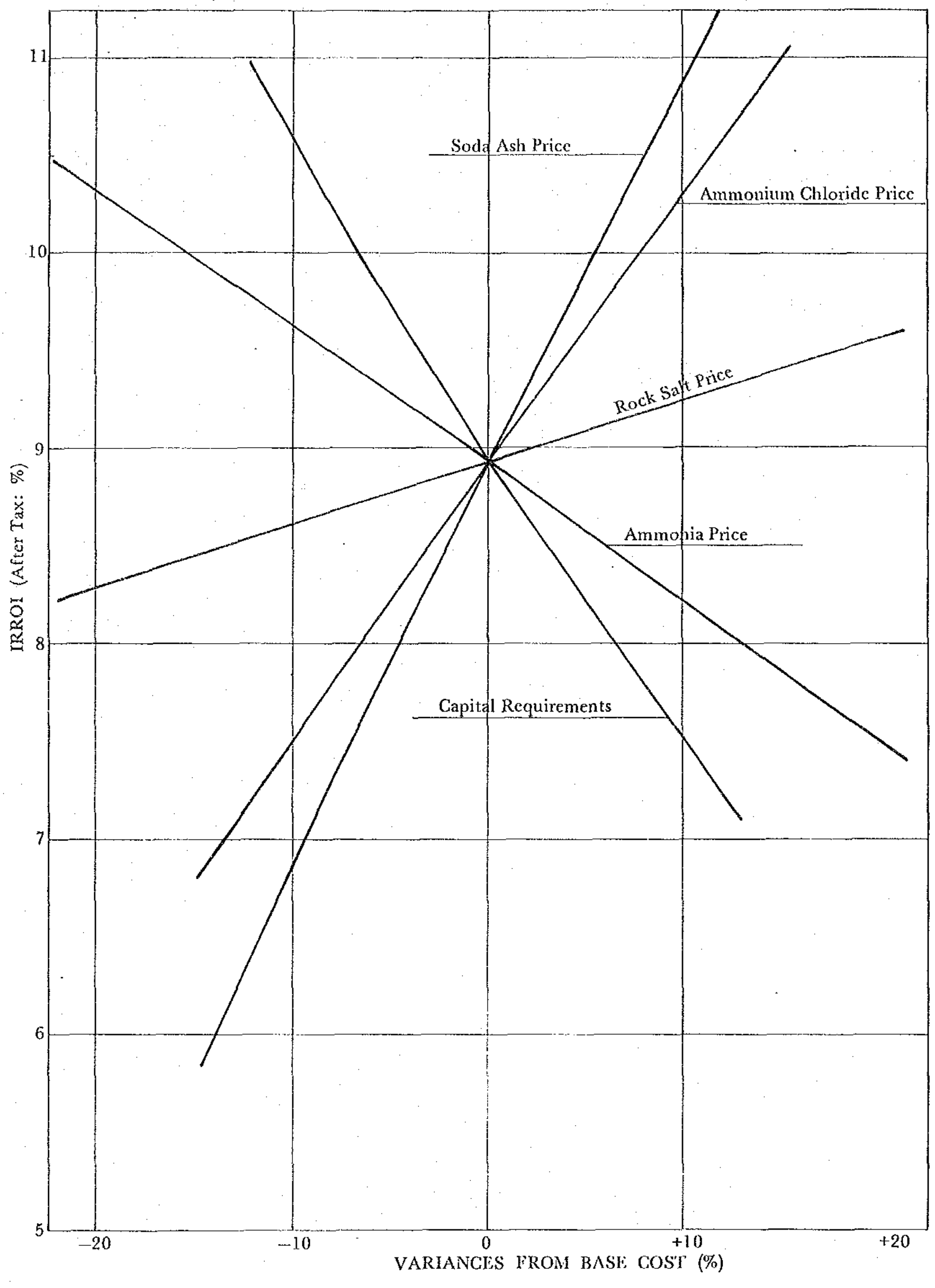


FIG. 4 SENSITIVITY ANALYSIS (CASE: BNYI)

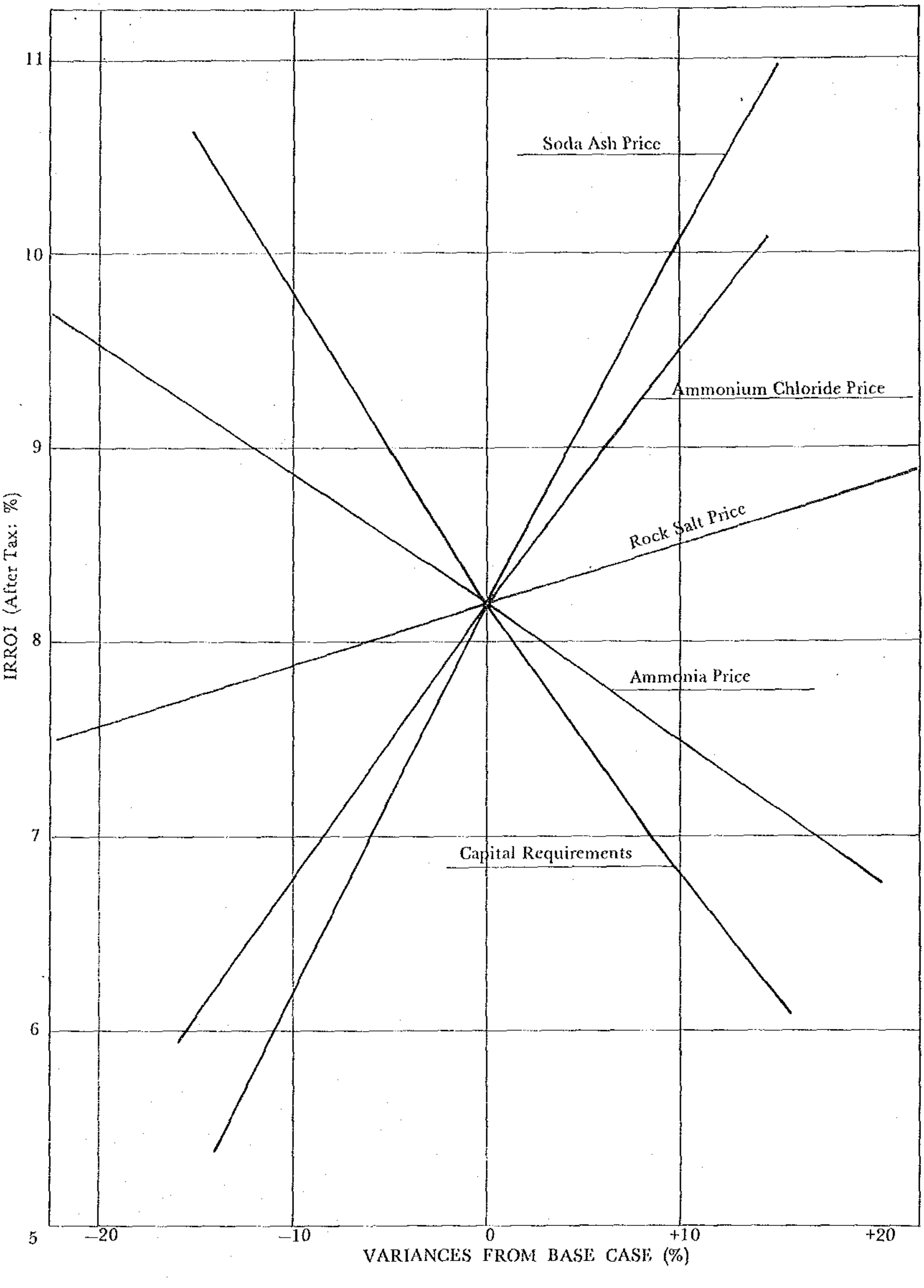


TABLE 1 FACILITIES INCLUDED IN THE PROJECT SCOPE

Facilities			Rated Capacity
1.	Process Plants	Soda Ash	1,200 t/d
		Ammonium Chloride	1,200 t/d
2.	Utilities Plants		
1)	Demineralizer		880 m^3/h
2)	Main substation		20,000 KW (25,000 KVA)
3)	Cooling tower		8,000 m^3/h
4)	Steam boilers		55 t/d x 2 sets
5)	Instrument and plant air		960 Nm^3/h
6)	Emergency diesel generator		750 KW
7)	Effluent treatment		
8)	Utilities distribution		
3.	Off-site Facilities		
3.1	Raw materials and products handling and storage See Table 2		
3.2	Common Facilities		
1)	Equipment and machines for maintenance and workshops		
2)	Equipment for laboratories		
3)	Drinking water and fire-fighting system		
4)	Intercommunication system		
5)	Lighting and lightening system		
6)	Miscellaneous equipment and machines for common facilities		
3.3	Off-site Building and Structures		
			Total Floor Area
1)	Maintenance shop		1,680 m^2
2)	Laboratory		360 m^2
3)	Local laboratories	30 m^2 x 5	
4)	Gatehouses	50 m^2 x 2	
5)	Garage		150 m^2
6)	Administration office		1,250 m^2
7)	Cafeteria and locker room		1,400 m^2
8)	Warehouses	1,400 m^2 x 2	
9)	Workshop		2,000 m^2
10)	First aid house		200 m^2
11)	Maintenance and engineering office		1,000 m^2
12)	Fencing	as required	
3.4	Utilities during construction	as required	

TABLE 2 SHORT SPECIFICATION OF OFF–SITE FACILITIES

Item	Laem Chabang	Ban Nong Yai		Ban Mab Chalood	
		Ammonia Import	Ammonia Domestic	Ammonia Import	Ammonia Domestic
1. Carbon Dioxide Supply (from PTT)	20,000 Nm^3/h	20,000 Nm^3/h		20,000 Nm^3/h	
Pipe Line Length (m)	61,000	24,000		1,000	
2. Ammonia Storage Capacity (tons)					
at Plant Site	5,000	500	500	500	500
at Port Area		5,000	—	5,000	—
3. Ammonia Pipe Line Length (m)	1,000	8,000	23,000	31,000	1,000
4. Rock Salt Storage (tons)		20,000		20,000	
at Plant Site	70,000				
at Port Area		50,000		50,000	
5. Soda Ash Storage (tons)					
5.1. Bulk Storage (Silo)		16,000		16,000	
at Plant Site	36,000				
at Port Area		20,000		20,000	
5.2. Bagged Product Storage		18,000		18,000	
at Plant Site	36,000				
at Port Area		18,000		18,000	
6. Ammonium Chloride Storage at Plant Site (tons)	36,000	36,000		36,000	
7. Handling & Transportation					
7.1. At Plant Site					
7.1.1 Rock Salt Train Unloading (t/y)	1,200,000	600,000		600,000	
7.1.2. Soda Ash Train Loading (t/y)	None	400,000		400,000	
7.2. At Port Area					
7.2.1. Rock Salt					
i. Train Unloading (t/y)	= Plant Site	600,000		600,000	
ii. Belt Conveyor to Ship Loader (m)	1,875	500		500	
7.2.2. Soda Ash					
i. Train Unloader (t/y)	None	400,000		400,000	
ii. Belt Conveyor to Ship Loader (m)	1,410	500		500	
7.7.3. Railway Sidings at Plant Site (m)	3,200	5,000		800	
8. Draining Ditch Length (m)	1,000	5,000		1,000	

TABLE 3 TOTAL CAPITAL REQUIREMENT FOR EACH ALTERNATIVE

		Interest 6%			Interest 5%			Interest 4%		
		F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
Rock Salt Mine		26,838 (49.65%)	27,213 (50.35%)	54,051 (100%)	26,239 (29.09%)	27,213 (50.91%)	53,452 (100%)	25,633 (48.52%)	27,213 (51.48%)	52,866 (100%)
Soda Ash Plant	Case BMCD	243,193 (74.74%)	82,207 (25.26%)	325,400 (100%)	239,587 (74.45%)	82,207 (25.55%)	321,794 (100%)	236,060 (74.17%)	82,207 (25.83%)	318,267 (100%)
	Case BMCI	262,262 (75.45%)	85,358 (24.55%)	247,620 (100%)	258,410 (75.17%)	85,358 (24.83%)	343,768 (100%)	254,642 (74.89%)	85,358 (25.11%)	340,000 (100%)
	Case BNYD	250,698 (73.56%)	90,129 (26.44%)	340,827 (100%)	246,921 (73.26%)	90,129 (26.74%)	337,050 (100%)	243,227 (72.96%)	90,129 (27.04%)	333,356 (100%)
	Case BNYI	254,696 (73.77%)	90,576 (26.23%)	354,272 (100%)	250,870 (73.47%)	90,576 (26.53%)	341,446 (100%)	247,128 (73.18%)	90,576 (26.82%)	337,704 (100%)
Total Capital Requirement	Case BMCD	270,031 (71.16%)	109,420 (28.84%)	379,451 (100%)	265,826 (70.84%)	109,420 (29.16%)	375,246 (100%)	261,693 (70.51%)	109,420 (29.49%)	371,133 (100%)
	Case BMCI	289,100 (71.97%)	112,571 (28.03%)	401,671 (100%)	284,649 (71.66%)	112,571 (28.34%)	397,220 (100%)	280,272 (71.34%)	112,571 (28.66%)	392,866 (100%)
	Case BNYD	277,536 (70.28%)	117,342 (29.72%)	394,878 (100%)	273,160 (69.95%)	117,342 (30.05%)	390,502 (100%)	268,860 (69.61%)	117,342 (30.39%)	386,222 (100%)
	Case BNYI	281,534 (70.50%)	117,789 (29.50%)	399,323 (100%)	277,109 (70.17%)	117,789 (29.83%)	394,898 (100%)	272,761 (69.84%)	117,789 (30.16%)	390,570 (100%)

Note: F.C. = Foreign Currency Portion, L.C. = Local Currency Portion
Plant Site; BMC = Ban Mab Chalood, BNY = Ban Nong Yai
Ammonia Source; I = Import, D = Domestic

TABLE 4 SENSITIVITY ANALYSIS ON OVERALL PROJECT
(Rock Salt Mine: 1,800,000 t/y)

(%)

Case	IRR (Before)	IRR (After)
BMCD	10.02	8.94
BNYI	9.24	8.20
BNYD	9.42	8.37
BMCI	9.07	8.04

Sensitivity		Case BMCD		Case BNYI	
		Before	After	Before	After
IRR on Equity	4%	—	14.76	—	13.05
	5%	—	14.26	—	12.57
	6%	—	11.87	—	10.13
Investment	10% up	6.52	7.52	7.76	6.82
	10% down	11.74	10.58	10.93	9.80
Sales R/S	20% up	10.69	9.57	9.89	8.82
	10% up	10.36	9.26	9.57	8.51
	10% down	9.68	8.61	8.90	7.88
	20% down	9.33	8.28	8.56	7.56
Sales S/A	10% up	12.05	10.88	11.22	10.08
	10% down	7.81	6.87	7.07	6.19
Sales A/C	10% up	11.46	10.31	10.65	9.53
	10% down	8.50	7.50	7.74	6.80
Ammonia	20% down	11.46	10.31	10.65	9.54
	10% down	10.75	9.63	9.95	8.87
	10% up	9.27	8.22	8.50	7.51
	20% up	8.49	7.50	7.74	6.80

PART I OUTLINE DESCRIPTION OF THE PROJECT

PART I OUTLINE DESCRIPTION OF THE PROJECT

CHAPTER 1 ROCK SALT MINE

1–1 REGION WHERE ROCK SALT IS TO BE MINED

Following the original plan of the Thai Government, rock salt in deposits in the Bamnet Narong area of Northeastern Thailand is to be mined. It is proposed that mining be done in Halite-A of S-Area.

1–2 LOCATION OF ROCK SALT MINE

Bamnet Narong (about 225 km northeast of Bangkok).

1–3 SCALE OF MINE PRODUCTION

As agreed in the Supplemental Agreement on the ASEAN Rock Salt – Soda Ash Project (Thailand), the ASEAN member states decided that the production capacity of the rock salt mine shall be 1.8 million T/Y based on three shifts operation of 2,000 T/D per shift and 300 working days a year, and that the Thai Shareholders Entity shall be responsible for off-taking all the surplus of rock salt produced at the rock salt mine which could annually arise after the supply to the soda ash plant to meet its requirements.

1–4 MINING METHOD

The room and pillar method is to be used. A belt conveyor along the inclined shaft is to be used to transport the mined rock salt to the surface of the ground.

1–5 UTILITIES

Electric power:	To be supplied from the EGAT system, requiring construction of a 60 km transmission line.
Water:	To be supplied by means of a pipeline from the Amphoe Bamnet Narong swamp about 8 km from the mine.

CHAPTER 2 SODA ASH PLANT

2–1 LOCATION OF PLANT SITE

As has been proposed by the Thai Government (GOT), the plant is to be either at Ban Mab Chalood in Rayong Province or at Ban Nong Yai in Chonburi Province.

2–2 SODA ASH PRODUCTION PROCESS

As a result of technical and economic comparison of he Solvay Process, the Partial AC Process, and the Full AC Process, it is proposed that the Full AC Process be employed.

2–3 DESIGN CAPACITY

Whereas the Thai Government had anticipated that the initial production capacity would be 400,000 T/Y and that it would later be increased to 500,000 T/Y, when the Full AC Process is employed, the marketability of ammonium chloride becomes the limiting factor and in view of that the following design capacity is proposed:

Soda ash: 400,000 T/Y
Byproduct ammonium chloride: 400,000 T/Y

2–4 REQUIRED MATERIALS

2–4–1 Rock Salt

A rock salt storage facility is to be established in the site of soda ash plant and is to be used for shipment of rock salt to be exported as well as storage for supply to the plant. Rock salt is to be transported from the mine to the storage facility by railway wagon, and transport of the rock salt from the facility to the soda ash plant is to be by belt conveyor.

2–4–2 Carbon Dioxide

Carbon dioxide which is separated from natural gas at the PTT natural gas processing plant in Rayong Province can be collected rather than discharged, and conveyed to the soda ash plant by a pipeline to be constructed as part of this Project.

2–4–3 Ammonia

Two sources, i.e., supply by importation and supply from the domestic fertilizer production project which is now being negotiated by the GOT, are considered.

2–5 UTILITIES

2–5–1 Electric Power

IEAT will supply receiving from the EGAT network to the battery limit of the soda ash plant.

2–5–2 Water

Royal Irrigation Department will lay a pipeline from the Dok Krai reservoir to the Intake Pond at Ban Mab Chalood. From the Intake Pond to each plant site, IEAT will distribute water through pipeline network.

2–5–3 Natural Gas

PTT will supply natural gas to the battery limit of the soda ash plant.

2–6 INFRASTRUCTURES

2–6–1 Railway

Rock salt will be transported by railway from the rock salt mine to the soda ash plant as well as to the Sattahip Port for export. This operation requires the following, however it is assumed that hopper cars and marshaling locomotives will be procured by the TSR at its cost.

(1)	Rail spur for the rock salt mine	5.7 km
(2)	Rail spur for the soda ash plant	
	at Ban Mab Chalood	0.8 km
	at Ban Nong Yai	5.0 km

As for the product soda ash, it is to be transported from the soda ash plant to the Sattahip Port by railway and from the Sattahip Port it will be exported. It is also assumed that hopper cars and marshaling locomotives for this operation will be procured by the TSR at its cost.

For information, the required quantities of hopper cars and marshaling locomotives are:

Main locomotives	9 cars
Marshaling locomotives	3 cars
Hopper cars for rock salt	181 cars
Hopper cars for soda ash	18 cars

Identical hopper cars will be used for both rock salt and soda ash.

2–6–2 Harbour Facilities

The GOT has decided to implement a project to expand the Sattahip Deep Sea Port with a schedule that the expansion project will be completed so as to be ready for use by the time when the ASEAN Rock Salt – Soda Ash Project (Thailand) begins functioning, so the Project will use the harbour facilities of the Sattahip Deep Sea Port for the exportation of soda ash as well as rock salt. Even in this event, the installation and construction of storage facilities, bulk materials loading facilities, belt conveyors and ship loaders are to be part of the present Project.

2–7 IMPLEMENTATION SCHEDULE

The start of operation of the plant and the mine is assumed to be in mid-1985.

PART II MARKET STUDY

PART II MARKET STUDY

CHAPTER 1 SODA ASH

1–1 OUTLOOK FOR SODA ASH DEMAND, AND PROJECTED VOLUME OF SODA ASH SALES OF THIS PROJECT

The ASEAN nations have reached an agreement guaranteeing their purchases of soda ash from this Project. The sales volume as projected by the Thai Government is shown in Table II-1.

Table II–1 PROJECTED SALES OF SODA ASH TO THE ASEAN NATIONS (Forecast by the Thai Government)

(Unit: 1,000 T)

	1980	1985	1990
Thailand	81	127	205
Malaysia	34	54	86
Singapore	18	26	36
Indonesia	68	110	176
Philippines	104	143	202
ASEAN Total	305	460	705

On the basis of the above envisioned arrangements, supply of soda ash from the Project would satisfy the majority of ASEAN nations' requirements. Demand for soda ash in the ASEAN nations, as forecast by the Study Team, is given in Table II-2.

Table II–2 ESTIMATED DEMAND FOR SODA ASH IN THE ASEAN REGION (Forecast by the Study Team)

(Unit: 1,000 T)

	1985	1990	1995
Thailand	119.6	175.3	223.3
Malaysia	53.5	74.2	100.3
Singapore	22.7	26.3	30.1
Indonesia	124.6	170.1	223.3
Philippines	109.1	146.7	193.3
ASEAN Total	429.5	592.6	770.3

However, the following conditions would be taken into consideration: (a) the Southeast Asian market's historically having been the major market for natural ash from Kenya, and having been a spot market for East European and Korean products, and (b) particularly that Kenya is planning on doubling production capacity of natural ash. In order to secure markets for the soda ash of this Project, it seems to be essential that preferential arrangements within the ASEAN market are made for soda ash under the Preferential Trading Arrangements. Nevertheless, since it is not known yet as to what arrangements will be made, in view of these conditions, it is projected that the marketable quantity of the soda ash produced by this Project is to be as shown below, in Table II–3.

Table II–3 MARKETABLE QUANTITY OF SODA ASH IN THE ASEAN REGION (Forecast by the Study Team)

(Unit: 1,000 T)

	1985	1990	1995
Thailand	120	175	223
Malaysia	43	60	80
Singapore	16	18	21
Indonesia	93	128	168
Philippines	96	129	170
ASEAN Total	368	510	662

As is evident from Table II-3, the forecast made by the Study Team of the marketable quantity of soda ash from the Project is lower than that which had been forecast by the Thai Government.

1–2 SODA ASH MARKET PRICE

The major source of soda ash supply in the past has been synthetic soda ash, but due to the discovery of natural ash in the United States and Kenya the relative cost competitiveness of the synthetic product has declined, and natural ash has come to dominate soda ash trade. In the ASEAN region, reflecting this worldwide situation, the status of Japan which had been a major exporter to the ASEAN markets has steadily experienced a decline and, simultaneously, the status of Kenya products in the ASEAN market gained in importance. Moreover, it is expected that in the future American exports to the ASEAN region will also increase.

In the past Kenya maintained its market share on the strength of the low price of its natural ash, but recently has changed its approach and whereas in the past the Kenya product had been lower in price than that of the United States, recently it has tended to follow the American product in terms of price. It is expected that this tendency will continue in the future. Therefore it may be assumed that in the future the market price will be determined by the American product's price. The outlook is that in the United States from about 1985 there will be a shortfall in supply of soda ash, and at such a time it is to be expected that price formation will take place within the entire soda industry, including caustic soda. In view of this it is expected that the price of American natural ash will increase. On the other hand, Kenya has embarked on a program intended to double its supply capacity and because Kenya will be faced by a tendency for there to be an over-supply, it is likely that Kenya will export ash at prices somewhat lower than those of the American product.

On the basis of consideration of the conditions as described above, the CIF prices for soda ash in the ASEAN nations are as in Table II-4 below.

Table II–4 PROJECTED SALES PRICE FOR SODA ASH IN THE ASEAN NATIONS (1985)

(Unit: US$/T)

	CIF price in country of destination
Thailand	225
Malaysia	229
Singapore	230
Indonesia	229
Philippines	225

CHAPTER 2 ROCK SALT AND AMMONIUM CHLORIDE

2–1 INTRODUCTION

This chapter presents the outcome of market study with regard to rock salt and ammonium chloride. It must be noted, however, that according to the Minutes of Meetings held between the Thai counterpart team and the Study Team prior to the execution of this study, market studies were excluded from the present study, so that the market outlook and future demand projection presented in subsequent sections are based on the previous study conducted in September, 1980, without any revision referring to changes in salt demands which are currently reported in respect of Indonesia and the Philippines.

Hence it should be further noted that this chapter is presented for the purpose of completeness of the report.

2–2 ROCK SALT

2–2–1 Outlook for Rock Salt Demand, and Marketable Rock Salt Quantity from This Project

Although the Thai Government sought to obtain purchase guarantees from other ASEAN countries for rock salt, because it has not proved possible to obtain such consent, it has become necessary for the entity implementing this Project to undertake the marketing of surplus rock salt (i.e., rock salt available after requirements for production of soda ash in the plant are met) under free market conditions within Thailand, and the exporting of it.

According to the Thai Government plan, as shown in Table II-5, a considerable quantity of exports to the ASEAN nations is anticipated. This marketing plan was formulated on the basis of the demand projections made by SNC, the Canadian firm retained as the consultant by the Thai Government, at the stage of the feasibility study for this Project. Because the SNC study did not take into account the supply of solar salt in each country, its report contains inflated figures for rock salt demand in those countries.

Table II–5 ANTICIPATED QUANTITY OF ROCK SALT MARKETED IN THE ASEAN REGION (Thai Government Forecast)

(Unit: 1,000 T)

	1980	1985	1990
Thailand	149	216	362
Malaysia	82	120	206
Singapore	37	46	65
Indonesia	220	354	606
Philippines	115	161	226
ASEAN Total	603	897	1,465

(Note) Rock salt supplied to the soda ash plant is excluded from the above.

In actuality, production of solar salt is being undertaken in Thailand, Indonesia and the Philippines, and with the exception of a portion of industrial salt each country has satisfied its demand by means of this solar salt. In the case of Thailand in particular not only are domestic requirements being met by solar salt but the country is exporting solar salt to Malaysia and Singapore besides, and this situation is not expected to change in the near future. Meanwhile, faced with increased demand for industrial salt, Indonesia and the Philippines are progressing with plans for significant increases in domestic production capacity of industrial salt, and moving toward positions wherein they will be self-sufficient with regard to salt, including industrial salt. Because the quality of Thai-produced solar salt is low, it is possible that rock salt can be used as industrial salt in that country. But in view of the conditions as described above, the only countries in the ASEAN region other than Thailand which could use Thai rock salt, and become potential export markets for rock salt thereby, are Malaysia and Singapore. But even in this case, as is described below, because of a problem concerning the quality of the Thai rock salt, as well as competition with Australian salt, optimism over the prospects for exportation of rock salt are not justified. The quantity of rock salt which may be considered marketable in the ASEAN region, in light of the foregoing conditions, is as shown in Table II-6.

Table II–6. ANTICIPATED QUANTITY OF ROCK SALT MARKETED IN THE ASEAN REGION (Study Team Forecast)

(Unit: 1,000 T)

	1985	1990	1995
Thailand	81	178	245
Malaysia	147	199	217
Singapore	8	8	9
Indonesia	–	–	–
Philippines	–	–	–
ASEAN Total	236	385	471

(Note) Rock salt supplied to the soda ash plant is excluded from the above.

In addition, about 100,000 T/Y could be exported to outside the ASEAN region (mainly Taiwan) by using 15,000 to 20,000 DWT class vessels. If 60,000 DWT class vessels can be used, the exports to non-ASEAN would be increased. Moreover, with a soda ash production level of 400,000 T/Y, the quantity of rock salt supplied to the soda ash plant would be about 200,000 T in 1985 (70% utilization of capacity, and half-year operation), and about 560,000 T in 1990 (100% utilization of capacity). With the inclusion of these quantities, the total anticipated quantity of marketable rock salt, as shown in Table II-7, is much lower than the level which had been expected by the Thai Government.

Table II–7 OUTLOOK FOR MARKETABLE ROCK SALT FOR THIS PROJECT

(Unit: 1,000 T)

	1985	1990	1995
Supply to soda ash plant	198*	562	562
Domestic sales in Thailand	81	178	245
Exports to ASEAN region	155	207	226
Malaysia	(147)	(199)	(217)
Singapore	(8)	(8)	(9)
Exports to outside ASEAN region	100	100	100
TOTAL	534	1047	1133

(Note) *Assuming the soda ash plant starts operation in July, 1985.

2–2–2 Marketability of Thai Rock Salt

In view of the sodium chloride content of the rock salt to be mined in this Project, it has a quality comparable to other sources of salt being used as industrial salt. The Thai rock salt appears to have slightly higher contents of the insoluble matter (I.M.) particularly the sulfates, although this is still a provisional view, assumed on the basis of a limited number of samples available for analysis. Because users which might use this as industrial salt would have to incur additional costs of purification of the salt, it would be necessary to lower the sales price to them to some extent. Nevertheless, this salt is of a quality which lies within the range of usability as industrial salt and it is judged that it is marketable given the stipulation that the price is discounted as described below.

2–2–3 Rock Salt Sales Price

Australia and Mexico are the two major exporting countries engaged in world salt trade. Japan is the world's largest importer, and Australia and Mexico compete for share in that market. Price formation for salt is strongly influenced by the cost of ocean freight. Both Australia and Mexico have sought to reduce unit freight costs through such measures as utilizing large carriers (60,000 DWT class) and improving loading capacity. Both countries' export price (FOB) to other countries is determined on the basis of the FOB price for sale to Japan.

Australia is the major exporter to the Southeast Asian market, and exports from Thailand would have to compete with Australian salt. The CIF price to each country would be determined by adding to the Australian FOB price the cost of ocean freight which is determined in turn by the size of the vessel used, and it is necessary for any exports from Thailand to be competitive with the CIF price for Australian salt in importer-country delivered prices.

Using these assumptions, the CIF price for each country, as the 1985 price, and the FOB price obtained by subtraction of the freight cost from Thailand, are given in Table II-8 below.

Table II–8 EXPORT PRICE LEVEL FOR THAI ROCK SALT (1985)

(Unit: US$/T)

Destination	Destination country CIF price	Cost of transportation from Thailand	Thai FOB price
Malaysia	50	17	33
Singapore	41	15	26
Taiwan	34	15	19
S. Korea	34	19	15
Japan	34	19	15

(Note) Assuming the use of 15,000–20,000 DWT class or smaller vessels.

The above assumes that the quality of Thai export rock salt is equivalent to that of Australian product as already in the market. But in view of the slightly lower purity of Thai salt relative to the Australian products, some discount in price is needed to compensate for the quality differential. It would also be necessary to consider additional discounting as being necessary in order to become established in a new market. In view of these conditions, the projected Thai FOB price for each importer country are as follows. It is noted that the ocean freight charges to Taiwan, S. Korea and Japan cited above were estimated on the assumptions that 15,000 to 20,000 DWT vessels are used, due to constraints in Thailand port facilities. If it is possible to use 60,000 DWT class vessels, the freight could be reduced to US$17/T, so that the Thai FOB price could be increased to US$16/T, even taking a discount into account.

Table II–9 SALES PRICE OF ROCK SALT PRODUCED BY THIS PROJECT (1985)

(Unit: US$/T)

Destination	Price
Thailand	30
Malaysia	29
Singapore	24
Non-ASEAN (Taiwan)	*17
Non-ASEAN (Others than Taiwan)	16

(Note) Assuming the use of 60,000 DWT class vessels.

2–3 AMMONIUM CHLORIDE

2–3–1 Outlook for Ammonium Chloride Demand, and Marketable Ammonium Chloride Quantity from This Project

Ammonium chloride is one form of nitrogen fertilizer and, accordingly its marketability is largely dependent on the combination in each country of types of crops cultivated, soil characteristics, and fertilizer use patterns. In the ASEAN countries, other than Thailand, urea and ammonium sulphate are the most commonly used nitrogen fertilizers (in some countries extensive use is made of ammonium nitrate), so there is no outlook for exportation of ammonium chloride to these countries. The most commonly used fertilizer in Thailand has been compound fertilizer; as the source of nitrogen in its production, imported ammonium chloride has been used. Hence, if ammonium chloride is produced by this Project, it can substitute for those imports. It is though that production of compound fertilizer, as well as facilities for its production, will increase in the future in keeping with the growth of demand. Moreover, there is some use of ammonium chloride as straight fertilizer.

Whereas ammonium chloride or ammonium-chloride-containing compound fertilizer has been used for paddy rice cultivation in the past, it is expected that this trend will continue. In view of this and relevant conditions, the outlook for the quantity of ammonium chloride marketable in the domestic Thai market is as shown in Table II-10.

Table II–10 OUTLOOK FOR MARKETABLE AMMONIUM CHLORIDE IN THAILAND (Study Team Forecast)

(Unit: 1,000 T)

1985	1990	1995
285	373	433

Outside of the ASEAN region, India and China have been the major nations which have made use of imports of ammonium chloride from Japan. If the product of this Project is cost-competitive, it is expected that exports on the order of 40,000–50,000 tons will be possible.

2–3–2 Ammonium Chloride Sales Price

The market price of ammonium chloride is determined in relation to the prices of other nitrogen fertilizers.

The price in 1985, taking into consideration this linkage, is forecast to be as follows.

– Price in the domestic Thai market   US$150/T

PART III STUDY OF TECHNICAL ASPECTS OF DEVELOPMENT PLANNING OF THE ROCK SALT MINE

PART III STUDY OF TECHNICAL ASPECTS OF DEVELOPMENT PLANNING OF THE ROCK SALT MINE

CHAPTER 1 ROCK SALT DEPOSIT

The Bamnet Narong rock salt deposit is located in the southwest portion of the Khorat Plateau in northeastern Thailand, at approximately 15°28′ northern latitude and 101°24′ eastern longitude. The deposit is in strate laying below 60–80 m from the surface, and is 100–280 m thick (see Figure III-1).

There are two strata of rock salt in the deposit, but the higher-quality Halite-A stratum (S-Area) is of primary concern. The mining level is at the elevation of 61 m from sea level, at about 140 m under the surface of the ground. The recoverable reserves of salt within the selected zone are estimated to be 37 million tons and at the scale of production envisioned in this study (1.8 million tons/year) this quantity of reserves is adequate for 20 years operation, which is adequate over the life of this Project.

It must be noted, however, that the above selection is still in a preliminary stage from an engineering point of view, although it provides a basis sufficient for financial evaluation, and will require precise review in order to develop the final design which should be prepared for inviting contractors. For this end it is recommended that rock mechanic tests, soil tests and other relevant efforts be made by the Thai authorities in order to collect and analyze more data and information as required.

There are some analyses indicating that higher purity of rock salt exists in a deeper stratum. However, since these analyses provide limited information to determine whether such higher purity of rock salt is prevalent or not, the mining level cited above has been selected as the basis for the present study. It is recommended that further efforts be made by the Thai authorities with regard to the collection and analysis of additional samples.

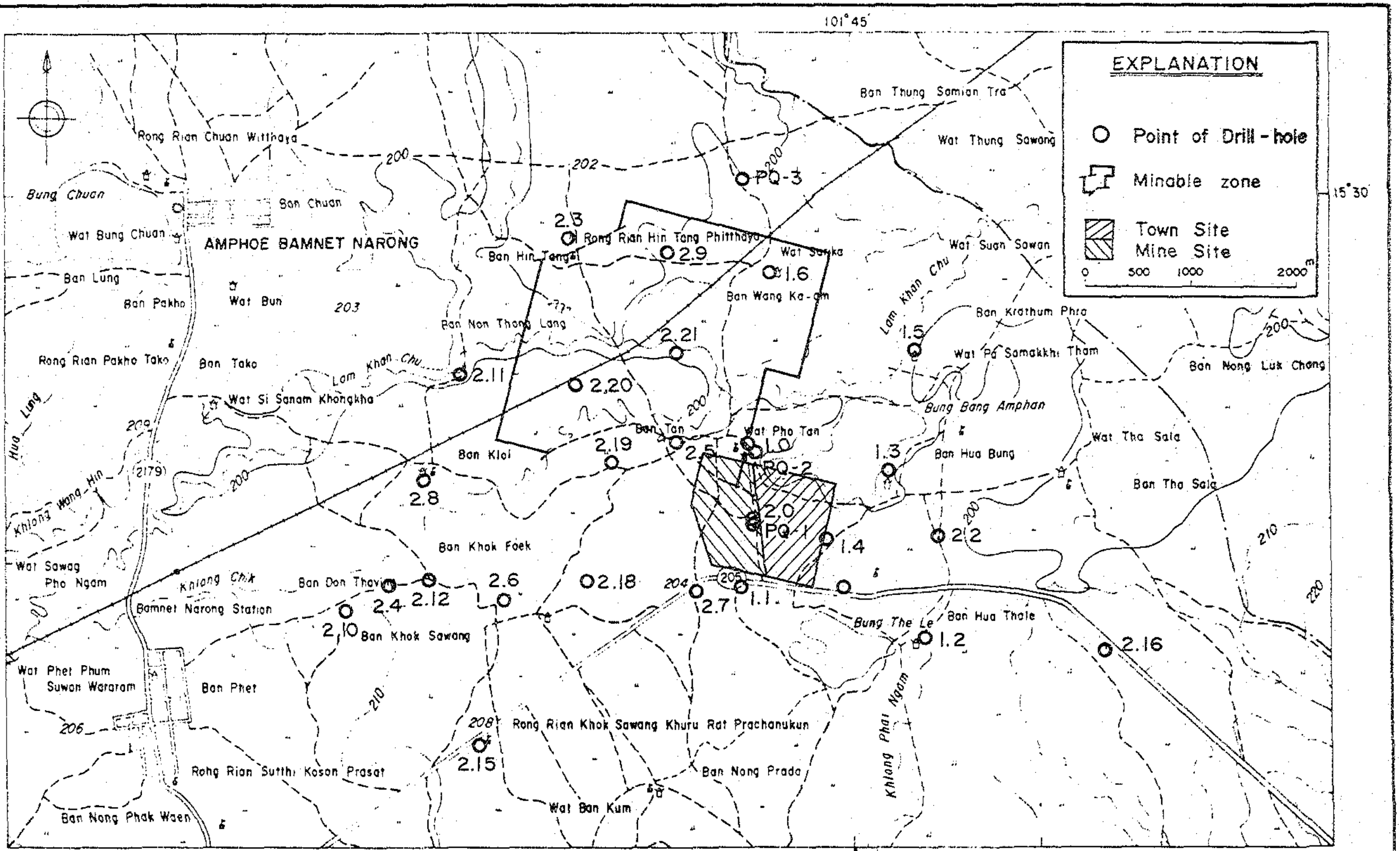


Fig. III–1 INDEX MAP OF BAMNET NARONG AREA

CHAPTER 2 MINING PLAN

The scale of mine production is taken to be 2,000 tons per single 8-hour shift. On the assumption that the mine is worked in three shifts and worked 300 days out of the year.

The room and pillar method is to be employed, and considerations are to be given so as not to interfere with the railroad, fields and paddies, villages, etc. on the surface. Blasting is to be employed in order to minimize loose salt and also minimize investment cost.

Mechanized mining methods are to be used. Crushing and screening are to be performed within the mine, so as to prevent any environmental problems caused by noise and airborne salt particles. Salt which has been crushed and screened will be transported to outside the mine by a belt conveyor and charged to a bunker for loading of freight cars.

Supply of utilities required for the mine is to be as follows.

– Electric power : To be supplied from EGAT's system and hence to require a 60 km transmission line.

– Water : To be obtained from a swamp at Amphoe Bamnet Narong, at a distance of about 8 km from the site.

All of the facilities, equipment and structures for the mine, including those directly required for production, utilities and ancillary use (e.g., worker's housing quarters) are to be newly constructed and acquired. A rail spur is to be constructed for use in transporting products from the mine.

CHAPTER 3 IMPLEMENTATION SCHEDULE AND MANPOWER PLAN

Construction of the mine and related facilities including utility facilities is to be accomplished in 3 years. Therefore, operation is assumed to begin in mid-1985.

For three shifts, about 250 employees including a Mine Manager will be required to operate the mine.

CHAPTER 4 CONSIDERATION ON PREVENTION OF ENVIRONMENTAL PROBLEMS

In examing the design of mine facilities, mining method and excavation work as well as mine operation, full consideration has been given to the prevention of any environmental problems caused by the construction and operation of the rock salt mine.

PART IV STUDY OF RAIL TRANSPORTATION OF ROCK SALT AND SODA ASH

PART IV STUDY OF RAIL TRANSPORTATION OF ROCK SALT AND SODA ASH

CHAPTER 1 INTRODUCTION

In this Project, following products are to be transported by railway.

1. Rock Salt
   Annual volume : 1,800,000 tons
   Section : from Bamnet Narong
   to Soda ash plant
   – Ban Mab Chalood
   or – Ban Nong Yai
   to Export harbor
   – Sattahip Port

2. Soda Ash
   Annual volume : 400,000 tons
   Section : from Soda Ash plant
   – Ban Mab Chalood
   or – Ban Nong Yai
   to Export harbor
   – Sattahip Port

In order to plan the transportation of the products, it is necessary to study following points.

1. Possibility of using the State Railway for rock salt and soda ash transportation
2. To define and conceptually design the required facilities
3. Rail freight charges for product transportation

However, in the Previous Report, 1. and 2. above were studied in detail. And the difference from the Previous Report is only in the transportation distances, therefore, in this Report discussion will be made for the results of study leaving the design criteria etc. as in the Previous Report.

CHAPTER 2 TRANSPORTATION ROUTE

The proposed transportation route is shown in Figure IV-1. The section between Chachengsao – Sattahip is under construction and it will be completed by the end of 1983, before the scheduled commencement of commercial operation of the Project by middle of 1985. Therefore, even if completion of the construction of this section is delayed, there is still ample time for the line to be opened prior to the start of the operation of the soda ash plant. Thus, it is assumed that the Project will be able to avail itself of use of this section.

On the other hand, the proposed Ban Phu Ta Luang – Rayong section is planned to be completed by the middle of 1985. In addition to this plan, a Bangkok by-pass line is being proposed by TSR so as to connect Khlong Sip Kao and Ban Pha Chi.

Distances between major stations are as follows:

1. Bamnet Narong – Sattahip Port

Rock salt mine	
	5.7 km
Bamnet Narong	
	345.8 km
Chachengsao	
	134.0 km
Sattahip	
TOTAL	485.5 km

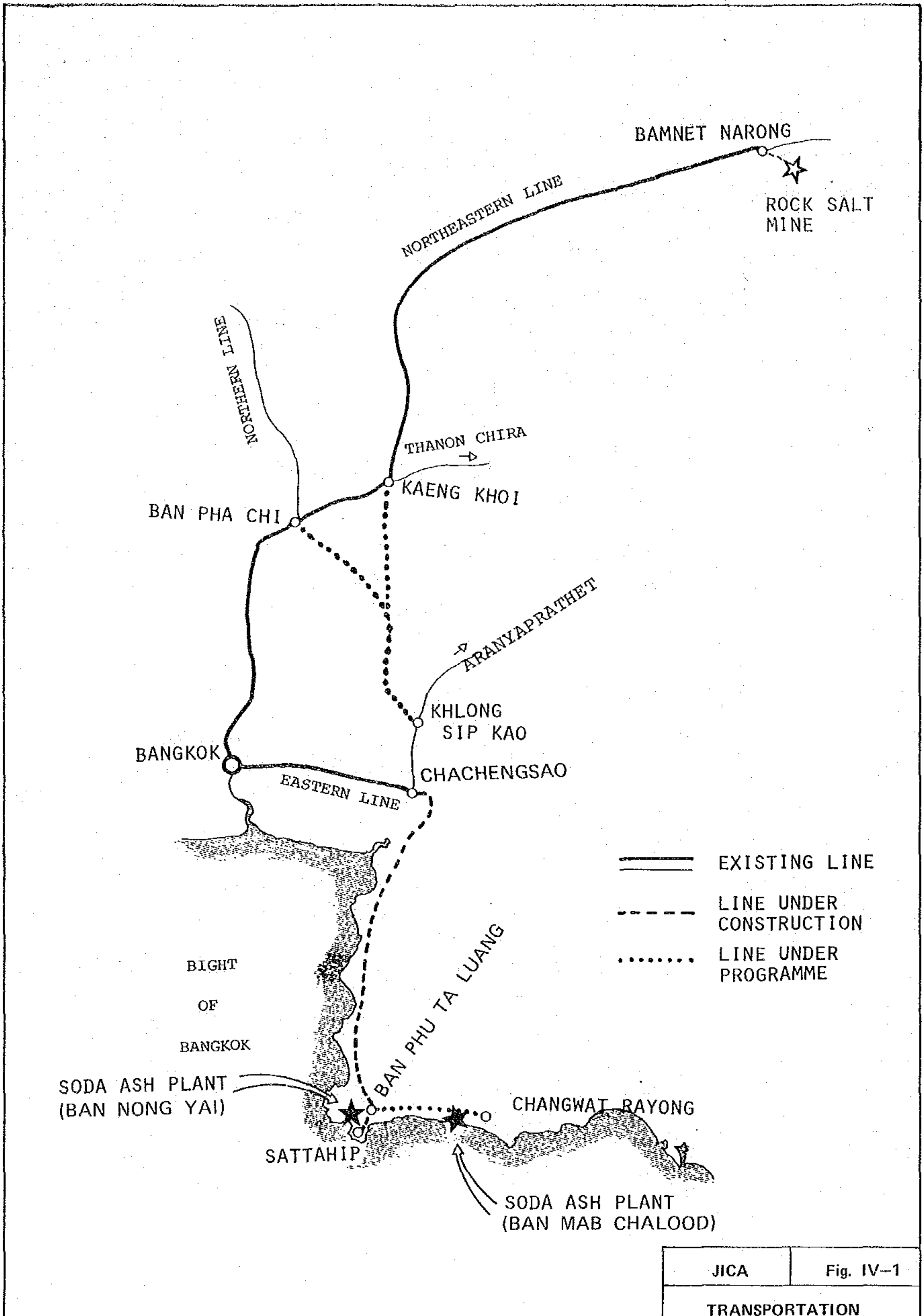
2. Bamnet Narong – Ban Mab Chalood

Rock salt mine	
	351.5 km
Chachengsao	
	141.5 km
Ban Mab Chalood	
	0.8 km
Soda ash plant	
TOTAL	493.8 km

3. Bamnet Narong – Ban Nong Yai

Rock salt mine	
	351.5 km
Chachengsao	
	123.5 km
Ban Phu Ta Luang	
	5.0 km
Soda ash plant	
TOTAL	480.0 km

4. Sattahip – Ban Mab Chalood 28.5 km
5. Sattahip – Ban Nong Yai 15.8 km



JICA	Fig. IV–1
TRANSPORTATION ROUTE MAP	

CHAPTER 3 TRANSPORTATION PLAN

3–1 ROCK SALT TRANSPORTATION

3–1–1 Rolling Stock and Train Operation

(1) Main line locomotives

Type	:	Alsthom type
Axle load	:	13.75 tons
No. of axles	:	6
Traction load	:	1,398 tons

(2) Freight cars

Type	:	Hopper cars as shown in Figure IV-2
Car capacity	:	60 tons

(3) Trains

Hopper cars	:	23 cars
Length	:	399 m
Capacity	:	1,005 tons/train of rock salt

3–1–2 Train Operation Plan

(1) Rock salt transport train
1. Rock salt mine – Sattahip port
2. Rock salt mine – Soda ash plant

2 exclusive use trains

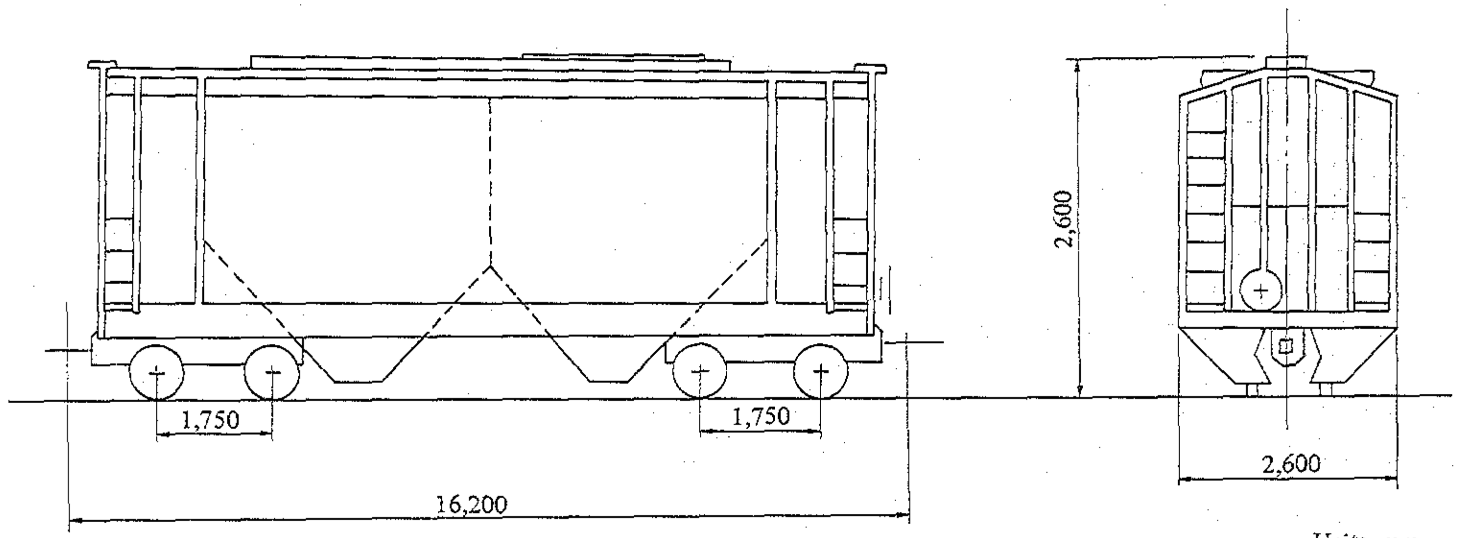
(2) Required number of trains

Daily requirements (1,005 tons/train)

1.	Rock salt mine – Sattahip Port	3 trains
2.	Rock salt mine – Soda ash plant	2 trains

(3) Number of hopper cars per train

Including one train of spare, 8 trains are required for annual operation, therefore, 181 hopper cars are required.



Axle Loading	15 ton
Car Capacity	60 ton
Light Weight	16.3 ton
Load Limit	43.7 ton

FIG. IV-2 60-TON CAPACITY COVERED HOPPER CAR FOR ROCK SALT

3–2 SODA ASH TRANSPORTATION

On the basis of following product movement, train system for soda ash transportation is projected.

Product	:	Soda ash in bulk
Annual transportation amount	:	400,000 tons
(1) Rolling stock		
Locomotive	:	1 car
Hopper cars	:	18 cars
Caboose	:	1 car
Length of a train	:	277 m
(2) Number of trains required	:	2 trains/day

CHAPTER 4 RAILWAY SPURS AT ROCK SALT MINE AND SODA ASH PLANT

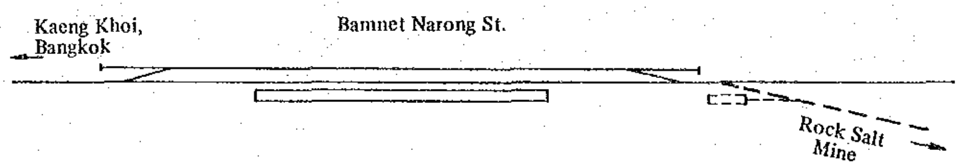
4–1 INTRODUCTION

In the Previous Report, design criteria for conceptual design of railway spur is defined and, on that basis, spurs for rock salt mine and soda ash plant are conceptually designed. Therefore, in this Chapter, only the results of conceptual design of spurs are discussed.

4–2 MINE SPUR

4–2–1 Bamnet Narong – Mine Spur

Figure IV-3 illustrates this spur and as for spur in the Bamnet Narong station, it is shown below.

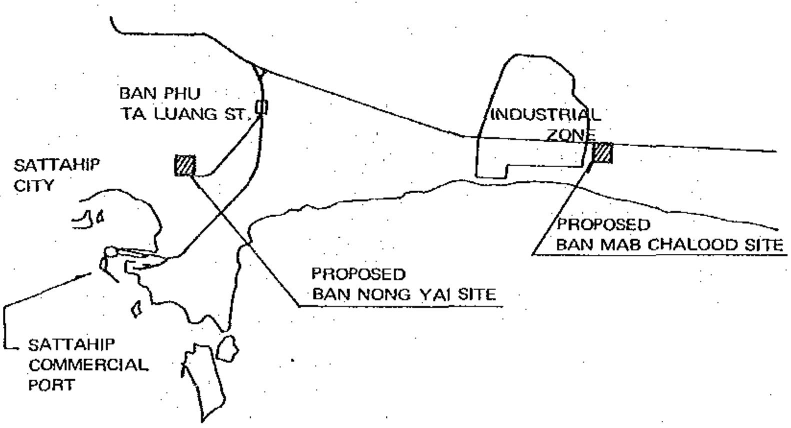


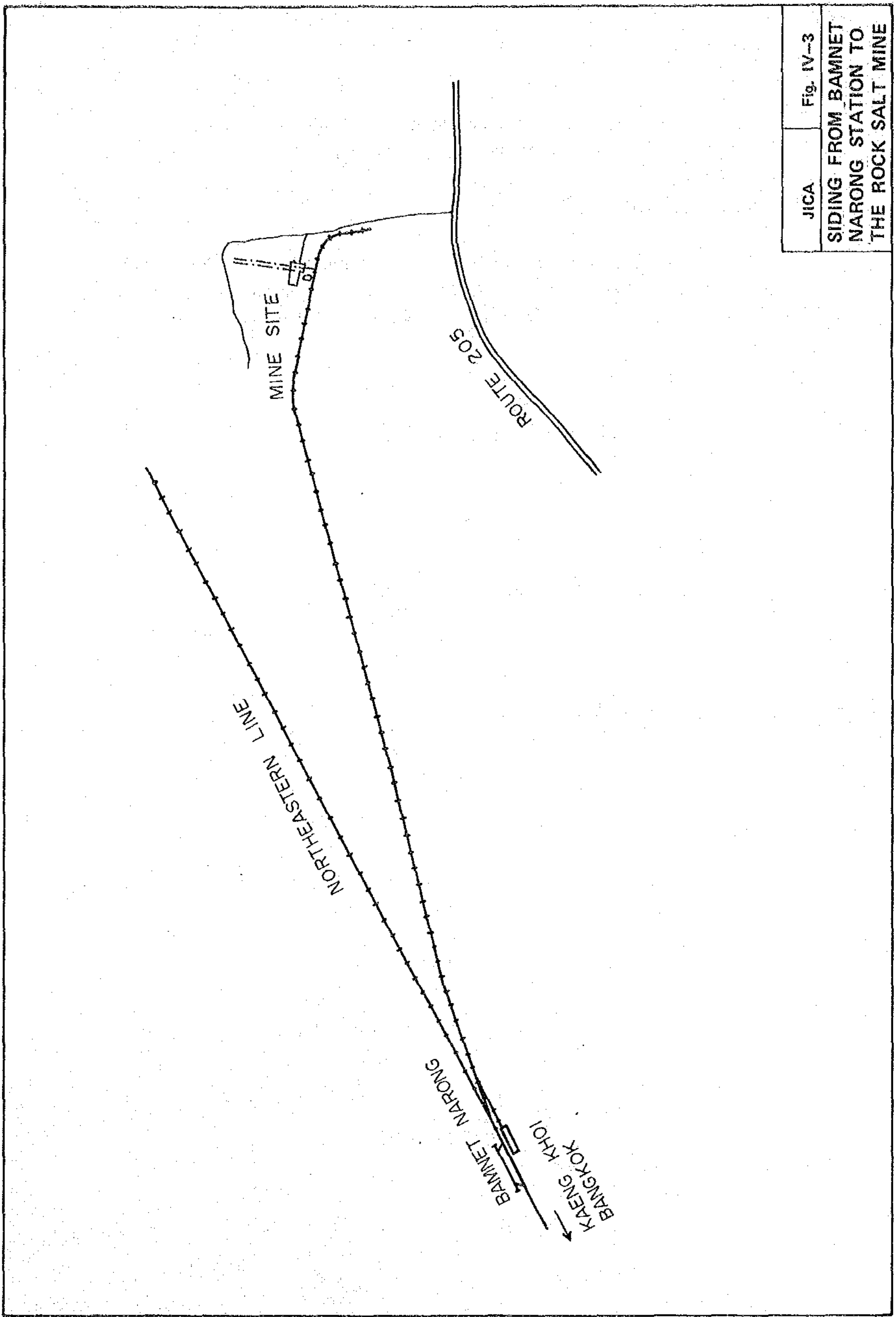
4–2–2 Yard Track in the Mine

It is shown in Figure IV-4.

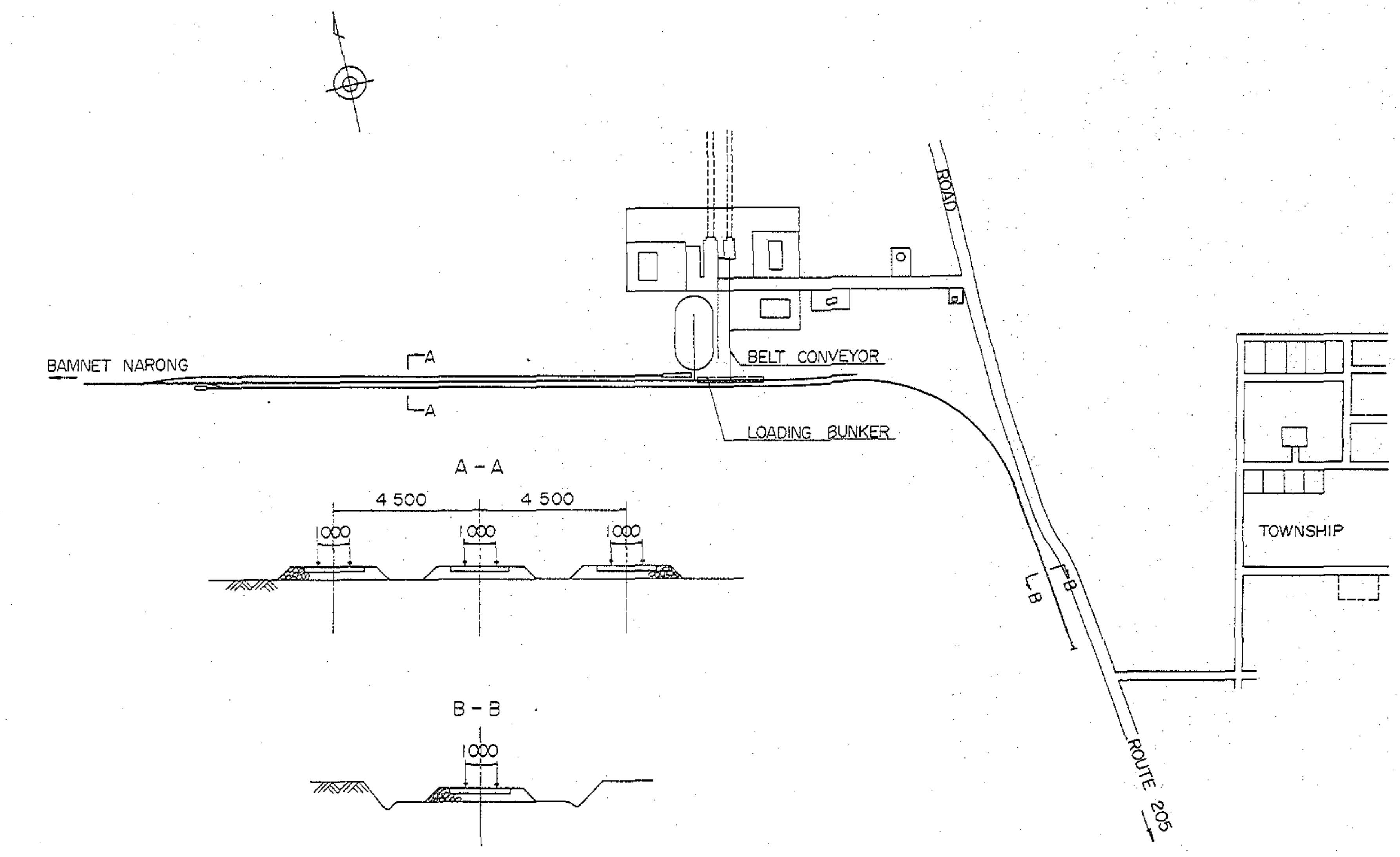
4–3 SODA ASH PLANT SPUR

Proposed location of soda ash plant is to be either Ban Mab Chalood or Ban Nong Yai, therefore, spurs for both sites are conceptually designed hereafter.





JICA — Fig. IV–3 SIDING FROM BAMNET NARONG STATION TO THE ROCK SALT MINE



JICA | Fig. IV–4

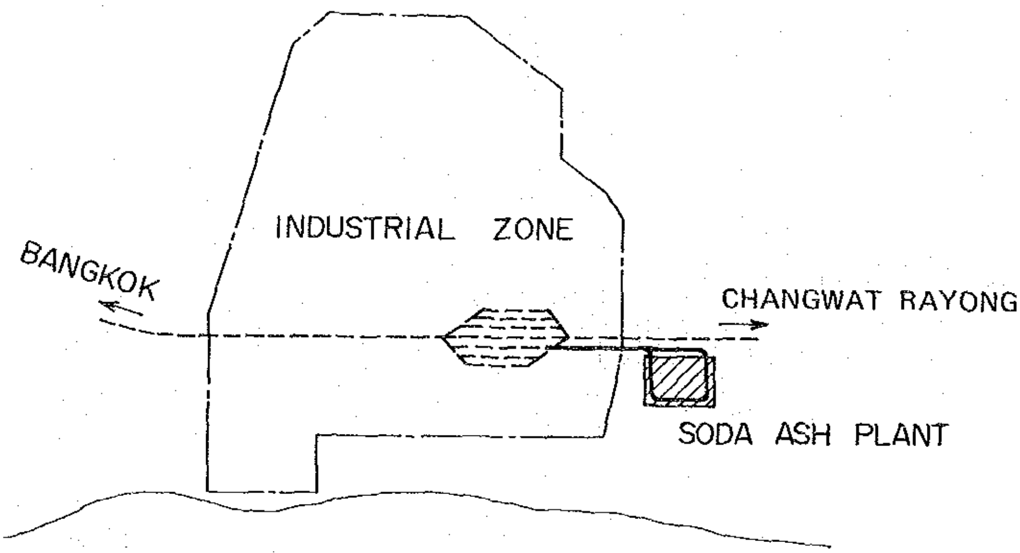
YARD TRACKS IN THE ROCK SALT MINE

4–3–1 Ban Mab Chalood Site

(1) Spur between Ban Mab Chalood marshalling yard and soda ash plant

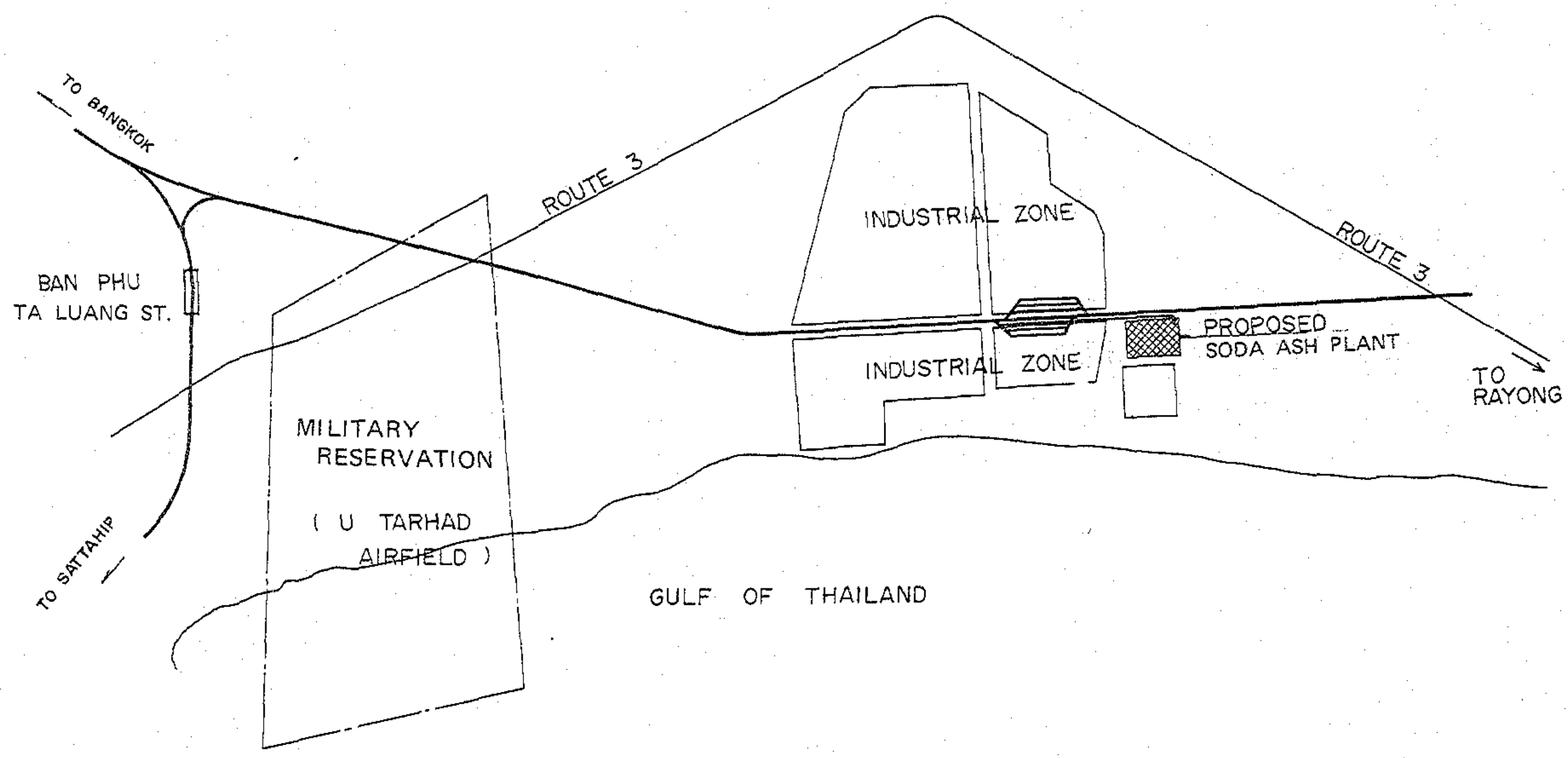
The line between Chachengsao and Sattahip is under construction by TSR and, extending this line, a line is being proposed to connect between Ban Phu Ta Luang marshalling yard and Changwat Rayong (See Figure IV–5). Soda ash plant site is to be located along side the proposed Changwat Rayong line, which is planned to run through the proposed Rayong Industrial Zone as shown below.

A marshalling yard is proposed to be located at the center of the Industrial Zone. Therefore, the spur for the Project is required to be approximately 800 m between the soda ash plant and the marshalling yard.



(2) Yard track in the soda ash plant

Shown in Figure IV-6.



JICA	Fig. IV–5

PROPOSED RAYONG LINE AND BAN MAB CHALOOD SITE

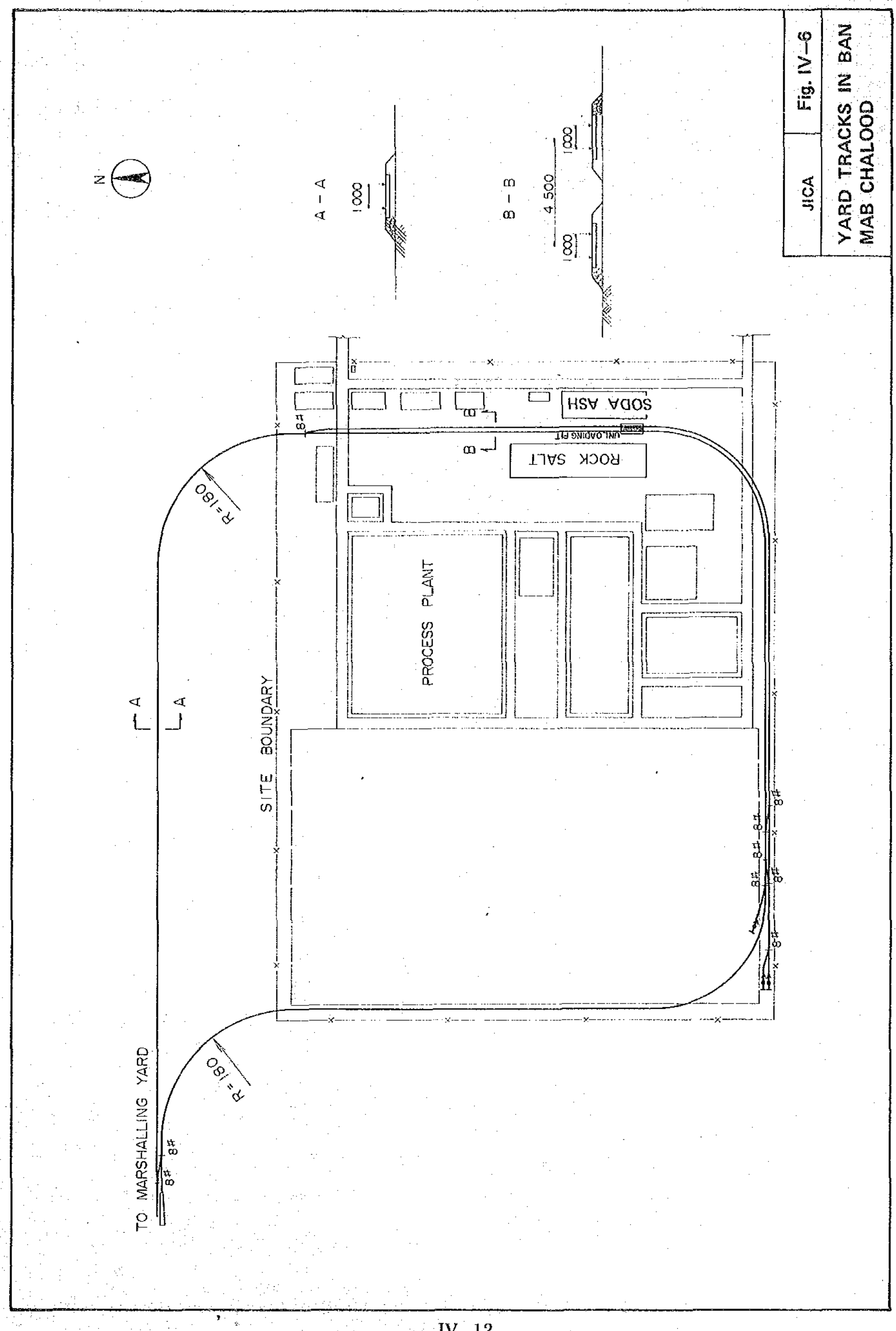
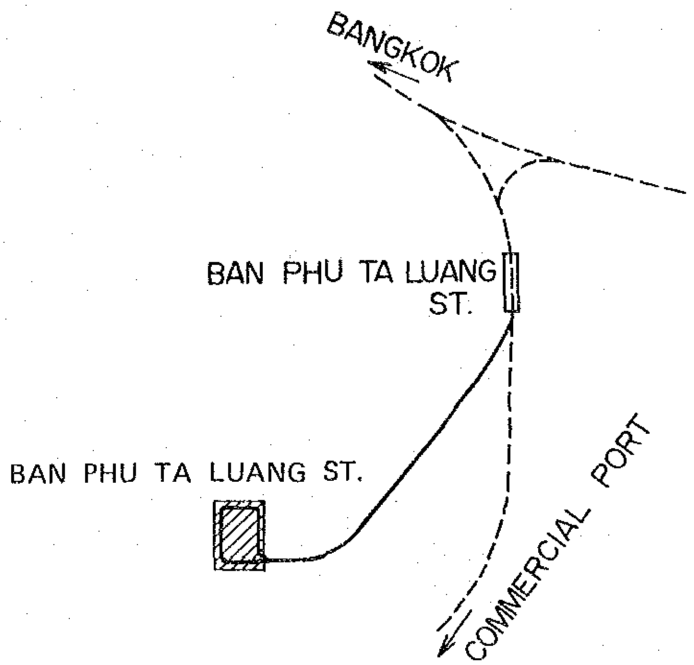


Fig. IV–6 YARD TRACKS IN BAN MAB CHALOOD

4–3–2 Ban Nong Yai Site

(1) Spur between Ban Phu Ta Luang station and soda ash plant

On the Chachengsao – Sattahip line, it is to be constructed a station at Ban Phu Ta Luang. Therefore, the soda ash plant is proposed to be connected with this station, thus the proposed spur length is approximately 5,000 m.



(2) Yard tracks in the soda ash plant

As shown in Figure IV-7.

4–4 SHUNTING LOCOMOTIVE

Shunting locomotives will be furnished by the Thai government for use in moving cars at the mine and the plant. Specifications are shown in Figure IV-8.

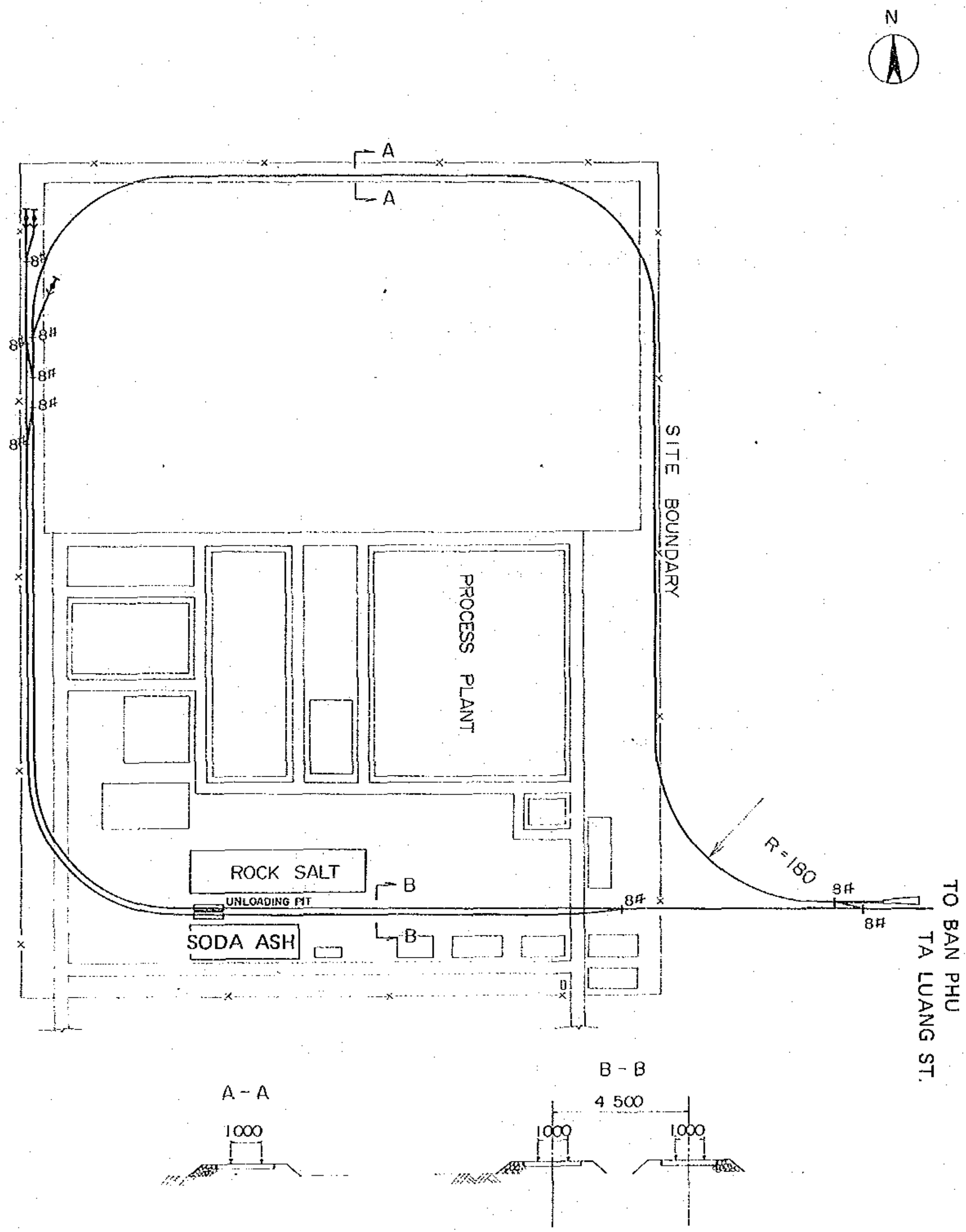
4–5 EMPLOYEES

The job categories and number of people needed for loading and unloading work at the mine and the plant are as follows:

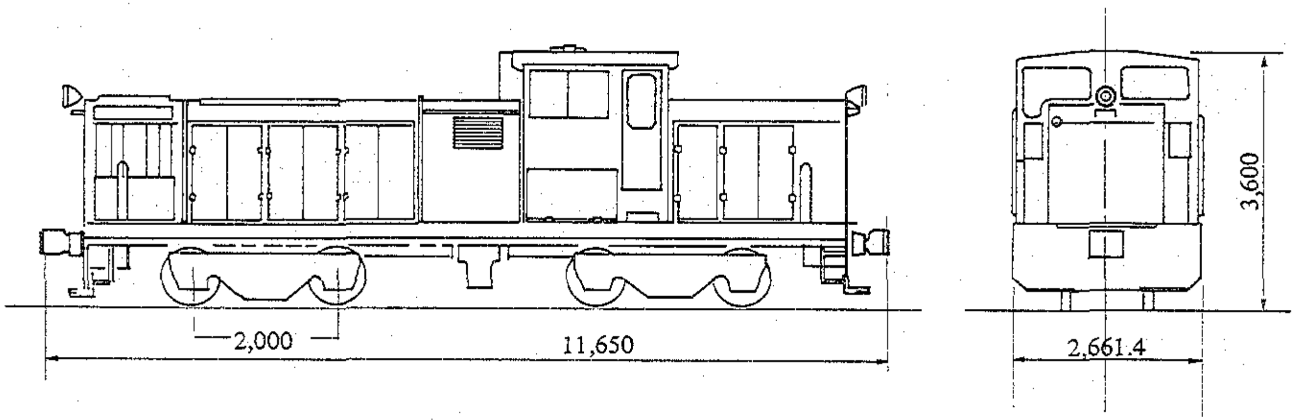
Locomotive engineer	:	1 person
Yard man	:	3 persons
Loading and unloading workers	:	4 persons

The men are to work three shifts. Allowing for holidays and 50% reserve, the number of men needed is:

$$[(1 + 3 + 4) \times 3 \times 1.5] \times 2 = 72$$



JICA	Fig. IV-7
YARD TRACKS IN BAN NONG YAI	



Unit: mm

Weight in Working Order (ton)	45
Gauge (mm)	1,000
Wheel Arrangement	B-B
Max. Speed (Approx. km/h)	35
Engine Output (p.s.)	500

FIG. IV-8 SHUNTING DIESEL HYDRAULIC LOCOMOTIVE

CHAPTER 5 RAILWAY TARIFF

In this Chapter, transportation costs of rock salt and soda ash are projected with reference to the TSR tariff dated June 1st, 1981.

5–1 ROCK SALT

According to the TSR tariff, rock salt belongs to the Class 4 cargo and charges for each destination are:

1. Bamnet Narong – Sattahip Port : Bahts 192.7/ton
2. Bamnet Narong – Ban Mab Chalood : Bahts 196.0/ton
3. Bamnet Narong – Ban Nong Yai : Bahts 189.3/ton

Above figures are based on the existing lines, if the Bangkok by-pass line is completed, those will be reduced by Bahts 13.4/ton.

5–2 SODA ASH

According to the TSR tariff, soda ash belongs to the Class 3 cargo and charges are:

1. Ban Mab Chalood – Sattahip Port : Bahts 16.1/ton
2. Ban Nong Yai – Sattahip Port : Bahts 16.1/ton

PART V TECHNICAL STUDY ON THE SODA ASH PLANT CONSTRUCTION PROJECT

PART V TECHNICAL STUDY ON THE SODA ASH PLANT CONSTRUCTION PROJECT

CHAPTER 1 SUMMARY

1–1 INTRODUCTION

Because of the number of technical problems involved, and the complexity of the alternative plans, a number of case studies are required in connection with formulation of the plan for construction of the soda ash plant.

Here, the following three points are selected as the objectives of the case studies:

(1) Selection of the process for soda ash production
(2) Selection of the soda ash plant site
(3) Determination of the source of ammonia supply

1–2 SELECTION OF THE PROCESS FOR SODA ASH PRODUCTION

Three processes for soda ash production have been commercialized to date; they are:

(1) Solvay process
(2) Partial ammonium chloride (AC) process
(3) Full ammonium chloride (AC) process

In selecting one of these three which is most suitable for this Project it is necessary to take into account the following factors:

(1) Amount of soda ash demand (Unit: 1,000 MT)

1985	429.5
1990	592.6

(2) Soda ash plant production capacity
(3) Amount of demand for byproduct ammonium chloride (Unit: 1,000 MT)

1985	283.1
1990	373.2

(4) Ammonium chloride production capacity

The study mission has formulated the following alternate project definitions on the basis of the above.

	Production process	Production Capacity (MT/Y) Soda ash	Ammonium chloride
Case A	Solvay	500,000	--
Case B	Partial AC	500,000	380,000
Case C	Full AC	400,000	400,000

Study of Case C was made in two parts, Cases C-D and C-E, which have the following basic characteristics.

Case C – D: The amount of ammonium chloride produced is to be equal to the domestic Thai demand. This therefore results in a reduction of the amount of soda ash produced.

Case C – E: The full production capacity of the soda ash plant is used, and the surplus ammonium chloride (maximum 45,717 T/Y) is exported.

The evaluation criteria employed in study of these cases are as follows.

(1) Initial investment cost
(2) Types and amounts of raw materials (i.e., plant inputs)
(3) Products and waste products (i.e., plant output)
(4) Standard production cost
(5) Internal rate of return

As the result of the study (see ANNEX V-2 in the previously submitted evaluation report), it was determined that Case C is the most suitable one for this Project.

Therefore, the present report is concerned with technical matters related to construction of a soda ash plant which uses the Full AC Process and produces 400,000 T/Y of soda ash (and 400,000 T/Y of ammonium chloride as byproduct).

1–3 SELECTION OF THE SODA ASH PLANT SITE

The Government of Thailand (GOT) has determined that either Ban Mab Chalood (Rayong Province) or Ban Nong Yai (Chonburi Province) is to be used as the site of the plant.

The study mission therefore has investigated technical and economic aspects of these two potential sites. The GOT will utilize standards of its own in addition to those employed for this study, but has the intention of selecting one of these as the site for the plant.

The following three basic policies of the GOT were taken to be assumptions for the technical and economic evaluation and comparison of the two potential sites.

(1) Supply of utilities and related infrastructure would be made equally to both sites by the GOT
(2) By the time the soda ash plant construction is completed, the GOT will have developed the harbor at Sattahip so as to be a Deep Sea Port, in view of Sattahip's being the port which would be needed for use for the Project no matter which of the two sites is selected.
(3) After Sattahip is developed as a Deep Sea Port, suitable land for construction of warehouses, storage facilities, and material handling facilities, which would be required as part of the Project, would be available at the Sattahip Deep Sea Port.

This study therefore includes the preparation of a conceptual design for a soda ash plant constructed at both sites under consideration.

1–4 DETERMINATION OF THE SOURCE OF AMMONIA SUPPLY

This Project would require 128,000 T/Y of ammonia. Three cases are conceivable with regard to the supply source of this ammonia:

(1) Production as an integral part of this Project,
(2) Production within Thailand
(3) Importation

The problems associated with each case are discussed below.

1–4–1 Ammonia Production within the Project

If the required amount of ammonia is to be supplied from a facility included as part of this Project it would be necessary to construct an ammonia plant having 430 T/D capacity as it is to be assumed that it will operate at 90% of capacity (annual base). Not only would this be less than half the present standard scale for an ammonia plant which is 1,000 T/D, but also this scale would not be sufficient, for technical reasons, for use of a process wherein there is a self-balance of energy. Therefore, in view of the matter of economics of scale, and of energy consumption, production of ammonia as a part of the Project would be relatively costly, and it is concluded that such production will not be attempted.

1–4–2 Domestic Production

The Ministry of Industry, GOT, has a plan for construction of a large-scale fertilizer complex based on natural gas which is now being produced in the Gulf of Thailand. In the belief that this fertilizer complex is best implemented through a joint venture between the government and one or more private concerns, the Ministry is now conducting negotiations with a group of prospective partners. If the completion of construction of the fertilizer project coincides with that of the soda ash plant and the former can supply ammonia to the latter at a price set at the level of the international market price, then ammonia can be acquired at least with the saving of the equivalent of ocean freight for imported ammonia, which would be beneficial to the soda ash project. Moreover, the GOT has decided to locate the fertilizer complex in Ban Mab Chalood, and in the event that the soda ash plant could be supplied with ammonia by means of a pipeline, the financial burden the soda ash project must bear would be less.

1–4–3 Importation

From the viewpoint of the world balance of ammonia supply and demand it is judged possible to obtain in the world market the volume of ammonia required for this Project. It is particularly possible that importation from within the ASEAN region – from Indonesia – could be achieved. A large-scale fertilizer complex is in operation in that country, and a second fertilizer complex, also large in scale, is now under construction.

In this Evaluation Study, it is assumed that ammonia will be imported but consideration has also been given to the possibility of acquiring ammonia from the fertilizer complex, if it is constructed.

1–5 IDENTIFICATION OF ALTERNATIVES FOR CASE STUDIES

On the basis of the foregoing, the factors to be considered in case studies are defined as follows.

(1) Plant site
- Ban Mab Chalood (BMC)
- Ban Nong Yai (BNY)

(2) Ammonia source
- Domestic production
- Importation

These have been used to construct the matrix shown below and to identify each case by name.

Ammonia / Site	Domestic production (D)	Importation (I)
Ban Mab Chalood	BMCD	BMCI
Ban Nong Yai	BNYD	BNYI

CHAPTER 2 CHARACTERISTICS OF SODA ASH PLANT FACILITIES

2–1 INTRODUCTION

The soda ash plant is described in general terms as follows.

(1) Production process and products

Production process: Full AC Process

Products and capacity: Soda Ash 400,000 T/Y

Ammonium Chloride 400,000 T/Y

(2) Raw material requirements

Raw Material	Consumption per ton of soda ash produced	Required Annual Ammount
Salt (100% NaCl)	1,371 kg	548,400 T
Ammonia	320 kg	128,000 T
Carbon dioxide gas	332 Nm^3	132,800 Nm^3
Quicklime	46 kg	18,400 T
Caustic soda	42 kg	16,800 T
(or soda ash)	(60 kg)	(24,000 T)

(3) Utility requirements

Utility	Consumption per ton of soda ash produced	Required Annual Amount
Power	496 KWH	198.4 MWH
Water	25.6 m^3	10.24 million m^3
Fuel	0.208 m^3	83.2 thousand m^3 (fuel oil equiv.)

In this chapter, on the basis of the material balance of the above inputs, the source of their supply is examined and then the requirements for the soda ash plant facilities are examined.

2–2 RAW MATERIAL SUPPLY SOURCES AND RAW MATERIAL TRANSPORT

2–2–1 Rock Salt

As indicated in Part IV, rock salt mined at Bamnet Narong is to be transported to the plant by rail, but the rock salt which would be mined for use in this Project is assayed to be high in calcium and in sulphate ion concentration, in comparison to rock salt available in other parts of the world, and the quality of the salt is low. Because it will therefore be necessary to refine the rock salt at the soda ash plant, the cost of the salt to this Project will be about 10% higher than rock salt of average international grade. However, other than this, no special problem will be encountered regarding processing.

The following facilities are assumed to be provided at the plant for the purpose of receiving train shipments of rock salt. The rock salt receiving facilities are to have the capacity for handling 600,000 T/Y.

(1) Railway spur: A spur must be laid from the existing TSR line to the plant site. Other necessary railway facilities are described in Part IV and are excluded from the present scope of this Project.

(2) Rock salt receiving facilities: Unloading facilities which match the specifications of the rail wagons (hoppers, belt conveyors, etc.) must be provided for receiving rock salt discharged from rail wagons and transporting it to storage facilities.

Because the two sites are both located at a considerable distance from port facilities it will be necessary to erect the same facilities as listed above, at Sattahip Deep Sea Port, for exportation of rock salt, these facilities are to have the capacity of about 400,000 T/Y.

2–2–2 Ammonia

As indicated in Chapter 1, there are two viable alternative sources of ammonia: importation or domestic production. Facility requirements differ for these two alternatives.

(1) Imported ammonia

An unloading arm is erected on the pier at Sattahip Deep Sea Port. After ammonia is temporarily stored in a tank nearby the pier it is moved through a pipeline to the soda ash plant site. A pump installed aboard the tanker is used to unload the ammonia, but the temporary storage tank and facilities related to the pipeline are considered to be within the scope of this Project.

(2) Domestic ammonia

The GOT is now negotiating with a group of private foreign firms regarding the above-mentioned fertilizer complex. In connection with that complex, IEAT has begun to buy land adjacent to Ban Mab Chalood, which is one of the alternative sites for the soda ash plant. Therefore, for this study it is assumed that the fertilizer complex is constructed on land adjacent to Ban Mab Chalood and that ammonia is supplied by means of a pipeline from the complex's storage facilities. This pipeline is deemed to be within the scope of the soda ash project.

2-2-3 Carbon Dioxide Gas

Three cases, noted below, are possible with regard to the supply of carbon dioxide gas. Of these, the least costly is the second one, whereby the gas is supplied from PTT. Moreover this is the most reliable of the three choices. (Refer to Part V and ANNEX V-5 of the previously submitted evaluation report.)

(1) Calcination of quicklime is carried out at the soda ash plant site, to generate carbon dioxide gas.

(2) Carbon dioxide gas contained in natural gas is obtained from a PTT gas separation plant in Rayong.

(3) Carbon dioxide gas is obtained from the fertilizer complex which the GOT is negotiating with a group of private companies.

Therefore, in order to receive carbon dioxide gas from the PTT gas separation plant, it will be necessary to install the following equipment, as part of this Project.

(1) Carbon dioxide gas compressor
(2) Various equipment required in connection with the compressor
(3) Carbon dioxide gas pipeline
(4) Holder for receiving carbon dioxide gas

Of these, (1) and (2) are to be installed within the PTT gas separation plant site.

2–2–4 Quicklime

In order to remove impurities from the liquid circulating within the soda ash plant, and in order to refine the crude salt, quicklime must be used. The required quality must be at least 95% CaO, and the concentrations of MgO, SiO_2, other impurities, and insoluble solids must be low. Large quantities of quicklime are being produced in Thailand. It is planned to purchase quicklime from this source, and no problem is anticipated regarding reliability of the supply or the quality of the quicklime.

2–2–5 Caustic Soda (or Soda Ash)

At the time of initial operation of the soda ash plant, caustic soda will be supplied from the chlorine industry in Thai domestic, however after the commencement of the commercial operation of the Project, it will be self balanced consuming the soda ash within the Project.

2–3 SOURCE OF UTILITIES AND THEIR SUPPLY CONDITIONS

2–3–1 Power

According to EGAT's plan, power is to be supplied to a transformer station in the vicinity of the PTT gas separation plant in Rayong at 230 KV, from the Bang Pakong thermal power plant (the power source believed to be most reliable due to being based on natural gas). The power line from the transformer station to the soda ash plant site is to be provided by the GOT. Distribution facilities on the plant side of the transformer station are to be within the soda ash plant site.

2–3–2 Water

The GOT plans to have water from the Dok Krai reservoir conveyed by a pipeline to a point near the PTT gas separation plant in the Rayong district. Water supply from that point to the potential plant sites in the Rayong district is to be provided by IEAT, and water for each plant site will be supplied by pipes to the boundary of their respective sites. Therefore, although the water supply facilities within the site of the soda ash plant are considered to be part of the Project, the pipeline is out of the scope of the Project.

2–3–3 Fuel

Fuel oil or natural gas may be used as fuel for the Project. The GOT has decided that the fuel for this Project is to be natural gas, and will supply the gas by pipeline to the selected site. It is therefore assumed that for this Project an internal pipe will be connected to this pipeline at the boundary of the site, for conveyance and distribution of the fuel within the site, and that a meter will be installed at the point to measure the volume of gas used. All pipeline facilities within the site including the meter are to be considered as part of this Project.

2–4 PRODUCT HANDLING FACILITIES

The quantities of products of this Project and the physical form in which they must be handled are as follows.

Product	Annual quantity handled	Physical form
Soda ash	400,000 T	Bulk and bagged
Ammonium chloride	400,000 T	Flexible container
Crude salt	1,000,000 T	Bulk

These products are to be shipped to domestic and foreign markets.

For the shipment of bagged products to domestic market, they will be moved by belt conveyors from the storage points in the plant to trucks and/or freight cars. In the case of export, the bagged products are to be moved by trucks and/or freight cars to the storage facilities in the Port. Trucks will be used for transporting bagged products to the pier, where the ship's derricks will be used for loading to the ships.

In the case of bulk product shipments, the following facilities are presumed to be needed because both potential sites are located some distance from a harbor (Sattahip Deep Sea Port).

(1) Soda ash facilities

Rail transport is to be used between product storage facilities within the plant site to the harbor, where the soda ash is unloaded and transferred to a storage facility from which ships are to be loaded. Loading of ships is to be done by transferring the soda ash from harbor storage facilities to the ships by means of a belt conveyor and ship loader.

(2) Crude salt

Crude salt destined for export markets (annual quantity, 1,000,000 T) is to be conveyed directly from the mine to the harbor, by rail. The transported salt is unloaded at the harbor facilities and transferred to storage facilities prior to loading of ships which is performed by use of a belt conveyor and ship loader.

For the above operations, the following facilities are required.

<u>Within the soda ash plant</u>

Soda ash storage facilities
Facilities for loading railway wagons with soda ash
Railway spur for wagons carrying soda ash

<u>At the harbor</u>

Facilities for unloading salt from railway wagons
Facilities for unloading soda ash from railway wagons
Salt storage facilities
Soda ash storage facilities
Belt conveyor for salt } To ship loader
Belt conveyor for soda ash } To ship loader
Ship loader

For pierside facility requirements use will be made of such facilities as are available at Sattahip Deep Sea Port (under construction).

CHAPTER 3 PROPOSED LOCATIONS OF THE SODA ASH PLANT

3–1 INTRODUCTION

The GOT has identified two locations as being acceptable as sites for the soda ash plant (see Figure V–1).

(1) Ban Mab Chalood
(2) Ban Nong Yai

This Chapter is concerned solely with a comparison of the characteristics of the two locations; in view of the fact that neither site possesses characteristics which disqualify it from consideration in accordance with the criteria given below, a consideration of the conceptual design of the plant is provided in the following chapter for both sites.

The general requirements which the site must satisfy to be used for the plant area are as follows.

(1) Physical requirements: soil qualities, load-bearing qualities (discussed in this Chapter)

(2) Materials and utilities handling, supply and transport requirements (discussed in Chapter 2 of this Part)

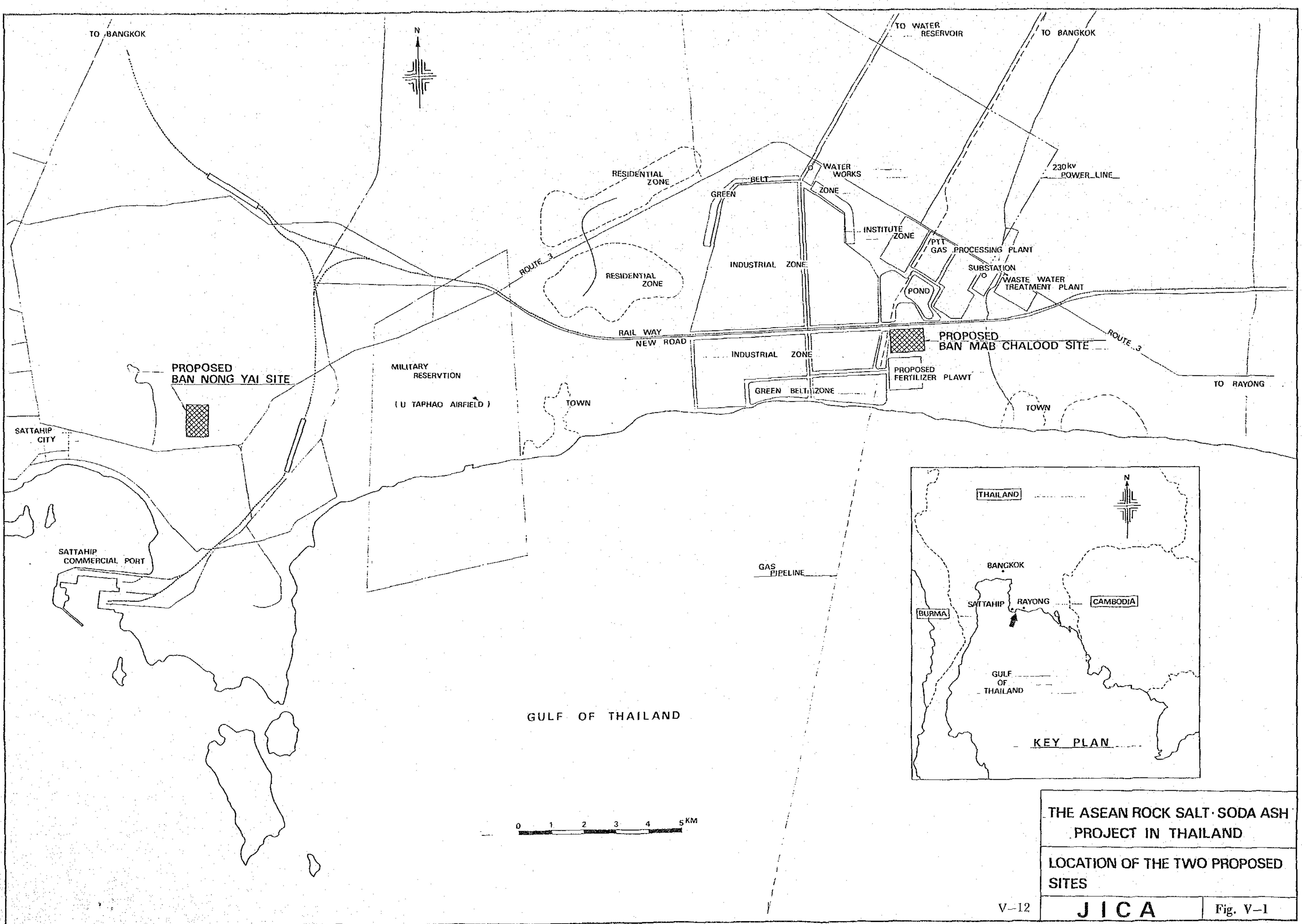
(3) Product shipping requirements (discussed in Chapter 2 of this Part)

(4) Transport of equipment and construction materials to site (discussed in this Chapter)

On the other hand, a plant constructed at either location will have to rely on use of Sattahip Deep Sea Port which is now being planned by the GOT. The present status of this port project may be summarized as follows.

(1) Existing commercial port at Sattahip

The existing facilities were constructed by the U.S. Navy in 1968 as a military port, and were converted to commercial use in September 1978. The strength and durability of the piers, however, are not adequate from the viewpoint of requirements for a commercial port.



THE ASEAN ROCK SALT · SODA ASH PROJECT IN THAILAND

LOCATION OF THE TWO PROPOSED SITES

JICA

Fig. V-1

(2) Master plan for development of Sattahip Deep Sea Port

The GOT considers development of the port at Sattahip to be of fundamental importance as part of the infrastructure of the Eastern Seaboard, and has hired an Australian consultant to start work on a master plan, in January 1982. The plan is to be completed by June 1982.

(3) Construction plan for Sattahip Deep Sea Port

Parallel to preparation of the master plan for the port, the GOT is making use of an engineering loan from the World Bank, to engage a consultant in May 1982 for preparation of detail designs. The GOT plans on completing work on Pier No. 1 by some time during 1985.

Therefore, the study team has assumed that the Sattahip Deep Sea Port will be completed and ready for use by the time that the present Project begins operation. Moreover, the layout of the port is assumed to be as indicated in the preliminary study report by the consultant mentioned above (see Figure V–2).

3–2 PHYSICAL CONDITIONS

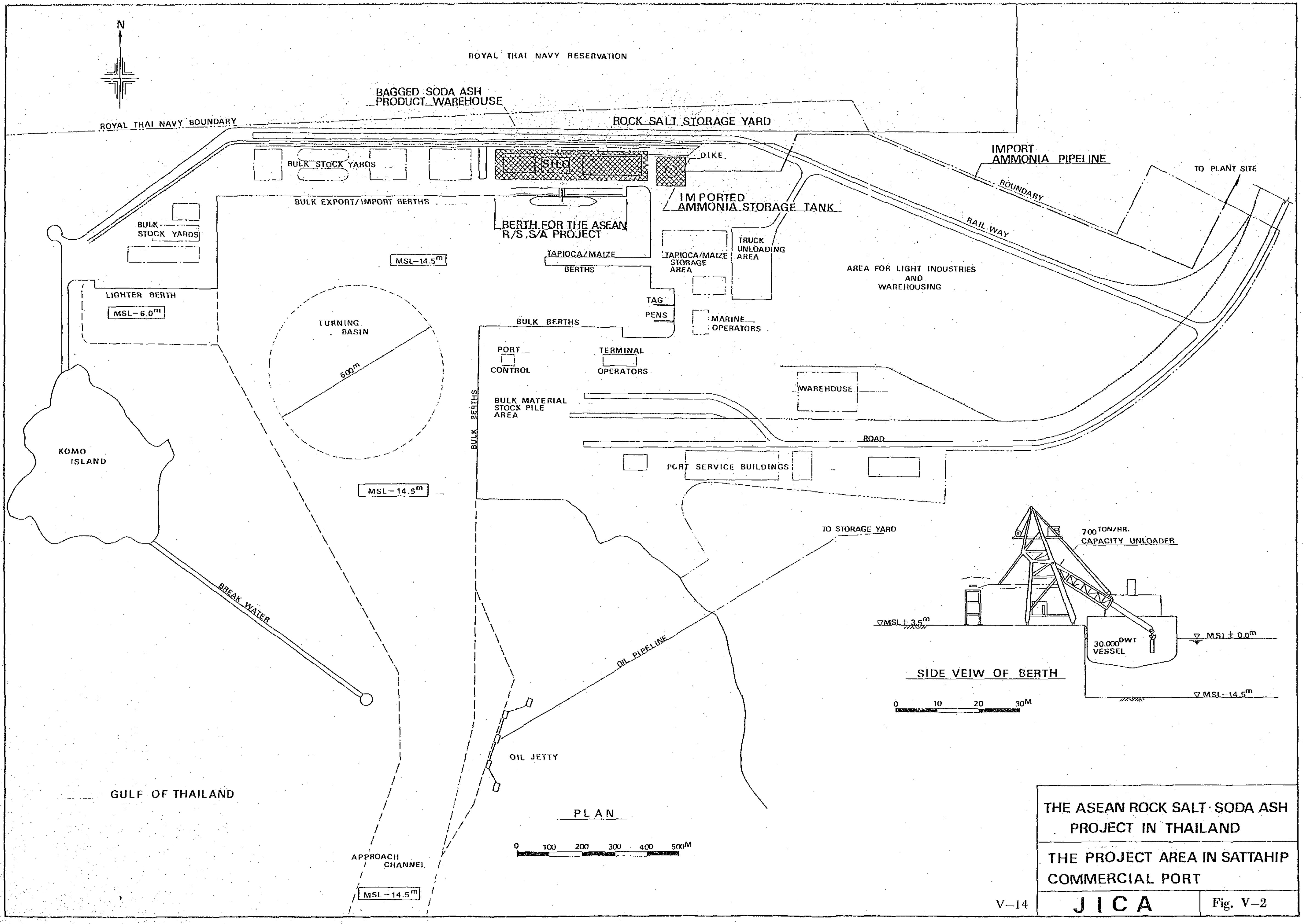
3–2–1 Introduction

(1) Ban Mab Chalood

The PTT natural gas separation plant is to be constructed at Ban Mab Chalood, and IEAT intends to develop an industrial estate for heavy industry there. It is planned that the proposed fertilizer complex is to be constructed there. This district as shown by Figure V–1, lies between the shoreline of the Gulf of Thailand and National Highway No. 3. Moreover the TSR is now planning an extension of the Chachengsao – Sattahip line (under construction) to go to Rayong through Ban Mab Chalood which is 31 km from Sattahip harbor.

(2) Ban Nong Yai

To the south of Ban Nong Yai is a naval installation and to the west are suburban residences outside Sattahip. To the north are hills. According to the GOT, naval authorities have given their permission for this location to be used and will not subject such use to any restrictions. National Highway No. 3 passes through this area which is 8 km from Sattahip harbor. In connection with disposal of waste water, the distance from the proposed site to the harbor, by a direct line traversing Navy land, is about 5 km.



THE ASEAN ROCK SALT·SODA ASH PROJECT IN THAILAND

THE PROJECT AREA IN SATTAHIP COMMERCIAL PORT

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Fig. V-2

3–2–2 Physiography

(1) Ban Mab Chalood

This location is about 31 km from Sattahip harbor on National Highway No. 3 on the way to Rayong, at 101°08′ east longitude and 12°42′ north latitude. The region is an alluvial plain, and is relatively level land with a difference of 5–6 m between high and low points. The entire region is characterized by sandy soil, and tropical vegetation. Tapioca, coconut, mango, pineapple and other crops are being produced on the land.

(2) Ban Nong Yai

This location is facing National Highway No. 3, about 8 km north of Sattahip harbor, at 100°57′ east longitude and 12°41′ north latitude. The proposed site is surrounded on three sides by hills which average about 200 m in elevation, and is open to the south. The entire area is sandy soil. Existing vegetation is the same as that at Ban Mab Chalood.

3–2–3 Geology

Both proposed locations are in similar geological zones.

3–3 TRANSPORTATION OF MATERIALS AND EQUIPMENT TO THE SITE

Both proposed locations are dependent on use of Sattahip harbor. Although materials and equipment would be brought in during the time that Sattahip Deep Sea Port is being constructed, it is thought that there would be an existing pier or one would be constructed. In the event that this is not possible there would not be a great increase in cost if materials and equipment are transferred to a barge while the ship which has carried the materials and equipment is at anchor in the Rayong Bay, so it is assumed that Sattahip Port is used.

After the materials and equipment have entered at Sattahip Port, it will be necessary to transport them overland 31 km to Ban Mab Chalood or 8 km to Ban Nong Yai. In either case, no problem due to bridges on National Highway No. 3 would be encountered.

Thus, there would be no problems in transporting materials and equipment to either location.

CHAPTER 4 CONCEPTUAL DESIGN OF THE SODA ASH PLANT

4–1 INTRODUCTION

In this Chapter the conceptual design of the soda ash plant at both proposed locations, is provided, in accordance with the existing and assumed conditions noted above, as well as the features of the required equipment. Design standards are provided in Section 4–2, after which general specifications are given for the main equipment.

4–2 DESIGN STANDARDS

4–2–1 Meteorological and Oceanological Conditions

Detailed information on meteorological conditions are given in Table V–1 and Figures V–3 and V–4. The following values were used in making the conceptual designs.

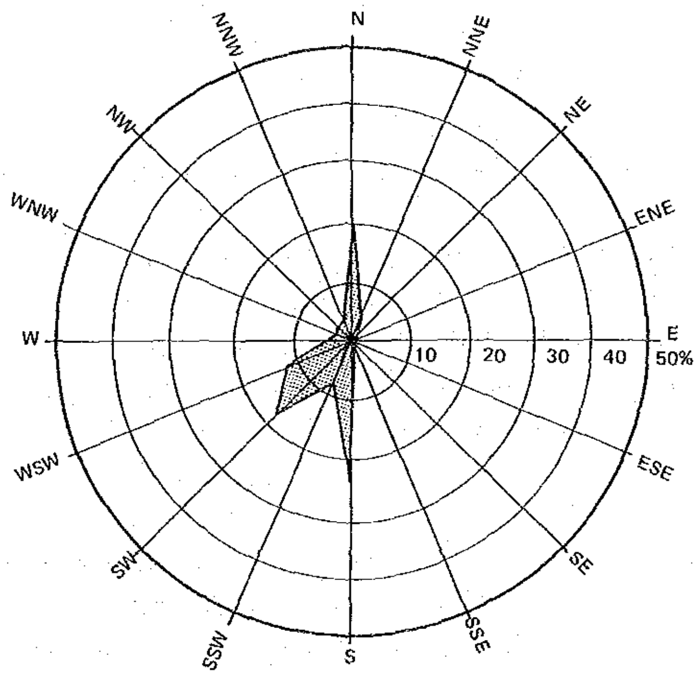


Fig. V–3 ANNUAL WIND ROSE (Sattahip)

Table V–1 CLIMATOLOGICAL DATA (SATTAHIP)

Station	SATTAHIP	Elevation of station above MSL	16.00 meters
Index Station	48 477	Height of barometer above MSL	18.00 meters
Latitude	12°41″ N	Height of thermometer above ground	1.35 meters
Longitude	100°59″ E	Height of wind vane above ground	12.00 meters
		Height of raingauge	0.73 meters

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Pressure (+ 1000 or 900 mbs)													
Mean	12.81	11.76	10.98	09.59	07.99	07.66	07.74	07.80	08.48	10.20	11.58	12.59	09.93
Ext. Max	21.37	20.27	18.04	17.97	14.62	13.84	13.64	13.77	14.63	16.34	18.62	20.27	21.37
Ext. Min.	06.17	05.47	04.68	02.02	01.54	00.27	00.93	00.76	00.67	99.64	96.52	05.66	96.52
Mean Daily Range	3.74	3.83	3.93	3.95	3.66	3.08	2.99	3.22	3.84	3.90	3.74	3.71	3.63
Temperature (°C)													
Mean	26.7	27.9	28.9	29.7	29.2	28.9	28.4	28.4	27.9	27.1	26.5	26.1	27.9
Mean Max.	33.2	33.6	34.1	34.6	33.3	32.7	32.4	32.5	32.2	31.9	32.2	32.4	32.9
Mean Min.	22.1	24.2	25.6	26.5	26.2	26.4	25.7	25.6	25.0	24.0	22.6	21.6	24.6
Ext. Max.	39.0	39.4	39.5	40.5	40.5	37.2	37.8	37.2	37.4	36.2	37.4	38.3	40.5
Ext. Min.	12.3	16.8	18.7	21.0	21.5	20.9	19.0	21.5	19.0	19.5	15.0	12.8	12.3
Relative Humidity (%)													
Mean	70.0	75.0	76.0	77.0	79.0	76.0	77.0	77.0	81.0	83.0	76.0	70.0	76.9
Mean Max.	84.2	88.2	87.6	87.3	88.8	86.0	87.4	97.6	90.7	93.3	89.0	84.7	87.9
Mean Min.	51.2	57.0	59.9	61.1	66.6	65.5	74.2	65.9	68.3	69.1	60.7	53.0	61.9
Ext. Min.	25.0	17.0	29.0	33.0	43.0	43.0	47.0	48.0	45.0	38.0	28.0	21.0	17.9
Dew Point (°C)													
Mean	20.2	22.7	24.0	24.9	24.9	24.3	24.0	23.9	24.2	23.8	21.9	20.0	23.2
Evaporation (mm)													
Mean-Piche	98.0	75.9	84.2	83.6	73.1	79.4	77.7	76.6	59.9	47.2	73.9	97.1	926.6
-Pan					No Observation								
Cloudiness (0-8)													
Mean	3.9	4.1	4.3	4.9	6.4	6.5	6.8	6.9	6.9	6.0	4.8	3.7	5.4
Visibility (Km)													
0700 L.S.T.	7.8	7.8	8.1	9.6	10.6	11.2	10.9	10.8	10.6	9.3	9.3	9.3	9.7
Mean	8.6	8.3	8.6	10.0	11.0	11.4	11.1	11.3	11.0	10.4	10.4	9.9	10.2
Wind (Knots)													
Prevailing Wind	N	S	S	S	S.SW	SW	SW	WSW	WSW	N	N	N	–
Mean Wind Speed	6.0	6.8	7.4	7.2	7.2	9.8	9.4	9.1	7.4	5.8	6.8	7.1	–
Max. Wind Speed	35 N	36 NF	48 SE	46ESE	57 NW	58WSW	52 W	52 W	49WNW	59 W	73NNW	40 N	–
Rainfall (mm)													
Mean	28.4	56.8	66.2	90.9	205.5	76.4	95.8	99.7	226.1	288.4	99.7	17.1	1351.0
Mean Rainy Days	2.7	4.7	5.0	7.8	13.8	10.9	13.8	13.6	16.6	17.5	8.8	2.0	117.1
Greatest in 24 hr	53.2	117.6	116.1	108.7	170.0	62.8	155.0	89.7	107.7	302.7	319.6	87.0	319.6
Day/Year	26/73	27/68	22/70	28/71	4/71	17/71	22.51	25/65	25/63	22/52	30/70	1/70	30/70
Number of days with													
Haze	20.6	15.6	16.1	8.6	0.9	1.0	1.8	2.2	1.1	4.3	8.8	16.1	97.1
Fog	5.8	4.9	3.4	2.0	0.5	0.8	0.7	0.6	0.7	1.3	1.9	3.4	26.0
Hail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
Thunderstorm	0.7	1.4	3.5	7.7	10.3	3.8	3.9	3.7	8.3	10.2	4.8	1.0	59.3
Squall	0.0	0.1	0.2	0.4	0.2	0.4	0.4	0.2	0.2	0.1	0.1	0.0	2.3

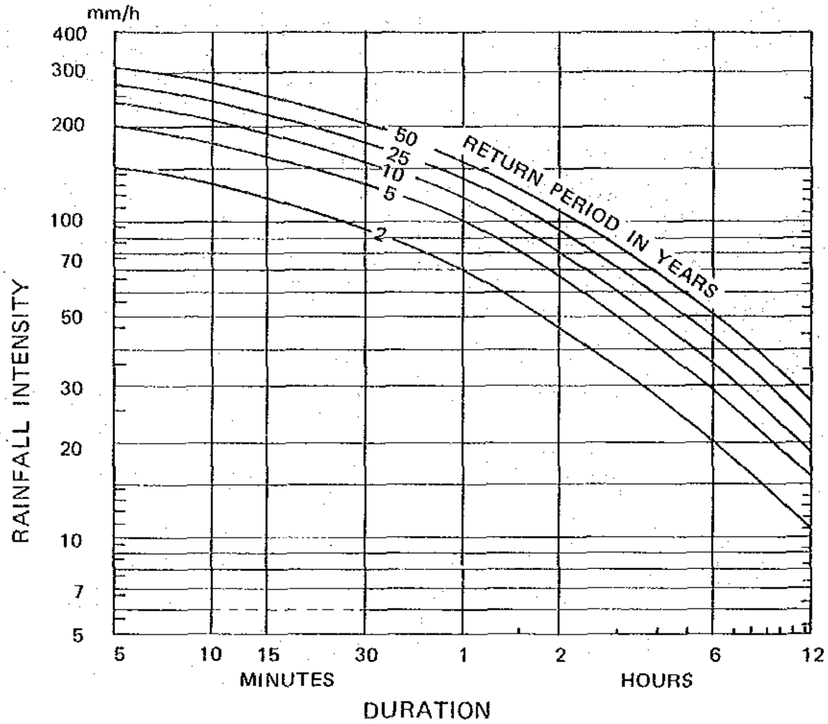


Fig. V–4 RAINFALL INTENSITY

Temperature	:	Max. 40.5°C Min. 12.3°C Avr. 27.9°C
Relative humidity	:	Max. 87.9% Min. 17.9% Avr. 76.9%
Precipitation	:	Annual (avr.) 1,351.0 mm Monthly max. 445.0 mm Monthly min. 0.0 mm 24-hour max. 319.6 mm Design rainfall intensity; see Figure V–4
Wind speed & direction	:	Prevailing direction; Feb. – Sept. S–SW Oct. – Jan. N Hourly avg. speed; 7.5 Knots (3.9 m/sec) 73.0 Knots (38 m/sec)
Tides	:	Difference 3.40 m H.W.L. MSL +1.20 m L.W.L. MSL –2.20 m

4–2–2 Soil Conditions

On the basis of soil data used for construction of the PTT gas separation plant, and data collected by the study team, soil condition at the two proposed sites were determined to be as follows.

GL ±0.000		N value	$\gamma t/m^3$
GL –2,000	Good quality sand layer, used as borrow	10	2.1
GL –10,000	Silty sand	20 – 30	2.0
	Sand	50	2.1

4–2–3 Site Preparation

The site preparation plan is prepared so as to minimize earthwork, while taking into consideration the characteristic of the site and the soil.

As a result of studying the site preparation plan, prepared according to the following requirements, it was determined that the optimum finished elevation would be MSL +19.5 m at Ban Mab Chalood and MSL +18.0 m at Ban Nong Yai.

(1) Cut and fill are to be balanced.

(2) Elevation is to be uniform throughout the site.

4–2–4 Plant Foundation

It has been determined that on the basis of the soil conditions, which indicate a very hard, stable sandy stratum at 2.0 m below ground level, that a mat foundation is to be used for the plant.

4–2–5 Raw Material Qualities

(1) Rock salt

Content	Composition
NaCl	+97.0%
H_2O	0.1 – 0.2%
SO_4	–1.0%
Ca^{++}	–0.4%
Mg^{++}	–0.08%
K^+	–0.001%
I.M.*	–0.5%

(*I.M. = insoluble matter)

(2) Ammonia

Purity	99.9%
Moisture	0.1%
Oil	–5 ppm

(3) Carbon dioxide gas:

Purity	98.5 Vol. %
Inert gas	1.5 Vol. %

(4) Quicklime

Content	Composition
CaO	+95.0%
MgO	0.3 – 2.5%
SiO_2	0.2 – 1.5%
Al_2O_3	0.1 – 0.5%
Fe_2O_3	0.1 – 0.4%
CO_2	0.4 – 1.5%

(5) Caustic soda

Content	Composition
$NaOH$	45%
$NaCO_3$	–1%
$NaCl$	–1.3%
Fe_2O_3	–0.02%

4–2–6 Utilities Qualities

(1) Power

Frequency	50 Hz
Voltage	6.6 KV

(2) Water

Water qualities are to be as follows, assuming that water from Dok Krai reservoir is to be used.

	Range
pH	6.7 – 7.8
Electrical Conductivity @25°C (micro ℧/cm)	100.0 – 130.0
Ca (ppm)	10.0 – 17.0
Mg (ppm)	2.0 – 3.0
Na (ppm)	5.0 – 7.0
HCO_3 (ppm)	44.0 – 59.0
Cl (ppm)	8.0
SO_4 (ppm)	0.0 – 2.0
Soluble Sodium Percentage	23.0 – 32.0

	Range
Sodium Absorption Ratio	0.4 – 0.5
Residual Sodium Carbonate (meg/l)	0.0 – 0.15
Turbidity (ppm)	25.0

(Source: Ministry of Industry)

(3) Natural gas

Caloric Value

Composition (Vol. %)	
CO_2	18.02
N_2	0.97
CH_4	65.03
C_2H_6	8.57
C_3H_8	4.53
C_4H_{10}	1.92
C_5^+	0.90
H_2	0.01
Total	100.00

(Source: PTT)

4–2–7 Product Qualities

(1) Soda ash (dense ash)

Purity			Apparent S.G.	Density	Angle of Repose
T.Na_2CO_3	NaCl	Fe_2O_3			
+99.0%	–0.5%	–0.01%	+1.0	2.53	40°

Particle size distribution (Reference values)				
Mesh 16 on	Mesh 16 – 32	Mesh 32 – 60	Mesh 60 – 100	Mesh 100 under
0.5%	6.0%	48.0%	38.5%	7.0%

(2) Ammonium chloride

Purity	Apparent S.G.	Density	Angle of Repose
Ammoniacal nitrogen			
+25.0%	0.76	1.53	43°

Particle size distribution (Reference values)			
Mesh 5 on	Mesh 5 – 8	Mesh 8 – 14	Mesh 14 under
1.0%	69.5%	29.0%	0.5%

4–3 SODA ASH PRODUCTION PROCESS PLANT

The process indicated in this study report, the Full Ammonium Chloride Process, is considered to be typical of the available processes and does not represent recommendation of any one process ones the other (see Figure V–5).

The major processes included in the Full Ammonium Chloride Process are listed below. Details appear in APPENDIX II.

(1) Rock salt purification
(2) Ammonium chloride extraction
(3) Carbonation
(4) Calcination and densification
(5) Ammonium chloride drying

4–4 UTILITIES FACILITIES

The major utilities facilities required in the plant are as follows.

(1) Power receiving and distributing facilities
(2) Emergency power generation facilities
(3) Water treatment facilities
(4) Cooling tower facilities
(5) Boiler facilities
(6) Instrumentation and plant air
(7) Waste water treatment facilities

On the basis of the nature of these facilities as described in Chapter 2 of this Part, the conceptual design was prepared; it is as shown in Table V–2.

4–5 OFF-SITE FACILITIES

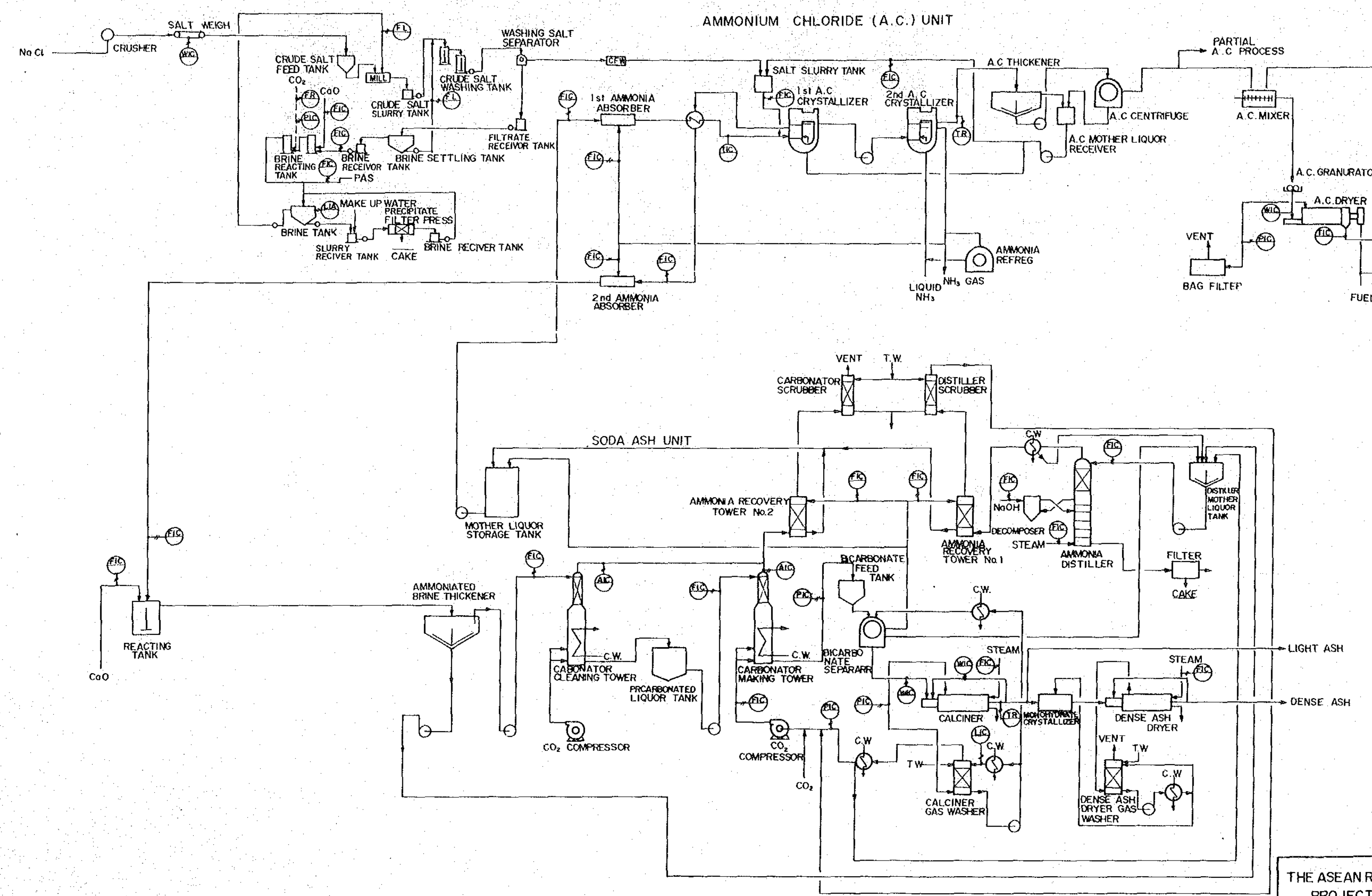
The following are required as off-site facilities for the soda ash plant.

(1) Raw materials receiving and storing facilities

- Rock salt receiving facilities: Facilities for storage of rock salt, and a belt conveyor for supply of rock salt from storage to the soda ash plant.

SODA ASH PROJECT IN THAILAND

PROCESS FLOW DIAGRAM



V-24

THE ASEAN ROCK SALT · SODA ASH PROJECT IN THAILAND

PROCESS FLOW DIAGRAM

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FIG V-5

Table V–2 FACILITIES INCLUDED IN THE PROJECT SCOPE

Facilities			Rated Capacity
1.	Process Plants	Soda Ash	1,200 t/d
		Ammonium Chloride	1,200 t/d
2.	Utilities Plants		
	1) Demineralizer		880 m^3/h
	2) Main substation		20,000 KW (25,000 KVA)
	3) Cooling tower		8,000 m^3/h
	4) Steam boilers		55 t/d x 2 sets
	5) Instrument and plant air		960 Nm^3/h
	6) Emergency diesel generator		750 KW
	7) Effluent treatment		
	8) Utilities distribution		
3.	Off-site Facilities		
3.1	Raw materials and products handling and storage See Table 2		
3.2	Common Facilities		
	1) Equipment and machines for maintenance and workshops		
	2) Equipment for laboratories		
	3) Drinking water and fire-fighting system		
	4) Intercommunication system		
	5) Lighting and lightening system		
	6) Miscellaneous equipment and machines for common facilities		
3.3	Off-site Building and Structures		
			Total Floor Area
	1) Maintenance shop		1,680 m^2
	2) Laboratory		360 m^2
	3) Local laboratories	30 m^2 x 5	
	4) Gatehouses	50 m^2 x 2	
	5) Garage		150 m^2
	6) Administration office		1,250 m^2
	7) Cafeteria and locker room		1,400 m^2
	8) Warehouses	1,400 m^2 x 2	
	9) Workshop		2,000 m^2
	10) First aid house		200 m^2
	11) Maintenance and engineering office		1,000 m^2
	12) Fencing	as required	
3.4	Utilities during construction	as required	

- Carbon dioxide gas: Carbon dioxide gas compression facilities installed at the PTT gas separation plant at Rayong, and a gas pipeline from there to the soda ash plant.

- Ammonia:

  - In the case of importation; Facilities for offloading of ammonia from tankers, and storage facilities at Sattahip, a pipeline to the soda ash plant, and storage facilities at the plant

  - In the case of domestic production; Compressor facilities for ammonia installed at the fertilizer complex, a pipeline to the soda ash plant and storage facilities at the plant

(2) Product storing and shipping facilities

- Rock salt: Storage facilities at Sattahip Port for rock salt to be exported as well as belt conveyor for moving rock salt and loading ships.

- Soda ash: Storage facilities at Sattahip Port for soda ash to be exported, as well as belt conveyor for moving soda ash and loading ships.

- Ship loader: for both rock salt and soda ash

(3) Other plant support facilities

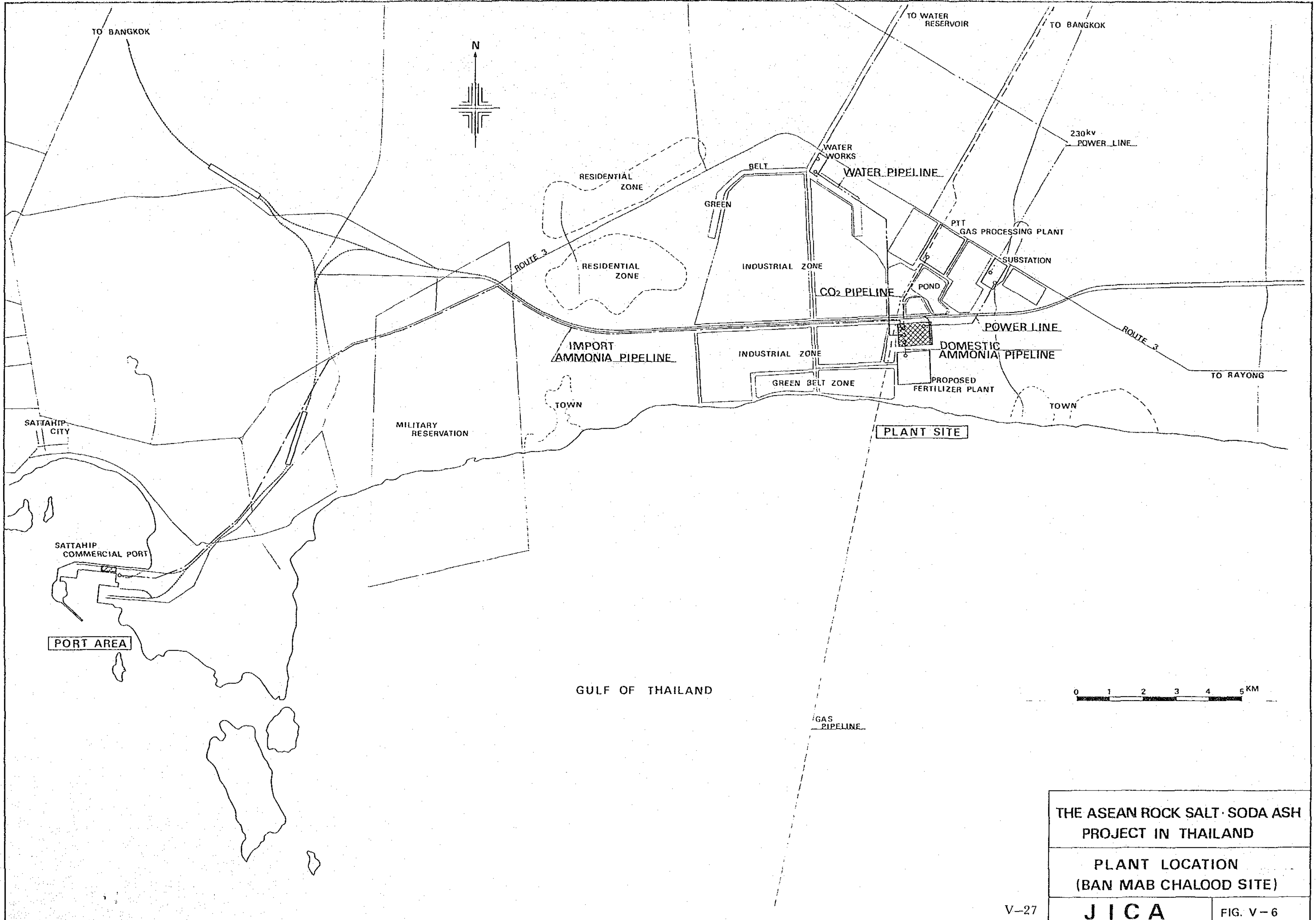
- Maintenance facilities
- Offices
- Miscellaneous structures

The conceptual design for a soda ash plant at each site was made based on the above and is as shown in Figures V–6 and V–7. The general layout for the plant is shown in Figure V–8. General specifications of the facilities are given in Table V–3.

4–6 IMPLEMENTATION AND OPERATION OF THE PROJECT

4–6–1 Implementation Schedule

The implementation schedule for this project, as anticipated by the study team, is as



THE ASEAN ROCK SALT · SODA ASH PROJECT IN THAILAND

PLANT LOCATION (BAN MAB CHALOOD SITE)

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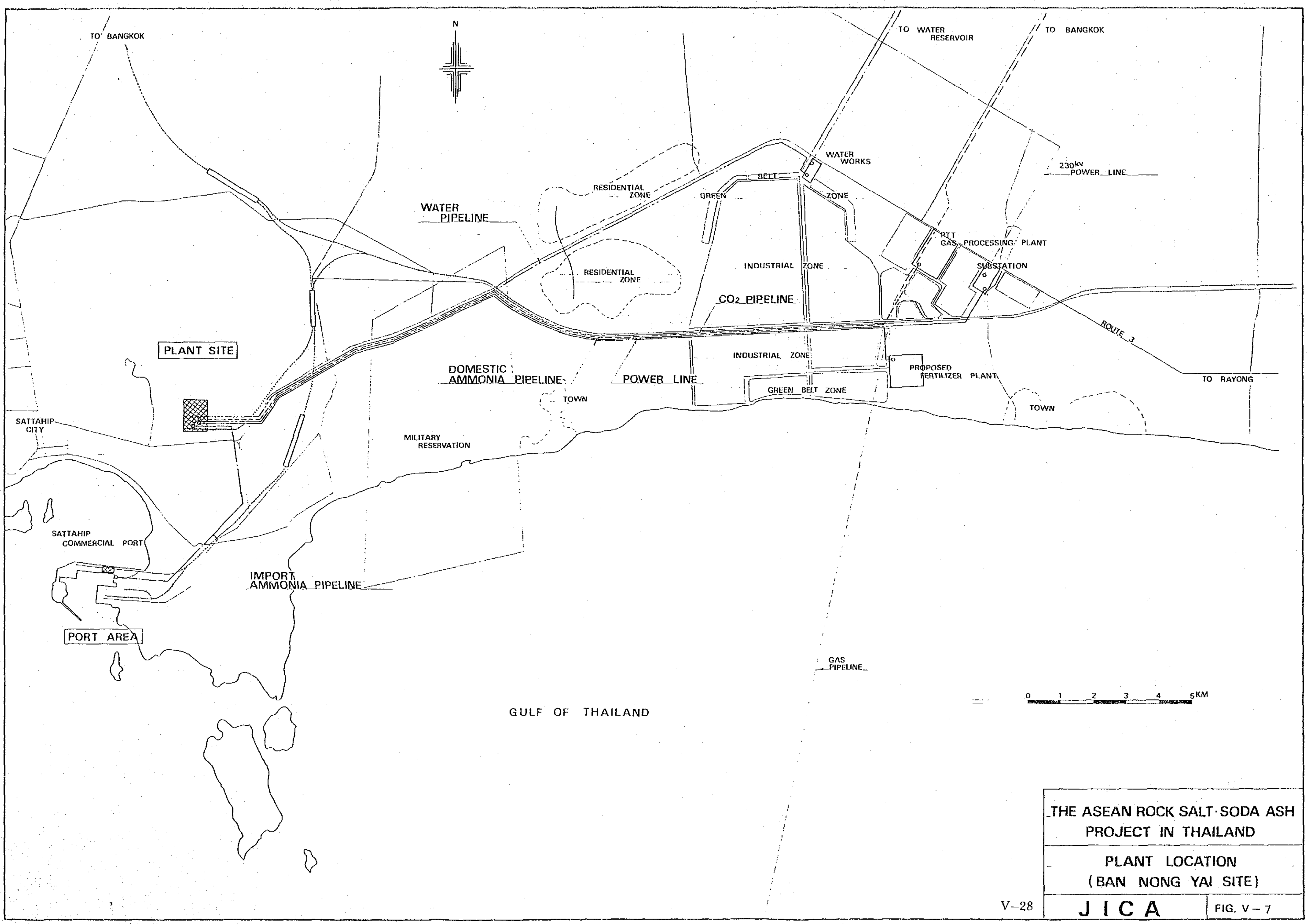
FIG. V-6

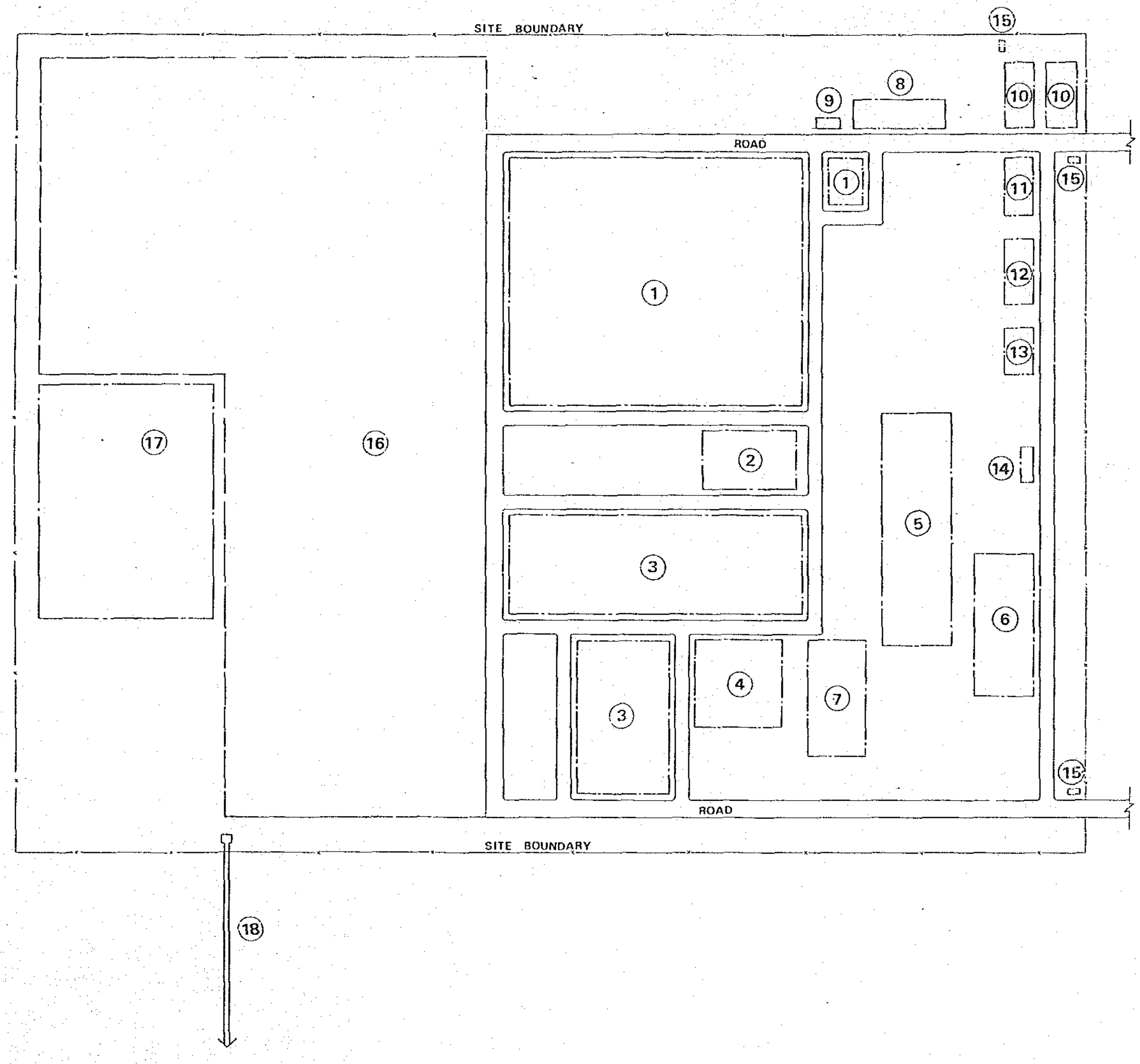


THE ASEAN ROCK SALT·SODA ASH PROJECT IN THAILAND

PLANT LOCATION (BAN NONG YAI SITE)

JICA

FIG. V – 7



NO	DESCRIPTION
1	PROCESS PLANT
2	SILO
3	UTILITY AREA
4	LIQUID AMMONIA TANK
5	ROCK SALT STORAGE YARD
6	PRODUCT STORAGE & BAGGING FACILITY
7	PRODUCT STORAGE FACILITY (BULK)
8	WORK SHOP
9	FIRST AID & FIRE FIGHTING
10	WAREHOUSE
11	GENERAL OFFICE
12	CANTEEN LOCKER
13	MAINTENANCE & ENGINEERING OFFICE
14	LABORATRY
15	GATE HOUSE
16	FUTURE & TEMPORARY AREA
17	WASTE WATER POND
18	DISCHARGE CHANNEL

0 50 100 150 200M

THE ASEAN ROCK SALT · SODA ASH PROJECT IN THAILAND

PLANT LAYOUT (PROCESS)

JICA

FIG. V – 8

Table V–3 SHORT SPECIFICATION OF OFF–SITE FACILITIES

Item	Laem Chabang	Ban Nong Yai		Ban Mab Chalood	
		Ammonia Import	Ammonia Domestic	Ammonia Import	Ammonia Domestic
1. Carbon Dioxide Supply (from PTT)	20,000 Nm^3/h	20,000 Nm^3/h		20,000 Nm^3/h	
Pipe Line Length (m)	61,000	24,000		1,000	
2. Ammonia Storage Capacity (tons)					
at Plant Site	5,000	500	500	500	500
at Port Area		5,000	–	5,000	–
3. Ammonia Pipe Line Length (m)	1,000	8,000	23,000	31,000	1,000
4. Rock Salt Storage (tons)		20,000		20,000	
at Plant Site	70,000				
at Port Area		50,000		50,000	
5. Soda Ash Storage (tons)					
5.1. Bulk Storage (Silo)		16,000		16,000	
at Plant Site	36,000				
at Port Area		20,000		20,000	
5.2. Bagged Product Storage		18,000		18,000	
at Plant Site	36,000				
at Port Area		18,000		18,000	
6. Ammonium Chloride Storage at Plant Site (tons)	36,000	36,000		36,000	
7. Handling & Transportation					
7.1. At Plant Site					
7.1.1 Rock Salt Train Unloading (t/y)	1,200,000	600,000		600,000	
7.1.2. Soda Ash Train Loading (t/y)	None	400,000		400,000	
7.2. At Port Area					
7.2.1. Rock Salt					
i. Train Unloading (t/y)	= Plant Site	600,000		600,000	
ii. Belt Conveyor to Ship Loader (m)	1,875	500		500	
7.2.2. Soda Ash					
i. Train Unloader (t/y)	None	400,000		400,000	
ii. Belt Conveyor to Ship Loader (m)	1,410	500		500	
7.7.3. Railway Sidings at Plant Site (m)	3,200	5,000		800	
8. Draining Ditch Length (m)	1,000	5,000		1,000	

follows.

July 1982	Design work be started
end of March 1985	Plant construction completed
July 1985	Commercial operation commenced

4–6–2 Construction Method

It is assumed that a turn-key, lump-sum contract will be used.

4–6–3 Need for Technical Support Service

On the basis of previous experience in Thailand, it is expected that a qualified foreign company will be engaged to provide the following services.

(1) Preliminary work for process selection and contractor screening, and technical support service for project management during the construction period.

(2) Technical support service for operation and maintenance for 2–3 years following start-up.

Therefore, provision is made for the cost of these services, in estimating capital requirements.

4–6–4 Organization of Personnel, and Staff Training

In addition to the soda ash plant itself an office in Bangkok will be required, staffing is to be as follows.

Executives	5 persons
Head office (Bangkok)	35 persons
Plant	833 persons
Total	873 persons

It will be necessary to train the staff, during the period of construction of the plant. The cost of such training is treated as a part of preparation costs and is included in the capital requirement estimate.

4–7 MANAGERIAL ARRANGEMENTS FOR PROJECT PROMOTION

It is believed that the Ministry of Industry/GOT, will function as the entity for promotion of this project in the planning stage, and in order for there to be assurance of consistency as the project progresses from the planning stage to implementation and operation, efforts should be made to insure that the project company that will be the implementing agency is suitably staffed in addition to which it is deemed necessary that staff be strengthened, that the project team similarly be strengthened, and that a suitable system for project management be adopted and used. Further, because there exist many matters related to promotions of this project requiring close coordination among the competent government agencies, it is believed to be necessary to establish a coordinating committee with the national government, as well as a working team, so that they can effectively deal with whatever problem may emerge.

4–8 POLLUTION PREVENTION

In addition to striving to eliminate the possibilities for pollution in the foregoing selection of raw materials, production process, and arrangement of on-site facilities, effort was made to keep the production of waste at the lowest quantitative levels possible. Further, provision was made in planning for facilities to process what waste will be produced. Adequate measures have been taken so as to assure that the soda ash plant will not cause pollution.

PART VI CAPITAL REQUIREMENTS AND FINANCING PLAN

PART VI CAPITAL REQUIREMENTS AND FINANCING PLAN

CHAPTER 1 CAPITAL REQUIREMENT

On the basis of technical requirements, conceptual design of facilities and implementation plan for this Project which were stated in Part III and V, the total capital requirements for the Project was estimated. The projected capital requirement is shown in Table VI-1 for the rock salt mine and Table VI-2 ∿ Table VI-5 for the soda ash plant.

Because the source of financing for the Project is not yet determined, some of the basic conditions for estimation of capital requirements are yet unknown. Nevertheless, the following conditions have been assumed as the bases for the estimation, on the basis of past conditions in Thailand and other relevant matters:

1. Type of contract

   Turn-key, lump-sum contract, with a single responsibility of each contractor to be separately engaged in the undertaking of construction of the rock salt mine and the soda ash plant.

2. Procedure for the award of contract

   Presumed to be by competitive bidding.

3. Basis for prices

   By application of suitable escalation rates to September, 1980 base prices, up to the time of expenditure for each item.

4. Escalation

   For the foreign exchange portion, 9% p.a.; for the portion to be procured within Thailand 12% p.a.

5. Exchange rates for cost estimation

   Local currency portion is calculated in Bahts, and converted to U.S. dollars at the rate of US$1 = B20.5. The foreign exchange portion is calculated in U.S. dollars and Japanese yen, and the yen portion is converted to dollars

Table VI–1 ESTIMATED CAPITAL REQUIREMENTS
– ROCK SALT MINE –

(Unit: US$1,000)

		Foreign	Local	Total
A.	Land Acquisition	0	970	970
B.	Site Preparation	0	53	53
C.	Facilities Direct Cost	9,769	8,246	18,015
D.	Railway Spur	829	1,347	2,176
E.	Construction Equipment	313	2,777	3,090
F.	Ocean Freight, Insurance & Local Handling	715	263	978
G.	Indirect Field Expenses	234	220	454
H.	Services	2,203	3,166	5,369
I.	Project Management	2,481	0	2,481
	Base Project Cost (B/C) (in Sept. End.–1980 Prices)	16,544	17,042	33,586
J.	Physical Contingency (% of B/C)	835 (5.0%)	1,296 (7.6%)	2,131 (6.3%)
K.	Price Contingency (% of B/C)	5,612 (33.9%)	7,844 (46.0%)	13,456 (40.1%)
L.	Initial Working Capital (in Mid.–1985 Prices)	442	1,031	1,473
	Total Project Cost (B.C.)	23,433	27,213	50,646
M.	Interest During Construction (I.D.C)			
	Interest Rate : 4%	2,220	0	2,220
	5%	2,806	0	2,806
	6%	3,405	0	3,405
	Total Financing Required (C.R.)			
	4%	25,633	27,213	52,866
	5%	26,239	27,213	53,452
	6%	26,838	27,213	54,051

Table VI–2 ESTIMATED CAPITAL REQUIREMENTS
– SODA ASH PLANT –

(Case : BMCD)

(Unit: US$1,000)

		Foreign	Local	Total
A.	Land Acquisition	0	1,155	1,155
B.	Site Preparation	0	2,843	2,843
C.	Plant Direct Cost	91,288	24,773	116,061
D.	Railway Spur	562	623	1,185
E.	Construction Equipment	5,031	2,778	7,809
F.	Ocean Freight, Insurance & Local Handling	13,585	2,895	16,480
G.	Indirect Field Expenses	1,070	4,237	5,307
H.	Services	30,337	2,671	33,008
I.	Project Management	4,672	1,051	5,723
J.	Pre-Operation Expenses	4,213	3,756	7,969
	Base Project Cost (B/C) (in Sept. End–1980 Prices)	150,758	46,782	197,540
K.	Physical Contingency (% of B/C)	12,336 (8.2%)	3,182 (6.8%)	15,518 (7.9%)
L.	Price Contingency (% of B/C)	46,812 (31.1%)	19,456 (41.6%)	66,268 (33.5%)
M.	Initial Working Capital (in Mid–1985 Prices)	12,787	12,787	25,574
	Total Project Cost	222,693	82,207	304,900
N.	Interest During Construction			
	Interest Rate : 4%	13,367	0	13,367
	5%	16,894	0	16,894
	6%	20,500	0	20,500
	Total Financing Required			
	4%	236,060	82,207	318,267
	5%	239,587	82,207	321,794
	6%	243,193	82,207	325,400

Table VI–3 ESTIMATED CAPITAL REQUIREMENTS
– SODA ASH PLANT –

(Case : BMCI)

Unit: US$1,000)

		Foreign	Local	Total
A.	Land Acquisition	0	1,155	1,155
B.	Site Preparation	0	2,843	2,843
C.	Plant Direct Cost	102,289	26,216	128,505
D.	Railway Spur	562	623	1,185
E.	Construction Equipment	5,031	3,044	8,075
F.	Ocean Freight, Insurance & Local Handling	15,127	3,197	18,324
G.	Indirect Field Expenses	1,070	4,237	5,307
H.	Services	30,337	2,671	33,008
I.	Project Management	4,672	1,051	5,723
J.	Pre-Operation Expenses	4,213	3,756	7,969
	Base Project Cost (B/C) (in Sept. End–1980 Prices)	163,301	48,793	212,094
K.	Physical Contingency (% of B/C)	13,590 (8.3%)	3,383 (6.9%)	16,973 (8.0%)
L.	Price Contingency (% of B/C)	50,684 (31.0%)	20,395 (41.8%)	71,079 (33.5%)
M.	Initial Working Capital (in Mid–1985 Prices)	12,787	12,787	25,574
	Total Project Cost	240,362	85,358	325,720
N.	Interest During Construction			
	Interest Rate : 4%	14,280	0	14,280
	5%	18,048	0	18,048
	6%	21,900	0	21,900
	Total Financing Required			
	4%	254,642	85,358	340,000
	5%	258,410	85,358	343,768
	6%	262,262	85,358	347,620

Table VI–4 ESTIMATED CAPITAL REQUIREMENTS – SODA ASH PLANT –

(Case : BNYD)

(Unit: US$1,000)

		Foreign	Local	Total
A.	Land Acquisition	0	1,155	1,155
B.	Site Preparation	0	3,843	3,843
C.	Plant Direct Cost	95,028	27,986	123,014
D.	Railway Spur	860	1,205	2,065
E.	Construction Equipment	5,108	2,979	8,087
F.	Ocean Freight, Insurance & Local Handling	14,120	3,047	17,167
G.	Indirect Field Expenses	1,070	4,237	5,307
H.	Services	30,337	2,671	33,008
I.	Project Management	4,672	1,051	5,723
J.	Pre-Operation Expenses	4,213	3,756	7,969
	Base Project Cost (B/C) (in Sept. End–1980 Prices)	155,408	51,930	207,338
K.	Physical Contingency (% of B/C)	12,879 (8.3%)	362.3 (7.0%)	16,502 (8.0%)
L.	Price Contingency (% of B/C)	48,152 (31.0%)	21,789 (42.0%)	69,941 (33.7%)
M.	Initial Working Capital (in Mid–1985 Prices)	12,787	12,787	25,574
	Total Project Cost	229,226	90,129	319,355
N.	Interest During Construction			
	Interest Rate : 4%	14,001	0	14,001
	5%	17,695	0	17,695
	6%	21,472	0	21,472
	Total Financing Required			
	4%	243,227	90,129	333,356
	5%	246,921	90,129	337,050
	6%	250,698	90,129	340,827

Table VI–5 ESTIMATED CAPITAL REQUIREMENTS
– SODA ASH PLANT –

(Case : BNYI)

(Unit: US$1,000)

		Foreign	Local	Total
A.	Land Acquisition	0	1,155	1,155
B.	Site Preparation	0	3,843	3,843
C.	Plant Direct Cost	97,343	28,416	125,759
D.	Railway Spur	860	1,205	2,065
E.	Construction Equipment	5,108	2,778	7,886
F.	Ocean Freight, Insurance & Local Handling	14,444	3,107	17,551
G.	Indirect Field Expenses	1,070	4,237	5,307
H.	Services	30,337	2,671	33,008
I.	Project Management	4,672	1,051	5,723
J.	Pre-Operation Expenses	4,213	3,756	7,969
	Base Project Cost (B/C) (in Sept. End–1980 Prices)	158,047	52,219	210,266
K.	Physical Contingency (% of B/C)	13,063 (8.3%)	3,652 (7.0%)	16,715 (7.9%)
L.	Price Contingency (% of B/C)	49,047 (31.0%)	21,918 (42.0%)	70,965 (33.8%)
M	Initial Working Capital (in Mid–1985 Prices)	12,787	12,787	25,574
	Total Project Cost	232,944	90,576	323,520
N.	Interest During Construction			
	Interest Rate : 4%	14,184	0	14,184
	5%	17,926	0	17,926
	6%	21,752	0	21,752
	Total Financing Required			
	4%	247,128	90,576	337,704
	5%	250,870	90,576	341,446
	6%	254,696	90,576	345,272

at the rate of US$1 = ¥ 210. Although the exchange rate of Bahts was modified on July 15, 1981, total construction cost in US$ is assumed not to change, since the local currency portion, in fact, contains substantial portion of imported items and devaluation itself may cause general price increases.

6. Import duty

Assumed to be exempted.

1-1 PROJECT CAPITAL REQUIREMENTS

The breakdown of the projected total capital requirements is shown in Table VI-1 for the rock salt mine and Tables VI-2 ∿ VI-5 for the soda ash plant. Because the source of financing is not determined at the present time, the interest rate is not known but for present purposes it is presumed that the interest rate will be 4–6% p.a. Using these rates, and including interest during construction, the capital requirements for the Project would be as follows:

TOTAL CAPITAL REQUIREMENT FOR EACH ALTERNATIVE

		Interest 6%			Interest 5%			Interest 4%		
		F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
Rock Salt Mine		26,838 (49.65%)	27,213 (50.35%)	54,051 (100%)	26,239 (29.09%)	27,213 (50.91%)	53,452 (100%)	25,633 (48.52%)	27,213 (51.48%)	52,866 (100%)
Soda Ash Plant	Case BMCD	243,193 (74.74%)	82,207 (25.26%)	325,400 (100%)	239,587 (74.45%)	82,207 (25.55%)	321,794 (100%)	236,060 (74.17%)	82,207 (25.83%)	318,267 (100%)
	Case BMCI	262,262 (75.45%)	85,358 (24.55%)	247,620 (100%)	258,410 (75.17%)	85,358 (24.83%)	343,768 (100%)	254,642 (74.89%)	85,358 (25.11%)	340,000 (100%)
	Case BNYD	250,698 (73.56%)	90,129 (26.44%)	340,827 (100%)	246,921 (73.26%)	90,129 (26.74%)	337,050 (100%)	243,227 (72.96%)	90,129 (27.04%)	333,356 (100%)
	Case BNYI	254,696 (73.77%)	90,576 (26.23%)	354,272 (100%)	250,870 (73.47%)	90,576 (26.53%)	341,446 (100%)	247,128 (73.18%)	90,576 (26.82%)	337,704 (100%)
Total Capital Requirement	Case BMCD	270,031 (71.16%)	109,420 (28.84%)	379,451 (100%)	265,826 (70.84%)	109,420 (29.16%)	375,246 (100%)	261,693 (70.51%)	109,420 (29.49%)	371,133 (100%)
	Case BMCI	289,100 (71.97%)	112,571 (28.03%)	401,671 (100%)	284,649 (71.66%)	112,571 (28.34%)	397,220 (100%)	280,272 (71.34%)	112,571 (28.66%)	392,866 (100%)
	Case BNYD	277,536 (70.28%)	117,342 (29.72%)	394,878 (100%)	273,160 (69.95%)	117,342 (30.05%)	390,502 (100%)	268,860 (69.61%)	117,342 (30.39%)	386,222 (100%)
	Case BNYI	281,534 (70.50%)	117,789 (29.50%)	399,323 (100%)	277,109 (70.17%)	117,789 (29.83%)	394,898 (100%)	272,761 (69.84%)	117,789 (30.16%)	390,570 (100%)

Note: F.C. = Foreign Currency Portion, L.C. = Local Currency Portion
Plant Site; BMC = Ban Mab Chalood, BNY = Ban Nong Yai
Ammonia Source; I = Import, D = Domestic

The capital requirements cited above are for the rock salt mine which is capable to produce 1.8 million t/y of rock salt by three shift operation and also for the soda ash plant which is to adopt a Full AC Process and to have the capacity of 400,000 t/y each of soda ash and ammonium chloride. With regard to the mining level of the rock salt mine, it was assumed to be 140 m below the ground surface.

1-2 INCREMENT IN CAPITAL REQUIREMENTS DUE TO DELAY IN COMMENCEMENT OF CONSTRUCTION

According to the construction schedule of the rock salt mine and the soda ash plant, it is assumed that operation of this project is to begin in July, 1985. It is anticipated that in the event of a delay in the commencement of construction, whatever the cause, there will be need for increased capital expenditure due to the influence of inflation.

It is herein presumed that the escalation of the foreign exchange cost will be 9% p.a., and that of the Thai currency cost will be 12% p.a., and moreover that the capital requirement is approximately US$430 million, which may be taken as being composed of 69% foreign exchange component and 31% Thai currency component. Under such circumstances, the following increment in the total capital requirements is to be expected in the event of a delay in the commencement of construction:

6 months delay:	4.9% increase
12 months delay:	9.9% increase

1-3 ASSUMPTIONS FOR CAPITAL COST ESTIMATE OF EACH COMPONENT

The breakdown of the projected capital requirements is given in Tables VI-1 and VI-2 ∿VI-5, and the bases of estimation of each cost component shown in those tables are provided as the Attachment to Tables. Explained below are major assumptions taken for the estimation. (Reference is made to each item of cost component shown in those tables.)

1-3-1 Rock Salt Mine

(1) Construction of the mine

It is assumed that the construction of the mine, particularly shaft excavation and the mining facilities construction, will be commissioned to an experienced foreign contractor.

(2) Cost for land acquisition

Land requirements for the mine and related facilities comprise 159 ha. (994 Rai) of land. The land acquisition cost accounts for the costs for acquiring this area of land.

(3) Site preparation cost

The site preparation cost accounts for the costs for grading work. The scope of this work is limited to such an extent that a local contractor undertaking this job can proceed with execution of work prior to the award of contract for the mine construction, and does not include the work for construction of roads and drainage etc. located inside the boundary of the mine site.

It must be noted that this work should be controlled by the foreign contractor in order to insure the completion of the mine as scheduled.

(4) Facilities direct cost

In the facilities direct cost is included equipment and materials, spare parts, including materials and construction labor cost. It is presumed that all of this equipment and materials except the civil materials are provided. The estimated costs are FOB costs. It is assumed that an initial stock of spare parts needed for two years' operation will be procured at the initial stage. The estimated cost is 7% of the cost of the above-noted equipment and materials. Civil materials for local procurement are listed in the Attachment to Table VIA-1. It is assumed that materials not available for procurement in Thailand will be imported.

(5) Construction equipment

It is assumed that crushing equipment for temporary use will be imported and used for crushing rock salt which is excavated during the construction of the mine, and after the completion of the mine this equipment will be sold to others at a price 30% less than the FOB purchase price. Regarding other construction equipment, it is assumed that procurement will be made by means of leasing from local sources.

(6) Ocean freight, marine insurance, and landing and inland transportation costs

It is assumed that unloading of heavy equipment will be done by using heavy-duty derrick cranes. Packing cost, stevedoring costs and other costs and expenses incurred for exports after delivery to export yards are separately estimated. The landing and inland transportation costs are estimated on the assumption that imported equipment and materials are landed at Sattahip port and transported to the mine by rail or roads. It is assumed that the foreign contractor will purchase marine insurance to cover all imported equipment and materials and the premium paid for that insurance will be reimbursed by the owner. The cost of marine insurance premium is estimated at the rate of 0.3% of C&F cost for imported equipment and materials, and is appropriated in the foreign exchange portion.

(7) Contingency

Refer to item (K, L) of the Attachment to Table VIA-1.

(a) Physical contingency

The physical contingency is provided in order to cover any costs which may occur in excess of those estimated here due to such factors as the degree of precision of the conceptual design, meteorological conditions in the site area, soil conditions and other matters. The results of this estimate is shown in Table VIA-1. It is noted that the physical contingency for the railway spur cost is the equivalent of 10% of the Base Cost in the foreign exchange portion, 9.7% of the Base Cost in the local exchange portion, and 9.8% of the total Base Cost of this item.

(b) Price contingency

Price contingency is that provision for price increases in the future due to inflation. The escalation rates used for the estimates are 9% per annum for the foreign exchange portion and 12% per annum for the local currency portion. The contingency was estimated on compound basis by using these rates and for the period from the time of estimation of the Base Project Cost (as of the end of September in 1980) up to the time of disbursement on each cost component. The results are shown in Table VIA-1. It is noted in particular that the price contingency of the railway spur given as D in that table is the equivalent of 39.8% of the Base Cost in the foreign exchange portion, 53.7% of the Base Cost in the local currency portion, and 48.4% of the total Base Cost of this item.

(8) Interest during construction

Interest during construction is estimated on the following assumptions: (a) 70% of the total capital requirement will be financed through loans, (b) disbursement of loans will be made at 30% of the total loan amount in the first year, 40% in the second year and 30% in the third year, and (c) the interest rate (not yet determined) is 4–6% per annum.

(9) Railway spur cost

The railway spur cost accounts for the cost for construction of a railway spur of 5.7 km, including the costs for land acquisition and preparation of right-of-way. The breakdown of these costs is shown in the Attachment to Table VIA-1.

(10) Other expenses

The owner's cost incurred for the development is not included in the estimates assuming that these costs will be covered by the royalty, but other costs are included as required.

1-3-2 Soda Ash Plant

(1) Cost for acquisition of land

Land requirements for the soda ash plant and its related facilities comprise 68 ha. (425 Rai) for the plant site. The cost for land acquisition was estimated on this basis.

(2) Site preparation cost

The following are the major assumptions taken for the estimation of site preparation cost:

1. Site preparation work would be commissioned to local contractors in accordance with a site preparation plan drawn by a foreign contractor, and the local contractors undertaking this job would perform contracted work under the supervision of foreign supervisors.

2. The scope of site preparation work to be contracted to the local contractors would be limited to such an extent that they can proceed with execution of work prior to the basic design and engineering (especially the layout of facilities) of the soda ash plant which should be furnished by the general contractor undertaking the design and construction of the plant.

In short, the work included for the estimation of site preparation cost consists of excavation, filling and compacting, grading, the protection of slopes, and forming a drainage ditch around the plant site. Construction of roads and drainage ditch located inside the boundary of the plant site is excluded from this work.

It must be noted, however, that in the event that the site preparation work, as is assumed above, is performed by local contractors, the schedule of their work should be controlled by the general contractor in order to insure the completion of the plant as scheduled, because of the importance of the site preparation work, and the starting date of other construction activities.

(3) Plant direct cost

(a) Plant equipment and materials

Included in this cost component is the equipment and materials except civil and building materials for plant facilities. It is presumed that all of this equipment and materials be met by imports. The estimated costs denote FOB costs.

(b) Spare parts

It is assumed that an initial stock of spare parts needed for operation for two years will be procured at the same time as the plant equipment. On the basis of this assumption, the cost for spare parts to be procured initially is estimated at 3% of the cost of (a) above.

(c) Civil materials

Items of materials for local procurement are listed in the Attachment to Table VIA-2. It is assumed here that materials which are not available for local procurement in Thailand will be met by imports.

(d) Construction labor

The costs of this component include only those for local labor. The costs for foreign supervisors are included in the cost component given as item H, "Services" in the Attachment to Table VIA-2.

Work volume of local construction workers, including equipment operators, is estimated at 930,000 man-days (at 8 working hours per day) in total, and their costs are estimated at the average rate of US$15 per man-day (B308) including provisions for overtime pay, meals, transportation between work camp and site, lodgings, severance pay, bonus, etc.

(4) Construction equipment

For the estimation of construction equipment costs, there are two alternative methods to be used, as follows.

One method is that of cost estimation on a "Procurement Basis" in which it is assumed that all construction equipment required will be satisfied with the equipment purchased by the contractor at the expenses of plant owners, and this equipment being the owners' property will be retained at the site even after completion of the construction work.

The second method is that of cost estimation on a "Lease Basis" in which it is assumed that all the construction equipment required will be leased by the contractor and will be returned to the leasing company after the construction work.

In the case of the former, the construction equipment costs account for the costs for acquisition of new construction equipment, whereas in the latter the construction equipment costs account for compensation or lease charges for this equipment calculated for the period of using the leased equipment.

The following alternatives for procurement were deemed to be the procurement on the Lease Basis.

1. The contractor is to bring his own construction equipment into the site for use.

2. The contractor will lease equipment.

3. The contractor or the plant owner will purchase new construction equipment, and they will sell this equipment to others after use.

A list of construction equipment needed for construction of the plant is given in item F of the Attachment to Table VIA-2, where the equipment to be costed in the foreign exchange portion is distinguished from that to be costed in the local currency portion.

The construction equipment costed in the local currency portion consists mainly of that to be used for civil work. Some of this equipment is to be locally fabricated in Thailand and can be procured with local currency.

As for the equipment not available in Thailand, it is assumed that the local contractors who undertake the civil work for the plant would possibly purchase imported equipment, and, after completion of the construction work, would either use the equipment for other projects or otherwise would sell it as used construction equipment to other local contractors, because there exists large demand for such equipment in Thailand. On this presumption such costs are appropriated in the local currency portion.

The construction equipment of which the cost for use is appropriated in the foreign exchange portion consists of the equipment needed for inland transportation to the site and erection of heavy equipment. This construction equipment is not fabricated in Thailand. Nor could this equipment be expected to be owned by local contractors, because the cost of the equipment seems to be beyond the financial capacity of local contractors for purchasing and, moreover, it is unlikely that there exists demand for it in Thailand.

The costs appropriated in the foreign exchange portion are estimated by means of subtracting the anticipated resale prices from the purchase price of new construction equipment, whereas the costs appropriated in the local currency portion are estimated by means of calculating lease charges based on prevailing lease prices and the anticipated period of use of the leased equipment.

The resale price must be determined separately for each piece of equipment, because the depreciation and charges for use may vary from one to another, depending on the life of equipment and period of its actual use.

However, as an average, the cost for using the construction equipment to be paid by the project owner was estimated at about 45% of the price of new equipment. For the estimation of resale price of construction equipment which was appropriated in the foreign exchange portion, the expenses for reexport after use as well as ocean freight to the origin countries are subtracted from the resale price as estimated in the above manner.

(5) Ocean freight, marine insurance, and local handling costs (in end-September 1980 price)

(a) Ocean freight

The weight of the plant equipment and materials needed to build the plant is estimated at about 100,000 freight tons in total, and that includes many pieces of heavy equipment. In view of this fact, for the estimation of freight charges, it is assumed that chartered vessels having heavy-duty derrick cranes will be used for sea transportation of the equipment and materials. This estimate uses a freight rate of US$90.9 per freight ton in average. Packing costs, stevedoring costs and other costs and expenses incurred for exports after delivery to export yards are separately estimated.

(b) Landing and inland transportation cost

It is presumed that the equipment and materials for construction of the plant will be landed at Sattahip Port and transported to the plant site by roads.

(c) Marine insurance

It is assumed that the general contractor will purchase marine insurance to cover all imported equipment and materials for the plant, and the premium paid for that insurance will be reimbursed by the plant owner.

The cost of marine insurance premium is estimated at the rate of 0.3% of C & F cost for imported equipment and materials, and is appropriated in the foreign exchange portion.

(6) Contingencies

For the rates used for estimation of the cost contingency, refer to items (K, L) and (L, M) of the Attachment to Table VIA-2.

(a) Physical contingency

The physical contingency is provided in order to cover any costs which may occur in excess of those estimated here; this additional cost, which is unforeseeable at present, may arise from such factors as the degree of precision of the conceptual design, meteorological conditions in the site area, soil conditions and other matters encountered at the time of construction. The contingency rates were estimated individually for each cost item. The physical contingency thus estimated by means of applying the contingency rates, as is shown in the Attachment to Table VIA-2, is the equivalent of 8.3% of the Base Project Cost in the foreign exchange portion, 7.0% of the Base Project Cost in the local currency portion, and 8.0% of the total amount of Base Project Cost. It is noted that the total contingency rates for the rail spur cost shown in item D of the Attachment to Table VIA-2 is the equivalent of 10% of the Base Cost in the foreign exchange portion, 9.5% of the Base Cost in the local currency portion, and 9.8% of the total Base Cost in this item.

(b) Price contingency

Cost increases due to inflation are anticipated in the future. The rate of escalation (A) is estimated at 9% per annum for the costs of the foreign exchange portion and 12% per annum for the costs of the local currency portion, which are annual compound rates, and the period (B) from the time of estimation of the Base Project Cost (as of the end of September, 1980) up to the time of disbursement was projected on each cost component. The amount of price contingency is estimated by accumulating the amount of escalation on each cost component which is calculated by applying the formula of (A) x (B) in compound. The thus-estimated price contingency, as is shown in the Attachment to Table VIA-2, is the equivalent of 31.2% of the Base Project Cost in the foreign exchange portion, 42.9% of the Base Project Cost in the local currency portion, and 34.3% of the Base Project Cost in total. It is noted here that the price contingency for the rail spur given as D in the Attachment to Table VIA-2 is the equivalent of 39.7% of the Base Cost in the foreign exchange portion, 53.4% of the Base Cost in the local currency portion and 47% of the total Base Cost of this item.

(7) Interest during construction

Interest during construction is estimated on the following assumption: (a) 70% of the total capital requirements will be financed through loans, (b) disbursement of loans will be made at 30% of the total loan amount in the first year, 40% in the second year, and 30% in the third year, and (c) the interest rate (not yet determined) is 4–6% per annum.

(8) Railway spur

The railway spur cost accounts for the cost for construction of a railway spur of 0.8 km for siting at Ban Mab Chalood and 5.0 km for at Ban Nong Yai, including the costs for land acquisition and preparation of right-of-way. The breakdown of these costs is shown in the Attachment to Table VIA-2.