Table VII-1 PROJECT ECONOMIC RETURN
(Case B)

(M$'000)

Year	Economic Cost			Economic[3] Benefit	Present Value (Discount Rate: 9%)		Present Value (Discount Rate: 10%)	
	A) Capital[1] Cost	B) Operat-[2] ing Cost	Total (A) + (B)		Economic Cost	Economic Benefit	Economic Cost	Economic Benefit
1981	196,230		196,230		196,230		196,230	
1982	261,640		261,640		240,036		237,854	
1983	130,820		130,820		110,109		108,116	
1984	65,410	69,582	134,992	113,575	104,238	87,700	101,421	85,330
1985		88,493	88,493	169,999	62,691	120,432	60,442	116,111
1986		93,612	93,612	190,790	60,841	124,000	58,126	118,465
1987		93,612	93,612	192,521	55,818	114,794	52,841	108,672
1988		93,612	93,612	192,521	51,209	105,315	48,038	98,794
1989		93,612	93,612	192,521	46,981	96,621	43,671	89,813
1990		93,612	93,612	192,521	43,102	88,642	39,701	81,648
1991		93,612	93,612	192,521	39,543	81,323	36,091	74,225
1992		93,612	93,612	192,521	36,277	74,608	32,810	67,477
1993		93,612	93,612	192,521	33,282	68,447	29,828	61,343
1994		93,612	93,612	192,521	30,534	62,796	27,116	55,766
1995		93,612	93,612	192,521	28,013	57,612	24,651	50,697
1996		93,612	93,612	192,521	25,700	52,855	22,410	46,088
1997		93,612	93,612	192,521	23,578	48,490	20,373	41,898
1998		93,612	93,612	192,521	21,631	44,486	18,520	38,088
Total	654,100	1,375,031	2,029,131	2,784,616	1,209,813	1,228,121	1,158,239	1,134,415
				Benefit Cost:	+ 18,308		- 23,824	

$$\frac{18,308}{18,308 + 23,824} \times 1 = 0.43$$

9 + 0.43 = 9.43% (E.I.R.R.)

Notes:
1) See Attachment (1) to this table.
2) See Attachment (2) to this table.
3) Estimated at M$ 420/t (US$ 175 x 2.4) FOB for urea, and M$ 492/t (US$ 205 x 2.4) FOB for ammonia.

Table VII-1
ATTACHMENT (1)

ECONOMIC CAPITAL COST

Total Project Cost (Financial) excluding Interest during Construction

(US$ '000)

	Foreign Exchange Cost	Local Currency Cost	Total
	222,160	61,270	283,430
less: transferable cost*)	4,580	1,310	5,890
Economic Capital Cost (US$ '000)	217,580	59,960	277,540
	x 2.4	x 2.2	
Economic Capital Cost (M$ '000)	522,190	131,910	654,100

Note: *) Income tax to be paid by contractors' personnel

Table VII-1

ATTACHMENT (2)

ESTIMATED ANNUAL OPERATING COST

		1984	1985	1986	Onwards
(A) Local Currency Cost	(1) Natural Gas (US$'000)	10,410	14,151	15,854	15,854
	(2) Utilities (US$ '000)	2,607	3,556	3,992	3,992
	(3) Labour (US$ '000)	4,083	4,900	4,900	4,900
	(4) Maintenance Cost (US$ '000)	1,226	1,471	1,471	1,471
	(5) Overhead (US$ '000)	6,805	8,166	8,166	8,166
	(6) Total L.C. Cost in US$ (US$ '000)	25,131	32,244	34,383	34,383
	Total F.E. Cost in M$ (6) x M$ 2.2/US$ (M$ '000)	55,288	70,937	75,643	75,643
(B) Foreign Exchange Cost	(1) Catalyst & Chemicals (US$ '000)	1,053	1,432	1,604	1,604
	(2) Maintenance Cost (US$ '000)	4,903	5,883	5,883	5,883
	(3) Total F.E. Cost in US$ (US$ '000)	5,956	7,315	7,487	7,487
	Total L.C. Cost in M$ (3) x M$ 2.4/US$ (M$ '000)	14,294	17,556	17,969	17,969
Economic Cost (A) + (B) (M$ '000)		69,582	88,493	93,612	93,612

Notes: (A) Local currency cost

(1)	Natural gas:	US$ 1.32/MMBTU (opportunity cost)
(2)	Utilities:	less 15% of the rates assumed for financial projections
(3)	Labour cost:	less 10% of the cost used for financial projection
(4)	Maintenance cost:	20% of maintenance cost estimated for financial projections
(5)	Overhead:	As per cost estimated for financial projections

(B) Foreign exchange cost

(1)	Catalyst & Chemicals:	As per cost estimated for financial projections
(2)	Maintenance cost:	80% of maintenance cost for financial projections

Table VII-2 ESTIMATED STANDARD CONVERSION FACTOR & ESTIMATED SHADOW EXCHANGE RATE

Year	SCF*)
1974	0.929
1975	0.931
1976	0.907
1977	0.908
1978	0.917
	Average: 0.918

Estimated Shadow Exchange Rate: M$ 2.2/US$ ÷ 0.918 = M$ 2.4/US$

Note: *) SCF computed by applying the following formula:

$$SCF = \frac{IMP + EX}{IMP\ (1 + Tax^{imp} + TQ^{imp}) + EX\ (1 - Tax^{ex})}$$

Here:

- SCF = Standard Conversion Factor
- IMP = Gross value of major imports (CIF price)
- EX = Gross value of major exports (FOB price)
- Tax^{imp} = Weighted average of import duty rates
- TQ^{imp} = Import duty rates for tax varier
- Tax^{ex} = Weighted average of export tax rates

For computation of SCF, the following figures were applied:

- IMP: Refer to Table VII-2 ATTACHMENT.
- EX: Refer to Table VII-2 ATTACHMENT.
- Tax^{imp} : 30% (15% for import duty; 15% for surtax)
- TQ^{imp}: Nil
- Tax^{ex}: 10%

Table VII-2
ATTACHMENT

MAJOR EXPORTS/IMPORTS
(Malaysia)

Year	Major Exports (M$ millions)	Major Imports (M$ millions)
1974	7,706.5	9,800.9
1975	6,512.9	8,463.6
1976	9,947.7	9,644.9
1977	11,254.4	11,083.9
1978	12,301.2	13,547.7

Source: Quarterly Economic Bulletin, March/June, 1979, Bank Negara Malaysia.

APPENDIX I

APPENDIX I-1 MEMBERS LIST OF JAPANESE EVALUATION TEAM

(1) Member of assigned experts

	Name	Function at Team	Title and Organization
Team Members			
1.	Dr. Shigeo UEKI	Team Leader	General Manager, Technical Department Japan Consulting Institute
2.	Mr. Masayasu SAKANASHI	Assistant Team Leader, Techno-Economist	Director, UNICO International Corporation
3.	Mr. Makoto KUWABARA	Project Engineer	Manager, UNICO International Corporation
4.	Mr. Katsuo ADACHI	Project Engineer	Consultant, Japan Consulting Institute
5.	Mr. Isamu MUTO	Civil Engineer	Manager, Japan Consulting Institute
6.	Mr. Ryoji KIKAWA	Civil Engineer	Manager, Japan Consulting Institute
7.	Mr. Shozo INAKAZU	Project Engineer	Manager, UNICO International Corporation
8.	Mr. Tetsuo INOOKA	Agricultural Economist	Manager, UNICO International Corporation
9.	Mr. Yukio TAKITA	Petroleum Engineer	Chief Engineer, Japan Oil Engineering Corporation
10.	Mr. Yoshio SATO	Project Engineer – Logistics	Manager, UNICO International Corporation
11.	Mr. Kiyoshi YAMAGUCHI	Project Engineer	Japan Consulting Institute

(2) Officers in charge of ministries or agencies concerned

	Name	Function at Team	Title and Organization
1.	Mr. Masahiro KUMAGAE	–	Ministry of International Trade and Industry
2.	Mr. Akihiro MITARAI	–	Japan International Cooperation Agency

Name	Function at Team	Title and Organization
3. Mr. Norio FUKUBAYASHI	–	Japan International Cooperation Agency
4. Mr. Michio OHTA	–	The Overseas Economic Cooperation Fund

APPENDIX I-2 LIST OF COUNTERPARTS IN MALAYSIA

No.	Name	Function at Project	Title and Organization
	Administrative Member		
1.	En. Kamaruddin Nordin	—	Director, Industrial Division, Ministry of Trade and Industry, Malaysia
2.	En. Mohamed Feisal Ibrahim	—	Deputy Director, Industrial Division, Ministry of Trade and Industry, Malaysia
3.	En. N. Sadasivan	—	Deputy Director General, Malaysian Industrial Development Authority
4.	En. Geh Sim Hong	—	Director, Planning & Research Division, Malaysian Industrial Development Authority
5.	En. Sulbramaniam. P.	—	Economist, Malaysian Industrial Development Authority
6.	En. Tan Chin Huat	—	Economist, Malaysian Industrial Development Authority
7.	En. Salleh Amran	—	Deputy Under Secretary, Ministry of Finance, Malaysia
8.	En. Mustapha Bin Haron	—	Principal Assistant Secretary, Ministry of Agriculture
9.	En. Mohd. Som Bin Hj. Sulong	—	Managing Director, KPM NIAGA Sdn. Bhd.
10.	En. Mohd Tahir Haji Ahmad	—	Marketing Director, KPM NIAGA Sdn. Bhd.
11.	En. Haji Harun Bin Mohd. Avabee	—	Director, Development and Training, Department of Agriculture
12.	Ajit Singh	—	Deputy Director, Crop Production, Department of Agriculture
13.	Chin Kim Wah	—	Senior Agriculture Officer, Soil and Analytical Services, Department of Agriculture

	Name	Function at Project	Title and Organization
14.	Hashm Noor	–	Director of Research Services, MARDI
15.	Rahim B. Rahuiat	–	Director of Development, Farmers Organization Authority

PETRONAS (Petroliam Nasional Berhad)

	Name	Function at Project	Title and Organization
1.	En. Tan Sri Abdullah Salleh	–	Chairman, PETRONAS
2.	En. Rastam Hady	–	Managing Director, PETRONAS
3.	En. Abdul Aziz Ahmad (Succeeded by En. M. B. Hashim)	Chairman	Executive Director, Processing & Manufacturing Department, PETRONAS
4.	En. Ismail hashim	–	Executive Director, Finance Department, PETRONAS
5.	En. Adnan Abdul Wahab	Leader	Manager, Fertilizer Project Department, PETRONAS
6.	En. Mohd. Shukor Owar	Leader	Manager, Project Planning & Monitoring Department, PETRONAS
7.	En. Tan Hai Leng	Coordinator Technical Team	Processing & Manufacturing Department, PETRONAS
8.	En. Hasno Zakaria	Technical Team	Processing & Manufacturing Department, PETRONAS
9.	En. Wan Fauzi Tuanku Esim	Technical Team	Processing & Manufacturing Department, PETRONAS
10.	En. Abdul Ghani Muda	Technical Team	Processing & Manufacturing Department, PETRONAS
11.	Dr. Mohd Ayob	Gas Team	Exploration and Production Department, PETRONAS
12.	En. Mohd. Jusoh	Gas Team	Processing and Manufacturing Department PETRONAS

	Name	Function at Project	Title and Organization
13.	En. Ramanathan Krishna Iyer	Gas Team	Processing and Manufacturing Department, PETRONAS
14.	En. Hilmi Mohd. Nashir	Finance and Economic Team	Processing and Manufacturing Department, PETRONAS
15.	En. Juarez Rizal Abd. Hamid	Finance and Economic Team	Processing and Manufacturing Department, PETRONAS
16.	En. Abd. Ghani Arip	Finance and Economic Team	Finance Department, PETRONAS
17.	En. Bahari Kamar Shah	Market Team	Processing and Manufacturing Department, PETRONAS
18.	En. Awang Othman Awang Jaya	Marketing Team	Marketing Department, PETRONAS
19.	En. Mohd. Johari Ismail	Marketing Team	Marketing Department, PETRONAS
20.	En. D.M. Anwar Raja	Petroleum Engineer	Production Department, PETRONAS
21.	Ms. Siti Shamsiah Shaari	Marketing Team	Finance Division, PETRONAS
22.	En. Masri Yusoff	Coordinator	Area Manager, PETRONAS, Miri, Sarawak
23.	En. Ishak Bin Nordin	Coordinator	PETRONAS, Miri, Sarawak
24.	En. Wan Idris Yacob	Coordinator	PETRONAS, Miri, Sarawak
25.	Mr. Kohji Tanaka	Consultant	Project Director, C. Itoh Technical Consultants, Inc., Japan
26.	Mr. Hiroshi Ikemoto	Consultant	Project Manager, Mitsubishi Heavy Industries, Ltd., Japan

APPENDIX I-3 LIST OF ORGANIZATIONS VISITED AND PERSONS MET BY THE TEAM

(1) List of organizations visited

***

- Ministry of Finance, Malaysia
- Ministry of Trade and Industry, Malaysia
- Ministry of Agriculture, Malaysia

***

- Embassy of Japan
- Japan International Cooperation Agency, Kuala Lumpur, Malaysia

***

- PETRONAS (Petroliam Nasional Berhad)
- Malaysia LNG Sdn. Berhad

***

- Malaysian Industrial Development Authority
- Federal Land Development Authority
- Rubber Research Institute of Malaysia
- Rubber Industry Smallholders Development Authority
- Malaysian Agricultural Research and Development Authority

***

- Geological Survey Department, Kuala Lumpur
- Meteorological Department, Kuala Lumpur
- Telecommunications Department, Kuching, Sarawak
- Drainage and Irrigation Department, Kuala Lumpur

- Department of Agriculture, Kota Kinabalu, Sabah
- Padi Board, Kota Kinabalu, Sabah

***

- Bintulu Development Authority, Kuching, Sarawak
- Bintulu Developmelnt Authority, Bintulu, Sarawak
- Sarawak Electricity Supply Corporation, Kuching, Sarawak
- Sarawak Electricity Supply Corporation, Bintulu, Sarawak
- Public Works Department, Kuching, Sarawak
- Public Works Department, Bintulu, Sarawak
- Sarawak Land Development Board, Kuching, Sarawak
- Muda Agricultural Development Authority, Kedah
- Kuching Port Authority, Kuching, Sarawak
- Penang Port Committee, Penang

***

- Chemical Company of Malaysia
- Esso Malaysia Berhad
- Federal Fertilizer Company
- ICI (Malaysia) Sdn. Bhd.
- Ajinomoto (Malaysia) Berhad
- Daiya Malaysia Sdn. Bhd.
- Wee & Wee Fertilizers and Chemicals Sdn. Bhd, Kuching, Sarawak
- Trans-Asia Shipping Corp. Penang
- Guthrie Kimia Sdn. Bhd. Butterworth
- Perdagangan Perkasa Sdn. Bhd., Kota Kinabalu, Sabah
- Rira Corporation Sdn. Bhd., Penang

***

- Stanley Consultant, Kuala Lumpur
- Halcrow Balfour Ltd., Kuching, Sarawak
- Teamwork, Malaysia Sdn. Bhd.

(2) Persons met by the Evaluation Study Team

Name	Function at Team	Title and Organization
Bintulu Development Authority, BDA (Lembaga Kemajuan Bintulu)		
1. En. Yb Datuk Jamaludin	–	General Manager, Bintulu Development Authority, Kuching, Sarawak
2. En. Abang Helmi Datuk Amar Ikhwan	–	Secretary, Bintulu Development Authority, Kuching, Sarawak
3. En. Mohidin Ishak	–	Bintulu Development Authority, Bintulu, Sarawak
Public Works Department, PWD (Jabatan Kerja Raya, JKR)		
1. En. Michael K. N. Ting	–	Assistant Director, Public Works Department, Kuching, Sarawak
2. En. Stephen Kong Swee Meng	–	PWD, Land & Survey Dept., Kuching
3. En. Victor Vone	–	PWD, Road Branch, Kuching
4. En. Timothy Liaw Aik Hon	–	Public Works Department, Kuching, Sarawak
5. En. Ting Kong Siin	–	Engineer, Public Works Department, Kuching, Sarawak
6. Mr. Andrew Macoun	–	Advisor, Public Work Department, Kuching, Sarawak
7. En. Kong Bun Him	–	Public Works Department, Bintulu, Sarawak
8. En. Lim Chin Aun	–	Public Works Department, Bintulu, Sarawak
Sarawak Electricity Supply Corporation, SESCO (Perbadanan Pembekalan Letrik Sarawak)		
1. En. Roger Wong	–	Sarawak Electricity Supply Corporation, Kuching, Sarawak
2. En. Yao Sik Heng	–	Professional Engineer (M), Sarawak Electricity Supply Corporation, Bintulu, Sarawak

Name	Function at Team	Title and Organization
Telecommunications Department, TELECOMS (Jabatan Telekom, TELEKOM)		
1. En. Gordon Kong	–	Engineer TELECOMS
2. En. Chen Eng Kiat	–	SEA, TELECOMS
Kuching Port Authority (Lembaga Pelabuhan Kuching)		
1. En. Duke Shim	–	Assistant Manager, Kuching Port Authority, Kuching, Sarawak
2. En. Kho Chin Kay	–	Traffic Manager, Kuching Port Authority, Kuching, Sarawak
Esso Malaysia Berhad, Port Dickson		
1. Mr. C. A. Rose	–	Managing Director, Esso Malaysia Berhad
2. En. A. C. Mah	–	Acting Refinery Manager, Esso Malaysia Berhad
3. En. Y. S. Lee	–	Technical Manager, Esso Malaysia Berhad
4. En. R. Tharmarajah	–	Chemical/Project Manager, Esso Malaysia Berhad
5. En. H. S. Ho	–	Operations Superintendent
Chemical Company of Malaysia, ICI (Malaysia) Sdn. Bhd., Kuala Lumpur		
1. En. S. S. Sidhu	–	Assistant Works Manager, CCM
2. En. Mok Kum Ming	–	Managing Officer, ICI
3. En. Koh Ting Tien	–	Operations Department Manager, CCM
Halcrow Balfour Ltd., Kuching, Sarawak		
1. Mr. Michael W. Crabb	–	Chartered Engineer
2. Mr. Paul V. Sage	–	Chartered Engineer

Name	Function at Team	Title and Organization
Malaysian Industrial Development Authority, Kuching, Sarawak		
1. En. Mansor B. Abdullah	–	Regional Director
Geological Survey Department, Kuching, Sarawak		
1. En. Kho Chin Heng	–	Kuching Office
Meteorological Department, Kuala Lumpur		
1. En. Mohamad	–	Hydrologist

APPENDIX I-4 STUDY SCHEDULE OF JAPANESE EVALUATION TEAM

	JAPANESE TEAM MEMBER														
	Ueki	Sakanashi	Kuwabara	Adachi	Muto	Kikawa	Inakazu	Inooka	Takita	Sato	Yamaguchi	Kumagae	Ohta	Mitarai	Fukubayashi
September, 1979															
2 (S)	TKY/KL	-	TKY/KL	TKY/KL	TKY/KL	TKY/KL	TKY/KL	TKY/KL	TKY/KL	TKY/KL	TKY/KL	TKY/KL	TKY/KL	-	TKY/KL
3 (M)	KL	-	KL	KL	KL	KL	KL	KL	KL	KL	KL	KL	KL	-	KL
4 (T)	KL	-	KL	KL	KL	KL	KL	KL	KL	KL	KL	KL	KL	-	KL
5 (W)	KL	-	KL	KL	KL	KL	KL	KL	KL	KL	KL	KL	KL	-	KL
6 (T)	KL	-	KL	KL	KL	KL	KL	KL	KL	KL	KL	KL	KL	-	KL
7 (F)	KL	-	KL	KL	KL	KL	KL	KL	KL	KL	KL	KL	KL	TKY/KL	KL
8 (S)	KL/KG	-	KL/KG	KL/KG	KL/KG	KL/BTL	KL/KG	KL	KL	KL/KG	KL/KG	KL/KG	KL/BTL	KL/KG	KL/KG
9 (S)	KG/BTL	-	KG/BTL	KG/BTL	KG/BTL	BTL	KG/BTL	KL	KL	KG/BTL	KG/BTL	KG/BTL	BTL	KG/BTL	KG/BTL
10 (M)	BTL	-	BTL	BTL	BTL	BTL	BTL	KL	KL	BTL	BTL	BTL/KL	BTL/KG	BTL/KL	BTL
11 (T)	BTL	-	BTL	BTL	BTL	BTL	BTL	KL	KL	BTL	BTL	KL/TKY	KG/BTL	KL/TKY	BTL
12 (W)	BTL	-	BTL	BTL	BTL	BTL	BTL	KL/KBU	KL	BTL	BTL	-	KL	-	BTL
13 (T)	BTL/KG	-	BTL/KG	BTL/KG	BTL/KG	BTL/KG	BTL/KG	KBU/KL	KL	BTL/KL	BTL/KG	-	KL/TKY	-	BTL/KG
14 (F)	KG	-	KG	KG	KG	KG	KG	KL/PNG	KL	KL/PNG	KG	-	-	-	KG/KL
15 (S)	KG/KL	-	KG	KG/KL	KG/KL	KG	KG/KL	PNG	KL	PNG	KG/KL	-	-	-	KL/TKY
16 (S)	KL	-	-	KL	KL	KG	KG	PNG	KL	PNG	KL	-	-	-	-
17 (M)	KL	-	KG/KL	KL	KL	KG/KL	KG/KL	PNG	KL	PNG	KL	-	-	-	-
18 (T)	KL	-	KL	KL	KL	KL	KL	PNG/KL	KL	PNG/KL	KL	-	-	-	-
19 (W)	KL	TKY/KL	KL	KL	KL	KL	KL	KL	KL	KL	KL	-	-	-	-
20 (T)	KL	KL	KL	KL	KL	KL	KL	KL	KL	KL	KL	-	-	-	-
21 (F)	KL	KL	KL	KL/TKY	KL/TKY	KL	KL/TKY	KL	KL/TKY	KL/TKY	KL	-	-	-	-
22 (S)	KL	KL	KL	-	-	KL	-	KL	-	-	KL	-	-	-	-
23 (S)	KL	KL	KL	-	-	KL	-	KL	-	-	KL	-	-	-	-
24 (M)	KL	KL	KL	-	-	KL	-	KL/MNL	-	-	KL	-	-	-	-
25 (T)	KL	KL	KL	-	-	KL	-	MNL	-	-	KL	-	-	-	-
26 (W)	KL/TKY	KL/TKY	KL/TKY	-	-	KL/TKY	-	MNL	-	-	KL/TKY	-	-	-	-
27 (T)	-	-	-	-	-	-	-	MNL	-	-	-	-	-	-	-
28 (F)	-	-	-	-	-	-	-	MNL	-	-	-	-	-	-	-
29 (S)	-	-	-	-	-	-	-	MNL	-	-	-	-	-	-	-
30 (S)	-	-	-	-	-	-	-	MNL	-	-	-	-	-	-	-
October, 1979															
1 (M)	-	-	-	-	-	-	-	MNL/TKY	-	-	-	-	-	-	-

Abbreviation;
TKY; Tokyo KL; Kuala Lumpur KG; Kuching KBU; Kota Kinabalu BTL; Bintulu PNG; Penang MNL; Manila

APPENDIX I-5 LIST OF DATA, DOCUMENTS AND DRAWINGS RECEIVED

(1) Project Status

1) FINAL REPORT OF THE PART "B" OF THE DOWNSTREAM STUDY OF THE MASTER PLAN STUDY FOR THE DEVELOPMENT OF PETROLEUM RESOURCES IN MALAYSIA, VOLUME 1, 2, 3, 4 – DECEMBER, 1979. – PREPARED FOR PETRONAS BY C. ITOH & CO., LTD.

   (The Japanese Evaluation Team was allowed to review the documents during the study period in Malaysia and the documents were returned to PETRONAS).

2) INTRODUCTORY BRIEF ON THE ASEAN UREA PROJECT (MALAYSIA) – PETROLIAM NASIONAL BERHAD – PETRONAS

(2) Natural Gas Supply

1) Migrated Depth Contour Map, E11, F23, F6, E8, F13

2) Cross Section and Reservoir Quality, E11, F23, F6, E8, F13

3) Well Logs and Lithological Interpretation of Carbonate Section, E11, F23, F6, E8, F13

4) Central Luconia Reserve Parameters – Mean Values

5) Central Luconia Reserves

6) Reserve Estimating Procedure

7) Field Location Map with the Names of Fields to be Designated to MLNG and Urea Projects

8) Offshore Installations and Production Facilities, Central Luconia

9) MLNG Upstream Project Development Schedule

10) Proposed Central Luconia Completion Design

11) Central Luconia, No. of Wells per Field

12) Process Flow Sheet, Typical Field Facilities (offshore), Commingled Production

13) Tentative Plan - Bintulu Industrial Area, Sarawak

14) Production Scheme - Central Luconia Gas Supply to MLNG

15) Combined Peak Production Capacity vs Time

16) MLNG, into Plant Feed Gas Composition/Natural Gas Supply Schedule/Production Profile

17) Gas Composition of Central Luconia Fields

18) E11.3 Reservoir Parameters after Acidization

19) Summary of Production Test Results, F23.2

20) Gas Well Test Results, F6.5, F6.4

21) F6.4 Results of Production Tests

22) Gas Well Test Results, E8.4, E8.2

23) Analysis of BHP Survey, F13.3

24) F13.3 Back Pressure Curve after Acidization

3) Site Selection, Utility Supply and Infrastructure

1) Topographical Map, Proposed Site Area 1/2,500

2) Ammonia Urea Project Water Supply System Map 1/5,000

3) MLNG Overall Layout

4) Bintulu Deepwater Port Site Location Plan

5) Structure Plan for Bintulu Region

6) Mineral Resources Map of Sarawak

7) The Geology & Mineral Resources of the Suri-Baram, North-Sarawak

8) Miri/Bintulu Regional Planning Study Supplementary Report # 1, 1974

9) The Port Authority Ordinance 1961, Kuching

10) Meteorological Data

APPENDIX I-6 ASEAN UREA PROJECT (MALAYSIA)

6-1 Project History

(1) The ASEAN Economic Ministers at their Second Meeting in Kuala Lumpur on March 1976 decided that Indonesia and Malaysia shall each be allocated a urea project, provided that each ASEAN member state is satisfied with the viability of the project.

(2) PETRONAS engaged the firm of C. ITOH & CO. of Japan as its consultant for purpose of preparing a feasibility study. The report was completed in December 1977 with the conclusion that the setting up of 1,300 MTPD Ammonia Plant and 1,500 MTPD Urea Plant will be most viable.

(3) The Sixth Meeting of the ASEAN Economic Ministers (Jakarta, 5 - 7 June 1978) that the proposed capacity of the Ammonia Plant of the ASEAN Urea Project (Malaysia) should be revised downwards from 1,300 MTPD to 1,000 MTPD whilst that of Urea Plant still be at 1,500 MTPD.

(4) Upon detailed evaluation of the Project by the ASEAN member states, wherein certain changes were made to the project scope, the ASEAN Economic Ministers at its Seventh Meeting convened at Kuala Lumpur on 14 - 16 December 1978 agreed that the ASEAN Urea Project (Malaysia) is viable and accepted it as an ASEAN Industrial Project.

6-2 Current Status

PETRONAS as the implementing agency for the ASEAN Urea Project (Malaysia) proceeded with the following major activities:

(1) Formulaiton of the Joint Venture Agreement and the Articles and Memorandum of Association for the Company. The First Meeting of the Shareholder Entities was held at Kuala Lumpur on 17 - 19 July 1979.

(2) Selection of Technical Consultant to undertake the process selection, formulation

of the project specifications and bid package for the main contract, detail project costing, procurement and construction supervision and commissioning and start-up.

(3) Land acquisition, soil and subsoil investigation and site preparation. PETRONAS has engaged Jurutera Konsultant to do preliminary soil investigation.

(4) Formulation of the detail marketing and distribution plan for Urea and Ammonia in Malaysia.

APPENDIX I-7 PAPER ON PETRONAS STRATEGY AND ACTION PROGRAMS FOR DOMESTIC MARKETING OF UREA

19th October, 1979

By: Fertilizer Dept. P & M Division

PREAMBLE

Japan International Cooperation Agency (JICA) has been appointed to review and evaluate the feasibility of the ASEAN Urea Project. With this objective, JICA's Evaluation Team visited Malaysia from 2/9/1979 to 26/9/1979. On September 23, the Team presented an Interim Report containing a summary of Team's findings or observation in respect of the basis of the Project as well as major elements to be confirmed as a basis for its subsequent evaluation studies to be performed in Japan.

In the letter accompanying the report, JICA has requested PETRONAS to submit a paper stating a strategy and action programme contemplated for the marketing of ammonia/ urea as well as its present position for inclusion in their report to pertinent authorities in Japan.

MARKETING STRATEGY AND ACTION PROGRAMME CONTEMPLATED FOR THE MARKETING OF AMMONIA & UREA PRODUCED BY ASEAN UREA PROJECT IN MALAYSIA

1. Objective

The objective of this paper is to outline briefly the strategy and action programmes contemplated for marketing of ammonia and urea produced by ASEAN Urea Project in Malaysia as well as a description of the present marketing position.

2. Introduction

The agricultural sector is at present the largest sector of the Malaysian economy. In 1975, it contributed 29.8% of the GNP and provided employment of 49.5% of the Malaysian total labour force. It is also estimated that 69% of all poor households are found in this sector. In recent years, agricultural development has been substantial and will continue to increase as a result of Government direct role in order to attain the objectives of the New Economic Policy.

However, productivity in agricultural sector is still relatively low. Among Government measures to increase output are its modernization programmes, research programmes, improved drainage and irrigation system, expansion of replanting scheme, crop diversification programme, improved training and extension services, revamping credit and subsidies scheme and improved agricultural products marketing system. These will greatly contribute to the improvement of agricultural sector.

A stable supply of fertilizers at reasonable price to the agricultural sector as well as implementation of socio-economic measures to encourage the use of fertilizers is regarded as the key to increase output and development of this sector.

3. Strategy and Action Programme for Marketing & Distribution of Ammonia and Urea

3-1 Current Fertilizer Distribution Network

On the whole, Malaysia is heavily dependent on imports of her fertilizer requirements from a large number of countries, but four countries, Christmas Island, Germany, Canada and Japan, supply two-thirds of Malaysian fertilizer imports.

The import trade is handled by six major importers who also organize the wholesale and retail business. These commercial importers have their own fertilizer advisory services to assist in the marketing of the product. They work closely with Government research and extension agencies. Sales of these fertilizers by the importing firms are sometimes direct to the larger consumers such as estates and Government Agencies or through dealers.

In addition to these private dealers, farmers cooperatives, replanting agencies, and land development boards play an important part in the distribution of fertilizers to small farmers.

In normal times, the imports and distribution of fertilizers are 'free' and left to the private sectors for Malaysia which has a well developed import and distribution system run by experienced wholesalers and retailers.

The Government itself through the Ministry of Agriculture plays an important part in making fertilizers available to small farmers. Apart from organizing supplies of fertilizers to the farmers, the Government's role in fertilizer distribution includes:

a) organizing institutional credit to small farmers;

b) increasing fertilizer retail outlets at the farm level through the establishment of farmers cooperatives and small agricultural units;

c) providing fertilizers, subsidy schemes and other agricultural inputs, as a package programme so as to promote agricultural diversification and increase the productivity of small farmers;

d) Undertaking research to improve fertilizer-use by small farmers and other agricultural production units.

3-2 Basic ASEAN Urea Production & Marketing Arrangement

At present fertilizer manufacturing in Malaysia is limited to Ammonium Sulphate, Ammonium Nitrate and Compound Fertilizers. Demand for Urea is met entirely by import. The ASEAN Urea Plant (the Project) in Bintulu with the capacity of 1,000 MTPD liquid ammonia and 1,500 MTPD prilled bulk urea is expected to commence commercial operation by January, 1984. PETRONAS was appointed as the execution agency for the project.

As agreed by ASEAN shareholders the plant shall in the first place supply the total Malaysian domestic market and thereafter share equally with the Indonesian ASEAN Project the available ASEAN Market. The Joint Venture Company for the project will sell urea on Free on Board (FOB) basis to these markets and it has been agreed that the FOB price will be set at world prices in the range of the floor and ceiling price set with the maximum and minimum project rate of return. Offtaking of urea will be arranged in accordance with preferential Trading Arrangement among ASEAN member states.

The production policy of the plant will be to adjust its production in order to meet with the Malaysian and ASEAN demand patterns in the initial years. Should there be any surplus production, then Malaysia will guarantee to absorb them. From the Malaysian and ASEAN demand projection, it is observed that the Malaysian demand is increasing at a steady rate. With the production limited to the plant capacity of 1,500 MTPD, urea available for the ASEAN market allocated for the Project will gradually decrease. Hence there will be no surplus after the 6th year of production and the sales after this period outside ASEAN will be very unlikely.

3-3 PETRONAS Marketing Strategy and Action Programmes

As the plant will be on stream by 1984, PETRONAS is aware of the fact that the marketing activities should be implemented well in advance of this date in order to prepare for the marketing of the products.

In full recognition of the above, PETRONAS has already decided on the organization and development of domestic marketing systems so that the marketing and distribution system will be well organized and ready for operation at the time of commencement of commercial production of the project.

3-3-1 Basic policy and strategy

Based on preliminary analysis of data and information, basic marketing and distribution strategy and policy has been formulated.

For the purpose of marketing and selling the products for the domestic market, a Marketing Company will be formed which will be 100% Malaysian-owned. This Company will have bagging facilities in Bintulu for bagging of bulk urea.

The basic policy of the Company is to utilize the existing domestic distributors of fertilizers as its agents. A domestic distribution scheme (refer to Chart I) has been developed by PETRONAS for the Company to consider for adoption.

In the proposed scheme, the bagged urea will be shipped and delivered by the Company using third party shipping to the major ports in the country. In Sabah bagged urea will be shipped by coastal vessels to Kota Kinabalu, Sandakan and Tawau. In Sarawak, the ports of entry will be Miri and Kuching (urea can be sold ex-works in Bintulu itself). For Peninsular Malaysia it will be Port Kelang, Pasir Gudang, Kuantan and Butterworth. Bagged urea will be distributed to appointed agents at the above ports on CIF basis.

This Company is to have appointed agents in Peninsular Malaysia, Sabah and Sarawak to distribute the urea to dealers, for the following reasons:

i) Distribution of urea to the farmers, farmers cooperatives and dealers will be done by people experienced in the field and using established marketing channels.

ii) The Company will not have to invest in warehousing and transportation facilities. The appointed agents will have their own established warehousing facilities and transportation network. There will not be any deprivation of income or unnecessary duplication of facilities.

It is envisaged that the basic strategy and policy will ensure that the Malaysian agricultural sector will have a stable supply of urea at reasonable and stable prices and support of the effort of experienced fertilizer distributing agents such as FELDA*1), FELCRA*2), RISDA*3), MADA*4), and Farmers Organization. These agencies provide an important contract with the farmers.

3-3-2 Action programmes

To facilitate the planning and execution of the domestic marketing and distribution systems, PETRONAS intends to take the following action:

1) Appointment of Marketing Consultant

PETRONAS is in the process of appointing a Marketing Consultant of international repute with extensive experience and knowledge in the field of marketing and distribution of fertilizers to perform among others the following:

i) Re-examination of the foregoing basic policy, strategy and scheme, so as to establish an optimal and sound marketing and distribution plan. Such plans would include a plan for sound and efficient transportation and distribution facilities and systems, taking into account of the strength and the weaknesses of existing distributors as well as the capability and capacity of their facilities;

ii) Organization and manning requirement of the new Marketing Company;

iii) Formulation of a comprehensive training programme for key personnel contemplated to take up various responsible positions in the marketing and distribution operation;

iv) The formulation of a comprehensive plan for promotional and extension programmes and services with a view to encourage and educate farmers to use urea as well as to introduce and promote its application in other sectors as substitutes for other nitrogenous fertilizers;

v) Financial and financing requirement of marketing and distribution efforts.

2) Establishment of a Marketing Task Force

A Marketing Task Force has been established in PETRONAS to initiate the planning and implementation of the marketing programmes and activities prior to the incorporation of the Company.

In this connection, the Task Force have conducted and completed data and information collection supported by field survey, state by state within Malaysia. Based on the findings of this study a preliminary marketing and distribution plans have been developed.

An initial batch of three key marketing personnel have been sent abroad for training on marketing and distribution of fertilizers and have completed the programme. Meanwhile the Marketing Task Force are finalizing plans to send more personnel for training in various aspects of fertilizer marketing and distribution.

Among other activities, to be performed by the Marketing Task Force includes:

i) Meetings and discussions with various Government Agencies with the view to assess and develop governmental programmes and practices relating to:

   a) expansion of subsidy schemes in a long term

   b) further enhancement of extension services

   c) research by governmental institutes for application of urea

ii) Formulating and implementing the premarketing programmes to ensure that the marketing personnel are familiar with the practical aspects of the marketing and distribution of urea in Malaysia.

(Notes) *1) FELDA – Federal Land Development Authority

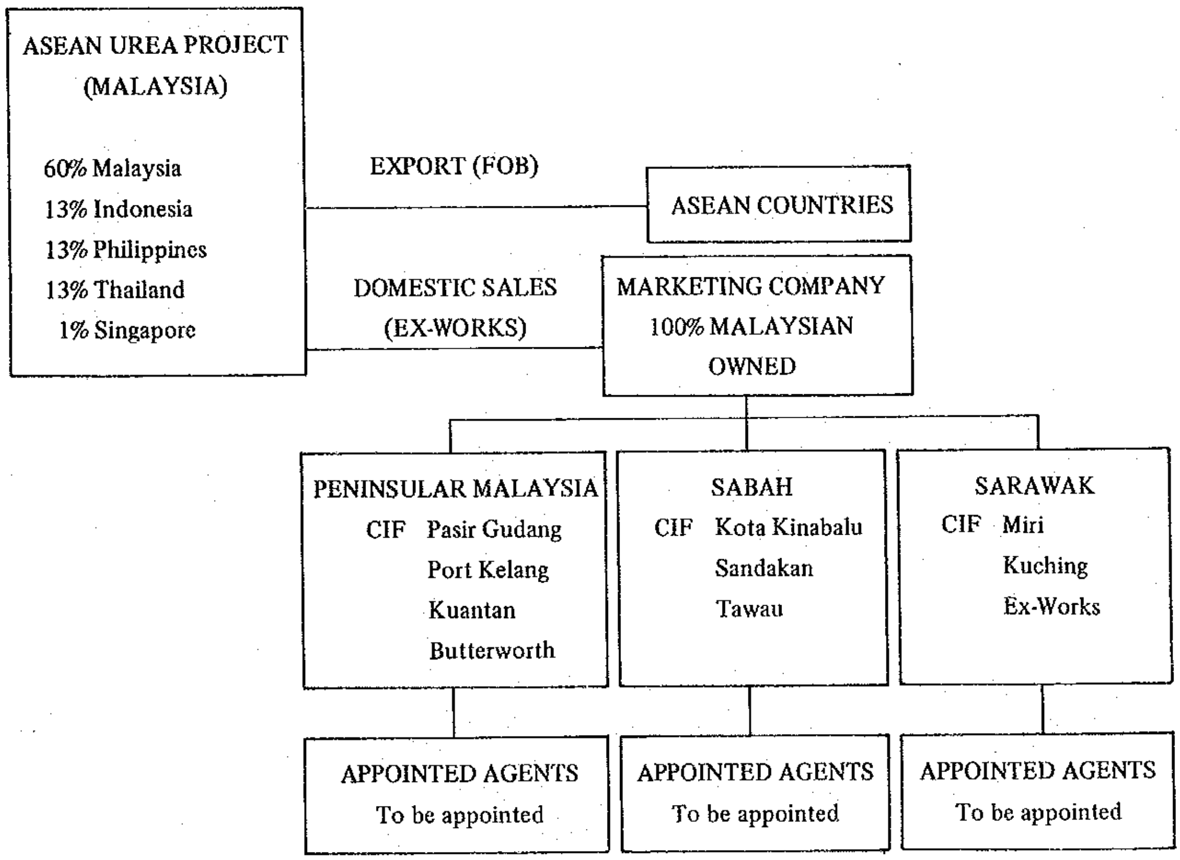
*2)	FELCRA	–	Federal Land Consolidation and Rehabilitation Authority
*3)	RISDA	–	Rubber Industry Smallholders Development Authority
*4)	MADA	–	Muda Agricultural Development Authority

24/10/79
Fertilizer Dept.
Processing & Manufacturing Div.

CHART 1

UREA DISTRIBUTION PATTERN

A PROPOSAL



APPENDIX II

APPENDIX II-1 PROJECTION OF DEMAND FOR AMMONIA AND UREA

1-1 Method of Projecting Demand

1-1-1 Demand projection of nitrogen fertilizer

(1) Projection of demand was made by crop. Some crops are subdivided into groups, in case the crops are major fertilizer-consuming crops, and the dosage is likely to vary considerably from group to group to such an extent that if the demand projection is made on the crop as a single group, a higher error is likely. The criteria for this subdivision was as follows:

1) Irrigated area and rainfed area

2) Participation and non-participation in land development or other agricultural schemes

3) Estate and smallholder farms

4) Main and off-season crops

5) Mature tree and immature tree

6) High-yielding varieties and conventional varieties

(2) The future levels of demand were projected for each crop or group, using the following formula:

(Future demand value) = (Cropped area) x (Ratio of fertilized area) x (Dosage per hectare)

For those crops for which it is difficult to estimate the ratio of fertilized area, the following formula was used:

(Future demand value) = (Cropped area) x (Average dosage per hectare of cropped area)

(3) As the first stage of making the projections, the historical ratio of fertilized area, and the dosage per hectare, were estimated. In making these estimations, the following data and study results were utilized:

1) Historical data on fertilizer use by crop group or by crop

2) Field information regarding fertilized area and dosages actually applied

3) Recommended dosage for each crop

(4) Using the historical data on fertilized areas, estimates of dosage per hectare, and historical data on cropped areas, projections were made for each factor, and the projection of demand was made by use of the formula cited above (2). With respect to the crops other than padi, oil palm and rubber, the demand for these crops was projected in aggregate, because the extent of influence of the demand for these crops on total demand is small.

(5) The outline description of the method of making projections for each factor is as follows:

1) Regarding the outlook for cropped area, see 1-2.

2) Regarding the fertilized area, taking into account irrigation and drainage conditions, and type of farm management, the area thought to be the maximum attainable was estimated, and it was postulated that the fertilized area would gradually expand to that level.

3) Regarding per hectare dosage, calculations were made on the basis of the recommended dosage for each crop. The future per hectare dosage is expected to gradually increase from the present level and approach the recommended level.

(6) Using the volume of demand of nitrogen fertilizer thus obtained, and taking into account cultivation techniques as well as customary practices, the projection of demand for urea was made.

1-1-2 Projection of demand for urea for industrial use

Demand for urea for industrial use in Malaysia is primarily for use in making urea resin adhesive.

Projection of demand for urea for such use was made by projecting demand for plywood, and calculating the corresponding adhesive requirement, and checking this estimation by comparison with production capacity of existing and planned adhesive plants.

1-1-3 Ammonia demand projections

The method of projecting ammonia demand is discussed in Chapter 2, 2-3-2 of the main text.

According to information obtained by the Evaluation Study Team during the field survey, the consumption of ammonia for use in processing rubber seems to be in a small quantity, and there was no available data showing actual consumption of ammonia for this use. Demand for ammonia for use in processing rubber which was estimated by using the amount of concentrated latex produced and amount of ammonia required for one ton of concentrated latex, as is shown in the following table, is about 1,100 tons a year in maximum.

Further, since the proportion of low-ammonia concentrated latex to the total concentrated latex produced is gradually increasing because of quality-related considerations, the demand for ammonia from rubber processing is unlikely to increase significantly.

Estimated Demand for Ammonia for Rubber Processing, W. Malaysia

(ton)

	1975	1976
Export*1) of concentrated latex from W. Malaysia		
- Concentrated latex containing less than 0.5 percent of ammonia	50,968	51,578
- Concentrated latex containing more than 0.5 percent of ammonia	135,870	140,734
Total	186,838	192,312
Estimated ammonia consumption for processing of concentrated latex*2)	1,053	1,088

Notes: *1) Breakdown of production volumes of concentrated latex into low-ammonia and high-ammonia volumes was not available. However, as almost all of the concentrated latex produced was exported, the breakdown was estimated by using export volumes.

*2) Demand for ammonia was calculated on the basis of the following ammonia requirement for processing one ton of concentrated latex:

high-ammonia concentrated latex; 7 kg of ammonia
low-ammonia concentrated latex ; 2 kg of ammonia

1-2 Trend and Outlook for Planted Area in Malaysia

The historical trend and future outlook for the planted area of each crop are shown in Tables AII-1 to AII-6.

The method used to formulate the future outlook for planted area is as follows:

i) Padi: Future acreage for padi was based on padi production plans provided by the Ministry of Agriculture in Malaysia. This plan expects padi area in 1980 in an acreage smaller than in 1974 (in actuality, the padi planted area has been declining since 1974). The plan sets the 1990 target area as being 19% higher than that in 1980, which is thought to be an attainable target.

ii) Rubber and oil palm: For each of the three groups of estates, smallholdings and government schemes, the following factors were investigated and trends of these factors were taken for use as the basis for projection.

1) Replanting ratio ... Ratio of area replanted to rubber to the area of mature trees (in the case of rubber only)

2) Ratio of diverting to other crops at time of replanting ... The ratio of [area replanted to crops other than rubber] to [area of rubber to be cut-down for replanting]

3) Newly planted area ... Area of land not previously used, which is developed and planted to crops

4) Proportion of area cropped by year planted

iii) Other crops: Factors influencing change in planted area for each crop, plans for each scheme, and plans for and direction of agricultural policy were taken into account and planted area was estimated for each crop.

Regarding the government schemes, it is assumed that the revised target areas of the Third Malaysia Plan will be attained, and that from 1981 on, target areas equivalent to those of the Third Malaysia Plan will be adopted.

1-3 Recommended Dosage, and Trend of Fertilizer Application by Crop

(1) The recommended dosages and historical values for application of fertilizer, by crop, used for making projections, are as given in Table AII-7.

(2) Dosages used for projecting potential demand was estimated on the basis of the following information sources:

1) Field interviews with:

MARDI, RRIM, MADA, FELDA, SLDB, Sarawak; SPB, Sabah; Sabah Department of Agriculture, Several fertilizer distributors in both West and East Malaysia

2) Publication, etc.:

– K. Kanapathy, "Guide to Fertilizer Use in Peninsular Malaysia"

– ICI (Malaysia) Sdn. Bhd., "Fertilizer Handbook"

(3) The method used to obtain the historical trend of fertilizer use by crop was as follows:

1) Gross consumption: [(Imports) + (Domestic production) - (Exports)] is taken as representing the "apparent consumption" for that year, and the three-year moving average of "apparent consumption" was used as the value for the central year of the three.

2) Wet padi: Data in Chapter 8, "Farming Practices as Observed through Crop Cutting Survey", in; Department of Statistics, Malaysia, "Crop Cutting Survey for Estimating Yield Rate of Padi".

3) Rubber: Total fertilizer consumption for rubber was calculated by use of Department of Statistics, Malaysia, "Rubber Statistical Handbook, Malaysia". The nitrogen fertilizer share was calculated by the additional use of the NPK ratio in dosage standards given in the ICI's "Fertilizer Handbook".

4) Oil palm: Taking the unit price of fertilizer used for rubber as being the same price as for oil palm; calculated from the values of fertilizer consumption given in the Department of Statistics, Malaysia, "Oil Palm, Coconut and Tea Statistics"; for the share of nitrogen fertilizer, the above-mentioned ICI handbook's NPK ratios were used.

5) Other crops: The remainder when the consumption for the above three crops is subtracted from gross consumption was taken as the consumption for "other crops".

Table AII-1 ESTIMATED AND PROJECTED PLANTED AREA OF PADI IN WEST MALAYSIA

('000 ha)

	Estimated								Projected		
	1967	1968	1969	1970	1971	1972	1973	1974	1980	1985	1990
Irrigated area											
Main season											
of which:											
HYV area	33	54	86	123	128	112	158	166	204	223	235
LV area	77	76	60	67	58	93	97	121	48	34	28
Total	110	130	146	190	186	205	255	287	252	257	263
Off-season											
HYV area	64	91	96	132	159	197	212	217	191	211	232
Unirrigated area											
HYV area	7	16	38	25	28	22	21	14	48	84	126
LV area	239	221	199	166	159	134	93	71	45	34	15
Total	246	237	237	191	187	156	114	85	93	118	141
Grand Total	420	458	479	512	532	558	581	588	536	586	636

Table AII-2 ACTUAL AND PROJECTED PLANTED AREA OF OIL PALM IN W. MALAYSIA

('000 ha)

	Actual										Projected		
	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990
–Estates													
Mature tree	71.1	84.3	100.5	122.7	145.5	169.1	188.5	214.9	243.1	277.5	386.7	480.3	508.0
Immature tree	58.3	69.7	76.9	70.8	68.4	76.3	86.3	109.6	112.1	99.9	87.6	24.3	13.0
Total	129.5	154.1	177.4	193.4	213.9	245.4	274.8	324.5	355.2	377.4	474.3	504.6	521.0
–Smallholdings													
Mature tree													
FELDA	3.9	7.8	14.5	15.9	23.5	38.0	59.2	70.5	85.3	103.6	215.5	351.9	493.9
RISDA											8.3	30.3	51.3
Others		N.A.	0.4	0.3	0.5	1.0	2.6	5.0	12.7	22.1	36.5	84.0	131.5
Sub-total		N.A.	14.9	16.2	24.0	39.0	61.8	75.5	98.0	125.7	260.3	466.2	676.7
Immature tree													
FELDA	20.3	29.0	36.9	49.1	53.0	58.8	65.3	85.3	96.3	111.9	108.0	113.6	113.6
RISDA							0.2	2.4	5.1	8.3	17.8	16.8	16.8
Others		N.A.	2.0	2.5	3.2	5.6	9.9	12.6	14.3	14.4	38.0	38.0	38.0
Sub-total		N.A.	38.9	51.6	56.2	64.4	75.4	100.3	115.7	134.6	163.8	168.4	168.4
Total		N.A.	53.8	67.8	80.2	103.4	137.2	175.8	213.7	260.3	424.1	634.6	845.1
–Total planted area													
Oil palm		N.A.	231.2	261.2	294.1	348.8	412.0	500.3	568.9	637.7	898.4	1,139.2	1,366.1

Table AII-3 ACTUAL AND PROJECTED PLANTED AREA OF RUBBER IN W. MALAYSIA

('000 ha)

	Actual							Projected		
	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990
– Estates										
Mature trees	544.7	533.9	522.1	508.0	490.1	472.4	462.2	429.6	405.7	398.2
Of which 21 years and over	212.7	196.0	177.3	157.2	140.7	128.8	121.9	184.3	244.4	270.8
Immature trees	101.9	97.7	88.2	81.5	84.1	90.9	91.1	83.9	78.0	73.4
Total	646.6	631.6	610.3	589.5	574.2	563.3	553.3	513.5	483.7	471.6
– Smallholdings										
Mature trees										
FELDA	23.7	34.5	36.9	40.8	43.7	44.5	45.9	105.1	155.7	206.3
Of which 21 years and over								5.9	41.3	59.8
FELCRA	0	0	1.0	2.1	3.7	5.7	8.3	23.6	26.7	26.7
Of which 21 years and over								0	0	5.7
RISDA	329.6	351.2	383.5	399.3	414.4	435.9	454.2	555.9	622.1	624.9
Of which 21 years and over			0	11.9	21.1	31.3	50.2			
Others	575.8	551.4	518.2	483.1	464.9	444.5	436.7	242.0	203.2	164.5
Sub-total	929.1	937.1	939.6	925.3	926.7	930.6	945.1	926.6	1,007.7	1,022.4
Immature trees										
FELDA	36.1	33.1	39.3	48.0	50.6	60.6	68.8	50.6	50.6	50.6
FELCRA	5.7	8.3	14.0	19.4	19.9	20.4	17.9	3.1	0	0
RISDA	106.4	108.0	79.1	111.9	120.4	120.0	116.0	105.0	41.6	31.1
Sub-total	148.2	149.4	152.4	179.3	190.9	201.0	202.7	158.7	92.2	81.7
Total	1,077.3	1,086.5	1,092.0	1,104.6	1,117.6	1,131.6	1,147.8	1,085.3	1,099.9	1,104.1
– Total rubber planted area	1,723.9	1,718.1	1,702.3	1,694.1	1,691.8	1,694.9	1,701.1	1,598.8	1,583.6	1,575.7

Table AII-4 ACTUAL AND PROJECTED PLANTED AREA OF MISCELLANEOUS CROPS IN WEST MALAYSIA

('000 ha)

	Actual							Projected		
	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990
– Coconut										
Estates	22.4	21.6	20.7	18.8	18.0	17.4	17.2	14.3	12.1	10.8
– Cocoa	3.4	7.5	12.1	11.6	13.6	17.6		26.9	36.2	45.5
– Pineapple										
Estates	5.0	6.1	6.1	6.1	6.1	6.1		7.1	7.9	8.7
Smallholdings (for canning only)	11.3	11.3	11.3	11.3	11.3	11.3		6.4	6.4	6.4
Total	16.3	17.4	17.4	17.4	17.4	17.4		13.5	14.3	15.1
– Sugarcane										
FELDA			0.8	2.0	3.5	4.0	4.0	7.6	11.6	15.6
Others	5.6	9.7	13.7	16.9	16.9	16.9	16.9	16.9	16.9	16.9
Total			14.5	18.9	20.4	20.9	20.9	24.5	28.5	32.5

Table AII-5 ACTUAL AND PROJECTED PLANTED AREA OF MAIN CROPS IN SABAH

('000 ha)

	Actual								Projected		
	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990
– Wet Padi											
Main season		31.1	32.8	32.5	32.8	33.8	29.3	31.3	33.5	33.5	33.5
Off-season		1.8	2.5	3.9	5.7	3.8	3.8	2.1	6.5	9.0	11.5
Total		32.9	35.3	36.4	38.5	37.6	33.1	33.4	40.0	42.5	45.0
– Oil Palm											
Estates	19.4	20.2	21.7	23.1	28.5	29.7	30.6	34.4	40.0	50.0	60.0
Land schemes	8.5	11.9	13.5	14.8	17.6	19.5	23.9	31.2	45.0	65.0	85.0
Smallholdings	1.4	1.4	2.9	5.0	5.7	5.0	3.4	2.6			
Total	29.3	33.5	38.1	42.9	51.8	54.2	57.9	68.2	85.0	115.0	145.0
– Rubber											
Estates	29.2	27.4	24.6	24.7	20.0	19.6	17.4	17.1	16.3	15.8	15.5
Land schemes	3.9	3.6	3.7	3.4	3.2	3.2	4.1	3.8	5.5	6.5	7.0
Smallholdings	72.6	74.4	76.7	76.4	80.7	81.2	82.3	87.3			
Total	105.7	105.4	105.0	104.5	103.9	104.0	103.8	108.2			
– Cocoa		4.0	4.5	5.5	6.2	8.1	9.8	11.7	25.0	40.0	55.0

Table AII-6 ACTUAL AND PROJECTED PLANTED AREA OF MAIN CROPS IN SARAWAK

('000 ha)

	Actual								Projected		
	1969	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990
-- Wet Padi	51.6	61.6	60.1	48.2	50.7	54.3	58.1	(41.7)	53.5	53.5	53.5
– Pepper	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	23.6	24.0	25.0	26.0
– Oil Palm											
Estates	0.2	0.6	1.4	2.2	3.1	3.6	4.0	4.1	4.5	4.9	5.2
Land schemes	0	0.4	1.3	3.3	4.6	7.6	11.1	12.3	14.5	17.3	20.1
Smallholdings	0	0	0	0	0.1	0.4	0.6	0.6	0.7	0.8	0.9
Total	0.2	1.0	2.7	5.5	7.8	11.6	15.7	17.0	19.7	23.0	26.2
– Rubber											
Estates	3.2	3.1	3.0	3.0	2.8	2.8	2.7	2.7	2.6	2.5	2.4
Land schemes	5.4	5.8	5.8	5.8	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Smallholdings	178.3	181.4	184.1	184.1	184.5	184.6	184.7	184.7			
Total	186.9	190.3	192.9	192.9	192.8	192.9	192.9	192.9			

Table AII-7 ESTIMATED POTENTIAL DOSAGES OF NITROGEN FERTILIZERS BY CROP, MALAYSIA

Crops		Estimated Potential Dosages (N kgs/ha)			Suitable Types of Fertilizers	Notes
		Region I	Region II	Region III		
Padi	HYV				U/CX	
	main season	95	84	67		
	off-season	78	56	56		
	LV	67	51	45		
Rubber	Mature trees	40			AS/AN/CX	Effects of fertilizer use on rubber is good for trees below 20 years in age.
	Immature trees	35				
Oil palm	Mature trees	82.5			On coastal clay: U/CX	
	Immature trees	41.3			On inland soils: AS/AN/CX	
Sugarcane		110				
Pineapple		280				
Cocoa		45			-U/AN/CAN/CX -Sulphur-containing fertilizer is not suitable	
Coconut	Mature trees	65			-U/AN/CAN/ACL/CX -Sulphur-containing fertilizers are not advisable	

Note: Abbreviations used for suitable types of fertilizers are:
U - Urea AS - Ammonium sulphate AN - Ammonium nitrate CAN - Calcium ammonium nitrate ACL - Ammonium Chloride
CX - Compound fertilizers

APPENDIX II-2 PROJECTION OF UREA TRADE

2-1 In projecting urea trade volume in the world, the outlook for world demand for nitrogen fertilizer was projected first (the results of this projection are given in Table AII-8), and then trade of nitrogen fertilizer was projected on the basis of that. In projecting the volume of trade in nitrogen fertilizer, with the exception of the following regions, the difference between supply and demand of nitrogen fertilizer was taken as equivalent to the volume of trade; for the regions noted below, the historical trade (see Table AII-9) shows a lack of equivalence between the difference in supply and demand and the volume of trade, and therefore the projections were made with the following points in mind:

(1) In the case of West Europe as well as the North American countries, because they do importing on one hand and exporting on the other, the volume of trade would be greater than the total of individual countries' differences between supply and demand. As may be seen in Table AII-9, a relationship exists between (a) import volume and demand volume, and between (b) export volume and supply volume; this is because the importers and exporters have their respective sales channels. Therefore, import volume and export volume were projected in relation to each country's demand volume and supply volume.

(2) In the case of East Europe, there is a tendency for the volume of imports to exceed the required volume of imports and for the volume of exports to be less than the exportable volume. This is believed to be a reflection of each country's efforts at building up domestic stocks. The projection of trade volume takes this into account.

2-2 The volume of urea trade was calculated on the basis of the past trend of urea's percentage of nitrogen fertilizer trade in each regions.

The results are shown in Table AII-10.

Table AII-8 WORLD NITROGEN FERTILIZER SUPPLY, DEMAND AND BALANCE

(N '000 ton)

		Actual		Projected		
		1975/76	1977/78	1980/81	1985/86	1987/88
S.E. Asia	S	361	570	1,153	2,328	2,458
	D	858	1,235	1,518	1,900	2,036
	B	-497	-665	-365	428	422
S.W. Asia	S	1,994	2,450	3,605	5,461	6,235
	D	2,698	3,804	4,479	6,176	6,875
	B	-704	-1,454	-874	-715	-640
E. Asia	S	5,658	7,155	9,569	10,066	9,945
	D	5,928	7,424	8,527	9,601	10,027
	B	-270	-269	1,042	465	-82
Mideast	S	837	1,026	1,730	3,023	3,180
	D	787	1,030	1,184	1,443	1,526
	B	50	-4	546	1,580	1,654
Oceania	S	180	215	182	379	371
	D	185	243	286	356	383
	B	-5	-28	-104	23	-12
W. Europe	S	8,932	9,706	10,601	12,618	12,870
	D	7,743	8,353	9,340	10,852	11,461
	B	1,189	1,353	1,261	1,766	1,409
E. Europe	S	13,873	15,090	20,539	28,145	28,126
	D	11,870	12,093	16,134	18,952	19,722
	B	2,003	2,997	4,405	9,193	8,404
N. America	S	10,178	11,281	13,134	13,945	13,677
	D	9,947	9,687	11,479	13,528	14,348
	B	231	1,594	1,655	417	-671
C. America	S	727	752	1,994	2,734	2,738
	D	1,223	1,308	1,418	1,588	1,641
	B	-496	-556	576	1,146	1,097
S. America	S	481	607	813	2,301	2,667
	D	799	1,268	1,497	1,900	2,007
	B	-318	-661	-684	401	660
Africa	S	611	759	1,237	2,453	2,607
	D	1,247	1,323	1,863	2,481	2,729
	B	-636	-564	-626	-28	-122
World Total	S	43,832	49,611	64,557	83,453	84,874
	D	43,285	47,768	57,725	68,777	72,755
	B	547	1,843	6,832	14,676	12,119

Note: S: Supply (in the case of past) or Supply ability (in the case of projection)
D: Demand
B: Balance

Table AII-9 COMPARISON BETWEEN SUPPLY/DEMAND BALANCE AND NET EXPORT OF NITROGEN FERTILIZERS, WORLD BY REGION

(N '000 ton)

		1971/72	1972/74	1975/76
Asia	X	1,577	1,738	1,224
	M	2,857	3,473	3,345
	Net X	-1,280	-1,735	-2,121
	B	-1,540	-1,423	-1,401
Oceania	X	56	18	16
	M	22	46	24
	Net X	34	-28	-8
	B	38	-21	-5
W. Europe	X	2,642	3,303	2,662
	M	1,315	1,445	1,606
	Net X	1,327	1,858	1,056
	B	1,549	1,934	1,189
	D	6,822	7,411	7,743
	M/D (%)	19.3	19.5	20.7
	S	8,371	9,345	8,932
	X/S (%)	31.6	35.3	29.8
E. Europe	X	1,221	1,520	1,635
	M	391	492	341
	Net X	830	1,028	1,294
	B	1,385	1,568	2,003
	Import Requirement (a)	305	324	224
	M/a (%)	128.2	151.9	152.2
	Export Potentiality (b)	1,690	1,892	2,227
	X/b (%)	72.2	80.3	73.4
N. America	X	1,375	1,206	1,290
	M	781	730	704
	Net X	594	476	586
	B	1,274	1,151	231
	D	7,622	8,810	9,947
	M/D (%)	10.2	8.3	7.1
	S	8,896	9,961	10,178
	X/S (%)	15.5	12.1	12.7
C. America	X	161	135	76
	M	503	582	573
	Net X	-342	-447	-497
	B	-406	-455	-496
S. America	X	91	67	75
	M	348	488	405
	Net X	-257	-421	-330
	B	-262	-420	-318
Africa	X	33	33	37
	M	578	595	651
	Net X	-107	-562	-614
	B	-471	-623	-636
World	X	7,156	8,020	7,015
	M	6,795	7,851	7,649

Notes:
1. Abbreviation used are;
   X–Export, M–Import, Net X–Net export (= X-M)
   B–Balance between supply and demand [= (Supply) - (Demand)]
   D–Demand, S–Supply
2. "Import requirement" means the total of supply deficits of individual countries in the region.
3. "Export potentiality" means the total of supply surpluses of individual countries in the reigon.

Table AII-10 PROJECTION OF UREA TRADE

(N '000 ton)

		1979	1981	1983	1985	1987	1990
S.E.Asia	Import	402	471	501	411	401	477
	Export	250	431	564	656	621	558
S.W. Asia	Import	391	502	680	265	482	499
	Export	11	23	244	351	221	90
E. Asia	Import	444	351	541	556	727	708
	Export	1,083	1,393	1,300	1,225	1,011	871
Mideast	Import	668	294	197	68	71	13
	Export	348	528	790	907	916	1,132
Oceania	Import (or Export)	36	48	25	(9)	5	22
W. Europe	Import	120	128	136	144	152	164
	Export	916	960	1,042	1,090	1,112	1,115
E. Europe	Import	389	170	216	214	242	269
	Export	1,883	2,548	3,345	3,941	3,655	3,387
N. America	Import	296	318	340	362	383	416
	Export	316	356	363	366	359	332
C. America	Export	612	633	836	1,146	1,097	1,542
S. America	Import (or Export)	231	201	89	(120)	(198)	(318)
Africa	Import	387	246	34	18	79	85
World Total	Import	3,364	2,729	2,759	2,038	2,542	2,653
	Export	5,419	6,872	8,484	9,811	9,190	9,345

Note: Import – Projected import amount
Export – Projected amount of potential export

APPENDIX II-3 BASE DATA FOR PROJECTION OF INTERNATIONAL MARKET PRICES OF AMMONIA AND UREA

3-1 The main assumed factor prices used for projecting international prices are given in Table AII-11.

3-2 The prices given in Table AII-11 were mostly obtained by extending price trends of 1973-1979 (estimates) into the future, although special consideration was given to the following.

Natural gas price: The changes in price of natural gas have displayed completely different movement according to the following three categories of countries:

i) Industrial countries: In these countries, large quantities of natural gas are consumed not only for industrial use but also for home use and therefore these countries have a high level and wide variety of demands for natural gas. Moreover, when the cost of other sources of energy increases, natural gas substitutes for part of the demand for those sources. For that reason natural gas has shown a close relationship to energy prices and since late 1970's in particular the price per calory of natural gas has tended to come closer to the price for other energy sources (see Fig. II-3).

ii) Developing, oil-producing countries: In this category of countries, in general, demand for natural gas is low relative to its supply, although their situations vary depending on the level to which natural gas-using industries have been developed. In these countries, the most prospective demand for natural gas is for production of LNG for export. But since LNG demand in the world is still in a limited extent, because the development of LNG projects requires enormous cost and time and, moreover, the number of countries who would import LNG is limited, it will be some time before LNG is widely used in the world to substitute other sources of energy, in response to changes in the price of those energy sources.

At that stage of development, it is general for the price of natural gas to be supplied to the ammonia industry to be set independently of the prices of other energy sources, and to be set at a low level in order to promote the development of the ammonia industry.

For projection of the natural gas price in the present study, taking the foregoing conditions into consideration, it was assumed that in these countries, up to 1985 there would not be major price increases beyond current levels, and that after 1985 the price of natural gas would gradually approach that of other energy sources, in accompaniment with growth of the utilization of natural gas for LNG.

iii) Developing, non-oil-producing countries: The price of natural gas in countries lacking any domestic sources of energy other than natural gas is set in response to the prices of imported energy. Thus, the manner of price formation of the natural gas is fairly similar to that in industrial countries; however, in contrast to the industrial nations, because there is little competition between industrial and household users, and also because of considerations related to national policy for domestically-produced energy (e.g., the impact on prices in general) it is assumed that it is not as directly related to other energy sources' prices as in the industrial countries.

Table AII-11 MAIN ASSUMED FACTOR PRICES USED IN FORECASTING INTERNATIONAL MARKET PRICES OF UREA

		Actual					Assumed					
		1973	1975	1979	Annual increase rate 1973-79	Annual increase rate 1975-79	1980	1985	1990	Annual increase rate 1975-80	Annual increase rate 1980-85	Annual increase rate 1985-90
Feedstock prices:												
- NG												
U.S.A.	(US$/MMBTU)	0.26	0.58	1.86	38.8	33.8	2.18	4.19	5.55	30.3	14.0	5.8
	(1975 = 100)	44.8	100	320.7			375.9	722.4	956.9			
Indonesia	(US$/MMBTU)	0.22	0.35	0.60	18.2	14.4	0.67	1.00	3.89	13.9	8.3	31.2
	(1975 = 100)	62.9	100	171.4			191.4	285.7	1111.4			
Mideast	(US$/MMBTU)	0.01	0.05	0.30	76.3	56.5	0.36	0.54	2.66	48.4	8.5	37.6
	(1975 = 100)	20.0	100	600.0			720.0	1080.0	5320.0			
W. Europe	(US$/MMBTU)	0.53	0.87	3.03	33.7	36.6	3.57	6.16	7.37	32.6	11.5	3.7
	(1975 = 100)	60.9	100	348.3			410.3	708.1	847.1			
- Naphtha												
Japan	(US$/T)	58.7	115.1	199.6	22.6	14.8	210.1	305.0	400.0	12.8	7.7	5.6
	(US$/MMBTU)	1.33	2.62	4.54			4.78	6.93	9.09			
	(1975 = 100)	51.0	100.0	173.4			182.5	265.0	347.5			
W. Europe	(US$/T)	68.3	120.0	252.5	24.4	20.4	219.0	318.0	417.0	12.8	7.7	5.6
	(US$/MMBTU)	1.55	2.73	5.74			4.98	7.23	9.48			
	(1975 = 100)	56.9	100.0	210.4			182.5	265.0	347.5			
- Crude Oil	(US$/BBL)	3.3	11.5	14.9	28.5	6.7	19.8	28.2	36.5	11.5	7.3	5.3
	(US$/MMBTU)	0.56	1.94	2.51			3.34	4.76	6.15			
	(1975 = 100)	28.7	100.0	129.6			172.5	245.0	317.5			
Index numbers of whole sale prices (1975 = 100)												
- Developed countries		77.8	100.0	135.8	9.7	8.0	147.5	195.0	242.5	8.1	5.7	4.5
- Developing countries		60.9	100.0	152.0	16.5	11.0	162.5	225.0	287.5	10.2	6.7	5.0
Index numbers of wage rates (1975 = 100)												
- Developed countries		84.8	100.0	143.5	9.2	9.5	157.5	215.0	272.5	9.5	6.4	4.9
- Developing countries		69.2	100.0	157.9*)	17.9	16.5	177.5	255.0	332.5	12.2	7.5	5.5

Note: *) In 1978

APPENDIX III

APPENDIX III - 1 RESERVE ESTIMATING PROCEDURE

1-1 Volumetric Calculations

Reserves have been calculated by either or both of two methods, the probabilistic and the conventional.

Probabilistic calculations have been made using the computer program. The program requires probabilistic distributions, type and quantifying parameters for all input parameters used in reserve calculations (except for the chance factor, which is single-valued).

For distributions where no minimum and maximum exists, values of four times the standard deviation on either side of the mean are used. These parameters are retained throughout the calculation of fluids in place and ultimate recoveries. The final distributions are represented by beta functions, which are integrated to find the percentile points of the expectation curves.

The conventional reserve calculations have been made using the computer program PISC. Fluids in place are calculated using single-valued volumetric parameters and uncertainty is allowed for by assigning a single-valued probability for the existence of the fluids. Reserves may then be estimated by multiplying the fluids in place by a recovery factor or alternatively by extrapolating reservoir performance. Part of these reserves which are related to seen fluids combined with a recovery factor which has a high probability of achievement are designated "proven". Unproven reserves are related to unproven fluids in place and/or to uncertainty in recovery factor. Therefore the apparent recovery factor may be physically meaningless if, for example, the unproven reserve results from uncertainty in recovery factor.

To obtain an "Expectation Curve" for ultimate recoveries calculated by conventional means, a normal distribution is fitted through the proven U.R. (= 95%) and the expectation (= 50%).

1-2 Definitions

Expectation Curve: is a plot of the estimated probability that a certain volume or more of hydrocarbons will be recoverable versus that volume of hydrocarbons.

Expectation of Reserve: represents the volume of hydrocarbons which is thought to be technically and economically recoverable.

It is equal to the area under the expectation curve.

If the reserves are proportioned into a proven part and an unproven part, the expectation of reserve is taken as the sum of the proven and discounted unproven part.

High Estimate of Reserve: is the quantity of reserve which has a 15% cumulative probability of being recovered.

Low Estimate of Reserve: is the quantity of reserve which has a 85% cumulative probability of being recovered.

Possible Reserve: is the reserve which is supported by favourable engineering and geological data but which is subject to some element of risk which prevents classification as Proven Reserve.

Proven Reserve: is the quantity of hydrocarbons which geological and engineering data demonstrate with reasonable certainty (say 95%) to be recoverable in the future under existing economic and operating conditions. It represents strictly technical judgements, and is not knowingly influenced by attitudes of conservatism or optimism.

APPENDIX IV

APPENDIX IV-1 PRELIMINARY INVESTIGATION OF ADEQUACY OF THE STORAGE CAPACITY OF THE PROJECTED DAM

1-1 General

To satisfy the increasing demand for water in the Bintulu area, PWD is proceeding with a project to construct a pumped storage dam having water storage capacity of 350 million gallons (1.6 million m^3) with a catchment area of 100 acres, which is located on the basin of the Sika river, a tributary of the Sungai Sibiu river.

In order to justify the adequacy of the dam capacity, the following two points should be satisfied in particular:

(1) Whether the dam is capable of impounding a sufficient volume of water for storage, in view of the rainfall and topography in the dam area.

(2) Whether the designed storage capacity (350 million gallons) of the dam is adequate to supply a sufficient volume of water during a dry season.

Regarding the point (1) above, it is deemed to be satisfactory, because the dam is to store the water pumped up from the Sibiu river when the river is at a high level. Therefore, the investigation is concentrated on the point (2). It must be noted, however, that this investigation is preliminary in nature, because detailed data needed for detailed investigation will not be available until completion of investigation of soil and subsoil conditions of the dam area. This latter investigation is now being performed by Halcrow Balfour Ltd., a British consultant, for developing the bases for detailed design of the dam.

Steps taken for this investigation are shown in the flow chart in Fig. AIV-1. In accordance with the given steps, the requirements for water to be stored in the dam in order to ensure sufficient volume of discharge (V) was first calculated, and then compared with the designed storage capacity of the dam (350 million gallons). If the designed dam capacity is larger than the thus-estimated requirement (V), it is judged that the dam has adequate water supply capacity.

1-2 Method of Calculating the Requirements for Water to be Stored in the Dam (V)

As is stated earlier, water to be stored in the dam will be primarily from the Sika river, but because the water of this river is not sufficient, additional volume of water will be pumped up from the Sungai Sibiu. Since the water impounded by the dam is to be kept at the required level by means of pumping up the river water, to the extent that water is discharged from the dam, as far as the water flow of the Sika river and Sibiu river remains at a rate over the required discharge from the dam, there is no deficit in the water of the dam to discharge. The stream of Sika river flows into the Sibiu river, and therefore the water flow volume of the Sibiu river downstream from where the Sika river enters, is deemed to be the total volume of water flow of both rivers.

In this context, it can be said that the storage capacity of the dam should not be less than that corresponding to the aggregated annual volume of present water flow of the Sibiu river which is in deficit in relation to the required discharge from the dam. Therefore, as an approach to this investigation, the required volume of water to be stored in the dam can be calculated by means of estimating such an aggregated annual deficit in the water flow of the river, below that needed by the dam in order to hope the required discharge rate.

Thus, the requirements for water to be stored in the dam (V) were calculated by using the following formula:

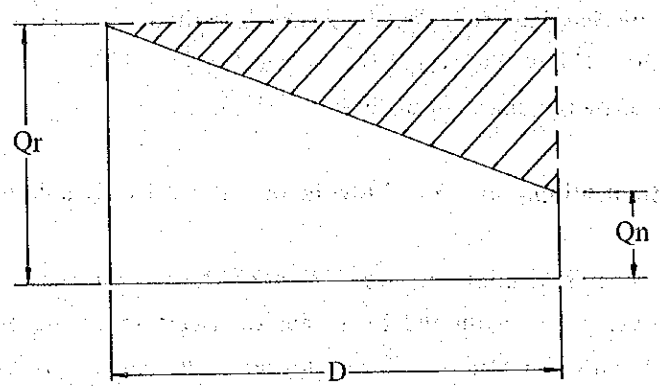
$$V = \frac{Qr - Qn}{2} \times D$$

Where,

Qr: Rate of water flow in the Sibiu river which is required for water supply to the dam to meet requirements for discharging from the dam.

Qn: Probability rate of minimum daily water flow in the Sibiu river in a period of "n" years.

D: Maximum number of days during which the water flow rate of the river is below the required rate.



It is assumed here that the daily volume of make-up water which is pumped up from the Sungai Sibiu, would decrease to the extent that the water flow volume of the river decreases, and such decrease (from "Qr" to "Qn" in the above picture) would be in a linear form. It is derived from the changes in the water level of the Sungai Sibiu which shows a nearly linear trend when the river flow is at a low level (see Fig. AIV-2).

1-3 Hydrological Data Used

Hydrological data used for this study are as follows:

1) Record of water level in the Sungai Sibiu (recorded by one measurement every day)

   Period of the record: 8 years (1969 - 1976)

2) Record of daily rainfall

   Period of the record: 12 years (1967 - 1978)

1-4 Estimation of the Rate of Water Flow in the Sungai Sibiu which is Required for Water Supply to the Dam to Meet Requirements for Discharging from the Dam (Qr)

Volume of water to be discharged from the dam is first estimated so as to meet the water demand of the Bintulu area (14.5 million gallons; 0.767 m^3/sec.), projected by PWD. Assuming that the extent of water intake from the Sungai Sibiu is 90% of the river flow volume, the rate of water flow in the Sungai Sibiu which is required for water supply to the dam to meet the requirements for discharging from the dam (Qr) is estimated to be 0.852 m^3/sec. (0.767 m^3/sec. divided by 0.9). The water level of the river at this required water flow rate is estimated as 0.76 m (2.53 ft) by using the chart shown in Fig. AIV-3.

1-5 Probability Rate of Minimum Water Flow in the Sibiu River in a Period of "n" Years (Qn)

Probability rates of minimum water flow of the river in the respective periods of 5, 10, 20, 50 and 100 years are estimated by means of ascertaining the cumulative frequency distribution of data showing the minimum for each year in the past record of daily water flow of the river, plotting the data on a log probability sheet and joining the plotted points by closest straight line possible (see Fig. AIV-4). The results are as shown below.

No.	Month and Year of Occurrence	Minimum Daily Water Flow Rate (m^3/sec.)	$\frac{n}{N+1} \times 100$ (%)
1	3/1970	2.30	13
2	7/1975	1.54	25
3	2/1969	1.05	38
4	7/1972	0.82	50
5	6/1974	0.62	63
6	8/1976	0.47	75
7	2/1973	0.40	88
			(n = 7)

Period of Years: N =	5	10	20	50	100
Probability Rate of Minimum Water Flow (m^3/sec.)	0.45	0.32	0.23	0.17	0.13

1-6 Estimation of Maximum Number of Days during which the Water Flow Rate of the River is below the Required Rate (D)

Maximum number of days during which the water flow rate of the river is below the required rate (D) is estimated in two ways; one estimation using water level data (as stated in 1-6-1) and another using rainfall data (as stated in 1-6-2). The thus-estimated "D" is 40 days in the case of the former way, and 45 days in the case of the latter, so 45 days is used as the basis.

1-6-1 Estimation using water level data

The number of days each year when the water level of the river was less than that required was counted, using the past record of the river water level.

This number of days counted is shown below.

Year	1969	1970	1971	1972	1973	1974	1975	1976
No. of days	0	0	-	-	23	7	0	32

The maximum number of days during which the water flow rate of the river is below the required rate (D) was determined by adding 20%, as a safety factor, to the counted number of days. Thus, estimated (D) is 40 days (32 days x 1.2).

1-6-2 Estimation using rainfall data

It is a well-known theory that decrease in water flowing in a river from a certain catchment area, which takes place in the event there is a number of rainless days following a rainfall, would make a trend at a certain rate of curvature. By applying this theory, the "number of days in which the rate of river water flow decreases to a certain rate" (D-1) and "number of days during which the rate of river water flow is below the certain rate" (D-2) are estimated.

The "D-1" was first estimated for the catchment area of the Sibiu river by using data given in Fig. AIV-5. The results show the following two typical patterns regarding the "D-1":

(a) In the event when there is a rainfall after a long period of rainless days, and after the rainfall there is a long period of rainless days again: D-1 of 6 days.

(b) In the event when there is a rainfall after a short period of rainless days, and after the rainfall there is another period of rainless days: D-1 of 13 days.

By using the thus-estimated "D-1" and rainfall data for each year, the "D-2" for each year was estimated. The results are as shown below.

Year	No. of Days
1967	3
1968	2
1969	17
1970	12
1971	21
1972	35
1973	24
1974	13
1975	0
1976	27
1977	11
1978	0

The maximum number of days during which the water flow rate of the Sibiu river is below the required rate (D) was determined by adding 20%, as a safety factor, to the maximum of the above estimated "D-2". Thus, estimated (D) is 45 days (35 days x 1.2).

1-7 Result of Investigation

The "V" was calculated on the basis of "Qr", "Qn", and "D" estimated above and by using the calculation formula given in 1-2. The following table shows the thus-estimated "V" and a safety ratio of the storage capacity of the projected dam against the "V". (For this comparison, the dam capacity was based on an effective storage capacity which was determined as 90% of the designed storage capacity of the dam. The designed storage capacity is 350 million gallons (1,591,000 m^3). Thus, the effective storage capacity is: 1,591,000 m^3 x 0.9 = 1,431,900 m^3.)

The following comparison indicates that the capacity of the dam would have a safety ratio of 1.02 against the requirements for water to be stored in the dam which was estimated even with a probability period of 100 years, and hence it is believed that the designed storage capacity of 350 million gallons is satisfactory for meeting requirements.

N	Qn (m³/sec.)	Qr (m³/sec.)	D (days)	V (m³)	Safety Ratio of Dam Capacity against "V"
5	0.45			781,500	1.83
10	0.32			1,034,200	1.38
20	0.23	0.852	45	1,209,200	1.18
50	0.17			1,325,800	1.08
100	0.13			1,403,600	1.02

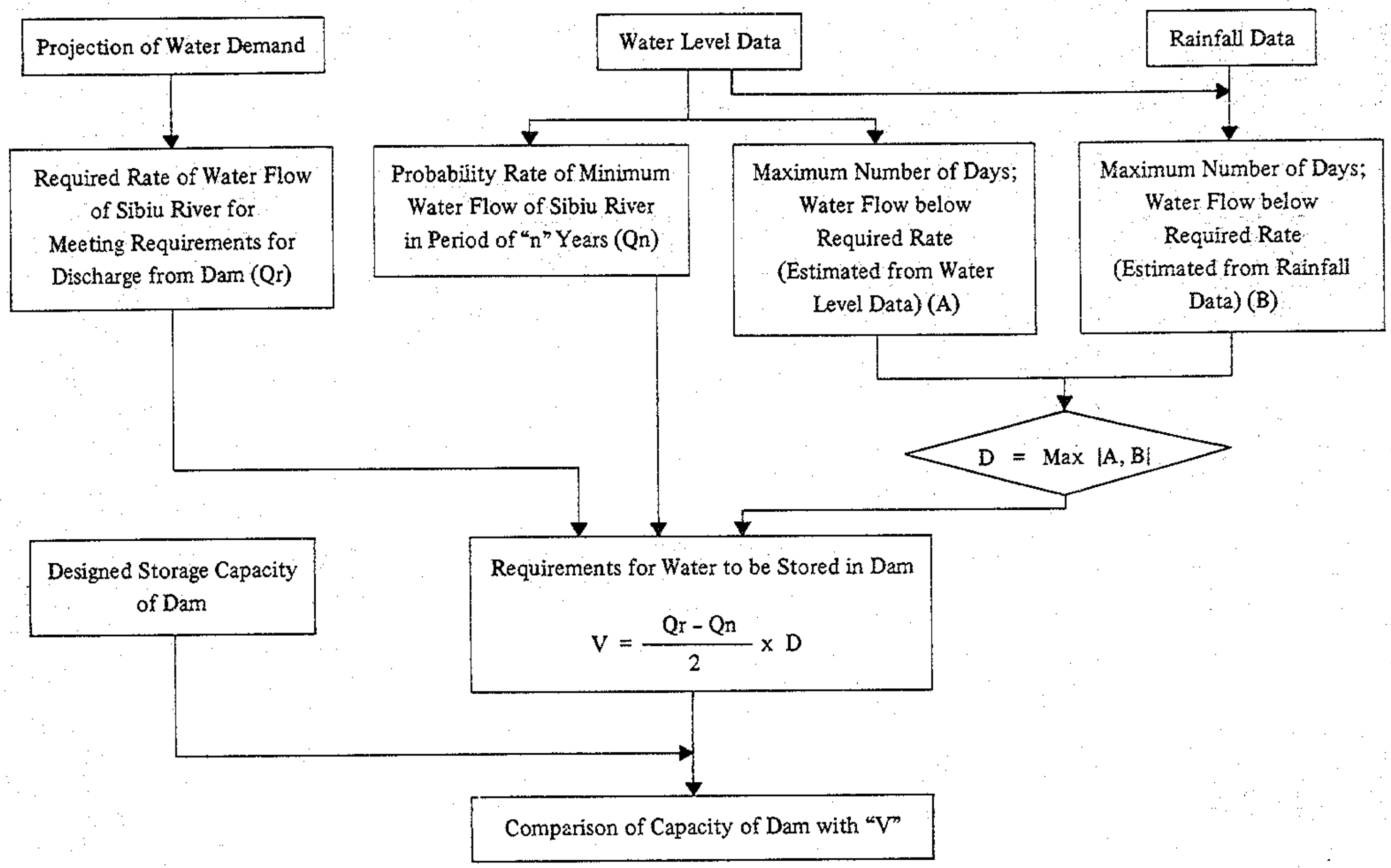


Fig. AIV-1 FLOW CHART SHOWING STEPS FOR PRELIMINARY INVESTIGATION OF DAM CAPACITY

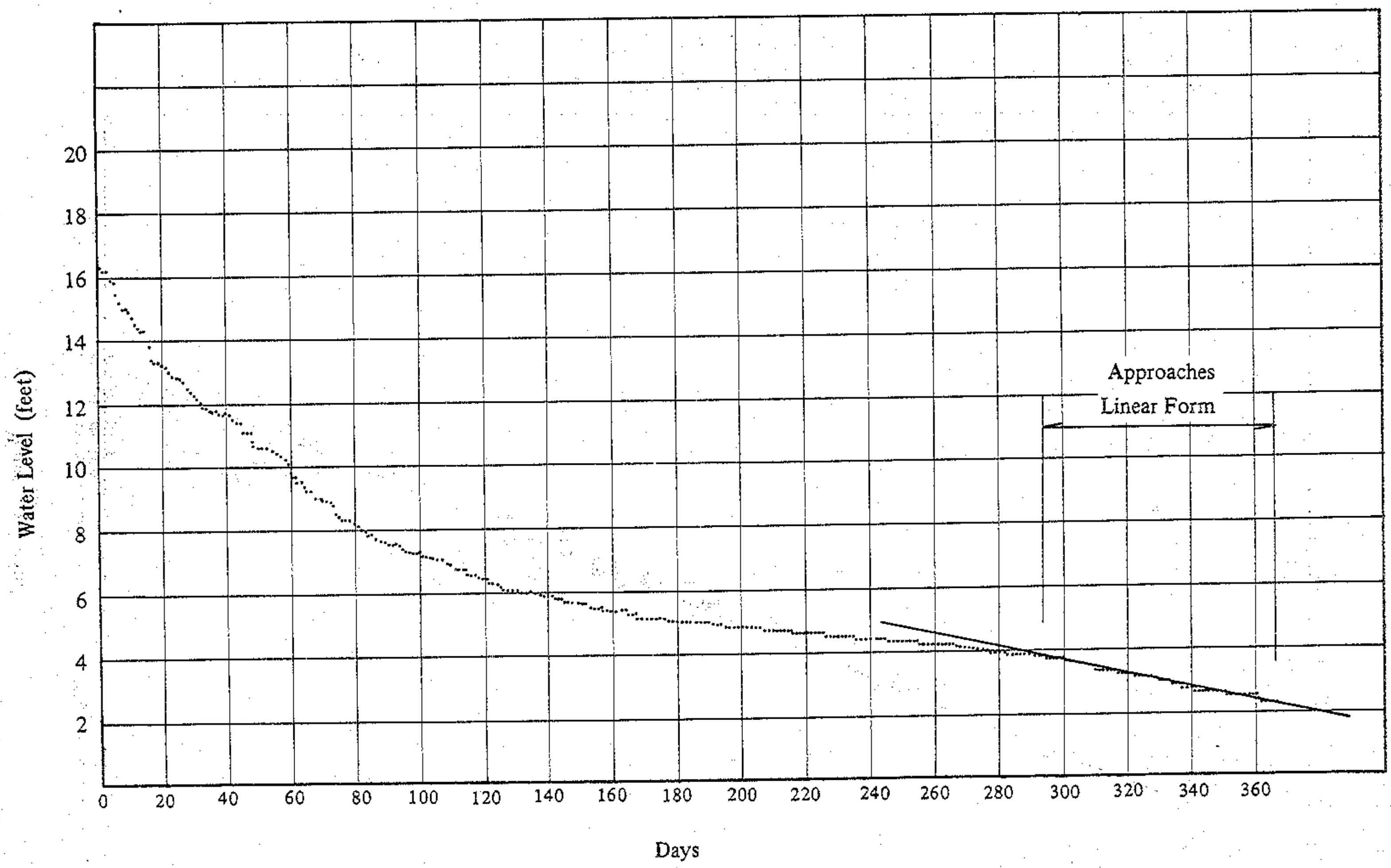


Fig. AIV-2 DAILY WATER LEVEL IN SUNGAI SIBIU IN 1974

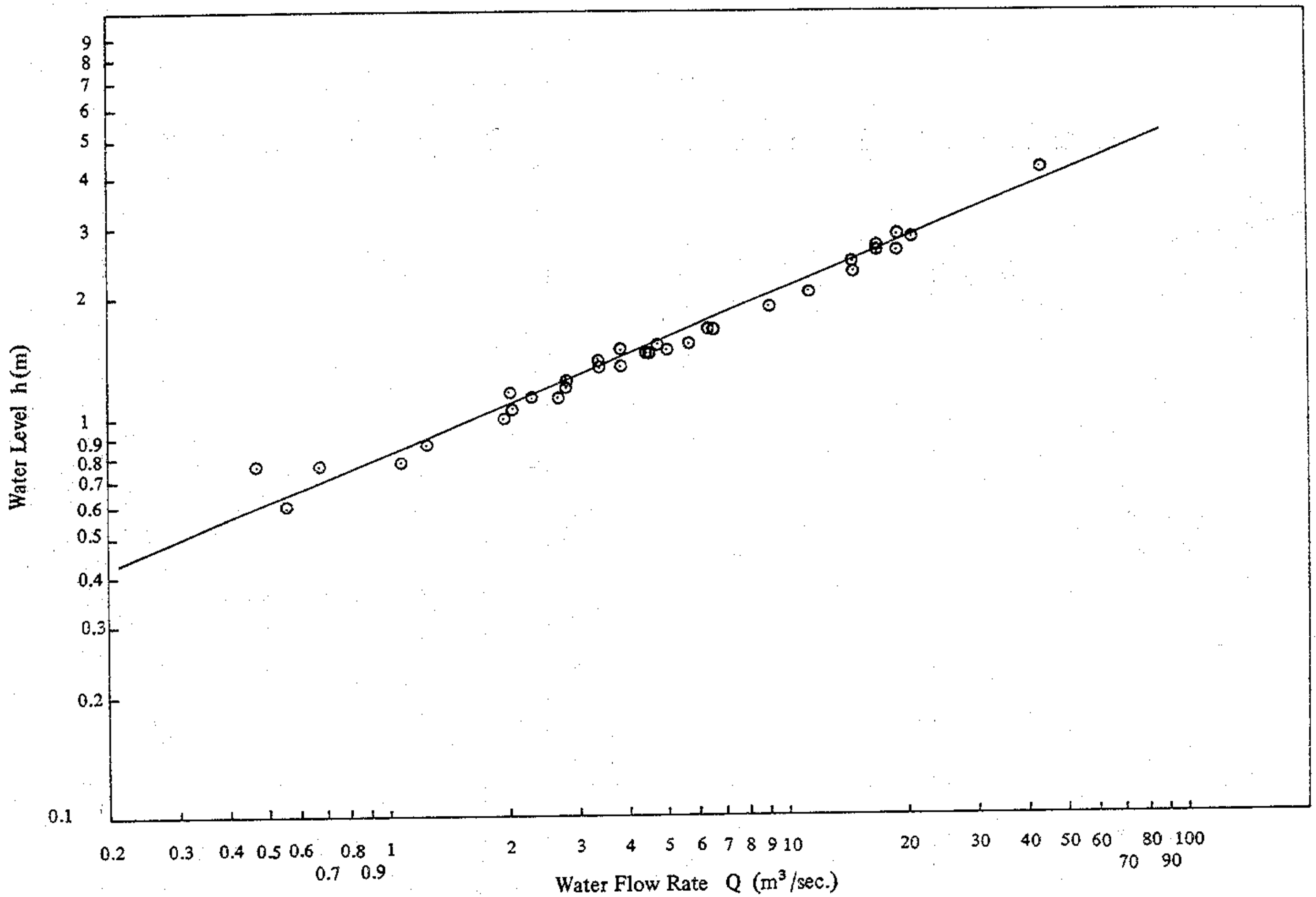


Fig. AIV-3 WATER LEVEL AND WATER FLOW RATE IN SUNGAI SIBIU

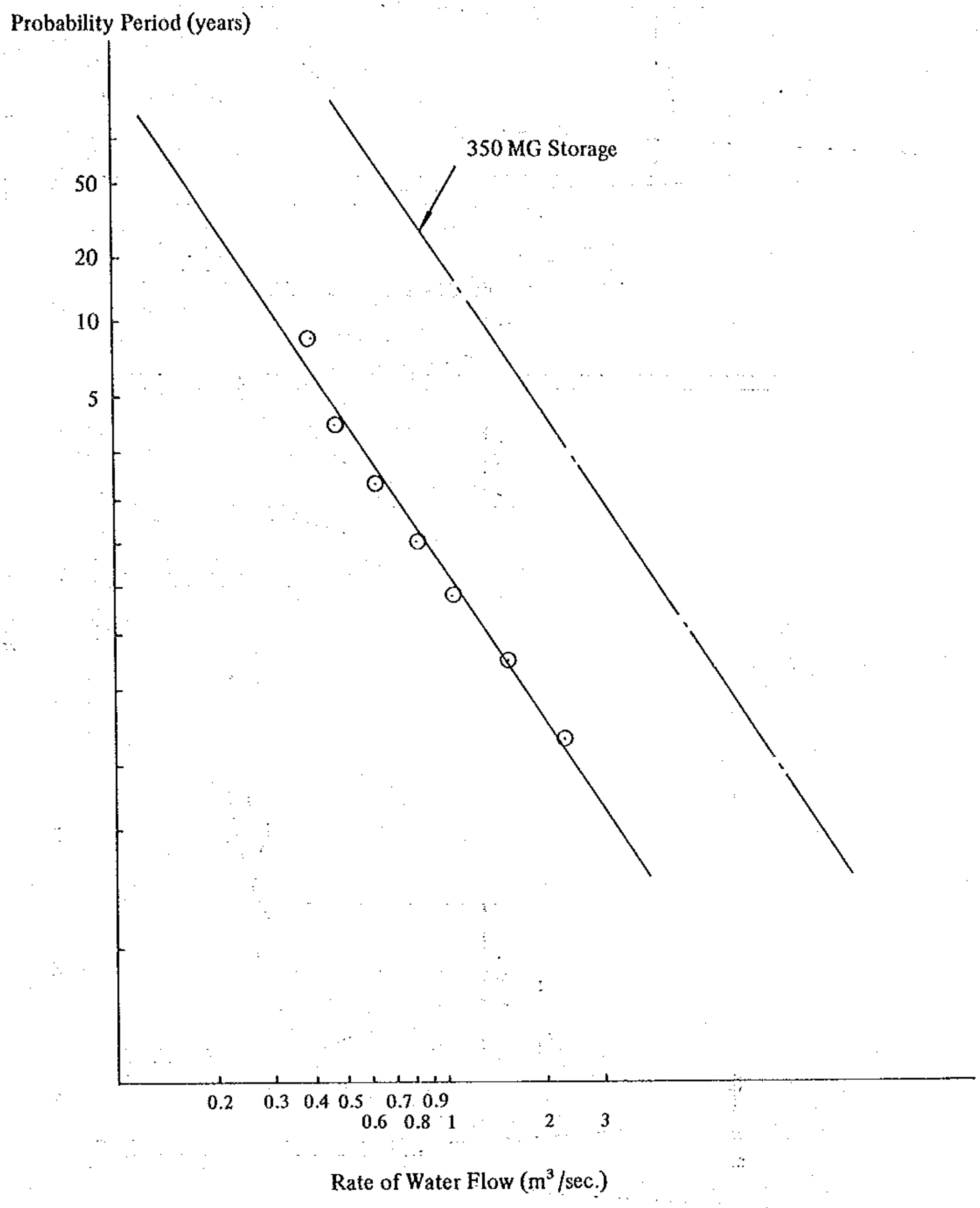


Fig. AIV-4 PROBABILITY RATE OF MINIMUM WATER FLOW IN SUNGAI SIBIU IN PERIOD OF "N" YEARS

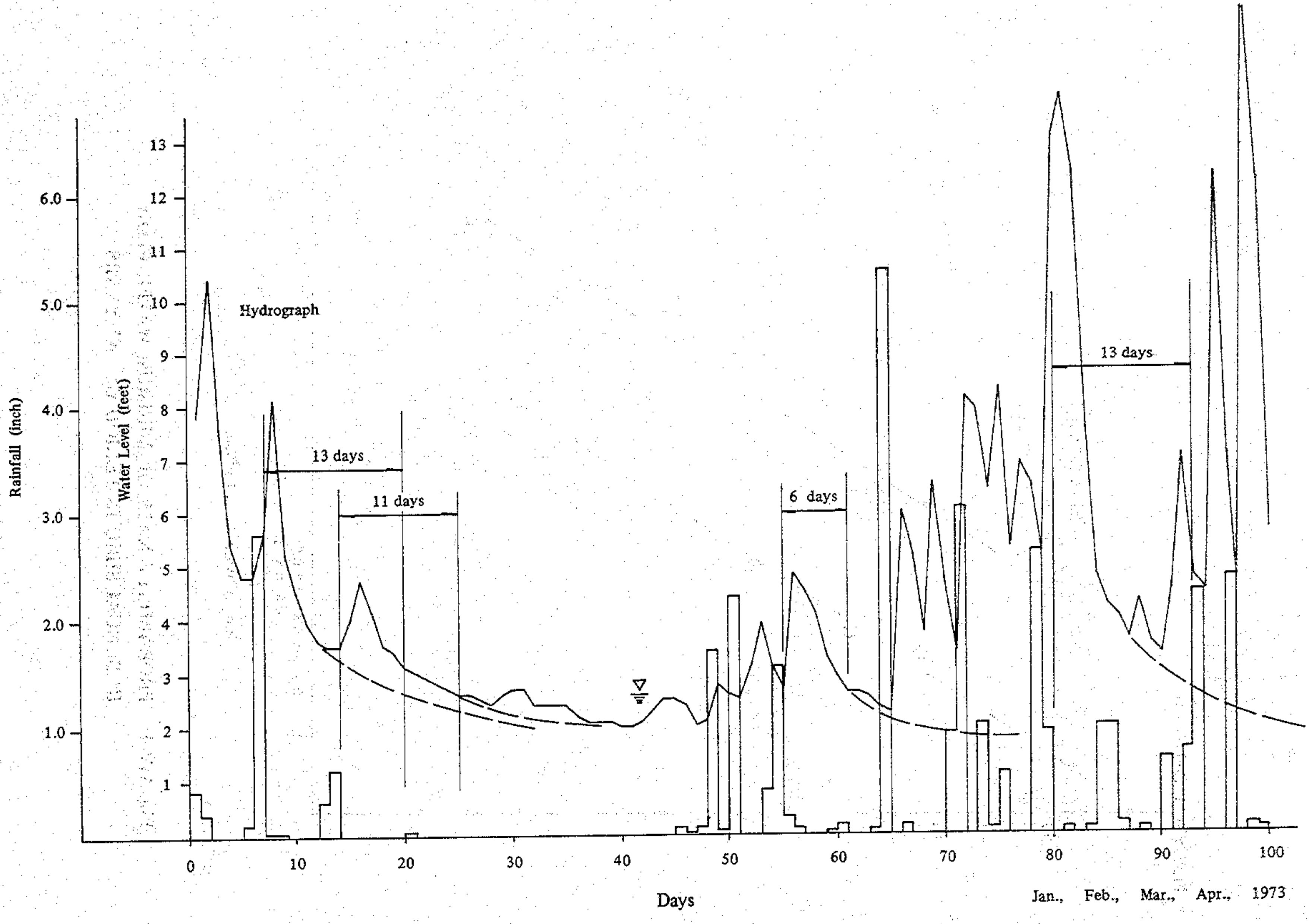


Fig. AIV-5 DAILY CHANGE IN RAINFALL AND HYDROGRAPH (SUNGAI SIBIU)

APPENDIX IV-2 INVESTIGATION ON AVAILABILITY OF PORT FACILITIES

2-1 Possible Occupancy Rates of Bulk Cargo Pier

2-1-1 Method of investigation

The steps commonly used for investigation of the rates of possible occupancy of piers are shown in a flow chart in Fig. AIV-6. According to the given steps, investigation is made of these rates for the Bulk Cargo Pier of the projected Bintulu Deepwater Port which is to be used for shipment of products from the Ammonia and Urea Complex.

The determinants of these rates are the volume of cargo handled, the number of piers used, the working efficiency for cargo handling operation, and the duration of time for the piers to be occupied by ships. For the investigation of occupancy rates for the Bulk Cargo Pier, of the determinant factors mentioned above, the working efficiency for cargo handling operation at the pier was estimated by using available data in respect of meteorologic and oceanographic conditions in the Bintulu Deepwater Port area, since it was believed that by using this method the estimation could be made at a satisfactory level. Regarding the duration of time for the pier to be occupied by ships, however, because there is no record at the present time, a standard rate in Japan, which had been estimated by referring to past records in Japanese ports, was applied.

The investigation was made on the assumption that only the Bulk Cargo Pier would be used for the shipment of products from the Complex.

2-1-2 Conditions of operation and assumed conditions

(1) Conditions of operation

(a) Annual volume handled (A)

On the basis of 330 days per year of plant operation, and further assuming that the output will be 90% of the plant capacity, the annual volume of products produced at the Complex and handled through the pier is assumed to be:

Urea: 1,500 t/d x 330 days x 0.9 = 445,500 t/y

Ammonia: 130 t/d x 330 days x 0.9 = 38,610 t/y

(b) Type of vessel (B)

The vessels used are to be 7,500 to 10,000 tons ships for urea, and 400 to 1,500 tons ships for ammonia.

(c) Port calls (C)

Annual port calls would be as shown in Table AIV-1.

Table AIV-1 ANNUAL NUMBER OF CALLS FOR EACH VESSEL

Cargo	Vessel	No. of Calls per Year*
Urea	10,000 tons	45
	7,500 tons	60
Ammonia	1,500 tons	26
	400 tons	97

(*: Determined by dividing volume of product by vessel capacity.)

(2) Other assumptions

(a) Annual number of days pier could be used (H)

The number of days per year that the pier could be used is greatly influenced by such factors as wind and wave conditions, visibility, etc. Conditions at the pier are quite calm as there are almost no days during the year when the hourly mean wind velocity exceeds 8 m/sec. The wind is mainly from the southwest from May to September, and from the northeast from November to April; the winds from the northeast are stronger than those from the southwest. However, the harbor's breakwater has been planned to provide protection from the northeast. The pier is to be located inside of both the Outer Breakwater and Inner Breakwater, where the average wave height is low as 0.34 m (NORCONSULT, May, 1976) and would not adversely influence the movements of tugs or performance of loading activities. Visibility is good throughout the year and on an annual basis visibility of less than 2 miles (3.2 km) occurs with a frequency of less than 1.7%. On the basis of these conditions, it is judged that the pier can be used during 70 ~ 80% of the calendar year, and hence this range of figures has been used in the present investigation (in the NORCONSULT Report, the visibility was estimated to be 70%).

(b) Number of working days per daylight day (I)

On an annual basis, assuming that work could be performed for 11 hours each daylight day, the number of working days per calendar day is:

11 hours/24 hours = 0.46 days

(c) Net number of days at pier per call (D)

The duration of pier occupancy by a ship is generally measured as the gross hours from mooring to casting off of ship after loading or unloading.

The net number of days at the pier per call for each type of cargo and size of ship is as shown in Table AIV-2. In performing the calculation for preparation of the data given in this table, it was assumed that loading would be performed during the daytime.

2-1-3 Results of investigation

The possible pier occupancy rate, annual number of days the pier could be used, and the annual number of days for pier occupancy, as estimated on the basis of the above operating conditions and according to the flow chart, are shown in Fig. AIV-7, and Tables AIV-3 and AIV-4.

As is clear from the figure and tables, the rate of possible pier occupancy is within the range of 50% ~ 63%. In port planning work in Japan, the rate of possible pier use of 60 ~ 70% is generally used. Judging from this, when cargo loading is done during the daytime only, even though the pier would have some unused capacity, it would be

Table AIV-2 NET NUMBER OF DAYS OF PIER OCCUPANCY PER CALL

		Ammonia		Urea	
		400 Tons Vessel	1,500 Tons Vessel	7,500 Tons Vessel	10,000 Tons Vessel
Full-load volume		400 t	1,500 t	7,500 t	10,000 t
Cargo handling capacity		100 t/h	100 t/h	600 t/h	600 t/h
Actual cargo handling capacity		90 t/h	90 t/h	450 t/h	450 t/h
Duration of use of pier (hours)	Arrival, mooring	0.3	0.5	1.0	1.0
	Hook-up cargo handling equipment	0.3	0.3	0.5	0.5
	Loading	4.4	16.7	16.7	22.3
	Remove cargo handling equipment	0.3	0.3	0.5	0.5
	Lift anchor, depart	0.3	0.5	0.5	0.5
	Sub-total	5.6	18.3	19.2	24.8
Net pier occupancy period per call (hours)		6.0	18.5	19.5	25.0
Net pier occupancy period per call (working day)		6.0/11.0 = 0.55	18.5/11.0 = 1.68	19.5/11 = 1.77	25/11 = 2.27

necessary for the pier to be available for the exclusive-use for loading products of this Project.

Table AIV-3 POSSIBLE PIER OCCUPANCY RATE BY SIZE OF VESSEL

Size of Vessel		Ammonia		Urea	
		400 tons	1,500 tons	7,500 tons	10,000 tons
Number of days of pier occupancy per call (Do)		0.55 days	1.68 days	1.77 days	2.27 days
Annual number of days of pier occupancy (D_L)		54 days	44 days	107 days	113 days
Possible pier occupancy rate	H = 256 days	21 %	17 %	42 %	40 %
	H = 292 days	18 %	15 %	37 %	35 %

Table AIV-4 POSSIBLE PIER UTILIZATION RATE BY COMBINATION OF VESSELS

Combination of Vessels	Ammonia Urea	1,500 tons 10,000 tons	1,500 tons 7,500 tons	400 tons 10,000 tons	400 tons 7,500 tons
D_L (days)		147	151	157	161
Possible pier occupancy rate	H = 256 days	57 %	59 %	61 %	63 %
	H = 292 days	50 %	52 %	54 %	55 %

2-2 Requirements for Cargo Handling Facilities

It is necessary for the cargo handling facilities to be used for this Project to have the the following characteristics.

(a) Annual volume of shipments

Bulk urea:	495,000 t/y
Liquid ammonia:	42,900 t/y

(b) Vessels using pier

Bulk carriers:	7,500 to 10,000 tons
Tankers:	400 to 1,500 tons

(c) Required draught: 10 m

The ancillary facilities which must be provided in conjunction with the above are as follows:

(a) Loading equipment

Bulk loader:	Rated capacity;	600 t/h
	Working capacity;	450 t/h
Liquid loader:	Rated capacity;	100 t/h
	Working capacity;	90 t/h

(b) Tugboats

(c) Channel markers

(d) Telecommunications facility

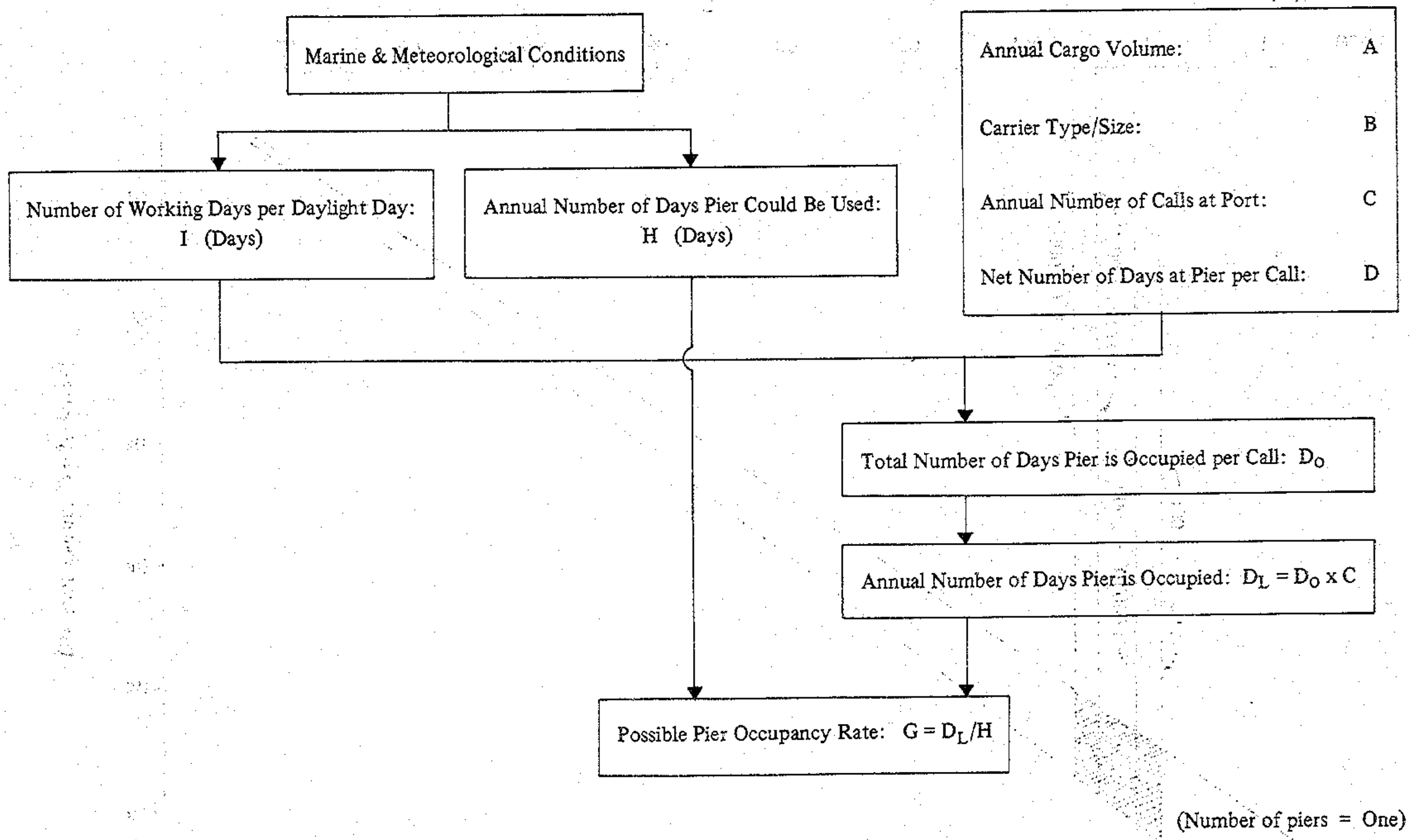


Fig. AIV-6 FLOW CHART FOR STUDY OF PIER OCCUPANCY RATE

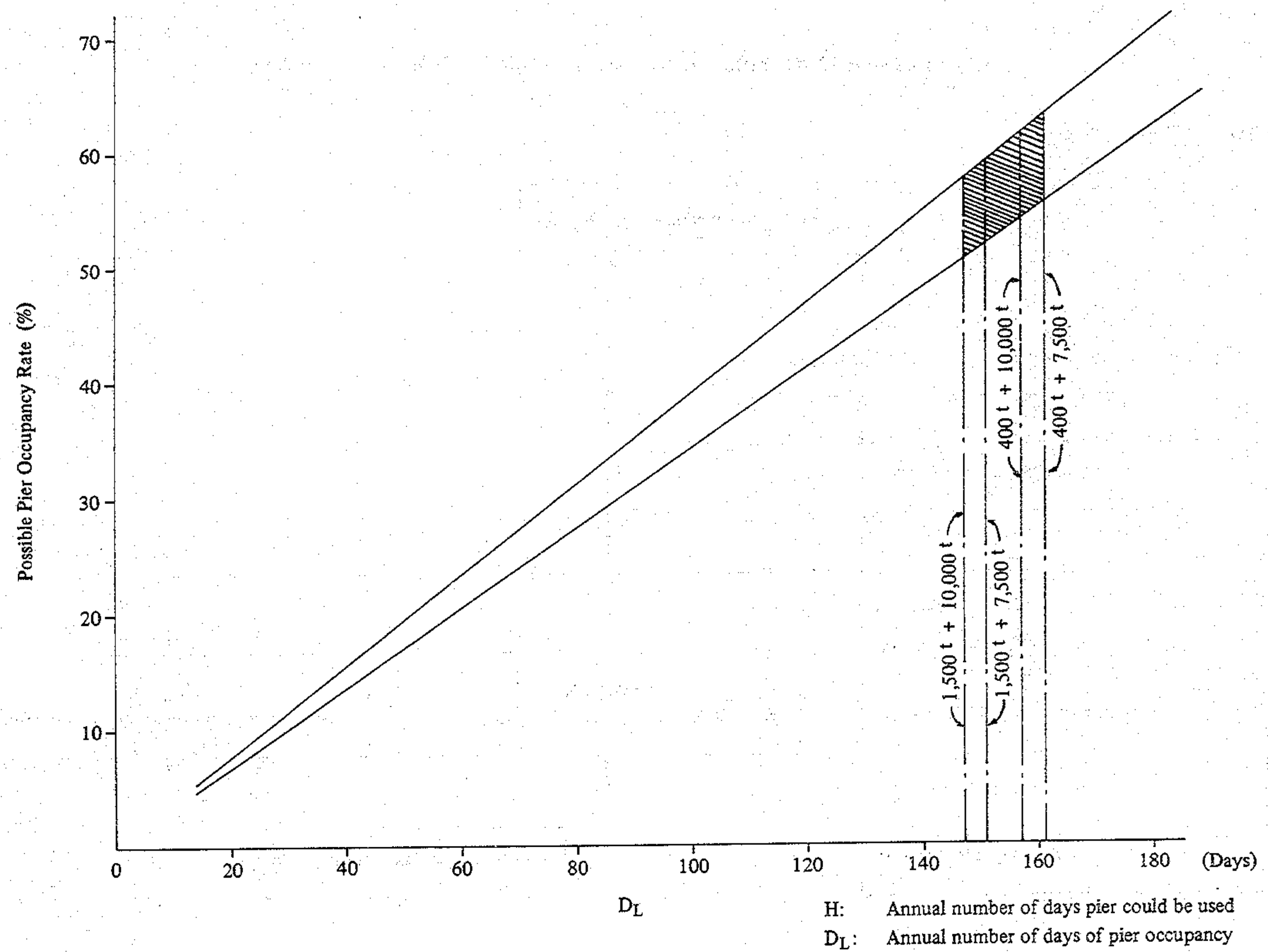


Fig. AIV-7 RELATIONSHIP OF POSSIBLE PIER OCCUPANCY RATE, H AND D_L

APPENDIX IV-3 AMMONIA AND UREA FACILITIES

The ammonia and urea plants are the heart of the Complex. In view of the scale of production capacity and product quality, these plants planned for this Project, as described in Part IV, are a standard type of one-train plants; a number of similar type of ammonia and urea plants have recently been built in various part of the world. Although steady progress is being made in improvement of ammonia and urea manufacturing processes applied to those plants, and in plant performance and reliability, fundamentally the basic technology has been standardized, and as long as the plants are built on the basis of the know-how of a highly reputed process owner, and are built by a highly reputed engineering contractor, a high degree of reliability may be expected. There are a number of engineering contractors which are capable of undertaking the work. Even though there will be variations in details of plant design made from company to company, the technological and economic differences between them are not so great, so it is suitable to make a process evaluation and selection in a precise manner at the stage of selecting a contractor who undertakes the design, engineering, procurement and construction of these plants.

In this context, the following description is given as one example of typical processes, but it does not suggest or recommend any specific process.

(1) Ammonia production facilities

A typical flow sheet for ammonia manufacturing process is provided as Fig. AIV-8.

The natural gas which is supplied at the Complex fence is divided into two flows after metering, one flow is to supply gas to be used as feedstock, and the other to supply gas to be used as fuel at the primary reformer of the ammonia plant and the steam boiler facility.

Natural gas to be used as feedstock, after removal of sulphur compounds and carbon dioxide, is preheated, mixed with steam, and introduced to the tube of the primary reformer, in which under catalyst, hydrocarbons in the fed gas are reformed to yield synthesis gas consisting mainly of hydrogen, carbon monoxide and carbon dioxide. The reformed gas is mixed with air and introduced to the secondary reformer where unreacted hydrocarbons are oxidized to produce gas composed of hydrogen, carbon monoxide and carbon dioxide.

Secondary reformer gas is passed through shift converters where carbon monoxide in the gas is converted to hydrogen and carbon dioxide; carbon dioxide is removed and then, by means of methanation, residual carbon dioxide and carbon monoxide are converted to inerts and a synthesis gas with the mol ratio of hydrogen-to-nitrogen of 3 : 1 is produced. The synthesis gas is compressed and fed to an ammonia reactor charged with catalyst in which the ammonia synthesis reaction takes place. Ammonia in the reaction gas is separated by cooling and is recovered as liquid ammonia while unreacted gas is recycled and sent to the reactor to produce ammonia. The thus-produced ammonia is stored in tanks prior to loading for the shipment, while it is supplied to a urea plant.

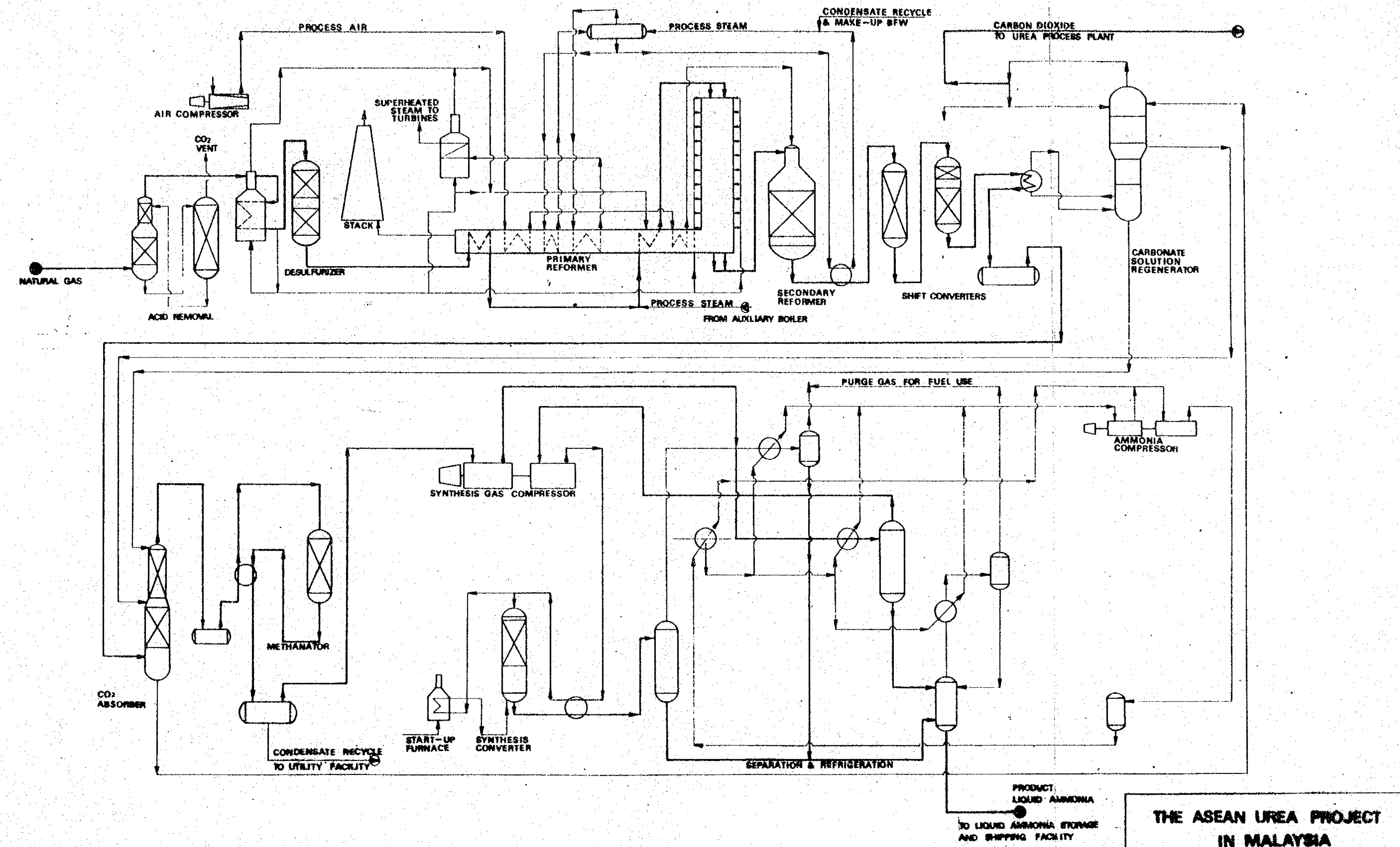
(2) Urea production facilities

A typical process flow sheet for urea manufacturing process is shown as Fig. AIV-9.

From liquid ammonia and carbon dioxide removed out in the process of manufacturing ammonia, urea is produced through ammonium carbamate formation which is achieved under conditions of high temperature and pressure in a reactor. The reactions in the reactor are between ammonia, carbon dioxide, ammonium carbamate and water to form urea and by reducing the pressure, stripping and increasing the temperature downstream from the reactor, the residual ammonium carbamate is decomposed into ammonia and carbon dioxide, and urea solution is obtained.

A crystallizer is used to obtain crystal urea from the urea solution and the urea crystals are separated by use of a centrifuge and then dried, melted and prilled at the prilling tower. The prilled urea product is conveyed to a bulk storage warehouse for temporary storage prior to being shipped in bulk.

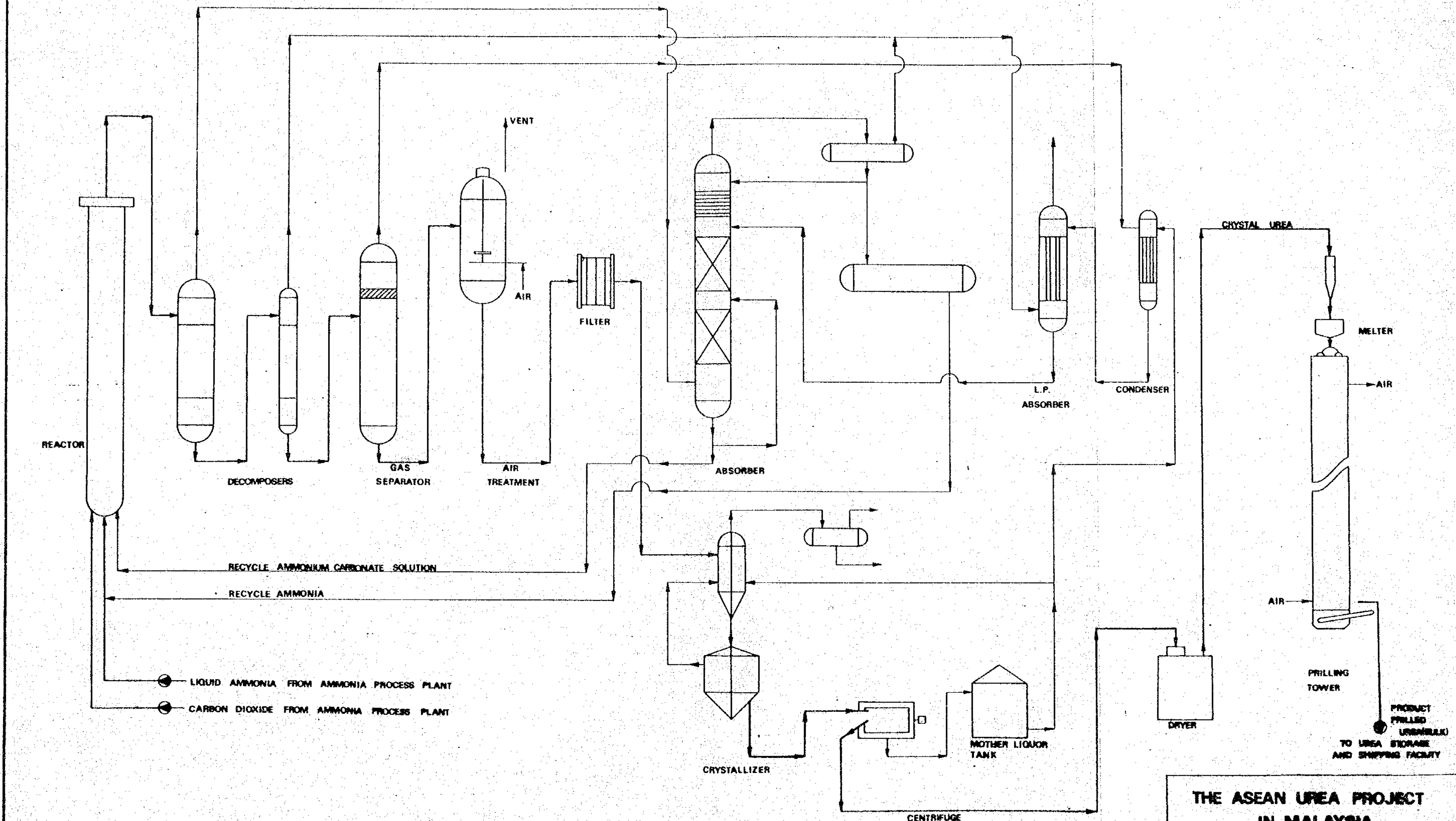
Ammonia and carbon dioxide which have been recovered at the preceding process and urea solution containing a high biuret concentration recovered are recycled and fed to the urea reactor with freshly fed ammonia and carbon dioxide.



THE ASEAN UREA PROJECT IN MALAYSIA

TYPICAL AMMONIA PROCESS

JICA | FIG.IV-8



THE ASEAN UREA PROJECT IN MALAYSIA

TYPICAL UREA PROCESS

J I C A

FIG. AIV-9

APPENDIX IV-4 SITE PREPARATION

4-1 Present Conditions

4-1-1 Topography

The proposed Complex site is in an elevated area in the southern part of the Kidurong peninsula. The northern boundary follows an east-west ridge which is at elevations of 60 ~ 70 m, and the southern boundary follows the Tg. Kidurong road which is at the elevation of 12 m. Therefore the site's northern and east-west boundaries are at higher elevations, and there are strong undulations spreading in a generally southern direction. The site is about 40 ha in area.

The site is divided into three parts by two marshes which are oriented east-west. The marshes form small swamps in low areas near the Kidurong road.

4-1-2 Soil

Because no boring logs are available for land within the site, it is not possible to make a reliable judgement, but the following observations may be made on the basis of the geological maps published by Malaysia's Geological Survey, soil data for Bintulu Deepwater Port, and field reconnaissance of site preparation work underway for the LNG plant.

The ground is covered by a thin stratum (0.2 to 0.3 m) of topsoil which contains considerable organic matter, below which is a stratum (3 to 4 m) of sandy silt (so-called tropical laterite). Below that is Neogene sedimentary sandstone and shale.

4-1-3 Vegetation

With the exceptions of the swamps and marshes, most of the site is covered by a dense growth of young broadleafed trees and undergrowth which is about 2 m in height. Most of the trees within the site are slender and tall.

4-2 Preconditions for Site Preparation

For this Project, planning for preparation of the site is worked out in consideration of the topography and soil conditions of the site area and with the objective of drawing the optimum site plan which requires the least costs for site preparation work, while satisfying other conditions, that is, (a) the finished grade of the site would be as flat as feasible, and (b) the site would facilitate the carrying-in of heavy goods and long-measure equipment.

In this context, the following was set as preconditions for examination of the site preparation plan:

(1) Conditions provided for moving of equipment to the site

In order to facilitate moving of heavy goods and long-measure equipment to the site, the grade of the access road from the Tg. Kidurong road to the site should be no more than 5%, and curves should have ample radii.

(2) Conditions concerning the site

The area required for the Complex, not including provision for future expansion, is to be 150,000 m^2. The site area should be flat to the maximum extent possible.

4-3 Case Studies

The important step in examining the site preparation plan is to select the most economical one, among several alternatives, regarding the finished form and level of the site which would satisfy the conditions stated in 4-2 above. It is a general practice for engineering of site preparation how to draw the plan by which the volume of earth to be cut and filled could be balanced to the greatest extent possible, and earthmoving would be minimized. In the case of this site, however, because there is a limited space of flat land due to the strong undulation of the land and steep gradient, a site preparation plan designed to obtain a balance of the volume of earth for cutting and filling would result in the finished grade being considerably above the elevation of the road.

In view of the above characteristics, a few alternative plans were prepared, on the basis that difference between the elevations of the road and finished grade of the site is kept at about 15 m in order to keep the slope of the access road at no more than 5%, and among these alternative plans, a plan which could attain least volume of earthwork was selected as the recommendable one. The process of these examinations is presented below.

Five cases were studied. In Cases 1, 2 and 3 (see Figs. AIV-10, 11 and 12), the plans are to cut much of the high northern ridge and fill the swamps, thereby preparing the required site area; a great volume of earthmoving is needed in these cases.

In Cases 4 and 5 (see Figs. AIV-13 and 14), in order to minimize earthmoving, the plans are designed to prepare the minimum required area by leaving the north-south ridge, cutting land along on both sides of it, and filling the low land on the south; these cases require much less earthmoving than the preceding cases. The quantities for each of these cases are indicated as Table AIV-5. From these, Case 5, in which the whole area of the site is to be made at the elevation of 30 m, was identified as the best and used for further study of the site.

4-4 Site Preparation Planning

4-4-1 Protection of the environment

In order to build the Complex which is in harmony with its natural environment, it is planned that the primeval forest within the northern boundary of the site, and outside the eastern boundary, will be left in its present state, so that they may function as a greenbelt.

Such plans would also be effective to protect the Complex from any damage which may occur due to rapid surface run-off of rain, because retained vegetation would serve to keep water-retaining capacity of the soil high as well as to prolong the duration of time surface rain-water reaches the Complex site.

4-4-2 Earthwork planning

The range of earthwork is to comprise the 0.2 to 0.3 m stratum of topsoil, the 3 to 4 m stratum of sandy silt below it, and the Neogene sedimentary stratum below that.

The quantity of cut will be about 1.07 million m^3, and that of fill about 1.00 million m^3, all to be moved by mechanical force.

The upper, weathered soft portion of the sedimentary stratum can be broken up and moved by use of a bulldozer or ripper, but blasting will be necessary for a part of the sedimentary deposits.

Good quality sandy silt as well as weathered soft rock from the sedimentary deposits are to be used as fill. Topsoil and sandy silt which are not suitable for use as fill are to be removed from the site for disposal at a suitable place.

4-4-3 Road planning

Specifications of the roads are designed in conformity to the Sarawak Public Works Department's Road Standard.

Paving thickness is to be 14 cm to 48 cm depending on the grade of road; all road surfaces are to be paved with bitumen or concrete.

The longitudinal slope of the access road from the Tg. Kidurong road is to be no more than 5% in order that the access road may be used for carrying plant equipment into the site.

4-4-4 Damage accident, preparation planning

Most of the damages and accidents which happen during site preparation work are caused by water and soil.

In view of the characteristics of the site preparation work for this Complex which include the cutting of strongly undulating land and filling low land, it is necessary to plan for preventive measures which may protect the site preparation work from any damage or accident caused by rain-water run-off or the collapse of soil embankments. Further, regarding the protection of slopes and installation of adequate drainage and sewer facilities, careful attention must be given in surveys, designs and supervision of work. The major points to which consideration was given are as stated below.

(1) Planning of the slope protection

In principal the inclinations of cut faces is to be 1.5 : 1, and that of fill embankments to be 1.8 : 1; the slopes are provided with berms of 2 m in width every 5 m in height, and the surfaces of slopes are to be vegetated so as to prevent the earth from collapsing. Also, to prevent collapse at the toe of the slope, the toe part is to be provided with 2 to 3 m of stonework and a drainage channel is to be formed at the edge.

(2) Drainage of rain-water

By means of open drainage ditches, run-off rain-water on the site will be collected and discharged by gravity into the nearby river.

The volume of run-off rainfall is to be estimated on the basis of study of rainfall data.

4-5 Problems and Points Requiring Attention

(1) Soil data

At the present time, because of the lack of soil data, the present planning was made on the basis of data from nearby areas. However, prior to proceeding with detailed planning of site preparation work, it is necessary to make investigation based on soil boring tests and plan the detailed site preparation work for execution, on the basis of soil data thus obtained.

(2) Needs for a map showing topography of the area in detail

It is necessary to prepare a more detailed topographical map of the site than is now available, such as a 1/600 plan, which is needed for calculation of work volume, design and formulation of execution plan for site preparation.

(3) Damage and accident prevention

It is essential to plan for measures for prevention from damage and accident during site preparation work, including plans for proper drainage of rain-water during construction, prevention of the collapse of earth embankments and for maintenance of slope.

(4) Settlement of fill

Even if fill is compacted, settlement cannot be prevented. Further, differential settlement is to be anticipated. These eventualities are to be taken into consideration during design work.

(5) Soil disposal

Because it will be necessary to dispose, off the site, topsoil and silty clay which is not suitable for fill, it will be necessary to secure a suitable site for such disposal, and road access to it.

Table AIV-5 QUANTITIES FOR EACH CASE STUDY

Case	Final Elevation m (MSL)	Area Worked ha	Cut m^3 x 1,000	Fill m^3 x 1,000	Off-site Disposal m^3 x 1,000
1	22	25	5,305	265	5,040
2	27, 32, 37	27	3,445	756	2,689
3	27, 32	25	2,800	768	2,032
4	27, 30	18	1,427	586	841
5	30, 33	18	1,063	994	69

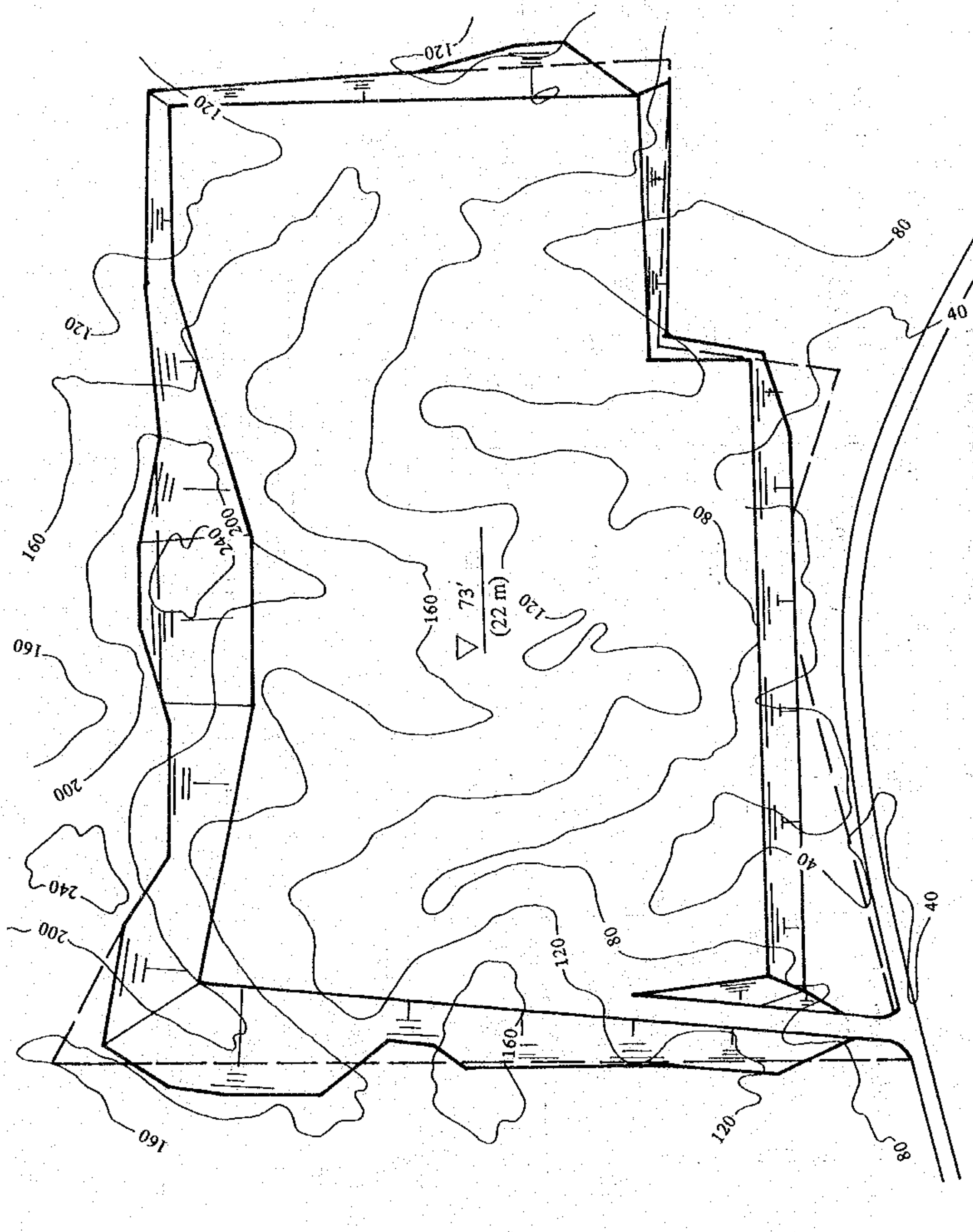


Fig. AIV-10 SITE PREPARATION (CASE 1)

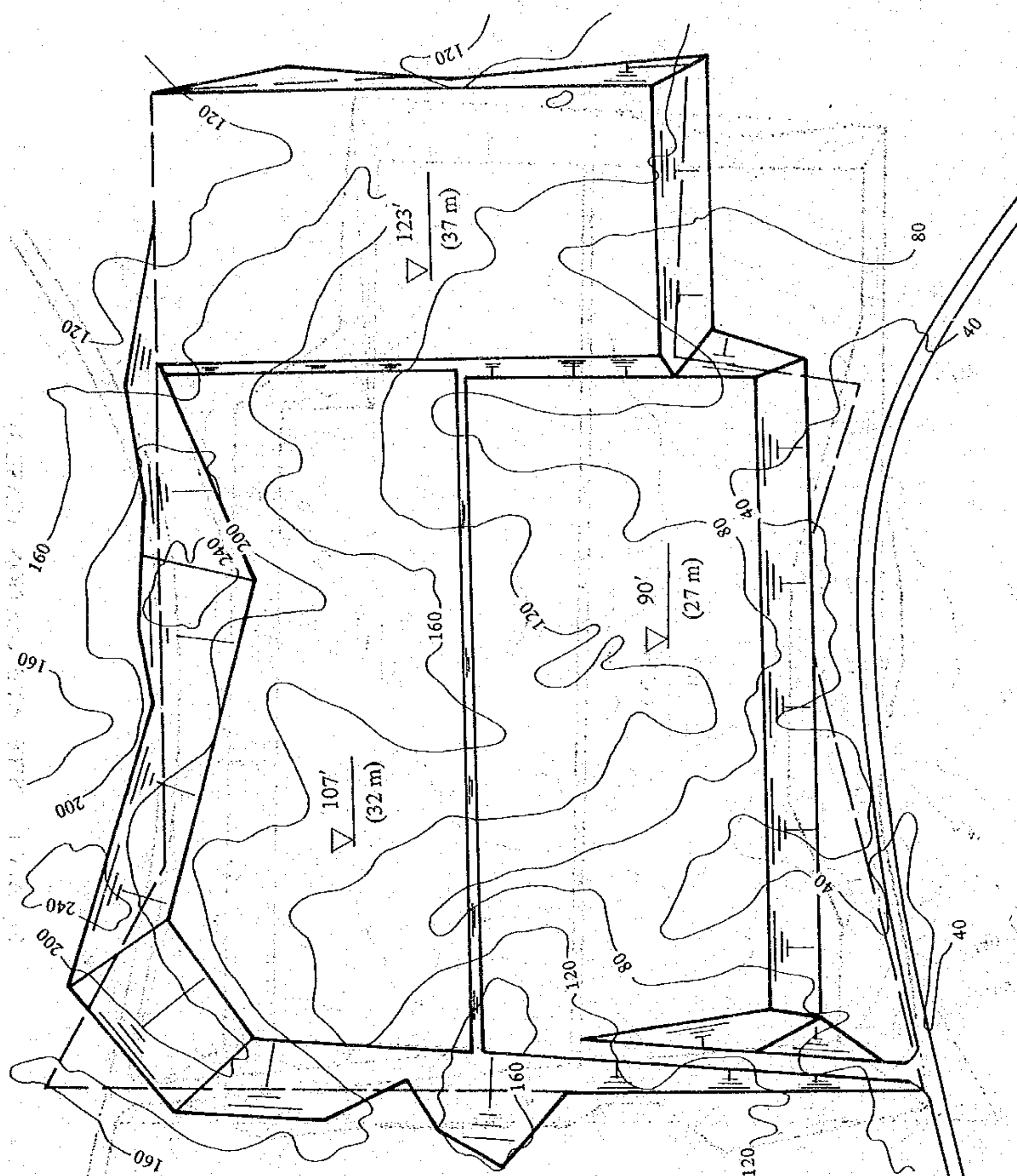


Fig. AIV-11 SITE PREPARATION (CASE 2)

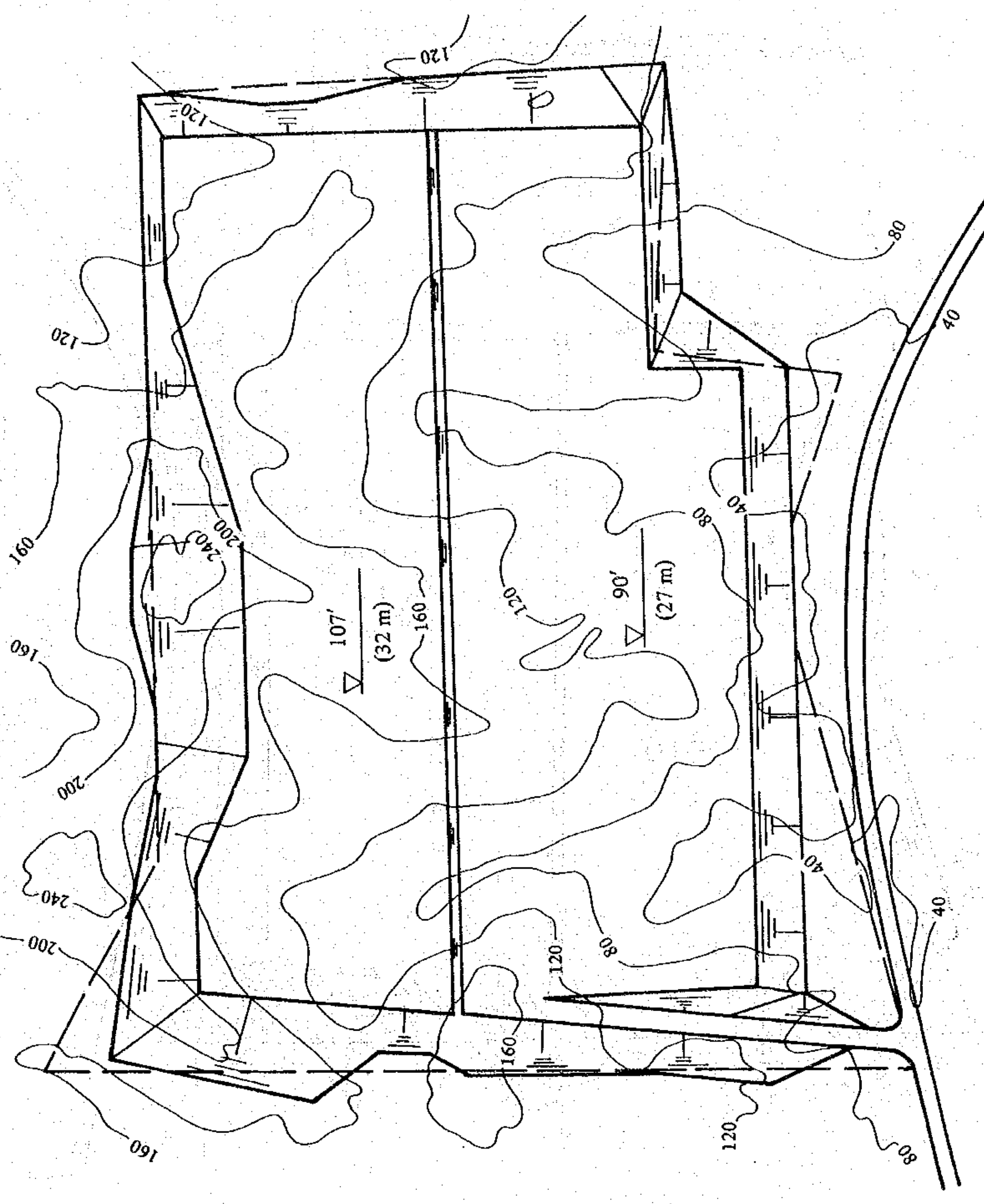


Fig. AIV-12 SITE PREPARATION (CASE 3)