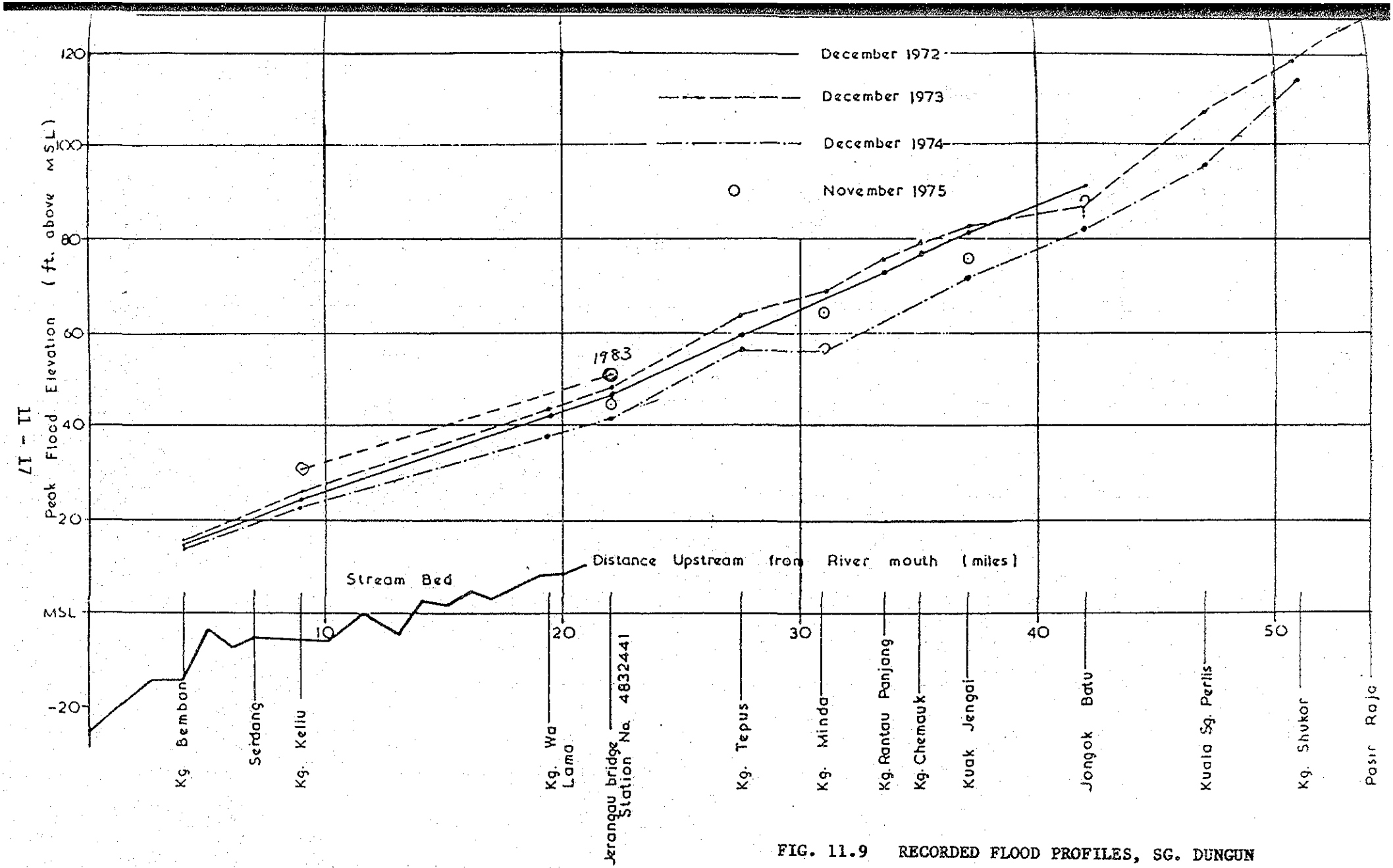


FIG. 11.9 RECORDED FLOOD PROFILES, SG. DUNGUN

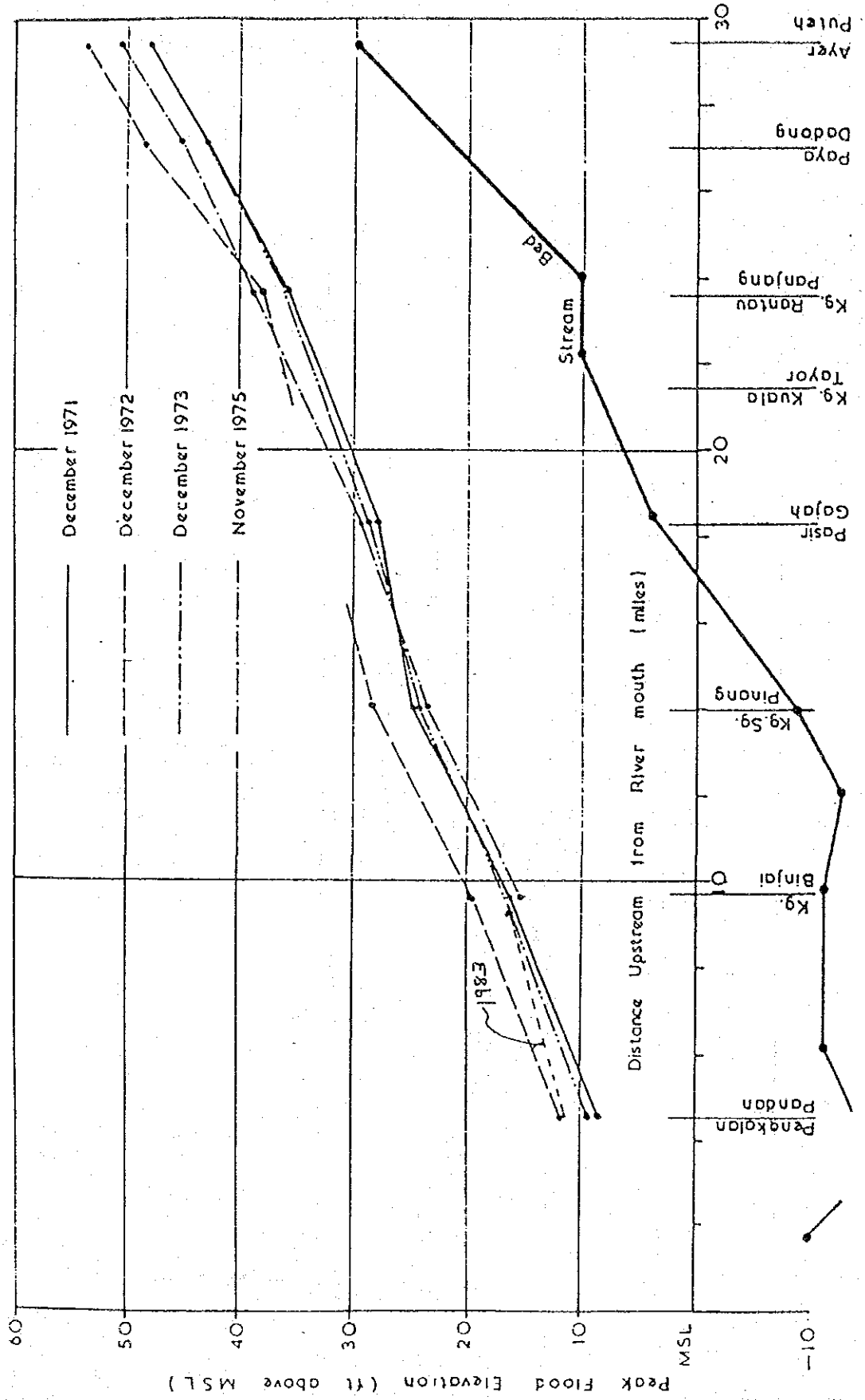


FIG. 11.10 RECORDED FLOOD PROFILES: SG. KEMAMAN

Source: SCTWR

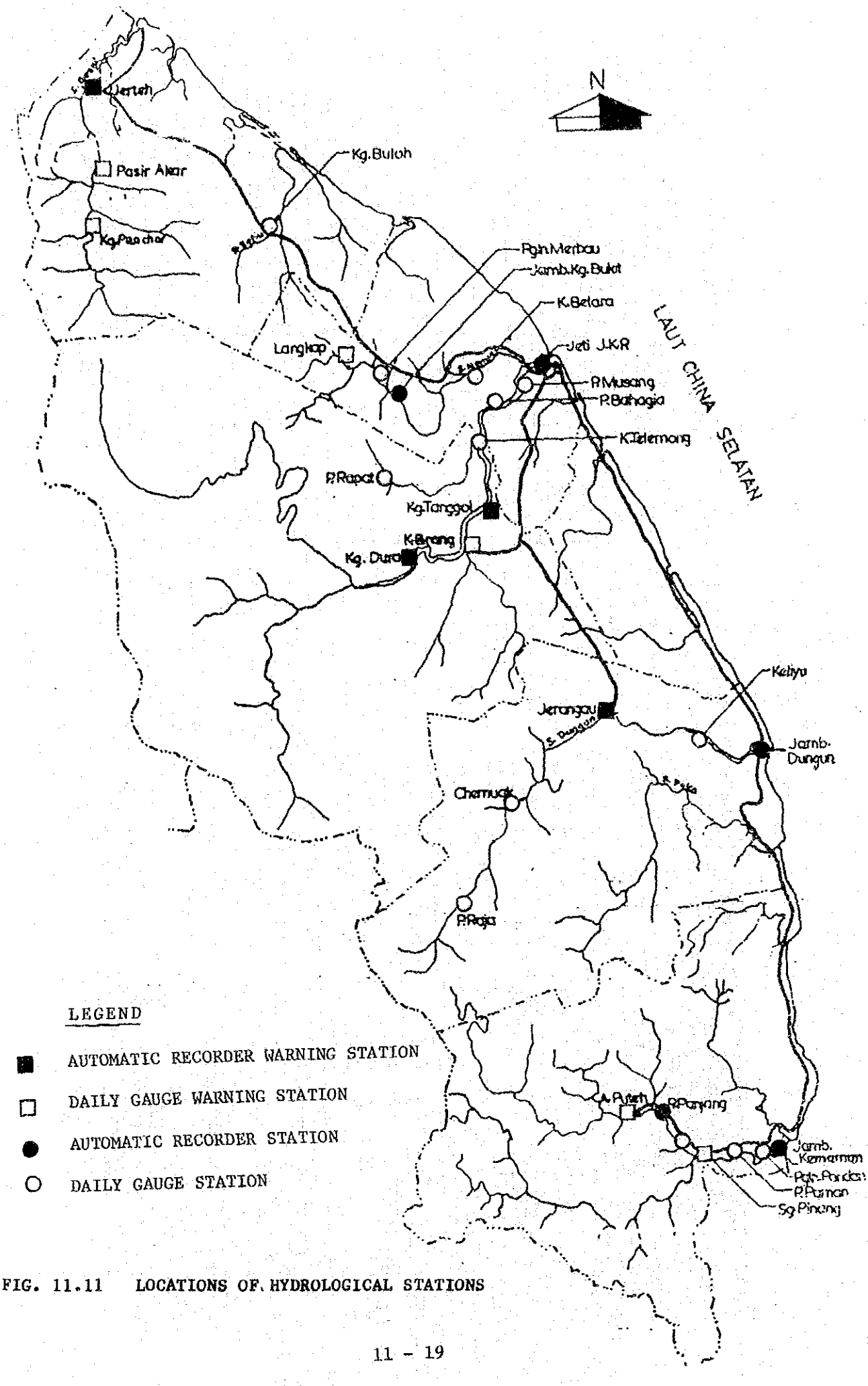


FIG. 11.11 LOCATIONS OF HYDROLOGICAL STATIONS

HYDROGRAPH SUNGAI DUNGUN

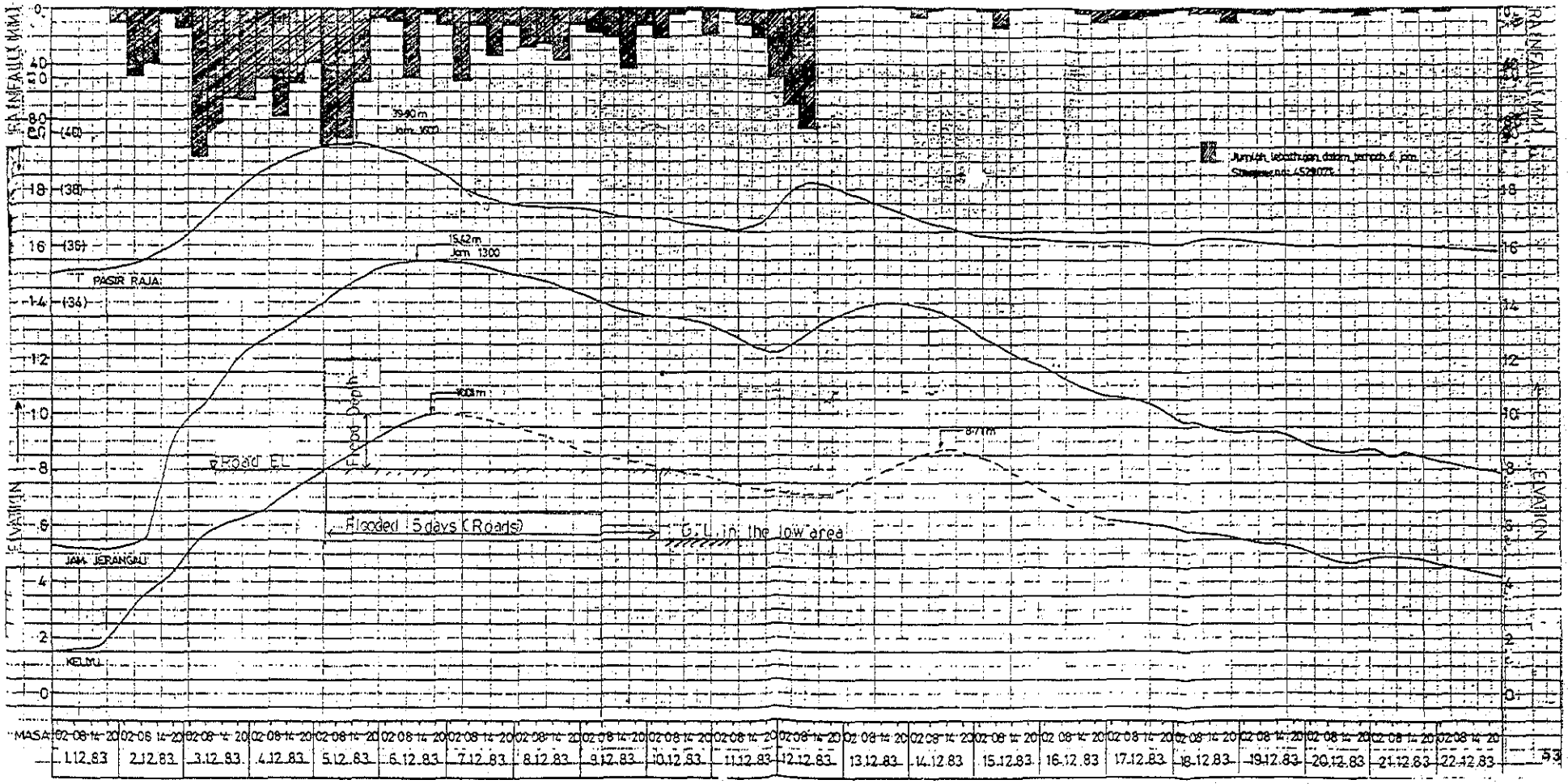


FIG. 11.12 HYDROGRAPH SUNGAI DUNGUN

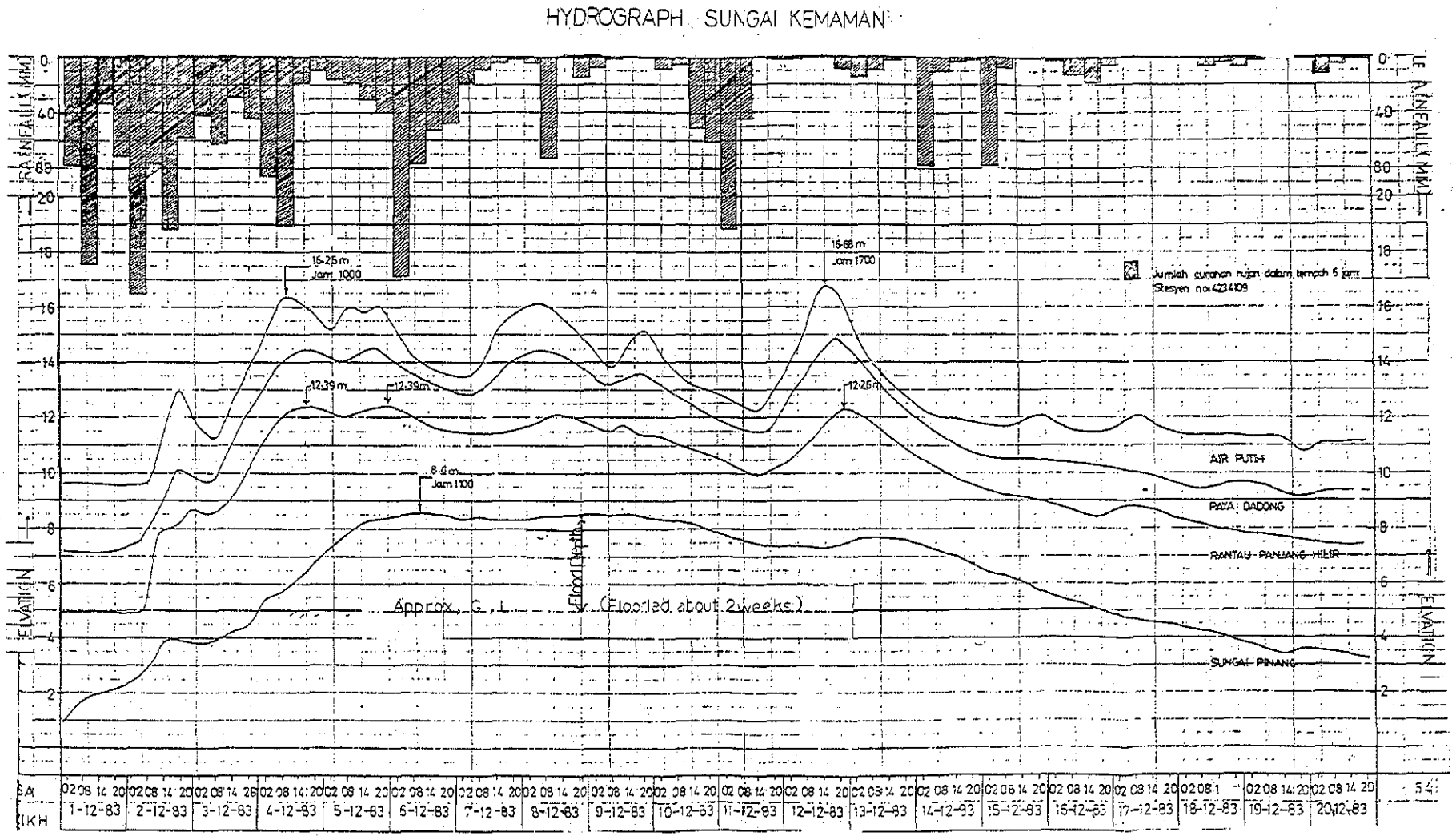


FIG. 11.13 HYDROGRAPH SUNGAI KEMAMAN

3.2 Problems in Relation to the Development

Many kinds of development have been implemented or under planning. They are agricultural, mining, residential purposes in the upstream area, and the town and industrial developments in the coastal strip. In the process of development, no sufficient consideration of the flood characteristics of the area seems to be taken in. The reasons may be due to rapid development and insufficient information about flood characteristics and the area drainage. Major problems related to the flood are:

(1) Road

- Long periods of road closures and deep water
- Increase of sediment run-off
- Effects on water levels caused by narrow or low bridges and inadequate drainage culverts

(2) Town Development

- Development in the flood prone areas

(3) Industrial Development

- Development in the flood prone areas

(4) Agricultural Development

- Development in the flood prone areas
- Increase of flood discharge and sediment run-off especially during construction

(5) Others

- Sediment run-off from old mines
- Houses on the sand spits

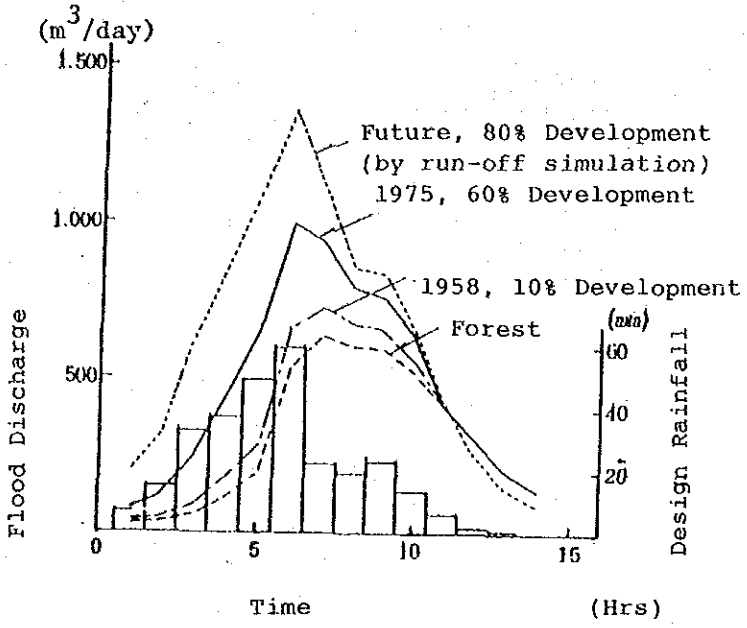
These activities will increase the necessity of flood control and the cost of countermeasures as well.

In the case of laterite soil of the study area, the ratio may be greater than the figures given in Table 11.3. An example of effects of development on flood discharge and sedimentation in the river is shown in Fig. 11.14. An example of discharge increase in the river mainly caused by river improvement is shown in Fig. 11.15.

Table 11.3 DIFFERENCES IN SEDIMENT RUN-OFF BY GROUND SURFACE CONDITIONS, 1962, BY KAWAGUCHI

	Average Yearly Erosion Depth (mm)	Yearly Sediment Run-off (tons/ha)	No. of Data	Ratio
Forest Area	0.2	1.8	6	1
Grass Land	0.2	2.1	10	1.2
Cultivated Area	1.1	14.8	17	8.2
Bare Ground	6.7	87.1	11	48.4
Desolated Area	23.6	306.9	11	120.5

Source: Tadaki Akai et al, Forest and its Functions (1974)



Note: River basin was originaly hilly forest area developed for residential purpose.

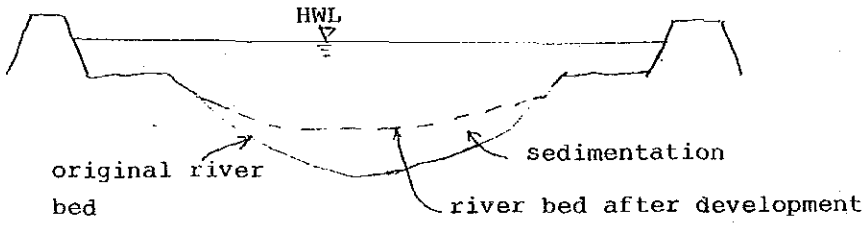
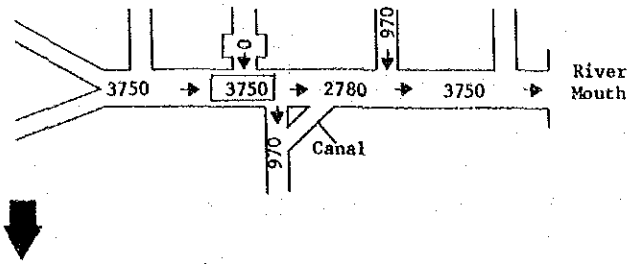
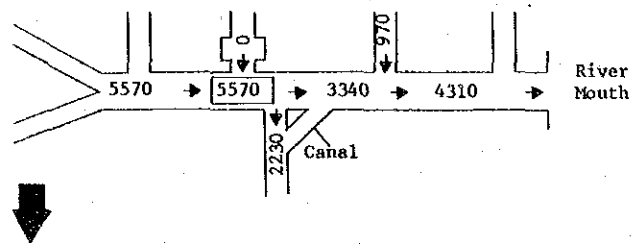


FIG. 11.14 EFFECTS OF DEVELOPMENT ON FLOOD DISCHARGE (LAND USE CHANGE), TSURUMI RIVER, JAPAN

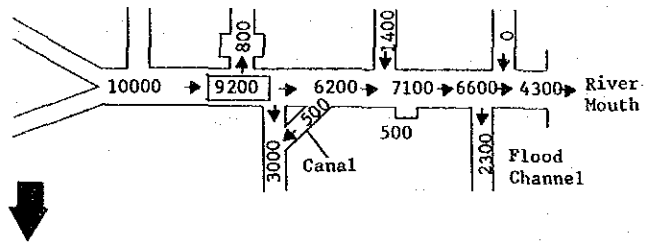
(a) River Improvement Plans Against the 1896 Flood



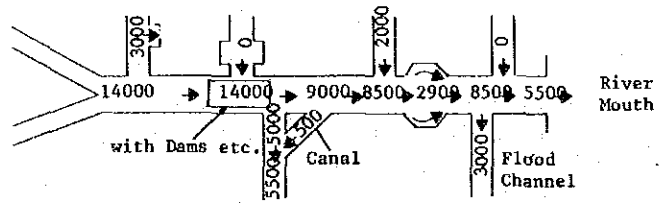
(b) River Improvement Plans Against the 1910 Flood



(c) River Improvement Plans Against the 1935 Flood



(d) River Improvement Plans Against the 1947 Flood



Note: Flood discharge has increased greatly mainly because of decrease in storage volume of flood water in the upstream area along the river.

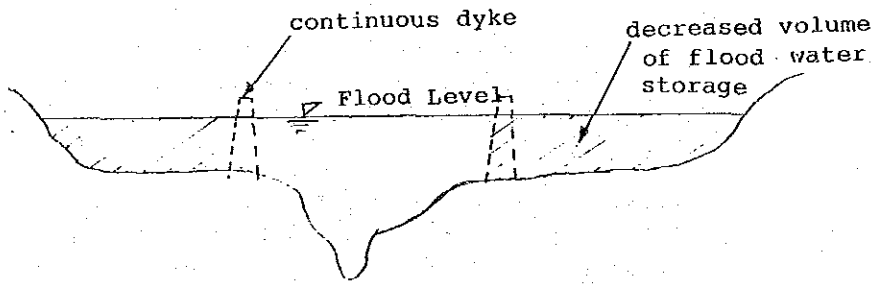


FIG. 11.15 EFFECTS OF RIVER IMPROVEMENT ON FLOOD DISCHARGE/ HISTORY OF DESIGN FLOOD DISCHARGE, TONE RIVER, JAPAN

3.3 Possibility of Countermeasures

(1) General

Methods of flood control in general are considered as follows:

1) River Improvement

- Diversion channel, floodway
- River mouth improvement
- Dyke and dredging
- Reprofiling of major bed

2) Storage of Flood Water

- Storage of flood water and sediments come from development areas
- Dams, retarding basins, provide storage in the river channel
- Forest conservation

3) Improvement of Local Drainage

- Improvement of bottlenecks
- Drainage in the development areas

4) Raising

- Houses, buildings and roads
- Ground elevation in the low area

5) Flood Warning

6) Landuse

- Usage of land and location of facilities
- Necessary land for flood control and drainage

7) Control Facility

- Pumping station
- Flood gate, control gate

8) Other methods to mitigate flood damages

It is difficult to obtain future design flood flows by river dredging only because of difficulty in obtaining riverbed stability and the required river width. Therefore, it is necessary to consider a combination of dyke, dredging and other methods.

There is a possibility of dams in the upstream area and retarding basins in the swamp areas. But, in the case of dams, vast agricultural areas in the KETENGAH should be excluded from the reservoir areas. Main purpose of flood control is to mitigate the flood damage in the downstream area, where population and properties are concentrated.

Effects of river mouth improvement on flood level for heavy flooding seem to be on the order of one metre, based on flood level records in the Dungun, Paka and Kemaman Rivers. In the downstream low area, combined methods (3) through (8) will be practical. In the upstream area, the storage of flood water will take an important role.

(2) Dungun River

Possibility of dam is limited in the tributaries that have small catchment areas, because of KETENGAH development and villages along the main stream. Therefore, the efficiency of flood control by dams for the downstream is small, but is effective for the small villages along the rivers.

There is a large swamp in the Jerangau - Kumpal area. There is a possibility to use it as a retarding basin, combined with a diversion channel from Jerangau, if topographic conditions are suitable. There is less possibility of constructing retarding basins in other swamps in the Dungun River basin.

Head loss at the river mouth is not clear because of the hydraulic effects of the bottleneck at the upstream bridge. It seems to be in the range of 1.5 to 2 meters during large floods. River improvement of the downstream portion is necessary together with widening of the bridge openings.

(3) Paka River

The possibility of a dam is quite small because of the agricultural area. A possible swamp retarding basin is in the vicinity of Sg. Apu confluence with a catchment of 329 km^2 (about 40% of the total area of Paka basin).

(4) Kerteh River

There are no topographic data except for the marine chart and a small scale map to determine the flood characteristics. Judging from the map, river conditions may be similar to that of the Paka River.

River improvements and retarding basins in the swamp area will possibly be effective. River mouth improvements will be costly because of wide shallow area of the estuary compared with the Paka River.

(5) Kemaman River

Dams in the upstream of the main stream and Sg. Cherul may be possible, depending on topography and geology. Though the dam will be effective for the downstream area of each river, flood problems of the low areas along downstream Kemaman River will not be solved. Even if the flood control dams are provided, it is necessary to raise ground elevation or to provide pumped drainage.

Possibility of retarding basins in the swamp areas is considered near the junction of Sg. Cherul. A flood channel, if possible, toward the sea would be effective for the low lying town area in the downstream.

Two alternatives of river mouth improvements will be considered. One is to provide training dykes on both sides of the existing mouth, and the other is to make a cut at the Kg. Geliga. The former will have few social problems but the latter will have problems though it is considered physically the better scheme.

The river mouth improvements shall be studied together with the river improvement strategy.

3.4 Flood Control Strategy

The flood characteristics and the possibility of countermeasures give the following strategy for the smooth implementation of the development.

(1) General Notes

- To recognize that the flood problem is one of the biggest impediments for development.
- The rivers shall be improved downstream towards upstream in principle.
- Drainage principle is quick drain in the downstream reaches, and storage of flood water or slow drain in the upstream areas.
- Sediment problems shall be taken into account for both river improvement and development.
- Any development shall be implemented considering future flood control possibility to minimize social costs.
- Flood control works shall be implemented stage by stage based on future plans and urgent needs.
- Natural gravity flow drainage shall be adopted in principle, especially in town areas.
- Flood control methods shall be simplified, as much as possible, for management.
- Flood warnings shall be continued until flood control works are completed to a certain level.
- Estimation of design flood discharge shall be based on the planned development and improved river conditions.
- Change of feeling of the people affected by floods due to modernization shall be taken into consideration.

(2) Dungun River

Improvements downstream in the main stream and diversion channel, if possible, are considered. The river improvements include river mouth improvement, dredging and providing dykes. Upstream areas shall not be developed without flood control countermeasures, such as dam and retarding basin.

Therefore, necessary land for future river improvement shall be acquired. Detailed physical and social possibilities for the diversion channel should be studied together with the use of swamps as retarding basins. The town area near the river mouth, which is easily flooded, shall be reclaimed by raising ground elevation above flood level of the river.

(3) Paka River

River mouth improvement combined with downstream river improvement are considered necessary. Retarding basin in the swamp will be considered if necessary. Height of the dykes will be lowered if the river mouth is improved.

(4) Kerteh River

River mouth improvements will become necessary if the surrounding area is widely developed. Topography in the estuary will be affected by the training dykes. Therefore, it is necessary to consider these together with landuse by reclamation.

(5) Kemaman River

Flood problems of the low town areas along the Kemaman River will not be solved except by pumped drainage or reclamation.

To minimize the earth volume for reclamation, the most effective method is the floodway to divert all flood waters to the sea. A retarding basin or dam will be considered if necessary for the development or improvement of the upstream area.

There are many problems to be studied, such as landuse of the Cukai river basin, river mouth improvement, river improvement, etc. All problems are related to the floodway construction, in other words, depending on whether it is possible or not. Further study to decide the flood control and drainage system shall be carried out.

3.5 Land Classification

In order to minimize the flood problem, suitable landuse is an important factor to be considered in the development plan.

Existing towns in the coastal strip are located in a relatively flood free area. The industrial areas on sand bars are in a similar condition. But, developments are extending to flood prone areas especially in Cukai.

Desirable development will be implemented under situations of reduced flood effects to neighbouring areas, flood free developed areas and low cost countermeasures against flooding. Effect of flooding is small in the coastal development, if there are enough drainage systems established to drain to the sea. Land classification from the viewpoint of drainage in the coastal area is included as a factor in the landuse plan.

3.6 Methods of Solution

(1) Road

Flooded portion of the road shall be raised by embankment or by continuous bridging in most cases. In the case of embankment, enough openings based on the future drainage plan at reasonable locations shall be provided. It is necessary to provide some drainage on both sides of the openings to minimize head loss due to the embankment. Enough openings means enough to pass flotsam and the future design flood discharge.

This method shall be started with the most important road.

(2) Town and Industrial Area along the Coast

In order to minimize flood damage in the coastal area, the following methods are considered to be effective:

- River mouth improvement, though it is necessary to check the actual phenomena.
- Gravity flow drainage for the sand bar or relatively high area.
- Raising the ground of the low area.

Raising will be carried out block by block using pump dredgers. But this is difficult to perform in a densely populated area.

(3) KETENGAH Area

In the KETENGAH development area, flood prone areas are relatively wide. These areas are considered under unfavourable condition for plantation development.

(4) Traditional Kampungs along the Rivers

Flood problems of these areas will not be solved by providing ring levees, unless drainage pumps are provided because of heavy rainfall and the gentle flood water surface slope of the rivers. Raising of the residential area will be practical because it has less effect on floods downstream.

(5) Sedimentation in the River

Storage of sediments at the ends of the developed areas together with associated flood water will be a moderate solution. Localized solutions such as silt traps, log traps, etc. are recommendable. Other "in-situ" solutions such as the use of cover vegitation for cleared land, clearing of trees felled, slope protection works, etc. should be implemented.

History of change in river cross-sections and the difference in sediment run-offs shall be checked.

(5) River Mouth Sedimentation and Beach Erosion

1) General

Movement of sand in the estuary and beach is a complicated phenomenon affected by wave, swell, coastal current, river flow, bed material, topography and civil works. Sand bars or sand spit formations appear in the estuary of the rivers in the study area. In these places the most influencial factor among the above ones for the movement of sand bars is the waves caused by wind. River mouth sedimentation affects not only navigation but also flooding.

Of these river mouths, the existing status and the associated problems were discussed in the previous studies such as TMPS and TCRS. The rivers of Dungun, Paka and Kerteh have a similar phenomenon at the river mouth which becomes shallow and is navigable at high tide for small fishing boats. Bar formation is also observed.

The Kemaman River mouth was dredged in 1979 for the navigation of palm oil boats and log lighters. The status seems less severe than the above three rivers, although it is said to have occasional draft restrictions.

Beach Erosion at Dungun

The beach from the Dungun River mouth toward the south (about 1.5 km) has been eroded. The eroded beach is protected by rubble mound and the rubbles are partially removed by wave action. According to TCRS, the erosion began in 1950s and occurs in the monsoon seasons.

In relation to the flood problems, sedimentations in the river mouths shall be taken into consideration. Sedimentation in the river channel decreases its capacity to flow the flood discharge and raises the flood level. Sedimentation at the river mouth causes head loss during the floods.

Sediment run-off in the study area is considered to be large in specific volumes because of its geology. In addition, the vast development in the mountainous areas will increase sediment run-off during rainfall. The sediments produced in the upstream area flow into the river and are partially deposited in the channel especially the downstream portion where velocity of flood flow decreases. Most of the sediments will be transported to the South China Sea and transported away by ocean currents.

River mouth topography in the study area are characterised mainly by monsoon waves and hard portions (rocks) at the tanjung. Movement of sand in the estuary is considered to be affected by the following factors:

a) NE monsoon wind waves and swells (strong and high frequency): sand bars, and southward direction of sand spits formation, beach erosion in the south of tanjung.

b) SE wind waves and swells: northward direction of sand spits formation by littoral current

c) River flow especially flood flows: flushing force of sediments

d) River flow due to tidal range: flushing force of sediments

e) Ocean current: unknown forces

f) Other coastal currents

g) Deposition in the river mouths by density currents or combination of silty soils

h) Topography

i) Physical characteristics of sediments

j) Civil works, etc.

k) Other factors.

2) Necessity of River Mouth Improvement

a) Dungun River

There is a large sand bar at the river mouth which seems to affect flood levels greatly. According to the flood profile of 1983 flood, flood level of the river near the mouth is about 4 metres above M.S.L. Sea level during peak of the flood was not observed, but may be on the order of 1 or 1.5 metres above M.S.L. The difference of 2.5 or 3 metres are regarded almost same as head loss due to sedimentation.

But, hydraulic characteristics are not obvious because of bottlenecks around the Dungun Bridge. From the viewpoint of flood control, it is necessary to know the effects of sand bar on flood level.

This study just points out that there is a possibility of effects of the sedimentation on flooding. Effeciency of the river mouth improvement is considered to be large at this stage both for flooding and navigation.

b) Paka River

The road along the Paka River is easily suspended by flood. In order to solve this traffic problem, river improvement including the mouth and moderate raising of the road are considered to be effective together with mitigation of flood damage in the low area along the river.

c) Kerteh River

River mouth improvement will become necessary in the future if the low area is developed. For the time being, efficiency of the river mouth improvement is small while the cost is high.

d) Kemaman River

The floodway will be effective for the development. If the floodway is constructed, the river mouth improvement is not important for flood control purpose. As to navigation, the situation is better than that of Dungun River.

e) Summary

The necessity of river mouth improvement is high in Paka River followed by Dungun River. Dungun and Kemaman shall be studied more, together with drainage and navigation problems.

3) Countermeasures

a) River Mouth Improvement

Though the phenomena of river mouth sedimentation and beach erosion are complicated, countermeasures are small in number. Practical solutions for river mouth sedimentation is to provide training dykes on both sides of the river mouth.

According to the empirical study on river mouth improvement for the 160 rivers of Japan, by the Ministry of Construction of Japan, the following conclusions were obtained:

- Impermeable training dykes which do not allow overtopping wave are successful in the case where the river mouth width is smaller than the distance between shore line and wave breaking point.

- Short training dykes provided around shore line are not successful.

- River dredging was quickly filled back by sediments transported from upstream areas in some cases.

- Interval of dykes (river width) shall be wide and dykes shall be straight for future improvement possibility. But, it is effective to bend slightly at the tip of the dyke to prevent wave intrusion.

- Countermeasures against wave and scouring action for necessary portion of a dyke are required.

- In order to maintain water depths in the river, it seems necessary to extend the dykes until water depth at tips become 3 - 4 metres.

- One side training dyke cannot prevent sand bar formation from the opposite side.

- In case of both sides dykes, a dyke facing predominant waves shall be longer than the other side.

- Training dykes shall have smooth alignment.

- Too much wide river mouths cause sedimentation in the river mouth. Saline wedge formation during flood which is caused by wide river mouth shall be avoided, etc.

Though these general notes are not based on adequate study and phenomena of the river mouths of the study area are a little different from that of Japan, it is helpful to decide the outline of river mouth improvement.

Major differences of natural features between the east coast and coasts in Japan are as follows:

	East Coast	Japanese Coast
Tidal Range	About 2 metres	0.3 - 1.0 metres
Wind	Frequent and long term in NE monsoon	Large in velocity and not long term
River Discharge	Long term flood	Short term flood

There is no definite solution for river mouth sedimentation because of its complicated phenomenon. But the above mentioned general notes and the differences give the outline of countermeasures and points of further study to be carried out.

b) Beach Erosion

In the case of erosion at Dungun beach, rubble mound protection or off-shore dykes are considered as suitable methods to solve the problem.

Rubble mound protection has a tendency to be scoured at their bottom. Therefore, it is necessary to add some rocks or concrete blocks to prevent scouring action. Off-shore dyke type is considered to be successful in the case of sandy beach like Dungun, according to empirical study by the Ministry of Construction of Japan. Importance of the natural beauty and aesthetic value of the beach should be duly considered. Figs. 11.17 and 11.18 present the concept of improvement.

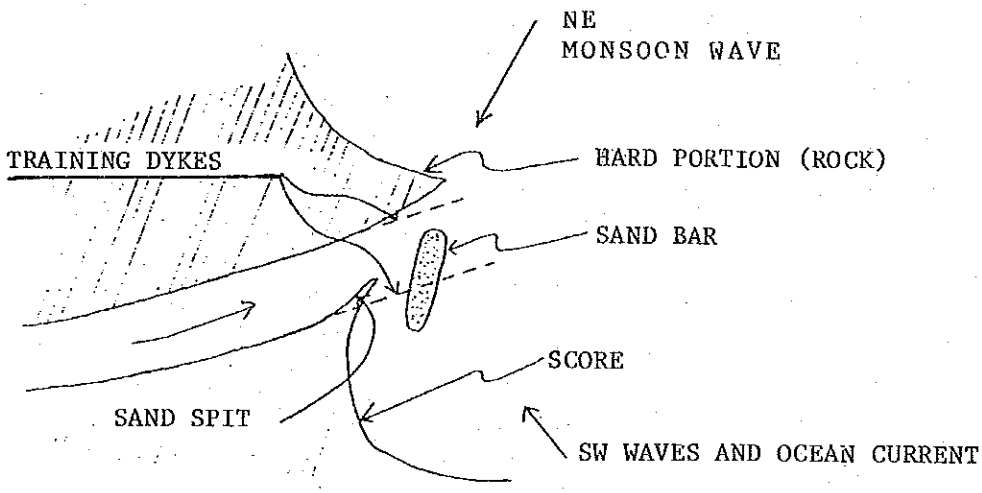


FIG. 11.16 TYPICAL PHENOMENON AT RIVER MOUTH

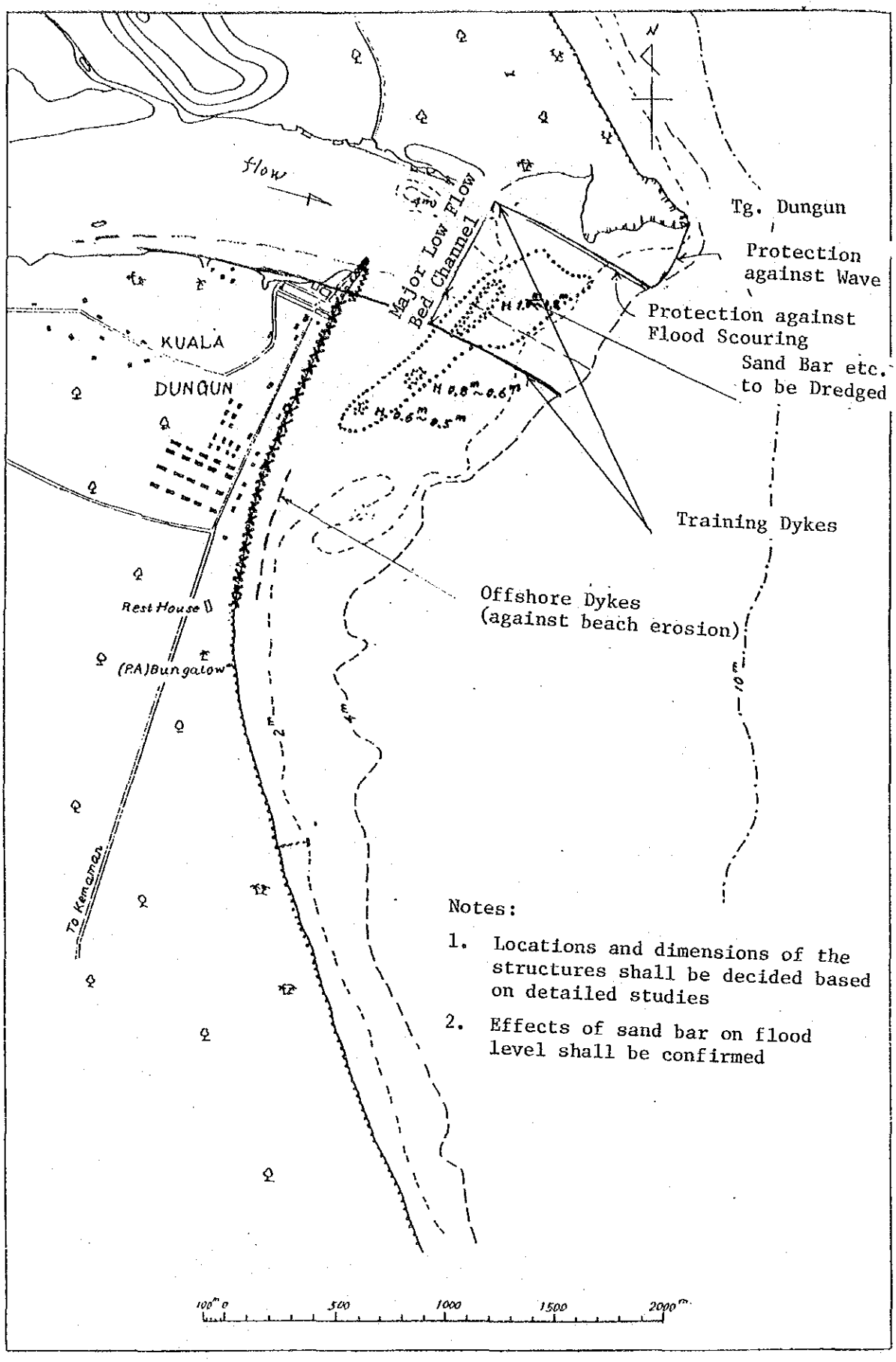
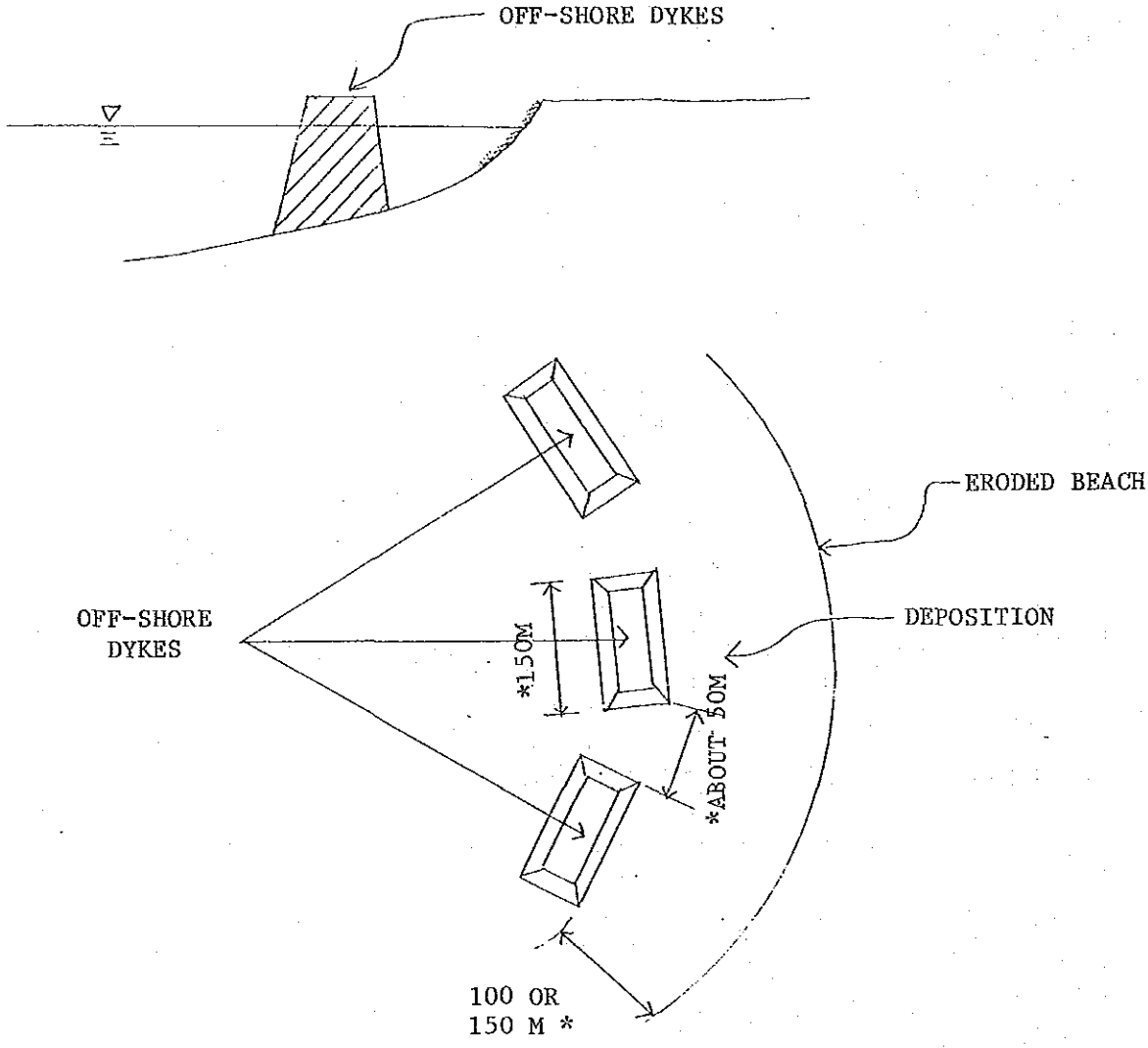


FIG. 11.17 CONCEPTUAL PLAN, DUNGUN RIVER



* FIGURES SHOW HIGH PROBABILITY IN SUCCEEDING CASES

FIG. 11.18 OFF-SHORE DYKES

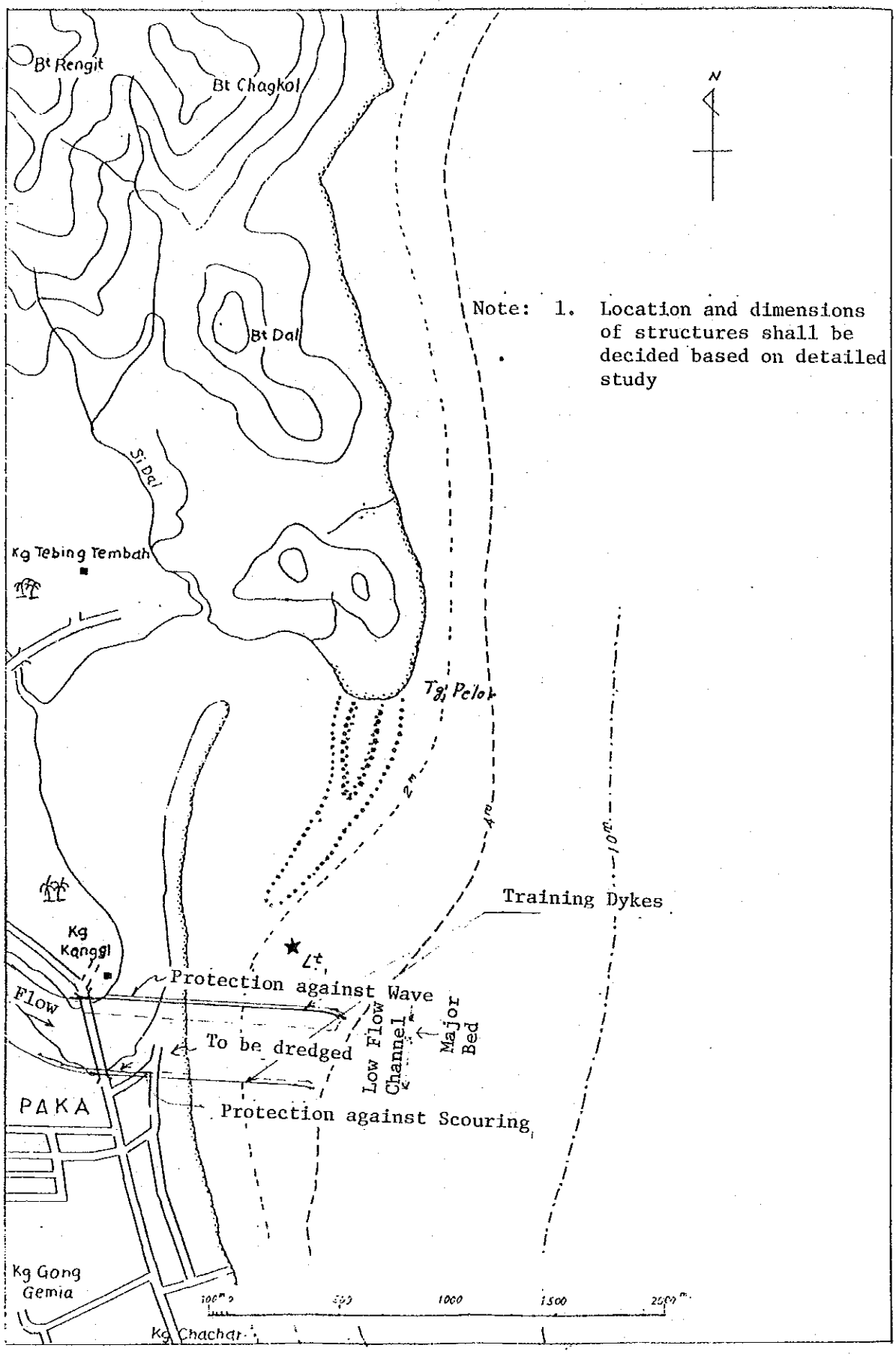


FIG. 11.19 CONCEPTUAL PLAN, PAKA RIVER

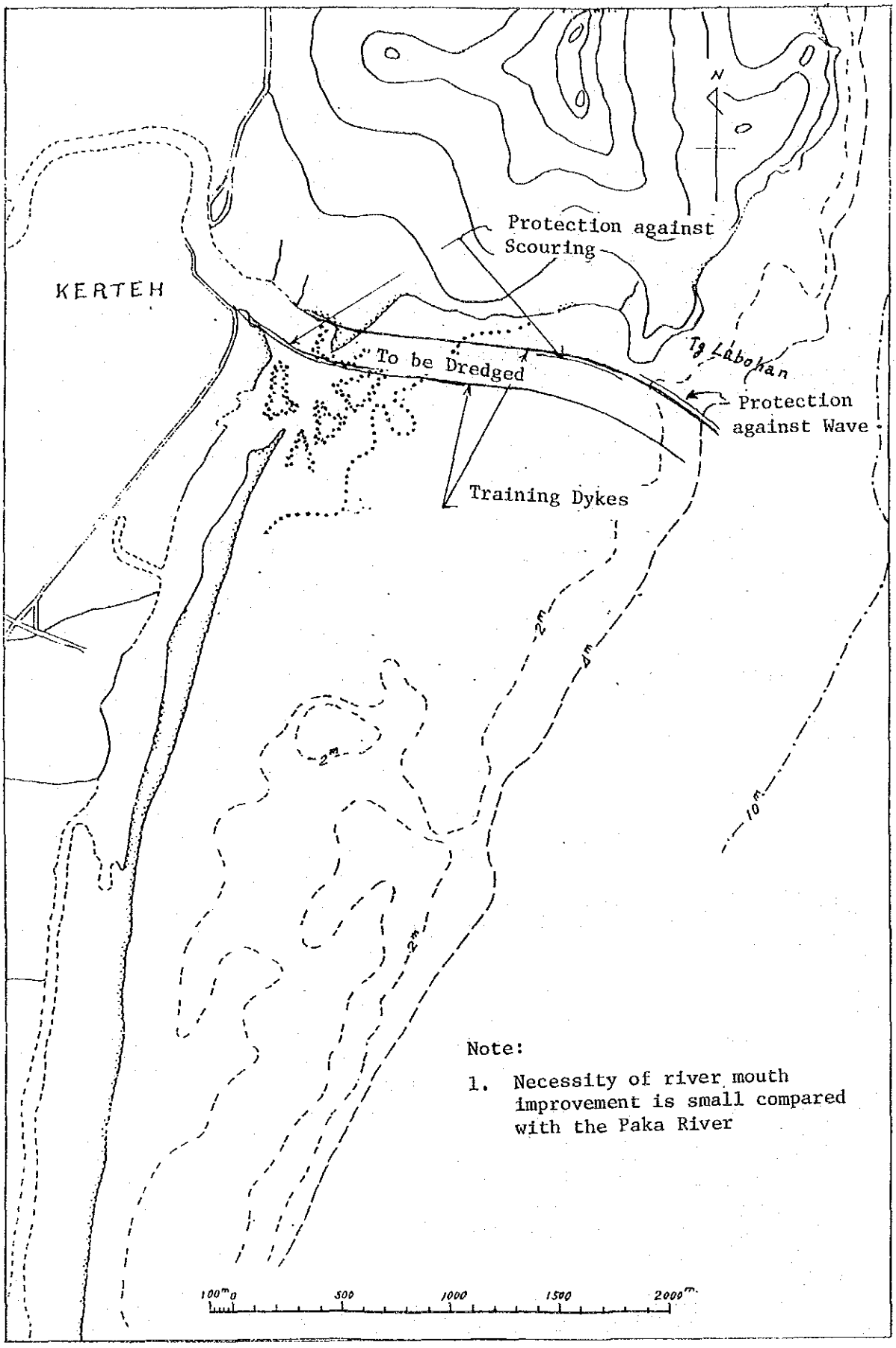


FIG. 11.20 CONCEPTUAL PLAN, KERTEH RIVER

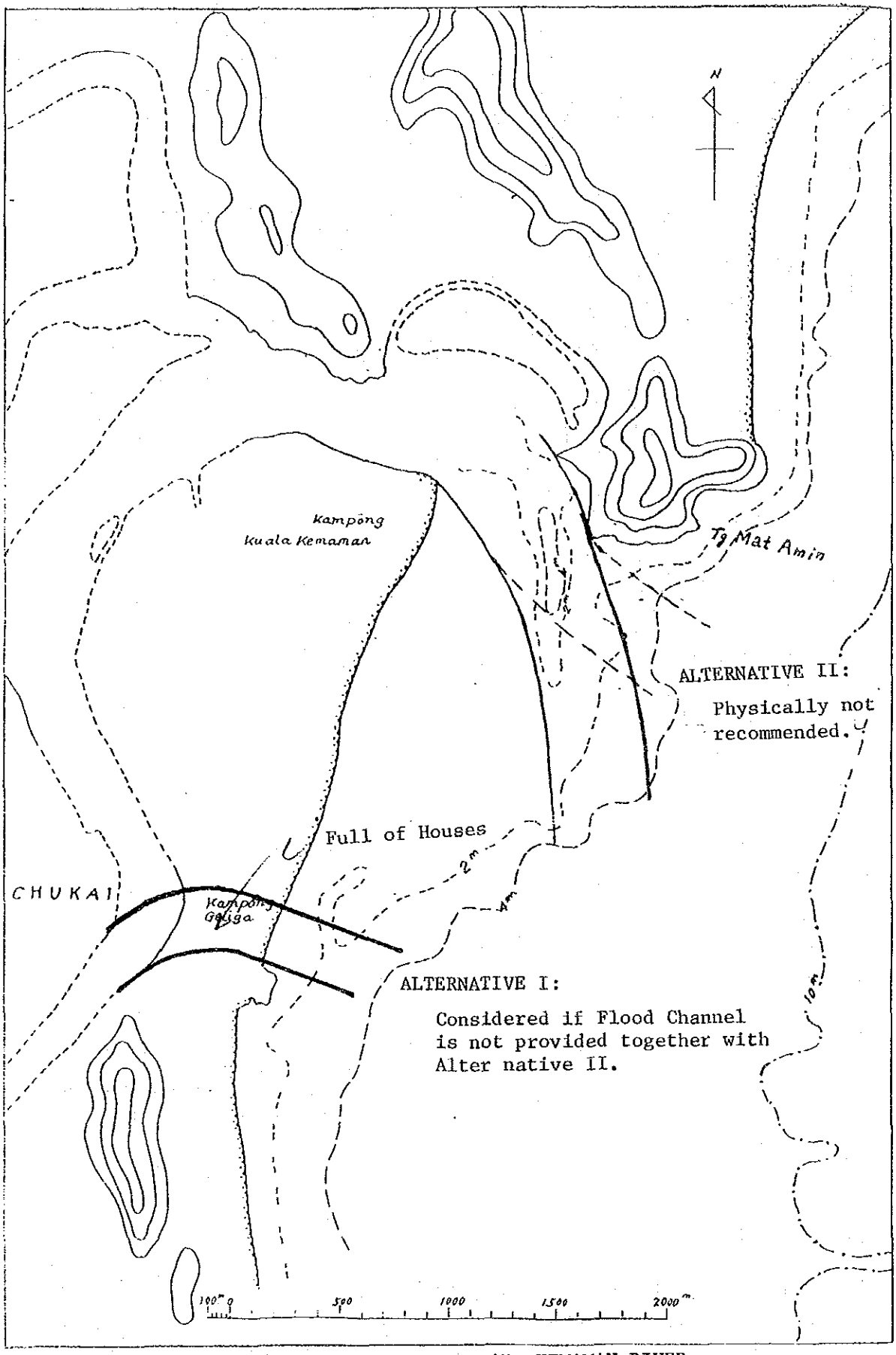


FIG. 11.21 CONCEPTUAL PLAN, KEMAMAN RIVER

4. Water Use

4.1 Water Supply

Low flow discharge of the rivers in the study area is abundant because of the following reasons:

- Storage of water in the forest
- Moderate distribution of rainfall in non-monsoon season

The study on water uses was conducted in SCTWR and TMPS. According to the studies, requirements of the domestic and industrial water use are forecasted at 7.03 mgd (0.370 m^3/s) for Dungun River and 43.67 mgd (2.30 m^3/s) for Kemaman river in 2000. In addition, irrigation water demand in 2000 is estimated 67.45 mgd (3.55 m^3/s) for the Dungun, Paka and Kemaman River basins.[4)]

The minimum flows of the rivers for 1/50 year frequency are estimated at 110 mgd (5.79 m^3/s) at Jerangau of Dungun River and 131 mgd (6.90 m^3/s) for the total of the Sungai Pinang intake of Kemaman River and the Kampung Kertapi intake of Paka River.[5)]

These figures indicate that in the year 2000 there would be sufficient water flows with which the water use requirement can be met. Ground water use is seen in less populated kampungs. The government is implementing the programmes to install piped water distribution system into these areas. Dependency on ground water use would be negligibly small in 10 to 15 years from now.

Increase in water demand will be due to population increase and modernization such as increased use of air conditioners, flush toilets, car washing, etc.

Balance of supply and demand of water shall be checked stage by stage as recommended in the Master Plan. A programme for the implementation of water supply for domestic and industrial uses has been studied in detail.

4.2 Study on Salinity Problem

Salinity intrusion at the intakes of Dungun, Paka, Kerteh and Kemaman Rivers is a major problem for water supply. (SCTWR)

The deepest riverbed of these rivers in the downstream reaches are lower than sea level. Tide propagates quickly toward the upstream. Therefore, saline wedge goes up very far from the river mouth in the case of a gentle slope river.

This density current phenomenon is delicate affected by river flow, profile of the river and tide.

Source: 4) State Report Vol. 7, NWRSM
5) Vol. 1, SCTWR

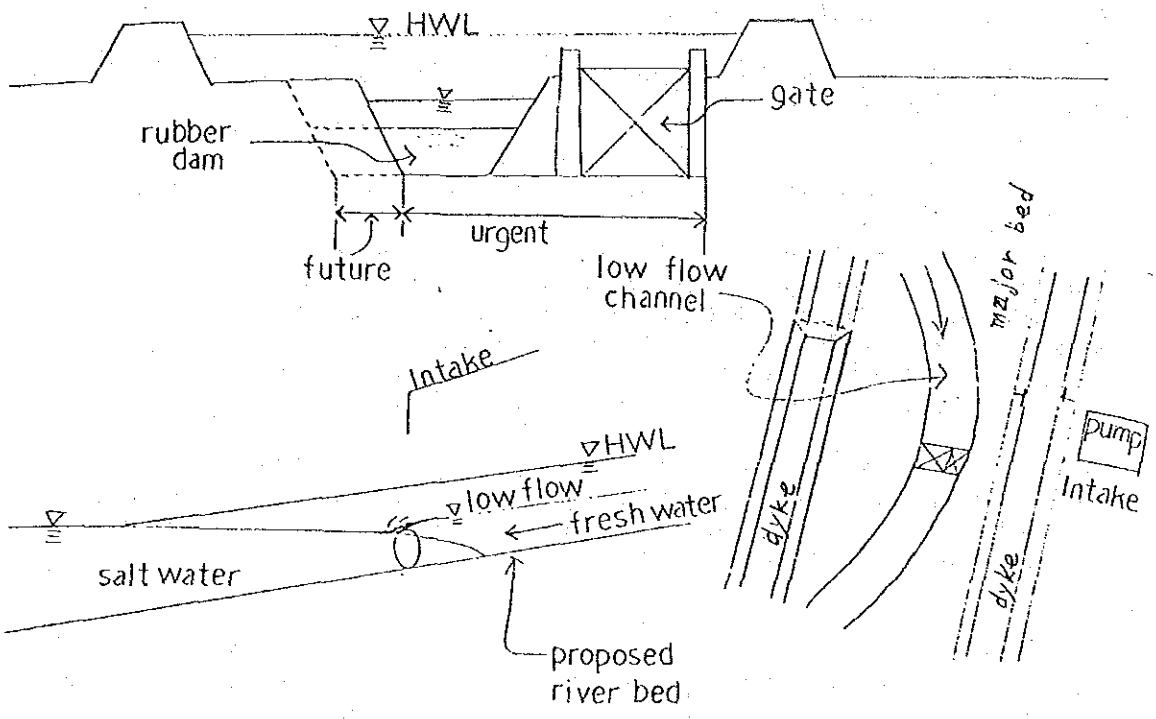


FIG. 11.22 STUDY ON SALINITY PROBLEM

If the river is improved, saline wedge will go upstream more. Possibility of improvement in lower reaches of these rivers is high for flood control purpose.

In order to solve the problem of salinity intrusion at the intakes, there are two major methods of solution as follows:

- To change the location of the intake
- To provide a barrage

In the upstream of the rivers, high concentration of suspended solids during and after rainfall is a problem. Storage of water is considered as a temporary method to solve the problem.

In the case of barrage (weir), steel gate type is expensive and troublesome to operate, while rubber dam type in low flow channel is economical and easy to maintain. Heights of rubber dams are less than 3 metres in most cases of the past example.

Top elevation of the dam shall be higher than saline wedge at the intake under high tide and small river discharge conditions. Detailed study to decide structural plan of the barrages together with the location of intakes shall be made before river improvement schemes are commenced.

5. Recommendations

5.1 Flood Control

(1) Priority and Programme

1st Stage (urgent)

- Cukai Town Drainage : Because of rapid development in the flood prone area, it is necessary to determine a trunk surface drainage network in the urban area coordinated with plans of river improvement, landuse, roads and others.

- Dungun Town Drainage : Determine an overall main drainage network and coordinate it with the ongoing drainage project in the central area.

- Main Road along the Coast

  . Dungun : local drainage, road raising and river improvement of the bottlenecks.

  . Paka : road raising together with river improvements.

  . Kerteh : local drainage and road raising

  . Cukai : local drainage and road raising

2nd Stage

- Main Feeder Roads

- An overall river plan for main rivers in the study area and implementation programme.

3rd Stage

- Detailed design according to the programme, and construction.

(2) Further Study

1) River Plan of Kemaman River System

- Floodway (alternative study)
- Drainage of the downstream area
- Method of flood free roads from Cukai to the Highway
- Plan for barrages at the intakes
- Overall flood control plan
- Implementation programme

2) River Plan of Dungun River System

- River improvement and study of barrage
- Diversion channel with retarding basin
- Overall flood control plan
- Implementation programme
- Drainage of Dungun town area

3) Paka River System

- River improvement and study of barrage
- Flood free roads
- Drainage of downstream low area
- Retarding basin in upstream areas
- Overall flood control plan
- Implementation programme

4) Kerteh River System

- Drainage of downstream areas
- Method of flood free roads
- River improvement
- Implementation programme

5) River Mouth and Beach

- Paka River:

Observation of monsoon waves, sounding, study of river improvement and sand movement, etc.

- Dungun River:

Study of flood profile, observation of monsoon waves, sounding, study of offshore dykes, study of training dykes if necessary.

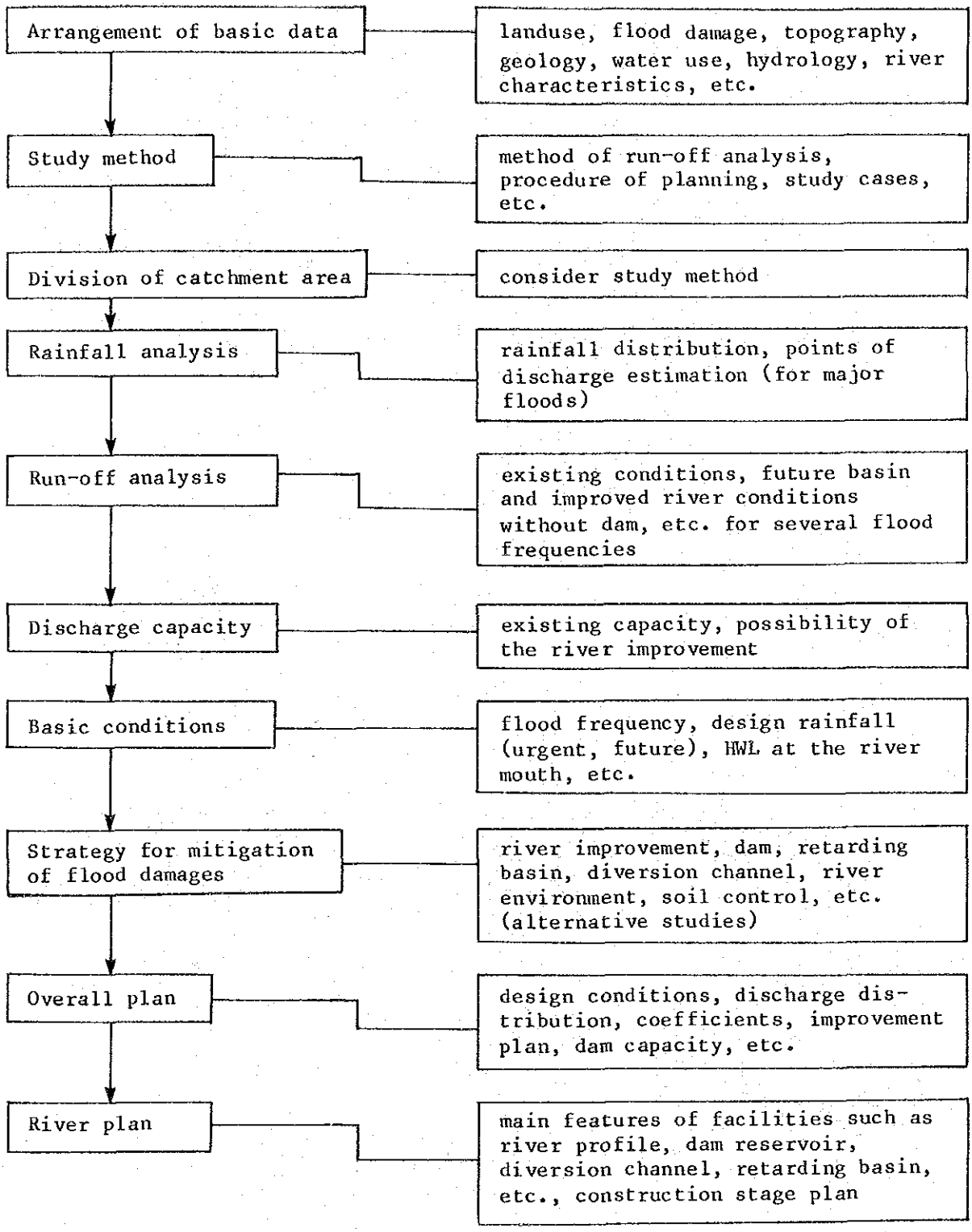


FIG. 11.23 FLOW CHART OF RIVER PLANNING (FLOOD CONTROL)

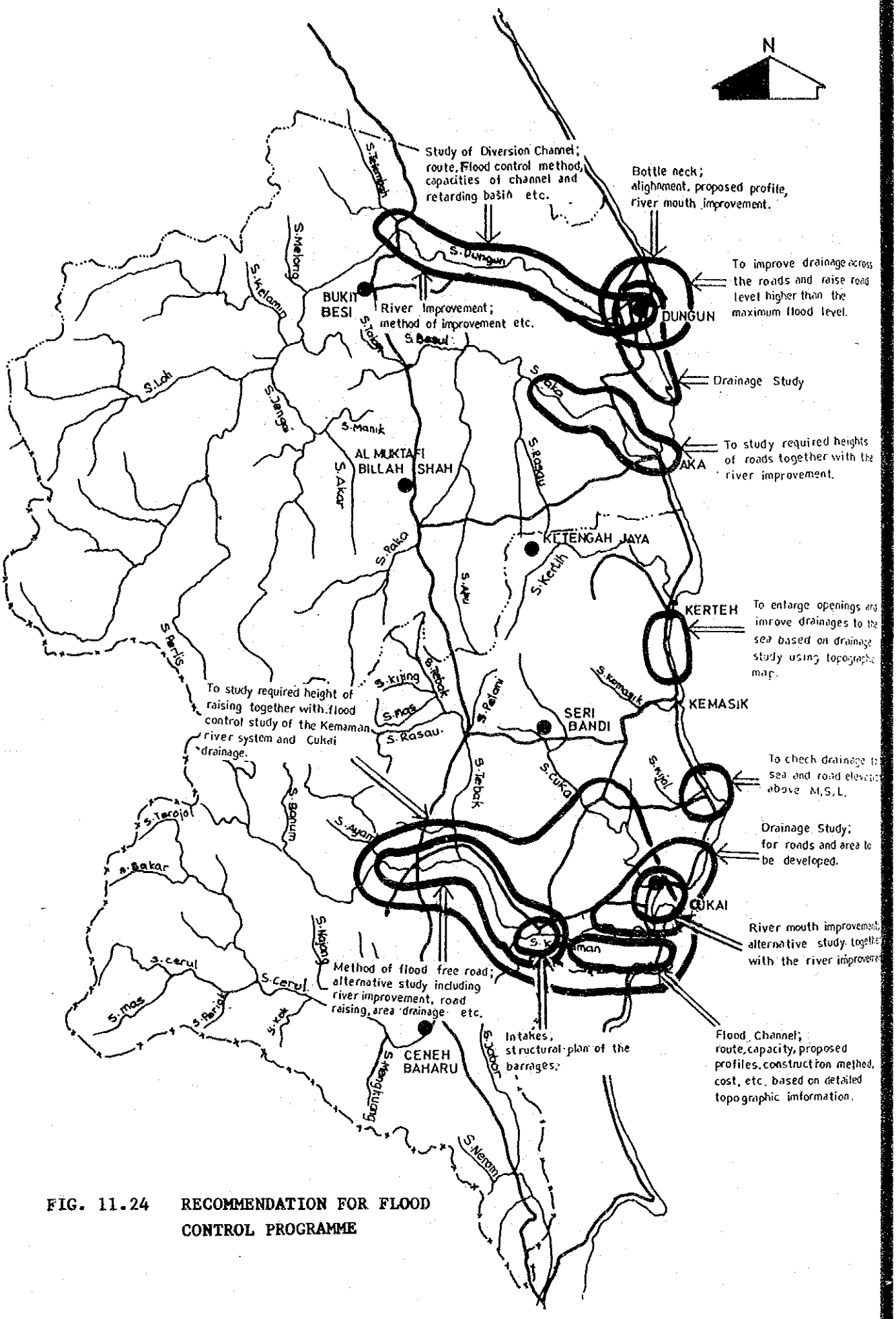


FIG. 11.24 RECOMMENDATION FOR FLOOD CONTROL PROGRAMME

(3) Necessary Information

1) A topographic map prepared to a scale of about 1/10,000 or photo mosaic with contour lines every 2 metres or less, for the coastal area and low area along main rivers.

   - for estimation of flood water volume and river improvement plan, etc.

2) Cross-sectional profile along the Dungun, Paka and Kemaman Rivers at about one kilometre interval for one kilometre width.

3) Longitudinal profile along the river to be improved indicating heights of ground, riverbed, flood water and bridge girder, etc.

4) To arrange the following data of the flooded main roads.

   - longitudinal profile showing heights of road surface, ground elevation

   - general drawings of main structures across the rivers with elevations

   - topographic map showing drainage system. All elevations shall be based on the mean sea level datum.

5) To observe or survey flood profile along the Dungun River from the sea to Keliyu.

   - to know hydraulic characteristics of the river mouth and bottlenecks around the Dungun Bridge

6) Other general information for river planning:

   a) Hydrological Data

      - flood characteristics (relation between rainfall and discharge in hourly basis at standard points)

      - flood levels at river mouths, flood area, etc.

      - sediment data such as physical characteristics of riverbed materials, development areas and the desolated areas.

   b) Landuse Information

      - history, existing and future conditions of landuse in the basin area.

   c) Water Use

- facilities for water use in the river (existing and future plan)

d) River Use and Environment

- navigation, recreation, natural features, etc.

5.2 Water Use

(1) Water Supply

To continue the programme shown in SCTWR, and assess and evaluate supply and demand situation.

(2) Salinity Intrusion

To continue storage of water as planned by JKR.

To study location and determine structural plan for barrage in low-flow channel.

APPENDICES

Appendix 1. Rough Estimation of Design Flood Discharge (under the existing river conditions)

(1) Method of Estimation

Design flood shall be decided based on the detailed river plan including hydrological analysis both of future and existing river conditions as a flood control project.

In this study, rough estimation under existing river conditions is tried to obtain information of drainage study for the coastal area. Results of hydrological study by SCTWR and NWRSM are used for the estimation.

Appendix Table 11.1 RESULT OF THE STUDY BY SCTWR

Recurrence Interval	Peak Discharge (m^3/s)			
	A = 1,515 km^2 Sg. Dungun at Jerangau		A = 622 km^2 Sg. Kemaman Sg. Rantan Panjang	
	m^3/s	$m^3/s/km$	m^3/s	$m^3/s/km^2$
2	1,699	1.122	538	0.866
5	2,690	1.777	793	1.277
10	3,256	2.151	991	1.596
20	3,964	2.618	1,189	1.915
50	4,389	2.899	1,444	2.325
100	4,814	3.180	1,699	2.736

Source: SCTWR, P10.9

(2) Estimated Flood Discharge

a) Dungun River

At the river mouth, A = 1,812 km^2

Frequency (Year)	Discharge for A = 1,515 km^2 Q_o (m^3/s)	Discharge for A = 1,812 km^2 Q (m^3/s)
2	1,699	2,040
5	2,690	3,220
10	3,256	3,900
20	3,964	4,750
50	4,389	5,250
100	4,814	5,760

$$Q = Q_o \times \frac{1,812}{1,515}$$

b) Paka River (A = 830 km^2)

Frequency (Year)	Discharge for A = 622 km^2 Q_o (m^3/s)	Discharge for A = 830 km^2 Q (m^3/s)
2	538	690
5	793	1,020
10	991	1,270
20	1,189	1,530
50	1,444	1,850
100	1,699	2,180

$$Q = Q_o \times \frac{Q830}{Q622} = Q_o \times \frac{2,050}{1,600}$$

c) Kemaman River

At the junction of Cukai river, A = 1,780 km^2

Frequency (Year)	Discharge for A = 622 km^2 Q_o (m^3/s)	Discharge for A = 1,780 km^2 Q (m^3/s)
2	538	1,180
5	793	1,740
10	991	2,170
20	1,189	2,600
50	1,444	3,160
100	1,699	3,720

$$Q = Q_o \times \frac{Q1,780}{Q622} \; Q_o \times \frac{3,500}{1,600}$$

Appendix 2. Drainage of Cukai Town Area

The western area of the existing Cukai town is under development. Ground elevation of this area is about 3 metres lower than maximum flood level. In order to develop the low areas along the Kemaman River, the following flood control methods are considered:

(1) To improve the existing Kemaman River and provide pumping stations for inland storm water drainage.

(2) To provide pumping station in the development area surrounded by a ring levee as studied by DID.

(3) To provide a floodway

It is not practical to raise the ground elevation because of the large depth of raising.

Method 1) Existing River Improvement with Pumping Station

This is the ordinary method of flood control. But, in this case, it is obviously of higher cost than methods 2) or 3) because of the length of river improvement required and the large pumping capacity required. Method 2) and 3) are practical.

Comparison of methods 2) and 3) is made as follows:

Method 2) Pumping Station with Ring Levee

Daily rainfall	50 year	576 mm/day
	20 year	504 mm/day
	10 year	420 mm/day
	5 year	348 mm/day

Area drained by pumps = 10.5 km^2

Pump capacity	Storage capacity of pond
50 year = 49 m^3/s	1.06 x $10^6 m^3$
20 year = 43 m^3/s	0.93 x $10^6 m^3$
10 year = 36 m^3/s	0.78 x $10^6 m^3$
5 year = 30 m^3/s	0.64 x $10^6 m^3$

(run-off coefficient = 0.7)

Construction cost

	Pumping Station	Pond dredging	Dyke	Total (MS Mil.)
50 year	$1x10^6\$/m^3/s$ x 49	$5\$/m^3 x 1.06x10^6 m^3$	1000$/mx10,000m	64
20 year	$1x10^6\$/m^3/s$ x 43	$5\$/m^3 x 0.93x10^6 m^3$	1000$/mx10,000m	58
10 year	$1x10^6\$/m^3/s$ x 36	$5\$/m^3 x 0.78x10^6 m^3$	1000$/mx10,000m	50
5 year	$1x10^6\$/m^3/s$ x 30	$5\$/m^3 x 0.64x10^6 m^3$	1000$/mx10,000m	43

Method 3) Floodway

Floodway shall be designed for adequate capacity to carry away large flood discharge, otherwise flood damage will be large when flood water overtops the dyke. Design flood shall be performed for a 50-year frequency or more for the future stage.

Length = 10 km, Width = 500 m

Flood discharge	50 year	3200 m^3/s
20 year	2600 m^3/s	
10 year	2200 m^3/s	

Construction cost

50 year $10{,}000m \times 1000m^3/m \times 5\$/m^3 = 50 \times 10^6\$$ $(60 \times 10^6\$)$

20 year $50 \times 10^6 \times \frac{2600}{3200} = 41 \times 10^6\$$ $(51 \times 10^6\$)$

10 year $50 \times 10^6 \times \frac{2200}{3200} = 35 \times 10^6\$$ $(45 \times 10^6\$)$

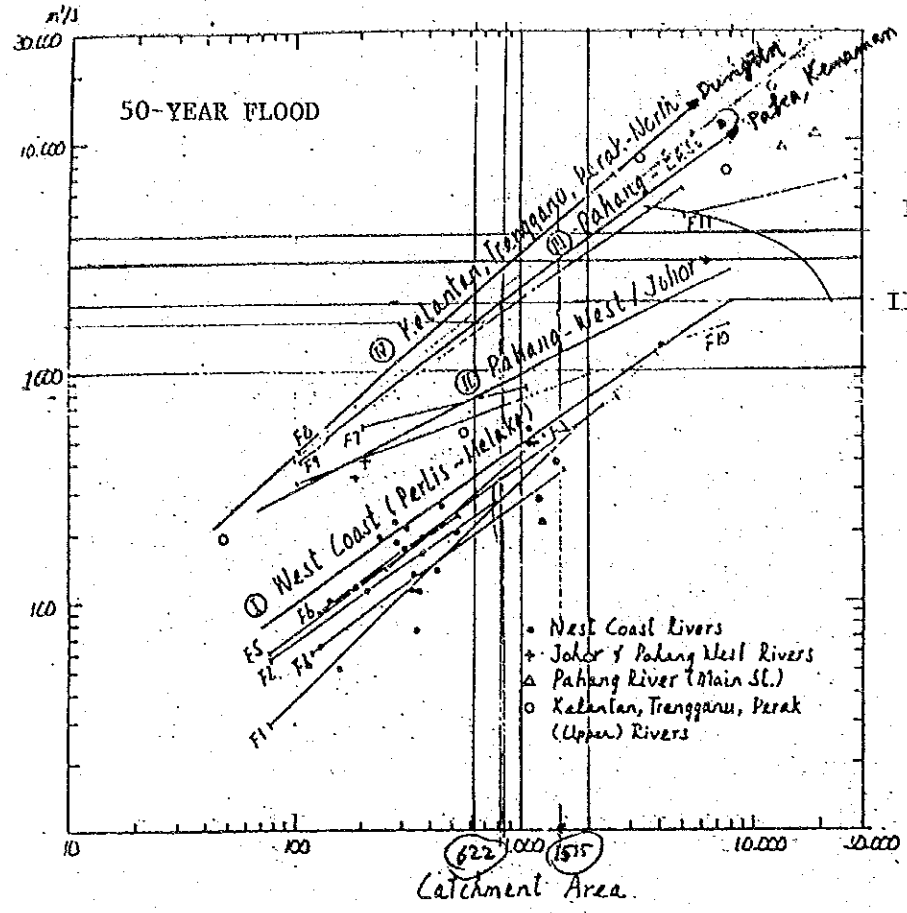
Land acquisition $10{,}000m \times 500m \times \frac{1}{10{,}000} = 500$ ha

$20{,}000\$/ha \times 500$ ha $= 10 \times 10^6\$$

Construction costs of methods 2) and 3) do not differ so much. But, in the case of Method 2), the following demerit must be taken into account.

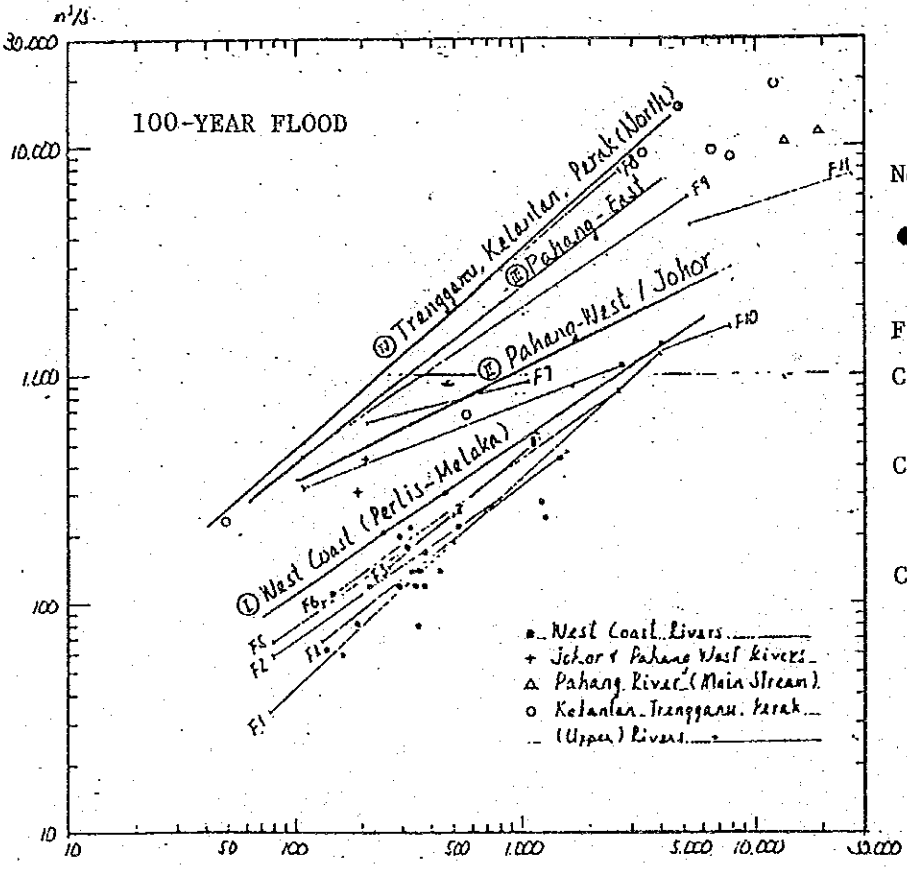
- Area drained by the pumps is small compared with the area protected by floodway.
- The pumps have to be replaced every 20 years.
- Troubles in maintenance and operation and its cost. (about 0.5% of the construction cost a year)
- Pump capacity is usually decided by 5 or 10 year frequency flood. Therefore, towns will be flooded once every 5 or 10 years.

Therefore, Method 3) is recommended both for future and urgent requirements. The costs estimated above are very rough, because of the lack of topographic and, geological information and not being based on detailed study.



IV Dungun (Bridge) 1515 km²

III Kemaman (Rantau) 622 km²



Note:

●+△○ Probable discharge at selected gauges

F1-F9 Ref.PN 11

Curve I drawn by enveloping ● of F1-F6

Curves II & III are as analysed in Ref.PN 8

Curve IV drawn by enveloping ○ of F8

APPENDIX FIG. 11.1 ENVELOPE CURVES FOR REGIONAL FLOOD

Source: Sectoral Report PN, NWRSM

Appendix 3. Drainage of Paka

The road along the Paka River is easily flooded and is affected by the flooding of the main stream. Flood level will be lowered by the river improvement which includes training dykes, dredging, short-cut and low river dykes.

A plan of raising the road more than 2 metres will result in better conditions for traffic. But it will not improve drainage conditions of the downstream area. A combined plan of river improvements and slight raising of the road surface is better for the future drainage of the area.

Rough cost estimate for river improvement is shown below:

Length = 10 km, Width = 300 m

$$I = \frac{1}{6,000}$$

Design flood discharge = 1,530 m^3/s
(20-year frequency)

Dredging = 6×10^6 m^3

Cost for dredging and dykes will be
6×10^6 m^3 x 5\$/m^3 = M\$30 million.

CHAPTER 12

E N V I R O N M E N T

CHAPTER 12 ENVIRONMENT

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CHAPTER 12 ENVIRONMENT

1. Basic Concept of Environment Control

1.1 Environment Control in Advance

As the economy and society develops, the environment changes through industrialization and urbanization. Development imposes a load on the environment by emitting surplus substances and energy into the common property of the people. When the load exceeds the limit of purificative and restorative capacity, co-existence of the people and the environment would be seriously damaged. Once it has occurred, in general, the cost of remedy is so large that it surpasses the cost of countermeasures to be provided before hand. Prevention of environmental deterioration in advance is an effective way of avoiding the extra cost.

1.2 Enhancement of Living Environment in Towns

The living environment of a town changes as the population increases as a result of urbanization and accumulation of individual discharging sources.

In the case of garbage, human wastes, household effluent and other efluent produced in the course of daily life, local government manages to dispose these, since it is difficult for individual household to treat them properly. As the production and consumptin are activated in towns, the volume or surplus discharge increases. A major direction of measures to deal with these urban/living type pollution is to strengthen management of the treatment process by public services with a collective intensive method.

Moreover, in order to achieve the overall enhancement of living environment, comprehensive town planning regarding the land use, transport and infrastructure system should be carried out. Well planned and controlled development of a town is a prerequisite to achieve a higher amenity, which is a fundamental function for the productive future.

1.3 Industrialization and Environment

Industrialization is, in a way, a tool of proverty eradication by means of restructuring the economic framework and generating more employment opportunities.

The increase of income raises the living standard of people, because they generally seek higher amenity as they have more spare time and extra income. Consequently they ask for better living environment. Thus, industralization is indirectly related to demand for a better quality of life.

On the other hand, however, the industrial activities cause increase of effluent and emission through the production process. Pollutants are produced in the process of burning oil and gas, when the emission gas is exhausted into the atmosphere without proper treatment. The effluent from the production process are not favourable for human health unless it is treated properly.

The toxic substances dissolved in the effluent would pollute the water resources on the surface and under the ground, and also the ground itself. The industrial waste is a subject for environmental management whether it is burned or discharged into dumps.

The effluent, emission and waste should be managed properly so that they do not damaged the environment seriously. Appropriate measures prior to the environmental deterioration should be introduced to safeguard human health from any harm due to the industrial activities. The cost for these measures should be basically born by the polluters.

1.4 Environmental Impact Assessment

The procedure and guidelines for environmental impact assessment in Malaysia have been developed in line with the Government policy statements contained in XI of the Third Malaysia Plan 1976 - 1980 (TMP). It was recognized that development and environmental conservation should be kept in balance so that the benefits of development are not negated by environmental damage and disruption.

The Government stated that in the evaluation of all relevant projects, an assessment of the overall impact of these projects on the environment would be undertaken before embarking on the implementation of such projects, to identify all likely environmental effects as well as the means to overcome them.

The Environmental Impact Assessment Handbook (Procedures and Guidelines) was prepared in 1979, and received the endorsement in principle of the Environment Quality Council. This procedure applies to all development works and projects initiated within the public and private sectors that fall into the following categories:

1) All development works and projects initiated by Ministries/ Departments/Statutory Authorities or State Governments.

2) All development works and projects inititated by the private sector which are wholly or in part financed by Federal or State Government loan or grant or by a loan guaranteed by the Federal or State Government.

3) All development works and projects initiated by the private sector which require a licence, permit or approval from any Federal or State Government Ministry, Department or Statutory Authority.

It provides for the Preliminary Assessment and the Detailed Assessment as follows:

Preliminary Assessment

The objectives of Preliminary Assessment are, for selected projects:

i) to examine and select from the project options available, and

ii) to identify and incorporate into the project plan appropriate abatement and mitigating measures.

Preliminary Assessment is normally initiated at an early stage, or in the prefeasibility study of project planning.

Detailed Assessment

The objectives of Detailed Assessment are, for projects with potentially significant residual environmental impact:

i) to describe the significant residual environmental impacts predicted from the final project plan, and

ii) to specify mitigating and abatement measures in the final project plan.

Detailed Assessment is required to be made in the feasibility study stage.

In this kind of regional study, conceptual assessment is intended before starting the Preliminary Assessment for project indentification in respect of the environmental issues. This process also works to recognize and minimize the anticipated adverse effect of the recommended project at this early stage. In the next process of Prefeasibility Study, the preliminary assessment can be used as a tool for environmental control.

2. Environmental Planning of Towns

2.1 Necessity of Environmental Planning of Towns

The increase of population of a town stimulates more production and consumption. First it requires more living space and generation of more trips follows. The population needs more supply of water, and consequently discharge more effluent, household sewage and waste.

For a good quality of life, the management systems of household discharge cannot be neglected. Here the solid waste management and water quality in Dungun and Chukai are mainly discussed.

2.2 Solid Waste Management

2.2.1 General

The solid waste in Malaysia can be classified into four kinds; household waste, street waste, industrial waste, and night-soil. The household waste consists of many different substances from individual sources, mainly garbage and rubbish. The household waste and street waste (including park and other open spaces) are usually managed by the Local Government.

Industrial waste includes construction waste and factory waste. They are generally managed by the responsible industry at its own cost under the instruction of Local Government.

Night-soil is collected once in a while from the houses which use pitholes or septic tanks.

In Malaysia, about 17% of the local authorities dispose of these wastes by controlled tipping at designated landfill sites. Open burning is practiced by 55% of the local authorities, while incineration is practiced by 2% of them.

The average size of sanitary fills in the country is 100 m^2 per 100 people. Land for waste disposal is running out in the developing regions such as Pahang, Kelantan and Terengganu. An estimate shows that 40% of these disposal sites will be filled up in the next 5 years.

The uncollected or improper disposal of waste can be a source of odour nuisance and health hazard through rodents and pasts. The leachate from the dump site would contaminate the surface and ground water, and soil. Improper disposal is often seen along the river side. People use the river as a dump site or a conveyor of refuse to the sea. This kind of dumping should not be abused because it directly pollutes the water and interrupts the drainage system. Therefore, solid waste disposal should be controlled and managed properly by the local authority with cooperation of people to achieve a better environment and higher quality of life.

2.2.2 Solid Waste Management in Dungun

The houshold waste in Dungun is collected daily except Friday by lorries, and dumped at Bukit Lat landfill site and burned in the open air. The other dump site is along the Santong Road, about 6 km west of Route III. This site receives their waste from Paka area.

The waste is mostly fruit left over and paper. The District Council is planning to build and incineration plant to treat the household waste. The residual incineration waste will be disposed of on farms.

The solid waste management of Dungun should be strengthened by installation of an incineration plant as programmed, and also by careful collection so that the waste will not be left on the street or thrown into the river. Moreover, the monitoring system should be set up in the near future to observe the waste treatment management of the new industries which may discharge different kinds of residue other than the traditional waste.

2.2.3 Solid Waste Management in Cukai

The household waste in Cukai is collected daily except Fridays by lorries, and dumped at Paya Geliga landfill site, and burned in the open air. But as this area is being developed as a residential area, the site will be changed to Bukit Takat. The District Council of Cukai also covers the Kerteh area. The construction waste at Kerteh is, however, managed by the construction companies.

The waste is mostly fruit left over and paper. A new local rule was made last year that for a new residential area, the council sells plastic bags for waste disposal to the residents, and it is not collected unless the bag countaining waste is hung on the fence.

The council has a programme to install an incineration plant in the near future to burn especially the wet waste during rainy season, because burning the waste in open air is difficult during this season.

The solid waste management of Cukai should be strengthened by installation of an incineration plant according to the plan. The collection system should be upgraded so that the waste is not left on the street or thrown into the river.

Discharge from the construction site in Kerteh should be watched carefully so that it is treated properly.

2.3 Water Quality

2.3.1 Present Condition of Water Quality in the Study Area

The Study Area is drained by four major river systems: Sg. Kemaman, Sg. Cukai/Kerteh, Sg. Paka and Sg. Dungun as classified under the Water Quality Control Regions (WQR) of 38, 39, 40 and 41 respectively (Figure 12.1). The monitoring stations were selected based on the following criteria;

i) Intake point of water supply
ii) Near the water pollution source
iii) Representative points of the river section
iv) Accessibility to the point

The parameters used for analysis of all the samples are: temperature, PH, BOD, COD, NH3 and suspended solid (SS). The average results of BOD (the organic pollution indicator) and suspended solid (the turbidity indicator) are displayed on the water quality maps (Figures 12.2 and 12.3).

In terms of BOD, the map shows that most of the rivers in the study area are clean except two tributaries of Sg. Kemaman: Sg. Ransan and Sg. Neram in 1980. These small rivers suffered most severely from the discharge of the palm oil mills. The mean BOD levels recorded at the stations at Sg. Ransan (4332618) and Sg. Nerma (3933616) were 286.5 mg/1 and 311.0 mg/1 respectively.

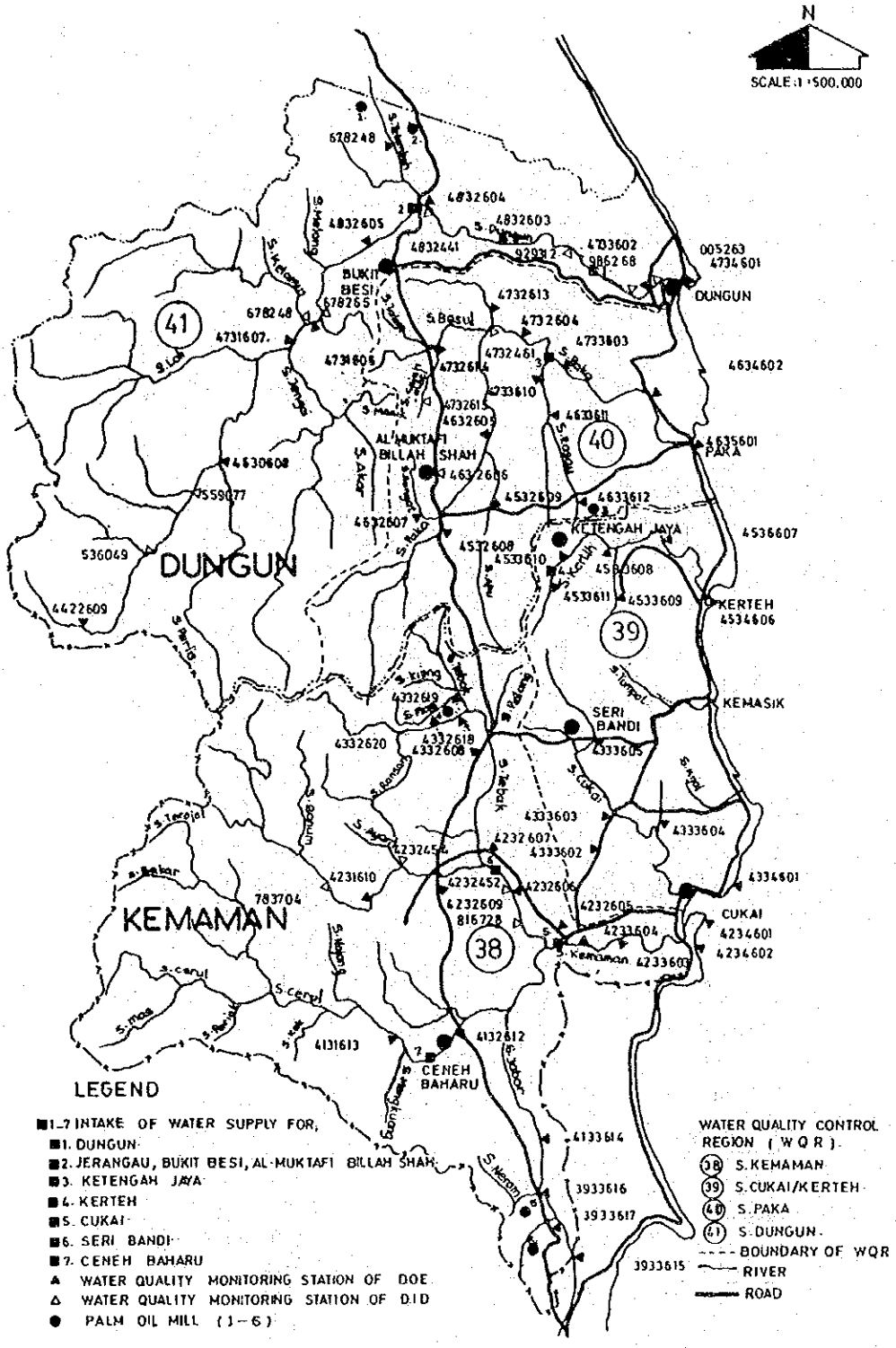
As to SS, a large portion of the rivers were found to exceed 50 mg/1 which is the limit for drinking water indicated in the Environmental Quality (Sewage and Industrial Effluents) regulations 1978 (Table 12.1).

In the study area, standard A in the Table 12.1 is applied for the following four catchment areas.

1. Sg. Dungun
2. Sg. Kemaman
3. Sg. Kerteh
4. Sg. Tumpat

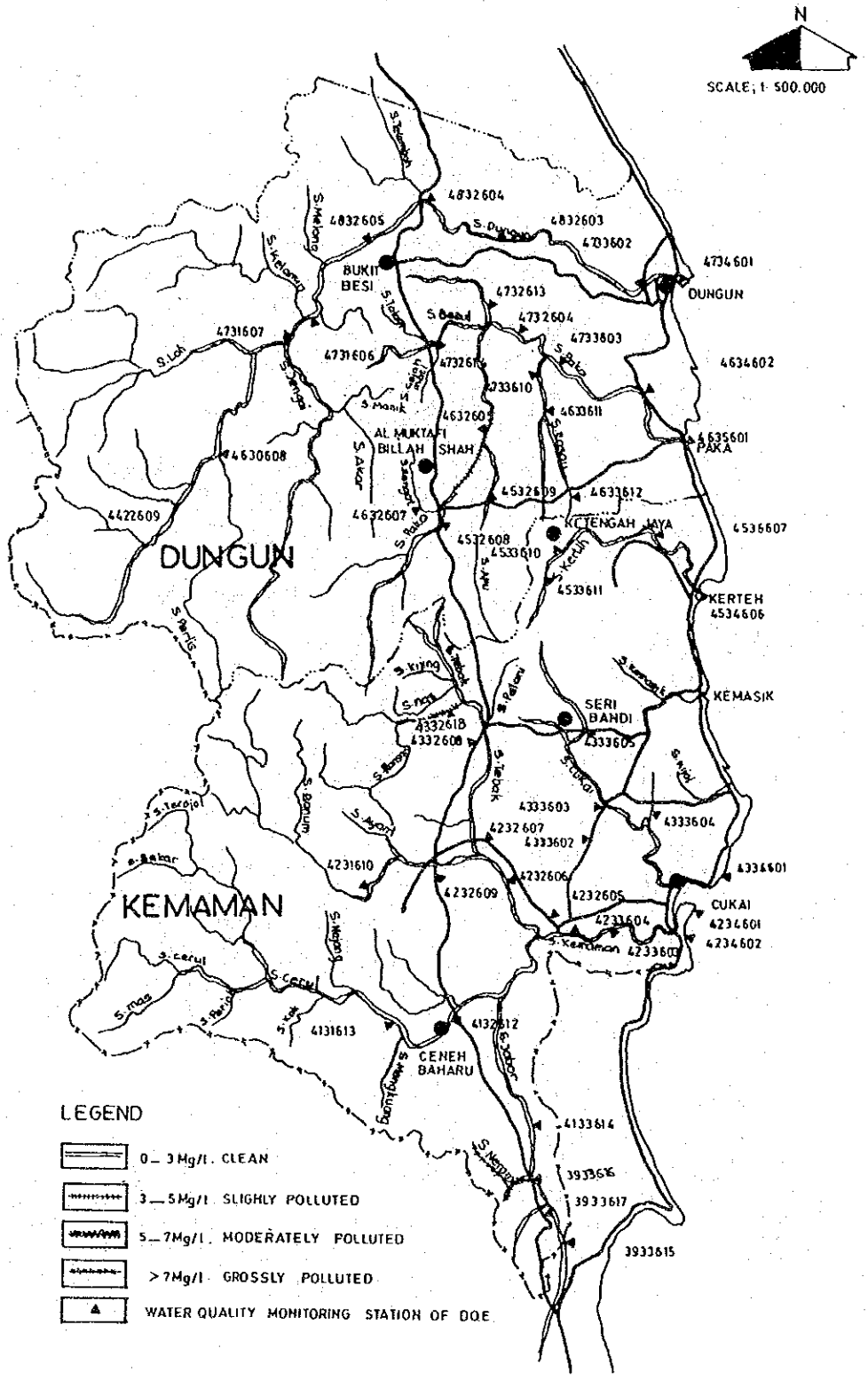
In the Sungal Kemaman region, the high SS level of Sg. Tebak could be attributed to the effect of the Terengganu Development Management Berhad (TDMB) Palm Oil Mill, and the mining activities in the Tebak catchment area.

Sg. Paka showed the SS level ranging from 80 to more than 110 mg/1 probably due to the logging and mining activities in the upper reaches. The SS level of Sg. Dungun ranged from 30 to more than 110 mg/1, possibly caused by logging activities in the upper catchment.



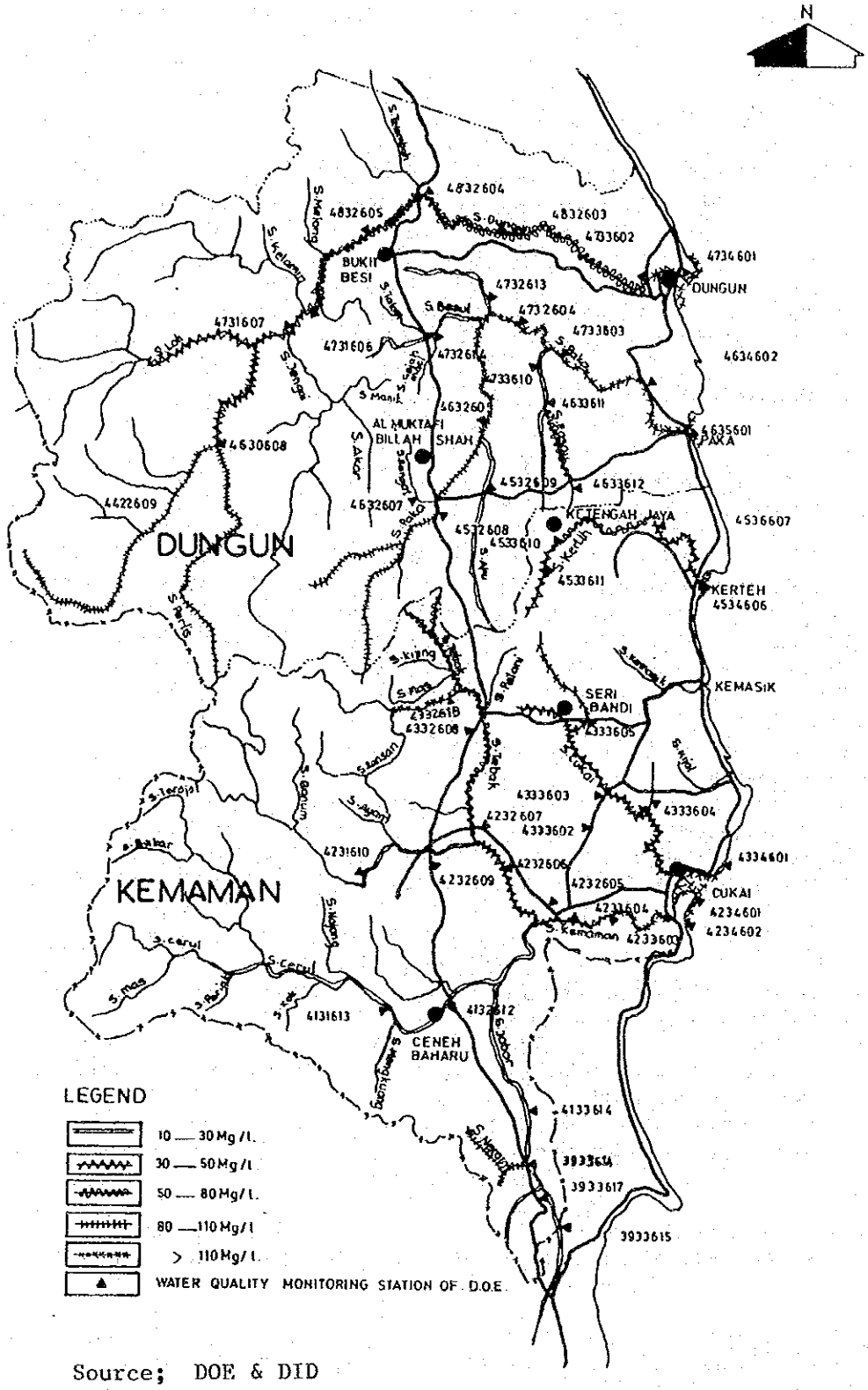
Source; DOE

FIG. 12.1 WATER QUALITY CONTROL REGION AND MONITORING STATIONS (1980)



Source; DOE

FIG. 12.2 PRESENT CONDITION OF WATER QUALITY (B.O.D.) 1980



Source; DOE & DID

FIG. 12.3 PRESENT CONDITION OF WATER QUALITY (S.S) 1980

Table 12.1 PARAMETER LIMITS OF EFFLUENT OF STANDARDS A AND B

Parameter	Unit	Standard	
		A	B
(1)	(2)	(3)	(4)
1. Temperature	C	40	40
2. pH Value	-	6.0-9.0	5.5-9.0
3. BOD_5 at 20°C	mg/l	20	50
4. COD	mg/l	50	100
5. Suspended Solids	mg/l	50	100
6. Mercury	mg/l	0.005	0.05
7. Cadmium	mg/l	0.01	0.02
8. Chromium, Hexavelent	mg/l	0.05	0.05
9. Arsenic	mg/l	0.05	0.10
10. Cyanide	mg/l	0.05	0.10
11. Lead	mg/l	0.10	0.5
12. Chromium, Trivalent	mg/l	0.20	1.0
13. Copper	mg/l	0.20	1.0
14. Manganess	mg/l	0.20	1.0
15. Nickel	mg/l	0.20	1.0
16. Tin	mg/l	0.20	1.0
17. Zinc	mg/l	1.0	1.0
18. Boron	mg/l	1.0	4.0
19. Iron (Fe)	mg/l	1.0	5.0
20. Phenol	mg/l	0.001	1.0
21. Free Chlorine	mg/l	1.0	2.0
22. Sulphide	mg/l	0.50	0.50
23. Oil and Grease	mg/l	Not Detectable	10.0

Notes: A is applicable to the rivers of Dungun, Kemaman, Kerteh and Tumpat.
B is applicable to others.

Source: Environmental Quality (Sewage and Indstrial Effluents) Regulations 1978

The Report on 1980 Water Quality Monitoring Program for Terengganu Tengah Region concludes that;

- The major rivers in Terengganu Tengah, based on the mean levels of BOD_5 @ 20°C and ammonia nitrogen recorded in 1980, were not suffering from any major degree of pollution. Only the tributaries (very small rivers), which were under the impact of the discharge from palm oil mills showed severe degree of pollution (of BOD and ammonia nitrogen).

- Township development in the new towns, the mining activities and the palm oil mills' discharge had contributed to the high levels of suspended solids in certain sections of Terengganu Tengah rivers.

2.3.2 Water Quality Control

(1) Organization

Desiring to evolve appropriate policies and programmes to ensure that economic development goes hand in hand with sound management of the environment, the Environmental Quality Act, 1974 was adopted. The Division of Environment was established in 1975, and renamed as the Department of Environment (DOE) now functions under the Ministry of Science, Technology and Environment.

The efforts of DOE were concentrated on the development of administrative procedures and regulations for pollution control. To improve the water quality of the most chronic sources, Environment Quality Regulations on crude palm oil and raw natural rubber were enforced on 1st July, 1978 and 1st April, 1979 respectively. The regulations on sewage and industrial effluents were enforced in December, 1979.

The branch offices of DOE have been established in Lembaga Kemajuan Pehang Tenggara (DARA) and Lembaga Kemajuan Terengganu Tengah (KETENGAH) respectively with effect 1979.[1)] These DOE special units were established in compliance with the loan agreement with the Asian Development Bank.

Taking cognizance of the magnitude and type of development, the DOE special unit for KETENGAH drew up a river water quality monitoring programme to achieve the following objectives:

1) To assess the suitability of the water for the beneficial uses which include drinking, industrial water supply, agricultural irrigation, and fisheries.

   (There is little dependence on the rivers for fish protein in this region. The main industry is the processing of oil palm while irrigation is entirely for padi cultivation).

Note: 1) The DOE office moved out from the KETENGAH building in May, 1984.

2) To evaluate the impact of the various development activities on the regional water quality.

3) To determine if the water quality standards are being achieved.

(2) Impact of the various activities on the egional water quality.

Among the DOE's objectives, assessment of the suitability of the water for beneficial uses was made by DOE as implied in the present condition of water quality. The data show that the water of the main rivers of the study area is safe for drinking, fisheries and industrial and agricultural uses.

The major activities which cause a large impact on the regional water quality are twonship development, agricultural development, mining activities, and palm oil mills.

The outstanding effect of the township and agricultural development on the water quality is measured by its turbidity or by the suspended solids (SS) due mainly to erosion of the cleared land (Fugire 12.4). The soil erosion and siltation of rivers raise the needs for flood control, regulation of stream flows and purification of water supplies.

The impact of the discharge from palm oil mills is severe when it is not treated properly. Mills in the study area are obliged to check the water quality of effluent monthly and submit the data to DOE three times a year.

The Director General is authorized to issue a licence either subject to conditions or unconditionally (Environmental Quality Act, 1974, Section 10). The licence is renewed every year after approval and payment of the licence fees prescribed according to the following factors;

a) the class or premises;
b) the location of such premises;
c) the quantity of waste discharged;
d) the pollutant or class of pollutants discharged;
e) the existing level of pollution.

The data submitted by the six mills to DOE in 1980 are summarised in Table 12.2.

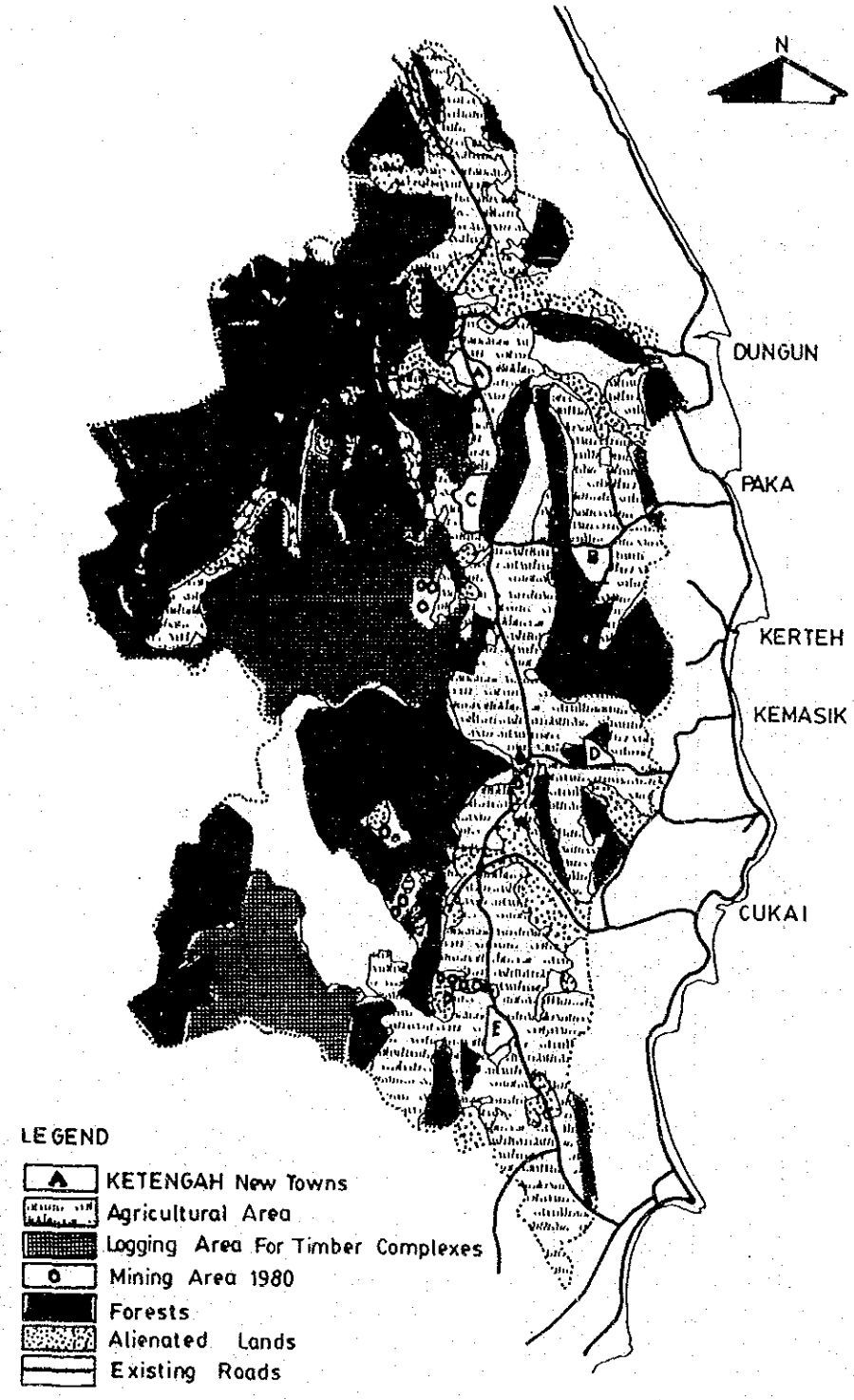


FIG. 12.4 LOCATION MAP OF THE DEVELOPMENT ACTIVITIES

Table 12.2 WATER QUALITY OF EFFLUENT OF PALM OIL MILLS

(mg/l in 1980)

NO.[1]	NAME OF THE MILL	DATE	BOD[2]	COD	TS	SS	OIL	NH_3	TN	PH
1	Felda Jerangau Barat (West)	16'Feb.	30	408	758	41	14	23	32	7.8
2	Felda Jerangau	29'Feb.	70	236	1,870	45	8	43.3	73.9	7.7
3	Felda Rasau Kerteh	7'Jan.	12	75	247	30	10	15	22	7.5
4	TDMB	29'Feb.	40	124	315	99	9	69.0	75.6	7.6
5	Felda Neram	29'Feb.	280	293	1,440	129	8	66.3	242.5	7.6
6	Jabor Valley	29'Feb.	38	496	468	12	9	6.8	10.6	7.1

Note : 1) No. corresponds to that of the location map (Fig. 12.1).

2) BOD level is detained from a test of 3 days - 30°C.

3) Terminology

BOD	Biochemical Oxygen Demand	COD	Chemical Oxygen Demand
TS	Total Solids	SS	Suspended Solids
OIL	Oil and Grease	NH_3	Ammoniacal Nitrogen
TN	Total Nitrogen	PH	PH

Source : DOE office in Kuala Terengganu

The limit of different parameters of effluent have been set in the Environmental Quality (Crude Palm Oil) Regulations 1977 as shown in Table 12.3.

Table 12.3 PARAMETER LIMITS FOR WATER COURSE DISCHARGE (mg/l)

Period	BOD	COD	TS	SS	OIL	NH3	TN	PH	T[1)]
1.7.1978-30.6.1979	5,000	10,000	4,000	1,200	150	25	200	5.0-9.0	45
1.7.1979-30.6.1980	2,000	4,000	2,500	800	100	15	100	5.0-9.0	45
1.7.1980-30.6.1981	1,000	2,000	2,000	600	75	15	75	5.0-9.0	45
1.7.1981-30.6.1982	500	1,000	1,500	400	50	10	50	5.0-9.0	45
1.7.1983-31.12.1983		250[2)]							
1.1.1984-30.6.1984		100[3)]							

Note: 1) T indicates the Temperature (C°).
2), 3) These values were obtained at DOE office in Kuala Terengganu.

The comparison of the surveyed BOD value in Table 12.2 with the regulation limit, 100 mg/l for 1984, shows that the levels of 5 mills satisfy the limit. The value of FELDA NERAM exceeded the limit of BOD.

Municipal wastes affect the water quality in towns when they enter water bodies. They are garbage and sewage from households, public markets and industries. The absence of sewerage systems in most parts of the country is the main cause of the city-type water pollution. According to the Annual Report on Natural Environmental Quality of Malaysia 1979, only 58.2% of the rural population were served by sanitary latrines (pits/septic tanks).

These activities influence the water quality so much when managed poorly that quality control should be pursued properly in conformity with the related regulations.

3. Environmental Planning of Industries

3.1 Necessity of Environmental Planning of Industries

The environmental planning of industries is needed for three different stages:

1) Site allocatin stage,
2) Construction stage, and
3) Operation stage.

During the site allocation stage, a study should be made from the viewpoint of environmental conservation to decide the appropriate location of industry. The study differs for types and sizes of industry, and for the characteristics of the candidate area. Naturally, a more comprehensive study is required for a large scale industrial complex in an environmentally sensitive area than for a small industry in an ordinary area.

For the construction stage, special care should be taken to minimize the influence of construction to the adjacent areas as much as practical. The construction method and transportation of the construction materials and waste should be carefully studied so that the effect to the people would be minimum.

The impact of the operatin stage differs depending on the type of industry. The major issues, in general, are water pollution and air pollution. In terms of water pollution, in order to prevent polluting the public water bodies, the effluent from indstry should be treated properly by the individual industry. For prevention of air pollution, adequate measures should be taken to minimize the emission of pollutants to the open air.

3.2 Present State of Environmental Pollution by Indutries

3.2.1 Water Pollution

The identified sources of water pollution in Malaysia were the oil palm and rubber industries. Though the number of factories and the effluent volumes are small relative to the other industries, their proportions in terms of BOD are remarkably large (Table 12.4).

Table 12.4 WATER POLLUTION OF 3 CLASSIFIED INDUSTRIES, 1976

Source	Number	Effluent Volume cu.m/day	BOD Load tonnes/day
Palm oil	130	14,200	284
Rubber	375	116,000	208
Other industries	6,000	412,000	124

Source : Annual Report on Natural Environment Quality 1979.

In order to offset these water pollution, the following regulations were enforced under the Environmental Quality Act, 1974:

1) Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulation, 1977

2) Environment Quality (Prescribed Premises) (Raw Natural Rubber) Regulations, 1978

3) Environmental Quality (Sewage and Industrial Effluents) Regulations, 1979.

With the effective enforcement of these regulations, it was estimated that 80 percent of the industrial pollution would have been overcome.

3.2.2 Air Pollution

Air pollution is not as widespread as water pollution, however, it deserves priority attention at it directly related to human health through breathing.

The major share of air pollution in Malaysia is generated from vehicles which exhaust emission gas containing a large amount of carbon monoxide (CO). The CO gas constitutes 48.7% of all the pollutants emitted into the atmosphere as a result of fuel combustion, followed by sulphur dioxide 31.3%, nitrogen oxide 11.2%, hydrocarbons 6%, and grit and dust 2.8%. Transportation contributes 96% of the total hydrocarbons and 70% of the total nitrogen oxide.

The industrial sector is the main source of sulphur dioxide (SO_2) and particulate matter. The industries emit 51.6% of the total SO_2, and the power stations solely emit 46.1%. With regard to the total particulates emission, woodburning accounted for 40%.

In the study area, air pollution is caused by sawmill industries and waste burning in the open air, although the degree of pollution is not serious yet.

3.3 Environmental Planning of Industries in the Study Area

For the site allocation of industries in the study area, special attention should be given to conservation of the natural conditions.

The coastal region of south Terengganu is known for its natural beauty, which is a major attraction to visitors. Especially, Rantau Abang is famous for the giant leathery turtles that come ashore yearly to lay their eggs on the desolate beaches. The Government has set a programme to restrict collection and sale of their eggs to ensure that the species will not be endangered. Special care should be taken to cease destruction of nature, and to prevent marine pollution.

For the harmonious existence of the industries with nature and people, provision of the buffer distance is requested by the Department of Environment. The strategy adopted in preparing the guidelines involves the classification of industries according to their potential to generate air, water, land and noise pollution. Four groups of industries namely Light, General 'A', General 'B' and Special Industries were selected and for each group of industries, buffer distances between them and residential areas were recommended (Table 12.5).

The Environmental Impact Assessment Procedure was approved by the National Development Planning Committee in 1978. The Environment Impact Assessment Handbook prepared in 1979 shows a list of projects which require the Preliminary Assessment in the Pre-Feasibility Study. The list shows among others that one of the manufacture of petroleum products, and none of basic metal industries are exempted from preparation of the assessment.

For the further study of industrial development in the study area, close coordination with the Department of Environment is needed for achievement of well-controlled development without spoiling the environment for the benefit or not only the present, but the future generations.

Table 12.5 RECOMMENDED BUFFER DISTANCE FOR INDUSTRIES

Type of Industry	Characteristics	Buffer Distance (m)
Light	Not create air, water, land and noise pollution	200 - 500
General A	Not produce toxic and dangerous materials	500 - 1,000
General B	Produce dust, odour, noise and liquid waste	1,000 - 1,000
Special Industries	Potentially hazardous Industries; pulp and paper mills, integrated steel mills, power station, refineries, petrochemical plants, primary alluminium works, cement works, acid manufacturing works, quarry works, etc.	1,500 - 3,000 or more

Source : Department of Environment

CHAPTER 13

PETROCHEMICAL COMPLEX STUDY: APPENDICES

PETROCHEMICAL COMPLEX STUDY: APPENDICES

Appendix 1 ENVIRONMENT PROTECTION

Appendix 1 ENVIRONMENTAL PROTECTION

1.1 Introduction

It is aimed in this study that the petrochemical complex being planned at Terengganu district shall utilize the latest technology available and shall form by itself a totally enclosed system to achieve conservation of resources and energy, and environmental protection.

This petrochemical complex will, therefore, basically be pollution free, eliminating the hazardous substances within its process plants and preventing their discharge to the environment.

In this study, the plants are planned and designed based upon the Japanese regulations for environment protection which are regarded as the most severe in the world. Environmental standards of Malaysia are also applicable to this study with a few exceptions which are considered inadequate from the technical as well as economical viewpoints.

In the planning of environment protection measures the following steps are adopted.

(1) Confirmation of Source of Pollutants

(2) Establishment of Standards for Pollution Prevention and Control

To prevent any pollution caused by the operation of the complex, standards are to be established for waste gas and effluent. The standards so established are based on applicable laws and regulations in Japan, standards in Malaysia, and the applicability of pollution prevention and control technology.

(3) Design of Pollution Prevention Facilities

Waste treatment and disposal methods and facilities necessary to achieve the environment protection targets (for waste gas and effluent emission) are designed in accordance with the standards as established above. For this design, the optimum combination of two methods was considered to be adopted; those two methods are:

a) Control over generation of waste, by improvement of processes (including change of the design of equipment)

b) Containment, whereby to the greatest extent contained at their sources.

1.2 Wastes from Petrochemical Complex

(1) General

Studying the sources and nature of wastes makes it possible to establish pollution prevention measures. To insure proper operation of the complex, technology which has been proven in existing plants including utilities plants and pollution prevention plants, is to be used.

We explained the some example as follows:

(2) Ethylene Plant Wastes

The ethylene plant is designed to form a closed system from the requirements of energy conservation as well as:

a) Minimizing the waste effluents

b) Treating each waste effluent at the origin and making best use of it. The quantity of quench water blow-down, for example, has been greatly reduced as compared to the conventional plant. As the various schemes like this have been applied to the latest ethylene plant the waste effluents to the outside are minimized or are almost nonexistent.

As shown in Fig. A-1-1, effluent and gaseous emissions are generated when the ethylene plant is operated under normal conditions.

The major liquid phase effluents from the ethylene plant are as follows.

- Quench Water Blow-down

  Steam is mixed with ethane as a diluent prior to pyrolysis. Most of the condensate of this steam, called "quench water", is recycled for generating steam.

  To prevent scale, part of the condensate is replenished with fresh water (make-up water). The water which is removed from the cycle is called quench water blow-down. Recycling of the remainder reduces the required capacity of the effluent processing facility.

  The blow-down is permitted to cool before conveyance to predisposal processing facility.

- Spent Caustic Soda Solution

  Cracked gas is washed by caustic soda solution to remove acid gas (mostly carbon dioxide). The spent caustic from this and wash water are sent to the effluent processing facility after neutralization with dilute sulfuric acid. The spend caustic after neutralization only contains 5-10% sodium sulfate.

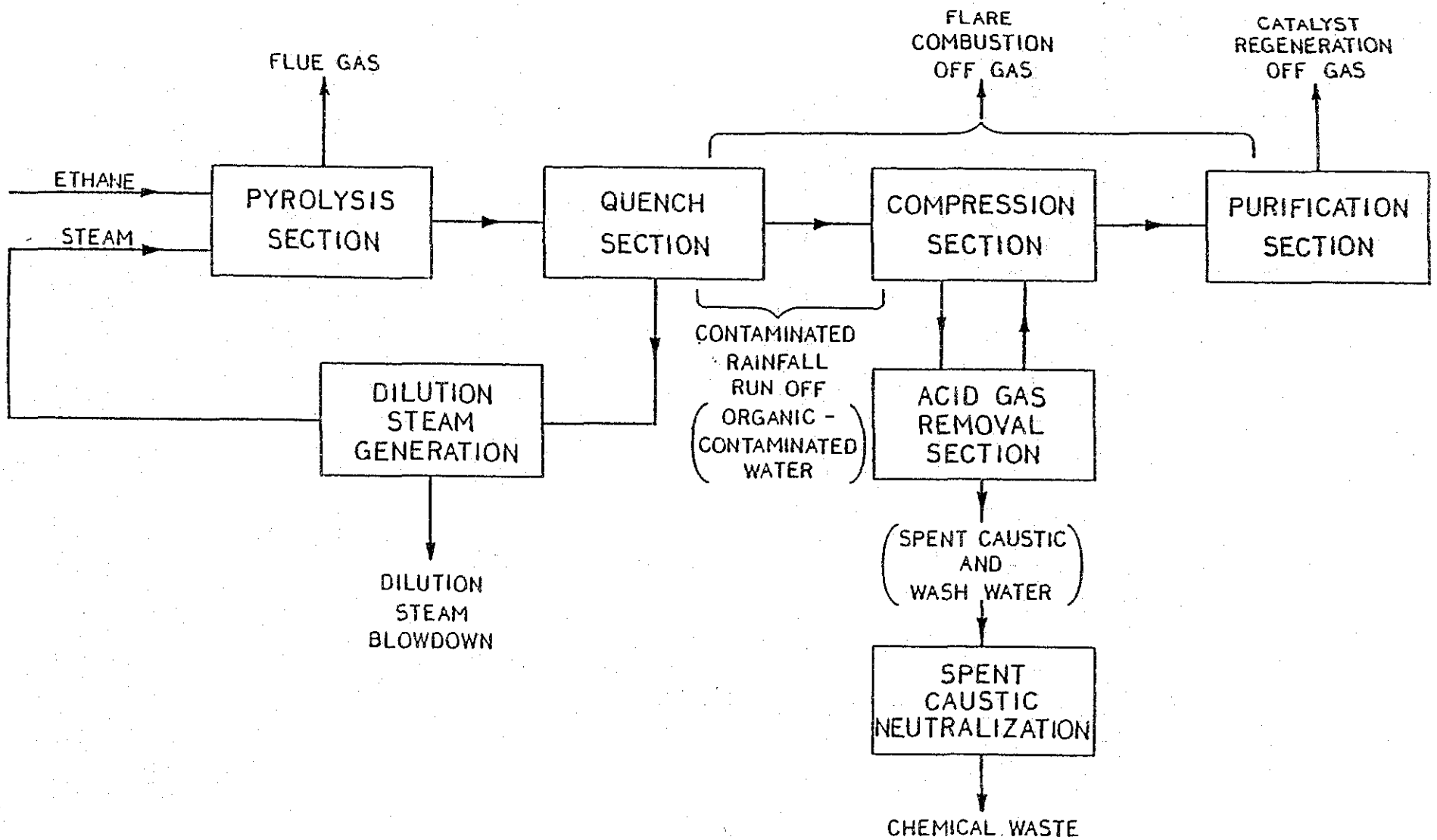


FIG. A-1-1 ETHYLENE PLANT BLOCK FLOW DIAGRAM

- Boiler Water Blow-down

  A high-pressure boiler is installed to recover waste heat from the cracking furnace. To prevent scale, part of the boiler water is changed. The blow-down is reused as caustic wash water.

- Surface Runoff Containing Oil

  Surface runoff contaminated with oil in the area of the facilities is collected in the waste water pit, then conveyed to the centralized waste water treatment facilities.

  Regarding waste gas from the ethylene plant, control of the concentration of pollutants in gaseous emission from the plant is carried out at each source of emissions. The waste gases, the processes whereby they are produced, their nature and control methods are described as follows.

- Cracking Heater Flue Gas

  Cracking heater flue gas is the waste gas generated in largest quantity. It contains no sulfur compounds as natural gas is used as fuel and therefore no SO_x is released. NO_x flue gas quantity; however, it is not regulated in Japan.

- Catalyst Regeneration Off-gas

  Two reactors for selective hydrogeneration of acetylene are installed in the ethylene plant (one for standby use). During normal operation carbon is deposited on the catalyst, reducing the activity of the catalyst. Therefore, operation is stopped at regular intervals and the catalyst is regenerated.

  Before regenerating the catalyst, the carbon deposits are stripped by injection of steam, and are sent to a blow-down stack to be burned. Therefore, no carbon is released. During catalyst regeneration, carbon is only burned, so no pollutant is released.

- Blow-down Flare Stack Gas

  The gaseous hydrocarbon is not purged out during normal operation, however, the large scale flare stack is furnished to treat the gas by complete combustion in case the gas should be released during start-up operation or emergency. To prevent smoke atomizing steam is introduced. NO_x content in flare gas is less than 100 ppm.

(3) Wastes from the VCM Plant

To minimize pollution from the VCM production process the oxygen-based oxychlorination process is to be used.

As shown in Fig. A-1-2, the VCM plant consists of two reaction sections (oxychlorination and EDC cracking) and two purification sections (EDC purification and VCM purification).

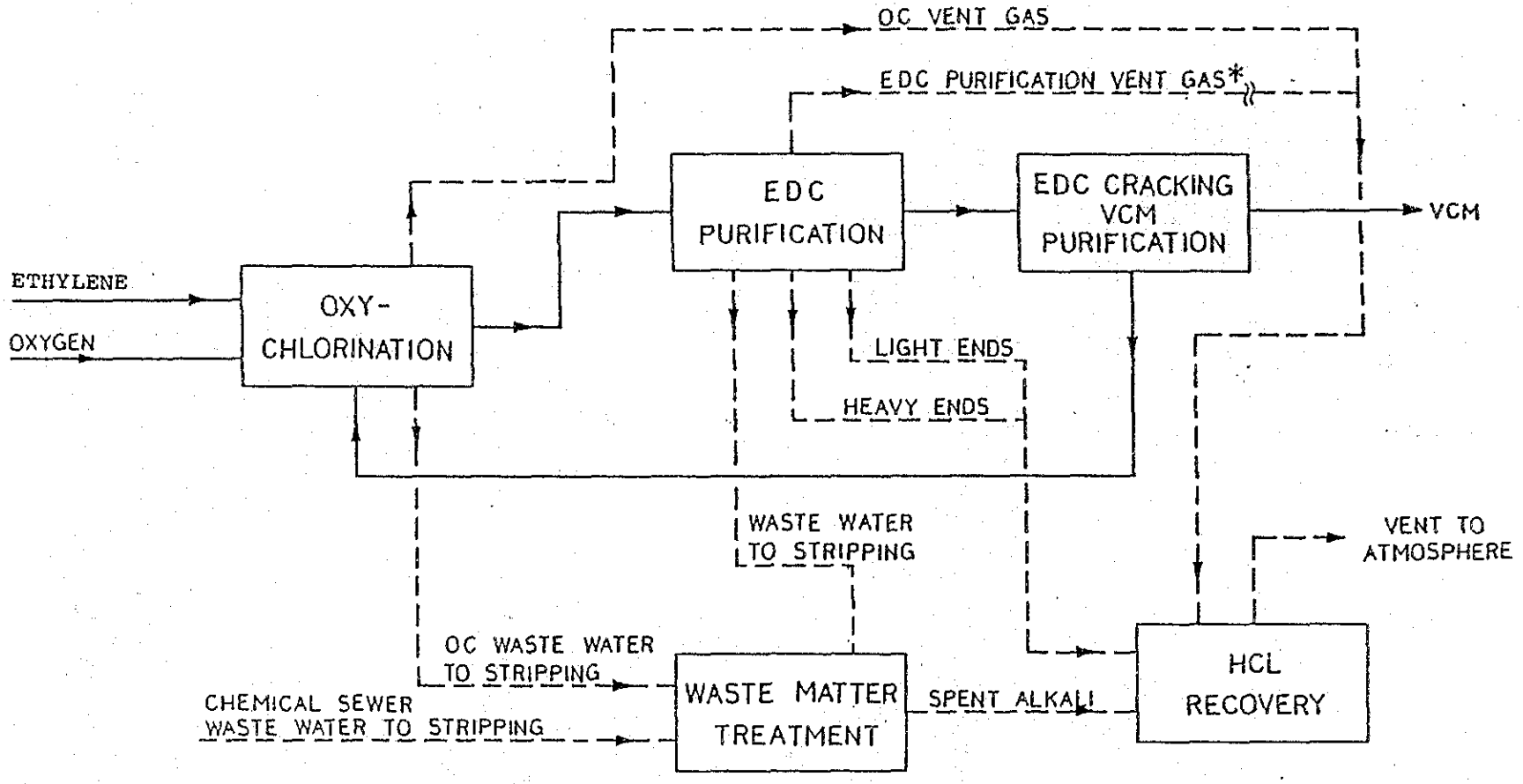


FIG. A-1-2 VCM PLANT BLOCK FLOW DIAGRAM

VCM plant wastes are to be rendered harmless in the facilities provided for that purpose (waste processing section and hydrochloric acid recovery section), and after that sent to the centralized waste water treatment facilities in the utility center.

- Waste Products

  Wastes from this plant comprise gases, effluent and waste water. The waste gases are vent gases from the oxychlorination section and from the EDC purification section. Because these gases contain chlorinated hydrocarbons, they are sent to the furnace in the hydrochloric acid recovery section to be burned at high temperature Gaseous hydrochloric acid, a byproduct, is recovered as a hydrochloric acid. The distillation effluent comprises light ends from the EDC distillation section and heavy ends from the EDC purification section.

  These are sent to the furnace where they are burned at high temperature, together with the waste gases. The quality of hydrochloric acid recovered from this is adequate for use in the electrolysis plant. Waste water will be emitted from the oxychlorination section, and the EDC/VCM purification section; these are to be sent to the EDC stripper in the waste processing facility.

(4) Utility Facility Waste

The utility facilities will generate the following emissions and effluents.

Facility	Waste	Pollutant
Boiler Water Purification Facility	Water blow-down	Salts
Cooling Tower	Water blow-down	Salts
Boiler	Water blow-down	Salts
	Fuel vent gas	NO_x
Gas Turbine	Fuel vent gas	NO_x

Effluent from the utilities facilities includes only salts, in a slightly higher concentration than usual industrial water, and it is not necessary to send the effluent to the processing facility. There will be no water pollution problems.

The fuel used is processed natural gas; because the processing removes sulfur, no SO_x is contained in fuel gas from the energy section of the utilities facilities. The concentration of NO_x in gas from the gas turbine is 130 ppm, and that in gas from the boiler is 100-130 ppm (the latter value ranges depending upon the use of a low-NO_x burner).

1.3 Environmental Protection Standards

(1) General

Environmental protection standards for the petrochemical complex are devised from the stand point of view of insuring the most efficient operation of the complex and the highest degree of protection of the environment, by taking into consideration the following.

a) Pollutant control levels are to be established and applied to waste products from the complex.

b) Existing Malaysian environmental protection standards are to be applicable.

c) The Japanese statutory requirements regarding pollution control are to be applicable.

d) The most widely adopted technology is to be utilized.

(2) Air Pollution Control Standards

Pollutants from the complex and the respective countermeasures are as shown below. Note should be made that Malaysia does not at present have statutory requirements concerning such emissions.

(Air Pollution Abatement)

Pollutant	Countermeasures Considered
NO_x [1]	Control generation by use of a low-NO_x burner; use of NO_x elimination facility is not considered necessary.
Soot	Generation of soot to be controlled by regulation of combustion. Precipitators etc. are not needed.
SO_x	No SO_x is generated because the fuel is sulfur-free.

Note: 1) A De-NO_x process to reduce emission of NO_x to 40 ppm is available. However, in this project, as the plant is to be located in a sparsely-populated and industrialized area, it is not considered necessary to provide it with the De-NO_x. A 130 ppm NO_x without treatment may be acceptable, because in most of the industrialized countries the De-NO_x unit is installed only in heavily populated and industrialized locations.

Standards for emission into the atmosphere are established for this study as follows.

(Atmospheric Emission Standards)

Emission	Source Facility	Standard (Maximum)
1/ Hydrochloric Acid	VCM plant	5 ppm
2/ NO_x	Gas-fired boiler	130 ppm
3/ Soot	Gas-fired boiler	0.20 g/Nm^3
	Incinerator	0.70 g/Nm^3

Notes: 1/ 5 ppm can be easily attained by caustic soda washing and this figure clears the emission limit in Japan.

2/ NO_x is said to be a cause of photochemical smog. In Japan, environmental standard limit of NO_2 is 0.04 ppm. However, that of NO_x is regulated case by case depending upon type of industry or facility, and the gas-fired boiler is only regulated at present (no regulation for NO_x exists in Malaysia). In this project, therefore, the conceptual design for boiler is made in accordance with the standard in Japan. The minimum figure to be attained by up-to-date low NO_x burner which will clear "the limit for the existing facility" in Japan may be recommendable, because the limit applied for the facility to be newly built is not accomplished by adopting only low NO_x burners.

3/ Based on the permissible limit in Japan, because there is no specific requirement in Malaysia.

(3) Waste Water Control Standards

Waste water control standards are determined on the basis of the following:

a) Treated waste water is to be discharged into the ocean through the sewer.

b) The following processes are to be used to prevent or reduce pollutants in waste water.

(Waste Water Control Standards)

Process	Function
Primary Processing:	
Gravitational separation of oil (CPI oil separator)	Removal of oil
Coagulative flotation	Removal floating suspended solids
Coagulative sedimentation	Remove finely suspended solids
Filtration	Remove suspended solid
Secondary Processing:	
Activated carbon absorption	Removal of matter causing COD

c) Biochemical treatment methods are not employed because of operation reasons expected in Malaysia and the nature of the effluent.

The standards for waste water control are set up in this study as shown below:

(Standards for Waste Water)

Effluent Item	Standard
pH	5 - 9
BOD	50 mg/l
COD	100 mg/l
Suspended solids	30 mg/l
Total dissolved substances (TDS)	Not regulated
Oil and grease	5 mg/l
Phenols	1 mg/l
Copper	1 mg/l
Zinc	1 mg/l
Free chlorine	1 mg/l
Temperature	40°C

1.4 Pollution Preventing System to Meet the Environmental Protection Standards

(1) Air Pollution Preventing Facilities

The following measures are to be adopted to prevent air pollution.

Air Pollutant	Source Facility	Measures
NO_x 1/	Boiler	Use low-NO_x burner
Hydrochloric Acid	Incinerator	Caustic soda washing
Chlorine	Incinerator and Electrolysis Plant	Caustic soda washing

Note: 1/ No special measure is provided for the cracking heaters, because as stated in the subsection 1.2 (4) above, NO_x content in the fuel gas from the cracking heaters is less than 100 ppm and no regulation exists in Japan.

(2) Central Waste Water Treatment System

Effluent from the plants is to undergo a primary treatment in the plants where it is generated, and if required will undergo further treatment in the centralized waste water treatment facilities provided in the utilities center which will treat the waste water so that it conforms to the standards set forth here prior to being discharged into the ocean.

a) Spent Caustic Soda Solution from the Ethylene Plant

Spent caustic soda solution from the ethylene plant is passed through the clarifier, then the sand filter to the guard basin.

b) Quench Water Blow-down

Oil is separated out in the CPI oil separator; the blow-down is then passed through the sand filter and subjected to activated carbon adsorption in order to reduce COD.

c) Runoff Containing Oil, from the Ethylene Plant

Oil is separated by the CPI oil separator and suspended solids are removed by coagulative sedimentation.

d) VCM Plant Waste Water

Suspended solids are removed by the sand filter and material influencing COD is eliminated by activated carbon adsorption.

e) Sludge from Water Processing Facilities

Solids and water are separated in the thickner and suspended solids are removed by the sand filter.

f) Effluent not Processed in Central Waste Treatment Facilities

The following effluent is not to be processed in the central waste water treatment facilities and is to be sent directly to the guard basin, because no pollutants are present:

- Cooling tower blow-down
- Circulating water from the boiler water treatment facility
- Boiler blow-down

For reference, standards in use in Japan are as follows:

Emission Standards (National Level)

Pollutant	Facilities	Permissible Limit
Chlorine	Electrolysis plant	30 mg/Nm^3
Hydrochloric Acid	Electrolysis VCM plant	80 mg/Nm^3
	Incinerator	700 mg/Nm^3
NO_x	Gas-fired boiler	100 ppm (for new boilers)
	Gas-fired boiler	160 ppm (for existing boilers)
Soot	Gas-fired boiler	0.2 g/Nm^3
	Incinerator	0.7 g/Nm^3

Source: Air Pollution Control Law (1977)

Waste Water Standards (National Level)

Pollutant	Permissible Limit
pH	5.0 - 9.0
BOD	160 mg/l (monthly average 120 mg/l)
COD	160 mg/l (monthly average 120 mg/l)
Suspended solids	200 mg/l (monthly average 150 mg/l)
Compounds extracted by n-hexane (mineral oil content)	5 mg/l
Phenols content	5 mg/l
Copper content	3 mg/l
Zinc content	5 mg/l
Total dissolved solid	Not regulated
Free chlorine	Not regulated
Temperature	Not regulated

Source: Air Pollution Control Law (1979)

Appendix 2 CAPITAL COST ESTIMATE FOR PETROCHEMICAL COMPLEX

Table A-2-1 CAPITAL COST ESTIMATE FOR PETROCHEMICAL COMPLEX (KERTEH)
(Ethylene: 142,000 T/Y)

(USD Million in Constant 1984 price)

	Ethylene			LLDPE			HDPE			VCM			Propylene		
	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL
FOB Equipment	37.0	-	37.0	16.2	-	16.2	13.5	-	13.5	9.5	-	9.5	13.7	-	13.7
Civil	1.3	7.1	8.4	0.6	3.1	3.7	0.5	2.6	3.1	0.5	1.9	2.4	0.5	2.6	3.1
Erection	1.6	8.6	10.2	0.7	3.8	4.5	0.6	3.1	3.7	0.8	1.8	2.6	0.6	3.2	3.8
Engineering	13.8	-	13.8	6.0	-	6.0	5.0	-	5.0	4.5	-	4.5	5.1	-	5.1
Transportation & Insurance	5.4	1.5	6.9	2.4	0.6	3.0	2.0	0.5	2.5	1.3	0.3	1.6	2.0	0.5	2.5
Supervising	3.0	0.6	4.4	1.7	0.2	1.9	1.4	0.2	1.6	2.5	0.3	2.8	1.4	0.2	1.6
Plant Cost (as erected)	62.9	17.8	80.7	27.6	7.7	35.3	23.0	6.4	29.4	19.1	4.3	23.4	23.3	6.5	29.8
Land Cost															

	PP			Utilities			Off-Site			TOTAL		
	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL
FOB Equipment	13.0	-	13.0	13.0	-	13.0	24.4	-	24.4	140.3	-	140.3
Civil	0.5	2.5	3.0	0.4	2.0	2.4	4.6	25.3	29.9	8.9	47.1	56.0
Erection	0.6	3.0	3.6	0.8	4.1	4.9	1.9	10.7	12.6	7.6	38.3	45.9
Engineering	4.9	-	4.9	1.6	-	1.6	4.1	-	4.1	45.0	-	45.0
Transportation & Insurance	1.9	0.5	2.4	1.7	0.5	2.2	8.1	2.1	10.2	24.8	6.5	31.3
Supervising	1.3	0.2	1.5	1.4	0.2	1.6	2.8	0.2	3.0	16.3	2.1	18.4
Plant Cost (as erected)	22.2	6.2	28.4	18.9	6.8	25.7	45.9	38.3	84.2	242.9	94.0	336.9
Land Cost										-	13.1	13.1
Pre-Operation Expense										5.7	16.3	22.0

Note: Including spare parts and catalyst for 2 years
Including inland transportation cost
F.C.: Foreign Currency Portion
L.C.: Local Currency Portion

Table A-2-2 CAPITAL COST ESTIMATE FOR PETROCHEMICAL COMPLEX (TELOK KALONG)
(Ethylene: 142,000 T/Y)

(USD Million in Constant 1984 Price)

	Ethylene			LLDPE			HDPE			VCM			Propylene		
	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL
FOB Equipment	37.8	-	37.8	16.2	-	16.2	13.5	-	13.5	8.5	-	8.5	13.7	-	13.7
Civil	1.3	7.4	8.7	0.6	3.1	3.7	0.5	2.6	3.1	0.5	1.6	2.1	0.5	2.6	3.1
Erection	1.6	8.9	10.5	0.7	3.8	4.5	0.6	3.1	3.7	0.8	1.5	2.3	0.6	3.2	3.8
Engineering	13.8	-	13.8	6.0	-	6.0	5.0	-	5.0	4.5	-	4.5	5.1	-	5.1
Transportation & Insurance	5.4	1.4	6.9	2.4	0.6	3.0	2.0	0.5	2.5	1.3	0.3	1.6	2.0	0.5	2.5
Supervising	3.8	0.6	4.4	1.7	0.2	1.9	1.4	0.2	1.6	2.5	0.3	2.8	1.4	0.2	1.6
Plant Cost (as erected)	63.7	18.3	82.0	27.6	7.7	35.3	23.0	6.4	29.1	18.1	3.7	21.8	23.3	6.5	29.8
Land Cost															

	PP			Utilities			Off-Site			TOTAL		
	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL
FOB Equipment	3.2	3.8	13.0	13.0	-	13.0	24.4	-	24.4	140.1	-	140.1
Civil	-	5.1	3.0	0.4	2.0	2.4	4.6	25.3	29.9	3.9	47.1	56.0
Erection	0.5	2.5	3.6	0.8	4.1	4.9	1.9	10.7	12.6	7.6	38.3	45.9
Engineering	0.2	1.6	4.9	1.6	-	1.6	4.1	-	4.1	45.0	-	45.0
Transportation & Insurance			2.4	1.7	0.5	2.2	8.1	2.0	10.2	24.8	6.3	31.1
Supervising				1.4	0.2	1.6	2.8	0.2	3.0	16.3	2.1	18.4
Plant Cost (as Erected)	1.4	0.2	1.6	18.9	6.8	25.7	45.9	38.2	84.1	242.7	93.8	336.5
Land Cost										-	13.1	13.1
Pre-Operation Expense										5.7	16.3	22.0

Note: Including spare parts and catalyst for 2 years
Including inland transportation cost
F.C.: Foreign Currency Portion
L.C.: Local Currency Portion

Appendix 3 SENSITIVITY ANALYSIS FOR PETROCHEMICAL FACTORS (CASE 1 - CASE 6)

Figure A-3-2 SENSITIVITY ANALYSIS ON THE MAJOR FINANCIAL FACTORS

(Case 2)

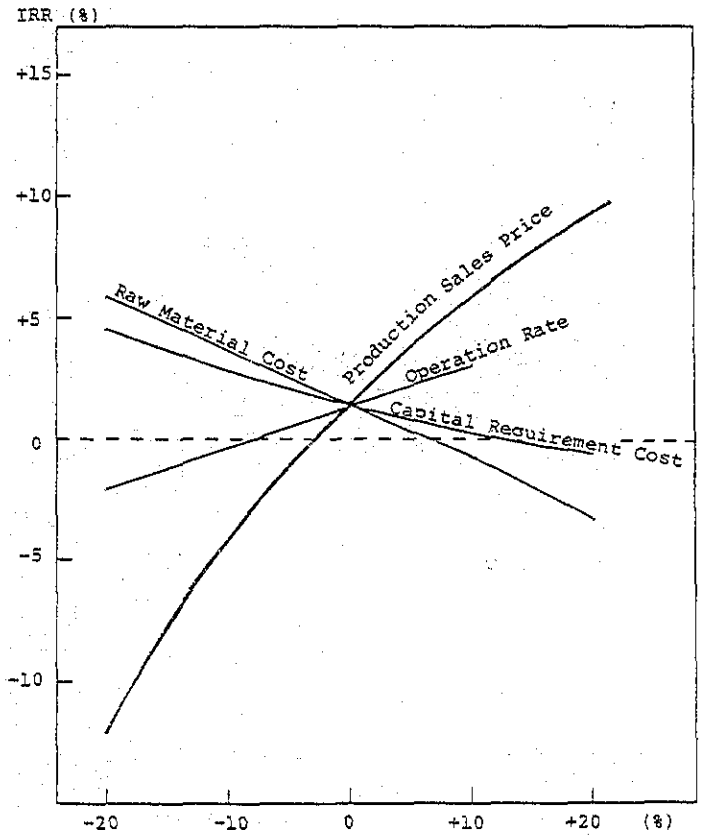


Figure A-3-1 SENSITIVITY ANALYSIS ON THE MAJOR FINANCIAL FACTORS

(Case 1)

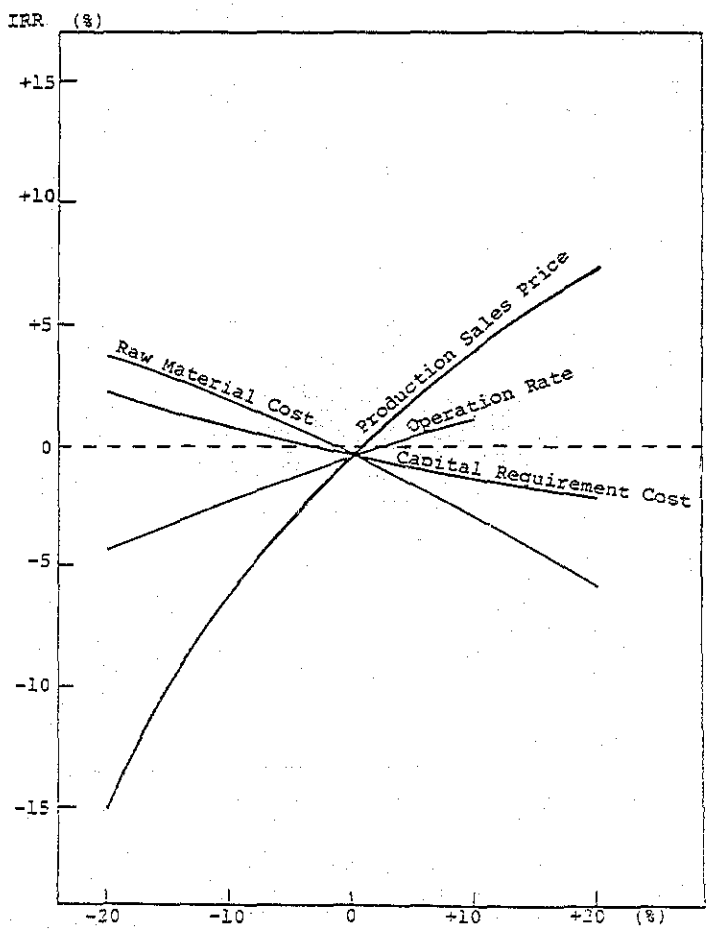


Figure A-3-4 SENSITIVITY ANALYSIS ON THE MAJOR FINANCIAL FACTORS

(Case 4)

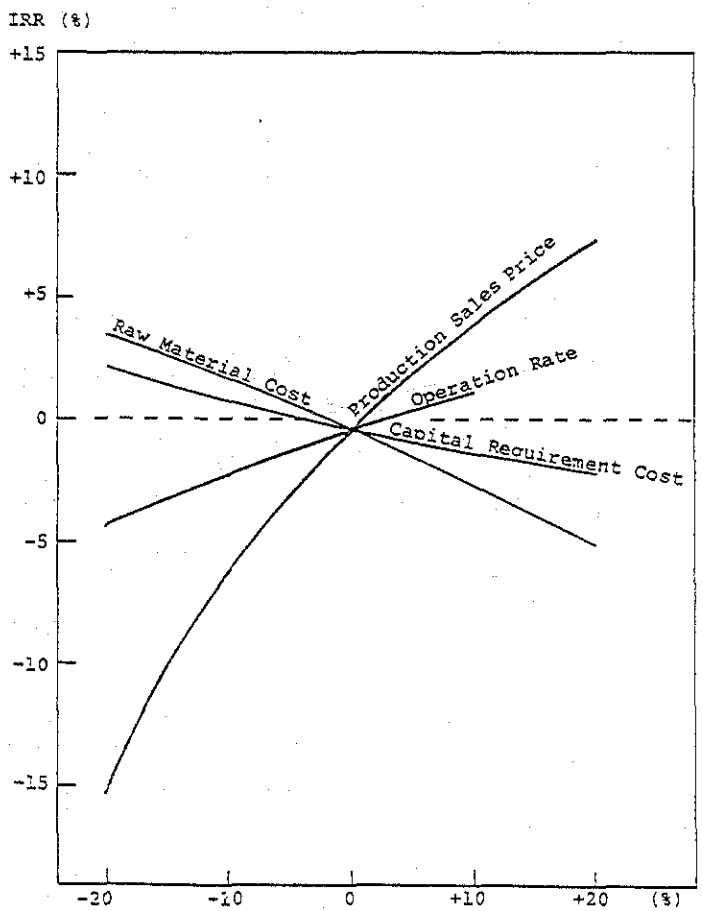


Figure A-3-3 SENSITIVITY ANALYSIS ON THE MAJOR FINANCIAL FACTORS

(Case 3)

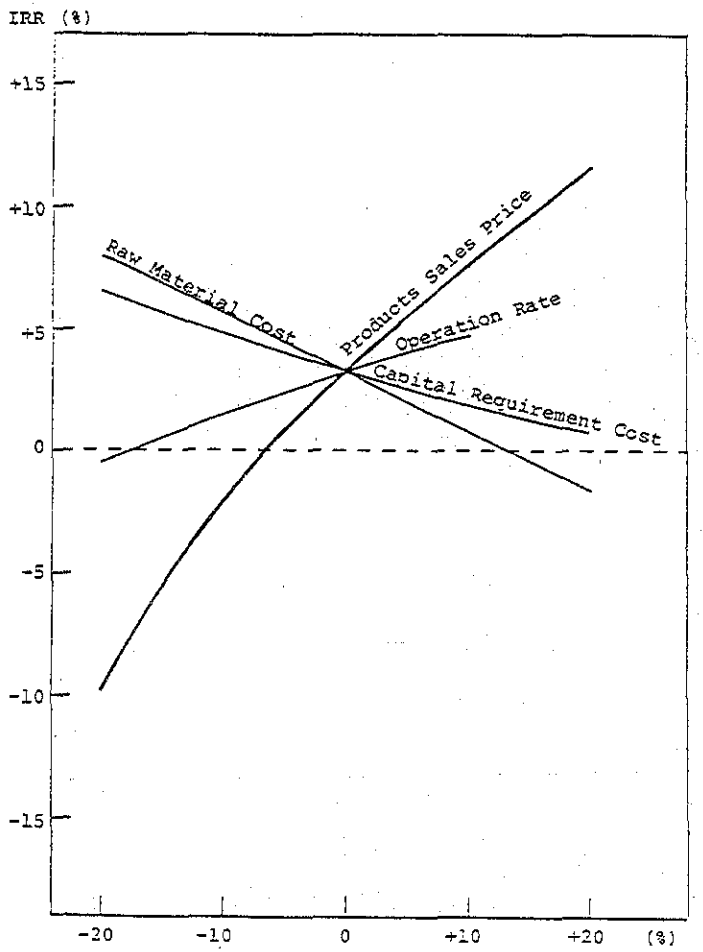


Figure A-3-6 SENSITIVITY ANALYSIS ON THE MAJOR FINANCIAL FACTORS

(Case 6)

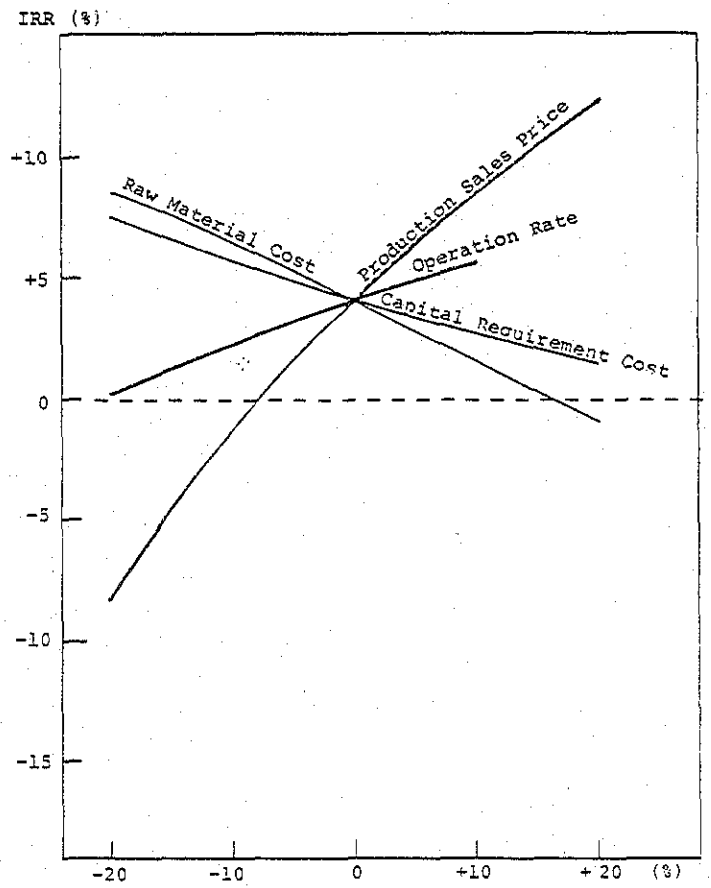
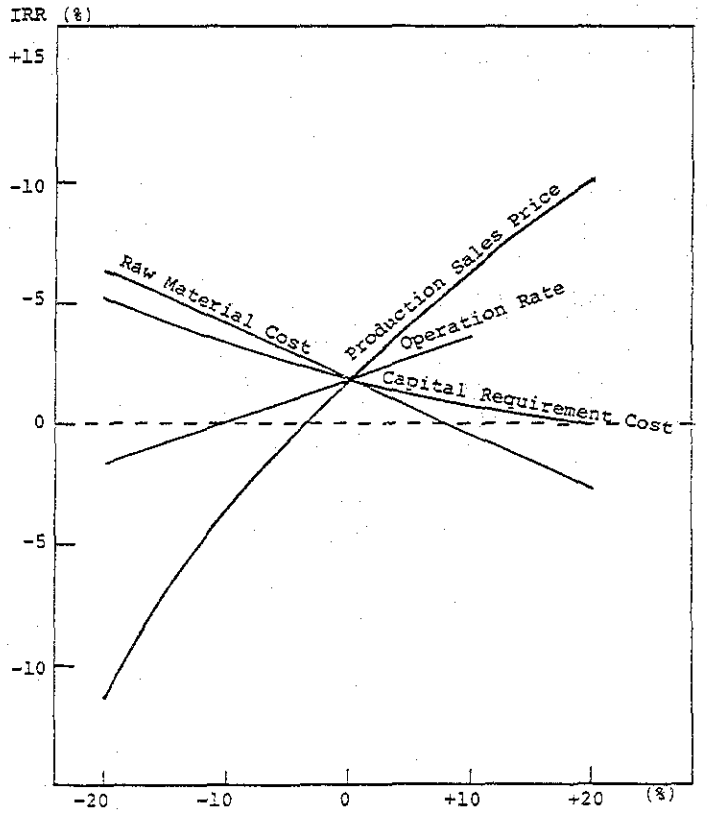


Figure A-3-5 SENSITIVITY ANALYSIS ON THE MAJOR FINANCIAL FACTORS

(Case 5)



Appendix 4 ORGANIZATION CHART

Figure A-4-1 ORGANIZATION CHART FOR THE ETHYLENE PLANT

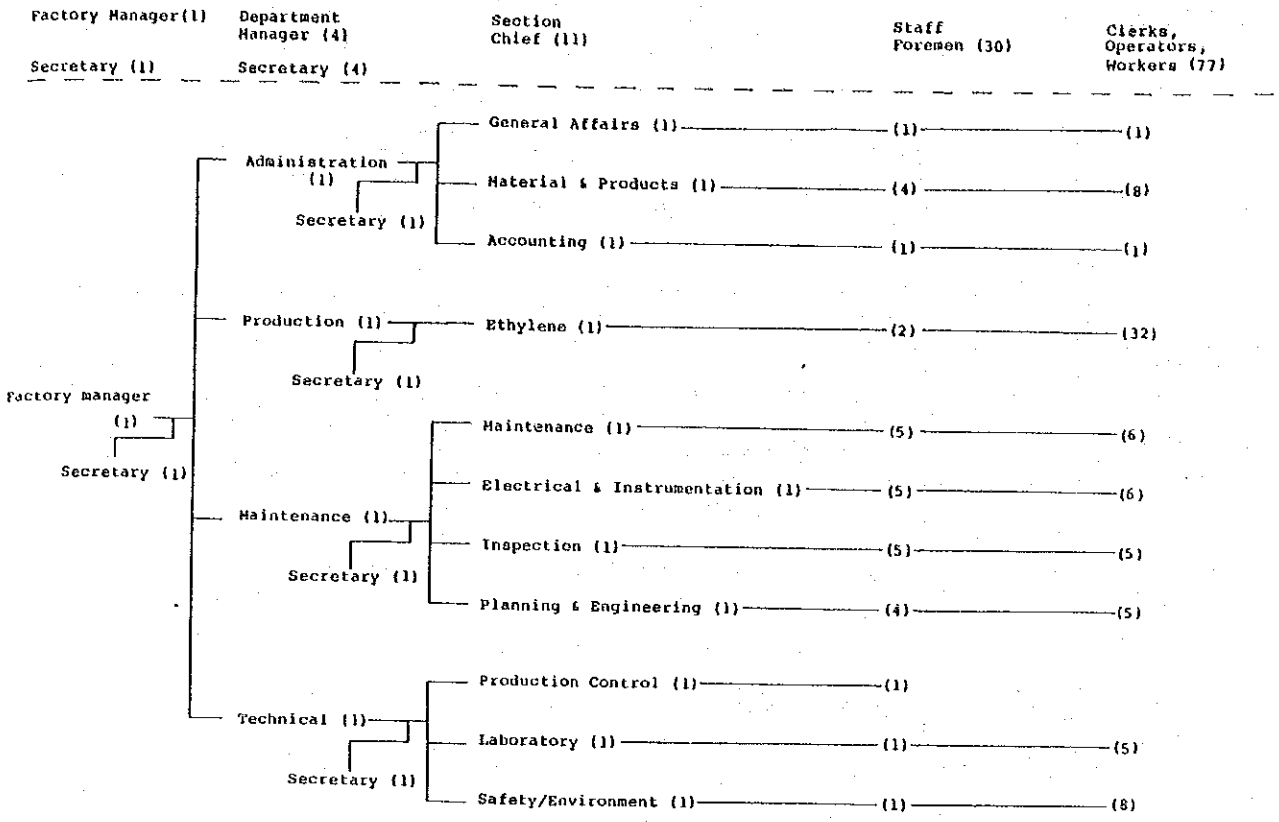


Figure A-4-2 ORGANIZATION CHART FOR PROPYLENE PLANT

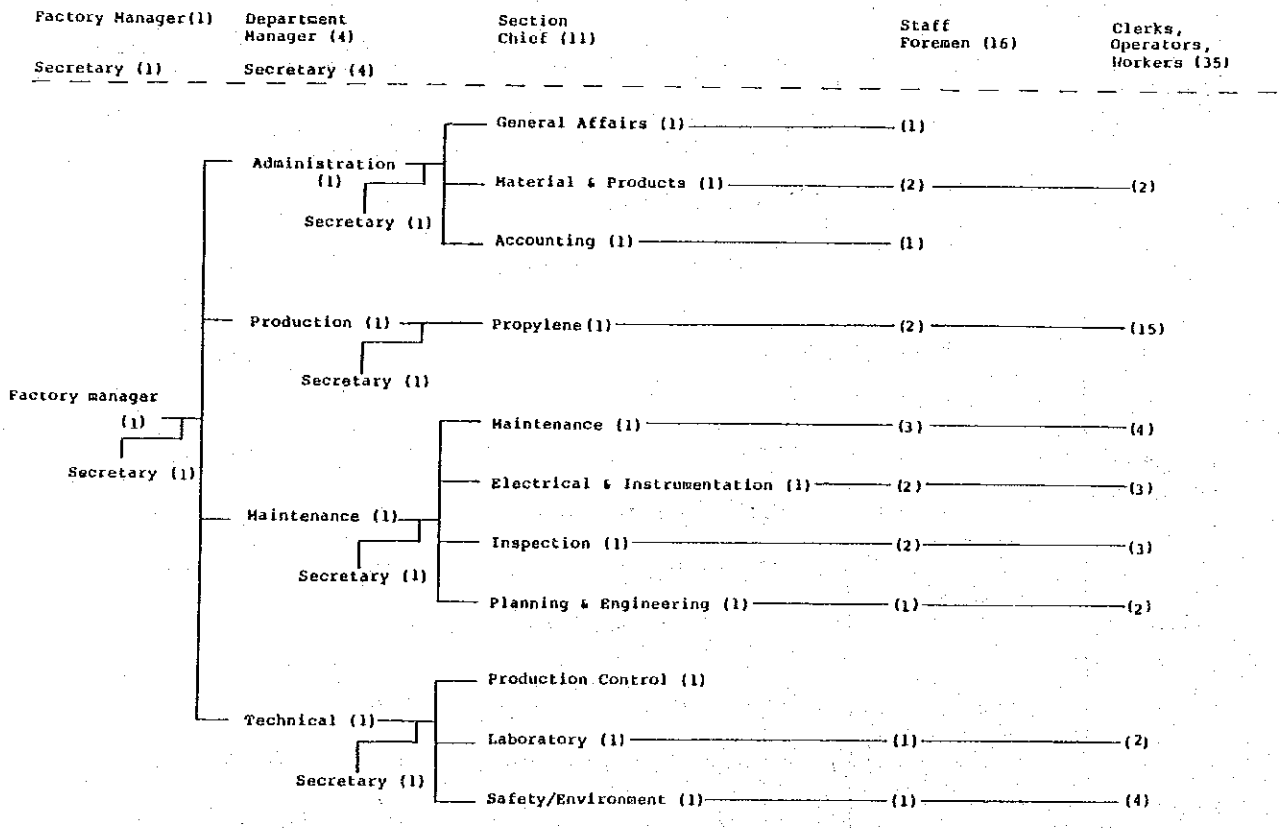


Figure A-4-3 ORGANIZATION CHART FOR LLDPE PLANT

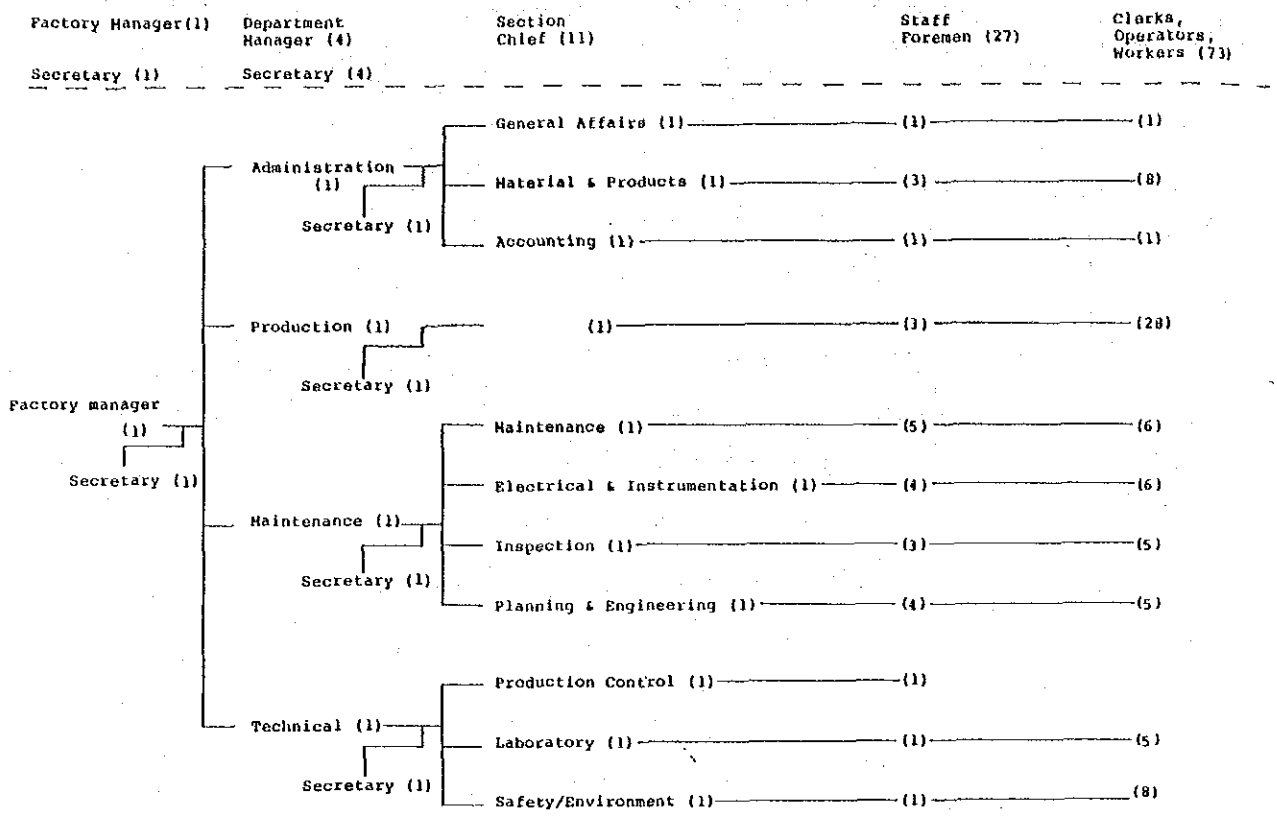


Figure A-4-4 ORGANIZATION CHART FOR HDPE PLANT

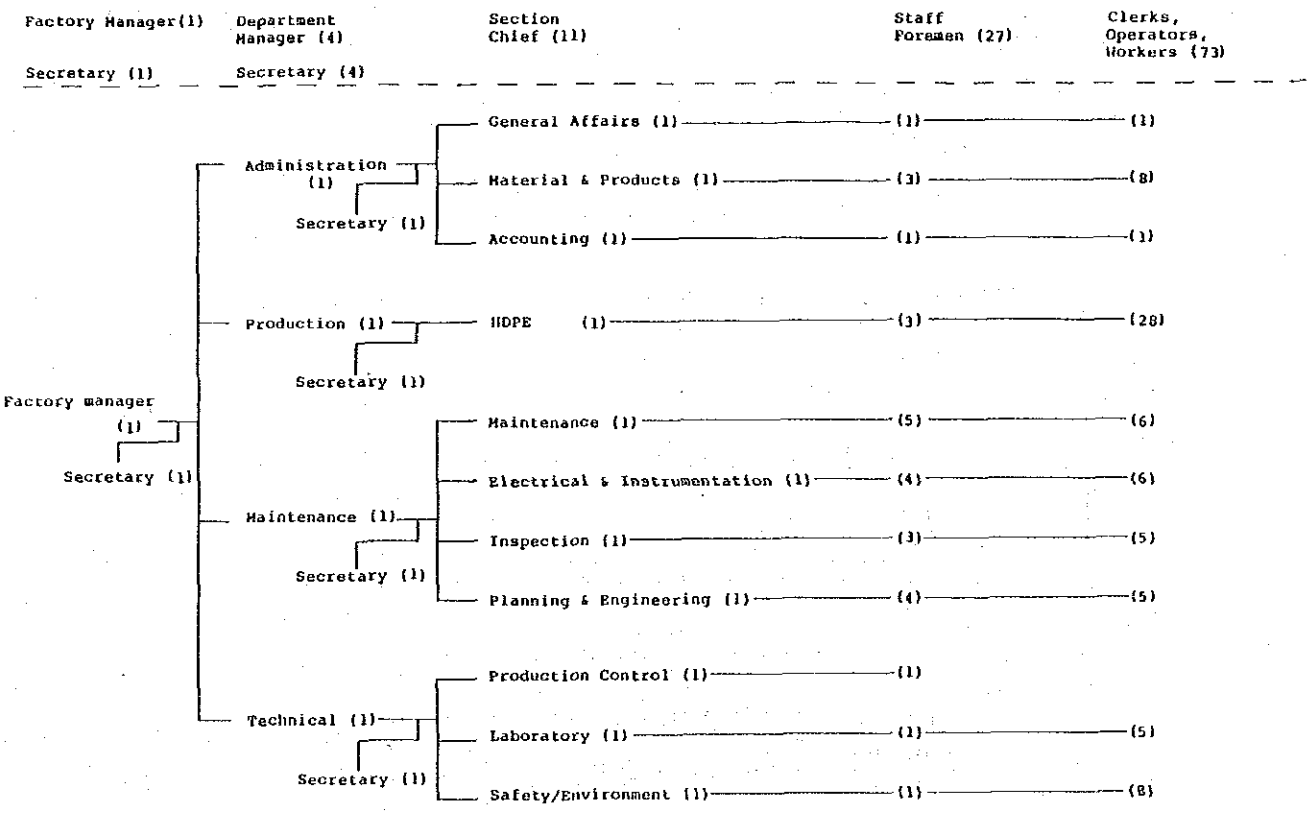


Figure A-4-5 ORGANIZATION CHART FOR VCH PLANT

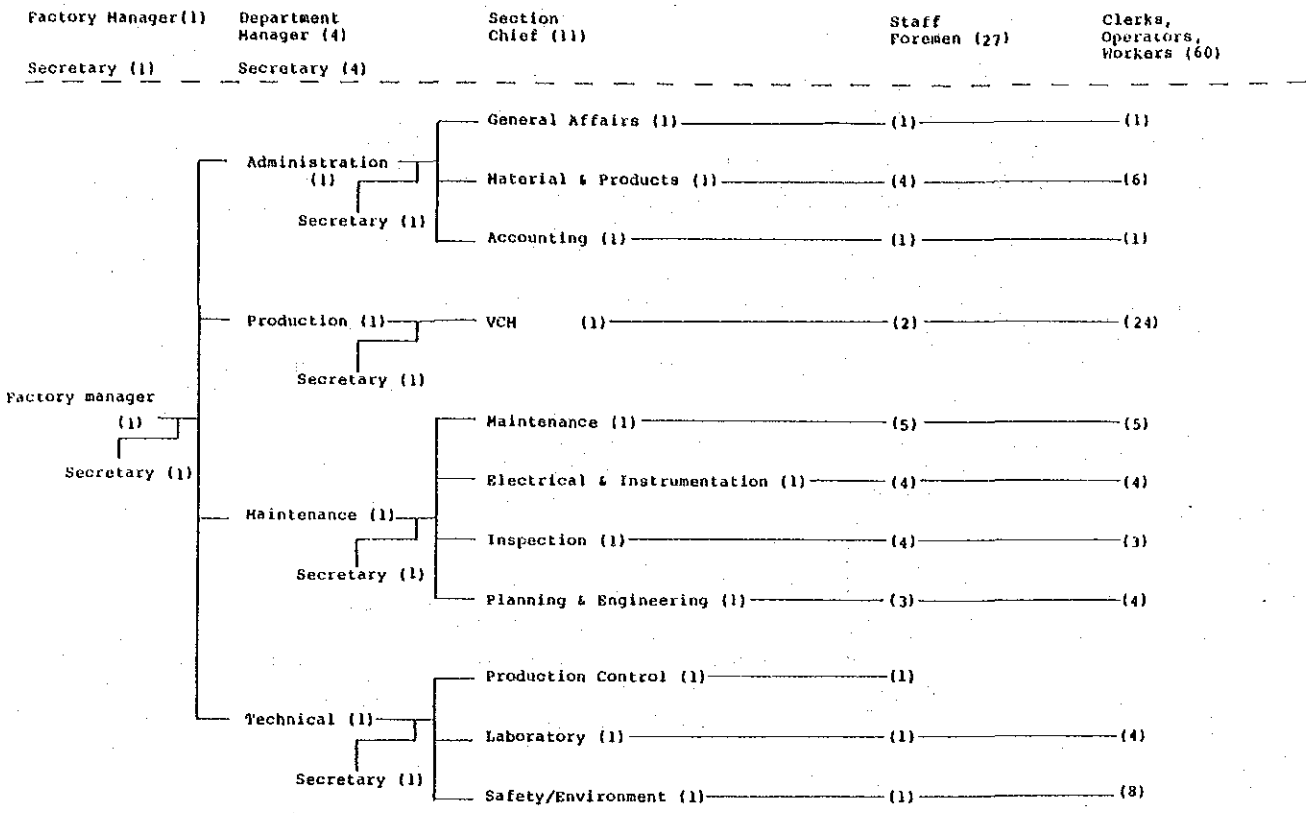


Figure A-4-6 ORGANIZATION CHART FOR PP PLANT

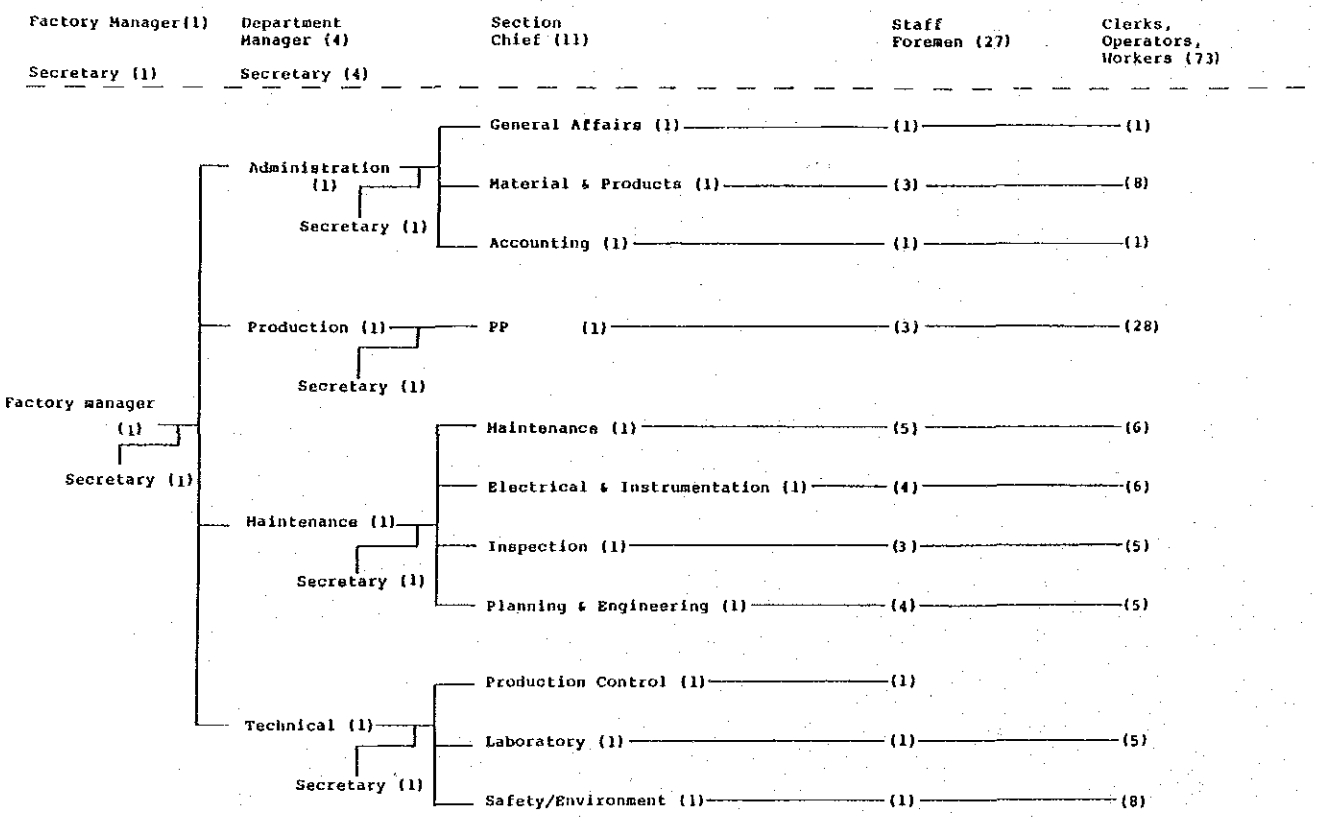
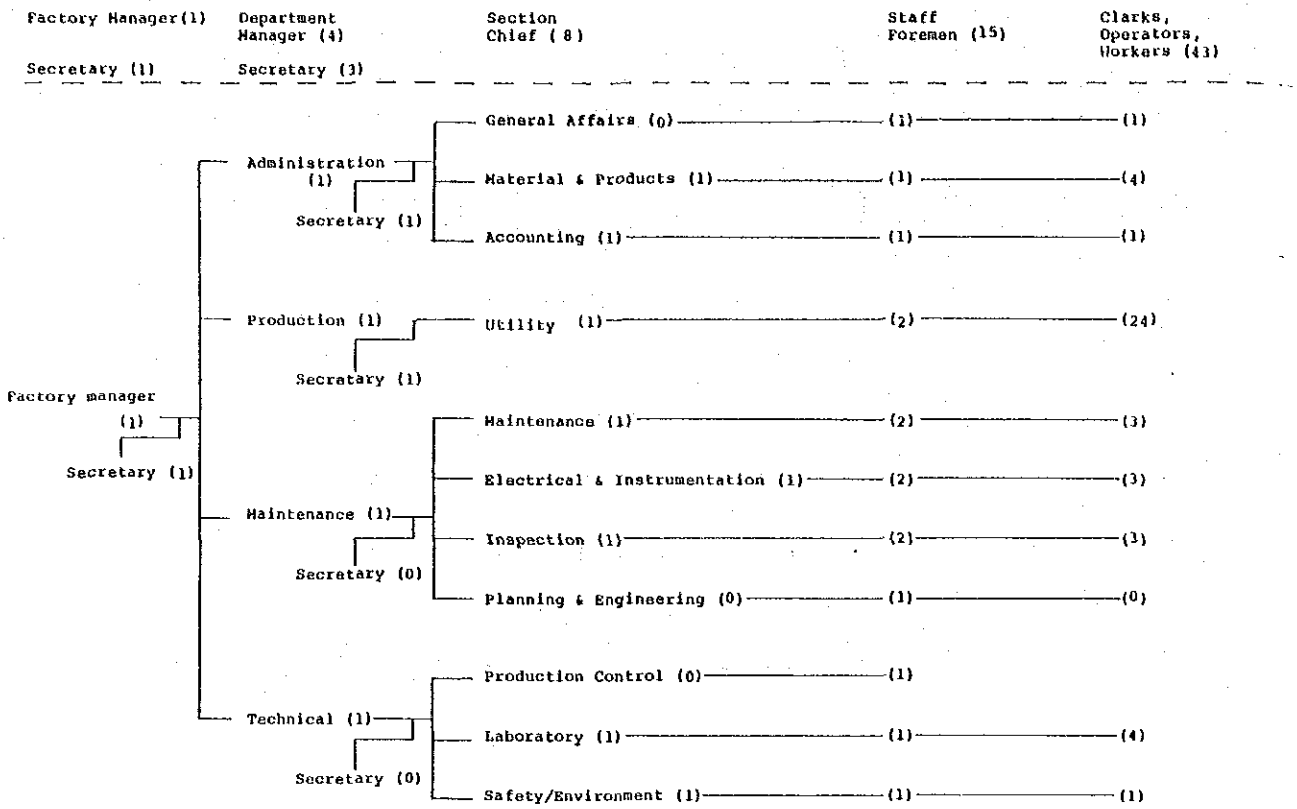


Figure A-4-7 ORGANIZATION CHART FOR THE UTILITY PLANT



Appendix 5-1 RESULT ON FINANCIAL ANALYSIS

ETHYLENE
PROPYLENE
LLDPE
HDPE
VCM
PP

INCOME STATEMENTS
FUNDS FLOW STATEMENTS
FINANCIAL RATE OF RETURN
(CURRENT PRICE, CONSTANT PRICE)

INCOME STATEMENTS (FOR ENDING DECEMBER 31)

CASE 1-1 ***** KERTEH - ETHYLENE ***** (USD 1000)

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
OPERATING INCOME	0.	0.	37634.	64274.	76873.	81586.	86481.	91669.	97170.	103000.
TOTAL SALES REVENUE	0.	0.	37634.	64274.	76873.	81586.	86481.	91669.	97170.	103000.
COST OF SALES	0.	0.	29661.	50638.	56784.	59273.	61895.	64675.	67622.	70746.
VARIABLE COST	0.	0.	17715.	30045.	35829.	37978.	40257.	42673.	45233.	47947.
DIRECT FIXED COST	0.	0.	2981.	5111.	5418.	5743.	6087.	6452.	6839.	7250.
DEPRECIATION AND AMORTIZATION	0.	0.	9077.	15561.	15561.	15561.	15561.	15561.	15561.	15561.
INC. IN PRODUCT INVENTORY	0.	0.	112.	79.	23.	9.	10.	10.	11.	12.
GROSS PROFIT ON SALES	0.	0.	7972.	13636.	20088.	22313.	24585.	26994.	29547.	32254.
SALES EXPENSES	0.	0.	188.	321.	384.	408.	432.	458.	486.	515.
OPERATING PROFIT	0.	0.	7784.	13315.	19704.	21905.	24153.	26536.	29062.	31739.
NON-OPERATING EXPENSES	0.	0.	6642.	8627.	7711.	6794.	5878.	4962.	4046.	3130.
INTEREST ON LONG TERM DEBT	0.	0.	6642.	8627.	7711.	6794.	5878.	4962.	4046.	3130.
INTEREST ON SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NET PROFIT OR (LOSS) BEFORE TAX	0.	0.	1142.	4688.	11993.	15111.	18275.	21574.	25015.	28609.
INCOME TAX	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NON-TAXABLE INCOME	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NET PROFIT OR (LOSS) AFTER TAX	0.	0.	1142.	4688.	11993.	15111.	18275.	21574.	25015.	28609.
DIVIDENDS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
RETAINED EARNINGS	0.	0.	1142.	4688.	11993.	15111.	18275.	21574.	25015.	28609.

INCOME STATEMENTS (FOR ENDING DECEMBER 31)

CASE 1-1 ***** KERTEH - ETHYLENE ***** (USD 1000)

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
OPERATING INCOME	109180.	115731.	122674.	130035.	137837.	146107.	154873.	164166.	174016.	184456.
TOTAL SALES REVENUE	109180.	115731.	122674.	130035.	137837.	146107.	154873.	164166.	174016.	184456.
COST OF SALES	74057.	77567.	72244.	69694.	73850.	78281.	82978.	87956.	93234.	98828.
VARIABLE COST	50824.	53873.	57105.	60532.	64164.	68013.	72094.	76420.	81005.	85865.
DIRECT FIXED COST	7685.	8146.	8635.	9153.	9702.	10284.	10901.	11555.	12248.	12983.
DEPRECIATION AND AMORTIZATION	15561.	15561.	6484.	0.	0.	0.	0.	0.	0.	0.
INC. IN PRODUCT INVENTORY	12.	13.	-20.	-10.	16.	17.	18.	19.	20.	21.
GROSS PROFIT ON SALES	35123.	38164.	50430.	60341.	63987.	67826.	71896.	76209.	80782.	85629.
SALES EXPENSES	546.	579.	613.	650.	689.	731.	774.	821.	870.	922.
OPERATING PROFIT	34577.	37585.	49817.	59691.	63298.	67096.	71121.	75389.	79912.	84706.
NON-OPERATING EXPENSES	2214.	1298.	382.	0.	0.	0.	0.	0.	0.	0.
INTEREST ON LONG TERM DEBT	2214.	1298.	382.	0.	0.	0.	0.	0.	0.	0.
INTEREST ON SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NET PROFIT OR (LOSS) BEFORE TAX	32363.	36287.	49435.	59691.	63298.	67096.	71121.	75389.	79912.	84706.
INCOME TAX	0.	0.	0.	9546.	27316.	29540.	31853.	34265.	36784.	39419.
NON TAXABLE INCOME	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NET PROFIT OR (LOSS) AFTER TAX	32363.	36287.	49435.	50145.	35982.	37556.	39268.	41124.	43128.	45288.
DIVIDENDS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
RETAINED EARNINGS	32363.	36287.	49435.	50145.	35982.	37556.	39268.	41124.	43128.	45288.

INCOME STATEMENTS (FOR ENDING DECEMBER 31)

CASE 1-1 ***** KERTEH - ETHYLENE ***** (USD 1000)

YEAR	2008	2009
OPERATING INCOME	195524.	207255.
TOTAL SALES REVENUE	195524.	207255.
COST OF SALES	104757.	111043.
VARIABLE COST	91017.	96478.
DIRECT FIXED COST	13762.	14588.
DEPRECIATION AND AMORTIZATION	0.	0.
INC. IN PRODUCT INVENTORY	22.	24.
GROSS PROFIT ON SALES	90766.	96212.
SALES EXPENSES	978.	1036.
OPERATING PROFIT	89789.	95176.
NON-OPERATING EXPENSES	0.	0.
INTEREST ON LONG TERM DEBT	0.	0.
INTEREST ON SHORT TERM DEBT	0.	0.
NET PROFIT OR (LOSS) BEFORE TAX	89789.	95176.
INCOME TAX	42180.	45077.
NON-TAXABLE INCOME	0.	0.
NET PROFIT OR (LOSS) AFTER TAX	47609.	50099.
DIVIDENDS	0.	0.
RETAINED EARNINGS	47609.	50099.

FUNDS FLOW STATEMENTS (FOR ENDING DECEMBER 31)

CASE 1-1 ***** KERTEH - ETHYLENE ***** (USD 1000)

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
SOURCE OF FUNDS	47441.	71162.	61848.	28876.	35265.	37466.	39714.	42097.	44623.	47301.
CASH GENERATED	0.	0.	16861.	28876.	35265.	37466.	39714.	42097.	44623.	47301.
PROFIT AFT. TAX, BFR INT.	0.	0.	7784.	13315.	19704.	21905.	24153.	26536.	29062.	31739.
DEPRECIATION AND AMORTIZATION	0.	0.	9077.	15561.	15561.	15561.	15561.	15561.	15561.	15561.
FINANCIAL RESOURCES	47441.	71162.	44987.	0.	0.	0.	0.	0.	0.	0.
SHARE CAPITAL	14232.	21348.	13496.	0.	0.	0.	0.	0.	0.	0.
LONG TERM DEBT	33209.	49813.	31491.	0.	0.	0.	0.	0.	0.	0.
SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
OTHER CASH	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NON-CASH FUNDS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
USES OF FUNDS	46069.	71153.	55066.	22095.	20107.	18602.	17694.	16800.	15907.	15016.
FIXED CAPITAL EXPENDITURE	46069.	71153.	38928.	0.	0.	0.	0.	0.	0.	0.
NON DEPRECIABLE FIXED ASSETS	540.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DEPRECIABLE FIXED ASSETS	44157.	66235.	36798.	0.	0.	0.	0.	0.	0.	0.
INTEREST DURING CONSTRUCTION	1372.	4917.	2130.	0.	0.	0.	0.	0.	0.	0.
CHANGE IN WORKING CAPITAL	0.	0.	2817.	2017.	945.	356.	365.	386.	410.	434.
DEBT SERVICES	0.	0.	13322.	20078.	19162.	18246.	17330.	16414.	15497.	14581.
REPAYMENT OF LONG TERM DEBT	0.	0.	6680.	11451.	11451.	11451.	11451.	11451.	11451.	11451.
REPAYMENT OF SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
INTEREST ON LONG TERM DEBT	0.	0.	6642.	8627.	7711.	6794.	5878.	4962.	4046.	3130.
INTEREST ON SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DIVIDENDS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CASH INCREASE OR (DECREASE)	1372.	9.	6782.	6781.	15158.	18864.	22020.	25297.	28716.	32284.
BEGINNING CASH BALANCE	0.	1372.	1381.	8163.	14943.	30102.	48966.	70986.	96283.	124998.
ENDING CASH BALANCE	1372.	1381.	8163.	14943.	30102.	48966.	70986.	96283.	124998.	157282.