CHAPTER 4

PROPOSED DRAINAGE SYSTEM

4.1 Description of and Recommended for Individual Drainage Basin

Delineation of the drainage basins proposed is identical to that proposed in the WHO Assignment Report, which is elaborated in the following. (Ref. Figures IV-2 and 3)

(1) Drainage Basin I

For this area PMP is applied. The basin is situated in the north-eastern part of the Project Area. It has steep terrain with palm and rubber tree cover and no sizable community exists in it. At the present stage, the area is not subject to flooding.

The outlets are Sungai Kubang Simang and Tuah Abdullah, which confluence to Sungai Derhaka. For the two drains, reserve requirement and storage area are recommended as shown in Figures IV-2 and 3.

Because the ground surface of the area is steep, developments in upstream portions will result in abrupt increase of runoffs. Therefore, it is preferable to store stormwaters inside areas to be developed and limit discharges to the two major outlets, which would result in alleviation of Sungai Derhaka in downstream portion.

(2) Drainage Basin II

The basin occupies a part of Mukim 6, 8, 11, 15 and 17 of Central district. The total area of the basin is 3,793 hectares (9,372 acres). The boundary is the watershed of the Sungai Rambai in the north and the limits of the Project Area in the south and east. The basin is bounded by the watershed of the Bukit Tengah drain (A) in the west as shown in Figures IV-2 and 3. The entire area except sub-basin S_{2-8} is tributary to the Juru river.

The basin comprises higher hilly residential and lower agricultural area. Areas east from about the railway is the hilly part with ground elevation ranging from RL+229 meters (+751 ft) to around RL+5.0 meters (+16.4 ft) in the west limits of Bukit Mertajam town. The Bukit Mertajam is only one urbanized area in this basin and is covered by commercial and densely populated residential area with population density of about 120 persons per hectare.

DMP (Design Master Plan) is applied for main drain ARA. 1 - 3, TAN., PAY. 1, 2, RAM. 5, 6, BUK. 1, 2, PAS. 1 - 3, PEK. 1 - 3, BKC.

and BKD.(*1) Remaining drains are studied under PMP.

Stormwater runoff in the urban area flows into the Bukit Mertajam drain which have a capacity to convey stormwater derived from 5-yr frequency storm at the present stage. The drain flows through core portion of the urban area and it seems to be very difficult to find spaces for widening the drain for the future requirement. It is apparent that upstream of the built-up area still has a potential for development, it should be considered to limit discharge volume to the drain at the present level. And it is necessary to consider several submain drains which run parallel with the Bukit Mertajam drain and confluent to it at downstream of the urban area in which land spaces are still available for improvement of the drain. It would be also required to store stormwater increment inside areas to be developed hereafter. Other main drains which receive stormwater runoff from the urban area are the Sungai Ara, Rambai, Pasir and Pekan Baru. Although flooding problems have not been reported in the area served by these drains, runoff would be increased due to development in the near future. Therefore, cross-sections and longitudinal plan of these drains are proposed as shown in Figures IV-2 and 3.

Outskirt of Bukit Mertajam urban portion can be delineated as mixture of sparsely inhabited residential and agricultural area within which land spaces for drainage facilities are relatively available. Therefore, main drains in this area are studied under PMP.

This portion of Drainage basin II is on the high terrain and is not subjected by back-up of the Juru river. Stormwater runoff in this hilly area can gravitate into the Juru river. Urbanization of this area will cause flooding in the downstream areas, hence it is necessary to hold stormwaters inside the area during intensive rainfall. The allowable discharge quantity to the Juru river is that derived from 2-yr frequency storm with 0.35 runoff coefficient. The required storage capacity is indicated in Figures IV-2 and 3. Because of the absence of any regional or town plan, location of storage ponds can not be clarified at the present stage.

When the major storm occurs, the water level in the proposed drains will rise about 0.6 meters from the existing ground elevation. Due to the steep topography the velocity in the drains would be very large and damages would be of considerable ones. The concept to be applied here is to spread and conduct stormwaters by planning the layout of drains within which several sub-main are running in parallel with the main drain. The combination of this measure and the storage of stormwater increment in areas to be developed will alleviate or eliminate damages due to the major storm.

(*1) These abbreviations are tabulated in Table IV-2.

The west side area of the railway is flat and low-lying and tributary to the Juru river. This area is covered by palm or rubber platation, paddy field and swamps. Although, data on the ground elevation in this low-lying area are not available, information* obtained when the Juru tidal gate was constructed, suggest that the low side of the ground elevation is around RL +0.46 meters (+1.5 ft). Comparing with the mean high water level in the sea of RL +1.10 meters (+3.6 ft) it is understood that this area is very low. To cope with the expected flood here, land filling would generally be preferable to internal storage, because of the expected type of development, which supposedly is piece by piece. In case of internal storage, due to necessity of bunding, the basin wide drainage strategy would have to be incorporated. A basin wide development is not likely to happen in the area hereafter but it would be piecemeal one resulting in gradual urbanization.

The storage area and reserve requirement as shown in Figures IV-2 and 3, have to be included for any new developments when planning permission is applied for.

* During the construction of the tidal gate, it was experienced that numerous complaints for prolonged flooding were received from the farmers when the river was kept at levels between RL +0.46 meters (+1.5 ft) and RL +0.61 meters (+2.0 ft).

(3) Drainage Basin III

The basin bounded by the Prai river in the west and north, and in the east the watershed of Bukit Tengah drain (A) and a boundary of the Project Area. The southern limit of this basin is the shore line along Prai industrial development area. The basin is undeveloped area which is covered by rubber trees and swamps. For this basin PMP is applied.

In the west adjacencies of the basin, Butterworth town extends and in the east paddy fields. It covers an area of 3,964 hectares (9,795 acres). Throughout the basin it is flat and low-lying, with ground elevation ranging from RL +3.48 meters (+11.4 ft) to Rl +0.61 meters (+2.0 ft).

Stormwaters in the basin discharge into three different receiving water bodies including the Prai river, the Juru river and the sea.

The two development areas, the Prai and Seberang Jaya, have their own drainage systems with catchment area independent from surroundings, therefore these areas are not included in this study.

Quantity of discharges from paddy field are considered to be equal to the volume resulted from 2-yr frequency storm with 0.35 runoff coefficient. Reserve requirement and storage area are proposed as shown in Figures IV - 2 and 3. When the area is developed

the proposed spaces have to be set aside for the drainage facilities. In some lowest part of the area, land filling on interior storage with bunding would be inevitable. The selection of proper method should be made after the development scale become clear.

(4) Drainage Basin IV

The entire Butterworth town limit is included in this basin. The northern boundary is the limit of the air force base at which existing major drains have their heads. The west border faces to the channel between Penang Island and Province Wellesley and the east to the Prai river. This basin is the most urbanized and densely populated area in the Project Area. It occupies the whole area of Mukim 14 and 15 of Northern District with the population of 141,800 in the year 2000, which is equivalent to 22 percent of the whole population of the Project Area.

The shape of the basin is almost rectangular to being wide in north and south direction and narrow in east and west. Surface elevations vary from RL +3.8 meters (+12.5 ft) at the basin's northern extremity and RL +1.8 meters (+5.9 ft) at the southern limit near the ferry port.

Existing main drains, called presently "monsoon drain", are named under this Project as is indicated in Figure IV - 4. Those flow in parallel with the shore line of Butterworth from the north to the south and eventually discharge into the Prai river.

Because of topographical situation in which the ground surface forms wave mortion with peaks and troughs running in parallel with the shore line, the stormwaters are not able to gravitate toward the sea. As a result, the length of the drains reaches as long as 4.0 km (2.5 miles) - 6.5 km (4.0 miles), while the distances from the drains to the shore line are between 1.8 km (1.1 miles) and 0.8 km (0.5 miles).

The diversion of runoffs to the sea shore has been investigated as one of alternatives to be considered. (Ref. Appendix J, "Drainage System Consideration") The recommended drainage system consists of main drains which are improved existing drains and reservoirs to cut peak discharge. This system is termed alternative III in the study in Appendix J, Volume III. It becomes clear the diversion system is costy and bears engineering difficulties including sand accumulation problems at the outlet of diversion ditches and inconveniences for the traffic during construction period of box culverts under the main roads. Thus the diversion system is not recommended for the area.

Butterworth drains A, B and C (BWA, BWB, and BWC, Ref. Figures IV - 2 and 3) are piecemeal improvement of natural water course that existed before the urban development began. They are heavily silted and impaired with vegetation. Generally, these existing drains with meandering alignment of varied widths and depths present the single need for improvement. Because of swamps existed

in the area to which the main drains are dispersing at several portions, flooding in the basin is not so serious in spite of the inadequate conditions in drainage systems.

The present situations mentioned above indicate the great contribution of swamps for alleviating floods. Although being preferable to preserve these existing swampy areas, difficulties in land acquisition are expected because Butterworth area is valuable estate. In this Master Plan, therefore, storage areas to cope with extreme intense rain of 100-yr frequency is not considered for the basin.

Neverthless, it is emphasized that at the final design the availability of storage area should be investigated carefully and considered to store stormwaters as much as possible. For areas to be developed hereafter, the municipality can impose spaces needed for storage of stormwaters to developers as the basic requirement for approval of the development application.

Areas along the BWA are built-up and the availability of land space in both sides of the drain is limited. Downstream areas of the BWB and BWC have already been developed densely and constitutes industrial, commercial and housing areas.

Accounting those situations above, the reserves assigned for the drains are the least spaces required for open channels having capacity to convey runoff derived from 5-yr frequency storm and the access for maintenance works of 4.0 meters. The recommended channel is of rectangular section of reinforced concrete which will result in least land spaces requirement.

The water level in these channels is below the general ground level of much of Butterworth area, it will be possible for stormwater to gravitate into the Prai river. However, if the sea level rises up to the maximum recorded level of RL +1.68 meters (+5.5 ft) some lower swampy areas will be flooded. It is therefore necessary to raise the ground by filling.

The construction of reservoirs is recommended in BWB and BWC. Stormwaters derived from the storm with frequency larger than 5-yr will be stored in the reservoirs during heavy rains and released after rain stops. To protect the industrial area of Mak Mandin, the storage of stormwaters in upstream area will be desired and it should be investigated in the feasibility study deeply on the basis of detail data.

When the major storm occurs the water level in the drain will be 0.6 meters (2 ft) higher than the existing ground elevation. At the point just downstream of the reservoir the water level rises as high as 1.2 meters (4 ft) above the ground surface, because the cross section at the point is smaller than that of adjacent portion. Considering topographical feature in this basin, expected damages would be inundation up to the ground floor. The velocity of the

flood water would be low and the destruction of premises would be unlikely. To minimize damages, the floor level in new housing scheme and the level of bridges to be constructed newly should be determined on the basis of the major flood level shown in Figures J-6, 7 and 8 of Appendix J, "Drainage System Consideration", Volume III. Recommended networks of smaller drains are shown in Figures J-12 and 13, Appendix J. These consist of rectangular shape concrete ditches to conserve valuable real estate.

(5) Drainage Basin V

Basin V, 570 hectares (1,408 acres) in extent, is situated in the east of basin IV and lies exclusively in Mukim 16 of Northern District. Runoff in the area discharges into two sizable irrigation waterways, eventually flowing into the Prai river. Existing ground elevation is less than RL +0.9 meters (+3 ft) and mostly flat. The area is mixture of swamps and palm trees.

The basin is studied by the Preventative Master Plan. In Figures IV - 2 and 3, the reserve requirement and storage area to be set aside are indicated.

The water level of the Prai river to which the basin is tributary, will be kept at RL +0.60 meters (+2.0 ft) during dry weather by the barrage to be constructed in the future. According to the Prai river reclamation plan, the water level, at the time of intense storm (40-yr return period) will rise as high as RL +1.37 meters (+4.5 ft). Considering the relation between both levels of the Prai river and ground surface of the basin, the land filling is necessary as has been planned for the new development now applied for the municipality. For that development of housing area, the storage of stormwaters and land filling are adopted as stormwater drainage strategy. As far as the basin is urbanized gradually by piecemeal development, it will be preferable to cope with expected flood with land filling and storage of runoff.

At the time of the final design of main drains proposed, the water quantity discharged from paddy field extended in upstream area of the drains, should carefully be investigated.

(6) Drainage Basin VI

In the extremity of northern position of the Project Area, the Basin VI is situated and occupies portions of Mukim 7 and 9 of Northern district. The area is 544 hectares (1,344 acres) excluding the air force base.

The area consists of paddy field and palm trees plantation. Only one sizable community is found in the north-western corner of the basin. Surface elevation is about RL +2.7 meters (+9.0 ft) at the southern limit and RL +3.4 meters (+11.1 ft) in the north. It is possible for stormwaters to gravitate into the Prai river.

Runoff of the area is now discharged together with wastewaters from paddy fields by existing Benggali drain flowing toward south and Abdul drain to north eventually discharging to the Prai river and the sea respectively.

4.2 Proposed Drainage Facilities

4.2.1 Main Drain

Main drains in built-up areas are studied in accordance with the Design Master Plan requirement and ones in undeveloped areas are under the Preventative Master Plan.

General layout and recommendations are shown in Figures IV - 2 and 3. Criteria used for the decision of reserves are as follows:

a. In built-up areas

Space required for open channel having capacity of conducting stormwater resulted from 5-yr frequency storm plus the maintenance access of four meters.

b. In undeveloped areas

Stormwater quantity derived from the major storm with runoff coefficient of 0.65 is initially estimated. Based on the quantity, reserve requirement is determined on the basis of the standard of Drainage and Irrigation Division, Ministry of Agriculture, Malaysia.

Proposed routes of the main drains are based on that of existing major water courses, natural or artificial, which are shown in available topographical map and confirmed by field investigation. In case of Butterworth area, the routes are decided through a comparative study of alternatives.

Flows are estimated on the basis of criteria shown in Section 3.3, Part IV. Considering land availability, the recommended shape of cross section of main drains is a rectangle in densely populated areas and a trapezoid in sparsely populated ones. Reinforced concrete is used for the rectangular drain and stone or earth for the trapezoidal drain. (Ref. Appendix J, "Drainage System Consideration)

4.2.2 Network of Smaller Drain

In Figures J-12 and 13 of Appendix J, "Drainage System Consideration", the typical network of smaller drains in residential and industrial areas are shown.

Pre-cast "U" shape drains in sizes form 240 x 240 mm to 900 x 900 mm are used, and, for larger sizes, cast-in-place reinforced concrete rectangular channels are adopted because of advantages in which the land space will be conserved and maximum development will be permitted. The network of smaller drains shown in Figures J-12 and 13 are intended to be illustrative for the estimated unit construction cost in terms of M$/ha.

4.2.3 Storage System

The concept of a storage of stormwater is applied in this master plan. The objective of storage is to eliminate damages due to the Major Storm (100-yr return period) in undeveloped areas within which land spaces for storage area are available. At the time any development plan is applied the area for storage of stormwaters has to be set aside and increment of stormwater runoff derived from the development should be stored in that assigned area. The area should be gazetted as the zone not to permit any development and to be utilized for green belts or parks. The required storage area in individual sub-basin is shown in Figures IV - 2 and 3. Because of absence of any town or regional plan in those undeveloped areas, the location of storage areas are not clarified at the present stage.

On the other hand, in built-up area, especially Butterworth in this master plan, reservoirs to cut peak discharge from the Initial Storm are furnished as the economical measure after a comparison of alternative systems. (Ref. Section 3.3, Part IV) Because, in built-up areas, land is not available for storage areas to deal with the major storm, the reservoir for the Initial Storm is adopted in Butterworth area. The capacities of these reservoirs are 10,000 cu m and 17,000 cu m as shown in Figures IV-2 and 3.

The necessary capacity of these storage areas and reservoirs are calculated using the criteria described in Sections 2.2 and 3.5, Part IV. In case of final design the gate size has to be calculated on the basis of the principle mentioned above while accounting situation of the individual reservoir. The level of the base of reservoirs should be higher in any case than that of drains to which stored stormwaters are to be discharged.

Typical profile of the recommended reservoir is shown in Figure J-9, Appendix J, "Drainage System Consideration".

4.2.4 Materials and Methods of Construction

(1) Construction Materials

Cements, sands and gravels are available with adequate quantities in Malaysia. It is able to get stones for construction of masonry channel rather easily and they have been used in Malaysia as favorable materials with reasonable price.

All materials used for the construction of proposed drainage system would be available locally. It is confirmed that any type of pre-cast concrete channel could be produced by the existing firms in Malaysia.

(2) Construction Methods

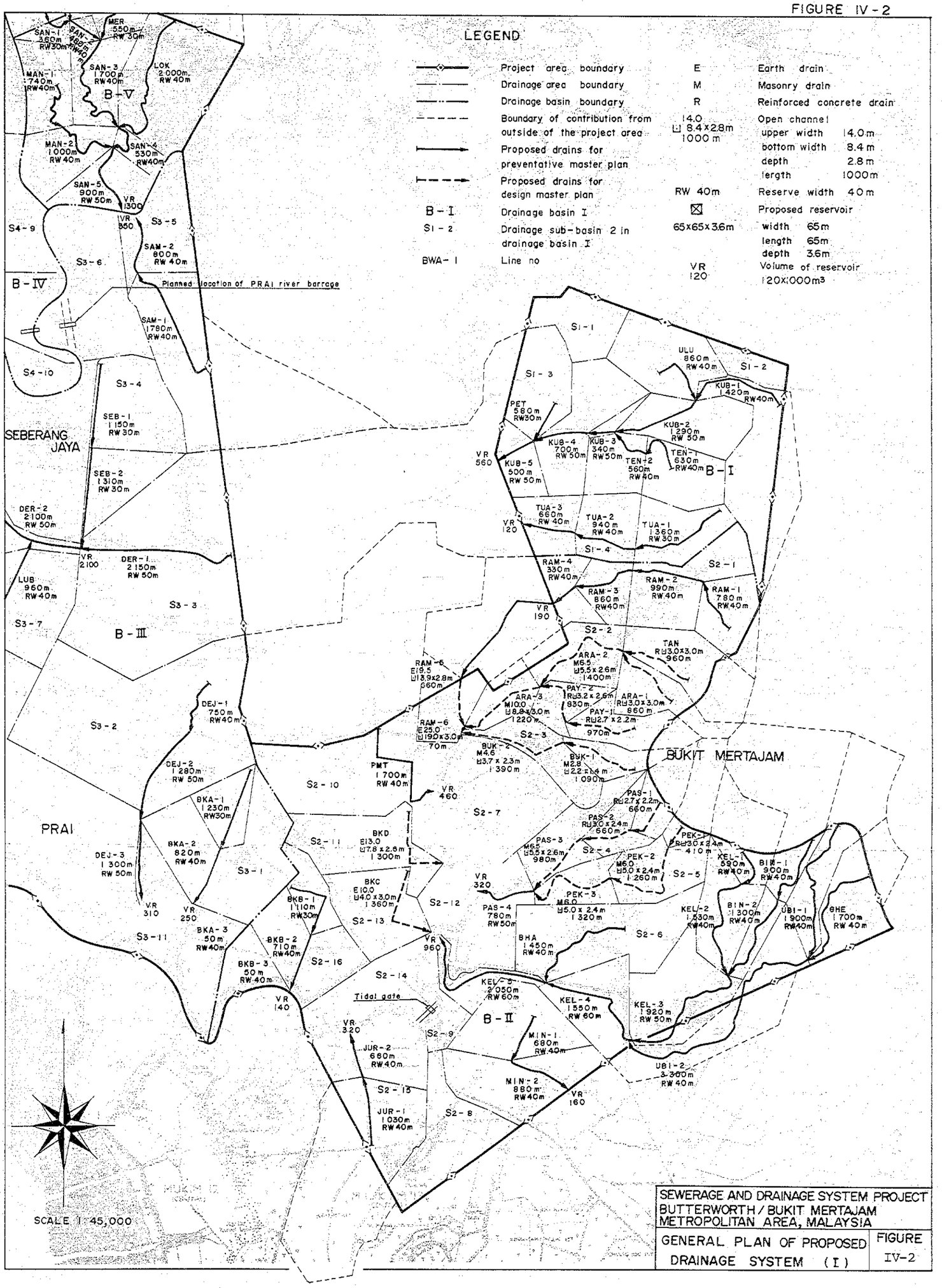
Machine excavation, steel sheet piling and any other mechanical works required for the construction of drainage systems can be done with equipments locally available.

Discussions with government staff and observation on various civil works which are on-going in Penang State convince that any construction method required for the Project would be feasible.

However, availability of land is the another factor to be considered when construction method is to be determined. In the case of areas still to be developed, it is possible to take greater variety of construction methods into account because of adequate space for works.

On the other hand, in case of built-up area such as Butterworth, constraints will be imposed due to the inadequate space and the traffic problems during the construction period.

FIGURE IV-2


LEGEND
Project area boundary
Drainage area boundary
Drainage basin boundary
Boundary of contribution from outside of the project area
Proposed drains for preventative master plan
Proposed drains for design master plan
B-I Drainage basin I
S1-2 Drainage sub-basin 2 in drainage basin I
BWA-1 Line no
E Earth drain
M Masonry drain
R Reinforced concrete drain
14.0 □ 8.4x2.8m 1000 m Open channel upper width 14.0m bottom width 8.4 m depth 2.8 m length 1000m
RW 40m Reserve width 40 m
Proposed reservoir
65x65x3.6m width 65m length 65m depth 3.6m
VR 120 Volume of reservoir 120x1000m3
Planned location of PRAI river barrage
B-I
B-II
B-III
B-IV
B-V
BUKIT MERTAJAM
PRAI
SEBERANG JAYA
Tidal gate
SCALE 1:45,000
SEWERAGE AND DRAINAGE SYSTEM PROJECT
BUTTERWORTH / BUKIT MERTAJAM METROPOLITAN AREA, MALAYSIA
GENERAL PLAN OF PROPOSED DRAINAGE SYSTEM (I)
FIGURE IV-2

SCALE 1: 45,000

LEGEND

——◇——	Project area boundary
——·——	Drainage area boundary
——··——	Drainage basin boundary
- - - - - -	Boundary of contribution from outside of the project area
⊢——→	Proposed drains for preventative master plan
⊢- - -→	Proposed drains for design master plan
B-I	Drainage basin I
S1-2	Drainage sub-basin 2 in drainage basin I
BWA-1	Line no
E	Earth drain
M	Masonry drain
R	Reinforced concrete drain
14.0 ⊔ 8.4x2.8m 1000 m	Open channel upper width 14.0m bottom width 8.4 m depth 2.8 m length 1000m
RW 40 m	Reserve width 40 m
☒	Proposed reservoir
65x65x3.6m	width 65m length 65m depth 3.6m
VR 120	Volume of reservoir 120x1000 m³

AIR FORCE BASE

BUTTERWORTH

SEBERANG JAYA

PRAI

B-I B-II B-III B-IV B-V B-VI

S1-1 S1-2 S2-1 S2-2 S2-10 S3-1 S3-2 S3-3 S3-4 S3-5 S3-6 S3-7 S3-8 S3-9 S3-10 S4-1 S4-2 S4-3 S4-4 S4-5 S4-6 S4-7 S4-8 S4-9 S4-10 S6-1 S6-2 S6-3

GEL-1 650m RW30m
GEL-2 1030m RW30m
BAG-3 1300m RW40m
BAG-2 1130m RW30m
BAG-1 800m RW30m
BEN-1 650m RW30m
BEN-2 630m RW30m
BEN-3 800m RW30m
JAY 250m RW30m
VR 120
SAN-1 360m RW30m
SAN-2 480m RW30m
MER 550m RW30m
LOK 2000m RW40m
SAN-3 1700m RW40m
MAN-1 740m RW30m
MAN-2 1000m RW40m
SAN-4 530m RW40m
SAN-5 900m RW50m
VR 1300
SR 350
SAM-2 800m RW40m
SAM-1 780m RW40m
SEB-1 1150m RW30m
SEB-2 1310m RW30m
DER-2 2100m RW50m
VR 2100
DER-1 2150m RW50m
LUB 960m RW40m
BWA-1 1000m RU35x2.8m
BWA-2 910m RU40x2.2m
BWA-3 1000m RU45x3.6m
BWA-4 870m RU50x4.0m
BWA-5 820m RU55x4.4m
BWA-6 830m RU55x4.4m
BWA-7 1250m RU62x4.4m
BWB-1 900m RU45x3.6m
BWB-2 900m RU45x3.6m
BWB-3 1960m RU45x3.6m
BWB-4 1020m RU45x4.4m
BWB-5 930m RU47x3.8m
BWB-6 220m RU76x4.7m
BWC-1 890m RU40x3.0m
BWC-2 1810m RU45x3.6m
65x65x2.8m VR10
80x80x3.2m VR17
BWD 320m RU22x1.3m
BWE RU45x4.2m 870m
Planned location of PRAI river barrage

SEWERAGE AND DRAINAGE SYSTEM PROJECT
BUTTERWORTH/BUKIT MERTAJAM
METROPOLITAN AREA, MALAYSIA

GENERAL PLAN OF PROPOSED DRAINAGE SYSTEM (II) — FIGURE IV-3

4.3 Staging of Construction

Priorities have to be established in implementing the construction programme in accordance with the urgency of the work involved and for justification of initial investment. The major factors considered are:

(1) Even the degree of flooding is in the stage of minor "nuisance", the damages to public health due to repetitious pondings can not be ignored, so flood-prone areas are given high priority.

(2) The priority should be high in the areas within which rapid urbanization is proceeding, where stormwater runoff quantities are expected to increase and cause deteriorated situations in terms of drainage conditions in the near future.

(3) It is preferable to coincide with the sewerage system staging programme so that the network of smaller drains will be constructed together with the sanitary sewers.

On the basis of the above consideration, following staging programmes are proposed and are shown in Figure IV-4. Tables IV-7 - 14 give construction cost of individual stage.

(1) First Stage Programme

The first stage programme includes the general improvement of drainage situations in two urbanized areas, Butterworth and Bukit Mertajam. Those consists of increasing the capacity of existing main drains by converting them to rectangular channel of reinforced concrete or enlarging cross-sectional area of existing earth drains. The construction of two reservoirs and the extention of BWC in its upstream portion are also carried out in this stage.

These improvements are necessary for alleviation of local flooding occured at present and coping with the expected increase in stormwater runoff quantities resulted from rapid urbanization which is proceeding now. The improved main drains would function as the back-bone of the drainage system in the area. As a result many ponding areas would be dried up and it would contribute to the control of mosquito breeding. Development in the area would be accelerated because of land conditions free from flooding problem. The provision of the network of smaller drains would be carried out along with the development of the area.

The area covered by the first stage programme is shown in Figure IV-4.

(2) Second Stage Programme

The improvement of two main drains in Basin-VI, flowing along

the boundary of the air force base, Benggali and Bagan Tambang drains, are to be included in the second stage programme.

By these earth drains, the safety of the air field, in terms of flooding due to stormwater runoff from outside of the area, will be guaranteed.

The improvement of network of smaller drains in existing built-up areas including S_{3-7}, S_{3-8}, S_{3-9}, and S_{3-10} of Basin III will be conducted during this stage.

By the end of the second stage programme, the majority of existing built-up areas would be served by adequate drainage systems.

(3) Third Stage Programme

The provision of network of smaller drains to Drainage Basin V, VI and a part of sub-basin S_{3-2} and S_{3-3} are included in the third stage programme.

The improvement of the Sungai Tuan Abdullah, Rambai and Pekan Bharu together with the provision of road-side drains to their tributary will be implemented during this stage.

The construction work will be carried out simultaneously with the sewerage system provision.

(4) Fourth Stage Programme

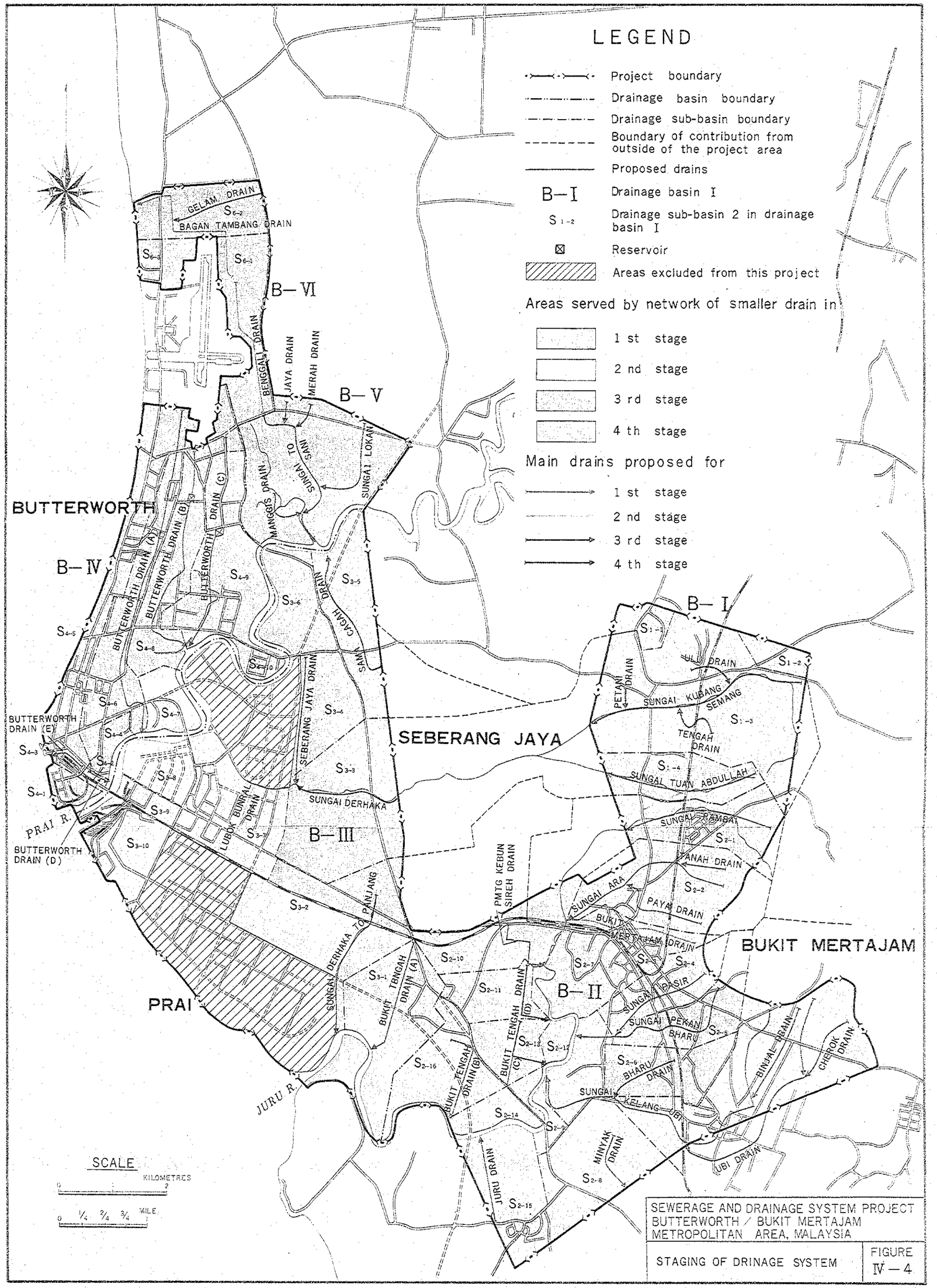
In the fourth stage following works will be included.

i) The improvement of Sungai Kubang Semang and Kelang Ubi.

ii) The construction of new drains including the Juru, Bukit Tengah (A), Bukit Tengah (B) and Seberang Jaya drain.

iii) The provision of network of smaller drains in Basin-I, a part of S_{2-4} and S_{2-6}, S_{2-8}, S_{2-9}, a part of S_{2-10}, S_{2-11}, S_{2-13} and S_{2-14}, S_{2-15}, S_{2-16} of Basin II, and S_{3-1}, a part of S_{3-2} and S_{3-3}, S_{3-4}, S_{3-5}, S_{3-6}, and S_{3-11} of Basin III.

FIGURE IV-4



SEWERAGE AND DRAINAGE SYSTEM PROJECT
BUTTERWORTH / BUKIT MERTAJAM
METROPOLITAN AREA, MALAYSIA

STAGING OF DRINAGE SYSTEM | FIGURE IV — 4

CHAPTER 5

CONSTRUCTION AND MAINTENANCE COST

5.1 Construction Cost

5.1.1 Main Drains

1) Unit Cost

The unit cost estimates used in preparing the drainage programme and presented herein are based on the available unit cost of lavour, materials, power, equipment and transportation, as applicable in Penang in 1976. (Ref. Appendix E, "Design Data") As described in Section 3.4, three types of open channels are recommended for this Project. For individual type of drains cost curve is developed, taking into account the available or estimated cost of excavation, sheeting, shoring, dewatering, reinforcing, forming, concrete spreading and restoration of paving. They do not include unusual soil and dewatering problems or any other extra costs. In Figure J-10, developed curves of unit cost are presented. (Ref. Appendix J, "Drainage System Consideration")

2) Construction Cost of System

Construction cost of main drains are estimated on the basis of designed cross section and unit construction cost mentioned in previous section. The construction cost shown in Table IV-4 consists of direct lavour and material cost, overheads of 20 percent of the direct cost, contingencies of 20 percent and 10 percent engineering fee. Land acquisition cost includes that for maintenance roads as shown in Figure J-11, Appendix J.

In Butterworth area, average of 3.0 meters are allocated for maintenance roads. Because the sites through which main drains flow are apart from existing roads in most of the cases, the construction work would involve various difficult conditions with extra cost. Therefore, 20 percent contingencies are estimated as described above.

5.1.2 Network of Smaller Drains

1) Unit Cost

Unit construction cost of network of smaller drains is estimated on the basis of street plan in the housing development area

and industrial area. These are shown in Figures J-12 and J-13. The required size of individual road-side drain is calculated and construction cost is estimated depending on cost curves shown in Figure J-10, with assumption that the commercial and densely populated residential areas would have the same characteristics in terms of layout of smaller drains. The cost of industrial area is also estimated. It is considered the cost in sparsely inhabited residential areas with population density of 52 persons per hectare could be approximated by the following equation.

$$C_1 = \frac{52}{120} \times C_2$$

where

C_1 = construction cost in sparsely inhabited residential area with population density of 52 persons/ha.

C_2 = construction cost in densely inhabited residential area with population density of 120 persons/ha

Calculated unit construction costs are summarized as follows:

Residential area		
densely populated	32,400	M$/ha
sparsely populated	14,300	"
Commercial area	32,400	"
Industrial area	30,000	"

Table IV-5 of the present document gives construction cost of the network of smaller drains in individual drainage basin.

5.1.3 Reservoirs

The Construction cost of reservoirs is estimated depending on cost curve shown in Figure J-10. In Table IV-4, cost required for the reservoir is shown.

TABLE IV-4 Construction Cost of Drainage Basin at 1976 Price Level
(Government Contribution)

(M$ 1,000)

	Description	Basin I	Basin II	Basin III	Basin IV	Basin V	Basin VI	Total	Remarks
a.	Main Drains	7,790	48,090	7,480	37,030	5,560	2,340	108,290	
b.	Reservoirs for Initial Storm	-	-	-	350	-	-	350	
c.	Reservoirs for Major Storm	5,300	19,700	23,100	-	9,000	1,000	58,100	
d.	Land Acquisition	-	2,050	-	3,400	-	-	5,450	
(A)	Sub-Total	13,090	69,840	30,580	40,780	14,560	3,340	172,190	
(B)	Contingency	2,620	13,970	6,110	8,150	2,910	660	34,420	(A)x0.20
(C)	Engineering Fee								
	Design	780	4,190	1,830	2,440	870	200	10,310	(A+B)x0.05
	Supervision	780	4,190	1,830	2,440	870	200	10,310	(A+B)x0.05
	Total	17,270	92,190	40,350	53,810	19,210	4,400	227,230	

TABLE IV-5 Construction Cost of Smaller Drain at 1976 Price Level
(Private Contribution)

(M$ 1,000)

	Description	Basin I	Basin II	Basin III	Basin IV	Basin V	Basin VI	Total	Remarks
(A)	Network of Smaller Drains	14,110	53,130	44,210	30,140	6,900	7,530	156,020	
(B)	Contingency	2,820	10,620	8,840	6,020	1,380	1,510	31,190	(A)x0.20
(C)	Engineering Fee								
	Design	850	3,190	2,650	1,800	410	450	9,350	(A+B)x0.05
	Supervision	850	3,190	2,650	1,800	410	450	9,350	(A+B)x0.05
	Total	18,630	70,130	58,350	39,760	9,100	9,940	205,910	

5.2 Maintenance Cost

(1) Unit Cost

Maintenance work for drains consists mainly of removal of deposits from drains and carrying those wastes from the sites to assigned dumping places. Repairing of broken parts of channels are also included in the maintenance work. For the purpose of estimating maintenance cost, it is assumed that the cost for removing deposits from drains is the same as that of excavation. For main drains, machine excavation will be applied and for smaller ones, hand excavation will be applied. For the cost of carrying removed materials from the site to planned dumping places, the cost of disposing of excess soil is applied.

On the basis of assumptions above, the unit cost for maintemance is estimated at 5 M$/cu m. The average volume of deposits in drains is estimated roughly on the assumption which the part of accumulation of silt to be removed would be 10 percent of the cross section area. The average cross section area of main drains proposed, is 22 sq m. The deposit volume, therefore, is 22 x 0.1 = 2.2 cu m per one meter of drains.

The unit maintenance cost for smaller drains is expressed in Malaysian dollar per one hectare. The average cross section area of smaller drains is 0.50 sq m with the average volume of deposits of 0.05 cu m per unit length.

It is estimated that the drain length per one hectare in densely populated residential area is about 450(*1) meters. The volume of deposits to be removed is 0.05 x 450 = 22.5 cu m. It is summarized as follows:

Maintenance costs of main drains : M$11/m

Maintenance costs of network of smaller drains

(in densely populated area) : M$110/ha
(in sparsely populated area)(*2): M$50/ha

(*1): The total length of drains in selected representative residential area (Ref. Figure J-12) is 13,716 meters and the area is 30.57 hectares. The length of drains per hectare, therefore, is 13,716 / 30.57 = 449 m/ha, say 450 m/ha.

(*2): The maintenance cost in sparsely populated area is,

$$22.5 \times 5 \times \frac{52}{120} = \text{M\$50/ha.}$$

Table IV-6
Table IV-7

(2) Maintenance Cost of System

As a basis of the maintenance cost estimate, the amount of maintenance work has to be clarified.

TABLE IV-6 Amount of Maintenance Work

Stage	Area Served by Smaller Drain		Length of Main Drain (km)
	Densely Populated (ha)	Sparsely Populated (ha)	
1st	2,184	743	53.88
2nd	3,516	1,289	67.62
3rd	4,149	2,998	84.51
4th	4,261	7,192	109.80

Based on practice in Japan, it is assumed that all drains will be cleaned at least every four years. Table IV-7 gives cost required for maintenance work concerning with the amounts shown in Table IV-6.

TABLE IV-7 Drainage Maintenance Cost

(M$1,000/year)

Stage	Maintenance Cost of Smaller Drains		Maintenance Cost of Main Drains	Total
	In Densely Populated Area	In Sparsely Populated Area		
1st	240	40	590	870
2nd	390	60	740	1,190
3rd	460	150	930	1,540
4th	470	360	1,210	2,040
Total	1,560	610	3,470	5,640

5.3 Stagewise Construction Cost

On the basis of the unit cost described above, and with the proposed facilities for each of the stages recommended, total cost for each of the stages is estimated and expressed in Tables IV-8 - 15.

TABLE IV-8 Summary of Drainage Construction Costs for First Stage Programme with 1985 Completion (Government Contribution)

(In thousand of M$ at 1976 Price Level)

Description	Local Currency	Foreign Currency	Total Cost	Remarks
a. Main Drains	37,550	9,390	46,940	
b. Reservoirs for Initial Storm	280	70	350	
c. Reservoirs for Major Storm	-	-	-	
d. Land Acquisition	4,490	-	4,490	
(A) Sub-Total	42,320	9,460	51,780	
(B) Contingency	8,460	1,890	10,350	(A) x 0.20
(C) Engineering Fee				
Design	3,100	-	3,100	(A+B) x 0.05
Supervision	3,100	-	3,100	(A+B) x 0.05
Total	56,980	11,350	68,330	

Note: Twenty percent of construction cost is estimated as foreign currency, and no foreign currency is estimated for engineering fee.

TABLE IV-9 Summary of Drainage Construction Costs for First Stage Programme with 1985 Completion (Private Contribution)

(In thousand of M$ at 1976 Price Level)

Description	Local Currency	Foreign Currency	Total Cost	Remarks
Network of Smaller Drains	31,870	7,970	39,840	
(A) Sub-Total	31,870	7,970	39,840	
(B) Contingency	6,370	1,590	7,960	(A) x 0.20
(C) Engineering Fee				
Design	2,390	-	2,390	(A+B) x 0.05
Supervision	2,390	-	2,390	(A+B) x 0.05
Total	43,020	9,560	52,580	

Note: Twenty percent of construction cost is estimated as foreign currency, and no foreign currency is estimated for engineering fee.

TABLE IV-10 Summary of Drainage Construction Costs for Second Stage Programme with 1990 Completion (Government Contribution)

(In thousand of M$ at 1976 Price Level)

Description	Local Currency	Foreign Currency	Total Cost	Remarks
a. Main Drains	4,040	1,010	5,050	
b. Reservoirs for Initial Storm	-	-	-	
c. Reservoirs for Major Storm	800	200	1,000	
d. Land Acquisition	330	-	330	
(A) Sub-Total	5,170	1,210	6,380	
(B) Contingency	1,030	240	1,270	(A) x 0.20
(C) Engineering Fee				
Design	380	-	380	(A+B) x 0.05
Supervision	380	-	380	(A+B) x 0.05
Total	6,960	1,450	8,410	

Note: Twenty percent of construction cost is estimated as foreign currency, and no foreign currency is estimated for engineering fee.

TABLE IV-11 Summary of Drainage Construction Costs for Second Stage Programme with 1990 Completion (Private Contribution)

(In thousand of M$ at 1976 Price Level)

Description	Local Currency	Foreign Currency	Total Cost	Remarks
Network of Smaller Drains	15,240	3,810	19,050	
(A) Sub-Total	15,240	3,810	19,050	
(B) Contingency	3,050	760	3,810	(A) x 0.20
(C) Engineering Fee				
Design	1,140	-	1,140	(A+B) x 0.05
Supervision	1,140	-	1,140	(A+B) x 0.05
Total	20,570	4,570	25,140	

Note: Twenty percent of construction cost is estimated as foreign currency, and no foreign currency is estimated for engineering fee.

TABLE IV-12 Summary of Drainage Construction Costs for Third Stage Programme with 1995 Completion (Government Contribution)

(In thousand of M$ at 1976 Price Level)

Description	Local Currency	Foreign Currency	Total Cost	Remarks
a. Main Drains	13,660	3,420	17,080	
b. Reservoirs for Initial Storm	-	-	-	
c. Reservoirs for Major Storm	9,200	2,300	11,500	
d. Land Acquisition	630	-	630	
(A) Sub-Total	23,490	5,720	29,210	
(B) Contingency	4,700	1,140	5,840	(A) x 0.20
(C) Engineering Fee				
Design	1,750	-	1,750	(A+B) x 0.05
Supervision	1,750	-	1,750	(A+B) x 0.05
Total	31,690	6,860	38,550	

Note: Twenty percent of construction cost is estimated as foreign currency, and no foreign currency is estimated for engineering fee.

TABLE IV-13 Summary of Drainage Construction Costs for Third Stage Programme with 1995 Completion (Private Contribution)

(In thousand of M$ at 1976 Price Level)

Description	Local Currency	Foreign Currency	Total Cost	Remarks
Network of Smaller Drains	27,380	6,850	34,230	
(A) Sub-Total	27,380	6,850	34,230	
(B) Contingency	5,470	1,370	6,840	(A) x 0.20
(C) Engineering Fee		-		
Design	2,050	-	2,050	(A+B) x 0.05
Supervision	2,050	-	2,050	(A+B) x 0.05
Total	36,950	8,220	45,170	

Note: Twenty percent of construction cost is estimated as foreign currency, and no foreign currency is estimated for engineering fee.

TABLE IV-14 Summary of Drainage Construction Costs for Fourth Stage Programme with 2000 Completion (Government Contribution)

(In thousand of M$ at 1976 Price Level)

Description	Local Currency	Foreign Currency	Total Cost	Remarks
a. Main Drains	31,380	7,840	39,220	
b. Reservoirs for Initial Storm	-	-	-	
c. Reservoirs of Major Storm	36,480	9,120	45,600	
d. Land Acquisition	-	-	-	
(A) Sub-Total	67,860	16,960	84,820	
(B) Contingency	13,570	3,390	16,960	(A) x 0.20
(C) Engineering Fee				
Design	5,080	-	5,080	(A+B) x 0.05
Supervision	5,080	-	5,080	(A+B) x 0.05
Total	91,590	20,350	111,940	

Note: Twenty percent of construction cost is estimated as foreign currency, and no foreign currency is estimated for engineering fee.

TABLE IV-15 Summary of Drainage Construction Costs for Fourth Stage Programme with 2000 Completion (Private Contribution)

(In thousand of M$ at 1976 Price Level)

Description	Local Currency	Foreign Currency	Total Cost	Remarks
Network of Smaller Drains	50,320	12,580	62,900	
(A) Sub-Total	50,320	12,580	62,900	
(B) Contingency	10,060	2,520	12,580	(A) x 0.20
(C) Engineering Fee				
Design	3,770	-	3,770	(A+B) x 0.05
Supervision	3,770	-	3,770	(A+B) x 0.05
Total	67,920	15,100	83,020	

Note: Twenty percent of construction cost is estimated as foreign currency, and no foreign currency is estimated for engineering fee.

CHAPTER 6

BENEFITS

6.1 Introduction

Proper construction and operation of drainage systems are expected to result in certain types of benefits towards inhabitants of the areas concerned. These benefits include items, both quantifiable and non-quantifiable as follows:

(a) Prevention of the occurrence of flood damages.

(b) Stimulation of development in the protected areas and increase of land value.

(c) Improvement of comfort and convenience of the individual and community.

(d) Decrease swampy area and mosquito breeding.

The items above are discussed in the following sections.

6.2 Prevention of Occurrence of Flood Damages

In urban areas local flooding can and does cause considerable nuisance and hardship to those affected, which the problem can be alleviated by proper remedial work on the drainage system. The implementation of such works will result in considerable benefit to the community at large, in terms of public road and private properties becoming flood free, and also, in a more significant benefit, to the living condition of people whose houses and business premises were previously flood prone.

The quantifiable benefit expected by preventing flooding is equivalent to the amount of damages due to the flood. In the absence of data concerning flood damages the quantity of benefit is not figured. However, it should be kept in mind that the expenditure to recover flood damages is recurrent cost upon residents or the municipality and will increase unless flood relief measures are undertaken.

6.3 Stimulation of Development in the Protected Areas and Increase of Land Value

With the provision of infrastructure including drainage system, development programme, for both public and private sectors, will be greatly stimulated and land values increased. The value added to the land tends to equal or exceed the pro rata share of the total investment involved.

The added land value will be major economic benefit which will stimulate larger scale of financial transaction, and will cause additional source of taxation for the revenue in favour of the government agencies concerned. (Ref. Part III, "Sewerage Master Plan")

6.4 Improvement of Comfort and Convenience of the Individual and Community

Benefits under this item can be understood easily when situations in which certain area is flooded and all kinds of waste water including sullage, human excreta and discharge from industry, are mixed each other spreading coliforms, disease germs and toxic materials.

It is generally recognized through abundant experiences in the past that after flooding the cases of waterborne disease increase. Together with that of the sewerage system, contribution of the drainage systems to public health improvement can be expected to be very significant, especially in areas where people depend on bucket systems and pit privies for disposal of excreta.

6.5 Decrease Swampy Area and Mosquito Breeding

Considerable part of the Project Area is occupied by swampy areas which raises the problem of mosquito breeding. MPSP has spent a great deal of money every year for spreading chemicals to prevent mosquito breeding. The provision of proper drainage systems will result in the reduction of marshy area and breeding of mosquito. Thus the considerable part of recurrent costs for maintenance on mosquito control is expected to be reduced.

PART V

MANAGEMENT STUDIES

CHAPTER 1

INTRODUCTION

The managerial arrangements with due consideration on organization framework, legal supports and financial planning are necessary to bring the planned systems into being and make it viable at a continual base.

With regard to the organizational arrangements, the recommendations are made based on the conception that the too rigid requirements which entail the time consuming efforts in legal modifications and recruiting the personnel of high calibre can best be avoided to encourage the early initiation of the Project.

The above conception coincides with the Government's inclination on stepwise systems construction without any extensive and extravagant systems construction which requires a significant amount of investment. In this context more practicable approach is adopted avoiding drastic evolution and therefore existing organizational framework in the Municipal Council which administers the Project area is recommended to be fully utilized at the initiation of the Project taking account of exemplary organization in an adjacent city and assessment of other alternative organizational arrangement. The basic objectives are presented, however, for the incumbent organization to develop its functions in accordance with the changing requirements with objective to reach ultimately to fulfilment of basic requirements.

The legislative recommendations are also presented based on the similar approach to that of organizational recommendation. The existing legislations of Municipal Ordinance, Local Government Act, 1976 and Street, Drainage and Building Act, 1974 are recommended to be fully applied with minor modifications which will be minimum requirements to eliminate the obstacles for the implementation of sewerage and drainage system developments. The preliminary consideration on financial arrangement are given to make the estimation of substantial funding requirements and potential revenue plan for the Project by which a detailed financial plan can be projected at the stage of feasibility study for implementation of each staged programme.

CHAPTER 2

ORGANIZATION

2.1 General

There is no organized modern sewerage system in the Project Area presently except for rudimentary sewage disposal system as septic tank, night soil buckets collection and surface drains, hence no comprehensive sewerage organization to undertake effective planning, construction, operation, maintenance, management, and administration of the sewerage systems.

The existing organizations which are directly concerned with sanitary control including sewage disposal in the Project Area are Engineering Department and Health Department of Municipal Council Province Wellesley (MPSP), and Drainage and Irrigation Department and Public Works Department of State Government. The Engineering Department is mainly responsible for operation and control of existing sanitary system including desludging of septic tanks and Imhoff tanks. The Health Department is generally concerned with administrative control for public health regulating nuisance wholly or partly related to sanitary systems in the Project Area including bucket collection of night soil and cleaning of drains within the town limit.

Drainage and Irrigation Department (DID) is responsible mainly for construction and improvement of main drains and reservoirs including irrigation channels. Public Works Department (PWD) is mainly responsible for the construction and maintenance of roadside drains pertinent to the Federal and state roads reserve.

The completely new organization or a partial modification to existing organization may be necessary to be charged with the functions required when proposed plan is implemented. The new organization is suggested with due consideration on combination of the existing agencies with the standard generally accepted for the sewerage and drainage works. Consideration on some alternatives are attempted as can be seen In Appendix K, "Alternative Organization."

The proposed organizational structure presented in this chapter is, however, the suggested guideline to be followed with appropriate modifications on the basis of the Government's own policy.

2.2 Basic Organization Requirements

The following consideration may serve in considering an administrative organization sufficient to cope with the work for management of the Project, operation and maintenance of the sewerage and drainage system.

Basic Objectives

(1) To establish effective organization with capabilities in financially self-supporting, staffed with sufficient number of qualified personnel available.

(2) To provide a dependable service of sewerage and drainage facilities with efficient system of management preferably at the lowest possible cost.

(3) To coordinate with other agencies, governmental and private, and integrate the sewerage and drainage programme into development programme for the overall improvement of health and sanitation.

Functional Units Required

On the basis of the above consideration, the basic requirement of the services required for the new organization should include the following.

(1) Administration

(a) Personnel

The personnel recruitment and training as well as wage and salary administration would be included.

(b) Procurement

The procurement management of local and imported supplies.

(c) Finance

This function would include budgeting, accounting, payroll, billing, and collection of bills for the services rendered. The financial reports would be prepared to provide adequate information for evaluating and controlling sewerage and drainage operation, and for planning future development of sewerage and drainage system.

(d) Legal

This function would include provision of legal basis for taking appropriate measures to ensure proper operation and maintenance of sewerage and drainage system in compliance with Government ordinances including acquisition of rights-of-way and land.

(2) Engineering

(a) Design

This function would include detailed designing of all new construction including new service connection with cost estimation, the drawing and reproduction of engineering plans, and control of plumbing and service connections through the inspection and permits. The maintenance of engineering records would be also contained.

(b) Construction

This function would include supervision of all construction work connected with repair, improvement and expansion to assure compliance of the plan and designs in accordance with the established regulations.

(3) Operation/Maintenance Division

(a) Operation

This function would include the efficient operation of the treatment plants and pumping stations on a continuous base and monitoring of stream, river, drain and illegal effluent from cesspools and septic tanks as well as industries.

(b) Maintenance

This function would contain keeping entire sewerage and drainage system in good working order, including plants, pumping, and piping facilities, drains and house connections, and perform necessary repairs for damaged facilities and equipments.

2.3 Proposed Organization

The advantages and disadvantages of all alternatives as explored in Appendix K, "Alternative Organizations" are evaluated taking into account of the background and current situation.

The first alternative is to create new regional organization in a form of Penang Sewerage and Drainage Authority, covering both the Penang Island and Province Wellesley, and the second alternative is to add sewerage and drainage activities into the existing Penang Water Authority in the state wide level. The third alternative calls for expansion and modification of the existing Engineering Department and others in Municipality of Province Wellesley.

While each of these alternatives has logical sequence to establish well organized agency to cope with the administrative responsibilities, the third alternative is deemed to be more practical for implementation within the organizational framework of existing Municipal Council Province Wellesley (MPSP) by adding minimum of the needed staff mainly to the existing Engineering Department in collaboration with State Government agencies. This is further elaborated, therefore, with the description of the responsibilities to be added in the following;

Engineering Department:

The newly added functions for sewerage and drainage system operation in the Engineering Department are to undertake activities, by creating Sewerage and Drainage Division in the Department, in conformance with basic guideline for functional units described in previous paragraph. The new organization as graphically indicated by Figures V-1 and V-2 will have the following functional units in the Division:

(1) Operation and Maintenance Section

Two sub-sections for each objective are provided under the head of this Section.

Sub-section of Treatment Plant and Pumping Station will be responsible for proper operation and maintenance of treatment plant and pump to achieve desired quality of effluent and target volume of sewage treated and proper disposal of plant effluent as well as uninterrupted conveyance of sewage.

This Section will be also responsible for the maintenance and repair of the treatment plant works and equipments to keep it in good working order including pumps, structures and plant premises.

Sewer and Drain Sub-section will be responsible for proper maintenance of the public sewers and all drains together with pertinent reservoirs and their appurtenances conducting routine inspection for physical damage and obstruction in the sewers and all drains with pertinent reservoirs including control of the illegal discharge from industries, septic tanks into main sewers and drains. Any violation of related regulations established in Municipal Ordinance and/or related By-Laws detected by inspection will be reported to file court suits against violators.

(2) Section of Designing

This section will be responsible for preparation of engineering design and specification necessary to receive tenders for

construction of sewerage and smaller drainage systems including service connection with pertinent cost estimation, drawings and reproduction of engineering plans, and the issuance of permits for new service connections requested by owners of buildings. The designing of main drains and reservoirs will be undertaken by existing Drainage and Irrigation Department (DID) of State Government and roadside drains pertinent to State road will be designed by Public Works Department (PWD).

(3) Section of Construction

This section will be responsible for supervision of all new construction with attendant surveys and inspections to assure compliance with required specification and standards. The construction of main drains and reservoirs is, however, suggested to be undertaken by Drainage and Irrigation Department (DID) of State Government. Public Works Department (PWD) is suggested to undertake the construction of roadside drains in Federal and State roads reserve.

Taking into consideration the probable shortage of required staff to be assigned in Design Section and Construction Section which will be a restraint to initiation of the implementation of planned project, the external engineering consultants are suggested to undertake detailed designing and preparation of tender documents and subsequent supervision of construction at initial stage of programme.

Only a few selected key personnel as counterpart staff are required to participate with consultants' work to develop their capability gradually with ultimate objective to undertake designing and construction supervision as well as operation and maintenance of the sewerage and drainage systems on independent base at subsequent stages.

(4) Laboratory Section

This section will be required to conduct routine laboratory analysis and test for sewage and industrial wastewater as required from time to time.

The following existing functional units already existing in Municipal Council P.W. (MPSP) are proposed to extend their functions for sewerage and drainage operations.

Secretariat Department:

Under the existing Secretariat Department, the following terms of reference should be added in its respective Sections:

(1) Administration Section

This section should include to perform personnel administration and control over procurement and supplies of materials for sewerage and drainage operation.

(2) Legal Section

This section should expand its functions necessary for proper operation of the new systems as specified in (d) of Functional Units in previous page V-3.

(3) Special Task Section

The public relation services presently undertaken by this section is proposed to undertake an intensive public relations programme to enhance public concerns to environment sanitation and encourage public to avail themselves of the sewerage system.

Finance and Treasurey Department

This Department is presently undertaking financial control over all activities involved in Municipal Council. However, a separate financial section within the Department exclusively for sewerage and drainage system operation is suggested to perform financial functions as budgeting, accounting, billing and maintenance of financial records separately from other departments in order to ensure sound management practice and accurate operating result of the proposed sewerage and drainage systems.

Health Department

While the proposed sewerage and drainage project will eventually replace night soil collection and septic tank systems with complete sewerage systems, there will be a continuing need to collect and dispose of night soil and septic tank deposits and clean the drains, which are presently undertaken by the Health Department. There is an apparent need for Health Department to continue its present service and coordination between the new sewerage and drainage organization and the Health Department for the foreseeable future until the complete sewerage system is implemented.

In addition to above departments the following existing departments of State Government are proposed to collaborate with Municipal Council specifically on the drainage works.

Drainage and Irrigation Department (DID), Pennang State Government

This department is presently providing engineering services on planning designing and construction of major drainage and irrigation systems in State of Penang including Project Area. It is suggested that proposed construction of the main drains and reservoirs would be undertaken by this department providing Engineering Department of MPSP take care of smaller drains within the town limit.

Public Works Department (PWD), Penang State Government

This department is presently responsible for general civil works for development project within the State boundary including construction and maintenance of Federal and State roads. The roadside drains are constructed in concurrence with such road construction and maintained by PWD.

PWD is therefore suggested to assume the responsibility for such drainage construction and improvement providing that minor maintenance works as cleaning and desilting are undertaken by Municipal Council.

FIGURE V-1 Added functional unit in existing organization of Municipal Council Province Wellesley

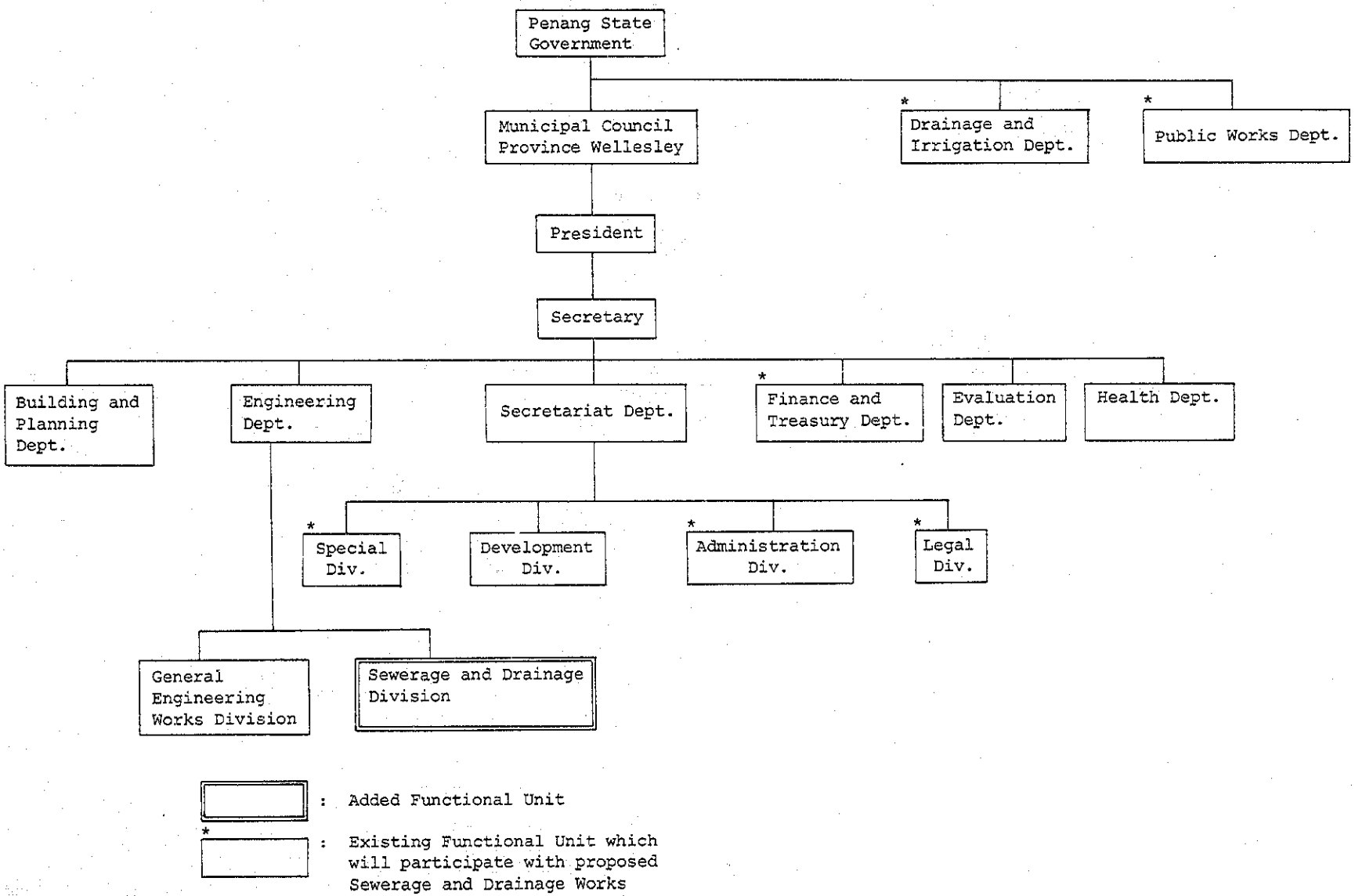


Figure V-1

Figure V-2

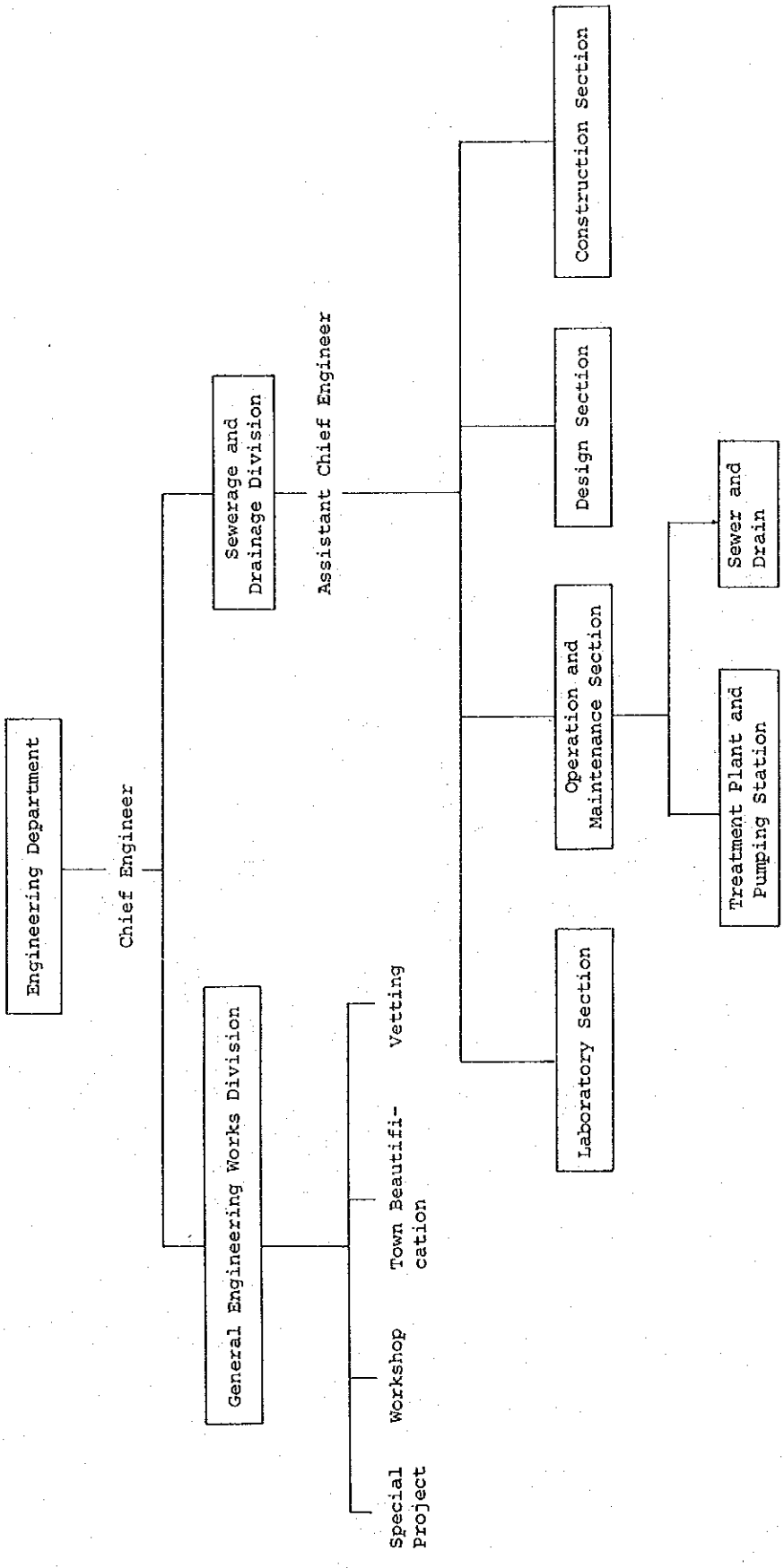


FIGURE V-2 Suggested functional units for sewerage and drainage works organization

CHAPTER 3

LEGAL ASPECTS

3.1 General

It is important that the explicit set of published regulations be available for the efficient operation of the sanitary sewerage and drainage system, and Municipal Council Province Wellesley (MPSP), be given authority to issue and enforce regulations for effective operation and maintenance on the basis of national and state legislations. This may be done by the office in charge of legal affairs in the new organization for the sewerage and drainage system proposed.

Therefore, the existing regulations and by-laws pertinent to proposed Project are reviewed herewith, and brief suggestions and recommendations are presented in the following paragraphs.

3.2 Municipal Ordinance

The Municipal Ordinance enacted as Chapter 133 of old Strait Settlement in 1913 involves the provisions pertinent to the work proposed in this Report. The substantial parts of the pertinent sections of ordinance are outlined as follows:

Financial Power

Section 59: Municipal Council is empowered to levy a separate or consolidated rate or rates limited to the maximum 35 percent based on the annual rental value of all rated properties including buildings and lands within the municipality for the capital cost of sewerage works. There is no provision to charge the capital cost to the owners of the properties directly benefited by the construction of sewerage facilities.

Section 229: The power is given to recover the cost incurred in part or in whole for the connection, and fee for sewage removal as the operation cost in addition to any rate levied under section 59. The above sewage removal fee is limited to M$2.00 monthly per water closet or urinal.

The rate was established in 1959 and appears to be outmoded to meet the current practice of sewerage system operation.

Sections 215, 220 and 230: Power is given to collect fees for licensing public latrines and inspection fees for sewer and etc. and nightsoil collection fees as prescribed by the municipality.

Section 343 and 344: The Municipal Council may borrow such sums of money as are necessary for the acquisition of land, the erection of buildings and execution of any permanent work including sewerage works. The amount of loan shall not exceed five time the annual rental value of all rated properties including buildings and land for remunerative works provided that the loan for unremunerative works shall not exceed double the annual rental value. This power for loan limiting especially for unremunerative works including sewerage works will impose a restriction on the construction development programme.

Executive Power

Section 133 and 134: Power is given to the Municipal Council for the construction and maintenance of sewage disposal systems.

Required Use of Public Sewers

Section 221, 222 and 223: It is prohibited to discharge or deposit in any stream, the solid, industrial wastewater or liquid sewage matter. No diffinition is made for above liquid sewage matter, however, it is normally defined as combination of the liquid and water-carried wastes from sanitary conveniences of residences, commercial buildings, industrial plants and institutions including "sullage", and these sections should suggest the "sullage" to be all domestic wastes to be disposed to public sewers.

Section 140: It is empowered to require the owners of a house to install of proper water-closets, urinals, sinks and bathrooms and require such water-closets, urinals, sinks and bathrooms to be connected with public sewers provided that there is a public sewer 100 ft of the boundary of the premises where house is located.

Private Sewage Disposal Systems

Section 219 and 220: Power is given to regulate and control the construction and maintenance of private sewage and wastewater disposal systems including septic tank and cesspool, and to enter any land or building for inspection, alternations and repairs of such systems. The by-law of this Ordinance, Building By-Laws, 1950, include the provisions pertinent to the construction and maintenance

of private sewage disposal systems in its Article III - Works and Fittings.

Plumbing

There is no specific provision regulating the connection of building sewer with the public sewer. However, by section 143, power is given to make by laws for plumbing. In the Building By-Laws 1950 includes the provisions for this purpose in the Article III - Works and Fittings.

Regulations on Discharge into Public Sewers

There is no provisions regulating the substance or materials to be discharged to public sewers except Section 113 which regulates the rain water discharge from roof of the house. Section 136 requires the consent of Municipal Council to make any drain into public sewers and permits to discharge the night soil or excrementious matters from watercloset or privy into public sewers.

Other Provisions

Sections 363, 364 and 365: Power is given to purchase or sell any land and obtain easement or right of way for the public purposes authorized by Municipal Council.

Section 367: Power is granted to enter into and upon any building or land for inspection as well as the execution of the work authorized by the Ordinance.

Sections 390 and 391: Any person who commit any offence under the Ordinance or its by-laws shall be arrested by police and shall be subject to prosecution and penalties.

3.3 Local Government Act, 1976

This Act is recently enacted and in force to supplement and renew some provisions of old Municipal Ordinance. The provisions related to sewerage and drainage are, however, less comprehensive than those of Municipal Ordinance. Such related provisions are presented below.

Financial Power

Sections 127, 128, 129, 130, 131 and 132: The local authority is empowered to impose the annual rate or rates for the purpose to perform the duty of the local authority not exceeding 35 percent of the annual value. In addition to above rate or rates a sewerage improvement rate within 5 percent of annual value can be imposed on a holding served or to be served by sewerage system to meet the whole or part of the cost of the sewerage system and maintenance, and drainage rate within 5 percent of annual value can be imposed to meet the cost of the construction of any drainage system. Such rate or rates can be imposed on the whole area or areas divided into two or more parts and further differential rating can be imposed within such part or parts.

Section 39: The revenue of the local authority shall consist of rates, taxes, rents, license fees, charges payable to authority, charges or profits arising from any service or undertaking carried on by the local authority, interest and income arising from the investment or property, other revenue as grants, contributions and endowments from the Federal or State Government.

Section 41: The local authority is empowered to borrow money subject to the approval of State Authority for the acquisition of land, the erection of any building and the execution of any permanent work, the provision of renewal of any plant. The amount of loan shall not exceed five times the annual value of the local authority.

Section 46: In addition to powers of borrowing as stipulated in Section 41, the local authority may borrow money from any person for the purpose of carrying out any development for residential, commercial and industrial undertakings with the approval of State Authority.

Section 47: Federal or State Government may grant loans to any local authority at such rates of interest and on such terms and conditions as it shall think fit out of its revenue set aside or appropriated for the purpose.

Executive Power

Section 72: The local authority is empowered to establish, maintain and carry out sanitary services for the removal and destruction, or otherwise dealing with, among others, night soil and all kind of refuse and effluent.

Required Use of Public Sewers

There is no specific provision to enforce the use of public sewers except for such provisions of Section 69 and 70 which prohibit the disposal of individual wastewater or liquid sewage matter into any stream implying eventual use of public sewers for above disposal.

The provisions related to private sewage disposal systems, plumbing regulation on discharge into public sewers are not available in this Act.

3.4 Street, Drainage and Building Act, 1974

The recently enacted Street, Drainage and Building Act, 1974 includes the provisions required for sewerage and drainage works with adequate improvement and consolidation of provisions set forth in Municipal Ordinance and Local Government Act. This Act is, however, still subject to the approval and gazetting by State Authority and has not been enforced as yet. In view of the availability of existing regulation in that the Municipal Ordinance is apparently outmoded in various respects to meet the current practice of sewerage works and Local Government Act, 1976 is less comprehensive in terms of sewerage and drainage works, the early implementation of Street, Drainage and Building Act is desirable.

The legal powers and their applications particularly relevant to sewerage management required in the proposed project are presented as follows:

Executive Power

Section 49 and 50: The power is given to local authority for which definition is made to include Municipal Council, to undertake the construction and maintenance of sewerage and drainage works.

Financial Power

It is of vital importance that legal supports to financial operations are given to sewerage authorities especially if financially autonomous authority is required. The provisions for this purpose are significantly improved as against Municipal Ordinance.

Section 51: Local Authority is given power to recover the capital cost of the sewerage and drainage works including cost of land acquisition by means of frontage charge.

It is also authorized to recover the cost from any developer in such a manner that they may be claimed by way of deposit before developers proceed to develop an area.

Section 64: Local Authority is given the powers to levy fees or charges as may be prescribed to be paid by the sewer users.

This section implies that the Local Authority may recover the cost for the sewerage operation and maintenance by setting fees in an appropriate manner as a surcharge to water consumption.

There is no particular reference to rate or tax as indicated by Section 59 of Municipal Ordinance. If the rate or tax is regarded as necessary to be included in rate structure of proposed sewerage works, the Section 59 of Municipal Ordinance should be applied.

Section 132: The power is given to Local Authority to establish "Improvement Service Fund". This Fund can be administered by Local Authority at its absolute discretion. This suggests that the completely separate account can be maintained for the capital investments and financing for sewerage operation. This section, therefore, deemed to be appropriately applied to the financially autonomous management of proposed organization.

Required Use of Public Sewers

Section 58 (2) and (7): The power is given to require the owner(s) of any house or building the installment of water-closets, urinals, sinks, and bathrooms to be connected with public sewer if the public sewer is available within 100 ft of the boundary of the premises.

The above section stipulates the mandatory use of public sewers. However, it may be necessary to provide the stipulation requiring such connections to be made at the expense of the owner(s).

Private Sewage Disposal Systems

Section 58 (3) and (14): Private disposal systems as septic tank, and cesspool are allowed to be provided where there is no sewer under the direction of Local Authority and such systems are required to be kept in proper order.

Section 62: Local Authority may in its discretion decide to take over the control, supervision, maintenance and repair of private septic tanks or other sewage purification plants to such extent that fees or charges may be levied.

There is no specific provision for such septic tank and cesspool to be abandoned at such time a public sewer becomes available.

The mandatory use of public sewer as stipulated in Section 58 (2) should also be effectuated by provisions enforcing direct connection with sewers when it becomes available.

Plumbing

No specific provisions are found in this Act. for the control of the connection of public sewer with building disposal facilities. The Building By-Laws 1950 includes the provisions in its Article III - Works and Fittings.

Regulations on Discharge into Public Sewers

Section 55: The prior written permission is required to make any drain into any of the public sewers. No night-soil, excrementious matter and trade effluent can be discharged into sewers without prior written permission of Local Authority.

The discharge of trade effluent or industrial wastewaters are subject to specific conditions to be imposed by Local Authority.

There is an apparent need to control and regulate the quality, quantity and the manner of discharge into the sewerage systems in order to keep the satisfactory performance of the system's functions.

The domestic sewage may be controlled without providing specific conditions due to its constituent easily prescribed. The industrial wastewater should, however, be controlled by providing more specific and individual conditions.

There is a likelihood of attending problem in controlling the industrial wastewater because of different interests and opinions towards industrial development policy and control of the resultant wastes. It will be necessary, however, to provide certain standards on which the owner(s) of industries and Local Authority can negotiate to achieve agreement satisfactory to both parties.

It is suggested here that the relevant articles of the model ordinance developed by the Sub-committee on Municipal Sewer Ordinances of the Water Pollution Control Federation of U.S.A. be utilized with appropriate modification to develop an acceptable standards on industrial wastewater control in the Project Area. Such articles relevant to control of discharge into sewers and/or sewage treatment plants are quoted below with minor adjustments.

Section 1. No person shall discharge or cause to discharge any storm water, surface water, groundwater, roof runoff, subsurface drainage, uncontaminated cooling water, or unpolluted industrial process waters to any sanitary sewer.

Section 2. Storm water and all other unpolluted drainage shall be discharged to such sewers as are specifically designated as combined sewers or storm sewers, or to a natural outlet approved by the Local Authority. Industrial cooling water or unpolluted process waters may be discharged, on approval of the Local Authority, to a storm sewer, combined sewer, or natural outlet.

Section 3. No person shall discharge or cause to discharge any of the following described waters or wastes to any public sewers:

(a) Any gasoline, benzene, naphtha, fuel oil, or other flammable or explosive liquid, solid, or gas.

(b) Any waters or wastes containing toxic or poisonous solids, liquids, or gases in sufficient quantity, either singly or by interaction with other wastes, to injure or interfere with any sewage treatment process, constitute a hazard to humans or animals, create a public nuisance, or create any hazard in the receiving waters of the sewage treatment plant, including but not limited to cyanides in excess of two (2) mg/l as CN in the wastes as discharged to the public sewer.

(c) Any waters or wastes having a pH lower than 5.5, or having any other corrosive property capable of causing damage or hazard to structures, equipment, and personnel of the sewage works.

(d) Solid or viscous substances in quantities or of such size capable of causing obstruction to the flow in sewers or other interference with the proper operation of the sewage works such as, but not limited to, ashes, cinders, sand, mud, straw, shavings, metal, glass, rags, feathers, tar, plastics, wood, unground garbage, whole blood, paunch manure, hair and fleshings, entrails and paper dishes, cups, milk containers, etc. either whole or ground by garbage grinders.

Section 4. No person shall discharge or cause to be discharged the following described substances, materials, waters, or wastes if it appears likely in the opinion of the Local Authority that such wastes can harm either the sewage treatment process, or equipment, have an adverse effect on the receiving stream, or can otherwise endanger life, limb, public property, or constitute a nuisance. In forming his opinion as to the acceptability of these wastes, the Local Authority give consideration to such factors as the quantities of subject wastes in relation to flows and velocities in the sewers, materials of construction of the sewers, nature of the sewage treatment process, capacity of the sewage treatment plant, degree of treatability of wastes on the sewage treatment plant, and other pertinent factors. The substances prohibited are:

(1) Any liquid or vapor having a temperature higher than sixty-five (65)°C.

(2) Any water or waste containing fats, wax, grease, or oils, whether emusified, or not, in excess of one hundred (100) mg/l or containing substances which may solidify or become viscous at temperatures between zero (0)° and sixty-five (65)°C.

(3) Any waters or wastes containing strong acid, iron, pickling wastes, or concentrated plating solutions whether neutralized or not.

(4) Any waters or wastes containing strong acid, iron, pickling wastes, or concentrated plating solutions whether neutralized or not.

(5) Any waters or wastes containing phenols or other taste or odor-producing substances, in such concentrations exceeding limits which may be established by the Local Authority as necessary, after treatment of the composite sewage, to meet the requirements of the Government of Malaysia for such discharge to the receiving waters.

(6) Any radioactive wastes or isotopes of such half-life or concentration as may exceed limits established by the Local Authority in compliance with applicable regulations.

(7) Any waters or wastes having a pH in excess of 9.5.

(8) Materials which exert or cause:

(a) Unusual concentrations of inert suspended solids (such as, but not limited to, fullers earth, lime slurries, and lime residues) or of dissolved solids (such as, but not limited to, sodium chloride and sodium sulfate).

(b) Excessive discoloration (such as, but not limited to, dye wastes and vegetable tanning solutions).

(c) Unusual BOD, chemical oxygen demand, or chlorine requirements in such quantities as to constitute a significant load on the sewage treatment works.

(d) Unusual volume of flow or concentration of wastes constituting "Slugs" as defined herein.

(9) Waters or wastes containing substances which are not amenable to treatment or reduction by the sewage treatment processes employed, or are amenable to treatment only to such degree that the sewage treatment plant effluent can not meet the requirements of other agencies having jurisdiction over discharge to the receiving waters.

Section 5. If any waters or wastes are discharged or are proposed to be discharged to the public sewers, which waters contain the substances or possess the characteristics enumerated in Section 4 and which in the judgment of the Local Authority may have a deleterious effect upon the sewage works, processes, equipment, or receiving waters, or which otherwise create a hazard to life or constitute a public nuisance, the Local Authority:

(a) Reject the wastes

(b) Require pretreatment to an acceptable condition for discharge to the public sewers

(c) Require control over the quantities and rates of discharge, and/or

(d) Require payment to cover the added cost of handling and treating the wastes not covered by existing taxes or sewer charges under the provisions of Section 10.

If the Local Authority permits the pretreatment or equalization of waste flows, the design and installation of the plants and equipment shall be subject to the review and approval of the Local Authority and subject to the requirements of all applicable codes ordinances, and laws.

Section 6. Grease, oil, and sand interceptors shall be provided when, in the opinion of the Local Authority, they are necessary for the proper handling of liquid wastes containing grease in excessive amounts, or any flammable wastes, sand, or other harmful ingredients; except that such interceptors shall not be required for private living quarters or dwelling units. All interceptors shall be of a type and capacity approved by the Local Authority, and shall be located as to be readily and easily accessible for cleaning and inspection.

Section 7. Where preliminary treatment or flow-equalizing facilities are provided for any waters or wastes, they shall be maintained continuously in satisfactory and effective operation by the owner at his expense.

Section 8. When required by the Local Authority the owner of any property serviced by a building sewer carrying industrial wastes shall install a suitable control manhole together with such necessary meters and other appurtenances in the building sewer to facilitate observation, sampling, and measurement of the wastes. Such manhole, when required, shall be accessibly and safely located and shall be constructed in accordance with plans approved by the Local Authority. The manhole shall be installed by the owner at his expense, and shall be maintained by him so as to be safe and accessible at all times.

Section 9. All measurements, tests, and analyses of the characteristics of waters and wastes to which reference is made in this ordinance shall be determined in accordance with the latest edition of "Standard Methods for the Examination of Water and Wastewater", published by the American Public Health Association, and shall be determined at the control manhole provided, or upon suitable samples taken at said control manhole. In the event that no special manhole has been required, the control manhole shall be considered to be the nearest downstream manhole in the public sewer to the point at which the building sewer is connected. Sampling shall be carried out by customarily accepted methods to reflect the effect of constitutents upon the sewage works and to determine the existence of hazards to life, limb, and property. (The particular analyses involved will determine whether a twenty-four (24) hour composite of all outfalls of a premise is appropriate or whether a grab sample or samples should be taken. Normally, but not always, BOD and suspended solids analyses are obtained from 24-hr. composites of all outfalls whereas pH's are determined from periodic grab samples.)

Section 10: No statement contained in this article shall be construed as preventing any special agreement or arrangement between the Local Authority and any industrial concern whereby an industrial waste of unusual strength or character may be accepted by the Local Authority for treatment, subject to payment therefore, by the industrial concern.

Other Provisions

The Local Authority is empowered to enter into any private property or premises to execute the works as altering, enlarging, repairing or cleaning the sewer and drains by Sections 52 and 53.

Section 97 reads in part "Any Local Authority may, for the purposes of this Act, ... enter at all reasonable house ... any building or land as well for the purpose of making any survey or inspection as for the purpose of executing any work authorized by this Act ..... Sections 122, 123, 124, 125, 126 provide legal procedures as court trial, prosecution, conviction, arrest for any person guilty of an offence under this Act or any by-laws made thereunder.

3.5 Town and Country Planning Act, 1976

This Act is recently enacted through Parliament Assembly pursuant to the Federal Constitution for the uniformed control of town and country planning in each local authority in whole Malaysia. This Act applicable to State of Penang has not been adopted and gazetted yet, however, as well as Street, Drainage and Building Act, 1974 subject to the approval of State Authority. Under the assumption that this Act will be adopted in due course, the provisions relevant to the Project are studied.

In this Act no person shall use any land or building without permission of local planning authority to be established in Municipal Council and such permission shall be given in conformity with local development plan. Any authority established by law is, however, authorized to undertake any development including provision and improvement of sewer pipes and drains without such permission. A development charge is levied to the local developer who undertake any development works which are expected to enhance the value of land. Such legal provision is construed that developers are required to contribute a part of their profit accrued from the land development by paying the charge or alternatively providing the utility systems as required by local planning authority. The local planning authority has a power to refuse any development plan proposed by an applicant on the ground that the land proposed to be developed is intended for public use even before such land is officially declared as development area. Any land owners who are aggrieved by the fact that their land is refused to be developed and such land is not capable of beneficial use are qualified to require the local planning authority to purchase such land at a reasonable price.

The local authority is empowered to declare a certain area or areas to be development area or areas at any time after a local plan has been adopted. The local authority is, however, required to purchase the area in such development area at fair market value. In this Act the local authority is empowered to borrow sums of money as are necessary for financing the development of a development area declared.

3.6 The Environmental Quality Act, 1974

Under this Act, the Minister of Environment is appointed to be charged with the responsibility for environmental protection of whole of Malaysia.

Under the Minister, Director General of Environmental Quality is appointed to execute all activities required to environmental pollution control. The Environmental Quality Council is also established as an advisory council consisting of the members representing various authorities and institutions concerned.

The provisions which have direct or indirect bearings on sewerage works are Sections 21, 24 and 25 for regulation on discharge of waste into soil, land and inland waters, Sections 26, 27 and 29 on oil discharge into Malaysian waters, and Section 31 which enforces the provision of adequate equipment to control and eliminate polluted waste from industries.

3.7 Conclusion

As far as the existing regulations are concerned, each regulation has bearings partly on the sewerage and drainage works and no specific regulation comprehensive of provisions related to such works is available. The Street, Drainage and Building Act, 1974 is, among others, considered more or less provided with adequate provisions to be required for the proposed sewerage and drainage works. While it is recommended that the Street, Drainage and building Act, 1974 would be basically applied for the above works for the time being, a more detailed by-law incorporating such provisions as closely related to the sewerage and drainage works is recommended to be established at an early date.

The followings are some minor changes or supplements suggested for the Street, Drainage and Building act, 1974.

In Section 50 the Local Authority is empowered to request the State Authority to acquire any property, for the construction of surface and storm water drains only. However, sewerage works also be qualified for the compulsory acquisition of lands.

In Section 51 the Local Authority is authorized to recover the capital cost of the sewerage and drainage works including costs of land acquisition by means of frontage charge from any developers, before preceeding to develop the area. However, a legal provision would be necessary for requiring the developer to provide sewerage facilities or deposit a frontage charge as a condition of approval of the development.

In Section 55 the prior written permission is required for the discharge of trade effluent, however, subject to the conditions imposed to such permission. This section refers to general trade effluent but does not deal in detail with the conditions imposed on the quality and strength of trade wastes.

In Section 64 Local Authority is empowered to levy fee or charges to compensate the necessary expenses for operation and maintenance of the system plus debt service payment to be paid by the sewer users. In this section the provision would be required to authorize the collection of sewerage service fee by means of surcharge based on water consumption and quality and strength of trade wastes.

The more specific controlling conditions would be necessary to protect the sewerage and drainage systems. In this connection the provision of regulations based on the standard articles of model ordinance as presented in previous pages V -20-24 would be recommended or alternative Trade Waste By-Laws should be considered.

The By-Laws for the Sewerage and Sanitary Installation would also be necessary as no specific provision are presently found for the plumbing of sewerage and drainage systems in order to control the connection of public sewer and drain with household and building disposal facilities.

CHAPTER 4

FINANCIAL CONSIDERATION

4.1 General

This chapter deals with the financial aspects of the project extended to the year 2000 with the objective to estimate the minimum requirements for the implementation of the planned Project. The description is, therefore, limited to preliminary analysis of financial viability providing that the details will be provided in feasibility report to be prepared consecutively.

4.2 Cost Estimation

The total cost of the Sewerage and drainage of the Project up to the year 2000 is estimated on the basis of 1976 prices together with figures escalated at annual inflation rate of 5 percent as indicated in following pages. As it is necessary to define the capital requirements for the Government the division of the costs to be borne by the Government and private sector including developer is attempted to provide the base on which required amount of capital to recover the costs from various sources will be estimated.

The price escalation is normally required to be reflected in estimation of required capital for the construction extended over the years to avoid any substantial discrepancy between estimated costs and costs actually required at the implementation of the construction programme. It should be noted, however, that it is difficult to make a realistic estimates of future trends of inflation over an extended period of time especially when world economic situation is showing wide fluctuation.

In Malaysia the ratio of inflation has also marked upward and downward variations until recent stabilization of economy. The present inflation rate of 5 percent projected by nation wide census is utilized, however, to illustrate the notional reflection of the inflation on the project costs as a whole as indicated in the brackets noted under 1976 prices in each table of cost estimation. Those notional figures in brackets indicate the costs escalated up to the middle year of each stage to obtain average figures.

TABLE V-1 Total Construction Cost by Stage at 1976 Price Level

(M$ 1,000)

Element of System	Stage	1st Stage (1981-1985)	2nd Stage (1986-1990)	3rd Stage (1991-1995)	4th Stage (1996-2000)	Total
(A) to be borne by public sector	Sewerage	63,250	116,850	85,300	86,200	351,600
		(88,990)	(209,820)	(195,520)	(252,200)	(746,530)
	Drainage	68,330	8,410	38,550	111,940	227,230
		(96,140)	(15,080)	(88,330)	(327,490)	(527,040)
	Total	131,580	125,260	123,850	198,140	578,830
		(185,130)	(224,900)	(283,850)	(579,690)	(1,273,570)
(B) to be borne by private sector	Sewerage	100,790	51,410	137,110	163,480	452,790
		(141,800)	(92,320)	(314,250)	(478,190)	(1,026,560)
	Drainage	52,580	25,140	45,170	83,020	205,910
		(73,980)	(45,150)	(103,540)	(242,840)	(465,510)
	Total	153,370	76,550	182,280	246,500	658,700
		(215,780)	(137,470)	(417,790)	(721,030)	(1,492,070)
(C) Grand Total		284,950	201,810	306,130	444,640	1,237,530
		(400,910)	(362,370)	(701,640)	(1,300,720)	(2,765,640)

Note: Figures in the brackets include 5 percent escalation per annum starting from 1977 up to 1983 for the 1st stage, 1988 for the 2nd stage, 1993 for the 3rd stage and 1998 for the 4th stage. This is due to the fact the amount indicated above are the gross estimated costs and are not broken down into the detailed disbursement schedules, hence escalation is applied up to the middle of each stage duration in order to estimate average escalated amount for the planning purpose.

TABLE V-2 Sewerage Construction Cost by Stage at 1976 Price Level
(to be borne by public sector)

(M$ 1,000)

Description / Stage	1st Stage (1981-1985)	2nd Stage (1986-1990)	3rd Stage (1991-1995)	4th Stage (1996-2000)	Total	Remarks
a. Public Sewers (main)	32,480 (45,700)	34,510 (61,970)	47,000 (107,720)	51,900 (151,820)	165,890 (367,210)	
b. Pumping Stations	- 	4,750 (8,530)	230 (520)	200 (580)	5,180 (9,630)	
c. Treatment Plants	9,860 (13,870)	21,470 (38,550)	8,600 (19,710)	10,020 (29,310)	49,950 (101,440)	
d. Land Acquisition	5,590 (7,860)	27,800 (49,920)	8,810 (20,190)	3,200 (9,360)	45,400 (87,330)	
(A) Sub-Total	47,930 (67,430)	88,530 (158,970)	64,640 (148,140)	65,320 (191,070)	266,420 (565,610)	
(B) Contingency	9,580 (13,480)	17,700 (31,790)	12,920 (29,620)	13,060 (38,210)	53,260 (113,100)	(A)x0.20
Design	2,870 (4,040)	5,310 (9,530)	3,870 (8,880)	3,910 (11,460)	15,960 (33,910)	(A+B)x0.05
Supervision	2,870 (4.040)	5,310 (9,530)	3,870 (8,880)	3,910 (11,460)	15,960 (33,910)	(A+B)x0.05
Total	63,250 (88,900)	116,850 (209,820)	85,300 (195,520)	86,200 (252,200)	351,600 (746,530)	

TABLE V-3 Drainage Construction Cost by Stage at 1976 Price Level
(to be borne by public sector)

(M$ 1,000)

Description \ Stage	1st Stage (1981-1985)	2nd Stage (1986-1990)	3rd Stage (1991-1995)	4th Stage (1996-2000)	Total	Remarks
a. Main Drains	46,940 (66,040)	5,050 (9,060)	17,080 (39,140)	39,220 (114,720)	108,290 (228,960)	
b. Reservoirs for Initial Storm	350 (490)	-	-	-	350 (490)	
c. Reservoirs for Major Storm	-	1,000 (1,790)	11,500 (26,350)	45,600 (113,390)	58,100 (161,530)	
d. Land Acquisition	4,490 (6,310)	330 (590)	630 (1,440)	-	5,430 (8,340)	
(A) Sub Total	51,780 (72,840)	6,380 (11,440)	29,210 (66,930)	84,820 (248,110)	172,190 (399,320)	
(B) Contingency	10,350 (14,560)	1,270 (2,280)	5,840 (13,380)	16,960 (49,620)	34,420 (79,840)	(A)x0.20
(C) Engineering Fee						
Design	3,100 (4,370)	380 (680)	1,750 (4,010)	5,080 (14,880)	10,310 (23,940)	(A+B)x0.05
Supervision	3,100 (4,370)	380 (680)	1,750 (4,010)	5,080 (14,880)	10,310 (23,940)	(A+B)x0.05
Total	68,330 (96,140)	8,410 (15,080)	38,550 (88,330)	111,940 (327,490)	227,230 (527,040)	

TABLE V-4 Sewerage Construction Cost by Stage at 1976 Price Level
(to be borne by private sector)

(M$ 1,000)

Description / Stage	1st Stage (1981-1985)	2nd Stage (1986-1990)	3rd Stage (1991-1995)	4th Stage (1996-2000)	Total	Remarks
a. Branch and Lateral Sewers	59,410 (83,590)	25,670 (46,090)	89,580 (205,310)	106,540 (311,650)	281,200 (646,640)	
b. House Connection	16,950 (23,850)	13,290 (23,860)	14,300 (32,770)	17,310 (50,630)	61,850 (131,110)	
(A) Sub Total	76,360 (83,590)	38,960 (46,090)	103,880 (205,310)	123,850 (311,650)	343,050 (646,640)	
(B) Contingency	15,270 (23,850)	7,790 (23,860)	20,770 (32,770)	24,770 (50,630)	68,600 (131,110)	(A)x0.20
(C) Engineering Fee						
Design	4,580 (6,440)	2,330 (4,190)	6,230 (14,280)	7,430 (21,730)	20,570 (46,640)	(A+B)x0.05
Supervision	4,580 (6,440)	2,330 (4,190)	6,230 (14,280)	7,430 (21,730)	20,570 (46,640)	(A+B)x0.05
Total	100,790 (141,800)	51,410 (92,320)	137,110 (314,250)	163,480 (478,190)	452,790 (1,026,560)	

Note: In above table branch and lateral sewer costs include the costs of all sewers which are branched from the main sewers for which costs will be recovered from the adjacent land owners. The house connection costs cover the facilities lying within private property and the portions of connection pipe that lie within the public rights of way.

TABLE V-5 Drainage Construction Cost by Stage at 1976 Price Level
(to be borne by private sector)

(M$ 1,000)

Description \ Stage	1st Stage (1981-1985)	2nd Stage (1986-1990)	3rd Stage (1991-1995)	4th Stage (1996-2000)	Total	Remarks
(A) Network of Smaller Drains	39,840 (56,050)	19,050 (34,210)	34,230 (78,450)	62,900 (183,990)	156,020 (352,700)	
(B) Contingency	7,960 (11,210)	3,810 (6,840)	6,840 (15,690)	12,580 (36,790)	31,190 (70,530)	(A)x0.20
(C) Engineering Fee						
Design	2,390 (3,360)	1,140 (2,050)	2,050 (4,700)	3,770 (11,030)	9,350 (21,140)	(A+B)x0.05
Supervision	2,390 (3,360)	1,140 (2,050)	2,050 (4,700)	3,770 (11,030)	9,350 (21,140)	(A+B)x0.05
Total	52,580 (73,980)	25,140 (45,150)	45,170 (103,540)	63,020 (242,840)	205,910 (465,510)	

TABLE V-6 Operation and Maintenance Cost at 1976 Price Level

(M$ 1,000/year)

Element of System	Stage	1st Staged Area	2nd Staged Area	3rd Staged Area	4th Staged Area
Sewerage	Sewer (main)	330 (460)	350 (620)	470 (1,070)	560 (1,630)
	" (small)	720 (1,010)	310 (550)	1,080 (2,470)	1,300 (3,800)
	Pumping Station	-	110 (190)	30 (60)	20 (50)
	Treatment Plant	250 (350)	310 (550)	260 (590)	270 (780)
Drainage	Drain (main)	590 (830)	740 (1,320)	930 (2,130)	1,210 (3,530)
	" (small)	280 (390)	450 (800)	610 (1,390)	830 (2,420)
Total		2,170 (3,040)	2,270 (4,030)	3,380 (7,710)	4,190 (12,210)

Note: No costs for house connections are provided in above table since the ownerships of those house connections are to be vested in individual household owners who will be obliged to maintain and control their house connections at their own expenses.

4.3 Potential Sources of Capital and Operation Revenue

The substantial amount of capital is normally required for the project which involves the extensive construction as sewerage and drainage works. It is therefore necessary for the Government to consider the specific arrangement to generate the funds to meet the capital requirements for the construction as well as operation of the systems after completion.

The viability of the project is largely dependent on adequately arranged source of funds including less burdensome long term and low interest loans, the Government's grant, equitable sewer use charge and other revenue projections. The specific arrangement for funding would be needed during the early years of the programme when there is virtually no means to generate revenue through services.

In previous table the costs for the element (A) to be borne by public sector indicates the costs to be financed by the Government's own capital source or arrangement of external loan either from multilateral or bilateral lending agency and the costs for the element (B) are to be recovered from developers and those individuals who will receive the direct benefits from systems construction including household and property owners.

The followings are potential sources of capital for construction and revenue required for operation of the systems.

Capital Sources from Public Sector

(1) Long-term Loans

Prior to the construction, the funding arrangement will be necessary through one of several alternative sources, loans from Federal Government or State Government, multilateral and bilateral lending agency.

It is desirable to arrange the loans of long term and low interest to support the viability of the Project with deferred repayment of principal to mitigate the cash flow problem in early years of construction while there are no means to raise the funds through connections to the sewerage system. The World Bank and Asian Development Bank are examples of multilateral sources of loans. The recent loans provided by both World Bank and Asian Development in Malaysia indicates interest rate 8 - 9 percent, and repayment terms of 20 years with grace period of 5 years. The World Bank has recently been providing loans to Malaysia with favorable terms. Bilateral loan agreements are also considered to be made with U.S.A., Japan, Germany, Canada and others that have aid programmes for developing nations, sometimes with more favorable conditions than those from the multilateral sources.

(2) Government Grant

Since the sewerage and drainage works include the construction of the systems such as treatment and disposal facilities which provide community benefits accruing to the population at large, some form of support from Government is relevant similar to other public works for infrastructure development such as road construction.

The direct grant from the Government will enable the construction of downstream disposal and other major facilities earlier than would be effectuated through the funds raised by other means.

In addition to direct grant, there are indirect grants in various forms such as interest-free advances, advance payment of direct benefit charges against Government properties or the establishment of special favorable loan terms from Government sources, and setting up a revolving fund to assist houseowners who may have difficulty in paying the required cash for the connection and relevant plumbing costs.

Capital Sources from Private Sector

The capital to be obtained from the individuals who will receive the direct benefits from the systems usage will significantly contributes to reduce the amount of loan required for development project and decrease the financial burden on the Government. There are several alternative methods to raise such capital.

(1) Benefit Assessments

Benefit assessments are basically applied to cover the costs for branch and lateral sewers and drains which provide benefits to the property served by improving the marketability and value of the properties. The assessments can be levied against all property owners based on front footage, or the area of property or assessed value, or annual equivalent rental value of the properties.

(2) House Connection

The full costs of connecting a property to a branch or lateral sewer including relevent replumbing costs are recovered by individual houseowners since the benefits derived from such connection accrue to the properties connected only. The specific arrangement will be necessary, however, for the collection method of charge as well as legal enforcement to prevent a delayment of connection resulting from houseowners' reluctancy to the connection.

(3) Developers Contribution

The infrastructure systems including sewerage and drainage

system should preferably be developed prior to the other constructions on the new housing and industrial development areas, otherwise, it will cause inconvenience and extra costs such as rebuilding and remodelling of existing systems. In order to avoid such inconvenience, the developers are commonly required to construct such infrastructure systems when they develop the areas. The costs incurred from such constructions can be compensated by including such costs in their sale prices of lands. Therefore, incumbent developers in this proposed Project will be fully responsible for the construction of branch and lateral sewers and drains as well as house connections. The installment of the systems can be made either by developers' own capital or by the Government who may recover the costs from the developers.

Potential Sources of Operation Revenue

The well planned revenue sufficient to sustain the Project on a financially viable base will be necessary during the whole life of the Project. The revenues are basically required to meet the costs for operation and maintenance of the system including administration expenses plus long term debt service payment. Among the several methods commonly applied to raise the revenue, the well suited to the proposed Project with simple, logical practicable, enforceable and equitable nature should be selected.

(1) Service Charge

The service charges are applied to individual users of the systems on proportion to the use they make. In calculating the charge there are following methods available in some cities in the world.

(a) Pedestal Charge

The flat rate is multiplied by the numbers of water closet (WC) pedestal in the households to calculate the charge on the theory that the waste volume is linked with pedestal. The collection of the charge is administratively easy, but, it does not appear that the waste discharge is closely related to the pedestal, and, more adequate method should be considered.

(b) Fixture-unit Charge

The numbers of water fixtures, such as faucets, water heaters, air coolers, and flush toilets, are multiplied by flat rate so as to provide the revenue required based on the theory that volume of waste discharge is related to the volume of water consumption, hence to the numbers of fixtures. The households which have many fixtures do not necessarily

consume much water and more rational method should be considered.

(c) Per Capita Charge

The charge is calculated multiplying the numbers of residents or employees in the households or commercial property by a flat rate fee based on the theory that volume of waste discharge proportionate to the numbers of residents. This method has also a disadvantage in obtaining the accurate waste discharge as same as above method.

(d) Water Rate Surcharge

The water rate surcharge is service charge related to water use which is calculated by adding a fixed rate to metered water consumption. This method would appear to be the best alternative satisfying the required nature for recommendable method as mentioned above. The volume of waste discharge is closely related to water consumption which is accurately metered. The collection of the charge is enforceable by cutting-off the water supply in the event of non-payment. The collection of charge can be made without difficulty in combination of billing procedure for water supply already in existence. There will be certain cases where water consumption is difficult to measure as consumers draw water from private sources (wells). However, the most water in the Project area is supplied by pipe, and there will be no setback in adopting this method.

(2) Annual Subsidies from Government

The self-supporting system without any Government subsidies is most desirable in operation of public utility systems, including sewerage and drainage systems, but, it depends ultimately on the ability of the users to pay the required charge of the system who may be liable to substantial burden. In as much as the amount of revenue collectable from the users is limited to defray not necessarily to cover all the expenses for operation and maintenance expenses, and debt service payment, certain amount of Government subsidies will be justified as a social costs for improvement of public health and sanitation as well as protection of water pollution of the area at large.

4.4 Preliminary Financing Plan

The components of the recommended financial plan are presented below and summarized in TABLE V-7 to provide basic guideline by

which future financial projections can be made at the stage of feasibility study.

(1) Long term international or domestic loan with low interest and longer grace period to cover the initial construction costs.

(2) Government grant for the construction of major facilities especially for construction of treatment plants and disposal facilities, and subsidies to cover balance of annual revenue and actual expenditure.

(3) Benefit assessments against property owners to cover the costs for branch and lateral sewers and drains in the form best suited to the locality (either one of the assessments based on front footage, area of property, assessed value, or annual equivalent rental value of the properties).

(4) Direct payments by household owners of the full costs of house connections (including pipes in public right of way) and conversion of plumbing systems in the household wherever necessary.

(5) Water rate surcharge based on water consumption with ad hoc rate on quality of trade waste when necessary to meet the costs for operation and maintenance and debt service payments.

(6) Developers' contribution for the construction of branch and lateral sewers and drains as well as individual house connections in the development area.

TABLE V-7 Preliminary Financing Plan for Sewerage and Drainage Programme up to the Year 2000

Elements	Required Funds by Stage (M$ 1,000)					Suggested Sources of Funds
	1st stage	2nd stage	3rd stage	4th stage	Total	
Construction of Public Main Sewers and Drains, Treatment Plants, Pumping Stations, Reservoirs, and Land Acquisition	131,580 (185,130)	125,260 (224,900)	123,850 (283,850)	198,140 (579,690)	578,830 (1,273,570)	Long term loan and Government grant.
Construction of Branch and Lateral Sewers and Drains and House Connections	153,370 (215,780)	76,550 (137,470)	182,280 (417,790)	246,500 (721,030)	658,700 (1,492,070)	Benefit assessments against property owners, developers' contribution for branch and lateral sewers and drains. Direct payments by household owners of house connection.
Annual System Operation and Maintenance Costs excluding debt service payments	2,170/yr (3,040/yr)	2,270/yr (4,030/yr)	3,380/yr (7,710/yr)	4,190/yr (12,210/yr)		Water rate surcharge based on water consumption and Government subsidies.

Note: The figures are on 1976 price level, and those figures in brackets include 5 percent escalation per annum as indicated in detail by foot note of TABLE V-1.