4.4 Design of Bridge, Culvert and Access Road

4.4.1 Design criteria

Due to the expansion of the existing drainage channels, 76 existing bridges were planned to be reconstructed. Design of these bridges was made in accordance with Indonesian Codes and Standards related to bridge design and planning issued by BINA MARGA. For the design criteria which have not been covered by these Codes and Standard, Japanese Standard or AASHTO for highway bridges were applied.

(1) Design specifications for bridge

(a) Fundamental design policy

Except as modified herein, the selected structure element will be designed in according with the above mentioned standards.

(b) Superstructure

The service load method (allowable stress design) will be used for design of the girder bridge and ultimate capacity will be properly checked using the strength design method (load factor design)

(c) Substructure

The strength design method (load factor design) will be used for the design of substructure elements.

(d) Ancillary structures

Most suitable structural type for the ancillary works of the bridge will be studied and selected among the typical structure drawings depicted in the Indonesian and Japan Standards.

(e) Pedestrian bridge

This is designed according to Indonesian Bridge Design Code, referring to Japan Pedestrian Bridge Standard.

(2) Loading condition for the bridges to be designed

(a) Live load

The existing bridges have been provided on the national roads and other small roads.

The loading condition for the bridges to be designed was specified as follows:

(i) The bridge on the national road is designed by applying 100 % of live load according to the Load Specification Standard.
(ii) Other bridges except for the national road is designed by applying 80 % instead of 70 % for T-load assuming entering of heavy cars into rural road.

(b) Combination of load

The members of the roadway bridge structure are designed to withstand all combinations of possible working loads and forces such as live load impact, wind load, thermal force, earthquake force, longitudinal force induced by friction at movable bearings, centrifugal forces and collision force. In accordance with the loading possibilities and characteristics of each stress combination under consideration, the allowable stresses of the structure are increased.

(3) Special provisions

(a) Vertical clearance

Allowance for the vertical clearance is totally as follows,

$H \geq h1 + h2$

where;

h1: Allowance for freeboard, which is varied by the river width:

For the river width $W \geq 15$ m : $h1 \geq 0.5$ m

$5 \text{ m} < W < 15$ m : $h1 \geq 0.4$ m

$W < 5$ m : $h1 \geq 0.3 - 0.2$ m

Remarks :Minimum vertical clearance required by normal stream flow is 0.3 m according to the Bridge Design Code, 1.4.4.

h2: Allowance for land subsidence of 14 years after.

The total subsidence up to the target year, 2010, namely, 14 years from now on was estimated.

(b) Lifting method of bridge girders

To cope with the large land subsidence which may occur in future stage, the lifting measures shall be introduced at design stage for re-positioning the bridge girder on the

heightened abutments and piers, being followed simultaneously by the rehabilitation of the access road with additional embankment and new pavement.

(4) Type of superstructure

Based on the study on the relationship among bridge span, girder height and kind of superstructures, two types of the superstructures, pre-tension girder and in situ slab type bridges are applied. Width of bridge was determined under the following concepts:

(i) Width of the bridges is checked in accordance with Road Geometric Design Standard and decided after comparison with the bridge inventory data.
(ii) Width of the bridges coincides with width of the existing road for which there is heavy traffic volume. The width of the bridges for which there are less traffic volume does not always coincides with width of the existing road from the economical viewpoint, but, in any cases, width of new bridges should be larger than that of the existing bridge.

(5) Type of foundation

Foundation of the bridge structures consists of clay layer, silt sand/clay and clay/sand with N value of about 16 at depth of 9 m. Considering the geological conditions of the bridge structures, namely, expecting both resistance of pile of tip and skin, pile type was selected as foundation.

(6) Type of pier

Pile trestle type was selected considering relatively small vertical reaction from small spanned superstructure, horizontal reaction due to load, height of pier and economical view points, according to Indonesian standard drawings.

(7) Type of abutment

Pile trestle abutment was selected due to the same reason as the pier and considering foundation condition of the abutment and height of the abutment provided on the existing ground.

(8) Elevation of bridge

Elevation of the girder bottom of the proposed bridges shall be set above the vertical clearance restricted by the freeboard and allowance of land subsidence. The elevation of deck surface shall be calculated as:

Bridge surface elevation = H.W.L+ Freeboard +Land subsidence +Girder height +Pavement depth +Cross- fall.

Total land subsidence up to target year, 2010 was assumed as follows:

Name of drainage channel	Annual land subsidence(mm/year)	Duration of year(year)	Total land subsidence(mm)
-Kamal(main)	60	14	840
-Kamal(branch)	60	14	840
-Tanjungan	60	14	840
-Gede/Bor	80	14	1,120

These criteria were applied for the bridge with length more than 6m. For in-situ slab bridge of which span length is less than 6m, allowance against land subsidence is not applied because side protection for access road to be constructed in front of the densely populated area disturbs visual amenity, besides, it is easily possible to heighten the substructure by jack method even if the ground elevation is settled down due to land subsidence.

(9) Criteria for culvert

(a) Definition

In order to avoid confusion of term usage for culvert, it is defined that the term, "Culvert" is a crossing structure constructed in subsurface for water stream or that of constructed close to surface with the opening size of less than 2 m x 2 m.

(b) Applicable codes and standards

There is only one Indonesian Code, i.e. Standard Drawings of Culvert translated in English for "Standard Duiker", in which the principal dimensions of box type culvert with the opening of less than 2 m x 2 m are tabulated. In connection with the Standard, Japan Bridge Design Manual issued by Japan Highway Authority set out the design procedure on the various type of culvert not only for the box culvert but also pipe

culvert, arch, portal and so on, consequently it is recommendable to use the Japan Standard properly in addition to the Indonesian Standard above stated.

(c) Design load

As to the live load, the same load as previously described for bridge criteria will be used and soil pressure and bearing strength under the culvert will be computed based on the soil data.

(d) Special provisions

For the measure of subsidence, followings shall be considered:

(i) Siphon system shall not be used to obtain smooth stream of water without concern about accumulation of debris mats.
(ii) Open type culvert with cover at the top of the culvert shall be applied to cope with land subsidence.

4.4.2 Design of bridge

(1) Kind of bridges, their number and dimension

Location of the bridges and their dimension were determined based on the following concepts:

- Location of the bridges is the same sites as those of the existing bridges so that the road alignment of new bridge shall be basically on the center of the existing bridges unless otherwise specified..
- The bridge width and configuration are planned in accordance with Indonesian Code with keeping at least those of existing bridges
- Maximum length of the pre-tension girders is limited to less than 17.5 m and its height is limited as low as possible taking into account the severe construction conditions to be executed in narrow space at residential area and the transportation restraints on the national road.

Based on the above concepts, number of the bridges for respective drainage channels was estimated as follows and their locations are illustrated in Fig 4.4.1.

Drainage Channel	Girder Bridge	Slab Bridge	Total
-Kamal(main)	9	-	9
-Kamal(branch)	17	2	19
-Tanjungan	5	-	5
-PIK Junction	-	4	4
-Gede/Bor	10	-	10
-S,Cengkareng	13	-	13
-Meruya	-	16	16
Total	54	22	76

Among these, 54 are normal sized bridges with pre-tension girders, while, 22 bridges are in-situ slab type. In this design work, structure with the span length of more than 2m is defined as the bridge. In order to standardize the bridges and culverts, these 76 proposed bridges were classified by bridge width and girder length and following standardized type of bridge were selected:

Type of Bridge	Number of Standardized Type
- Girder type bridge	31
- In-situ slab type bridge	6
Total	37

In this design work, 37 type bridges were designed and designed structural sections were applied to the remaining 39 proposed bridges. Relationship among name of the bridges, the bridges with different size and total number of bridges for each drainage channel is as follows:

Name of Drainage Channel and No of Bridge								
Kamal(Main)	Kamal(Branch)	Tanjungan PIK	Junction	Gede/Bor	S,Cengkareng	Meruya	Bridge with different	Total No of Bridge
(1) Girder Type Bridge								
BKM 1	BKE 1	BTM 1		BGM 1,2	BCM 2		5	6
BKM 3	BKE 2,6,9	BTM 3		BGM 3	BCM 3		5	7
BKM 4	BKE 3,4,5,7	BTM 4,5		BGM 4,8,9	BCM 4		5	11
BKM 5	BKE 8	BTM 6		BGM 5,6,7	BCM 5		5	7
BKM6, 7					BCM 7		2	3
BKM 8	BKE 10			BGM 10	BCM 6		4	4
	BKE 11,18				BCM 8,9		2	4
					BCM 10		1	1
BKM 10,11	BKE 13				BCM 11,12,		3	5
	BKE 14,15				BCM 13		2	3
	BKE 16,17				BCM 14		2	3
7(9)	9(17)	4(5)		5(10)	11(13)	-	36	54
(2) In-situ Slab Type Bridge								
-	BKE 19,20	-	BNK1-4	-	-	BMM1-8,	2	7
						BMM9-12	1	3
						BMM15,16		
						BMM 13,14		
	1(2)		1(4)			4(16)	6	22
7(9)	10(19)	4(5)	1(4)	5(10)	11(13)	4(16)	42	76

Note: Figures in brackets show total number of the proposed bridges.

Relationship between above bridge number and bridge dimension is as follows:

No of Bridge	Bridge Dimension(m)			No of Bridge	Bridge Dimension(m)		
	Length	Width	Unit span length		Length	Width	Unit span length
BKM 1	44.79	4.6	14.9	BKE 8	16.86	2.5	8.4
BKM 3	40.14	9.6	13.35	BKE 10	14.66	6.6	7.3
BKM 4	39.96	2.5	13.1	BKE 11,18	14.66	4.6	7.3
BKM 5	56.72	9.6	14.15	BKE 13	14.66	8.2	7.3
BKM 6,7	36.54	2.5	12.15	BKE 14,15	14.66	3	7.3
BKM 8	38.79	4.6	12.9	BKE 16,17	14.66	2.5	7.3
BKM 10,11	35.79	9.6	11.9	BTM 1	40.59	6.6	13.5
BKE 1	16.86	3	8.4	BTM 3	23.86	10.6	11.9
BKE 2,6,9	16.86	4.6	8.4	BTM 4,5	19.26	12.2	9.6
BKE 3,4,5,7	16.86	6.6	8.4	BTM 6	18.46	2.5	9.2

No of Bridge	Bridge Dimension(m)			No of Bridge	Bridge Dimension(m)		
	Length	Width	Unit span length		Length	Width	Unit span length
BGM 1,2	15.83	9.6	15.8	BCM 4	14.63	2.5	14.6
BGM 3	15.83	2.5	15.8	BCM 5	15.83	6.6	15.8
BGM 4,8,9	15.83	6.6	15.8	BCM 6	14.13	6.6	14.1
BCM 5,6,7	15.83	4.6	15.8	BCM 8,9	12.63	2.5	12.6
BGM 10	15.83	3.5	15.8	BCM 11,12	13.53	12.2	13.5
BCM 2	15.83	9.6	15.8	BCM 13	11.33	8.2	11.3
BCM 3	15.83	4.6	15.8	BCM 14	10.53	9.6	10.5
BCM 7	15.83	2.5	15.8	BKE 19,20	2.33	4.6	2.3
BCM10	14.93	6.6	14.9	BNM1	2.83	8.2	2.8
				BNM2,3,4	2.83	4.6	2.8
				BMM 1,7,8	1.83	7.6	1.8
				BMM2-6	1.83	9	1.8
				BMM9-11	1.58	7.6	1.55
				BMM12	1.58	10.6	1.55
				BMM13,14	2.53	7.6	2.5
				BMM15,16	1.53	7.6	1.5

The bridge category will be divided into several groups since there are many bridges of which unit span length is slightly different though the bridge width is the same size. The bridges with slightly different length were classified into several groups to set out standardized type of bridge. Following table shows bridge category divided by classifying the bridges with slightly different unit span length as one bridge group in respect of width and number of the bridges to be designed.

Kamal(main)	Kamal(branch)	Tanjungan	PIK Junction	Gede/Bor	S,Cengkareng	Meruya	Total of Bridge Number	No of Bridge to be designed
(1) Girder Type Bridge								
				(road class:	I-3) BCM 11,12(13.5)(2)		1(2)	1
		W= 10.6m BTM 3(11.9(1)	(road class:	I-2)			1(1)	1
		W= 12.2m BTM 4,5(9.6)(2)	(road class:	II-3)			1(2)	1
	W= 8.2m BKE 13(7.3)(1)	(road class:			BCM 13(11.3)(1)		2(2)	1
W= 4.6m BKM 1(14.9(1)) BKM 8(12.9)(1)	(road class: BKE 2.6.9(8.4)(3) BKE 11,18(7.3)(2)	IV-1)		BGM 5.6.7(15.8)(3)	BCM 3(15.8)(1)		6(11)	6
W= 9.6m BKM 3(13.35)(2) BKM 10,11(11.9)(1), BKM5(14.15)(1	(road class:	III-2)		BGM 1.2(15.8)(2)	BCM 2(15.8)(1) BCM 14(10.5)(1)		6(8)	5
W= 2.5m BKM 6,7(12.15)(2),BKM4(13.1)(1) BKM 9(11.5)(2)	(road class: BKE 8(8.4)(1) BKE 16,17(7.3)(2)	P.B) BTM6(9.2)(1)		BGM 3(15.8)(1)	BCM 4(14.6)(1) BCM 8,9(12.6)(2,BCH7(15.8)(1)		7(12)	7
	W= 6.6m BKE 3.4.5.7(8.4)(BKE 10(7.3)(1)	(road class: BTM 1(13.5)(1)	III-3)	BGM 4.8.9(15.8)(3)	BCM 5(15.8)(1) BCM 6(13.5)(2),BC 1110(14.9(1)		9(12)	8
				W= 3.5m BGK	(road class:	IV-S)	1(1)	1
	W= 3m BKE BKE 14,15(7.3)(2)	(road class:	IV-S)				2(3)	2
Total for(1) 7(9)	9(17)	4(5)		5(10)	11(13)		36(54)	31
(2) Slab Type Bridge								
	BKE 19,20(2)		BNM1-4((4)			BMM1-8,BMM9-12,BMM13,14, BMM15,16	3(10)	6
Total for(2)	1(2)		1(4)			4(16)	6(22)	6
Total ((1)+(2)) 6(9)	10(19)	4(5)	1(4)	5(10)	11(13)	4(16)	42(76)	37

(2) Superstructure

The girder type bridge with an uniform rectangular section was designed. The relation between the stress by service load and allowable stress at girder center was calculated to determine the dimension of the girder section. Typical section of the girder type bridge is shown in Fig 4.4.2.

The computation results of each girder section are summarized in the stress sheets by showing the relation between the stress by service loads and the allowable stress at girder center and further safety ratio of ultimate moment by combined load to destructive strength are also computed. These calculation certificates that each girder has been designed safely with specific safety factor. The reaction shown at same sheets can be used for the design of substructure. Table 4.4.1 shows the stress summary of all bridges.

Girder has an uniform rectangle section height through the girder length which is composed of 700 mm in width and 400 mm in height for the shortest span of 7.m and 700 mm x 700 mm for the 17.5 m in length respectively. The slenderness ratio of the girder varies from 1 / 17.5 for 7 m in length and 1/25 for 17.5 m respectively, which are far less than that of I girder type, i.e. approx. 1/16, that contributes to shortening of the access road, while the height of pedestrian bridge varies from 350 mm to 500 mm with 700 mm in width, of which the slenderness ratio is from 1/20 to 1/31.6, being far flatter than those of road bridges. Table 4.4.2 depicts the typical section of each girder.

(3) Substructure

The following matters shall be considered for the design of substructure:

(i) Pile trestle type which consists of piles and hammer head has been selected due to the economical and structural reasons as stated in the interim report as follows :

- Reactions from superstructure are comparatively small due to short span.
- Since the height of the piles exposed on the channel bed is only about 3 m to 3,5 m at most, the transverse flexibility is not significant for this case.
- In addition to the above item, the bridge location is situated in the region of small seismic coefficient, that was checked in accordance with Indonesian Earthquake- proof Design Standard.

(ii) The structural detail of hammer head has been designed subject to the local standard, where vertical piles are used instead of battered piles to ease the driving work of piles with small tolerance, while PC Pile is chosen to increase more transverse strength rather than RC Pile in consideration of earthquake -proof design.

(iii) Since there are so many bridges to be located along the channels in wide stretch and the Dutch Corn Sounding shall be used for reading the final position of pile tip to be settled, the smaller allowable capacity, of piles i.e. 44.1 tons at 16 blows of N value has been selected to take safer side among 3 cases of trial computation proposed in the interim report and further 20 blows of N value which is generally considered reliable bearing layer of clay is used for pointing out the position of pile tips. Although the safer side has been taken as a pile capacity, the pile number is mainly decided by the balanced arrangement of piles instead of minimum number computed by the pile capacity to secure the stress safety of the hammer head and to support the hammer head in stability.

(a) Typical section of hammer head

The typical section of hammer head is composed of 2 m x 0.65 m (width x height)of rectangular for the pier and 1.8 m x 0.65 m for the abutment. These rectangular are supported in balance with double squads, which are used for the bridges with comparatively long span more than 11 m and large reaction such as class I road and pier with multi-spans. For shorter bridge span less than 11 m and pedestrian bridges are computed of 1.2 m x 0.65 m section supported with single squad to save construction cost.

For the countermeasures of subsidence in future, the superstructure can be lifted with the operation of flat jack (30 to 42 m/m depth) by the installation of it between the substructure and superstructure. Fig. 4.4.3 illustrates the typical section of abutment and pier.

(b) Pile strength

Concerning the pile strength for computing the number of piles required to support the reaction from the superstructure and the self weight of hammer head, the allowable bearing capacity is described in the interim report for three cases possibly occurred based on the soil exploration as follows:

Tip of pile	N-value at pile tip(blow)	Type of tip	Depth(m)	Allowable bearing
Stiff clay	24 blows	Friction	15	88
C, clay	15	Friction	9	41
C,S	32	End bearing	8	85

Among above three cases, 41 tons has been selected due to the following reasons ;

- Since many bridges are planned to be located in wide stretch, it is practical to choose the safer side of pile strength among the results of 6 core borings.
- The pile number shall be decided by the stress check of hammer head from the view points of strength and stability of pile trestle, namely the number has been decided for the strength balance of the trestle rather than designed by the pile strength.

In addition to the above consideration for the pile capacity, the geological configuration of stratum along the channels had been investigated by way of the Dutch Cone Test, and it was specified that the tip of pile to be settled shall examined and decided to lie on the stratum of safer side, i.e. 20 blows of N value which is generally considered stiff clay suitable for bearing layer of pile.

(c) Arrangement of pile

The number of pile to support superstructure and hammer head was obtained by dividing the total load acting on the piles by the allowable pile capacity. The number to be practically used are studied from respects of the stability of pile trestle and the strength of hammer head as stated previously and finally decided with the consideration of suitable arrangement of piles connected safely to the lower portion of the hammer head. The usage of single or double squads of piles is decided based on the following criteria:

- The bridge with the span of more than 11 m is supported with double squads according to the Indonesian Standard.
- The bridges on National Highway (Road Class - 1) administered by Bina Marga are of double squads to resist repeated loads by heavy traffic.
- Piers of multi-spans of road bridge are to be supported by double squads to avoid the eccentric load at the top of pile.
- The other substructures exclusive of the above conditions i.e. those of simple span with under 11 m and pedestrian bridges are put on single squad of piles to make

the construction cost lower.

To determine the pile arrangement in consideration of service and seismic loads, stress of hammer head was checked. Hammer head comprising one of trestle structure transmitting the reaction from superstructure to pile head has been designed under the following preconditions according to Indonesian Standard :

(i) Beam theory was applied for the analysis of the structure since a beam is supported longitudinally with mullet- piles.
(ii) Reaction of dead load from superstructure is acting uniformly and longitudinally on the hammer head.
(iii) Impact loads are included for both live loads, i.e. BM 100 (10 tons concentrated load) and BM 70 (8 tons instead of 7).
(iv) Horizontal force by earthquake is loaded on the top of hammer head.

For the stress check of the hammer head, typical loading cases and deployment of piles which induce maximum moment has been selected in respect of both squad cases, single and double among all pile trestles.

Pile arrangement has been decided after the following examinations:

(a) Stress check of pile in respect of not only service loads but also seismic ones, which affect the pile strength and number.
(b) Strength of hammer head which affects the distance of pile support.

The final deployment of pile is illustrated in Table 4.4.3.

(d) Pile length

The geological data are fully used to presume the bearing layer penetrated with pile tips. In the geological survey result, the geological cross section connecting the bore data of 6 points and geological profiles of the Dutch Cone Sounding along the channels are depicted, which can be effectively used to point out the tip location of pile with the insert method of putting bridge location between sounding positions of the profiles. The layers with more than 20 blows of N value have been read on the profiles as a bearing stratum, in which the following depth are roughly assessed for each channel:

Drainage channel	D(N:20)(m)
- Kamal(main)	10.0-16
- Kamal(branch)	7.0-19
- Tanjungan	9.0-17
- PIK Junction	8.8-11
- S, Cengkareng	5.0-9
- Gede/Bor	9.0-10

(e) Earthquake- proof design of substructure1

(i) Design standard

The seismic design of substructure has been carried out properly according to Indonesian Standards, "Procedure of Designing Earthquake Proof for Highway Bridges, SNI 03-2833-1992.

(ii) Equivalent horizontal seismic coefficient (Kh)

Kh can be obtained from the following equation:

$$Kh = Kr \cdot f \cdot p \cdot b$$

where:

Kr =0.15 (combined response coefficient, natural period of bridge(Tg) is considered less than 0.4 second per cycle in Zone 4 in the above standard, which is the safer side of evaluation.)

f = 1.0(structural factor, for the bridge of BM 100 located on national road)

f = 0.8 (same as above, for that of BM 70 located on local road)

p =1.3 (material factor, for PC structure)

Consequently,

Kh = 0.15 .1.0 .1.0 .1.3 = 0.195 for BM 100

Kh = 0.15 .1.0 .0.8 .1.3 = 0.156 for BM 70

Horizontal force can be computed by the multiplication of "Kh" to the reaction of dead load as follows:

H = Kh x Rd

where:

H : Equivalent horizontal force. (t)

Rd Reaction by dead load (t)

(iii) Equation to compute the section force of pile

Since there are usually differences much or less between presumption of calculation and real structures, following two methods with different preconditions were applied to check the safety of pile stability, for which the bigger section force has been selected:

Method-1: Equations to obtain section force of pile are simplified with the consideration of portal shape of pile trestle and also the convenience of manual computation as follows:

i) Fundamental structural system has been set up based on the condition that a column driven in soil is supported with the elasticity of soil.

ii) Horizontal seismic force acting on the top of pile is transmitted to the pile top at ground surface with two forces i.e. moment and shearing force, in which the moment is supposed to add to the maximum moment brought about by the shearing force at under ground. This equation is established for the analysis of section force of pier.

iii) For abutment, a hinge connection at pile top is presumed as a boundary condition for analyses model that is considered as safer side computation.

Method-2: The preconditions of the equation are based on the following model:

i) Structural system is a single column supported downward with the elasticity of soil.

ii) For the analysis of single squad piles irrespective of foundation type i.e. pier or abutment, the boundary condition is set up that the horizontal force is acting at column top in free rotation.

iii) For that of double squad piles, single column is presumed to be fixed at the top for moment .

In the above two methods, the section force of moment and shearing force are considered for computation but not normal force because moment force is considered to be predominant on the ultimate strength of pile.

(iv) Calculation of section force

The sectional force was computed by method-1 based on the condition that 3 blows of N value of upper layers is taken as typical soil condition due to affecting the section force more than lower layers. For Method-2, the coefficient of two layers, i.e., upper and lower layers has been used to calculate the section force in detail.

(v) Stress check of pile

Stress check has been carried out based on the operation of two methods. Bigger moment out of two outputs was selected to compare with the allowable resistant moment of pile defined as ultimate strength.

4.4.3 Design of culvert

(1) Small bridge and culvert

Definition of border line between bridge and culvert is set at the span length of 2 m, however, this definition is not necessarily known internationally. But, the classification by span length is generally accepted in Indonesia because it is stipulated in two standard, i.e. that of in-situ bridge with 2 to 6 m long span and culvert for spanning 2 m.

According to the above definition, in-situ bridges are estimated at 22, i.e. 2 in the Kamal (branch), 4 in the PIK Junction and 16 in Meruya. Besides, two types of box culvert are planned under ground for the Meruya area. These are 2.2 m x 1.6 m size and 288 m long, and 3 m x 2.2 m size and 504 m long.

(2) Typical section

Typical sections of In-situ slab bridge are illustrated in Fig 4.4.4, according to Indonesian standard. The detail design is being carried out.

4.4.4 Design of access road

The elevation of new bridges are positioned over the vertical clearance restricted by the height of freeboard and the allowance of land subsidence, therefore the elevation gap between bridge surface and existing ground line shall be smoothly connected with each other by the access road with transition curve. For the design of transition curve and ancillary belongings related to the access road, the following points are taken into consideration :

- Gradient angle, transition curve and length of the access road are designed basically according to Indonesian road alignment standard.
- For the pedestrian bridge the straight line of 10% or stairs for an alternative will be used.
- Since it is very difficult to obtain specific alignment with formal transition curve

according to the standard because of technical reasons and from the inconvenience of daily life for residents, special consideration should be made, i.e.: straight curve is inevitably taken at the place of few traffic volume for the access road although it is out of the standard.

- Storm sewage are provided on both sides of the access road.
- If there is narrow space between houses and road side at residential area the guard-rails are installed within the retaining walls to prevent the residents against car accidents.

(1) Gradient and transition curve

Maximum gradient transition curve and their length are stipulated in the standard for Geometric Design of Urban Road. Table 4.4.4 shows the specific figures for maximum gradient, transition curve radius and minimum length of curvature in respect of each design speed and in addition applied road classes to the specific design speed are recommended in remarks column.

(2) Bridge elevation

The elevation of deck surface has been calculated as the following equation:

Bridge Elevation = H.W.L + Free Board + Land Subsidence + Girder Height + Pavement Depth + Cross-fall

(3) Classification of mound up height

In line with the elevation gap between bridge surface and ground line, the classification of mound up height for the access road is as follows:

	Mound up height(m)						Total
	0<h<0.5 and h=0	0.5<h<1.0 and h=0.5	1.0<h<1.5 and h=1.0	1.5<h<2.0 and h=1.5	2.0<h<2.5 and h=2.0	2.5<h<3.0 and h=2.5	
Number of bridge	18	4	10	21	19	4	76

This table shows that the number of the bridge between 1m to 2.5m is 50, amounting to 66% of the total number. Twenty three bridges with less than 0.5m are in-situ slab bridges with small span less than 6m, which are planned without allowance for land subsidence due to easy works of heightening of deck slab of bridges with relatively light

weight.

(4) Classification of side protection

The side protection works of the access road will be classified into following types, namely, sod facing-6, retaining wall-42, stairs for pedestrian-11 and no need of embankment -10. It shows that the retaining wall type occupies 88 % of all of the access roads because the bridge is remarkably approached to the residential areas. Table 4.4.5 tablets the regional classification of above statement.

(5) Access road length

The total length of access road can be computed mechanically according to the standard as follows ;

	Road length(one side)(m)	
Drainage channel	Carriageway	Pedestrian
- Kamal(main)	30.5-60.5	15.7-21.3
- Kamal(branch)	31.2-50.1	18.7-21.6
- Tanjungan	49.2-68.8(83.5*)	
- S, Cengkareng	27.6-57(84*)	13.8-26
- Gede/bor	43.9-79	19.1

* : National road (Class 1st)

Above table indicates that the approach length is 50 to 70 m for local road, about 85 m for National Highway and about. 25 m for pedestrian bridges. The breakdown of the length is shown in Table 4.4.6.

(6) Typical section of access road

The typical section of access road is planned in two different types, whether the bridges are situated at field area or residential area. The embankment in field can be provided with gentle slope for side protection while in resident area, retaining wall of concrete or concrete blocks shall be built to minimize the total width of access road and furthermore the installation of guard-rail and storm drainage shall be provided on the retaining walls. Fig 4.4.5 shows typical section of access road.

5 COST ESTIMATE

5.1 Basic Condition of Cost Estimate

The financial cost was estimated under the following conditions:

(1) Financial cost

The financial cost comprises main construction cost, compensation cost for households and land acquisition, engineering service and administrative costs, physical and price contingencies and interest during construction. The main construction cost was estimated on a unit price basis.

(2) Project execution method

All the construction works of the project will be executed on a contract basis. The construction equipment, materials and labor to be required for the works will be supplied by the contractors to be selected through an international tendering for each package.

(3) Price level

The cost estimate is made at the price level as of June 1997 because basic costs of labor, material and equipment had been collected at this period.

(4) Currency in cost estimate

The cost estimate is made in terms of US Dollars for both the foreign currency portion and the local currency portion.

(5) Foreign exchange rates

The exchange rate in the cost estimate is US$1.0 = ¥115.00 = Rp. 2,350, on the bases of the TTS (=Telegram Transfer Selling) rates of the Bank of Tokyo-Mitsubishi in Japan as of monthly mean rates in June 1997.

(6) Classification of foreign and local currencies

The financial cost is divided into foreign currency portion and local currency portion. The following conditions for the classification of foreign currency portion and local currency portion are applied in the cost estimate:

Local currency portion:
- All labor costs;
- Net local portion of construction material costs;
- Annual management and part of maintenance costs of construction equipment;
- Cost of local portion of engineering services.
- All costs of administration expense for the government staff,
- Land acquisition and compensation costs;
- Value Added Tax;
- Local portion of contingencies, and
- Local portion of interest during construction.

Foreign currency portion:
- Part of maintenance and full amount of depreciation costs of equipment;
- Net and indirect portions of construction material costs,
- Cost of foreign engineering services.
- Foreign portion of contingencies, and
- Foreign portion of interest during construction.

The proportions of foreign and local currency components of the major construction materials and other unit price components are assumed as follows:

Description	Foreign portion (%)	Local portion (%)
1 Labor	0	100
2 Construction equipment	80	20
3 Construction materials		
(1) Cement	70	30
(2) Re-bar	70	30
(3) Fuel, oil and lubricant	80	20
(4) Aggregate and stone material	70	30
(5) Cobble, gravel and sand	40	60
(6) Lumber, playwood & wooden materials	40	60
(7) RC products	70	30
(8) Asphalt bituminous	60	40
(9) Steel sheet piles	90	10
(10) Structural steel	90	10
(11) PVC waterstop	80	20

(7) Unit prices

Unit prices of local materials were estimated based on the prices of local markets or local suppliers. The labor rates are based on the prevailing rates.

(8) Unit work cost

The unit work cost was estimated based on the unit prices of materials, labors and equipment. It consists of direct cost, indirect cost including contractor' profit, office expense, contractor risk insurance, unforeseen contingency, miscellaneous expenses and income tax for local portion.

(9) Compensation of households and acquisition of land

Compensation cost for households and acquisition of lands was estimated based on experienced cost data in city of Jakarta.

(10) Engineering service and administrative costs

The engineering service cost for assistance of tendering and construction supervision of the project works by consultant was estimated on an actual cost basis. The administration cost necessary for operation expenses of the project management office was estimated at 5 % of the main construction cost.

(11) Contingency

The contingency comprises physical and price contingencies. The physical contingency was estimated at 10 % of the sum of main construction cost, land and house compensation, and engineering service and administrative costs. The price contingency to cope with annual price escalation was estimated at 2 % for both the foreign and local currency portions.

(12) Tax

The income tax was estimated at 10 % of the construction cost and engineering services.

(13) Interest during construction

The annual interest amount during construction period was calculated by applying fixed rate of 3 % against accumulated financed amount in each year.

5.2 Financial Cost and Annual Disbursement Schedule

The financial cost estimated based on the above conditions is US$ 88.973 million comprising foreign currency portion of US$ 28.016 million and local currency portion of US$ 60.957 million including tax. Table 5.1 shows the summary of the financial cost.

An annual disbursement schedule of the project works was estimated as shown in Table 5.2 based on the proposed construction schedule. The budget to be disbursed annually is summarized as follows:

Year	Amount (1,000 US$)
1997	1,030
1998	760
1999	3,403
2000	9,138
2001	14,783
2002	16,066
2003	11,836
2004	15,130
2005	10,994
2006	7,450
Total	90,590

6 ECONOMIC EVALUATION

6.1 General

The economic viability of the project was examined incorporating the estimated project cost and flood damage. The economic cost was estimated deducting the transfer payment from the financial cost. The project benefit was estimated assuming that the annual average flood damage corresponding to less than 10-year probable flood for the Cengkareng west area and 5-year probable flood for the Meruya area is regarded as the flood control benefit. The economic evaluation was made by means of internal rate of return (EIRR).

6.2 Economic Cost

The economic cost of the urban drainage project was estimated under the following conditions and assumptions:

(1) Costs are estimated on the price level of June 1997.
(2) The exchange rate is US1 = Rp. 2,350 = Yen 115 was applied.
(3) Costs for the following items are excluded:
- Income tax: 10 % of material, equipment and labor cost
- Corporate tax: 30 % of contractor profit
- Price escalation: 2 % of direct cost

(4) Shadow price is applied to the common labor cost. It is estimated at 60% of common labor cost.

Based on the above conditions and assumptions, the economic cost was estimated at US$ 51.42 million for the Cengkareng west and Meruya area as shown in Table 6.1

It is presumed that a pumping facilities may be needed in the following years at downstream of the Tanjungan, Kamal, Saluran Cengkareng and Gede/Bor drainage channels if land subsidence at a rate of 6cm/year occurs and tidal level is unchanged:

- Tanjungan drainage channel 2016
- Kamal drainage channel 2018

- S.Cengkareng drainage channel 2018
- Gede/Bor drainage channel 2024

The economic cost necessary for pumping facilities including regulation ponds and pump facility was approximately estimated at US$ 26.7 million in total.

6.3 Project Benefit

Project benefit expected from the urban drainage project was estimated under the following procedures.

(1) Estimation of inundation area
(2) Category of damage
(3) Estimation of unit value of assets
(4) Estimation of damage by inundation depth
(5) Estimation of probable flood damage
(6) Estimation of project benefit

6.3.1 Estimation of inundation area

Based on the available data, the inundation area was estimated at about 255ha for the Cengkareng west area and 15 ha for the Meruya area. The inundation takes place in lowland and the area along the river or channel. Approximately 7% of residential area and 4 % of industrial area with the inundation depth ranging from 20cm to 100cm are considered as a flood prone area.

6.3.2 Category of damage

The flood damages are divided into two types: direct damage and indirect damage. The direct damage is defined as damage to the general assets such as assets for residence, shops, offices, factories, public services, household goods, facilities in the buildings, and agricultural properties (paddy) in the flood prone area. Indirect damage includes the damage to economic activities, such as income loss due to its activities stagnation. Other possible damages, such as a forgone development in the flood prone area and cost of emergency measures made by local government are also estimated.

6.3.3 Estimation of unit value of assets

In order to estimate the flood damage, the value of assets in the flood prone area was calculated. The value of general assets such as houses, shops, factories, and public offices have been estimated by the survey conducted for the study on comprehensive river management plan in JABOTABEK. The basic data for assets was utilized for this study. In order to find the appropriate value of the assets for the project area, additional data was collected from Kecamatan offices and other related agencies.

The general assets are categorized into three types of land use: residential area, industrial area, swamp (paddy). Shops, offices, public buildings are included in the residential area.

(1) Assets in the residential area

The value of assets for residential area was calculated in the following manner.

- Estimate the unit value (US$/ha) of assets for houses, shops, offices, and public buildings, and
- Find the average value in the residential area by taking the ratios of the number of houses, shops, offices, and public buildings.

The estimated value for each parameter in the residential area is shown in Table 6.2. Based on the value estimated for each parameter, total unit value in the residential area was calculated assuming following ratios of the number of houses, shops, offices, and public buildings in the residential area:

The ratio in the residential area	
House	95.2 %
Shop	2.4 %
Office	1.8 %
Public building	0.6 %
Total	100 %

The value in a residential area was estimated from the value of assets and the assumed ratio. The estimated unit value in the residential area was calculated to be 680,183 US$/ha as shown in Table 6.3.

(2) Assets in the industrial area

The assets in the industry area was calculated from the value of the buildings and the property (stocks of products, raw material and machine and equipment). The estimated value of assets in the industry area is 4,546,060 US$/ha as shown in Table 6.4.

(3) The damage to the paddy

Since the average duration of flood is less than a day, and the paddy area in the project area is relatively small, the damage to the paddy is considered to be small. Then, the damage to the paddy was deleted from estimation.

(4) Damages to infrastructure

The damages to infrastructure such as roads, railway were estimated to be 20% of damage to general assets based on the survey at the Kecamatan office.

(5) Indirect damage

The damage to the net income loss for goods and loss of services to the nation due to the interruption of economic actives in the project area was regarded as indirect damage. Indirect damage is assumed to be 6% of damage to general assets.

(6) Other damages

The other possible damages were estimated for the items listed below. The item that is the largest in other damages is the forgone development in the project area in which the value of land will go up as much as five times the current value after the area is free from flood. The other damages were estimated to be 20% of the sum of direct damage, damage to infrastructure, and indirect damage

- Forgone development in the flood prone area.
- Cost of emergency measures made by local government
- Fears, misgiving and inconvenience people experience
- Insanitary and danger of infectious diseases.
- Injury to human lives

6.3.4 Estimation of damage by inundation depth

The flood damage rate prepared by the Ministry of Construction, Japan was utilized for estimating the unit flood damage. The unit flood damage for one hectare for a residential area and an industrial area was calculated from the unit value of assets and the flood damage rate. The result is shown in Table 6.5.

The direct damage for different inundation depth in the project area was estimated by multiplying the unit flood damage for one hectare and the inundation area for a different level of inundation depth. Since an accurate inundation map is not available, field investigations and interviews were conducted to estimate the relationship between inundation area and inundation depth. The estimated direct damage for a different inundation depth is summarized in Table 6.6.

6.3.5 Estimation probable flood damage

Probable flood damage, which includes direct damage, indirect damage, damage to infrastructure, and other damages was calculated under various magnitude of flood events. Conditions for the relationship between the inundation area and the flood probability of 2 years, 5 years, and 10 years were assumed as follows:

- Two-year probable flood will inundate 7% of residential area and 4 % of industrial area with an inundation depth up to 20cm.
- Five-year probable flood will inundate the area approximately 10 % more area than the rain with the return period of 2 years and will cause inundation depth up to 50cm.
- Ten-year probable flood will inundate the area approximately 30 % more area than the inundation area with the rain with 2year period and will cause the inundation depth up to 100cm.

Based on the above assumptions, the probable flood damage was calculated as shown in Table 6.7.

6.3.6 Estimation of project benefit

The difference of annual average flood damage without the project and with the

project is regarded as economic benefit of the project. Annual average flood damage was estimated by applying average occurrence probability to the corresponding probable flood damage.

Based on the probable flood damage, the annual average flood damage was calculated. After the drainage project works are completed, the project area will be free from 10-year probable flood for the Cengkareng west area and 5 year probable flood for Meruya area. Thus, it was assumed that the annual average flood damage corresponding to less than 10-year probable flood for the Cengkareng west area and 5-year probable flood for the Meruya area would be regarded as the flood control benefit. The estimated economic benefit for Cengkareng west area is US$ 7.6 million, and US$ 0.2 million for Meruya area as shown in Table 6.8.

6.4 Economic Evaluation

Economic viability of the project was examined on the following assumptions:

(1) Base year: 1997
(2) Project life time: 50 years after completion of the project works
(3) Annual operation and maintenance cost (O/M cost):0.5% of the main construction cost. The O/M cost is assumed to incur from the following year of completion of the project works through the entire project time.
(4) Benefit: 100 % of the benefit is attained from the following year of completion of the whole project works. The benefit during the construction period is assumed to occur in accordance with the ratio of the project cost disbursed by preceding year.
(5) The cost necessary for provision of pumping facility may occur in the year as stated in Section 6.2.

Based on the cost and benefit flow as shown in Table 6.9, the economic internal rate of return (EIRR) was estimated at 17.9 %.

To check the sensitivity of the project due to variation of project conditions, EIRR was calculated on the following assumptions.

Case 1 : Construction costs increase by 15%
Case 2 : Economic benefits decrease by 15%
Case 3 : Case 1 plus Case 2

The result of sensitivity analysis is as follows:

(unit: %)

Case	EIRR
1	14.8
2	14.2
3	11.7

7 OPERATION AND MAINTENANCE PLAN

7.1 Present Conditions of Operation and Maintenance (O/M) works

7.1.1 Organization for O/M works, staffing and their functions

Operation and maintenance works for the drainage facilities in the city of Jakarta have been carried out by DPU DKI, Jakarta. Present organization map for operation and maintenance works of DPU DKI, Jakarta is given in Fig 7.1.Under the chief of DPU DKI, maintenance division has been established. This maintenance division has four sections, namely, technical and planning for water related project, technical and planning for road and bridge, controlling and supervision for water related project and controlling and supervision for road and bridge. These four sections treat with large scale drainage channels such as primary drainage channel or first class road and bridges. The maintenance works have bee carried out by both a force account and a contract system depending on the amount of the maintenance works. In case that the cost of the maintenance works is less than Rp. 15 million, the maintenance works have been carried out by the force account system by hiring labor force and equipment from sub-district division as stated in the following. The maintenance works with cost more than Rp 15 million are performed by local contract system.

Number of staff for sum of these four sections is 118, namely, about 30 for each section. Function of the respective four sections is as follows:

(1) Technical and planning for water related project
- Monitoring and inspection for the large scale drainage and sewerage projects
- Survey and investigation for damaged facilities
- Design works of maintenance works for drainage and sewerage project

(2) Technical and planning for road and bridge
- Monitoring and inspection for the large scale road and bridge projects
- Survey and investigation for damaged facilities
- Design works of maintenance works for road and bridge project

(3) Controlling and supervision for water related project
- Execution of maintenance works with less maintenance cost

- Tendering works for selection of local contractor for maintenance works with the cost more than Rp. 15 million
- Supervision works of the maintenance works for the contracted water related project
- Supervision of the maintenance works done by the sub-restrict divisions

(4) Controlling and supervision for road and bridge project
- Execution of maintenance works with less maintenance cost
- Tendering works for selection of local contractor for maintenance works with the cost more than Rp. 15 million
- Supervision works of the maintenance works for the contracted road and bridge project
- Supervision of the maintenance works done by the sub-restrict divisions

A smaller scale drainage channel such as secondary and tertiary drainage channels has been treated with sub-division which is controlled by mayor's office. This sub-restrict division which has the same organization as the maintenance division controlled by governor has been established in five districts in the city of Jakarta, namely, north, south, central, west and east sub-districts. The maintenance works in this sub-restrict division have been also carried out by both the force account and local contract systems, depending on the amount of the maintenance works.

7.1.2 Annual budget for O/M works

An average annual budget for the operation and maintenance works disbursed for all the city of Jakarta by maintenance division controlled by the governor in the past was Rp 24.5 billion, comprising Rp. 3 billion financed by national budget, Rp. 7.5 billion financed by regional budget, and Rp14 billion financed by routine budget. The maintenance division always requests the budget of a larger amount of maintenance works to the governor, but due to financial limitation of the city of Jakarta, an approved budget is smaller than that requested. Under this condition, maintenance works are obliged to be performed by giving priority for the proposed maintenance works.

The sub-restrict division office controlled by the mayor's office has their own budget for maintenance works for the smaller scale projects.

7.2 Proposed Operation and Maintenance Plan

7.2.1 Proposed organization and system for O/M works

The proposed project for the Cengkareng west and Meruya areas comprises the following facilities:

Drainage Channel			Related structures	
Name	Length(m)	Width(m)	Bridges	Gate facilities
(1) Cengkareng west area				
- Kamal	7.2	2 - 35	28	23
- Tanjungan	2.5	15 - 25	5	7
- PIK Junction	0.8	2.2	4	1
- Gede/Bor	1.2	10 - 11	10	5
- Saluran Cengkareng	4.2	6 - 10	13	15
(2) Meruya area	2.3	1.2 - 5	16	0
Total	18.2		76	51

Number of gate facilities increases remarkably compared with present drainage condition in the project area. In addition, culvert with a long distance to be provided under ground in the Meruya area is also planned. In order to carry out complete operation and maintenance works, effective organization and system should be established. To meet this requirement, following revision of the present organization will be necessary:

(i) Operation of the metal works in the Cengkareng west area is only for a gate facility at the outlet portion of the Saluran Cengkareng drainage channel at present. Under this situation, priority is given only to maintenance works. Since feature of the drainage system will be drastically changed, combination of systematic operation and maintenance works is duly needed.

(ii) In order to carry out harmonized operation and maintenance works, a operation group for metal works is established in the controlling and supervision section.

Fig. 7.2 shows the proposed organization for operation and maintenance works. This organization was established under the following principles:

(i) In order to keep National Program of Clean Water Management (Prokasih), monitoring and observation of the completed drainage channels networks are unavoidable.

(ii) It is anticipated that an artificial inundation may take place unless systematic and synchronized gate operation is carried out in the Kamal and Saluran Cengkareng drainage channel where 27 slide and flap gates are installed. Thus, systematic operation of the gate facilities is duly required and transfer of operation technology to residents will be needed since some of gates should be operated by residents themselves.

(iii) In order to do timely maintenance of the drainage facilities, minimum repairing equipment such as wheel loader, dump truck, etc. should be kept by maintenance works group.

In the proposed organization, technical and planning unit will be divided into monitoring and observation group and design group. Under the controlling and supervision unit, operation groups for metal works and maintenance groups are established. Required number of key staff in operation and maintenance units in one district is 38.

7.2.2 Technical and planning for drainage facilities

(1) Monitoring and observation

1) Water quality

Most of water in the drainage channels stagnates in the dry season due to very gentle channel bed slope and insufficient flow capacity. Besides, Due to throwing garbage into the drainage channel by resident, this phenomenon is accelerated

The national clean water campaign (Prokasih) was launched in 1989 to maintain water quality and to secure river and channel environment for sanitation and human welfare. The Prokasih is the first comprehensive relief pollution control on channel water by reduction of pollution load resulting from effluent discharge of both domestic and industrial waste water.

In line with the above, it is recommended to establish water quality monitoring system to maintain a sanitation environment. In this water quality monitoring system, water sampling in the following sites is proposed in every month:

Drainage channel	Sampling site
- Kamal	2

- Tanjungan	1
- PIK Junction	1
- Gede/Bor	1
- S. Cengkareng	2
- Menya	1
Total	8

It is proposed to carry out these sampling and following laboratory tests once a month per year by entrusting to local contractor. In laboratory test, value of Ammonia Nitrogen (NH_3-N), Hydrogen Sulphide(H_2S), Nitrites(NO_2-N), and Dissolved Oxygen(DO) will be detected. Result of the laboratory test should be evaluated by comparing the standard specified by environmental committee.

2) Survey and investigation of damaged portions

To obtain the basis for planning and design works of the maintenance works, necessary survey and investigation for the damaged drainage facilities will be made by this monitoring and observation group.

(2) Design of maintenance works

Design of the maintenance works for the drainage facilities including planning, design, cost estimate and maintenance method should be made considering the following inspection and check points:

1) Drainage channel
   - Dumping of garbage
   - Occurrence of vegetation: water hyacinth, encenggondok, etc. which may occur under stagnated water and disturb smooth water flow
   - Occurrence of sand bar in the channel and deposit of sediment load, especially after flood time.
   - Barrier made for private use

2) Levee
   - Crest deterioration due to miring and subsequent trouble to traffic
   - Erosion due to rainfall
   - Cracks, leakage of water or piping, hole caused by nest of ants
   - Slope failure of levee
   - Partial cutting of levee crest and slope due to crossing of inhabitants

- Illegal works on levee such as construction of private or public facilities and temporary building, piling, excavation, etc.

3) Parapet wall
   - Erosion or scouring of channel bank at which parapet wall is constructed
   - Crack on the parapet wall
   - Leakage through the wall body or wall foundation
   - Cultivation of foot portion of the parapet wall
   - Removal of a part of the parapet wall for crossing or water intake
   - Illegal works on the parapet wall such as private or public facilities, temporary building, etc.

4) Revetment (wet masonry and gabion mattress types)
   - Crack on the slope pavement
   - Channel bed lowering in front of foundation and erosion or scouring at the channel bank upstream and downstream of the revetment works
   - Opening of construction joint
   - Sinking of gabion works due to flowing out of foundation materials
   - Sucking out of the filling materials behind slope facing due to high flow velocity

5) Sluiceway (conduit structure and gate facilities)
   - Crack on concrete or deformation due to foundation settlement
   - Crack or cave-in in bank near or levee above the conduit
   - Clogging of sluiceway due to dumping of garbage, sand bank, etc.
   - Seepage in foundation around the conduit
   - Settling down of concrete conduit due to scouring of foundation in front of the conduit
   - Missing of a part of gate facilities
   - Throwing stone around gate leaves and obstruction of gate operation
   - Improper or insufficient arrangement of gate operation

6) Bridge structure

a) Check point by routine inspection:
   - Clogging of bridge due to garbage, water vegetation, etc.
   - Damage of bridge related structures such as sign, name plate, etc.
   - Damage of asphalt surface
   - Damage of painting of hand rail,

b) Check points by periodical inspection
   - Damage of steel members
   - Damage of bank slope

7.2.3 Controlling and supervision

(1) Patrol and inspection

The patrol and inspection of the drainage facilities should be made once a month during a dry season and once a week in a rainy season. During flood occurrence, the patrol and inspection should be carried out several times a day as required. Through the patrol and inspection, places or facilities to be maintained or replaced should be identified and notice to the maintenance section should be made without delay.

(2) Operation of metal works

It has been planned to provide 51 units of gates comprising majority of slide gates and few numbers of flap gates in the proposed drainage channels. Since majority of the gates will be installed in densely populated areas in series in the Kamal and Saluran Cengkareng drainage channels, timely and systematic operation of these gates is duly needed to avoid artificial inundation, especially for slide gate at the outlet of the Saluran Cengkareng drainage channel. The flap gate operates automatically by difference of water head between main channel side and inland side. However, its operation is sometimes disturbed due to the outlet bottom sedimentation, obstacle by garbage, etc. To cope with the above situations, following measures should be adopted:

(i) Learning of operation technique by all of the key staff in the operation group
(ii) Transfer of operation technique to residents concerned to operation
(iii) Removal of sedimentation or garbage causing jamming
(iv) Closure of the sluiceway conduit with stoplog if necessary to prevent an adverse river water flowing into inland area through the conduit.
(vi) Promotion of campaign to stop throwing garbage into drainage channel to residents living along the drainage channels

(3) Maintenance works

The maintenance works will be performed by maintenance group by hiring labor and apart of equipment from sub-district for a small scale maintenance works. In case that the maintenance works is a large scale, maintenance works will be made by local contract system under supervision of the maintenance group. Maintenance method for respective drainage facilities is as follows:

1) Collection of articles flowing in drainage channel and their disposal

Due to lack of collection system of garbage, residents living along the drainage channels apt to throw garbage into the drain age channels. This garbage accelerate not only to contaminate the drainage water but also to reduce flow capacity of the drainage channels.

It is proposed to carry out removal of garbage by hiring labor and equipment from sub-district. But, to promote timely disposal of garbage, minimum equipment such as small scale backhoe and dump truck should be kept by this group.

2) Maintenance works

a) Drainage channel

The maintenance works for the drainage channel will be occupied by removal of vegetation and sediment load deposited on the channel bed. Removal of the deposited sediment load and vegetation will be made using backhoe and dump truck for small channels and dredger and dump truck for large channels.

b) Levee

(i) Against cracking of the levee, the surface soil shall be removed by trench excavation along the cracking portion and suitable soil shall be filled with an adequate moisturing and sufficient compaction.

(ii) Against a partial cutting and shoulder collapse, surface soil at the damaged portion shall be removed and earth embankment shall be made in an ordinary levee embankment method.

(iii) Against the slope collapse, earth materials in the range of collapse portion shall be removed entirely and slope surface shall be treated with bench cutting. Afterwards, earth embankment shall be made by ordinary embankment method.

c) Parapet wall

(i) Against the erosion or scouring of channel bank, the channel bank portion shall be excavated to the depth of at least 0.5 m horizontally and gabion mattress shall be placed to protect foot portion.

(ii) Against crack on the parapet wall, cracked portion shall be removed in V-shape by about 10 cm in depth along the crack and fresh mortar shall be filled in the removed portion.

(iii) Against leakage through the wall body, the leakage portion shall be removed and

reconstructed by same materials.

d) Revetment

(i) Maintenance for crack or sucking out on wet masonry shall be made in a manner that cobble stones adjacent to both sides of the crack or sucking out portion shall be removed and vacancy after removal shall be filled with wet masonry.

(ii) Against slope failure due to settling down of foundation, additional placement of gabion mattress shall be made.

(iii) Against erosion or scouring at channel bank neighboring to each revetment, extension or new application of bank protection shall be planned.

e) Sluiceway

(i) Civil works for repairing cracks, cave- in, etc. at the foundation, channel bank or levee shall be made in a same manner as those for levee.

(ii) A series of maintenance of the gate facilities and routine civil works are as follows:

- Mechanical repair and part supply for gate, their accessories in case of irregularities, damage or loss
- Test operation and greasing of gate and their accessories at a once a year
- Painting of gate leaves at least once three years
- Cleaning of gate and their accessories at least three times a year
- Removal of deposit at channel bank near the sluiceway and in the conduit openings and inlet and outlet channels

f) Bridge structure

Maintenance works of the bridge structure will be divided into routine maintenance and periodical maintenance. Scope of respective maintenance works is as follows:

(i) Routine maintenance

- Cleaning operation such as removal of earth, gravel, sand and rubbish from the portion which will be exerted by harmful influence, removal of vegetation around bearings and expansion joints, washing signs and painted portions
- Repair of minor damages such as road sign, bridge number plate, etc.
- Minor painting for hand rail and parapet
- Maintenance of damaged asphalt surface on bridge

(ii) Periodical maintenance

- Repainting of steel parts and timber
- Renewal of asphalt road surface
- Major cleaning of bridge such as washing of outside of the girders fringe of girder, bearing sills, etc.
- Maintenance of bearings
- Minor repair such as renewing of parts and minor elements, repairing of hand and guard rail and strengthening of structural members

7.2.4 Operation and maintenance cost

The operation and maintenance cost for this project was estimated for routine operation and maintenance works based on the work quantity of the project works and unit rate of work components. Basic conditions and assumptions for estimation are as follows:

(i) Water quality observation is made on contract basis

(ii) Collection of garbage is carried out at a rate of once a week for 0.5 % of the whole volume of the garbage. The collected garbage is transported a disposal area at about 10 km from the garbage collecting site.

(iii) Excavation of sediment deposited on the channel bed id excavated at a rate of one time per year for 0.5 % 0f the whole volume of the deposited sediment The excavated sediment is transported to a disposal area at about 10 km from the excavated portion.

(iv) Grass cutting and earth filling for levees are performed at a rate of 2 times per year of 0.5 % of whole volume of grass and embankment.

(v) Maintenance works for revetment is made at a rate of 0.5 % of the total revetment volume per year.

(vii) Maintenance works for slide and flap gates are carried out at a rate of 2 times per year.

The annual operation and maintenance cost for this project estimated based on the above conditions and assumptions is Rp. 1 billion as shown in Table 7.1.

8 ENVIRONMENTAL IMPACT ASSESSMENT

8.1 Introduction

Physico-chemical environment including water quality, air quality and noise, biological environment including flora and fauna in the project area and socio-economic environment were studied based on the collected data in this study. Major positive and negative impacts were identified in this study. Measures to mitigate the negative impacts are studied in the environmental management and monitoring plans.

8.2 Environmental Impact Statement (ANDAL)

8.2.1 Physico-chemical environment

(1) Present conditions

(a) Air Quality and Noise Level

Air quality and noise level in the project area has been measured during the EIA study period. Obtained data are suggested to use as reference data for monitoring works during the construction period. Monitoring data for air quality analysis and noise level are shown in the Tables 8.1 and 8.2 respectively. Corresponding sampling locations for both of them are shown in Fig 8.1. Table 8.1 shows that lead (Pb) concentrations throughout the project area are slightly above (30-31 μ / m^3), or at the limit of standard concentration for DKI Jakarta (29 μ / m^3), indicating the level of air pollution derived from vehicular traffic in the project area.

Result of noise measurements indicate that the average daily noise level in all of the sampling locations exceeds the maximum standard level for human settlements of DKI Jakarta (60 dB), ranging from 79dB to 64 dB. Minimum recorded noise levels has been recorded at the downstream of the Saluran Cengkareng drainage channel.

(b) Water quality

Classification of water pollution in the project area has been established according to the Water Standard of DKI Jakarta. The existing water pollution in general is classified into four classes in terms of BOD values as follows:

Class		BOD (mg/l)	Pollution Level
I	:	0 - 30	Slight
II	:	30 - 60	Significant
III	:	60 - 90	Heavy
IV	:	> 90	Very Heavy

The upper limit for maintaining aquatic life in the Environmental Standards of Indonesia is 30 mg/l of BOD.

The extent of organic pollution within the drainage channels of the project area is considered relatively high, especially in the entire length of the Saluran Cengkareng drainage channel, the upstream area of the Kamal drainage channel and the Tanjungan drainage channel. Coupled with the water pollution, therefore, silt material at the bottom of drainage channels would contain highly polluted materials. The result of water quality analysis is shown in the Table 8.3 and the corresponding sampling locations are shown in Fig 8.3. Standard of Water of DKI Jakarta is shown in Fig 8.4. Table 8.3 shows that the most significant values deviating from the standard are those measured for Ammonia Nitrogen (NH_3-N), Hydrogen Sulphide (H_2S), Nitrites (NO_2-N), and Dissolved Oxygen (DO), indicating evidence of organic pollution, probably derived from the disposal of raw sewerage coming from the adjacent human settlements. This condition is enhanced by the low oxygenation capacity of the channels, and thus generating high H_2S, and low DO readings, along with offensive odors. These results are in accord with the low biodiversity index found during the aquatic biota (Benthos) survey. Other values reported to be above the official standards are Zinc (Zn), which is probably derived from the leaching of metal components such as car parts, junk etc. It is disposed off directly into the drainage channels and rivers of the project area at present.

(c) Topography

Topography of the project area is predominantly flat. Northern area of the project area is a typical coastal plain. The elevation above sea level in the project area is 3-6 m. Several areas are subject to flooding during the rainy season due to the poor drainage and low elevation conditions.

Coastal area to the northeast of the project area is occupied by swamps and fish ponds as well as the growth of mangrove. These features contribute stagnation of water i.e. pollution in the bodies of water.

(2) Environmental impacts associated with the project

(a) Air quality and noise level

With a regular procedure for the contractor of the construction works such as to install silencer in exhaust pipes on the construction equipment, constant spraying of water during dry season for dust suppression, most of the ambient air quality degradation and noise emanation during the construction period could be reduced. Close monitoring works by the Engineer should be conducted in order to meet the requirement of air quality standard adapted by DKI Jakarta.

(b) Water quality

Degradation of water quality for all drainage channels, especially the turbidity, is inevitable during the construction period. However, it will not affect water use or the aquatic life in most cases as regular construction procedure is exercised.

The Tanjungan drainage channel is constructed in the middle of mangrove growth area as well as the fish pond area. Thus great care is necessary when access road and dike construction works are conducted.

Upon completion of the project, amount of water flowing through the drainage channels would be increased. Thus dilution effect should improve present level of water pollution in the drainage channels to a limited extent.

(c) Topography

Widening drainage channels within the project area changes river morphology and the topography of the project area. Subsequently it changes land use. These changes would cause positive effect to the economic activities.

In general, amicable environment would be increased as a result of the implementation of the project as flood events are reduced, embankments provide wide open areas, and inspections road provide smooth flow of traffic. Thus economic activities are consequently stabilized.

(d) Excavated sludge material

Most of the sludge excavated from the bottom of the drainage channels during the construction works of the project has to be disposed. Although odor emanated during the construction period would cause some degree of unpleasantness among the local residents, this is a virtual "clean-up" of the polluted sludge from the drainage channels in

the project area. Thus negative impact of emanating unpleasant odor from the excavated would pause upon completion of the excavation works i.e. positive impact of cleaning up of the bottom of drainage channels during the construction period is expected.

While, cleaning-up of sludge material is favorable to improve environment around the drainage channels within the project area, but disposal of sludge to other areas may create pollution problem. At current administrative practice, sludge disposal area is designated by DKI Jakarta upon application for disposal of sludge is submitted by the contractor. Thus greater care has to be taken when sludge is stockpiled on site before hauled to the designated disposal area. As is required by the regulations of DKI Jakarta, disposal area will have be covered by top soil to prevent unwanted odor from emanating while thin layer of soil is to enhance growth of vegetation over time.

(e) Borrow area

Filling material for the project is purchased from the area extensive excavation has been taking place during the past decades in Tangerang. Thus, environmental management plan or any mitigation plan to maintain current environmental conditions of the borrow area is responsibility of the owner of the borrow area.

8.2.2 Biological environment

(1) Present conditions

(a) Vegetation on land

Vegetation on the land within the project area has already been replaced by urban development of commercial, industrial and residential areas as well as agriculture areas during the past decades. Vegetation in the swamp in the upstream area of the Kamal drainage channel remains probably the only in-land natural vegetation within the project area. This swamp area maintains natural wetland ecology significant to nurture water plant, insects and the bird species that pray on the insects. However, because of the rapid urban development during the past years, the area will no longer maintain nurture insects, aquatic life and the bird species attracted by the wetland.

(b) Mangrove forest and plantation area

The Tanjungan drainage channel is constructed through in the middle of mangrove plantation area. Thus greater care has to be taken during the construction period as the area is designated as "Protection Forest" and that the area contains seedlings of mangrove.

This is the area that cutting trees, maintaining pet or domestic animals in the area, or constructing any structures within the area. However, this is the area possible to open for development project conducted by a government agency as it is considered necessary.

As shown in Fig 8.3, a couple of patches of natural mangrove forest remain on the coastal area between Cengkareng floodway and the Kamal drainage channel within the project area. In the future, this mangrove forest and the plantation area are joined for wider mangrove growth area.

(c) Fauna

There is no fauna of scientific, economic or recreational importance in the project area. Some small populations of nesting birds have been reported to exist in the remaining mangrove forest in Jakarta Bay. Ibis (*Ibis cinerens)*, of Bluwok in Indonesian, Egret *(Egretta sp)* have been reported feeding in the coastal zone and swamp area around the mouth of the Tanjungan drainage channel in a school of 100 - 200 birds.

(d) Aquatic biota

Survey carried out in the project area shows the predominance of aquatic species indicative to polluted waters. Most of the species found in the project area belong to the Oligochaeta, Diptera, and Polychaeta groups. There are approximately 8 groups, and the number of individuals per group is so large as about 700 - 65,000. This is an indication of the low diversity of aquatic biota but it indicates very high degraded aquatic environment.

Several commercial species of fish are still found in the Jakarta Bay, including 2 species of shrimp, 2 species of mollusks, and several pollution resistant fishes of small size. The fish catch in the area is low and declining, and the species captured are considered a hazard for human consumption.

(2) Environmental impacts associated with the project

(a) Mangrove growth area

During the construction period, seedlings of mangrove plantation area might be affected by the construction works to some extent. Thus excessive turbidity in the water caused by the construction works should be monitored during the construction period. Any sign of significant impact on the seedlings should be monitored and any necessary mitigation measures of avoiding turbidity in the water should be implemented by the Contractor.

(b) Fauna

Bird species flocking in the mangrove growth area will stay away from the coastal area of the project area as construction works for the Tanjungan drainage channel is conducted. Since there are similar area of the mangrove growth along the coast of Jakarta Bay and/or beyond, they will move to these areas at large. To some extent, this is the only and probably light impact induced by the project to the wildlife within the project area.

(c) Aquatic Biota

During the excavation works conducted in each of the drainage channel within the project area, sludge containing benthos is virtually cleaned up. This operation would not cause any significant degradation of aquatic ecology within the drainage channels of the project area.

8.2.3 Socio-economic environment

(1) Present conditions

(a) Population

As shown in Table 8.5, population of the project area is 261,894 in 1994. Density of population is 5,806 persons/km^2. Predominantly low income families working for various industries operating in and out of the project area are the characteristics of occupation of the population within the project area.

Large number of squatters, some have been in their places for more than 20 years, concentrated in the areas along the drainage channels is also one of the significant characteristics of the population within the project area.

(b) Relocation of local residents

There are a large number of local residents living in the areas along the drainage channels within the project area subject to relocation. There are three different types of local residents as follows:

(i) Legal residents with land certificate;
Those who own land, or rent land and/or house. These land are registered at the Office of Regional Land Administration. Therefore these land owners are considered as legal residents. There are 211 households in the project area.

(ii) Squatters with RW/RT numbers - Type A;

Those who have established themselves as members of the local neighborhood association of Rukun Warga (RW) and Rukun Tattanga (RT). Their RW/RT numbers are mailing address and therefore electricity and telephone as they can afford to pay can be distributed. Their residential areas are generally belonging to the Department of Public Works and they recognize the risk of their residential status. Some have been living in their present area for more than 20 years as there was no development project took place in the past. There are 534 households of this type in the project area.

(iii) Squatters without RW/RT numbers - Type B;

Those who have not established themselves as members of the neighborhood association. Thus there is no recognition of their residential status. As they establish themselves in the present area, they will be recognized as members of the neighborhood association. They might stay in the place for a few decades if no development project would took place. There are 908 households of this type in the project area.

Details of the characteristics of the local residents subject to relocation are described in the "Social Impact Management Plan".

(c) Public health

Air born diseases, waterborne diseases and the diseases generated by solid waste are noticeable among the population within the project area. Cholera has their origin in water puddles and in the inadequate solid waste disposal area. Pollution of surface and groundwater, the blockage of drainage, including flooding and the proliferation of pests and disease vectors induced by air pollution caused by garbage burning and gaseous contamination are all causing substandard of public health within the project area.

(d) Economic activities

The project area is one of the fastest growing regions in DKI Jakarta, supported by the road system of Outer Ring Road, Jl. Tol Prof. Sediyatmo, and Jl Tol Jakarta-Merak. Ranging from family-run shops such as grocery stores to eating places and to the commerce and industry of various scales such as the cottage industry run by a family to large scale shopping centers, economic activity within the project area shows virtually no consistency but diversification.

There are some people living along the mouth of the Kamal drainage channel that are densely located depending their income on fishing in Jakarta Bay. On the other hand, there are still relatively wide area of agriculture fields producing up-land crops and rice and that there are relatively large numbers of farmers within the project area.

(e) Land use

Present land use within the project area, based on the administrative area, is summarized as follows:

Land Use	Area (km^2)	%
Residential area	24.4	46.7
Industrial/commercial area	8.0	15.3
Agricultural area	9.7	18.6
Fish pond	6.3	12.0
Swamp/depression(open space)	3.9	7.4
Total	52.3	100

*Note: the above land use area within the project area that are directly and indirectly affected by the project is wider than the catchment area of 37.98 km^2.

Most of the swamp and fishponds areas within the project area are in possession of the private developers for housing and commercial development in the future. Agricultural area is still left in the project area in further inland from the coast line, while industrial/commercial area is concentrated along the road linking Tangerang and DKI Jakarta.

(f) Areas of scientific, cultural and religious importance

There is no identified area of scientific, cultural or religious importance within the project area.

(g) Areas of aesthetic value

There is no area of aesthetic importance of regional, national and international value within the project area.

(2) Environmental impacts associated with the project

(a) Relocation of local residents

i. Local residents with land certificate

Relocation of the local residents would be the most significant and negative impacts associated with the implementation of the project. With the relocation program, details of which are described in the "Social Impact Assessment", most of the significant impact are canceled out.

ii. Squatters

Relocation of the squatters with conventional method and policy will probably cause further negative impacts as the squatters removed from the current residential areas would move into other riverside areas. Thus, it would be sensible to prepare resettlement areas specifically designated for relocation of the squatters. Details of the relocation program dealt with the squatters are described in the "Social Impact Management Plan". With such plan, social impacts are further mitigated.

(b) Traffic congestion during construction period

There are a number of bridges reconstructed during the construction period. Some of these are foot bridges that may not cause any traffic congestion. However, reconstruction of the vehicular bridges on the major route of transportation would probably cause very significant traffic congestion despite the fact that precautionary and preventive measures as well as the construction of temporary bridges are planned to conduct by the contractor during the construction period.

(c) Public health

Public health conditions would be slightly improved upon completion of the project as water quality in the river is improved. Moreover, as stricter use of water in the river is imposed as fences are erected on the side of drainage channels upon completion, public health hazard should be reduced to a very limited extent.

(d) Improvement of the traffic conditions upon completion of the project

Condition of the traffic within the project area will be improved to some extent as inspection road constructed on either side of drainage channels constructed within the framework of the project is made available for public use. This will subsequently change ways of land use in and around the project area over time.

8.3 Environmental Management Plan (RKL)

8.3.1 Physico-chemical environment

(1) Air quality, noise level, vibration and dust

Muffler, silencer and anti-vibration devices installed on heavy construction equipment should be closely monitored in reference to the data on air quality and noise level measured during the period of EIA Study.

Any devices installed on the construction equipment substandard to the regulations adapted by DKI Jakarta should not be allowed to use. Proper tuning up of this equipment has to be conducted regularly by the contractor of the construction works.

Spraying water during the dry season to the exposed earth surface has to be constantly conducted as a part of environmental management on construction site during the construction period.

As shown in Table 8.6, environmental management plan related to air quality, noise level, vibration and dust is conducted throughout the construction period of the project. This is the work closely associated with the monitoring works. Thus the contractor of the project has to organize monitoring works that would provide various indicators for the environmental management measures.

8.3.2 Biological environment

(1) Mangrove growth area

During the construction works for the Tanjungan drainage channel, mangrove growth area would be disturbed to some extent. Depending on the turbidity of the water in the mangrove growth area while the construction works are conducted, greater care has to be taken. Upon completion of the construction works, mangrove plantation works should resume as currently planned.

This is the area within the jurisdiction of PANTURA in the future while the area is under the command of the Department of Forestry, DKI Jakarta for mangrove plantation.

It would be very sensible to ask for monitoring works to the Department of Forestry, DKI Jakarta, while the contractor conducts measures to manage impacts induced by the construction works during the construction period.

Upon completion of the Tanjungan drainage channels, the area equivalent to the area lost to the Tanjungan drainage channel can be designated to increase mangrove growth. Any area in the wetland between Cengkareng floodway to the Kamal drainage channel is selected for this purpose.

8.3.3 Socio-economic environment

(1) Relocation of local residents

Relocation of the local residents to the designated resettlement areas selected at their own discretion would be the only way to manage environmental impact of the relocation of the local residents. Thus monetary compensation is the option conducted for compensation made to the local residents subject to relocation.

There are 211 residents with land certificate, or so termed as "legal residents". Factories, schools, mosque, market, and government office and public space, including illegal residents have made up to 1,716 units subject to relocation.

Rate of compensation per unit of land, building and improvements are subject to determination by land procurement committee, which will be established upon final approval of the project was made by the Government of Indonesia. The committee is established at the Kotamadya level, one for Jakarta Barat and the other for Jakarta Utara.

Based on the past experiences of the Department of Housing, DKI Jakarta, approximately 75 % of the local residents subject to relocation would select low cost housing built by DKI Jakarta if low income families are involved in the relocation program. In this project, 77 % would come under this case.

The rest of families whose income is higher, or who own shops, or who run small factory would select to resettle in the areas they selected themselves. These measures would manage most of the major obstacles of the project, while individuals would still face minor problems upon relocation.

As shown in Table 8.6, most of the relocation operation itself is a kind of environmental management plan. The relocation process also contains monitoring works, i.e. it has a "self-monitoring mechanism" built in it as it is necessary to observe smooth transfer of properties.

(2) Traffic diversion

During the reconstruction period of bridges, traffic diversion is necessary. With a coordination of the Traffic Police and the Department of Traffic, DKI Jakarta, the contractor of the project is required to divert traffic with proper road sign, signal and attendants. Traffic police will also assist the arrangement of traffic diversion.

Depending on the scale of bridge construction works, the size of road, and the volume of traffic, one whole street may have to be blocked for through traffic. Period of road blockage will be as long as the period of bridge construction works, i.e. over a year or two depending on the amount of works.

All these arrangement should be conducted with the Department of Traffic, DKI Jakarta and the Traffic Police of DKI Jakarta. There is no other way to manage traffic congestion during the bridge reconstruction works of the project, i.e. precautionary measures is the only way to deal with the traffic during the construction period.

8.4 Environmental Monitoring Plan (RPL)

8.4.1 Physico-chemical environment

(1) Air quality and noise level

Periodic check-up of once every week on the performance of heavy equipment used on site is suggested to conduct by the Engineer of the project. Standard monitoring equipment for gas analysis and audiometer should be used in routine check-ups for emissions of the construction equipment used on site.

On the other hand, it would be ideal to maintain the sampling locations of the air quality and noise level the same locations as those selected for the EIA Study. Sampling frequency is every 3 months.

Data obtained during the EIA Study should be used as reference data as well as the standard adapted by DKI Jakarta. Monitoring of air quality and noise level is conducted during the construction period only as is indicated in Table 8.6. Present conditions of air

quality, noise level and dust are given in Tables 8.1 and 8.2 that are required to use as reference data during the construction period for monitoring.

(2) Water quality

Table 8.3 shows the present data on water quality and Table 8.4 shows the Standard of Water in DKI Jakarta. These data are to be used as reference data when water quality analysis was conducted during and after the construction works.

As shown in Table 8.6, monitoring frequency for the area around the Tanjungan drainage channel is every three months. In other areas, frequency of monitoring should be conducted at least before and after the construction works.

8.4.2 Biological environment

(1) Mangrove plantation area

During the construction preparation period as well as the construction period of the Tanjungan drainage channel, turbidity in the water where mangrove planting activity is on-going should be closely monitored by the Department of Forestry, DKI Jakarta, in relation to the growth of mangrove. As necessary, preventive measures to minimize adverse impacts to mangrove should be taken by the contractor of the project .

(2) Fish pond

The Tanjungan drainage channel is constructed through mangrove plantation area. Among the planted area, fish pond has been operated for commercial purpose. It is therefore necessary to monitor turbidity of the water in the area during the dike construction period.

No specific monitoring device is necessary but visual observation as well as the fish pond owner/keeper's complaints and recommendations should be taken as necessary precaution. Based on the observation, complaints and recommendations, further actions as environmental management plan of this particular area should be taken by the contractor.

8.4.3 Socio-economic environment

(1) Resettlement area

Resettlement areas receiving local residents from the project area should be monitored for the quantity and quality of infrastructure prepared for them, the level of planned socio-economic programs, and the accessibility to public facilities.

The period conducting the monitoring program is approximately 6 months after all of the local residents are moved out and settled in the designated resettlement areas.

Four experts on sociology, socio-economics, public health and resettlement should form a survey team. Questionnaire should be used for individual interview survey. Result of the survey is evaluated and a report to the owner of the project should be produced.

9 SOCIAL IMPACT MANAGEMENT PROGRAM

9.1 Introduction

It is expected that habitual floods will be minimized by implementation of the project and living environment will be improved by minimizing public health hazard induced by flood water. On one hand, the project involves relocation of more than 1,700 households including squatters. It will create side effect in terms of negative impact to social environment in the project area to a large extent and to natural environment to a small extent. In order to successfully implement the project, an appropriate relocation program has to be established. This social impact management program was prepared to assist the authorities concerned for promotion of the relocation problem.

9.2 Classification of the Local Residents

Local residents within the project area are classified as follows:

- The residents with land certificate that are registered at the National Land Administration or its regional/district office;
- Those in possession of land right by custom that have been paying property tax since the colonial period; And
- Squatters

It appears that there is no household with land right by custom within the project area. Thus, there are legal residents with land certificate and the squatters subject to relocation with in the project area. Further, there are factories and private schools subject to compensation. Mosques, market places as well as the government offices including police posts are also subject to relocation.

9.3 Number of Households and Other Buildings Subject to Relocation

Numbers of households and other buildings subject to relocation are as follows:

- Local Residents with Land Certificate	211	households;
- Squatters	1,422	households; and
- Factories, schools, market places, etc.	63	places.

Details of the numbers of households, factories and others in each kelurahan and the drainage channel(s) within the kelurahan are shown in the Table 9.1.

9.4 Cost of Compensation and Land Acquisition

9.4.1 Cost of compensation for relocation

The total cost of compensation including the cost of individual plots, houses and improvement, as well as others such as factories etc. are summarized as follows:

a.	Local Residents with Land Certificate;		
	Rp.42.01 million/household	x 211 households	Rp. 8,864.2 million
b.	Squatters;		
	Rp.200,000/household	x 534 households	Rp 106.8 million
	Rp. 50,000/household	x 908 households	Rp. 45.4 million
c.	Factories and others		Rp. 8,427.3 million
	Total		Rp. 17,443.7 million

Individual costs of compensation for each kelurahan and the drainage channel(s) within each kelurahan are shown in the Table 9.2.

9.4.2 Cost of land acquisition

There are open spaces such as unused low lying areas, agricultural lands, and fish ponds within the project area that are subject to acquisition for drainage channel construction works. These areas necessary for drainage channels are subject to land acquisition in addition to the compensation for individual houses, factories and others. The total required area of land acquisition and its cost are as follows

- Overall Land Area for the project 321,489 m^2
- Total Cost of Land Acquisition Rp. 53,045.7 million

Individual costs of land acquisition for each kelurahan and the drainage channel(s) within each kelurahan are shown in the Table 9.2.

9.5 Resettlement Areas

9.5.1 Resettlement areas for those with land certificate

(1) Policy of resettlement within DKI Jakarta

It is a policy of Department of Housing, DKI Jakarta, that the low income families should be given a low cost apartment (LCA) when they are relocated as a development project is implemented in DKI Jakarta. Based on the past experiences, Department of Housing, DKI Jakarta recognizes that approximately 75 % of local residents subject to relocation would move into the low cost apartment. This is assumed 77 % in the project area. Thus, 161 households are considered to move into the low cost apartment. A floor space per unit is usually 21 m^2 when the low cost apartment is constructed.

Based on the past experiences of the Department of Housing approximately 75 % of the local residents involved in the development project and that became subject to relocation would move into the low cost apartment. The relocation area available within the project area, Bulak Wadon, shown in the Fig 9.2 is wide enough to accept the local families subject to relocation from the drainage areas within the project area. The area has been developed by the Department of Housing in 1995 and it is capable to construct sufficient units of low cost apartment blocks.

(2) Required number of LCA unit

Depending on the floor space the local residents owned before they move into the low cost apartment, some households can take more than one unit of the low cost apartment based on the following criteria of the previously owned floor space:

-	Those who own less than 50 m^2	1 Unit
-	Those who own 50 - 100 m^2	2 Units
-	Those who own more than 100 m^2	3 Units

Based on the above, numbers of households entitled to claim a single unit or plural units of the low cost apartment are classified as follows:

-	Those who claim a single unit	38 households	38 units
-	Those who claim double units	73 households	146 units
-	Those who claim triple units	51 households	153 units
	Total	162 households	337 units

(3) Cost of construction of LCA unit

The prevailing cost of construction per unit of the low cost apartment is Rp.32.85 million. Thus, the total cost of construction of the low cost apartment complex would be:

- Rp. 32.85 million x 337 units = Rp.11,070.5 million

The cost of construction of these low cost apartments would be a separate account of the project as Department of Housing, DKI Jakarta is responsible for budgeting of the cost of construction. Suggested block plan for Bulak Wadon is shown in the Fig 9.3.

(4) Location of the low cost apartment

The low cost apartment complex on Jl.Flamboyan II, Tegal Alur, Cengakareng Barat is in the area that the Department of Housing, DKI Jakarta has developed in 1995. The area is shown in the Table 9.1. This area has a capacity to house all of the local residents subject to relocation from the project area as necessary low cost apartment units are constructed. At the moment, there are only two low cost apartment complexes in operation.

(5) Individual resettlement areas

Those who are in need of grocery store space, working space for their own business or family owned factory establishment as well as high income families, would look for individual plots to resettle themselves and resume their own business or life. There are 49 households that would look for their own places and therefore they would move out to their own plots. In case of some of the high income families, private housing estate areas might be their option. Alternatively, the area being developed by National Urban Development Corporation (PERUM PERMUNAS) would be their option. Those who own shops, commercial or industrial establishment would have to find plots suitable to their own purpose of economic activities.

9.5.2 Resettlement areas for the squatters

Illegal residents are encouraged to return to their own villages of origin. However, some are from DKI Jakarta and some have been living in DKI Jakarta for a considerably long period of time that they do not possess any area to stay in their village of origin. Thus suggestion was made in the Section 9.7.

9.6 Implementation Program

9.6.1 Budget plan

Since the cost of compensation and land acquisition is a considerably large amount, it is essential to subdivide the budget according to the construction program. In general, compensation and land acquisition of the area subject to construction works of a given one year should be completed prior to the commencement of the construction preparation works. It is also essential to maintain the amount of compensation and land acquisition for easy disbursement from the view points of the budget plan of DKI Jakarta.

As is shown in the Figure 9.4, except for Kamal Drainage Channel - Main & Branch, each drainage channel is subdivided into sections based on the annual disbursement schedule. On the other hand, Kamal Drainage Channel - Main & and Branch are subdivided into three stages and each stage is further divided into sections based on the annual disbursement schedule. Thereby, the large sum of the budget for compensation and land acquisition is relatively distributed over the construction period of nine years, as shown below.

DPU DKI Jakarta has obtained Rp.2,000 million to begin with Kamal Drainage Channel for land acquisition for the Fiscal Year 1997/1998.

Each year's disbursement could be therefore as follows:

	(Unit: Rp. million)	
Year 1997	2,000.0	(2.8 %)
Year 1998	1,474.4	(2.1 %)
Year 1999	5,446.2	(7.7 %)
Year 2000	7,909.5	(11.2 %)
Year 2001	17,668.9	(25.1 %)
Year 2002	19,135.5	(27.2 %)
Year 2003	9,127.9	(12.9 %)
Year 2004	4,822.8	(6.8 %)
Year 2005	2,904.5	(4.2 %)
Total	70,489.4	(100.0 %)

Corresponding schedule of suggested annual work plan of relocation and its annual disbursement plan are shown in the Table 9.3 - 9.5.

9.6.2 Method of relocation operation

(1) Land procurement committee

As shown in the Fig 9.5, Land Procurement Committee is formed as soon as the project implementation is approved at the government level.

Kotamadya Jakarta Barat and Jakarta Utara will establish their own Land Procurement Committee for assessment of the rate of compensation for the area within their administrative areas. In the case of the project area, a portion of Kamal drainage channel, Tanjungan drainage channel and PIK Junction Drainage Channel in the northeast area of Jl.Kamal Muara are inside of Jakarta Utara. Thus, Land Procurement Committee of Jakarta Utara will make decision on the rate of compensation. The rest is in the jurisdiction of Jakarta Barat.

(2) Establishment of the drainage area

As soon as the project implementation is determined, parallel to the formation of Land Procurement Committee, the person-in-charge of the project should establish geographical area of a drainage channel prior to negotiation with individual households, factories and others owning building and land within the boundaries of drainage channel.

Upon consultation with Department of Urban Planning, DKI Jakarta, for demarcation of each drainage channel area and its area for right-of-way according to the Local Government Act of the West Jakarta No.2/1985 regarding Demarcation for Urban Drainage, each drainage channel area is established.

(3) Negotiation and evaluation

As soon as the geographical area of the drainage area is established, the person-in-charge of the project should begin a series of sessions of negotiation with the households and others owning building and/or land within the boundaries of drainage channel. General procedures are as follows:

- A formal request is made to the Head of Jakarta Barat and Jakarta Utara for negotiation of relocation. Each kotamadya then undertakes to form a team of negotiators. It is termed as Assisting Team for Execution of Procurement of Land. This team is usually the staff of the Department of Housing, DKI Jakarta. Duties of the Assisting Team for Execution of Procurement of Land would be:

(i) to collect data and information on the location of land required to procure for the project;
(ii) to prepare complete inventory regarding the status of land owners, buildings, and improvements;
(iii) to prepare detailed map showing the packages of land to be cleared for the project;
(iv) to estimate the compensation cost of the project;
(v) to report to the person-in-charge of the project on the troubles and other issues encountered on site and their solutions in relation to the negotiation for relocation; and
(vi) to accompany the head of Kecamatan and Kelurahan witnessing the payment of compensation.

- The Assisting Team will begin negotiation with each households and other land/building owners. They are witnessed with a representative of Kecamatan, Kelurahan, as well as those member of Rukun Tattange and Rukun Warga during the negotiation. The Rate of compensation will be based on the decision made by the Land Procurement Committee formed within each kotamadya. The area subject to compensation will be based on the geographical areas established as drainage channels based on the survey described in (2) above. Individual households, if agreed, will produce their land certificate, building permit, right of building, or any other legitimate certificate;

- Contents of the negotiation and evaluation will includes, number of families, age, income, type of the current occupation, area of plot and floor space, number and area of improvement subject to compensation and their monetary values, available resettlement area/housing/industrial estate, their selection of resettlement areas, and clarification of the arrangement of payment for compensation;

- Squatters will also be brought under formal negotiations. Those who have built permanent houses may demand large sum of compensation. Depending on the proof of building certificate, or the letter of recognition of the payment of building, amount of compensation will be assessed individually. Those of illegal residents will also be paid at nominal amount of money for evacuation;

- Upon agreement is made and amount of compensation is paid, each plot is cleared based on the procedure set out in the Minister of Home Affairs, Regulation No.2 of the Year 1985 and the President Decree No.55 of the Year 1993. The person-in-

charge of the project will notify the right of land utilization of the acquired plot to Jakarta Utara or Jakarta Barat depending on the location of the acquired plot. The notification should contain the sum of compensation paid, type of land ownership, complete record of the negotiation procedure including dispute if any; and

- The area where there is no resettlement operation is involved, the person-in-charge of the project negotiate with land owners of the agricultural areas, fishpond and mangrove growth area. In the case of mangrove growth area, negotiation should be held with Department of Forestry, DKI Jakarta, to open up the mangrove growth area for drainage channel.

(4) Payment procedure

As both parties of the person-in-charge of the project and the households reached an agreement of relocation, the agreed amount of compensation is paid in cash in person with witnesses from the kelurahan and kecamatan. The resettlement plan is financed by the Regional Budget of APBD TK II allocated to each kotamadya.

Upon payment, a land certificate is exchanged. This concludes the negotiation and then the formal hand over of the land is completed. If certificate was not exchanged for the reasons that it is used for bank/loan guarantee, etc. the relevant third party with original certificate should be present at the time of payment. Depending on the contents of agreement, type of disbursement for relocation will be subdivided as follows:

- Resettling in the low cost apartment in Bulak Wadon as part of compensation is spent on the down payment and loan of the low cost apartment, or receiving the balance of compensation;
- Resettling in individual resettlement area as they choose to receive full amount of compensation in cash;
- Squatters; and
- Tenant residents that have no right to any part of compensation. Only the owner will deal with compensation for relocation.

(5) Registration of the drainage area

Upon payment, land clearing is conducted. Parallel to the clearing operation, invitation and consultation with the Regional Office of National Land Administration in Jakarta Barat and Jakarta Utara for the survey result of acquired land is conducted. Thereby the Regional Office of National Land Administration in Jakarta Barat and Jakarta Utara will

declare the acquired land as state land, specifically make use of for drainage channels in the name of the Head of Land Registration. The procedure is further approved by the Head of National Land Administration.

(6) Resettlement arrangement

Whether the local residents resettle in the low cost apartment or individual resettlement areas, the person-in-charge of the project will coordinate with the Department of Housing for preparation of the low cost apartment for allocation of unit to those entitled to move into the low cost apartment. Same consultation is conducted for the those resettling in their own resettlement areas. Actual moving operation is conducted by the Department of Housing, DKI Jakarta.

Upon completion of resettlement operation, arrangement for issuing of official certificate of resettlement for those subject to resettlement should be conducted with the Regional Office of Land Administration in Jakarta Barat and Jakarta Utara.

Dissemination of information on the result of land acquisition and relocation operation to those related to the project as shown in Fig 9.5. This figure indicates the heads of Rukun Warga and Rukun Tattanga.

(7) Organizations concerned with the resettlement program

As described above, a large number of organizations are required to be informed of the progress of the resettlement program and its timing as well as the completion. The person-in -charge of the project is responsible to notify, request assistance and clarification, and disseminate information on the completion of the resettlement of the project.

The person-in-charge of the project is responsible to notify, request assistance and clarification, and disseminate information on the project.

9.7 Suggestion to Create Resettlement Areas for the Squatters

9.7.1 Bare land for rent

Resettlement areas for the squatters prepared by the government is not popular in Indonesia. However, as they are paid with nominal amount of compensation, it is very likely that they are going to move into other riverside areas. Thus, preparing several bare

lands for them to move in and restore their new residential and commercial buildings is essential for the following reasons:

- To prevent them from moving into other drainage channel areas within the project area and claiming for extra money for relocation; and
- To provide a model case as a solution for the chronicle squatter problem in DKI Jakarta.

As shown in the sample calculation below, the cost of preparation for bare lands as resettlement areas for the squatters would be recoverable subject to reselling of the land. Preparation of bare lands for the squatters, that are illegal residents, spending a portion of the government tax is not a popular way. However, this is a method that the North Coast Reclamation and Revitalization Board, known as PANTURA has considered to conduct as reclamation area will be completed by the Year 2020. In their case, they plan to construct low cost apartments for the squatters living on the coastal area of Jakarta Barat. The difference between PANTURA and the suggestion made for the project is that the former conducts the plan on the commercial basis. Initial investment is necessary but the cost is recovered after the 10 year renting period as above. In general, the more the scale is large, the more large the profit becomes.

The squatters can become legal residents as they move into the resettlement area. The area for rent could be established with the following concept:

Preparation of bare land as renting area for the squatters

	Item	Amount
1	Total cost of the preparation of land for renting (million Rp.)	24,934.4
2	Rent of the land (Rp./month/m^2)	700
3	Renting area/household (m^2)	80
4	Expected No.of the squatters renting the land (No.)	1,442
5	Total renting area (m^2)	115,360
6	Revenue/year (million Rp.)	969.02
7	Revenue for the period of 10 years (million Rp.)	9,690.24
8	Sale of the land to private developers by the year 10 (million Rp.)	32,533.74
9	Amount of compensation paid to an individual household (million Rp.)	5.28
10	Total amount of compensation for resettlement* (million Rp.)	5,142.72
11	Total revenue over 10 year period (6 + 7)	42,223.98
	Profit over 10 year period (11 - 1 - 10)	+ 12,146.86

Four areas within the project area have been selected in the locations from Areas-1 to 4, as shown in the Figs 9.1 and 9.2. These areas are so selected that fishermen are catered for the resettlement area near the area to Jakarta Bay. Others are selected as the areas near the present area of residence or commercial activities.

These selected areas are paddy field or fish pond at the moment. Thus filling operation is necessary to create resettlement areas. Upon completion of the preparation of these resettlement areas, the squatters moving into the area are charged with rent so that the government can recover the cost of preparation of the resettlement areas for the squatters. Detailed cost estimation for preparing the resettlement areas for the squatters are subject to further elaboration.

9.7.2 Low cost apartment in the north coast reclamation areas

PANTURA, the North Coast Reclamation and Revitalization Board, has been preparing a master plan to construct low cost apartment buildings for the squatters that are present at the moment within their project area. PANTURA plans to complete the reclamation works in the Year 2020 before they begin construction of the low cost apartment complex. This is a new policy away from the present policy of "Return to the Village (Kumbali Kampong)".

Thus, preparing bare land to rent as described above for the project should be conducted as a transitional measures before the squatters can move into the low cost apartment constructed within the areas under the jurisdiction of PANTURA.

Alternatively, the Department of Housing, DKI Jakarta, could build a new complex of low cost apartments in each resettlement area prepared for the squatters within the framework of the project. In this case, the squatters are evacuated from the resettlement areas, which will cause further squatter problems elsewhere in DKI Jakarta.

10 CONSTRUCTION PLAN AND IMPLEMENTATION SCHEDULE

10.1 Implementation of the Project

10.1.1 General

The project will be implemented by the Government of Indonesia under assistance of the consulting engineers. The construction works of the project will be divided into three packages and carried out by a selected contractor through an international competitive tender for each package in accordance with the standard international guidelines. The execution of the works is to be made based on the following basic implementation plan.

10.1.2 Implementing agency

The proposed organization for implementation of the project is shown in Fig. 10.1. An executing agency of the project will be Directorate General of Human Settlements (CIPTA KARYA), Ministry of Public Works, the Republic of Indonesia, which is responsible for management of the project works including loan appraisal, loan agreement and overall management of the project works.

Upon approval of the loan project fund, DPU DKI Jakarta will carried out land acquisition and compensation works for households with assistance and cooperation of department of housing.

The implementation of the project works will be administrated by DPU DKI Jakarta. The construction works will be entrusted and carried out by the Project Management Office, DPU DKI Jakarta, which will be controlled by steering committee and technical committee. The Project Management Office, DPU DKI Jakarta will also be controlled by Director General of CIPTA KARYA. KANWIL PU will function as administrative support which will be instructed by Minister, PU. Overall management by Director General of CIPTA KARYA will be transmitted to the Project Manager of Project Management Office, DPU DKI Jakarta through the Steering Committee. The technical management by DPU DKI Jakarta and DINAS PU will also be transmitted to the Project Management Office, DPU DKI Jakarta, through the Technical Committee.

Consultant will function as technical assistance for staff of the Project

Management Office, DPU DKI Jakarta for construction works of the project and coordination between the Project Management Office and official foreign loan agency for technical aspects.

10.1.3 Financial source

The foreign currency portion and a part of the local currency of the construction cost are expected to be financed by an international organization with its soft loan. The remaining local currency portion will be covered by the Indonesian national budget.

10.1.4 Engineering services

A selected competitive bid will be applied for procurement of engineering consultant for assistance of the tendering matters during pre-construction period and construction supervision matters during construction period.

10.1.5 Contract package and project implementation plan

(1) General

Study on the contract packaging and project implementation plan was studied from two aspects, namely, sequence with emphasis on implementation of drainage channel system and sequence with emphasis on implementation of drainage works in local area with less compensation problems.

(2) Study on contract packaging and project implementation plan with emphasis on implementation of drainage channel system

1) Study on sequence of implementation of drainage works

In order to determine the contract package, sequence of implementation of the drainage works was studied from three aspects, namely,

(i) Prospect of compensation of households and land
(ii) Investment effect of the project cost, and
(iii) Technical priority

Study results for respective aspects are as follows:

(a) Prospect of land acquisition and compensation of households

The cost of compensation of households and land acquisition for respective drainage channels has been estimated as follows:

(Unit: Rp. million)

Name of drainage channel	Total cost
- Kamal	39,596
- Tanjungan	18,610
- PIK Junction	-
- S. Cengkareng	9,325
- Gede/Bor	1,055
- Meruya	1,904

While, DKI scheduled to proceed with the followings:

(i) DKI enacted that relocation of the Kamal and Tanjungan drainage channels is duly necessary.

(ii) DKI intends to proceed with budget procedures for compensation of the Kamal and Tanjungan drainage channels in fiscal year, 1996/1997. The estimated cost is Rp. 16,000 million for the Kamal area and Rp. 8,000 for the Tanjungan area.

Considering the above information, the cost required for compensation of households and land acquisition is as follows:

(Unit: Rp. million)

Name of drainage channel	Total cost	Cost already budgeted	Required cost
- Kamal	39,596	16,000	23,596
- Tanjungan	18,610	8,000	10,610
- PIK Junction	-		-
- S. Cengkareng	9,325		9,325
- Gede/Bor	1,055		1,055
- Meruya	1,904		1,904
Total	70,490	24,000	46,490

It can be said that the drainage channel with less compensation cost has high possibility for realization. While, it is also said that the compensation for households is rather difficult than the compensation of land. It means that the drainage channel with less households to be relocated is high possibility for realization. In view of these two aspects, order of implementation will be as follows:

Name of drainage channel	Order in view of less compensation cost	Order in view of less households	Overall order
- Kamal	6	6	6
- Tanjungan	5	3	4
- PIK Junction	1	1	1
- S. Cengkareng	4	5	5
- Gede/Bor	2	4	3
- Meruya	3	2	2

(b) Investment effect of the project cost

The investment effect of the project cost was evaluated by (i) investment cost per unit area and (ii) population per unit area.

(i) Investment cost per unit area

The relationship between the investment cost (direct cost) and drainage area is as follows:

Name of drainage channel	Investment Cost (10^3 US$)	Drainage Area (km^2)	Investment Cost /unit area (10^3 US$)
- Kamal	11,550	20.89	552.9
- Tanjungan	5,250	4.25	1,235.3
- PIK Junction	600	2.70	222.2
- S. Cengkareng	8,100	3.08	2,629.9
- Gede/Bor	8,250	2.41	1,182.6
- Meruya	1,650	1.27	1,299.2

Large amount of construction cost of the Saluran Cengkareng drainage channel is attributable to the provision of open culvert with mesh cover and trashrack for prevention of dust and garbage and sluice gates. It is contemplated to promote early implementation giving priority on the drainage channel with less investment cost per unit area. Priority of the investment cost per unit area will be as follows:

Name of D. Channel	Order
- Kamal	2
- Tanjungan	4
- PIK Junction	1
- S, Cengkareng	6
- Gede/Bor	3
- Meruya	5

(ii) Population per unit area

Population density in the project area in 1994 has been reported as follows:

Population Area		Population density(persons/km^2)
(i)	Eastern part of Cengkareng area	10,423
(ii)	Western part of Cengkareng area	9,737
(iii)	Kamal area	6,003
(iv)	Meruya area	5,303

It is essential to proceed with early improvement of the drainage area having high population density to stabilize living environment. Priority of the drainage area in consideration of the above population density is as follows:

Name of D. Channel	Order
- Kamal	5
- Tanjungan	3
- PIK Junction	2
- S. Cengkareng	1
- Gede/Bor	4
- Meruya	6

Priority of implementation from two aspects is summarized as follows:

Order	Aspect(a)	Aspect(b)	Overall
1	PIK Junction	S.Cengkareng	PIK Junction
2	Kamal	PIK Junction	S.Cengkareng
3	Gede/Bor	Tanjungan	Tanjungan
4	Tanjungan	Kamal	Gede/Bor
5	Meruya	Gede/Bor	Kamal
6	S. Cengkareng	Meruya	Meruya

(c) Technical priority

Parameters for the technical priority will be (i) extent of drainage area and (ii) flood control effect.

(i) Extent of drainage area

Improvement of the drainage condition will be largely facilitated by early implementation of the drainage channel with larger drainage area. Percentage of the

drainage area for respective drainage channels is as follows:

Name of D. Channel	Drainage area(km^2)	Percentage(%)
- Kamal	20.89	60
- Tanjungan	4.25	12
- PIK Junction	2.7	8
- S. Cengkareng	3.08	9
- Gede/Bor	2.41	7
- Meruya	1.27	4
Total	34.6	100

In view of the extent of the drainage area, priority of implementation is as follows:

Name of D. Channel	Order
- Kamal	1
- Tanjungan	2
- PIK Junction	4
- S. Cengkareng	3
- Gede/Bor	5
- Meruya	6

(ii) Flood control effect

Hydrological study clarifies that frequency of flood event in each drainage area is as follows:

	Area	Frequency	Percentage(%)
(i)	Northern part of Cengkareng area	37	31.36
(ii)	Eastern part of Cengkareng area	15	12.71
(iii)	Western part of Cengkareng area	12	10.17
(iv)	Central part of Cengkareng area	54	45.76

It is desirable to proceed with early improvement of the drainage condition for the drainage area having high frequency of inundation to avoid social inequality for living condition. Priority of implementation of the drainage area in view of the above frequency of flood is as follows:

Name of D. Channel	Order
- Kamal	1
- Tanjungan	2
- PIK Junction	4
- S. Cengkareng	3
- Gede/Bor	5
- Meruya	6

Priority of implementation from two aspects is as follows:

Order	Aspect(a)	Aspect(b)	Overall
1	Kamal	Kamal	Kamal
2	Tanjungan	Tanjungan	Tanjungan
3	S.Cengkareng	S.Cengkareng	S.Cengkareng
4	PIK Junction	PIK Junction	PIK Junction
5	Gede/Bor	Gede/Bor	Gede/Bor
6	Meruya	Meruya	Meruya

(d) Overall sequence of implementation of the drainage channel

Overall sequence in consideration of items (i), (ii), and (iii) is as follows:

Order	Item(i)	Item(ii)	Item(iii)	Overall
1	PIK Junction	PIK Junction	Kamal	PIK Junction
2	Meruya	S. Cengkareng	Tanjungan	Tanjungan
3	Gede/Bor	Tanjungan	S. Cengkareng	S. Cengkareng
4	Tanjungan	Gede/Bor	PIK Junction	Gede/Bor
5	S. Cengkareng	Kamal	Gede/Bor	Kamal
6	Kamal	Meruya	Meruya	Meruya

2) Determination of contract package and project implementation plan

(a) Determination of contract package

The contract package was determined in consideration of the following aspects:

(i) Sequence of implementation for drainage channel works studied so far

(ii) Harmonization of implementation works to avoid social inequality and

administrative imbalance as pointed out by vice governor.

(iii) Early implementation of drainage channel with less compensation area

(iv) Combination of drainage channels works in consideration of topographic conditions for construction works and of avoiding traffic jamming due to different contract packaged works

(v) Amount of contract package in consideration of international tendering

The item (ii) is reflected in the studied results on sequence of implementation in item (i), especially, on sequence for population per unit area and flood control effect. For item (iii), it is considered that the sequence of implementation should be given to PIK Junction drainage channel since no compensation is needed for this drainage channel. The compensation of households for Tanjungan drainage channel is considered to be easy because the number of households is only 54 and compensation for land is easier than the compensation of households. It is proposed to combine the Tanjungan and PIK Junction drainage channels as one package and to execute in initial phase since these drainage channels are ranked as higher priority for implementation, both channels are located closely and total cost for tendering of both drainage channel works is applicable for the international tendering. The Saluran Cengkareng, Gede/Bor and Meruya drainage channel are in second rank from the viewpoint of the sequence study results and these are situated in the southern part of the project area. Thus, it is proposed to combine these three drainage channels as one package and to execute in the second phase. Both the construction and compensation costs for the Kamal drainage channel are remarkably large and sequence of implementation is in low rank. Considering long terms to be needed for compensation matters, it is proposed to execute the Kamal drainage channel in the last phase. It is recommended to commence the construction work of the Kamal drainage channel from the stretch with less compensation area.

In consideration of the above situations, it has been proposed to proceed with the construction works of the drainage channels by dividing into the following three packages:

Package	Name of D. Channel	Construction Cost(10^3 US$)
Package-1	- Kamal	8,921
Package-2	- Tanjungan	4,069
	- PIK Junction	256
Total of Package-2		4,325
Package-3	- Gede/Bor	1,855

	- Saluran Cengkareng	6,808
	- Meruya	1,986
Total of Package-3		10,649

(b) Formulation of Project Implementation Plan

For formulation of the project implementation plan, the following matters were contemplated:

(i) Early implementation of drainage channel with less compensation area
(ii) Loan validity by an international financing agency, and
(iii) Balanced compensation cost to be disbursed annually

At the explanation of the draft final report, it was requested by DKI Jakarta that the first priority should be given to Package-1 and next priority is Package-2, due to the reason that the drainage areas along the Jl. Tol Prof. Sediyatmo (highway) were quite densely populated and the highest economic development potential zones, and early implementation of the drainage channels for Packages-1 and 2 was required.

In consideration of the above requested comments and items (ii) and (iii), it was proposed to execute the Package-1, Kamal drainage channel in the initial stage and Package-2, Tanjungan and PIK Junction drainage channels in the second phase. The Package-3, Gede/Bor, Saluran Cengkareng and Meruya drainage channels is scheduled to be executed in the final stage. It is scheduled to execute the construction works of the Kamal drainage channel in 4 years due mainly to avoiding traffic jamming for detour of traffic for construction of about 30 bridges. It is generally specified in the international financing agency that the loan validity is around 6 ~7 years with pre-qualification activities. While, the overall construction period should be confined within 6 ~7 years, taking into account rather high compensation cost. Therefore, it is recommended that loan validity is around 8 years including pre-construction period of 1.5 years and construction activities of 6.5 years.

The proposed implementation schedule in accordance with the above concept is illustrated as shown in Fig 10.2.

(3) Study on contract packaging with emphasis on implementation of drainage works in local area with less compensation problems.

1) General

Compensation problems are key factor for implementation of this project. As an alternative for study on contract packaging with emphasis on implementation of drainage channel system, contract packaging with emphasis on implementation of drainage works in local area with less compensation problems was studied in consideration of the difficulty of land compensation.

2) Alternative plan for packaging

The drainage area in the northern part of the highway is considered as less compensation area. It is contemplated to combine the drainage works in the northern part of the highway as one package due to less compensation problems. However, this alternative has the following problem: even if flow capacity of only in the drainage channel in the northern part of the highway is increased, the drainage effect of one drainage system will not be expected unless drainage works in the southern part of the highway where drainage is in the worst condition are executed because drainage condition from secondary channel will not be improved unless the main drainage channel is improved, namely, increase in the safety factor of one drainage system would not be expected unless safety factor of the drainage channel from downstream to upstream is increased uniformly.

In consideration of the above disadvantages, it is proposed to proceed with the drainage works with emphasis on implementation of the drainage channel system.

10.1.6 Implementation schedule

The overall project implementation schedule is shown in Fig 10.2.

Upon approval of the project loan, selection of consultant for tendering and construction supervision, selection of contractor including pre-qualification and tendering will be carried out.

The project works will be executed dividing into three packages. The Package-1 works which include construction of Kamal drainage channel consist mainly of widening of the existing drainage channels and construction of earth type levees, concrete parapet walls, revetments and bridges and installation of slide gates and flap gates. The Package-2 works which include construction of the Tanjungan and PIK

Junction drainage channels comprise excavation of the drainage channels, construction of revetments and bridges and installation of slide and flap gates. The Package-3 works which include construction of Gede/Bor, Saluran Cengkareng drainage channels and drainage channel in Meruya area comprise excavation of the drainage channels, construction of revetments, concrete parapet walls, a open culvert with mesh cover, bridges, and sluiceways and installation of slide and flap gates. It is scheduled to execute the drainage works from the year 2000 from Package-1 as the initial phase, Package-2 from 2003 as second phase and Package-3 from 2004 as the last phase.

10.2 Construction Method

10.2.1 Basic conditions

(1) Structural feature and major work quantities

The structural features and major work quantities are calculated as follows:

(a) Package 1

(i) Kamal drainage channel (main) : 4,463 lin.m

- Levee embankment	5,535	lin.m
- Concrete parapet wall	484	lin.m
- Revetment, type I	1,741	lin.m
- Revetment, type II	1,591	lin.m
- Sluiceway	15	nos.
- Roadway girder bridge	6	nos.
- Pedestrian girder bridge	3	nos.

(ii) Kamal drainage channel (branch) : 2,755 lin.m

- Levee embankment	1,528	lin.m
- Heightening of exist. masonry	624	lin.m
- Revetment, type I	1,714	lin.m
- Revetment, type II	1,629	lin.m
- Concrete ditch	452	lin.m
- Sluiceway	8	nos.
- Sluice culvert	2	nos.
- Sluice ditch	2	nos.
- Roadway girder bridge	14	nos.
- Pedestrian girder bridge	3	nos.
- Roadway in-situ bridge	2	nos.

(b) Package 2

(i) Tanjungan drainage channel : 2,536 lin.m

- Levee embankment	3,531	lin.m
- Concrete wall	1,134	lin.m
- Revetment, type II	347	lin.m
- Sluiceway	7	nos.
- Roadway girder bridge	4	nos.
- Pedestrian girder bridge	1	no.

(ii) PIK Junction drainage channel : 765 lin.m

- Concrete ditch	765	lin.m
- Sluiceway	1	no.
- Roadway in-situ bridge	4	nos.

(c) Package 3

(i) Saluran Cengkareng drainage channel : 4,213 lin.m

- Levee embankment	4,589	lin.m
- Concrete parapet wall	1,285	lin.m
- Revetment, type I	2,388	lin.m
- Revetment, type II	1,800	lin.m
- Concrete culvert, 3-lane	391	lin.m
- Sluiceway	15	nos.
- Roadway girder bridge	9	nos.
- Pedestrian girder bridge	4	nos.

(ii) Gede/Bor drainage channel : 1,203 lin.m

- Levee embankment	265	lin.m
- Revetment, type I	265	lin.m
- Revetment, type II	2,101	lin.m
- Sluiceway	5	nos.
- Sluice ditch	1	no.
- Roadway girder bridge	9	nos.
- Pedestrian girder bridge	1	no.

(iii) Menya drainage channel : 2,269 lin.m

- Concrete culvert, open	1,986	lin.m
- Concrete culvert, box	812	lin.m
- Roadway in-situ bridge	16	nos.

(2) Working conditions

(i) Workable day and hour

Workable day was assumed as follows:

(Unit : days)

Work	Dry season May - Oct.	Rainy season Nov. - Apr.	Annual total
Excavation, earth	24	18	252
Filling, earth	22	16	228
Concrete	23	23	276
Piling	24	24	288

The actual operation hour is assumed to be 8 hours per day out of 10-working hour per shift in principle.

(ii) Hauling distance

The material subject to transportation will be excavated material to be disposed and demolished structures. The planned spoil bank is located at Teluknaga area in Tangerang region. Hauling distance for disposal is assumed at around 15 km on an average for each package.

(3) Plan of procurement method of major construction materials

(i) Excavated earth materials in every sites may not be suitable for embankment and filling works. Furthermore, embankment materials are restricted to be procured in DKI Jakarta area by the local government. In this connection, embankment materials for levee and pavement foundation is planned to be procured from Serpong in Tangerang region at around 20 km far from the project sites. Such material is scheduled to be procured to necessary sites through licensed suppliers. Excavated materials above water level will be selectively utilized for back filling. Excavated earth material will be selected and stocked just beside excavated site till back filling is carried out.

(ii) Aggregates for concrete and pavement works and stone materials for masonry and drainage works will be procured through licensed suppliers due to costly quarry development in West Java because of small work quantities.

(iii) Precast concrete products are satisfactorily available in Jakarta city with various kinds of dimensions and suppliers by a ready-made or an order-made system.

10.2.2 Construction works

Outline of the construction plan of major structures described herein is developed taking into account the present site conditions and assuming that the construction works will be performed by an international contractor for each package employing mechanized construction methods. On the same time, conventional construction methods are also considered taking into account capability of local labors. Construction works of river structures will be principally executed from downstream part. Construction of sluiceways will be executed at the location where land compensation completed. For bridge construction, neighboring bridges shall never be constructed on the same time to keep detour way. For the bridges having heavy traffic condition, temporary bridge and relocation road may be provided prior to demolition of the existing bridge.

10.3 Construction Time Schedule

10.3.1 Basic conditions for setting of construction time schedule

The drainage channel stretches are divided into several sections for construction purpose in consideration of characteristics of compensation as well as construction orders of river structures in drainage channel and bridges.

In the viewpoint of compensation, construction priority is given to the section having the smallest number of households. In this sense, embankment type levee has priority over parapet type levee, because parapet wall will be constructed at the sections having dense households.

While, in the viewpoint of construction purpose, construction priority is given by the criteria shown below.

- The drainage channel shall be executed from downstream part in principle.
- Sluiceway under revetment shall be constructed during revetment construction period.
- Sluiceway under levee shall be constructed during levee construction period.
- Channel structures under and around a bridge shall complete prior to commencement of the bridge construction at least for 10 m long in both the upstream and downstream parts of the bridge.

- Bridge construction in each section shall be made from downstream part in order to follow river structure construction.
- The construction periods of neighboring bridges shall not be overlapped.

10.3.2 Construction time schedule for each package

The construction time schedule was formulated based on the above conditions. Relationship between channel stretch and working period for each package is as follows:

(1) For contract package-1

Section	Length (m)	Priority	Work Period
1. Kamal drainage channel (main)	4,299		
Stage I			
KM 00'+0m - KM 15+0m	1,257	1	Aug. 2000 - Aug. 2003
Stage II			
KM 16+0m - KM 21+0m	312	3	Jan. 2001 - Sep. 2002
KM 21+0m - KM 26+0m	434	2	May 2001 - Jul. 2002
KM 26+0m - KM 40+32m	992	4	Jul. 2001 - Sep. 2003
KM 40+32m - KM 48+0m	542	5	Aug. 2001 - Jan. 2004
Stage III			
KM 48+0m - KM 57+0m	762	6	Jun. 2002 - Apr. 2004
2. Kamal drainage channel (branch)	2,755		
KE 00+0m - KE 10+7m	626	1	Apr. 2000 - Oct. 2003
KE 10+7m - KE 21+34m	905	2	Jul. 2001 - Mar. 2004
KE 31+34m - KE 30+4m	772	3	Jan. 2002 - Feb. 2004
KE 30+4m - KE 33+0m	452	4	Nov. 2002 - Feb. 2004

(2) For contract package-2

Section	Length (m)	Priority	Work Period
1. Tanjungan drainage channel	2,610		
TM 00 - TM 17-0m	1,530	1	May 2003 - Oct. 2004
TM 18+0m - TM 25+5m	527	3	Jan. 2004 - Jan. 2005
TM 25+5m - EP	553	2	Aug. 2003 - Feb. 2005
2. PIK Junction drainage channel	765		
BP - NM 32-0m	455	1	Apr. 2003 - Mar. 2004
NM 32-0m - EP	310	2	Apr. 2003 - Jan. 2004

(3) For contract package-3

Section	Length (m)	Priority	Work Period
1. S. Cengkareng drainage channel	4,214		
CM 01+0m - CM 07-4m	548	3	Apr. 2004 - Sep. 2006
CM 07-4m - CM 15+0m	672	5	Aug. 2004 - Nov. 2006
CM 15+0m - CM 29+0m	1,362	2	Apr. 2004 - Sep. 2006
CM 29+0m - CM 32+101m	435	1	Apr. 2004 - Oct. 2005
CM 32+101m - CM 36-4m	57	4	Jul. 2004 - May 2006
CM 36-4m - CM 49+1m	1,140	6	Dec. 2004 - Oct. 2006
2. Gede/Bor drainage channel	1,182		
GM 00+0m - GM 03+0m	47	1	Apr. 2004 - Apr. 2005
GM 03+10m - GM 10+0m	570	2	Apr. 2004 - Dec. 2006
GM 10+0m - EP	565	3	May. 2005 - Nov. 2006
3. Meruya area	2,269		
MM 101+0m - MM 302+6m	520	1	Jan. 2005 - Oct. 2005
MM 302+6m - MM 310+5m	348	4	Nov. 2005 - Sep. 2006
MM 310+5m - MM 14+0m	328	3	Jul. 2005 - Oct. 2006
MM 14+0m - MM 21+46m	548	2	Feb. 2005 - Oct. 2006
MM 21+46m - EP	525	5	Nov. 2005 - Oct. 2006