APPENDIX J

INUNDATION DAMAGE AND ECONOMIC EVALUATION

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Table of Contents

List of Tables

List of Figures

J.1 Inundation Damage

J.1.1 Damage Survey

Interview surveys were conducted to grasp the situation of inundation in the Study area. The surveyed areas are selected among those frequently inundated on the basis of the information furnished by the district offices in Vientiane Municipality. The selected areas are shown in Fig. J.1. The sites are selected chiefly in the urbanized and low lying area where the side ditches of road are not adequate. The specifications of surveys are as summarized below;

Period: from May 3, 1989 to May 8, 1989

No. of samples: 853

Major survey items:
- Frequency of inundation
- Water level and durations
- Identifications of serious problems due to inundation on:
  - House
  - Household goods
  - Disease
  - Casualty
  - Trouble in traffic
  - Trouble in electricity supply
  - Trouble in water supply
  - Trouble in telecommunication
  - Damage to business
  - Damage to crops
  - Damage to livestock
  - Loss of wages
- Value of house
- Value of household goods
- Income/sales
- Assets of factory, farm and shops

Method: Home visit interviews

J.1.2 Inundation Damage Potentials

The major damages in the Study area identified by damage survey are as follows:

- Damage to house
- Damage to household articles
- Damage to shop and factory
- Damage to public infrastructure
- Damage to traffic
- Sales loss
- Wage Loss
- Damage to daily life of inhabitants
- Damage to health condition
- Damage to crop
- Other damage

The damaged values of a house varies from place to place for each identified item. This is because of the difference in the values of a house, in case the house damage. another reason for the difference is the damage ratio which depend on the topographic condition and the durability of a house. The potential damage of one item, a house for instance, is defined as the unit value of damage potential (UVDP) and depends on the value of the unit and its damage ratio.

According to the results of the damage survey the unit value of damage potentials of each area are different according to the land use pattern in the relevant areas. This might be one of the reason why the inundation damage in the central city area is high as compared with that of rural area. In this connection, the Study area is classified into three groups, according to land use patterns and socio-economic features at present as follows:

Share of Built-up Area		Sub-area (Present)
Area I :	More than 85% (Located in central city of Vientiane)	H, L
Area II :	20%-85%	A, B, C, D, E, F, G, I, J, K, M, O, P, Q
Area III :	Less than 20%	A.N

The features of each classified area are presented below;

Area	Land Use
Area I :	Central, Public & Commerce Industrial Area
Area II :	Residential Area in Urban Area
Area III :	Residential Area in Rural Area

The unit value of damage potential of Area I are assumed to be that in central, public, commerce and industrial area in the Study area. The unit value of damage potential of Area III is assumed to be that in the residential area in the rural area. Meanwhile the unit value of damage potential in Area II is adopted to the residential area in the remaining area. The damage may be estimated applying this value to the lot number located in the inundated area.

As for the damage to crop, the unique unit value of damage potential is estimated and used to the entire inundated agricultural land in the Study area.

J.1.3 Assumed Inundation Area and the Lot Number Therein

The inundation areas to be incurred by the 10-year storm are estimated on the basis of Geomorphological Survey Map of the Mekong river basin and the field surveys which was conducted during the Study.

The inundation area is assumed to be 2,288 ha for the 10-year inundation as shown in Fig. J.2. The assumed inundation areas by land uses in 1989 and 2020 are estimated supervising the inundation map on the present and future land use maps.

Department of Agricultural service and the offices of four districts in the Study area assume that 70% of the green area are agricultural land. The assumption is adopted in this Study.

The inundation area by sub-area are summarized in Table J.1.

The population in the inundation area are estimated on the basis of the population density in each sub-area and the land use. The number of house, shop, factory and major public facilities are estimated by the following methods.

(1) The number of house including small shop and factory except large market and industrial facility are estimated on the basis of population and average household size.

(2) The estimated number are reviewed referring to the number of houses and building estimated with 1: 5000 Map prepared in 1983. The huge building including market, factory and major public facilities are identified by the above map and field survey.

(3) The number of small shop and factory are estimated on the basis of following share of shop and factory against to total number of houses according to information of Department of Commerce and Industry, Vientiane Municipality.

Area	Share of Shops* and Factories (%)
Area I	10
Area II	40
Area III	80

The details of above estimation are shown in Table J.2 to J.5.

J.2 Damage for the 10-year Storm

The inundation damage potentials due to the 10-year storm are evaluated based on the past damage data and related informations collected by the damage survey and field survey. The damage potentials are estimated at economic price in 1989, adopting the following assumptions.

- The rate of 0.9 is adopted for the conversion factor to convert financial price to economic price same as the previous study of JICA.
- The rate of 0.37 is adopted for the shadow wage rate of unskilled labour same as the previous study of JICA.
- The unit price of a crop is evaluated by border price

The damage potentials at 1989 economic price by damage item are estimated in following sections.

J.2.1. Damage to House

According to the result of damage survey, 15% of sample households in inundated area were damaged due to inundation. The damaged households were forced to spend on the repair and reconstruction of their houses.

The economic damage potential to house in each sub-area is estimated on the basis of following function:

$$Dh = Vh \times D \times N \times DR \times C.F.$$

Where,
- Dh : Economic damage potential to house
- Vh : Original value of house at 1989 year price
- D : Depreciation ratio
- N : Number of houses in the inundation area
- DR : Damage Ratio
- C.F. : Conversion Factor

Houses in the Study area are classified into 3 types according to the materials of house, that is, bamboo/wood, wood/brick and cement/brick as shown in following table. The share of houses by each type against total

number of house is estimated on the basis of the data obtained from the damage survey. The original value and the average durable year of house by material type are assumed according to the interview with the construction companies in Vientiane.

Material Type	Share by Type of Material (%)*			Original Value of House** (10^3 kips)	Average Durable Year
	Area I	Area II	Area III		
Bamboo/Wood	5	5	5	1,770	10
Wood/Brick	95	85	80	3,540	30
Cement/Brick	0	10	15	10,620	50

Note : * The share against the total number of houses to be interviewed.

** Original value of house with 120 m^2 of average floor area

According to above data, the weighted average of house value and durable year in each area category are estimated. The average original value of house with 120 m^2 of floor area and 2 stories are estimated to be 3,452 x 10^3 kips for houses in Area I, 4,160 x 10^3 kips for houses in Area II and 4,513 x 10^3 kips for houses in Area III. The average durable years of house are estimated to be 30 years for houses in Area I, 31 years for houses in Area II and 32 years for houses in Area III.

The depreciation rate is set on the basis of average depreciation period of house after construction according to the result of the damage survey and the average durable years of house in each area.

The average present value of house in each area are estimated on the basis of the original value of house and depreciation as shown below:

Area Category	I	II	III
Original Value (1,000 kip)	3,452	4,160	4,513
Depreciation Period (year)	11	12	13
Average Durable Years (years)	30	31	32
Depreciation Rate (%)	64%	61%	59%
Present Value	2,210	2,540	2,660

The damage ratios for the 10-year storm are set by adopting the figures obtained from the damage survey. In Area II and III where inundations mainly concentrated, the floor height of houses and buildings are estimated to be less than 50 cm in each sub-area according to the damage survey while that in Area I are estimated to be 130 cm. The damage ratios are estimated on the basis of the proportion of the average damage amount against the average present value of house per sample household to be damaged and the share of number of damaged household in total number of sample households in inundation area. The damage ratios are assumed to be 0.5% in Area I, 1.4% in Area II and 1.6% in Area III for the 10-year storm.

The unit economic value of damage potential for the 10-year storm per one household in inundation area is estimated as follow :

Area	Present Value (1,000 kip)	Damage Ratio	Conversion Factor	Unit Damage (1,000 kip/HH)
Area I	2,210	0.5%	0.9	10
Area II	2,540	1.4%	0.9	32
Area III	2,660	1.6%	0.9	38

The total economic damage potentials by sub-area are shown in Table J.6.

J.2.2 Damage to Household Article

The household articles are damaged for only 5% of the households in the inundated area. The cause of relatively small damages to household articles are

speculated that the inhabitants in the inundation area move their important articles in advance to safe places before the inundation occurs according to the experiences in every year.

The economic damage potential value of household articles is estimated on the basis of following function.

$$Dha = Vha \times N \times DR \times C.F.$$

Where, Dha : Economic damage potential to household article
Vha : Average value of household articles per household
N : Number of houses in the inundation area
DR : Damage Ratio
C.F. : Conversion Factor

The common household articles in the Study area are carpet, furniture, clothes, kitchen equipment and bicycle. In addition some luxury goods, such as, refrigerators, air conditioners, fan, radio, stereo set TV and Mobylette are owned in especially in central city in Vientiane.

The average value of these household articles per one household and damage ratio for the 10-year storm are estimated. The average value of household articles per one household is estimated on the basis of average amount of household articles owned by the sample households in the inundation area. The damage ratio is assumed to be proportion of the average damage amount against the average value of household articles per one sample household. The unit economic damage value per one household in inundation area is estimated as follow:

Area	Average Value of Household Article (1,000 kip)	Damage Ratio	Conversion Factor	Unit Economic Damage Value (1,000 kip/HH)
Area I	470	3.0%	0.9	13
Area II	500	4.1%	0.9	18
Area III	810	4.5%	0.9	33

The total economic damage potentials of household articles for the 10-year storm are estimated and results are shown in Table J.7.

J.2.3 Damage to Shop and Factory

There are most important commercial zone and 15 major markets in the Study area. Small scale factories also concentrate in the Study area. The direct damages to shop and factory compose of damage to assets (machinery, display, equipment) and the stocked materials. These assets and stocked materials are liable to be the victim of inundation and have brought the most serious damage to economic activity.

The damage potential of shop and factory is estimated on the basis of following function.

$$Dsf = (Vsa \times DRsa + Vss \times DRss) \times N \times C.F.$$

Where,
- Dsf : Economic damage potential to shop and factory
- Vsa : Average value of assets per shop and factory
- Vss : Average value of stocks per shop and factory
- N : Number of shop and factory in the inundation area
- DRsa, DRss: Damage Ratio
- C.F. : Conversion Factor

average value of and the damage ratio due to inundation.

The average value of assets and stocks per one shop and factory are estimated as follows.

Unit : 1,000 kip

Area	Average Value of Assets	Average Value of Stock
Area I	730	430
Area II	962	600
Area III	1,134	640

Note: Average value of assets and stock owned by interviewed shop

For this study, the damage ratio are calculated on the basis of the share of damage amount per one damaged shop and factory in average amount of assets and stocks to be owned by one shop and factory and the proportion of damaged shops and factories against total number of shops and factories in the inundation area. These data were obtained from the damage survey. From the damage survey to shop owner, the inundation damages due to the 10-year storm are identified to be different by area categories. The damage ratios for the 10-year storm are estimated as follows.

Area	Damage Ratio to Assets	Damage ratio to Stock
Area I	3.2%	2.4%
Area II	1.3%	0.9%
Area III	3.6%	2.5%

The unit economic value of damage potential per one shop or factory in inundation area for the 10-year storm is estimated as below:

Unit : 1,000 kip

Area	Average Damage Value			Conversion Factor	Unit Economic Damage
	Assets	Stock	Total		
Area I	23	10	33	0.9	30
Area II	12	5	17	0.9	15
Area III	41	16	57	0.9	51

The total economic damage potentials to shop and factory for 10-year frequency inundation are estimated as shown in Table J.8.

J.2.4 Damage to Public Infrastructure

The existing public infrastructures in the Study area are road, bridge, hospital, school, government offices and public facilities of water supply system, electricity distribution system, sanitation and telecommunication

system. According to the information of Vientiane Municipality, the most serious damage to public infrastructure due to inundation is identified to be damage to road. As for the damages to electricity supply, water supply and telephone services are estimated as the indirect damage and data of damage to other public facilities are not available. In this study, the damage to road is adopted as the direct damage to public infrastructure.

The economic damage to road is estimated on the basis of following function.

$$Dr = Cr \times L \times DR \times C.F.$$

Where,
- Dr : Economic damage potential to road
- Cr : Average repair cost of damaged road per meter
- L : Length of road in the inundation area
- DR : Damage Ratio
- C.F. : Conversion Factor

In the Study area the road is classified into two categories, that is, the first grade road and the second grade road according to the road width. The first grade road is paved with asphalt and the second grade road is composed of asphalt pavement road, laterite pavement road and non-pavement road. According to Vientiane Municipality, the laterite pavement roads were damaged by inundation and the repair work was required while the damage to road of other type were relatively small. For this study, the repair cost of the second grade road paved with laterite is considered. The damage value of road in the inundation area is estimated on the basis of the average repair cost per meter and the average damage ratio due to inundation.

The average repair cost per meter for laterite pavement road is set on the basis of data from Vientiane Municipality. According to the criteria of Vientiane Municipality, the second grade road is classified to two types as follow:

Type I	Width	6 m
	Thickness of pavement	30 cm
	Paved volume per meter	1.8 m^3

Type II	Width	4 m
	Thickness of pavement	20 cm
	Paved volume per meter	0.8 m^3

The unit repair cost of damaged laterite pavement road is set to be 1,000 kips per square meter and the repair cost per meter is estimated to be 1,800 kips for type I and 800 kips for type II on the basis of above paved volume. The average repair cost of damaged road is estimated to be 1,400 kips by assuming that 60% of the damaged road is classified as type I and remaining 40% of the damaged road is classified as type II.

The total length of second grade road of each sub-area are estimated by measuring the road alignment in the inundation area utilizing with 1 : 5,000 Map covering Sub-area B, C, D, E, F, G, H, I, K, L, P and Q. The road length of remaining area are assumed by calculating the average road density of the second grade road in above sub-areas. In order to estimate the inundated road length, the proportion of inundated area to total area of each sub-area are assumed as the proportion of the inundated road length against total road length of each sub-area. In addition, 10% of inundated road is assumed to be damaged due to inundation according to the information of Vientiane Municipality. Adopting above assumption, the length of damaged road is estimated by multiplying the inundated road length and 10% of the damage ratio. The total economic value of damage potentials of road due to inundation are estimated by adopting 0.9 of conversion factor as shown in Table J.9.

J.2.5 Damage to Traffic

During the inundation period, the hindrance to the traffic system occur and the transportation of both passenger and cargo are disturbed. From the damage survey, this damage is identified to be the most serious damage for the inhabitants.

The economic damage potentials to traffic are estimated by calculating as the loss of traffic charge of bus, taxi and other transportation. The damage potential to traffic is estimated on the basis of following formula.

$$Dt = Vt \times Ft \times Pt \times DR \times C.F.$$

Where
- Dt : Total economic damage potential to traffic
- Vt : Daily traffic Volume in the Inundation Area
- Ft : Average traffic charge per persons•km or t.km
- Pt : Average traffic block period
- DR : Damage ratio
- C.F. : Conversion Factor

The damage potentials are estimated both for the passenger transportation and cargo transportation.

The daily traffic volume in the inundation area are calculated according to the information of Vientiane Municipality. In 1988 the total traffic volume in Vientiane city were 9,903,722 persons•km and 80% of these traffic volume concentrated in the Study Area. The daily traffic volumes in the Study Area are estimated to be 21,707 persons•km and 158,989 t.km.

The traffic volume is distributed to each sub-area with share of population in each sub-area against total population in the Study area and traffic volume in inundation area is also estimated according to share of population in inundation area to that of sub-area. The traffic volume of each sub-area is shown in Table J.10.

The average charges of transportation in the Study area are assumed to be 44 kip/persons•km and 25 kip/t.km according to Vientiane Municipality and UNDP data. The average period of hindrance for 10-year storm is set according to the result of the damage survey. The damage ratio is estimated as the proportion of number of household to be blocked of their traffic against the total number of household in inundation area. The above data are summarized in following table.

Area	Average Traffic Cost	Period of Hindrance	Damage Ratio(%)	Conversion Factor
Area I				
Passenger	44 kip/p.km	26 hour	70%	0.9
Cargo	25 kip/t.km	26 hour	70%	0.9
Area II				
Passenger	44 kip/p.km	31 hour	62%	0.9
Cargo	25 kip/t.km	31 hour	62%	0.9
Area.III				
Passenger	44 kip/p km	14 hour	71%	0.9
Cargo	25 kip/ t.km	14 hour	71%	0.9

The total economic damage potentials to traffic for 10-year storm are estimated by adopting 0.9 of conversion factor as shown in Table J.11 and J.12.

J.2.6 Sales Loss

(1) Sales loss of shops

The sales of shops are decreased during the inundation period. The economic damage potential to sales loss of shop is estimated on the basis of following function.

$$Dss = Sd \times P \times N \times DR \times C.F.$$

Where :
- Dss : Total economic damage potential to sale of shop
- Sd : Average daily sale in the inundation area
- P : Average damage period
- N : Number of shops in inundation area
- DR : Damage ratio
- C.F. : Conversion Factor

The average proportion of average sales loss per one damaged shop against average daily sales per one shop in inundation area due to 10-year storm is estimated to be 20% in Area I, 27% in Area II and 32% in

Area III respectively according to the damage survey. The shops in inundation area lost their sales during the inundation period as well as the restoration period after inundation. The average periods to decrease sales of damaged shops are estimated to be 2 days in Area I and 3 days in Area II and III on the basis of results of the damage survey.

The average value of sale loss per one shop in inundation area for the 10-year storm is estimated on the basis of the average daily sales per shops in the Study Area obtained from Vientiane Municipality, 4 District offices and the damage survey. The average value is converted to economic value by adopting 0.9 of conversion factor.

Area	Average Daily Sales (kip)	Damage Ratio (%)	Damage Period	Conversion Factor	Average Value of Damage (kip)
Area I	4,300	20%	2 days	0.9	1,548
Area II	9,330	25%	2 days	0.9	4,199
Area III	15,200	27%	3 days	0.9	11,080

The total economic damage potentials of sales loss for the 10-year storm in each sub-area are calculated based on assumed number of shops as show in Table J.3. The results are summarized in Table J.13

(2) Sales loss of market

In addition above, inundation damages to the large markets were identified in the damage survey. The list of markets in inundation area are shown as below.

District	Name of Market	Sub-area	Number of Shop	Total Daily Sales (1,000 kip)
Chantabury	Thong Kham	H	360	2,000
Chantabury	Phong Tong	K	30	150
Saysettha	That Luang	P	222	740
Sikhotabong	Kok Pho	M	60	200
Sikhotabong	Si Kay	N	220	2,500
Sisatanak	Soune Mone	B	60	360
Sisatanak	Nong Chanh	G	170	850

Source : District office of Chantabury, Saysettha, Sikhotabong and Sisatanak.

The economic damage potential of each market for the 10-year storm is estimated on the basis of following function.

$$Dsm = Sd \times P \times DR \times C.F.$$

Where :
- Dsm : Total economic damage potential to sale of market
- Sd : Average daily sale of market in the inundation area
- P : Average damage period
- DR : Damage ratio
- C.F. : Conversion Factor

The sales loss in economic price of each market is estimated by adopting 27% of the damage ratio and 2 days of damage period of shops in Area II and results are shown as follows.

Name of Market	Total Daily Sales (1,000 kip)	Damage Ratio	Damage Period (day)	Conversion Factor	Total loss of sales (1,000 kip)
Thong Kham	2,000	27%	2	0.9	972
Phong Thong	150	27%	2	0.9	73
That Luang	740	27%	2	0.9	360
Kok Pho	200	27%	2	0.9	97
Sikay	2,500	27%	2	0.9	1,215
Soune Mone	360	27%	2	0.9	175
Nong Chanh	850	27%	2	0.9	413
Total					3,305

J.2.7 Wage Loss

The wages of workers are lost not only in the inundation period but in the restoration period. The total wage loss in economic price due to 10-year storm is estimated on the basis of following function.

$$Dw = W \times P \times N \times DR \times C.F.$$

Where :
- Dw : Total wage loss in economic price
- W : Average daily wage per one household
- P : Average damage period
- N : Number of household in inundation area
- DR : Damage ratio
- C.F. : Conversion Factor

The average daily wage per one household in the inundation area, average off-work period per one damaged household due to inundation are estimated according to the damage survey. The proportion of number of damaged household against total number of household in inundation area is adopted as the damage ratio. The average economic value of damage per one household in the inundation area is estimated by adopting 0.33 of the conversion factor. The results are shown as follows.

Area	Average Daily Wage(kip)	Off-work Period	Damage Ratio	Conversion Factor	Average Value of Damage(kip)
Area I	1,640	2 days	5.0%	0.33	54
Area II	1,780	2 days	7.0%	0.33	82
Area III	1,980	3 days	8.5%	0.33	167

* Damage Ratio = No. of damaged household/No. of inundated household
* Conversion Factor = 0.33 = 0.9 of Standard Conversion Factor x 0.37 of shadow wage rate

The economic damage potentials for the 10-year storm are estimated by above average value of wage loss per one household and the number of inundated population in sub-area and results are shown in Table J.14

J.2.8 Damage to Daily Life of Inhabitants

The daily life of inhabitants is affected by both inundation itself and indirect damage to economic activities such as shortage of food, luck of public services and closing of schools and hospitals. From the damage survey, the following damages are identified.

- Stop of water supply
- Stop of electricity supply
- Stop of telephone service

The damage to electricity supply is major problem of daily life of inhabitants due to the inundation and about 20% of households in the inundation area were affected by stop of electricity supply for the 10-year storm. The economic damage potential of stop of electricity supply is estimated according to following function :

$$D_E = C \times R \times P \times H \times DR \times C.F.$$

Where : D_E : Damage potential of stop of electricity
C : Average daily charge of electricity
R : Propagation ratio
P : Period of stop of electricity
H : Households in inundation area
DR : Damage Ratio
C.F. : Conversion Factor

The average daily charge and the propagation ratio are estimated according to the damage survey as well as information from EDL. The average period of stop of electricity per one damaged household is estimated on the basis of damage survey. The damage ratio is calculated to be share of damaged household in total number of households in the inundation area. The above data are summarized as below :

Area	Average Daily Charge (kip)	Propagation Ratio (%)	Period of Stop of supply	Damage Ratio (%)
Area I	45.5	92	6 hour	10%
Area II	57.6	94	11 hour	20%
Area III	59.0	99	12 hour	27%

Source : EDL, Damage survey

The average value of damage potential per one household in the inundation area is estimated to be 1.1 kip in Area I, 5.0 kip in Area II and 7.9 kip in Area III for the 10-year storm.

According to the damage survey, stop of water supply and telephone service occurred for less than 2% of households in the inundation area. The damage potential of above two damage is a most negligible and is thus excluded.

The total economic damage potential to daily life of inhabitants for the 10-year storm are estimated by adopting 0.9 of conversion factor as shown in Table J.15.

J.2.9 Damage to Health Condition

From the damage survey, it is found that the poor sanitary condition due to the inundation is the most serious problem for the inhabitants. Dysentery and diarrheal are typical epidemic diseases due mainly to the poor sanitation as well as the inundation.

In 1987, the number of patients of the dengue fervor amounted to 6,728 persons in Vientiane Municipality and 90% of total patient concentrated in the urban area according to the information furnished by the Department of Public Health, Vientiane Municipality. This figure enunciate that almost 3% of the inhabitant in the Study area suffer from the dengue fervor as well as malaria that is the most dangerous epidemic disease and related closely to inundation. The damage potential to health condition is estimated to be as the medical expenses and the income loss due to disease caused by the inundation.

The medical expense due to 10-year storm is estimated in economic price on the basis of following function.

$$Dme = Em \times DR \times N \times C.F.$$

Where
- Dme : Total medical expenses in economic price
- Em : Average medical expenses per one damaged household
- N : Number of household in inundation area
- DR : Damage ratio
- C.F. : Conversion Factor

The average medical expense of diseases per one damaged household due to the 10-year storm is estimated only for medicines according to the damage survey because the remaining medical expense is covered by the government.

The actual medical expense is assumed to be 3 times of that of medicine cost according to the Department of Public Health, Vientiane Municipality. In this study, above assumption is adopted and the average medical expense per one damaged household is estimated on the basis of the average expenditure for medicine obtained from the damage survey. The share of number of damaged

households in total number of households in inundation area are adopted as damage ratio.

The average economic cost of medical expenses per one household in inundation area for the 10-year storm are estimated by adopting 0.9 of conversion factor as follows:

Area	Average Medical Expenses(kip)	Damage Ratio	Conversion Factor	Average cost (kip)
Area I	18,200	3.0%	0.9	491
Area II	16,136	7.7%	0.9	1,118
Area III	9,320	21.6%	0.9	1,812

The income loss in economic price caused by bad health condition are estimated on the basis of the following function.

$$Di = W \times P \times N \times DR \times C.F.$$

Where :
- Di : Total wage loss in economic price
- W : Average daily wage per one household
- P : Average off-work period due to disease
- N : Number of household in inundation area
- DR : Damage ratio
- C.F. : Conversion Factor

According to the Department of Public Health, Vientiane Municipality, almost patients of typical epidemic diseases caused by inundation, such as, dengue, dysentery and diarrheal were children or infants. The direct wage loss are not counted, so the wage loss of family member who nurse the patients are estimated for the this study.

The average period of wage loss are assumed to be one week per one damaged household according to interview to household and the share of number of damaged households in total number of households in inundation area are adopted as damage ratio. The average economic value of damage

potential of wage loss due to nursing per one household in inundation area for the 10-year storm is estimated as follow:

Area	Average Wage (kip/day)	Off-work Period	Damage Ratio	Conversion Factor	Average Damage Value (kip/HH)
Area I	1,640	7 days	3.0%	0.33	114
Area II	1,780	7 days	7.7%	0.33	317
Area III	1,980	7 days	21.6%	0.33	988

The total economic damage potentials to health condition for the 10-year storm are estimated according following average damage value per one household in inundation area and results are shown in Table J.16

	Average Damage per Household(kip)
Area I	605
Area II	1,435
Area III	2,800

J.2.10 Damage to Crop

The damage to crop is evaluated by damage to paddy, vegetable, soybeans and other crop due to the inundation. The damage potential to crop is estimated on the basis of the average unit yield in the rainy season, the period of inundation and the average inundation depth for the 10-year storm.

The major damaged crop is paddy to be counted more than 95% of the damaged amount of crop on the basis of the damage survey. In this study, the damage to other crops than paddy is assumed to be negligible damage and damage to paddy is estimated as damage to crop in the Study area.

The damage to paddy is evaluated as the economic production foregone due to the inundation by adopting the unit damaged production of paddy per ha

of the the inundation area and inundation area in the study area The unit damage production is estimated according following assumptions.

(1) The economic farm gate price of paddy is estimated on the basis of the import parity price of rice calculated from "Price Prospects for Major Primary Commodities", World Bank. The estimation of the economic farm gate price of paddy is summarized in Table J.17.

(2) The unit yield of paddy per ha is assumed to be 3 t/ha according to the estimation of the Department of Agricultural Service of Vientiane Municipality.

(3) The production cost of paddy per ha is assumed to be 35% of gross production according to the the Department of Agricultural Service of Vientiane Municipality.

(4) On the basis of damage survey, 50% of the cultivated area in the inundation area are damaged and 15% of net production in the damaged area is lost due to the 10-year storm. So the damage ratio against net production of the inundation area is assumed to be 7.5% by multiplying 15% and 50%.

Thus the unit economic damage production per ha in the inundation area is estimated as below:

Farm gate price	128,357 Kip/t
Unit yield	3 t/ha
Gross production	385,071 Kip/ha
Net production (65% of Gross production)	250,000 Kip/ha
Damage ratio per ha in inundation area	7.5%
Damaged production per ha in inundation area	18,750 Kip/ha

The cultivated land is assumed to be 70% of total green area on the basis of the present share of cultivated land in the green area in the Study area according to the Department of Agricultural Service of Vientiane Municipality.

The damage potential to crop in economic price is estimated as shown in Table J.18.

J.2.11 Other Damage

In above clauses, the tangible damage due to inundation are discussed in monetary terms. However, there are various intangible damage due to inundation, such as, effects on environment, amenity and comfortableness of inhabitants. In addition, ten persons were injured and one person was killed by inundation in 1988. In this study, the damage amount of other damage which can not be quantified is assumed to be 10% of total damage to be estimated in J.2.1 to J.2.11.

J.2.12 Summary of Inundation Damage

The damage potentials of the 10-year storm in each area are estimated on the basis of the unit damage value and inundation volume discussed in the previous subsections.

The future damages are estimated on the basis of land use projection and the unit value of damage potential of each item. The unit values of damage potential in each year are increased by adopting the growth rate of GRDP in the Study area as follows:

1989 - 2000	7.6%
2000 - 2010	8.1%
2010 - 2020	8.4%
Over all period	8.0%

The summary of damage potential for the 10-year storm at economic price is shown in Table J.19 and J.20.

J.3 Economic Benefit

J.3.1 Annual Economic Benefit

The economic benefit of the project is considered to be the damage reduction through provision of the drainage improvement works. The damage reduction is estimated as the difference in the possible damages in with and without the project cases.

The damage potentials of each inundation by probable storm are estimated on the basis of damage potentials for the 10-year storm. In this estimation, the damage potential is assumed to be proportional to the inundated area. A hydrologic and hydraulic study entailed the indices to estimate the inundation area corresponding to the probable rainfall as follows;

Probable Rainfall Frequency	Inundation Area (ha)	Index
2	4.5	21
5	18	86
10	21	100
20	24	114
50	28	133

The expected reduction of damage amount is evaluated by the average annual damage amount reduced due to the projects. Although the project is designed against the 10-year storm, it is not expected that whole the damage due to the probable storm less than the 10-year storm is protected. Some damages should be considered to remain. This unprotected damage should be reduced from the estimated benefit. The unprotected indices were assumed on the basis of the hydrologic and hydraulic studies as follows:

Probable Rainfall Frequency	Inundation Area (ha)		Area of Reduction	Reduction Rate
	Without Project	With Project		
2	4.5	0	4.5	100%
5	18	5	13	72%
10	21	11	10	48%
20	24	15	9	38%
50	28	21	7	25%

In addition above, the reduction of inundation damage due to small storm less than 2-year storm is to be considered. According to the automatic gauge records of the Study team in Vientiane, inundations due to the small storm less than 2-year storm were assumed to occur four times a year as discussed in Appendix A.10.4. Thus the average damage potential due to these small storm are estimated to be 5% of the damage due to 10-year storm and added to benefit calculation.

J.3.2 Economic Benefit for the Priority Projects

The economic benefits of following priority projects are estimated on the basis of economic benefit in each covered sub-area.

Priority Project	Sub-area
Hong-Ke System	C, E, F, G, H
Nam Pasak System	L
Sub-area I (Hong Kai Keo System)	I
Sub-area K	K

The economic benefits of the Priority Projects are assumed on the basis of following conditions.

(1) Each project is composed of both construction of main canal and construction of lateral canal. The main canal is assumed to be constructed from the first year of the master plan period. The lateral

canal is assumed to be constructed to cover the estimated built-up area by the year of 2020. So the lateral canal is constructed annually following the expansion of inundated built-up area. The construction of lateral canal is completed in year of 2020.

(2) On the basis of above construction schedule, the benefit is accrued from the next year of completion of the main canal and increased according to progress of improvement of lateral canal up to year of 2020.

(3) The inundation area except built up area at present is assumed to locate below El. 168 m which is inundated due to their topographical conditions. In this area the complete reduction of inundation is not expected even in with the project case. Thus 80% of the economic benefit in this area is reduced from benefit calculation.

(4) The benefit after year of 2020 are assumed to be increased by the growth rate of GRDP in each sub-area.

On the basis of above mentioned conditions, the economic benefits by each priority project are estimated as follows:

Unit: US$ 10^3

	2000	2020	2030	2040
Hong-Ke System	306	1,996	5,177	13,429
Nam-Pasak	27	410	1,063	2,758
Area I (Hong Kai Keo System)	42	310	556	996
Area K	15	200	358	641

J.3.3 Economic Benefit for the Basic Plan

The annual economic benefits by each project in the Basic Plan are summarized in Table J.21. The procedures to be used in J.3.2. are adopted.

J.4 Economic Cost

J.4.1 Conversion of Financial Cost to Economic Cost

For the economic evaluation, all the costs involved in the project have to be measured as economic costs, i.e. the real resource costs or "opportunity costs" incurred from the view point of the nation's economy. The measurement of economic cost of any commodity depends on how it is likely to be produced - whether by increasing import, decreasing export, expanding domestic production or divesting from other uses.

In this study, the financial cost presented in previous chapter is converted to economic costs on the basis of above mentioned concept. The procedures of adjustment of financial costs to economic costs are as follows.

(1) Elimination of non-resource costs

The internal transfer among the national economy, such as, tax and subsidy of the government are excluded from the financial costs. In this study, 5% of the foreign portion cost is eliminated as the import tax.

(2) Adjustment of price distortions

All the financial costs of the project are adjusted their price distortion due to foreign exchange premium, overvalued labour costs and land acquisition cost of land in order to the real costs or "opportunity costs". For this adjustment, 0.9 of the conversion factor is assumed for traded goods. As for the land acquisition cost for cultivated land, the production foregone is estimated as the economic cost instead of adopting conversion factor for land. The real cost of labour is evaluated by applying 0.37 of the shadow wage rate.

The financial costs of the project are classified into three categories, construction materials plus equipment, labour and land acquisition cost. The financial costs are converted by each cost items.

The detailed adjustment of financial cost to economic cost of each cost items is summarized as follows.

(1) Foreign portion

All cost of the foreign portion are estimated at C.I.F. price plus import tax. The economic cost for the foreign portion is estimated by eliminating import tax from the financial cost.

(2) Local Portion

- Tradable goods

The financial cost of tradable goods in the local portion is converted to economic cost by adopting 0.9 of the conversion factor.

- Labour cost

The labour cost are converted by adopting 0.37 of the shadow wage rate and 0.9 of the conversion factor. The labour cost are assumed to be 20% of the local portion.

- Land acquisition cost

The present value of production foregone is estimated as economic cost of the land acquisition cost for cultivated land. The economic costs of the land acquisition cost for residential house and other facilities are estimated by multiplying 0.9 of the conversion factor with the financial land acquisition cost.

J.4.2 Summary of Economic Cost

The economic cost consists of the construction cost of main canal, construction cost of lateral canal and annual operation and maintenance cost for the project.

(1) Construction cost of main canal

The financial and economic costs of construction of the main canal by the priority project are summarized in Table J.22 to J.25.

The conversion method of the economic cost above mentioned are applied to cost categories such as direct cost, land acquisition,

government administration and engineering service. The economic cost of the excavation cost of the Nong Chanh retarding basin and the Nam Pasak shortcut canal are assumed to be 50% and 70% of their financial cost respectively, because the excavation materials should be used for the embankment materials.

The operation and maintenance equipment cost is deducted from the economic construction cost and the annual depreciation costs of these equipment are added to the annual operation and maintenance cost.

(2) Construction cost of lateral canal

The lateral canal are constructed in the inundated built-uparea following the expansion of the built-up area and completed in year of 2020. According to the land use projection, the built-up area in the inundated area increases by year to year as shown in Table J.26.

The unit direct cost of lateral canal is estimated to be US$24,000 per ha and 30% of the direct cost is added as the indirect cost. Thus the construction cost is estimated by adopting above unit cost as shown in Table J.26.

(3) Operation and maintenance cost

The operation and the maintenance cost in economic term are assumed to be 1% of total economic construction cost of both the main canal and the lateral canal.

J.5 Economic Evaluation

J.5.1 Introduction

The economic viability of the project is analyzed from the point of view of the national socio-economy as a whole. The economic evaluation is carried out according to the following approach. In this study, the EIRR is adopted as the evaluation index

(1) Priority study

The evaluations of the priority projects are carried out and the implementation priority of the priority projects is decided on the basis of evaluation results. The each priority project is assessed by assuming that the project would be started in 1991.

(2) Evaluation of the Basic Plan

The economic justification of the Basic Plan is evaluated on the basis of the overall implementation schedule. The evaluation period is assumed to be 50 years from the year of 1991, the first year of the Basic Plan and the salvaged value at the end of the evaluation periods is counted in 2040.

J.5.2 Major assumption

The economic evaluation is made on the basis of the following assumptions:

(1) The economic life of the project is taken at 50 years from the commencement of the construction.

(2) The base period for the cost estimate is set in October, 1989.

(3) The exchange rate of US$ 1 = Kip 590 = Yen 141 is applied.

(4) In estimating capital cost for construction, the physical contingency allowance is estimated to be 10% of the direct cost.

(5) In this study, the opportunity cost of capital is assumed to be 10% on the basis of the interest rate of long-term lending of the central bank.

J.5.3 Economic Internal Rate of Return

The economic internal rate of return (EIRR) of the projects is estimated on the basis of economic cost and benefit cashflow as shown in Table J.27 to J.31. The results are summarized as follows:

(1) Priority Project (Commenced in 1991)

Hong-Ke	7.3%
Nam Pasak	4.2%
Hong Kai Keo (Area I)	3.5%
Area K	3.5%

(2) Overall Master Plan

Overall Master Plan	5.8%
Priority Project (Hong Ke System, Nam Pasak, Hong Kai Keo (Sub-area I) Sub-area K)	6.3%
Sub-area D, J, M, O and P	4.8%
Sub-area A and B	5.5%

TABLES

Table J.1 Inundation Area in 1988 and 2020

Year: 1989 Unit: ha

Sub-area	Central	Residential	Public & Commercial	Industrial	Water	Green	Other	Total
A		0.0			74.7	87.3		162.0
B		49.8				211.3		261.1
C		11.3						11.3
D		23.5				80.3		103.8
E		18.1	4.7		5.0	33.8		61.6
F		9.0				3.8		12.8
G		13.3						13.3
H		42.7	1.9					44.6
I			7.1			133.3		140.4
J		58.1			10.0	60.0		128.1
K		20.4		2.7	7.6	73.8		104.5
L		28.5						28.5
M		52.0				255.1		307.1
N		92.2				762.8		855.0
O		0.0						0.0
P		10.1				43.8		53.9
Q		0.0						0.0
Total	0.0	429.0	13.7	2.7	97.3	1,745.3	0.0	2,288.0

Year: 2020

Sub-area	Central	Residential	Public & Commercial	Industrial	Water	Green	Other	Total
A					35.1	126.9		162.0
B		97.8				163.3		261.1
C		11.3						11.3
D		85.1	5.1			13.5		103.7
E		28.1	9.8		3.4	20.3		61.6
F		12.8						12.8
G	13.6							13.6
H	17.6	25.1	1.9					44.6
I		49.4	38.9			52.0		140.3
J		78.8	20.0		1.8	27.5		128.1
K		89.7		7.1	7.6			104.4
L	28.5							28.5
M		71.6				235.5		307.1
N		112.2				703.5	39.3	855.0
O								0.0
P		51.4	2.5					53.9
Q								0.0
Total	59.7	713.3	78.2	7.1	47.9	1,342.5	39.3	2,288.0

Table J.2 Inundation Area and Inundated Population in 1989

Sub-area	Inundation Area (ha)					Total Population in Sub-area	Total Built-up Area(ha)	Population Density (per ha)	Inundation Population			
	Area I	Area II	Area III	Green	Total				Area I	Area II	Area III	Total
A				87.3	87.3	3,004	71.1	42.3	0	0	0	0
B		49.8		211.3	261.1	12,584	457.4	27.5	0	1,370	0	1,370
C		11.3			11.3	11,537	160.2	72.0	0	814	0	814
D		23.5		80.3	103.8	11,191	125.8	89.0	0	2,091	0	2,091
E		18.1	4.7	33.8	56.6	6,363	106.2	59.9	0	1,085	282	1,367
F		9.0		3.8	12.8	5,084	106.1	47.9	0	431	0	431
G		13.3			13.3	3,944	28.6	137.9	0	1,834	0	1,834
H		25.1	19.5		44.6	19,522	162.0	120.5	0	3,025	2,350	5,375
I		0.0	7.1	133.3	140.4	13,487	138.8	97.2	0	0	690	690
J		58.1		60.0	118.1	4,369	164.8	26.5	0	1,540	0	1,540
K		20.4	2.7	73.8	96.9	679	89.2	7.6	0	155	21	176
L		28.5			28.5	5,213	186.7	27.9	0	796	0	796
M		52.0		255.1	307.1	30,898	417.1	74.1	0	3,852	0	3,852
N	92.2			762.8	855.0	7,309	224.6	32.5	3,000	0	0	3,000
O					0.0	3,547	18.4	192.8	0	0	0	0
P		10.1		43.8	53.9	8,538	109.8	77.8	0	785	0	785
Q					0.0	1,716	36.4	47.1	0	0	0	0
TOTAL	92.2	319.2	34.0	1,745.3	2,190.7	148,985	2,603.2	57.2	3,000	17,778	3,343	24,121

Table J.3 Number of Inundated House in 1989

Sub-area	No. of Household				No. of Residential House				No. of Shop and Factory			
	Area I	Area II	Area III	Total	Area I	Area II	Area III	Total	Area I	Area II	Area III	Total
A	0	0	0	0	0	0	0	0	0	0	0	0
B	0	228	0	228	0	137	0	137	0	91	0	91
C	0	136	0	136	0	82	0	82	0	54	0	54
D	0	349	0	349	0	209	0	209	0	140	0	140
E	0	181	47	228	0	109	9	118	0	72	38	110
F	0	72	0	72	0	43	0	43	0	29	0	29
G	0	306	0	306	0	184	0	184	0	122	0	122
H	0	504	392	896	0	302	78	380	0	202	314	516
I	0	0	115	115	0	0	23	23	0	0	92	92
J	0	257	0	257	0	154	0	154	0	103	0	103
K	0	26	4	30	0	16	1	17	0	10	3	13
L	0	133	0	133	0	80	0	80	0	53	0	53
M	0	642	0	642	0	385	0	385	0	257	0	257
N	500	0	0	500	450	0	0	450	50	0	0	50
O	0	0	0	0	0	0	0	0	0	0	0	0
P	0	131	0	131	0	79	0	79	0	52	0	52
Q	0	0	0	0	0	0	0	0	0	0	0	0
												0
Total	500	2,965	558	4,023	450	1,780	111	2,341	50	1,185	447	1,682

Table J.4 Inundation Area and Inundated Population in 2020

Sub-area	Inundation Area (ha)					Total Population in Sub-area	Total Built-up Area(ha)	Population Density (per ha)	Inundation Population			
	Area I	Area II	Area III	Green	Total				Area I	Area II	Area III	Total
A				126.9	126.9	23,647	288.0	82.1	0	0	0	0
B		97.8		163.3	261.1	30,880	503.2	61.4	0	6,002	0	6,002
C		11.3			11.3	18,797	175.7	107.0	0	1,209	0	1,209
D		85.1	5.1	13.5	103.7	22,927	230.0	99.7	0	8,483	508	8,991
E		28.1	9.8	20.3	58.2	13,758	121.3	113.4	0	3,187	1,112	4,299
F		12.8			12.8	11,549	123.0	93.9	0	1,202	0	1,202
G			13.6		13.6	4,487	29.1	154.2	0	0	2,097	2,097
H		25.1	19.5		44.6	27,304	169.2	161.4	0	4,050	3,147	7,197
I		49.4	38.9	52.0	140.3	26,348	224.0	117.6	0	5,811	4,576	10,387
J		78.8	20.0	27.5	126.3	15,119	214.9	70.4	0	5,544	1,407	6,951
K		89.7	7.1		96.8	9,237	158.5	58.3	0	5,228	414	5,642
L			28.5		28.5	13,996	186.7	75.0	0	0	2,137	2,137
M		71.6		235.5	307.1	41,861	417.1	100.4	0	7,186	0	7,186
N	112.2			703.5	815.7	18,771	261.5	71.8	8,054	0	0	8,054
O					0.0	5,930	35.6	166.6	0	0	0	0
P		51.4	2.5		53.9	16,018	153.6	104.3	0	5,360	261	5,621
Q					0.0	4,371	49.4	88.5	0	0	0	0
TOTAL	112.2	601.1	145.0	1,342.5	2,200.8	305,000	3,340.8	91.3	8,054	53,262	15,659	76,975

Table J.5 Number of Inundated House in 2020

Sub-area	No. of Household				No. of Residential House				No. of Shop and Factory			
	Area I	Area II	Area III	Total	Area I	Area II	Area III	Total	Area I	Area II	Area III	Total
A	0	0	0	0	0	0	0	0	0	0	0	0
B	0	1,000	0	1,000	0	600	0	600	0	400	0	400
C	0	202	0	202	0	121	0	121	0	81	0	81
D	0	1,414	85	1,499	0	848	17	865	0	566	68	634
E	0	531	185	716	0	319	37	356	0	212	148	360
F	0	200	0	200	0	120	0	120	0	80	0	80
G	0	0	350	350	0	0	70	70	0	0	280	280
H	0	675	525	1,200	0	405	105	510	0	270	420	690
I	0	969	763	1,732	0	581	153	734	0	388	610	998
J	0	924	235	1,159	0	554	47	601	0	370	188	558
K	0	871	69	940	0	523	14	537	0	348	55	403
L	0	0	356	356	0	0	71	71	0	0	285	285
M	0	1,198	0	1,198	0	719	0	719	0	479	0	479
N	1,342	0	0	1,342	1,208	0	0	1,208	134	0	0	134
O	0	0	0	0	0	0	0	0	0	0	0	0
P	0	893	44	937	0	536	9	545	0	357	35	392
Q	0	0	0	0	0	0	0	0	0	0	0	0
Total	1,342	8,877	2,612	12,831	1,208	5,326	523	7,057	134	3,551	2,089	5,774

Table J.6 Damage to House in 1989

Unit: 1,000 Kip

Sub-area	Unit Value of Damage			No. of House			Total Damage Potential			
	Area I	Area II	Area III	Area I	Area II	Area III	Area I	Area II	Area III	Total
A	10	32	38	0	0	0	0	0	0	0
B	10	32	38	0	228	0	0	7,296	0	7,296
C	10	32	38	0	136	0	0	4,352	0	4,352
D	10	32	38	0	349	0	0	11,168	0	11,168
E	10	32	38	0	181	47	0	5,792	1,786	7,578
F	10	32	38	0	72	0	0	2,304	0	2,304
G	10	32	38	0	306	0	0	9,792	0	9,792
H	10	32	38	0	504	392	0	16,128	14,896	31,024
I	10	32	38	0	0	115	0	0	4,370	4,370
J	10	32	38	0	257	0	0	8,224	0	8,224
K	10	32	38	0	26	4	0	832	152	984
L	10	32	38	0	133	0	0	4,256	0	4,256
M	10	32	38	0	642	0	0	20,544	0	20,544
N	10	32	38	500	0	0	5,000	0	0	5,000
O	10	32	38	0	0	0	0	0	0	0
P	10	32	38	0	131	0	0	4,192	0	4,192
Q	10	32	38	0	0	0	0	0	0	0
Total				500	2,965	558	5,000	94,880	21,204	121,084

Table J.7 Damage to Household Article in 1989

Unit: 1,000 Kip

Sub-area	Unit Value of Damage			No. of House			Total Damage Potential			
	Area I	Area II	Area III	Area I	Area II	Area III	Area I	Area II	Area III	Total
A	13	18	33	0	0	0	0	0	0	0
B	13	18	33	0	228	0	0	4,104	0	4,104
C	13	18	33	0	136	0	0	2,448	0	2,448
D	13	18	33	0	349	0	0	6,282	0	6,282
E	13	18	33	0	181	47	0	3,258	1,551	4,809
F	13	18	33	0	72	0	0	1,296	0	1,296
G	13	18	33	0	306	0	0	5,508	0	5,508
H	13	18	33	0	504	392	0	9,072	12,936	22,008
I	13	18	33	0	0	115	0	0	3,795	3,795
J	13	18	33	0	257	0	0	4,626	0	4,626
K	13	18	33	0	26	4	0	468	132	600
L	13	18	33	0	133	0	0	2,394	0	2,394
M	13	18	33	0	642	0	0	11,556	0	11,556
N	13	18	33	500	0	0	6,500	0	0	6,500
O	13	18	33	0	0	0	0	0	0	0
P	13	18	33	0	131	0	0	2,358	0	2,358
Q	13	18	33	0	0	0	0	0	0	0
Total				500	2,965	558	6,500	53,370	18,414	78,284

Table J.8 Damage to Shop and Factory in 1989

Unit: 1,000 Kip

Sub-area	Unit Value of Damage			No. of House			Total Damage Potential			
	Area I	Area II	Area III	Area I	Area II	Area III	Area I	Area II	Area III	Total
A	30	15	51	0	0	0	0	0	0	0
B	30	15	51	0	91	0	0	1,365	0	1,365
C	30	15	51	0	54	0	0	810	0	810
D	30	15	51	0	140	0	0	2,100	0	2,100
E	30	15	51	0	72	38	0	1,080	1,938	3,018
F	30	15	51	0	29	0	0	435	0	435
G	30	15	51	0	122	0	0	1,830	0	1,830
H	30	15	51	0	202	314	0	3,030	16,014	19,044
I	30	15	51	0	0	92	0	0	4,692	4,692
J	30	15	51	0	103	0	0	1,545	0	1,545
K	30	15	51	0	10	3	0	150	153	303
L	30	15	51	0	53	0	0	795	0	795
M	30	15	51	0	257	0	0	3,855	0	3,855
N	30	15	51	50	0	0	1,500	0	0	1,500
O	30	15	51	0	0	0	0	0	0	0
P	30	15	51	0	52	0	0	780	0	780
Q	30	15	51	0	0	0	0	0	0	0
Total				50	1,185	447	1,500	17,775	22,797	42,072

Table J.9 Damage to Public Infrastructure in 1989

Sub-area	Unit Value of Damage (1,000 Kip)	Length of 2nd Grade Road (m)	Inundated Ratio	Length of Inundated Road (m)	Damage Ratio	Length of Damage Road (m)	Total Damage Potential (1,000 Kip)
A	1.3	64	0.00%	0	10.0%	0	0
B	1.3	3,417	10.89%	372	10.0%	37	47
C	1.3	1,197	7.05%	84	10.0%	8	11
D	1.3	1,539	18.68%	287	10.0%	29	36
E	1.3	806	21.51%	173	10.0%	17	22
F	1.3	329	8.49%	28	10.0%	3	4
G	1.3	254	45.86%	116	10.0%	12	15
H	1.3	978	27.53%	269	10.0%	27	34
I	1.3	1,647	5.11%	84	10.0%	8	11
J	1.3	1,233	35.21%	434	10.0%	43	55
K	1.3	81	25.96%	21	10.0%	2	3
L	1.3	596	15.24%	91	10.0%	9	11
M	1.3	3,115	12.47%	388	10.0%	39	49
N	1.3	203	40.98%	83	10.0%	8	10
O	1.3	135	0.00%	0	10.0%	0	0
P	1.3	122	9.18%	11	10.0%	1	1
Q	1.3	297	0.00%	0	10.0%	0	0
Total		16,013		2,444		244	309

Table J.10 Traffic Volume in the Inundated Area in 1989

Unit: Person•km, t•km

Sub-area	Traffic Volume (Passenger)				Traffic Volume (Cargo)				Traffic in Study Area	
	Area I	Area II	Area III	Total	Area I	Area II	Area III	Total	Passenger	Cargo
A	0	0	0	0	0	0	0	0	438	3,206
B	0	200	0	200	0	1,462	0	1,462	1,833	13,429
C	0	119	0	119	0	869	0	869	1,681	12,312
D	0	305	0	305	0	2,231	0	2,231	1,631	11,942
E	0	158	41	199	0	1,459	301	1,459	927	6,790
F	0	63	0	63	0	460	0	460	741	5,425
G	0	267	0	267	0	1,957	0	1,957	575	4,209
H	0	441	342	783	0	5,736	2,508	5,736	2,844	20,833
I	0	0	101	101	0	736	736	736	1,965	14,393
J	0	225	0	225	0	1,643	0	1,643	637	4,622
K	0	23	3	26	0	188	22	188	99	725
L	0	116	0	116	0	849	0	849	760	5,563
M	0	561	0	561	0	4,111	0	4,111	4,502	32,973
N	437	0	0	437	3,202	3,202	0	6,404	1,065	7,800
O	0	0	0	0	0	0	0	0	517	3,785
P	0	114	0	114	0	838	0	838	1,244	9,111
Q	0	0	0	0	0	0	0	0	250	1,831
Total	437	2,592	487	3,516	3,202	25,741	3,567	28,943	21,709	158,949

Table J.11 Damage to Traffic (Passenger) in 1989

Unit: 1,000 Kip

Sub-area	Unit Value of Damage			Traffic Volume (person•km)			Total Damage Potential			
	Area I	Area II	Area III	Area I	Area II	Area III	Area I	Area II	Area III	Total
A	0.0297	0.0315	0.0162	0	0	0	0	0	0	0
B	0.0297	0.0315	0.0162	0	200	0	0	6	0	6
C	0.0297	0.0315	0.0162	0	119	0	0	4	0	4
D	0.0297	0.0315	0.0162	0	305	0	0	10	0	10
E	0.0297	0.0315	0.0162	0	158	41	0	5	1	6
F	0.0297	0.0315	0.0162	0	63	0	0	2	0	2
G	0.0297	0.0315	0.0162	0	267	0	0	8	0	8
H	0.0297	0.0315	0.0162	0	441	342	0	14	6	20
I	0.0297	0.0315	0.0162	0	0	101	0	0	2	2
J	0.0297	0.0315	0.0162	0	225	0	0	7	0	7
K	0.0297	0.0315	0.0162	0	23	3	0	1	0	1
L	0.0297	0.0315	0.0162	0	116	0	0	4	0	4
M	0.0297	0.0315	0.0162	0	561	0	0	18	0	18
N	0.0297	0.0315	0.0162	437	0	0	13	0	0	13
O	0.0297	0.0315	0.0162	0	0	0	0	0	0	0
P	0.0297	0.0315	0.0162	0	114	0	0	4	0	4
Q	0.0297	0.0315	0.0162	0	0	0	0	0	0	0
Total				437	2,592	487	13	83	9	105

Table J.12 Damage to Traffic (Cargo) in 1989

Unit: 1,000 Kip

Sub-area	Unit Value of Damage			Traffic Volume (t•km)			Total Damage Potential			
	Area I	Area II	Area III	Area I	Area II	Area III	Area I	Area II	Area III	Total
A	0.017	0.018	0.009	0	0	0	0	0	0	0
B	0.017	0.018	0.009	0	1,462	0	0	26	0	26
C	0.017	0.018	0.009	0	869	0	0	16	0	16
D	0.017	0.018	0.009	0	2,231	0	0	40	0	40
E	0.017	0.018	0.009	0	1,158	301	0	21	3	24
F	0.017	0.018	0.009	0	460	0	0	8	0	8
G	0.017	0.018	0.009	0	1,957	0	0	35	0	35
H	0.017	0.018	0.009	0	3,228	2,508	0	58	23	81
I	0.017	0.018	0.009	0	0	736	0	0	7	7
J	0.017	0.018	0.009	0	1,643	0	0	30	0	30
K	0.017	0.018	0.009	0	166	22	0	3	0	3
L	0.017	0.018	0.009	0	849	0	0	15	0	15
M	0.017	0.018	0.009	3,202	4,111	0	0	74	0	74
N	0.017	0.018	0.009	437	0	0	55	0	0	55
O	0.017	0.018	0.009	0	0	0	0	0	0	0
P	0.017	0.018	0.009	0	838	0	0	15	0	15
Q	0.017	0.018	0.009	0	0	0	0	0	0	0
Total				3,639	18,972	3,567	55	341	33	429

Table J.13 Sales Loss in 1989

Unit: 1,000 Kip

Sub-area	Unit Value of Damage			No. of Shop			Total Damage Potential			
	Area I	Area II	Area III	Area I	Area II	Area III	Area I	Area II	Area III	Total
A	1.548	4.199	11.080	0	0	0	0	0	0	0
B	1.548	4.199	11.080	0	91	0	0	382	0	382
C	1.548	4.199	11.080	0	54	0	0	227	0	227
D	1.548	4.199	11.080	0	140	0	0	588	0	588
E	1.548	4.199	11.080	0	72	38	0	302	421	723
F	1.548	4.199	11.080	0	29	0	0	122	0	122
G	1.548	4.199	11.080	0	122	0	0	512	0	512
H	1.548	4.199	11.080	0	202	314	0	848	3,479	4,327
I	1.548	4.199	11.080	0	0	92	0	0	1,019	1,019
J	1.548	4.199	11.080	0	103	0	0	432	0	432
K	1.548	4.199	11.080	0	10	3	0	42	33	75
L	1.548	4.199	11.080	0	53	0	0	223	0	223
M	1.548	4.199	11.080	0	257	0	0	1,079	0	1,079
N	1.548	4.199	11.080	50	0	0	77	0	0	77
O	1.548	4.199	11.080	0	0	0	0	0	0	0
P	1.548	4.199	11.080	0	52	0	0	218	0	218
Q	1.548	4.199	11.080	0	0	0	0	0	0	0
Total				50	1,185	447	77	4,975	4,952	10,004

Table J.14 Wage Loss in 1989

Unit: 1,000 Kip

Sub-area	Unit Value of Damage			No. of House			Total Damage Potential			
	Area I	Area II	Area III	Area I	Area II	Area III	Area I	Area II	Area III	Total
A	0.054	0.082	0.167	0	0	0	0	0	0	0
B	0.054	0.082	0.167	0	228	0	0	19	0	19
C	0.054	0.082	0.167	0	136	0	0	11	0	11
D	0.054	0.082	0.167	0	349	0	0	29	0	29
E	0.054	0.082	0.167	0	181	47	0	15	8	23
F	0.054	0.082	0.167	0	72	0	0	6	0	6
G	0.054	0.082	0.167	0	306	0	0	25	0	25
H	0.054	0.082	0.167	0	504	392	0	41	65	106
I	0.054	0.082	0.167	0	0	115	0	0	19	19
J	0.054	0.082	0.167	0	257	0	0	21	0	21
K	0.054	0.082	0.167	0	26	4	0	2	1	3
L	0.054	0.082	0.167	0	133	0	0	11	0	11
M	0.054	0.082	0.167	0	642	0	0	53	0	53
N	0.054	0.082	0.167	500	0	0	27	0	0	27
O	0.054	0.082	0.167	0	0	0	0	0	0	0
P	0.054	0.082	0.167	0	131	0	0	11	0	11
Q	0.054	0.082	0.167	0	0	0	0	0	0	0
Total				500	2,965	558	27	244	93	364

Table J.15 Damage to Daily Life in1989

Unit: 1,000 Kip

Sub-area	Unit Value of Damage			No. of House			Total Damage Potential			
	Area I	Area II	Area III	Area I	Area II	Area III	Area I	Area II	Area III	Total
A	0.001	0.005	0.007	0	0	0	0	0	0	0
B	0.001	0.005	0.007	0	228	0	0	1	0	1
C	0.001	0.005	0.007	0	136	0	0	1	0	1
D	0.001	0.005	0.007	0	349	0	0	2	0	2
E	0.001	0.005	0.007	0	181	47	0	1	0	1
F	0.001	0.005	0.007	0	72	0	0	0	0	0
G	0.001	0.005	0.007	0	306	0	0	1	0	1
H	0.001	0.005	0.007	0	504	392	0	2	3	5
I	0.001	0.005	0.007	0	0	115	0	0	1	1
J	0.001	0.005	0.007	0	257	0	0	1	0	1
K	0.001	0.005	0.007	0	26	4	0	0	0	0
L	0.001	0.005	0.007	0	133	0	0	1	0	1
M	0.001	0.005	0.007	0	642	0	0	3	0	3
N	0.001	0.005	0.007	500	0	0	0	0	0	0
O	0.001	0.005	0.007	0	0	0	0	0	0	0
P	0.001	0.005	0.007	0	131	0	0	1	0	1
Q	0.001	0.005	0.007	0	0	0	0	0	0	0
Total				500	2,965	558	0	14	4	18

Table J.16 Damage to Health Condition in1989

Unit: 1,000 Kip

Sub-area	Unit Value of Damage			No. of House			Total Damage Potential			
	Area I	Area II	Area III	Area I	Area II	Area III	Area I	Area II	Area III	Total
A	0.605	1.435	2.800	0	0	0	0	0	0	0
B	0.605	1.435	2.800	0	228	0	0	327	0	327
C	0.605	1.435	2.800	0	136	0	0	195	0	195
D	0.605	1.435	2.800	0	349	0	0	501	0	501
E	0.605	1.435	2.800	0	181	47	0	260	132	392
F	0.605	1.435	2.800	0	72	0	0	103	0	103
G	0.605	1.435	2.800	0	306	0	0	439	0	439
H	0.605	1.435	2.800	0	504	392	0	723	1,098	1,821
I	0.605	1.435	2.800	0	0	115	0	0	322	322
J	0.605	1.435	2.800	0	257	0	0	369	0	369
K	0.605	1.435	2.800	0	26	4	0	37	11	48
L	0.605	1.435	2.800	0	133	0	0	191	0	191
M	0.605	1.435	2.800	0	642	0	0	921	0	921
N	0.605	1.435	2.800	500	0	0	303	0	0	303
O	0.605	1.435	2.800	0	0	0	0	0	0	0
P	0.605	1.435	2.800	0	131	0	0	188	0	188
Q	0.605	1.435	2.800	0	0	0	0	0	0	0
Total				500	2,965	558	303	4,254	1,563	6,120

Table J.17 Import Parity Price of Rice in 1989

(Unit: forecasted price in 1988 constant term)

	Description	Currency	Value/ton
1.	F.O.B. Banbkok (Thai 5% broken)	US$	297
2.	Freight and Insurance (Bangkok - Thanaleng)	US$	+35
3.	Value C.I.F. Thanaleng	US$	332
	(exchange rate: US$ 1 = Kip 590)	Kip	195,880
4.	Port Handling Charge and Bagging	Kip	+800
5.	Transportation Cost from Thanaleng to Vientiane	Kip	+700
6.	Price of Milled Rice at Rice Mill	Kip	197,380
7.	Conversion from Rice to Paddy in the Husk (recovery rage: 65%)	Kip	128,297
8.	Milling Charge	Kip	-1,250
9.	Value of Bran	Kip	+1,430
10.	Handling and Transportation Cost from Farm Gate to Rice Mill	Kip	-120
11.	Economic Farm Gate Price of Paddy	Kip	128,357

Sources: 1. Price Prospects for Major Primary Commodities, 1988 - 2000
2. Unit prices or costs are obtained from MAF.

Table J.18 Damage to Agriculture in 1989

	Unit Value of Damage (1,000 Kip)	Green Area (ha)	Total Damage Potential (1,000 Kip)
A	13.1	87.3	1,144
B	13.1	211.3	2,768
C	13.1	0.0	0
D	13.1	80.3	1,052
E	13.1	33.8	443
F	13.1	3.8	50
G	13.1	0.0	0
H	13.1	0.0	0
I	13.1	133.3	1,746
J	13.1	60.0	786
K	13.1	73.8	967
L	13.1	0.0	0
M	13.1	255.1	3,342
N	13.1	762.8	9,993
O	13.1	0.0	0
P	13.1	43.8	574
Q	13.1	0.0	0
Total		1745.3	22,863

Table J.19 Economic Damage Potential for the 10-year Storm in 1989

Year : 1989

Unit: 1,000 Kip

Sub-area	House	Household Article	Shop & Factory	Public Facility	Traffic	Sales	Market	Wage	Daily Life	Health Condition	Crop	Sub-total	Other	Total
A	0	0	0	0	0	0		0	0	0	1,144	1,144	114	1,258
B	7,296	4,104	1,365	47	33	382	175	19	1	327	2,768	16,517	1,652	18,169
C	4,352	2,448	810	11	19	227		11	1	195	0	8,074	807	8,881
D	11,168	6,282	2,100	36	50	588		29	2	501	1,052	21,808	2,181	23,989
E	7,578	4,809	3,018	22	29	723		23	1	391	443	17,037	1,704	18,741
F	2,304	1,296	435	4	10	122		6	0	103	50	4,330	433	4,763
G	9,792	5,508	1,830	15	44	512	414	25	1	439	0	18,580	1,858	20,438
H	31,024	22,008	19,044	34	100	4,327	972	107	5	1,821	0	79,442	7,944	87,386
I	4,370	3,795	4,692	11	8	1,019		19	1	322	1,746	15,983	1,598	17,581
J	8,224	4,626	1,545	55	37	432		21	1	369	786	16,096	1,610	17,706
K	984	600	303	3	4	75	73	3	0	49	967	3,061	306	3,367
L	4,256	2,394	795	11	19	223		11	1	191	0	7,901	790	8,691
M	20,544	11,556	3,855	49	92	1,079	97	53	3	921	3,342	41,591	4,159	45,750
N	5,000	6,500	1,500	10	68	77	1,215	27	0	303	9,993	24,693	2,469	27,162
O	0	0	0	0	0	0		0	0	0	0	0	0	0
P	4,192	2,358	780	1	19	218	360	11	1	188	574	8,702	870	9,572
Q	0	0	0	0	0	0		0	0	0	0	0	0	0
Total	121,084	78,284	42,072	309	532	10,004	3,306	365	18	6,120	22,865	284,959	28,496	313,455

Table J.20 Economic Damage Potential for the 10-year Storm in 2020

Year : 2020

Unit: 1,000 Kip

Sub-area	House	Household Article	Shop & Factory	Public Facility	Traffic	Sales	Market	Wage	Daily Life	Health Condition	Crop	Sub-total	Other	Total
A	0	0	0	0	0	0	0	0	0	0	18,066	18,066	1,807	19,873
B	348,000	196,000	65,200	509	9,625	18,253	1,897	891	49	15,595	23,248	679,267	67,927	747,194
C	70,296	39,592	13,203	115	1,939	3,696	0	180	10	3,150	0	132,181	13,218	145,399
D	527,177	307,659	129,930	393	14,013	34,016	0	1,414	76	24,638	1,922	1,041,238	104,124	1,145,362
E	261,193	170,491	116,548	238	6,007	27,495	0	809	40	13,910	2,890	599,621	59,962	659,583
F	69,600	39,200	13,040	38	1,927	3,651	0	178	1	3,119	0	130,754	13,075	143,829
G	144,550	125,650	155,120	159	1,691	33,716	4,499	635	27	10,650	0	476,697	47,670	524,367
H	451,725	320,775	276,690	369	9,032	62,895	10,563	1,554	74	26,502	0	1,160,179	116,018	1,276,197
I	652,331	463,841	401,184	115	13,009	91,158	0	2,248	106	38,329	7,403	1,669,724	166,972	1,836,696
J	418,607	265,469	164,462	594	10,025	39,522	0	1,250	63	21,561	3,915	925,468	92,547	1,018,015
K	331,605	195,487	87,194	29	8,718	22,503	792	901	48	15,683	0	662,960	66,296	729,256
L	147,028	127,804	157,890	124	1,723	34,318	0	646	27	10,833	0	480,393	48,039	528,432
M	416,904	234,808	78,077	532	11,524	21,858	1,056	1,067	59	18,683	33,527	818,095	81,810	899,905
N	146,278	189,222	43,684	113	12,245	2,254	13,204	788	15	8,824	100,154	516,781	51,678	568,459
O	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P	328,936	190,824	77,581	15	8,806	20,505	3,912	876	47	15,365	0	646,867	64,687	711,554
Q	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	4,314,230	2,866,822	1,779,803	3,343	110,284	415,840	35,923	13,437	642	226,842	191,125	9,958,291	995,829	10,954,120

Table J.21 Expected Benefit by Sub-area

US$1,000

	Sub-area	2020	2030	2040
Hong Ke System	C, E, F, G, H	1,996	5,117	13,429
Nam Pasak System	L	410	1,063	2,758
Sub Area I	I	310	556	996
Sub Area K	K	200	358	641
Sub Area M	M	532	1,806	6,133
Sub Area J	J	508	907	1,625
Sub Area D	D	330	712	1,539
Sub Area P	P	167	299	536
Sub Area A	A	15	25	46
Sub Area B	B	334	598	1,071

Table J.22 Financial and Economic Cost of Main Work in Hong Ke System
(as of October,1989 price)

	Financial cost				Ecconomic cost		
	F.C. (J.Yen 1,000)	F.C. (US$1,000)	L.C. (US$1,000)	Total (US$1000)	F.C. (US$1000)	L.C. (US$1000)	Total (US$1000)
1. Direct cost total	704,253	4,995	3,896	8,891	4,630	2,803	7,433
2. Land acquisition cost	0	0	122	122		84	84
3. Government administrarion		0	226	226	0	203	203
4. Enginering service	134,805	956	136	1,092	1,009	136	1,145
5. Contingency	70,425	499	390	889	463	280	743
Total	909,483	6,450	4,747	11,197	6,102	3,506	9,608

Note: O&M equipment cost is excluded in the financial cost

Table J.23 Financial and Economic Cost of Main Work in Nam Pasak System
(as of October,1989 price)

	Financial cost				Ecconomic cost		
	F.C. (J.Yen 1,000)	F.C. (US$1,000)	L.C. (US$1,000)	Total (US$1000)	F.C. (US$1000)	L.C. (US$1000)	Total (US$1000)
1. Direct cost total	313,903	2,226	2,440	4,666	1,918	1,668	3,586
2. Land acquisition cost	0	0	226	226		203	203
3. Government administrarion		0	109	109	0	98	98
4. Enginering service	61,617	437	84	521	255	39	294
5. Contingency	31,390	223	244	467	192	167	359
Total	406,910	2,886	3,103	5,989	2,365	2,175	4,540

Note: O&M equipment cost is excluded in the financial cost

Table J.24 Financial and Economic Cost of Main Work in Sub-area I (Hong Kai Keo System)
(as of October,1989 price)

	Financial cost				Ecconomic cost		
	F.C.		L.C.	Total	F.C.	L.C.	Total
	(J.Yen 1,000)	(US$1,000)	(US$1,000)	(US$1,000)	(US$1,000)	(US$1,000)	(US$1,000)
1. Direct cost total	138,575	982	1,039	2,021	933	857	1,790
2. Land acquisition cost	0	0	25	25		11	11
3. Government administrarion		0	47	47	0	50	50
4. Enginering service	27,715	197	38	235	187	34	221
5. Contingency	13,858	98	104	202	93	86	179
Total	180,148	1,277	1,253	2,530	1,213	1,038	2,251

Note: O&M equipment cost is excluded in the financial cost

Table J.25 Financial and Economic Cost of Main Work in Sub-area K
(as of October,1989 price)

	Financial cost				Ecconomic cost		
	F.C.		L.C.	Total	F.C.	L.C.	Total
	(J.Yen 1000)	(US$1000)	(US$1000)	(US$1000)	(US$1000)	(US$1000)	(US$1000)
1. Direct cost total	36,736	261	214	475	248	176	423
2. Land acquisition cost	0	0		0			0
3. Government administrarion		0	11	11	0	10	10
4. Enginering service	7,050	50	8	58	50	7	57
5. Contingency	3,674	26	22	48	25	18	42
Total	47,459	337	255	593	322	210	532

Note: O&M equipment cost is excluded in the financial cost

Table J.26 Economic Cost of Lateral Canal

Unit: US$10^3

	1992 - 2000	2000 - 2020
1. Hong Ke*1		
Target area (ha)	101	9
Annual financial cost	180	23
Annual economic cost	157	20
2. Nam Pasak		
Target area (ha)	29	0
Annual financial cost	111	0
Annual economic cost	97	0
3. Sub-area I		
Target area (ha)	7	81
Annual financial cost	27	127
Annual economic cost	24	111
4. Sun-area K		
Target area (ha)	33	74
Annual financial cost	90	115
Annual economic cost	78	110

*1 In 1991, the following cost is disbursed for construction of 3 km of the model lateral canal in Hong Ke area.

Financial cost US$1,174 x 10^3
Economic cost US$1,025 x 10^3

After 1993, the construction cost of remaining area are disbursed as shown in above table.

Table J.27 Economic Cost and Benefit Stream of Hong Ke System

Unit US$1,000 EIRR = 7.3%

		Construction Cost							
		Main Canal		Lateral Canal		Total	O & M cost	Benefit	Net Benefit
		FC	LC	FC	LC				
1	1991	496	28	0	0	724			-724
2	1992	2,781	20	591	434	5,526			-5,526
3	1993	2,825	1,558	90	66	4,587			-4,587
4	1994			90	66	156	112	97	-171
5	1995			90	66	156	114	121	-149
6	1996			90	66	156	116	148	-124
7	1997			90	66	156	118	180	-94
8	1998			90	66	156	120	216	-60
9	1999			90	66	156	121	258	-19
10	2000			11	8	19	122	306	165
11	2001			11	8	19	122	336	195
12	2002			11	8	19	122	369	228
13	2003			11	8	19	122	405	264
14	2004			11	8	19	122	445	304
15	2005			11	8	19	123	489	347
16	2006			11	8	19	123	537	395
17	2007			11	8	19	123	590	448
18	2008			11	8	19	123	648	506
19	2009			11	8	19	124	711	568
20	2010			11	8	19	124	781	638
21	2011			11	8	19	124	858	715
22	2012			11	8	19	124	943	800
23	2013			11	8	19	124	1,035	892
24	2014			11	8	19	125	1,137	993
25	2015			11	8	19	125	1,249	1,105
26	2016			11	8	19	125	1,372	1,228
27	2017			11	8	19	125	1,507	1,363
28	2018			11	8	19	126	1,655	1,510
29	2019			11	8	19	126	1,817	1,672
30	2020			0	0	0	126	1,996	1,870
31	2021			0	0	0	126	2,196	2,070
32	2022			0	0	0	126	2,415	2,289
33	2023			0	0	0	126	2,657	2,531
34	2024			0	0	0	126	2,922	2,796
35	2025			0	0	0	126	3,215	3,089
36	2026			0	0	0	126	3,536	3,410
37	2027			0	0	0	126	3,890	3,764
38	2028			0	0	0	126	4,279	4,153
39	2029			0	0	0	126	4,707	4,581
40	2030			0	0	0	126	5,177	5,051
41	2031			0	0	0	126	5,695	5,569
42	2032			0	0	0	126	6,265	6,139
43	2033			0	0	0	126	6,891	6,765
44	2034			0	0	0	126	7,580	7,454
45	2035			0	0	0	126	8,338	8,212
46	2036			0	0	0	126	9,172	9,046
47	2037			0	0	0	126	10,089	9,963
48	2038			0	0	0	126	11,098	10,972
49	2039			0	0	0	126	12,208	12,082
50	2040			0	0	0	126	13,429	13,303

Table J.28 Economic Cost and Benefit Stream of Nam Pasak System

Unit US$1,000 EIRR = 4.2%

	Construction Cost							
	Main Canal		Lateral Canal		Total	O&M Cost	Benefit	Net Benefit
	F.C.	L.C.	F.C.	L.C.				
1 1991	192	141	0	0	333			-333
2 1992	1,078	1,067	56	41	2,242			-2,242
3 1993	1,095	966	56	41	2,158			-2,158
4 1994			56	41	97	48	3	-142
5 1995			56	41	97	49	5	-141
6 1996			56	41	97	50	8	-139
7 1997			56	41	97	51	11	-137
8 1998			56	41	97	52	15	-134
9 1999			56	41	97	53	20	-130
10 2000			0	0	0	53	27	-26
11 2001			0	0	0	53	34	-19
12 2002			0	0	0	53	39	-14
13 2003			0	0	0	53	44	-9
14 2004			0	0	0	53	50	-3
15 2005			0	0	0	53	57	4
16 2006			0	0	0	53	65	12
17 2007			0	0	0	53	74	21
18 2008			0	0	0	53	85	32
19 2009			0	0	0	53	97	44
20 2010			0	0	0	53	110	57
21 2011			0	0	0	53	126	73
22 2012			0	0	0	53	143	90
23 2013			0	0	0	53	164	111
24 2014			0	0	0	53	186	133
25 2015			0	0	0	53	213	160
26 2016			0	0	0	53	242	189
27 2017			0	0	0	53	277	224
28 2018			0	0	0	53	315	262
29 2019			0	0	0	53	360	307
30 2020			0	0	0	53	410	357
31 2021			0	0	0	53	451	398
32 2022			0	0	0	53	496	443
33 2023			0	0	0	53	546	493
34 2024			0	0	0	53	601	548
35 2025			0	0	0	53	661	608
36 2026			0	0	0	53	727	674
37 2027			0	0	0	53	800	747
38 2028			0	0	0	53	880	827
39 2029			0	0	0	53	968	915
40 2030			0	0	0	53	1,065	1,012
41 2031			0	0	0	53	1,172	1,119
42 2032			0	0	0	53	1,289	1,236
43 2033			0	0	0	53	1,418	1,365
44 2034			0	0	0	53	1,560	1,507
45 2035			0	0	0	53	1,716	1,663
46 2036			0	0	0	53	1,888	1,835
47 2037			0	0	0	53	2,077	2,024
48 2038			0	0	0	53	2,285	2,232
49 2039			0	0	0	53	2,514	2,461
50 2040			0	0	0	53	2,765	2,712

Table J.29 Economic Cost and Benefit Stream of Sub-area I (Hong Kai Keo)

Unit US$1,000 EIRR = 3.5%

	Construction Cost							
	Main Canal		Lateral Canal		Total	O&M Cost	Benefit	Net Benefit
	F.C.	L.C.	F.C.	L.C.				
1 1991	99	67	0	0	166			-166
2 1992	1,114	971	14	10	2,109			-2,109
3 1993	0	0	14	10	24	24	3	-45
4 1994			14	10	24	24	6	-42
5 1995			14	10	24	24	9	-39
6 1996			14	10	24	24	14	-34
7 1997			14	10	24	25	19	-30
8 1998			14	10	24	25	26	-23
9 1999			14	10	24	25	33	-16
10 2000			64	47	111	26	42	-95
11 2001			64	47	111	28	46	-93
12 2002			64	47	111	29	51	-89
13 2003			64	47	111	30	57	-84
14 2004			64	47	111	32	63	-80
15 2005			64	47	111	33	69	-75
16 2006			64	47	111	34	77	-68
17 2007			64	47	111	35	85	-61
18 2008			64	47	111	37	94	-54
19 2009			64	47	111	38	103	-46
20 2010			64	47	111	39	114	-36
21 2011			64	47	111	40	126	-25
22 2012			64	47	111	42	140	-13
23 2013			64	47	111	43	154	0
24 2014			64	47	111	44	170	15
25 2015			64	47	111	45	188	32
26 2016			64	47	111	47	208	50
27 2017			64	47	111	48	230	71
28 2018			64	47	111	49	254	94
29 2019			64	47	111	51	281	119
30 2020			0	0	0	51	310	259
31 2021			0	0	0	51	329	278
32 2022			0	0	0	51	349	298
33 2023			0	0	0	51	370	319
34 2024			0	0	0	51	392	341
35 2025			0	0	0	51	415	364
36 2026			0	0	0	51	440	389
37 2027			0	0	0	51	467	416
38 2028			0	0	0	51	495	444
39 2029			0	0	0	51	524	473
40 2030			0	0	0	51	556	505
41 2031			0	0	0	51	589	538
42 2032			0	0	0	51	625	574
43 2033			0	0	0	51	662	611
44 2034			0	0	0	51	702	651
45 2035			0	0	0	51	744	693
46 2036			0	0	0	51	789	738
47 2037			0	0	0	51	836	785
48 2038			0	0	0	51	886	835
49 2039			0	0	0	51	939	888
50 2040			0	0	0	51	996	945

Table J.30 Economic Cost and Benefit Stream of Sub-area K

Unit US$1,000 EIRR = 3.5%

	Construction Cost							
	Main Canal		Lateral Canal		Total	O&M Cost	Benefit	Net Benefit
	F.C.	L.C.	F.C.	L.C.				
1 1991	26	14	0	0	40			-40
2 1992	296	196	45	33	570			-570
3 1993	0	0	45	33	78	7	1	-85
4 1994			45	33	78	8	2	-84
5 1995			45	33	78	9	3	-84
6 1996			45	33	78	10	5	-83
7 1997			45	33	78	11	7	-82
8 1998			45	33	78	12	10	-80
9 1999			45	33	78	12	13	-78
10 2000			58	43	100	14	13	-101
11 2001			58	43	100	15	15	-100
12 2002			58	43	100	16	17	-99
13 2003			58	43	100	17	20	-98
14 2004			58	43	100	18	23	-96
15 2005			58	43	100	19	26	-94
16 2006			58	43	100	21	30	-91
17 2007			58	43	100	22	34	-88
18 2008			58	43	100	23	39	-84
19 2009			58	43	100	24	45	-79
20 2010			58	43	100	25	52	-74
21 2011			58	43	100	26	59	-68
22 2012			58	43	100	27	68	-60
23 2013			58	43	100	29	77	-52
24 2014			58	43	100	30	89	-42
25 2015			58	43	100	31	102	-30
26 2016			58	43	100	32	116	-16
27 2017			58	43	100	33	133	0
28 2018			58	43	100	34	153	18
29 2019			58	43	100	36	175	39
30 2020			0	0	0	36	200	164
31 2021			0	0	0	36	212	176
32 2022			0	0	0	36	225	189
33 2023			0	0	0	36	238	203
34 2024			0	0	0	36	253	217
35 2025			0	0	0	36	268	232
36 2026			0	0	0	36	284	248
37 2027			0	0	0	36	301	265
38 2028			0	0	0	36	319	283
39 2029			0	0	0	36	338	302
40 2030			0	0	0	36	358	323
41 2031			0	0	0	36	380	344
42 2032			0	0	0	36	402	367
43 2033			0	0	0	36	427	391
44 2034			0	0	0	36	452	417
45 2035			0	0	0	36	479	444
46 2036			0	0	0	36	508	473
47 2037			0	0	0	36	539	503
48 2038			0	0	0	36	571	535
49 2039			0	0	0	36	605	570
50 2040			0	0	0	36	641	606

Table J.31 Economic Evaluation of the Basic Plan (1)

Unit: US$1,000

	Master Plan Total (IRR= 5.8%)				First Period (1991-2000) (IRR = 6.5%)				Second Period (2001-2010) (IRR = 5.0%)				Third Period (2011-2020) (IRR = 2.9%)			
	Cost	O & M cost	Benefit	Net Benefit	Cost	O & M cost	Benefit	Net Benefit	Cost	O & M cost	Benefit	Net Benefit	Cost	O & M cost	Benefit	Net Benefit
1991	724	0	0	-724	724	0	0	-724								
1992	4,780	0	0	-4,780	4,780	0	0	-4,780								
1993	4,662	0	0	-4,662	4,662	0	0	-4,662								
1994	279	106	46	-339	279	106	46	-339								
1995	279	109	75	-313	279	109	75	-313								
1996	681	112	110	-683	681	112	110	-683								
1997	3,599	116	155	-3,560	3,599	116	155	-3,560								
1998	3,022	133	209	-2,946	3,022	133	209	-2,946								
1999	961	196	288	-869	961	196	288	-869								
2000	703	203	374	-532	703	203	374	-532								
2001	864	205	379	-690	88	205	379	86	776	0	0	-776				
2002	4,118	205	419	-3,904	88	205	419	126	4,030	0	0	-4,030				
2003	6,263	207	462	-6,008	88	207	462	167	6,175	0	0	-6,175				
2004	516	325	531	-310	88	208	510	214	428	117	21	-524				
2005	516	330	601	-245	88	208	564	268	428	122	37	-513				
2006	1,229	337	679	-887	88	210	623	325	1,141	127	56	-1,212				
2007	5,144	342	768	-4,718	88	211	689	390	5,056	131	79	-5,108				
2008	5,010	348	868	-4,490	88	211	762	463	4,922	137	106	-4,953				
2009	666	455	1,012	-109	88	213	843	542	578	242	169	-651				
2010	666	461	1,159	32	88	213	932	631	578	248	227	-599				
2011	1,048	471	1,327	-192	88	215	1,032	729	578	256	295	-539	382	0	0	-382
2012	3,154	477	1,517	-2,114	88	216	1,142	838	578	261	375	-464	2488	0	0	-2,488
2013	3,120	489	1,743	-1,866	88	216	1,265	961	578	269	468	-379	2454	4	10	-2,448
2014	850	548	1,999	601	88	218	1,401	1,095	578	274	575	-277	184	56	23	-217
2015	850	558	2,291	883	88	219	1,553	1,246	578	281	700	-159	184	58	38	-204
2016	1,193	568	2,621	860	88	219	1,721	1,414	578	288	845	-21	527	61	55	-533
2017	3,818	579	2,997	-1,400	89	221	1,909	1,599	578	295	1,011	138	3151	63	77	-3,137
2018	3,782	590	3,430	-942	89	222	2,116	1,805	578	303	1,212	331	3115	65	102	-3,078
2019	1,739	677	4,141	1,725	89	224	2,351	2,038	578	310	1,443	555	1072	143	347	-868
2020	0	677	4,802	4,125	0	224	2,606	2,382	0	310	1,680	1,370	0	143	516	373
2021	0	677	5,230	4,553	0	224	2,859	2,635	0	310	1,824	1,514	0	143	547	404
2022	0	677	5,698	5,021	0	224	3,136	2,912	0	310	1,982	1,672	0	143	580	437
2023	0	677	6,214	5,537	0	224	3,442	3,218	0	310	2,157	1,847	0	143	615	472
2024	0	677	6,775	6,098	0	224	3,776	3,552	0	310	2,347	2,037	0	143	652	509
2025	0	677	7,391	6,714	0	224	4,144	3,920	0	310	2,557	2,247	0	143	690	547
2026	0	677	8,068	7,391	0	224	4,547	4,323	0	310	2,789	2,479	0	143	732	589
2027	0	677	8,811	8,134	0	224	4,991	4,767	0	310	3,045	2,735	0	143	775	632
2028	0	677	9,626	8,949	0	224	5,478	5,254	0	310	3,327	3,017	0	143	821	678
2029	0	677	10,520	9,843	0	224	6,013	5,789	0	310	3,637	3,327	0	143	870	727
2030	0	677	11,503	10,826	0	224	6,600	6,376	0	310	3,981	3,671	0	143	922	779
2031	0	677	12,584	11,907	0	224	7,246	7,022	0	310	4,360	4,050	0	143	978	835
2032	0	677	13,774	13,097	0	224	7,956	7,732	0	310	4,781	4,471	0	143	1037	894
2033	0	677	15,079	14,402	0	224	8,735	8,511	0	310	5,245	4,935	0	143	1099	956
2034	0	677	16,519	15,842	0	224	9,592	9,368	0	310	5,761	5,451	0	143	1166	1,023
2035	0	677	18,101	17,424	0	224	10,533	10,309	0	310	6,333	6,023	0	143	1235	1,092
2036	0	677	19,845	19,168	0	224	11,568	11,344	0	310	6,968	6,658	0	143	1309	1,166
2037	0	677	21,763	21,086	0	224	12,704	12,480	0	310	7,671	7,361	0	143	1388	1,245
2038	0	677	23,878	23,201	0	224	13,953	13,729	0	310	8,454	8,144	0	143	1471	1,328
2039	0	677	26,208	25,531	0	224	15,326	15,102	0	310	9,324	9,014	0	143	1558	1,415
2040	-12,092	677	28,780	40,195	-847	224	16,834	17,457	-6,192	310	10,293	16,175	-5053	143	1653	6,563

Table J.31 Economic Evaluation of the Basic Plan (2)

Unit: US$1,000

IRR = 6.3%

	Priority Project															
	Hongke system			Nam-pasak			Area I			Area K			Priority Project Total			
	Cost	O & M cost	Benefit	Cost	O & M cost	Benefit	Cost	O & M cost	Benefit	Cost	O & M cost	Benefit	Cost	O & M cost	Benefit	Net Benefit
1991	724												724	0	0	-724
1992	4,780												4,780	0	0	-4,780
1993	4,662												4,662	0	0	-4,662
1994	279	106	46										279	106	46	-339
1995	279	109	75										279	109	75	-313
1996	308	112	110	333						40			681	112	110	-683
1997	308	116	155	2,403						888			3,599	116	155	-3,560
1998	308	119	207	2,319						395	14	2	3,022	133	209	-2,946
1999	308	123	267	258	54	18				395	19	3	961	196	288	-869
2000	308	126	338	0	54	30				395	23	6	703	203	374	-532
2001	33	127	336	0	54	34	166			55	24	9	254	205	379	-80
2002	33	127	369	0	54	39	0			55	24	11	88	205	419	126
2003	33	128	405	0	54	44	2,227			55	25	13	2,315	207	462	-2,060
2004	33	128	445	0	54	50	142	26	4	55	26	15	230	234	514	50
2005	33	128	489	0	54	57	142	28	8	55	26	18	230	236	572	106
2006	33	129	537	0	54	65	142	29	14	55	27	21	230	239	637	168
2007	33	129	590	0	54	74	142	31	20	55	28	25	230	242	709	237
2008	33	129	648	0	54	85	142	33	28	55	28	29	230	244	790	316
2009	33	130	711	0	54	97	142	34	36	55	29	35	230	247	879	402
2010	33	130	781	0	54	110	142	36	47	55	29	41	230	249	979	500
2011	33	131	858	0	54	126	142	38	59	55	30	48	230	253	1,091	608
2012	33	131	943	0	54	143	142	39	74	55	31	56	230	255	1,216	731
2013	33	131	1,035	0	54	164	142	41	91	55	31	66	230	257	1,356	869
2014	33	132	1,137	0	54	186	142	42	110	55	32	78	230	260	1,511	1,021
2015	33	132	1,249	0	54	213	142	44	133	55	33	91	230	263	1,686	1,193
2016	33	132	1,372	0	54	242	142	46	159	55	33	107	230	265	1,880	1,385
2017	33	133	1,507	0	54	277	142	47	189	56	34	125	231	268	2,098	1,599
2018	33	133	1,655	0	54	315	142	49	224	56	35	146	231	271	2,340	1,838
2019	33	134	1,817	0	54	360	142	51	264	56	36	174	231	275	2,615	2,109
2020	0	134	1,996	0	54	410	0	51	310	0	36	200	0	275	2,916	2,641
2021	0	134	2,196	0	54	451	0	51	329	0	36	212	0	275	3,188	2,913
2022	0	134	2,415	0	54	496	0	51	349	0	36	225	0	275	3,485	3,210
2023	0	134	2,657	0	54	546	0	51	370	0	36	239	0	275	3,812	3,537
2024	0	134	2,922	0	54	601	0	51	392	0	36	253	0	275	4,168	3,893
2025	0	134	3,215	0	54	661	0	51	415	0	36	268	0	275	4,559	4,284
2026	0	134	3,536	0	54	727	0	51	440	0	36	284	0	275	4,987	4,712
2027	0	134	3,890	0	54	800	0	51	467	0	36	301	0	275	5,458	5,183
2028	0	134	4,279	0	54	880	0	51	495	0	36	319	0	275	5,973	5,698
2029	0	134	4,707	0	54	968	0	51	524	0	36	338	0	275	6,537	6,262
2030	0	134	5,177	0	54	1,065	0	51	556	0	36	358	0	275	7,156	6,881
2031	0	134	5,695	0	54	1,172	0	51	589	0	36	379	0	275	7,835	7,560
2032	0	134	6,265	0	54	1,289	0	51	625	0	36	402	0	275	8,581	8,306
2033	0	134	6,891	0	54	1,418	0	51	662	0	36	426	0	275	9,397	9,122
2034	0	134	7,580	0	54	1,560	0	51	702	0	36	452	0	275	10,294	10,019
2035	0	134	8,338	0	54	1,716	0	51	744	0	36	479	0	275	11,277	11,002
2036	0	134	9,172	0	54	1,888	0	51	789	0	36	508	0	275	12,357	12,082
2037	0	134	10,089	0	54	2,077	0	51	836	0	36	538	0	275	13,540	13,265
2038	0	134	11,098	0	54	2,285	0	51	886	0	36	570	0	275	14,839	14,564
2039	0	134	12,208	0	54	2,514	0	51	939	0	36	604	0	275	16,265	15,990
2040	0	134	13,429	-531	54	2,765	-933	51	996	-316	36	640	-1,780	275	17,830	19,335

Table J.31 Economic Evaluation of the Basic Plan (3)

Unit: US$1,000

IRR = 4.6%

	Hong Kong System											
	Area J			Area M			Area O			Hong Kong System Total		
	Cost	O & M cost	Benefit	Cost	O & M cost	Benefit	Cost	O & M cost	Benefit	Cost	O & M cost	Benefit	Net Benefit
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998													
1999													
2000													
2001	346									346	0	0	-346
2002	2,221									2,221	0	0	-2,221
2003	2,196									2,196	0	0	-2,196
2004	149	50	9							149	50	9	-190
2005	149	52	15							149	52	15	-186
2006	149	54	22	713						862	54	22	-894
2007	149	55	31	4,628						4,777	55	31	-4,801
2008	149	57	42	4,494						4,643	57	42	-4,658
2009	149	59	55	150	100	31				299	159	86	-372
2010	149	60	71	150	102	51				299	162	122	-339
2011	149	62	90	150	104	74	382		0	681	166	164	-683
2012	149	64	112	150	105	101	2,304		0	2,603	169	213	-2,559
2013	149	66	138	150	107	133	2,270		0	2,569	173	271	-2,471
2014	149	67	169	150	109	169	0	50	0	299	226	338	-187
2015	149	69	206	150	110	211	0	50	0	299	229	417	-111
2016	149	71	249	150	112	259	0	50	0	299	233	508	-24
2017	149	73	303	150	114	314	0	50	0	299	237	617	81
2018	149	75	366	150	116	378	0	50	0	299	241	744	204
2019	149	77	440	150	117	450	0	50	0	299	244	890	347
2020	0	77	508	0	117	532	0	50	0	0	244	1,040	796
2021	0	77	538	0	117	601	0	50	0	0	244	1,139	895
2022	0	77	570	0	117	679	0	50	0	0	244	1,249	1,005
2023	0	77	604	0	117	768	0	50	0	0	244	1,372	1,128
2024	0	77	640	0	117	867	0	50	0	0	244	1,507	1,263
2025	0	77	678	0	117	980	0	50	0	0	244	1,658	1,414
2026	0	77	719	0	117	1,107	0	50	0	0	244	1,826	1,582
2027	0	77	762	0	117	1,251	0	50	0	0	244	2,013	1,769
2028	0	77	808	0	117	1,414	0	50	0	0	244	2,222	1,978
2029	0	77	856	0	117	1,598	0	50	0	0	244	2,454	2,210
2030	0	77	907	0	117	1,806	0	50	0	0	244	2,713	2,469
2031	0	77	961	0	117	2,041	0	50	0	0	244	3,002	2,758
2032	0	77	1,019	0	117	2,306	0	50	0	0	244	3,325	3,081
2033	0	77	1,080	0	117	2,606	0	50	0	0	244	3,686	3,442
2034	0	77	1,145	0	117	2,945	0	50	0	0	244	4,090	3,846
2035	0	77	1,214	0	117	3,328	0	50	0	0	244	4,542	4,298
2036	0	77	1,287	0	117	3,761	0	50	0	0	244	5,048	4,804
2037	0	77	1,364	0	117	4,250	0	50	0	0	244	5,614	5,370
2038	0	77	1,446	0	117	4,803	0	50	0	0	244	6,249	6,005
2039	0	77	1,533	0	117	5,427	0	50	0	0	244	6,960	6,716
2040	-1,429	77	1,625	-3,446	117	6,133	-1,982	50	0	-6,857	244	7,758	14,371

Table J.31 Economic Evaluation of the Basic Plan (4)

Unit: US$1,000

	Area D				Area P				Nong-hay and Soung mong Area											
	IRR = 3.9%				IRR= 11.6%				Area A				Area B				Nong-hai and Soung mong Area Total			IRR= 5.1%
	Cost	O & M cost	Benefit	Net Benefit	Cost	O & M cost	Benefit	Net Benefit	Cost	O & M cost	Benefit		Cost	O & M cost	Benefit		Cost	O & M cost	Benefit	Net Benefit
1991																				
1992																				
1993																				
1994																				
1995																				
1996																				
1997																				
1998																				
1999																				
2000																				
2001	264			-264																
2002	1,809			-1,809																
2003	1,752			-1,752																
2004	137	41	8	-170																
2005	137	42	14	-165																
2006	137	44	20	-161																
2007	137	45	28	-154																
2008	137	47	36	-148																
2009	137	49	47	-139																
2010	137	50	58	-129																
2011	137	52	72	-117	0			0												
2012	137	53	88	-102	184			-184												
2013	137	55	106	-86	184	4	10	-178												
2014	137	56	127	-66	184	6	23	-167												
2015	137	58	150	-45	184	8	38	-154												
2016	137	59	178	-18	184	11	55	-140	166				177				343	0	0	-343
2017	137	61	205	7	184	13	77	-120	1,004				1,963				2,967	0	0	-2,967
2018	137	63	244	44	184	15	102	-97	986				1,945				2,931	0	0	-2,931
2019	137	65	289	87	184	17	132	-69	0	22	14		888	54	201		888	76	215	-749
2020	0	65	330	265	0	17	167	150	0	22	15		0	54	334		0	76	349	273
2021	0	65	356	291	0	17	177	160	0	22	16		0	54	354		0	76	370	294
2022	0	65	384	319	0	17	188	171	0	22	17		0	54	375		0	76	392	316
2023	0	65	415	350	0	17	199	182	0	22	18		0	54	398		0	76	416	340
2024	0	65	448	383	0	17	211	194	0	22	19		0	54	422		0	76	441	365
2025	0	65	484	419	0	17	223	206	0	22	20		0	54	447		0	76	467	391
2026	0	65	523	458	0	17	237	220	0	22	21		0	54	474		0	76	495	419
2027	0	65	565	500	0	17	251	234	0	22	22		0	54	502		0	76	524	448
2028	0	65	610	545	0	17	266	249	0	22	23		0	54	532		0	76	555	479
2029	0	65	659	594	0	17	282	265	0	22	24		0	54	564		0	76	588	512
2030	0	65	712	647	0	17	299	282	0	22	25		0	54	598		0	76	623	547
2031	0	65	769	704	0	17	317	300	0	22	27		0	54	634		0	76	661	585
2032	0	65	831	766	0	17	336	319	0	22	29		0	54	672		0	76	701	625
2033	0	65	897	832	0	17	356	339	0	22	31		0	54	712		0	76	743	667
2034	0	65	969	904	0	17	378	361	0	22	33		0	54	755		0	76	788	712
2035	0	65	1,047	982	0	17	400	383	0	22	35		0	54	800		0	76	835	759
2036	0	65	1,131	1,066	0	17	424	407	0	22	37		0	54	848		0	76	885	809
2037	0	65	1,221	1,156	0	17	450	433	0	22	39		0	54	899		0	76	938	862
2038	0	65	1,319	1,254	0	17	477	460	0	22	41		0	54	953		0	76	994	918
2039	0	65	1,425	1,360	0	17	505	488	0	22	43		0	54	1,010		0	76	1,053	977
2040	-384	65	1,539	1,858	-589	17	536	8	5	22	46		-2,487	54	1,071		-2,482	76	1,117	3,523

FIGURES

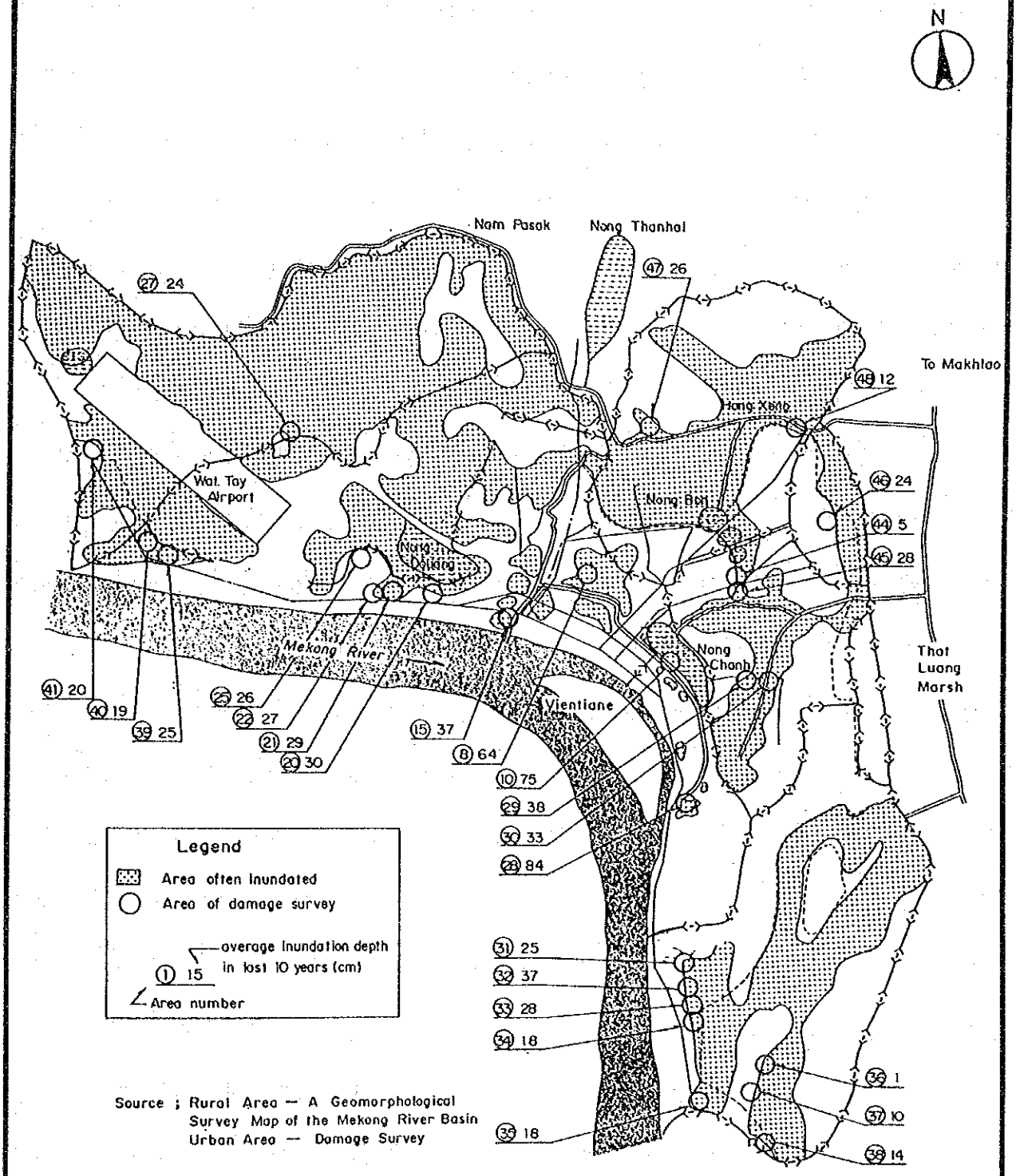

Fig. J.1 Selected Area of Inundation Damage Survey

LAO PEOPLE'S DEMOCRATIC REPUBLIC FEASIBILITY STUDY ON IMPROVEMENT OF DRAINAGE SYSTEM IN VIENTIANE
JAPAN INTERNATIONAL COOPERATION AGENCY

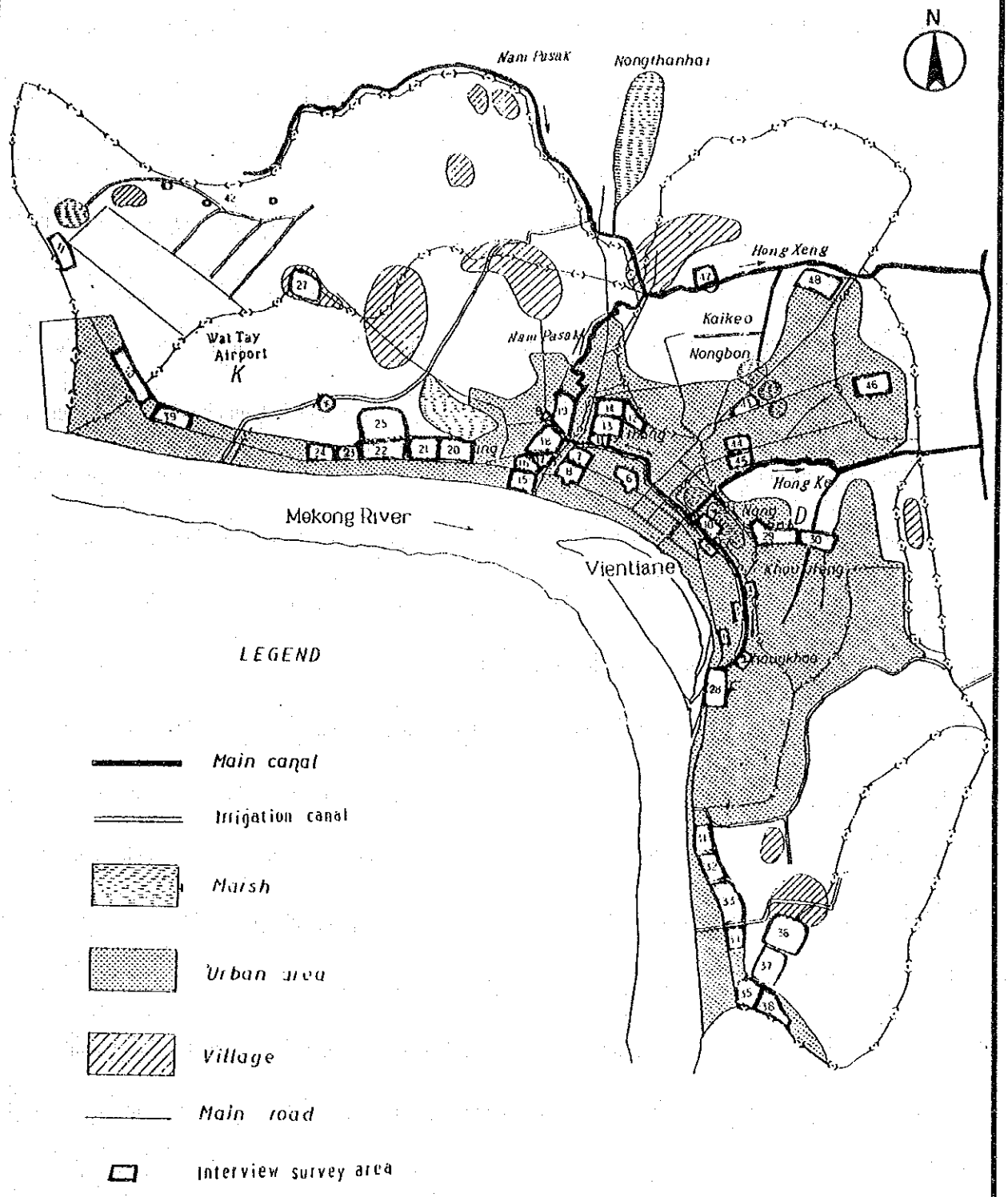

Fig. J.2 Estimated Inundation Area for 10-year Storm

LAO PEOPLE'S DEMOCRATIC REPUBLIC FEASIBILITY STUDY ON IMPROVEMENT OF DRAINAGE SYSTEM IN VIENTIANE
JAPAN INTERNATIONAL COOPERATION AGENCY

APPENDIX K

INSTITUTION AND ORGANIZATION

APPENDIX K. INSTITUTION AND ORGANIZATION

Table of Contents

List of Tables

List of Figures

K.1 Introduction

The reinforcement of the institution and organization related to construction, operation and maintenance work of the drainage system is important to ensure the success of the proposed projects. In this study, the analysis on the institution and organization related to the drainage system are conducted according to the following procedures.

- Examinations of the present situations
- Identification of the existing constraints
- Recommendation on the reinforcements

The data and informations about the institution and organization were obtained from the interview survey with the concerned personnels of the related organizations. The obtained data were compiled and analyzed under four categories classified as follows:

- Organization
- Personnel ,equipment and budget
- Institution and regulation
- Monitoring and data management

K.2 Present Conditions

In this section, the present condition of the institution and organization of the responsible agency for the drainage work in the Study area is examined according to above 4 aspects, that is, organization, personnel, equipment and budget, institution and regulation and monitoring and data management.

K.2.1 Existing Related Organization

The existing related organizations of the drainage work in the Study area are identified through the interview with the concerned organizations. The results are presented in the following sections and the competent organizations according to work items are shown in Table K.1.

K.2.1.1 Drainage Work

The responsible organization for the drainage work in the Study area is the Department of Communication, Transportation and Construction of the Municipality of Vientiane. The Municipality of Vientiane is composed of 18 departments and 8 districts as of 1989 and the Department of Communication, Transportation and Construction is responsible for mainly the construction, maintenance, operation and management of the road, bridge, transportation system, drainage, waste disposal and sanitation in the Vientiane Municipality area. The organizational chart of the Municipality of Vientiane is shown in Fig. K.1.

The Department of Communication, Transportation and Construction of the Municipality of Vientiane is engaged in planning, study, construction, operation, maintenance and repair of the drainage facilities including drainage canal and gate. The Department of Communication, Transportation and Construction of the Municipality of Vientiane is composed of 7 bureaus, 12 state enterprises/companies, 2 workshops, 2 factories and 1 technical school as shown in Fig. K.2. The sections of the Department of Communication, Transportation and Construction, that is, Bureau of Bridge and Road, State Enterprise of Survey and Design and State Enterprise of Bridge and Road carry out the drainage works. The present demarcation of the main work items of each section is summarized as follows:

(1) Bureau of Bridge and Road

- Drainage canal : Planning and finance
- Drainage gate : Planning, survey and finance

(2) State Enterprise of Survey and Design

- Drainage canal : Survey, construction, operation and maintenance
- Drainage gate : Construction, operation and maintenance

(3) State Enterprise of Bridge and Road

- Drainage canal: Construction
- Drainage gate: Construction

The district offices in the Study area, that is, Shikhottabong, Chanthabouly, Xaissettha and Sisattanak are the related organizations of the drainage work. The Department of Communication, Transportation and Construction of the 4 districts concern with the maintenance of the drainage system in the district area by cooperating with the Municipality of Vientiane. The district office monitors the drainage conditions in the district area and informs the situations and problems to Municipality of Vientiane.

K.2.1.2 Related Work

The organizations to be responsible for the related works of the drainage system are also studied and the results are summarized as follows:

(1) Road and Bridge

- Bureau of Bridge and Road, Municipality of Vientiane
- State Enterprise of Survey and Design, Municipality of Vientiane
- State Enterprise of Bridge and Road, Municipality of Vientiane
- State Enterprise of Rural Road and Bridge,Municipality of Vientiane

(2) Dike of Mekong River

- Ministry of Agricultural Service

(3) Irrigation facilities (canal, pump, gate)

- Department of Agriculture, Forest, Irrigation and Agricultural Cooperative, Municipality of Vientiane
- Ministry of Agricultural Service

(4) Data management of rainfall gage

- Ministry of Agricultural Service

(5) Waste disposal

- Bureau of Environment Protection
- Sanitation State Company

(6) Sanitation

- Sanitation State Company

K.2.2 Personnel, Equipment and Budget

The number of stuff of the Department of Communication, Transportation and Construction of Municipality of Vientiane is presented in Table K.2. The number of the stuff of the Bureau of Bridge and Road is 3 persons and that of the State Enterprise of Survey and Design is 75 persons.

The major equipments to be used for the drainage work at present are the excavation equipment and truck and the list of the available equipment owned by the Department of Communication, Transportation and Construction, the Municipality of Vientiane is shown in Table K.3.

The budget of the Department of Communication, Transportation and Construction of the Municipality of Vientiane was amounted to be 200 million kips in year of 1989 and 210 million kips in year of 1990. In 1989, 98.4 million kips was disbursed for the improvement of drainage system including following work items:

(1) 8 million kips for repair of drainage canals including to change the corrugate pipes, to repair the defects of lateral canals and change the cover of lateral canal

(2) 10 million kips for the newly construction of lateral canal, box culvert and walk way

(3) 5 million kips for the maintenance of drainage canal including the remove of garbage and dredging of deposits in Hong Tong (about 800 m from Hong Si Noi Road to Morning Market)

(4) 73 million kip for special project for the construction of lateral canal from Wat Tay Airport to Nam Pasak along Luang Prabang Road

The budget for the construction of lateral canal from Wat Tay Airport to Nam Pasak along the Luang Prabang Road was the development budget and

remaining budget was the current budget. The current budget for the drainage project has been amounted to be 25 million kip to 30 million per year in the past. Table K.4 shows the annual budget of the Department of Communication, Transportation and Construction during year of 1978 to 1990 and the breakdown of the budget in 1989 is shown in Table K.5.

K.2.3 Institution and Regulation

The regulations related to the drainage work have been prepared to maintain the drainage canal. There is the regulation to prohibit the dumping of the waste and garbage into the drainage canals, however it is not so effective because of the poor waste disposal system in the Study area. The regulation to prohibit the construction of the houses and other structures on the inspection yard or slope of the drainage canal had not been effective. As for the water quality control there is no regulation to control the water quality of the waste water of the residentials as well as the factories.

According to the Department of Communication, Transportation and Construction, Municipality of Vientiane about 30% of total lateral canal in the Study area was cleaned in their ditches by volunteers of the inhabitants per one year. However, these utilization of the volunteers in the maintenance work of the drainage canal is insufficient due to luck of the propagation.

K.2.4 Monitoring and Data Management

The detail historical data on hydrology, meteorology, topography, flood, inundation and socio-economy in the Study area have not been collected and compiled by the Department of Communication, Transportation and Construction, Municipality of Vientiane. Part of the data are available by collecting from various organizations. For example, the records of the rainfall gage at the main canals to be the basic data for the monitoring the condition of the canals are collected by the Ministry of Agriculture and Forest while there is no systematic access to that data in the Department of Communication, Transportation and Construction, Municipality of Vientiane. The data collection covering all over the drainage system both inside and outside of the Study area are not conducted.

K.3 Identification of the Existing Constraints

The present conditions of the institution and organization for the drainage work are discussed in the above section and the existing institutional and organizational constraints of the drainage work are examined. According to the existing conditions, the following constraints are identified.

K.3.1 Luck of Budget, Stuff and Equipment

The luck of budget is identified as the major constraint to carry out smooth implementation of the drainage work on the basis of the proposed plan. The luck of the stuff to be engaged in the drainage work in quantity as well as in quality are also the serious problems. Besides, the equipments available for the drainage work are not enough for implementation of the proposed improvement work.

K.3.2 Luck of the Inter-organizational Coordination

There are various organization related to the drainage work. However, the communication between these organization is not enough so that some troubles due to the luck of communication occur. The gate at the outlet of Hong Ke canal to That Luang Marsh is usually operated by the farmers under the control of the Department of Agriculture, Forest, Irrigation and Agricultural Cooperative, Municipality of Vientiane. However, there are some inadequate operations for the drainage side, because the farmer is apt to close the gate to keep high water level at the outlet of Hong Ke for their fishing in the rainy season. This problem is caused by the luck of the coordination between the Department of Agriculture, Forest, Irrigation and Agricultural Cooperative and the Department of Communication, Transportation and Construction.

K3.3 Luck of Waste Disposal and Sanitary Improvement Work

The waste disposal and sanitary improvement work in the Study area are important aspects for the smooth implementation of the drainage improvement work. The dumping of waste to drainage canal is serious problem from the point of view of environment as well as the operation and

maintenance of the canal. The removal of the waste in the drainage canal has required the huge budget in every year while the dumped waste have effected negatively on the water quality and amenity. The main cause of these illegal dumping of the waste is the poor waste disposal system in the Vientiane.

At present the sanitation system in the Study area depends on the traditional sanitary facilities and there are no regulation of water quality of waste water from the factories. So the disposal water from the residential houses as well as the factories are not treated at present and the negative impacts on the water quality are identified.

K.3.4 Insufficient Utilization of Non-structural Measure

The non-structural measures to implement the drainage work are not utilized sufficiently at present. The arrangement of institution and regulation related to the drainage work is not sufficient and the existing regulations are not effective. The enlightenment of the inhabitants to inform the importance of the drainage work in order to improve their environmental conditions is not carried out. The luck of the propagation of the drainage work causes the insufficient utilization of the volunteers in the maintenance work of the drainage canal.

K3.5 Poor Data Management System

The poor data management system causes to the poor maintenance work by providing inadequate informations. The required data for the preparation of the survey and design of the drainage system are not available due to the luck of the basic data, such as, hydrologic, meteorologic, topographic and other engineering data. Besides, the socio-economic data, such as , land use, population, production and property to be required for preparation of long-term planning are not available.

K.4 Recommendation

The following reinforcements of institution and organization are recommended on the basis of above analysis.

(1) Reinforcement of the Responsible Organization

The required budget, stuff and equipment according to the proposed long-term basic plan should be prepared for the reinforcement of the Department of Communication, Transportation and Construction, Municipality of Vientiane. The required stuff for the operation and maintenance of the basic plan is shown in Table K.6 and required budget and equipment for the overall implementation of the Basic Plan are discussed in Appendix H.

(2) Establishment of the Inter-organization Coordination

The inter-organization coordination among the related organizations for the drainage work should be established to clarify the demarcation of the responsibility of each organization in overall drainage work and to strengthen the relation among the organizations.

(3) Improvement of the Waste Disposal and Sanitation System

The improvement of the waste disposal and sanitation system should be carried out accompanied with the drainage improvement work in order to ensure of sufficient effects of the proposed drainage work.

(4) Utilization of Non-structural Measure

The non-structural measures to implement the drainage work should be utilized including of the arrangement of institution and regulation related to the drainage work, the enlightenment of the inhabitants to inform the importance of the drainage work and the attendance of inhabitants as the volunteers in the maintenance work of the drainage canal.

(5) Establishment of Data Management System and Monitoring System

The data management system and monitoring system on various aspects including water quality, other environment conditions, hydrology, meteorology, topography, socio-economy to be required for the planning, study, implementation, operation and maintenance of the drainage system.

TABLES

Table K.1 Competent Organization for the Drainage Work

Work Item	Competent Authority	Department of Communication, Transportation and Construction of MOV						Department of Agriculture, Forest, Irrigation and Agricultural Cooperative, MOV	District office of the districts in MOV	Ministry of Agricultural Service
		Bureau of Bridge & Road	State Enterprise of Survey & Design	State Enterprise of Bridge & Road	State Enterprise of Rural Road & Bridge	Bureau of Environment Protection	Sanitation State Company			
1. Drainage										
1-1 Canal		P, F	S, C, O&M, T	C						
1-2 Gate		P, F, S	C, O&M	C						
1-3 Data Management (Rainfall gage)										P, F, S, C O&M, T
2. Road and Bridge		P, F	S	C, O&M, T	C, O&M, T					
3. Dike (Mekong)										P, F, S, C
4. Irrigation										O&M, T
4-1 Canal/Pump								P, F, S, C O&M, T		F, S, C, T
4-2 Gate								P, F, S, C, T	O&M	P, F, S, C, T
4-3 Irrigation drainage								P, F, S, C O&M, T		
5. Waste Disposal						P, F	S, O&M, T		F	
6. Sanitation							O&M			

Note: P. Planning, S. Study, C. Construction, O&M. Operation and Maintenance, T. Stuff training, F. Finance
Source: Department of Communication, Transportation and Construction of MOV

Table K.2 Number of Stuff by Bureau and State Company

	List of Bureau and State Company	Stuff	Remarks
1	Bureau of Planning, Statistic and Finance	7	
2	Bureau of Administration and Establishment	13	
3	Bureau of Bridge and Road	3	
4	Bureau of Housing and Urban	5	
5	Bureau of Transportation	4	
6	Bureau of Environmental Protection	8	
7	Bureau of Cetion Equipment	24	
8	Technical School	15	51 students
9	State Enterprise of Bridge and Road	n.a.	
10	State Enterprise of Rural Road and Bridge	n.a.	
11	State Enterprise of Design and Survey	71	
12	State Company of Transport	n.a.	
13	State Bus Company	91	
14	Lao Shipper Company	n.a.	
15	State Enterprise of Vientiane Construction	117	
16	Decoration and Construction State Company	n.a.	
17	International Construction State Company	n.a.	
18	State Enterprise of Design Municipality Housing	n.a.	
19	Sanitation State Company	56	
20	Workshop of Light Equipment	n.a.	
21	Workshop of Heavy Equipment	n.a.	
22	Factory of Brick and Tile	125	
23	Factory of Mable	n.a.	
24	Draw and Decoration State Company	9	

Source : Department of Communication, Transportation and Construction
Municipality of Vientiane

n.a. : not available

Table K.3 List of Equipment for Drainage Work

	Designation	Number	Manufacturer	H.P.	1st Service Year	Wear %
	Heavy Equipment					
1	Bulldozer	1	SSSR	160	1986	30
2	Motor Crader	1	SSSR		1986	35
3	Whell Loader	1	SSSR, Maz		1987	10
4	Whell Loader	1	Kawasaki	80	1982	55
5	Hydrolic Excavator	1	SSSR		1987	10
6	Makadam Roller	1	Sakai	75	1982	55
	Transport Vehicles					
7	Dump Truck	2	Zil, SSSR	90	1986	45
8	Dump Truck	3	Zil, SSSR	90	1985	50
9	Dump Truck	1	Zil, SSSR	90	1985	55
10	Dump Truck	2	Maz, SSSR	125	1987	10
11	Water Tanker	1	Zil, SSSR		1985	45
12	Cargo Truck	2	KAZ 52		1980	55
13	Maintenance Truck	1	-		1982	50
14	Pick Up	1	Toyata		1987	10
	Miscellaneous					
15	Truck Crane	1	Maz, SSSR	15	1987	10

Source : Department of Communication, Transportation and Construction Municipality of Vientiane

Table K.4 Annual Budget, 1978 - 1990

Unit : Kip

Year	Budget Execution
1978	2,100,000
1979	1,600,000
1980	5,000,000
1981	4,000,000
1982	13,000,000
1983	24,000,000
1984	35,500,000
1985	70,000,000
1986	110,000,000
1987	140,000,000
1988	160,000,000
1989	200,000,000
1990	210,000,000

Source: Department of Communication, Transportation and Construction, Municipality of Vientiane

Table K.5 Distribution of Budget in 1989

	Description of Projects	Budget (kip)
1	Construction of canal along Louang Prabang Road	73,000,000
2	Bitumen Access Roads	28,000,000
3	Expenditure for debt of the year of 1988	32,000,000
4	Bitumen Roads shouldersonly left side (That Khao - Chinaimo)	4,000,000
5	Excavation Route Khokhe - Phaya Lat	5,000,000
	Kaolieo - Nam tone	1,000,000
6	Reconstruction and repair road bitumed	
	Ho Kham -km 6	2,000,000
	Roads in municipality	2,000,000
7	Repair access road into Nam Kieng - Naxab	3,000,000
8	Bank protection, 100m	4,000,000
9	Improvement of the drainage system	25,400,000
10	Hydrographic and hydrologic survey	5,600,000
11	Continue work shop's construction of heavy equipments	5,000,000
12	Construction of mable factory	10,000,000
	Total amount of budget in 1989	200,000,000

Source : Department of Communication, Transportation and Construction
Municipality of Vientiane

Table K.6 Requird Staff and Labour of Operation and Maintenance

(Yearly basis)

Description	Unit	Q'ty
Director	M/M	12
Chief	M/M	30
Engineer/Officer	M/M	70
Technician	M/M	30
Administrative Staff	M/M	60
Driver (Office)	M/M	40
Foreman	M/day	310
Mechanic	M/day	310
Carpenter	M/day	310
Operator	M/day	270
Driver	M/day	270
Rigger	M/day	310
Skilled Labor	M/day	520
Common Labor	M/day	1,650

FIGURES

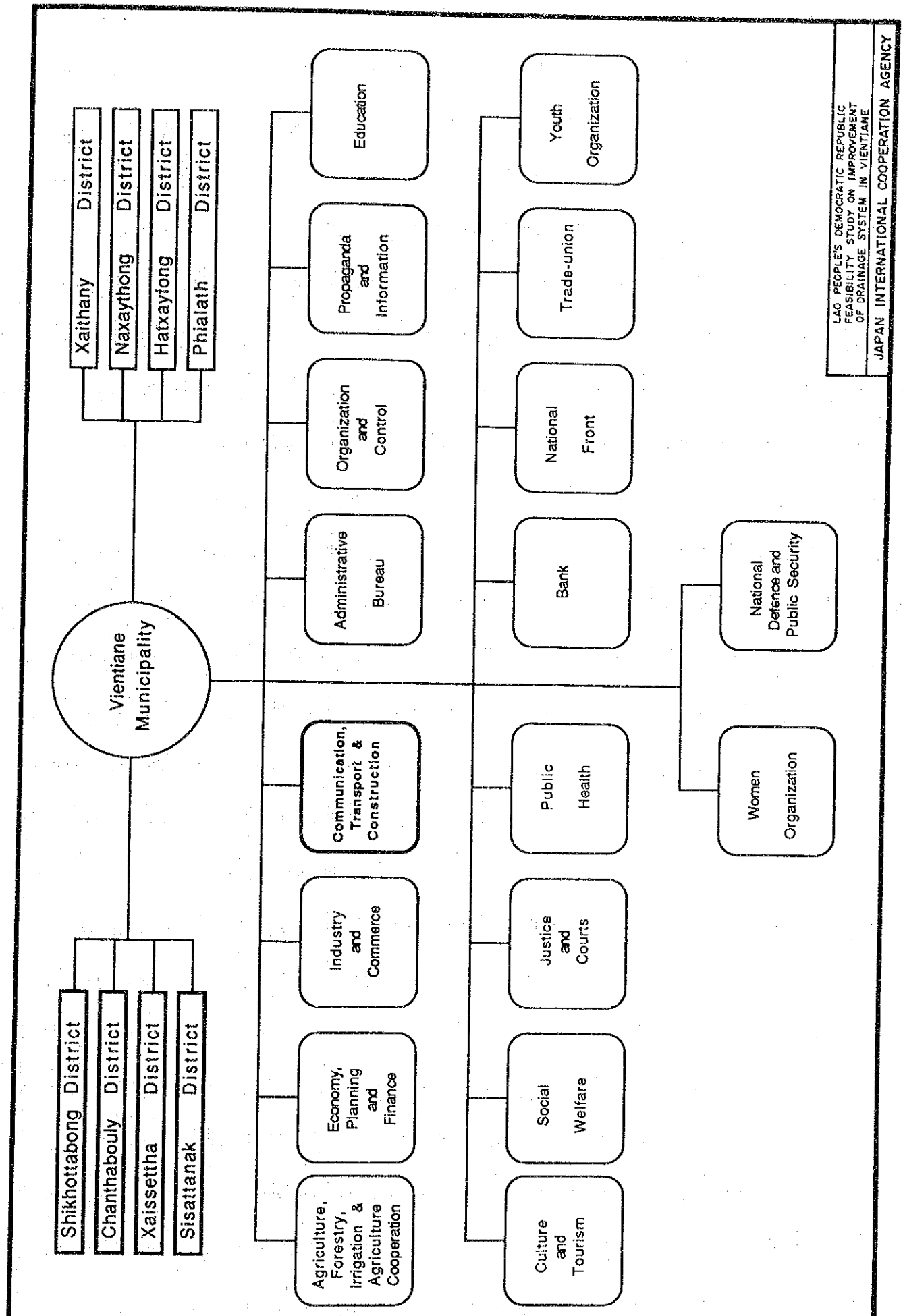

Fig. K.1 Organizational Structure of Municipality of Vientiane

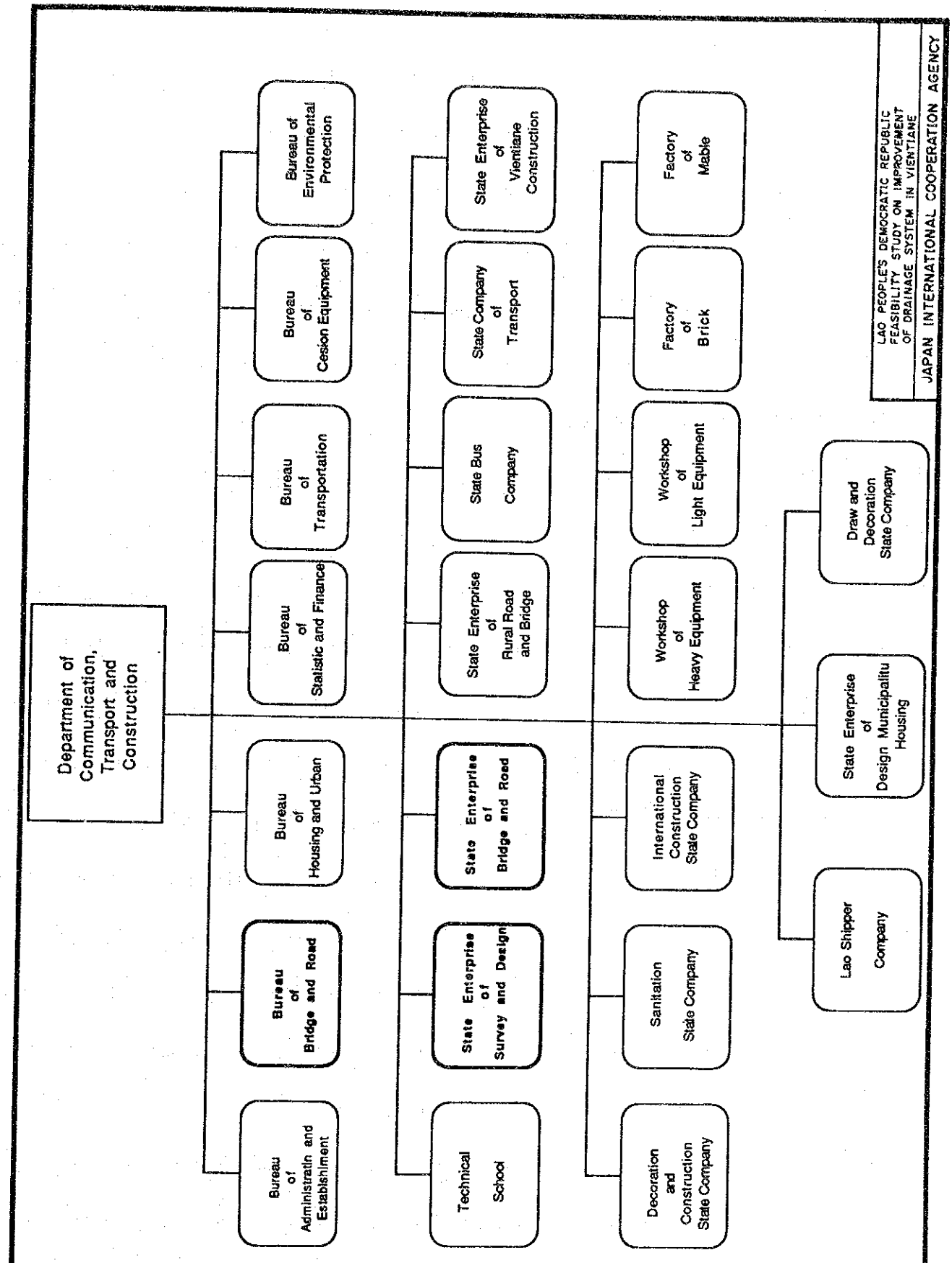

Fig. K.2 Organizational Structure of Department of Communication, Transportation and Construction

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