

Table Q.10 Economic Benefit and Cost Flow (Unit:Million Baht)

	Green Belt Project		Green Belt +		Study Project		Study Project	
	Alternative I		Alternative I		Alternative II		Alternative I	
	Benefit	Cost	Benefit	Cost	Benefit	Cost	Benefit	Cost
1984	113	250	0	0	0	0	113	250
1985	226	194	0	0	0	0	226	194
1986	339	12	0	0	0	0	339	12
1987	452	12	0	689	0	446	452	458
1988	565	12	167	705	131	456	696	468
1989	678	12	333	721	262	466	940	478
1990	791	12	500	737	393	477	1,184	489
1991	904	12	666	755	524	489	1,428	501
1992	1,017	12	833	820	655	473	1,672	485
1993	1,130	12	1,012	837	779	483	1,909	495
1994	1,243	12	1,191	853	903	493	2,146	505
1995	1,356	12	1,370	870	1,027	503	2,383	515
1996	1,496	12	1,549	889	1,151	517	2,647	529
1997	1,582	12	1,728	1,033	1,275	546	2,857	558
1998	1,695	12	1,938	1,054	1,406	555	3,101	567
1999	1,765	12	2,149	1,075	1,537	565	3,302	577
2000	1,838	12	2,359	1,098	1,667	577	3,505	589
2001	1,914	12	2,569	247	1,798	437	3,717	449
2002	1,914	12	2,569	247	1,849	444	3,763	456
2003	1,914	12	2,569	247	1,900	451	3,814	463
2004	1,914	12	2,569	247	1,952	459	3,866	471
2005	1,914	12	2,569	247	2,003	468	3,917	480
2006	1,914	12	2,569	247	2,054	473	3,968	485
2007	1,914	12	2,569	247	2,105	480	4,019	492
2008	1,914	12	2,569	292	2,207	531	4,070	543
2009	1,914	12	2,569	292	2,258	539	4,121	551
2010	1,914	12	2,569	292	2,309	546	4,172	558
2011	1,914	12	2,569	292	2,361	558	4,223	570
2012	1,914	12	2,569	292	2,413	565	4,275	577
2013	1,914	12	2,569	313	2,465	575	4,327	587
2014	1,914	12	2,569	313	2,517	582	4,379	594
2015	1,914	12	2,569	313	2,569	591	4,431	603
2016	1,914	12	2,569	313	2,569	293	4,483	305
2017	1,914	12	2,569	313	2,569	293	4,483	305
2018	1,914	12	2,569	247	2,569	293	4,483	305
2019	1,914	12	2,569	247	2,569	271	4,483	283
2020	1,914	12	2,569	247	2,569	271	4,483	283
2021	1,914	12	2,569	247	2,569	271	4,483	283
2022	1,914	12	2,569	247	2,569	271	4,483	283
2023	1,914	12	2,569	247	2,569	271	4,483	259

Table Q.11 Summary of Economic Evaluation and Sensitivity Analysis

Condition Indicator	Original			Sensitivity Test 1			Sensitivity Test 2			Sensitivity Test 3			Sensitivity Test 4					
	N.P.V.* (₹ Mil- lion)	B/C*	I.R.R. (%)	N.P.V.* (₹ Mil- lion)	B/C*	I.R.R. (%)	Benefit Cost +10%	N.P.V.* (₹ Mil- lion)	B/C*	I.R.R. (%)	Benefit Cost +20%	N.P.V.* (₹ Mil- lion)	B/C*	I.R.R. (%)	Benefit Cost -20%	N.P.V.* (₹ Mil- lion)	B/C*	I.R.R. (%)
Project Implemen- tation																		
Green Belt Project	4,253	11.2	136.6	4,761	13.7	189.5	3,744	9.2	104.6	5,269	16.9	297.0	3,236	7.5	82.7			
G.B + Proposed Project	5,137	2.5	81.7	6,315	3.1	138.6	3,958	2.1	52.3	7,494	3.8	256.8	2,780	1.7	35.8			
																Alter- native I		
Proposed Project	5,261	3.3	105.5	6,253	4.0	161.0	4,269	2.7	72.8	7,246	4.9	273.4	3,276	2.2	51.6			
																Alter- native II		
Alter- native I Project	884	1.3	21.6	1,555	1.6	27.0	214	1.1	17.1	2,225	2.0	33.6	-456	0.9	13.3			
																Alter- native II		
Alter- native II Project	1,009	1.5	26.5	1,493	1.9	33.1	525	1.2	21.0	1,977	2.3	41.3	41	1.0	16.2			

Note: *N.P.V. (Net Present Value) and B/C (Benefit Cost Ratio) Calculated

under the condition of opportunity cost of Capital at 16%.

8.3 Sensitivity Analysis

The purpose of the sensitivity analysis is to test the feasibility of the project by changing some factors that affect the results. In this study, the sensitivity test is conducted in such a way as shown in Table Q.12.

Table Q.12 Cases of Sensitivity Test

Test Case	Benefit	Cost
Test I	+ 10%	-10%
Test II	- 10%	+10%
Test III	+ 20%	-20%
Test IV	- 20%	+20%

The results of the sensitivity test are shown in Table Q.11. In the sensitivity test IV, the total Package shows the lower I.R.R. of 13.2 percent than the prime lending rate of 16 percent. However, even in this case, if the unquantifiable benefits such as environmental benefit and psychological relief are considered, this project might still prove to be viable for implementation.

9. Other Benefit

In evaluating the feasibility of the project, it is necessary to evaluate the project not merely from the economic aspects based on the results of economic analysis, but comprehensively also from the technical, social, environmental, political, and financial aspects. In the former section, the study project is proved to be feasible economically. There are two important benefits which are not counted the previous benefits.

9.1 Improvement of Environment

The benefits of environmental improvement will be enjoyed not only by residents living in the Master Plan Area but also by visitors to the area. Its importance, however, depends mainly on public awareness and recognition of the benefits that stem from the flood protection system, which differs from person to person. Generally speaking, it is expected that the higher the public living standard, the higher the public recognition of benefits. Especially, the elimination of the present offensive odours from the drain and sludge accumulations will result in an improvement of environmental aesthetics, particularly for those living in or near the flood-prone atmosphere and unsightly environment. Then, the attractiveness of the enhanced environment should be conducive to the new commercial and industrial activities in the Master Plan Area.

9.2 Increase in Land Value

The improved living environment through the flood protection project should obviously give spur for the development programme and the consequential large-scale financial transactions, which provide sufficient impetus for the increase of land value in the project area. Therefore, it is expected that BMA would obtain the additional revenue through this increase in value of private property.

10 Justification

There will be no doubt that the study project will produce the high social benefits such as upgrading the existing living environment and will develop the economy, and also contribute towards a betterment of the inconveniences of community life.

With the rising level of living standards, what once seemed as tolerable has come to be recognized as being intolerable. Also, if the flood protection project is not implemented, flooding will become more serious due to the anticipated land subsidence, and population inflow into the Master Plan Area. Thus, the implementation of this project would make a big contribution to satisfactory living condition in the Master Plan Area, therefore, the implementation of the proposed flood protection project is justified.

Appendix Q.13

Back Data for Linear Regression Analysis

- Direct Damage -

(Unit : Baht)

Depth	Duration Item	Less Than One Month	One Month to 3 Months	More Than 3 Months	Equation for Damage Projection
Less Than 10 cm	Total Damage Cost	111,000	63,000	31,700	$D_1 = - 1961.109$ $+ 140.2839H$ $+ 909.8498L$ (r = 0.9451)
	Sample Size	75	24	12	
	Average Damage Coat	1,480	2,625	2,642	
10 cm to 50 cm	Total Damage Cost	294,940	854,700	319,500	
	Sample Size	42	114	33	
	Average Damage Cost	7,022	7,498	9,682	
More Than 50 cm	Total Damage Cost	119,600	1,103,800	899,700	
	Sample Size	23	69	45	
	Average Damage Cost	8,678	15,997	19,993	

r : Correlation Coefficient
 H : Depth (cm)
 L : Duration (month)

Appendix Q.14

Back Data for Linear Regression Analysis

- Investment of Flood Protection (Permanent) -

(Unit:Baht)

Depth	Duration Item	Less Than One Month	One Month to 3 Months	More Than 3 Months	Equation for Damage projection
less Than 10 cm	Total Damage Cost	2,300	4,979		$D_2 = - 48.353$ $+ 2.27787H$ $+ 55.7333L$ (r = 0.8818)
	Sample Size	75	36		
	Average Damage Cost	31	183.738		
10 cm to 50 cm	Total Damage Cost	4,297	22,260		
	Sample Size	33	147		
	Average Damage Cost	130	151		
More Than 50 cm	Total Damage Cost	2,833	48,438		
	Sample Size	20	112		
	Average Damage Cost	142	432		

r : Correlation Coefficient
 H : Depth (cm)
 L : Duration (month)

Appendix Q.15 Back Data for Linear Regression Analysis

- Investment of Flood Protection (Temporary) -

(Unit: Baht)

Depth	Item	Duration		Equation for Damage Projection
		Less Than One Month	One Month to 3 Months	
Less Than 10 cm	Total Damage Cost	13,356	9,430	$D_5 = 134.2896$ $+ 14.02582H$ $+ 269.3333L$ (r : 9361)
	Sample Size	75	36	
	Average Damage Cost	178	962	
10 cm to 50 cm	Total Damage Cost	53,050	285,730	
	Sample Size	42	144	
	Average Damage Cost	1,263	1,980	
More Than 50 cm	Total Damage Cost	40,263	225,300	
	Sample Size	25	106	
	Average Damage Cost	1,610	2,125	

r : Correlation Coefficient

H : Depth (cm)

L : Duration (month)

Appendix Q.16 Back Data for Linear Regression Analysis

- Loss of Transportation Cost -

(Unit: Baht)

Depth	Item	Duration		Equation for Damage Projection
		Less Than One Month	One Month to 3 Months	
Less Than 10 cm	Total Damage Cost	386	250	$D_2 = - 1.95318$ $+ 0.17988H$ $+ 4.11992L$ (r = 0.8835)
	Sample Size	72	43	
	Average Damage Cost	5	6	
10 cm to 50 cm	Total Damage Cost	141	1,985	
	Sample Size	15	77	
	Average Damage Cost	9	25	
More Than 50 cm	Total Damage Cost	272	2,958	
	Sample Size	18	102	
	Average Damage Cost	15	29	

r : Correlation Coefficient

H : Depth (cm)

L : Duration (month)

Appendix Q.17

Back Data for Linear Regression Analysis

- Additional Medical Payment -

(Unit:Baht)

Depth	Item	Duration			Equation for Damage Projection
		Less Than One Month	One Month to 3 Months	More Than 3 Months	
Less Than 10 cm	Total Damage Cost	780	7,180		$D_3 = 10.1180$ $+ 1.00779H$ $+ 57.6L$ $(r = 0.9388)$
	Sample Size	75	36		
	Average Damage Cost	10	199		
10 cm to 50 cm	Total Damage Cost	3,520	33,370		
	Sample Size	24	142		
	Average Damage Cost	147	235		
More Than 50 cm	Total Damage Cost	2,060	27,910		
	Sample Size	17	101		
	Average Damage Cost	121	276		

r : Correlation Coefficient

H : Depth (cm)

L : Duration (month)

APPENDIX R
SCOPE OF WORK

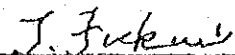
APPENDIX R SCOPE OF WORK

Table of Contents

1.	Introduction	R-2
2.	Objective of the Study	R-2
3.	Study Area	R-2
4.	Scope of Study	R-3
5.	Study Schedule	R-5
6.	Reports	R-5
7.	Undertaking of the Government of Thailand	R-6
8.	Undertaking of the Government of Japan	R-7

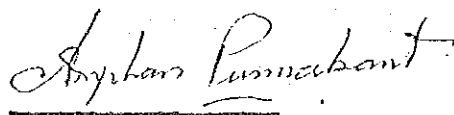
SCOPE OF WORK
FOR
PRELIMINARY AND MASTER PLAN
ON
FLOOD PROTECTION/DRAINAGE PROJECT
IN
THE EASTERN SUBURBAN--BANGKOK IN THE KINGDOM OF THAILAND

AGREED UPON BETWEEN
THE BANGKOK METROPOLITAN ADMINISTRATION
AND
JAPAN INTERNATIONAL COOPERATION AGENCY



Tsunekazu Fukui

Leader,
JECA Preliminary Study Team



Anphan Punnakant

Deputy Governor
of the Bangkok Metropolitan
Administration
(for the governor of BMA)

1. Introduction

In response to the request of the Government of Thailand, the Government of Japan has decided to conduct the Preliminary and Master Plan Study on the Flood Protection/Drainage Project in Suburban Bangkok (hereinafter referred to as the Study), within the general framework of technical cooperation between Japan and Thailand which is set forth in the Agreement on Technical Cooperation between the Government of Japan and the Government of the Kingdom of Thailand signed on 5 November 1981. The Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of technical cooperation programme of the Government of Japan, will accordingly undertake the study in accordance with the relevant laws and regulations in force in Japan, in close cooperation with the Department of Drainage and Sewerage, Bangkok Metropolitan Administration (DDS BMA) and other Thai authorities concerned.

2. Objective of the Study

The objective of the study is to carry out a preliminary study on the Flood-Protection/Drainage Project in Suburban Bangkok, and to conduct a master plan study on the high priority area to be identified and based on the result of the preliminary study.

3. Study area

1. The study area of preliminary study covers the eastern suburbs of approximately 600 sq.Km located between the Viphavadee Ransit Highway and the Green Belt Zone.
2. The study area of the master plan will be selected from the result of the preliminary study,

4. Scope of Study

4. I. Preliminary Study

1-1 Data collection and analysis related to the study are of two groups as follow:

- (a) Those data and materials to be provided by the BMA.
- (b) Those data and materials to be provided by the BMA with the assistant of JICA

(1) Land use

- a. Existing land use map (a)
- b. Existing road net work (in map) (a)
- c. Existing open drain network (in map) (a)
- d. Existing main building (office, school, hotel etc.) (b)

(2) Population

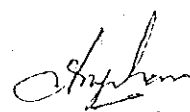
- a. Population and its annual change (in Bangkok) (a)
- b. Population density of the Study Area and each zone (a)
- c. Day-time and night-time population of the study area and each zone (b)

(3) City planning

- a. Future population (b)
- b. Future demand of land by use (a)
- c. Land use plan (a)
- d. Network of road and railway (a)
- e. Network of open drains (b)
- f. Future development plan (a)
 - new housing area
 - new industrial area
 - others

(4) Natural condition

- a. Meteorological data (a)
- b. Hydrological data (a)
- c. Geographical data such as klongs, configuration, elevation, land subsidence etc. (b)



- (5) Previous flood and damages
 - a. Rainfall, runoff and flood damages (b)
 - b. The hydrological regime of the river (b)
 - c. Frequency (b)
 - d. Flooding areas, recession time and damages (b)
 - e. The operation of pumps and gates of the BMA. (b)
- (6) Institution and finance
 - a. Organisation and management of the BMA and other authorities relating to the flood and drainage (a)
 - b. Annual budget, financial planning of the BMA (a)
 - c. Tax revenue and property (a)
- (7) Related maps and drawings
 - a. Topographical map of the Study Area (a)
 - b. Aerial photograph of the Study Area (a)
- (8) Miscellaneous items
 - a. Existing water supply project and future plan (a)
 - b. Ground water usage and level (a)
 - c. Green-belt project (b)
 - d. Lower Chaopraya Basin Management project (b)

1-2 Review of Previous Study

(1) Review of previous study carried out in 1968 by C.D.M.

- 1-3 Development of the criteria to formulate the drainage zone
- 1-4 Development of the criteria to set the priority of the drainage zone
- 1-5 Analysis for selecting master plan area
- 1-6 Definition of survey area for master plan
- 1-7 Rough study of flood protection and drainage method
- 1-8 Studies of organization, operation and management plan

J.F.

Chyphum

4.II Master Plan Study

- 2-1 Supplemental data collection and analysis.
- 2-2 Establishment of the target year for planning.
- 2-3 Study of flood protection and drainage system.
- 2-4 Study of facilities.
- 2-5 Study of construction method and materials.
- 2-6 Study of available construction materials and man-power for construction, operation and maintainance.
- 2-7 Study of construction programme.
- 2-8 Rough estimation of costs for construction, operation and maintainance.
- 2-9 Rough estimation of benefits.
- 2-10 Study of finance.
- 2-11 Studies of organisation, operation and management plans.
- 2-12 Study of the priority of the project.
- 2-13 Proposing the area for the feasibility study.

5. Study schedule

The whole study will be conducted in accordance with the attached schedule.

6. Reports:

JICA will prepare and submit the following reports to the DDS in the course of the preliminary and master plan study:

1. Inception report
20 copies
at the beginning of the field survey.
2. Progress report
20 copies
at the end of the field survey.

The DDS will submit to JICA its comment within one month after the receipt of the report.

3. Interim report

20 copies at the end of the field survey.

The DDS will submit to JICA its comments within one month after receiving the report.

4. Draft final report

20 copies within 3 months after the receipt of comments on the progress report.

Another 20 copies within 4 months after the receipt of comments on the interim report.

The DDS will provide JICA with its comments within one month after the receipt of the D/F

5. Final report For the Preliminary study report, 40 copies and Master plan, 200 copies within 2 months after the receipt of the comments on the D/F.

7. Undertaking of the Government of Thailand

In accordance with the Agreement on Technical Cooperation between the Government of Japan and the Government of the Kingdom of Thailand, the Government of Thailand shall accord privileges, immunities and other benefits to the Japanese team and, through the authorities concerned, take necessary measures to facilitate smooth conduct of the study.

The BMA shall make the necessary arrangement with proper agencies concerned as follows:

- (1) Coordination of the study will be provided through the BMA.
- (2) To provide the counterparts fund for the execution of the study.
- (3) To secure all available relevant studies and data for the use of the study team.
- (4) To provide the study team with the followings:
 - a. Appropriate number of personnels as counterparts.
 - b. Office space, equipment and supplies for the study team.
 - c. Vehicles with drivers for the study team.
 - d. Credentials of identification (ID) cards to the members of the study team who shall be working in Thailand for the execution of the study.

JJ.

Amphan

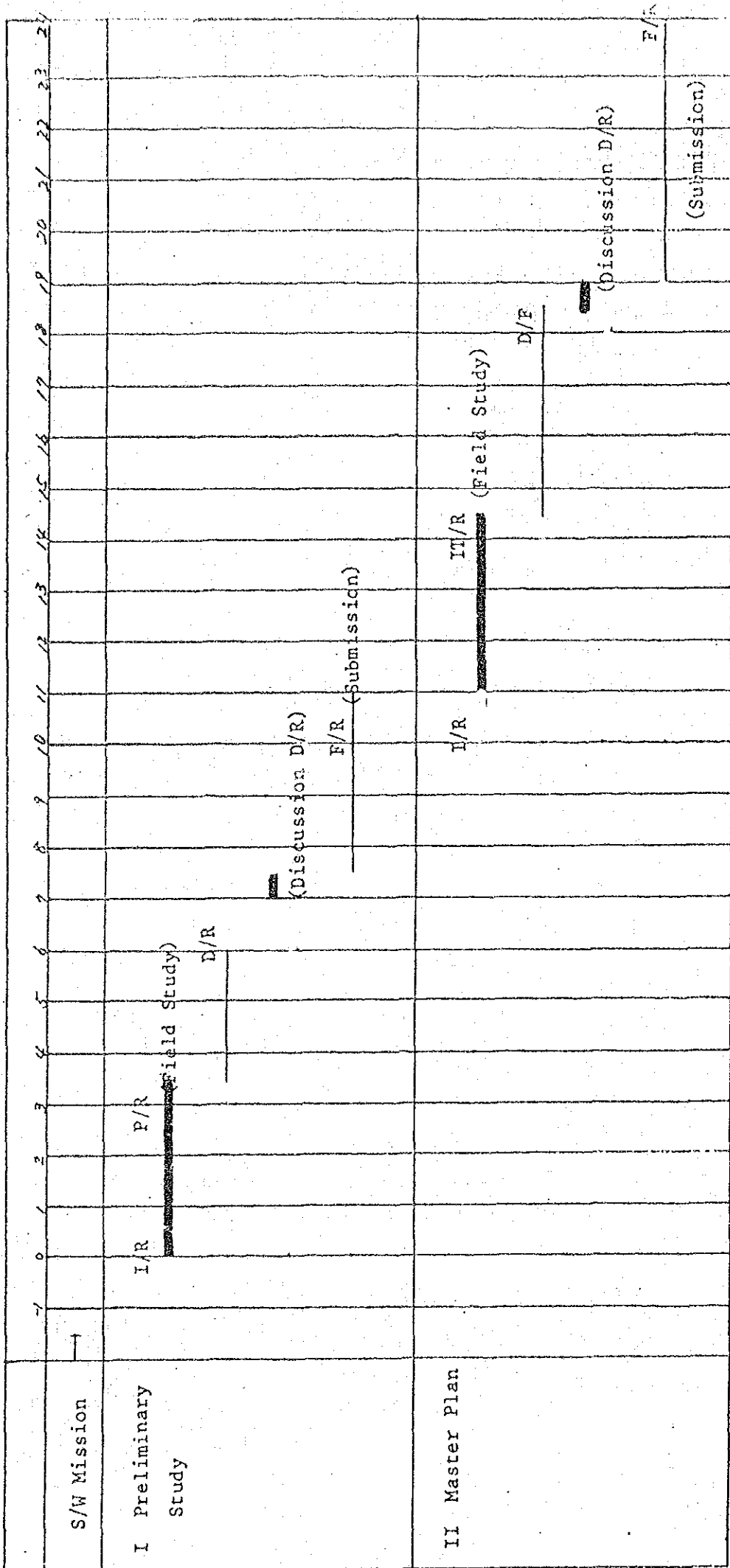
8. Undertaking of the Government of Japan

- (1) To transfer knowledge to the Thai counterpart personnel during the study.
- (2) To give technical advices for the flood protection/drainage project being carried out by the DDS during the stay of the study team in Thailand.

77

Chyhen

Study Schedule



Thailand

Japan

I/R Inception Report

P/R Progress Report

IT/R Interim Report

D/R Draft Final Report

F/R Final Report

Stephen

JICA