VOLUME 3 – SECTOR V

RIVER CHANNEL IMPROVEMENT PLAN

**THE STUDY ON INTEGRATED URBAN DRAINAGE IMPROVEMENT
FOR MELAKA AND SUNGAI PETANI
IN MALAYSIA**

FINAL REPORT

VOLUME 3: SUPPORTING REPORT ON DRAINAGE STRUCTURE PLAN

SECTOR V: RIVER CHANNEL IMPROVEMENT PLAN

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SECTOR V

RIVER CHANNEL IMPROVEMENT PLAN

1. GENERAL

The flood problem is classified into two types. First is the inundation by stagnant storm rainwater due to insufficiency of inland drainage capacity. Second is the overflow from the rivers due to insufficiency of river flow capacity. The inundation by stagnant of storm rainwater occurs more frequently than the river overflow causing a great hindrance to the regional economy and an inconvenience to urban life including serious traffic jams. Hence, the drainage improvement plan to cope with this problem was proposed as the principal study object as described in Sector IV of Vol. 3.

The river overflow also occurs along an extensive stretch with an interval of about two to five years as described in the following Section 1. The overflow discharge spreads out into the low-lying area along the river occasionally leading to flooding at the houses above floorboards. Under this condition, a preliminary study is extended to the second problem and described in this Sector.

The on-going intensive land in the upper reaches will accelerate the present river overflow conditions in the future. From this viewpoint, highlighted is the basin detention facilities proposed in the drainage improvement plan (refer to Sector IV of Vol.3). That is, should the basin flood detention facility be induced, the future increment of basin runoff discharge toward the year 2020 could be controlled to be marginal small as listed below (refer to Table V-1).

Name of Study Area	Name of River	Probable Peak Discharge of 1/100 year at Downstream End of River (m3/s)		
		Present	Future in 2020	
			w/o Detention Facility	with Detention Facility*
Sungai Petani	1. Lalang	296	556	279
	2. Tukang	105	139	99
	3. L. Besar	92	106	88
	4. C. Bima	53	115	55
	5. Petani	325	390	315
	6. Pasir	262	367	258
Melaka	1. Lereh	334	540	357
	2. Malim	507	969	567
	3. Melaka	377	456	388
	4. Cheng	368	581	382
	5. Putat	283	346	275

* In case of the optimum drainage improvement plan

As estimated above, the basin flood detention facility could maintain the present runoff conditions even in 2020 contributing to prevention of river overflow. However, the facility could hardly decrease the future runoff discharge below the present level. Thus, the present states of river overflow will continue in the future, unless a particular prevention work for overflow is provided. The present flow capacity is extremely low, while the present intensive urbanization in the study area will certainly require expansion of land development into the present habitual inundation area along the river and not allow overflow from rivers.

2. EXISTING RIVER CHANNEL CONDITIONS

There are the following six (6) major river basins in the Study Area:

Sungai Petani		
Name of River	Major Tributary	Catchment Area (km2)
1. Lalang	Bakap, Line A	25
2. Tukang		8
2. Petani	Line A1	38
3. Pasir		23

Sungai Melaka		
Name of River	Major Tributary	Catchment Area (km2)
1. Sg. Lereh	Udang, Gajah	35
2. Sg. Malim	Ayer .Salak, Ayer Hitam	52
3.Sg. Melaka	Cheng, Putat	92

The rivers in Sungai Petani flows into estuary of Sg. Merbok river. The channel bed slope of river channels have a range of 1/1,000 to 1/7,500 in the downstream, and 1/700 to 1/800 even in the middle-stream. Thus, the rivers have a quite gentle slope and therefore, the substantial extent of the river channel is seriously affected by the tidal backwater effect. Moreover, the rivers are remained as the natural channels without any major river channel improvement, and the bank level is extremely low as compared with the Mean High Spring Tide Level. As the results, the channel flow capacity is marginal and the flood overflow frequently occurs. The serious flood occurs in particular when the flash flood hits the river channels during a time of high tide.

According to the hydraulic analysis on channel flow capacity as described in Sector I of Vol. 3, all river channels except a few tributaries in the upper reaches have far smaller channel flow capacity than the probable discharge of even 2-year return period (refer to Table V-2 (1/2) and Figs. V-1 (1/13) to (6/13)). Moreover, there are 33 box culvert in total crossing over the river channel, which are the great hindrance for the channel flow (refer to Table V-3). In spite of such small channel flow capacity, the basin runoff discharge tends to remarkably increase due to the intensive land use. According to the interview survey at the site, the condition of flood inundation is being more serious year by year.

As for rivers in Melaka, all rivers directly inflow into Melaka Strait. Similarly to the conditions of Sungai Petani, the downstream of river in Melaka has a very gentle channel slope of 1/1,000 to 1/10,000, and it is seriously affected by the tidal influence. Among the rivers in Melaka, Sg. Lereh, and tributaries of Melaka such as Sg. Cheng, and Sg. Putat are remained as the natural conditions without any major river channel improvement. As the results, the present channel river flow capacity of these rivers are extremely low as compared even the probable discharge of 2-year return period (refer to Fig. V-1 and Table V-2 (2/2)).

In contrast to the above rivers, the river channel improvement was made to downstream of Sg. Malim and its tributaries of Sg. Ayer Salak which have a rather large channel flow capacity to prevent channel overflow from the probable discharge of 5 to 100 year return period (refer to Fig. V-1 and Table V-2 (2/2)).

The downstream of Sg. Melaka has been also improved by the construction of flood by-pass channel and channel improvement works. As shown in Fig. V-2, the flood discharge of Melaka river is diverted into by-pass channel before it enters into the urban center of Melaka. The river flow in the urban center is regulated by the regulator which closes if the overflow of diversion weir occurs and the flood discharge is diverted into the bypass channel. The channel flow capacity of the by-pass channel is designed to accommodate a probable discharge of 50-year return period which was verified in this study through non-uniform calculation (refer to the channel flow capacity of Sg. Malim in Table V-2 (2/2)). As the results, the downstream of Melaka is prevented from channel overflow by a probable discharge of 50year return period. It is, however, noted that Sg. Putat flows into Melaka river in the downstream from the regulator. The present channel flow capacity of Sg. Putat is extremely small and, the flood overflow occurs along Sg. Putat during a flood time. As the results, the flood discharge from Sg. Putat is not likely to seriously increase, at present, the flood flow discharge in the downstream of Melaka river. However, should Sg. Putat be improved to prevent channel overflow, the runoff discharge from Sg. Putat will concentrate to Melaka river. As the results, the downstream of Melaka from the regulator will remarkably increase the river discharge and have far smaller channel flow capacity than even the probable discharge of 2-year return period as shown in Fig. V-1 (11/13) and Table V-2 (2/2).

3. RIVER CHANNEL IMPROVEMENT PLAN

3.1 Objective Rivers

The Study defines the river different from the drain (trunk drain) such that the river has a catchment area of more than 4km^2, while the drain has a catchment area of less than 4km^2 as described in Sector IV of Vol.3. Based on this definition, the prevention measure of river overflow was examined for the following six (6) major rivers and their tributaries.

Sungai Petani		
Name of River	Major Tributary	Catchment Area (km2)
1. Lalang	Bakap, Line A	25
2. Tukang		8
3. Petani	Line A1	38
4. Pasir		23

Sungai Melaka		
Name of River	Major Tributary	Catchment Area (km2)
1. Lereh	Udang, Gajah	35
2. Malim	Ayer .Salak, Ayer Hitam	52
3.. Melaka	Cheng, Putat	92

Among the above rivers, Sg. Malim and Sg. Melaka have already been provided with the river channel improvement works including construction of by-pass channel, and could prevent the cannel overflow from 5 to 50-year return period flood. On the other hand, others are remained as the natural rivers without any major river improvement works and could not meet even 2-year return period flood as described in the foregoing Section 1..

3.2 Target Design Level

The river improvement plans has been formulated and/or implemented only to 13 river system out of 150 river systems in Malaysia including Sg. Melaka. Among the 13 river systems, the recent major improvement plans for the rivers in and around the regional urban centers have the design flood levels of 1/50 to 1/100 year return period with target completion year of 2000 to 2005 as listed below. According to an interview survey to DID, all of the future river improvement plan for regional urban centers will apply the design flood level of 1/100 year in principal, unless particular difficulties in applying the design level arise. In due consideration of these future and foregoing design levels, the design level of 1/100 year is preliminarily assumed as the target design level for prevention plan of river overflow in this study.

Name of River System	State	Design Level	Target Project Completion Year	Proposed in
1. Klang	Selangor	1/100 year	2005	1989
2. Muda	Kedah/Penang	1/50 year	2010	1995
3. Rivers in Gorgetown, Penang	Penang	1/50 year	2010	1991
4. Melaka	Melaka	1/50 year	Completed	1990

3.3 Possible Measures for Prevention of River Overflow

The possible countermeasures against river overflow are classified into (1) enlargement of river channel and/or construction of new bypass channel, and (2) construction of flood retarding basins and/or flood control dam. The measures of (1) function to increase the river flow capacity, while the measures of (2) are to store the flood runoff discharge from the catchment and reduce the peak of design flow discharge

As sown in Fig. V-3, the standard design discharge of 1/100 year return period for the most rivers will have a large gap as compared with the present river channel flow capacity. It is herein noted that the standard design discharge is defined as the target maximum design river flow capacity, which could be reduced by regulation effect of flood detention facilities such as flood retarding basin and flood control dam.

Among the possible countermeasures, the measures of (1) will require far larger channel cross-sections than the existing sections to meet the big gap between the present river channel flow capacity and the standard design discharge. Accordingly, the measures will require an extensive land space. Moreover, the measures need to be implemented from the downstream toward upstream in order to avoid an excessive discharge flowing into the downstream. A substantial part of the downstream of rivers are located in the existing and/or projected built-up area, and difficulties are foreseeable in acquiring the necessary land space.

Due to the above difficulties in land-acquisition, highlighted are the measures of (2), and the possible sites of the measures were scrutinized through field reconnaissance. As the results, it is identified that the possible site for flood control dam is hardly secured due to rather flat topography in the study area, but there are several possible site for flood retarding basins as shown in Fig V-4. The possible retarding basins are presently swamp areas and/or vacant glass land located in the low-lying plain along rivers. Among them, the prominent retarding basins are enumerated as those along Sg. Lalang (Reference No. RSA-1 in Fig. V-4), Sg. Tukang (RTU-1), Sg. Pasir, (No. RPA-1) and Sg. Cheng (No. RCE-1). These retarding basins are located at the downstream and/or middle stream of rivers covering a substantial part of catchment area, and therefore could have a significant effect on reduction of peak of the flood runoff discharge. As for the rivers other than the above four (4) rivers, the effect of retarding basins could not be expected, and only the measures of river channel improvement and/or construction of by-pass channel are applicable to the rivers.

Construction of the above countermeasures for river overflow will be required in parallel with the drainage improvement works so as to get rid of all types of flood problems. In this connection, the detailed topographic survey for the possible retarding basins need to be undertaken to clarify the hydraulic potential capacity of flood retarding basin and determine the design flood discharge and structural features both for retarding basins as well as the river channels. At the same time, the detailed parcel survey will be required to clarify the contents of land acquisition for construction of retarding basins and river channel improvement.

TABLES

Table V-1 (1/2) Present Channel Flow Capacity and Probable Flow Discharge of Rivers (Sg. Petani)

River		Channel No.	Distance (m)*1		Average Flow Capacity (m3/s)		Probable Discharge (m3/s)		
			Downstream	Upstream	Average	Minimum	2 year	5 year	100 year
Lalang	Bakap	CLA-7	0.0	2840.5	4.4	0.1	76	92	137
		CLA-6	2840.5	4045.0	77.1	1.7	41	50	72
	Line A	CLA-5	0.0	3556.5	6.9	0.6	45	55	85
	Main Stream	CLA-4	0.0	1549.0	Nil	Nil	162	193	296
		CLA-3	1549.0	3016.0	8.7	Nil	160	199	304
		CLA-2	3016.0	5239.0	4.1	0.7	53	66	101
		CLA-1	5239.0	6989.0	4.8	1.9	36	44	70
Tukang	Main Stream	CTU-3	0.0	1825.0	6.3	Nil	53	67	105
		CTU-2	1825.0	2542.0	5.9	0.8	32	39	58
		CTU-1	2542.0	3900.0	2.3	0.3	27	32	47
Petani	Line A1	CPE-13	0.0	870.0	0.6	Nil	50	67	101
		CPE-12	870.0	2200.0	140.1	2.2	55	61	91
	Main Stream	CPE-10	0.0	4193.0	Nil	Nil	150	196	325
		CPE-9	4193.0	4723.0	Nil	Nil	174	220	348
		CPE-8	4723.0	5711.0	Nil	Nil	158	199	311
		CPE-7	5711.0	6691.0	Nil	Nil	149	183	279
		CPE-6	6691.0	7193.0	Nil	Nil	152	185	282
		CPE-5	7193.0	8193.0	28.3	Nil	140	170	256
		CPE-4	8193.0	8900.0	7.2	5.1	139	168	255
		CPE-3	8900.0	9482.0	7.1	3.0	138	167	251
		CPE-2	9482.0	10400.0	14.8	4.8	125	154	233
		CPE-1	10400.0	11200.0	5.5	2.5	112	135	201
Pasir	Main Stream	CPA-6	0.0	1400.0	Nil	Nil	131	165	262
		CPA-5	1400.0	4254.0	8.3	Nil	119	149	233
		CPA-4	4254.0	4954.0	3.3	1.0	112	138	211
		CPA-3	4954.0	6554.0	2.7	0.5	96	120	185
		CPA-2	6554.0	7654.0	8.4	0.3	83	103	159
		CPA-1	7654.0	10054.0	8.6	0.2	63	77	115

Note : *1 : Distance from river mouth or confluence with mainstream.

Table V-1 (2/2) Present Channel Flow Capacity and Probable Flow Discharge of Rivers (Melaka)

River		Channel No.	Distance (m)[*1]		Average Flow Capacity (m3/s)		Probable Discharge (m3/s)		
			Downstream	Upstream	Average	Minimum	2 year	5 year	100 year
Lereh	Main Stream	CLE-1	0.0	2800.0	14.9	7.2	117	172	334
	Udang	CLE-2	4383.0	7231.0	10.0	2.7	85	112	191
		CLE-3	0.0	4383.0	7.1	Nil	101	134	227
	S.Gajah	CLE-4	0.0	1800.0	9.0	2.4	32	47	93
Malim	Main Stream	CMA-1	365.7	2682.1	288.2	239.0	180	261	507
	Ayer Salak	CMA-2	0.0	1200.0	470.3	346.4	69	91	155
		CMA-3	1200.0	3000.0	167.6	84.9	70	97	174
		CMA-4	3000.0	4800.0	135.6	81.7	82	116	210
	Bertam ULU	CMA-5	0.0	600.0	31.8	15.5	41	58	111
	Ayer Hitam	CMA-6	4000.0	4650.0	51.9	39.6	54	76	143
		CMA-7	3100.0	4000.0	42.9	28.4	58	81	153
		CMA-8	1500.0	3100.0	30.0	23.2	58	158	158
		CMA-9	0.0	1500.0	41.8	20.4	64	92	174
Melaka	Main Stream (1)[*2]	CME-1	13536.0	14451.2	440.1	383.5	155	221	425
	Main Stream (2)*	CME-2	11400.0	13600.0	13.5	10.7	11	14	21
		CME-3	9600.0	11400.0	20.1	10.5	60	82	141
		CME-4	8400.0	9600.0	14.7	5.8	148	210	380
		CME-5	7400.0	8400.0	9.9	5.9	147	208	382
		CME-6	5200.0	7400.0	12.0	6.0	146	208	387
		CME-7	4400.0	5200.0	12.6	5.3	148	211	393
		CME-8	2800.0	4400.0	22.9	5.3	148	211	393
		CME-9	2000.0	2800.0	56.6	46.0	144	206	384
		CME-10	1000.0	2000.0	61.1	6.0	138	200	377
Cheng	Main Stream	CCH-1	0.0	2000.0	14.7	Nil	123	184	368
	Paya Rumput	CCH-3	0.0	1400.0	2.8	1.1	26	37	69
	Jenuang	CCH-5	0.0	2400.0	1.9	Nil	33	50	102
	Jeram	CCH-6	0.0	1800.0	21.5	17.0	82	121	245
Putat	Ayer Keroh	CPU-1	0.0	1400.0	9.5	1.2	17	22	39
	Main Stream	CPU-2	5625.0	6500.0	9.6	1.8	54	71	117
		CPU-3	4200.0	5625.0	10.2	2.8	128	171	294
		CPU-4	1800.0	4200.0	10.2	1.5	128	171	294
		CPU-5	0.0	1800.0	Nil	Nil	122	163	283

Note : *1 Distance from river mouth or confluence with mainstream.
*2 Upstream from Diversion point
*3 Downstream from Diversion point

Table V-2 Present Flow Capacity of Culvert

Sg.Petani

River		Chainage No.		Average Flow Capacity (m3/s)	No.	Flow Capasity of Culvert	Remarks
		Down	Up				
Lalang	Main Stream	3016.00	5239.00	4.1	3764.00	0.22	Pipe Culvert D=0.2 x 4
	Line A	0.00	3556.00	6.9	327.50	1.57	Pipe Culvert D=1.25
					2201.50	56.90	Box Culvert 2.65 x 4.6
		3556.00	4900.00	1.7	3846.00	12.36	Pipe Culvert D=2.2
	Bakap	0.00	2840.50	4.4	2831.00	4.17	Box Culvert 1.0 x 3.1
		2891.00	4045.00	77.1	3392.00	0.64	Pipe Culvert D=0.5 x 2
					3547.00	5.97	Box Culvert 1.0 x 1.0 x 3
		4045.00	4475.80	1.5	4191.00	1.98	Pipe Culvert D=1.2
					4456.00	56.81	Box Culvert 1.82 x 1.85 x 2
Tukang	Main Stream	0.00	1825.00	6.3	1324.00	8.20	Pipe Culvert D=1.5
		1825.00	2542.00	5.9	1962.00	5.33	Pipe Culvert D=1.5 x 2
					2128.00	1.09	Pipe Culvert D=0.65
		2542.00	3900.00	2.3	3136.00	1.09	Pipe Culvert D=1.2
					3354.00	0.58	Pipe Culvert D=1.0
					3712.00	3.09	Pipe Culvert D=1.6
					3751.00	3.09	Pipe Culvert D=1.6
		3900.00	3990.00	0.8	3955.00	3.25	Pipe Culvert D=1.5
					3980.00	4.37	Pipe Culvert D=1.2
Petani	Line A1	870.00	2200.00	140.1	1105.00	0.96	Pipe Culvert D=0.8
					1593.00	33.06	Box Culvert 2.05 x 2.4 x 3
					1895.00	26.89	Box Culvert 2.1 x 2.7 x 2
					2163.00	21.27	Box Culvert 2.2 x 2.2
		2600.00	2800.00	2.4	2653.00	0.42	Pipe Culvert D=0.8
					2725.00	2.91	Box Culvert 1.78 x 1.1
Pasir	Main Stream	0.00	1400.00	Nil	804.50	Nil	Box Culvert 2.3 x 3.2
					1239.60	2.48	Pipe Culvert D=1.69
		1400.00	4254.00	8.3	1913.00	5.39	Pipe Culvert D=1.4
					3426.60	10.54	Box Culvert 1.4 x 1.33 x 2
		4254.00	4954.00	3.3	4795.30	3.99	Pipe Culvert D=1.3
		4954.00	6554.00	2.7	5310.00	1.53	Pipe Culvert D=1.37 x 2
					5484.50	1.78	Pipe Culvert D=1.38 x 2
		6554.00	7654.00	8.4	7135.00	0.29	Pipe Culvert D=1.23
		7654.00	10054.00	8.6	8431.00	2.58	Pipe Culvert D=1.5

Melaka

River		Chainage No.		Average Flow Capacity (m3/s)	No.	Flow Capasity of Culvert	Remark
		Down	Up				
Lereh	S.Gajah	0.00	1800.00	9.0	1392.00	1.15	Pipe Culvert D=1.2 x 2
	Udang	4383.00	7231.00	13.0	6741.30	18.19	Pipe Culvert D=1.524 x 2
Malim	Ayer Salak	4800.00	5464.64	35.0	4803.00	46.65	Box Culvert 1.5 x 1.8 x 2
	Bertam ULU	0.00	600.00	31.8	348.00	12.45	Box Culvert 2.1 x 3.1 x 2