

A STUDY ON POLLUTION PREVENTION AND WATER QUALITY IMPROVEMENT FOR SUNGAI SEPETANG, PERAK

FINAL REPORT

Volume 1: Executive Summary



DEPARTMENT OF ENVIRONMENT



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PART A
EXECUTIVE
SUMMARY

EXECUTIVE SUMMARY

INTRODUCTION

1. This report documents the “Study on Pollution Prevention and Water Quality Improvement for Sg Sepetang, Perak”. The study area lies in between 4° 45.18’ N, 100° 36.65’ E and 4°59.28’ N, 100° 48.72’ E, covering three river basins, namely Sg Sepetang river basin, Sg Larut River basin, and combined Sg Reba and Sg Menangis River basin. The main focus of the study is on Sg Sepetang and Sg Larut River basins. Less attention is given to Sg Reba and Sg Menangis which are predominantly estuarine river basin. Flanked between Sg Sepetang and Sg Larut, this estuarine river basin can be regarded more as the “receptient” of the inland pollutants discharged by both Sg Sepetang to its north, and Sg Larut (south).The basin is part of the Matang Mangrove Forest. The total combined area of three river basins measure about 34,782 hectares or 347.82 square km.
2. Sg Sepetang is about 28.8 km in length and originates from Bukit Ulu Sepetang (elevation of about 150 m) and higher ranges of Ladang Subur Bahagian Norseman. The upstream of Sg Sepetang flows through major rubber and oil palm estates. Part of its tributaries flow through major areas of the Kamunting industrial area, situated towards the north of Taiping and houses most of the manufacturing industries in Northern Perak. The town of Kuala Sepetang is situated about 1km south of Sg Sepetang where it drains into Kuala Sangga and then to the Straits of Malacca.
3. Sg Larut discharges itself into Kuala Sangga about 5 km south of Kuala Sepetang town. Sg Larut originates from Bukit Wray (elevation 1,020 m) at Bukit Larut Forest Reserve which flows through gentler and flatter landforms of Taiping town, meandering westward through the coastal plains, and finally discharges in the Straits of Malacca.
4. The river-mouth and surrounding coastline of Sg Sepetang river basin form the important Matang mangrove forest. This large expanse of mangrove forest is situated in a huge bay stretching from Kuala Gula in the north to Pengkalan Baharu in the south, with 51km of coastline and up to 13 km wide. Sg Kelumpang and Sg Selinsing are other minor rivers in the forest reserve. Two mangrove islands, Pulau Kelumpang and Pulau Terong, have permanent inundated lakes. The forest reserve includes 32,686 hectares of productive forest and 7,360 hectares of unproductive forest. About 95% of the mangroves are tidal swamp dominated by *Rhizophoraceae*. The main socio-economic activities are forestry, aquaculture and eco-tourism. The mangrove

water-ways and mud banks are important habitats for many economically important species of fishes and prawns. The relative locations of the three river basins are shown in Figure ES-1.

SG SEPETANG BASIN

5. Sg Sepetang basin covers an area of about 16,742.44 hectares. More than half (52.83 percent) of the Sepetang basin is devoted to agricultural land use (mainly oil palm estates). The upper catchments area is forested hill slopes making about 20.40 % of the basin area. Urban land uses (including industrial, residential, institutional, utilities, governmental use, commercial & services, and transportation use) accounted for about 1,248.30 hectares or 7.46 % of the basin. Much of these urban related land uses are located in the central part of the basin. These urbanized areas include Kamunting Industrial zone as well as fairly new residential and commercial development areas. Most of these urban areas are within Sg Malai and Sg Rantin sub-basins.

RIVER BRANCHES AND SUB-BASINS WITHIN SG SEPETANG BASIN

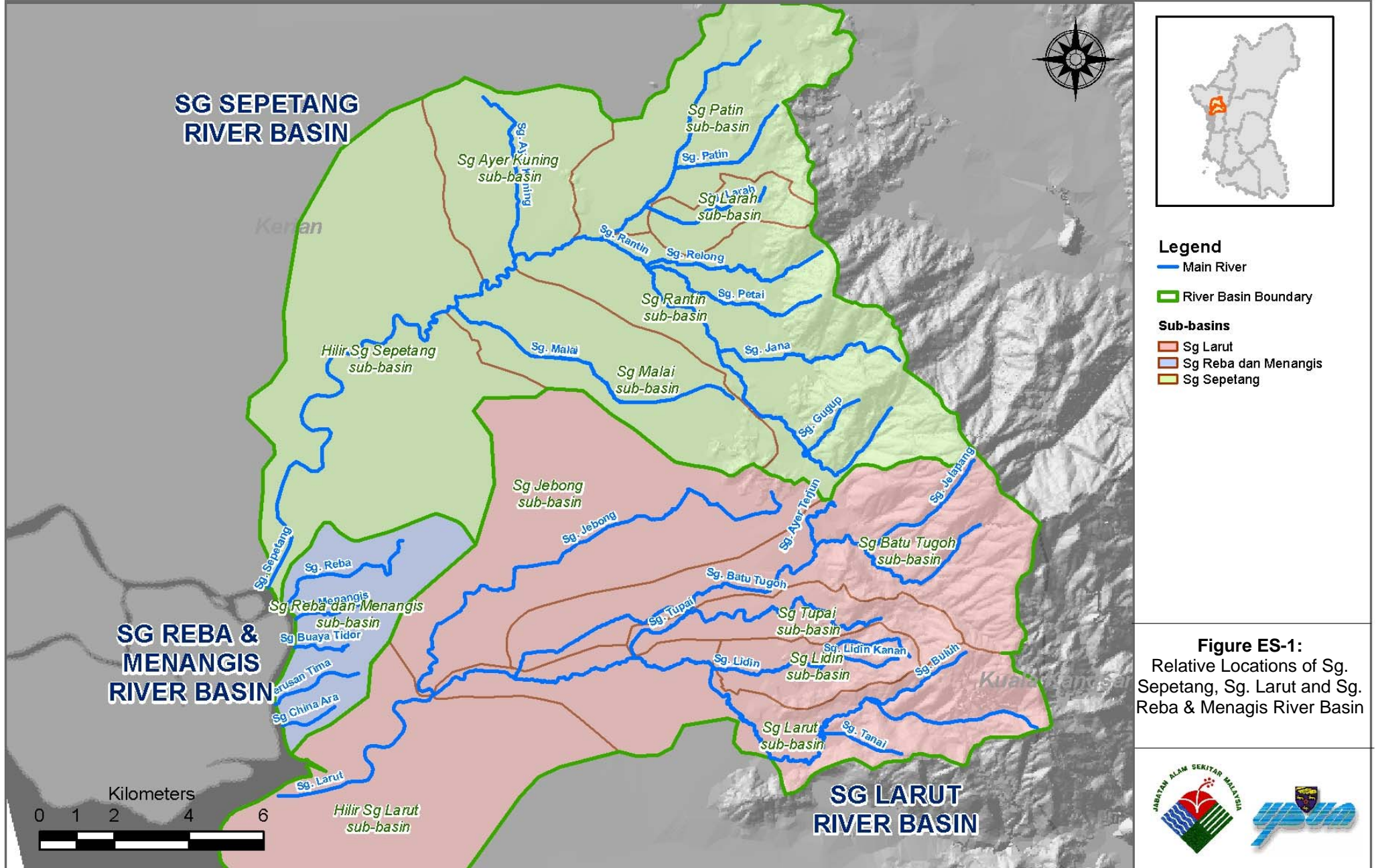
6. Sg Sepetang stretches about 28.86 km from upstream to river mouth with the following tributaries:

NO	RIVER	LENGTH
1.	Sg Ayer Kuning	5.2 km
2.	Sg Gugup	2.5 km
3.	Sg Jana	5.8 km
4.	Sg Larah	4.0 km
5.	Sg Malai	8.8 km
6.	Sg Patin	3.8 km
7.	Sg Petai	5.6 km
8.	Sg Relong	5.9 km

Sg Gugup, Sg Jana, Sg Relong and Sg Petai have all been included as part of Sg Rantin sub-basin. These are minor tributaries draining into Sg Rantin which in turn flows into Sg Sepetang

For the purpose of this study, Sg Sepetang basin has been divided into six (6) sub-basins. The 6 sub-basins have been identified based on the size of the tributaries, potential contribution to the Sepetang river water quality, as well as suitability for water quality management unit.

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The 6 sub-basins are as listed below:

- a) Sg Ayer Kuning sub-basin
- b) Sg Patin sub-basin
- c) Sg Larah sub-basin
- d) Sg Rantin sub-basin
- e) Sg Malai sub-basin
- f) Hilir Sg Sepetang sub-basin

These sub-basins and summary of the land use-pattern are shown in Figure ES-2.

SG LARUT BASIN

7. Sg Larut river basin is a drainage area for Sg Larut and its tributaries. Sg Larut runs through the town area of Taiping. It covers an area of about 16,342.80 hectares. Sg Larut basin has larger urban area compared to Sg Sepetang basin (1,991.80 hectares compared to 1,248.30 hectares). In terms of proportion, about 12.19 percent of Sg Larut is considered urbanised land as compared to 7.46 percent in Sg Sepetang. Taiping town center and the older parts of the urban areas are found within Sg Larut sub-basin.

Despite being more urbanised than Sg Sepetang basin, about 41 percent of Sg Larut Basin are still forested area. The forested areas are not just limited to up the rugged stream areas of Bukit Larut but also toward the coastal plains (mangrove forest near the river mouth, in Hilir Sg Larut sub-basin).

In the middle zones lies Taiping town area, in which most man-induced pollutants are located. Urban development pattern extends in the middle of the basin, in North-South direction. Therefore, urban related land uses appear dissecting the central portions of the basin – with forested areas in the East (hilly area) and the West (mangrove forest in the coastal plains). Much of the urban land use are devoted for residential use (870.5 hectares), roads and transportation network (726 hectares), industrial (217.92 hectares), and commercial land-use (94.41 hectares). As a whole, industrial and commercial areas take up only 1.91 percent of the whole Sg Larut sub-basin. (Refer Figure-ES-3).

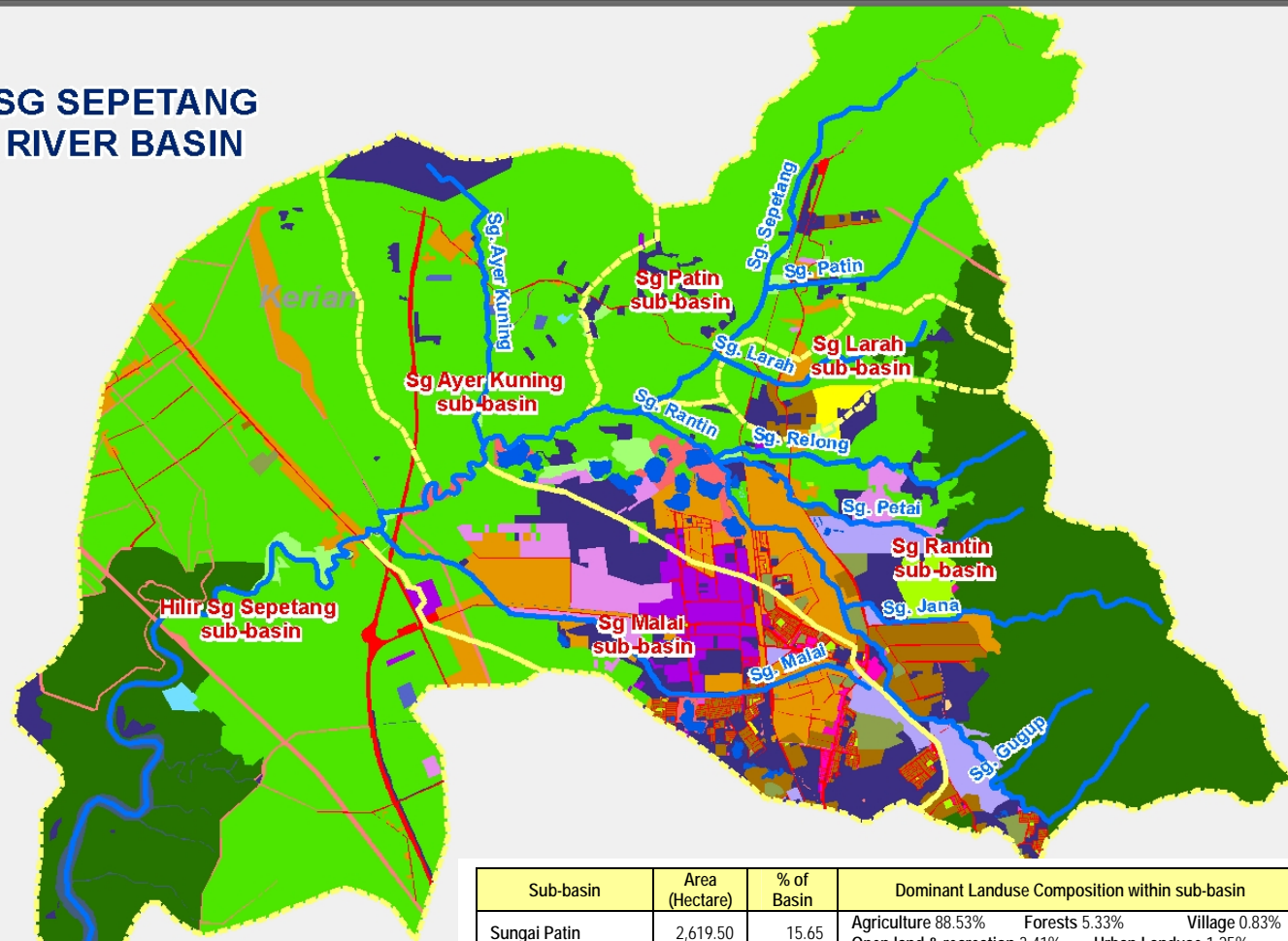
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SG SEPETANG RIVER BASIN



Legend

- Main River
- Sub-basins
- Agricultural
- Animal Husbandry
- Aquaculture Pond
- Buffer Zone
- Commercial
- Development Area
- Ex-Mining Pond
- Field
- Forest
- Fruit Orchards
- Government Building
- Industrial
- Institution
- Open Land
- Public Amenities
- Recreation
- Residential
- River
- Sewage Treatment
- Shrubs
- Transportation
- Utilities
- Village Settlement
- Waterbody



Sub-basin	Area (Hectare)	% of Basin	Dominant Landuse Composition within sub-basin			Current river WQI
Sungai Patin	2,619.50	15.65	Agriculture 88.53%	Forests 5.33%	Village 0.83%	Class II
Sungai Larah	541.20	3.23	Agriculture 49.17%	Forests 25.64%	Village 3.87%	Class II
Sungai Rantin	3,997.51	23.88	Agriculture 14.09%	Forests 51.08%	Village 8.04%	Class II
Sungai Malai	2,123.46	12.32	Agriculture 26.92%	Forests 2.02%	Village 15.78%	Class III
Sungai Ayer Kuning	1,874.26	11.19	Agriculture 85.82%	Forests 1.19%	Village 1.52%	Class III
Hilir Sungai Sepetang	5,586.51	33.37	Agriculture 62.93%	Forests 23.58%	Village 3.77%	-not applicable, saline waterbody
Total Sepetang Basin	16,742.44	100.00	Entire Sepetang Basin Agriculture 52.83% Forests 22.12% Village 5.60% Open land & recreation 8.04% Urban Landuse 7.46%			-

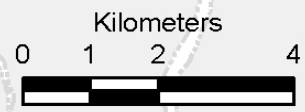


Figure ES-2:
Sg. Sepetang sub-basins and its land use pattern.



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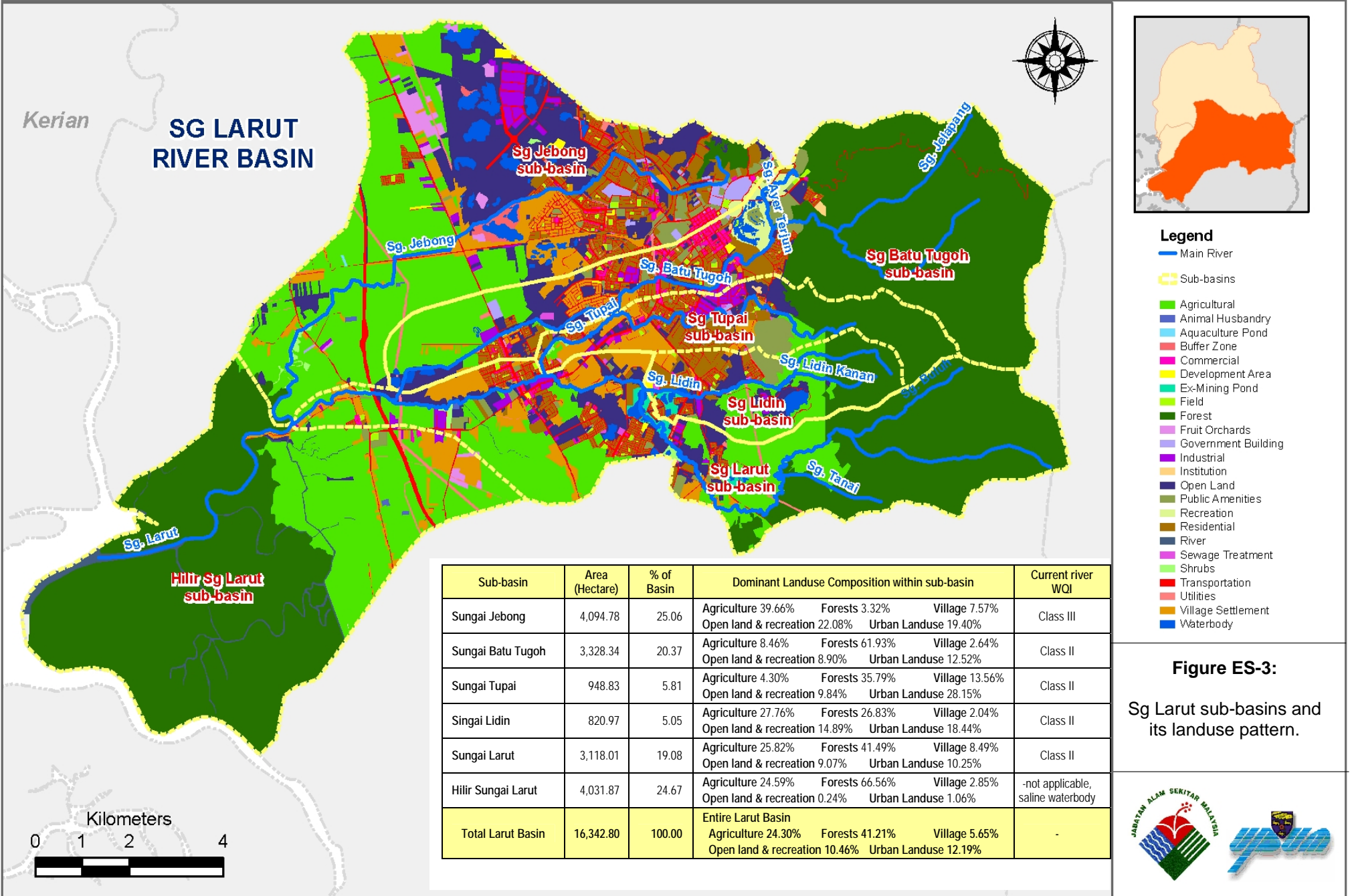


Figure ES-3:
Sg Larut sub-basins and its landuse pattern.



RIVER BRANCHES AND SUB-BASINS WITHIN SG LARUT BASIN

8. Sg Larut consists of the following 8 main river tributaries:

NO	RIVER	LENGTH
1.	Sg Batu Tugoh	16.7 km
2.	Sg Buluh	3.2 km
3.	Sg Jebong	15.0 km
4.	Sg Jelapang	4.0 km
5.	Sg Larut	29.5 km
6.	Sg Lidin	6.5 km
7.	Sg Tanai	2.2 km
8.	Sg Tupai	9.7 km

Sg Buluh and Sg Tanai are a sub-tributaries to Sg Larut and thus are included as part of the Sg Larut sub-basin. Sg Jelapang is a sub-tributary of Sg Batu Tugoh and thus included as part of the Sg Batu Tugoh sub-basin. All of these three sub-tributaries are covered by forest.

For the purpose of this study, Sg Larut basin has been divided into six (6) sub-basins, namely:

- i. Sg Jebong sub-basin
- ii. Sg Batu Tugoh sub-basin
- iii. Sg Tupai sub-basin
- iv. Sg Lidin sub-basin
- v. Sg Larut sub-basin
- vi. Hilir Sg Larut sub-basin

These sub-basins and summary of the land-use pattern are shown in Figure ES-3.

SG REBA AND MENANGIS RIVER-BASIN

9. Sg Reba and Sg Menangis are small estuarine rivers that flow through Kuala Sepetang town. Both river basins have been combined as Sg Reba and Sg Menangis river basin. The river basin is flanked between Sg Sepetang basin (to the north) and Sg Larut (south).
10. As these two rivers are highly susceptible to tidal flow and marine waters, the current WQI method is not quite applicable here. However, the area can be

regarded as the “recipient” of inland pollutants that flows from both Sg Sepetang and Sg Larut. This area is a well-known fishing community that relies on fish, cockles, shrimps, and many other sea and coastal resources. Aquaculture and eco-tourism are also important economic activities within this region. The land-use pattern of Sg Reba and Sg Menangis basins is shown in Figure ES-4.

POINT SOURCES INVENTORY

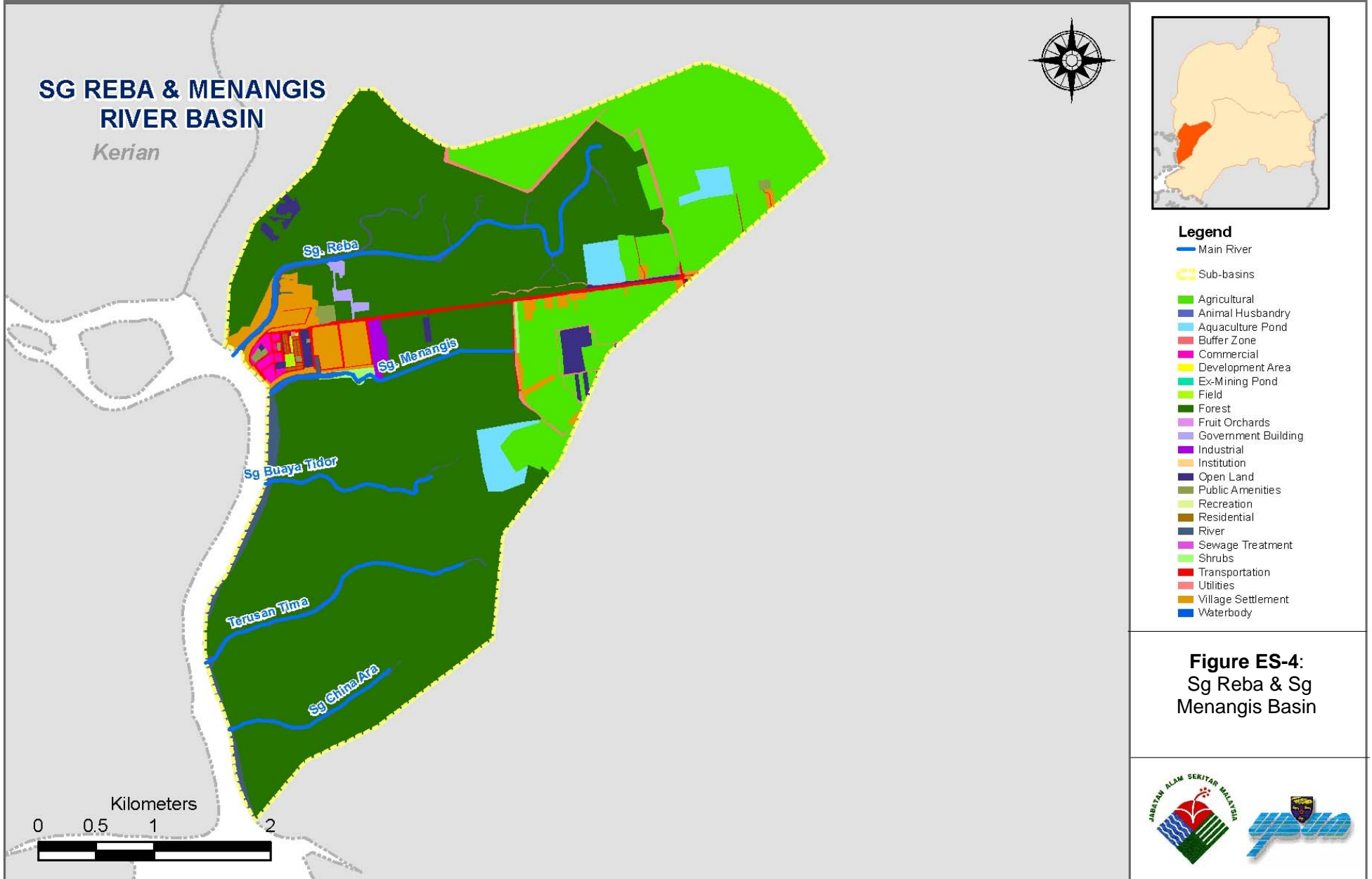
11. Point sources survey was conducted throughout the study area and a total of 979 point sources have been identified, of which 609 are within Sg Larut, 310 are within Sg Sepetang, and 45 are within Sg Reba and Sg Menangis. 15 point sources are outside the study area.

The detail breakdown by the different types of pollution sources for each basin and sub-basins are shown in Figures ES-5 to ES-7. Detail Point Pollution source inventory has been documented in the Volume 5: “Field Survey of Point & Non-Point Pollution Sources Report”.

WATER QUALITY IN SG SEPETANG BASIN

12. Currently, the DOE has established a total of eleven (11) monitoring stations throughout the entire Sepetang river basin. Two water intake points are situated at Hulu Sepetang, at Sg Jana and Sg Rantin, respectively.
13. There are six (6) DOE monitoring stations and 4 water intake points present within the Sg Larut catchment area.
14. Water quality status at Sg Sepetang and Sg Larut were classified as moderately polluted since 2004 based on the DOE National River Water Quality Monitoring Programme (Figures ES-8 & ES-9).

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Point Pollution Sources Category	Sungai Patin	Sungai Larah	Sungai Rantin	Sungai Malai	Sg Ayer Kuning	Hilir Sg Sepetang	Total Larut Basin
Factories & Manufacturing	-	-	6	25	-	5	36
Workshops	1	4	13	55	-	-	73
Petrol & Diesel Stations	-	-	1	5	-	-	6
Public Sewerage Treatment Plants	1	-	35	45	-	-	81
Private Sewerage Treatment Plants	1	1	8	3	-	3	16
Waste Mgmt & Recycling	-	-	-	-	-	-	-
Restaurants, Food Stalls, & Food Ct	1	1	14	51	-	1	68
Wet Markets	-	-	-	3	-	-	3
Livestock	2	-	11	1	4	-	18
Aquaculture	-	-	1	1	-	-	2
Others	-	-	2	5	-	-	7
Total	6	6	91	194	4	9	310

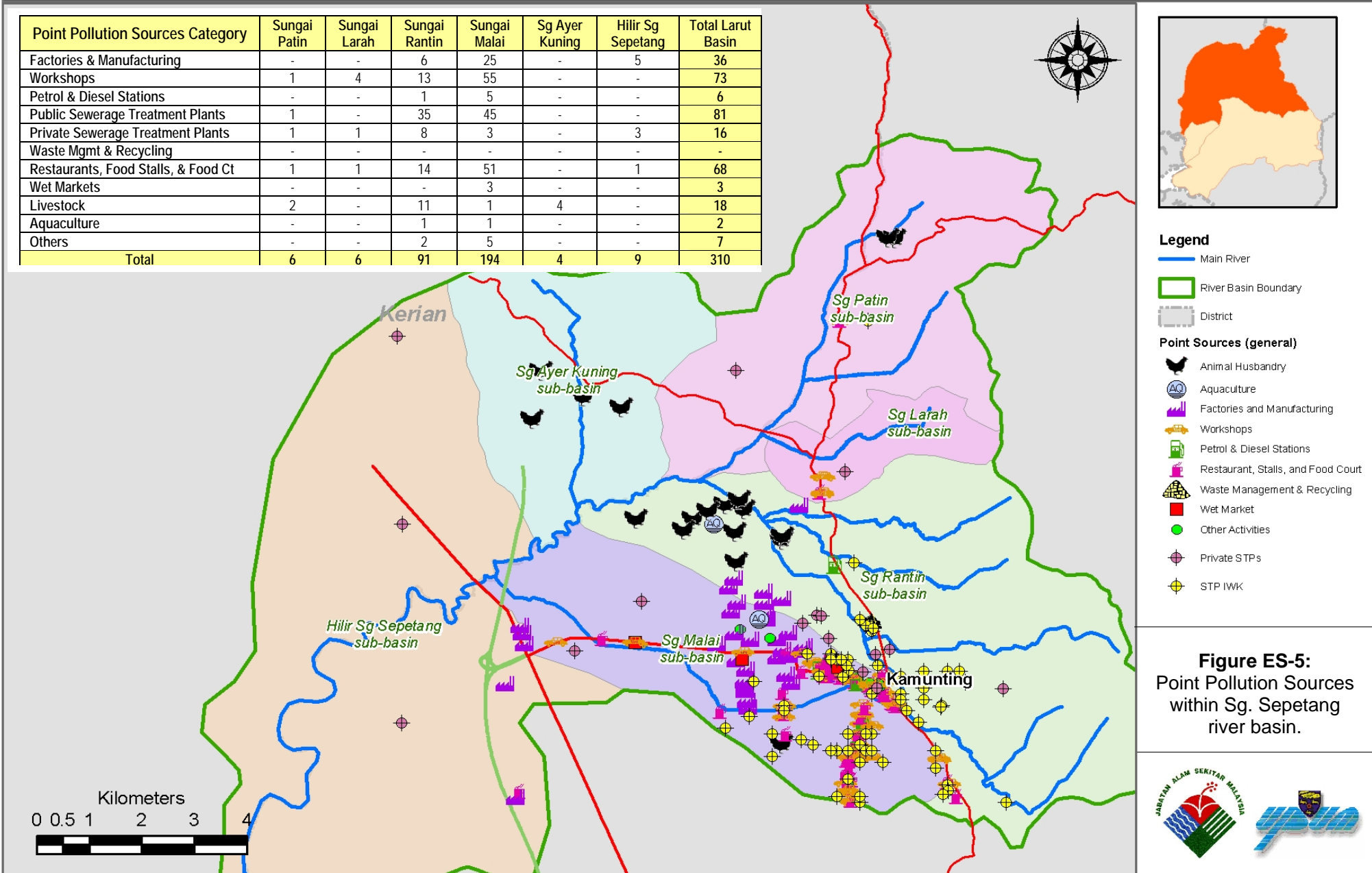


Figure ES-5:
Point Pollution Sources within Sg. Sepetang river basin.



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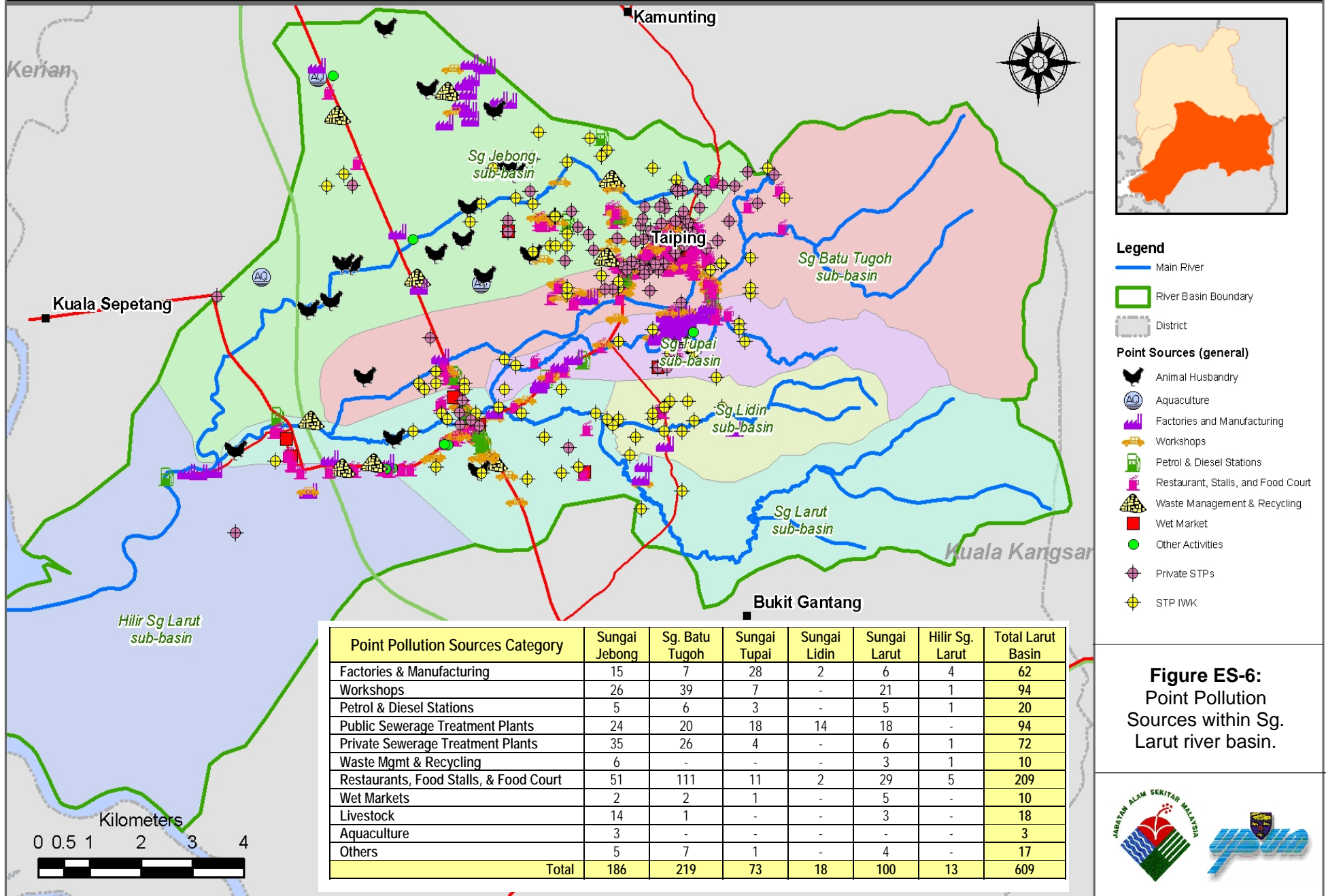
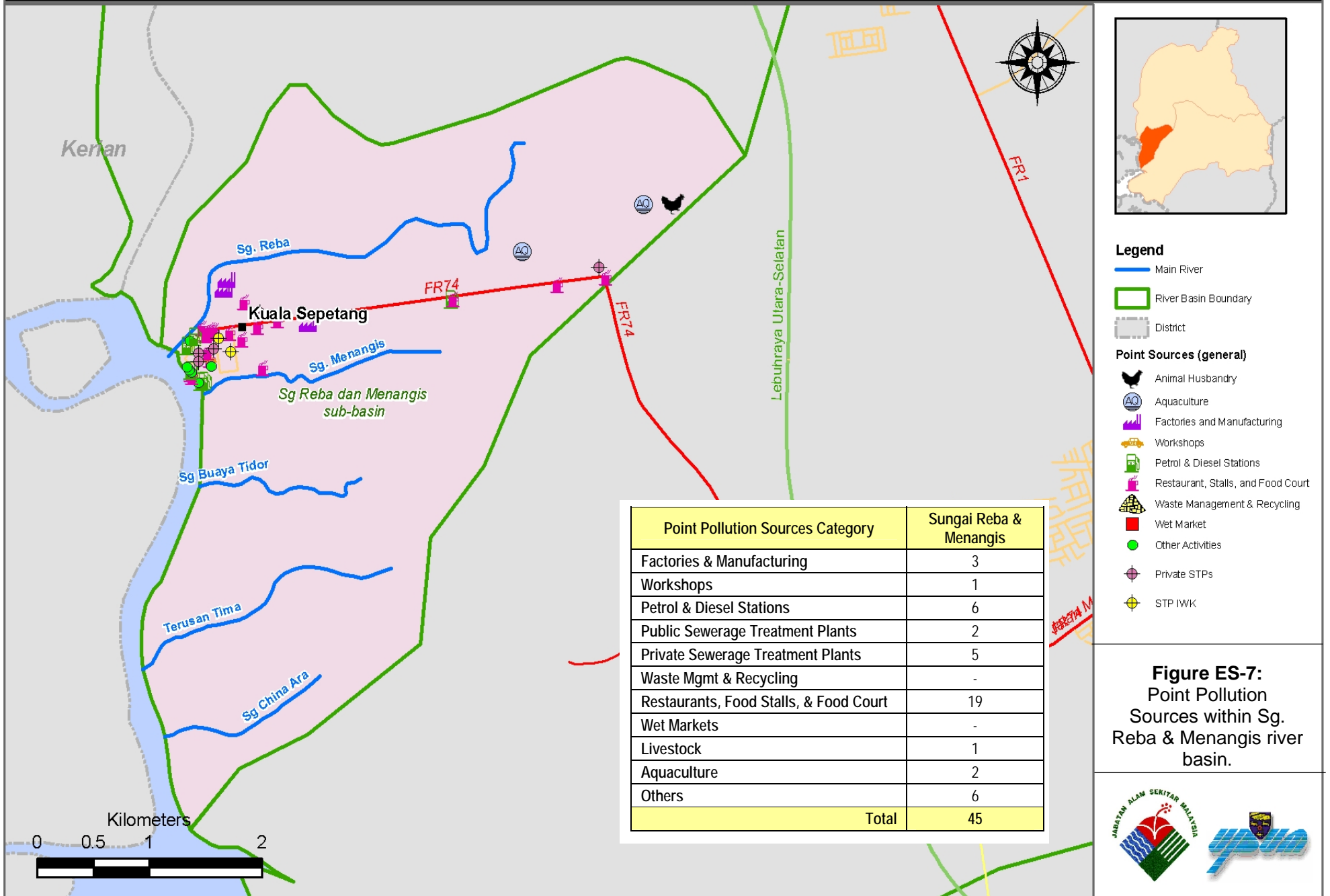


Figure ES-6:
Point Pollution Sources within Sg. Larut river basin.



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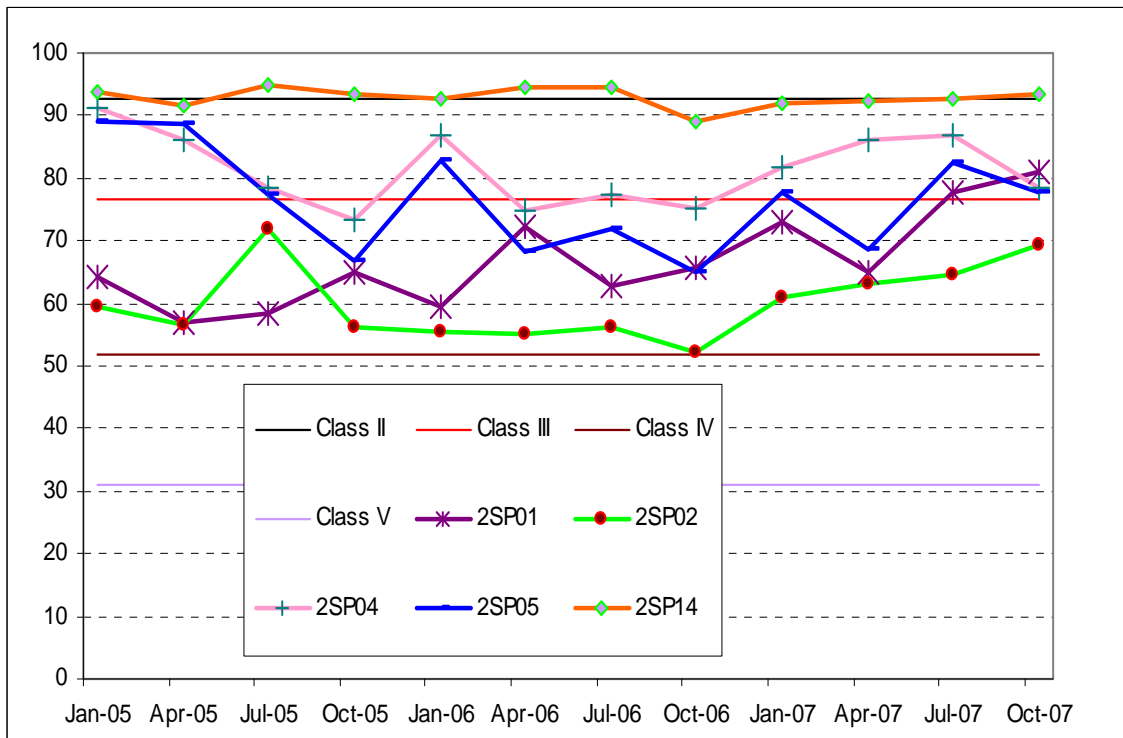


Figure ES-8: Temporal trend of DOE-WQI for Sg. Sepetang Basin from January 05 until October 07

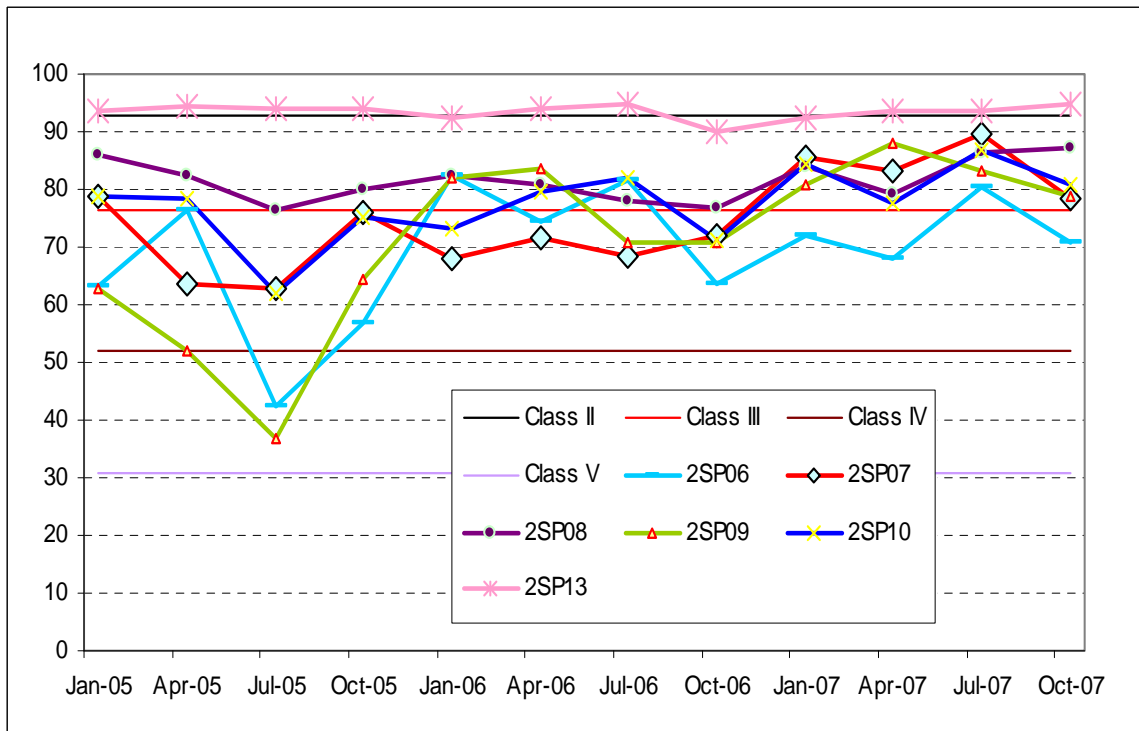


Figure ES-9: Temporal trend of DOE-WQI for Sg. Larut Basin from January 05 until October 07

15. The water quality classification during low flow (June) and high flow (September) based on actual collection at pre-determined sites during the study are presented in Table ES-1 and ES-2, respectively.

16. The highest WQI value of 90.5 was found in Sg Patin (WSB 03) during the low flow condition while the lowest WQI was observed in Sg Ayer Kuning (WSB 01) during the high flow condition with a value of 63.8. The highest concentration of COD (49 mg/l-low flow and 47 mg/l-high flow) and ammoniacal-N (0.9 mg/l-low flow and 0.49 mg/l-high flow) were found at Sg Malai (WSB 07) along with a high value of BOD (4 mg/l-low flow and 5 mg/l-high flow). Refer to Table 4.4 and 4.5 , Volume 2: Main Report.

Table ES-1: Sepetang Sub-basin: River Water Quality during high and low flow conditions

Sg. Sepetang	WSB 01	WSB 02	WSB 03	WSB 04	WSB 05	WSB 06	WSB 07
	Ayer Kuning	Ulu Sepetang	Patin	Rantin	Larah	Kuala Sepetang	Malai
LOW FLOW							
DOE-WQI	71.3	88.0	90.5	81.6	85.3	72.4	70.2
Class	III	II	II	II	II	III	III
HIGH FLOW							
DOE-WQI	63.8	85.7	85.8	77.9	76.9	86.0	72.4
Class	III	II	II	II	II	II	III

Table ES-2: Larut Sub-basin: River Water Quality during high and low flow conditions

Sg. Larut	WSB 08	WSB 09	WSB 10	WSB 11	WSB 12	WSB 13
	Batu Tugoh	Larut	Kuala Larut	Jebong	Tupai	Lidin
LOW FLOW						
DOE-WQI	80.0	87.4	70.2	67.9	80.7	82.8
Class	II	II	III	III	II	II
HIGH FLOW						
DOE-WQI	80.6	94.6	70.0	62.6	78.3	66.7
Class	II	I	III	III	II	III

17. The highest WQI value of 94.6 was found in Larut (WSB09-high flow) while the lowest was observed in Sg Jebong (WSB11-high flow) with WQI value of 62.6. The highest concentration of BOD (11 mg/L) and COD (34 mg/l) were found at WSB13 (Sg Lidin) during the high flow while the highest ammoniacal-N (1.58 mg/L) was found at WSB11 (Sg Jebong) during the high flow condition.
18. Based on the statistical analysis of the DOE database (Jan'05-Oct'07), it was observed that COD, ammoniacal-Nitrogen and DO were the

primary frequent polluting contributors for a Class III denotation for the both basins. The WQI statistical analysis is presented in Table ES-3.

Table ES-3: WQI Statistical Analysis (January 05 - October 07)

Parameter	Class I	Class II	Class III	Class IV	Class V
Ammoniacal Nitrogen	32%	20%	25%	18%	5%
BOD ₅	24%	45%	20%	8%	2%
COD	0%	48%	48%	4%	0%
DO	20%	25%	37%	17%	1%
pH	11%	79%	10%	0%	0%
TSS	68%	23%	8%	0%	0%
Water Quality Index (WQI)	13%	44%	41%	2%	0%

19. The water quality observed throughout the different reaches and sub-basins within the Sg Sepetang river basin varied greatly mainly due to different dominant land-use pattern prevailing at each sub-catchment.
20. The water quality of tributaries flowing through residential, urban set-up and industrial land was consistently poorer compared to tributaries located within rural, agriculture and forested area.

LAND-USE, POLLUTION SOURCES AND LOADING

21. Agriculture is the single most dominant land-use within the sub-basins of Sg Patin, Sg Larah, Sg Malai, Sg Ayer Kuning and Sg Hilir Sepetang in the Sepetang River Basin and accounts for 52.83% of the overall river basin area.
22. In Larut river basin, the forested area accounts for 41.21% of the overall area whereby it forms the single most dominant land-use within the sub-basins of Sg Batu Tugoh, Sg Tupai, Sg Larut and Sg Hilir Sg Larut.
23. A total of 310 point sources have been identified within Sg Sepetang catchment area (Table ES-4) and Figure ES-5 while Sg Larut registered a total of 609 points sources, twice the amount found at Sg Sepetang (Table ES-5) and Figure ES-6. The single biggest source of pollution at Sg Sepetang Catchment is the Public Sewage Treatment Plants.

24. Sg Malai and Sg Rantin are the main recipients of the point sources within the Sepetang Catchment area. Sg. Malai contributed 63% of the point sources followed by Sg. Rantin (29%).
25. There are 36 factories and manufacturing facilities located within the Sg Sepetang basin and 81% of them are located in the Sg Malai sub-basin. 56% of the Public Sewage Treatment Plants are also located within the same sub-basin.
26. In Sg Larut basin, Batu Tugoh (36%) and Jebong (31%) sub-basins are the biggest recipients of pollution sources (Table ES-5). Industries are more concentrated within the Tupai and Jebong sub-basins while Public STPs are found to be highest in Jebong sub-basin. The single biggest source of pollution in Sg Larut basin is restaurants and stalls which account for 34% of the total sources identified within the basin.

Table ES-4: Sg Sepetang Pollution Source Inventory

Point Source	Patin	Larah	Rantin	Malai	Ayer Kuning	Hilir Sepetang	TOTAL
Factories/ Manufacturing	-	-	6	25	-	5	36
Workshops	1	4	13	55	-	-	73
Petrol & Diesel Stations	-	-	1	5	-	-	6
Public STPs	1	-	35	45	-	-	81
Private STPs	1	1	8	3	-	3	16
Waste Recycling	-	-	-	-	-	-	-
Restaurants & Stalls	1	1	14	51	-	1	68
Wet Markets	-	-	-	3	-	-	3
Livestocks	2	-	11	1	4	-	18
Aquaculture	-	-	1	1	-	-	2
Others	-	-	2	5	-	-	7
TOTAL	6	6	91	194	4	9	310

Table ES-5: Sg Larut Pollution Source Inventory

Point Source	Jebong	Batu Tugoh	Tupai	Lidin	Larut	Hilir Larut	TOTAL
Factories/ Manufacturing	15	7	28	2	6	4	62
Workshops	26	39	7	-	21	1	94
Petrol & Diesel Stations	5	6	3	-	5	1	20
Public STPs	24	20	18	14	18	-	94
Private STPs	35	26	4	-	6	1	72
Waste Recycling	6	-	-	-	3	1	10
Restaurants & Stalls	51	111	11	2	29	5	209
Wet Markets	2	2	1	-	5	-	10
Livestocks	14	1	-	-	3	-	18
Aquaculture	3	-	-	-	-	-	3
Others	5	7	1	-	4	-	17
TOTAL	186	219	73	18	100	13	609

27. In terms of pollution loading, Sg Malai sub-basin contributes the highest loading compared to the other 5 sub-basins. The main contributor in terms of pollution loading in Sg Sepetang is BOD and

COD which account for more than 80% of the total loading (Table ES-6).

28. Malai and Hilir Sepetang sub-basins receive the largest pollution load from point sources which in turn contribute significantly to the lower water quality of Sg Sepetang basin.
29. Industrial source is the main contributor of pollution to the Malai sub-basin followed by Public STPs and the wet market. The Kamunting Raya and Kamunting Industrial area are the major sources of pollution loading which translate to about 85% of the total industrial loading. Pasar Borong Kamunting is also another major source of pollution loading especially in terms of BOD and COD.
30. In Sg Larut basin, the main contributors of pollution loading are BOD, COD and TSS (Table ES-7). Jebong, Batu Tugoh and Larut sub-basins receive the largest point source loading which affects to a great extend the overall water quality of Sg. Larut basin.
31. Sg Jebong sub-basin constitutes the single largest contributor of point source loading for BOD, COD, TSS, Oil & Grease while Sg Lidin sub-basin contributes to the NH₃-N loading.

Table ES-6: Total Point Source Contribution of each sub-basin to the Sepetang Basin

SUB-BASIN	Pollution Load (kg/day)						
	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
1. MALAI	1,284.5	4,191.0	1,371.3	76.4	654.0	47.4	336.0
2. HILIR	113.1	554.3	107.8	19.9	41.9	0.0	31.6
3. RANTIN	103.6	421.6	452.9	12.8	28.9	10.0	71.8
4. LARAH	2.7	5.1	4.6	0.0	0.6	0.0	2.3
5. PATIN	1.5	2.9	2.4	0.0	0.3	0.0	1.1
6. AYER KUNING	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Loading	1,504.4	5,174.9	1,939	109.1	725.7	47.4	44.28

Table ES-7: Point Source Contribution of each sub-basin to the Larut Basin

SUB-BASIN	Pollution Load (kg/day)						
	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
1. JEBONG	1,019.0	44,78.6	1,497.0	54.7	119.6	63.2	251.9
2. BATU TUGOH	249.8	859.3	472.2	27.3	23.8	25.2	225.8
3. LARUT	143.7	385.3	180.3	10.7	61.6	11.7	74.7
4. LIDIN	156.1	516.2	166.8	11.3	30.5	46.6	303.1
5. TUPAI	74.3	223.2	99.8	5.2	26.7	5.1	50.4
6. HILIR LARUT	11.5	64.4	43.1	2.7	595.4	0.2	8.5
Total Loading	1,654.4	6,527	2,459.2	111.9	857.6	152	914.4

32. Industrial sources played a significant polluting role at the Jebong sub-basin, contributing significant amounts of BOD, COD, TSS and Oil & Grease loading followed by public and private STPs. The public STPs contributed the most significant loading for ammoniacal nitrogen. Pig farm contributed the least in terms of point source loading due to the small scale of that activity within the Jebong sub-basin.
33. The contribution of point and non-point sources of pollution to the total loading at Sg Sepetang and Sg Larut basins during high and low flow conditions are shown in Tables ES-8 to ES-15.
34. TSS is largely contributed by Non-Point Source (NPS) with a total loading of 6,013.5 kg/day to the Malai sub-basin during high flow.
35. In Sg Larut basin, TSS, Oil and Grease are largely contributed by NPS while others are mostly point source based. NPS has contributed 6,276.5 kg/day of TSS to the Jebong sub-basin during high flow.

Table ES-8: Point Sources Contribution of each sub-basin to the Sepetang Basin during High Flow Condition

MALAI-Pollution Load (kg/day)							
POINT SOURCES	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
INDUSTRY	585.2	2751.0	1029.4	44.9	602.7	18.3	166.9
WET MARKET	497.9	810.4	13.1	3.6	0.0	10.2	54.5
PUBLIC STP	179.2	595.4	318.4	24.5	51.3	18.8	112.3
RESTAURANT	19.9	29.6	5.8	2.9	0.0	0.1	0.0
PRIVATE STP	2.3	4.6	4.6	0.46	N.a	N.a	2.31
HILIR SEPETANG-Pollution Load (kg/day)							
INDUSTRY	110.2	548.7	102.7	19.3	41.9	0.0	29.1
RESTAURANT	0.4	0.6	0.1	0.1	0.0	0.0	0.00
PRIVATE STP	2.5	4.95	4.95	0.5	N.a	N.a	2.5
RANTIN-Pollution Load (kg/day)							
INDUSTRY	3.8	49.7	214.7	2.6	2.4	0.1	0.8
PUBLIC STP	86.4	347.9	220.7	7.8	26.5	9.9	63.1
RESTAURANT	5.5	8.1	1.6	0.8	0.0	0.0	0.01
PRIVATE STP	7.9	15.9	15.9	1.6	N.a.	N.a.	7.9
LARAH-Pollution Load (kg/day)							
RESTAURANT	0.4	0.6	0.1	0.1	0.0	0.0	0.00
PRIVATE STP	2.3	4.5	4.5	0.5	N.a.	N.a.	2.3
PATIN-Pollution Load (kg/day)							
RESTAURANT	0.4	0.6	0.1	0.1	0.0	0.0	0.00
PRIVATE STP	1.1	2.3	2.3	0.23	N.a.	N.a.	1.1

Table ES-9: Point Sources Contribution of each sub-basin to the Sepetang Basin during Low Flow Condition

MALAI-Pollution Load (kg/day)							
POINT SOURCES	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
INDUSTRY	585.2	2751.0	1029.4	44.9	602.7	18.3	166.9
WET MARKET	497.9	810.4	13.1	3.6	0.0	10.2	54.5
PUBLIC STP	179.2	595.4	318.4	24.5	51.3	18.8	112.3
RESTAURANT	19.9	29.6	5.8	2.9	0.0	0.1	0.0
PRIVATE STP	2.3	4.6	4.6	0.46	N.a	N.a	2.31
HILIR SEPETANG-Pollution Load (kg/day)							
INDUSTRY	110.2	548.7	102.7	19.3	41.9	0.0	29.1
RESTAURANT	0.4	0.6	0.1	0.1	0.0	0.0	0.00
PRIVATE STP	2.5	4.95	4.95	0.5	N.a	N.a	2.5
RANTIN-Pollution Load (kg/day)							
INDUSTRY	3.8	49.7	214.7	2.6	2.4	0.1	0.8
PUBLIC STP	86.4	347.9	220.7	7.8	26.5	9.9	63.1
RESTAURANT	5.5	8.1	1.6	0.8	0.0	0.0	0.01
PRIVATE STP	7.9	15.9	15.9	1.6	N.a.	N.a.	7.9
LARAH-Pollution Load (kg/day)							
RESTAURANT	0.4	0.6	0.1	0.1	0.0	0.0	0.00
PRIVATE STP	2.3	4.5	4.5	0.5	N.a.	N.a.	2.3
PATIN-Pollution Load (kg/day)							
RESTAURANT	0.4	0.6	0.1	0.1	0.0	0.0	0.00
PRIVATE STP	1.1	2.3	2.3	0.23	N.a.	N.a.	1.1

Table ES-10: Non-Point Sources Contribution of each sub-basin to the Sepetang Basin during High Flow Condition

DEVELOPMENT- Pollution Load (kg/day)							
SUB-BASIN	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
1. MALAI	2.3	21.6	778.5	0.6	1.1	0.0	0.4
2. HILIR SEPETANG	49.7	472.2	16998.8	13.7	23.2	0.1	8.9
3. RANTIN	8.5	80.9	2911.0	2.3	4.0	0.02	1.5
4. LARAH	1.5	14.6	524.6	0.4	0.7	0.0	0.3
5. PATIN	3.0	28.7	1033.8	0.8	1.4	0.0	0.5
6. AYER KUNING	-	-	-	-	-	-	-
RESIDENTIAL- Pollution Load (kg/day)							
1. MALAI	285.0	1409.1	4890.1	75.7	47.1	0.6	0.9
2. HILIR SEPETANG	92.5	457.4	1587.2	24.6	15.3	0.2	0.3
3. RANTIN	159.5	788.3	2735.6	42.3	26.4	0.33	0.5
4. LARAH	13.2	65.5	227.2	3.5	2.2	0.0	0.0
5. PATIN	13.1	64.5	223.9	3.5	2.2	0.0	0.0
6. AYER KUNING	-	-	-	-	-	-	-
COMMERCIAL- Pollution Load (kg/day)							
1. MALAI	92.3	207.0	128.7	24.8	0.9	0.0	1.3
2. HILIR SEPETANG	14.1	31.6	19.6	3.8	0.1	0.0	0.2
3. RANTIN	21.5	48.1	29.9	5.8	0.2	0.0	0.3
4. LARAH	2.0	4.5	2.8	0.5	0.0	0.0	0.0
5. PATIN	1.2	2.6	1.6	0.3	0.0	0.0	0.0
6. AYER KUNING	-	-	-	-	-	-	-
AGRICULTURE- Pollution Load (kg/day)							
1. MALAI	5.0	47.5	216.3	1.7	1.4	0.2	0.6
2. HILIR SEPETANG	45.1	432.1	1966.2	15.6	12.8	1.8	5.4
3. RANTIN	11.7	112.0	509.5	4.0	3.3	0.46	1.4
4. LARAH	4.1	39.0	177.7	1.4	1.2	0.2	0.5
5. PATIN	27.8	266.8	1214.0	9.6	7.9	1.1	3.3
6. AYER KUNING	-	-	-	-	-	-	-

Table ES-11: Non-Point Sources Contribution of each sub-basin to the Sepetang Basin during Low Flow Condition

DEVELOPMENT- Pollution Load (kg/day)							
SUB-BASIN	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
1. MALAI	0.0	6.6	7.8	0.0	0.0	0.0	0.0
2. HILIR SEPETANG	0.0	145.3	169.6	0.0	0.0	0.0	0.0
3. RANTIN	0.0	24.9	29.0	0.0	0.0	0.0	0.0
4. LARAH	0.0	4.5	5.23	0.0	0.0	0.0	0.0
5. PATIN	0.0	8.8	10.3	0.0	0.0	0.0	0.0
6. AYER KUNING	-	-	-	-	-	-	-
RESIDENTIAL- Pollution Load (kg/day)							
1. MALAI	0.0	123.4	152.8	0.0	0.0	0.0	0.0
2. HILIR SEPETANG	0.0	7.6	17.1	0.0	0.0	0.0	0.0
3. RANTIN	0.0	29.5	45.4	0.0	0.0	0.0	0.0
4. LARAH	0.0	1.1	2.5	0.0	0.0	0.0	0.0
5. PATIN	0.0	1.1	2.4	0.0	0.0	0.0	0.0
6. AYER KUNING	-	-	-	-	-	-	-
COMMERCIAL- Pollution Load (kg/day)							
1. MALAI	26.3	32.7	0.2	0.0	0.0	0.0	0.0
2. HILIR SEPETANG	4.0	5.0	0.02	0.0	0.0	0.0	0.0
3. RANTIN	6.1	7.6	0.04	0.0	0.0	0.0	0.0
4. LARAH	0.6	0.7	0.0	0.0	0.0	0.0	0.0
5. PATIN	0.3	0.4	0.0	0.0	0.0	0.0	0.0
6. AYER KUNING	-	-	-	-	-	-	-
AGRICULTURE- Pollution Load (kg/day)							
1. MALAI	0.0	9.5	18.0	0.0	0.0	0.0	0.0
2. HILIR SEPETANG	0.0	86.4	163.9	0.0	0.0	0.0	0.0
3. RANTIN	0.0	22.4	42.5	0.0	0.0	0.0	0.0
4. LARAH	0.0	7.8	14.8	0.0	0.0	0.0	0.0
5. PATIN	0.0	5.6	53.4	0.0	0.0	0.0	0.0
6. AYER KUNING	-	-	-	-	-	-	-

Table ES-12: Point Sources Contribution of each sub-basin to the Larut Basin during High Flow Condition

JEBONG-Pollution Load (kg/day)							
POINT SOURCES	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
INDUSTRY	790.8	3,849.6	1,116.6	27.2	71.1	54.1	62.6
PUBLIC STP	117.5	419.5	205.6	8.6	48.5	8.2	108.9
PIG FARM	13.7	25.7	14.8	0.6	0.0	0.8	3.3
RESTAURANT	19.9	29.6	5.8	2.9	0.0	0.1	0.0
PRIVATE STP	117.5	419.5	205.6	8.6	48.5	8.2	108.9
BATU TUGOH-Pollution Load (kg/day)							
INDUSTRY	104.4	336.6	259.4	9.6	2.2	20.3	24.3
PUBLIC STP	42.5	231.3	121.3	3.7	21.5	4.8	71.4
WET MARKET	7.2	21.8	8.8	0.9	0.0	0.1	0.1
LANDFILL	18.5	137.5	2.3	0.0	0.1	0.0	96.1
RESTAURANT	43.3	64.4	12.7	6.3	0.0	0.0	0.0
PRIVATE STP	33.9	67.7	67.7	6.8	N.A	N.A	33.9
LARUT-Pollution Load (kg/day)							
INDUSTRY	4.5	16.3	4.9	0.5	17.6	0.2	1.1
PUBLIC STP	112.6	324.4	159.1	7.2	44.0	11.2	69.4
WET MARKET	12.1	21.5	6.7	0.8	0.0	0.2	1.0
RESTAURANT	11.3	16.8	3.3	1.6	0.0	0.1	0.0
PRIVATE STP	3.15	6.3	6.3	0.63	N.a	N.a	3.15
LIDIN-Pollution Load (kg/day)							
INDUSTRY	52.3	213.4	34.8	4.4	11.2	36.6	236.0
PUBLIC STP	103.0	301.6	131.8	6.8	19.3	10.0	67.1
RESTAURANT	0.8	1.2	0.2	0.1	0.0	0.0	0.0
TUPAI-Pollution Load (kg/day)							
INDUSTRY	2.4	19.7	7.7	1.0	1.8	0.4	2.7
PUBLIC STP	54.2	169.4	81.1	2.9	24.9	4.6	43.6
WET MARKET	10.2	21.3	3.4	0.1	0.0	0.1	0.9
RESTAURANT	4.3	6.4	1.3	0.6	0.0	0.0	0.0
PRIVATE STP	3.2	6.3	6.3	0.63	N.a	N.a	3.2
HILIR LARUT-Pollution Load (kg/day)							
INDUSTRY	1.6	45.7	26.7	0.8	595.4	0.2	0.6
PRIVATE STP	7.9	15.8	15.8	1.58	N.a.	N.a.	7.9
RESTAURANT	2.0	2.9	0.6	0.3	0.0	0.0	0.0

Table ES-13: Point Sources Contribution of each sub-basin to the Larut Basin during Low Flow Condition

JEBONG-Pollution Load (kg/day)							
POINT SOURCES	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
INDUSTRY	790.8	3,849.6	1,116.6	27.2	71.1	54.1	62.6
PUBLIC STP	117.5	419.5	205.6	8.6	48.5	8.2	108.9
PIG FARM	13.7	25.7	14.8	0.6	0.0	0.8	3.3
RESTAURANT	19.9	29.6	5.8	2.9	0.0	0.1	0.0
PRIVATE STP	117.5	419.5	205.6	8.6	48.5	8.2	108.9
BATU TUGOH-Pollution Load (kg/day)							
INDUSTRY	104.4	336.6	259.4	9.6	2.2	20.3	24.3
PUBLIC STP	42.5	231.3	121.3	3.7	21.5	4.8	71.4
WET MARKET	7.2	21.8	8.8	0.9	0.0	0.1	0.1
LANDFILL	18.5	137.5	2.3	0.0	0.1	0.0	96.1
RESTAURANT	43.3	64.4	12.7	6.3	0.0	0.0	0.0
PRIVATE STP	33.9	67.7	67.7	6.8	N.A	N.A	33.9
LARUT-Pollution Load (kg/day)							
INDUSTRY	4.5	16.3	4.9	0.5	17.6	0.2	1.1
PUBLIC STP	112.6	324.4	159.1	7.2	44.0	11.2	69.4
WET MARKET	12.1	21.5	6.7	0.8	0.0	0.2	1.0
RESTAURANT	11.3	16.8	3.3	1.6	0.0	0.1	0.0
PRIVATE STP	3.15	6.3	6.3	0.63	N.a	N.a	3.15
LIDIN-Pollution Load (kg/day)							
INDUSTRY	52.3	213.4	34.8	4.4	11.2	36.6	236.0
PUBLIC STP	103.0	301.6	131.8	6.8	19.3	10.0	67.1
RESTAURANT	0.8	1.2	0.2	0.1	0.0	0.0	0.0
TUPAI-Pollution Load (kg/day)							
INDUSTRY	2.4	19.7	7.7	1.0	1.8	0.4	2.7
PUBLIC STP	54.2	169.4	81.1	2.9	24.9	4.6	43.6
WET MARKET	10.2	21.3	3.4	0.1	0.0	0.1	0.9
RESTAURANT	4.3	6.4	1.3	0.6	0.0	0.0	0.0
PRIVATE STP	3.2	6.3	6.3	0.63	N.a	N.a	3.2
HILIR LARUT-Pollution Load (kg/day)							
INDUSTRY	1.6	45.7	26.7	0.8	595.4	0.2	0.6
PRIVATE STP	7.9	15.8	15.8	1.58	N.a.	N.a.	7.9
RESTAURANT	2.0	2.9	0.6	0.3	0.0	0.0	0.0

Table ES-14: Non-Point Sources Contribution of each sub-basin to the Larut Basin during High Flow Condition

DEVELOPMENT- Pollution Load (kg/day)							
SUB-BASIN	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
1. JEBONG	4.4	43.5	1565.5	1.3	2.1	0.0	0.8
2. BATU TUGOH	2.7	25.4	913.9	0.7	1.2	0.0	0.5
3. LARUT	5.6	53.6	1927.9	1.6	2.6	0.0	1.0
4. LIDIN	4.0	38.2	1376.5	1.6	1.9	0.0	0.7
5. TUPAI	4.1	38.7	1394.8	1.1	1.9	0.0	0.7
6. HILIR LARUT	0.8	7.7	276.4	0.2	0.4	0.0	0.1
RESIDENTIAL- Pollution Load (kg/day)							
1. JEBONG	235.1	1162.4	4033.9	62.4	38.9	0.5	0.7
2. BATU TUGOH	114.3	564.9	1960.5	30.3	18.9	0.2	0.4
3. LARUT	187.2	925.4	3211.3	49.7	30.9	0.4	0.6
4. LIDIN	42.3	209.1	725.5	49.7	7.0	0.4	0.1
5. TUPAI	72.3	357.6	1241.1	19.2	12.0	0.1	0.2
6. HILIR LARUT	56.6	280	971.7	15.0	9.4	0.1	0.2
COMMERCIAL- Pollution Load (kg/day)							
1. JEBONG	114.2	256.2	159.2	30.7	1.1	0.0	1.6
2. BATU TUGOH	143.7	322.3	200.3	38.6	1.4	0.0	2.0
3. LARUT	83.9	188.2	117.0	22.5	0.8	0.0	1.2
4. LIDIN	9.7	21.7	13.5	22.5	0.1	0.0	0.1
5. TUPAI	50.7	113.6	70.6	13.6	0.5	0.0	0.7
6. HILIR LARUT	12.1	27.1	16.9	3.2	0.1	0.0	0.2
AGRICULTURE- Pollution Load (kg/day)							
1. JEBONG	11.9	113.8	517.9	4.1	3.4	0.5	1.4
2. BATU TUGOH	3.1	30.2	137.3	1.1	0.9	0.1	0.4
3. LARUT	9.4	90.4	411.5	3.3	2.7	0.4	1.1
4. LIDIN	3.6	35.0	159.0	3.3	1.0	0.4	0.4
5. TUPAI	0.5	4.7	21.2	0.2	0.1	0.0	0.1
6. HILIR LARUT	6.9	66.6	302.9	2.4	2.0	0.3	0.8

Table ES-15: Non-Point Sources Contribution of each sub-basin to the Larut Basin during Low Flow Condition

DEVELOPMENT- Pollution Load (kg/day)							
SUB-BASIN	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
1. JEBONG	0.0	13.4	15.6	0.0	0.0	0.0	0.0
2. BATU TUGOH	0.0	7.8	9.1	0.0	0.0	0.0	0.0
3. LARUT	0.0	16.5	13.0	0.0	0.0	0.0	0.0
4. LIDIN	0.0	11.8	13.7	0.0	0.0	0.0	0.0
5. TUPAI	0.0	11.9	13.9	0.0	0.0	0.0	0.0
6. HILIR LARUT	0.0	2.4	2.8	0.0	0.0	0.0	0.0
RESIDENTIAL- Pollution Load (kg/day)							
1. JEBONG	0.0	19.3	43.5	0.0	0.0	0.0	0.0
2. BATU TUGOH	0.0	9.4	21.2	0.0	0.0	0.0	0.0
3. LARUT	0.0	15.4	34.7	0.0	0.0	0.0	0.0
4. LIDIN	0.0	19.9	7.8	0.0	0.0	0.0	0.0
5. TUPAI	0.0	5.9	113.4	0.0	0.0	0.0	0.0
6. HILIR LARUT	0.0	4.6	10.5	0.0	0.0	0.0	0.0
COMMERCIAL- Pollution Load (kg/day)							
1. JEBONG	32.6	40.5	0.2	0.0	0.0	0.0	0.0
2. BATU TUGOH	41.1	50.9	0.3	0.0	0.0	0.0	0.0
3. LARUT	24.0	29.7	0.2	0.0	0.0	0.0	0.0
4. LIDIN	2.8	3.4	0.0	0.0	0.0	0.0	0.0
5. TUPAI	14.5	17.9	0.1	0.0	0.0	0.0	0.0
6. HILIR LARUT	3.5	4.3	0.0	0.0	0.0	0.0	0.0
AGRICULTURE- Pollution Load (kg/day)							
1. JEBONG	0.0	22.8	43.2	0.0	0.0	0.0	0.0
2. BATU TUGOH	0.0	6.0	11.4	0.0	0.0	0.0	0.0
3. LARUT	0.0	18.0	34.3	0.0	0.0	0.0	0.0
4. LIDIN	0.0	7.0	13.3	0.0	0.0	0.0	0.0
5. TUPAI	0.0	0.9	1.8	0.0	0.0	0.0	0.0
6. HILIR LARUT	0.0	13.3	25.2	0.0	0.0	0.0	0.0

POLLUTION CONTROL STRATEGY

36. In order to formulate strategic design approach for improvement of the river water quality, analysis was made on public sewage treatment plants and outfall data from selected industrial areas to estimate the actual organic load that enters into the two river basins, Sg Sepetang and Sg Larut.
37. Some measures and mitigation plan have been drafted to remedy the deteriorating river water quality at three river stretches along Sg Sepetang namely, Sg Rantin, Sg Malai and Sg Sepetang-Hilir. The main pollution sources are primarily due to industrial effluent and sewage discharge. For Sg Larut basin, three river stretches have been identified that need further improvement work, namely, Sg Lidin, Sg Batu Tugoh and Sg Larut-Hilir. In these sub-basins, pollution is coming from domestic sewage followed by some industrial discharge.
38. Performance of STPs was evaluated in terms of meeting the effluent standard. Immediate attention and upgrading work are required to address and overcome the problematic STPs, which is about 52 of the total public STPs. Sg Lidin (17,780 PE) and Sg Jebong (26,164 PE) are noted to have very high PE loading, but on the overall score, Sg Larut basin is having a more serious problem as far as sewage is concerned.
39. In terms of pollutant load, industries within Sg Sepetang - Sg Malai contribute highest BOD, COD and Ammoniacal-N (Refer Figure 5.45 Volume 2: Main Report). The Kamunting Industrial Area scores the highest level of polluting load followed by Kamunting Raya and Simpang Empat Industrial Estates.
40. The strategic approach for reducing the pollutant load in the river has been recommended which consist of eight river water quality improvement projects for Sg Sepetang and Sg Larut Basins. One new centralized STPs is proposed in Kamunting and Taiping area, which will effectively manage sewage effluent in urban and developed areas. In addition, artificial wetland in pond system is proposed to clean and reduce organic load in some critical parts of the river. Four strategic locations have been identified for installation of the wetland ponding system. The sites are upstream areas of Sg Malai Sg Sepetang, Sg Lidin and Sg Jebong.

41. There are scattered areas of squatters along the rivers and their contributions towards river pollution are minimal. Hence, the issue of relocating them is not a priority as long as the numbers do not increase and under control by the local authorities.
42. Another concern is the high pollution level generated from Pasar Borong Kamunting where a wastewater treatment plant is proposed. Similarly, Jebong Landfill is a potential hazard due to poorly treated leachate. Therefore, a new leachate treatment plant is proposed using upgraded anaerobic pond and polished by wetland ponding system.
43. The proposed eight projects are part of the overall strategies for Sg Sepetang and Sg Larut river rehabilitation programmes for improvement of the river water quality. The beneficial impact will be seen from the results of QUAL2K model study. The selected parameters used in the modelling results are BOD, DO and Ammoniacal-N.
44. For Sg Sepetang, Table ES-16 shows the simulated data if all projects are implemented. Tables ES-17 and ES-18 show simulated data for the sewage treatment plant and wetland projects if they are implemented separately.
45. It was found that the BOD change is significant for some stretches. There will be 30% improvement in BOD for Sg Sepetang (at km 0.51) as shown in Table ES-16. Similarly, Ammoniacal-N level would also be reduced at Sg Sepetang (km 18.97) by 28.2%.
46. If only the proposed new STP is to be implemented, the simulated data show major improvement for Ammoniacal-N. The data clearly indicate up to 38% reduction of Ammoniacal-N which may occur for Sg Rantin. (Table ES-17). Sg Malai will also show improvement by as much as 10.3% (Ammoniacal-N level).

Table ES-16: River Improvement after Implementation of All Projects – Sg. Sepetang Basin

River Name	BOD Before	BOD After	% Change	Stretch km*
Sg Sepetang	4.24	2.95	30.4	0.51
River Name	AN Before	AN After	% Change	Stretch km*
Sg Sepetang	0.39	0.28	28.2	18.97
Sg Malai	0.97	0.84	13.4	0.49
Sg Ayer Kuning	0.30	0.29	3.3	3.59
Sg Rantin	0.93	0.59	36.5	3.46

* distance measured from starting point of the river concerned

Table ES-17: River Improvement after Implementation of Sewage Treatment Plant – Sg Sepetang Basin

River Name	AN Before	AN After	% Change	Stretch km*
Sg Sepetang	0.40	0.29	27.5	19.90
Sg Malai	0.97	0.87	10.3	0.49
Sg Ayer Kuning	0.30	0.29	3.3	3.59
Sg Rantin	1.07	0.66	38.3	4.44

* distance measured from starting point of the river concerned

47. For wetland projects, the BOD will be significantly decreased, resulting in more than 20% improvement in river water quality. DO is expected to increase by 13.5% and Ammoniacal-N will be reduced by 17.5%, particularly at Sg Malai.

Table ES-18: River Improvement after Implementation of Wetland – Sg. Sepetang Basin

River Name	BOD Before	BOD After	% Change	Stretch km*
Sg Sepetang	3.74	2.98	20.3	15.53
Sg Malai	3.67	2.83	22.8	4.44
River Name	DO Before	DO After	% Change	Stretch km*
Sg Malai	4.46	5.06	13.5	3.46
River Name	AN Before	AN After	% Change	Stretch km*
Sg Malai	0.97	0.80	17.5	0.49

48. For Sg Larut basin, Tables ES-19 to ES-22 present all the simulated results of the river water quality parameters.
49. It was found that the BOD change is significant for many river stretches. There will be 40% improvement in BOD for Sg Lidin (at km 0.41) as shown in Table ES-19. The DO level also demonstrates a major improvement of more than 104% at Sg Jebong (km 1.52). Ammoniacal-N level would also be reduced at Sg Larut (km 13.42) by 60%.

Table ES-19: River Improvement after Implementation of All Projects – Sg. Larut Basin

River Name	BOD Before	BOD After	% Change	Stretch km
Sg Jebong	3.52	2.46	30.1	1.50
Sg Batu Tugoh	3.03	2.90	4.3	5.30
Sg Larut	3.00	2.58	14.0	9.60
Sg Lidin	3.38	2.00	40.8	0.41
River Name	DO Before	DO After	% Change	Stretch km*
Sg Jebong	2.68	5.45	104	1.52
Sg Batu Tugoh	6.74	6.92	2.6	6.26
Sg Larut	4.40	5.71	29.7	5.40
River Name	AN Before	AN After	% Change	Stretch km*
Sg Jebong	1.34	0.89	33.6	9.65
Sg Batu Tugoh	0.56	0.27	51.8	7.03
Sg Larut	1.20	0.48	60.0	13.42
Sg Tupai	0.44	0.29	34.1	0.51
Sg Lidin	2.76	1.02	63.0	0.41

* distance measured from starting point of the river concerned

50. If only the proposed new STP is to be implemented, the simulated data also shows major improvement for BOD, DO and Ammoniacal-N. Sg.Jebong (km 10.67) will have obtained 19.7% improvement of BOD. Apparently, the DO level in Sg. Jebong (km 0.51) will increase significantly by 58%. The data also clearly indicates up to 50% reduction of Ammoniacal-N which may occur at Sg. Batu Tugoh.

Table ES-20: River Improvement after Implementation of Sewage Treatment Plant only – Sg Larut Basin

River Name	BOD Before	BOD After	% Change	Stretch km*
Sg Jebong	3.60	2.89	19.7	10.67
Sg Batu Tugoh	3.03	2.90	4.3	5.30
Sg Larut	3.00	2.85	5.0	9.68
River Name	DO Before	DO After	% Change	Stretch km*
Sg Jebong	2.59	4.09	57.9	0.51
Sg Batu Tugoh	6.91	7.05	2.0	7.23
Sg Larut	4.40	5.07	15.2	5.40
River Name	AN Before	AN After	% Change	Stretch km*
Sg Jebong	1.34	0.89	33.6	9.65
Sg Batu Tugoh	0.12	0.06	50.0	11.09
Sg Tupai	0.44	0.30	31.8	0.51
Sg Lidin	2.76	2.64	4.4	0.41

* distance measured from starting point of the river concerned

51. For wetland project, it appears that the BOD will be significantly decreased, resulting in more than 39% improvement in river water quality. DO is expected to increase up to 107% at Sg Jebong and Ammoniacal-N will be reduced by about 60%, particularly at Sg Jebong and Sg Lidin.

Table ES-21: River Improvement after Implementation of Wetland only – Sg. Larut Basin

River Name	BOD Before	BOD After	% Change	Stretch km*
Sg Jebong	3.31	2.27	31.42	7.62
Sg Lidin	3.38	2.04	39.65	0.41
Sg Larut	3.18	2.76	13.21	5.40
River Name	DO Before	DO After	% Change	Stretch km*
Sg Jebong	2.59	5.36	106.95	0.51
Sg Larut	4.40	5.51	25.23	5.40
River Name	AN Before	AN After	% Change	Stretch km*
Sg Jebong	1.04	0.83	20.20	0.51
Sg Lidin	2.76	1.06	61.60	0.41
Sg Larut	1.35	0.56	58.52	15.08

* distance measured from starting point of the river concerned

52. If only landfill project is implemented the BOD at downstream of the landfill area will improve slightly by 2% at Sg Batu Tugoh (km 0.48), but the DO shows a dramatic improvement of 42.9% in Sg Jebong (km 0.51) [Table ES-22].

Table ES-22: River Improvement after Implementation of Landfill only – Sg. Larut Basin

River Name	BOD Before	BOD After	% Change	Stretch km*
Sg Batu Tugoh	3.04	2.98	2.0	0.48
River Name	DO Before	DO After	% Change	Stretch km*
Sg Jebong	2.59	3.70	42.9	0.51

* distance measured from starting point of the river concerned

53. It is observed that some selected stretches of Sg. Sepetang, namely in the Malai sub-basin will experience an improvement in the DO level, resulting a small stretch to change from Class IV to Class III .
54. For Sg Larut basin, there will be a significant change in water quality class due to DO improvement at Sg Jebong sub-basin. The downstream part of Sg Jebong will improve from existing Class III to Class II.

55. The total capital cost involved for all the projects is estimated to be RM 192.4 million. The centralized STPs costs about RM 87 million, and the ponds/wetland projects will amount to RM 3.4 million. It is estimated that operation and maintenance cost is estimated to be about RM 3.14 million per year. However, the costing does not include land cost if they need to be acquired.

WATER QUALITY MODELLING

56. One of the essential aspects of the current study is to provide water quality modeling for Sg Sepetang river basin that can simulate the quantity and quality of the water due to various pollution discharges along the river. The river water quality modeling was performed using the 1-Dimensional Stream Water Quality Model (QUAL2K). For the development of the model, Sg Sepetang River Basin has been divided into two main river system, i.e. Sg Sepetang and Sg Larut river systems. Sg Sepetang river system consists of six sub-basins, namely the Sg Ayer Kuning, Sg Larah, Sg Malai, Sg Patin, Sg Rantin and Hilir Sg. Sepetang, while Sg Larut river network consists of six sub-basins, namely Sg Larut, Sg Lidin, Sg Tupai, Sg Batu Tugoh, Sg Jebong and Hilir Sg Larut. The total length modeled for Sg Sepetang is about 18km while for Sg Larut the modeled length is 23.5km. The model stops before the estuarine area to avoid complications that may arise from the tidal effects of the river mouth. It is important to note that the model does not simulate the whole length of Sg.Sepetang and Sg Larut due to the limitation of QUAL2K model. The hydraulic characteristics of the model, hydrological and contaminants data for various locations along the river basin were obtained from the relevant agencies, previous studies, and field sampling. The coefficients for the water quality parameters were sourced from the relevant literatures. The developed model was calibrated and validated using the data collected from June to November 2007 (High Flow).
57. The results obtained from the modelling exercise have shown reasonable agreement between simulated and the measured values, except for certain stations where the model underestimates or overestimates the parameters. Four parameters were simulated by the model, namely the dissolved oxygen (DO), biochemical oxygen demand (BOD), ammoniacal nitrogen (AN) and pH. The response of model predicted calculations is consistent with the trends of the observed data ranges but not with absolute values in all cases. The model seems to have difficulties in matching the DO, BOD, pH, and AN near the most downstream stations for both river systems. These stations are located downstream of the last tributaries, and the salinity

readings recorded at these stations imply that salt water intrusion is possible. Furthermore, the location of these stations is quite close to the estuarine area which may experience the tidal effects. This could lead to differences between the model and observed values as the model cannot simulate the saline water intrusion and the dynamic of the tidal effects. In addition, the natural variations of these parameters along the reaches may also contribute to the discrepancies.

58. Comparison between the results for low flow and high flow seasons has also been presented. In summary for both rivers, the BOD shows an increase in concentration during the high flow season. On the other hand, the AN depicts a higher concentration during low flow season. Some differences for the pH can also be seen, while no significant difference for the DO value between the seasons.

DECISION SUPPORT SYSTEM – SEPETANG AND LARUT POLLUTION INFORMATION SYSTEM – DECISION SUPPORT SYSTEM (SeLaPIS-DSS)

59. A user-friendly Decision Support System using GIS has been developed. The system is named as **SeLaPIS-DSS** for **Sepetang and Larut Pollution Information System – Decision Support System**.
60. SeLaPIS-DSS provides seamless integration between ArcGIS 9.2 with Qual2K version 2.07 (released in March 2007), running on Microsoft XP. SeLaPIS-DSS also houses the point-sources inventory survey database as well as high resolution (0.67 meter) Quickbird satellite images, land use information, and a host of other related GIS data (e.g., cadastral lot, administrative districts and mukim, river, road lines, and the like). SeLaPIS is a specially customized and programmed application compiled as ArcGIS ArcView 9.2 extension containing functionalities such as reporting function, point sources data editing function, and QUAL2K integration function.

Qual2K integration allows “what-if” scenario analysis to be conducted within SeLaPIS-DSS. Based on default or existing scenario, a user may change certain inputs or conditions, and the system would enable visualisation or effects due to the changes. As an example, the user may close certain point sources and thus reduce loading into the river segment. The effect of such changes could then be visualise immediately in ArcGIS. Such “what-if” analysis would enable users to test certain configuration or potential solutions deem beneficial to the improvement of river water quality.

The system has been developed for users with minimal GIS training or exposure to ArcGIS ArcView software. The Detailed of this system can be further explored in the SeLaPIS-DSS user manual.

STATUS OF AQUATIC BIOLOGY

61. River water at various temporary monitoring stations in Sepetang river basin was sampled during relatively high-flow (April 2007) and low-flow periods (July 2007). Chlorophyll a content was determined according to the procedure of APHA standard method of 10200H. The chlorophyll a content of river samples at Sg. Batu Tugoh, Sg. Tupai, and Sg. Larut (Kuala) was found to be 15.5, 12.8, and 7.7 µg/L, respectively. The water samples of other sampling points contained chlorophyll content of less than 5.0 µg/L.
62. The P-PO₄ concentration in Sepetang river basin varied from 0.01 mg/l (Sg Patin) to 0.39 mg/l (Sg Batu Tugoh) during low-flow period.
63. The *E. coli* enumerations in various sub-basins of the Sepetang river basin were either of Class III or IV. This indicates that the river water is slightly polluted with faecal materials derived from STPs and non-point sources. With the exception of Sg Sepetang (Ulu) and Sg Patin, the source of faecal contamination may arise from human.
64. Informal interview with fisherman was carried out to assess qualitatively the aquatic life available in the river basin. The species of fishes caught at or near the upper stretch of Sepetang river (N 04° 56.704'; E 100° 41.314') were tilapia (*Tilapia mossambica*), ikan putih (*Puntius binotatus*, common barb) and lampam jawa (Javanese carp). Udang galah (giant freshwater prawn) of medium size was also caught in river Sepetang at Kg. Dew (N 04° 54.560'; E 100° 39.826'). Since the tolerance level of *P. binotatus* was recorded as 2.5 (class II), the upper stretch of Sg. Sepetang should have a water quality at least of class II.
65. The fresh water aquaculture in Sepetang river basin is relatively small, occupying a total area of less than 150 ha. The common species are red tilapia, carps and river carps of various types.
66. The Sepetang and Larut rivers flow through an important mangrove forest called the Matang Mangrove Forest Reserve before draining into the Straits of Malacca. The Matang Mangrove Forest Reserve is located in the administrative districts of Krian, Larut/Matang and

Manjung in the State of Perak, on the northwest coast of Peninsular Malaysia. It measures about 40,466 hectares excluding major waterways. The reserve consists mostly of *Rhizophora apiculata* stands ranging in age from 1-30 years and represents about 40% of the total mangroves in Malaysia. A total productive forest area of 29,794 hectares (74%) and restrictive productive forest of 2,892 hectares (7%) has sustainable production of timber outputs, mainly for the production of charcoal and construction poles. The annual production of charcoal and firewood from May 2006 to April 2007 was estimated as 13,917 metric tonnes and 6,129 metric tonnes, respectively. The total number of charcoal kilns in Matang forest reserve for 2007 stands at 348. In Sepetang river basin, there are 177 kilns with 100 kilns at Kuala Sepetang and 77 kilns situated at Kampung Dew and other locations along downstream of Sg. Sepetang.

67. The Matang Mangrove Forest Reserve is an important brackish aquaculture site consisting of a total of 90 hectares and 31,073 sq. m. of brackish ponds and cages (3,385), respectively in 2007. The three main cultured fishes are giant seabass (*Lates calcalifer*), golden snapper (*Lutjanus johii*) and red snapper (*Lutjanus argentimaculatus*).
68. The mud flats adjacent of the Matang Mangrove Forest are suitable cultural areas for cockle production. In 2005, there were 237 culturists, operating on 5,220.8 ha of mud-flats in Perak. At least half of culturists operate in Matang Mangrove Forest and about 63% of cockle producing mud-flats in Perak. Kuala Sangga is the most important cockle production area, occupying at least 30% cockle producing area in Perak. The total production of cockles in Matang was 32,612.38 and 28,342 tonnes in 2004 and 2005, respectively. The Matang Mangrove Forest reserve produces about 50% of the total cockles in Malaysia. However, Matang produces only 5-10 % of the cockle seeds/spat.
69. Fireflies are of late getting more important as a natural resource in ecotourism industry. Fireflies belong to the family Lampyridae and are members of the Coleoptera. The species of fireflies found in Sepetang river basin is *Pteroptyx valida* Olivier. From 300 m downstream of Kg. Dew Bridge to about 8 km downstream along the Sepetang river, night-time congregation of synchronous fireflies of *Pteroptyx tener* Olivier, were observed and scattered onto some 60% of the riparian berembang trees (*Sonneratia caseolaris* Engl.). In 2006, the Department of Forestry has put up a proposal to the State Government to include fireflies watching on display trees as another project for ecotourism along Sepetang river.

70. In conclusion, Sg Sepetang river basin at its present status has vast potential to support important aquaculture industries for the State of Perak as well as an ecotourism destination for the public.

SOCIO – ECONOMICS

71. The socio-economic section reports on the result of contingent valuation study on household demand for water quality improvement and industrial sector (firm) expenditure on environmental protection as well as firm expenses to avoid or reduce the pollution resulting from the development of their commercial activities. In general the households were well aware of pollution related to Sg Sepetang Basin.
72. In the survey, the respondents were asked on their understanding of the pollution problem faced by the river basin and almost 31% have heard about the pollution while 30% never come across or heard of the problem. About 16.2% heard about the pollution problem through newspapers while 10.4% has personally observed the pollution level of the Sepetang River/Larut River.
73. Most of the respondents reported a positive willingness to pay for the water quality improvement for the Sg Sepetang Basin. The average WTP is about RM4.60 per months. This is considered as a “fair value” as compared with other studies conducted elsewhere. Thus, it can be safely concluded that the members of the public are quite willing to contribute a fair amount of resources to keep the river clean. The willingness to pay (WTP) for water quality improvement is dependent on the status of household income.
74. The educational factor correlates well with WTP. Higher correlation (0.79) has been recorded for sub-sample urban respondents whereas the average correlation (0.45) was observed in rural sub-sample respondents. Education factor combined with increasing living standards (increase in income) may improve the awareness on the environmental issues among the community.
75. In brief, firms operating in the study area are involved in diverse activities, such as food, oil palm, manufacturing, resource-based as well as in services such as the auto, medical supply and services. Capital spending on pollution abatement remains relatively small as it only represents 11% of the total sales and 0.013% of the operational capital. Firms that have a relatively higher share of pollution abatement expenditure (operational cost) include those related to oil palm and food manufacturing/processing plants.

76. None of the firms took advantage of the environmental incentive plan as offered by MIDA while a few adopt in-house energy saving schemes that could result in substantial saving of income. A relatively small number of firms adopt the ISO1400 and there is a continuous need to adopt such scheme as it would allow fully integrated environmental management strategies among the firm. In the long run, firms adopting such standard practices may be able to gain some cost savings in terms of pollution/effluent abatement.
77. Some concluding highlights of the socio economic section include the followings:
- i) Most of the respondents reported a positive willingness to pay (WTP) where the average WTP is about RM4.60 per months. Despite a higher willingness to pay, the level of awareness is fairly low especially among the low income earners.
 - ii) The total forecasted population for the Larut and Matang District is expected to reach 218,196 persons (2005), 240,316 persons (2010), 245,002 persons (2015), 249,780 persons (2020), 254,651 persons (2025), and 259,616 persons (2030).
 - iii) Firms spend an average of RM19,400 per year for installing treatment plants to address pollution.
 - iv) A sizeable number of firms adopt pollution control in some other ways, especially in energy saving techniques.
 - v) Only 7% of the total number of firms received tax exemption to conduct environmental monitoring and research in conservation projects to a tune of RM1000-RM1050 for the financial period reported.
 - vi) Econometric model shows an inverse relationship between expenditure spent on effluent and firm willingness to adopt environmental management standard such as ISO400. In the long run, firms adopting such standard practices may be able to gain some cost savings for pollution.

ACTION PLAN

78. An action plan has been proposed to improve water quality status so that the Sepetang River Basin will maintain its quality in the coming future. The action plan includes various aspects on management control of point sources, plans for water quality improvement and pollution control as well as public awareness programs. The management related action plans and activities include:

- i. Installation of gross pollutant traps (GPT) for commercial areas, hawker centres, motor workshops and markets;
- ii. Management of Larut development and agricultural activities to reduce TSS loading in urban run off;
- iii. Management of pollution loading from workshop and service station.

The plans for water quality improvement and pollution controls are:

- i. Installation of central sewage treatment plants at Kamunting and Taiping for effective treatment of domestic sewage especially ammoniacal nitrogen;
 - ii. Construction of wetland system for Sg Malai, Sg Sepetang, Sg Lidin and Sg Jebong;
 - iii. Construction of leachate treatment and wetland system for Jebong landfill.
79. The action plan for public awareness and participation is to educate the public on the importance of preventing river pollution.
80. The action plan also recommends the establishment of Sg Sepetang Secretariat to manage the water resource of Sg Sepetang Basin.
81. The action plan also suggests to install nine water quality stations to establish a comprehensive water quality network in Sg Sepetang Basin.

BENEFIT COST ANALYSIS

82. The component related to the benefit aspect of Sg. Sepetang water quality improvement projects was directly derived from contingent valuation approach which includes:
- a) User value which includes physical use or access to the river basin which include recreation, tourism, and source of income derive from the river as well as the aesthetics value of the river.

- b) Existence values which include the societies value for environmental goods such the river system. In this study, the society willingness to pay (WTP) provide a conservative measure of how much the society as a whole is willing to pay to preserve and implement project for water quality improvement for Sepetang River basin.
83. Based on the benefit stream, the net present value and benefit cost ratio were calculated and presented in Table ES-23.

Table ES-23: Benefit Cost Analysis and Net Present Value

Base	Discount rate		
	7.5%	10%	13%
Benefit Cost Present value(BCPV)			
Net Present Value	RM136.0m	R132.0m	RM129.0m
Benefit Cost Ratio	1.75	1.77	1.79

All calculations were adjusted for 6% of inflation rate

84. Since the benefit cost ratio is greater than one, the option to implement the project is considered feasible. As such the ratio indicates that for every ringgit of costs imposed on society, there is RM1.75 to RM1.79 in realized benefits in terms of health and cleaner environment. Based on the alternative methods of present value of net benefits (PVNB) and since PVNB is greater then zero (based on the 3 level of discount rates), the policy option is economically feasible. The PVNB indicator is totally based on benefit-cost differential and it also measures the monetary (RM) value of excess benefits. As such, it directly implies the net gain of the projects to the society.

CONCLUSION

85. Sepetang and Larut river basins are the two important basins in the Northwest part of the State of Perak. Kamunting and the Kamunting Industrial Area are situated in the Sepetang river basin whereas Taiping is an important municipal district in the Larut river basin. Since 2004, the overall classification of water quality of these two river basins have been classified as Class III. The objective of the present study is to produce strategies and action plan for the pollution prevention and enhancement of river water to clean water.
86. All the point sources (PS) and non-point sources (NPS) of pollution have been identified by field survey. All records on these pollution sources have been edited and converted into a GIS-Database.

87. At various head-water (HW) stations and sampling stations, the water quality and hydrological survey was conducted during high-flow and low-flow conditions.
88. By using the QUAL2K Water Quality model, the quantity and quality of the water due to various pollution discharges along the river can be simulated. Various simulation studies have been conducted to identify suitable action plans so that the water quality in these river basins can be maintained at Class II in all times. Eight main engineering projects have been proposed. These action plans could certainly improve the water quality and protect the many biological resources, such as fish and prawn species, cockles from pollution, especially in the Matang Mangrove Forest situated at the mouths of the river basins.

PART B
RINGKASAN
EKSEKUTIF

RINGKASAN EKSEKUTIF

PENGENALAN

1. Laporan ini berkaitan “Kajian Pencegahan Pencemaran dan Peningkatan Kualiti Air Sg Sepetang, Perak”. Kawasan kajian terletak diantara $4^{\circ} 45.18'N$, $100^{\circ} 36.65' E$ dan $4^{\circ} 59.28'N$, $100^{\circ} 48.72' E$, meliputi tiga lembangan Sg, iaitu Sg Sepetang, Sg Larut dan gabungan Sg Reba dan Sg Menangis. Fokus utama kajian adalah pada lembangan Sg Sepetang dan lembangan Sg Larut. Fokus sekunder ditujukan ke atas lembangan Sg Reba dan Sg Menangis, yang hampir keseluruhannya lembangan berhampiran laut. Terletak diantara Sg Sepetang dan Sg Larut kawasan ini boleh dianggap sebagai penerima bahan pencemar yang mengalir dari kedua-dua Sg Sepetang dan Sg Larut. Lembangan ini adalah sebahagian daripada Hutan Paya Bakau Matang. Keseluruhan luas kawasan kajian ialah 34,782 hektar atau 347.82 km².
2. Sg Sepetang dengan panjang lebih kurang 28.8 km, bermula dari Bukit Ulu Sepetang (ketinggian lebih kurang 150 m dari paras laut) dan tanah tinggi Ladang Subur Bahagian Norseman. Hulu Sg Sepetang merentasi ladang getah dan kelapa sawit. Sebahagian daripada anak Sg Sepetang merentasi kawasan Perindustrian Kamunting yang terletak di utara Taiping dan menempatkan banyak perusahaan dan industri utama di utara Negeri Perak. Pekan Kuala Sepetang adalah sejauh 1 km ke selatan di mana air Sg Sepetang memasuki Kuala Sangga dan kemudian ke Selat Melaka. Kuala Sepetang berada antara lembangan Sg Reba dan Sg Menangis.
3. Sg Larut mengalir keluar di Kuala Sangga, lebih kurang 5 km ke selatan pekan Kuala Sepetang. Sg Larut bermula dari Bukit Wray (ketinggian 1,020 m) yang terletak di Hutan Simpan Bukit Larut yang mengalir terus ke kawasan rendah dan lebih rata di Bandar Taiping, melengkuk ke arah barat melalui tanah landai dataran pantai dan akhirnya keluar ke Selat Melaka.
4. Muara Sg Sepetang dan kawasan dataran pantai sekitarnya membentuk kawasan hutan bakau Matang yang penting. Hamparan luas hutan bakau tersebut terletak di teluk yang besar, merentasi muara dan kepulauan kecil dari Kuala Gula di utara hingga ke Pengkalan Baharu di selatan, dengan garis tepian pantai sepanjang 51 km dan 13 km lebar. Sg Kelumpang dan Sg Selinsing adalah dua sungai kecil lain merentasi simpanan hutan bakau tersebut. Dua kepulauan bakau, Pulau Kelumpang dan Pulau Terong, sentiasa ditenggelami air dan berpaya. Kawasan hutan simpanan ini meliputi kawasan seluas 32,686 hektar hutan produktif dan 7,360 hektar tidak produktif. Lebih kurang 95 peratus bakau dipengaruhi pasang surut dan

kebanyakannya adalah dari jenis *Rhizophoraceae*. Aktiviti sosio-ekonomi utama di kawasan ini termasuk perhutanan, akuakultur, dan ekopelancongan. Laluan air dan tebingan lumpur hutan bakau ini merupakan habitat penting bagi banyak spesis ikan dan udang. Lokasi relatif bagi ketiga-tiga kajian lembangan sungai adalah seperti Rajah ES-1.

LEMBANGAN SG SEPETANG

5. Lembangan Sg Sepetang merangkumi kawasan seluas 16,742.44 hektar. Lebih daripada separuh (52.83%) kawasan lembangan Sepetang digunakan untuk pertanian (terutamanya ladang kelapa sawit). Kawasan hulu lembangan adalah kawasan hutan bercuram, merangkumi lebih kurang 20.40% lembangan. Guna tanah bandar (termasuk perindustrian, perumahan, institusi, utiliti, kegunaan kerajaan, perdagangan dan perkhidmatan, dan pengangkutan) meliputi kira-kira 1,248.30 hektar atau 7.46% kawasan lembangan. Aktiviti perbandaran tersebut berada di bahagian tengah lembangan. Kawasan ini termasuk Zon Perindustrian Kamunting, serta pembangunan kawasan perumahan dan perdagangan yang baru dan rancak dibangunkan. Kebanyakan kawasan perbandaran terletak di dalam sub-lembangan Sg Malai dan Sg Rantin.

ANAK SUNGAI DAN SUB-LEMBANGAN SG SEPETANG

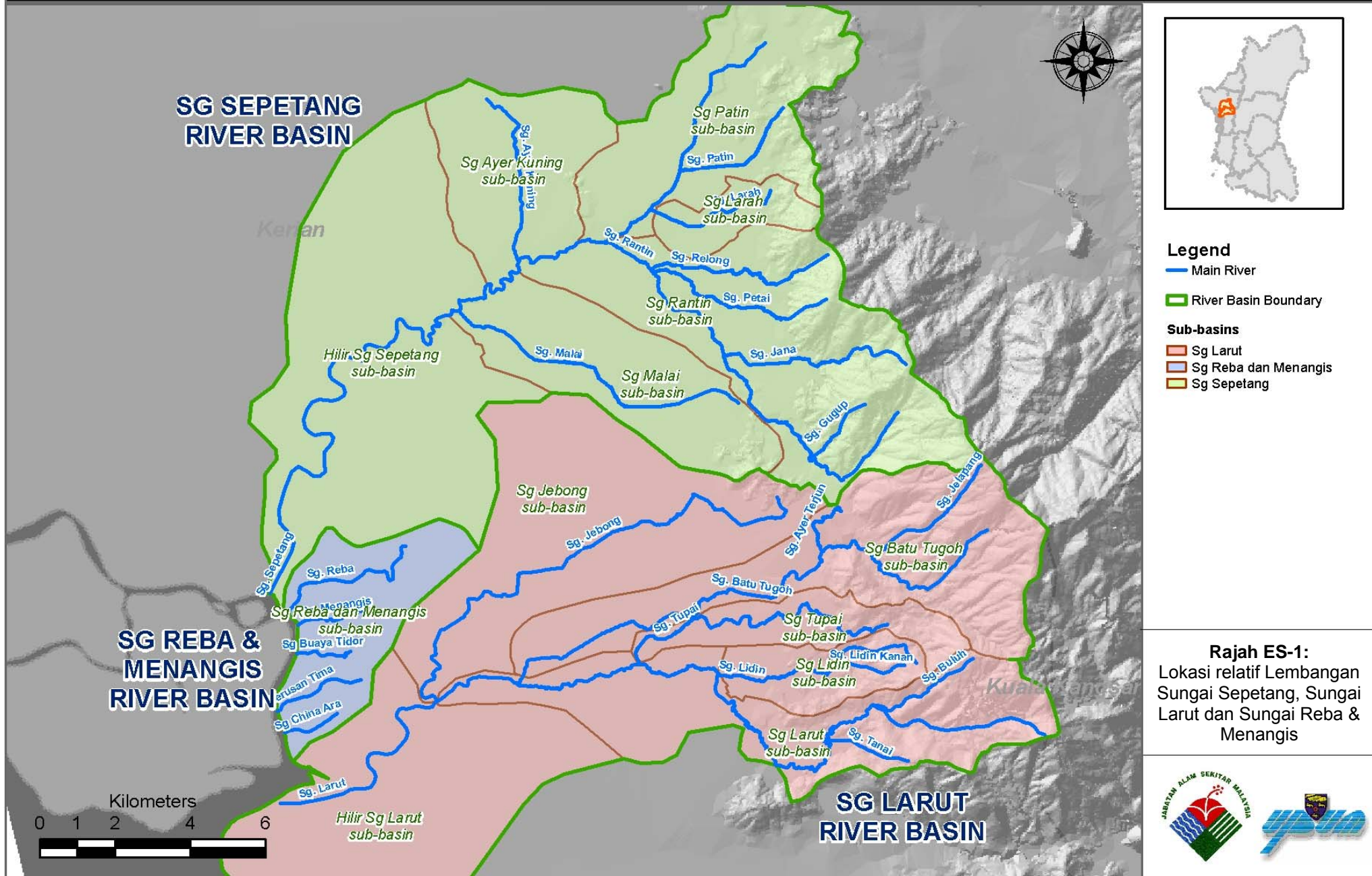
6. Sg Sepetang mengalir sepanjang lebih kurang 28.86 km dari hulu ke muara dan dengan anak-anak dan cabang sungai seperti berikut:

NO	SUNGAI	PANJANG
1.	Sg Ayer Kuning	5.2 km
2.	Sg Gugup	2.5 km
3.	Sg Jana	5.8 km
4.	Sg Larah	4.0 km
5.	Sg Malai	8.8 km
6.	Sg Patin	3.8 km
7.	Sg Petai	5.6 km
8.	Sg Relong	5.9 km

Sg Gugup, Sg Jana, Sg Relong dan Sg Petai adalah sebahagian daripada Sg Rantin. Sungai-sungai ini adalah anak-anak sungai yang mengalir ke Sg Rantin dan akhirnya mengalir ke Sg Sepetang.

Bagi tujuan kajian ini, lembangan Sg Sepetang telah dibahagikan kepada enam (6) sub-lembangan. Pembahagian keenam-enam sub-lembangan tersebut telah dibuat mengikut saiz cabang sungai, potensi sumbangan pencemaran kualiti air kepada Sg Sepetang, serta kesesuaiannya sebagai unit pengurusan kualiti air.

STUDY ON POLLUTION PREVENTION AND WATER QUALITY IMPROVEMENT FOR SUNGAI SEPETANG, PERAK



Keenam-enam sub-lembangan tersebut adalah:

- a) Sub-lembangan Sg Ayer Kuning
- b) Sub-lembangan Sg Patin
- c) Sub-lembangan Sg Larah
- d) Sub-lembangan Sg Rantin
- e) Sub-lembangan Sg Malai
- f) Sub-lembangan Hilir Sg Sepetang

Kesemua sub-lembangan dan corak guna tersebut adalah seperti yang dipaparkan dan corak guna tanah diringkaskan dalam Rajah ES-2.

LEMBANGAN SG LARUT

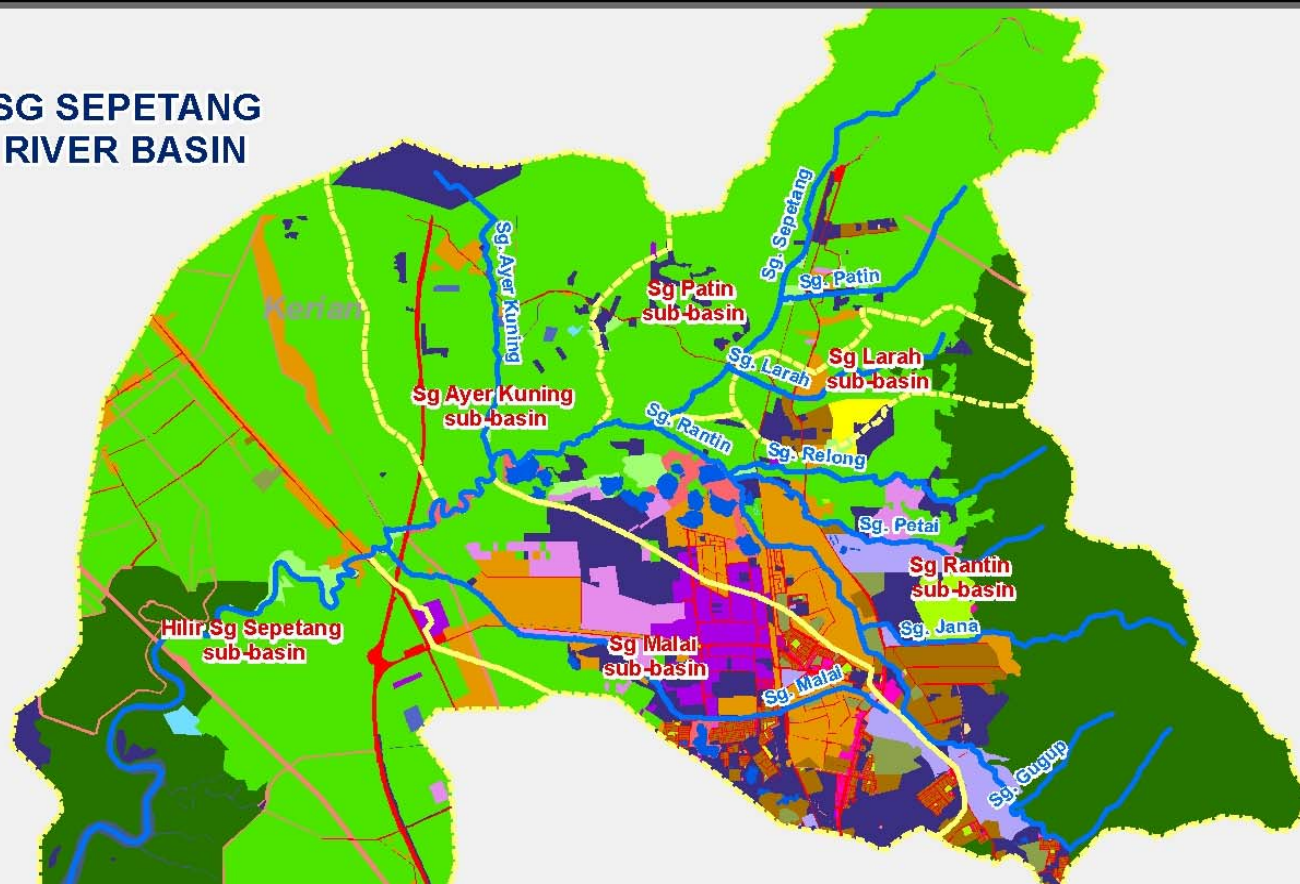
7. Lembangan Sg. Larut adalah kawasan saliran untuk Sg. Larut dan semua estuarnya. Sg. Larut mengalir melalui kawasan bandar Taiping. Lembangan Sg Larut meliputi kawasan seluas 16,342.80 hektar. Lembangan ini mempunyai kawasan guna tanah bandar yang lebih luas berbanding lembangan Sg Sepetang (1,991.80 hektar berbanding 1,248.30 hektar). Dari segi peratusan, 12.19% lembangan Sg Larut adalah kawasan perbandaran berbanding hanya 7.46% di lembangan Sg Sepetang. Pusat bandar Taiping serta kawasan pembangunan bandar lama terletak di lembangan Sg Larut.

Walaupun, kawasannya lebih bandar dari Sg Sepetang, lebih kurang 41% lembangan Sg Larut masih diliputi hutan. Kawasan hutan bukan sahaja terhad kepada kawasan tanah tinggi liar di hulu sungai sekeliling Bukit Larut, tetapi juga di kawasan dataran pantai (hutan bakau berhampiran muara sungai, di sub-lembangan Hilir sungai).

Bandar Taiping terletak di bahagian tengah lembangan, dan di sini adalah lokasi utama punca pencemaran utama sumbangan manusia. Corak pembangunan bandar melewati bahagian tengah lembangan ini, di dalam orientasi Utara ke Selatan. Oleh itu, kawasan bandar dilihat seperti membelah kawasan tengah lembangan tersebut dengan kawasan hutan ditimur (kawasan tanah tinggi) dan di barat (hutan bakau di dataran pantai). Kebanyakan guna tanah bandar adalah untuk tujuan perumahan (870.5 hektar), jalan dan jaringan pengangkutan (726 hektar), perindustrian (217.92 hektar), dan perdagangan (94.41hektar). Secara keseluruhannya perindustrian dan perdagangan hanya menggunakan 1.91% daripada keseluruhan kawasan lembangan Sg Larut (Rujuk Rajah ES-3).

STUDY ON POLLUTION PREVENTION AND WATER QUALITY IMPROVEMENT FOR SUNGAI SEPETANG, PERAK

SG SEPETANG RIVER BASIN



Legend

- Main River
- Sub-basins
- Agricultural
- Animal Husbandry
- Aquaculture Pond
- Buffer Zone
- Commercial
- Development Area
- Ex-Mining Pond
- Field
- Forest
- Fruit Orchards
- Government Building
- Industrial
- Institution
- Open Land
- Public Amenities
- Recreation
- Residential
- River
- Sewage Treatment
- Shrubs
- Transportation
- Utilities
- Village Settlement
- Waterbody

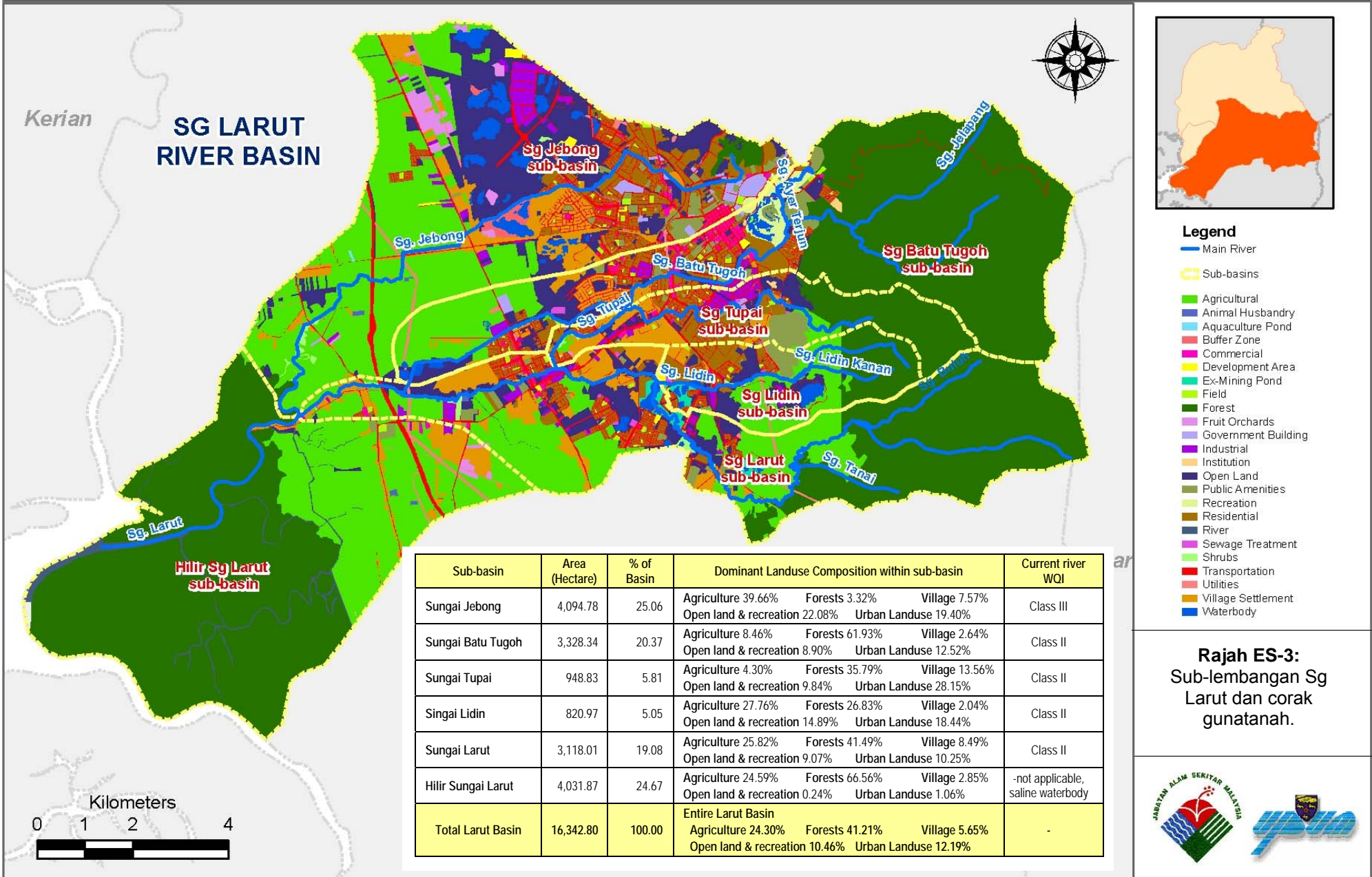


Sub-basin	Area (Hectare)	% of Basin	Dominant Landuse Composition within sub-basin			Current river WQI
Sungai Patin	2,619.50	15.65	Agriculture 88.53%	Forests 5.33%	Village 0.83%	Class II
Sungai Larah	541.20	3.23	Agriculture 49.17%	Forests 25.64%	Village 3.87%	Class II
Sungai Rantin	3,997.51	23.88	Agriculture 14.09%	Forests 51.08%	Village 8.04%	Class II
Sungai Malai	2,123.46	12.32	Agriculture 26.92%	Forests 2.02%	Village 15.78%	Class III
Sungai Ayer Kuning	1,874.26	11.19	Agriculture 85.82%	Forests 1.19%	Village 1.52%	Class III
Hilir Sungai Sepetang	5,586.51	33.37	Agriculture 62.93%	Forests 23.58%	Village 3.77%	-not applicable, saline waterbody
Total Sepetang Basin	16,742.44	100.00	Entire Sepetang Basin			
			Agriculture 52.83%	Forests 22.12%	Village 5.60%	
			Open land & recreation 8.04%	Urban Landuse 7.46%		

Rajah ES-2:
Sub-lembangan Sg Sepetang dan corak gunatanah.



STUDY ON POLLUTION PREVENTION AND WATER QUALITY IMPROVEMENT FOR SUNGAI SEPETANG, PERAK



ANAK SUNGAI DAN SUB-LEMBANGAN SG LARUT

8. Sg Larut terdiri daripada 8 anak sungai berikut:

NO	SUNGAI	PANJANG
1.	Sg Batu Tugoh	16.7 km
2.	Sg Buluh	3.2 km
3.	Sg Jebong	15.0 km
4.	Sg Jelapang	4.0 km
5.	Sg Larut	29.5 km
6.	Sg Lidin	6.5 km
7.	Sg Tanai	2.2 km
8.	Sg Tupai	9.7 km

Sg Buluh dan Sg Tanai adalah anak sungai Sg Larut dan termasuk sebahagian daripada sub-lembangan Sg Batu Tugoh. Ketiga-tiga anak sungai ini diliputi oleh hutan.

Bagi tujuan kajian ini, lembangan Sg Larut telah dibahagikan kepada enam (6) sub-lembangan, iaitu:

- i. Sub-lembangan Sg Jebong
- ii. Sub-lembangan Sg Batu Tugoh
- iii. Sub-lembangan Sg Tupai
- iv. Sub-lembangan Sg Lidin
- v. Sub-lembangan Sg Larut
- vi. Sub-lembangan Hilir Sg Larut

Keenam-enam sub-lembangan di dalam Lembangan Sg Larut adalah seperti yang dipaparkan dan corak guna tanah diringkaskan oleh Rajah ES-3.

LEMBANGAN SG REBA DAN SG MENANGIS

9. Sg Reba dan Sg Menangis adalah estuari kecil yang mengalir melalui pekan Kuala Sepetang. Kedua-dua Sg tersebut digabungkan sebagai lembangan Sg Reba dan Sg Menangis. Lembangan tersebut berada diantara lembangan Sg Sepetang (di bahagian utara) dan lembangan Sg Larut (di bahagian Selatan).

10. Oleh kerana kedua-dua sungai tersebut adalah tertakluk kepada ragam pasang surut dan limpahan air masin, kaedah penentuan Indeks Kualiti Air semasa (WQI) tidak sesuai untuk diaplikasikan di sini.

Bagaimanapun, kawasan ini boleh dianggap sebagai “penerima” bahan pencemar yang mengalir dari hulu sungai serta kawasan pedalaman Sg Sepetang dan Sg Larut. Kawasan ini juga adalah kawasan komuniti perikanan yang penting yang bergantung kepada ikan, kerang, udang, serta banyak lagi sumber laut dan pantai yang terdapat di sana. Akuakultur dan eko-pelancongan juga tidak kurang penting sebagai sumber ekonomi setempat di wilayah tersebut. Lembangan Sg Reba dan Sg Menangis adalah seperti yang dipaparkan dan corak guna tanah diringkaskan oleh Rajah ES-4.

INVENTORI PUNCA PENCEMARAN TETAP

11. Survei punca pencemaran tetap telah dijalankan di seluruh kawasan kajian dan sejumlah 979 punca tetap telah dikenalpasti – 609 terletak di lembangan Sg Larut, 310 di lembangan Sg Sepetang, dan 45 di lembangan Sg Reba dan Sg Menangis. 15 punca tetap yang direkodkan di lapangan terletak di luar kawasan kajian.

Jumlah dan lokasi punca tetap mengikut kategori, lembangan Sg, dan sub-lembangan Sg adalah seperti yang ditunjukkan dalam Rajah ES-5 ke Rajah ES-7. Inventori terperinci punca Pencemaran Tetap telah didokumentasikan dalam laporan “Volume 5: Field Survey of Point & Non-Point Pollution Sources Report”.

KEADAAN LEMBANGAN DAN KUALITI AIR

12. Pada masa kini, JAS mempunyai sebelas (11) stesyen pemantauan di keseluruhan lembangan Sg Sepetang. Dua takat pengambilan air dikenalpasti di Hulu Sepetang iaitu di Sg Jana dan Sg Rantin.
13. Terdapat 6 stesen pemantauan JAS dan 4 takat pengambilan air di lembangan Sg Larut.
14. Status Kualiti air di Sg Sepetang dan Sg Larut diklasifikasi sebagai separa tercemar sejak tahun 2004 berdasarkan program pemantauan sungai kebangsaan JAS (Rajah ES-8 & ES-9).

STUDY ON POLLUTION PREVENTION AND WATER QUALITY IMPROVEMENT FOR SUNGAI SEPETANG, PERAK

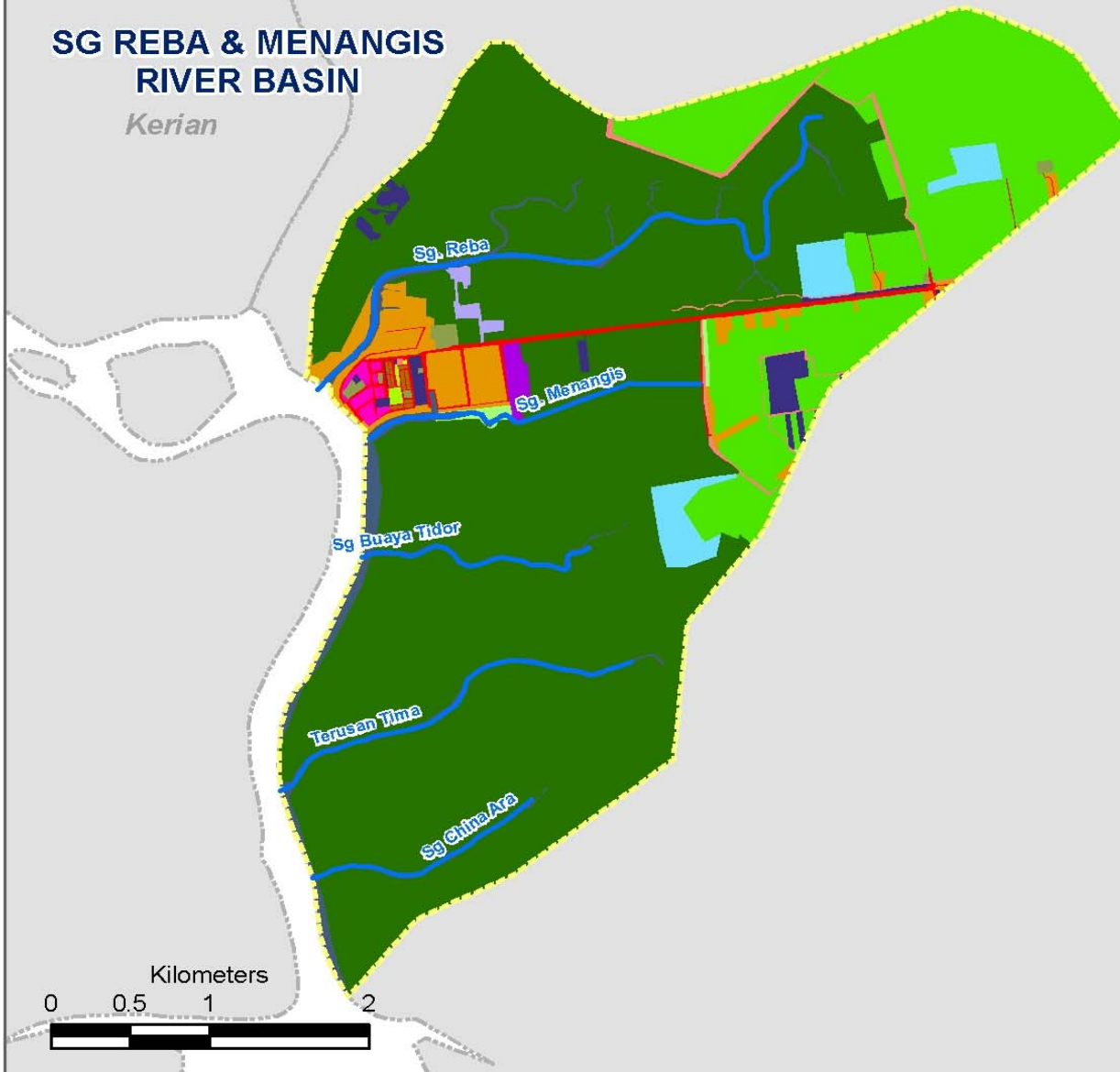
SG REBA & MENANGIS RIVER BASIN

Kerian



Legend

- Main River
- Sub-basins
- Agricultural
- Animal Husbandry
- Aquaculture Pond
- Buffer Zone
- Commercial
- Development Area
- Ex-Mining Pond
- Field
- Forest
- Fruit Orchards
- Government Building
- Industrial
- Institution
- Open Land
- Public Amenities
- Recreation
- Residential
- River
- Sewage Treatment
- Shrubs
- Transportation
- Utilities
- Village Settlement
- Waterbody



Rajah ES-4:
Lembangan Sg Reba & Sg Menangis



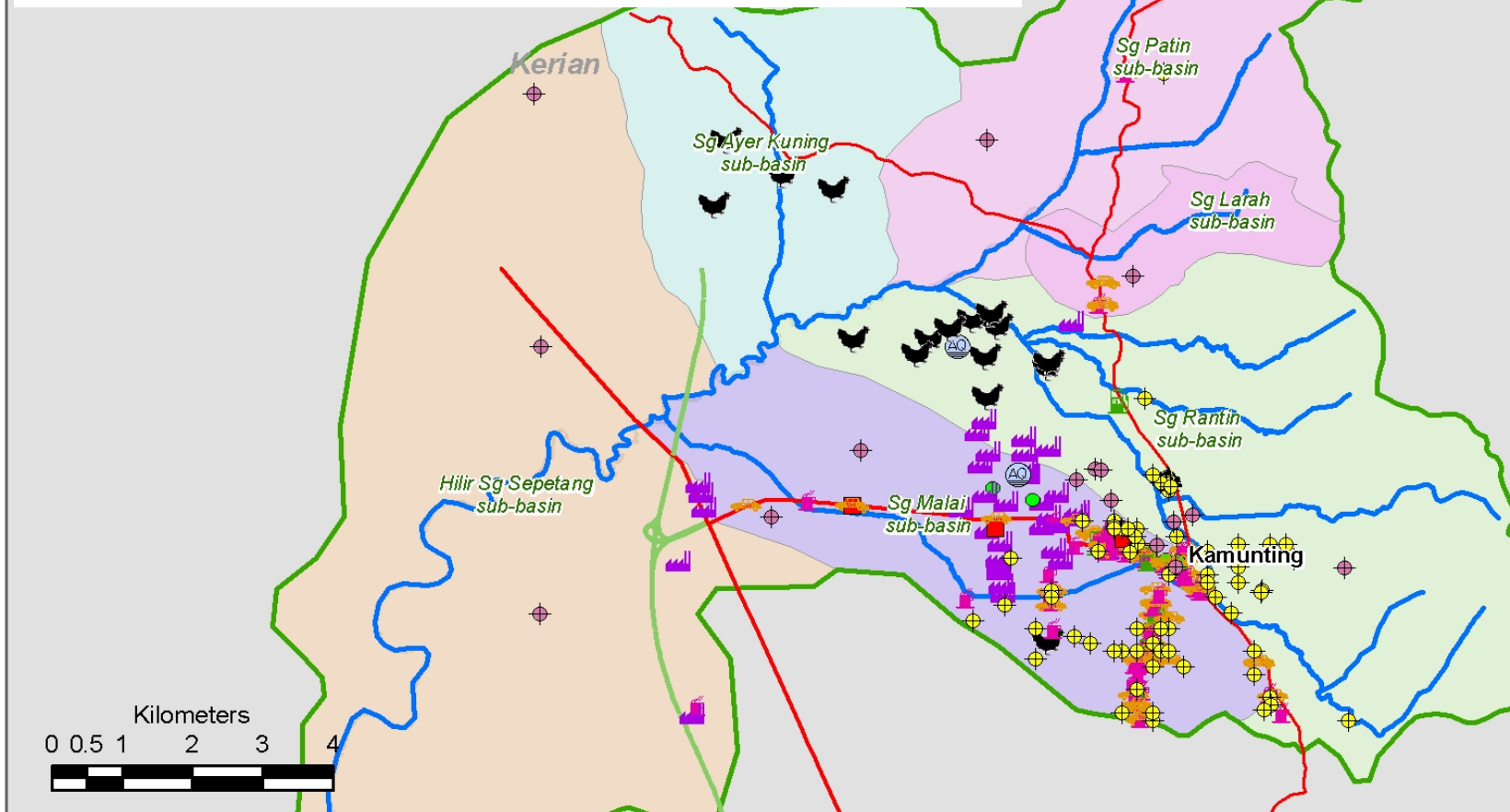
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Point Pollution Sources Category	Sungai Patin	Sungai Larah	Sungai Rantin	Sungai Malai	Sg Ayer Kuning	Hilir Sg Sepetang	Total Larut Basin
Factories & Manufacturing	-	-	6	25	-	5	36
Workshops	1	4	13	55	-	-	73
Petrol & Diesel Stations	-	-	1	5	-	-	6
Public Sewerage Treatment Plants	1	-	35	45	-	-	81
Private Sewerage Treatment Plants	1	1	8	3	-	3	16
Waste Mgmt & Recycling	-	-	-	-	-	-	-
Restaurants, Food Stalls, & Food Ct	1	1	14	51	-	1	68
Wet Markets	-	-	-	3	-	-	3
Livestock	2	-	11	1	4	-	18
Aquaculture	-	-	1	1	-	-	2
Others	-	-	2	5	-	-	7
Total	6	6	91	194	4	9	310



Legend

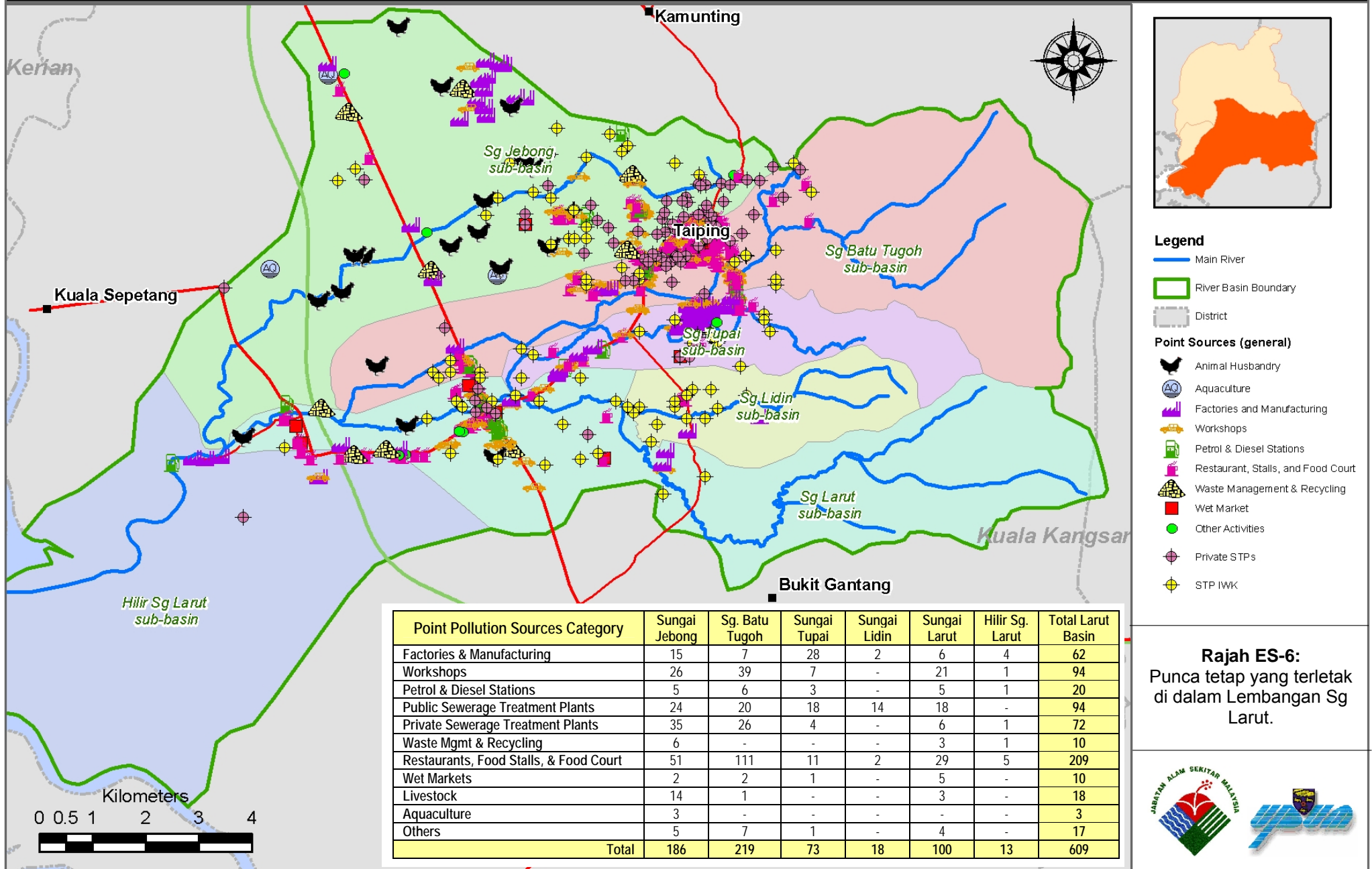
- Main River
- River Basin Boundary
- District
- Point Sources (general)**
 - Animal Husbandry
 - Aquaculture
 - Factories and Manufacturing
 - Workshops
 - Petrol & Diesel Stations
 - Restaurant, Stalls, and Food Court
 - Waste Management & Recycling
 - Wet Market
 - Other Activities
 - Private STPs
 - STP IWK



Rajah ES-5:
Punca tetap yang terletak di dalam Lembangan Sg



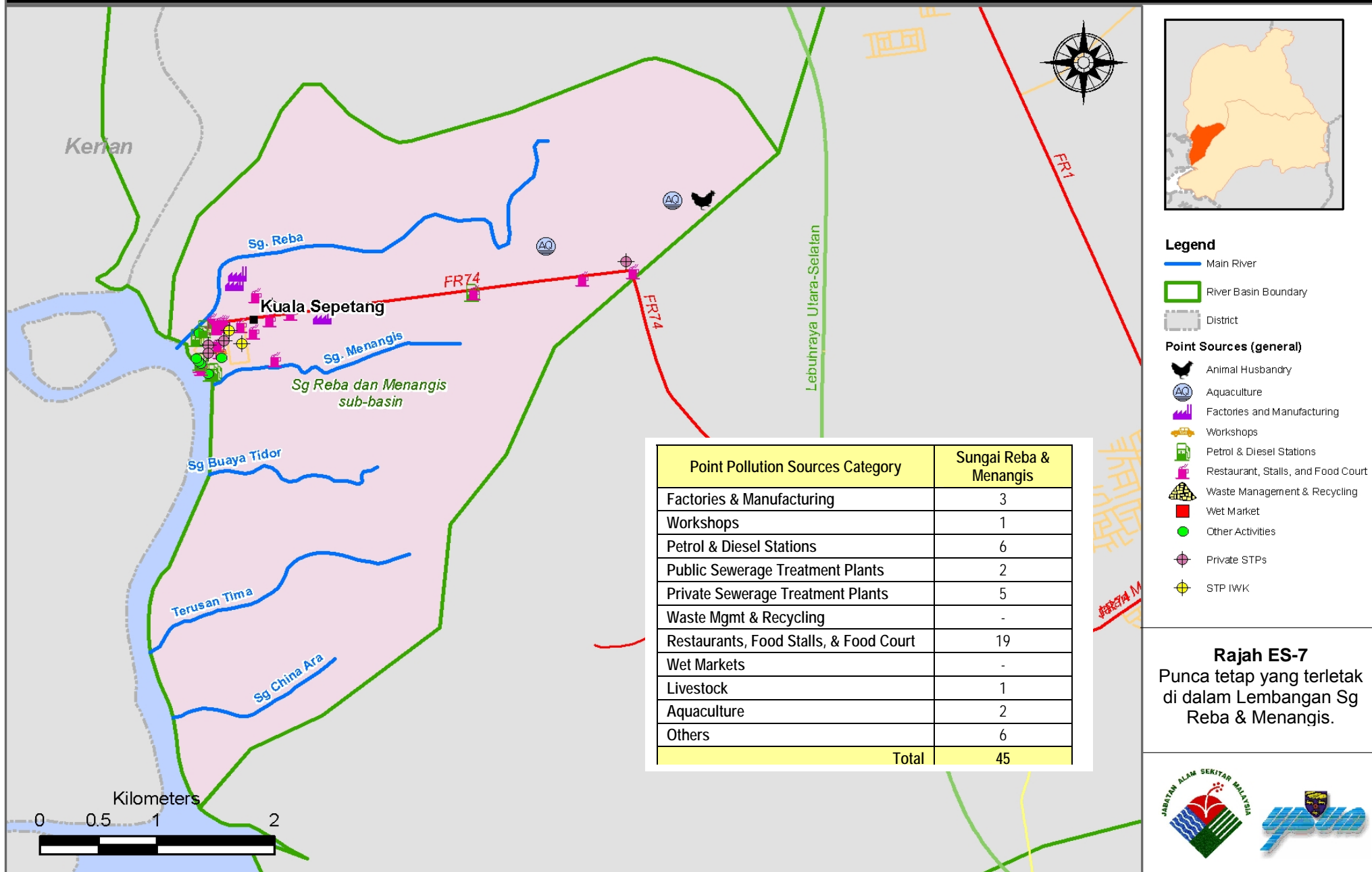
STUDY ON POLLUTION PREVENTION AND WATER QUALITY IMPROVEMENT FOR SUNGAI SEPETANG, PERAK

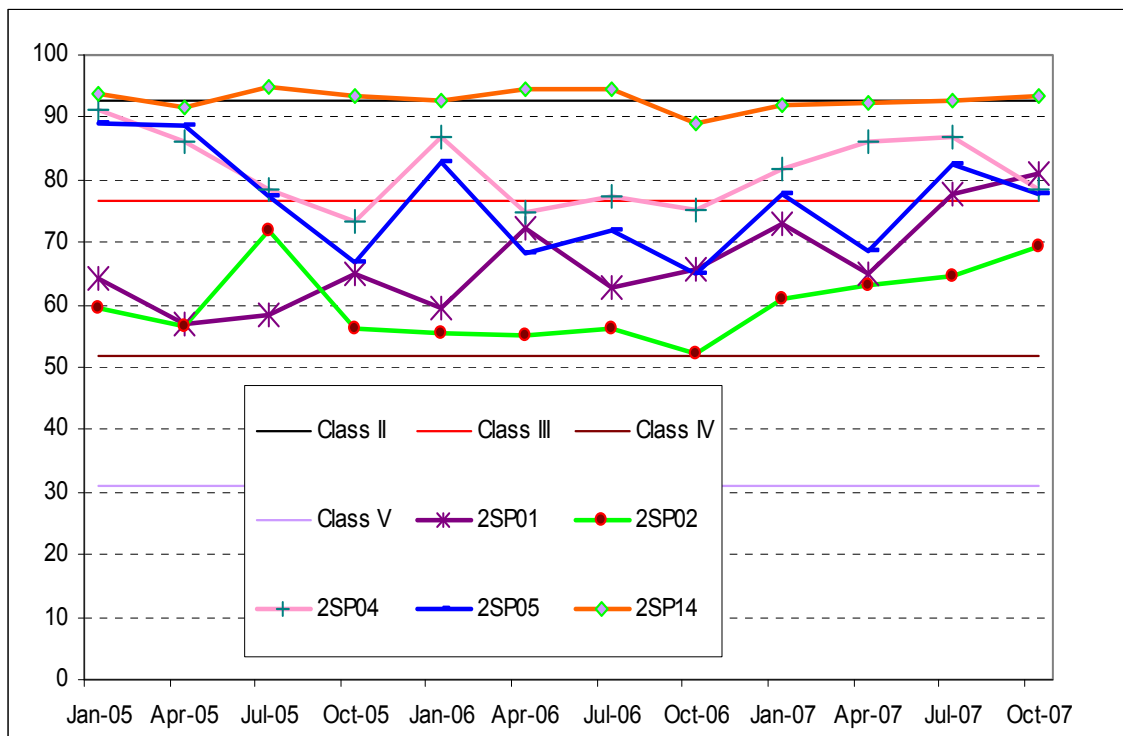


Rajah ES-6:
Punca tetap yang terletak di dalam Lembangan Sg Larut.

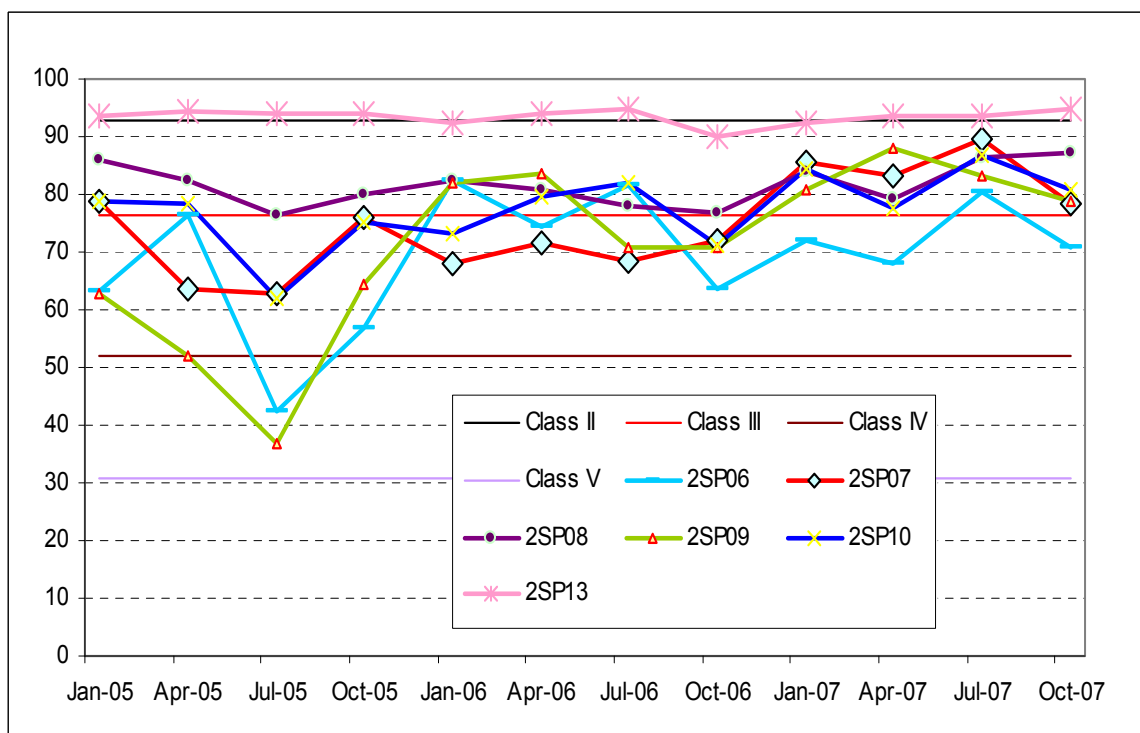


STUDY ON POLLUTION PREVENTION AND WATER QUALITY IMPROVEMENT FOR SUNGAI SEPETANG, PERAK





Rajah ES-8: DOE-WQI untuk Sg Sepetang Basin dari Januari 05 hingga Oktober 07



Rajah ES-9: DOE-WQI untuk Sg Larut dari Januari 05 hingga Oktober 07

15. Klasifikasi kualiti air semasa musim kering (Jun) dan musim hujan (September) berdasarkan pemantauan sebenar di tapak semasa kajian dinyatakan di Jadual ES-1 & ES-2.

16. Indeks WQI yang tertinggi iaitu 90.5 dikesan di Sg Patin (WSB 03) semasa aliran rendah sementara indeks WQI yang terendah dikesan di Sg Ayer Kuning (WSB 01) semasa aliran tinggi iaitu 63.8. Paras COD yang tertinggi (49 mg/l-aliran rendah dan 47 mg/l-aliran tinggi) dan NH₃-N (0.9 mg/l-aliran rendah and 0.49 mg/l-aliran tinggi) didapati di Sg Malai (WSB 07) bersama nilai BOD tinggi ((4 mg/l-aliran rendah and 5 mg/l-aliran tinggi). Rujuk jadual 4.4 dan 4.5 Volume 2: Main Report.

Jadual ES-1: Kualiti Air Sg Sepetang Sub-basin semasa keadaan aliran tinggi dan rendah

Sg Sepetang	WSB 01	WSB 02	WSB 03	WSB 04	WSB 05	WSB 06	WSB 07
	Ayer Kuning	Ulu Sepetang	Patin	Rantin	Larah	Kuala Sepetang	Malai
Kering							
DOE-WQI	71.3	88.0	90.5	81.6	85.3	72.4	70.2
Kelas	III	II	II	II	II	III	III
Hujan							
DOE-WQI	63.8	85.7	85.8	77.9	76.9	86.0	72.4
Kelas	III	II	II	II	II	II	III

Jadual ES-2: Kualiti Air Sg. Larut Sub-basin semasa keadaan aliran tinggi dan rendah

Sg Larut	WSB 08	WSB 09	WSB 10	WSB 11	WSB 12	WSB 13
	Batu Tugoh	Larut	Kuala Larut	Jebong	Tupai	Lidin
Kering						
DOE-WQI	80.0	87.4	70.2	67.9	80.7	82.8
Kelas	II	II	III	III	II	II
Hujan						
DOE-WQI	80.6	94.6	70.0	62.6	78.3	66.7
Kelas	II	I	III	III	II	III

17. Nilai WQI tertinggi 94.6 didapati di Larut (WSB09-aliran tinggi) sementara yang terendah dikesan di Sg. Jebong (WSB11-aliran tinggi) iaitu 62.6. Paras BOD yang tertinggi (11 mg/l) dan COD (34 mg/l) dikesan di WSB13 (Sg Lidin) semasa aliran tinggi sementara paras amoniakal-N tertinggi didapati di WSB11 (Sg Jebong) semasa keadaan aliran tinggi.
18. Berdasarkan analisa statistik data DOE (Jan'05-Oct'07), didapati bahawa COD, Ammoniakal-Nitrogen dan DO adalah penyumbang utama kepada klasifikasi Kelas III untuk kedua-dua lembangan. Analisa statistik WQI dinyatakan dalam Jadual ES-3 dibawah:

Jadual ES-3: Analisa Statistik WQI (Januari 05 - Oktober 07)

Parameter	Kelas I	Kelas II	Kelas III	Kelas IV	Kelas V
Ammoniacal Nitrogen	32%	20%	25%	18%	5%
BOD ₅	24%	45%	20%	8%	2%
COD	0%	48%	48%	4%	0%
DO	20%	25%	37%	17%	1%
pH	11%	79%	10%	0%	0%
TSS	68%	23%	8%	0%	0%
Indeks Kualiti Air	13%	44%	41%	2%	0%

19. Kualiti air yang diperhati di segmen dan sub-lembangan Sg Sepetang adalah berbeza dengan kadar yang besar disebabkan aktiviti gunatanah utama yang berbeza di setiap sub tadahan.
20. Kualiti air anak sungai yang mengalir melalui kawasan perumahan, bandar dan kawasan industri adalah rendah berbanding anak sungai yang mengalir melalui kawasan luar bandar, pertanian dan hutan.

GUNATANAH, PUNCA PENCEMARAN DAN BEBAN PENCEMARAN

21. Pertanian merupakan jenis gunatanah yang dominan di sub-basin Sg Patin, Sg Larah, Sg Malai, Sg Ayer Kuning dan Sg Hilir Sepetang didalam lembangan Sg Sepetang dengan 52.83% dari jumlah keluasan lembangan tersebut.
22. Di lembangan Sg Larut, keluasan hutan adalah 41.21% dari keseluruhan kawasan, merupakan jenis gunatanah yang paling dominan di sub-basin Sg Batu Tugoh, Sg Tupai, Sg Larut and Sg Hilir Sg Larut.
23. Sebanyak 310 punca tetap dikesan di lembangan Sg Sepetang (Jadual ES-4) dan (Rajah ES-5), sementara Sg Larut mencatat 609 punca tetap, dua kali ganda dari jumlah Sg Sepetang (Jadual ES-5) dan (Rajah ES-6). Punca pencemaran yang paling utama di tadahan Sg Sepetang adalah Loji Pengolahan Sisa Manusia.
24. Sg Malai dan Sg Rantin merupakan penerima utama punca tetap dalam lembangan Sg Sepetang. Sg Malai menyumbang 63% daripada segala punca tetap, diikuti oleh Sg Rantin (29%).
25. Terdapat 36 kilang dan pusat pengeluaran di lembangan Sg Sepetang dan 81% daripada jumlah tersebut dikesan di sub-lembangan Malai. 56% daripada

jumlah loji pengolahan sisa manusia juga terdapat pada sub-lembangan yang sama.

26. Di lembangan Sg Larut, sub-lembangan Batu Tugoh (36%) dan Jebong (31%) merupakan penerima punca pencemaran yang terbesar (Jadual ES-5). Industri lebin tertumpu di sub-lembangan Tupai dan Jebong sementara loji kumbahan awam didapati tertinggi di sub-lembangan Jebong. Punca pencemaran utama lembangan Larut adalah dari restoran dan gerai yang merupakan 34% dari jumlah punca tetap yang dikenal pasti di lembangan tersebut.

Jadual ES-4: Inventori Pencemaran Sg Sepetang

Punca Tetap	Patin	Larah	Rantin	Malai	Ayer Kuning	Hilir Sepetang	JUMLAH
Kilang	-	-	6	25	-	5	36
Bengkel	1	4	13	55	-	-	73
Stesen Minyak	-	-	1	5	-	-	6
STPs Awam	1	-	35	45	-	-	81
STPs Persendirian	1	1	8	3	-	3	16
Pusat Kitar Semula	-	-	-	-	-	-	-
Restoran/Warung	1	1	14	51	-	1	68
Pasar Basah	-	-	-	3	-	-	3
Ternakan	2	-	11	1	4	-	18
Akuakultur	-	-	1	1	-	-	2
Lain-lain	-	-	2	5	-	-	7
JUMLAH	6	6	91	194	4	9	310

Jadual ES-5: Inventori Pencemaran Sg Larut

Punca Tetap	Jebong	Batu Tugoh	Tupai	Lidin	Larut	Hilir Larut	JUMLAH
Kilang	15	7	28	2	6	4	62
Bengkel	26	39	7	-	21	1	94
Stesen Minyak	5	6	3	-	5	1	20
STPs Awam	24	20	18	14	18	-	94
STPs Persendirian	35	26	4	-	6	1	72
Pusat Kitar Semula	6	-	-	-	3	1	10
Restoran/Warung	51	111	11	2	29	5	209
Pasar Basah	2	2	1	-	5	-	10
Ternakan	14	1	-	-	3	-	18
Akuakultur	3	-	-	-	-	-	3
Lain-lain	5	7	1	-	4	-	17
JUMLAH	186	219	73	18	100	13	609

27. Dari segi muatan pencemaran, sub-lembangan Sg Malai menyumbang muatan yang paling tinggi berbanding dengan 5 sub-basin yang lain. Penyumbang utama dari segi beban pencemaran di lembangan Sg Sepetang adalah BOD dan COD yang menyumbang 80% dari jumlah muatan pencemaran (Jadual ES-6).
28. Sub-basin Malai dan Hilir Sepetang menerima muatan pencemaran yang paling tinggi yang menjadi penyumbang utama kepada kualiti air yang rendah di lembangan Sg Sepetang.

29. Industri merupakan penyumbang utama pencemaran kepada sub-basin Malai diikuti oleh STP awam dan pasar. Kawasan industri Kamunting Raya dan Kamunting merupakan punca pencemaran utama yang menyumbang 85% dari jumlah muatan pencemaran industri. Pasar Borong Kamunting juga merupakan penyumbang utama kepada muatan pencemaran terutama dari segi BOD dan COD.
30. Bagi lembangan Sg Larut, penyumbang utama muatan pencemaran adalah BOD, COD and TSS (Jadual ES-7). Sub-lembangan Jebong, Batu Tugoh dan Larut menerima muatan punca tetap yang tertinggi yang memberi kesan kepada kualiti air lembangan Sg Larut
31. Sub lembangan Sg Jebong merupakan penyumbang utama muatan pencemaran punca tetap bagi COD, TSS, Oil & Grease manakala sub-basin Sg Lidin menyumbang ke arah muatan NH₃-N.

Jadual ES-6: Sumbangan Muatan Pencemaran Tetap di setiap sub-basin di lembangan Sepetang

SUB-BASIN	Beban Pencemaran (kg/hari)						
	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
1. MALAI	1,284.5	4,191.0	1,371.3	76.4	654.0	47.4	336.0
2. HILIR	113.1	554.3	107.8	19.9	41.9	0.0	31.6
3. RANTIN	103.6	421.6	452.9	12.8	28.9	10.0	71.8
4. LARAH	2.7	5.1	4.6	0.0	0.6	0.0	2.3
5. PATIN	1.5	2.9	2.4	0.0	0.33	0.0	1.1
6. AYER KUNING	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JUMLAH	1,505.4	5,174.9	1,939	109.1	725.7	47.4	442.8

Jadual ES-7: Sumbangan Muatan Pencemaran Tetap di setiap sub-basin di lembangan Larut

SUB-BASIN	Beban Pencemaran (kg/hari)						
	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
1. JEBONG	1,019.0	44,78.6	1,497.0	54.7	119.6	63.2	251.9
2. BATU TUGOH	249.8	859.3	472.2	27.3	23.8	25.2	225.8
3. LARUT	143.7	385.3	180.3	10.7	61.6	11.7	74.7
4. LIDIN	156.1	516.2	166.8	11.3	30.5	46.6	303.1
5. TUPAI	74.3	223.2	99.8	5.2	26.7	5.1	50.4
6. HILIR LARUT	11.5	64.4	43.1	2.7	595.4	0.2	8.5
JUMLAH	1,654.4	6,527	2,459.2	111.9	857.6	152	914.4

32. Punca Industri sekali lagi memainkan peranan penting kepada sub-basin Jebong dengan menyumbang jumlah muatan BOD, COD, TSS and Oil & Grease yang tinggi diikuti dengan STP awam dan persendirian. Seperti jangkaan, STP awam menyumbang kepada muatan ammoniakal nitrogen yang tertinggi manakala ladang khinzir yang terendah disebabkan saiz operasi yang kecil.
33. Sumbangan punca pencemaran tetap dan tidak tetap untuk Sg Sepetang dan Sg Larut semasa keadaan aliran rendah dan tinggi disenaraikan di Jadual ES-8 hingga ES-15.
34. Dari segi punca tidak tetap, TSS disumbang oleh punca tidak tetap dengan jumlah muatan 6,013.5 kg/hari untuk sub-basin Malai dan yang selebihnya disumbang oleh punca tetap.
35. Di lembangan Larut, TSS dan Oil & Grease disumbang oleh punca tidak tetap dan selebihnya oleh punca tetap. Punca tidak tetap menyumbang sebanyak 6,276.5 kg/hari TSS untuk sub-basin Jebong.

Jadual ES-8: Sumbangan Punca Pencemaran Tetap setiap sub-basin kepada lembangan Sepetang semasa keadaan aliran tinggi

MALAI- Beban Pencemaran (kg/hari)							
PUNCA TETAP	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
INDUSTRI	585.2	2751.0	1029.4	44.9	602.7	18.3	166.9
PASAR BASAH	497.9	810.4	13.1	3.6	0.0	10.2	54.5
PUBLIC STP	179.2	595.4	318.4	24.5	51.3	18.8	112.3
RESTORAN	19.9	29.6	5.8	2.9	0.0	0.1	0.0
PRIVATE STP	2.3	4.6	4.6	0.46	N.a	N.a	2.31
HILIR SEPETANG- Beban Pencemaran (kg/hari)							
INDUSTRI	110.2	548.7	102.7	19.3	41.9	0.0	29.1
RESTORAN	0.4	0.6	0.1	0.1	0.0	0.0	0.00
PRIVATE STP	2.5	4.95	4.95	0.5	N.a	N.a	2.5
RANTIN- Beban Pencemaran (kg/hari)							
INDUSTRI	3.8	49.7	214.7	2.6	2.4	0.1	0.8
PUBLIC STP	86.4	347.9	220.7	7.8	26.5	9.9	63.1
RESTORAN	5.5	8.1	1.6	0.8	0.0	0.0	0.01
PRIVATE STP	7.9	15.9	15.9	1.6	N.a.	N.a.	7.9
LARAH-Beban Pencemaran (kg/hari)							
RESTORAN	0.4	0.6	0.1	0.1	0.0	0.0	0.00
PRIVATE STP	2.3	4.5	4.5	0.5	N.a.	N.a.	2.3
PATIN-Beban Pencemaran (kg/hari)							
RESTORAN	0.4	0.6	0.1	0.1	0.0	0.0	0.00
PRIVATE STP	1.1	2.3	2.3	0.23	N.a.	N.a.	1.1

Jadual ES-9: Sumbangan Punca Pencemaran Tetap setiap sub-basin kepada lembangan Sepetang semasa keadaan aliran rendah

MALAI-Beban Pencemaran (kg/hari)							
PUNCA TETAP	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
INDUSTRI	585.2	2751.0	1029.4	44.9	602.7	18.3	166.9
PASAR BASAH	497.9	810.4	13.1	3.6	0.0	10.2	54.5
PUBLIC STP	179.2	595.4	318.4	24.5	51.3	18.8	112.3
RESTORAN	19.9	29.6	5.8	2.9	0.0	0.1	0.0
PRIVATE STP	2.3	4.6	4.6	0.46	N.a	N.a	2.31
HILIR SEPETANG-Beban Pencemaran (kg/hari)							
INDUSTRI	110.2	548.7	102.7	19.3	41.9	0.0	29.1
RESTORAN	0.4	0.6	0.1	0.1	0.0	0.0	0.00
PRIVATE STP	2.5	4.95	4.95	0.5	N.a	N.a	2.5
RANTIN-Beban Pencemaran (kg/hari)							
INDUSTRI	3.8	49.7	214.7	2.6	2.4	0.1	0.8
PUBLIC STP	86.4	347.9	220.7	7.8	26.5	9.9	63.1
RESTORAN	5.5	8.1	1.6	0.8	0.0	0.0	0.01
PRIVATE STP	7.9	15.9	15.9	1.6	N.a.	N.a.	7.9
LARAH-Beban Pencemaran (kg/hari)							
RESTORAN	0.4	0.6	0.1	0.1	0.0	0.0	0.00
PRIVATE STP	2.3	4.5	4.5	0.5	N.a.	N.a.	2.3
PATIN-Beban Pencemaran (kg/hari)							
RESTORAN	0.4	0.6	0.1	0.1	0.0	0.0	0.00
PRIVATE STP	1.1	2.3	2.3	0.23	N.a.	N.a.	1.1

Jadual ES-10: Sumbangan NPS dari setiap sub-basin kepada lembangan Sepetang semasa keadaan aliran tinggi.

PEMBANGUNAN - Beban Pencemaran (kg/hari)							
SUB-BASIN	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
1. MALAI	2.3	21.6	778.5	0.6	1.1	0.0	0.4
2. HILIR SEPETANG	49.7	472.2	16998.8	13.7	23.2	0.1	8.9
3. RANTIN	8.5	80.9	2911.0	2.3	4.0	0.02	1.5
4. LARAH	1.5	14.6	524.6	0.4	0.7	0.0	0.3
5. PATIN	3.0	28.7	1033.8	0.8	1.4	0.0	0.5
6. AYER KUNING	-	-	-	-	-	-	-
PERUMAHAN - Beban Pencemaran (kg/hari)							
1. MALAI	285.0	1409.1	4890.1	75.7	47.1	0.6	0.9
2. HILIR SEPETANG	92.5	457.4	1587.2	24.6	15.3	0.2	0.3
3. RANTIN	159.5	788.3	2735.6	42.3	26.4	0.33	0.5
4. LARAH	13.2	65.5	227.2	3.5	2.2	0.0	0.0
5. PATIN	13.1	64.5	223.9	3.5	2.2	0.0	0.0
6. AYER KUNING	-	-	-	-	-	-	-
KOMERSIAL- Beban Pencemaran (kg/hari)							
1. MALAI	92.3	207.0	128.7	24.8	0.9	0.0	1.3
2. HILIR SEPETANG	14.1	31.6	19.6	3.8	0.1	0.0	0.2
3. RANTIN	21.5	48.1	29.9	5.8	0.2	0.0	0.3
4. LARAH	2.0	4.5	2.8	0.5	0.0	0.0	0.0
5. PATIN	1.2	2.6	1.6	0.3	0.0	0.0	0.0
6. AYER KUNING	-	-	-	-	-	-	-
PERTANIAN - Beban Pencemaran (kg/hari)							
1. MALAI	5.0	47.5	216.3	1.7	1.4	0.2	0.6
2. HILIR SEPETANG	45.1	432.1	1966.2	15.6	12.8	1.8	5.4
3. RANTIN	11.7	112.0	509.5	4.0	3.3	0.46	1.4
4. LARAH	4.1	39.0	177.7	1.4	1.2	0.2	0.5
5. PATIN	27.8	266.8	1214.0	9.6	7.9	1.1	3.3
6. AYER KUNING	-	-	-	-	-	-	-

Jadual ES-11: Sumbangan NPS dari setiap sub-basin kepada lembangan Sepetang semasa keadaan aliran rendah

PEMBANGUNAN - Beban Pencemaran (kg/hari)							
SUB-BASIN	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
1. MALAI	0.0	6.6	7.8	0.0	0.0	0.0	0.0
2. HILIR SEPETANG	0.0	145.3	169.6	0.0	0.0	0.0	0.0
3. RANTIN	0.0	24.9	29.0	0.0	0.0	0.0	0.0
4. LARAH	0.0	4.5	5.23	0.0	0.0	0.0	0.0
5. PATIN	0.0	8.8	10.3	0.0	0.0	0.0	0.0
6. AYER KUNING	-	-	-	-	-	-	-
PERUMAHAN - Beban Pencemaran (kg/hari)							
1. MALAI	0.0	123.4	152.8	0.0	0.0	0.0	0.0
2. HILIR SEPETANG	0.0	7.6	17.1	0.0	0.0	0.0	0.0
3. RANTIN	0.0	29.5	45.4	0.0	0.0	0.0	0.0
4. LARAH	0.0	1.1	2.5	0.0	0.0	0.0	0.0
5. PATIN	0.0	1.1	2.4	0.0	0.0	0.0	0.0
6. AYER KUNING	-	-	-	-	-	-	-
KOMERSIAL - Beban Pencemaran (kg/hari)							
1. MALAI	26.3	32.7	0.2	0.0	0.0	0.0	0.0
2. HILIR SEPETANG	4.0	5.0	0.02	0.0	0.0	0.0	0.0
3. RANTIN	6.1	7.6	0.04	0.0	0.0	0.0	0.0
4. LARAH	0.6	0.7	0.0	0.0	0.0	0.0	0.0
5. PATIN	0.3	0.4	0.0	0.0	0.0	0.0	0.0
6. AYER KUNING	-	-	-	-	-	-	-
PERTANIAN - Beban Pencemaran (kg/hari)							
1. MALAI	0.0	9.5	18.0	0.0	0.0	0.0	0.0
2. HILIR SEPETANG	0.0	86.4	163.9	0.0	0.0	0.0	0.0
3. RANTIN	0.0	22.4	42.5	0.0	0.0	0.0	0.0
4. LARAH	0.0	7.8	14.8	0.0	0.0	0.0	0.0
5. PATIN	0.0	5.6	53.4	0.0	0.0	0.0	0.0
6. AYER KUNING	-	-	-	-	-	-	-

Jadual ES-12: Sumbangan PS dari setiap sub-basin kepada lembangan Larut semasa keadaan aliran tinggi.

JEBONG-Beban Pencemaran (kg/hari)							
PUNCA TETAP	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
INDUSTRI	790.8	3,849.6	1,116.6	27.2	71.1	54.1	62.6
PUBLIC STP	117.5	419.5	205.6	8.6	48.5	8.2	108.9
LADANG KHINZIR	13.7	25.7	14.8	0.6	0.0	0.8	3.3
RESTORAN	19.9	29.6	5.8	2.9	0.0	0.1	0.0
STP PERSENDIRIAN	117.5	419.5	205.6	8.6	48.5	8.2	108.9
BATU TUGOH-Beban Pencemaran (kg/hari)							
INDUSTRI	104.4	336.6	259.4	9.6	2.2	20.3	24.3
PUBLIC STP	42.5	231.3	121.3	3.7	21.5	4.8	71.4
PASAR BASAH	7.2	21.8	8.8	0.9	0.0	0.1	0.1
LANDFILL	18.5	137.5	2.3	0.0	0.1	0.0	96.1
RESTORAN	43.3	64.4	12.7	6.3	0.0	0.0	0.0
STP PERSENDIRIAN	33.9	67.7	67.7	6.8	N.A	N.A	33.9
LARUT-Beban Pencemaran (kg/hari)							
INDUSTRI	4.5	16.3	4.9	0.5	17.6	0.2	1.1
PUBLIC STP	112.6	324.4	159.1	7.2	44.0	11.2	69.4
PASAR BASAH	12.1	21.5	6.7	0.8	0.0	0.2	1.0
RESTORAN	11.3	16.8	3.3	1.6	0.0	0.1	0.0
STP PERSENDIRIAN	3.15	6.3	6.3	0.63	N.a	N.a	3.15
LIDIN-Beban Pencemaran (kg/hari)							
INDUSTRI	52.3	213.4	34.8	4.4	11.2	36.6	236.0
STP AWAM	103.0	301.6	131.8	6.8	19.3	10.0	67.1
RESTORAN	0.8	1.2	0.2	0.1	0.0	0.0	0.0
TUPAI-Beban Pencemaran (kg/hari)							
INDUSTRI	2.4	19.7	7.7	1.0	1.8	0.4	2.7
PUBLIC STP	54.2	169.4	81.1	2.9	24.9	4.6	43.6
PASAR BASAH	10.2	21.3	3.4	0.1	0.0	0.1	0.9
RESTORAN	4.3	6.4	1.3	0.6	0.0	0.0	0.0
STP PERSENDIRIAN	3.2	6.3	6.3	0.63	N.a	N.a	3.2
HILIR LARUT-Beban Pencemaran (kg/hari)							
INDUSTRI	1.6	45.7	26.7	0.8	595.4	0.2	0.6
STP PERSENDIRIAN	7.9	15.8	15.8	1.58	N.a.	N.a.	7.9
RESTORAN	2.0	2.9	0.6	0.3	0.0	0.0	0.0

Jadual ES-13: Sumbangan PS dari setiap sub-basin kepada lembangan Larut semasa keadaan aliran rendah.

JEBONG-Beban Pencemaran (kg/hari)							
PUNCA TETAP	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
INDUSTRI	790.8	3,849.6	1,116.6	27.2	71.1	54.1	62.6
STP AWAM	117.5	419.5	205.6	8.6	48.5	8.2	108.9
LADANG KHINZIR	13.7	25.7	14.8	0.6	0.0	0.8	3.3
RESTORAN	19.9	29.6	5.8	2.9	0.0	0.1	0.0
STP PERSENDIRIAN	117.5	419.5	205.6	8.6	48.5	8.2	108.9
BATU TUGOH-Beban Pencemaran (kg/hari)							
INDUSTRI	104.4	336.6	259.4	9.6	2.2	20.3	24.3
STP AWAM	42.5	231.3	121.3	3.7	21.5	4.8	71.4
PASAR BASAH	7.2	21.8	8.8	0.9	0.0	0.1	0.1
LANDFILL	18.5	137.5	2.3	0.0	0.1	0.0	96.1
RESTORAN	43.3	64.4	12.7	6.3	0.0	0.0	0.0
STP PERSENDIRIAN	33.9	67.7	67.7	6.8	N.A	N.A	33.9
LARUT-Beban Pencemaran (kg/hari)							
INDUSTRI	4.5	16.3	4.9	0.5	17.6	0.2	1.1
STP AWAM	112.6	324.4	159.1	7.2	44.0	11.2	69.4
PASAR BASAH	12.1	21.5	6.7	0.8	0.0	0.2	1.0
RESTORAN	11.3	16.8	3.3	1.6	0.0	0.1	0.0
STP PERSENDIRIAN	3.15	6.3	6.3	0.63	N.a	N.a	3.15
LIDIN-Beban Pencemaran (kg/hari)							
INDUSTRI	52.3	213.4	34.8	4.4	11.2	36.6	236.0
STP AWAM	103.0	301.6	131.8	6.8	19.3	10.0	67.1
RESTORAN	0.8	1.2	0.2	0.1	0.0	0.0	0.0
TUPAI-Beban Pencemaran (kg/hari)							
INDUSTRI	2.4	19.7	7.7	1.0	1.8	0.4	2.7
STP AWAM	54.2	169.4	81.1	2.9	24.9	4.6	43.6
PASAR BASAH	10.2	21.3	3.4	0.1	0.0	0.1	0.9
RESTORAN	4.3	6.4	1.3	0.6	0.0	0.0	0.0
STP PERSENDIRIAN	3.2	6.3	6.3	0.63	N.a	N.a	3.2
HILIR LARUT-Beban Pencemaran (kg/hari)							
INDUSTRI	1.6	45.7	26.7	0.8	595.4	0.2	0.6
STP PERSENDIRIAN	7.9	15.8	15.8	1.58	N.a.	N.a.	7.9
RESTORAN	2.0	2.9	0.6	0.3	0.0	0.0	0.0

Jadual ES-14: Sumbangan NPS dari setiap sub-basin kepada lembangan Larut semasa keadaan aliran tinggi.

PEMBANGUNAN - Beban Pencemaran (kg/hari)							
SUB-BASIN	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
1. JEBONG	4.4	43.5	1565.5	1.3	2.1	0.0	0.8
2. BATU TUGOH	2.7	25.4	913.9	0.7	1.2	0.0	0.5
3. LARUT	5.6	53.6	1927.9	1.6	2.6	0.0	1.0
4. LIDIN	4.0	38.2	1376.5	1.6	1.9	0.0	0.7
5. TUPAI	4.1	38.7	1394.8	1.1	1.9	0.0	0.7
6. HILIR LARUT	0.8	7.7	276.4	0.2	0.4	0.0	0.1
PERUMAHAN - Beban Pencemaran (kg/hari)							
1. JEBONG	235.1	1162.4	4033.9	62.4	38.9	0.5	0.7
2. BATU TUGOH	114.3	564.9	1960.5	30.3	18.9	0.2	0.4
3. LARUT	187.2	925.4	3211.3	49.7	30.9	0.4	0.6
4. LIDIN	42.3	209.1	725.5	49.7	7.0	0.4	0.1
5. TUPAI	72.3	357.6	1241.1	19.2	12.0	0.1	0.2
6. HILIR LARUT	56.6	280	971.7	15.0	9.4	0.1	0.2
KOMERSIAL - Beban Pencemaran (kg/hari)							
1. JEBONG	114.2	256.2	159.2	30.7	1.1	0.0	1.6
2. BATU TUGOH	143.7	322.3	200.3	38.6	1.4	0.0	2.0
3. LARUT	83.9	188.2	117.0	22.5	0.8	0.0	1.2
4. LIDIN	9.7	21.7	13.5	22.5	0.1	0.0	0.1
5. TUPAI	50.7	113.6	70.6	13.6	0.5	0.0	0.7
6. HILIR LARUT	12.1	27.1	16.9	3.2	0.1	0.0	0.2
PERTANIAN - Beban Pencemaran (kg/hari)							
1. JEBONG	11.9	113.8	517.9	4.1	3.4	0.5	1.4
2. BATU TUGOH	3.1	30.2	137.3	1.1	0.9	0.1	0.4
3. LARUT	9.4	90.4	411.5	3.3	2.7	0.4	1.1
4. LIDIN	3.6	35.0	159.0	3.3	1.0	0.4	0.4
5. TUPAI	0.5	4.7	21.2	0.2	0.1	0.0	0.1
6. HILIR LARUT	6.9	66.6	302.9	2.4	2.0	0.3	0.8

Jadual ES-15: Sumbangan NPS dari setiap sub-basin kepada lembangan Larut semasa keadaan aliran rendah.

PEMBANGUNAN - Beban Pencemaran (kg/hari)							
SUB-BASIN	BOD	COD	TSS	O & G	NITRATE	TOTAL P	NH ₃ -N
1. JEBONG	0.0	13.4	15.6	0.0	0.0	0.0	0.0
2. BATU TUGOH	0.0	7.8	9.1	0.0	0.0	0.0	0.0
3. LARUT	0.0	16.5	13.0	0.0	0.0	0.0	0.0
4. LIDIN	0.0	11.8	13.7	0.0	0.0	0.0	0.0
5. TUPAI	0.0	11.9	13.9	0.0	0.0	0.0	0.0
6. HILIR LARUT	0.0	2.4	2.8	0.0	0.0	0.0	0.0
PERUMAHAN - Beban Pencemaran (kg/hari)							
1. JEBONG	0.0	19.3	43.5	0.0	0.0	0.0	0.0
2. BATU TUGOH	0.0	9.4	21.2	0.0	0.0	0.0	0.0
3. LARUT	0.0	15.4	34.7	0.0	0.0	0.0	0.0
4. LIDIN	0.0	19.9	7.8	0.0	0.0	0.0	0.0
5. TUPAI	0.0	5.9	113.4	0.0	0.0	0.0	0.0
6. HILIR LARUT	0.0	4.6	10.5	0.0	0.0	0.0	0.0
KOMERSIAL - Beban Pencemaran (kg/hari)							
1. JEBONG	32.6	40.5	0.2	0.0	0.0	0.0	0.0
2. BATU TUGOH	41.1	50.9	0.3	0.0	0.0	0.0	0.0
3. LARUT	24.0	29.7	0.2	0.0	0.0	0.0	0.0
4. LIDIN	2.8	3.4	0.0	0.0	0.0	0.0	0.0
5. TUPAI	14.5	17.9	0.1	0.0	0.0	0.0	0.0
6. HILIR LARUT	3.5	4.3	0.0	0.0	0.0	0.0	0.0
PERTANIAN - Beban Pencemaran (kg/hari)							
1. JEBONG	0.0	22.8	43.2	0.0	0.0	0.0	0.0
2. BATU TUGOH	0.0	6.0	11.4	0.0	0.0	0.0	0.0
3. LARUT	0.0	18.0	34.3	0.0	0.0	0.0	0.0
4. LIDIN	0.0	7.0	13.3	0.0	0.0	0.0	0.0
5. TUPAI	0.0	0.9	1.8	0.0	0.0	0.0	0.0
6. HILIR LARUT	0.0	13.3	25.2	0.0	0.0	0.0	0.0

STRATEGI KAWALAN PENCEMARAN

36. Dalam usaha merumuskan strategi untuk memperbaiki kualiti air sungai, penekanan dan analisis telah diberi terutama terhadap loji rawatan kumbahan dan data *outfall* yang mengalir dari beberapa kawasan industri yang terpilih dengan tujuan untuk mendapatkan nilai sebenar beban organik yang memasuki kedua-dua kawasan tadahan Sg. Sepetang dan Sg Larut.
37. Beberapa langkah pengukuran dan pelan pengurangan telah dirangka untuk memperbaiki kualiti air sungai di tiga anak sungai sepanjang Sg Sepetang iaitu Sg Rantin, Sg Malai dan Sg Sepetang-Hilir. Sumber pencemaran utama di kawasan ini adalah disebabkan oleh efluen industri dan sisa buangan kumbahan. Untuk kawasan Sg Larut, tiga anak sungai telah dikenalpasti memerlukan kerja pembaikan selanjutnya iaitu Sg Lidin, Sg Batu Tugoh dan Sg Larut-Hilir. Di kawasan ini, pencemaran telah dikenalpasti berpunca daripada sisa kumbahan domestik diikuti dengan pencemaran daripada efluen industri.
38. Prestasi loji kumbahan dinilai dari aspek kebolehannya memenuhi tahap yang ditetapkan. Sebanyak 31% daripada keseluruhan jumlah loji kumbahan memerlukan kerja-kerja menaiktaraf dan tindakan segera. Sg Lidin (17,780 PE) dan Sg Jebong (26,164 PE) adalah dua sungai yang mencatatkan mempunyai tahap beban PE tertinggi. Walaubagaimanapun untuk keseluruhan kawasan, tadahan Sg Larut merupakan kawasan yang mempunyai masalah lebih serius bagi masalah kumbahan.
39. Dari segi beban bahan pencemar, sektor industri di kawasan Sg Sepetang-Sg Malai menyumbang kadar BOD, COD dan AN tertinggi (Rujuk Rajah 5.45 Volume 2: Main Report). Kawasan Industri Kamunting merupakan kawasan yang tertinggi dalam peyumbangan terhadap beban pencemaran diikuti kawasan Kamunting Raya dan Simpang Empat Industrial Estates.
40. Pendekatan strategik untuk mengurangkan beban pencemaran didalam sungai telah dicadangkan yang mengandungi lapan projek meningkatkan kualiti air lembangan Sg Sepetang dan Sg Larut. Membina loji rawatan kumbahan baru secara berpusat di dalam kawasan Kamunting dan kawasan Taiping. Tujuannya adalah untuk mengatasi masalah sisa kumbahan di kawasan bandar dan kawasan maju. Sebagai tambahan, sistem wetland adalah dicadangkan untuk diaplikasikan dalam usaha membersihkan dan mengurangkan beban di sesetengah bahagian sungai yang kritikal. Empat lokasi yang strategik telah dikenalpasti untuk sistem wetland ini. Tapak-tapak yang dipilih adalah di kawasan hulu Sg Malai, Sg Sepetang, Sg Lidin dan Sg Jebong.

41. Terdapat penempatan setingan di sepanjang sungai. Walau bagaimanapun sumbangan mereka terhadap pencemaran adalah minima. Oleh itu, isu untuk memindahkan penempatan ini bukanlah perkara utama kerana bilangannya yang sedikit dan masih di bawah kawalan pihak berkuasa tempatan.
42. Perkara lain yang perlu diberi penekanan adalah tahap pencemaran yang tinggi daripada Pasar Borong Kamunting. Untuk mengatasi masalah ini, loji rawatan telah dicadangkan. Untuk mengatasi masalah dikawasan tapak pelupusan sampah di Jebong, loji rawatan air sampah (*leachate*) dicadangkan menggunakan kolam anaerobik dan kemudiannya akan disokong oleh sistem *wetland*.
43. Kelapan-lapan projek yang dicadangkan adalah sebahagian daripada proses memulihara dan meningkatkan kualiti air sungai Sg Sepetang dan Sg Larut. Faedah daripada projek ini dapat dilihat daripada keputusan model QUAL2K. Parameter yang digunakan adalah BOD, DO dan Ammoniakal-N.
44. Jadual ES-16 menunjukkan data simulasi yang diperoleh untuk Sg Sepetang sekiranya semua projek yang dicadangkan dilaksanakan. Jadual ES-17 dan ES-18 menunjukkan data simulasi yang diperoleh sekiranya loji kumbahan dan projek *wetland* dilaksanakan secara berasingan.
45. Didapati perubahan BOD adalah ketara di beberapa bahagian. Terdapat 30% penurunan BOD untuk Sg Sepetang (pada km 0.51) seperti yang ditunjukkan dalam jadual ES-16. Begitu juga dengan paras Ammoniakal-N di Sg Sepetang (pada km 18.97) telah berubah sebanyak 28.2%.
46. Sekiranya STP dilaksanakan data simulasi menunjukkan perubahan besar pada Ammoniacal-N. Data menunjukkan 38% perubahan Ammoniacal-N akan berlaku di Sg Rantin dan Sg Malai akan mencapai perubahan sehingga 10.3% (paras AN).

Jadual ES-16: Perubahan kualiti Sg selepas pelaksanaan semua projek -Sg. Sepetang

Nama Sungai	BOD Sebelum	BOD Selepas	% Perubahan	Lokasi km*
Sg Sepetang	4.24	2.95	30.4	0.51
Nama Sungai	AN Sebelum	AN Selepas	% Perubahan	Lokasi km*
Sg Sepetang	0.39	0.28	28.2	18.97
Sg Malai	0.97	0.84	13.4	0.49
Sg Ayer Kuning	0.30	0.29	3.3	3.59
Sg Rantin	0.93	0.59	36.5	3.46

* jarak diukur dari titik mula sungai berkaitan

Jadual ES-17: Perubahan kualiti Sg selepas pelaksanaan STP -Sg. Sepetang

Nama Sungai	AN Sebelum	AN Selepas	%Perubahan	Lokasi km*
Sg Sepetang	0.40	0.29	27.5	19.90
Sg Malai	0.97	0.87	10.3	0.49
Sg Ayer Kuning	0.30	0.29	3.3	3.59
Sg Rantin	1.07	0.66	38.3	4.44

* jarak diukur dari titik mula sungai berkaitan

47. Untuk projek wetland, BOD akan berkurang dengan ketara sehingga lebih daripada 20% perubahan dari segi kualiti air. DO dijangka akan bertambah sebanyak 13.5% manakal Ammoniacal-N akan dikurangkan sebanyak 17.5% di Sg Malai.

Jadual ES-18: Perubahan kualiti Sg selepas pelaksanaan Projek Wetland– Sg. Sepetang Basin

Nama Sungai	BOD Sebelum	BOD Selepas	% Perubahan	Lokasi km*
Sg Sepetang	3.74	2.98	20.3	15.53
Sg Malai	3.67	2.83	22.8	4.44
Nama Sungai	DO Sebelum	DO Selepas	% Perubahan	Lokasi km*
Sg Malai	4.46	5.06	13.5	3.46
Nama Sungai	AN Sebelum	AN Selepas	% Perubahan	Lokasi km*
Sg Malai	0.97	0.80	17.5	0.49

48. Untuk Sg Larut, Jadual ES-19 sehingga ES-22 menunjukkan data simulasi keseluruhan parameter kualiti air.
49. Didapati perubahan BOD adalah ketara di beberapa bahagian. Terdapat 40% perubahan BOD untuk Sg Lidin (pada km 0.41) seperti yang ditunjukkan dalam jadual ES-19. Begitu uga dengan paras DO yang menunjukkan perubahan ketara sebanyak 104% di Sg Jebong (km 1.52). Begitu juga dengan paras Ammoniacal-N di Sg Larut (km 13.42) berubah sebanyak 60%.

Jadual ES-19: Perubahan kualiti Sg selepas semua projek dilaksanakan – Sg. Larut Basin

Nama Sungai	BOD Sebelum	BOD Selepas	% Perubahan	Lokasi km
Sg Jebong	3.52	2.46	30.1	1.50
Sg Batu Tugoh	3.03	2.90	4.3	5.30
Sg Larut	3.00	2.58	14.0	9.60
Sg Lidin	3.38	2.00	40.8	0.41
Nama Sungai	DO Sebelum	DO Selepas	% Perubahan	Lokasi km*
Sg. Jebong	2.68	5.45	104	1.52
Sg Batu Tugoh	6.74	6.92	2.6	6.26
Sg Larut	4.40	5.71	29.7	5.40
Nama Sungai	AN Sebelum	AN Selepas	% Perubahan	Lokasi km*
Sg Jebong	1.34	0.89	33.6	9.65
Sg Batu Tugoh	0.56	0.27	51.8	7.03
Sg Larut	1.20	0.48	60.0	13.42
Sg Tupai	0.44	0.29	34.1	0.51
Sg Lidin	2.76	1.02	63.0	0.41

* jarak diukur dari titik mula sungai berkaitan

50. Sekiranya STP baru sahaja dilaksanakan, data simulasi juga menunjukkan perubahan untuk BOD, DO dan Ammoniacal-N. Sg Jebong (km10.67) akan mengalami perubahan 19.7% peningkatan BOD. Paras DO di Sg Jebong (km 0.51) akan berubah meningkat sebanyak 58%. Data juga menunjukkan pengurangan sebanyak 50% Ammoniacal-N di Sg Batu Tugoh.

Jadual ES-20: Perubahan Kualiti air selepas pelaksanaan projek STP sahaja –Lembangan Sg Larut

Nama Sungai	BOD Sebelum	BODSelepas	% Perubahan	Lokasi km*
Sg. Jebong	3.60	2.89	19.7	10.67
Sg. Batu Tugoh	3.03	2.90	4.3	5.30
Sg. Larut	3.00	2.85	5.0	9.68
Nama Sungai	DO Sebelum	DO Selepas	% Perubahan	Lokasi km*
Sg. Jebong	2.59	4.09	57.9	0.51
Sg. Batu Tugoh	6.91	7.05	2.0	7.23
Sg. Larut	4.40	5.07	15.2	5.40
Nama Sungai	AN Sebelum	AN Selepas	% Perubahan	Lokasi km*
Sg. Jebong	1.34	0.89	33.6	9.65
Sg. Batu Tugoh	0.12	0.06	50.0	11.09
Sg. Tupai	0.44	0.30	31.8	0.51
Sg. Lidin	2.76	2.64	4.4	0.41

* jarak diukur dari titik mula sungai berkaitan

51. Bagi projek wetland, BOD akan berkurang dengan ketara dan akan meningkatkan kualiti air sebanyak 39%. DO dijangka meningkat 107% dan Ammoniacal-N akan dikurangkan sebanyak 66% di Sg Jebong dan Sg Lidin.

Jadua ES-21: Perubahan kualiti Sg selepas pelaksanaan Projek Wetland – Lembangan Sg Larut

Nama Sungai	BOD Sebelum	BOD Selepas	% Perubahan	Lokasi km*
Sg Jebong	3.31	2.27	31.42	7.62
Sg Lidin	3.38	2.04	39.65	0.41
Sg Larut	3.18	2.76	13.21	5.40
Nama Sungai	DO Sebelum	DO Selepas	% Perubahan	Lokasi km*
Sg Jebong	2.59	5.36	106.95	0.51
Sg Larut	4.40	5.51	25.23	5.40
Nama Sungai	AN Sebelum	AN Selepas	% Perubahan	Loaksi km*
Sg. Jebong	1.04	0.83	20.20	0.51
Sg Lidin	2.76	1.06	61.60	0.41
Sg Larut	1.35	0.56	58.52	15.08

* jarak diukur dari titik mula sungai berkaitan

52. Sekiranya projek landfill dijalankan BOD di bahagian hilir landfill akan berubah sebanyak 2% di Sg Batu Tugoh (km 0.48) dan DO akan menunjukkan perubahan yang ketara sebanyak 42.9% di Sg Jebong (km 0.51) [Jadual ES-22].

Jadual ES-22: Perubahan kualiti Sg selepas pelaksanaan projek Landfill – Sg. Larut Basin

Nama Sungai	BOD Sebelum	BOD Selepas	% Perubahan	Lokasi km*
Sg Batu Tugoh	3.04	2.98	2.0	0.48
Nama Sungai	DO Sebelum	DO Selepas	% Perubahan	Lokasi km*
Sg Jebong	2.59	3.70	42.9	0.51

* jarak diukur dari titik mula sungai berkaitan

53. Didapati beberapa bahagian Sg Sepetang, terutama Sg Malai akan mengalami perubahan tahap DO, yang menyebabkan perubahan dari kelas IV ke kelas III.
54. Untuk Sg Larut akan berlaku perubahan besar pada DO di Lembangan Sg Jebong. Bahagian hilir Sg Jebong akan meningkat dari kelas III ke kelas II.
55. Jumlah kos untuk kesemua projek telah dianggarkan sebanyak RM 192.4 juta. Kos bagi projek pemusatan loji rawatan dianggarkan sebanyak RM 87 juta manakala projek kolam wetland telah dianggarkan sebanyak RM 3.4 juta. Kos operasi dan penyelenggaraan dianggarkan sebanyak RM 3.14 juta

setahun. Walaubagaimanapun, kos yang dinyatakan tidak termasuk kos yang diperlukan untuk mendapatkan tanah.

PEMODELAN KUALITI AIR

56. Satu daripada aspek penting dalam kajian terkini adalah untuk menyediakan permodelan kualiti air untuk lembangan Sg Sepetang yang boleh menjalankan simulasi kuantiti dan kualiti air disebabkan pelbagai aliran pencemaran di sepanjang sungai. Permodelan kualiti air sungai dilaksanakan menggunakan "1-Dimensional Stream Water Quality Model (QUAL2K)". Untuk pembangunan model ini, lembangan Sg Sepetang telah dibahagikan kepada dua sistem Sg utama, iaitu sistem Sg Sepetang dan sistem Sg Larut. Sistem Sg Sepetang terdiri daripada 6 sub-lembangan, iaitu Sg Ayer Kuning, Sg Larah, Sg Malai, Sg Patin, Sg Rantin dan Hilir Sg Sepetang, manakala di jaringan Sg Larut terdiri daripada 6 sub-lembangan, iaitu Sg Larut, Sg Lidin, Sg Tupai, Sg Batu Tugoh, Sg Jebong dan Hilir Sg Larut. Jumlah panjang permodelan untuk Sg Sepetang adalah 18 km sementara bagi Sg Larut panjang permodelan adalah 23.5km. Model dihentikan sebelum kawasan estuari untuk mengelakkan komplikasi yang mungkin timbul daripada kesan pasang surut di muara sungai. Adalah penting untuk dinyatakan bahawa simulasi permodelan tidak dilakukan untuk keseluruhan panjang Sg Sepetang dan Sg Larut disebabkan limitasi model QUAL2K itu sendiri. Ciri-ciri hidraulik untuk model, hidrologikal dan lokasi serta data bagi pelbagai punca pencemaran di sepanjang lembangan sungai diperolehi daripada agensi-agensi yang berkaitan, kajian-kajian terdahulu dan kerja lapangan. Pekali-pekali untuk parameter kualiti air diperolehi daripada literatur yang relevan. Pembangunan model ditertentukkan dan disahkan menggunakan data yang telah dikumpulkan daripada bulan Jun hingga November 2007 (aliran tinggi).
57. Keputusan yang diperolehi daripada hasil permodelan menunjukkan bahawa terdapat persamaan yang agak baik di antara nilai yang disimulasi dengan nilai yang telah diukur, kecuali bagi sesetengah stesen di mana nilai yang disimulasi adalah dibawah anggaran atau melebihi anggaran parameter. Simulasi dilakukan bagi empat parameter iaitu oksigen terlarut (DO), permintaan oksigen biokimia (BOD), ammonikal nitrogen (AN) dan pH. Hasil permodelan adalah konsisten dengan trend data pemerhatian tetapi bukan dengan nilai sebenar dalam semua kes. Terdapat sedikit masalah untuk memadamkan nilai DO, BOD, pH dan AN berdekatan stesen yang paling hilir untuk kedua-dua sungai. Stesen-stesen ini terletak di hilir anak sungai yang terakhir dan bacaan saliniti yang direkodkan pada stesen-stesen ini mengimplikasikan bahawa penerobosan air masin mungkin berlaku. Tambahan pula, lokasi semua stesen adalah sangat hampir dengan kawasan estuari di mana berkemungkinan berlakunya kesan pasang surut. Ini boleh

menyebabkan perbezaan di antara nilai permodelan dan nilai pemerhatian kerana model ini tidak boleh mengambilkira penerobosan air masin dan kesan pasang surut yang dinamik. Disamping itu, variasi semulajadi sebahagian parameter di sepanjang sungai boleh juga menyumbang kepada ketidaksamaan.

58. Perbandingan di antara keputusan untuk musim aliran rendah dan musim aliran tinggi juga dibentangkan. Secara ringkasnya untuk kedua-dua sungai, BOD didapati menunjukkan peningkatan dalam kepekatan semasa musim aliran tinggi. Sebaliknya, AN menunjukkan kepekatan yang tinggi semasa musim aliran rendah. Perbezaan untuk pH juga boleh dilihat, sementara tiada perbezaan yang ketara bagi nilai DO di antara kedua-dua musim.

Decision Support System- Sepetang and Larut Pollution Information System – Decision Support System (SeLaPIS-DSS)

59. Satu Sistem Sokongan Keputusan berdasarkan GIS telah dibangunkan. Sistem tersebut dinamakan **SeLaPIS-DSS (Sepetang and Larut Pollution Information System – Decision Support System)**.
60. SeLaPIS-DSS merupakan sistem berasaskan platform Microsoft XP yang telah mengintegrasikan ArcGIS 9.2 dengan Qual2K versi 2.07 (yang dikeluarkan pada Mac 2007). SeLaPIS-DSS juga menyimpan pangkalan data inventori punca pencemaran tetap, imej satelit Quickbird yang beresolusi tinggi (0.67 meter), maklumat guna tanah, dan data-data GIS lain yang berkaitan (contoh: data lot, sempadan daerah dan mukim, sungai, jalan, dan sebagainya).

SeLaPIS-DSS adalah aplikasi yang telah diprogramkan sebagai satu *extension* kepada perisian ArcGIS ArcView 9.2 yang mempunyai fungsi-fungsi seperti pelaporan, pengubahan data punca pencemaran tetap, dan juga integrasi dengan Qual2K.

Fungsi integrasi dengan Qual2K membolehkan analisis senario *what-if* dijalankan dalam SeLaPIS-DSS. Pengguna sistem boleh mengubah input kepada model Qual2K sedia ada yang telah dibangunkan dan memaparkan keputusan perubahan tersebut dalam peta GIS.

Sebagai contoh, pengguna sistem boleh menutup kilang tertentu bagi mengurangkan beban pencemaran ke dalam sungai. Kesan penutupan kilang tersebut (kesan ke atas kualiti air sungai) dengan mudahnya dapat divisualisasikan dalam SeLaPIS-DSS. Analisis *what-if* tersebut membolehkan pengguna sistem menguji konfigurasi dan/atau penyelesaian yang dapat

membantu membaiki pulih kualiti air sungai. SeLaPIS-DSS telah dibangunkan untuk pengguna yang kurang pengetahuan dalam GIS dan/atau yang kurang pengalaman menggunakan perisian ArcGIS ArcView.

Penerangan terperinci SeLaPIS-DSS boleh didapati dalam Manual Pengguna SeLaPIS-DSS.

STATUS AKUATIK BIOLOGI

61. Sampel air sungai di stesyen kawalan sementara (temporary station) diambil ketika musim aliran tinggi (April 2007) dan musim aliran rendah (Julai 2007). Kandungan klorofil *a* dikenapasti mengikut kaedah piawai APHA 10200H. Kandungan klorofil *a* sampel air sungai di Sg Batu Tugoh, Sg Tupai dan Sg Larut (Kuala) ketika musim aliran rendah mencatatkan bacaan 15.5, 12.8 dan 7.7 µg/l masing-masing. Tempat persampelan lain mencatatkan bacaan kurang daripada 5.0 µg/l.
62. Kandungan fosfat ($\text{PO}_4^- \text{P}$) di lembangan Sg Sepetang berbeza-beza daripada 0.01 mg/l (Sg Patin) sehingga 0.39mg/l (Sg Batu Tugoh) ketika musim aliran rendah.
63. Bilangan *E.coli* di sub-lembangan Sg Sepetang adalah didalam kelas III atau IV. Hal ini menunjukkan Sg tersebut adalah sangat tercemar dengan bahan kumbahan yang berpunca daripada loji kumbahan dan punca tidak tetap. Dengan pengecualian Sg Sepetang (Ulu) dan Sg Patin, punca pencemaran mungkin berpunca daripada manusia.
64. Temuramah dengan nelayan setempat telah dijalankan untuk menilai secara kualitatif hidupan akuatik di dalam lembangan sungai. Spesis ikan yang ditangkap adalah tilapia (*Tilapia mossambica*), ikan putih (*common barb*) and lampam jawa (*Javanese carp*). Udang galah yang bersaiz sederhana turut ditangkap di Kg Dew. Memandangkan paras *P. binotatus* dicatatkan 2.5 (kelas II), bahagian hulu Sg Sepetang sepatutnya mempunyai kualiti air sekurang-kurangnya pada kelas II.
65. Akuakultur air tawar di lembangan Sg Sepetang adalah kecil merangkumi kawasan seluas 150 hektar. Spesis yang sering dijumpai adalah tilapia merah, carp dan pelbagai sepsis lain.
66. Sg Sepetang dan Larut mengalir terus dan membentuk hutan simpan paya bakau yang penting iaitu Hutan Simpan Paya Bakau Matang sebelum mengalir terus ke Selat Melaka. Hutan simpan ini terletak di daerah Krian, Larut/Matang dan Manjung di bahagian utara semenanjung Malaysia. Hutan

simpan ini mengandungi kebanyakan *Rhizophora apiculata* yang berusia 1-30 tahun dan mewakili kira-kira 40% daripada jumlah bakau di Malaysia. Penghasilan tahunan untuk arang dan kayu api dari bulan Mei 2006 sehingga April 2007 dianggarkan 13,917 tan metrik dan 6,129 tan metrik masing-masing. Jumlah keseluruhan relau arang di Hutan Simpan Paya Bakau Matang untuk tahun 2007 ialah 348. Di lembangan Sg Sepetang, terdapat 77 relau yang terletak di Kg Dew dan beberapa lokasi lain sepanjang hilir Sg Sepetang.

67. Hutan Simpan Paya Bakau Matang adalah penting bagi kegiatan akuakultur ikan air tawar yang terdiri daripada 90 hektar dan 31,073 meter persegi kolam dan sangkar ikan air tawar masing-masing pada tahun 2007. Tiga spesies ikan utama adalah giant seabass (*Lates calcalifer*), golden snapper (*Lutjanus johnii*) and red snapper (*Lutjanus argentimaculatus*).
68. Keadaan tanah yang berlumpur di Hutan Simpan Paya Bakau Matang, adalah sangat sesuai untuk ternakan kerang. Pada tahun 2005, terdapat 237 pengusaha yang mengusahakan ternakan seluas 5,220.8 hektar di Perak. Sekurang-kurangnya separuh daripada pengusaha beroperasi di Hutan Paya Bakau Matang dan menyumbang kepada 63% daripada penghasilan kerang di Perak. Kuala Sangga adalah kawasan utama penghasilan kerang di Matang iaitu sebanyak 30% penghasilan kerang di Perak. Jumlah keseluruhan penghasilan kerang di Matang ialah 32,612 dan 28,342 tan pada tahun 2004 dan 2005 masing-masing. Hutan Simpan Paya Bakau Matang menghasilkan 50% daripada jumlah kerang di Malaysia. Walaubagaimanapun Matang hanya menghasilkan 5-10% daripada benih kerang.
69. Kelip-kelip menjadi semakin penting sebagai tarikan semulajadi dalam bidang pelancongan. Kelip-kelip adalah dari keluarga *Lampyridae* dan dari kumpulan *Coleoptera*. Spesies yang sering dijumpai di Lembangan Sg Sepetang adalah *Pteroptyx valida* Olivier. Kawasan ini ialah 300 m dari hilir jambatan Kg Dew sehingga kira-kira 8 km sepanjang Sg Sepetang. Pemandangan malam himpunan kelip-kelip spesies *Pteroptyx tener* Olivier boleh didapati berterbangan di atas hampir 60% pokok riparian berembang. (*Sonneratia caseolaris* Engl.) Pada tahun 2006, Jabatan Perhutanan telah mengemukakan pelan cadangan kepada kerajaan negeri agar menjadikan aktiviti melihat kelip-kelip di waktu malam sebagai salah satu haria tarikan pelancong.
70. Secara kesimpulannya lembangan Sg Sepetang mempunyai potensi yang besar bagi menampung industri akuakultur di negeri Perak disamping sebagai destinasi eko-pelancongan untuk orang ramai.

SOSIO-EKONOMI

71. Bahagian sosio-ekonomi membentangkan hasil kajian mengenai penilaian kontingen ke atas permintaan isi rumah terhadap peningkatan dalam kualiti air dan perbelanjaan oleh sektor perkilangan (firma) ke atas pencegahan serta perbelanjaan firma untuk mengelak atau mengurangkan pencemaran yang diakibatkan oleh pembangunan aktiviti komersil mereka. Umumnya, isi rumah menyedari sepenuhnya terhadap pencemaran yang berkaitan dengan Lembangan Sg Sepetang.
72. Dalam survei yang dijalankan, responden telah ditanya mengenai kefahaman mereka terhadap masalah pencemaran yang dihadapi oleh lembangan sungai dan hampir 31% telah mendengar mengenai perkara tersebut, manakala hampir 31% belum lagi mendengar atau mengetahuinya. Hampir 16.2% mendengar mengenai masalah pencemaran melalui surat khabar manakala 10.4% telah secara sendiri memerhatikan tahap pencemaran di Sg Sepetang/Sg Larut.
73. Sebahagian besar responden menyatakan kesanggupan membayar yang positif di mana purata WTP ialah lebih kurang RM 4.60 sebulan. Ini sudah dianggap sebagai “nilai yang patut” jika dibandingkan dengan beberapa kajian yang telah dilakukan di lain tempat. Oleh yang demikian, maka boleh dibuat kesimpulan bahawa orang ramai bersedia menyumbang sejumlah sumber yang patut terhadap penjagaan pembersihan sungai. Kesanggupan membayar (WTP) untuk peningkatan kualiti air adalah bergantung kepada tahap pendapatan isi rumah.
74. Faktor pendidikan mempunyai korelasi yang baik dengan WTP. Pendidikan yang tinggi (0.79) telah dicatatkan di kalangan responden di kawasan bandar, manakala korelasi purata (0.45) telah dicatatkan di kalangan sampel responden dari kawasan luar- bandar. Gabungan faktor pendidikan bersama peningkatan taraf hidup (kenaikan dalam pendapatan) boleh meningkatkan kesedaran mengenai isu alam sekitar di kalangan masyarakat.
75. Secara ringkas, firma-firma yang beroperasi dalam kawasan kajian telah terlibat dalam aktiviti yang pelbagai seperti makanan, minyak sawit, pembuatan, berasaskan-sumber termasuk juga perkhidmatan seperti auto, pembekalan peralatan kesihatan dan perkhidmatan. Perbelanjaan modal ke atas pencegahan pencemaran masih berada di tahap yang rendah kerana ia mewakili hanya 11% sahaja dari jumlah jualan dan hanya 0.013% sahaja dari modal operasi. Firma-firma yang mempunyai sumbangan yang tinggi terhadap perbelanjaan pencegahan pencemaran (kos operasi) termasuk kilang-kilang yang berkaitan dengan pembuatan/pemprosesan minyak sawit dan makanan.

76. Tetapi, tidak sebuah pun firma yang mengambil peluang dari pelan insentif alam sekitar yang ditawarkan oleh MIDA manakala beberapa buah sahaja firma yang menggunakan skim “adopt in-house energy saving” yang mengakibatkan penjimatan yang besar terhadap pendapatan firma. Sebahagian kecil firma menggunakan sijil pengiktirafan ISO1400 maka dengan itu terdapat keperluan yang berterusan untuk menggunakan skim sedemikian kerana ia boleh menjurus kepada pembentukan strategi pengurusan alam sekitar yang bersepadu di kalangan firma. Dalam jangka masa panjang, firma-firma yang menggunakan amalan sedemikian boleh menghasilkan penjimatan kos dalam bentuk pencegahan pencemaran/efluen.
77. Beberapa kesimpulan yang penting mengenai bahagian sosio-ekonomi termasuk yang berikut:
- i.) Sebahagian besar responden mencatatkan kesanggupan membayar (WTP) yang positif di mana purata WTP telah dianggarkan sebanyak RM 4.60 sebulan. Walaupun terdapat kesanggupan membayar yang tinggi, namun demikian, tahap kesedaran terhadap isu-isu alam sekitar masih lagi rendah terutama di kalangan penduduk yang berpendapatan rendah.
 - ii.) Jangkaan jumlah penduduk bagi Daerah Larut dan Matang dianggarkan mencapai seramai 218,196 orang (2005), 240,316 orang (2010), 245,002 orang (2015), 249,780 orang (2020), 254,651 orang (2025), dan 259,616 orang (2030).
 - iii.) Firma-firma membelanjakan secara purata sebanyak RM19,400 setahun bagi menyediakan peralatan rawatan pencegahan pencemaran.
 - iv.) Sebahagian firma mengamalkan pencegahan pencemaran dalam berbagai cara, terutama dari segi teknik penjimatan tenaga.
 - v.) Hanya 7% sahaja dari firma mendapat pengecualian cukai untuk menjalankan pemantauan alam sekitar dan penyelidikan dalam projek-projek pemuliharaan yang berjumlah RM1000-RM1050 bagi tahun kewangan yang dilaporkan.
 - vi.) Model ekonometrik menunjukkan hubungan songsang di antara perbelanjaan yang dilakukan ke atas efluen dan kesanggupan untuk menggunakan piawaian pengurusan alam sekitar seperti ISO14000. Dalam jangka masa panjang, firma-firma yang menggunakan amalan piawaian tersebut akan mengalami keuntungan melalui penjimatan kos untuk pencemaran.

PELAN TINDAKAN

78. Satu pelan tindakan telah dicadangkan supaya Lembangan Sg Sepetang dapat mengekalkan kualiti airnya pada masa akan datang. Pelan tindakan tersebut merangkumi pelbagai aspek mengenai pengurusan kawalan terhadap sumber-sumber setempat, pelan untuk meningkatkan kualiti air dan pengurusan kawalan serta program meningkatkan kesedaran awam. Pengurusan berkaitan pelan tindakan dan aktiviti termasuk:

- i. Pemasangan perangkap minyak di kawasan komersial, pusat penjaja bengkel kereta dan pasar borong.
- ii. Pengurusan penggunaan tanah dan aktiviti pertanian untuk mengurangkan nilai jumlah pepejal terampai (TSS) di kawasan bandar.
- iii. Pengurusan bahan pencemar dari bengkel kereta dan pusat servis kenderaan.

Pelan-pelan untuk meningkatkan kualiti air dan mengawal pencemaran adalah:

- i. Pemasangan loji kumbahan pusat di Kamunting dan Taiping untuk rawatan yang lebih berkesan bagi bahan buangan domestik terutama ammoniakal nitrogen.
 - ii. Pembinaan sistem wetland untuk Sg Malai, Sg Sepetang, Sg Lidin dan Sg Jebong.
 - iii. Pembinaan sistem rawatan leachate dan sistem wetland untuk tapak pelupusan sampah di Jebong.
79. Pelan tindakan kesedaran dan penglibatan orang ramai bertujuan untuk mendidik orang ramai tentang kepentingan mencegah pencemaran sungai.
80. Pelan tindakan juga mencadangkan penubuhan Sekretariat Sg Sepetang untuk menguruskan sumber air.
81. Pembinaan sembilan stesyen kawalan kualiti air untuk membentuk rangkaian kualiti air di lembangan Sg Sepetang turut dicadangkan.

ANALISIS KOS FAEDAH

82. Faedah dari peningkatan kualiti air Sg Sepetang ditukar dalam bentuk kewangan dengan menggunakan pendekatan penilaian kontinjen termasuklah:
- a) Nilai kepada pengguna termasuklah kegunaan fizikal kepada lembangan Sg termasuklah rekreasi, pelancongan dan pendapatan yang terjana daripada sungai dan nilai estetika sungai.
 - b) Nilai-nilai sedia ada termasuklah nilai keperihatinan masyarakat terhadap kepentingan sungai kepada alam sekitar. Dalam kajian ini, kesanggupan membayar oleh masyarakat menunjukkan masyarakat prihatin untuk menjaga dan meningkatkan kualiti air Sg Sepetang.
83. Berasaskan kos pelan tindakan dan manfaat-manfaat yang telah disenaraikan, nilai bersih semasa dan nisbah kos-faedah telah dihitung ditunjukkan dalam jadual ES-23.

Jadual ES-23: Nisbah Kos analisis dan Nilai Bersih

Kriteria	Kadar Diskaun		
	7.5%	10%	13%
Nilai Semasa Kos Faedah	RM136.0m	R132.0m	RM129.0m
Nilai Bersih Semasa	1.75	1.77	1.79

Semua pengiraan adalah berdasarkan 6% kadar inflasi

84. Memandangkan nisbah kos faedah lebih daripada satu, pilihan untuk melaksanakan projek adalah wajar. Nisbah ini menunjukkan setiap ringgit yang dikenakan kepada masyarakat akan terdapat faedah RM 1.75-RM 1.79 dalam persekitaran yang bersih dan sihat. Berdasarkan kaedah alternatif nilai semasa bersih (present value of net benefits) [PVNB]. Oleh kerana PVNB lebih besar daripada kosong (berdasarkan tiga aras kadar diakaun) polisi ini dikira wajar dari segi ekonomi. PVNB penentu didasarkan sepenuhnya kepada perbezaan kos faedah. Ia juga mengukur nilai wang dalam Ringgit Malaysia lebihan faedah. Ini merumuskan dengan jelas faedah-faedah projek ini kepada masyarakat

KESIMPULAN

85. Lembangan Sg Sepetang dan Larut adalah dua lembangan yang penting di bahagian Utara-Barat negeri Perak. Kamunting dan Industri Kamunting Jaya terletak di lembangan Sg Sepetang sementara Taiping merupakan bandar yang penting yang terletak di lembangan Sg Larut. Semenjak tahun 2004, klasifikasi kedua-dua lembangan sungai diklasifikasikan dalam Kelas III. Objektif kajian adalah untuk menghasilkan strategi dan pelan tindakan untuk mengatasi masalah pencemaran dan meningkatkan kualiti air sungai ke tahap bersih.
86. Semua punca tetap dan punca tidak tetap dikenalpasti melalui kajian survei. Kesemua rekod punca-punca pencemaran telah dikemaskini dan dimuatkan dalam pangkalan data GIS.
87. Di *headwater* dan tapak persampelan, kualiti air dan survei hidrologi telah dijalankan semasa musim aliran tinggi dan aliran rendah.
88. Menggunakan model QUAL2K, kuantiti dan kualiti air yang berpunca dari pelbagai punca pencemaran yang dialirkan ke sungai dapat disimulasi. Pelbagai kajian simulasi telah dijalankan untuk mengenalpasti pelan tindakan yang sesuai supaya kualiti air di lembangan sungai dapat dikekalkan pada Kelas II sepanjang masa. Lapan projek kejuruteraan telah dirangka. Pelan tindakan ini dijangka akan dapat meningkatkan kualiti air dan melindungi sumber-sumber biologi seperti spesis ikan dan udang serta kerang daripada pencemaran terutamanya di Hutan Paya Bakau Matang yang terletak di muara lembangan sungai ini.