CHAPTER 7: EVALUATION OF IMPACT

The proposed Project is expected to generate impacts which could be both positive as well as negative impacts. This chapter outlines the potential environmental impacts on the existing physical, biological and human environment resulting from the Project activities due to the Project activities are also outlined in this chapter. The potential environmental impacts are identified and evaluated by studying the interaction of the existing environment with the Project activities covering the following stages:

- Loging;
- Site-Preparation Stage;
- Pre-Planting Stage;
- Planting Stage;
- Operation Stage;
- Replanting Stage; and
- Abandonment Stage.

7.1 IDENTIFICATION AND PREDICTION ASSESSMENT OF IMPACTS

The potential impacts are described in accordance to their probability of occurrence, magnitude and duration of the impacts and their significance to the environment. The prediction and evaluation of the potential environmental impacts of the Project are performed on the basis survey findings and relevant studies as well as the professional judgment of the EIA Team's specialists and their respective expertise and experience.

The process of identifying and predicting the potential environmental impacts was aided with the use of an environmental impact assessment matrix that was suitably adapted for this Project. The matrix essentially identifies the potential environmental impacts that may result from interactions between the Project activities of each implementation phase and the environmental components or receptors likely to be impacted upon.

The results of the overall cross-linking of the Project activities and the environmental receptors and impacts are presented in the Environmental Impact Assessment Matrix in **Table 7-1**.

Table 7-1: Impact Identification Matrix

Key:

(empty box)	Insignificant and excluded from Matrix
/	Environmental impact that is potentially but on a temporary basis and will assue equilibrium after certain period of time
X	Environmental impact that is potentially significant but about which there is insufiticient data to make a reliable prediction.Close monitoring and control is recommended
\	Potentially significant adverse environmental impact for which a design solution has been identified
/ (dashed)	Residual and significant adverse environmental impact
X (dashed)	Significant environmental anhancemen

				PROJECT ACTIVITIES														
				SITE INVESTIGATION			DEVELOPMENT							OPERATION AND MAINTENANCE				
			Identification of Activities	SURVEY	INVESTIGATION	LAND ACQUISITION	ACCESS ROAD	BASE CAMP	BARRIERS AND FENCING	UTILITIES	LOGGING AND SITE CLEARING	BIOMASS AND SOLID WASTE	EARTHWORK, DRAINAGE AND EROSION CONTORL	FIELD ESTABLISHMENT	FERTILIZER AND PESTICIDES	HARVESTING	REPLANTING	ABANDONMENT
ENVIRONMENTAL COMPONENTS	PHYSICOCHEMICAL	LAND	Landforms										\					
			Soil Profile															
			Soil Composition															
			Slope Stability								X		\	\			\	
			Subsidence and Compaction										X					
			Seismicity															
			Flood Plains / Swamps										X	X				
			Land use								X	\	/ (dashed)	/				\
			Engineering and Mineral Resources															
			Buffer Zones										\					
			Flora						X		/ (dashed)		/ (dashed)					
			Fauna						X		/ (dashed)		/ (dashed)					
		SURFACE WATER	Shore Line															
			Bottom Interface															
			Flow Variation															
			Water Quality					\			X	\	\	\	/ (dashed)		/ (dashed)	
			Drainage Pattern								X		X					
			Water Balance								X							
			Flooding								X		X					
			Existing Use								X		/ (dashed)					
		GROUNWATER	Water Table								X							
			Flow Regime															
			Water Quality								X				/ (dashed)			
			Recharge								X							
			Aquifer Characteristics															
			Existing Use															
		ATMOSPHERE	Air Quality								\		\	\	X			
			Air Flow															
			Climatic Changes															
			Visibility															
		NOISE	Intensity								\		/	\				
			Duration								\		/	\				
			Frequency								\		/	\				
	BIOLOGICAL	SPECIES & POPULATION	Terrestrial Vegetation								/ (dashed)		/ (dashed)	/ (dashed)				
			Terrestrial Wildlife								/ (dashed)		/ (dashed)	/ (dashed)				
			Other Terrestrial Fauna								X		X	X				
			Aquatic / Marine Flora								X		X	X				
			Fish															
			Other Aquatic / Marine Fauna															
		HABITATS & COMMUNITIES	Terrestrial Habitats								/ (dashed)		/ (dashed)	/ (dashed)				
			Terrestrial Communities								/ (dashed)		/ (dashed)	/ (dashed)				
			Aquatic Habitats								X							
			Aquatic Communities								X							
			Estuarines Habitats															
			Estuarines Communities															
			Marine Habitats															
			Marine Communities															
	HUMAN	HEALTH & SAFETY	Physical Safety					\			X		\					
			Physiological Well Being															
			Parasitic Disease					\										
			Communicable Disease					\										
			Physiological Disease															
		SOCIAL & ECONOMIC	Employment										X (dashed)				X (dashed)	
			Housing															
			Education															
			Utilities															
			Amenities															
			Property & Settlement															
			Economy															
		AESTHETIC & CULTURAL	Landforms								/	\	/ (dashed)	/				/ (dashed)
			Biota								X		/ (dashed)					
			Wilderness								/ (dashed)		/ (dashed)					
			Water Quality								\	\	/ (dashed)	/ (dashed)	/ (dashed)		/ (dashed)	
			Atmospheric Quality									\	\					
			Climate															
			Tranquility															
			Sense of Community					\										
			Community Structure															
			Man-Made Objects															
			Historic Places or Structure															
			Religions Places or Structure															
			Cultural Heritage															
			Landscape															

7.2 OIL PALM AND COCONUT PALM PLANTATION DEVELOPMENT

7.2.1 Pre-Development Stage

Pre-development activities involve surveys and studies of the Project area which will involve minor land clearance for land survey and sampling activities. Minor land clearance is carried out which is not anticipated to have a significant impact and interference with public as the number of vehicles used are about 3 to 5 units covering site boundary and Project site.

7.2.2 Development Stage

Impacts to be considered during the development stage will be based on key activities which are site preparation and field establishment. Site preparation includes activities such as logging, transportation of machinery and materials, establishment of access road, base camp, utility provision, site clearing, biomass management, earthworks and drainage construction. Field establishment includes activities such as field lining and holing, culling and planting.

7.2.2.1 Logging

Removal of logs will cause soil erosion and destruction of flora and fauna and loss of existing ecosystem due to deforestation activity. Erosion can cause suspension of soil particles in the streams and rivers causing siltation of rivers. Minor impact on ambient noise level, air quality and road safety from heavy machineries and logging trucks are anticipated. Logging trucks are estimated about 10 trucks per day.

Impacts in relation to siltation and traffic movement can be minimised with appropriate mitigation measures.

7.2.2.2 Transportation of Machinery and Materials

The Jalan Felda Nitar is the nearest main transportation route for movement of materials and machinery to and from the Project Site. During the initial site preparation stage which involves logging and land clearance, the transportation will be mainly the removal of logs from the site which have economic value. The logs will be transported out via trucks to potential buyers. The number of trucks per day is estimated at 10 trucks/day

During the development field establishment and Planting stage the number of vehicles are estimated at 10 trucks/day and during harvesting is about 20 trucks/day.

Based on this estimation it can be deduced that the impacts can be minimal as the numbers are small. The truck movements will be in stages which are over a period of several years thus the impacts would be minimal.

Under uncontrolled circumstances, the transport vehicles can be a source of transient noise and exhaust emissions, while earth-moving lorries are also capable of soiling public roadways due to unwashed mud-laden tyres. Without proper safety measures, the additional truck movement could have a potential to contribute to increased risk of road accidents to the local villagers.

7.2.2.3 Land-Disturbing Pollution Prevention Mitigating Measures (LD-P2M2)

During the land clearing activities at the development site, which is expected to be between 14 months duration for the site clearing it is inevitable soil loss due to erosion, and migration of eroded soil as sediment will be transported by the stormwater runoff from rainfall events into the drainage system, which shall then convey into the existing external water body, respectively existing natural streams like Sg. Endau, Sg. Labong and Sg, Tarsap where the river flow shall eventually lead to the South China Sea on the northern side.

The transported sediments escaped into the external water body system (streams/rivers) shall eventually flow into to Sg. Endau, Sg. Labong and Sg. Tarsap . If the sediments transported with the surface runoff from these discharge points, the runoff water carrying sediments will eventually cause the turbidity level of the Sg. Endau increase, and if high turbid water happens after the stormwater discharge events, this may cause adverse impacts to the downstream water bodies connected to Sg. Endau.

It is therefore important to ascertain the assessment of erosion and sediment control shall take into consideration the development phases of the Project. It is assumed the site clearing and grading works shall be carried out at controlled manner and carried out in sub-lots to enable effective access infrastructure and efficient crop planting at the development site. After completion of grading works within the designated lot(s), stabilisation works at the lot(s) shall commence within 14 days of the grading works to reduce risks severe erosion which may lead to other untoward incidents such as land slide, land creep etc.

Methodology to quantify the soil loss, sediment yield and stormwater management has been developed in order to provide necessary design input to design sediment basin, which shall serve as the primary mitigation measure if sediment transport cannot be avoided at erosion sources.

i. Determination of Soil Loss

For the proposed Project, the erosion rate and sediment yield were estimated for the following scenario: -

- Existing condition (before clearing);
- During clearing (uncontrolled – without BMPs); and
- During clearing (controlled – with BMPs).

The land clearing of the proposed Project will be carried out in 3 phases as shown in **Table 7-2**.

Table 7-2: Project Development Phases

Plot	Phase	Area (ha)	Existing Land Use	Activities	Status
PTD 4121	1A	380.0	Shrub and bush	Site clearing	C=0.35 (bushes/shrubs 50% cover)
	1B	251.178	Shrub and bush	Site clearing	C=0.35 (bushes/shrubs 50% cover)
PTD 4177	1C	200.0	Shrub and bush	Site clearing	C=0.35 (bushes/shrubs 50% cover)
	1D	212.379	Shrub and bush	Site clearing	C=0.35 (bushes/shrubs 50% cover)
PTD 4118	2A	220.0	Forest area	Logging & Site Clearing	Fully unlogged C=0.35 (bushes/shrubs 50% cover)
	2B	184	Forest area	Logging & Site Clearing	Fully unlogged C=0.35 (bushes/shrubs 50% cover)
	2C	220.0	Forest area	Logging & Site Clearing	Fully unlogged C=0.35 (bushes/shrubs 50% cover)
	2D	185.38	Forest area	Logging & Site Clearing	Fully unlogged C=0.35 (bushes/shrubs 50% cover)
PTD 4963	2E	227.790	Shrub	Site clearing	Fully unlogged C=0.35 (bushes/shrubs 50% cover)
	2F	176.9	Oil Palm plantation	No site clearing	Oil Palm 0.2
PTD 4882	2G	169.0	Shrub	Site clearing	Fully unlogged C=0.35 (bushes/shrubs 50% cover)
	3C	789.022	Oil palm plantation	No site clearing	Oil Palm 0.2
	3D	155.0	Shrub	Site clearing	C=0.35 (bushes/shrubs 50% cover)
PTD 4085	3A	204.690	Forest area	Logging & Site Clearing	Fully unlogged C=0.35 (bushes/shrubs 50% cover)
	3B	200.0	Forest area	Logging & Site Clearing	Fully unlogged C=0.35 (bushes/shrubs 50% cover)

The erosion rate can be estimated by using the Universal Soil Loss Equation (USLE) and its replacement, the Revised Universal Soil Loss Equation (RUSLE) as shown below: -

A = R x K x LS x C x P

Where;

A	=	annual soil loss due to erosion (ton / ha / yr)
R	=	rainfall erosivity factor (MJ.mm/ha.yr)
K	=	soil erodibility factor (ton/ha) (ha.h/MJ.mm)
LS	=	topographic factor derived from slope length and slope gradient
C	=	cover and management factor
P	=	erosion control practice factor

The estimation of parameters R, K, LS, C and P could be obtained from Guideline for Erosion and Sediment Control in Malaysia (Department of Irrigation and Drainage, Ministry of Natural Resources and Environment Malaysia).

Determination of rainfall erosivity factor (R)

The rainfall erosivity factor (R) for the study area (Endau) is between 16,000 to 17,000 MJ/mm.ha.yr as shown in **Figure 7-1**. For evaluation purpose, the higher limit is used, therefore, R value of 17,000 MJ/mm.ha.yr is used.

Determination of soil erodibility factor (K)

The estimated soil erodibility index (K) can be estimated based on the soil texture of soil investigation taken at various bore hole within the site. The K factor will be determined using Soil Investigation (SI) data at the site. The location of the borehole points within the Project site is shown in **Figure 7-2** below.

Tew Equation is used to estimate K value: -

K= [1.0x10^ (-4) (12-OM) M^1.14+4.5(s-3) +(p-2)]/100

Where:

K - Soil Erodibility Factor, (ton/ac.) *(100ft.ton.in/ac.hr)

For SI unit (ton/ha) (ha.hr/MJ.mm), the conversion factor is 1/7.59

M - (% silt + % very fine sand) x (100 - % clay)

OM - Organic matter

S - soil structure code

P - permeability class

Soil structure code (S) and permeability code (P) are obtained from Guideline for Erosion and Sediment Control in Malaysia. The estimated value of K based on the equation is listed in **Table 7-3**.

Determination of slope length (L) and slope steepness (S) factor

The LS factor for the area depends on the slope length and steepness. The average LS is estimated using Geographical Information System (GIS). The Project area is almost flat with slope less than 2 %. The average slope length is about 100 m. Based on **Table 7-4**, the derived LS value is 0.288. The derived LS map for the Project area based on slope steepness and slope length is shown in **Figure 7-3**.

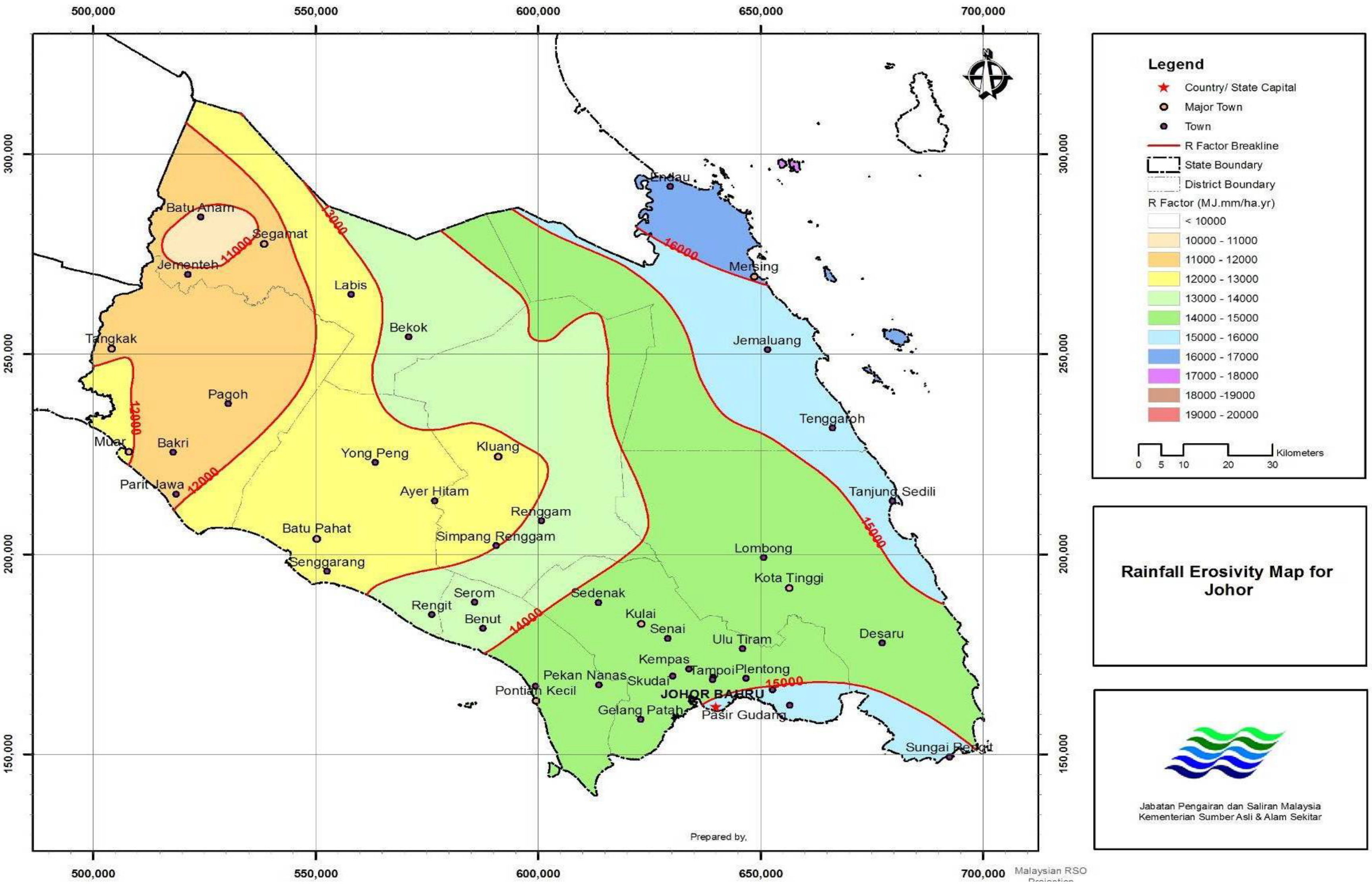


Figure 7-1: Rainfall Erosivity Map for Johor

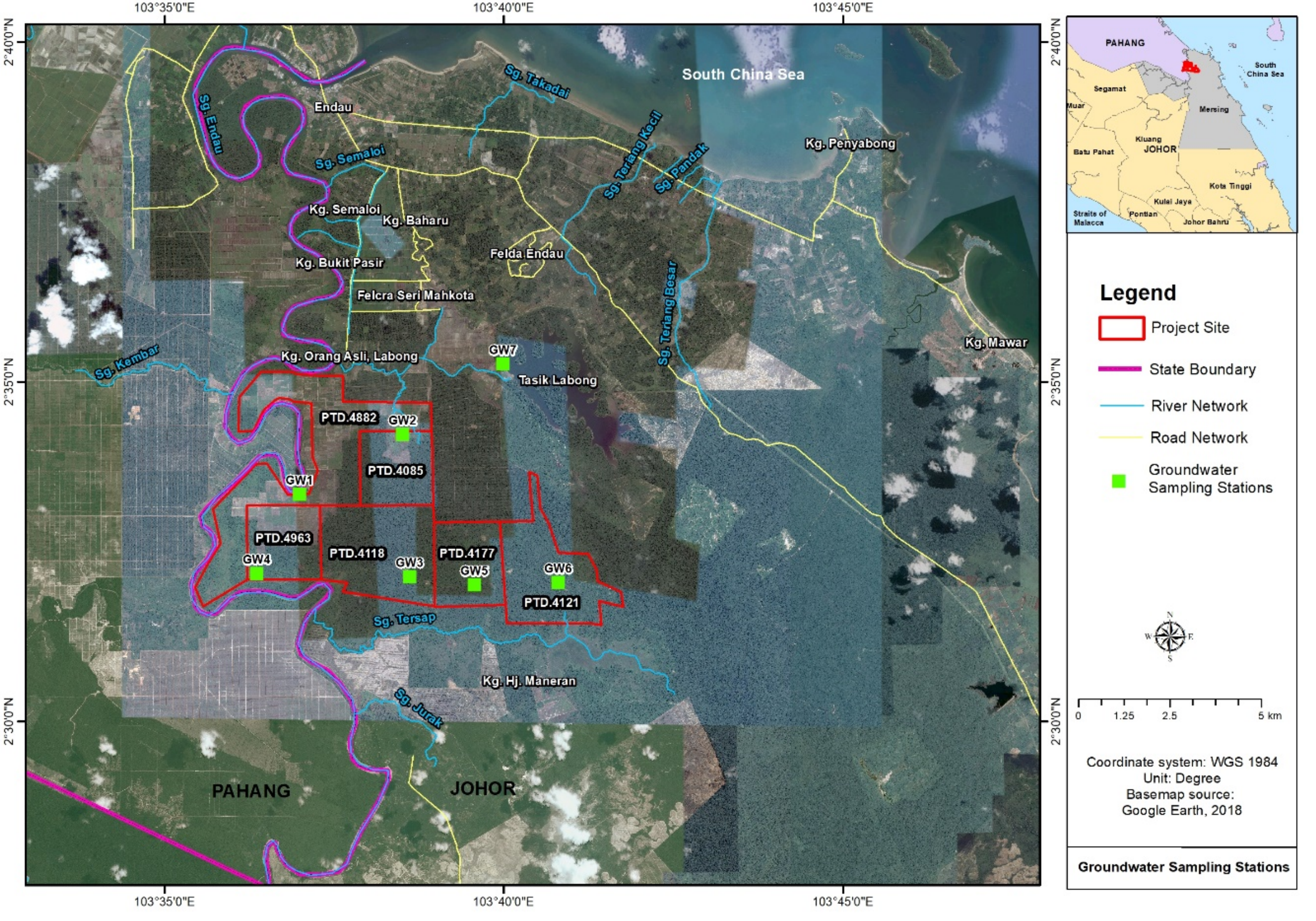


Figure 7-2: Location of Bore Holes

Table 7-3: Results of K Value

Bore Hole No.	Depth (m)	Particle Size Distribution (%)				Organic Matter		Structure Code (S)	Permeability Code (P)	K
		Silt	Sand	Clay	Gravel	OM	M			
1	0.5	21	6	42	31	1.7	1566	4	5	0.120
2	0.5	4	8	40	42	2.9	720	4	5	0.091
3	0.5	9	10	24	57	3.8	1444	3	3	0.043
4	0.5	1	10	51	38	4	539	4	5	0.085
5	0.5	3	7	50	41	1.2	500	4	3	0.068
6	0.5	40	29	22	0	4	5382	2	3	0.108

Table 7-4: LS Calculated using MSMA Approach

Slope			M	Slope Length in meters (λ)								
s(%)	S(o)	S(rad)		1.0	3	5	10	15	25	50	75	100
0.10	0.06	0.001	0.200	0.037	0.047	0.052	0.059	0.064	0.071	0.082	0.089	0.094
0.20	0.12	0.002	0.200	0.040	0.050	0.055	0.064	0.069	0.076	0.088	0.095	0.101
0.50	0.29	0.005	0.200	0.048	0.060	0.067	0.076	0.083	0.092	0.105	0.114	0.121
0.75	0.43	0.007	0.200	0.056	0.069	0.077	0.088	0.095	0.106	0.121	0.132	0.139
1.00	0.57	0.010	0.300	0.046	0.065	0.075	0.093	0.105	0.122	0.150	0.169	0.185
2.00	1.15	0.020	0.300	0.072	0.100	0.117	0.144	0.163	0.190	0.234	0.264	0.288
3.00	1.72	0.030	0.400	0.076	0.118	0.144	0.190	0.224	0.275	0.362	0.426	0.478
4.00	2.29	0.040	0.400	0.102	0.159	0.195	0.257	0.302	0.371	0.489	0.575	0.645
5.00	2.86	0.050	0.500	0.097	0.168	0.217	0.308	0.377	0.486	0.688	0.842	0.973
10.00	5.71	0.100	0.500	0.250	0.433	0.559	0.790	0.967	1.249	1.766	2.163	2.498
20.00	11.31	0.197	0.600	0.559	1.081	1.469	2.226	2.839	3.857	5.846	7.457	8.861
30.00	16.70	0.291	0.600	1.138	2.199	2.988	4.529	5.777	7.849	11.896	15.173	18.032
40.00	21.80	0.381	0.600	1.919	3.710	5.041	7.640	9.744	13.239	20.067	25.593	30.415
50.00	26.57	0.464	0.600	2.903	5.612	7.625	11.558	14.741	20.028	30.357	38.718	46.012
60.00	30.96	0.540	0.600	4.090	7.907	10.743	16.283	20.767	28.216	42.767	54.546	64.823
70.00	34.99	0.611	0.600	5.480	10.593	14.392	21.815	27.823	37.802	57.297	73.078	86.846

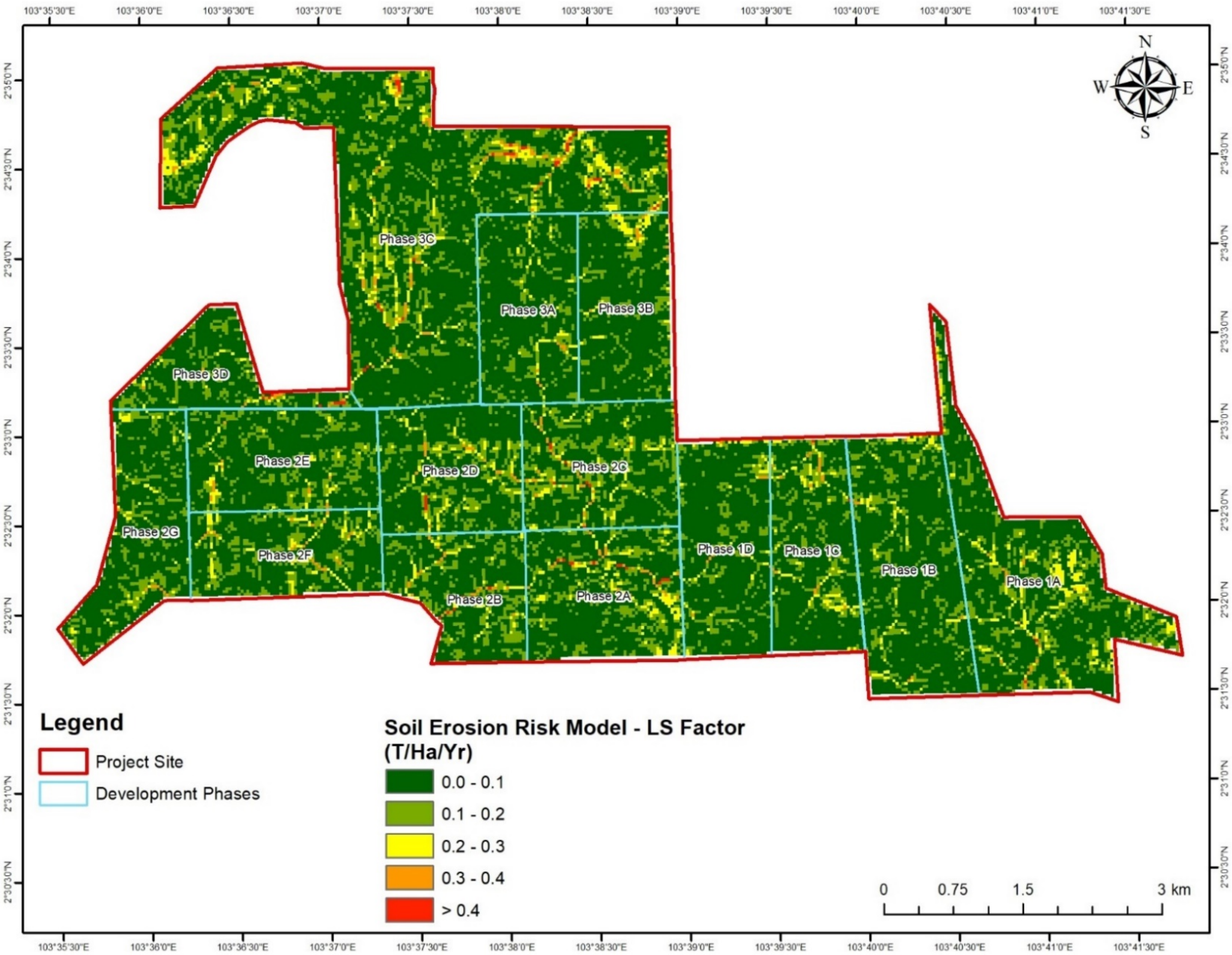


Figure 7-3: Length Slope Map

Determination of CP factor

The CP factor for existing and disturbed conditions are shown in **Table 7-5**.

Table 7-5: CP Factors for Various Scenarios

Scenario	C factor	P factor
Scenario 1: Existing condition	0.03 (forest/tree 100% cover)	Same as Scenario 3
Scenario 2: Clearing without BMPs	1 (bare land)	1 (bare soil)
Scenario 3: Clearing with BMPs	0.05 (turfing 60% cover)	0.5 (sediment basin) 0.55 (silt fence) 0.8 (check dam)

The estimated erosion rate is shown in **Table 7-6 – Table 7-7**. **Figure 7-4**, **Figure 7-5** and **Figure 7-6** shows the estimated spatial erosion risk map based on existing, with control and without control parameters. The erosion risk map for existing condition, clearing without BMPs and clearing with BMPs has been estimated for the Project area. Based on the assessment, it can be seen that with implementation of BMPs such as turfing, sediment basin, silt fence and check dam during clearing phase, the erosion rate can be reduced to the level near to existing condition.

Table 7-6: Estimated Erosion Rate for the Proposed Project (Phase 1)

Condition	Parameters	Phase			
		1A	1B	1C	1D
Existing	R	17000	17000	17000	17000
	K	0.108	0.108	0.068	0.068
	LS	0.288	0.288	0.288	0.288
	C	0.35	0.35	0.35	0.35
	P	1.00	1.00	1.00	1.00
	A (ton/ha/yr)	**185**	**185**	**117**	**117**
Plantation Operation Uncontrolled	R	17000	17000	17000	18000
	K	0.108	0.108	0.068	0.068
	LS	0.288	0.288	0.288	0.288
	C	1.00	1.00	1.00	1.00
	P	1.00	1.00	1.00	1.00
	A (ton/ha/yr)	**529**	**529**	**333**	**353**
Plantation Operation Controlled	R	17000	17000	17000	18000
	K	0.108	0.108	0.068	0.068
	LS	0.288	0.288	0.288	0.288
	C	0.05	0.05	0.05	0.05
	P	0.50	0.50	0.50	0.50
	A (ton/ha/yr)	**13**	**13**	**117**	**9**

Table 7-7: Estimated Erosion Rate for the Proposed Project (Phase 2)

Condition	Parameter	Phase						
		2A	2B	2C	2D	2E	2F	2G
Existing	R	17000	17000	17000	17000	17000	17000	17000
	K	0.085	0.085	0.085	0.085	0.043	0.043	0.043
	LS	0.288	0.288	0.288	0.288	0.288	0.288	0.288
	C	0.35	0.35	0.35	0.35	0.35	0.35	0.35
	P	1	1	1	1	1	1	1
	A (ton/ha/yr)	**146**	**146**	**146**	**146**	**74**	**74**	**74**
Plantation Operation Uncontrolled	R	17000	17000	17000	18000	17000	17000	17000
	K	0.085	0.085	0.085	0.085	0.043	0.043	0.043
	LS	0.288	0.288	0.288	0.288	0.288	0.288	0.288
	C	1	1	1	1	1	1	1
	P	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	A (ton/ha/yr)	**416**	**416**	**416**	**441**	**211**	**211**	**211**
Plantation Operation Controlled	R	17000	17000	17000	18000	17000	17000	17000
	K	0.085	0.085	0.085	0.085	0.043	0.043	0.043
	LS	0.288	0.288	0.288	0.288	0.288	0.288	0.288
	C	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	P	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	A (ton/ha/yr)	**10**	**10**	**146**	**11**	**5**	**5**	**74**

Condition	Parameters	Phase			
		3A	3B	3C	3D
Existing	R	17000	17000	17000	17000
	K	0.091	0.091	0.12	0.12
	LS	0.288	0.288	0.288	0.288
	C	0.35	0.35	0.35	0.35
	P	1.00	1.00	1.00	1.00
	A (ton/ha/yr)	156	156	206	206
Plantation Operation Uncontrolled	R	17000	17000	17000	18000
	K	0.091	0.091	0.12	0.12
	LS	0.288	0.288	0.288	0.288
	C	1.00	1.00	1.00	1.00
	P	1.00	1.00	1.00	1.00
	A (ton/ha/yr)	**446**	**446**	**588**	**622**
Plantation Operation Controlled	R	17000	17000	17000	18000
	K	0.091	0.091	0.12	0.12
	LS	0.288	0.288	0.288	0.288
	C	0.05	0.05	0.05	0.05
	P	0.50	0.50	0.50	0.50
	A (ton/ha/yr)	**11**	**11**	**206**	**16**

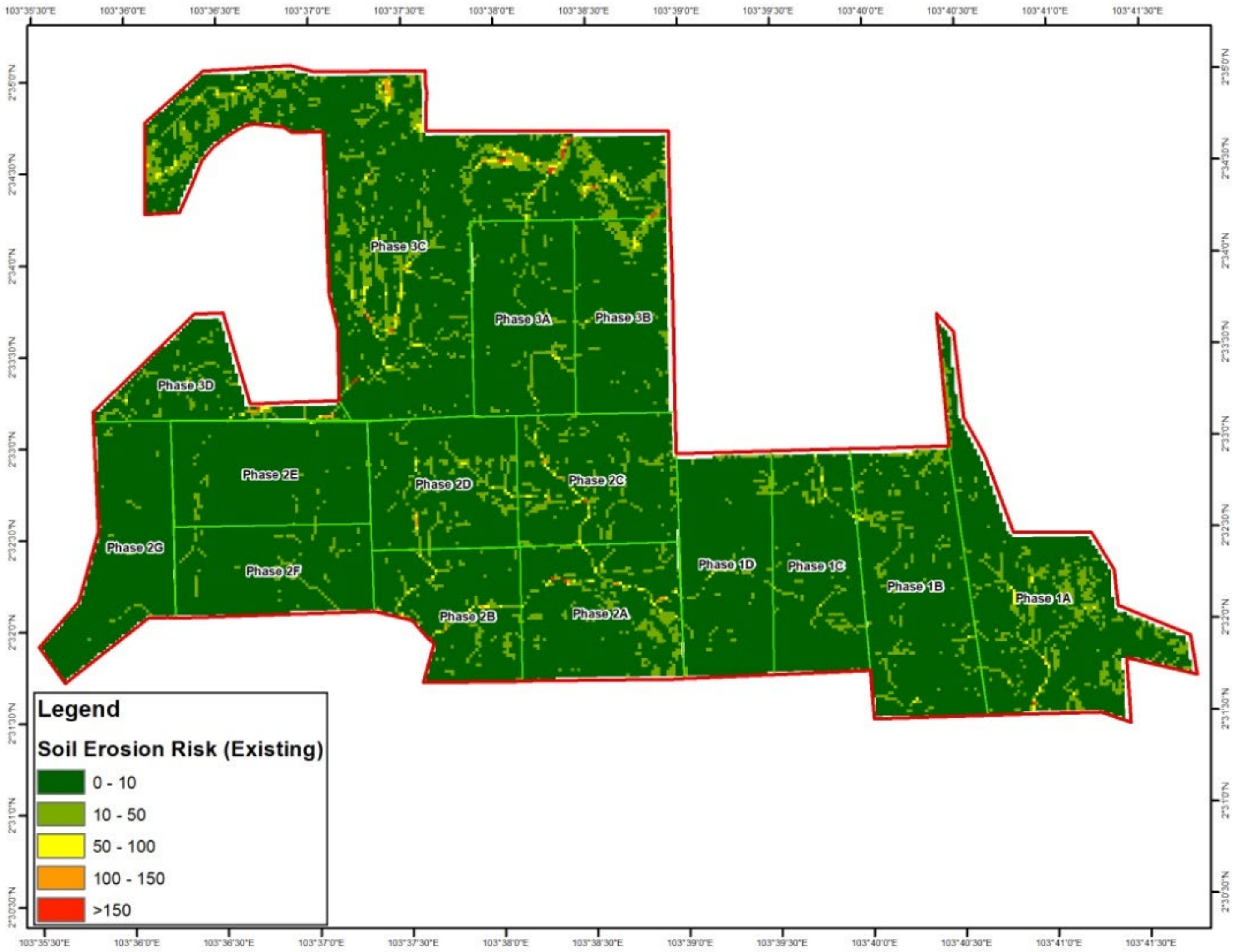


Figure 7-4: Soil Erosion Risk Map (Existing)

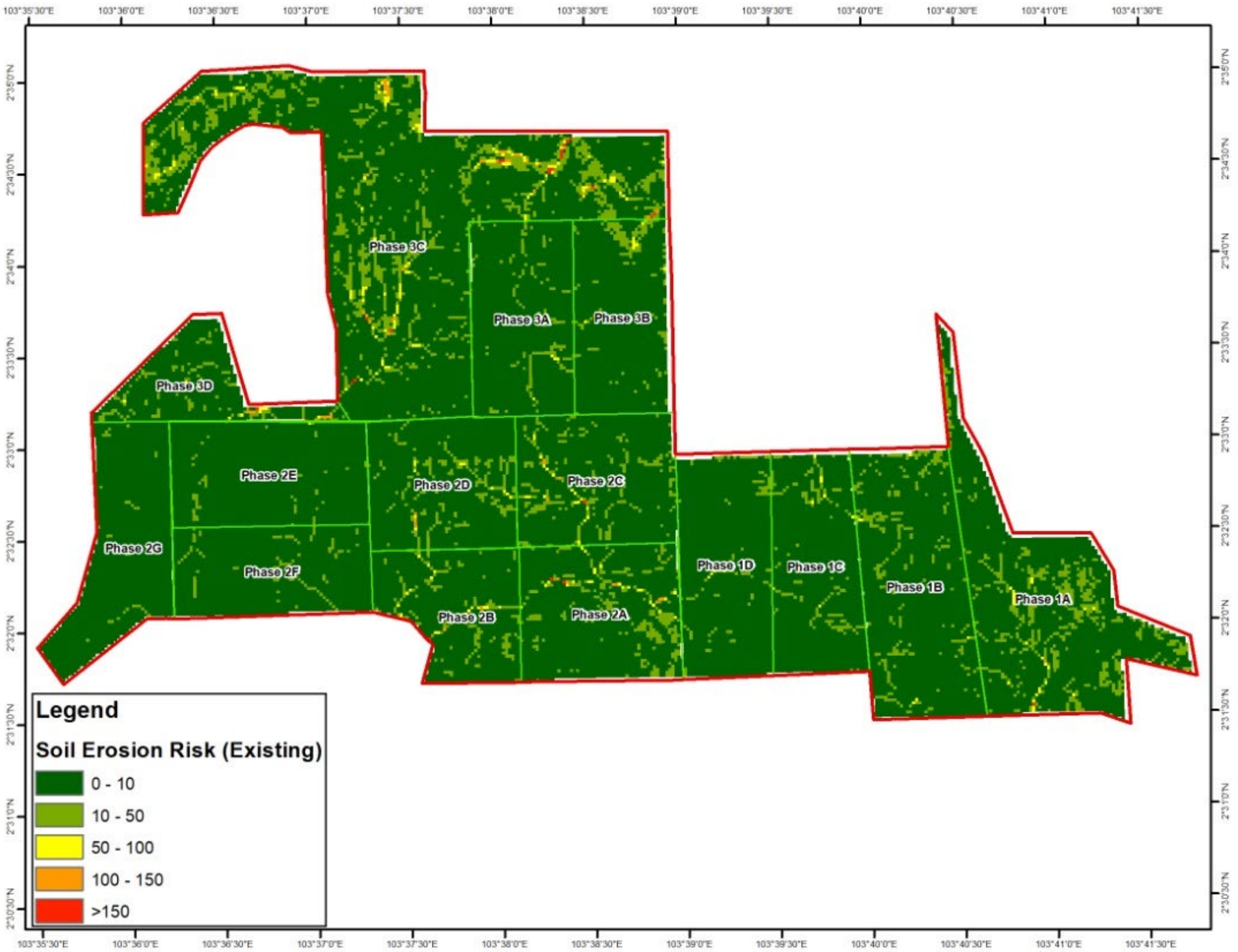


Figure 7-5: Soil Erosion Risk Map (Without Control)

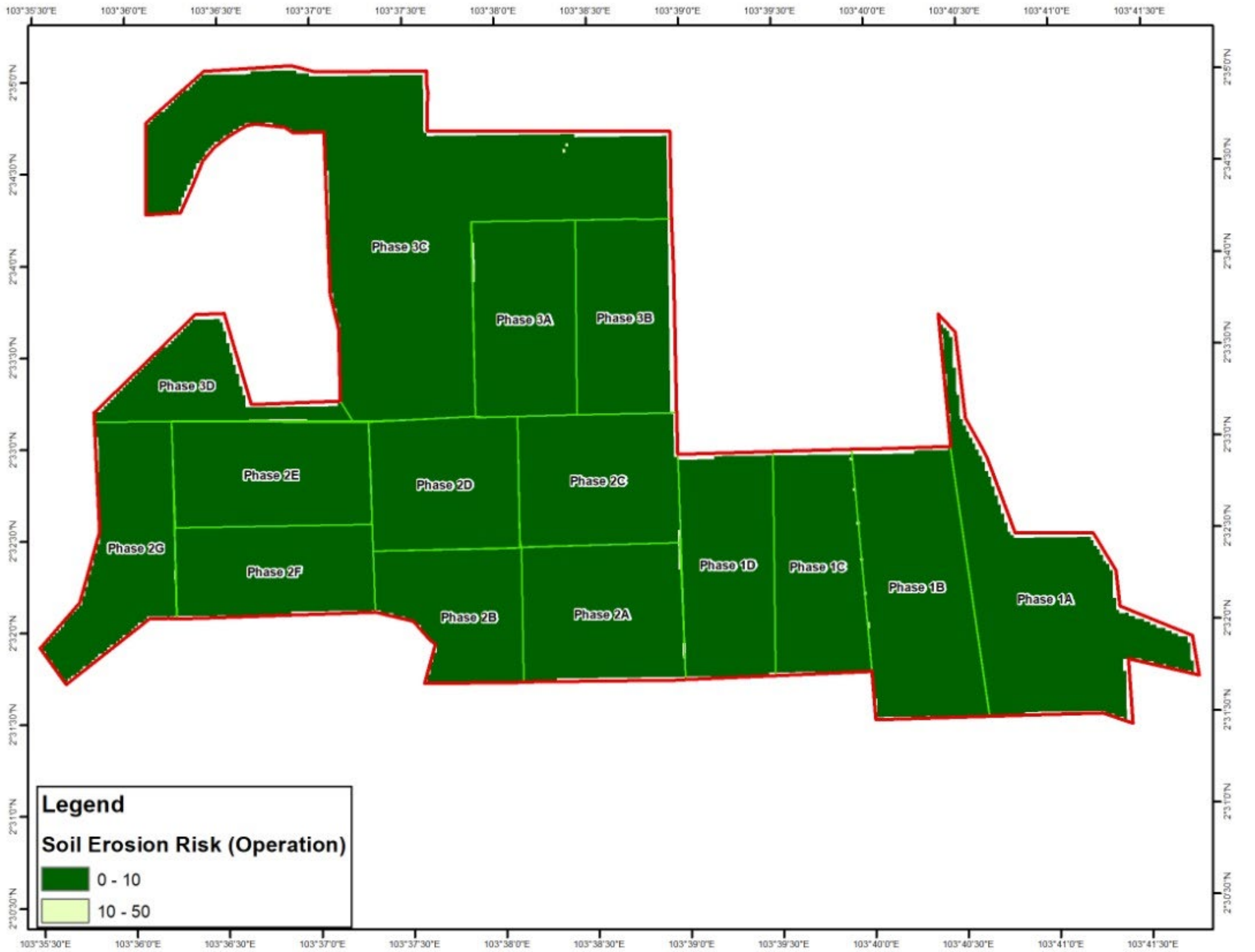


Figure 7-6: Soil Erosion Risk Map (Control)

ii. Determination of Sediment Yield

Calculation of sediment yield was carried out in accordance to the Guideline for Erosion and Sediment Control in Malaysia (Department of Irrigation and Drainage, Ministry of Natural Resources and Environment Malaysia).

Sediment yield estimated using MUSLE equation: -

$$\boldsymbol{Y = 89.6\ (V\ x\ Q_p)^{0.56}\ x\ K\ x\ LS\ x\ C\ x\ P}$$

Where;

Y	=	Sediment yield per storm event (tones)
V	=	Runoff volume in m^3
Q_p	=	Peak discharge in m^3/s

$$Q_y = \frac{C\,{}^{y}I_t A}{360} \qquad \text{Equation 2}$$

Q_y	=	year ARI peak flow (m^3/s)
C	=	Dimensionless runoff coefficient
${}^{y}I_t$	=	y year ARI rainfall intensity over t_c (mm/hr)
A	=	Catchment area (hectares)

The derived Tc serves as the duration of design storm. The design storm intensity for the area can be derived from the IDF curve. The IDF equation used to derive the rainfall intensity is shown in equation 2. There are a number of IDF curves within the state of Johor (**Table 7-8**). In this study, the IDF derived for the Stor JPS ENDAU station (**Figure 7-7**) will be used for the simulation of surface runoff as the station is located within the same river basin as the Project development site. The temporal pattern used for this study is based on the Johor temporal pattern. The design storm hyetograph of 2, 5, 10, 20, **50** years and **100** years ARI will be used in this study. **Table 7-9** and **Table 7-10** listed the rainfall intensity used in this study for various ARI's.

$$i = \frac{\lambda T^{\kappa}}{(d+\theta)^{\eta}}$$

Where;

i	=	Average rainfall intensity (mm/hr)
T	=	Average recurrence interval - ARI (0.5 ≤ T ≤ 12 month and 2 ≤ T ≤ 100 year)
d	=	Storm duration (hours), 0.0833 ≤ d ≤ 72
λ, κ, θ and η	=	Fitting constants dependent on the rain gauge location

Table 7-8: IDF Curves for Various Stations in Johor

State	No.	Station ID	Station Name	Constants			
				λ	κ	θ	η
Johor	1	1437116	Stor JPS Johor Bahru	59.972	0.163	0.121	0.793
	2	1534002	Pusat Kem. Pekan Nenas	54.265	0.179	0.100	0.756
	3	1541139	Johor Silica	59.060	0.202	0.128	0.660
	4	1636001	Balai Polis Kg Seelong	50.115	0.191	0.099	0.763
	5	1737001	SM Bukit Besar	50.554	0.193	0.117	0.722
	6	1829002	Setor JPS B Pahat	64.099	0.174	0.201	0.826
	7	1834124	Ladang Ulu Remis	55.864	0.166	0.174	0.810
	8	1839196	Simpang Masai K. Sedili	61.562	0.191	0.103	0.701
	9	1931003	Emp. Semberong	60.568	0.163	0.159	0.821
	10	2025001	Pintu Kaw. Tg. Agas	80.936	0.187	0.258	0.890
	11	2033001	JPS Kluang	54.428	0.192	0.108	0.740
	12	2231001	Ladang Chan Wing	57.188	0.186	0.093	0.777
	13	2232001	Ladang Kekayaan	53.457	0.180	0.094	0.735
	14	2235163	Ibu Bekalan Kahang	52.177	0.186	0.055	0.652
	15	2237164	Jalan Kluang-Mersing	56.966	0.190	0.144	0.637
	16	2330009	Ladang Labis	45.808	0.222	0.012	0.713
	17	2528012	Rmh. Tapis Segamat	45.212	0.224	0.039	0.711
	18	2534160	Kg Peta Hulu Sg Endau	59.500	0.185	0.129	0.623
	19	2636170	Setor JPS Endau	62.040	0.215	0.103	0.592

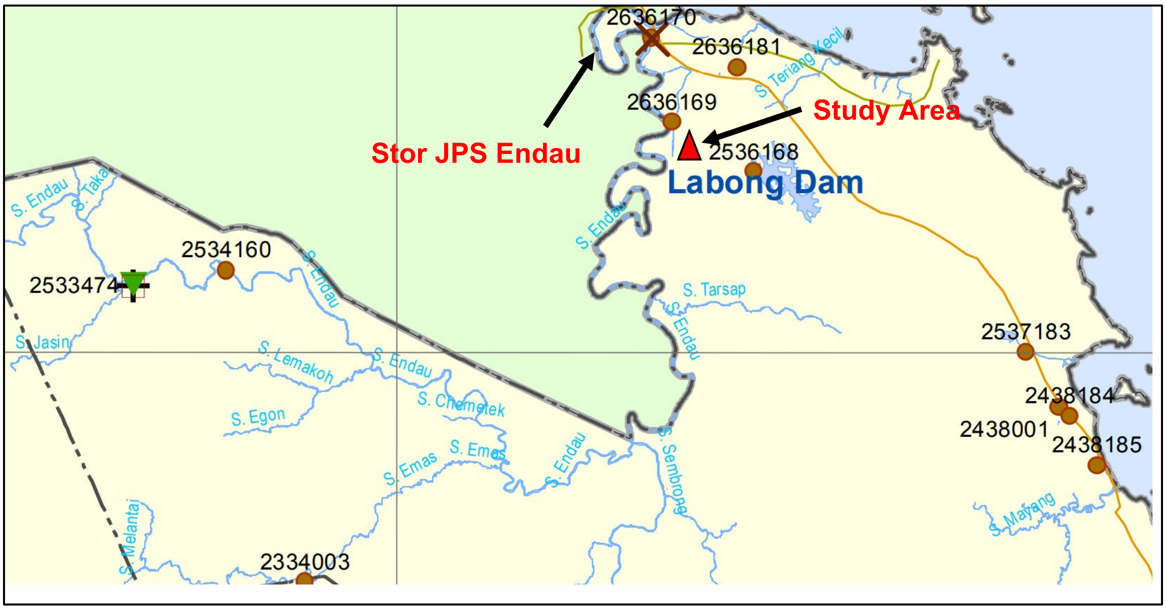


Figure 7-7: Study Area and the Selected Design Storm Station

Table 7-9: Rainfall Intensity (mm/hr) for Various Duration (minutes)

ARI (yrs)	30	60	90	120	180	360
2	124.93	87.69	69.45	58.35	45.23	28.75
5	179.98	126.33	100.06	84.07	65.17	41.43
10	237.24	166.52	131.90	110.82	85.90	54.61
20	312.72	219.50	173.86	146.07	113.22	71.98
50	450.54	316.24	250.48	210.45	163.12	103.70
100	593.88	416.84	330.16	277.40	215.02	136.69

Table 7-10: Rainfall Depth (mm) for Various Duration (minutes)

ARI (yrs)	30	60	90	120	180	360
2	62.46	87.69	104.18	116.71	135.69	172.52
5	89.99	126.33	150.09	168.14	195.50	248.56
10	118.62	166.52	197.84	221.64	257.69	327.64
20	156.36	219.50	260.78	292.15	339.67	431.87
50	225.27	316.24	375.72	420.90	489.37	622.20
100	296.94	416.84	495.25	554.81	645.06	820.14

Table 7-11: Recommended Runoff Coefficients for Various Land Use

Landuse	Runoff Coefficient (C)	
	For Minor System (≤10 year ARI)	For Major System (> 10 year ARI)
Residential		
Bungalow	0.65	0.70
Semi-detached Bungalow	0.70	0.75
Link and Terrace House	0.80	0.90
Flat and Apartment	0.80	0.85
Condominium	0.75	0.80
Commercial and Business Centres	0.90	0.95
Industrial	0.90	0.95
Sport Fields, Park and Agriculture	0.30	0.40
Open Spaces		
Bare Soil (No Cover)	0.50	0.60
Grass Cover	0.40	0.50
Bush Cover	0.35	0.45
Forest Cover	0.30	0.40
Roads and Highways	0.95	0.95
Water Body (Pond)		
Detention Pond (with outlet)	0.95	0.95
Retention Pond (no outlet)	0.00	0.00

Note: The runoff coefficients in this table are given as a guide for designers. The near-field runoff coefficient for any single or mixed landuse should be determined based on the imperviousness of the area.

The parameters in estimating the overland flow are as below;

Overland flow length = 100m
Duration of storm = 60 min
Intensity of design storm (2 Year ARI) = 87.69 mm/hr (**Table 7-9**)
Runoff coefficient (bare soil) = 0.5 (**Table 7-11**)

The peak flow for various sub-catchments was estimated using equation 1. Surface runoff volume was estimated based on triangular rational hydrograph method. The estimated peak flow and flow volume for the four sub-catchments is listed in **Table 7-12** to **Table 7-14**. The estimated peak flow and runoff volume would be used to estimate sediment yield for each sediment basin as shown in equation 2. The other sediment yield parameters such as K, LS, C and P are also shown in the same table. The estimated sediment yield for the three sediment basins with and without BMP's is listed in the **Table 7-15** to **Table 7-17**.

Table 7-12: Estimated Sediment Yield for The Sediment Basins (Without BMP's) – Phase 1

Phase	1A	1B	1C	1D
Design storm (mm)	50	50	50	50
Area (ha)	380	251	200	212
tc (min)	30.00	60.00	25	20
Duration storm, d (min)	60	60	30	30
i (mm/hr)	59.7	59.7	59.7	59.7
Q_p (m^3/s)	31.51	20.81	16.58	17.58
Volume (m^3)	56715	74924	24875	21094
K	0.108	0.108	0.068	0.068
LS	0.288	0.288	0.288	0.288
C	1.00	1.00	1.00	1.00
P	1.00	1.00	1.00	1.00
Sediment yield, Y (tonne)	8837	8188	2448	2306

Table 7-13: Estimated Sediment Yield for The Sediment Basins (Without BMP's) – Phase 2

Phase	2A	2B	2C	2D	2E	2F	2G
Design storm (mm)	50	50	50	50	50	50	50
Area (ha)	220	184	220	185.4	228	177	324
tc (min)	30.00	60.00	25	20	30.00	60.00	25
Duration storm, d (min)	60	60	30	30	60	60	30
i (mm/hr)	59.7	59.7	59.7	59.7	59.7	59.7	59.7
Q_p (m^3/s)	18.24	15.26	18.24	15.37	18.91	14.68	26.87
Volume (m^3)	32835	54924	27363	18447	34029	52835	40298
K	0.085	0.085	0.085	0.085	0.085	0.085	0.085
LS	0.288	0.288	0.288	0.288	0.288	0.288	0.288
C	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Sediment yield, Y (tonne)	3771	4551	3405	2481	3925	4358	5253

Table 7-14: Estimated Sediment Yield for The Sediment Basins (Without BMP's) – Phase 3

Phase	3A	3B	3C	3D
Design storm (mm)	50	50	50	50
Area (ha)	200	205	789	150
tc (min)	30.00	60.00	25	20
Duration storm, d (min)	60	60	30	30
i (mm/hr)	59.7	59.7	59.7	59.7
Q_p (m^3/s)	16.58	17.00	65.42	12.44
Volume (m^3)	29850	61193	98132	14925
K	0.091	0.091	0.12	0.12
LS	0.288	0.288	0.288	0.288
C	1.00	1.00	1.00	1.00
P	1.00	1.00	1.00	1.00
Sediment yield, Y (tonne)	3628	5499	20095	2763

Table 7-15: Estimated Sediment Yield for The Sediment Basins (With Silt Fence and Check Dam BMP's) – Phase 1

Phase	1A	1B	1C	1D
Design storm (mm)	50	50	50	50
Area (ha)	380	251	200	212
tc (min)	60	60	60	60
Duration storm, d (min)	60	60	60	60
i (mm/hr)	59.7	59.7	59.7	59.7
Q_p (m^3/s)	31.51	20.81	16.58	17.58
Volume (m^3)	113430	74924	59700	63282
K	0.108	0.108	0.068	0.068
LS	0.288	0.288	0.288	0.288
C	0.50	0.50	0.50	0.50
P	0.50	0.50	0.50	0.50
Sediment yield, Y (tonne)	3257	2047	999	1067

Table 7-16: Estimated Sediment Yield for The Sediment Basins (With Silt Fence and Check Dam BMP's) – Phase 2

Phase	2A	2B	2C	2D	2E	2F	2G
Design storm (mm)	50	50	50	50	50	50	50
Area (ha)	220	184	220	185.4	228	177	324
tc (min)	60	60	60	60	60	60	60
Duration storm, d (min)	60	60	60	60	60	60	60
i (mm/hr)	59.7	59.7	59.7	59.7	59.7	59.7	59.7
Q_p (m^3/s)	18.24	15.26	18.24	15.37	18.91	14.68	26.87
Volume (m^3)	65670	54924	65670	55342	68058	52835	96714
K	0.085	0.085	0.085	0.085	0.085	0.085	0.085
LS	0.288	0.288	0.288	0.288	0.288	0.288	0.288
C	0.50	0.50	0.50	0.50	0.50	0.50	0.50
P	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Sediment yield, Y (tonne)	1390	1138	1390	1147	1447	1089	2144

Table 7-17: Estimated Sediment Yield for The Sediment Basins (With Silt Fence and Check Dam BMP's) – Phase 3

Phase	3A	3B	3C	3D
Design storm (mm)	50	50	50	50
Area (ha)	200	205	789	150
tc (min)	60	60	60	60
Duration storm, d (min)	60	60	60	60
i (mm/hr)	59.7	59.7	59.7	59.7
Q_p (m^3/s)	16.58	17.00	65.42	12.44
Volume (m^3)	59700	61193	235517	44775
K	0.091	0.091	0.12	0.12
LS	0.288	0.288	0.288	0.288
C	0.50	0.50	0.50	0.50
P	0.50	0.50	0.50	0.50
Sediment yield, Y (tonne)	1337	1375	8203	1278

The estimation of sediment yield for each phase is based on the size of each sub-phases. The estimated sediment yield for the proposed Project for existing condition, clearing (without BMPs) and clearing (with BMPs) has been determined. Based on the assessment, it can be seen that with implementation of BMPs such as turfing, sediment basin, silt fence and check dam during clearing phase, the sediment yield can be reduced to the level near to existing condition.

7.2.2.4 Water Quality

Water pollution would mainly cause by physical works carried out during site clearing and field establishment activities. The impacts from those activities are as follows:

- Sediment runoff from the loosened soil may increase the TSS and turbidity levels of the receiving waterways;
- Spillage and/or leakage of fuel, oils and lubricants, either through improper storage or improper maintenance of machinery/equipment could cause contamination of the drainage channels;
- Indiscriminate disposal of solid wastes and debris by the workers and improper discharge of sewage and sullage from workers dwelling could cause pollution of the rivers.

During the development stage the main parameter of concern would be suspended solids. However, with mitigation measures recommended through the LD-P2M2 study, the impacts can be reduced.

Wastewater will be generated from the dwelling of the workers. Improper handling of the wastewater can cause pollution of the waterways. Thus, proper mitigations measures must be taken into account for the dwelling of the workers to reduce the impact on water quality and soils.

With the proper management of wastewater from the workers dwelling, it is anticipated that the impacts can be minimised.

Hydrocarbons and fuels, which are ubiquitous in all the activities associated with the palm oil activity. The soil is generally impacted through accidental spills that can happen without warning during the dispensing of fuels, lubricating oils, through bad work practices, and non-respect of correct procedures in the garage, workshops, or just through bad “Housekeeping “and general carelessness of personnel.

The impacts of hydrocarbons spill can have adverse effects on surface water courses and shallow underground water system. Soils contaminated by hydrocarbon spills must be remediated, which is expensive procedure which can be easily avoided through good work practices.

Water quality modelling study was carried out to predict and evaluate the level of impact on the existing water quality level.

7.2.2.4.1 Water Quality Modelling

i. Sampling Activities and Data Collection

The hydrological and water quality samplings have been carried out on 7th April 2021 to 8th April 2021 during the neap tide. According to National Oceanic and Atmospheric Administration (NOAA), Neap tide is generally occurred seven days after a spring tide; refers to a period of moderate tides when the sun and moon are at right angles to each other.

In terms of sampling time and its location, the sampling time for low tide was carried out between 7.45 am until 13.40 pm for all sampling stations on 7th April 2021 while the sampling time for high tide was carried out on 7th April 2021 at sampling stations; WQ3, WQ4, WQ6, WQ7 and WQ8 between 16.06 pm to 18.59 pm. The hydrological sampling during high tide at WQ1, WQ2 and WQ5 was carried out on 8th April 2021, between 17.02 pm to 18.01 pm. The details of sampling time and sampling station location and sampling activities were shown as below in **Table 7-18**, **Figure 7-8**, and **Table 7-19**, respectively.

Table 7-18: Sampling Time and Data Collection

Sampling Stations	Sampling Time / Date			
	Low tide		High tide	
WQ1	13.40 PM	7-April-21	18.01 PM	8-April-21
WQ2	13.07 PM	7-April-21	17.46 PM	8-April-21
WQ3	10.38 AM	7-April-21	18. 59 PM	7-April-21
WQ4	9.48 AM	7-April-21	18.17 PM	7-April-21
WQ5	12.02 PM	7-April-21	17.02 PM	8-April-21
WQ6	12.23 PM	7-April-21	17.49 PM	7-April-21
WQ7	9.12 AM	7-April-21	16.06 PM	7-April-21
WQ8	7.54 AM	7-April-21	16.48 PM	7-April-21

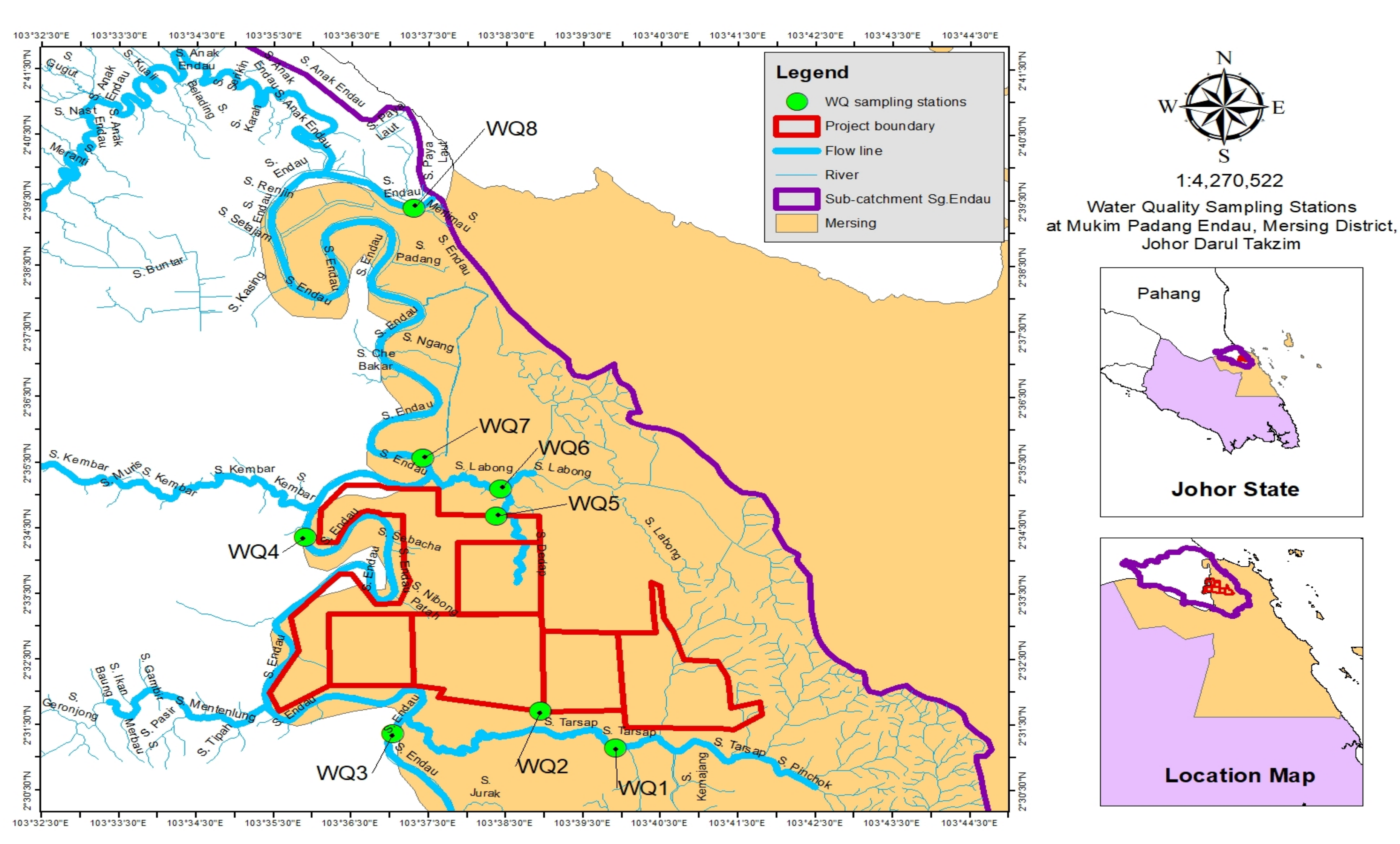
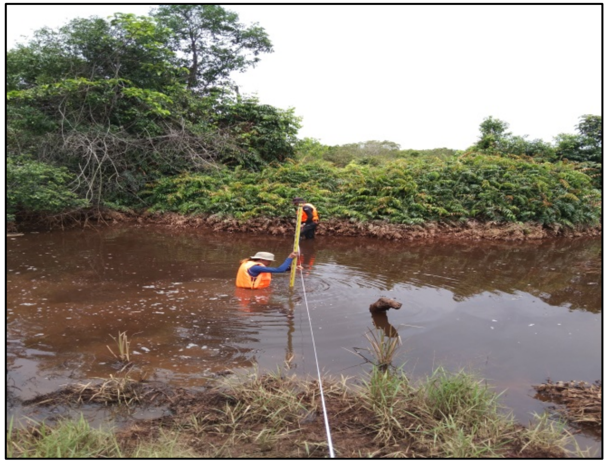


Figure 7-8: Water Quality Sampling Station

Table 7-19: Sampling Activities for Data Collection during High Tide and Low Tide

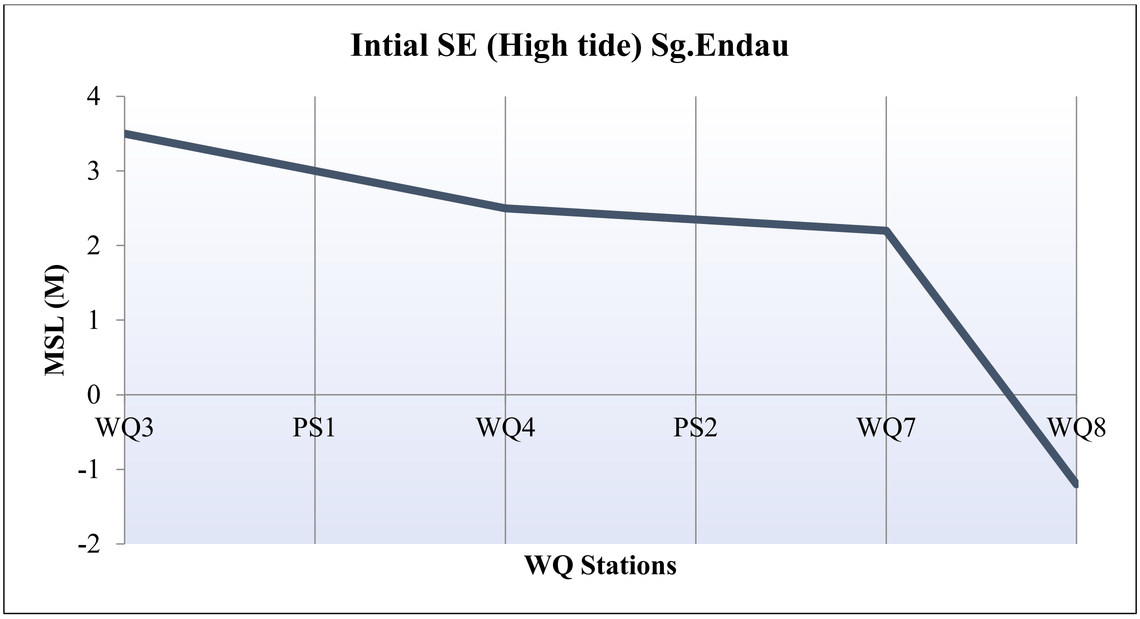
Sampling Station	Justification	Tide Level	
		High tide	Low tide
WQ1	Sg. Tarsap (Upstream of the Project site)		
WQ2	Sg. Tarsap (within the Project site)		

Sampling Station	Justification	Tide Level	
		High tide	Low tide
WQ3	Sg. Endau (Upstream of the Project site)		
WQ4	Sg. Endau (Boundary of the Project site)		

Sampling station	Justification	Tide level	
		High tide	Low tide
WQ5	Sg. Dedap (Within the Project site)		
WQ6	Sg. Labong (Upstream of the Project site)		

ii. River Morphology Survey

The river morphology survey is important in developing hydraulic model for future modelling work. The longitudinal profile for each river; initial surface elevation (SE), bottom elevation, and reference depth during high tide and low tide are shown in **Figure 7-9**, **Figure 7-10** and **Figure 7-11**, respectively.



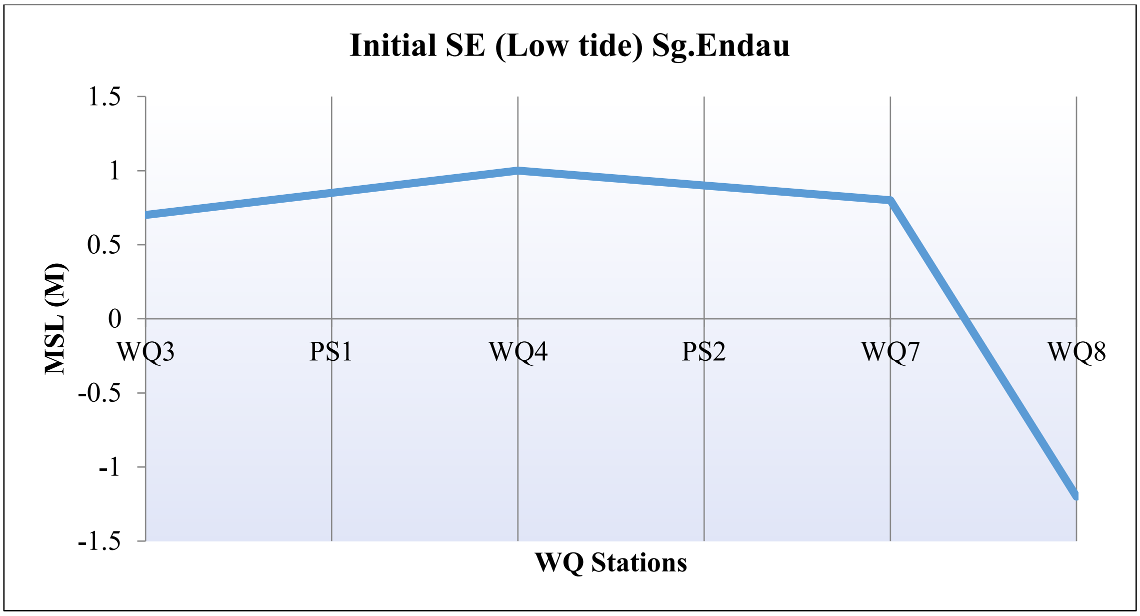


Figure 7-9: Initial Surface Elevation during High Tide and Low Tide along Sg. Endau

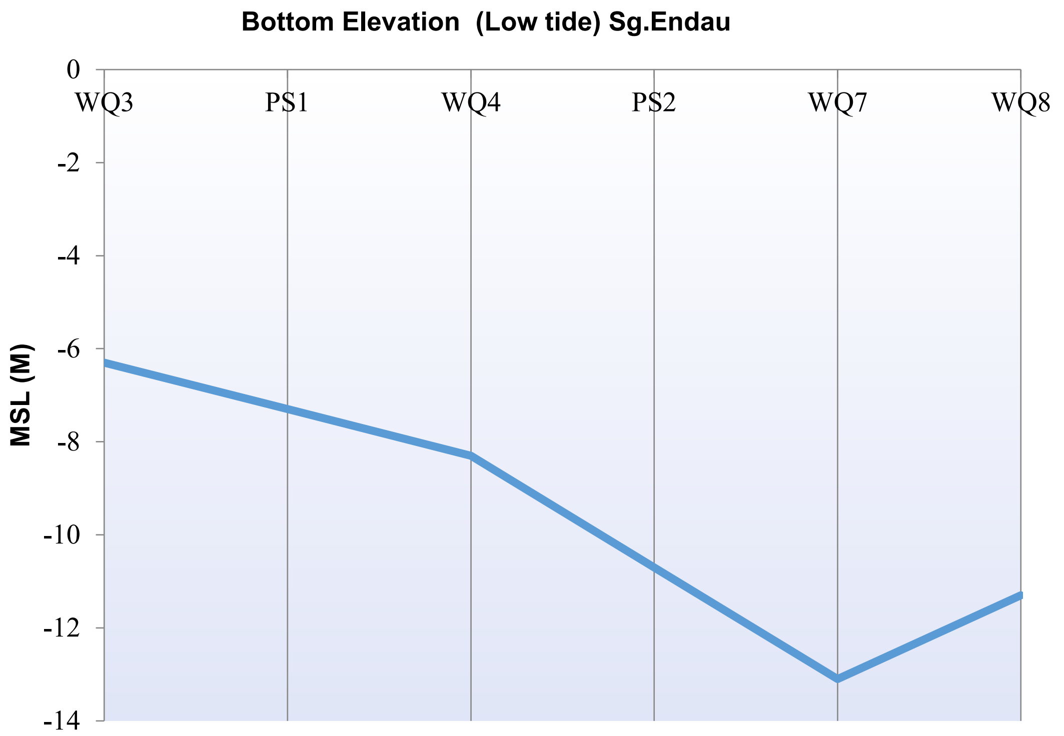


Figure 7-10: Bottom elevation during high tide and low tide along Sg. Endau

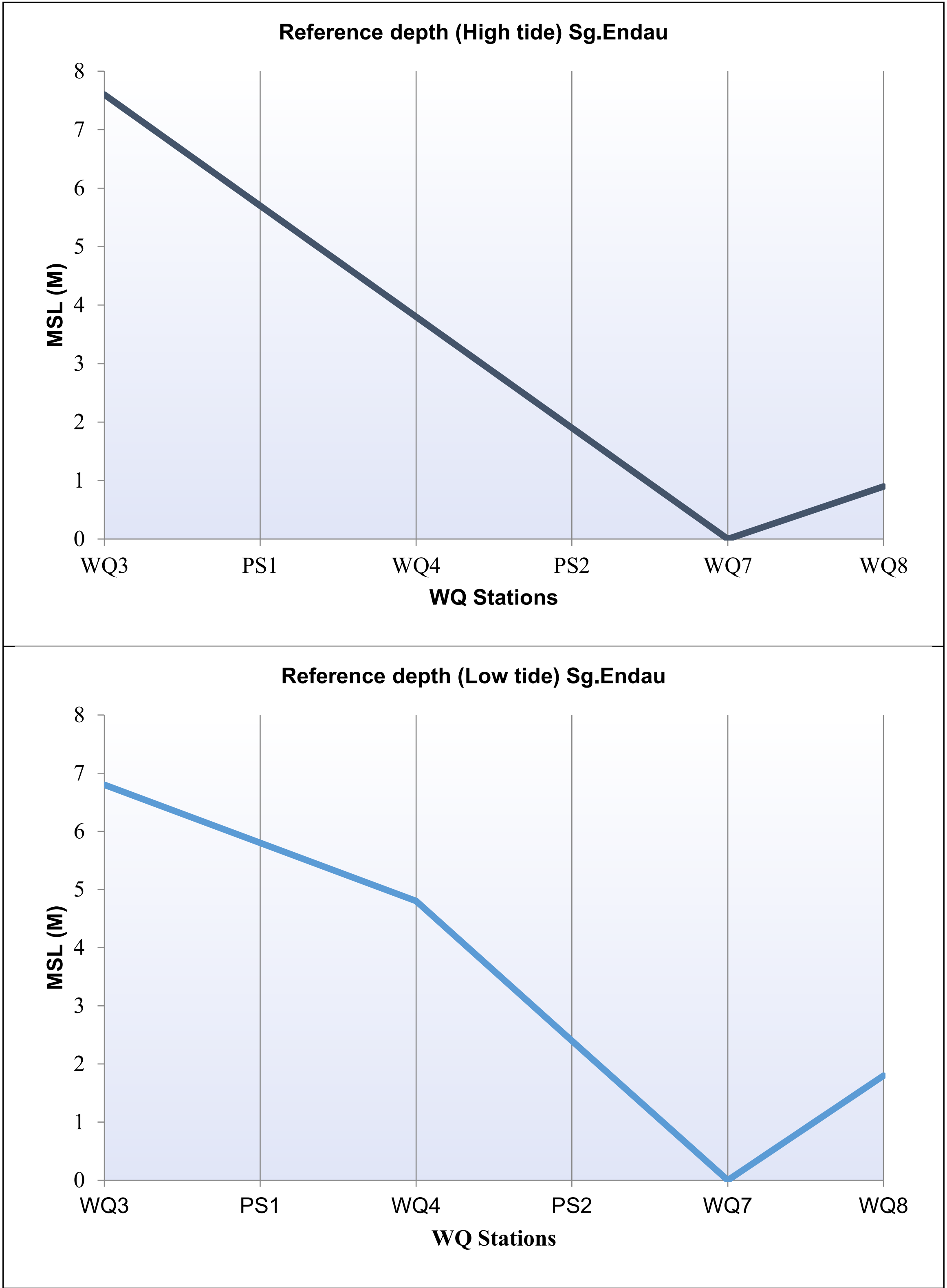
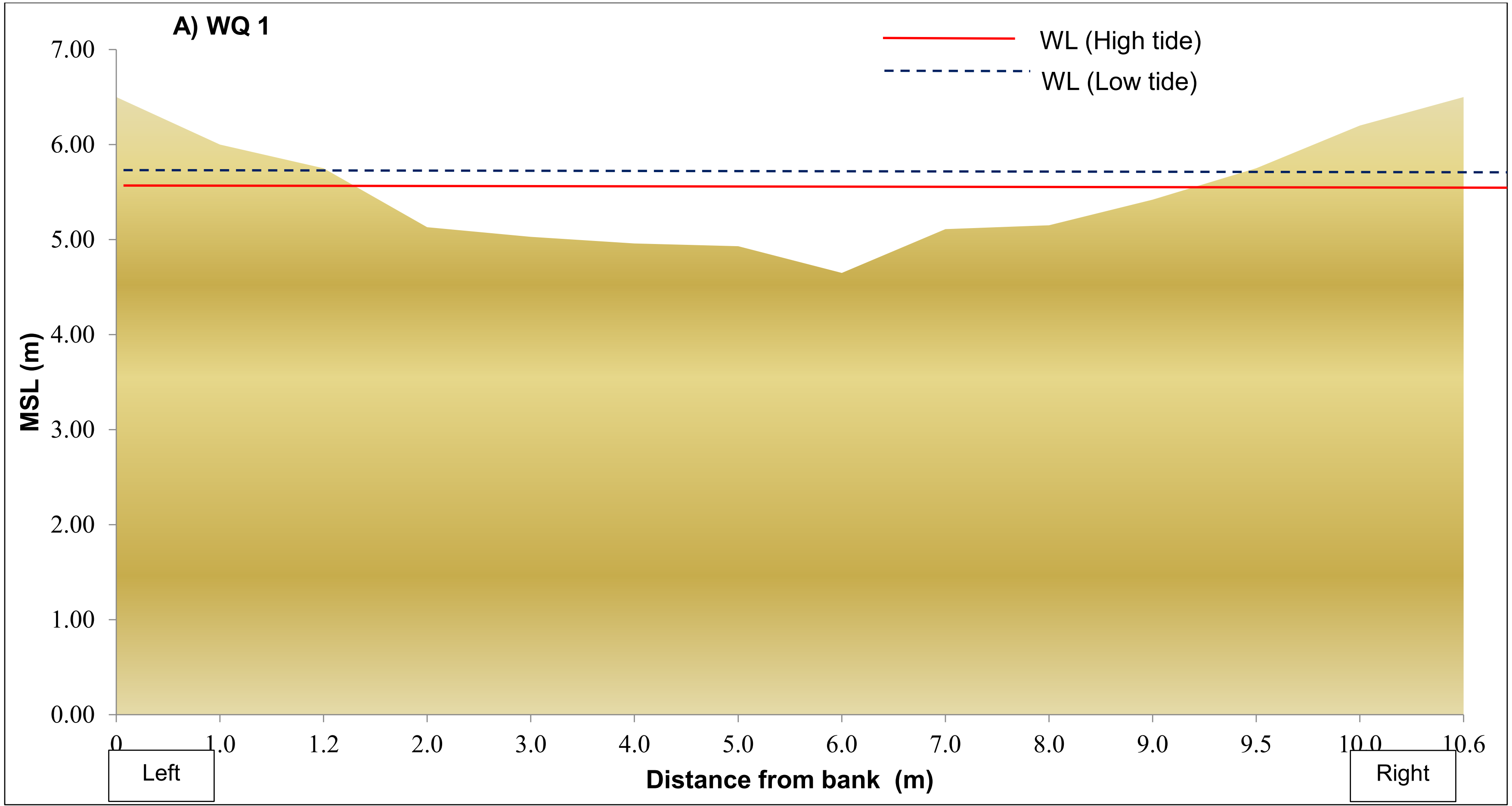


Figure 7-11: Reference depth during high tide and low tide along Sg. Endau

The river cross section at each water quality sampling station during high tide and low tide were depicted in **Figure 7-12** to **Figure 7-18**.



**Note: For WQ1, the MSL during low tide is slightly higher than high tide because the ruler position taken during sampling was not same*

Figure 7-12: River cross section at WQ 1 sampling station

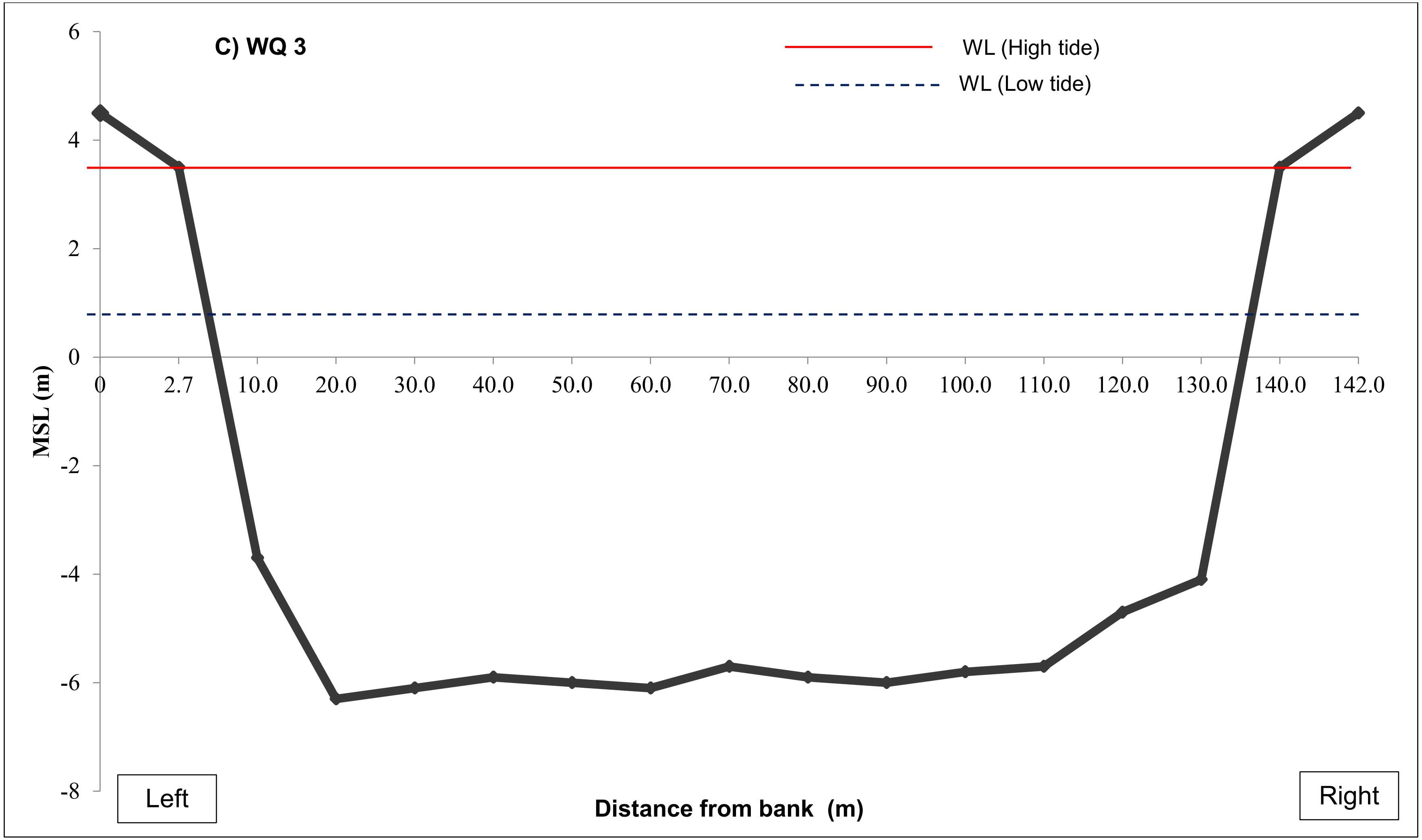


Figure 7-13: River cross section at WQ 3 sampling station

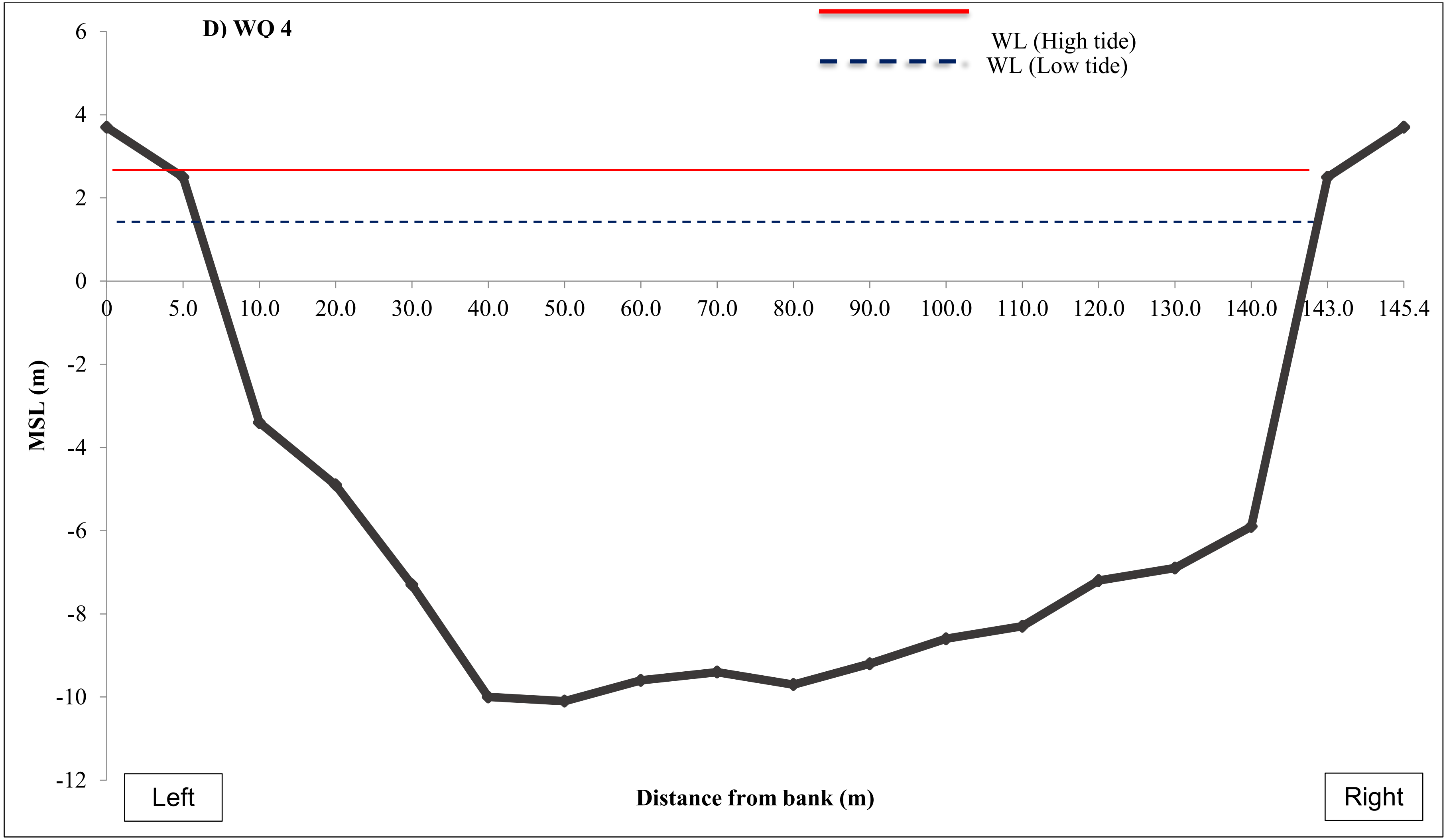


Figure 7-14: River cross section at WQ 4 sampling station

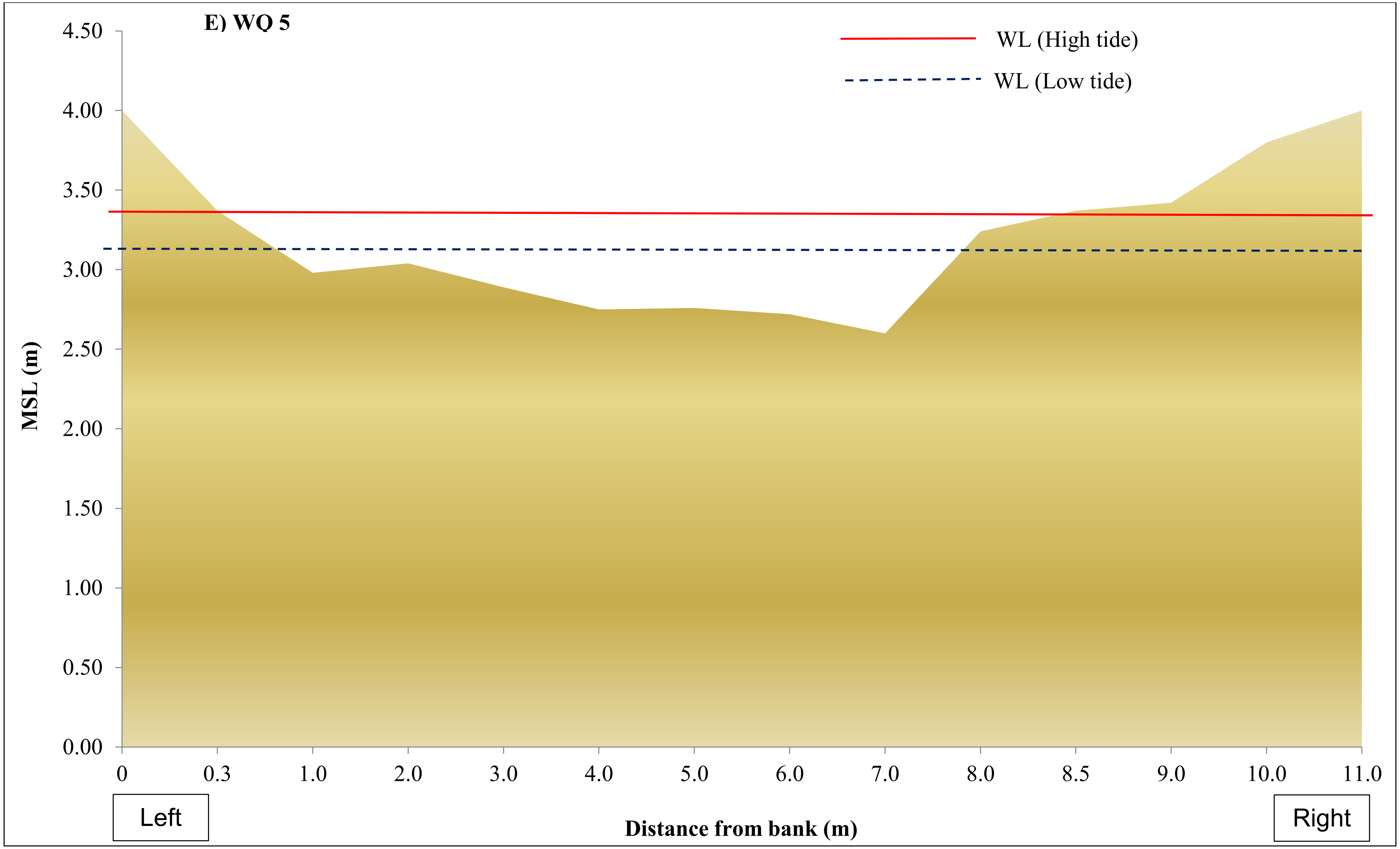


Figure 7-15: River cross section at WQ 5 sampling station

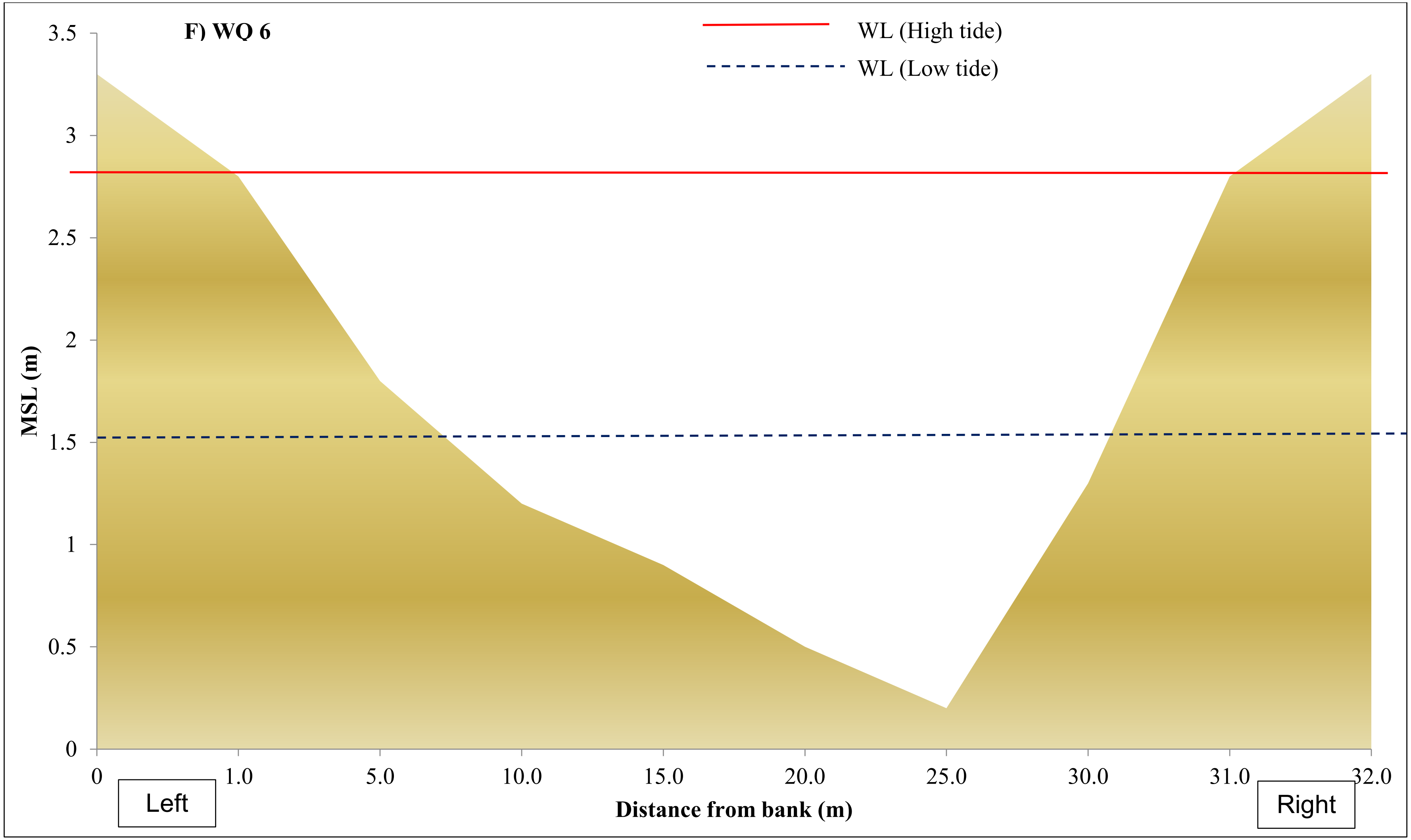


Figure 7-16: River Cross Section at WQ 6 Sampling Station

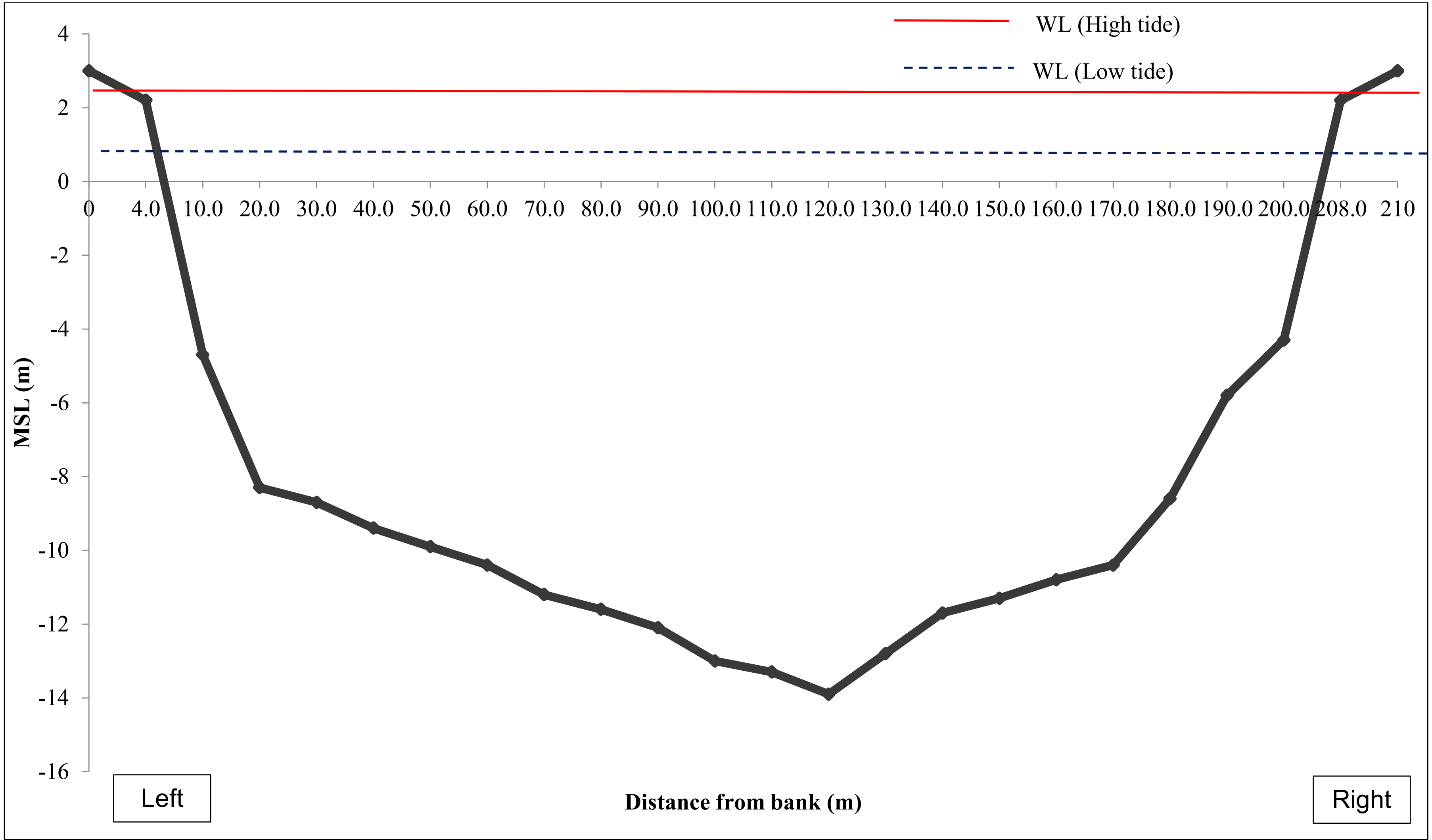


Figure 7-17: River Cross Section at WQ 7 Sampling Station

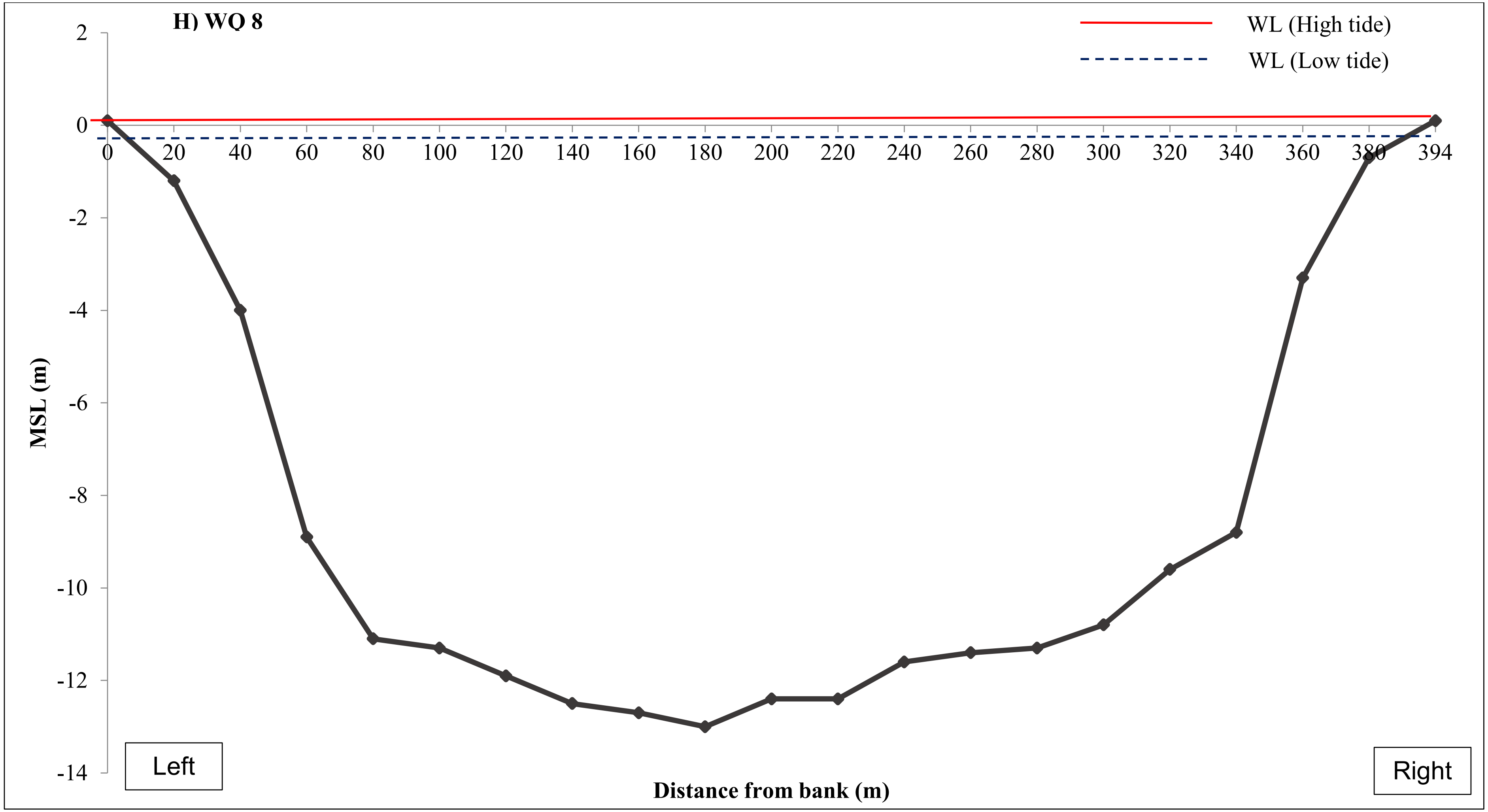


Figure 7-18: River cross section at WQ 8 sampling station

iii. Information on Water Level, Discharge and Stage-Discharge Relationship

The water level, discharge and stage-discharge relationship at Tanjung Gading also has been depicted in **Figure 7-19** to **Figure 7-23**. Based on **Figure 7-19**, the water level at Tanjung Gading area was highly influenced by the tidal effect, low tide and high tide. Generally, the low tide event was occurred during early in the morning until 2.00 pm in the evening, while the high tide event was occurred after 2.00 pm until the late of evening.

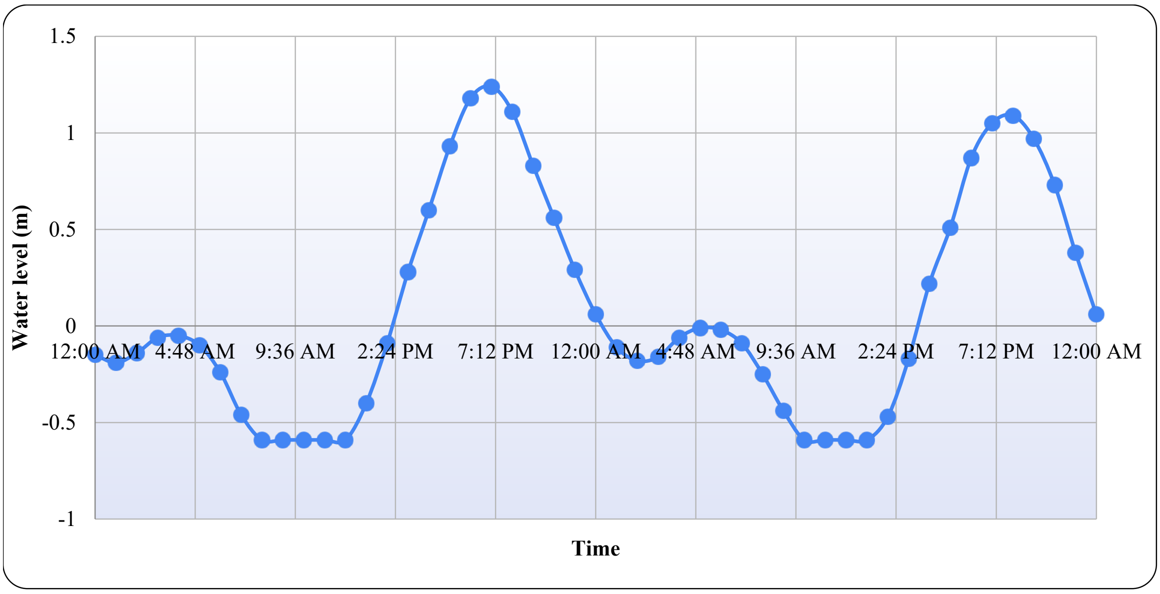


Figure 7-19: Water level at Tanjung Gading

Figure 7-20 below shows the hourly value of river discharge as being recorded at Tanjung Gading from 6th April 2021 to 8th April 2021. From the perspective of hourly variation, a consistent trend in the river discharge coincides with the trend of water level which can be observed at Tanjung Gading, Sg. Endau. The stage-discharge relationship trend at Tanjung Gading was displayed the increasing trend and showed that the increasing of water level had also increased the river discharge of Sg. Endau **(Figure 7-21)**. For the modeling purpose, the recorded of river flow discharge data at Tanjung Gading have been used as an input in WASP as shown in **Figure 7-22** and **Figure 7-23**.

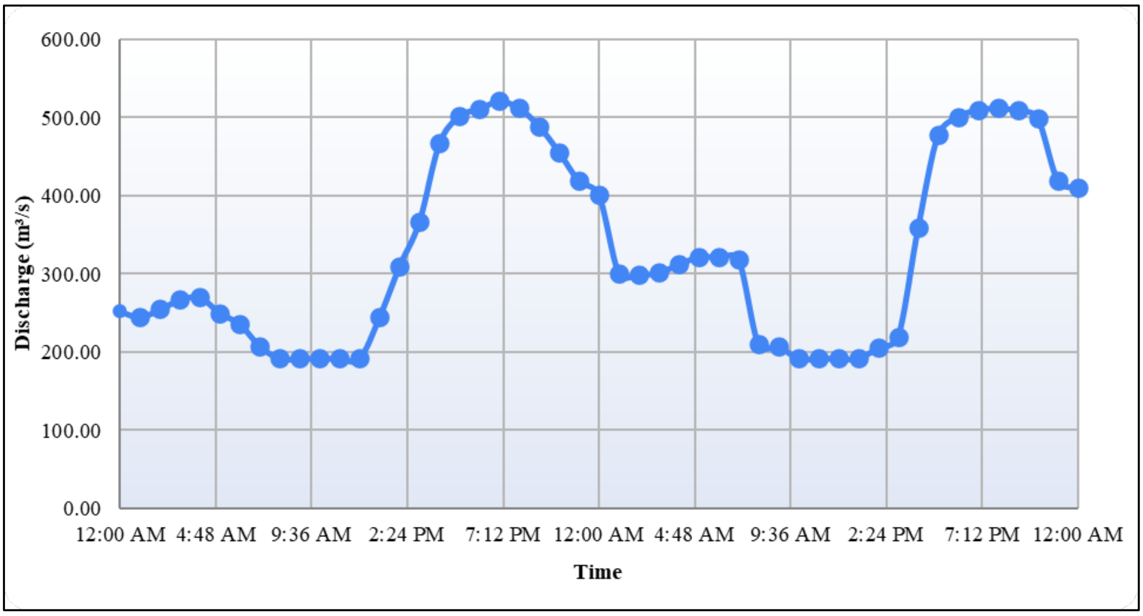


Figure 7-20: Discharge at Tanjung Gading

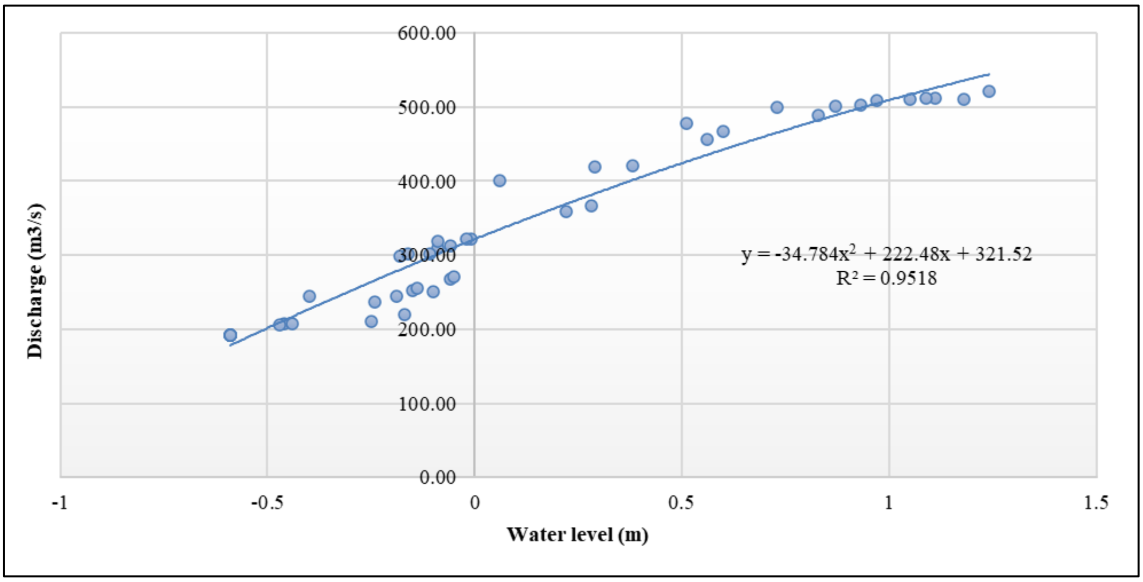


Figure 7-21: Stage-discharge relationship at Tanjung Gading

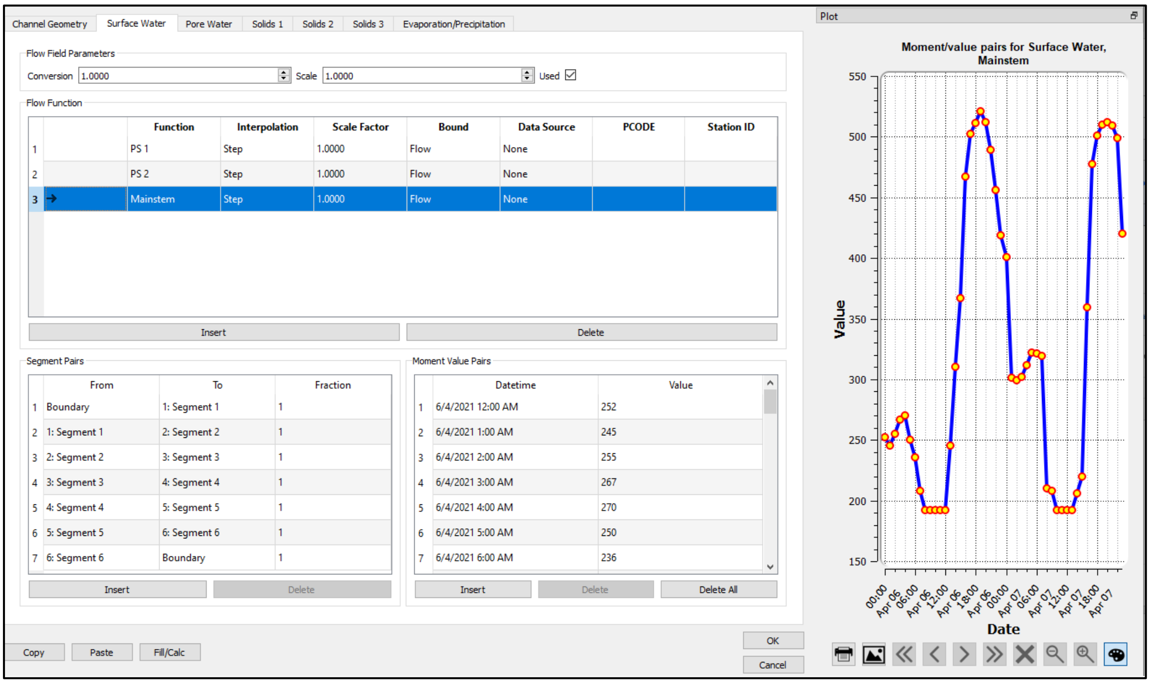


Figure 7-22: Flow input in WASP

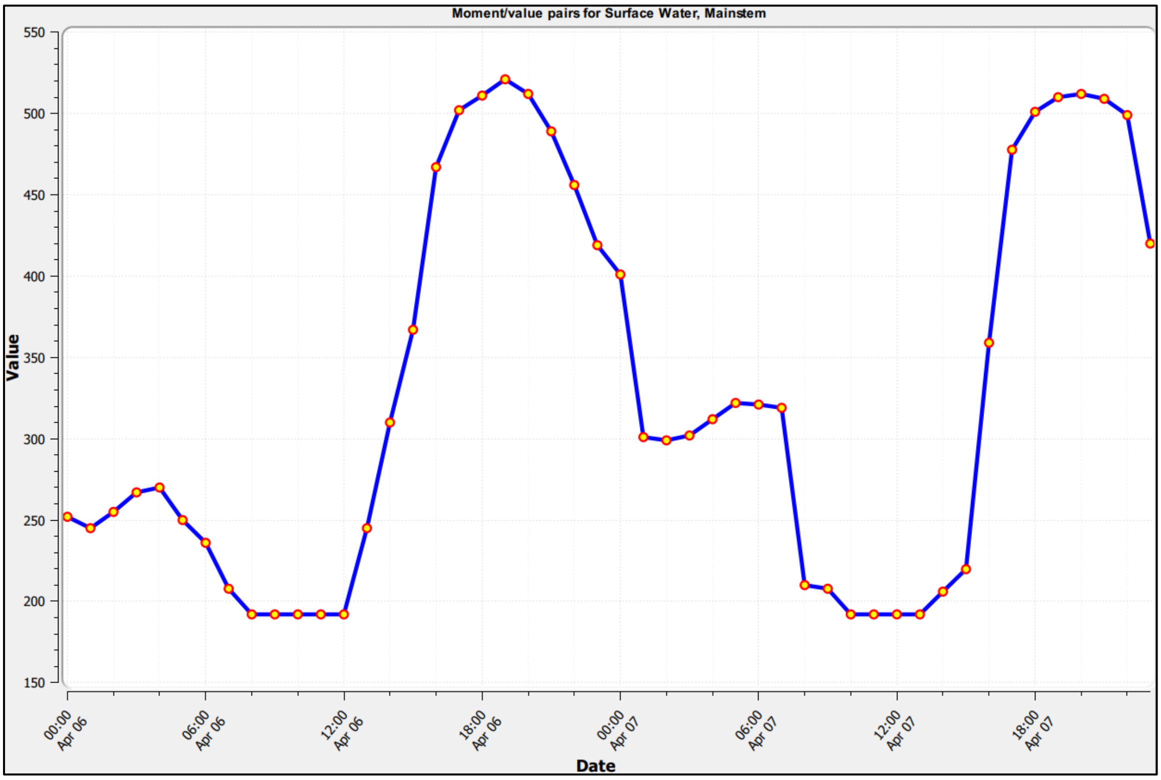


Figure 7-23: Flow input in WASP

a. Low Flow

Low Flow Estimation for Ungauged Site

The critical low flow could be determined from a review of the existing hydrological conditions of the river basins and their sub-basins. To obtain the minimum flow, the Hydrological Procedure (HP) No 12 is used. The historical record of the streamflow is utilized when it is available. In basins or sub-basins where there are no records, the estimation is carried out following the procedure for the ungauged catchment. The 7-day minimum flow for 10 years recurrence interval (Q7,10) could be used as criterion in determining the sustainability of continuous water supply.

The estimated 7Q10 at the downstream of the Project site (Sg. Tarsap at confluence with Sg. Endau) and (Sg. Labong at confluence with Sg. Endau) is 0.036 m^3/**s** and 0.0472 m^3/s**.** The estimated low flow using HP 12 is normally more conservative and the value serves as a guide for the condition of minimum flow for the study area.

7.2.2.4.2 River Water Quality

Generally, the historical data on water quality parameters was crucial and act as a baseline data for future references. The Project site is located at a very low elevation area as shown in **Figure 7-24**. The rapid development along Sg. Endau especially plantation area as shown in **Figure 7-25** will lead to the land use changes in the upstream area and can potentially cause the water quality degradation of the river especially the sediment load derived from land clearing activities. Thus, the proper application and maintenance on Best Management Practices (BMP) must be practices during development stage. While agriculture and plantation play a crucial role in the development of the socioeconomic of the region, these areas also are of the potential contributors to the nutrients and chemical compound introductions to the nearby water bodies. In a situation whereby a misapplication of fertilizer, pesticides, herbicides and other agricultural-related chemicals being used, an irreversible effect of eutrophication and nutrient enrichment of the receiving water bodies may occur (ammoniacal nitrogen, potassium, sulphate, phosphate, magnesium, etc.).

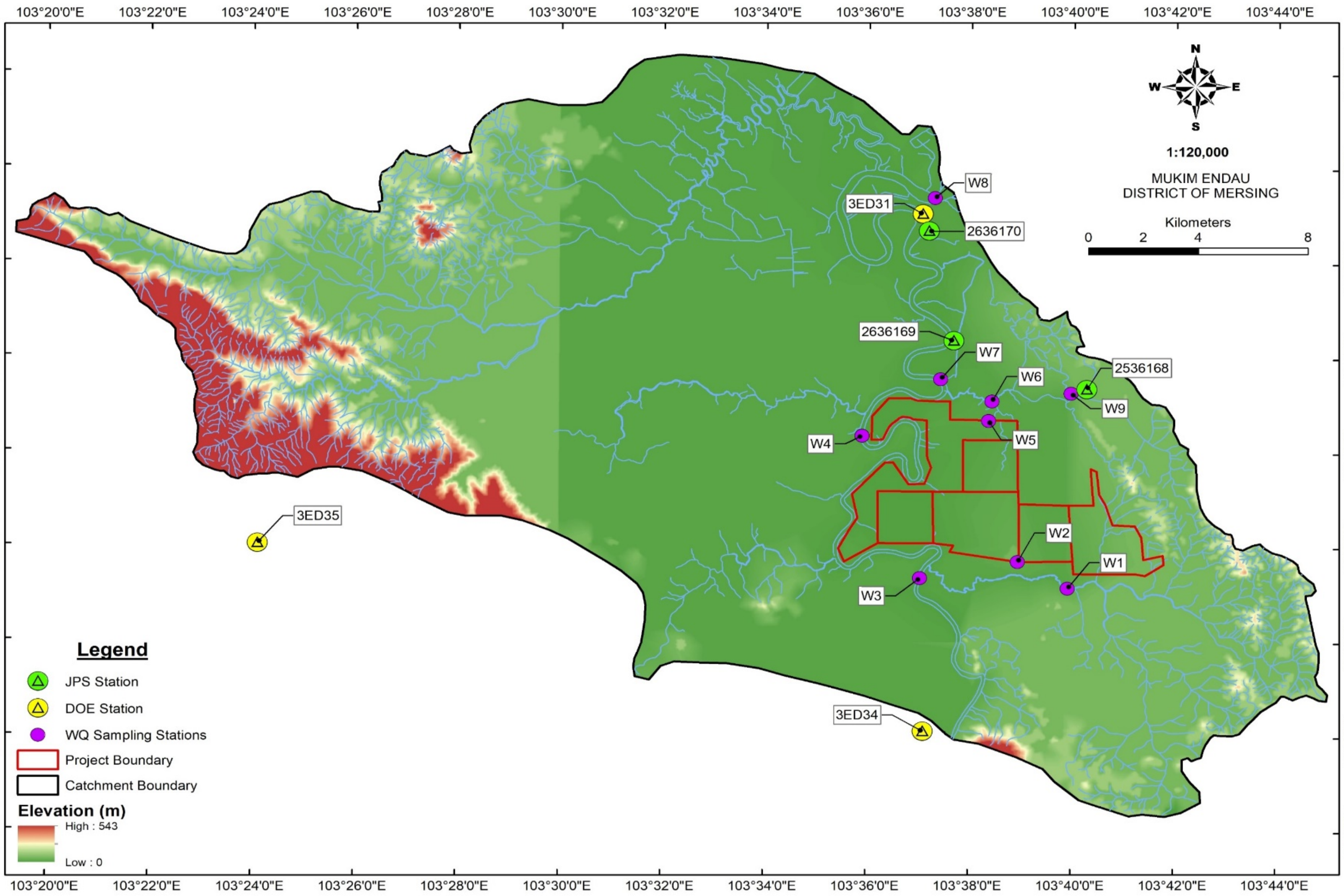


Figure 7-24: Elevation of Mukim Endau and Project Site

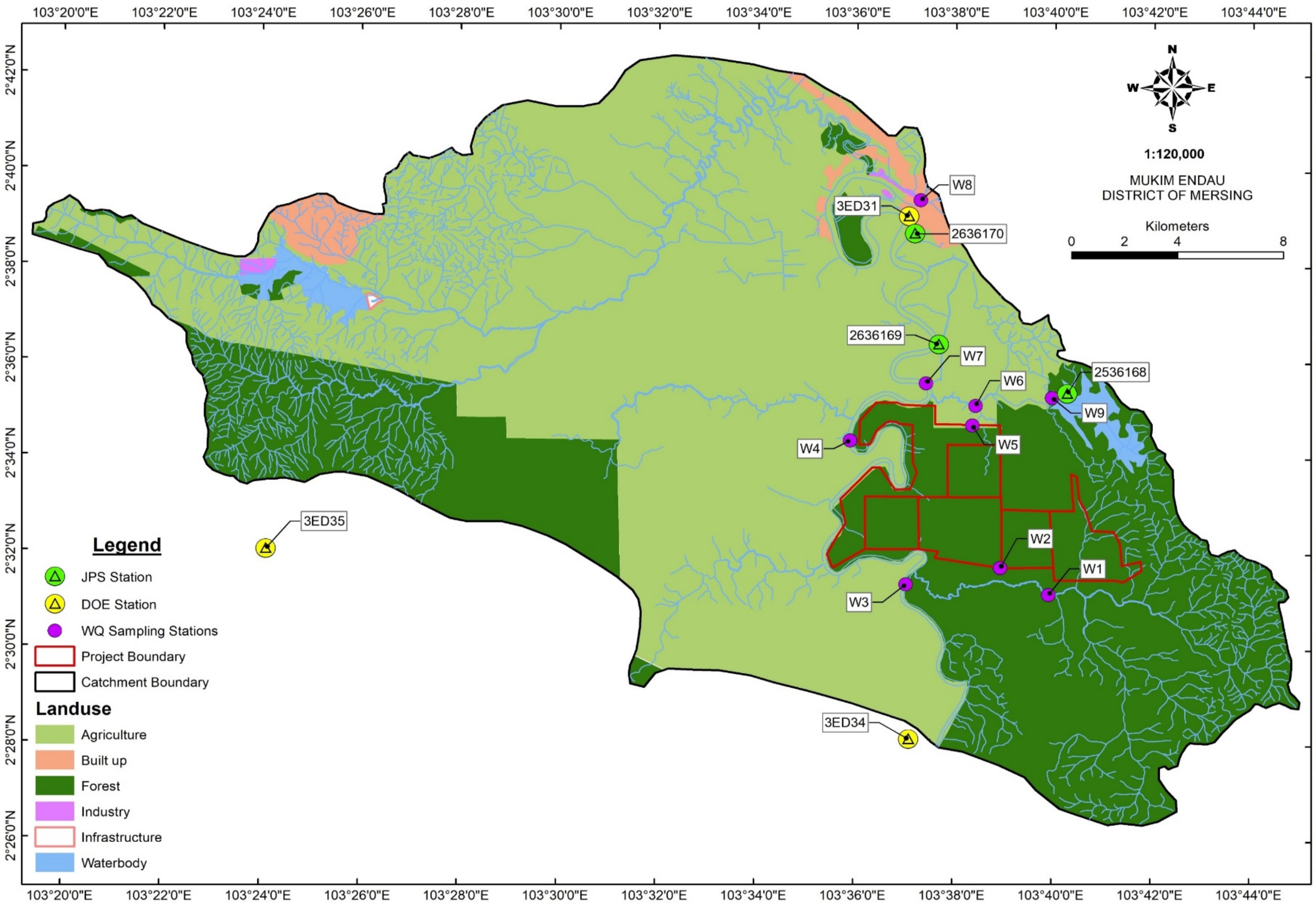


Figure 7-25: Landuse of Mukim Endau and Project Site

i. Historical Water Quality Data

The raw water quality data for Sg. Endau has been obtained from 2015 to 2019 for two (2) water quality monitoring stations known as; Station Jambatan Pekan Endau (downstream) and Station Jeti Sg. Endau, Kg. Orang Asli Tanah Abang (upper part of proposed Project site area) (**Figure 7-26 – Figure 7-27**). Based on these recorded years in **Table 7-20**, WQI for year 2015 and 2019 for both stations were consistently fall under the category II. However, in Station Jambatan Pekan Endau, the status of river was categorized as slightly polluted in year 2016 and 2017.

7.2.2.4.3 Primary Data Collection on Water Quality

The water quality sampling was conducted during high tide and low tide condition which included the in-situ and ex-situ parameters results as listed in **Table 7-21**. The samples for ex-situ parameters were taken to the laboratory after being preserved and labeled accordingly to the standard sample handling procedures requirement. Each parameter was compared to the National Water Quality Standard Class IIB, which are the acceptable limit for open channel water quality.

Generally, this study was conducted to study the impact of proposed plantation area toward the water quality of Sg. Endau. Topographically, the outflow of Sg. Endau will be the Tanjung Gading (WQ8) and flow toward the ocean area. In the context of landuse, the area was dominantly covered with plantation which causes the high level of NH_3-N concentration at WQ1 with 5.0mg/l.

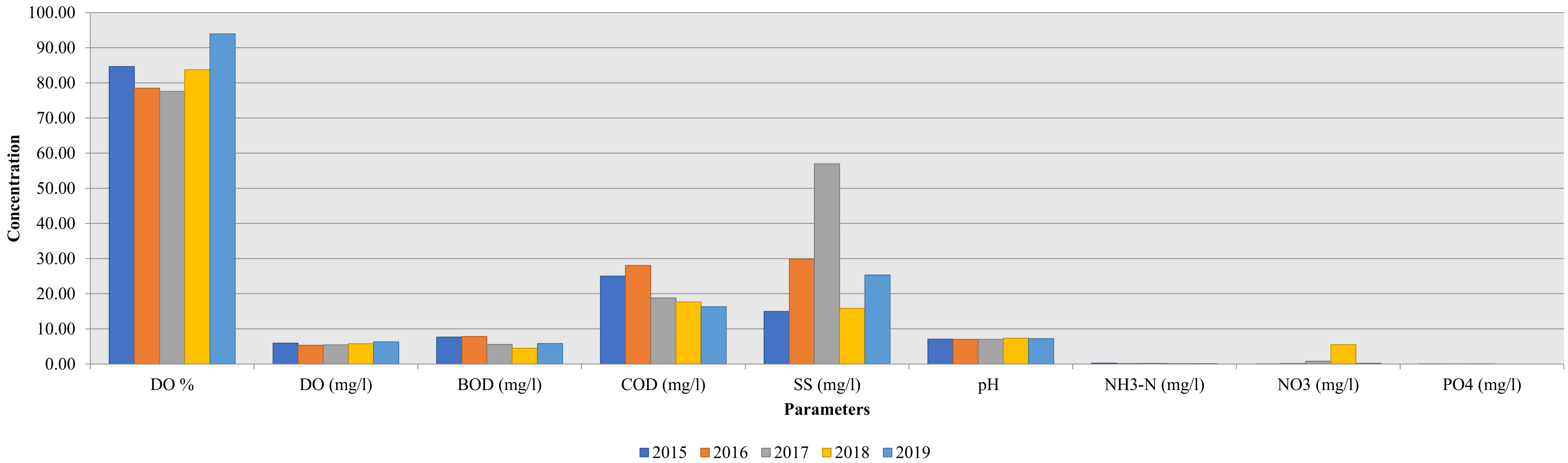
Table 7-20: Average Concentration of Water Quality Data for Sg. Endau at Station Jambatan Pekan Endau and Station Jeti Sg. Endau, Kg. Orang Asli Tanah Abang

A) LOCATION: JAMBATAN PEKAN ENDAU

YEAR	WATER QUALITY PARAMETERS																		WQI	CLASS	RIVER STATUS
	DO %	DO (mg/l)	BOD (mg/l)	COD (mg/l)	SS (mg/l)	pH	NH_3-N (mg/l)	NO_3 (mg/l)	PO_4 (mg/l)	Oil &Grease (mg/l)	*E-coli (cfu/100ml)*	*Temp. (°C)*	As (mg/l)	Hg (mg/l)	Cd (mg/l)	Cr (mg/l)	Pb (mg/l)	Zn (mg/l)			
2015	84.67	5.95	8	25	15	7.07	0.27	0.04	0.04	<1	600	29.34	0.0018	<0.0002	<0.001	<0.001	<0.01	0.03	81.52	II	CLEAN
2016	78.50	5.34	8	28	30	7.06	0.19	0.20	0.03	<1	100	30.03	0.0026	0.0003	<0.001	<0.001	<0.01	0.02	79.83	II	SLIGHTLY POLLUTED
2017	77.56	5.46	6	19	57	7.05	0.21	0.84	0.06	<1	1067	29.60	0.0028	<0.001	0.004	<0.001	0.002	0.04	80.26	II	SLIGHTLY POLLUTED
2018	83.72	5.81	5	18	16	7.38	0.18	5.50	<0.01	<1	2100	29.43	0.0028	<0.0010	<0.001	0.001	0.001	0.02	86.07	II	CLEAN
2019	93.95	6.35	6	16	25	7.27	0.12	0.21	< 0.01	< 1	286	29.90	0.0035	< 0.001	<0.001	0.001	0.002	0.03	87.31	II	CLEAN

B) LOCATION: JETI SG. ENDAU, KG. ORANG ASLI TANAH ABANG

YEAR	WATER QUALITY PARAMETERS																		WQI	CLASS	RIVER STATUS
	DO %	DO (mg/l)	BOD (mg/l)	COD (mg/l)	SS (mg/l)	pH	NH_3-N (mg/l)	NO_3 (mg/l)	PO_4 (mg/l)	Oil &Grease (mg/l)	*E-coli (cfu/100ml)*	*Temp. (°C)*	As (mg/l)	Hg (mg/l)	Cd (mg/l)	Cr (mg/l)	Pb (mg/l)	Zn (mg/l)			
2015	66.4	5.20	5	16	23	5.76	0.04	0.59	0.03	<1	50	27.99	0.0015	<0.0002	<0.001	<0.001	<0.01	0.02	81.85	II	CLEAN
2016	71.18	5.50	5	14	20	5.84	0.11	0.49	0.03	<1	120	28.71	0.0014	0.0005	<0.001	<0.001	<0.01	0.03	83.34	II	CLEAN
2017	70.7	5.54	4	16	44	5.75	0.08	2.09	0.11	<1	175	27.91	0.0010	<0.001	<0.001	<0.001	0.002	0.04	81.70	II	CLEAN
2018	73.17	5.71	5	14	31	6.75	0.09	3.69	0.06	<1	100	28.14	0.0010	<0.0010	<0.001	<0.001	0.001	0.05	84.41	II	CLEAN
2019	70.49	5.47	4	10	29	6.69	0.09	2.41	0.05	< 1	225	28.49	0.0014	< 0.001	< 0.001	< 0.001	0.002	0.01	85.20	II	CLEAN



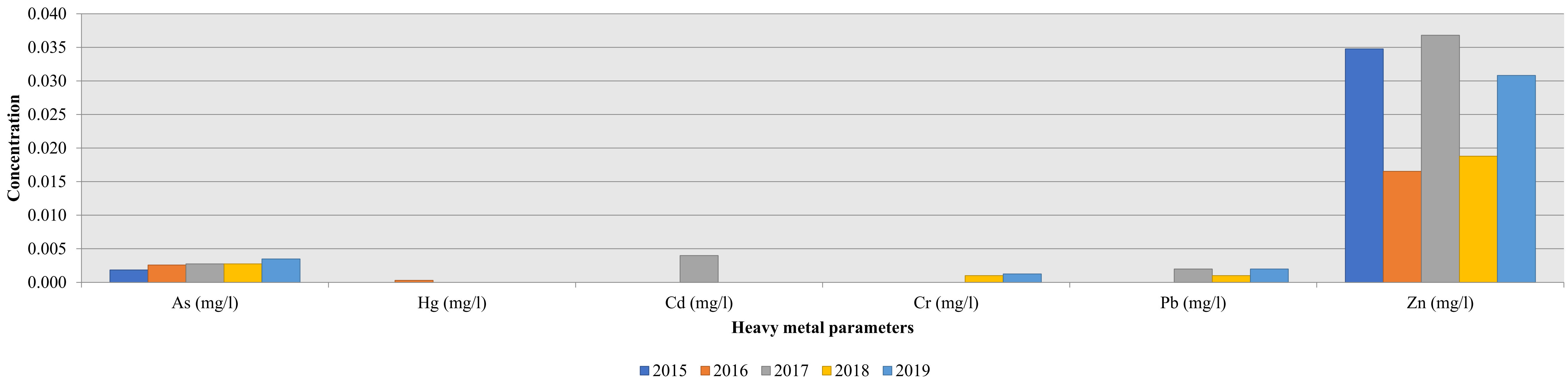
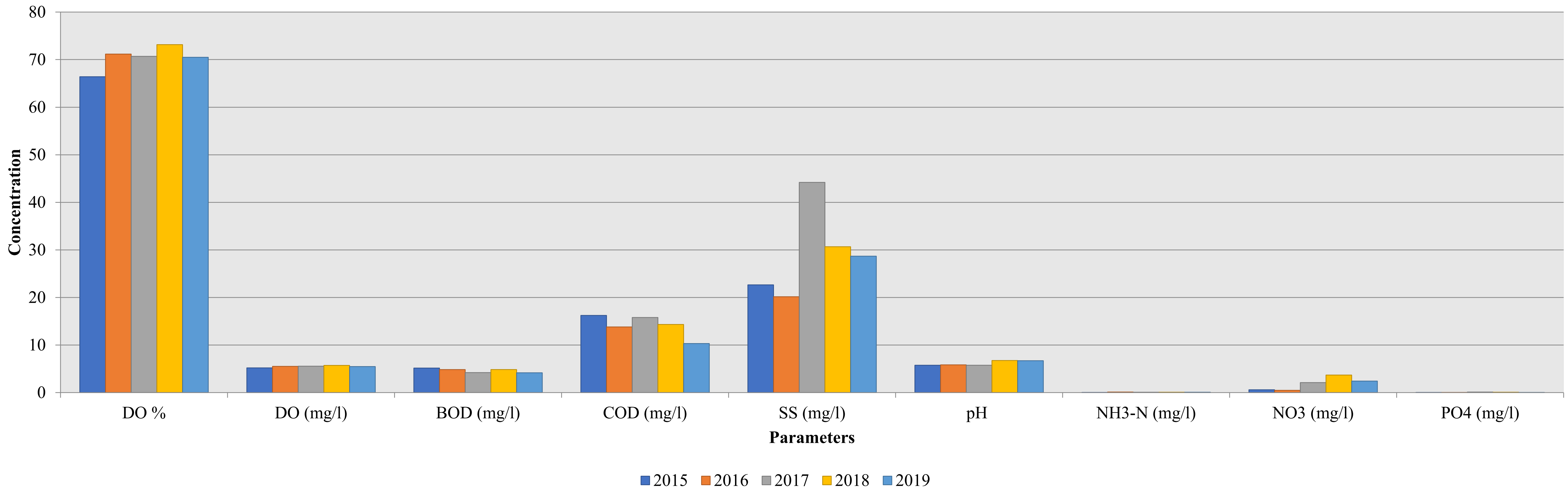


Figure 7-26: Raw Water Quality Data for Sg. Endau at Station Jambatan Pekan Endau



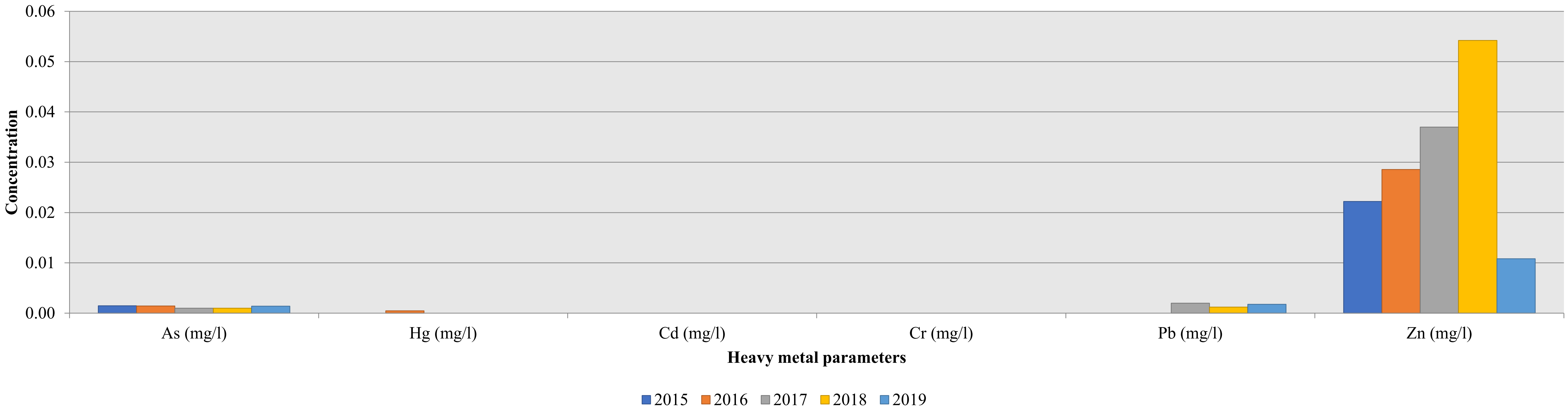


Figure 7-27: Raw Water Quality Data for Sg. Endau at Station Jeti Sg. Endau, Kg. Orang Asli Tanah Abang

Table 7-21: Water Quality for In-Situ Parameters and Lab Analysis

Sampling Station	Tide level	PH	Temp (ºC)	Salinity (psu)	Conductivity (ms)	DO (%)	DO, mg/l (ppm)	Turbidity (NTU)	TDS (ppm)	BOD (mg/l)	TSS (mg/l)	NH3-N (mg/l)	NO3-N (mg/l)	T-P (mg/l)	As (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
WQ1	High	3.8	35.1	0	287.1	49.6	3.18	51.2	43	<2	15	5.0	2.0	<0.1	<0.005	9.32	5.76	0.161
	Low	3.99	34.7	0	238.2	46.8	3.09	54.5	48.7	<2	21	2.5	2.2	<0.1	<0.005	10.5	7.12	0.154
WQ2	High	3.41	35.8	0	240.9	43.5	3.11	52.9	52.1	<2	60	2.6	<0.1	0.1	<0.005	1.14	2.52	0.008
	Low	3.3	35.2	0	235.7	46.3	3.25	53.6	59.8	<2	28	2.5	<0.1	0.2	<0.005	1.09	2.57	0.006
WQ3	High	4.7	29.4	0	52.9	0.4	0.03	34.4	34.3	<2	14	0.9	<0.1	0.1	<0.005	0.14	0.069	0.009
	Low	5.06	32	0	61.2	0.4	0.04	70.5	38.5	<2	22	1.6	<0.1	<0.1	<0.005	0.31	0.401	0.004
WQ4	High	4.32	30.2	0	21.8	0.4	0.03	13.4	14.1	<2	2	1.4	<0.1	<0.1	<0.005	0.24	0.081	0.013
	Low	5.6	31.8	0	53.7	0.4	0.03	37.1	34.8	<2	2	1.1	<0.1	<0.1	<0.005	0.12	0.052	0.006
WQ5	High	3.17	31.7	0.04	704	0.6	0.04	86.7	453	<2	46	2.8	1.4	<0.1	<0.005	7.91	6.76	0.075
	Low	3.07	37.6	0.03	659	1.1	0.06	57.8	442	<2	18	3.7	0.8	<0.1	<0.005	8.45	10.1	0.067
WQ6	High	4.69	31.3	0	88.8	0.4	0.03	15.9	58.4	<2	9	0.9	<0.1	0.1	<0.005	0.34	0.173	0.01
	Low	3.25	31	0.3	624	0.8	0.04	81.2	408	<2	26	2.2	0.4	<0.1	<0.005	6.53	3.45	0.068
WQ7	High	8.41	30.9	0	203	0.5	0.04	12.8	56.8	<2	6	1	<0.1	<0.1	<0.005	0.31	0.142	0.013
	Low	6.45	30.9	0.1	164.7	0.4	0.03	17.6	90.6	<2	4	1.1	<0.1	0.2	<0.005	0.18	0.072	0.006
WQ8	High	6.52	29.1	17.9	25.08	1.4	0.09	44.1	21.8	<2	32	0.9	0.3	0.1	<0.005	0.33	0.078	<0.001
	Low	5.5	29.3	2.8	5.11	1.4	0.12	46.6	3.32	<2	14	0.9	0.1	0.1	<0.005	0.26	0.135	0.016

7.2.2.4.4 Water Analysis Simulation Program (WASP 8)

The water quality modeling study for the Proposed Project Site had been carried out by using the Water Analysis Simulation Programmed (WASP 8) to evaluate the impact on river water quality based on multiple tested scenarios

WASP can be used to represent water quality processes in complex environments, such as in the case of river near to the coastal area, were tidal mixing results in varying flow regimes, albeit mostly in the downstream reaches (Wool et. al., 2001). This model helps users to interpret and predict water quality responses to natural phenomena and man-made pollution for various pollution management decisions. WASP8 is a dynamic compartment-modeling programmed for aquatic systems, including both the water column and the underlying benthos (**Figure 7-28**). The time-varying processes of advection, dispersion, point and diffuse mass loading and boundary exchange are represented in the basic programmed.

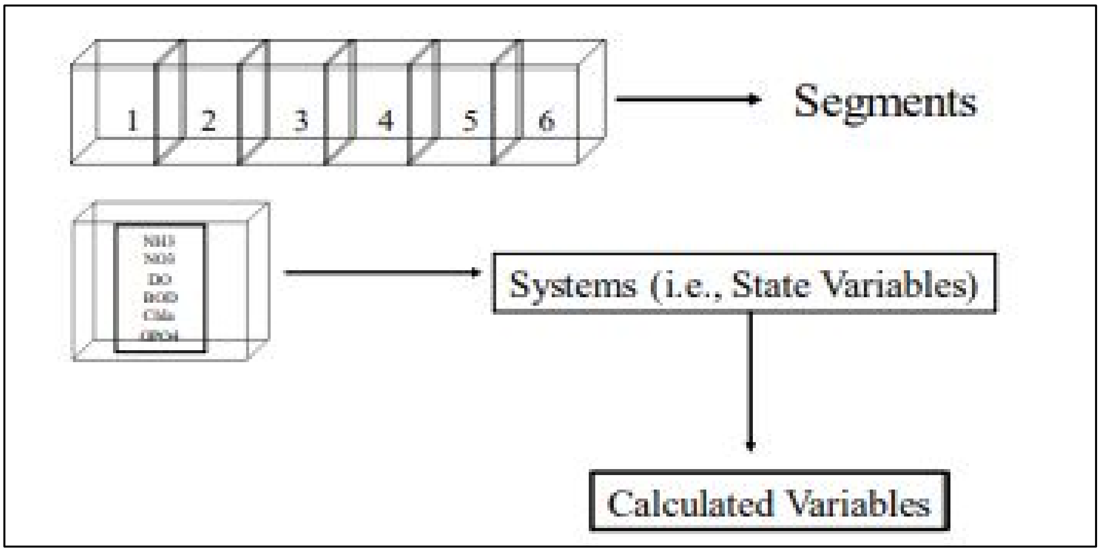


Figure 7-28: WASP Compartment Model (Segmental) Approach

The flexibility afforded by the Water Quality Analysis Simulation Programmed is unique. WASP8 permits the modeler to structure one, two, and three-dimensional models (**see Equation 1**); allows the specification of time-variable exchange coefficients, advective flows, waste loads and water quality boundary conditions; and permits tailored structuring of the kinetic processes, all within the larger modeling framework without having to write or re-write large sections of computer code. The two operational WASP8 models, TOXI and EUTRO, are reasonably general. In addition, users may develop new kinetic or reactive structures.

$$\frac{\partial C}{\partial t} = -\frac{\partial U_x C}{\partial x} + \frac{\partial}{\partial x}\left(E_x \frac{\partial C}{\partial x}\right) - \frac{\partial U_y C}{\partial y} + \frac{\partial}{\partial y}\left(E_y \frac{\partial C}{\partial y}\right) - \frac{\partial U_z C}{\partial z} + \frac{\partial}{\partial z}\left(E_z \frac{\partial C}{\partial z}\right) \pm Sources\ and\ Sinks$$

Equation 1

For this Project, dynamic flow had been selected for the water quality modeling. This model was indicated as one-dimensional flow that controlled by surface water slope. Besides, since the study area was confronted with tidal effect (low tide and high tide), the selection of dynamic flow for this model was capable to calculate the backwater flow.

i. Modeling Assumptions and Limitations

Several keys' factors were considered prior to model development, including; modeling assumptions, limitations, scenarios, delineation and data requirements. The general model assumptions and limitations that apply to this study include (Ujang and Zainudin, 2010):

- Streams are well mixed and generally homogenous with an evenly distributed concentration pattern, vertically and laterally. This is coherent to 1-dmensional water quality modeling (Chapra et. al., 2005).

- Water quality parameters that were simulated include dissolved oxygen (DO), biochemical oxygen demand (BOD5, uBOD represented), ammoniacal nitrogen (NH3-N), nitrate (NO3-N), phosphorus (P), solids (total suspended solids), Arsenic, Iron, Manganese, Magnesium and Potassium. The model is based on ultimate cBOD, so the 5-day measurement was extrapolated to acquire this value. A decay rate, k, of 0.23/day was assumed for the ambient stream conditions. It should be noted that, besides practical considerations of time and expense, there may be other benefits from using the 5-day measurement with extrapolation, rather that performing a longer-term cBOD. Although extrapolation does introduce some error, the 5-day value has the advantage that it would tend to minimize possible nitrification effects, which, even when inhibited, can begin to be exerted on longer time frames (Chapra et. al., 2005).

ii. Modeling Scenarios

Six (6) scenarios have been applied in the water quality modeling to simulate the water quality impact prediction at the proposed site. Specific focus on the potential pollutants is being considered in different treatment/pollutant removal scenario. The impacts of water quality have been modeled based on different pollutant-treatment scenarios as mentioned in **Table 7-22** below:

Table 7-22: Modeling scenarios

Scenario	Name	Timeline	Peak Discharge/ runoff (m^3/s)	Pollutants concentration input (mg/l)	Parameter modelled
1	Scenario 1: **Baseline condition**	Existing	none	none	BOD, TSS, NH3-N, NO3, TP, As, Al, Fe, Mn
2	Scenario 2: **BMPs failure at Peak flow condition**	During Construction	Phase 1 = 86.48 m^3/s; Phase 2 = 127.57 m^3/s Phase 3 = 111.44 m^3/s	Maximum TSS concentration used is based MASMA. Event Mean Concentration (EMC) for construction site is 5000mg/L. As = 0.288mg/l; Al = 2.75mg/l; Fe = 1.280mg/l; Mn = 0.230mg/l	TSS, As, Al, Fe, Mn
3	Scenario 3: **90% efficiency of BMPs measures** at **Peak Flow** Condition from sediment basin for each phase	During Construction	Phase 1 = 86.48 m^3/s; Phase 2 = 127.57 m^3/s Phase 3 = 111.44 m^3/s	TSS = < 50mg/l; As = 0.029mg/l; Al = 0.28mg/l; Fe = 0.128mg/l; Mn = 0.023mg/l	TSS, As, Al, Fe, Mn
4	Scenario 4: **BMPs failure at neap/low flow condition**	During Construction	Phase 1 = 86.48 m^3/s; Phase 2 = 127.57 m^3/s Phase 3 = 111.44 m^3/s	Maximum TSS concentration used is based MASMA. Event Mean Concentration (EMC) for construction site is 5000mg/L. As = 0.288mg/l; Al = 2.75mg/l; Fe = 1.280mg/l; Mn = 0.230mg/l	TSS, As, Al, Fe, Mn

Scenario	Name	Timeline	Peak Discharge/ runoff (m^3/s)	Pollutants concentration input (mg/l)	Parameter modelled
5	Scenario 5: **90% efficiency of BMPs measures** at **neap/low flow** Condition from sediment basin for each phase	During Construction	Phase 1 = 86.48 m^3/s; Phase 2 = 127.57 m^3/s Phase 3 = 111.44 m^3/s	TSS = < 50mg/l; As = 0.029mg/l; Al = 0.28mg/l; Fe = 0.128mg/l; Mn = 0.023mg/l	TSS, As, Al, Fe, Mn
6	Scenario 6: **During operation at low flow /critical flow: neap tide.** Based on application of total phosphorus and nitrogen for fertilizer.	During Operation	Detention Point 1 = 92 m^3/s Detention Point 2 = 101 m^3/s	TP = 0.95mg/L, BOD5 =0.32mg/L, ammonia nitrogen = 0.89mg/L, nitrate = 4.23mg/l, TSS = 50 mg/L	BOD, TSS, NH3-N, NO3, TP

The pollutant concentrations input for several parameters involved in this study were used based on previous studies for worst case scenarios as shown in **Table 7-23** below. **Figure 7-29** and **Figure 7-30** show the phases of land clearing and planting, and also the proposed locations of the flood ponds. During the land clearing activities in worst case scenario, the TSS concentration can be estimated up to 4000 mg/l and above where it can be worst during the rainy season due to the soil erosion. The schematic diagram of Sungai Endau Modelling stretch is shown in **Figure 7-31**.

Table 7-23: Pollutants concentration based on previous studies (used in worst case scenario)

Parameters	References	Pollutant Concentration (mg/l)
BOD	(Al-Badaii et al. 2019)	4.28
NH_3-N	(Al-Badaii et al. 2019)	1.91
NO^3	(Al-Badaii et al. 2019)	8.53
TP	(Al-Badaii et al. 2019)	1.90
TSS	EMC (Chapter 15: Pollutant Estimation from JPS)	4000
As	(Affandi & Ishak, 2018)	0.288
Al	(Affandi & Ishak, 2018)	2.750
Fe	(Abu Bakar et al., 2015)	1.28
Mn	(Abu Bakar et al., 2015)	0.23

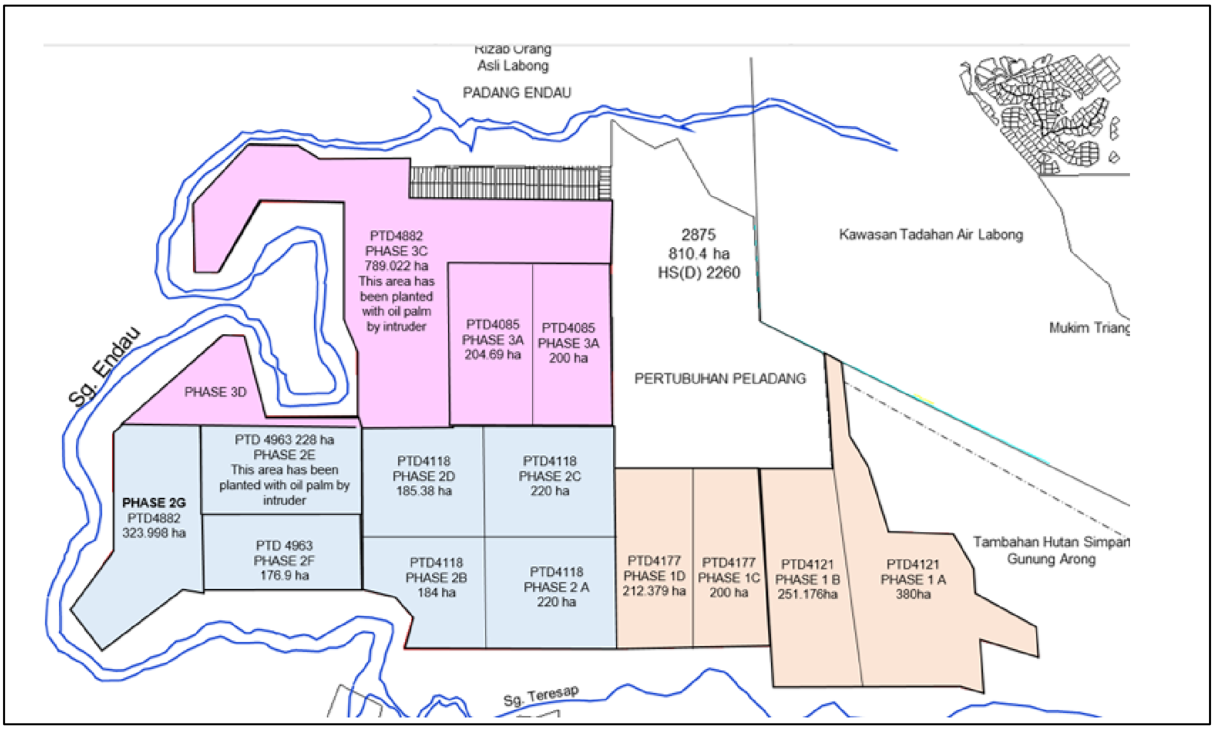


Figure 7-29: Phases of Land Clearing and Planting

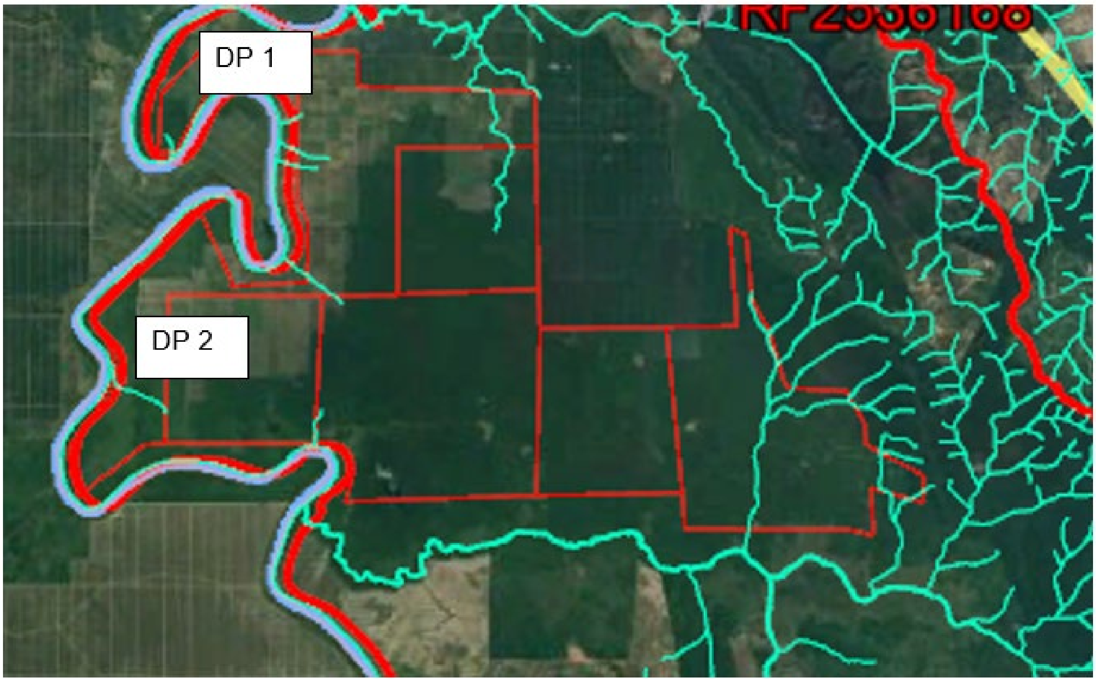


Figure 7-30: Proposed Locations of the Flood Pond

Schematic Diagram of Sungai Endau Modeling Stretch

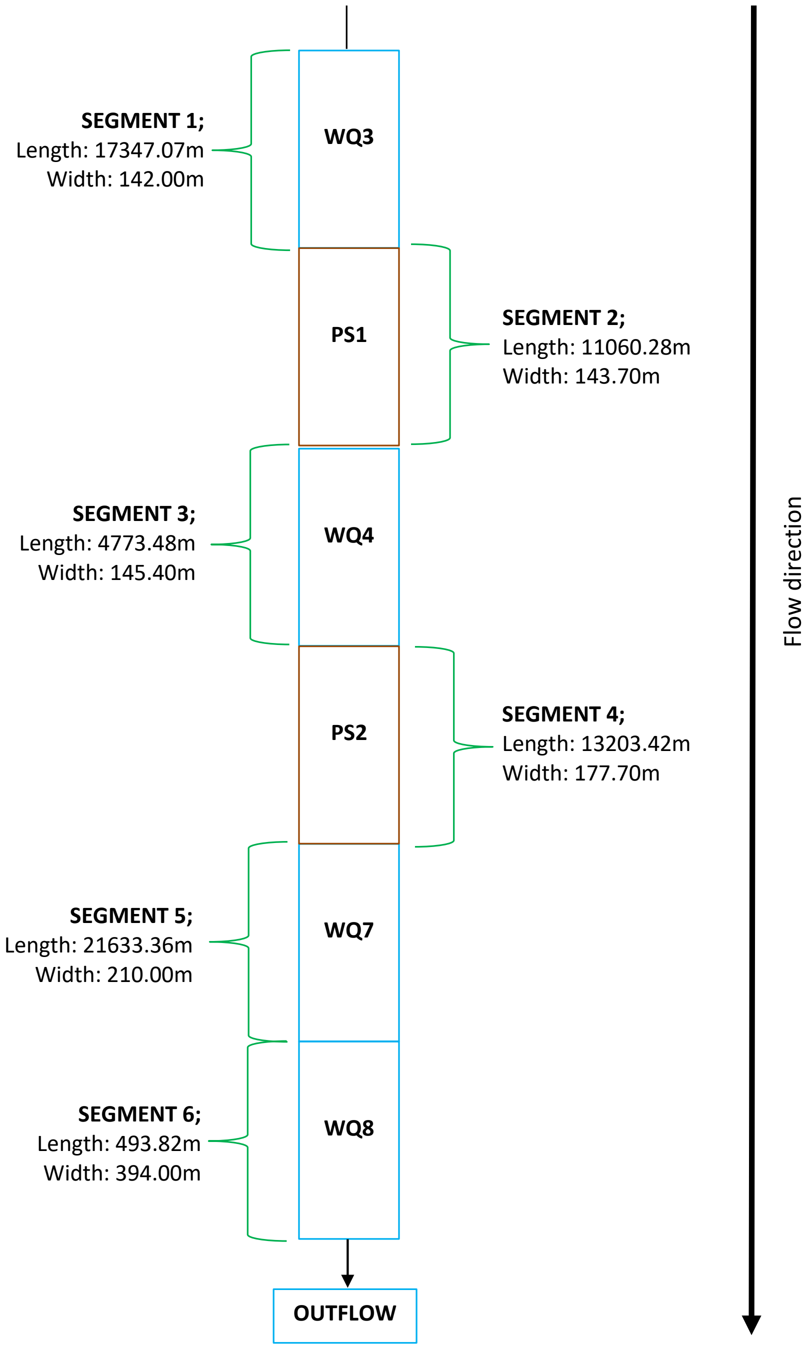


Figure 7-31: Schematic diagram of Sg. Endau Modeling Stretch

Dynamic flow transport mode settings had been selected for all segments. This model was indicated as one-dimensional flow that controlled by surface water slope. Besides, since the study area was confronted with tidal effect (low tide and high tide), the selection of dynamic flow for this model was capable to calculate the backwater flow as shown in **Figure 7-32**.

Segment Definition | Initial Conditions | Fraction Dissolved

	Segment Name	Segment Type	Transport Mode	Segment Below
1	Segment 1	Surface	Dynamic Flow	Segment 2
2	Segment 2	Surface	Dynamic Flow	Segment 3
3	Segment 3	Surface	Dynamic Flow	Segment 4
4	Segment 4	Surface	Dynamic Flow	Segment 5
5	Segment 5	Surface	Dynamic Flow	Segment 6
6	Segment 6	Surface	Dynamic Flow	None

Figure 7-32: Dynamic flow as input in WASP

Meanwhile, the hydraulic properties input for Segment Flow in WASP during low tides and high tides have been systematically presented in **Table 7-24** and **Table 7-25**, respectively.

Table 7-24: Hydraulic properties during low tides (Input for Segment Flow in WASP)

	Segment	Segment Name	Volume (m^3)	Length (m)	Avg Width (m)	Bottom Elevation (m)	Min. Depth (m)	Roughness	Avg Depth (m)	Initial Surface Elevation
Mainstem	1	WQ3	15367102.12	17347.07	142.00	5.00	0.001	0.035	6.24	0.70
Point source	2	PS1	10594142.44	11060.28	143.70	4.00	0.001	0.035	6.67	0.85
Mainstem	3	WQ4	4922896.74	4773.48	145.40	3.00	0.001	0.035	7.09	1.00
Point source	4	PS2	20181082.29	13203.42	177.70	0.60	0.001	0.035	8.60	0.90
Mainstem	5	WQ7	45929786.62	21633.36	210.00	0.50	0.001	0.035	10.11	0.80
Mainstem	6	WQ8	1878769.05	493.82	394.00	0.00	0.001	0.035	9.66	0.00

	Segment	Segment Name	Depth multiplier	Depth exponent	Avg velocity	Velocity exponent	Side slope	Q (m^3/s)
Mainstem	1	WQ3	0.064	0.30	0.1202	0.20	1.732	97.914
Point source	2	PS1	0.063	0.3	0.1182	0.20	1.732	106.299
Mainstem	3	WQ4	0.062	0.30	0.1163	0.20	1.732	114.685
Point source	4	PS2	0.055	0.30	0.1076	0.20	1.732	161.228
Mainstem	5	WQ7	0.049	0.30	0.0989	0.20	1.732	207.772
Mainstem	6	WQ8	0.026	0.30	0.1153	0.20	1.732	364.866

Table 7-25: Hydraulic properties during high tides (Input for Segment Flow in WASP)

	Segment	Segment Name	Volume (m^3)	Length (m)	Avg Width (m)	Bottom Elevation (m)	Min. Depth (m)	Roughness	Avg Depth (m)	Initial Surface Elevation
Mainstem	1	WQ3	22264297.15	17347.07	142.00	-6.30	0.001	0.035	9.04	3.50
Point source	2	PS1	15441695.07	11060.28	143.70	-8.20	0.001	0.035	9.72	3
Mainstem	3	WQ4	7213307.92	4773.48	145.40	-10.10	0.001	0.035	10.39	2.50
Point source	4	PS2	26633263.56	13203.42	177.70	-12.00	0.001	0.035	11.35	2.35
Mainstem	5	WQ7	55924398.94	21633.36	210.00	-13.90	0.001	0.035	12.31	2.20
Mainstem	6	WQ8	1752938.72	493.82	394.00	-13.00	0.001	0.035	9.01	0.00

	Segment	Segment Name	Depth multiplier	Depth exponent	Avg velocity	Velocity exponent	Side slope	Q (m^3/s)
Mainstem	1	WQ3	0.064	0.30	0.1189	0.20	1.732	141.159
Pointsource	2	PS1	0.062	0.3	0.1198	0.20	1.732	157.614
Mainstem	3	WQ4	0.060	0.30	0.1208	0.20	1.732	174.0684
Pointsource	4	PS2	0.051	0.30	0.1179	0.20	1.732	231.908
Mainstem	5	WQ7	0.042	0.30	0.1151	0.20	1.732	289.748
Mainstem	6	WQ8	0.019	0.30	0.1125	0.20	1.732	477.677

Time Function

Time function represent the environmental condition of the modelled scenario. There are three (3) time functions involved including solar radiation, air temperature and wind speed that have been used as inputs in WASP **(Figure 7-33)**.

Solar Radiation

Based on **Figure 7-33** below, the time range for solar radiation started from 8:00 a.m. and ended around 19:00 to 20:00 The highest solar radiation was recorded on 6th April 2021 at 15:00 with 980 W/m^2.

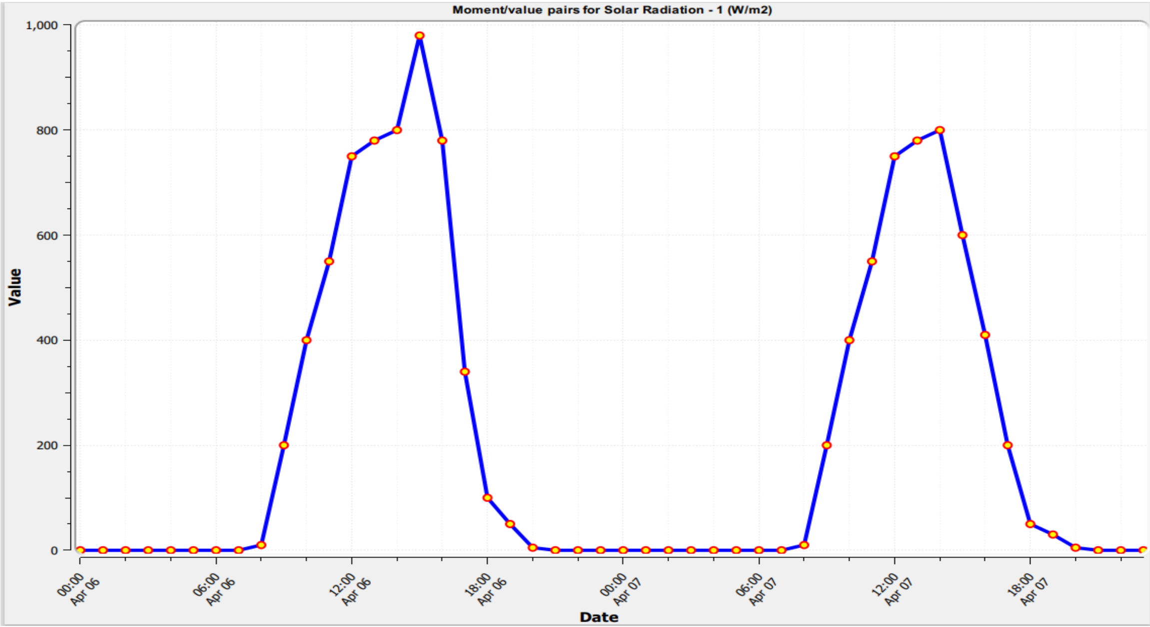


Figure 7-33: Solar radiation as input in WASP

Air Temperature

Based on **Figure 7-34**, the air temperature range was recorded between 25°C to 34°C. The highest air temperature was recorded on 6th April 2021 at 15:00 p.m to 16:00 p.m. with 34 °C.

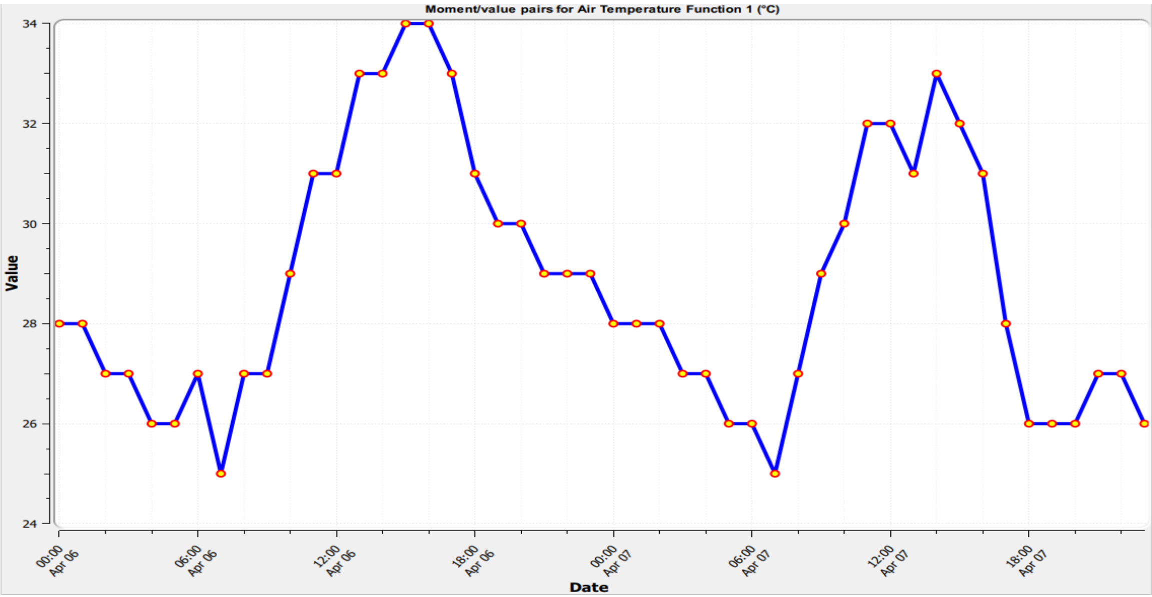


Figure 7-34: Air temperature as input in WASP

<u>Wind Speed</u>

Based on **Figure 7-35**, the wind speed range was recorded between 0km/hr to 20km/hr. The highest wind speed was recorded on 7th April 2021 at 18:00p.m. with 20km/hr.

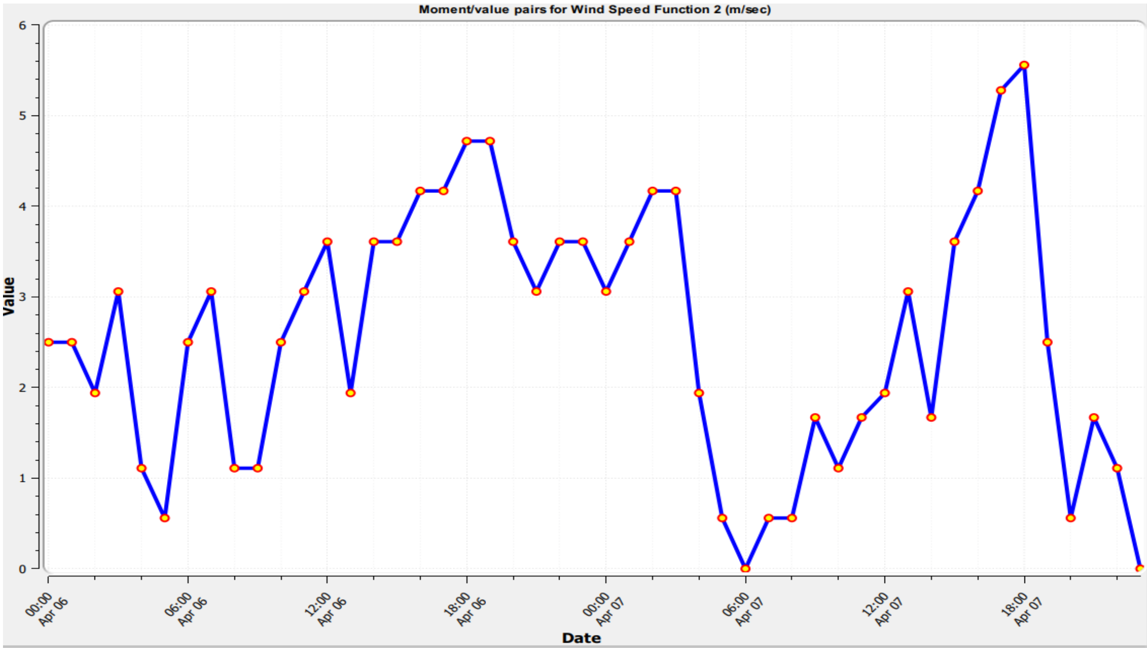


Figure 7-35: Wind speed as input in WASP

Constant

Table 7-26: Kinetic constant for WASP model (values obtained from literature and visual approach).

Table 7-26: Kinetic Constant for WASP Model

TABLE 1 Kinetic constants for WASP model (values obtained from literature and visual fit approach)

Parameters	Calibrated value
Global constant	
Fresh water = 0; Marine water = 1	0
Latitude, degrees	−15.25
Longitude, degrees	−71.04
Water temperature	
Heat exchange option (0 = full heat balance; 1 = equilibrium temperature)	0
Sediment (ground) temperature (°C)	7
Inorganic nutrient kinetics	
Nitrification rate constant @20°C (1/day)	1.5
Nitrification temperature coefficient	1.047
Half-saturation constant for nitrification oxygen limit (mg O_2/L)	2
Minimum temperature for nitrification reaction (°C)	10
Denitrification rate constant @20°C (1/day)	3.5
Denitrification temperature coefficient	0.9
Half-saturation constant for denitrification oxygen limit (mg O_2/L)	0.1
Inorganic nutrient partitioning	
Ammonia partition coefficient to water column solids (L/kg)	1,000
Orthophosphate partition coefficient to water column solids (L/kg)	1,000
Silica partition coefficient to water column solids (L/kg)	1,000
Dissolved oxygen	
Global reaeration rate constant @ 20°C (1/day)	0.388
Calc reaeration option (0 = Covar; 2 = Owens; 3 = Churchill; 4 = Tsivoglou)	2
Minimum reaeration rate (1/day)	1.028
Use total depth of water column for reaeration	1
Elevation above sea level (m)	4,550
Oxygen to carbon stoichiometric ratio	2.67
Theta – reaeration temperature correction	1.024
Theta – SOD temperature correction	1
Phytoplankton	
Phytoplankton maximum growth rate constant @20°C (1/day)	3.5
Phytoplankton growth temperature coefficient	1.068
Phytoplankton carbon to chlorophyll ratio (mg C/mg Chl)	50
Optimal temperature for growth (°C)	20
Shape parameter for below optimal temperatures	0.004
Shape parameter for above optimal temperatures	0.01
Phytoplankton respiration rate constant @20°C (1/day)	0.08

TABLE 1 (Continued)

Parameters	Calibrated value
Phytoplankton respiration temperature coefficient	1.045
Phytoplankton death rate constant (Non-Zoo Predation) (1/day)	0.1
Nitrogen fixation option (0 = no; 1 = yes)	1
Phytoplankton optimal light saturation (watts/m^2)	300
Phytoplankton half-saturation constant for mineralization rate (mg Phyt C/L)	0.001
Phytoplankton half-saturation constant for N uptake (mg N/L)	0.4
Phytoplankton half-saturation constant for P uptake (mg P/L)	0.08
Phytoplankton half-saturation constant for Si uptake (mg Si/L)	0.1
Phytoplankton detritus to carbon ratio (mg D/mg C)	2.5
Phytoplankton nitrogen to carbon ratio (mg N/mg C)	0.25
Phytoplankton phosphorus to carbon ratio (mg P/mg C)	0.025
Phytoplankton silica to carbon ratio (mg Si/mg C)	0.8
Light	
Fraction of solar radiation reflected at water surface	0.06
Fraction of PAR light (Photosynthetically active radiation)	0.464
Fraction of infrared light	0.5
Fraction of ultraviolet light	0.036
Light option (1 = uses input light; 2 = uses calculated diel light)	2
Include algal self shading light extinction in steele (0 = Yes; 1 = No)	0
Background light extinction coefficient (1/m)	0.0088
Detritus and Solids Light Extinction Multiplier 1/m/(mg/L)	0.1
Sediment diagenesis	
Activate sediment diagenesis model (1 = On; 0 = Off)	0
Decay constant for benthic stress (1/day)	0.03
Freshwater nitrification reaction velocity (m/day)	0.1313
Temperature coefficient for nitrification	1.123
Half-saturation coefficient for ammonia in nitrification reaction (mg/L)	0.728
Half-saturation coefficient for oxygen in the nitrification reaction (mg/L)	37
Temperature coefficient for denitrification	1.08
Solids option. 0: input vs, vd, vr; 1: vs, vd, vr calculated from shear stress	1
Critical shear stress for erosion of cohesive bed (N/m^{2})	2

Ammoniacal Nitrogen (AN)

Scenario 1: Baseline scenario

Figure 7-36 summarizes the predicted NH_3-N profile of Sg. Endau based on existing conditions. From the Figure, the NH_3-N concentration during existing condition fall under Class III category.

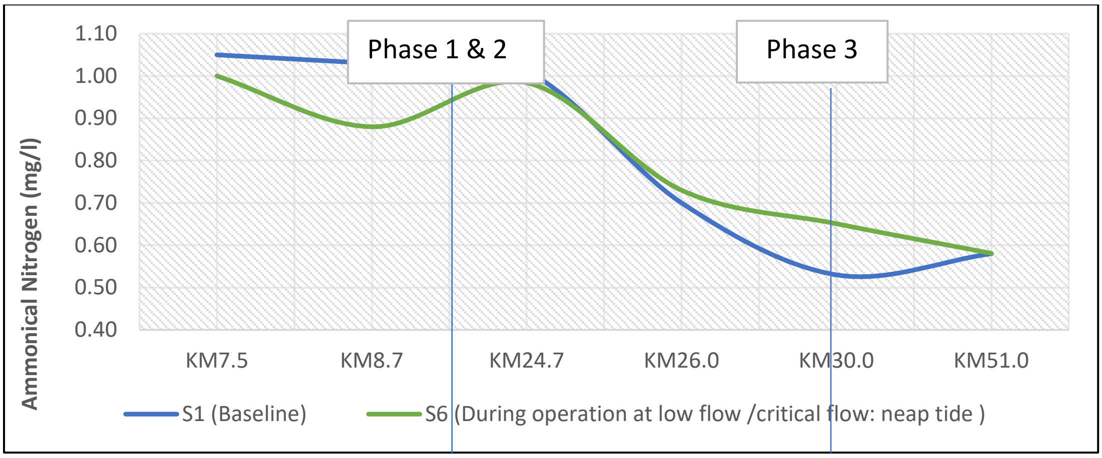


Figure 7-36: Result of Ammoniacal Nitrogen (AN)

Nitrate

Scenario 1: Baseline scenario

Figure 7-37 summarizes the predicted Nitrate profile of Sg. Endau based on existing conditions. From the Figure, about 1.18 mg/l of Nitrate concentration during existing condition is expected to reach the last station at WQ8 (KM51.0).

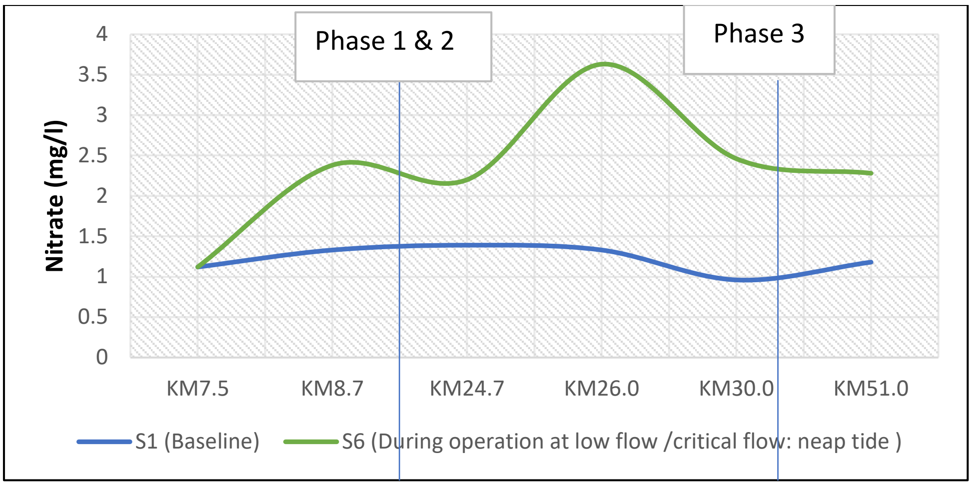


Figure 7-37: Result of Nitrate

Total Phosphorus

Scenario 1: Baseline scenario

Figure 7-38 summarizes the predicted Total Phosphorus (TP) profile of Sg. Endau based on existing conditions. From the Figure, approximately about 0.106 mg/l of TP concentration during existing condition is expected to reach the last station at WQ8 (KM51.0).

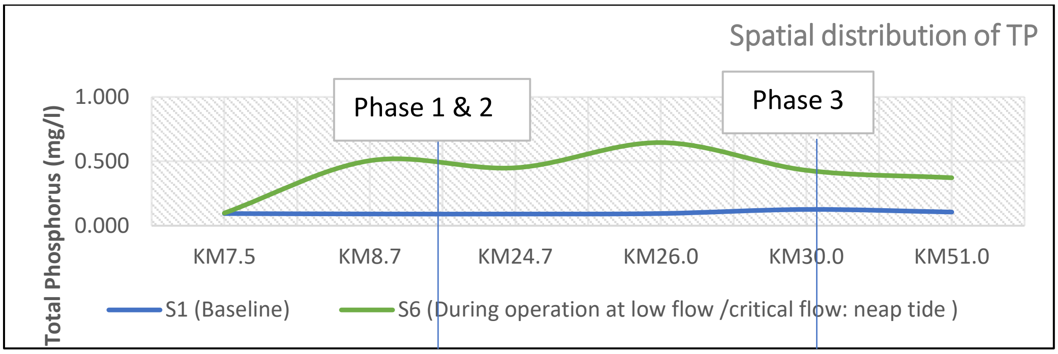


Figure 7-38: Result of Total Phosphorus

BOD

Scenario 1: Baseline scenario

Figure 7-39 summarizes the predicted Biochemical Oxygen Demand (BOD) profile of Sg. Endau based on existing conditions. From the above figure, 1.41 mg/l of BOD concentration (NWQS Class II) during existing condition is expected to reach the last station at WQ8 (KM51.0).

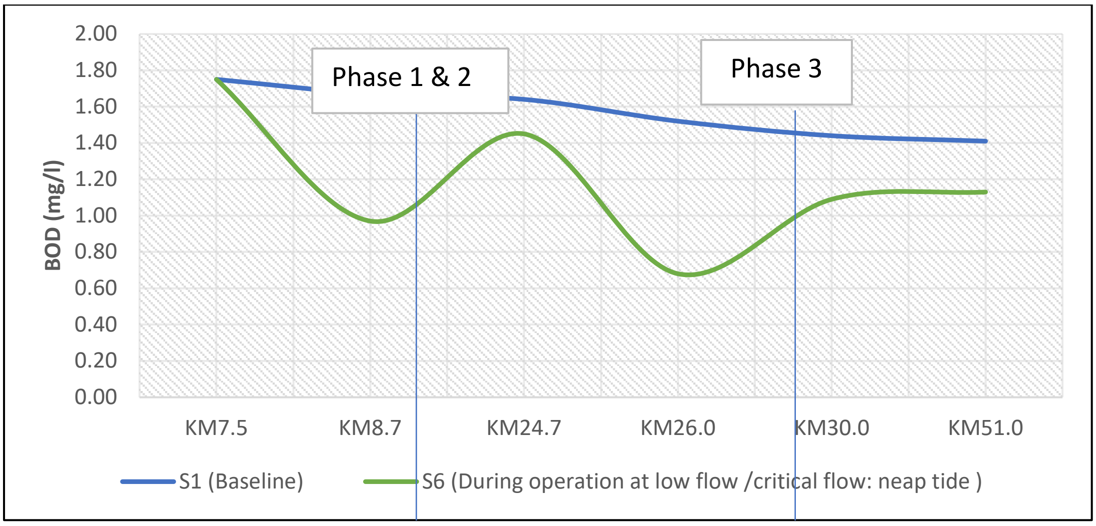


Figure 7-39: Result of BOD

Total Suspended Solids

Scenario 1: Baseline scenario

Figure 7-40 summarizes the predicted TSS profile of Sg. Endau from upstream to downstream area based on existing scenario under the normal conditions. From the Figure, the TSS Class I category of 17.62 mg/l from headwater was preset.

Scenario 2: BMPs failure at peak discharge

Figure 7-40 summarizes the predicted TSS profile of Sg. Endau from upstream to downstream area based on worst case scenario with BMPs failure during peak discharge period. Based on the Figure, the contribution of TSS is highly significant at KM8.7 (Phase 1 & Phase 2); and KM26.0 (Phase 3), as the discharge is drained from the proposed Project sites. On this simulation, 1331.71 mg/l of TSS concentration (NWQS Class V) is expected to reach the last station at WQ8 if there is an occurrence on BMPs failure during peak discharge.

Scenario 3: 90% efficiency of BMPs measures at Peak Flow Condition from sediment basin for each phase

Figure 7-40 also summarizes the predicted TSS profile of Sg. Endau from upstream to downstream based on 90% of BMPs efficiency at peak flow condition from sediment basin for each phase. Based on the simulation, the contribution of TSS is significant at KM8.7 (Phase 1 & Phase 2); and KM26.0 (Phase 3), as the discharge is drained from the proposed Project area with a proposed BMPs employment. The TSS loading that eventually reach the last station at WQ8 fall within Class II (34.09 mg/l), which is less than 50.00mg/l NWQS Class IIA/IIB for TSS concentration loading. This value is higher compared to the existing TSS condition in Scenario 1, but the TSS loading is highly improved in comparison to the worst-case scenario with BMPs failure during peak discharge.

Scenario 4: BMPs failure at neap/low flow condition

Figure 7-40 summarizes the predicted TSS profile of Sg. Endau from upstream to downstream based on worst case scenario with BMPs failure during neap/low flow condition. Based on the Figure, the contribution of TSS is highly significant at KM8.7 (Phase 1 & Phase 2); and KM26.0 (Phase 3), as the discharge is drained from the proposed Project sites. On this simulation, 1508.51 mg/l of TSS concentration (NWQS Class V) is expected to reach the last station at WQ8 in occurrence of BMPs failure during neap/low flow condition.

Scenario 5: 90% efficiency of BMPs measures at neap/low flow condition from sediment basin for each phase

Figure 7-40 also summarizes the predicted TSS profile of Sg. Endau from upstream to downstream based on 90% of BMPs efficiency at neap/low flow condition from sediment basin for each phase. Based on the simulation, the contribution of TSS is significant at KM8.7 (Phase 1 & Phase 2); and KM26.0 (Phase 3), as the discharge is drained from the proposed Project area with a proposed BMPs employment. The TSS loading that eventually reaches the last station at WQ8 fall within Class II (31.36 mg/l), which is less than 50.00mg/l NWQS Class IIA/IIB for TSS concentration. This value is higher compared to the existing TSS condition in Scenario 1, but the TSS loading is highly improved in comparison to the worst-case scenario with BMPs failure during neap/low flow condition.

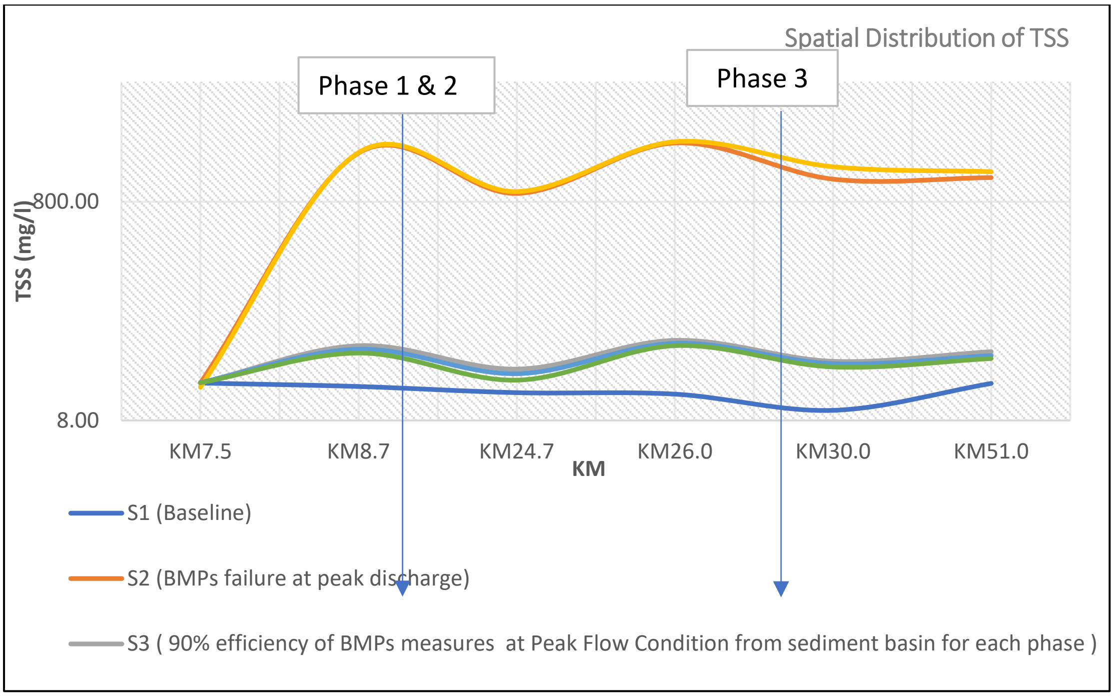


Figure 7-40: Result of TSS

Aluminum

Scenario 1: Baseline scenario

Figure 7-41 summarizes the predicted Al profile of Sg. Endau from upstream to downstream area based on existing scenario under the normal conditions. From the Figure, From the Figure, about 0.266mg/l of Al concentration loading is expected to reach at last station; WQ8 (KM51.0).

Scenario 2: BMPs failure at peak discharge

Figure 7-41 summarizes the predicted Al profile of Sg. Endau from upstream to downstream based on worst case scenario with BMPs failure during peak discharge period. Based on the Figure, the contribution of Al is highly significant at KM8.7 and KM26.0, as the discharge is drained from the proposed Project sites area. On this simulation, about 0.844 mg/l of Al concentration (NWQS Class V) is expected to reach the last station at WQ8.

Scenario 3: 90% efficiency of BMPs measures at Peak Flow Condition from sediment basin for each phase

Figure 7-41 also summarizes the predicted Al profile of Sg. Endau from upstream to downstream based on 90% of BMPs efficiency at peak flow condition from sediment basin for each phase. Based on the simulation, the contribution of Al is significant at KM8.7 and KM26.0, as the discharge is drained from the proposed Project area with a proposed BMPs employment. The Al concentrations that eventually reaches the last station at WQ8 fall within Class IV (0.276 mg/l). This value is higher compared to the existing Al condition in Scenario 1, but the Al concentrations is highly improved in comparison to the worst-case scenario with BMPs failure during peak discharge.

Scenario 4: BMPs failure at neap/low flow condition

Figure 7-41 summarizes the predicted Al profile of Sg. Endau from upstream to downstream based on worst case scenario with BMPs failure during neap/low flow condition. Based on the Figure, the contribution of Al is highly significant at KM8.7 and KM26.0, as the discharge is drained from the proposed Project sites area. On this simulation, about 0.980 mg/l of Al concentration (NWQS Class V) is expected to reach the last station at WQ8.

Scenario 5: 90% efficiency of BMPs measures at neap/low flow condition from sediment basin for each phase

Figure 7-41 also summarizes the predicted Al profile of Sg. Endau from upstream to downstream based on 90% of BMPs efficiency at neap/low flow condition from sediment basin for each phase. Based on the simulation, the contribution of Al is significant at KM8.7 and KM26.0, as the discharge is drained from the proposed Project area with a proposed BMPs employment. The Al loading that eventually reaches the last station at WQ8 fall within Class IV (0.282 mg/l). This value is higher compared to the existing Al condition in Scenario 1, but the Al concentration is highly improved in comparison to the worst-case scenario with BMPs failure during neap/low flow condition.

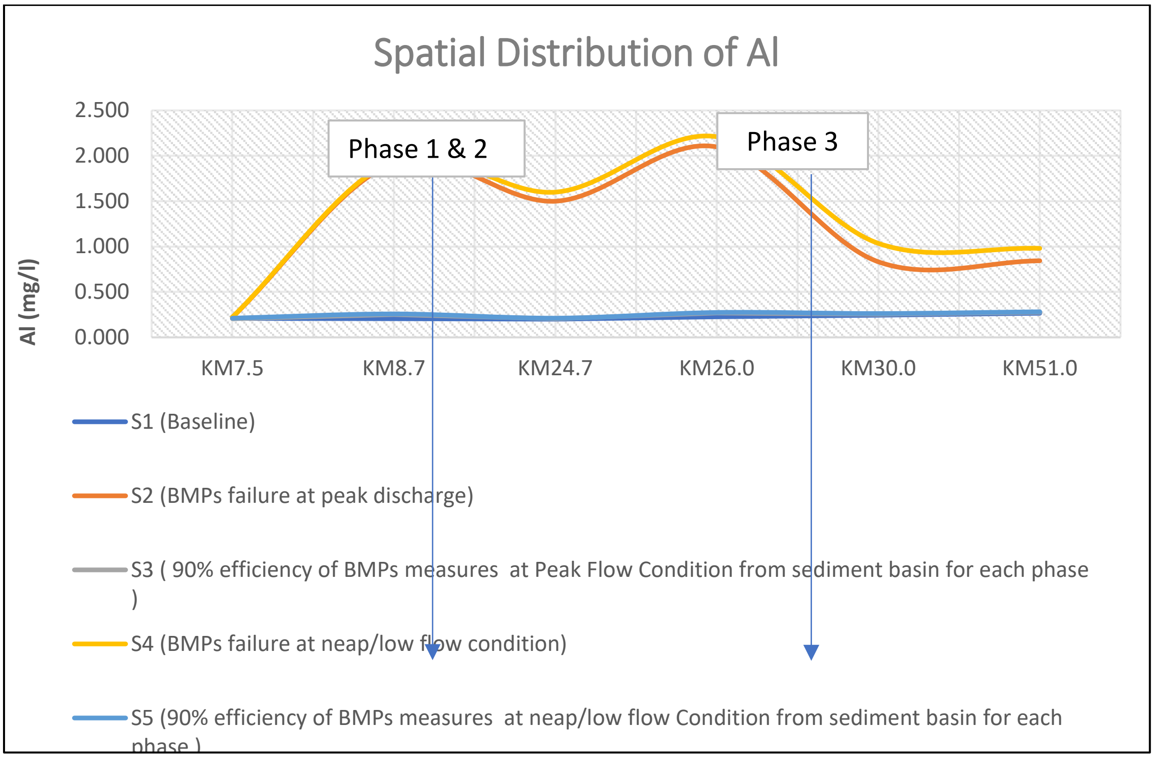


Figure 7-41: Result of Al

Arsenic

Scenario 1: Baseline scenario

Figure 7-42 summarizes the predicted As profile of Sg. Endau from upstream to downstream based on existing scenario under the normal conditions. From the Figure, From the Figure, about 0.0048mg/l of As concentration loading is expected to reach at last station; WQ8 (KM51.0).

Scenario 2: BMPs failure at peak discharge

Figure 7-42 summarizes the predicted As profile of Sg. Endau from upstream to downstream based on worst case scenario with BMPs failure during peak discharge period. Based on the Figure, the contribution of As is highly significant at KM8.7 and KM26.0, as the discharge is drained from the proposed Project sites area. On this simulation, about 0.0699 mg/l of As concentration loading (NWQS Class II) is expected to reach the last station at WQ8.

Scenario 3: 90% efficiency of BMPs measures at Peak Flow Condition from sediment basin for each phase

Figure 7-42 also summarizes the predicted as profile of Sg. Endau from upstream to downstream based on 90% of BMPs efficiency at peak flow condition from sediment basin for each phase. Based on the simulation, the contribution of As is significant at KM8.7 and KM26.0, as the discharge is drained from the proposed Project area with a proposed BMPs employment. The As concentration that eventually reaches the last station at WQ8 fall within Class I (0.0104 mg/l). This value is higher compared to the existing As condition in Scenario 1, but the As loading is highly improved in comparison to the worst case scenario with BMPs failure during peak discharge.

Scenario 4: BMPs failure at neap/low flow condition

Figure 7-42 summarizes the predicted As profile of Sg. Endau from upstream to downstream area based on worst case scenario with BMPs failure during neap/low flow condition. Based on the Figure, the contribution of As is highly significant at KM8.7 and KM26.0, as the discharge is drained from the proposed Project sites area. On this simulation, 0.0849 mg/l of As concentration loading (NWQS Class II) is expected to reach the last station at WQ8.

Scenario 5: 90% efficiency of BMPs measures at neap/low flow condition from sediment basin for each phase

Figure 7-42 also summarizes the predicted as profile of Sg. Endau from upstream to downstream based on 90% of BMPs efficiency at neap/low flow condition from sediment basin for each phase. Based on the simulation, the contribution of As is significant at KM8.7 and KM26.0, as the discharge is drained from the proposed Project area with a proposed BMPs employment. The As concentration that eventually reaches the last station at WQ8 fall within Class I (0.012 mg/l). This value is higher compared to the existing As condition in Scenario 1, but the As loading is highly improved in comparison to the worst case scenario with BMPs failure during neap/low flow condition.

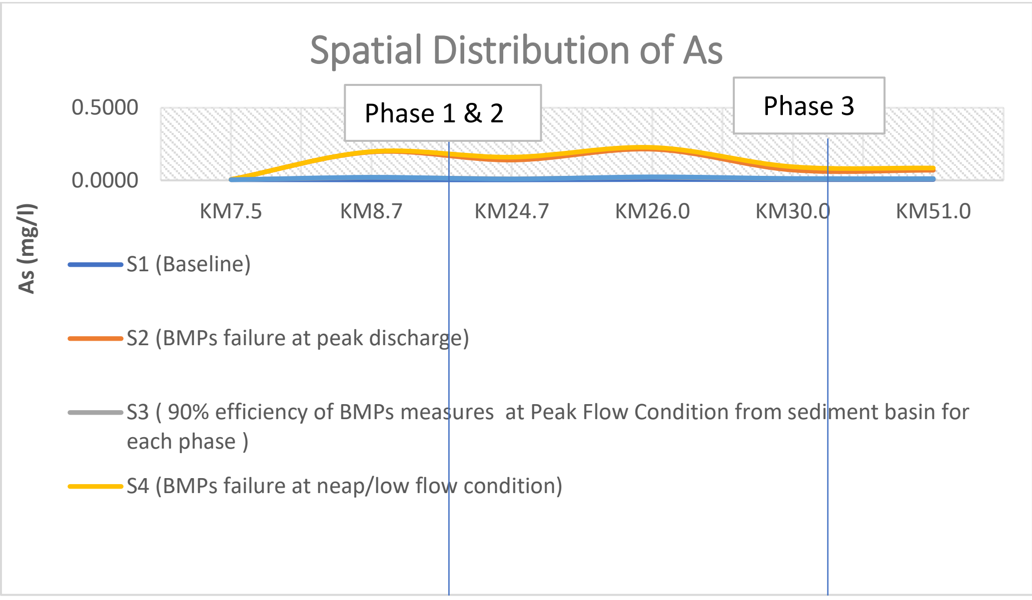


Figure 7-42: Result of As

Iron

Scenario 1: Baseline scenario

Figure 7-43 summarizes the predicted Fe profile of Sg. Endau from upstream to downstream based on existing scenario under the normal conditions. From the Figure, From the Figure, about 0.1529mg/l of Fe concentration loading is expected to reach at last station; WQ8 (KM51.0).

Scenario 2: BMPs failure at peak discharge

Figure 7-43 summarizes the predicted Fe profile of Sg. Endau from upstream to downstream based on worst case scenario with BMPs failure during peak discharge period. Based on the Figure, the contribution of Fe is highly significant at KM8.7 and KM26.0, as the discharge is drained from the proposed Project sites area. On this simulation, about 0.4114 mg/l of Fe concentration (NWQS Class I) is expected to reach the last station at WQ8.

Scenario 3: 90% efficiency of BMPs measures at Peak Flow Condition from sediment basin for each phase

Figure 7-43 also summarizes the predicted Fe profile of Sg. Endau from upstream to downstream area based on 90% of BMPs efficiency at peak flow condition from sediment basin for each phase. Based on the simulation, the contribution of Fe is significant at KM8.7 and KM26.0, as the discharge is drained from the proposed Project area with a proposed BMPs employment. The Fe loading that eventually reaches the last station at WQ8 fall within Class I (0.1467mg/l). This value is slightly lower compared to the existing Fe condition in Scenario 1, and the Fe loading is highly improved in comparison to the worst-case scenario with BMPs failure during peak discharge.

Scenario 4: BMPs failure at neap/low flow condition

Figure 7-43 summarizes the predicted Fe profile of Sg. Endau from upstream to downstream area based on worst case scenario with BMPs failure during neap/low flow condition. Based on the Figure, the contribution of Fe is highly significant at KM8.7 and KM26.0, as the discharge is drained from the proposed Project sites area. On this simulation, about 1.8735mg/l of Fe concentration (NWQS Class V) is expected to reach the last station at WQ8 if there is an occurrence on BMPs failure during neap/low flow condition.

Scenario 5: 90% efficiency of BMPs measures at neap/low flow condition from sediment basin for each phase

Figure 7-43 also summarizes the predicted Fe profile of Sg. Endau from upstream to downstream area based on 90% of BMPs efficiency at neap/low flow condition from sediment basin for each phase. Based on the simulation, the contribution of Fe is significant at KM8.7 and KM26.0, as the discharge is drained from the proposed Project area with a proposed BMPs employment. The Fe concentration that eventually reaches the last station at WQ8 fall within Class I (0.1409 mg/l). This value is slightly lower compared to the existing Fe condition in Scenario 1, but the Fe concentration is highly improved in comparison to the worst-case scenario with BMPs failure during neap/low flow condition.

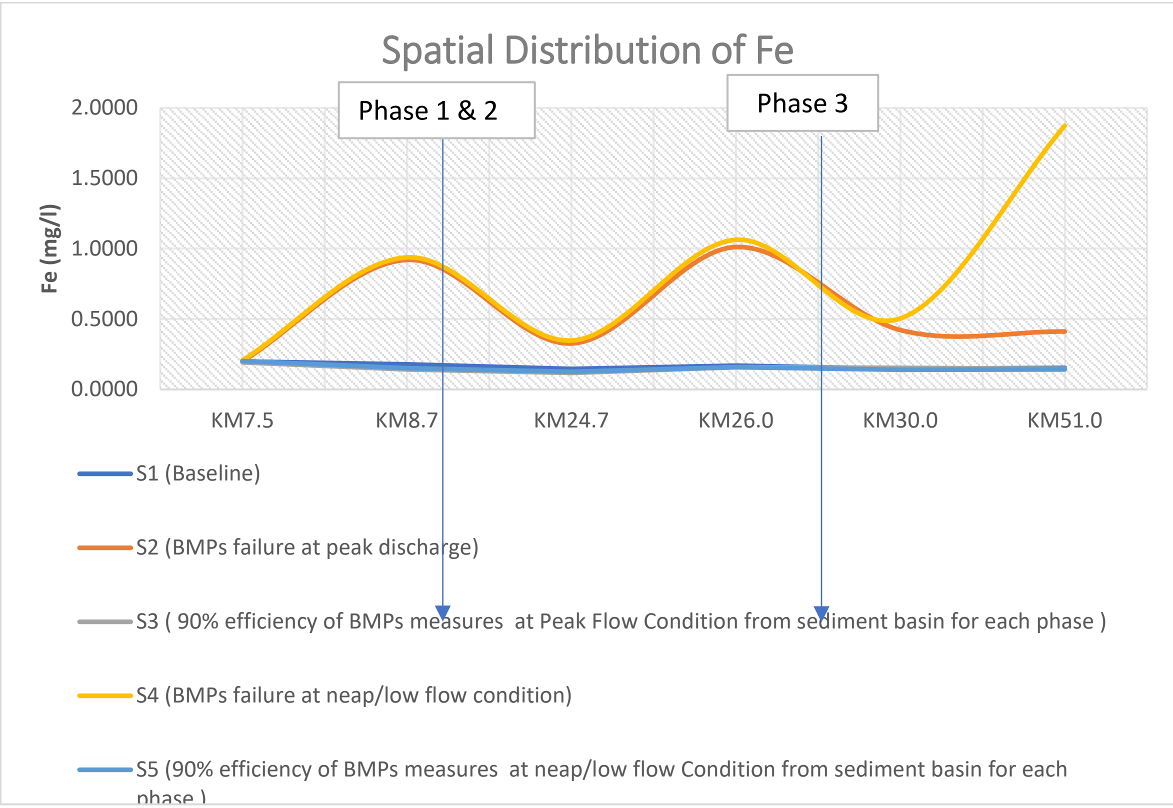


Figure 7-43: Result of Fe

Manganese

Scenario 1: Baseline scenario

Figure 7-44 summarizes the predicted Mn profile of Sg. Endau from upstream to downstream based on existing scenario under the normal conditions. From the Figure, about 0.0090mg/l of Mn concentration loading is expected to reach at last station; WQ8 (KM51.0).

Scenario 2: BMPs failure at peak discharge

Figure 7-44 summarizes the predicted Mn profile of Sg. Endau from upstream to downstream based on worst case scenario with BMPs failure during peak discharge period. Based on the Figure, the contribution of Mn is highly significant at KM8.7 and KM26.0, as the discharge is drained from the proposed Project sites area. On this simulation, 0.0599 mg/l of Mn concentration (NWQS Class I) is expected to reach the last station at WQ8.

Scenario 3: 90% efficiency of BMPs measures at Peak Flow Condition from sediment basin for each phase

Figure 7-44 also summarizes the predicted Mn profile of Sg. Endau from upstream to downstream based on 90% of BMPs efficiency at peak flow condition from sediment basin for each phase. Based on the simulation, the contribution of Mn is significant at KM8.7 and KM26.0, as the discharge is drained from the proposed Project area with a proposed BMPs employment. The Mn loading that eventually reaches the last station at WQ8 fall within Class I (0.0259 mg/l). This value is higher compared to the existing Mn condition in Scenario 1, but the Mn loading is highly improved in comparison to the worst-case scenario with BMPs failure during peak discharge.

Scenario 4: BMPs failure at neap/low flow condition

Figure 7-44 summarizes the predicted Mn profile of Sg. Endau from upstream to downstream based on worst case scenario with BMPs failure during neap/low flow condition. Based on the Figure, the contribution of Mn is highly significant at KM8.7 and KM26.0, as the discharge is drained from the proposed Project sites area. On this simulation, 1.8735mg/l of Mn concentration loading (NWQS Class V) is expected to reach the last station at WQ8.

Scenario 5: 90% efficiency of BMPs measures at neap/low flow condition from sediment basin for each phase

Figure 7-44 also summarizes the predicted Mn profile of Sg. Endau from upstream to downstream based on 90% of BMPs efficiency at neap/low flow condition from sediment basin for each phase. Based on the simulation, the contribution of Mn is significant at KM8.7 and KM26.0, as the discharge is drained from the proposed Project area with a proposed BMPs employment. The Mn concentration that eventually reaches the last station at WQ8 fall within Class I (0.0130 mg/l). This value is slightly higher compared to the existing Mn condition in Scenario 1, but the Mn concentration is highly improved in comparison to the worst-case scenario with BMPs failure during neap/low flow condition.

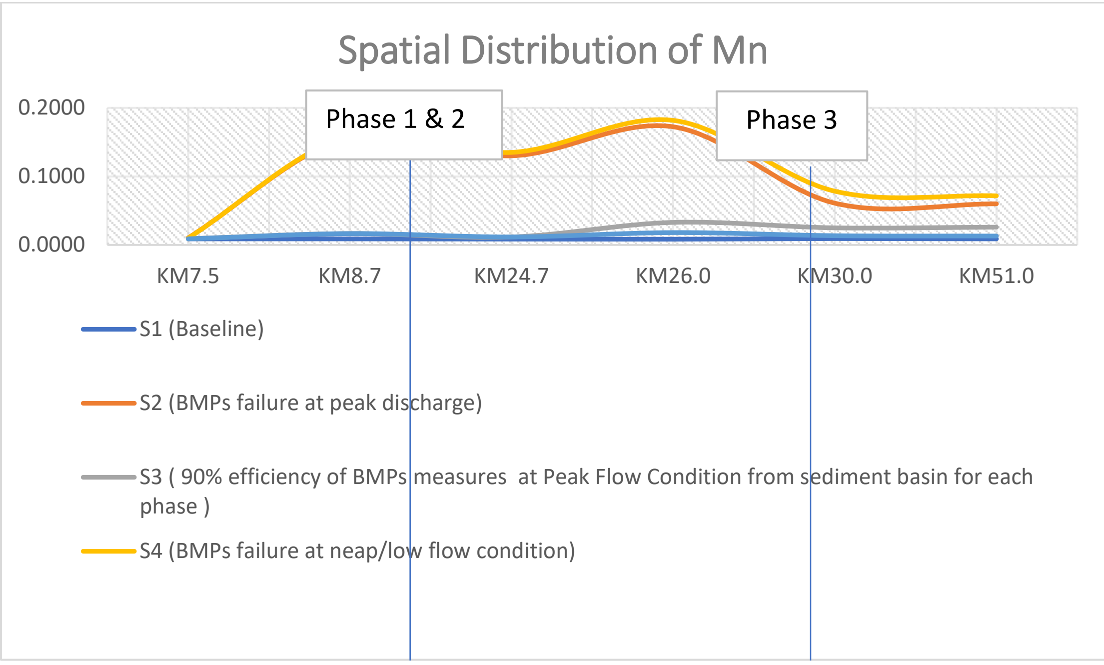


Figure 7-44: Result of Mn

Result summary

Summary of Water Quality Modeling (Comparison to limitation in NWQS):

Concentration at WQ8 (KM51.0)	Scenario 1: Baseline Condition	Scenario 2: BMPs failure at Peak flow condition	Scenario 3: 90% efficiency of BMPs (Peak Flow)	Scenario 4: BMPs failure at neap/low flow condition	Scenario 5: 90% efficiency of BMPs (neap/low flow)
1. Ammoniacal Nitrogen	0.58 Class III	-	-	-	-
2. Biochemical Oxygen Demand (BOD)	1.41 Class II	-	-	-	-
3. Nitrate	1.18 -	-	-	-	-
4. Total Phosphorus (TP)	0.106 -	-	-	-	-
5. Total Suspended Solid (TSS)	17.46 Class I	1331.71 Class V	34.09 Class II	1508.51 Class V	31.36 Class II
6. Aluminium (Al)	0.266 Class IV	0.844 Class V	0.276 Class IV	0.980 Class V	0.282 Class IV
7. Arsenic (As)	0.0048 Class I	0.0699 Class II	0.0104 Class I	0.0849 Class II	0.012 Class I
8. Iron (Fe)	0.1529 Class I	0.4114 Class I	0.1467 Class I	1.8735 Class V	0.1409 Class I
9. Manganese (Mn)	0.0090 Class I	0.0599 Class I	0.0259 Class I	1.8735 Class V	0.0130 Class I

Conclusion for water quality modelling

A study to predict the impact of proposed Project to the water quality of Sg. Endau was conducted using Water Quality Analysis Simulation Program (WASP) modeling during earlier stage of Project activity.

Several key points can be concluded from the modeling exercise:

1. To control the discharge from the Project site to be less than 50 mg/l, implementation of LDP2M2 should be executed stringently. Where from the simulation, the on-site mitigation should be at least 90% efficiency during peak discharge; and neap/low flow condition.

2. To comply with the TSS discharge compliance (TSS<50mg/l), the Project proponent is advised to adopt more than 90% BMPs efficiency as conserving water quality nearly to its existing pristine condition is the most responsible approach to be considered.

3. In view of the topography of this site dominated by flat area, the soil erosion might pose a lesser impact towards water quality deterioration, however, site clearing for the proposed development must be completed by stages where each stage of site clearing area is limited to contribute sediment-laden runoff into proposed sediment basin wherever possible with all sub-division contributing areas would be worked concurrently.

4. Despite of flat-dominated area, Project proponent is obligated to make sure all BMPs is functioning at its optimum capacity to avoid any further environmental damages.

5. Based on simulation model, to reduce the impact from this Project, proper BMPs shall be maintained and kept in good condition for the duration of the Project. In addition of that, before commencement of work, all BMPs such as Silt Trap, Sediment Basin, On-site Detention Pond (OSD) etc. shall be first established and regularly inspected and maintained throughout the development period. Any sediment accumulated especially after any storm event shall be removed immediately and any damage to the BMP's shall be immediately repaired to ensure its effectiveness.

6. Vegetation shall be retained and protected wherever possible and removed vegetation must be stacked to acts as natural filter to surface runoff. Any exposed and bared area shall be immediately plant with cover crop. Preserving the river buffer zone area is very important to make sure; there is an adequate filtration for any runoff from entering the river.

7. All the component that has been highlighted in LDP2M2 must be installed on-site, to ensure any possible runoff can be contained on-site prior to be released to the river.

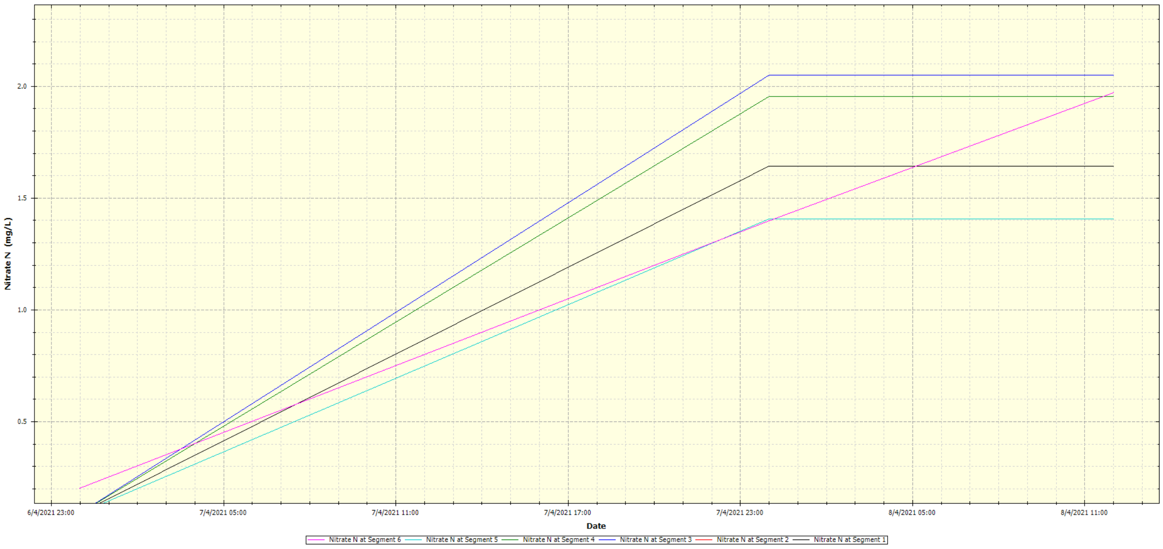
Temporal distribution

<u>Ammoniacal Nitrogen (AN)</u>

Scenario 1

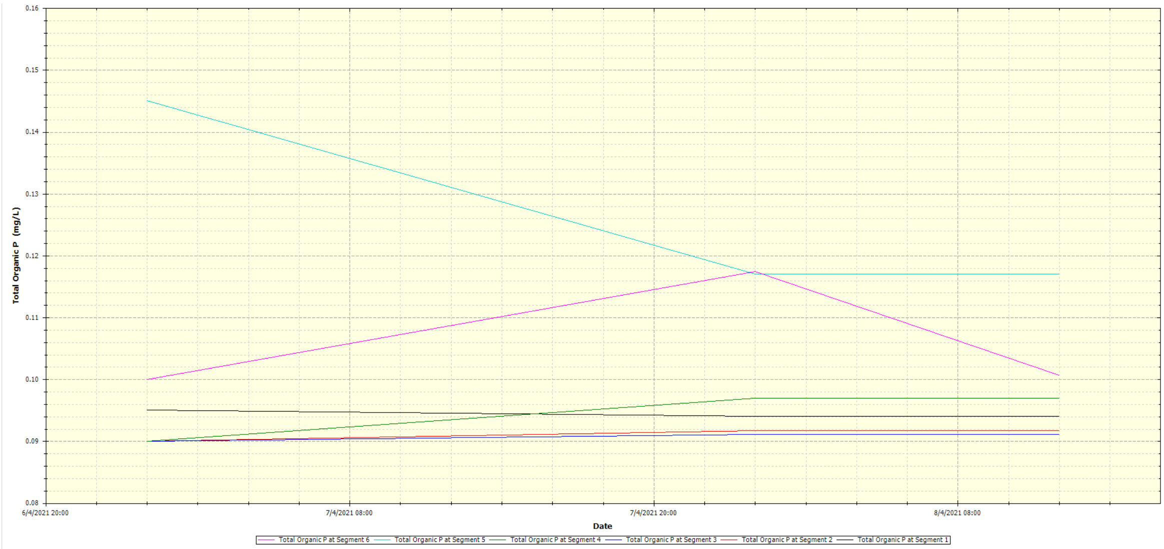
Nitrate

Scenario 1



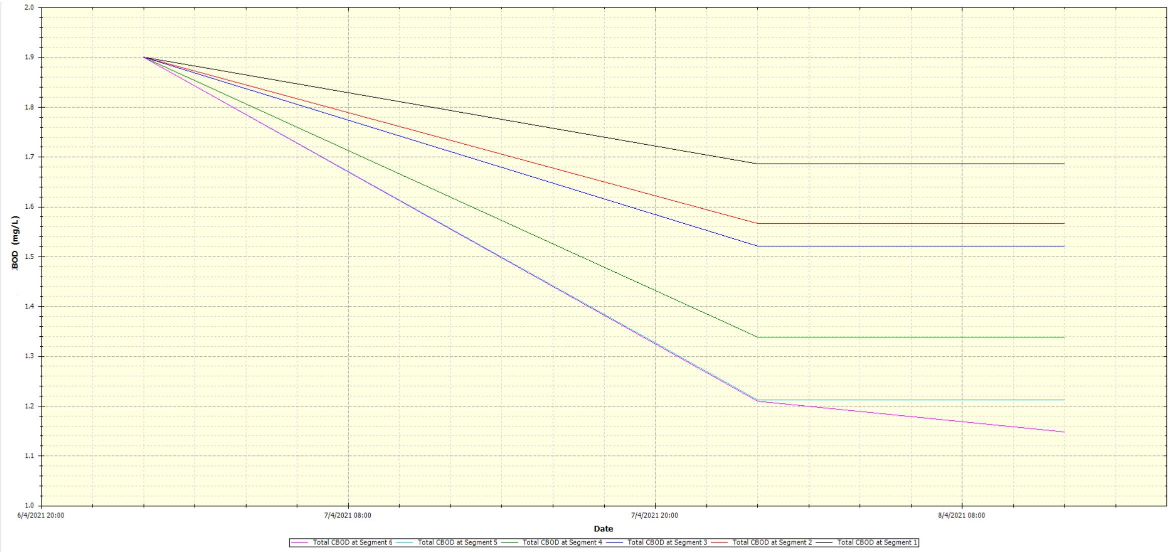
Total Phosphorus

Scenario 1



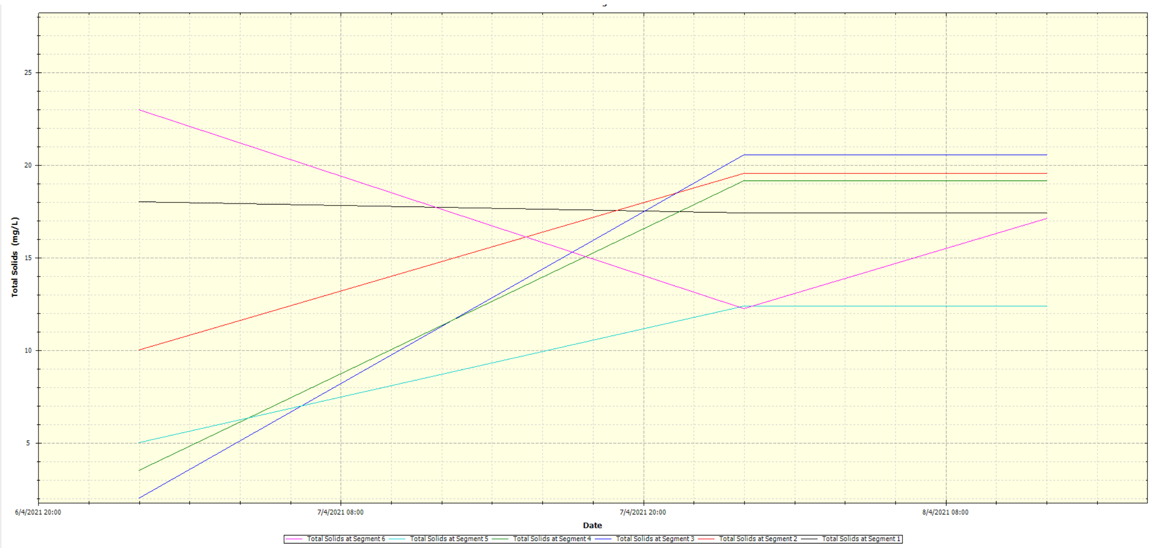
BOD

Scenario 1

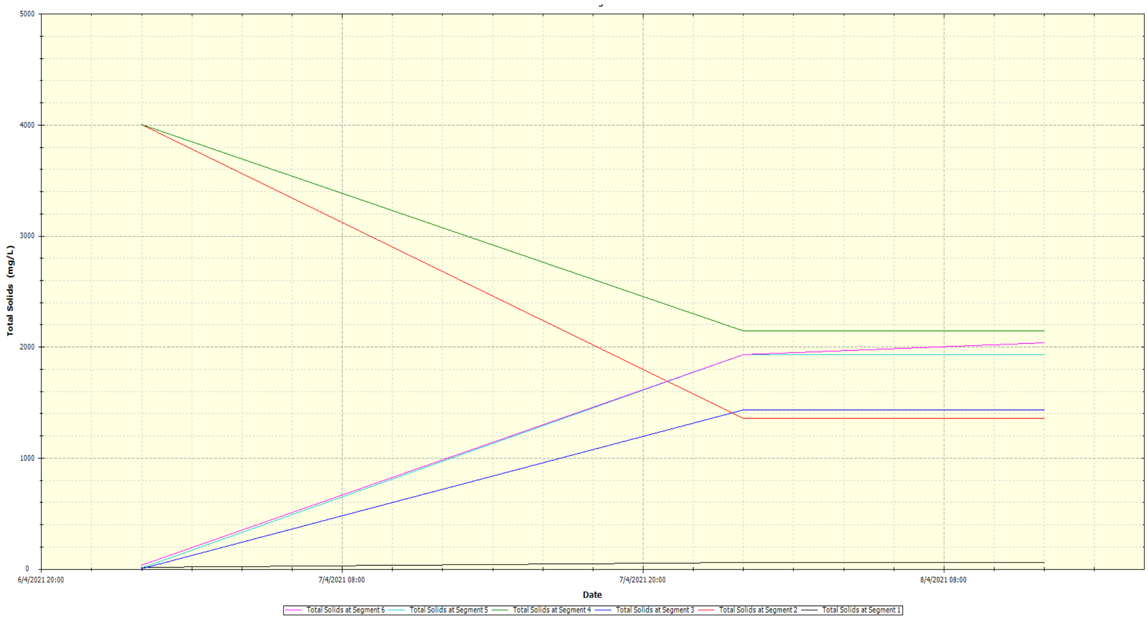


Total Suspended Solid (TSS)

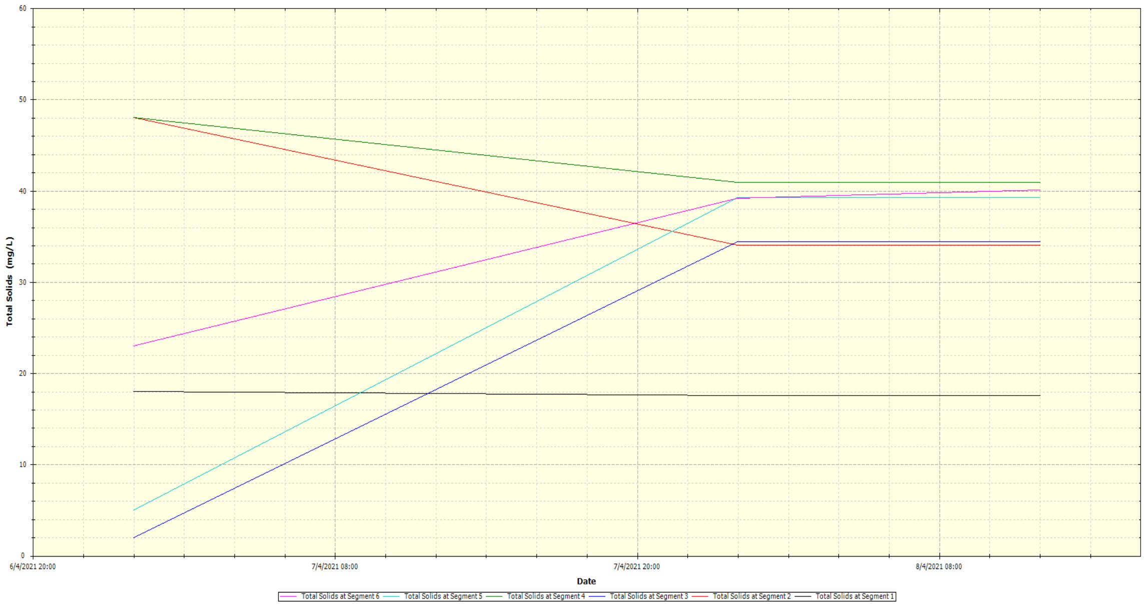
Scenario 1



Scenario 2

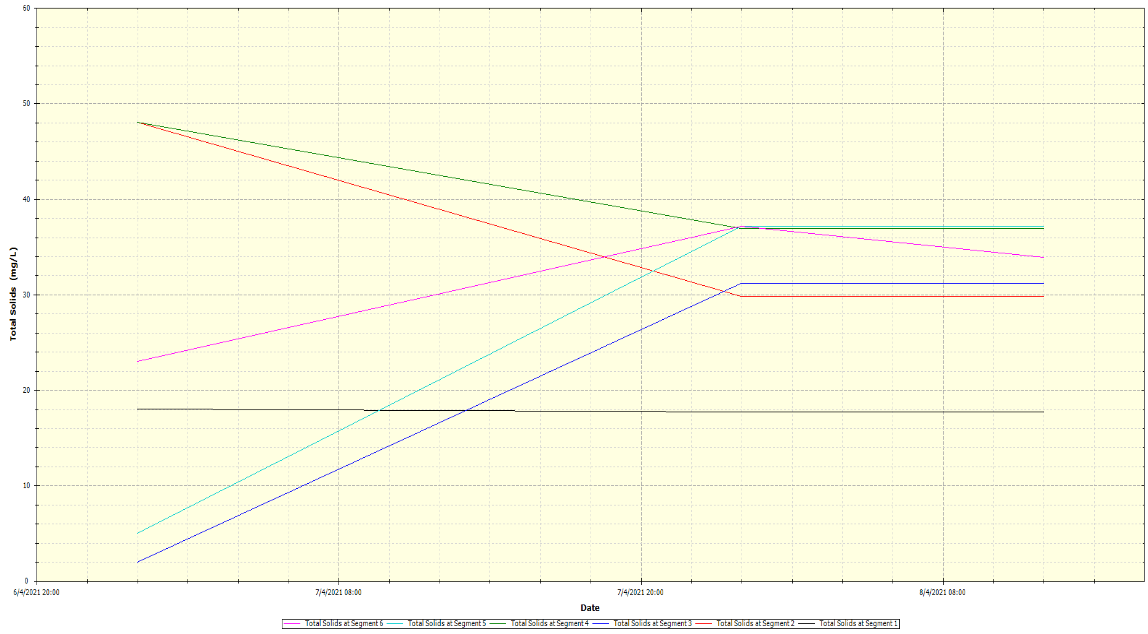


Scenario 3



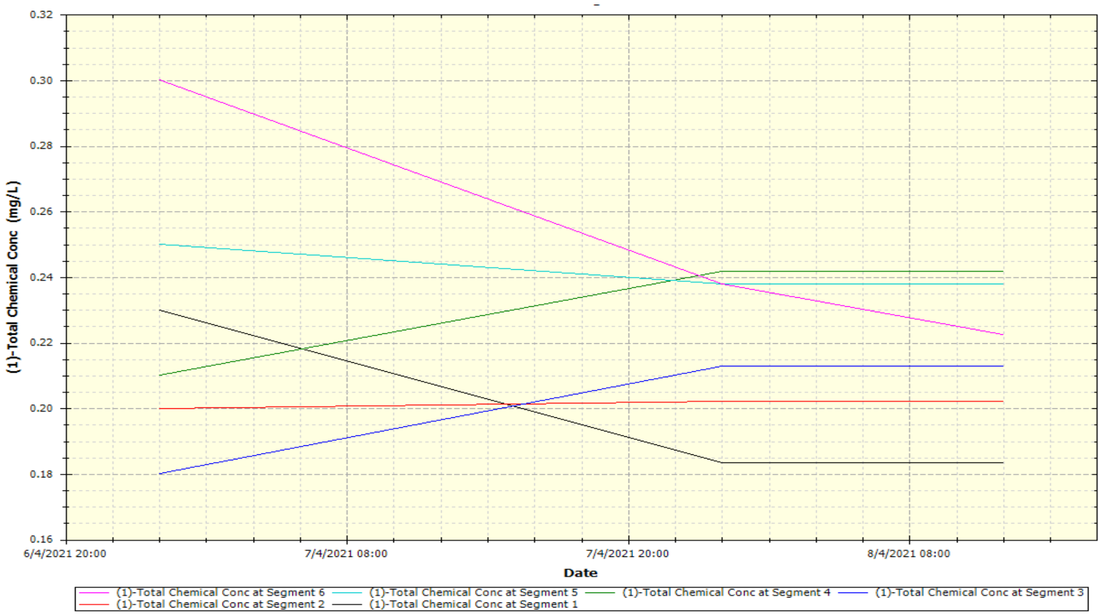
Scenario 4

Scenario 5



Aluminum

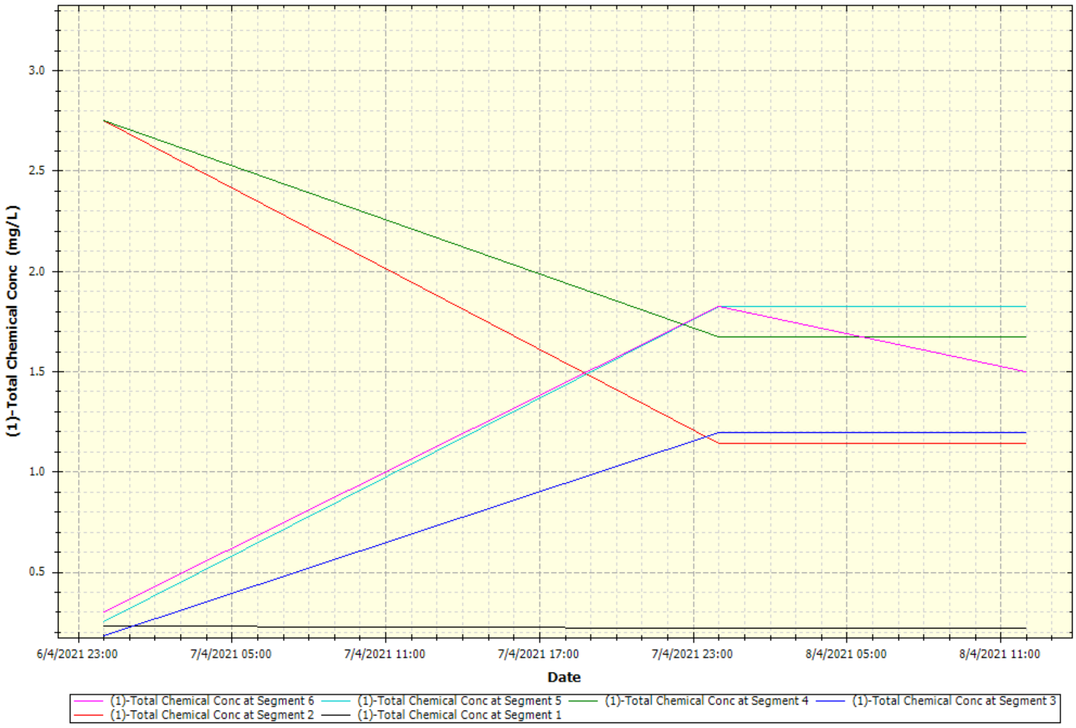
Scenario 1



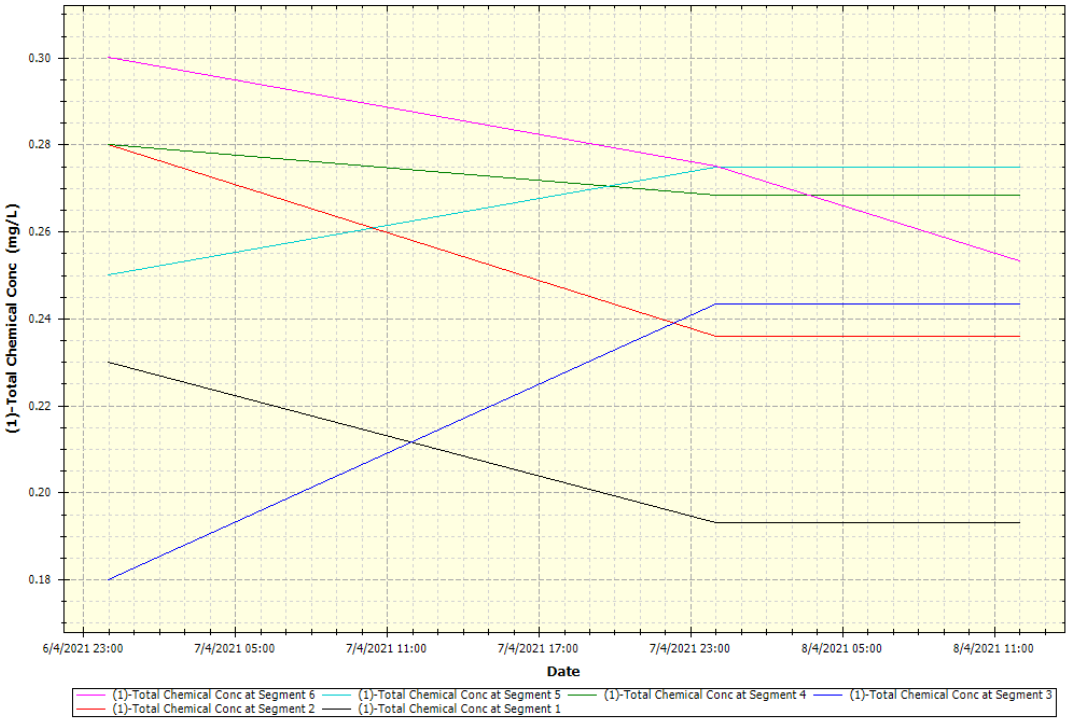
Scenario 2

Scenario 3

Scenario 4

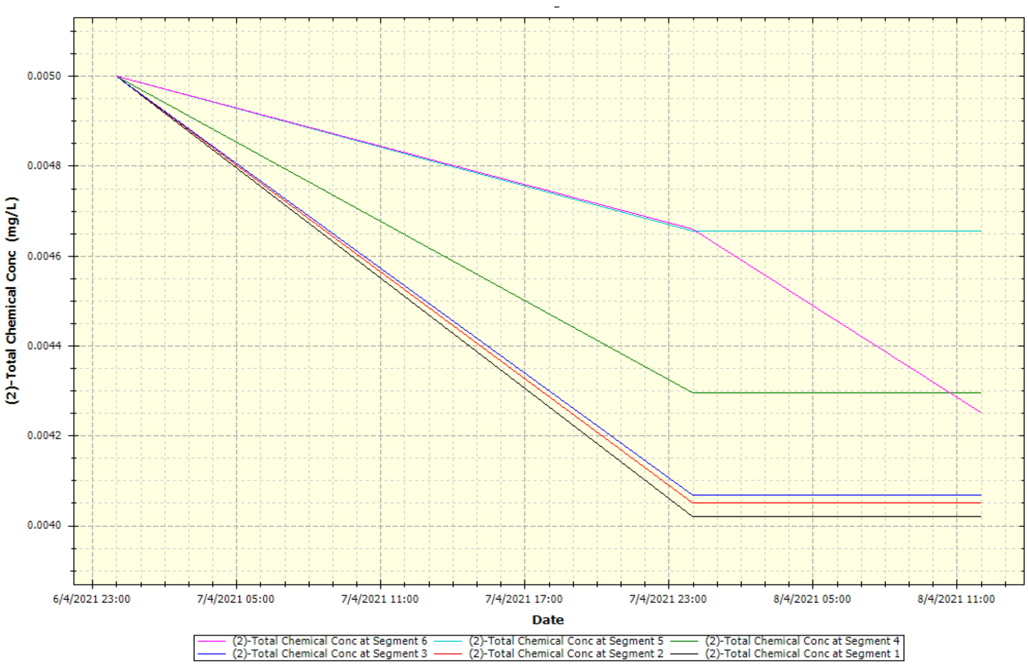


Scenario 5



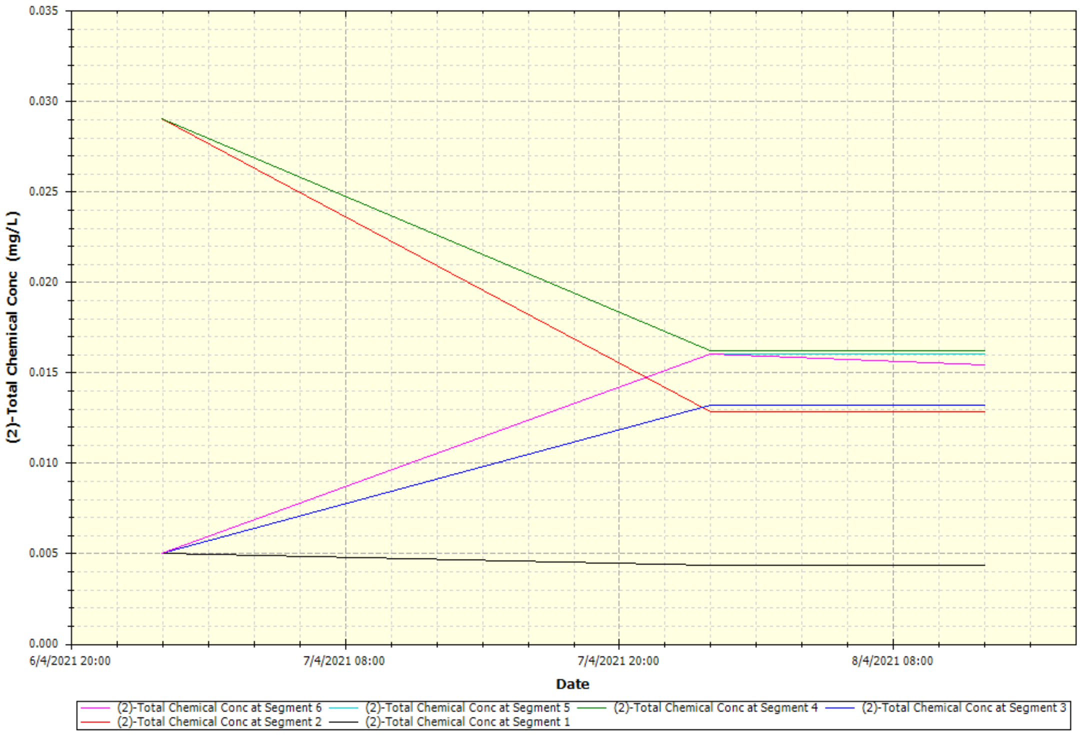
<u>Arsenic</u>

Scenario 1



Scenario 2

Scenario 3



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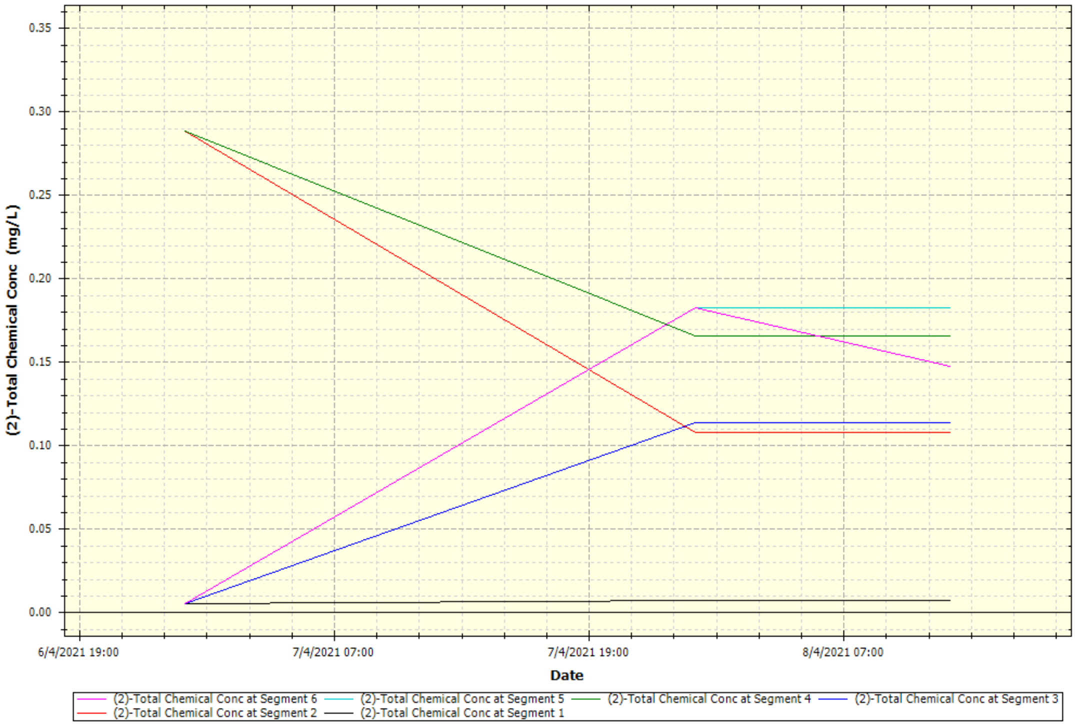

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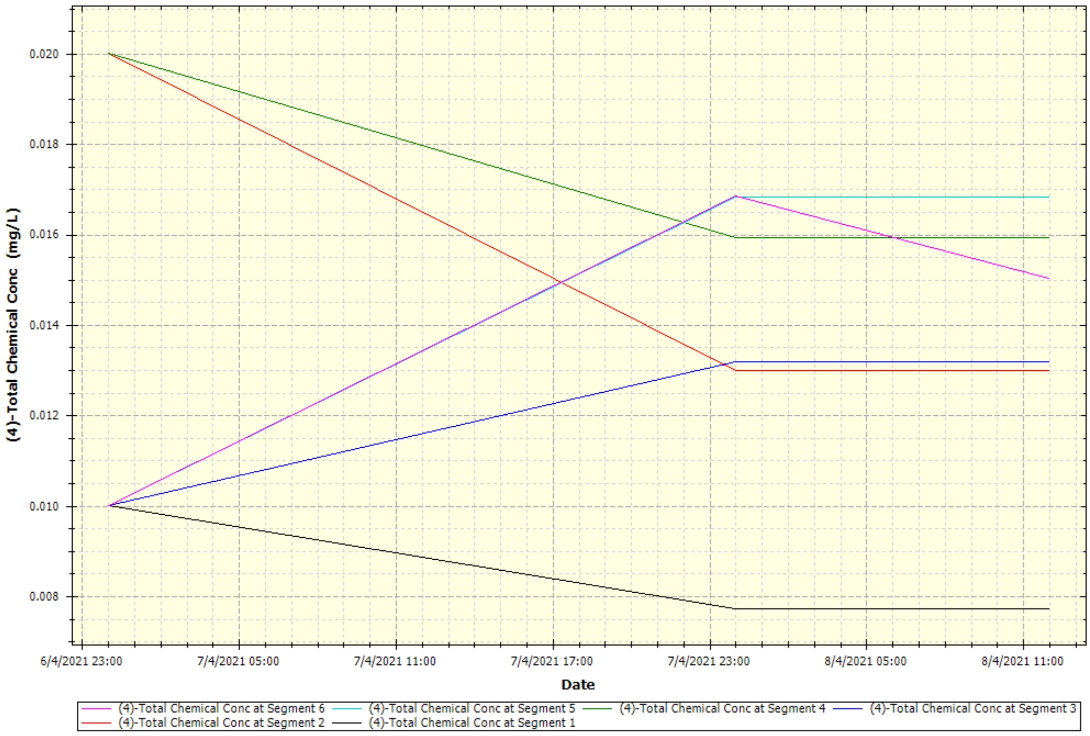
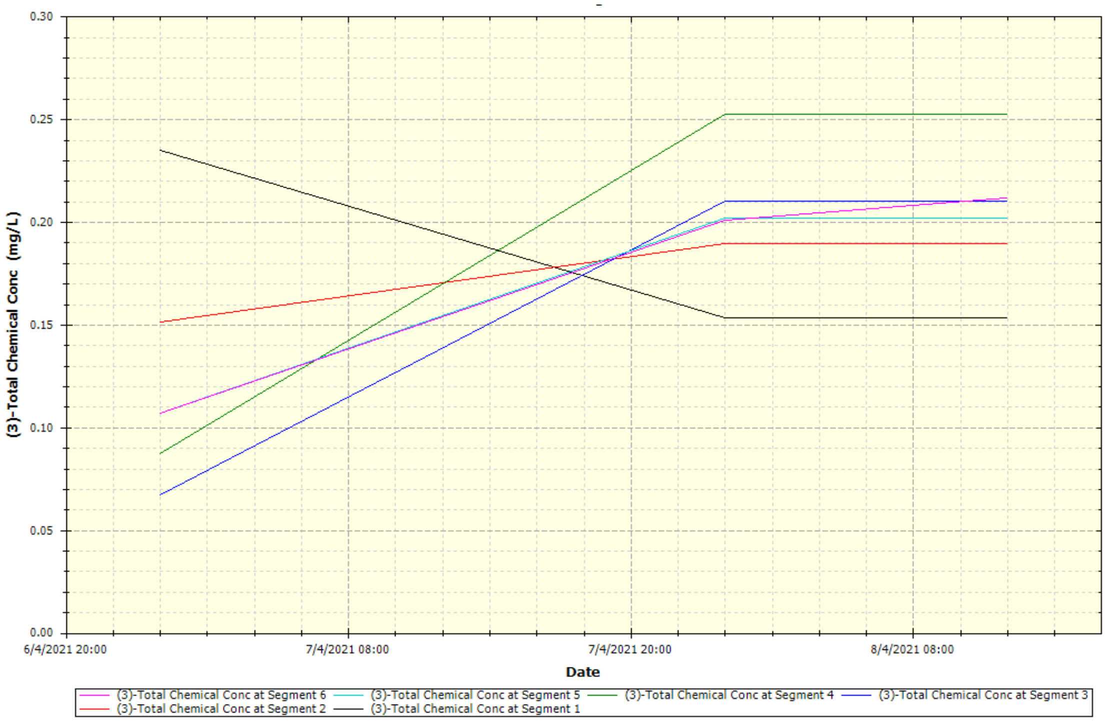
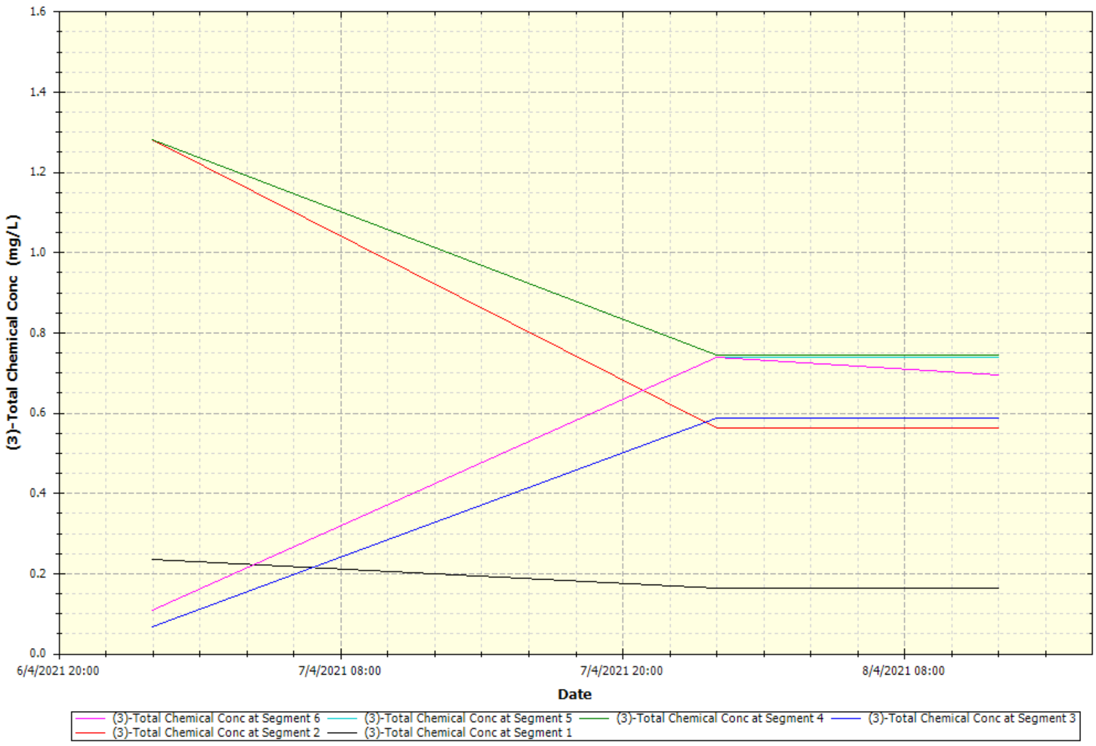


Iron

Scenario 1



Scenario 2



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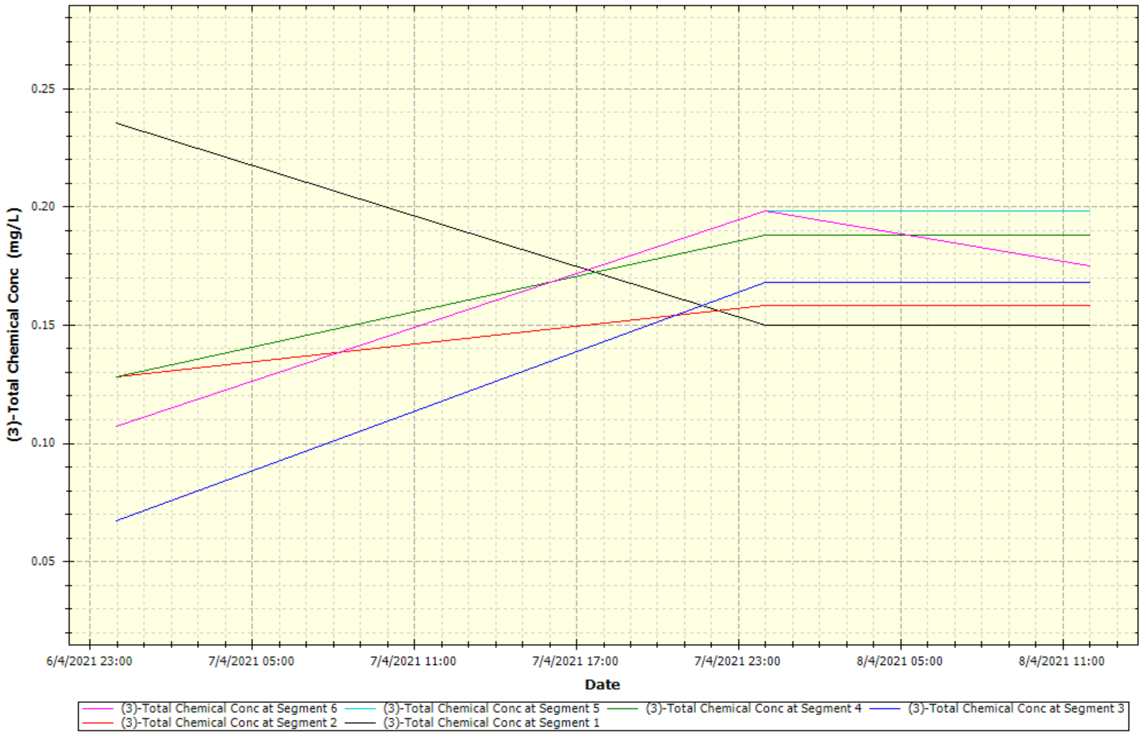

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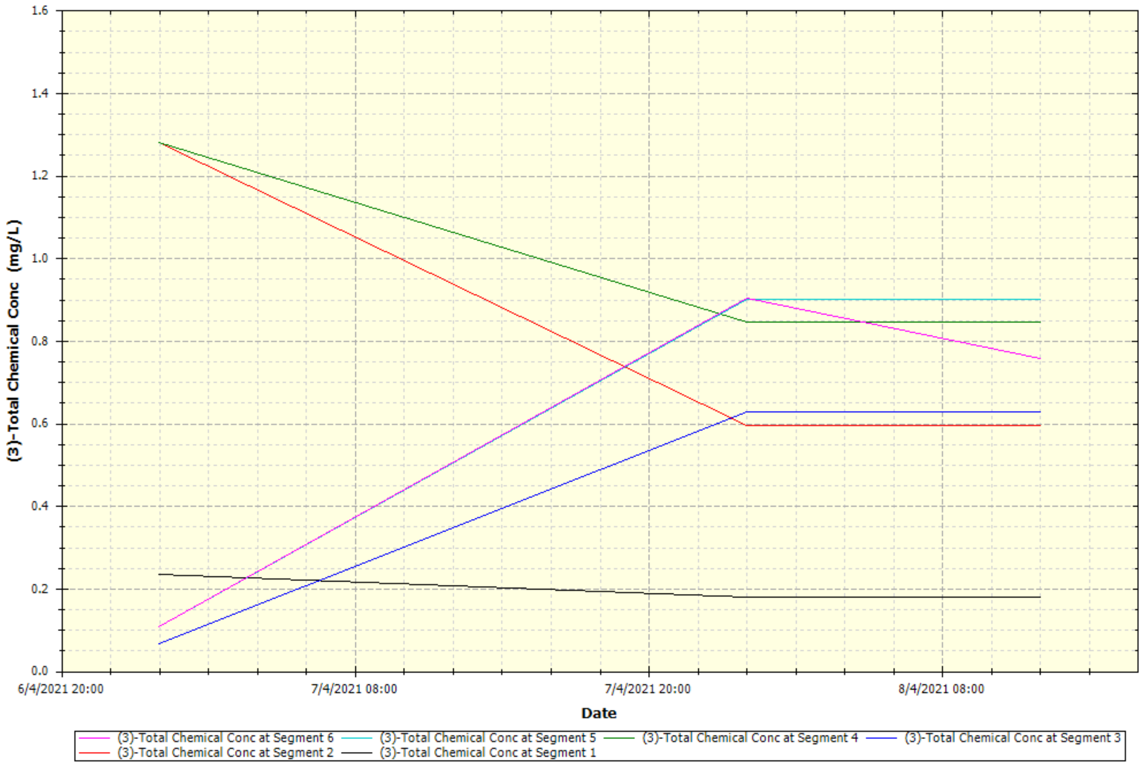

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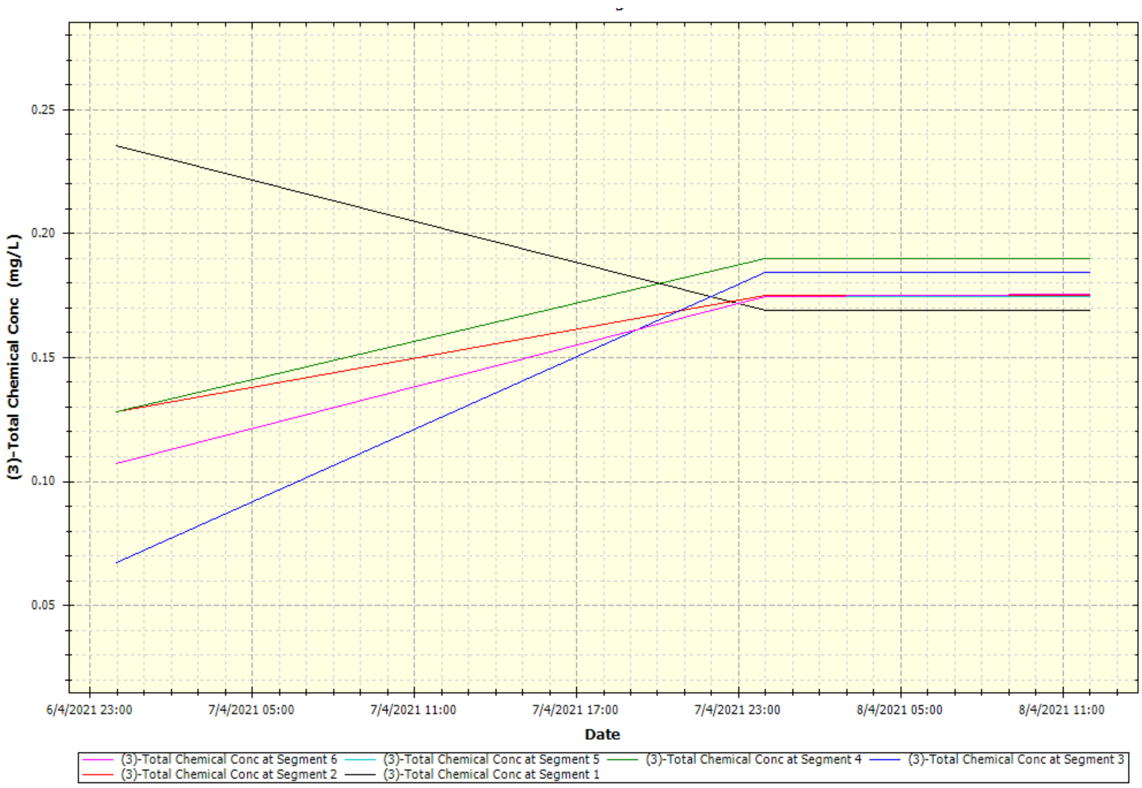
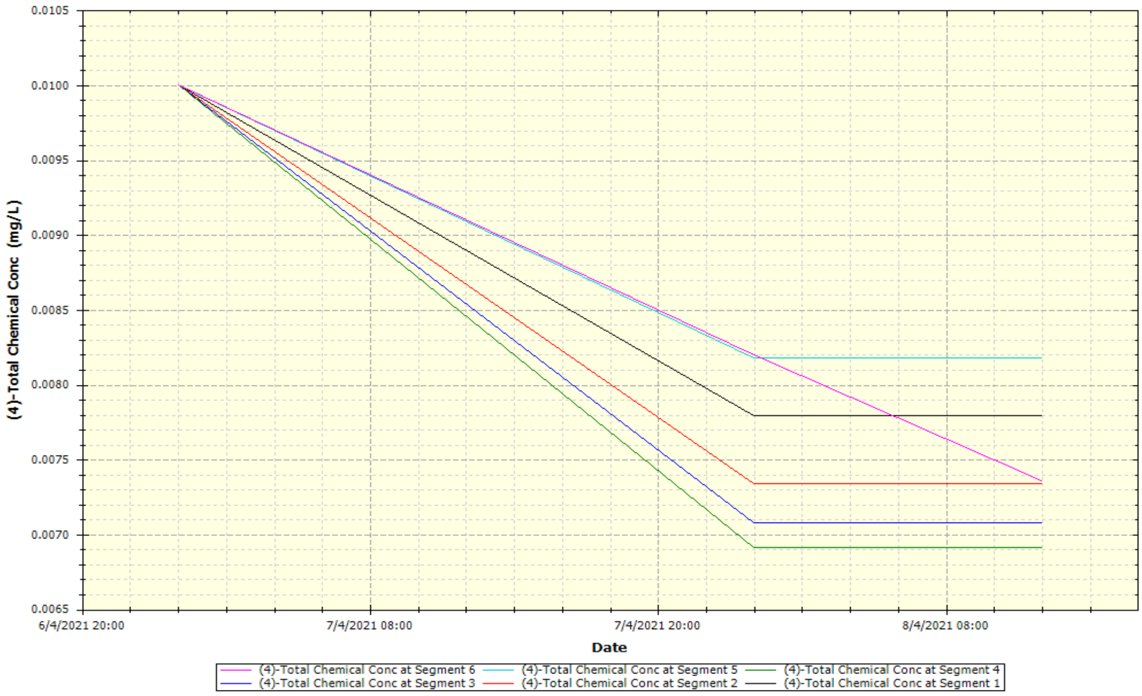


Manganese

Scenario 1



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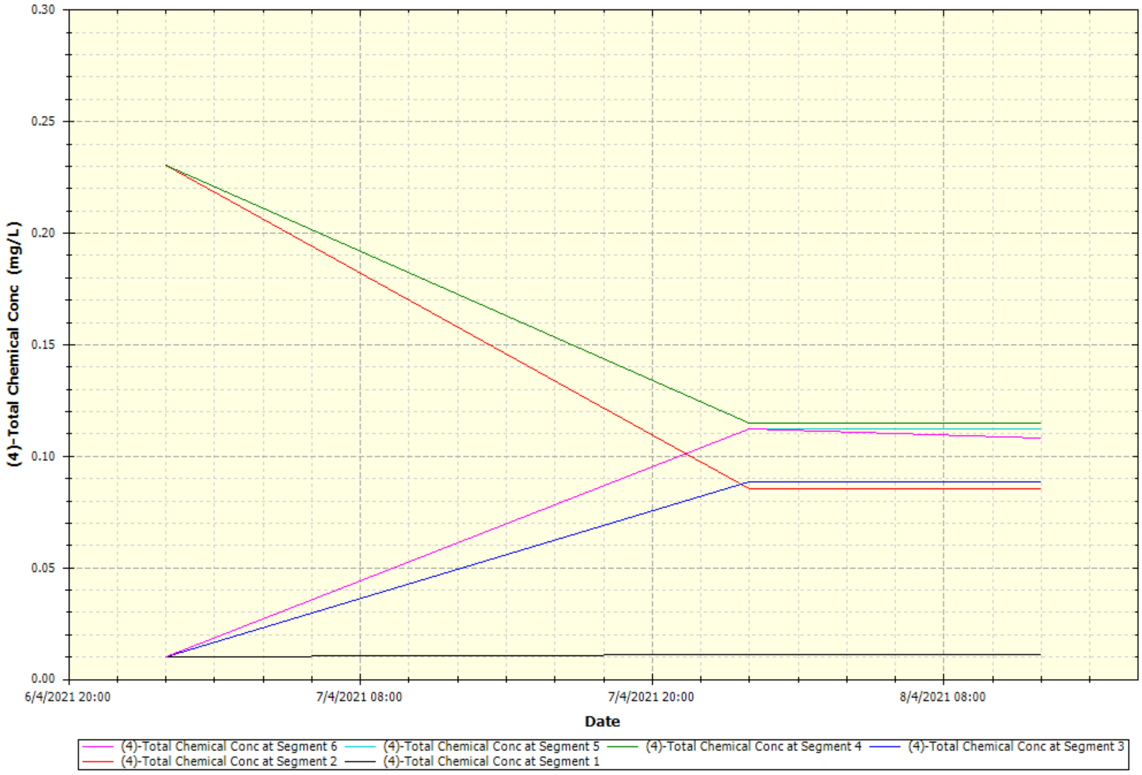

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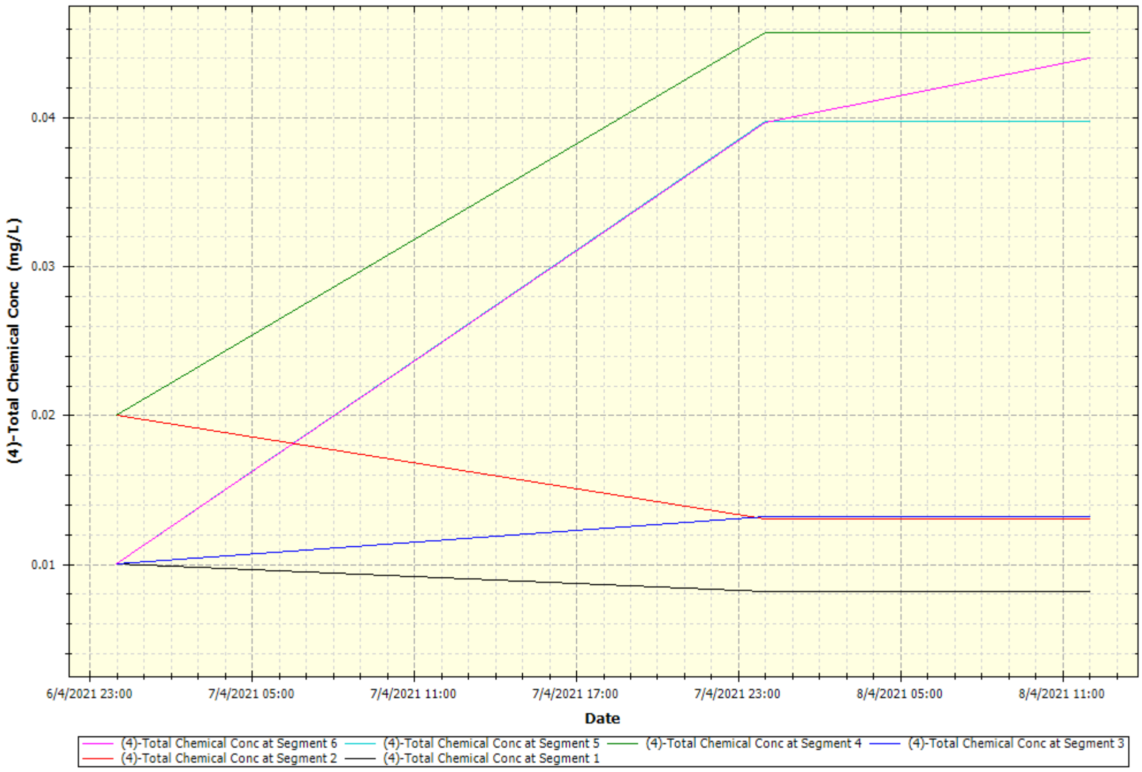

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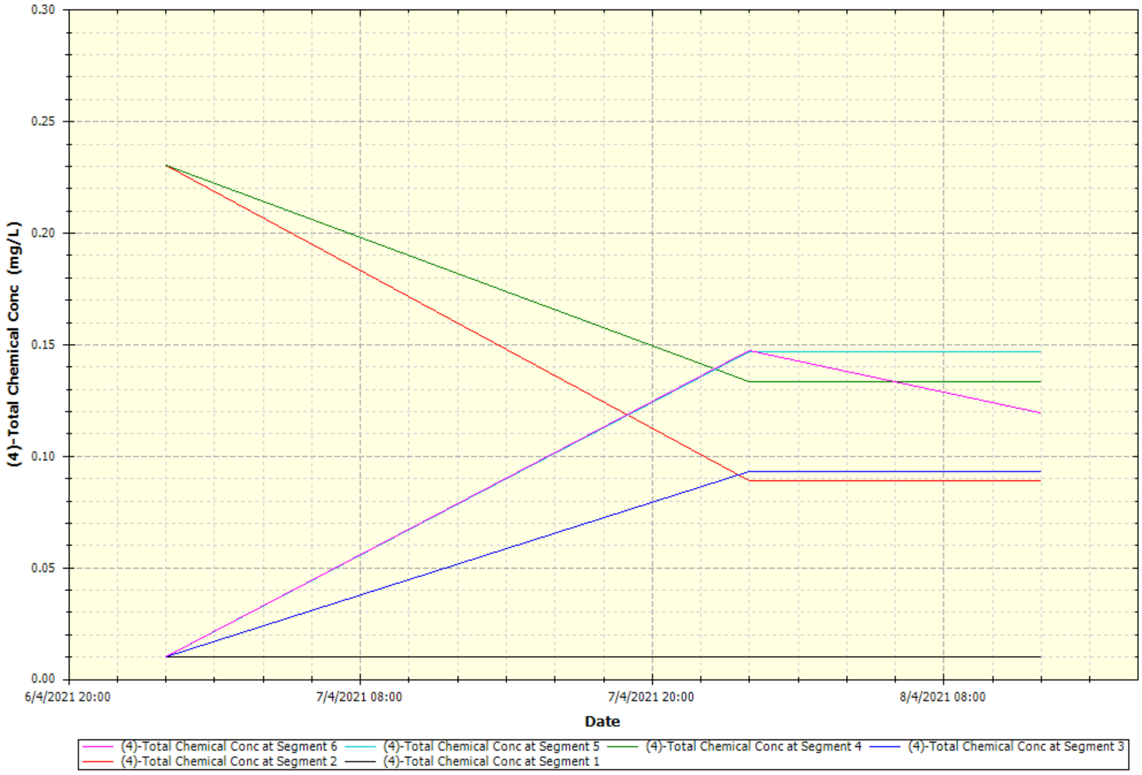

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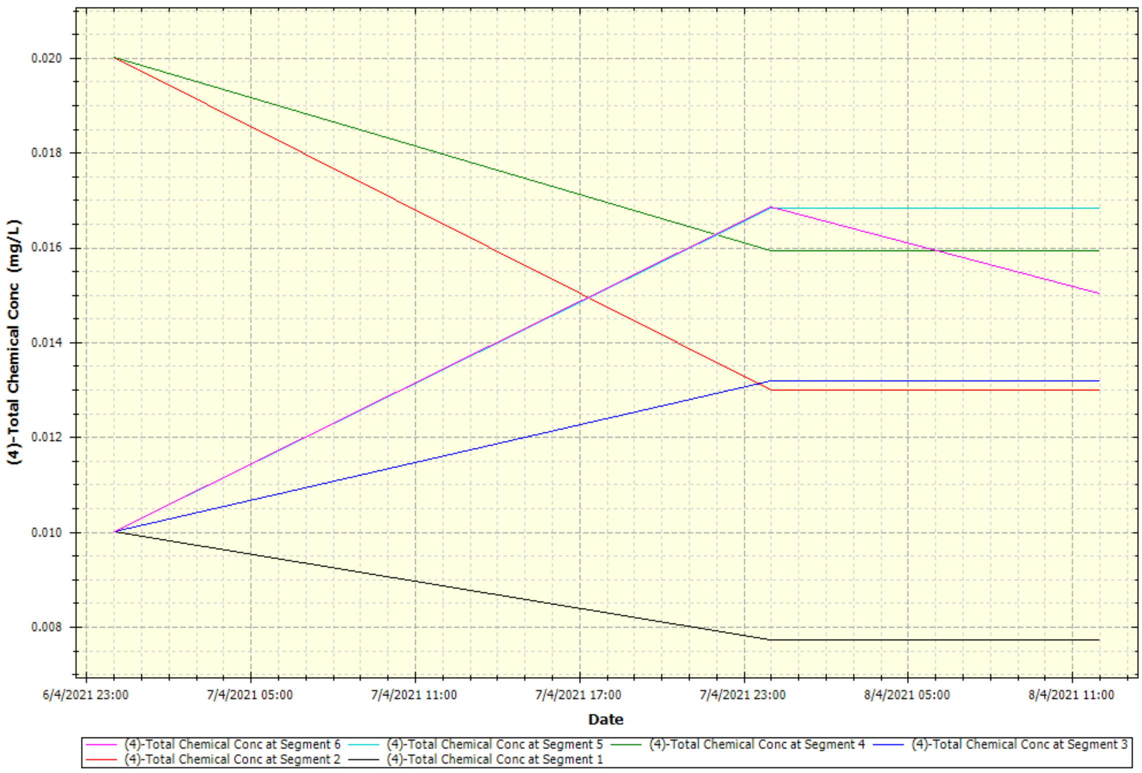


7.2.2.5 Groundwater Quality

Impacts associated with Hydrocarbons

Hydrocarbons and fuels, which are ubiquitous in all the activities associated with the Palm Oil operations. The soil is generally impacted through accidental spills that can happen without warning during the dispensing of fuels, lubricating oils, through bad work practices, and non-respect of correct procedures in the garage, workshops, or just through bad "Housekeeping "and general carelessness of personnel.

The impacts of hydrocarbons spill can have adverse effects on surface water courses and shallow underground water system. Soils contaminated by hydrocarbon spills must be remediated, which is expensive procedure which can be easily avoided through good work practices.

Impact To Labong Lake

The study area is located in the difference watershed with the Labong lake. The study area also located in the lower ground area compare to the lake. The groundwater flow based on the surface level vector indicated the groundwater flows from the Southeast direction to the Northwest direction (**Figure 7-45**). The groundwater recharge is from the higher ground within the study area flowing to the Sg. Endau area. Thus, the plantation activity in the Project area is not give an impact to the Labong lake.

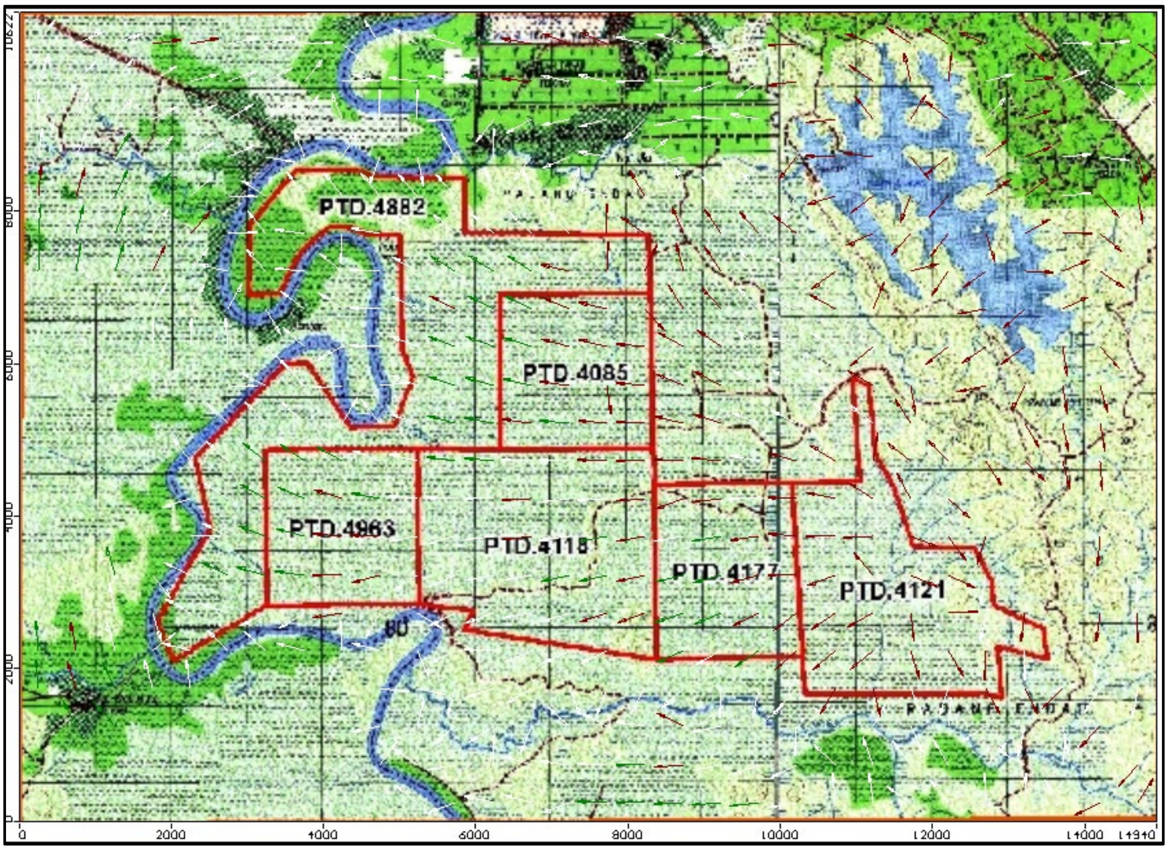


Figure 7-45: Arrows Showing the Groundwater Flow

7.2.2.6 Air quality

Dust generation from vehicle movement at unpaved access road, during transportation of machinery and materials as well as site clearing could be a source of reduced ambient air quality. Stockpiles of materials such as soil could become a source of airborne particulate.

The transportation of log and material shall affect the air quality by spillage of those materials into the ground and could increase the suspended dust into the atmosphere. At the public roads such as Jalan Felda Nitar, the spillage can reduce visibility and can harming the road users.

The used of heavy machineries and logging truck will cause unfavourable condition of air quality. The use of heavy machinery/equipment such as excavators and mobile generator set using diesel may emit dark smoke from the exhaust due to the inefficiency of the diesel engines. Other airborne pollutants and gases e.g. carbon monoxide (CO) will be generated from the exhaust emissions of vehicles especially from the trucks and heavy machineries.

7.2.2.7 Noise Level

During the development stage sources of noise pollution are expected from heavy vehicles such as logging truck and machinery operating within the site. Noise from the operation of machinery and vehicles will be intermittent, localized, short-term and restricted to the working hours. The nearest receptor in the vicinity of the proposed Project site was identified at SK Labong with 671 m distance from the Project boundary.

The noise level generated during development stage was determined for the nearest sensitive receptors as identified above. Noise level assessment was carried out using the empirical equation developed by the Ontario Ministry of Transportation of Communications (Davis & Cornwell, 1998) as shown below:

$$\mathbf{L_{p2} = L_{p1} - 20 \log (r_2/r_1) - Ae}$$

Where :

	L_{p1}	=	the measured sound pressure level (SPL) at angle θ and distance r_1 from source dB
	L_{p2}	=	The desired SPL at angle θ and distance r_2 from source dB
	r_1, r_2	=	Distance from source to measurement L_{p1} and L_{p2}, respectively
	A_e	=	Attenuation for the distance $r_2 - r_1$ dB

Assumption:
Assume that the L_{p1} measurement was taken at the same temperature and pressure that the L_{p2} estimate is to be made. Thus, the value of A_{e1} at r_2 is the same as the value at r_1, and the attenuation for the distance $r_2 - r_1$ is zero, that is, A_{e1} = 0.0

Table 7-27 presents the typical noise level from equipment to be used during development.

Table 7-27: Identified Significant Noise Generating Sources during Site Clearing Stage

Noise Source	Source Type	Number of Equipment	A-weighted Sound Pressure Level, L_{Aeq} at 10 m (dB)	Calculated Sound Power Level (dB(A))
Bulldozers	Point	1	81[a]	108.7
Excavator	Point	11	83[b]	111.0

Note: The height of the sources conservatively assumed to be at 1.0 m
[a]Refer to BS5228-1: Table C.2, Item 12 of BS5228-1:2009+A1:2014 (2014). Part 1: Noise. British Standards Institute, London.
[b]Refer to BS5228-1: Table C.4, Item 56 of BS5228-1:2009+A1:2014 (2014). Part 1: Noise. British Standards Institute, London.

Results and discussion

The recommended daytime guideline for receptors is at 75 dB(A) for L_{10} and L_{90} dB(A) for L_{max} under Schedule of Permissible Sound Levels, Sixth Schedule: Maximum Permissible Sound Levels (Percentile LN and L_{MAX}) of Construction, Maintenance and Demolition Work by Receiving Land Use during construction phase.

Table 7-28 shows the summary of predicted noise levels for the simulation during the site clearing stage for this study, while the results of the noise levels can be seen in **Figure 7-46**.

The finding shows that the L_{max} levels at the nearest sensitive receptor is far from the stipulated limit. Therefore, the noise pollution does not warrant much concern to the receptor as the distance is quite far from the Project site. In addition, the noise pollutant will be intermittent, localized and short-term. The disturbance will cease upon completion of the clearing activity.

Table 7-28: Summary of Predicted Noise Levels for The Simulation During the Development Phase

Nearest Sensitive Receptor	Distance from the Project boundary	Existing Noise Level (LAeq)	Cumulative Noise (dB(A))	Incremental Noise Level (dB(A))	Anticipated Community Response (Impact)@	Maximum Permissible Sound Level (L_{10}) (dB(A))
SK Labong	671 m	56.3	56.7	0.4	None	**L_{max} – 90** **L_{10} - 75**

Note: @Refer to the DOE's Guidelines for Environmental Noise Limits and Control (2021), Annex C: Procedures for Assessment of Community Annoyance, Human perception of sound and likely environmental impact as follows

Increase in sound level, dB	Subjective change in perceived loudness	Environmental Impact
3	Just perceptible	None
5	Noticeable difference	Little
10	Twice as loud	Medium
15	Large change	Strong
20	Four times as loud	Very strong

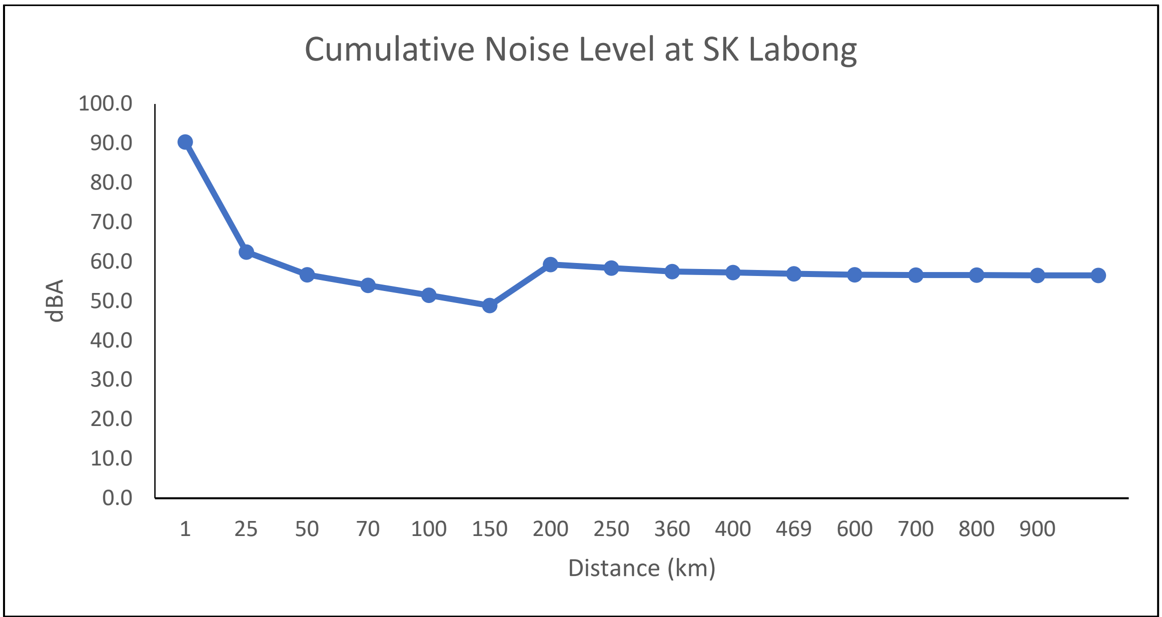


Figure 7-46: Predicted Noise Level during Development Stage at SK Labong

7.2.2.8 Biomass Management

The Project site is comprised of forest, shrub area and existing oil palm area. The forest area has been logged in March 2020. The shrub area consists of small trees with diameter of 0.09-3 m were spotted. The height of the big trees could reach up to 3-4 m.

The uneconomical plants and trees such as leaves, wood remnants, undergrowth and shrubs will be shredded on site using machinery that is commonly used for this purpose. The shredded vegetation will be stored on site for natural decomposition and decay (**Plate 7-1**). Impact on waterways and groundwater could arise with improper containment of the biomass decay process. The indiscriminate disposal of biomass into waterways will not only physically hinder the flow but may cause an increased oxygen demand and decreased dissolved oxygen due to the decaying vegetation.

Plate 7-1: Natural decomposition and decay of biomass

7.2.2.9 Solid Waste Management

Improper solid waste storage, disposal and housekeeping could cause unhygienic conditions and clogging of waterways which can cause breeding of vectors such as rats and mosquitoes. With proper storage bins in place and regular collection by approved licensed contractor, the impacts can be minimized.

7.2.2.10 Scheduled Waste Management

Schedule waste will be generated from maintenance work of equipment machinery. Wastes generated are mainly spent lubricants/oil and some chemicals, packing materials and rags. These wastes will be segregated into and transported for final disposal. Improper disposal and management of scheduled wastes can result in contamination of rivers.

The expected list of ‘Scheduled Waste (SW) to be generated from development stages are as follows:

- Spent Hydraulic Oil (SW 306)
- Spent Engine Oil (SW 305)
- Used Container (SW 409)
- Contaminated Cotton Rags, gloves and papers (SW 410)

It is anticipated that the scheduled waste would be minimal with proper storage and disposal practices in place, the impacts can be control.

It is anticipated that the scheduled waste would be minimal as the maintenance of heavy vehicle and machineries will be at outside.

7.2.2.11 Flora

Due to the nature of the development, there will be a total clearance of existing vegetation except for areas that is left uncut for river buffer or area that can’t be develop. This will mean a permanent in-situ loss of the plant species found in the proposed Project area that is cut where vvegetation such as trees, shrubs will be pulled, stacked and compact and leave to rot naturally.

However, the impact due to the permanent loss of the plant species would not have a major consequence on plant diversity at the national and global level. In addition, this proposed Project area is not one of the gazetted Permanent Forest Reserve (PRF).

Based on the components and layout of the Project, clearing and removal of habitats and existing vegetation would be unavoidable, however the impact is expected to be manageable.

7.2.2.12 Fauna

One of the significant impacts of any development is the intrusion into the wildlife natural areas and thus the sudden movement of wildlife out from the habitat to the adjacent or nearby areas. The operations of machineries and trees cutting will drive off the large animals to move out from forested part of Project site due to permanent habitat loss. There will be a major impact on slow moving ground mammals as well as most ground dwelling vertebrates during the land clearing phase been carried out.

Human wildlife conflicts, possibility of animal entering the Project site, entering to the nearest settlements could happen due to forest clearing and biomass removal during the start of earthwork stage.

Loss of orientation and direction may cause wildlife to roam away from their routine path and end up somewhere away from their home range. These individuals of wildlife are considered as displaced wildlife that are prone to cause conflicts with humans and also pose a threat to humans (e.g. elephant, wild boars and macaques). Food shortage due to the loss of existing habitats and habitat fragmentation may become one of the sources of this conflict. High possibility that they may come close to nearest human settlements adjacent to the proposed Project site.

In addition, most birds built their nests on or in trees or nearby shrubs while some species on the ground. With such diverse use of trees and its surroundings by the avifauna, trees felling imposes a significant impact to their habitat and survivability. This is because trees and its nearby surroundings provides shelter and protection and also provide resources (fruits and insects), and behavioural display areas (roosting, nesting, and mating).

7.2.2.13 Social and Health

Perception toward the Project – As been mentioned before, a social survey has been conducted during the pre-planting stage in order to capture the locals' perception toward the proposed Project. Based on the social survey, majority of the respondents, which comprises of 40.8% are disagreed as the Project may endanger their safety (34.6%) and cause destruction of forest and environmental (56.9%). Respondents and community representatives worried on the massive site clearing may cause the habitat loss of wildlife and the disturbance of the wildlife in the village areas.

7.2.2.14 Hydrology

The process of land use changes has increased the frequency of flash flood in an area that is not normally associated with flash flood. The process of land use change is normally associated with the reduction of natural infiltration rate due to removal of the existing undergrowth and increasing the percentage of impervious area. The changes in topography and land use could result in the tremendous increase in surface runoff. The flooding problem may aggravate due to increase of directly connected impervious area. This phenomenon could result in extensive flooding where property damage and loss of lives is imminent.

The land clearing and earthwork of the proposed Project area may expose the large tract of bare soil to erosion. The increase in sedimentation rate at the nearby river may not only reduce river conveyance capacities, but also may destroy the habitat for aquatic lives. The reduction in conveyance capacities may result in the occurrences of flash flood.

Rivers and water bodies play an important role in the assimilation process of point source pollution such as domestic or municipal waste and other non-point pollution sources such as surface runoff from plantation area. The river and the reservoir water quality would be adversely affected by the numerous drains and river tributaries that transport waste and pollutants to the water bodies. The situation could be aggravated during dry season or when the flow in the river is at low level (point source) and during wet season or when there is frequent storm (non-point source).

Low flow of natural streams depends on the recharge from groundwater to the stream. The rate of recharge from groundwater to streams depends on the catchment area, geologic condition, land use and mean annual rainfall of the catchment area. It also depends on the hydraulic gradient toward the stream and hydraulic conductivities of the aquifer to the stream.

The magnitude and frequency of low flow discharges is important for water supply planning, waste load allocation, storage facility design, irrigation, recreational and aquatic life.

A low flow characteristic can be defined as the minimum average flow for a selected consecutive day period for a given recurrence interval. For example, if a 7Q10 for Sg. Labong at the confluence with Sg. Endau is 0.5 m^3/s, it indicates that the annual minimum flow for 7 consecutive days is equal or less than 0.5 m^3/s, on average once in 10 years. In Malaysia, the water authority and DOE uses the 7Q10 as criteria for surface water withdrawals and allowable pollutant loads to be discharged to the rivers.

In this study, the value of 7Q10 is adopted as the minimum flow estimated at the nearest receiving water bodies of the Oil palm plantation site. oil palm plantation operators are permitted to discharge certain amount of pollutant to the receiving surface water so much so that the established minimum flow would be able to absorb the discharged pollutant. In this study, the minimum flow prior to the existence of the project should be established in order to determine the allowable waste discharged to the receiving river. For example, if the minimum flow (7Q10) at the project is capable of absorbing 30 mg/l, then it is expected that the allowable pollutant discharge limit should be observed when the project is in operation. If the minimum stream flow at the project site is not capable of absorbing the discharged pollutant from the project site, sufficient amount of flow should be discharged from the flood detention pond to ensure that the pollutant is diluted accordingly.

The critical low flow could be determined from a review of the existing hydrological conditions of the river basin and their sub-basins. To obtain the minimum flow, the Hydrological Procedure (HP) No 12 can be used as a guideline for ungaged catchment. The historical record of the stream flow at gaged locations will be utilized when it is available. Frequency analyses will be used to establish minimum flow at gaged catchment. In sub-catchment where there is no stream flow records, the estimation of low flow can be carried out following the procedure for the ungaged sites at gaged catchment and procedures for ungaged sites at ungaged catchment.

The purpose of the study is aimed at analyzing the impact of the existing and future land use within the catchment in terms of non-point source pollution and the impact of first flush to the river water quality. First flush is the initial surface runoff that is generated by the first 2.5 cm or 1.25 cm of rainfall. The initial surface runoff (first flush) is normally more polluted than the later surface runoff as the initial surface run off has wash off all the accumulated pollutants on the impervious surface. The longer the number of dry days prior to storm event, the more pollutant would accumulate on the surfaces. The initial storm water containing high pollutant need to be collected and treated as it could pollute the river. First flush collection system are employed by diverting the surface runoff to a holding pond before discharging toward nearby river. The proposed holding pond is to isolate the first flush at the tributary level.

Sg. Tarsap is the river that flows at the southern boundary of the project site before discharging towards Sg. Endau, while Sg. Labong flows near the northern boundary of the project site before discharging toward Sg. Endau. Sg. Tarsap and Sg. Labong at the confluence with Sg. Endau have catchment area of about 107 km^2 and 43 km^2. Sg. Endau combines with other tributaries to form Sg. Endau before draining out to South China Sea. The surface runoff from the project site flows toward these two rivers (**Figure 7-47**).

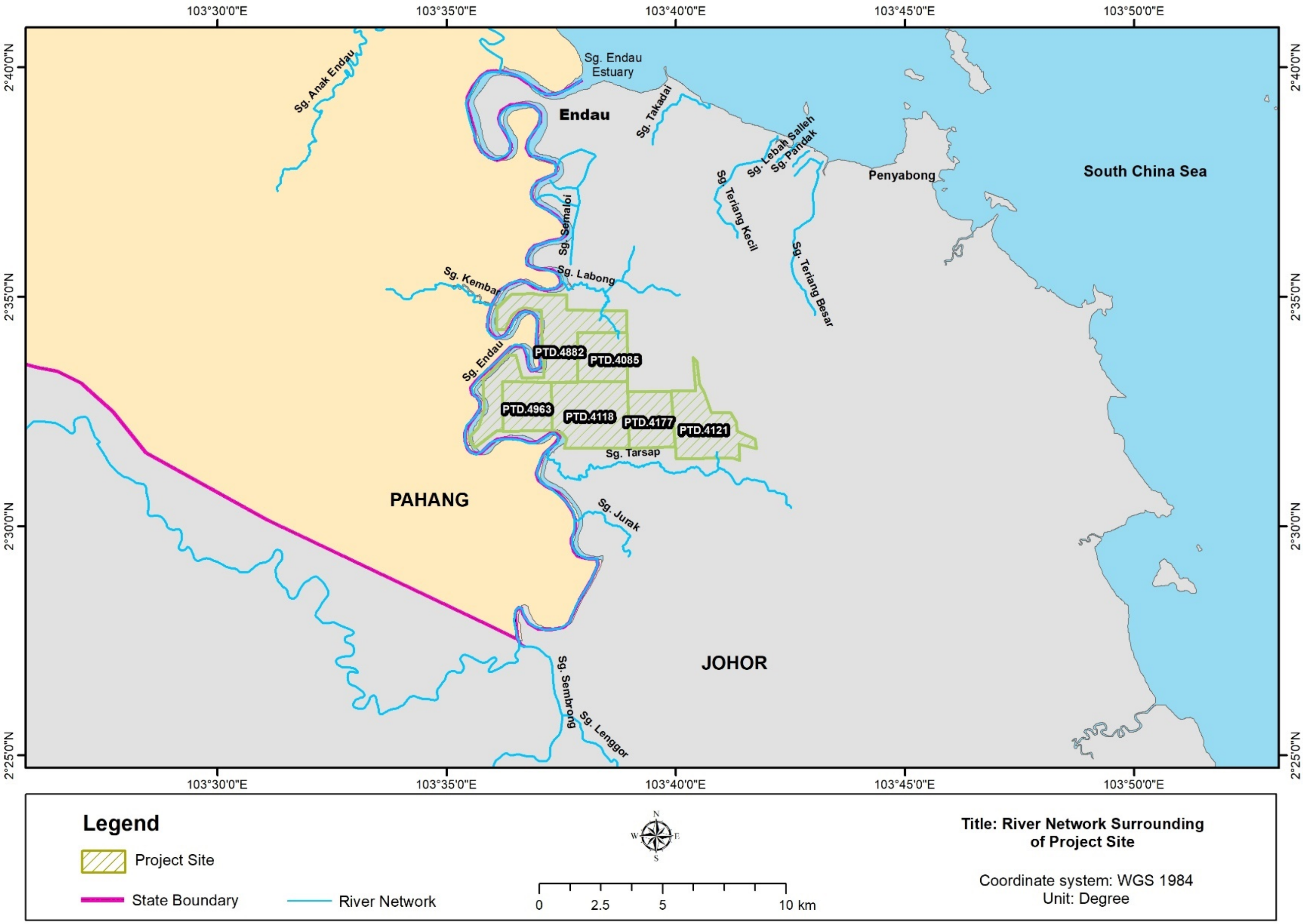


Figure 7-47: River Network Within the Project Site

Source of pollution to the natural river could be due to point and non-point source pollution from the upstream area of the oil palm plantation area and within the plantation area. However, the location of the plantation area that is quite close to the reservoir could lower the assimilative capacity of the river. The contribution of non-point source pollution (sediment load) to the river and the reservoir can be quite significant due to the existence of the plantation area especially during land clearing planting and during replanting of oil palm trees and coconut tree. It is also proposed that the first flush of Sg. Endau is to be regulated by diverting the first flush flow to a detention pond. Therefore, it is important to determine the first flush flow and the river water quality of Sg. Endau during the first flush at the location of the proposed plantation area.

The land use changes (forest and shrub to the plantation) could result in the tremendous increase in surface runoff. The problem may aggravate due to removal of flood storage such as swampy area. This phenomenon could result in the sudden increase of peak flow to the reservoir. Large overflow from the reservoir may cause extensive flooding to the downstream area where property damage and loss of lives is imminent. Both studies require general hydrologic data such as rainfall, stream flow and evaporation data. It also depends on the catchment and channel characteristics. However, each study might require different spatial and temporal data resolution.

The development of the Project site may expose the large tract of bare soil to erosion during land clearing works for planting and replanting. The increase in sedimentation rate at the nearby river and reservoir may not only reduce the river conveyance capacities of the river but also reduce the live storage of the reservoir. The reduction in river conveyance capacities and reduction in reservoir live storage may not only result in the occurrences of flash flood, but also reduce supply water for irrigation and domestic use.

7.2.2.14.1 Study Objectives

The objectives of the study are:

- To determine flood flow and low flow at various locations within the study area before the development of the plantation.
- To determine flood flow and low flow at various locations within the study area after the plantation was developed.

- To determine flood flow and low flow at various locations within the study area during the development of the plantation.

7.2.2.14.2 Scope of Study (Low Flow Analyses)

The proposed plantation area (PTD 4882, PTD 4085, PTD 4963, PTD 4118, PTD 4177 and PTD 4121) is about 37.75 km^2 and is located within tributaries of Sg. Labong and Sg Tarsap catchment area, which lies within Sg. Endau River Basin (**Figure 7-47**). The proposed plantation project is located just downstream of the Sg. Endau confluence, and will discharge it's surface runoff to the receiving water bodies (Sg. Endau and tributaries of Sg. Labong and Sg Tarsap) before discharging toward the main river (Sg. Endau). The river serves to supply water mainly for irrigation and for water supply. It is important to study the impact of the surface runoff discharge from the plantation activities to the receiving river (tributaries of Sg. Labong and Sg Tarsap) during minimum flow. The impact of the surface runoff discharge to the receiving river water quality at the project site and to the downstream area could be quite significant especially during low flow condition. The ability of the receiving river to absorb pollutant or to dilute pollutant could be reduced significantly if the flow is at minimum flow. The existing low flow will be determined at gauged and at ungauged stations downstream of the proposed development area before it was developed. The study will also look in to the impact of the surface runoff discharge from the plantation activities to the receiving river and the downstream area during critical condition (low flow). The methods used in this study to estimate 7Q10 are suitable for natural, unregulated or partially regulated and non-tidal streams. Low flow frequency analyses of stream flow data is not valid for catchment where 45% of the drainage area is regulated.

7.2.2.14.3 Scope of Study (Flooding Impact)

The scope of work for the study will be as follows:

- Collate and review available data and information on flooding and drainage problems encountered in the Study Area and collect additional data when necessary.
- Define the existing drainage system in the Study area and identify its inadequacies, constraint and potentials of the existing drainage system.
- Identify and evaluate the cause of future flooding and drainage problems encountered in the Study Area due to the proposed development.

- Carry out hydrological and hydraulic analyses using appropriate methods and procedures.
- Propose feasible structural and related non-structural works for immediate implementation to alleviate the flooding problems in the Study Area and enhance its drainage systems.

7.2.2.14.4 Methodology of Study (Low Flow)

Various techniques based on the Hydrological Procedure (HP) No. 12 were used to estimate low flow at various locations downstream of the proposed project. Low flow estimation at these locations will be estimated before, during and after the completion of the project. The estimation of low flow at various locations downstream of the project will be based on the following methods: i) frequency analyses on individual gauged sites ii) ungauged sites on gauged streams iii) ungauged sites on ungauged stream.

Low Flow Estimation for Ungauged Site at Ungauged Stream

The critical low flow could be determined from a review of the existing hydrological conditions of the river basins and their sub-basins. To obtain the minimum flow, the Hydrological Procedure (HP) No 12 is used. In sub-basins where there are no stream flow records, the estimation is carried out following the procedure for the ungauged catchment as described in HP 12. Occasionally, streams are gauged at certain locations that are not necessarily the point where the minimum flow would be determined. Therefore, ungauged method was applied to determine the low flow at that particular location even though just upstream or downstream of that location there is a gauged station.

In this study, the estimation of flow for ungauged sites at ungauged catchment is based on the procedure as described HP No 12. The purpose of applying ungauged method to gauged catchments is to test the reliability of the result obtained from the ungauged method when compared to the result obtained from observed low flow data. For the case of ungauged catchment, the regional low flow frequency regions (RC Regions) are based on the region developed in HP 12. Peninsular Malaysia is divided in to four low flow frequency regions, RC1, RC2,

RC3 and RC4. The parameters of the regional frequency low flow curves, and the regional $\frac{Q_{D,T}}{MAM}$ values for various ARI are listed in table 2.1 of the manual.
In order to obtain low flow for various consecutive numbers of days and various ARI, the MAM has to be correlated to the catchment characteristics. Regions for MAM may not have the same boundaries as in region for RC. Therefore, another set of regions was delineated for developing the regional MAM equation. The regional mean annual minimum flow (MAM) equation based on HP 12 is shown below;

MAM = a(X1)b1 (X2)b2…..(Xn)bn (7.4.4)

X1,X2,……Xn are catchment characteristics and b1, b2, bn are constants to be estimated. Catchment area (AREA) and the Mean Annual catchment Rainfall (MAR) are the only two variables considered in developing the equation. The Mean Annual Rainfall (MAR) shall be adopted from the rainfall stations located near and within the river basin. MAR is required in order to calculate the Mean Annual Minimum Flow (MAM). The MAR is entered in the low flow equation in order to determine the MAM. The low flow estimation $Q_{D,T}$ for the ungaged site are presented as average values to represent both wet and dry season condition, in which *D* is number of day and *T* is recurrence interval.

The general MAM flow equation based on HP No 12 is,

$$MAM = a\ (AREA)^{b1}\ (MAR)^{b2} \qquad (2.3)$$

Where AREA is the catchment area in km^2; MAR is the mean annual rainfall; a, b_1, b_2 are coefficients. In this study, rainfall record is available to estimate the MAR for the particular catchment. The MAR is entered in the low flow equation in order to determine the MAM. Values of coefficient a1, b1 and b2 vary depending on which region the study area is located. Based on the HP12, Peninsular Malaysia is divided in to three regions, RE1, RE2 and RE3. Results of dimensionless regional frequency analysis for various regions are available in HP No 12. Values of $\frac{Q_{D,T}}{MAM}$ for various ARI (T years) can be determined. $Q_{D,T}$ for various ARI can be obtained by multiplying the $\frac{Q_{D,T}}{MAM}$ against MAM.

Low Flow Estimation for Ungauged Site

The critical low flow could be determined from a review of the existing hydrological conditions of the river basins and their sub-basins. To obtain the minimum flow, the Hydrological Procedure (HP) No 12 is used. The historical record of the streamflow is utilized when it is available. In basins or sub-basins where there are no records, the estimation is carried out following the procedure for the ungauged catchment. The 7-day minimum flow for 10 years recurrence interval ($Q_{7,10}$) could be used as criterion in determining the sustainability of continuous water supply.

In this study, the low flow analysis will be based on the HP No 12. For the case of the ungauged catchment, the Mean Annual Rainfall (MAR) shall be adopted from Water Resources Publication No 12 (*Average Annual and Monthly Surface Water Resources of Peninsular Malaysia*), in order to calculate the Mean Annual Minimum Flow (MAM). If the rainfall data is available, the MAR is the average mean annual rainfall for the particular catchment. The MAR is entered in the low flow equation in order to determine the MAM. The low flow estimation $Q_{D,T}$ for the ungauged site are presented as average values to represent both wet and dry season condition, in which *D* is number of day and *T* is recurrence interval.

The general MAM flow equation based on HP No 12 is,

$$MAM = a\,(AREA)^{b1}\,(MAR)^{b2} \qquad (2.3)$$

where AREA is the catchment area in km^2; MAR is the mean annual rainfall; a, b_1, b_2 are coefficients. The rainfall data is available to estimate the MAR for the particular catchment. The MAR is entered in the low flow equation in order to determine the MAM. The low flow estimation $Q_{D,T}$ for the ungauged site are presented as average values to represent both wet and dry season condition, in which *D* is number of day and *T* is recurrence interval. Based on the HP12, Rompin is not listed in the low flow regionalization map as the area is affected by tidal flow. However, due to the proximity of the study area to the east coast of Malaysia such as Pahang. Therefore, the coefficient for this study area is assumed to similar to the coefficient for Central Pahang. The adopted coefficient for this study area is coefficient for region RE3 and RC3. For rivers on this study area, the coefficient a_1

= 1.675 x 10^{-16}, b_1 = 1.197, and b_2 = 3.586. Therefore, the relevant equation for can be written as,

$$M = 1.6A \times 17^{-1} M(A6 5)^{1.1} R(9M 7E)^{3.5} \quad (2.4)$$

Mean Annual Rainfall (MAR) for this area is about 2500 mm. Results of dimensionless regional frequency analysis for the Pahang region is available in HP No 12. Values of $\frac{Q_{D,T}}{MAM}$ for various ARI (T years) can be determined. Further, $Q_{D,T}$ is obtained by multiplying the $\frac{Q_{D,T}}{MAM}$ against MAM. Values of $\frac{Q_{7,10}}{MAM}$ for ARI 10 years is 0.569 (for RC3). Further, $Q_{7,10}$ is obtained by multiplying the 0.569 against estimated MAM. The MAM for every sampling point is listed in **Table 7-29**. **Table 7-30** shows the estimated annual minimum flow at selected locations within the river basin. The selected locations is basically similar to some of the locations of the base line water quality sampling points (**Figure 7-48**).

Table 7-29: MAM for Every Catchment Outlets

Sampling	Area	MAM
Point Locations	km^2	m^3/s
Catchment W1	35	0.049
Catchment W2	4.5	0.004
Catchment W4	3980	14.141
Catchment W5	4150	14.867
Catchment W6	5.1	0.005
Catchment W7	38.5	0.055
Catchment W8	42.3	0.061
Catchment W9	4739	17.426
Catchment W10	26	0.034

RC1		1.11	1.5	2.33	5	10	20	50
	1	1.592	1.136	0.878	0.656	0.545	0.476	0.42
	4	1.701	1.22	0.949	0.712	0.594	0.52	0.46
	7	1.792	1.228	1.006	0.765	0.645	0.571	0.512
	30	2.338	1.679	1.322	1.025	0.883	0.797	0.731

Table 7-30: Annual Minimum Flow for the Study Area Based on Ungauged Site Estimation

Catchment		Q_{DT} FOR VARIOUS RETURN PERIOD T (m^3/s)						
		1.11	1.5	2.33	5	10	20	50
	1	0.0779	0.0556	0.0430	0.0321	0.0267	0.0233	0.0206
Catchment 1	4	0.0832	0.0597	0.0464	0.0348	0.0291	0.0254	0.0225
	7	0.0877	0.0601	0.0492	0.0374	0.0316	0.0279	0.0251
	30	0.1144	0.0822	0.0647	0.0502	0.0432	0.0390	0.0358
	1	0.0067	0.0048	0.0037	0.0028	0.0023	0.0020	0.0018
Catchment 2	4	0.0071	0.0051	0.0040	0.0030	0.0025	0.0022	0.0019
	7	0.0075	0.0052	0.0042	0.0032	0.0027	0.0024	0.0022
	30	0.0098	0.0071	0.0056	0.0043	0.0037	0.0033	0.0031
	1	22.5117	16.0636	12.4154	9.2762	7.7066	6.7309	5.9390
Catchment 4	4	24.0530	17.2515	13.4194	10.0681	8.3995	7.3531	6.5046
	7	25.3398	17.3646	14.2254	10.8175	9.1206	8.0742	7.2400
	30	33.0606	23.7420	18.6938	14.4940	12.4861	11.2700	10.3367
	1	23.6675	16.8884	13.0528	9.2762	7.7066	6.7309	5.9390
Catchment 5	4	25.288	18.137	13.419	10.068	8.399	7.353	6.505
	7	26.641	18.256	14.225	10.818	9.121	8.074	7.240
	30	34.758	24.961	18.694	14.494	12.486	11.270	10.337
	1	0.008	0.006	0.004	0.003	0.003	0.002	0.002
Catchment 6	4	0.008	0.006	0.005	0.003	0.003	0.003	0.002
	7	0.009	0.006	0.005	0.004	0.003	0.003	0.002
	30	0.011	0.008	0.006	0.005	0.004	0.004	0.004
	1	0.087	0.062	12.415	8.739	6.872	5.656	4.652
Catchment 7	4	0.093	0.067	13.419	9.573	7.579	6.307	5.274
	7	0.098	0.067	14.225	10.125	8.046	6.717	5.472
	30	0.128	0.092	18.694	22.639	11.256	9.361	7.749
	1	0.0977	0.0697	0.0539	0.0403	0.0335	0.0292	0.0258
Catchment 8	4	0.1044	0.0749	0.0583	0.0437	0.0365	0.0319	0.0282
	7	0.1100	0.0754	0.0618	0.0470	0.0396	0.0351	0.0314
	30	0.1435	0.1031	0.0812	0.0629	0.0542	0.0489	0.0449
	1	27.7425	19.7962	15.3002	11.4316	9.4973	8.2949	7.3190
Catchment 9	4	29.6420	21.2600	16.5375	12.4075	10.3512	9.0616	8.0161
	7	31.2278	21.3994	17.5308	13.3310	11.2399	9.9504	8.9222
	30	40.7425	29.2586	23.0374	17.8619	15.3873	13.8887	12.7386
	1	0.0546	0.0389	0.0301	0.0225	0.0187	0.0163	0.0144
Catchment 10	4	0.0583	0.0418	0.0325	0.0244	0.0204	0.0178	0.0158
	7	0.0614	0.0421	0.0345	0.0262	0.0221	0.0196	0.0176
	30	0.0802	0.0576	0.0453	0.0351	0.0303	0.0273	0.0251

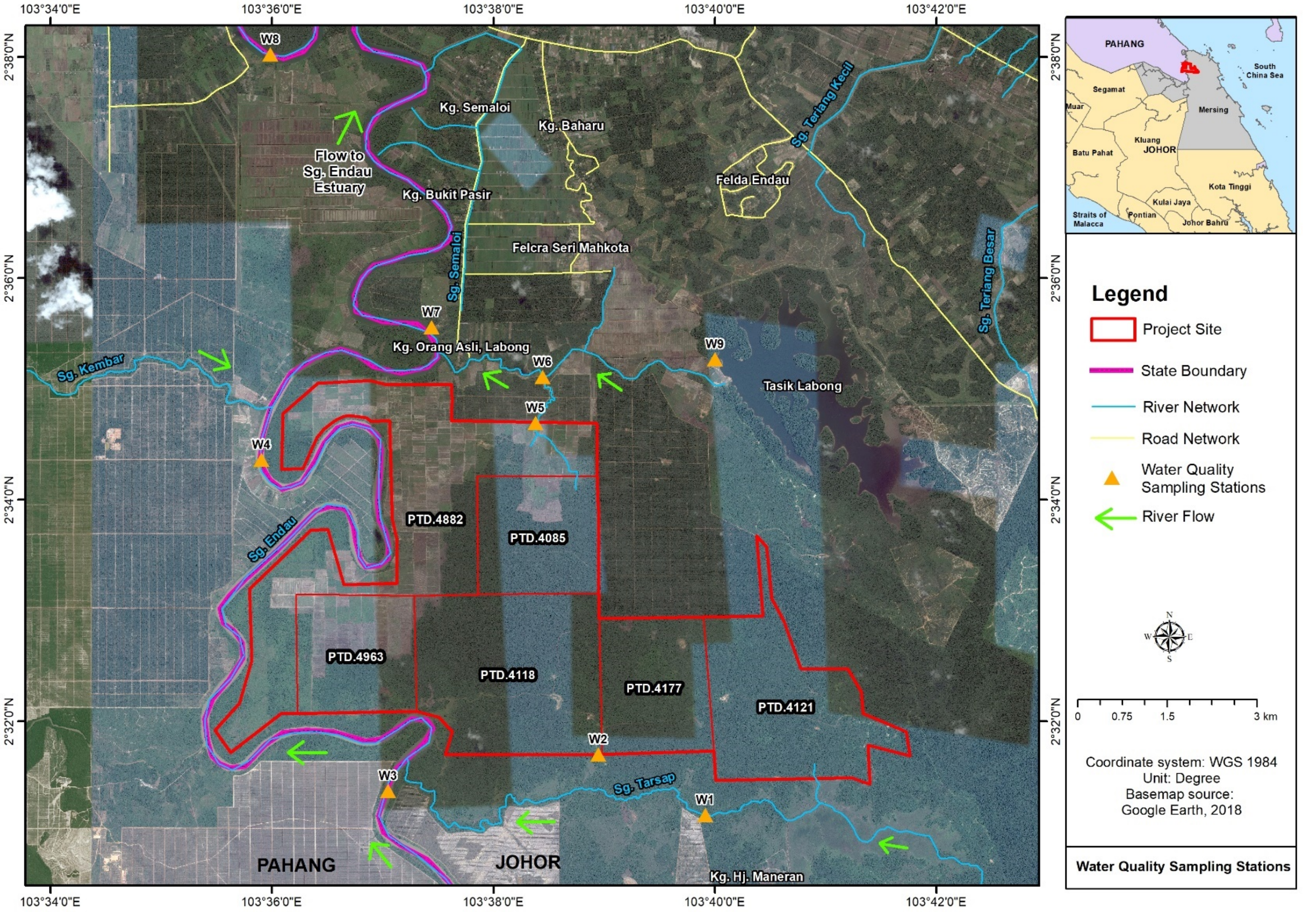


Figure 7-48: Sampling Location

The estimated 7Q10 at the downstream of the project site (Sg. Tarsap at confluence with Sg. Endau) and (Sg. Labong at confluence with Sg. Endau) is 0.036 m^3/s and 0.0472 m^3/s. The estimated low flow using HP 12 is normally more conservative and the value serves as a guide for the condition of minimum flow for the study area.

(b) Low Flow Estimation for Ungauged Site at Gauged Stream

Estimates of the 7Q10 for the ungauged site could be transformed from 7Q10 values that were obtained from gauged site based on the area of the catchment. A simple regression analyses between 7Q10 low flow and the catchment area for gaged stations defines the relationship between low flow and catchment area within the study area. In order to evaluate the characteristics of rivers in this basin, the low flow estimation at gaged site has been carried out for the gaged stream flow stations within the study area. Results from the frequency analyses of the gaged stations for the average 7-day minimum flow with 10 year ARI ($Q_{7,10}$) for the rivers in Sg. Endau River Basin are examined and the relationship between $Q_{7,10}$ and catchment area is established. Multiple regression analyses could also be performed between 7Q10 low flow and variables such as catchment area, pervious area and MAR.

(c) Low Flow Estimation for Gauged Site

The HP No 12 for low flow estimation is referred to estimate the low flow for gauged site. The plotting position is decided based on the procedure outlined for frequency analysis of individual station in the HP No 12. Frequency analysis of annual flow is carried out using the Gringorten formula plotting position if the length of the stream flow record available greater than 20 years. Weibull formula is for the length of record less than 20 years. The probability distribution adopted for the study is types I and type III of the General Extreme Value distribution. The mathematical description of the GEV distribution is given in Appendix 1 of the manual.

Results would be plotted in the form of $Q_{D,T}$ against the recurrence interval *T*. For the gauged site, the estimation of critical low flow is divided into the condition of wet season and dry season. Lowest return period denotes the wet season and highest return period indicates the dry season.

<u>Regional Low Flow Estimation Using Gauged Site</u>

Several gauged stations available in Pahang are used in the regional correlation study due to the absence of long stream flow records in the study area. A number of seven rivers are considered in the analysis. Results of correlation are used for evaluating river characteristics. Results of 7-day average flow estimation due to a 10-year storm (designated as$Q_{7,10}$) are used to establish the relationship between $Q_{7,10}$ and catchments areas (**Table 7-31**).

Table 7-31: Estimated $Q_{7,10}$ for various catchments in Johor.

River	$Q_{7,10,}$ (m^3/s)*	Catchment area, (km^2)
Sungai Johor, Kg Rantau Panjang	4.30	1130
Sungai Pengeli, Kota Tinggi	0.30	147
Sungai Sayong, Kota Tinggi	1.80	624
Sungai Lenggor, Mersing	0.90	207
Sungai Lenik, Segamat	0.29	286
Sungai Bekok, Segamat	0.86	350
Sungai Segamat	1.25	660

** Based on Gumbel method.*

The Gringorten formula is used to determine the plotting position for stream flow records exceeding 20 years while the Weibull formula is used for records less than 20 years. Graphs of $Q_{D,T}$ vs. T (Recurrence Intervals) are plotted. For the gauged sites, critical low flows are estimated for the wet season and dry season. The lowest return period represents the wet season while the highest return period represents the dry season.

From the analysis, a relationship between $Q_{7,10}$ and the catchments area (AREA) is established as follows:

$Q_{7,10} = 0.0009 (AREA)^{1.1614}$

The coefficient of regression obtained is $R^2 = 0.76$. The equation is applicable to catchment area less than 1000 km^2.

Based on the derived equation above, low flows (annual minimum) are estimated for the rivers in the study area and the results are shown in **Table 7-32**.

Table 7-32: Low Flow Estimation Based on Regional Analysis (Johor)

Sampling Points	Catchment area (km^2)	$Q_{7,10,}$ (m^3/s)
Catchment W1	35	0.049
Catchment W2	4.5	0.004
Catchment W4	3980	14.141
Catchment W5	4150	14.867
Catchment W6	5.1	0.005
Catchment W7	38.5	0.055
Catchment W8	42.3	0.061
Catchment W9	4739	17.426
Catchment W10	26	0.034

This low flow result shows that the amount of surface runoff that could be absorbed is small as the minimum flow during critical period is quite low. The dilution effect could be supplemented by releasing water from the dam or the surface runoff being diverted in to the existing detention pond within the project site. The volume of water stored in the detention pond could be used to dilute the surface runoff. It could also be released gradually depending on the loadings to the receiving river and the river flow at the time of release.

7.2.2.14.5 Methodology of Study (Rainfall-Runoff)

HEC-HMS and HEC-RAS model will be used in this study to analyze the hydrologic and hydraulic behavior of present catchment characteristics, and to simulate the impact of future development to the flooding problem. It is always a good practice the model be calibrated first prior to its simulation of future scenarios. The calibrated model could be used to predict the impact of future development to the flow hydrograph at the outlet. Proposed flood mitigation alternatives will be simulated and evaluated to determine the most suitable alternative.

7.2.2.14.6 Hydrologic Modeling

The purpose of hydrologic modeling is to estimate flow hydrograph from tributary catchment for various ARI's. The estimated flow hydrograph serves as an input to the hydraulic modeling of the study area. There are plenty of options available in this module for calculating catchment losses, transformation of excess rainfall and base flow estimation. The options for estimating hydrologic losses include Initial Constant Loss Method, Horton, Philips and Green & Ampt Method. The options for rainfall excess transformation include kinematic wave U – H methods and Non-Linear Reservoir method. The synthetic U-H and quasi U-H method that are available includes Nash, Snyder, Clark Time Area, SCS and Santa Barbara U-H. The Non-Linear Reservoir (NLR) method is based on the Laurensons Method. It is also known as Raft – XP. These empirical, conceptual or mathematical models have coefficients or parameters that need to be verified or quantified. Most of these parameters/coefficients are not measurable at site.

It is always good that the hydrologic and hydraulic model parameters be calibrated first prior to applying it for simulation of future scenarios. The purpose of calibration and validation of model parameters is to ensure the accuracy and reliability of flow estimation for the existing and future condition of the study area. If there is no gauged stream flow station in the study area, other prediction methods has to be employed in order to ensure the reliability of the simulated result. The method includes using calibrated parameters from nearby gauged catchment. The calibrated parameters will be extrapolated to the ungauged catchment in the study area, which is in the same river basin of the gaged catchment. The results obtained will be compared with other empirical methods such as HP 4, 5 and 11. The calibrated model parameters will be used to simulate for future land use flow hydrograph.

For the purpose of modeling, the catchment was divided into several sub-catchments. These sub-catchments are represented as nodes in SWMM - XP. The selections of nodes are based on the consideration of certain aspects of the catchment characteristics and locations where determination of flow is required. Each sub-catchment is given an ID number and provided with a link number for connectivity among the nodes.

7.2.2.14.7 Hydraulic Modeling

The objective of the hydraulic modeling is to perform hydraulic routing of flood flow in the drainage system, which uses the upstream inflow hydrograph generated from Runoff Mode. The hydraulic flow routing model in HEC-HMS AND HEC-RAS is called HEC-RAS. It is available under Hydraulic Mode. The simulated water surface profile and discharge will determine which area is prone to flooding under various scenarios (existing & future). The modelling scenarios will include existing and future conditions of the study area plus with existing and future flood mitigation facilities. The scenarios considered in this study are as follows:

(a) Existing condition;
(b) Future condition with existing channel capacity; and
(c) Future condition with mitigation facilities (on-site detention facilities).

HEC-RAS can model water surface profiles along the channels and flood plain in the drainage system. HEC-RAS model uses fully dynamic flood routing technique based on the St. Venant equation. The model is based on gradually varied one- dimensional flow. The channel cross sections were obtained from field measurement (bathymetry survey) as provided by the appointed surveyor. The provided river cross sections along the main channel and its tributaries will be used as data input in the model hydraulic simulation. This information will help determine water surface profile spatially (along the channel) and temporally (along the simulation period).

The proposed development will definitely change the streamflow at the outlet. The land cover changes from pervious to impervious will result in increase of surface runoff. As specified in the new drainage manual (MASMA), the developer is responsible in controlling the increase of surface runoff. The design storm selected for this study depends on the time of concentration of the study area (tc). The tc was estimated by using the Barnsby William formulae (Equation 1).

$$t_c = \frac{F_c \cdot L}{A^{1/10}\, S^{1/5}} \qquad \text{……………………} \qquad \text{Eqtn. 1}$$

Where,

t_c = the time of concentration (minute)

F_c = a conversion factor, 58.5 when area A is in km^2, or 92.5 when area is in ha

L = length of flow path from catchment divide to outlet (km)

A = catchment area (km^2 or ha)

S = slope of stream flow path (m/km)

The temporal pattern used for this study is based on the west coast temporal pattern. The design storm hyetograph of 5, **50** and **100** years ARI will be used in this study.

<u>Land Use and Development Factor</u>

The major land uses within Sg. Tarsap and Sg. Labong catchment include secondary forests, bushes and shrubs. The type of soils within the river basin was mostly water permeable. There were many forest areas that had been logged over. The changing of the land use from forest to plantation areas causes an increase of peak flow and volume in surface runoff water. The highly dense green areas that have been providing canopy storage for the interception of rainfall have been replaced with less dense green area, and this causes the increase of surface runoff that will be drained to the drainage system.

Rainfall Stations Network

Figure 7-49 shows the location of the rainfall stations and the boundary of project site in Google Map, while **Figure 7-50** shows the selected rainfall stations from many stations that are located near the project area. The rainfall station network in the project area is not uniformly distributed. The figure shows that the stations are concentrated at the central, northern and eastern of the study area. There are no stations on the western and southern part of the study area. The uneven distribution of the rainfall stations may grossly over estimate or under estimate the rainfall within the area.

There are about 5 rainfall stations all together that are selected within the district of Mersing that are close to project area. Out of 9 rainfall stations, only 5 rainfall stations have rainfall data that is still in operation**. Table 7-33** shows the list of rainfall stations within the study area that was established by JPS within Mersing district. Some of these rainfall stations are still operational, while a few stations have been closed or shifted to other locations. The rain gage at the rainfall stations are either manual or automatic gage with logger. The same table provides all the necessary information about the rainfall stations including it's locations. Only rainfall with long period of data will be used in this study to derive the rainfall isohyets.

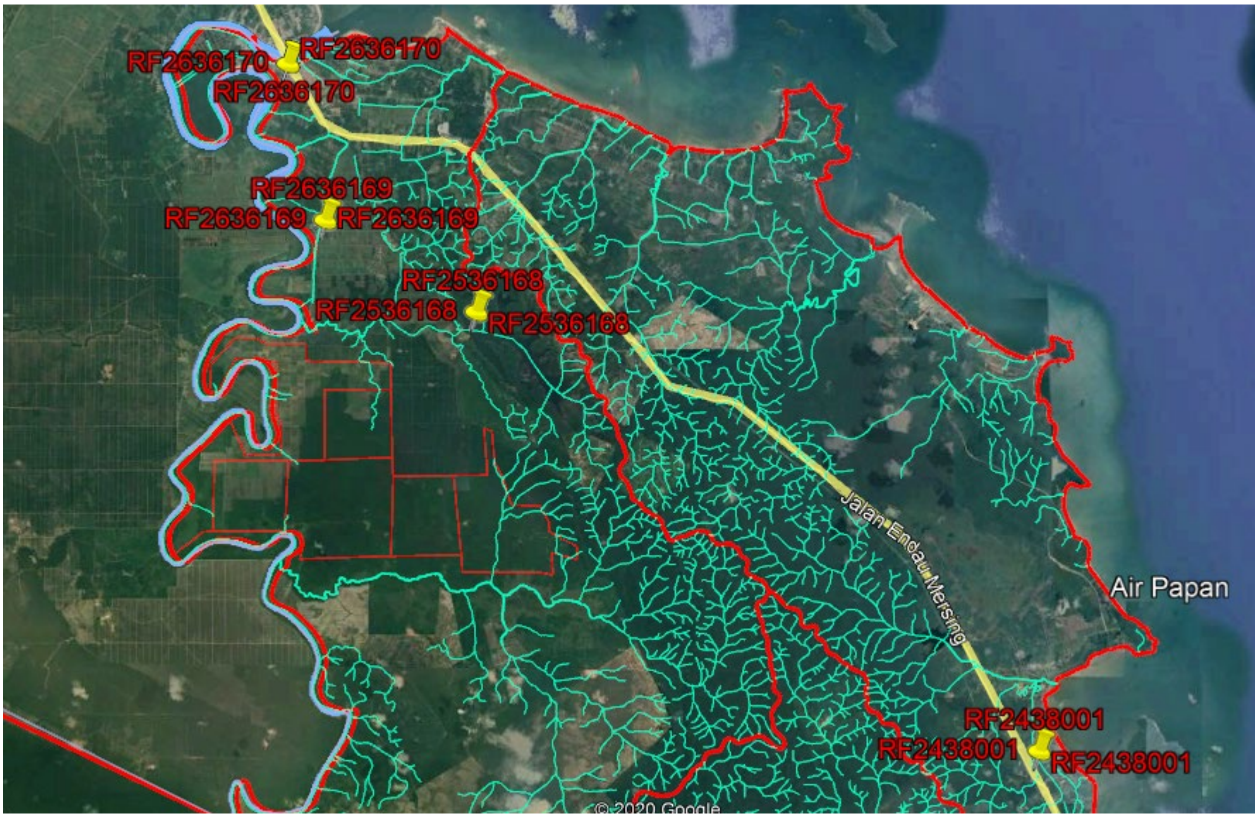


Figure 7-49: Location of Rainfall Stations Within and Surrounding Project Area

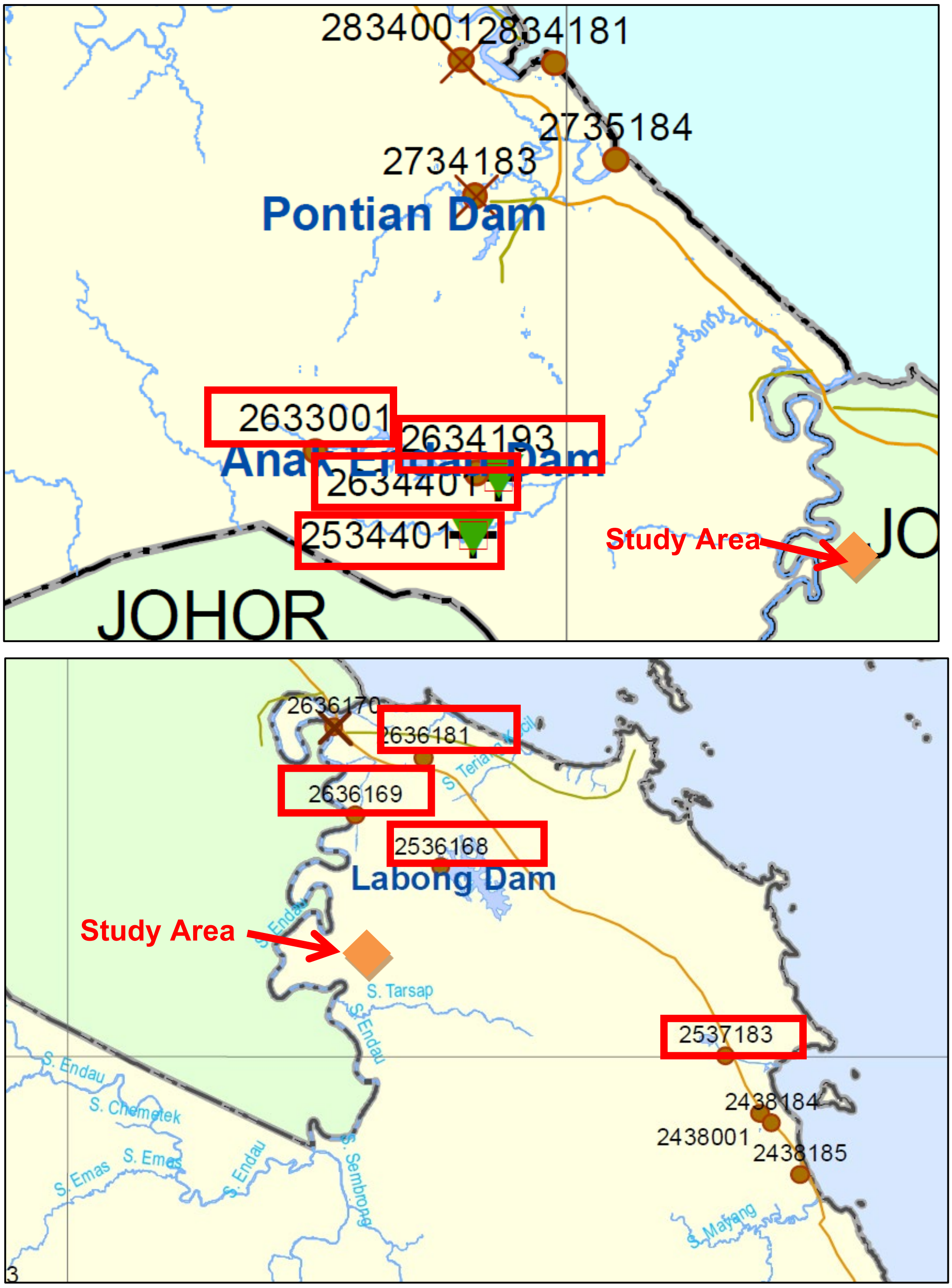


Figure 7-50: Selected Rainfall Stations Within and Near Study Area (Pahang and Johor)

Table 7-33 shows the lists of rainfall stations that were used to derive the annual average rainfall (AAR) and monthly Average Rainfall (MAR). However, there are still a number of rainfall stations that were listed on the JPS list but the data are not available.

Table 7-33 : Lists of Rainfall Stations Used to Derive Annual Average Rainfall and Monthly Average Rainfall

MERSING					
NO	**STN NAME**	**STATION**	**START**	**END**	**∑ YEAR Data**
1	Labong Dam Endau	2536168	1947	To date	74
2	Pusat Pertanian Endau	2636169	1948	To date	73
3	Stor JPS Endau	2636170	1947	To date	74
4	Stor JPS Batu 3 di Mersing	2438001	1970	To date	51
5	Kg. Peta Ulu Sg. Endau	2534160	1972	To date	49

Rainfall Result and Analyses

The annual average rainfall (AAR) and monthly average rainfall (MAR) were derived from the available rainfall data from each rainfall station. The result of the AAR and MAR for each rainfall station is shown in **Table 7-34**. The result at these point stations will be used to derive the AAR and MAR at other locations by using various interpolation techniques. The methods considered in this study are linear, spline and krigging interpolation technique. The result obtained shows that the interpolation technique using krigging provides smoother and better result. Since the study area is located near the coastal area, the number of rainfall stations on the western, northern and southern part of the study area will be used in this study. The station on the northern part of the study area is Labong Dam station (2536168). This station is also the nearest station to the project site. The section of the study area that was not covered by the interpolated rainfall data will be covered by merely extending the rainfall data at the last station. It is always better to have rainfall stations beyond the boundary of the study area in order to have better result. The result from the nearest station (2536168) will be adopted for the project site.

The Annual Rainfall for the stations near the study area is shown in **Table 7-34**, while **Table 7-35** shows the AAR for all the rainfall stations. The same table shows that the range of the AAR is between 1800 mm and 2429 mm. The result also shows that the rainfall is quite localized and shows large variation spatially. The 2536168 (Labong Dam) station which is the closest station to the project site receives about 1900 mm while the neighboring station (4227001) receives about 2429 mm. The monthly average rainfall (MAR) was derived based on the average monthly rainfall during one year and based on average monthly rainfall for a specific month (January to December). **Table 7-36** shows the MAR based on all stations, while **Table 7-37 – Table 7-42** show the MAR based on specific station. The result shows that the month of October to January receives more rainfall than the other months, while February is the driest month.

Table 7-34: Annual Rainfall for Various Station

YEAR	ANNUAL RAINFALL				
	2536168	2636169	2636170	2438001	2534160
1970					
1971			4058		
1972			1837	2458	
1973			3123	2109	
1974			2841	2091	
1975			2891	1238	
1976			2501		
1977			2184		
1978			2228		
1979			2690		2866
1980			2750		2165
1981			2824		3500
1982			3097		3296
1983			2593		3667
1984			2041		3396
1985			2455		3116
1986			3213		3515
1987			3094		2812
1988			2641		3790
1989			3384		2514
1990			4030		4024
1991			2628		2909
1992			3304		3266
1993			3047		6568
1994			3005		3499
1995			2301		2197
1996			3237		2197
1997			2572		4522
1998			3274		3001
1999			3070		4075
2000			2150		2695
2001			2833		
2002			2578		
2003			2932		
2004		2887	2075		
2005		3843	3267		
2006		2279	3859		
2007		2115	3369		
2008		3731.5	2392		
2009		3025.5			

YEAR	ANNUAL RAINFALL				
	2536168	2636169	2636170	2438001	2534160
2010	2042.5	3808			
2011	3754	2457			
2012	3196				
2013	3975.5				
2014	3054				
AVERAGE =	**3204.4**	2971.1	2950	1974	3099

Table 7-35: Annual Average Rainfall for Various Stations (Mersing)

MERSING				
NO	**STN NAME**	**STATION**	**AAR**	**∑ YEAR Data**
1	LABONG DAM ENDAU	2536168	1947	5
2	PUSAT PERTANIAN ENDAU	2636169	1948	8
3	STOR JPS ENDAU	2636170	1947	37
4	Stor JPS Batu 3 di Mersing	2438001	1970	4
5	Kg. Peta Ulu Sg. Endau	2534160	1972	21

Table 7-36: MAR for All Stations

YEAR	MONTHLY RAINFALL											
	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DIS
2536168	468	271	236	85	174	122	149	179	167	259	261	834
2636169	434	125	404	131	155	185	175	85	95	233	341	609
2636170	333	118	144	127	141	136	81	159	197	177	392	946
2438001	169	80	180	120	128	92	75	113	138	137	320	561
2534160	456	159	248	173	220	138	41	158	161	177	570	665
Mean	372	151	242	127	164	135	104	139	152	197	377	723

Table 7-37: MAR for Station 3825001 (LABONG DAM ENDAU)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AAR
2010	77	45	167	5	99	98	144	88	127	205	260	730	2043
2011	578	25	619	110	209	212	268	62	157	386	376	754	3754
2012	464	261	316	128	86	98	159	232	225	377	260	594	3196
2013	748	1027	27	136	237	20	73	227	196	194	182	911	3976
2014	476	0	52	46	240	183	103	288	131	131	226	1181	3054
AVERAGE	468	271	236	85	174	122	149	179	167	259	261	834	3204

Table 7-38: MAR for Station PUSAT PERTANIAN ENDAU (2636169)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AAR
2004	303	9	446	57	110	167	210	95	18	341	295	838	2887
2005	779	450	517	160	131	316	237	118	208	150	408	372	3843
2006	435	99	254	211	205	167	0	10	0	146	312	442	2279
2007	111	52	183	132	90	103	196	42	102	171	282	653	2115
2008	544	16	621	98	237	171	232	163	146	358	408	740	3732
2009	346	255	228	156	166	178	111	321	334	300	136	496	3026
2010	641	947	23	85	163	17	213	132	245	232	292	820	3808
2011	248	1	45	81	236	132	102	257	116	60	231	951	2457
AVERAGE	434	125	404	131	155	185	175	85	95	233	341	609	2971

Table 7-39: MAR for Station 2636170 (STOR JPS ENDAU)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1971	806	59	70	7	176	196	62	242	124	313	264	1740
1972	95	81	5	183	112	92	54	163	270	64	339	380
1973	570	131	217	57	69	126	82	102	258	185	500	826
1974	186	284	283	232	213	92	103	84	240	184	572	369
1975	7	36	143	158	136	175	105	207	92	138	283	1414
1976	95	336	62	17	142	176	220	166	109	141	529	511
1977	602	158	64	112	98	79	70	126	99	249	278	252
1978	187	42	229	102	154	165	55	45	167	291	429	365
1979	361	67	138	226	94	117	233	167	189	342	376	381
1980	259	178	148	90	56	102	102	55	147	141	537	937
1981	227	5	73	282	139	70	77	219	18	186	142	1390
1982	205	35	3	21	161	99	206	90	123	372	642	1142
1983	523	401	136	128	147	71	163	72	244	177	277	257
1984	247	232	431	149	108	64	102	141	96	181	279	13
1985	326	15	177	107	108	85	17	115	214	226	307	762
1986	626	20	36	237	140	131	113	159	154	191	261	1147
1987	231	367	693	182	82	118	157	190	197	118	536	227
1988	284	69	125	79	156	79	212	84	188	253	419	695
1989	622	326	38	135	123	151	126	83	291	158	576	758
1990	497	121	170	99	108	57	160	84	133	88	833	1682
1991	262	126	84	41	60	122	158	130	218	214	489	728

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1992	902	227	217	144	99	215	73	125	112	147	473	573
1993	163	114	448	94	350	268	159	183	86	42	650	492
1994	391	353	97	0	94	182	149	28	94	250	298	1071
1995	599	138	35	105	146	141	153	161	228	146	162	291
1996	591	21	112	45	159	150	113	102	155	271	236	1285
1997	305	241	202	203	137	206	115	233	84	224	313	310
1998	653	212	145	148	102	247	53	287	140	292	393	604
1999	805	243	219	124	189	121	179	71	269	200	282	368
2000	50	89	60	68	67	41	140	66	144	72	291	1063
2001	693	214	76	76	74	126	160	71	179	222	430	513
2002	179	14	381	59	23	126	161	40	78	527	297	695
2003	626	472	433	140	125	201	259	90	192	82	212	101
2004	74	45	313	125	69	63	224	75	85	100	253	652
2005	107	10	807	81	155	106	268	104	231	258	462	680
2006	496	371	391	227	140	204	315	275	248	324	134	736
2007	499	1092	11	72	86	3	75	212	151	141	255	773
2008	194	1	65	42	83	100	118	294	125	62	254	1057
AVERAGE	333	118	144	127	141	136	81	159	197	177	392	946

Table 7-40: MAR for Station Stor JPS Batu 3 di Mersing (2438001)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1971	806	59	70	7	176	196	62	242	124	313	264	1740
1972	95	81	5	183	112	92	54	163	270	64	339	380
1973	570	131	217	57	69	126	82	102	258	185	500	826
1974	186	284	283	232	213	92	103	84	240	184	572	369
1975	7	36	143	158	136	175	105	207	92	138	283	1414
1976	95	336	62	17	142	176	220	166	109	141	529	511
1977	602	158	64	112	98	79	70	126	99	249	278	252
1978	187	42	229	102	154	165	55	45	167	291	429	365
1979	361	67	138	226	94	117	233	167	189	342	376	381
1980	259	178	148	90	56	102	102	55	147	141	537	937
1981	227	5	73	282	139	70	77	219	18	186	142	1390
1982	205	35	3	21	161	99	206	90	123	372	642	1142
1983	523	401	136	128	147	71	163	72	244	177	277	257
1984	247	232	431	149	108	64	102	141	96	181	279	13
1985	326	15	177	107	108	85	17	115	214	226	307	762
1986	626	20	36	237	140	131	113	159	154	191	261	1147
1987	231	367	693	182	82	118	157	190	197	118	536	227
1988	284	69	125	79	156	79	212	84	188	253	419	695
1989	622	326	38	135	123	151	126	83	291	158	576	758
1990	497	121	170	99	108	57	160	84	133	88	833	1682
1991	262	126	84	41	60	122	158	130	218	214	489	728
1992	902	227	217	144	99	215	73	125	112	147	473	573

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993	163	114	448	94	350	268	159	183	86	42	650	492
1994	391	353	97	0	94	182	149	28	94	250	298	1071
1995	599	138	35	105	146	141	153	161	228	146	162	291
1996	591	21	112	45	159	150	113	102	155	271	236	1285
1997	305	241	202	203	137	206	115	233	84	224	313	310
1998	653	212	145	148	102	247	53	287	140	292	393	604
1999	805	243	219	124	189	121	179	71	269	200	282	368
2000	50	89	60	68	67	41	140	66	144	72	291	1063
2001	693	214	76	76	74	126	160	71	179	222	430	513
2002	179	14	381	59	23	126	161	40	78	527	297	695
2003	626	472	433	140	125	201	259	90	192	82	212	101
2004	74	45	313	125	69	63	224	75	85	100	253	652
2005	107	10	807	81	155	106	268	104	231	258	462	680
2006	496	371	391	227	140	204	315	275	248	324	134	736
2007	499	1092	11	72	86	3	75	212	151	141	255	773
2008	194	1	65	42	83	100	118	294	125	62	254	1057
AVERAGE	333	118	144	127	141	136	81	159	197	177	392	946

Table 7-41: MAR for Station 2636170 (STOR JPS ENDAU)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1971	806	59	70	7	176	196	62	242	124	313	264	1740
1972	95	81	5	183	112	92	54	163	270	64	339	380
1973	570	131	217	57	69	126	82	102	258	185	500	826
1974	186	284	283	232	213	92	103	84	240	184	572	369
1975	7	36	143	158	136	175	105	207	92	138	283	1414
1976	95	336	62	17	142	176	220	166	109	141	529	511
1977	602	158	64	112	98	79	70	126	99	249	278	252
1978	187	42	229	102	154	165	55	45	167	291	429	365
1979	361	67	138	226	94	117	233	167	189	342	376	381
1980	259	178	148	90	56	102	102	55	147	141	537	937
1981	227	5	73	282	139	70	77	219	18	186	142	1390
1982	205	35	3	21	161	99	206	90	123	372	642	1142
1983	523	401	136	128	147	71	163	72	244	177	277	257
1984	247	232	431	149	108	64	102	141	96	181	279	13
1985	326	15	177	107	108	85	17	115	214	226	307	762
1986	626	20	36	237	140	131	113	159	154	191	261	1147
1987	231	367	693	182	82	118	157	190	197	118	536	227
1988	284	69	125	79	156	79	212	84	188	253	419	695
1989	622	326	38	135	123	151	126	83	291	158	576	758
1990	497	121	170	99	108	57	160	84	133	88	833	1682
1991	262	126	84	41	60	122	158	130	218	214	489	728
1992	902	227	217	144	99	215	73	125	112	147	473	573
1993	163	114	448	94	350	268	159	183	86	42	650	492

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994	391	353	97	0	94	182	149	28	94	250	298	1071
1995	599	138	35	105	146	141	153	161	228	146	162	291
1996	591	21	112	45	159	150	113	102	155	271	236	1285
1997	305	241	202	203	137	206	115	233	84	224	313	310
1998	653	212	145	148	102	247	53	287	140	292	393	604
1999	805	243	219	124	189	121	179	71	269	200	282	368
2000	50	89	60	68	67	41	140	66	144	72	291	1063
2001	693	214	76	76	74	126	160	71	179	222	430	513
2002	179	14	381	59	23	126	161	40	78	527	297	695
2003	626	472	433	140	125	201	259	90	192	82	212	101
2004	74	45	313	125	69	63	224	75	85	100	253	652
2005	107	10	807	81	155	106	268	104	231	258	462	680
2006	496	371	391	227	140	204	315	275	248	324	134	736
2007	499	1092	11	72	86	3	75	212	151	141	255	773
2008	194	1	65	42	83	100	118	294	125	62	254	1057
AVERAGE	333	118	144	127	141	136	81	159	197	177	392	946

Table 7-42: MAR for Station 2438001 (Stor JPS Batu 3 di Mersing)

Year	Monthly Rainfall											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dis
1975	-	-	-	-	-	-	-	-	-	-	-	-
1976	27.5	10.0	56.0	76.5	151.5	148.5	102.0	263.5	126.0	231.0	281.5	242.5
1977	15.5	134.0	10.0	61.0	103.5	203.0	14.0	210.0	82.0	212.5	229.0	118.5
1978	177.5	111.0	155.5	200.0	180.0	108.5	70.0	48.5	126.0	230.0	163.0	271.5
1979	72.0	29.0	45.5	164.0	110.0	195.0	225.0	80.0	138.5	346.5	338.0	9.5
1980	56.0	37.2	197.9	280.8	96.7	70.0	115.0	69.0	194.5	174.0	360.0	271.5
1981	-	-	-	-	-	-	-	-	-	-	-	-
1982	18.6	10.6	96.5	261.5	157.5	89.0	225.5	64.5	81.5	226.5	205.5	187.0
1983	28.0	7.0	55.5	125.5	197.0	151.0	102.0	97.5	103.5	164.0	303.0	366.0
1984	235.0	288.5	223.0	123.5	133.5	156.5	178.5	99.5	347.5	315.0	143.5	127.0
1985	43.0	144.5	418.5	160.5	209.0	49.5	177.0	110.5	171.5	165.5	374.5	132.0
1986	94.0	56.0	83.5	290.0	145.0	225.0	111.5	28.5	350.5	223.5	253.4	229.6
1987	159.5	0.0	54.5	203.5	186.0	161.5	23.5	151.5	263.0	216.0	126.5	313.0
AVG =	**84.2**	**75.3**	**126.9**	**177.0**	**151.8**	**141.6**	**122.2**	**111.2**	**180.4**	**227.7**	**252.5**	**206.2**

Table 7-43MAR for Station 2534160 (Kg. Peta Ulu Sg. Endau)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AAR
1979	638	179	165	81	206	164	38	59	0	154	841	344	2866
1980	454	205	126	?	185	23	16	142	?	123	536	357	2165
1981	488	222	512	261	193	194	101	346	200	101	525	361	3500
1982	630	36	159	184	237	197	7	126	246	231	448	798	3296
1983	68	157	278	168	279	113	46	120	200	276	501	1465	3667
1984	344	177	163	153	242	126	295	168	237	299	524	671	3396

1985	233	110	320	361	145	69	101	124	298	356	471	529	3116
1986	717	523	96	293	305	210	141	176	133	421	246	257	3515
1987	53	367	118	339	120	126	140	182	40	161	403	766	2812
1988	662	37	233	148	108	321	305	259	218	397	157	949	3790
1989	368	196	272	148	13	107	113	3	86	220	374	616	2514
1990	871	611	247	434	287	138	75	94	172	151	377	567	4024
1991	610	117	242	292	295	159	155	76	126	214	152	472	2909
1992	406	433	269	66	161	166	211	209	164	114	448	621	3266
1993	4027	14	390	99	210	97	230	58	295	411	380	358	6568
1994	597	326	727	156	197	272	114	196	82	228	321	285	3499
1995	148	96	373	204	208	149	0	36	0	186	300	499	2197
1996	196	57	200	345	108	46	88	114	256	159	240	390	2197
1997	1242	56	552	197	398	140	62	237	268	290	302	780	4522
1998	395	403	303	327	229	93	67	168	190	214	223	392	3001
1999	516	855	68	193	353	47	206	148	170	191	330	1000	4075
2000	161	7	163	310	194	265	139	268	125	157	297	612	2695
AVERAGE	456	159	248	173	220	138	41	158	161	177	570	665	3099

7.2.2.14.8 Water Balance at Project Site

Water balance equation is used to obtain the total volume of rain water that infiltrate into soil as recharge to groundwater. The sandy soil within the area provides recharge area to the saturated zone. The water balance equation is as follows: -

$\Delta S/\Delta T = P - R - G - ET$

$\Delta S/\Delta T$ - Storage
P - Precipitation
R - Runoff
G - Groundwater
ET - Evapotranspiration

Therefore, $G = P - \Delta S/\Delta T - R - ET$

<u>Precipitation data</u>

The precipitation data was obtained from 2636170 (Station STOR JPS ENDAU) since it is the closest station to the project site with longer rainfall data period. The monthly and annual average rainfall for this station is shown in **Table 7-44** and **Table 7-45**. The annual average is higher than the national average by 1,000 mm. The monthly average shows that February is the driest month. The rest of the months provides plenty of rainfall for groundwater recharge and storm water.

Table 7-44: Monthly Rainfall Data for Station STOR JPS ENDAU (2636170)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1971	806	59	70	7	176	196	62	242	124	313	264	1740
1972	95	81	5	183	112	92	54	163	270	64	339	380
1973	570	131	217	57	69	126	82	102	258	185	500	826
1974	186	284	283	232	213	92	103	84	240	184	572	369
1975	7	36	143	158	136	175	105	207	92	138	283	1414
1976	95	336	62	17	142	176	220	166	109	141	529	511
1977	602	158	64	112	98	79	70	126	99	249	278	252
1978	187	42	229	102	154	165	55	45	167	291	429	365
1979	361	67	138	226	94	117	233	167	189	342	376	381
1980	259	178	148	90	56	102	102	55	147	141	537	937
1981	227	5	73	282	139	70	77	219	18	186	142	1390
1982	205	35	3	21	161	99	206	90	123	372	642	1142
1983	523	401	136	128	147	71	163	72	244	177	277	257
1984	247	232	431	149	108	64	102	141	96	181	279	13
1985	326	15	177	107	108	85	17	115	214	226	307	762
1986	626	20	36	237	140	131	113	159	154	191	261	1147
1987	231	367	693	182	82	118	157	190	197	118	536	227
1988	284	69	125	79	156	79	212	84	188	253	419	695
1989	622	326	38	135	123	151	126	83	291	158	576	758
1990	497	121	170	99	108	57	160	84	133	88	833	1682
1991	262	126	84	41	60	122	158	130	218	214	489	728
1992	902	227	217	144	99	215	73	125	112	147	473	573
1993	163	114	448	94	350	268	159	183	86	42	650	492
1994	391	353	97	0	94	182	149	28	94	250	298	1071
1995	599	138	35	105	146	141	153	161	228	146	162	291
1996	591	21	112	45	159	150	113	102	155	271	236	1285
1997	305	241	202	203	137	206	115	233	84	224	313	310
1998	653	212	145	148	102	247	53	287	140	292	393	604
1999	805	243	219	124	189	121	179	71	269	200	282	368
2000	50	89	60	68	67	41	140	66	144	72	291	1063
2001	693	214	76	76	74	126	160	71	179	222	430	513
2002	179	14	381	59	23	126	161	40	78	527	297	695
2003	626	472	433	140	125	201	259	90	192	82	212	101
2004	74	45	313	125	69	63	224	75	85	100	253	652
2005	107	10	807	81	155	106	268	104	231	258	462	680
2006	496	371	391	227	140	204	315	275	248	324	134	736
2007	499	1092	11	72	86	3	75	212	151	141	255	773
2008	194	1	65	42	83	100	118	294	125	62	254	1057

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AVERAGE	333	118	144	127	141	136	81	159	197	177	392	946

Table 7-45Annual Rainfall Data Obtained from Station STOR JPS ENDAU (2636170)

Year	Rainfall
1971	4058
1972	1837
1973	3123
1974	2841
1975	2891
1976	2501
1977	2184
1978	2228
1979	2690
1980	2750
1981	2824
1982	3097
1983	2593
1984	2041
1985	2455
1986	3213
1987	3094
1988	2641
1989	3384
1990	4030
1991	2628
1992	3304
1993	3047
1994	3005
1995	2301
1996	3237
1997	2572
1998	3274
1999	3070
2000	2150
2001	2833
2002	2578
2003	2932
2004	2075
2005	3267
2006	3859
2007	3369
2008	2392
AVERAGE	2950

Surface Runoff (R)

Runoff (R) is estimated to be about 40% of the total precipitation, therefore the R value is shown in **Table 7-46**.

Table 7-46:Estimated Runoff (mm/month)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Runoff(mm)	133	47	57	51	56	54	32	64	79	71	157	378

Evaporation (E)

Evaporation (E) for project site is obtained from the nearest evaporation station measured in Muadzam Shah. This station is suitable for the study since this station is located near coastal area. The evaporation rate for the project site is based on the value obtained from other evaporation station (Muadzam Shah). The recorded evaporation rate is from 2009 to 2014 (**Table 7-47**). The average evaporation rate ranges from 2.8 mm/day to 3.8 mm/day. The month of December records the lowest evaporation rate while month of April records the highest evaporation rate.

Table 7-47: Evaporation Rate Measured in Muadzam Shah

Year	Jan	Feb	Mac	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
2009	2.9	2.8	3.2	3.7	3.6	3.8	2.9	3.7	3.5	4.0	2.6	2.9
2010	3.3	4.2	4.1	3.5	3.4	3.5	3.2	3.8	3.8	2.8	2.9	2.8
2011	2.6	3.1	3.2	3.5	2.9	3.5	4.1	3.5	3.9	2.7	2.7	2.9
2012	3.0	3.3	3.7	3.3	3.4	3.3	3.4	3.3	3.5	3.1	2.8	2.5
2013	3.2	3.8	4.3	3.7	3.5	3.7	3.8	3.4	3.4	3.7	3.1	3.0
2014	3.2	3.8	4.3	3.7	3.5	3.7	3.8	3.4	3.4	3.7	3.1	3.0
Mean (mm/day)	3.0	3.5	3.8	3.5	3.4	3.6	3.5	3.5	3.6	3.3	2.9	2.8
Mm/month	93	98	118	105	108	108	108	108	108	102	87	87

ΔS/ΔT is assumed to be zero

The monthly recharge to groundwater (G) values is calculated using the water balance equation as shown in **Table 7-48**. The trend of the groundwater recharge is shown in **Figure 7-51**. The driest month in February provides little or no recharge to the groundwater. The project proponent should provide storage for storing surface runoff during wet season and use it during dry season. The continuous recharge throughout the year should provide enough groundwater to be used during the dry season.

Table 7-48: Monthly Groundwater Recharge (mm/month)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
GWATER	107	0	0	0	0	0	0	0	10	4	148	480

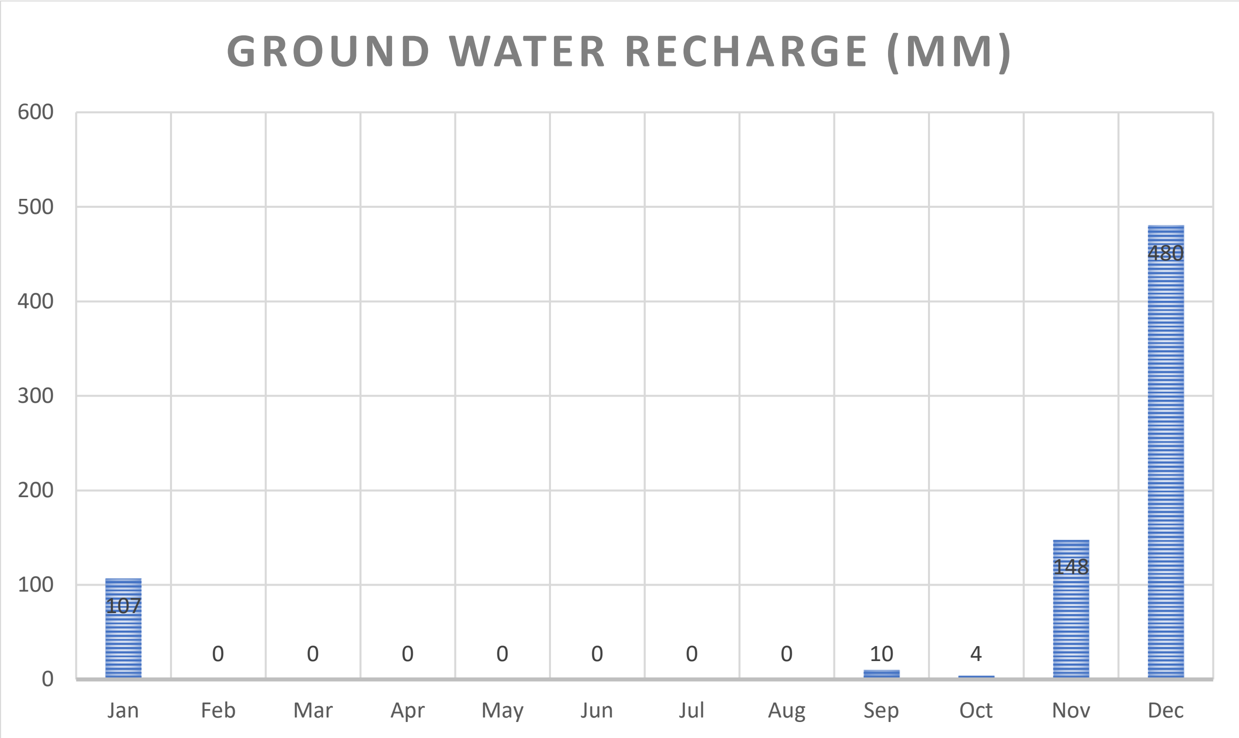


Figure 7-51: Trend of Groundwater Recharge

Hydrologic Modelling

Hydrologic modelling of the catchment area (**Figure 7-52**) was carried out using HEC-HMS model. The design storm selected for this study depends on the time of concentration (t_c) of the study area. The t_c was estimated by using the overland flow time formulae and drain flow time formula. The estimated t_c at the outlet of the sub-catchment is listed in **Table 7-49**.

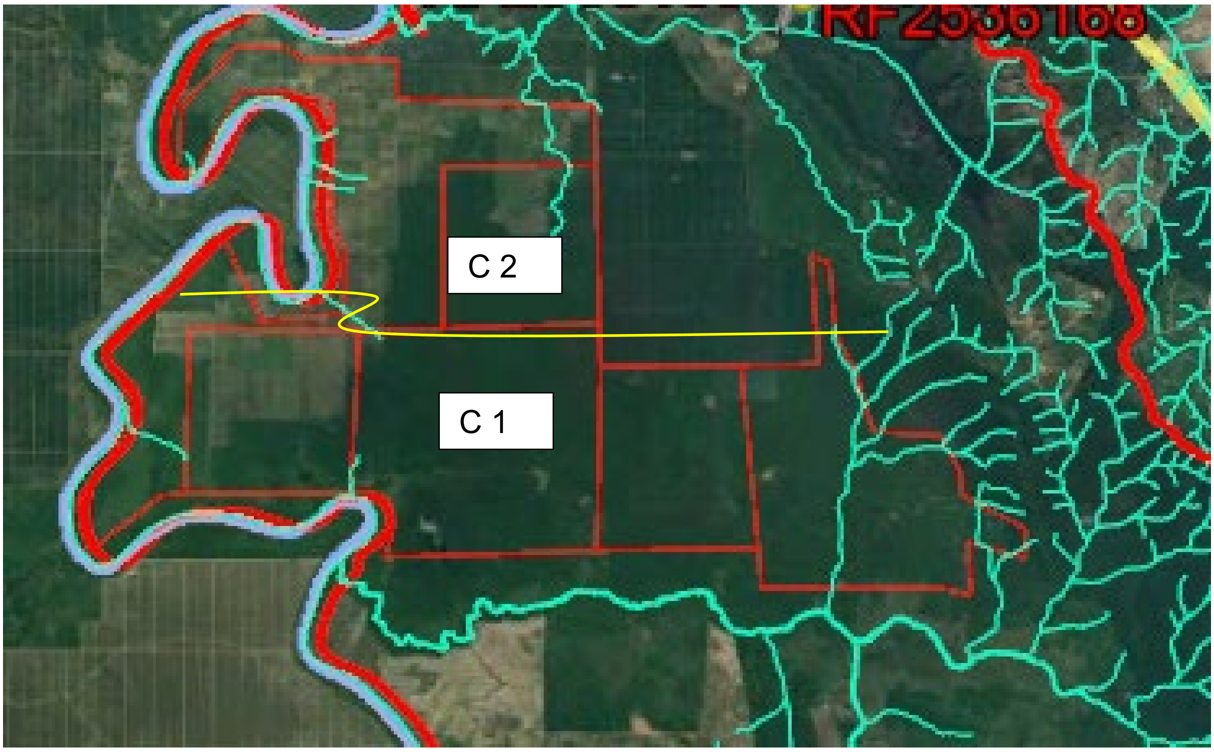


Figure 7-52: Sub Catchments Within the Project Area

Table 7-49: Estimated t_c values

Catchment	Area (km²)	Pre-Plantation	Post-Plantation
		Tc	Tc
1	15.5	4.5	3
2	22.25	6	5

The derived Tc serves as the duration of design storm. The design storm intensity for the area can be derived from the IDF curve. The IDF equation used to derive the rainfall intensity is shown in equation 2. There are a number of IDF curves within the state of Johor (**Table 7-50**). The closest IDF curve available for this study area is Stor JPS Endau (2636170) as shown in **Figure 7-53**. Stor JPS Endau station is located within the same catchment (Sg. Endau) as the project area. Therefore, the station is selected based on the station that is located within the same river basin. In this study, the IDF derived for the Stor JPS Endau will be used for the simulation of surface runoff as the station is located within the same river basin as the project development site. The temporal pattern used for this study is based on the Johor temporal pattern. The design storm hyetograph of 5, **50** years and **100** years ARI will be used in this study. **Table 7-50 - Table 7-53** listed the rainfall intensity used in this study for various ARI's.

$$i = \frac{\lambda T^{\kappa}}{(d+\theta)^{\eta}}$$

Equation 0.0

where,

i = Average rainfall intensity (mm/hr);

T = Average recurrence interval - ARI ($0.5 \leq T \leq 12$ month and $2 \leq T \leq 100$ year);

d = Storm duration (hours), $0.0833 \leq d \leq 72$; and

λ, κ, θ and η = Fitting constants dependent on the rain gauge location

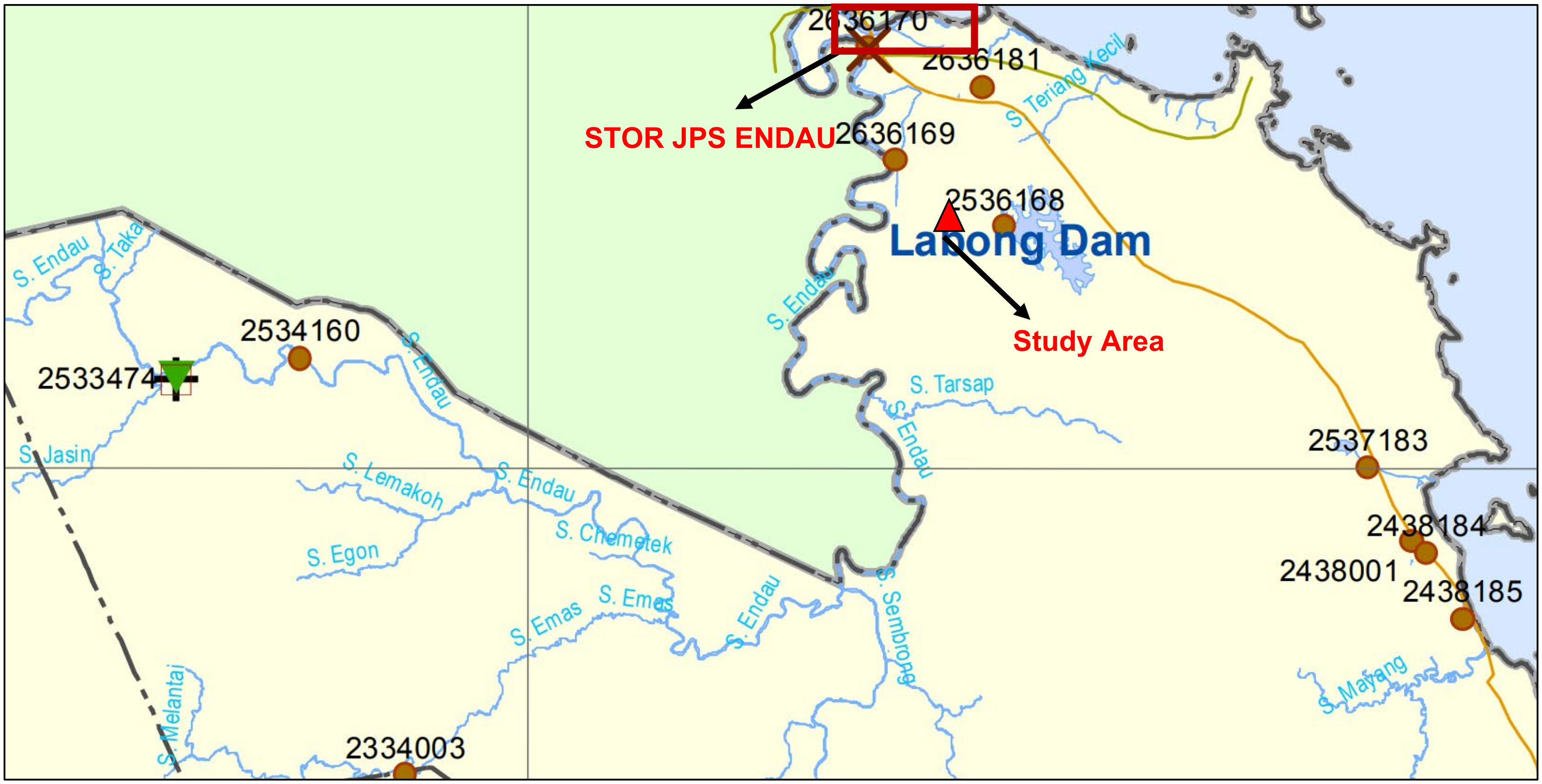


Figure 7-53: Study Area and the Selected Design Storm Station

Table 7-50: IDF Curves for Various Stations Within Johor

State	No.	Station ID	Station Name	Constants			
				λ	κ	θ	η
Johor	1	1437116	Stor JPS Johor Bahru	59.972	0.163	0.121	0.793
	2	1534002	Pusat Kem. Pekan Nenas	54.265	0.179	0.100	0.756
	3	1541139	Johor Silica	59.060	0.202	0.128	0.660
	4	1636001	Balai Polis Kg Seelong	50.115	0.191	0.099	0.763
	5	1737001	SM Bukit Besar	50.554	0.193	0.117	0.722
	6	1829002	Setor JPS B Pahat	64.099	0.174	0.201	0.826
	7	1834124	Ladang Ulu Remis	55.864	0.166	0.174	0.810
	8	1839196	Simpang Masai K. Sedili	61.562	0.191	0.103	0.701
	9	1931003	Emp. Semberong	60.568	0.163	0.159	0.821
	10	2025001	Pintu Kaw. Tg. Agas	80.936	0.187	0.258	0.890
	11	2033001	JPS Kluang	54.428	0.192	0.108	0.740
	12	2231001	Ladang Chan Wing	57.188	0.186	0.093	0.777
	13	2232001	Ladang Kekayaan	53.457	0.180	0.094	0.735
	14	2235163	Ibu Bekalan Kahang	52.177	0.186	0.055	0.652
	15	2237164	Jalan Kluang-Mersing	56.966	0.190	0.144	0.637
	16	2330009	Ladang Labis	45.808	0.222	0.012	0.713
	17	2528012	Rmh. Tapis Segamat	45.212	0.224	0.039	0.711
	18	2534160	Kg Peta Hulu Sg Endau	59.500	0.185	0.129	0.623
	19	2636170	Setor JPS Endau	62.040	0.215	0.103	0.592

Table 7-51: Storm Pattern for Region 2: Pahang, Negeri Sembilan, Melaka and Johor

No. of Block	Storm Duration								
	15-min	30-min	60-min	180-min	6-hr	12-hr	24-hr	48-hr	72-hr
1	0.255	0.124	0.053	0.053	0.044	0.045	0.022	0.027	0.016
2	0.376	0.130	0.059	0.061	0.081	0.048	0.024	0.028	0.023
3	0.370	0.365	0.063	0.063	0.083	0.064	0.029	0.029	0.027
4		0.152	0.087	0.080	0.090	0.106	0.031	0.033	0.033
5		0.126	0.103	0.128	0.106	0.124	0.032	0.037	0.036
6		0.103	0.153	0.151	0.115	0.146	0.035	0.040	0.043
7			0.110	0.129	0.114	0.127	0.039	0.046	0.047
8			0.088	0.097	0.090	0.116	0.042	0.048	0.049
9			0.069	0.079	0.085	0.081	0.050	0.049	0.049
10			0.060	0.062	0.081	0.056	0.054	0.054	0.051
11			0.057	0.054	0.074	0.046	0.065	0.058	0.067
12			0.046	0.042	0.037	0.041	0.093	0.065	0.079
13							0.083	0.060	0.068
14							0.057	0.055	0.057
15							0.052	0.053	0.050
16							0.047	0.048	0.049

No. of Block	Storm Duration								
	15-min	30-min	60-min	180-min	6-hr	12-hr	24-hr	48-hr	72-hr
17							0.040	0.046	0.048
18							0.039	0.044	0.043
19							0.033	0.038	0.038
20							0.031	0.034	0.035
21							0.029	0.030	0.030
22							0.028	0.029	0.024
23							0.024	0.028	0.022
24							0.020	0.019	0.016

Table 7-52: Rainfall Intensity (mm/hr) for various duration (minutes)

ARI (yrs)	30	60	90	120	180	360
2	82.00	61.57	50.80	43.95	35.50	24.21
5	99.85	74.97	61.86	53.51	43.23	29.49
10	115.90	87.02	71.80	62.11	50.17	34.22
20	134.52	101.01	83.34	72.10	58.24	39.72
50	163.82	123.00	101.48	87.80	70.92	48.37
100	190.14	142.77	117.79	101.90	82.31	56.15

Table 7-53: Rainfall depth (mm) for various duration (minutes)

ARI (yrs)	30	60	90	120	180	360
2	41.00	61.57	76.20	87.89	106.49	145.28
5	49.93	74.97	92.79	107.03	129.68	176.92
10	57.95	87.02	107.70	124.23	150.52	205.35
20	67.26	101.01	125.01	144.19	174.71	238.35
50	81.91	123.00	152.23	175.59	212.75	290.25
100	95.07	142.77	176.69	203.81	246.94	336.89

i. The temporal pattern used for this study is based on the temporal pattern for Pahang state. The design storm hyetograph of 5, 50 years and 100 years ARI's for 6-hour storm duration is also shown in **Table 7-54**. The adopted storm duration for this study is about 6 hours.

Table 7-54: Temporal Pattern for 6-hour Storms

Pattern	5 Year	50 year	100 Year
0.044	5.7	9.4	10.9
0.081	10.5	17.2	20.0
0.083	10.8	17.7	20.5
0.09	11.7	19.1	22.2
0.106	13.7	22.6	26.2
0.115	14.9	24.5	28.4

Pattern	5 Year	50 year	100 Year
0.114	14.8	24.3	28.2
0.09	11.7	19.1	22.2
0.085	11.0	18.1	21.0
0.081	10.5	17.2	20.0
0.074	9.6	15.7	18.3
0.037	4.8	7.9	9.1

The hydrologic losses for the area will be based on initial and continuing loss method. The initial loss is assumed to be 10 mm and the continuing loss is assumed to be 15 mm/hr. It is also assumed that the existing land cover consists of about 5% impervious area. The transformation of effective rainfall to the outlet area will be based on Clark time-area method. The two parameters used for the development of this synthetic unit hydrograph are T_C and R. These two parameters can be obtained from observed hydrograph. In the absence of the observed hydrograph, the parameters can be estimated from regression equations derived areas with gauged data. The regression equation used in this study is derived from a study in small rural watersheds in Illinois, USA (Straub, Melching and Kocher, 2000). The regression equations are as listed below.

$T_c = 1.54 L^{0.875} S^{-0.181}$ ....Equation 2.

$R = 16.4 L^{0.342} S^{-0.790}$ ....Equation 3.

L is the stream length measured along the main channel from the outlet to the watershed divide-in mile.

R is the main channel slope determined from elevation at points that represent 10 and 85 percent of the distance along the channel from the outlet to the watershed divide in ft/mile.

The T_C and R for the study area within the sub-catchments are listed in **Table 7-55**.

Table 7-55: Tc and R for the Study Area

Catchment	Area (km²)	Pre-Plantation		Post-Plantation	
		Tc (HR)	R (HR)	Tc (HR)	R (HR)
1	15.5	4.5	5.4	3	3.9
2	22.25	6	9	5	6.5

The base flow for the area is assumed to be constant at 0.1 m^3/sec. Based on these input data, the result obtained from the simulation is shown in **Table 7-55**. Comparison of estimated flow with other method such as Rational Method is also shown in the table. The flow hydrograph generated at the outlet of the plantation area on various storm durations and average recurrence interval is listed in **Table 7-56**.

Table 7-56: Comparison of estimated Pre-Development flow using Time-Area Method with Rational Method (50 Year ARI)

Catchment	Area (km^2)	HEC-HMS (m^3/s)	Rat Method Q post (m^3/s)
1	15.5	95	108
2	22.25	103	154

The result from the 50- and 100-year ARI flow hydrographs serves as an input to the Sg. Endau. The modelling scenario assumes that the storm events of 5-, 50- and 100-year ARI coincides with the Sg. Endau at full capacity level.

The new drainage manual specifically mentioned that the post-development flow at the outlet must be equal to or less than the pre-development level. The result clearly shows that the post-development peak flow exceeds the pre-development peak flow by about 30 m^3/sec. The proposed detention pond intends to bring down the post-development flow to the pre-development level. Detention pond normally consists of storage area, inlet to the pond and outlet out of the pond. The proposed flow control structure in the study area is flood detention pond. The storm flow from the plantation area and from the upstream area flows in to the flood detention pond (off-line pond), while the outflow from the pond flows to the nearest river (Sg. Endau) as shown in **Figure 7-54.** The representation of the catchments and ponds are shown in **Figure 7-55.** If the pond is off-line pond, the proposed flood detention pond surface area is about 2% of the oil palm plantation area**.**

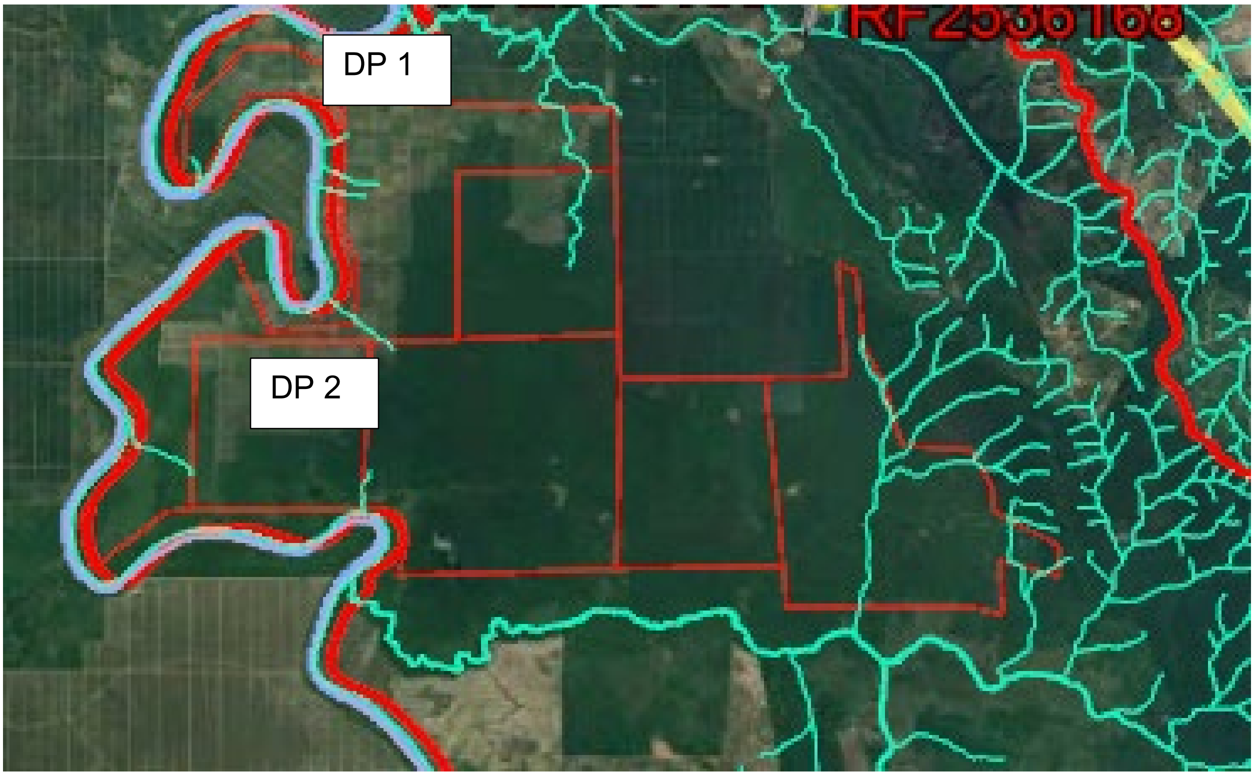


Figure 7-54: Proposed Locations of the Flood Pond

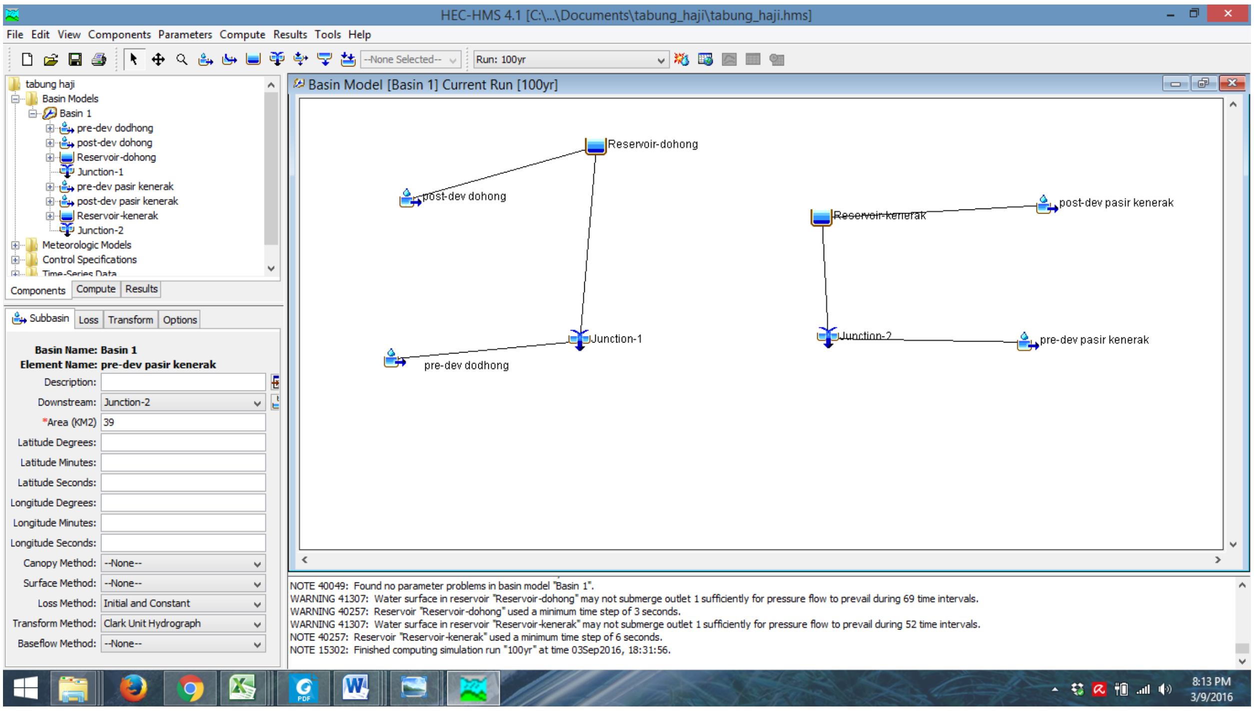


Figure 7-55: Representation of Sub-catchments and Flood Pond

The design storm should accommodate storm of 50 year ARI, while its spillway should be able to cater for 100 year storm. Therefore, enough storage volume within the ponds should be provided in order to control flood of 50 year ARI. The required storage volume can be estimated by using the linear regression formula developed by USDOT (Eqn 4). The preliminary required storage volume for these ponds is listed in **Table 7-57**.

$$V_s = \frac{1}{2} t_i (Q_i - Q_o) \text{.............................Equation 4.}$$

Where,

V_s = estimated storage volume (m^3/s)

Q_i = inflow hydrograph peak flow rate (m^3/s)

Q_o = allowable peak outflow rate (m^3/s)

t_i = time base of the inflow hydrograph (minutes)

Table 7-57: Preliminary Estimation of storage volume Based on 50 Year ARI

Catchment	Area (km^2)	Pre-D (m^3/s)	Post-D (m^3/s)	Required Pond Storage Volume (m^3)
1	15.5	95	124	125,800
2	22.25	103	139	155,000

The estimated storage volume required for the detention pond is about 125,800 m^3 and 155,000 m^3 for Sg. Labong and Sg. Tarsap catchment. Assuming that the shape of the pond is rectangular and the depth of the pond not exceeding 3 m, the proposed surface area of the pond is also shown in the **Table 7-58** below. The required pond surface area for detention pond is about 61 ha. However, if the detention pond is off line pond, the required surface area for the project site within Sg. Labong and Sg. Tarsap catchment is 25 ha and 36 ha.

Table 7-58: Proposed Design of Storage Volume (In-Line Pond)

Catchment	C. Area	Qpre	Qpost	Pond Size (m)			Pond Vol
	(KM^2)	(m^3/s)	(m^3/s)	Width	Length	Depth	(m^3)
1	15.5	95	124	700	350	3	735,000
2	22.25	103	139	800	450	3	1,080,000

Based on this required storage volume, the outlet for the pond is designed in order to develop the Storage Indication Curve. The outlets need to be design appropriately so that the discharge would meet the storm water control objective (less than pre-development discharge). The proposed outlet from the ponds should either consist of a culvert or an orifice to regulate the storm water flow up to 100 year ARI (major storm). The outlet should also consist of abroad crested weir to cater for rare storm of 100 year. The trial size of the outlets (culvert and broad crested weir) and pond size were used initially in order to determine the appropriate size. Using these trial data, the flow routing for the community pond is modelled using HEC-HMS. After a few models' trial runs, the selected size of the pond size and outlet dimensions for various detention ponds is listed in **Table 7-59**. The adopted detention ponds storage volume is about 50% more than the initial estimate. The results of the routed flow through the catchments and detention ponds are shown in **Table 7-60**. The result also clearly shows that the post-development with pond outflow is less than the pre-development flow.

Table 7-59: Outlet Design for Detention Ponds

Pond	Culvert			Weir	
	Invert Level (m)	Dia (m)	Number	Length (m)	Invert Level (m)
1	0	1	5	20	2
2	0	1	8	30	2

Table 7-60: Pre- and Post-Development Flows with and without Ponds (50 Year ARI)

Detention	Q_{pre}	Q_{post}	Q_{post} + pond	Reduction
Pond (DP)	m^3/s	m^3/s	m^3/s	(%)
1	95	124	92	26
2	103	139	101	27

The objective of constructing a detention pond is to meet the condition where the post-development peak outflow at the outlet is less than or equal to the pre-development condition. The result shows that this objective can be achieved through the proposed design of the community pond. This will help authorities control flooding downstream of the project area. The efficiency of the detention pond in peak flow reduction is shown in **Table 7-60**.

The percentage of peak flow reduction ranges from 26% to 27%. The detention ponds should also be designed to be able to withstand rarer flood (100 year ARI). The designed flood detention pond should be capable of draining the 100 year ARI peak flow from the ponds with its emergency spillway. The result of 100 year ARI discharge from the detention ponds is shown in **Table 7-61**. The outflow from the detention ponds is slightly more than the predevelopment level. It is important that the spillway is capable to drain the 100 year flood flow in order to prevent it from overtopping the detention pond. The maximum water level is slightly below the crest level but higher than the free board level (2.9 m).

Table 7-61: 50 Year Discharge from Detention Pond

Catchment	C. Area	Qpre	Qpost	Qpost + pond	Max. Pond W.L.
	(km^2)	(m^3/s)	(m^3/s)	(m^3/s)	(m)
1	24.3	95	124	92	2.9
2	0.03	103	139	101	2.9

7.2.2.14.9 Hydraulic Modelling

The objective of the hydraulic modelling is to perform hydraulic routing of flood flow in the drainage system, which uses the upstream inflow hydrograph generated from HEC-HMS. HEC-RAS can model water surface profiles along the channels and flood plain in the drainage system using fully dynamic flood routing technique based on the St. Venant equation. The model is based on gradually varied one-dimensional flow. Preliminary channel cross sections were obtained from field measurement. The estimated river cross sections will be used in the model simulation. The layout of the river within the project area is shown in **Figure 7-56,** while **Table 7-62** lists the river cross-section at sampling points. Since river cross sections data are not readily available, the river capacities at the outlet will be compared with the 50 year ARI peak flow using Mannings formula,

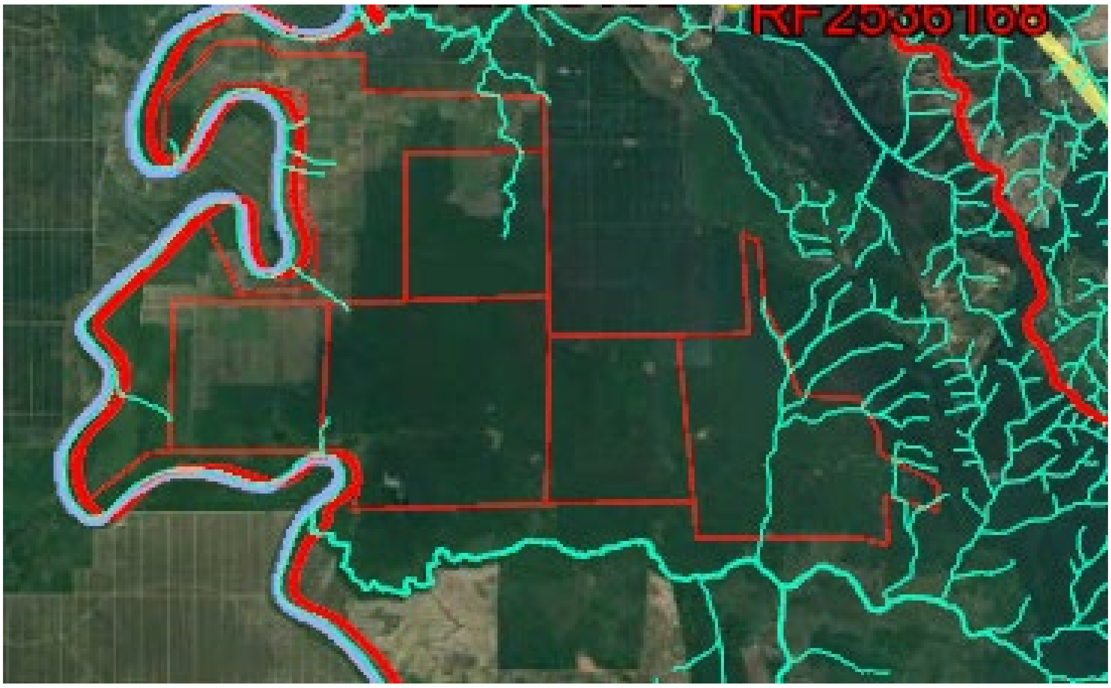


Figure 7-56: Layout of the Existing Drainage System Within the Proposed Oil palm plantation site

Table 7-62: River Cross-Sections at Catchment Outlets

Catchment Outlets	Area (km^2)	Qp (50 Yr) (m^3/s)	Depth (cm)	Velocity (m^3/s)	Cross Section (m)				Q Capacity
					A	B	C	D	(m^3/s)
1	24.3	64.5	110	0.4	0	3	10	20	70
2	0.03	0.07	2	0.2	0	0.2	0.5	0.8	0.002

The project site is affected by the water level in Sg. Endau. The observe tide level as measured at Kuala Sedili station are summarized in **Table 7-63**.

Table 7-63: Summary of Observed Water Level at Kuala Sedili

	HAT	MWL	LWL
Water Level (m)	1.93	1.38	0.4

Storms events considered in the simulations are those with 5, 50 and 100-year ARI's. The existing river capacities are shown in **Table 7-62**. The existing river capacity could not convey 50 year ARI peak discharge. The water surface profile of Sg. Labong and Sg. Tarsap (within the project area) generated by the 100-year ARI storms under the proposed plantation with the channel cross-sections remain unchanged. It shows that the existing capacity is not capable of conveying the 50 and 100 year peak flow.

However, it is proposed that the plantation with a total area be protected with bund along the project site to cater for the increase of storm flow from the plantation area. The bund will be able to prevent the 50 year flood level from overflowing the river bund. However, the existing channel conveyance capacities were able to cater for the 5 year ARI river flow (With Pond). Assuming that the flow from the plantation area will be somehow regulated, the existing channel capacity will be able to cater the 50 year storm flow. Tidal gate should also be built at the outlet to prevent tidal water from flooding the project area.

7.2.2.14.10 Impact of Sedimentation on River Conveyance Capacity

The land clearing works during planting may cause a lot of eroded materials to be transported and deposited within the river conveyance system. The deposited material would decrease the conveyance capacities of the river and increase the frequency of flash flood. The estimated soil erosion from the project site is listed in **Table 7-64** (10 Year ARI) (worst case scenario). The total annual loading of sediment to various tributaries is estimated to vary between 400 tonne to 60,000 tonne. The estimated density of the deposited material is about 1,520 kg/m^3. Therefore, the volume occupied by the deposited material is estimated to be about 250 m^2 to 40000 m^2 annually. The total storage volume of the river conveyance capacities is also listed in **Table 7-64**. Therefore, it will take about 1.8 years to fill up the river with sediment. The summary of the sedimentation based on worst case scenario is listed in **Table 7-64**.

Table 7-64: Estimated Sedimentation Within River System

Catchment	**Worst Case (Ton)**	Volume (m^3)	River Capacity (m^3)	Year to fill up
1	25,337	16,669	22,000	1.3

7.2.2.15 Fisheries

Inland water ecosystems provide important services, but most of the times is undervalued. Inland fisheries and aquaculture contribute about 25% to the world's production of fish. The value of freshwater production to human nutrition and incomes is generated by small-scale activities. Inland fisheries are often critical to local food security and most inland fisheries in the developing world are heavily exploited. Development to fulfill human needs is one of factor that threat inland sources through exploitation, habitat disturbance and pollutions.

The proposed project can be separated to few major phases namely pre-planting stage which involve site preparation for access road, base camp establishment and barrier and fencing installation. Logging and site clearance involve cutting timber and transportation and land preparation for planting. Planting phase involve fertilization and maintenance and harvesting phases involve transporting plantation products.

Fish as one of aquatic communities completely rely on water quality of the river. Therefore, any mitigating measures proposed for water quality protections would protect fish indirectly. However, more detail potential impacts and mitigating measures were given below.

The critical activities are logging, which involve cutting, 'matau' site preparation and transportations. Those activities could cause surface erosion which finally would produce significant sedimentation to nearby river and excessive TSS in water body would threat intolerant species such as *Poropuntius* and *Rasbora*. Land clearance makes the stream accessible to public which could enhance fishing activity.

Heavy machineries used for those activities possible to cause fuel and oil and grease leak and would be transported into the river water body through many ways. All aquatic communities are very sensitive to this type of contaminations.

7.3 OPERATIONS STAGE

During operations the main issues of concern would be the use of fertilizers and agrochemicals for plant growth and pest control. Thus, the environmental concerns would be water quality from runoff containing chemicals, scheduled waste from used chemical containers and noise from operations vehicles.

7.3.1 Water Quality

The use of fertilizers and pesticides during the operation stage can cause pollution of the rivers. It is anticipated that the use of fertilizers can increase the levels of BOD_5, Nitrate, NH_3-N, TSS and Phosphate for downstream areas.

Excessive fertilizer would create eutrophication that destroys the water body ecosystem. Thus, there could be an impact on the river waters downstream if proper usage and handling is not adhered to. The water quality modelling has been conducted for this Project and the results is described in the following sub-section.

Ammoniacal nitrogen (AN)

Scenario 6: During operation at low flow /critical flow: neap tide

Figure 7-57 summarizes the predicted NH_3-N profile of Sg. Endau from upstream to downstream area during operation at low flow or critical flow in neap tide condition. Based on the Figure, about 0.581 mg/l of NH_3-N concentration (NWQS Class III) is expected to reach the last station at WQ8 (KM51.0). This scenario is based on the application of fertilizer since there is a plantation area along Sg. Endau before reach at the WQ8. The amount of NH_3-N concentration is expected to be slightly higher than the existing condition during operation at low flow/critical flow condition.

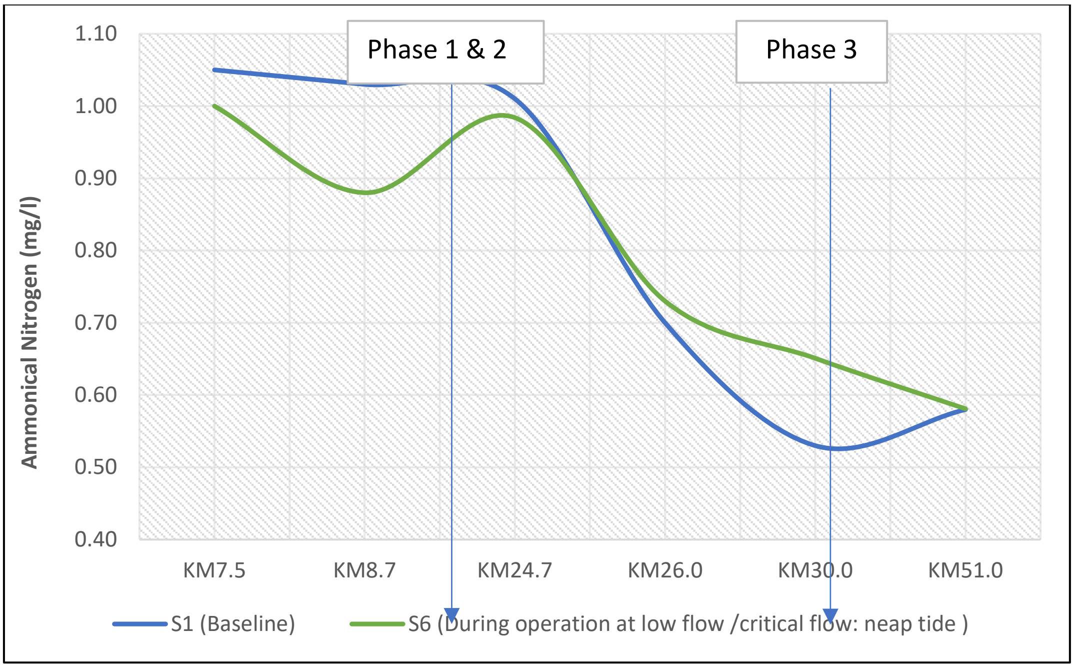


Figure 7-57: Result of Ammoniacal Nitrogen (AN)

Nitrate

Scenario 6: During operation at low flow /critical flow: neap tide

Figure 7-58 summarizes the predicted nitrate profile of Sg. Endau from upstream to downstream during operation at low flow or critical flow in neap tide condition. Based on the Figure, approximately about 2.28 mg/l of nitrate concentration is expected to reach the last station at WQ8 (KM51.0). The amount of nitrate concentration is expected to be higher than the existing condition during operation at low flow/critical flow condition.

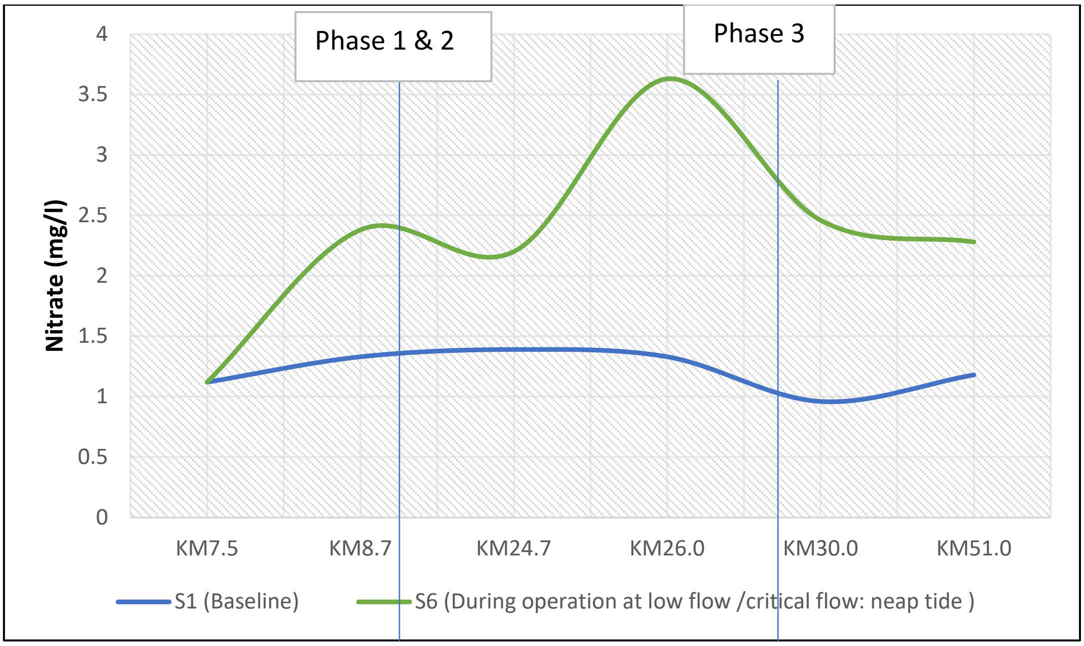


Figure 7-58: Result of Nitrate

Total Phosphorus

Scenario 6: During operation at low flow /critical flow: neap tide

Figure 7-59 summarizes the predicted TP profile of Sg. Endau from upstream to downstream area during operation at low flow or critical flow in neap tide condition. Based on the Figure, 0.372 mg/l of TP concentration loading is expected to reach the last station at WQ8 (KM51.0). The fertilizer runoff is one of the reasons of high TP concentration in waterbodies. Thus, the amount of TP concentration is expected to be higher than the existing condition during operation at low flow/critical flow condition as it becomes more concentrated. The higher concentration of TP along Sg. Endau stretch during operation at low flow/critical flow condition had indicated that the pollution is related with eutrophication condition.

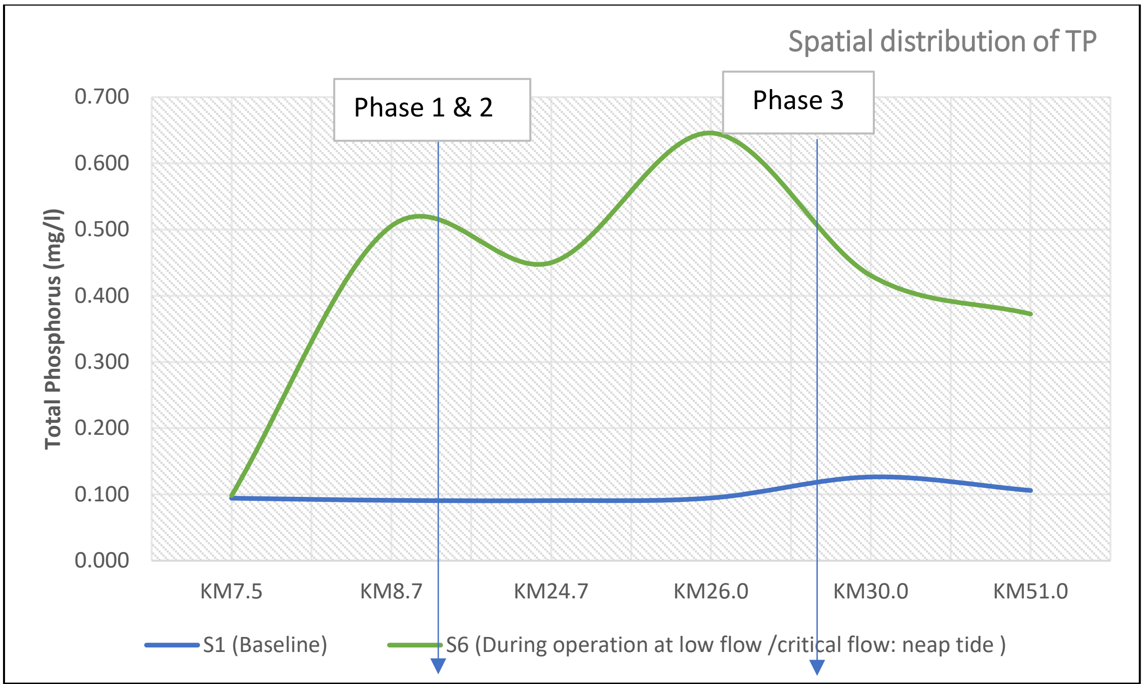


Figure 7-59: Result of Total Phosphorus

BOD

Scenario 6: During operation at low flow /critical flow: neap tide

Figure 7-60 summarizes the predicted BOD profile of Sg. Endau from upstream to downstream area during operation at low flow or critical flow in neap tide condition. Based on the Figure, 1.13 mg/l of BOD concentration is expected to reach the last station at WQ8 (KM51.0). This scenario is based on the application of fertilizer since there is a plantation area along Sg. Endau before reach at the WQ8. BOD concentration is directly related with DO concentrations. During low flow condition, the oxygen becomes dissolved in surface waters due to the high interaction and diffusion from atmosphere and aquatic plant during photosynthesis process. Thus, the high value of DO shows decline in BOD. Therefore, the amount of BOD concentration is expected to be lower than the existing condition during operation at low flow/critical flow condition.

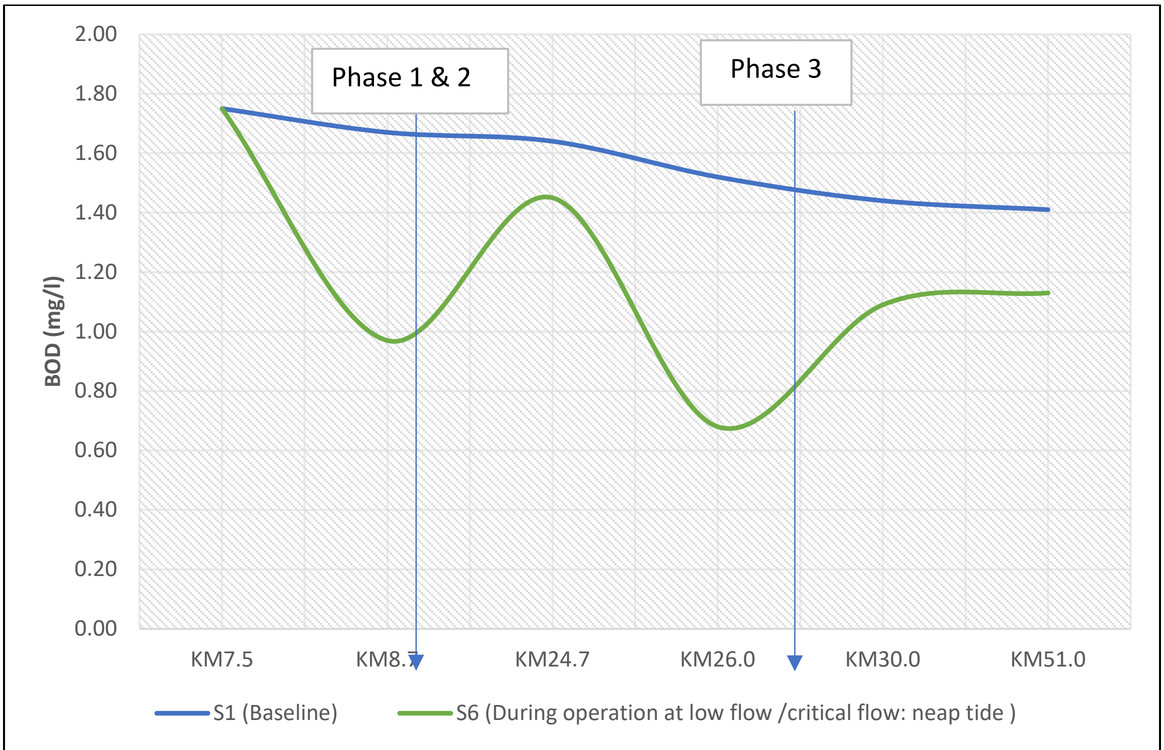


Figure 7-60: Result of BOD

Total Suspended Solids

Scenario 6: During operation at low flow /critical flow: neap tide

Figure 7-61 also summarizes the predicted TSS profile of Sg. Endau from upstream to downstream based on during operation at neap/low flow condition. Based on the simulation, the contribution of TSS is significant at KM8.7 (Phase 1 & Phase 2); and KM26.0 (Phase 3), as the discharge is drained from the proposed Project area with a proposed BMPs employment. The TSS loading that eventually reaches the last station at WQ8 fall within Class II (29.50 mg/l), which is less than 50.00mg/l NWQS Class IIA/IIB for TSS concentration loading. This value is slightly higher compared to the existing TSS condition in Scenario 1, but the TSS loading is highly improved in comparison to the Scenario 2, Scenario 3, Scenario 4 and Scenario 5.

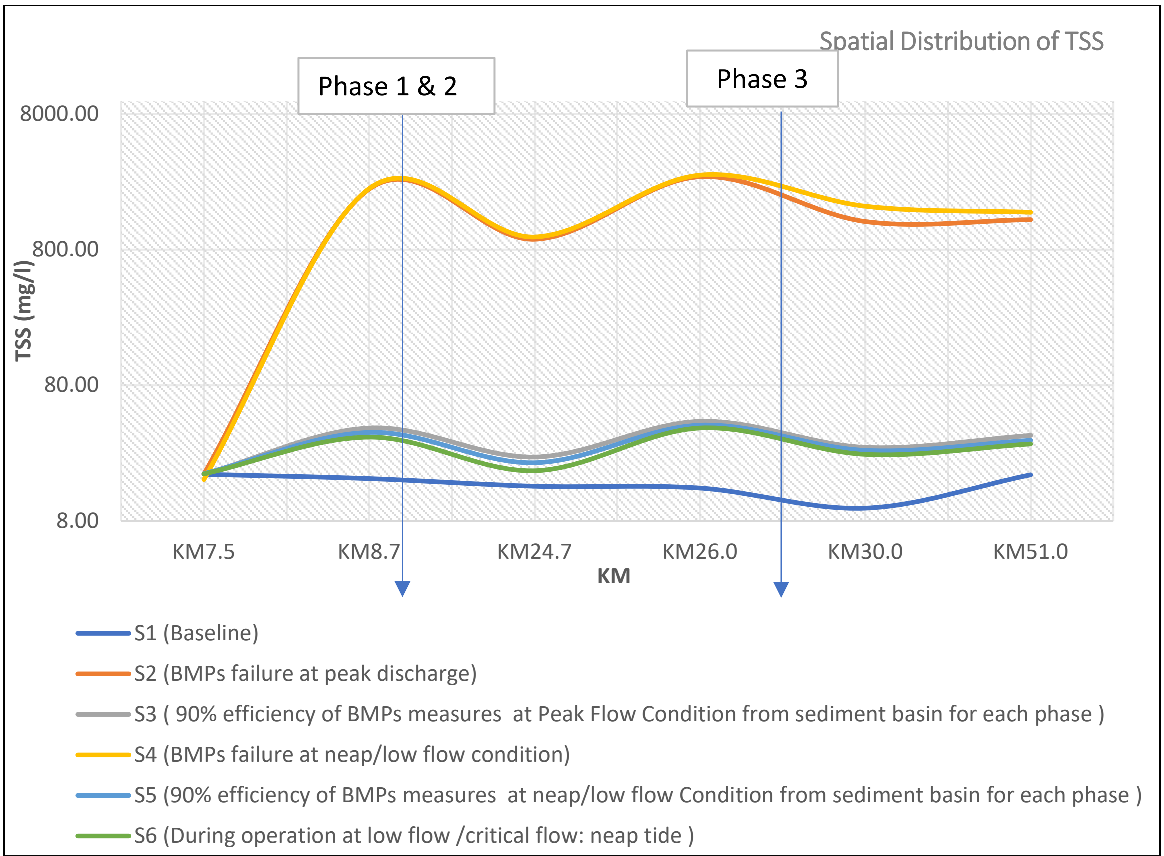


Figure 7-61: Result of Total Suspended Solids

Result summary

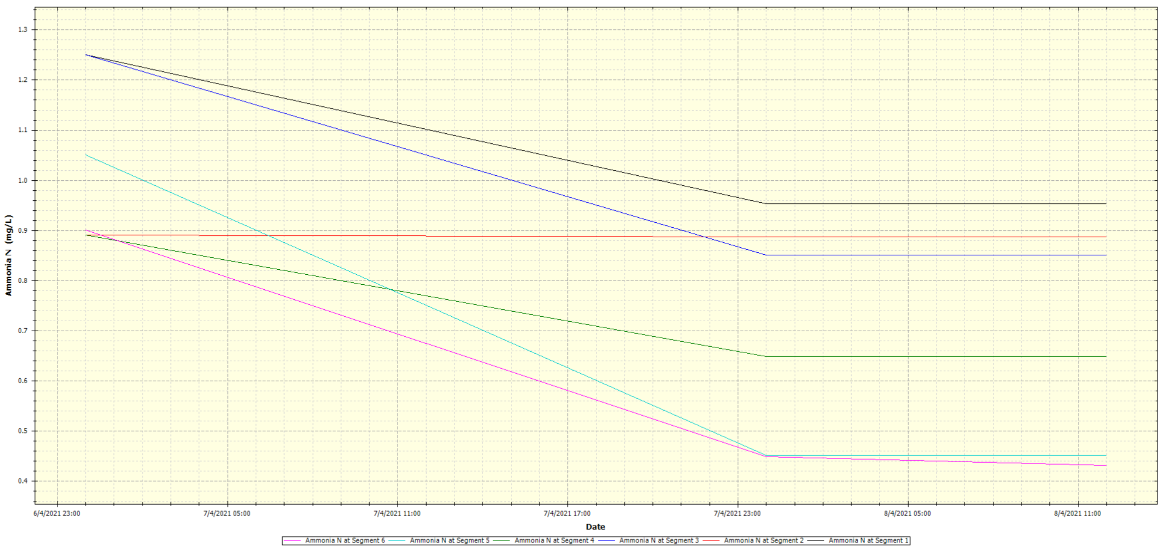
Summary of Water Quality Modeling (Comparison to limitation in NWQS):

Concentration at WQ8 (KM51.0)	Scenario 6: During operation at neap/low flow condition
1. Ammoniacal Nitrogen	0.581 Class III
2. Biochemical Oxygen Demand (BOD)	1.13 Class II
3. Nitrate	2.28 -
4. Total Phosphorus (TP)	0.372 -
5. Total Suspended Solid (TSS)	29.50 Class II
6.Aluminium (Al)	-
7. Arsenic (As)	-
8. Iron (Fe)	-
9.Manganese (Mn)	-

Temporal Distribution

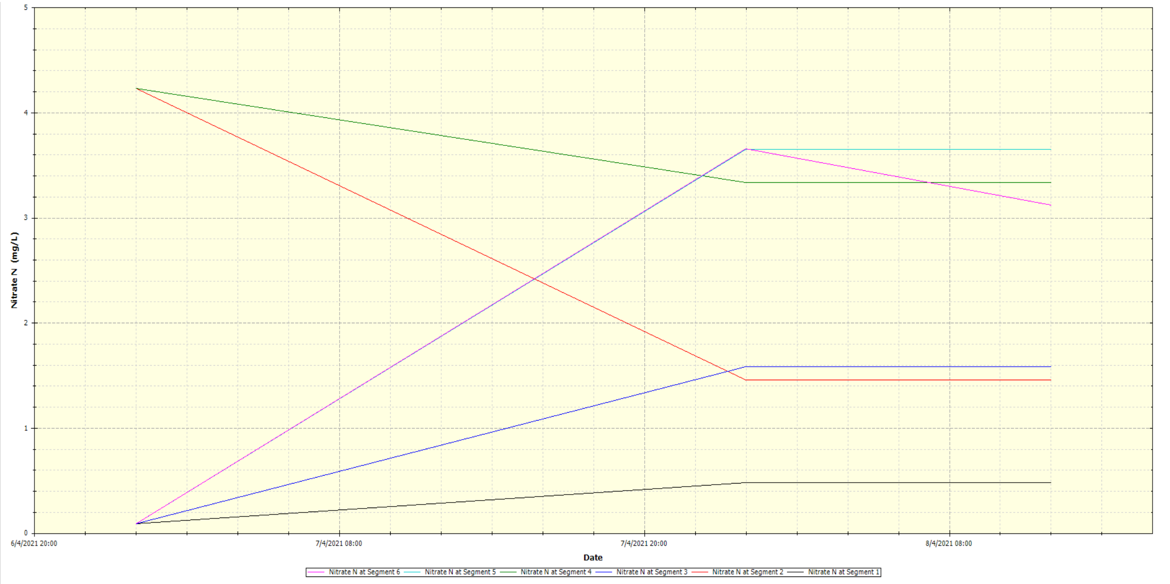
Ammoniacal nitrogen (AN)

Scenario 6



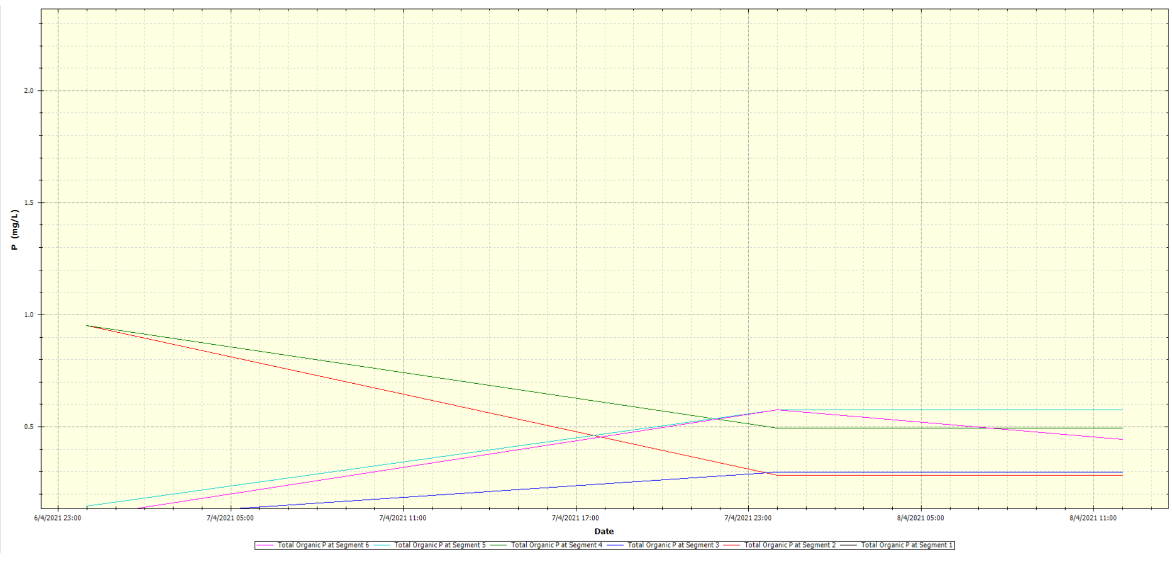
Nitrate

Scenario 6



Total Phosphorus

Scenario 6

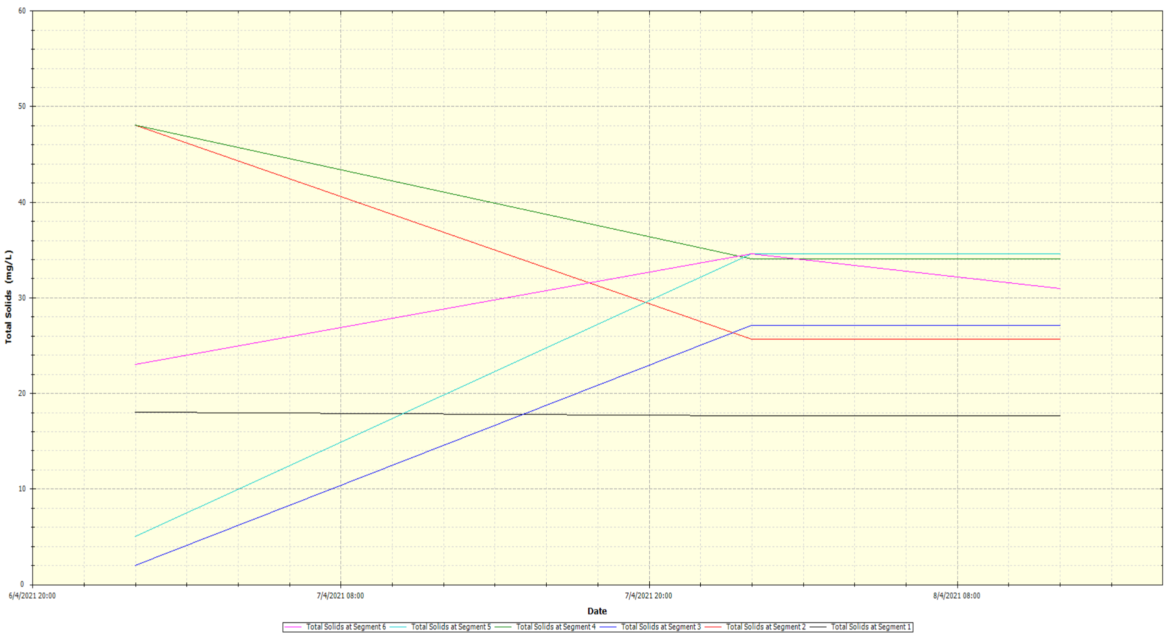


BOD

Scenario 6

Total Suspended Solid (TSS)

Scenario 6



7.3.2 Ambient Air Quality

During the operation stage, the maintenance and harvesting activity will include the process of manuring and controlling of disease, weed and pests. Once the oil palm plantation is established, air pollution will not be a major concern during the operations stage. Harvesting will be commencing within two (2) to three (3) years after field planting. The movement of vehicles and machinery during maintenance is reduced thus, dust dispersion will be low and not be significant.

Spraying of agrochemicals in controlling weeds, pests and diseases could introduce chemical pollutants into the air in the form of spray droplets suspended in the air and swept away by winds. Again, this source of atmospheric pollution is temporary in nature and can be easily minimized with proper control measures. Although the impacts of air pollution are temporary and short term, some mitigation measures are recommended.

7.3.3 Noise Level

Once the plantation area is in operation stage, the movement of vehicles and machinery during maintenance is reduced. Thus, noise pollution and noise annoyance are relatively insignificant and within the control range as compared to the standard requirements.

7.3.4 Scheduled Waste

Scheduled waste will be generated from maintenance work of equipment machinery. Wastes generated are mainly spent lubricants/oil and rags. These wastes will be segregated into scheduled and non-scheduled wastes and transported for final disposal. Improper disposal and management of scheduled wastes can result in contamination of rivers.

Empty fertilizer and pesticide containers are considered as scheduled waste and must be handled, stored and disposed in a proper manner in accordance to Environmental Quality (Scheduled Waste) Regulations 2005. The list of Scheduled Waste (SW) to be generated from this operation as follows:

- Spent Hydraulic Oil (SW 306)
- Spent Engine Oil (SW 305)
- Used Container (SW 409)
- Contaminated Cotton Rags, gloves and papers (SW 410)

It is anticipated that the scheduled waste would be minimal with proper storage and disposal practices in place, the impacts can be control.

7.3.5 Flora

During the operation phase, there will be no significant impact on flora as the oil palm tree have been planting and cover crop will be fully grown and established.

7.3.6 Fauna

Impact to wildlife at the operational is expected to be less significant. Impact probably expected to occurred from conflicts with elephant, wild boars and macaques that wanders through the plantation.

7.3.7 Fisheries

Planting activities involve transportation of planting materials, holling and planting the tree. Fertilization and herbicides use for immature palms would introduce chemicals such as nitrogen, phosphorus, ammonia and any type of pesticide used. Those chemicals would drift into the river through surface runoff especially after rain.

Exposed land is at high risk to be eroded especially after rain. Instead of logging, small bushed will be cleared for planting activities such as for nursery area preparation and fertilizer storage area.

7.3.8 Social Health

Potential Negative Impact

Disruption of Surrounding Community – Numbers of heavy vehicles is expected to be increased on the main road of 1399 Jalan Felda Nitar 1 and local road of 1398 Jalan Kilang Sawit Nitar during the planting and operational stages of

proposed development. This is due to the mobilization of machinery and equipment which required for site preparation, establishment of drainage systems and sedimentation basins, base camp establishment, logging and site clearing. The increase of heavy vehicles may disrupt the daily life of surrounding community especially residents of Kg Tanjung Tuan and FELDAs Nitar as they are located close to the proposed access road. The disruption is such as dust dispersion and noise annoyance from the lorry's mobilization. The heavy vehicles on the road tend to increase the travel time of the other road users as both local roads of 1398 and 1399 are single carriageway with only one lane for each direction. The heavy load vehicles also may damage the existing road, which disrupt the other road users.
In addition, the site clearing may cause the loss of wildlife habitat. This may cause the wildlife wandering to the site and human settlements, searching for food and new habitat. This issue will endanger the safety of the workers and locals.

Disruption to Fishermen Activity – Any negligence from the Project proponent during the planting phase may deteriorate the quality of the surrounding environment such as river pollution. The decreasing of river quality may affect the fishermen's daily catch especially lobster along the Endau River.

Health and Safety - The deteriorate of surrounding environment quality due to the dust dispersion may also affect the health of the locals, particularly residents of Kg Tanjung Tuan as they are using the same road as the access road of the Project. Moreover, if Project Proponent is hiring foreign workers, there will be risk of COVID-19 spreading among the workers and locals.

Both local roads of 1398 and 1399 are single carriageway with only one lane for each direction. Numbers of heavy vehicle along the narrow road especially Jalan Kilang Sawit Nitar may endanger the safety of the other road users.

Potential Positive Impact

Employment and Business Opportunities – The Project would likely create numbers of jobs from farmer to managerial positions. The creation of jobs will open job opportunities for the locals to fill. **Table 7-65** shows the total manpower during logging up to plantation stage are as follows: -

Table 7-65: Manpower Required

No.	Activity	Total Manpower
1.	Logging	8
2.	Site clearance up to plantation	13
	Total	**21**

(Source: Environmental Scoping Information (ESI), 2020.)

The creation of new business opportunities and will result in more population, which leads to the growth of retail stores, restaurants and facilities which would benefit the local and surrounding communities.

7.3.9 Application of Fertilisers and Pest Control

During the operations stage there will be a requirement for application of fertilisers and agrochemicals for plant growth and pest control.

Over usage or wrong application quantities of methods could cause them to be washed off into the water bodies. Since there is a water intake downstream, it is of utmost importance the uses of such chemicals are given much consideration. There could be a significant impact if proper usage and storage are not in place.

7.3.10 Harvesting

Upon maturing, the fruits are harvested and transported to buyers which are the local oil mills. Impacts are generally minimal as the fruits will be manually plucked, collected and transferred onto tractors prior to transporting to the potential buyers. Impacts are minimal as it is mainly a manual practice and tractors are used for transport. Safety of workers is a concern during harvesting as the fruit bunches can be stolen or attack from reptiles and mammals could occur.

The increase in vehicular movement could be a safety concern to the local road users.

7.4 REPLANTING STAGE

Replanting is only done when there is a requirement after the expected life span of the plantation. The life span of the plantation can go up to 26 years. The impacts during replanting will mainly be in relation to water quality and air emission due to land clearing causing exposed surfaces. Traffic would be higher due to transport of the vegetation and tree trunks out of the Project site.

7.5 ABANDONMENT STAGE

In the event the plantation has to be abandoned, the threes will be left as it is as a protection against erosion until the point of time the land has been designated for future use.

Minimal impacts are foreseen as mitigations measures will be taken to ensure site safety and prevention of pollution.