REPORT

Sediment Load Study

Agri-Food Innovation Park, Kranji Road, Singapore

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Executive Summary

CPG Consultants Pte. Ltd. (“CPG”) engaged Golder Associates (Golder) to undertake a Sediment Load Study (SLS) as part of the Environmental Baseline Study (EBS) for the Earthworks and Construction of Infrastructure at Agri-Food Innovation Park (AFIP) in Kranji Road, Singapore (the “Project”). The EBS comprises Fauna Baseline Study (FBS) (including development and implementation of a biodiversity monitoring program (BMP) (herein referred to in this Report as Environmental Management and Monitoring Plan (EMMP)) and SLS. The SLS was completed in accordance with the following:

- Golder proposal CX20434030-001-Rev1, dated 17 November 2020, as approved by CPG
- Inception Report 20434030-R001-Rev1, dated 23 March 2021, as approved by the National Parks Board (NParks)

The Project was required to undertake an EBS and EMMP implementation as a result of the Environmental Impact Assessment process. This Report describes the modelling work carried out for the SLS. The SLS was performed by Golder as EBS Consultant and Hydroinformatics Institute (H2i) as SLS Specialist.

The SLS aimed to show the movement of sediments through Sungei Pang Sua towards Johor Strait and to compare it with a baseline data. Specifically, the SLS aimed to present, through sediment transport modelling, that the total suspended solids (TSS) will not be more than 10% of the baseline at the river mouth or any identified sensitive receptors at the river mouth or along Sungei Pang Sua.

Surface water sampling and analysis were conducted at two sampling locations. Water sampling was carried out on 23 February 2021 and 12 March 2021. The sampling locations were selected to get representative downgradient and upgradient data at the mouth of Sungei Pang Sua (SP1) and Discharge Point 2 (SP2), respectively. Surface water sampling was carried out during dry weather conditions (“dry weather”) and immediately after rainfall (“after rain”). Water samples were collected by grab sampling. Collected water samples were placed in laboratory-provided sample bottles and sent to an accredited laboratory for analysis of TSS. Based on the laboratory results, level of TSS at SP2 increased by 97% after the rainfall event, while TSS level at SP1 decreased by 36% during the same rainfall event. Variation in the observations at SP2 was likely due to additional sediment load from the catchment area during rainfall. Sea water quality at SP1 was expected to be a more dominant factor of the governing water quality.

A 1D SOBEK hydraulic model with a transport module for suspended solids was used to model the movement of sediments through Sungei Pang Sua all the way to the mouth of Sungei Pang Sua. The study used an existing calibrated SOBEK model that was developed previously for a past project with JTC, with the latter’s approval. The model simulated the worst-case scenario for SLS study, where the rainfall runoff from DP1 and DP2 discharges into Sungei Pang Sua with 50 mg/L TSS. There were two scenarios in this SLS study. In Scenario 1, the rainfall occurs at the time where the seawater level is the highest (at 6am to 9am). In Scenario 2, the rainfall occurs at the time where the seawater level is the lowest (2 – 5am).

Based on the sediment load modelling performed, the highest percentage increase of TSS concentration in Sungei Pang Sua is 19.2% at the mouth of Sungei Pang Sua when compared to the lowest baseline TSS concentration, in the condition where there is low seawater level (mRL). Although the increase of TSS concentration is higher than the 10% of the baseline at the mouth of Sungei Pang Sua, it only lasts for 30 minutes before the TSS concentration drops to less than 10% of the baseline in both scenarios.

The modelling study evaluated the impact on sediment load caused by the development of Kranji AFIP in the vicinity during construction and operational stages. Land clearing and earthworks during construction and potential discharges from the facilities during Project operation may impact the TSS quality in Sungei Pang Sua. The result of the modelling study is applicable to both construction and operational stages, provided that the rainfall runoff from DP1 and DP2 discharges into Sungei Pang Sua with a maximum concentration of 50 mg/L TSS. The assumed concentration was applied as the worst-case scenario in the model, which is also the maximum allowable discharge limit to a watercourse as per local regulations. Based on the results of the SLS, the impact of the proposed development to sediment loading is Minor.

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1.0 INTRODUCTION

CPG Consultants Pte. Ltd. (“CPG”) engaged Golder Associates (Golder) to undertake a Sediment Load Study (SLS) as part of the Environmental Baseline Study (EBS) for the Earthworks and Construction of Infrastructure at Agri-Food Innovation Park (AFIP) in Kranji Road, Singapore (the “Project”). The EBS comprises Fauna Baseline Study (FBS) (including development and implementation of a biodiversity monitoring program (BMP) (herein referred to in this Report as Environmental Management and Monitoring Plan (EMMP)) and SLS. The SLS was completed in accordance with the following:

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Results of the FBS is presented in a separate report.

1.1 Project Description

JTC Corporation (“JTC") is the Master Developer of AFIP Phase 1 (**Figure 1**), and CPG is the consultant for infrastructure development. The main construction contract for AFIP Phase 1 infrastructure works was awarded to Huationg Contractors Pte Ltd. (“Huationg”).

AFIP is located within the greater Sungei Kadut area and will form part of a larger Northern Agri-Tech and Food Corridor. AFIP is intended to be a pilot cluster to catalyse innovation in the food- & agri-tech ecosystems and to bring together high-tech urban indoor farming, food production including alternative proteins, and associated research and development activities.

Based on the Masterplan 2019, AFIP Phase 1 consists of a total land area of approximately 25 hectares (ha), of which 18.75 ha is allocable.. The land will require existing high grounds to be cut and surplus earth disposed off-site, with the earliest site allocation expected to be in 2023. No fill materials will be brought onsite.

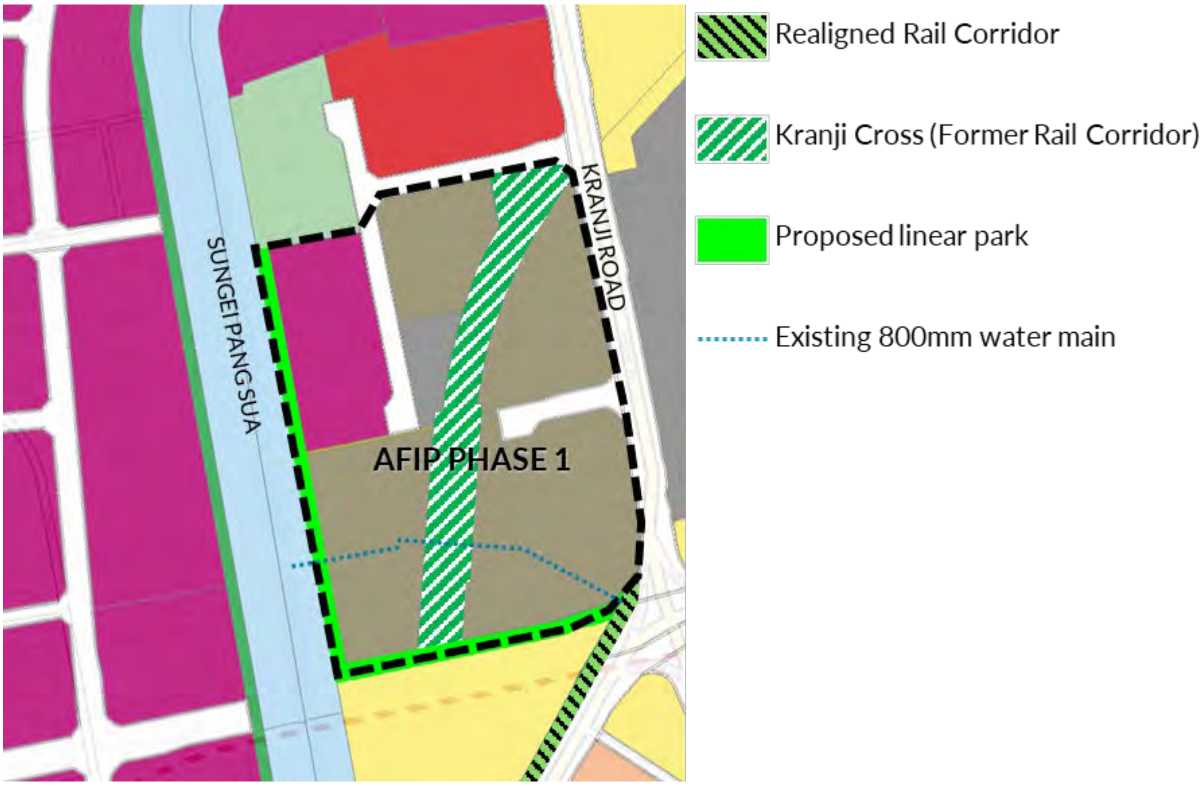

Figure 1: AFIP Phase 1

The Project area is bound by Kranji Close in the north, Kranji Road in the east, MRT track in the south and Sungei Pang Sua in the west (Figure 2). As of submission of this SLS Report, the construction works at the Project area has been put on hold since 16 February 2021. No activities were being undertaken at the Project area.

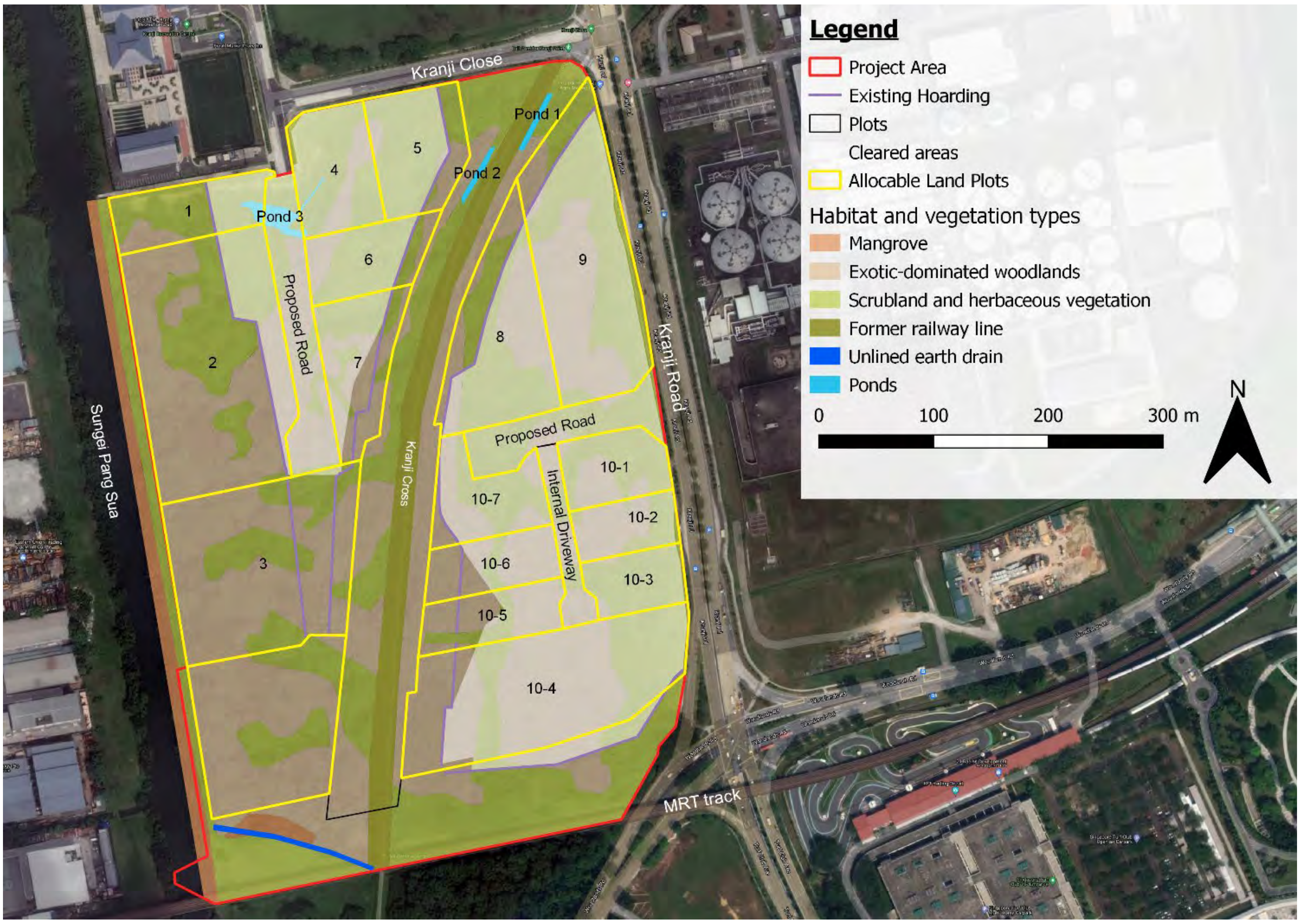

Figure 2: AFIP Phase I (Project area)[1]

1.1.1 Project Construction

AFIP Phase 1 is planned for allocation to food- and agri-tech companies from 2023. The sequence of work for the infrastructure works in this development is as follows:

- Cutting of vegetation and levelling of land beside Kranji Road
- Cutting of vegetation and levelling of land beside Kranji Close
- Construction of new roads and associated roadside drains
- Diversion of existing 700-millimetre (mm) diameter raw water pipeline which cuts through the land parcels into the proposed 15.0 m wide Park Connector
- Laying and construction of new 800-mm diameter raw water pipeline, demolition of existing 700-mm diameter pipeline
- Construction of a trapezoidal drain

The proposed drainage system includes construction of reinforced concrete (RC) U drain, RC box culvert, RC sump and trapezoidal drain. The proposed construction sequence is presented in the Method Statement for Cast In-Situ Drainage Works, which was prepared by Huationg and approved by CPG on behalf of JTC in June

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[1] Cleared areas presented in Figure 2 include both cleared and partially cleared areas. Land plot boundaries are indicative and figures throughout the report may show different variations of the plots.

2020, as presented in **Appendix A**. At the time of this SLS Report, construction stop work order was in place since 16 February 2021.

The Project area currently operates a total of five earth control measure (ECM) systems, each equipped with a Silt Imagery Detection System (SIDS), in accordance with PUB requirements. A layout of the ECM systems is presented in **Figure 3**. ECM1 and ECM2 discharge to Kranji Close while ECM3, ECM4 and ECM5 discharge to Kranji Road. The Project area does not discharge to Sungei Pang Sua during construction stage.

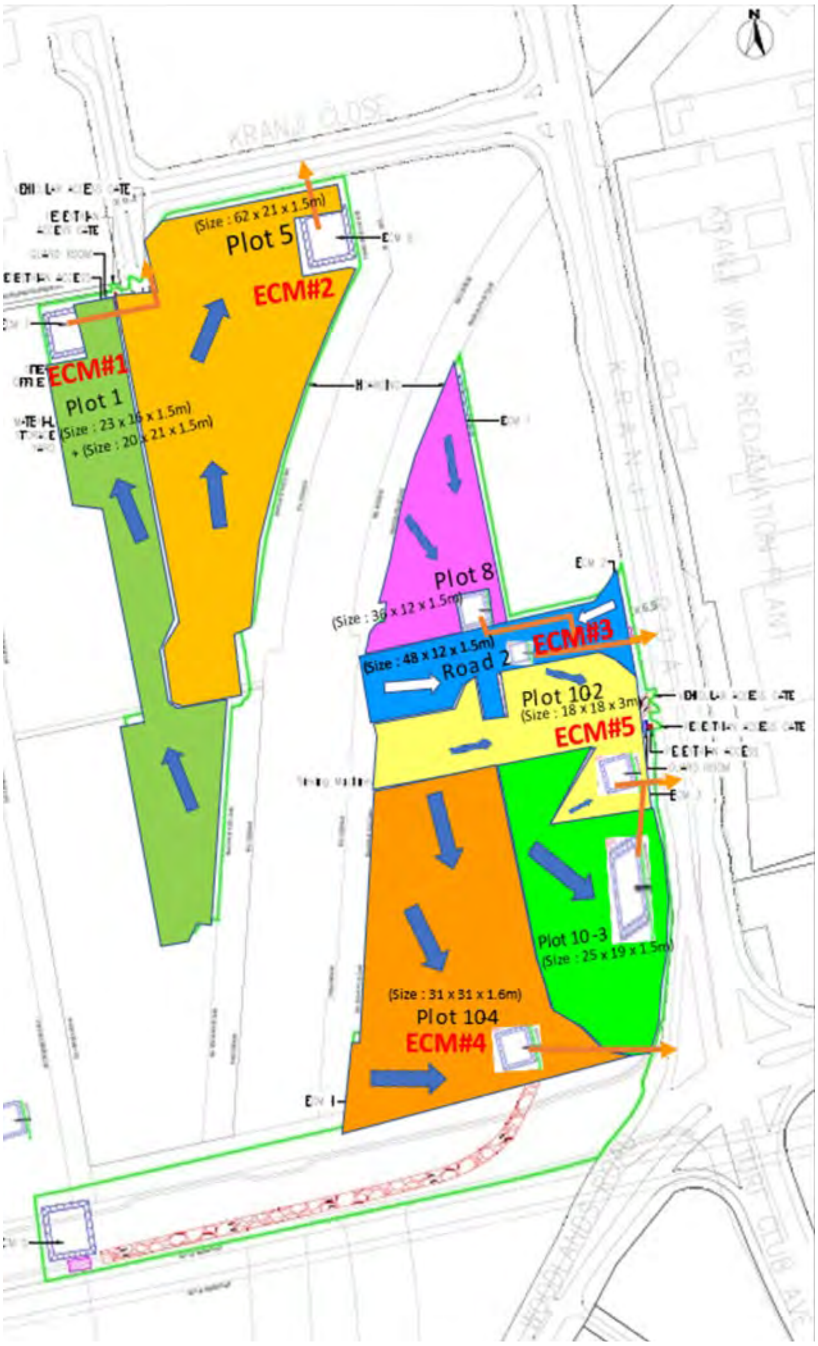


Figure 3: Layout of Project Area ECM Systems

1.1.2 Project Discharges

The SLS considered a study area comprising the stretch of Sungei Pang Sua starting from immediately upstream of the Project area to the river mouth (**Figure 4**) (herein referred to as the Study Area).

Figure 4: Flow of water in Sungei Pang Sua to the mudflat at the river mouth (red solid line) and Project area (yellow dashed line)

There are two runoff discharge points from the Project area to Sungei Pang Sua (**Figure 5)**. Discharge Point 1 and Discharge Point 2 are located in the north and immediately upstream of the Project area, respectively. Both discharge points will be used during the Project operational stage.

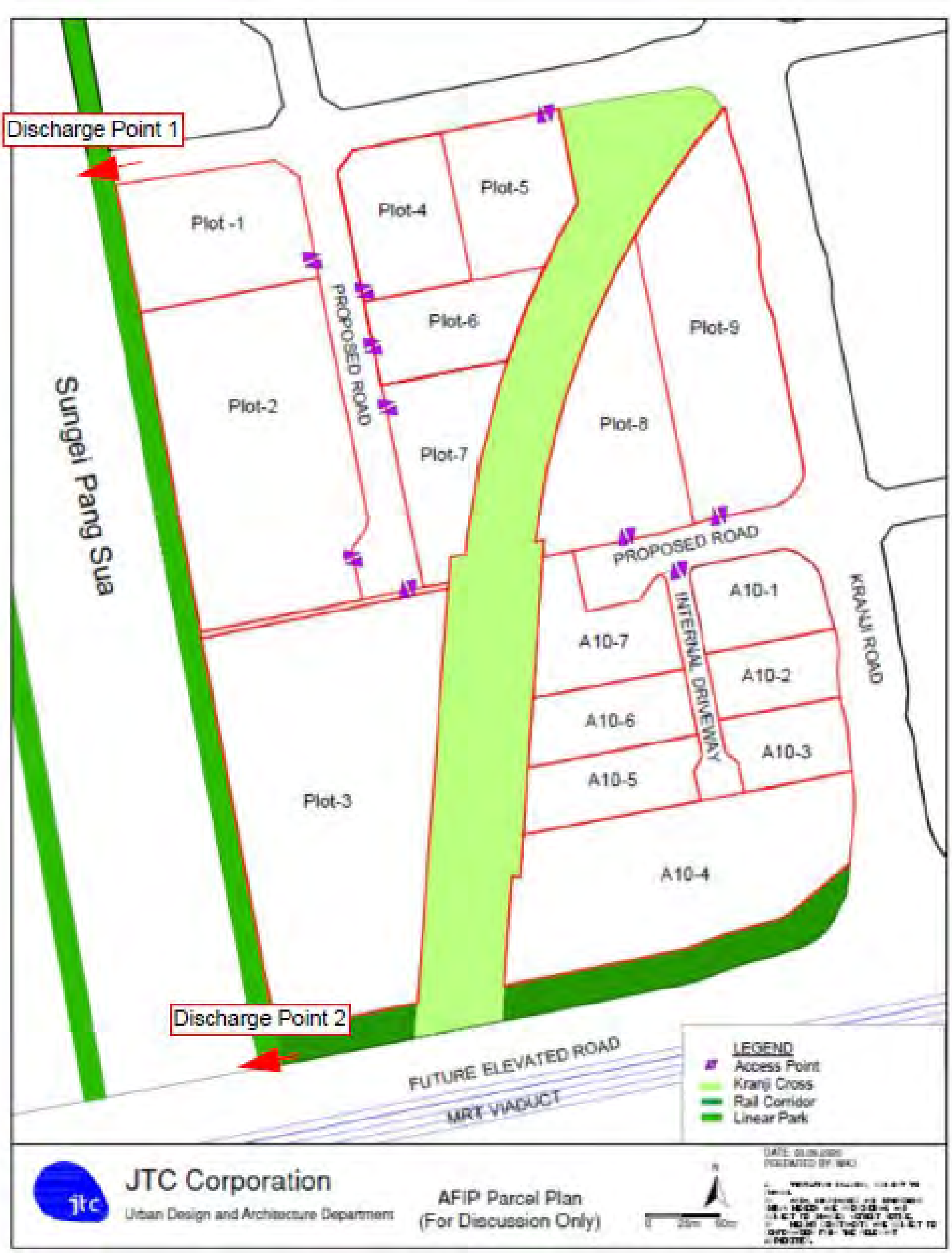


Figure 5: Locations of Discharge Point 1 and Point 2

2.0 SEDIMENT LOAD BASELINE STUDY

2.1 Total Suspended Solids Data Collection

Surface water sampling and analysis were conducted at two sampling locations. The sampling locations are described in **Table 1**. Water sampling was carried out on 23 February 2021 and 12 March 2021. The sampling locations were selected to get representative downgradient and upgradient data at the mouth of Sungei Pang Sua (SP1) and Discharge Point 2 (SP2), respectively. The sampling locations are presented in **Figure 6.**

Table 1: Surface water sampling locations

Sampling Location	Description	Coordinates	
		Latitude	Longitude
SP1	Sampling depth of 1 m	1.435898°	103.752871°
SP2	Sampling depth of 1 m	1.422284°	103.753067°

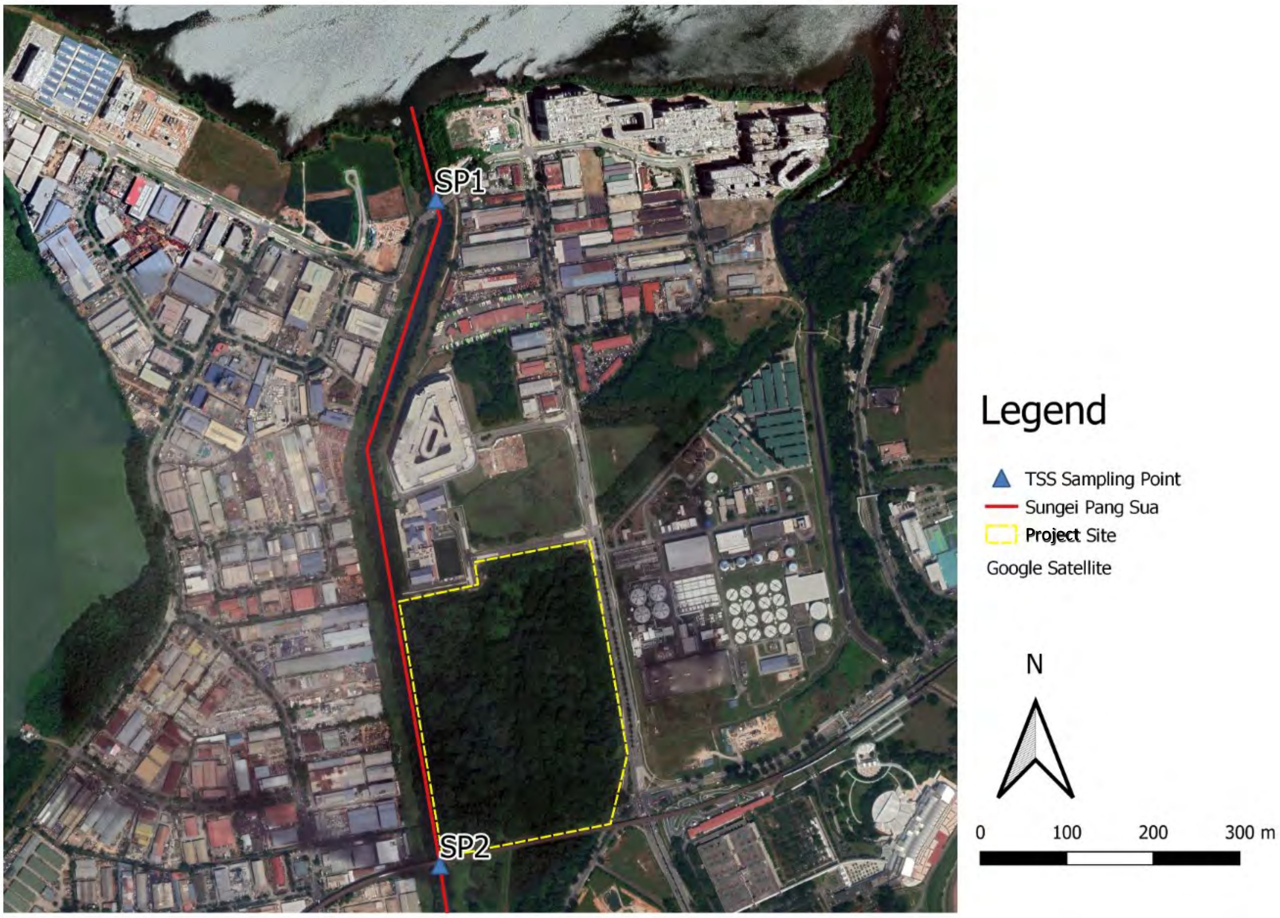


Figure 6: Surface water sampling locations

Surface water sampling was carried out during dry weather conditions (“dry weather”) and immediately after rainfall (“after rain”). Water samples were collected by grab sampling. Collected water samples were placed in laboratory-provided sample bottles and sent to an accredited laboratory for analysis of TSS.

Based on the laboratory results, the level of TSS at SP2 increased by 97% after the rainfall event, while TSS level at SP1 decreased by 36% during the same rainfall event. The increase in the observations at SP2 was likely due to additional sediment load from the catchment area during rainfall, whereas at SP1, seawater quality is expected to be a more dominant factor of the governing water quality. **Table 2** presents a summary of the TSS samples and laboratory results. The laboratory results are provided in **Appendix E.**

Table 2: Summary of TSS concentrations

Location	TSS concentration (mg/L TSS)	
	Dry Weather	After Rain
SP1	28 (Sample ID 8002)	15 (Sample ID 8004)
SP2	29 (Sample ID 8001)	57 (Sample ID 8005)

For quality assurance/quality control (QA/QC) purposes, duplicate samples were collected during each sampling event. Sample ID 8003 was taken from SP1 during the dry weather sampling while sample ID 8006 was taken from SP1 during the after rain event. Based on the laboratory results, the relative percentage difference (RPD) between primary and duplicate samples ranged from 18% to 28%, which shows that field QA/QC meets the surface water sampling quality objectives and do not indicate any quality issues on the field sampling activities. The surface water sampling activity followed Golder’s standard operating procedures and no deviations were reported.

Analytical results, including field QA/QC samples, as well as chain of custody documentation are attached in **Appendix E**.

2.2 Model Set-up

A 1D SOBEK hydraulic model with a transport module for suspended solids was used to model the movement of sediments from Sungei Pang Sua in the vicinity of the Site, through to the mouth of Sungei Pang Sua (**Figure 4**). The study used an existing calibrated SOBEK model that was developed previously for a past project with JTC, with the JTC’s approval.

The following subsections present the modelling assumptions and approach applied in this SLS.

2.2.1 Sub-Catchment Delineation

The sub-catchment delineation from the existing SOBEK model was further refined around the Project area. (**Figure 7**).

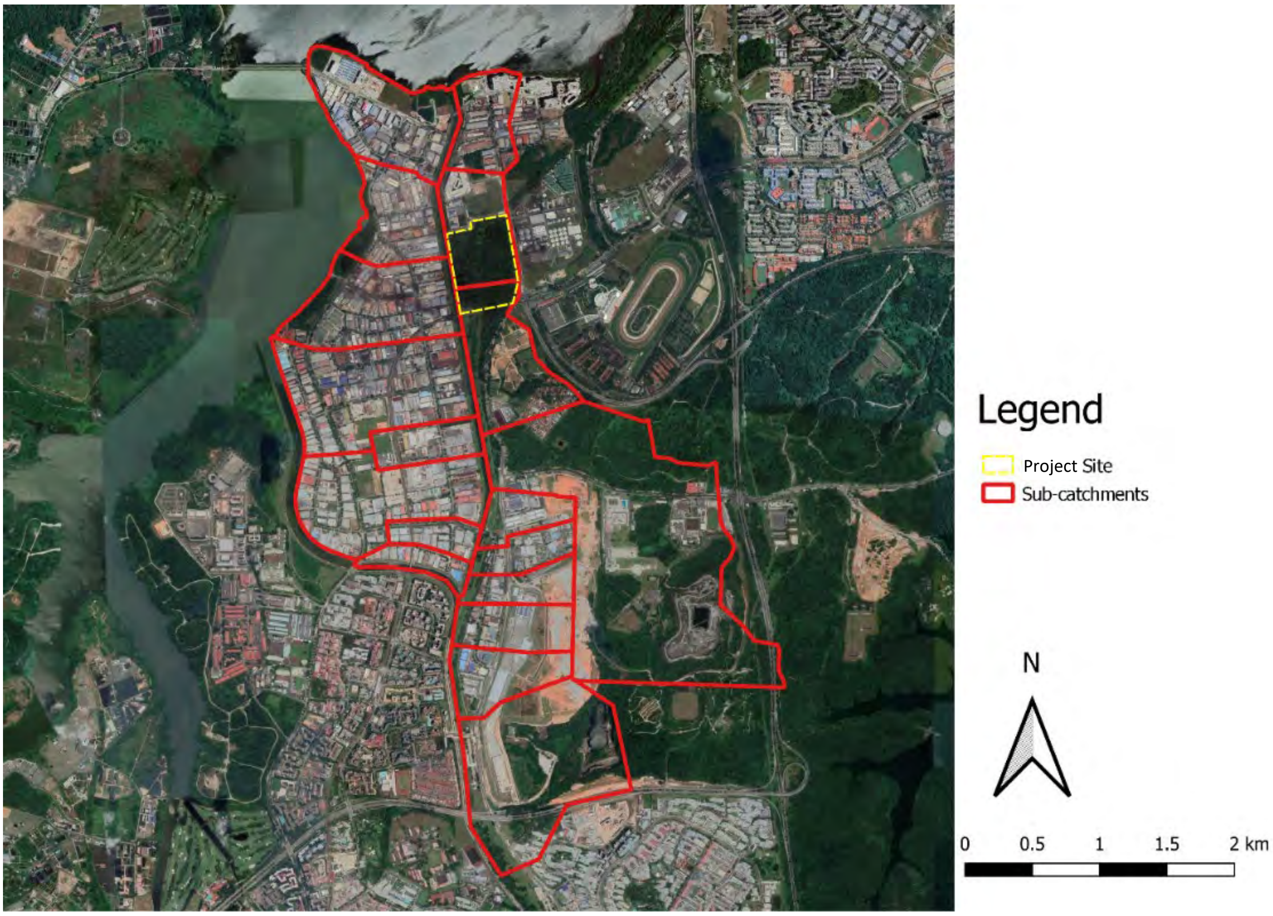
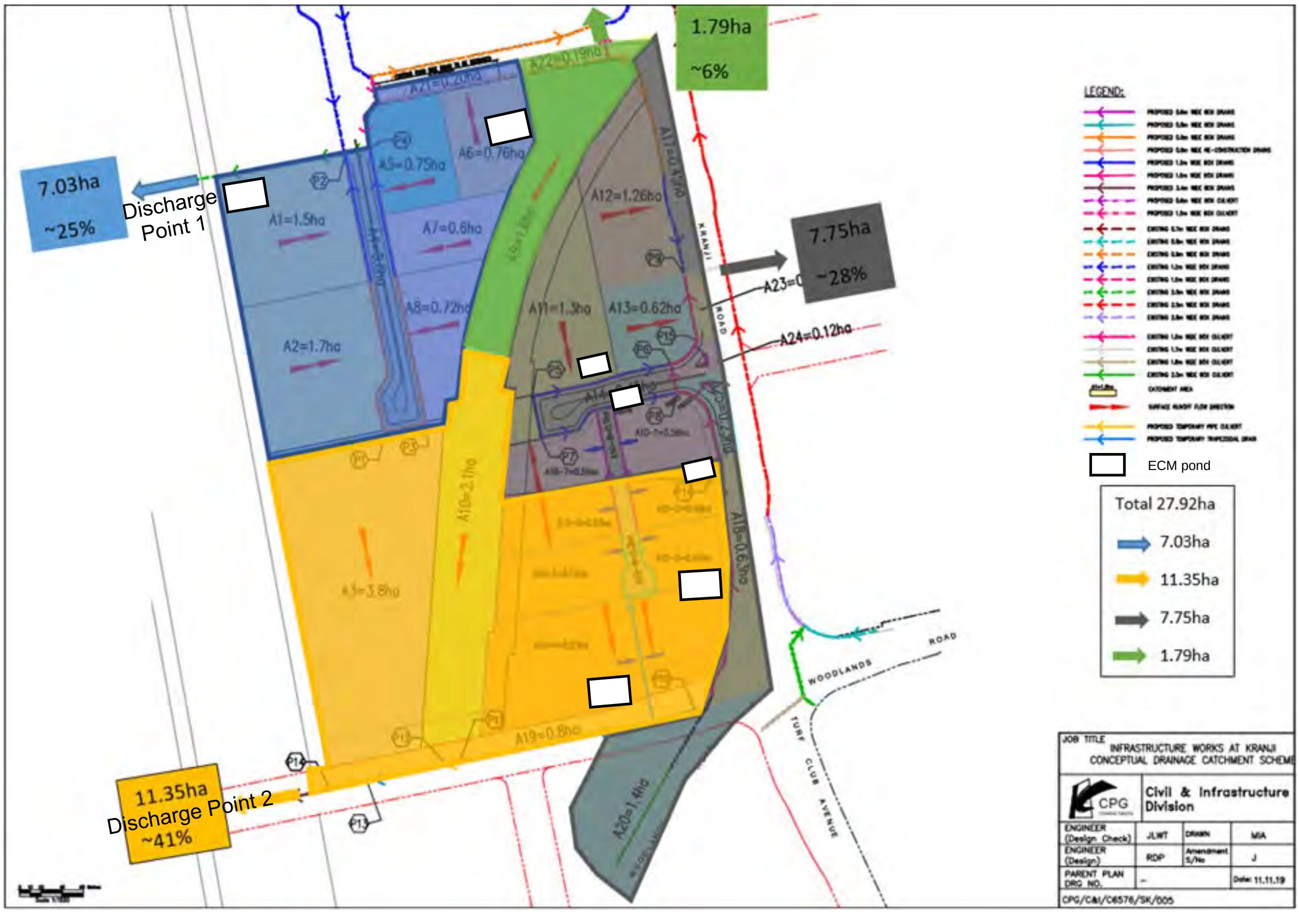


Figure 7: Original sub-catchment delineation in existing SOBEK model

The Project area is divided into four parts (**Figure 8**) with each part having one ECM pond. Only runoff from two ECM ponds, which are presented in blue and orange areas in **Figure 8** are discharged into Sungei Pang Sua. Runoff from the northwest area (blue) is discharged into Sungei Pang Sua through Discharge Point 1 while runoff from the southern area (orange) is discharged to Discharge Point 2.



Source: CPG

Figure 8: Project area catchment area

As the runoff from the green and grey areas presented in **Figure 8** are not flowing into Sungei Pang Sua, these areas were not presented in the model schematization. In this regard, the existing sub-catchment delineation was refined to divide the parcel into two parts, including Discharge Point 1 (DP1) and Discharge Point 2 (DP2) (**Figure 9**), with areas of 7.03 hectares (ha) and 11.35 ha, respectively.

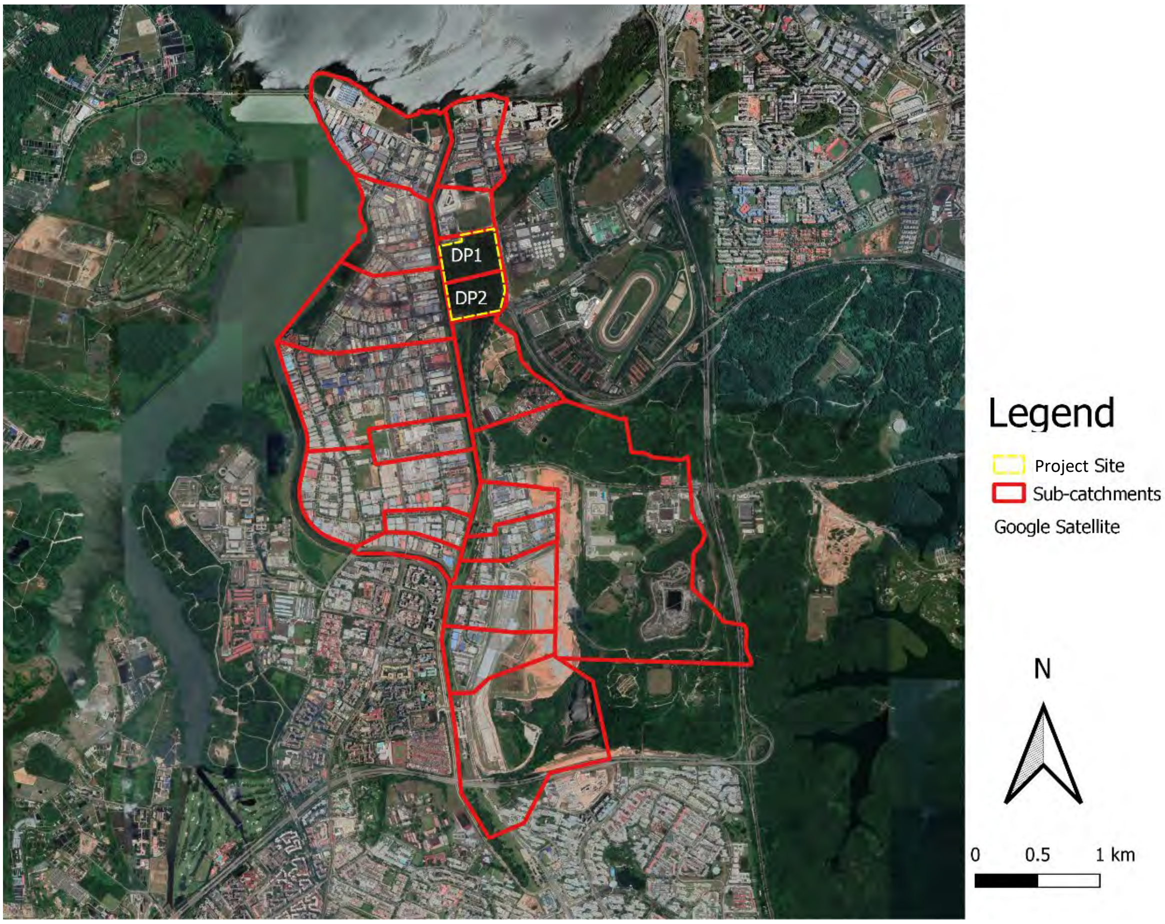


Figure 9: Refined sub-catchment delineation

2.2.2 Rainfall-Runoff Node

Catchment runoff is an important driver for and factor to determine sediment transport. Determining the amount of total runoff that will flow into the sea during a rainfall event is important to ascertain the concentrations of TSS in the water along Sungei Pang Sua.

In the SOBEK schematization, all sub-catchments in the Sungei Pang Sua catchment were presented with a rainfall-runoff node (**Figure 10**). Each blue node circled with red shows rainfall-runoff node and represents a sub-catchment. The settings for rainfall runoff node used the same settings from an existing calibrated model, with the exception of the Project area. The settings for DP1 and DP2 are redefined in this study due to the change in land use category of the Project area.

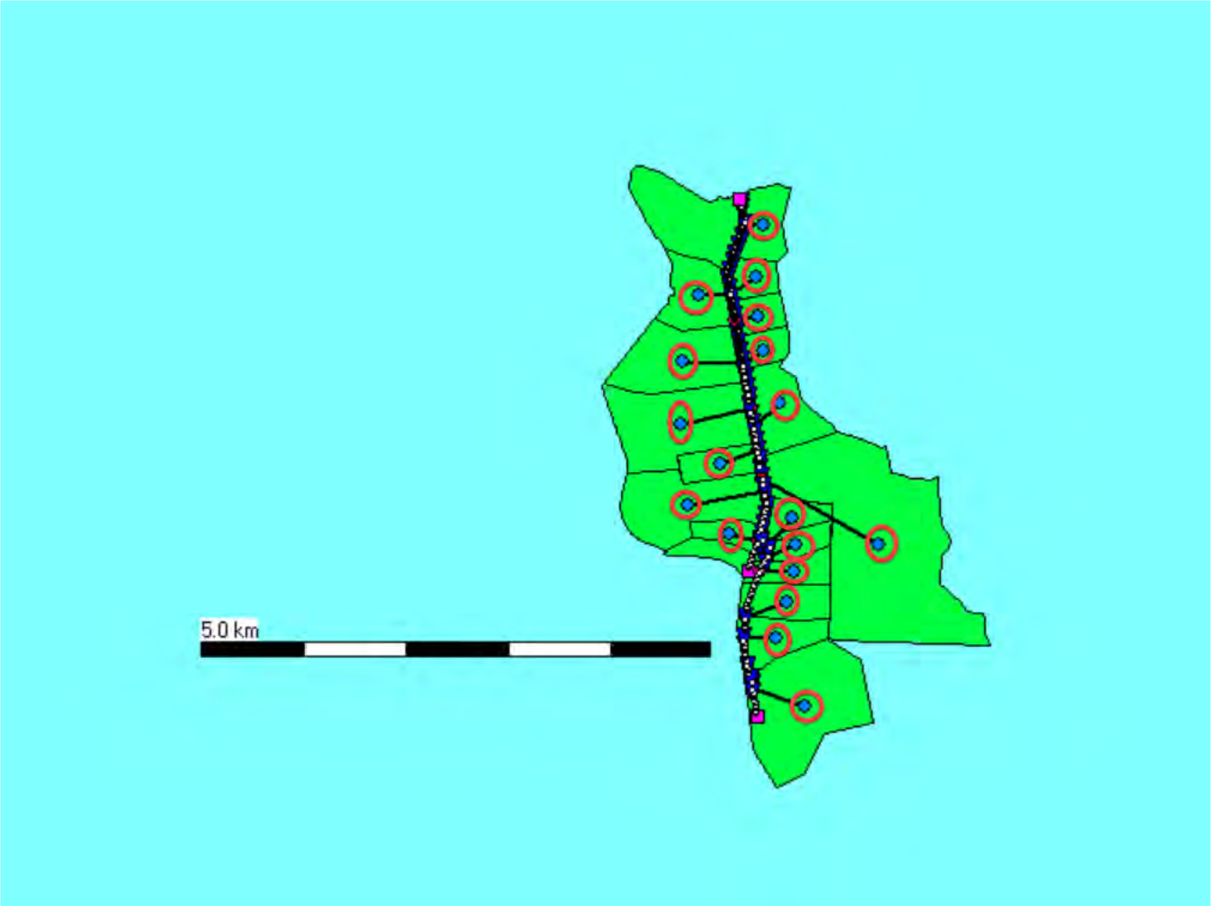


Figure 10: SOBEK schematization in Sg. Kadut catchment

2.2.2.1 Land Use Categories

Land use of the sub-catchments represented was defined in each rainfall-runoff node. There are up to twelve (12) different land-uses that can be defined in SOBEK (**Figure 11**). In the existing model, the land use for each sub-catchment was adjusted and modified to represent the current land use. Hydrological parameters such as storage, runoff delay coefficient, and infiltration were specified and calibrated for every land use category in the year 2017 (**Figure 12**).

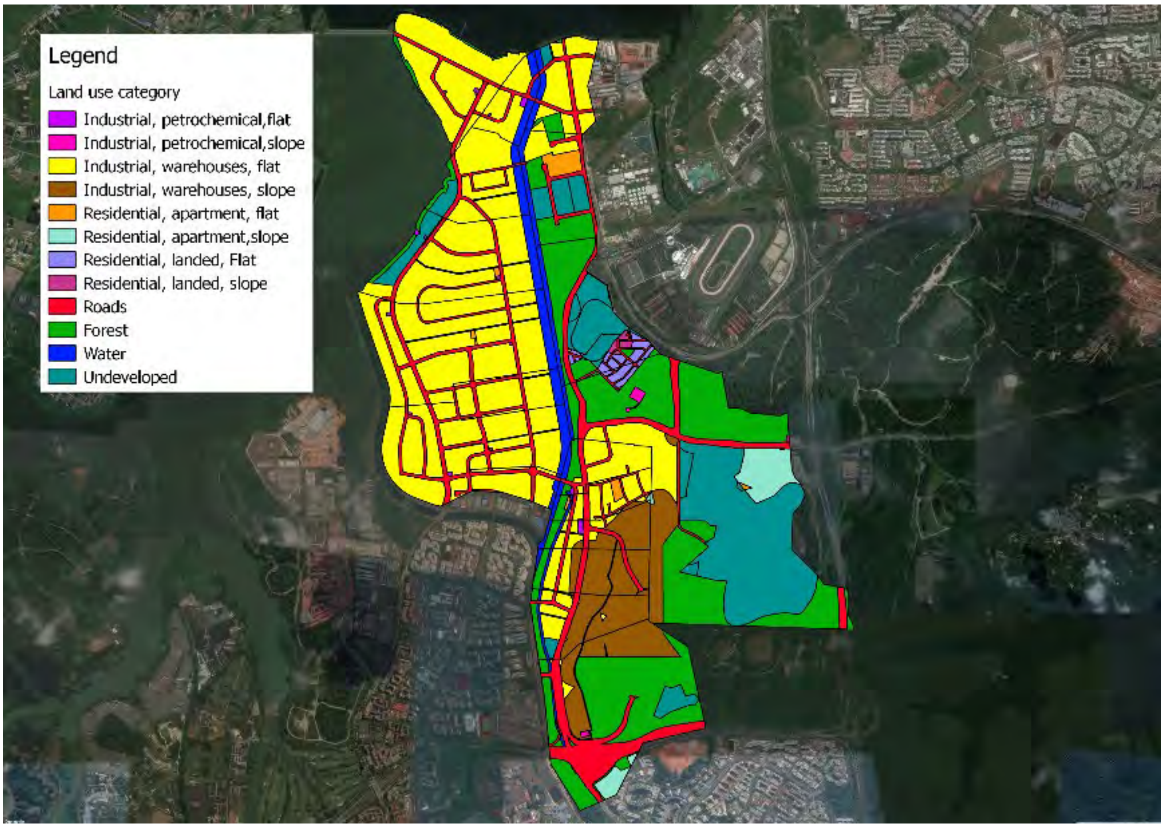
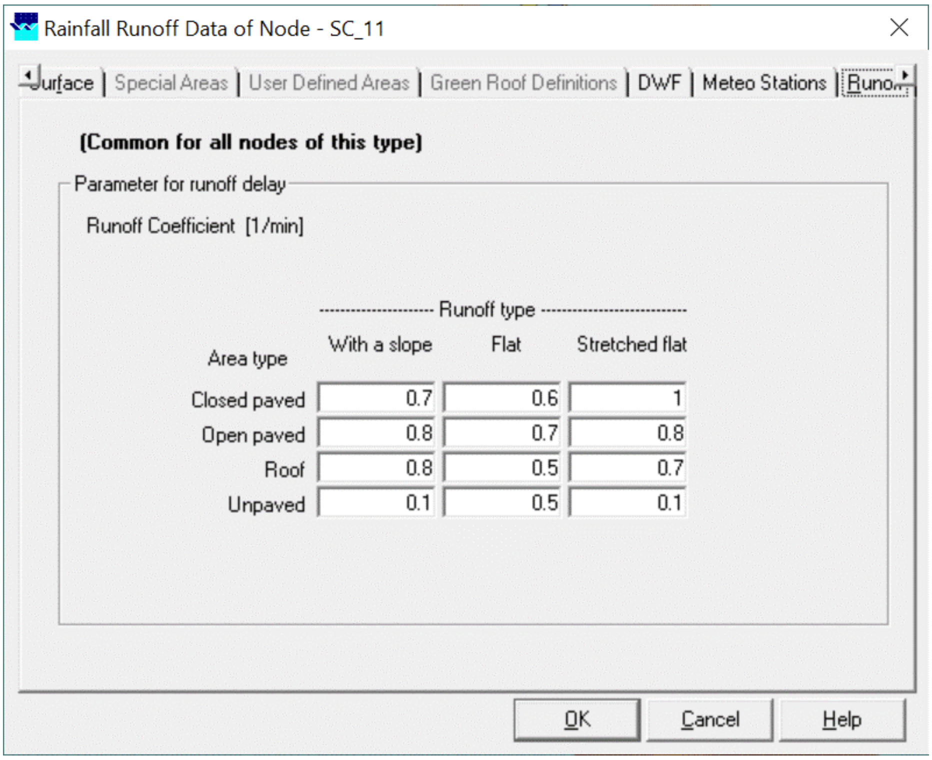


Figure 11: Land use categories in the vicinity of the Project area as defined in SOBEK



(Common for all nodes of this type)

Parameter for runoff delay

Runoff Coefficient [1/min]

	Runoff type		
Area type	With a slope	Flat	Stretched flat
Closed paved	0.7	0.6	1
Open paved	0.8	0.7	0.8
Roof	0.8	0.5	0.7
Unpaved	0.1	0.5	0.1

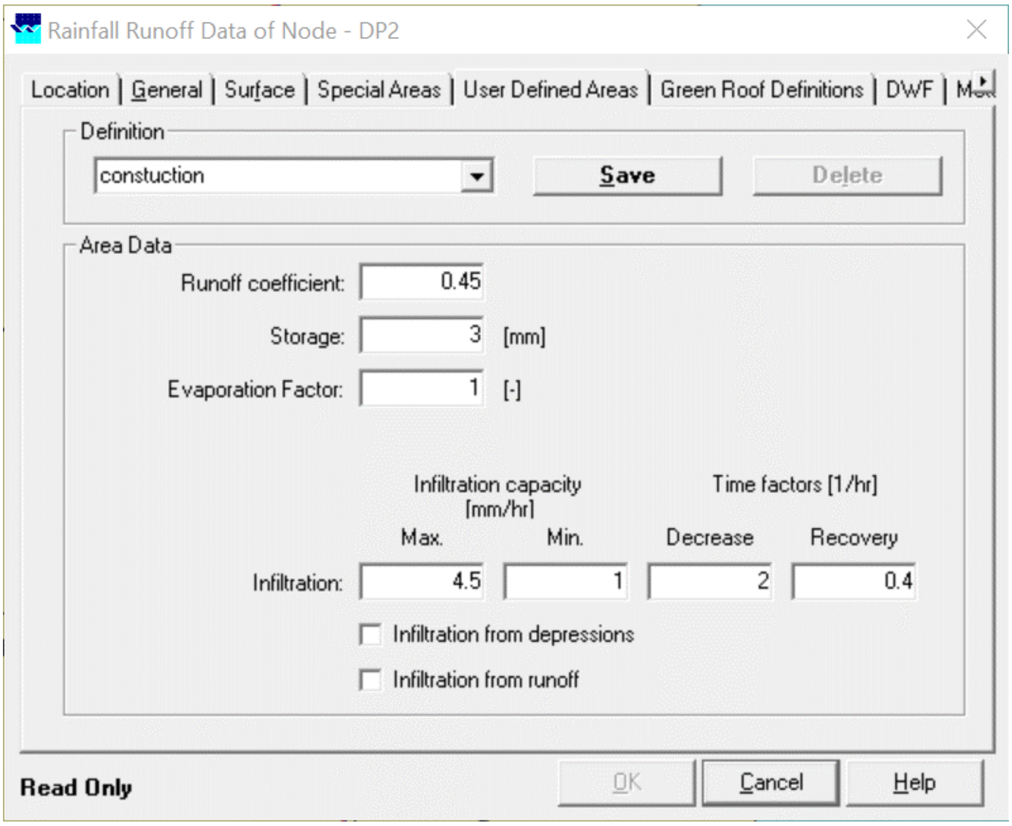
Figure 12: Example of land-use implementation for a rainfall-runoff node in SOBEK

The land use type of the Project area during construction phase does not fall under any categories defined in existing model setup. The Project area's original land use type is forest, and the parameters for the construction phase were set based on this assumption.

Other hydrological parameters set for the Project area in the construction phase are as follows (**Figure 13**):

- Runoff coefficient – 0.45, which is the runoff coefficient used for the calculation of estimated maximum sediment load from CPG (**Appendix B)**
- Storage coefficient – 3mm (storage coefficient for forest land use is 5mm)
- Infiltration capacity – 4.5 mm/hr (infiltration capacity for forest land use is 5 mm/hr)

The modelled peak discharge from DP1 and DP2 were 1.98 m^3/s and 2.7 m^3/s, which are aligned to the peak runoff calculation[2] provided by CPG (**Appendix B**) using Rational method as per the Public Utilities Board (PUB) Code of Practice (COP) on Surface Water Drainage.



Definition: constuction

Area Data

Runoff coefficient: 0.45

Storage: 3 [mm]

Evaporation Factor: 1 [-]

	Infiltration capacity [mm/hr]		Time factors [1/hr]	
	Max.	Min.	Decrease	Recovery
Infiltration:	4.5	1	2	0.4

☐ Infiltration from depressions

☐ Infiltration from runoff

Read Only

Figure 13: Example of special area and relevant parameter coefficients are defined in SOBEK

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[2] 1.802 m^3/s for DP1 and 2.796 m^3/s for DP2

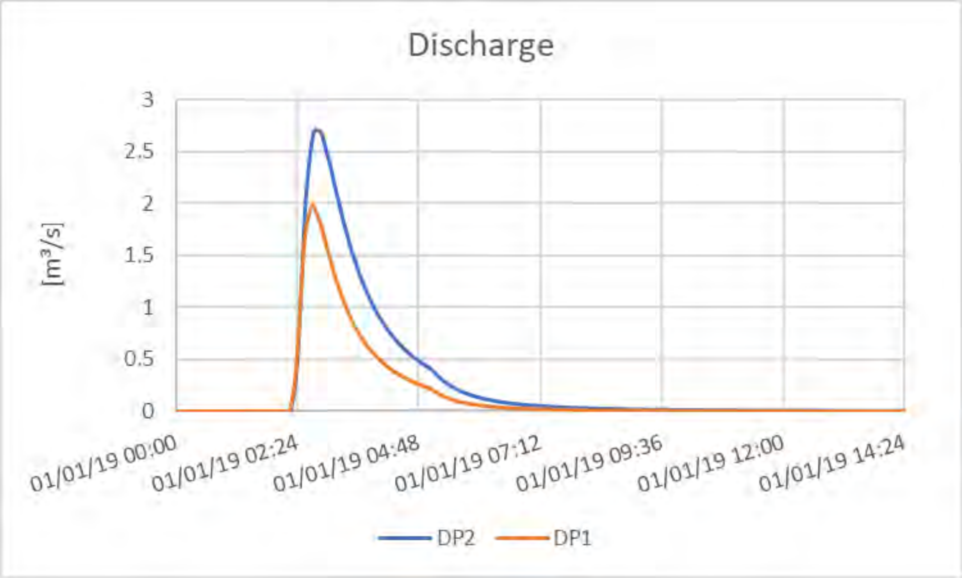

Figure 14: Discharge [m³/s] from DP1 and DP2, similar to the calculated values from Rational method

2.2.3 Implementation of 1DWAQ Module

The 1DWAQ module in SOBEK module was used to define the load of TSS in DP 1 and DP 2. The concentration of TSS in the discharge from the Project area was defined according to the maximum allowable TSS concentration (50 mg/L TSS) in the module.

CPG provided site investigation data[3], which was the basis of sediment particle size distribution data for DP1 and DP2. Particle size distribution curves of Samples TW 1T and TW 1B were used as these were taken closest to the surface layer. This information was used to define the settling velocity and the critical bed shear stress in the model.

The critical shear stress values are obtained based on the particle diameters D_{50} (U.S. Geological Survey, 2008). A semi-empirical formula from Soulsby (1997) was used to calculate the settling velocity.

Table 3 shows the critical shear stress and settling velocity values calculated for soil samples TW1B and TW1T. The values from TW1B are used as input for the model because soil sample TW1B has smaller D_{50} , which leads to smaller critical bed shear stress (0.06 N/m²) and smaller settling velocity (15 m/d). Thus, this is the most conservative scenario to compare with baseline TSS value. Smaller critical bed shear stress means resuspension processes are easier to occur than sedimentation, and a smaller settling velocity will lead to a smaller sedimentation flux. The maximum settling velocity in the SOBEK 1DWAQ module is 10 m/d. Hence this was used for the model.

Table 3: Critical shear stress and settling velocity for soil sample TW1B and TW1T

Sample no.	D50	Particle density [Mg/m³]	Critical bed shear stress [N/m²]	Settling Velocity [m/d]
TW1B	0.015	2.57	0.0630 -0.0826	15

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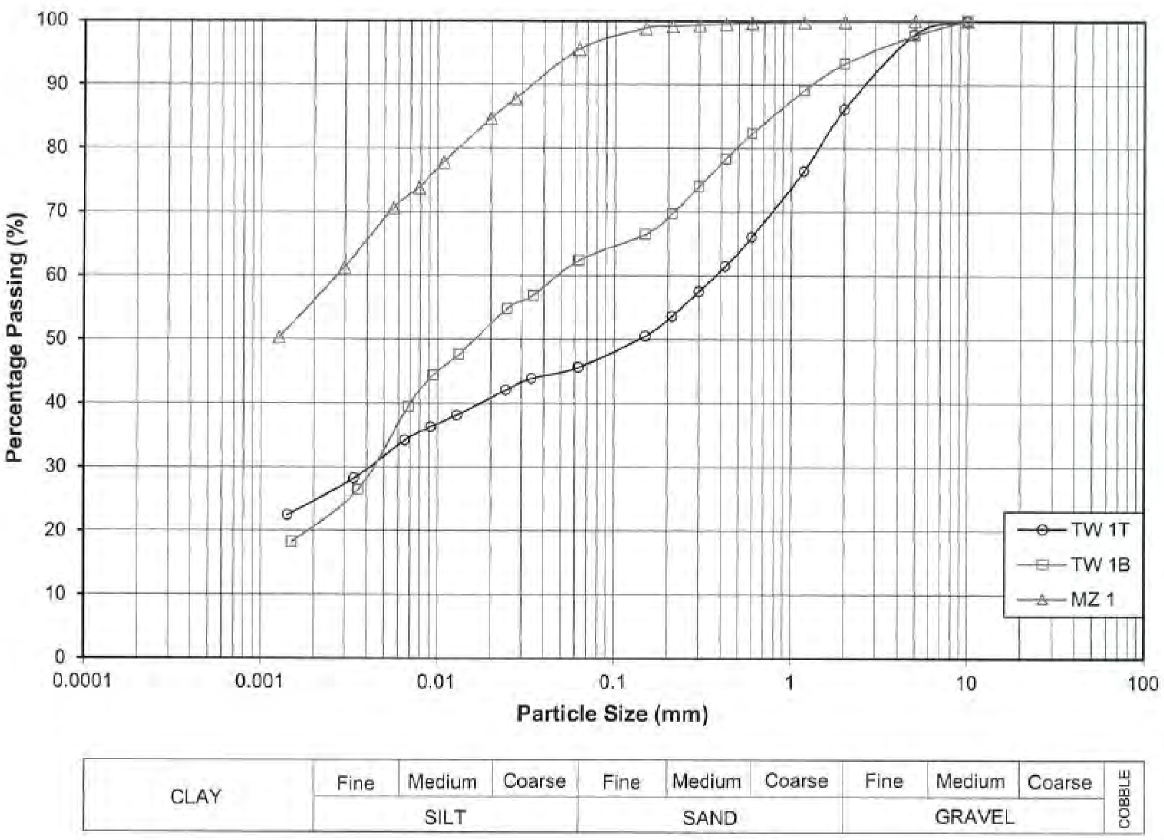
[3] Soil Investigation Works for AFIP, Kranji Road, dated 12 July 2019

Sample no.	D50	Particle density [Mg/m³]	Critical bed shear stress [N/m²]	Settling Velocity [m/d]
TW1T	0.15	2.65	0.145 – 0.194	1,424

In the model, the inorganic matter was divided into two fractions: IM1 and IM2. The baseline TSS concentration of Sungei Pang Sua is defined in IM1, while the suspended solids from the Study area is defined in IM2. **Table 4** shows the settling velocity and critical shear stress value for IM2 defined in SLS study.

Table 4: Settling velocity and critical shear stress values

Parameter	IM1	IM2
Critical shear stress (N/m²)	0.1 (default in SOBEK)	0.06
Settling velocity (m/d)	0.1 (default in SOBEK)	10



Sample No.	Depth (m)	Particle Size Analysis				Soil Description
		GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	
TW 1T	6.00-6.30	14	40	21	25	Grey mottled yellowish brown, Sandy CLAY (MADE GROUND)
TW 1B	6.30-6.30	7	31	41	21	Dark grey, Organic SILT with organic matter
MZ 1	20.00-21.00	0	4	40	56	Yellowish brown mottled grey and pinkish brown, CLAY

Figure 15: Particle size distribution curve used to calculate the settling velocity and critical shear stress for the model input

2.2.4 Time Step and Simulation Period

The model adopted a one (1)-minute time step for simulation. The simulation period was 1 day (1st of January 2019).

2.2.5 Scenario

The model simulated the worst-case scenario for SLS study, where the rainfall runoff from DP1 and DP2 discharges into Sungei Pang Sua with 50 mg/L TSS.

There were two scenarios in this SLS study:

- Scenario 1 - the rainfall occurs at the time where the seawater level is the highest (at 6AM to 9AM)
- Scenario 2 - the rainfall occurs at the time where the seawater level is the lowest (2AM to 5AM).

2.2.5.1 Setting of TSS Concentration

Based on the data collected for this study, the TSS concentration in Sungei Pang Sua was 28 mg/L during dry weather. The model was set up to 28 mg/L TSS as the initial TSS concentration. After a rainfall event, TSS concentration in Sungei Pang Sua was as high as 57 mg/L at SP2, which was slightly upstream of DP2. The IM1 concentration for Scenarios 1 and 2 was defined as 60 mg/L for the runoff from all sub-catchments during the rainfall event. The concentration of rainfall-runoff water was reduced to 28 mg/L after the rainfall event, which meant that the later part of the runoff was assumed to be less turbid then during peak discharge.

IM2 was implemented to assess the impact of the runoff from the Project area with 50 mg/L TSS on the TSS concentration in the whole section of Sungei Pang Sua. Only sub-catchments discharge runoff through DP1 and DP2 were assigned with 50 mg/L IM2 concentration. It was assumed that this concentration is valid for the entire runoff from the Project's construction area.

Table 5 and **Table 6** show the concentration of IM1 and IM2 implemented in Scenario 1 and 2.

Table 5: Concentration [mg/L] of IM1 and IM2 implemented in Scenario 1

Time	Other sub-catchments		Sub-catchments DP1 and DP2	
	IM1	IM2	IM1	IM2
01/01/2019 00:00:00	28	0	28	50
01/01/2019 06:00:00	60	0	60	50
01/01/2019 09:00:00	28	0	28	50
02/01/2019 00:00:00	28	0	28	50

Table 6: : Concentration [mg/L] of IM1 and IM2 implemented in Scenario 2

Time	Other sub-catchments		Sub-catchments DP1 and DP2	
	IM1	IM2	IM1	IM2
01/01/2019 00:00:00	28	0	28	50
01/01/2019 02:00:00	60	0	60	50
01/01/2019 05:00:00	28	0	28	50
02/01/2019 00:00:00	28	0	28	50

2.2.5.2 Boundary Conditions

A boundary condition was defined in the simulation model. In SOBEK schematization, the boundary condition is represented by a boundary node. In the existing model, the boundary node was located at the mouth of Sungei Pang Sua (**Figure 17)**. In both Scenarios 1 and 2, the boundary node was defined with the astronomical tide (**Figure 16)**. The IM1 and IM2 concentrations represented at the boundary node were set as 28 mg/L and 0 mg/L, respectively.

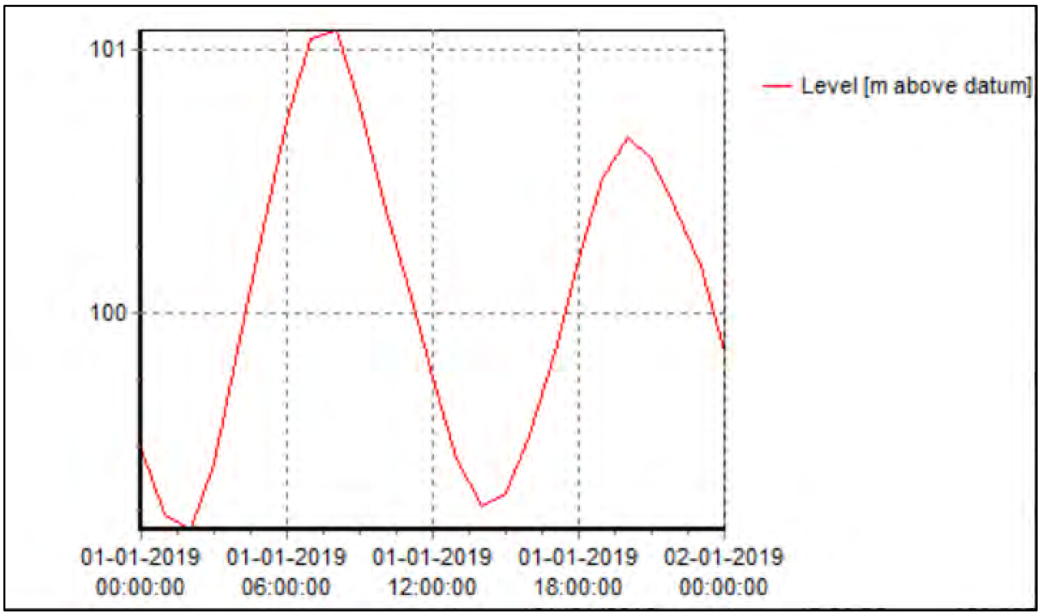


Figure 16: Seawater level [mRL] with tide used in Scenarios 1 and 2

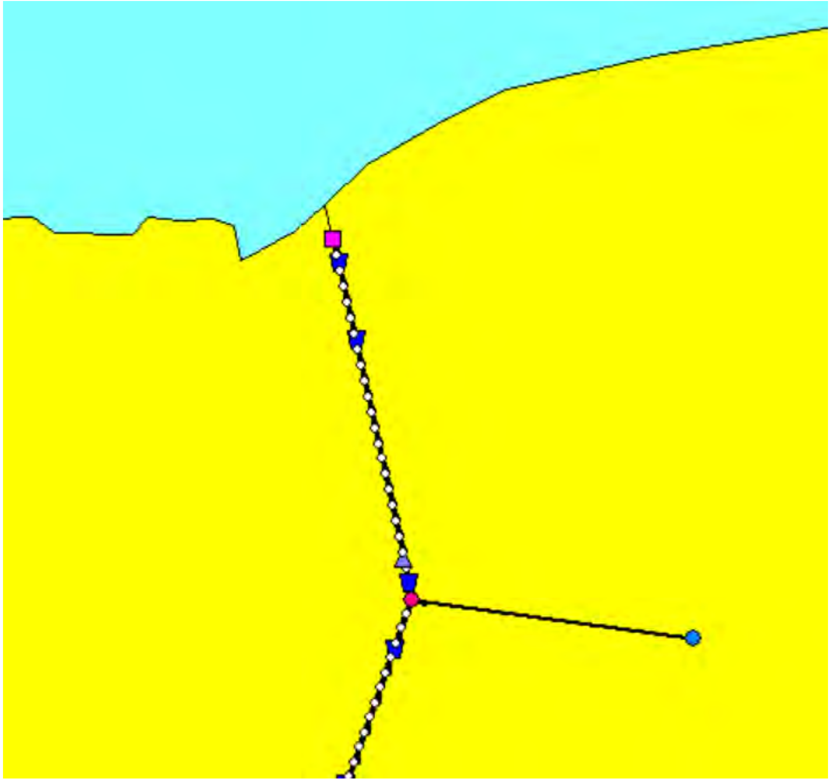


Figure 17: Mouth of Sungei Pang Sua represented with a boundary node (pink square box)

2.2.5.3 Rainfall

The model was run with 1 in 10-year rainfall derived from the Intensity-Duration-Frequency (IDF) curves in PUB COP on Surface Water Drainage. The rainfall event starts at 6 AM and lasts until 9 AM in Scenario 1 (**Figure 18**) when the seawater level is 99.17 mRL. Rainfall event starts at 2 AM and ends at 5 AM in Scenario 2 (**Figure 19**) when the seawater level is 101.04 mRL. The timestep for the rainfall event is 10 minutes, the rainfall event peak is 29.2 mm, and the total rainfall is 131.2 mm.

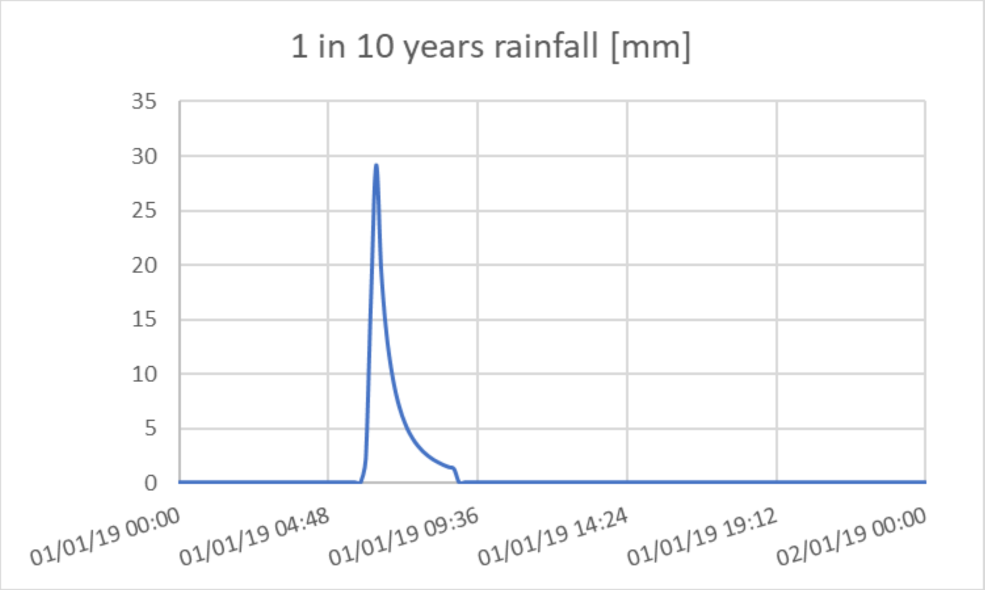


Figure 18: 1 in 10-year rainfall derived from IDF curves, used in Scenario 1

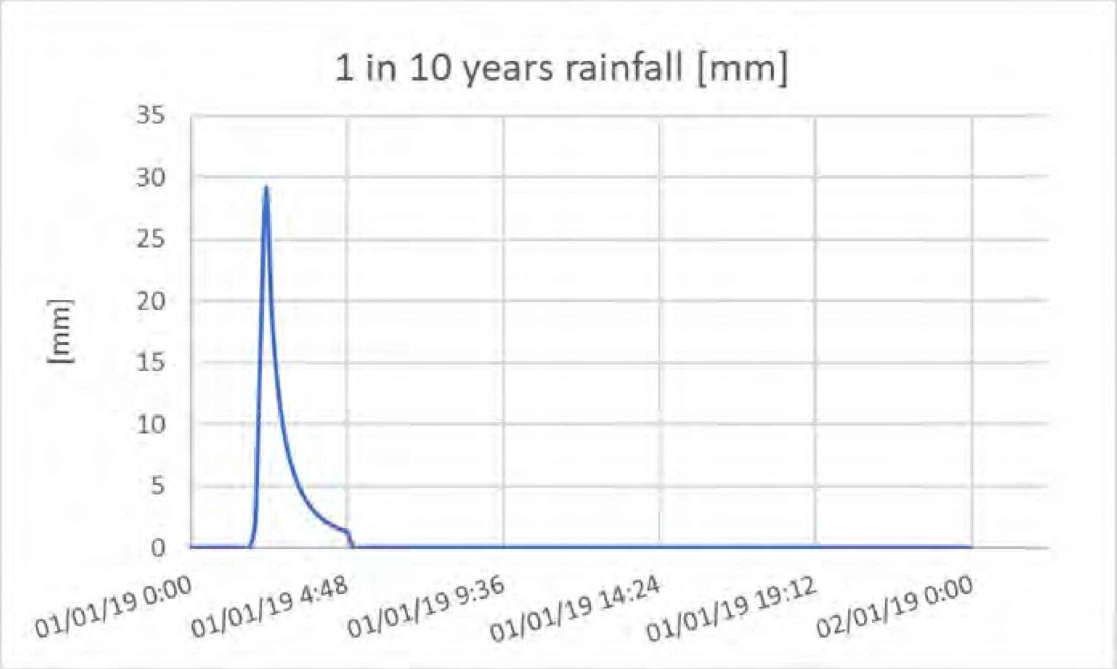


Figure 19: 1 in 10-year rainfall derived from IDF curves, used in Scenario 2

2.3 Results

This section presents the results of the modelling at four observation points/locations along Sungei Pang Sua (**Figure 20**):

1) Location 1: 100m before DP2

2) Location 2: Between DP1 and DP2

3) Location 3: 200 m after DP1

4) Location 4: mouth of Sungei Pang Sua, where sensitive receptors are located

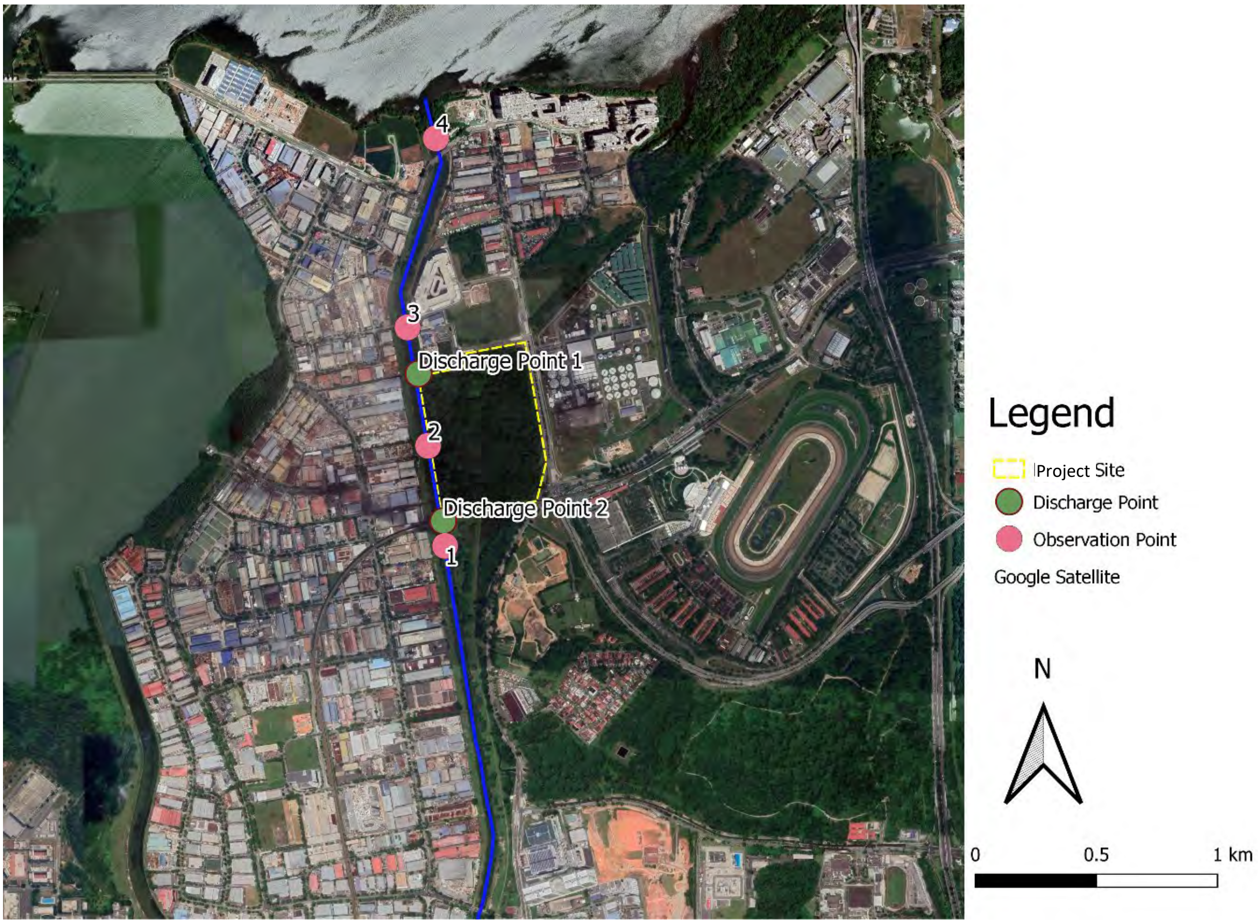


Figure 20: Observation points for IM1 and IM2

2.4 Scenario 1

Figure 21 shows the TSS concentration at each observation point. Concentration of IM1 at Location 4 shows a slower decrease than the other three stations after the rainfall event. The IM1 concentration at the mouth of Sungei Pang Sua returns to 28 mg/L after 7 hours from the start of rainfall event (around 3pm). The IM1 concentration in upstream of Sungei Pang Sua (Location 1, 2 and 3) drops to baseline concentration (28 mg/L) around 1pm and rises again to 36 mg/L when the tide level is high, and the remaining rainfall-runoff water is pushed back upstream. It is noted that Location 4 is very near to the sea and the entire water volume is replaced with sea water during the next tidal cycle.

Figure 21 and **Figure 22** show the IM1 concentration and total discharge at each observation point in Scenario 1. The simulation showed that the model, using the current settings for the boundary conditions, generates the suspended sediment concentration in the river during rainfall which was measured to be 57 mg/L. The simulation also indicated that during the rainfall event, the suspended sediment concentration downstream will increase to 60 mg/L (Location 4).

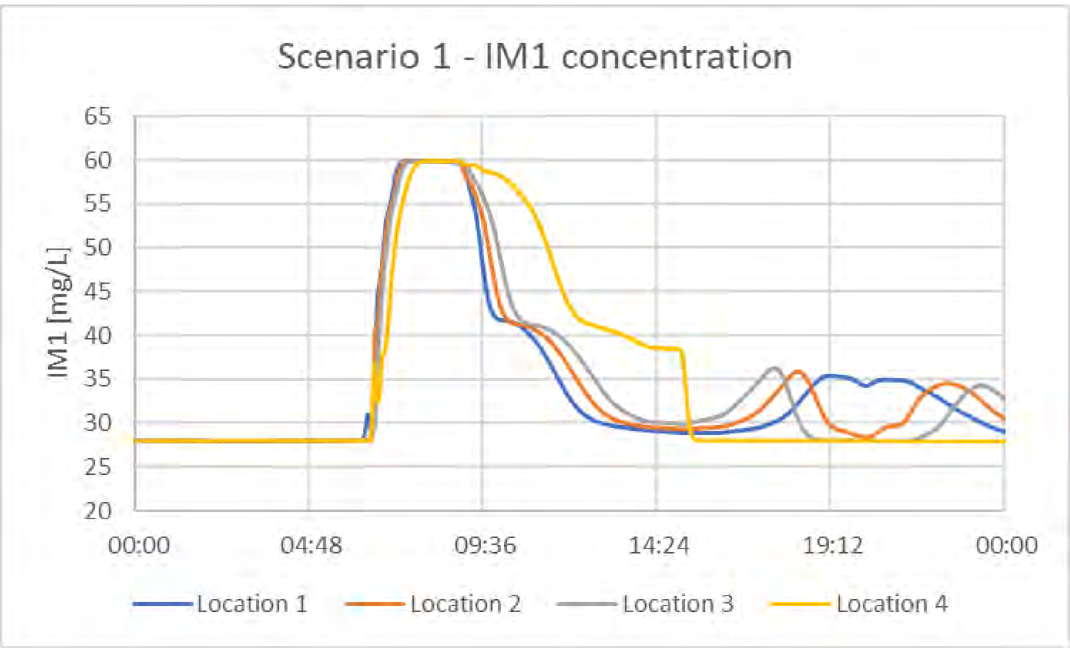


Figure 21: IM1 concentration (mg/L) at each observation point in Scenario 1

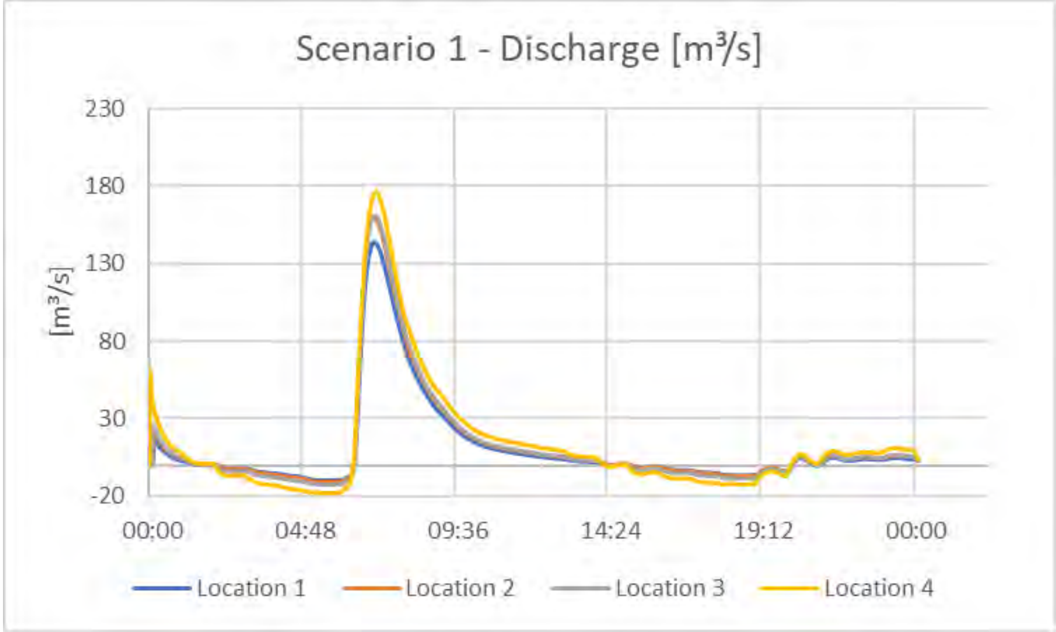


Figure 22: Discharge [m³/s] at each observation point in Scenario 1

Two peaks were noted at Location 4, which were not observed in other locations. These are:

- 6:35 AM – first peak due to runoff from sub-catchment nearest Location 4 with high TSS concentration
- 8:07 AM – second peak runoff from upstream sub-catchments reaches the section, and IM1 concentration is increased to 60 mg/L (**Figure 23**)

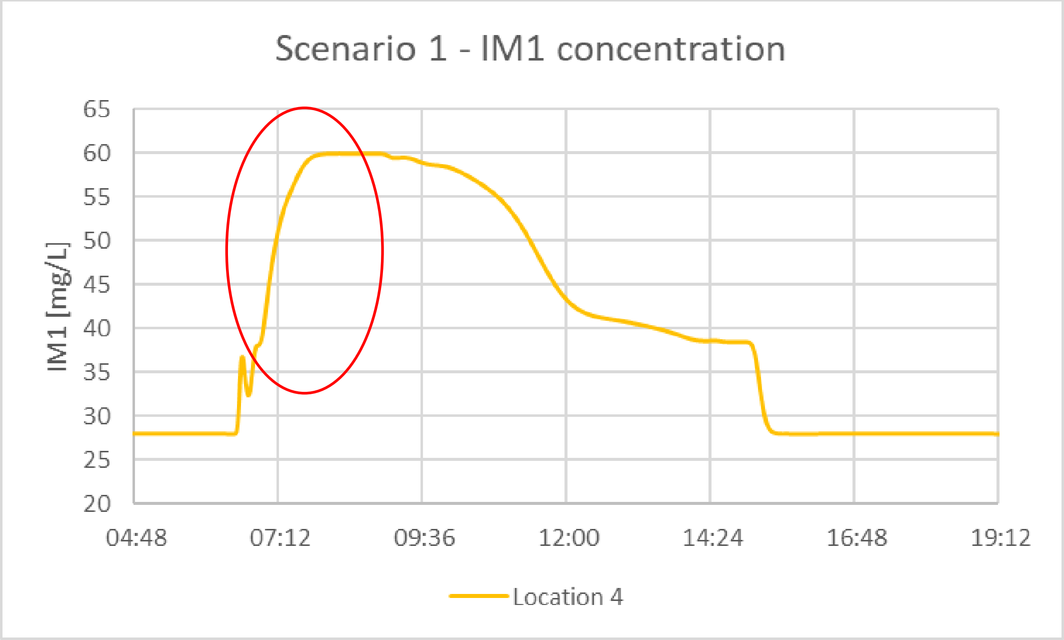


Figure 23: A closer look on the peaks of the IM1 concentration at Location 4

Figure 24 shows the IM2 concentration (mg/L) in each observation point in Scenario 1. Location 1, which is 100m upstream from DP2, has first peak during the rainfall event, and second peak occurs in the afternoon when there is high tide, that causes the water level rise and resuspension of IM2 (**Figure 25**).

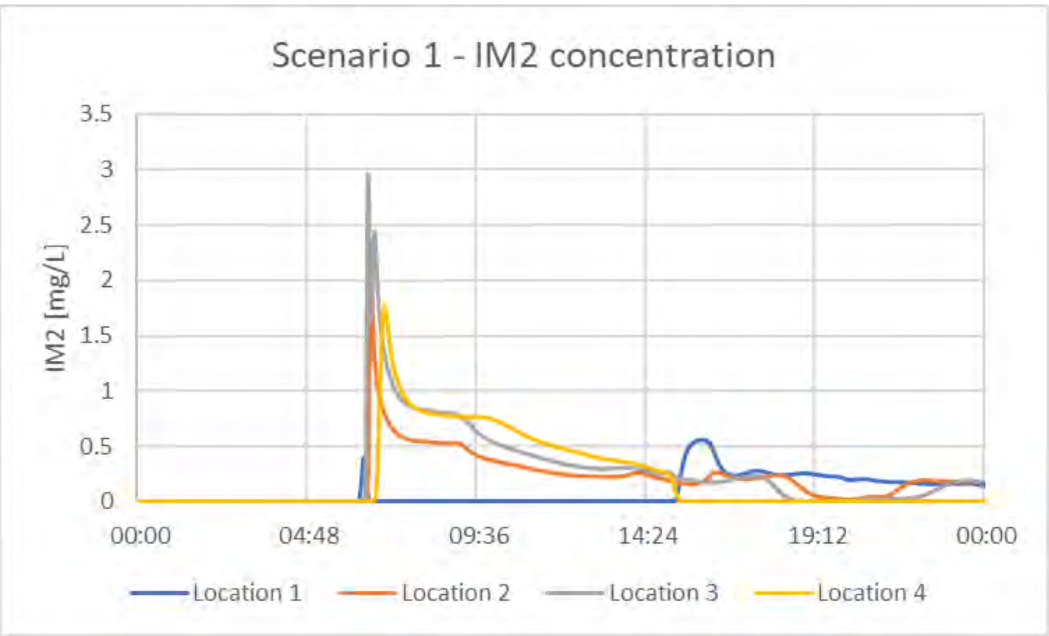


Figure 24: IM2 concentration (mg/L) at each observation point in Scenario 1

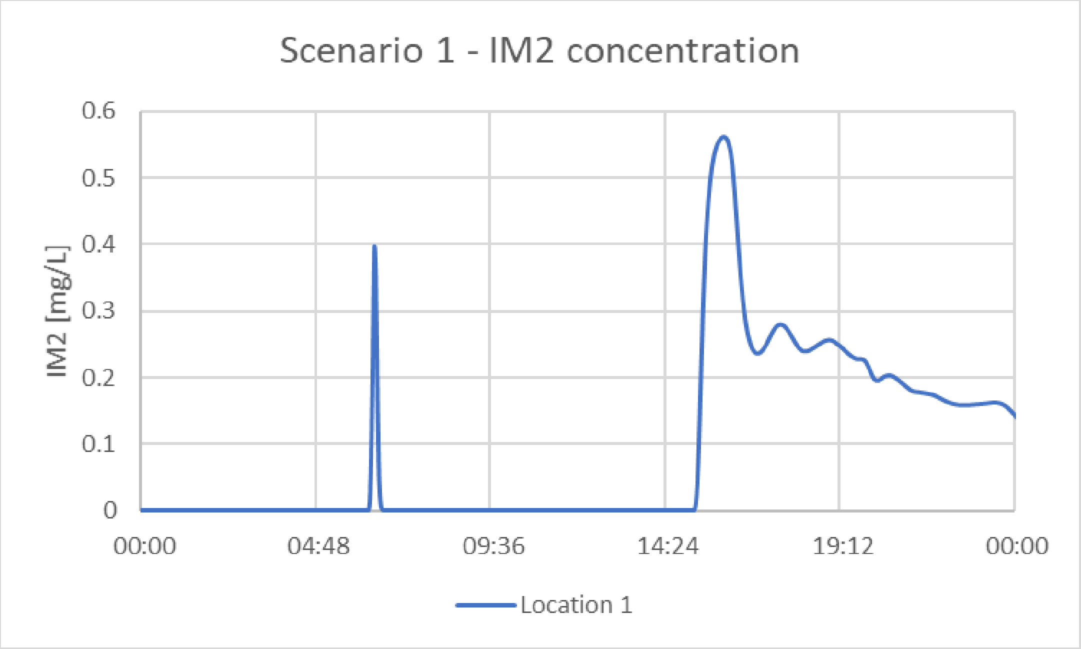


Figure 25: IM2 concentration (mg/L) at Location 1 in Scenario 1

The highest IM2 concentration was observed at Location 3 at 2.97 mg/L. There were two peaks observed at Location 3. The first peak resulted from the runoff discharge from DP1 while the second peak resulted from the IM2 released from DP2, which was brought by the discharge flow to Location 3.

The peak at Location 4 was lower than that in Location 3. This is because the total volume of water in that section is higher, which diluted the concentration of IM2 and some IM2 sedimented along the stretch of Sungei Pang Sua. The highest IM2 concentration at the mouth of Sungei Pang Sua (Location 4) is 1.77 mg/L.

Table 7 shows the percentage increase of TSS concentration in Sungei Pang Sua from the baseline TSS concentration retrieved during the sampling events undertaken for this study. The calculations show that the highest percentage increase of TSS concentration (mg/L) was 11.8% at the mouth of Sungei Pang Sua (after rain).

Table 7: Percentage increase of TSS concentration in Sungei Pang Sua compared to the baseline concentration

	Baseline TSS concentration (mg/L)		Maximum increase of TSS concentration (mg/L IM2)	Percentage increase of TSS concentration	
	After rain	Dry weather		After rain	Dry weather
At the mouth of Sungei Pang Sua	15	28	1.77	11.8%	6.32%
Upstream of Sungei Pang Sua	57	29	2.97	4.73%	10.24%

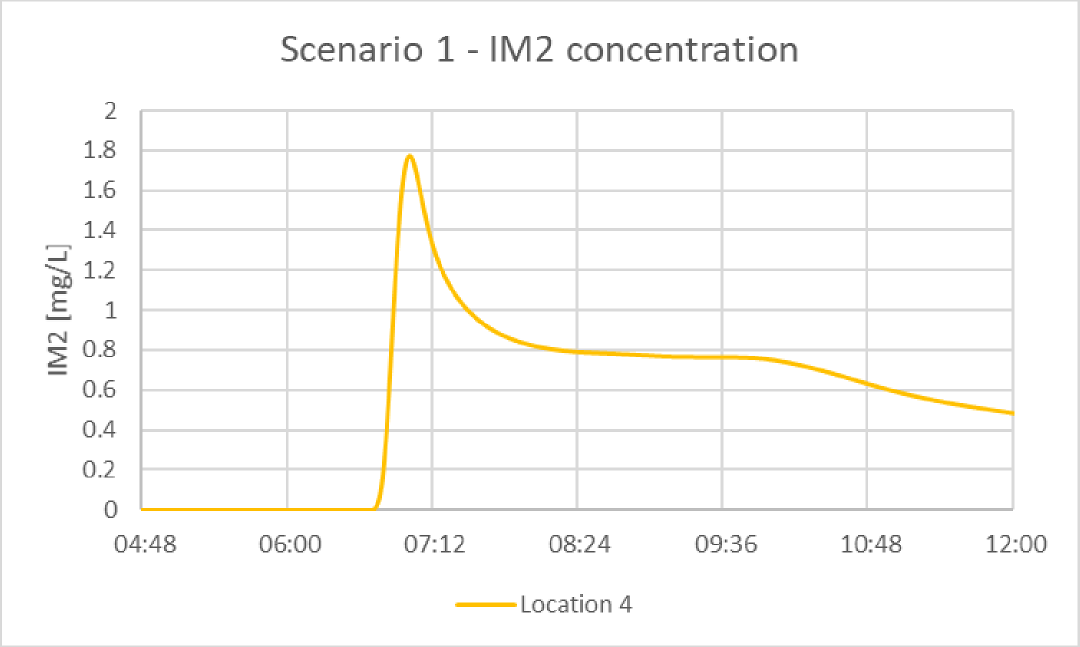


Figure 26: IM2 concentrations at Location 4 in Scenario 1

Although the percentage increase of TSS concentration was higher than 10% of baseline concentration (1.5 mg/L IM2) at the mouth of Sungei Pang Sua, the period that the TSS concentration was higher than 1.5 mg/L of IM2 was only 30 minutes **(Figure 26**) throughout the day.

When the Scenario 1 model results were compared with the baseline model results, only a modest increase in suspended solids over the course of the rainfall event takes place (**Figure 27**). This is because the model baseline took into consideration that the peak suspended sediment concentration at the mouth of Sungei Pang Sua may be higher than what has been observed in the field.

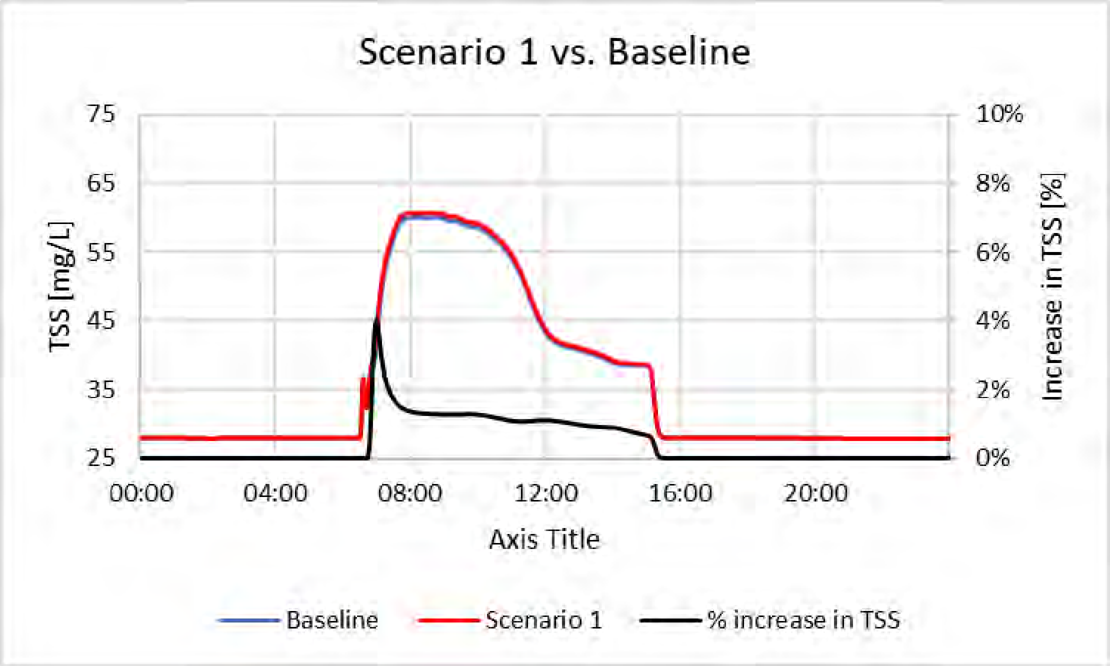


Figure 27: Comparison of TSS concentrations of Scenario 1 with baseline concentration

2.5 Scenario 2

Figure 28 shows the IM1 concentration in each observation point when the rainfall event occurs at the time when the seawater level is low. As Location 4 is located at the mouth of Sungei Pang Sua, it is influenced greatly by the seawater level. After the rainfall event, there is resuspension when there is high tide at Location 4. Location 2 and Location 3 are also affected by the high tide but in a lesser degree compared to Location 4. The maximum IM1 concentration at the whole section of Sungei Pang Sua is 60 mg/L.

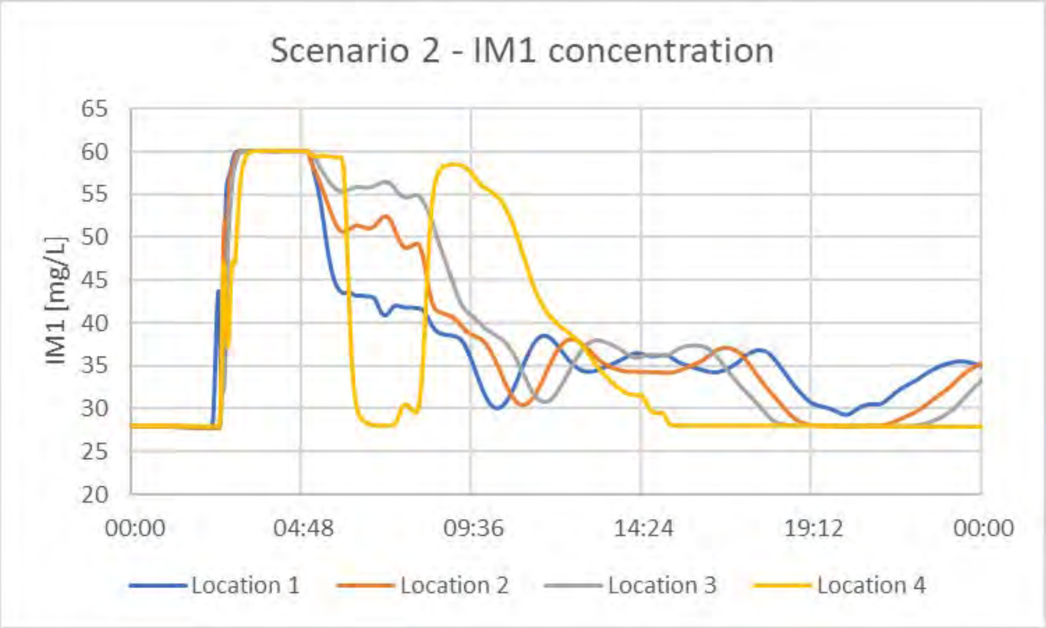


Figure 28: IM1 concentration in Scenario 2 (seawater level with tide)

For IM2 concentration, the maximum concentration is 7.81 mg/L at Location 3 (**Figure 29**). All locations are impacted by the tide and there is resuspension of IM2 when the tide level is high after the rainfall event (6 to 9 am). However, there is only less than 2.5 mg/L increase of IM2 caused by the resuspension process. The maximum increase of TSS in Sungei Pang Sua compared to baseline concentration (15 mg/L TSS) is 1.08 mg/L, which is 1.89%. The highest increase of TSS at the sensitive receptors, which is the mouth of Sungei Pang Sua, is 0.93 mg/L. The percentage increase of TSS concentration at the mouth of Sungei Pang Sua is 6.2%.

Table 8 shows the percentage increase of TSS concentration in Sungei Pang Sua compared to the baseline TSS concentration retrieved during the sampling events undertaken for this study. The calculations show that the highest percentage increase of TSS concentration (mg/L) is 19.2% at the mouth of Sungei Pang Sua when compare with the baseline TSS concentration after rain (15 mg/L TSS).

Table 8: Percentage increase of TSS concentration in Sungei Pang Sua compared to the baseline concentration (Scenario 2)

	Baseline TSS concentration (mg/L)		Maximum increase of TSS concentration (mg/L)	Percentage increase of TSS concentration	
	After rain	Dry weather		After rain	Dry weather
At the mouth of Sungei Pang Sua	15	28	2.88	19.2%	10.28%
Upstream of Sungei Pang Sua	57	29	7.81	13.71%	26.93%

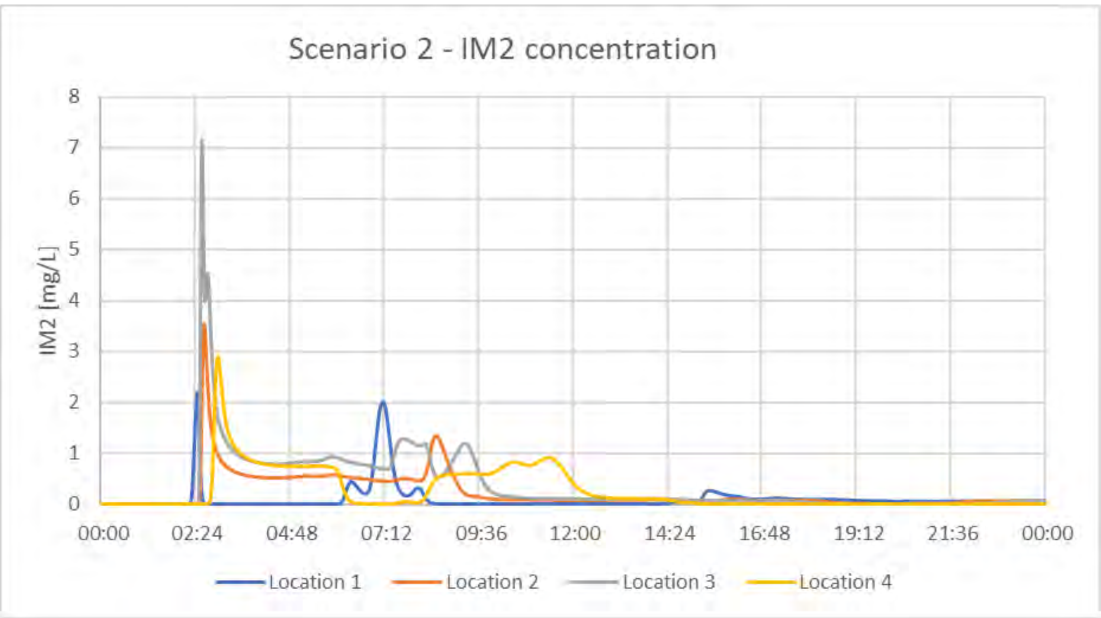


Figure 29: IM2 concentrations in Scenario 2 (seawater level with tide)

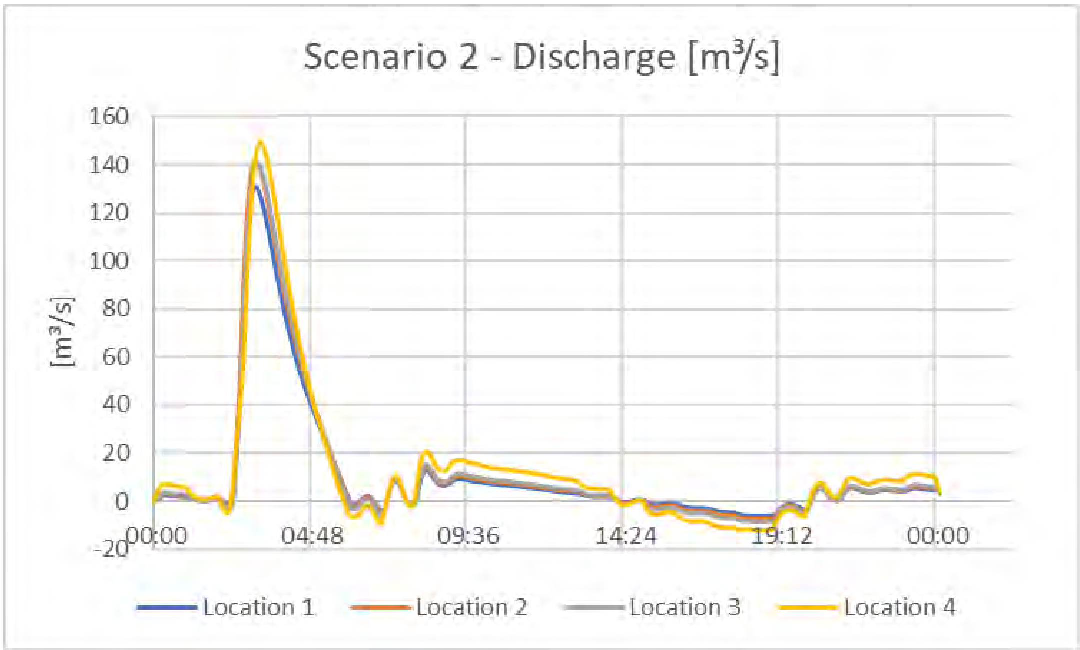


Figure 30: Discharges [m³/s] at each observation point in Scenario 2

Although the percentage increase of TSS concentration (19.2%) is higher than 10% of baseline concentration (1.5 mg/L IM2) at the mouth of Sungei Pang Sua, the period that the TSS concentration is higher than 1.5 mg/L of IM2 is only 30 minutes (**Figure 31**) throughout the day in Scenario 2. This also shows that the highest percentage increase of TSS concentration during 1 in 10 years rainfall event is 19.2% at the mouth of Sungei Pang Sua when the rainfall occurs at lower seawater level or drain water level.

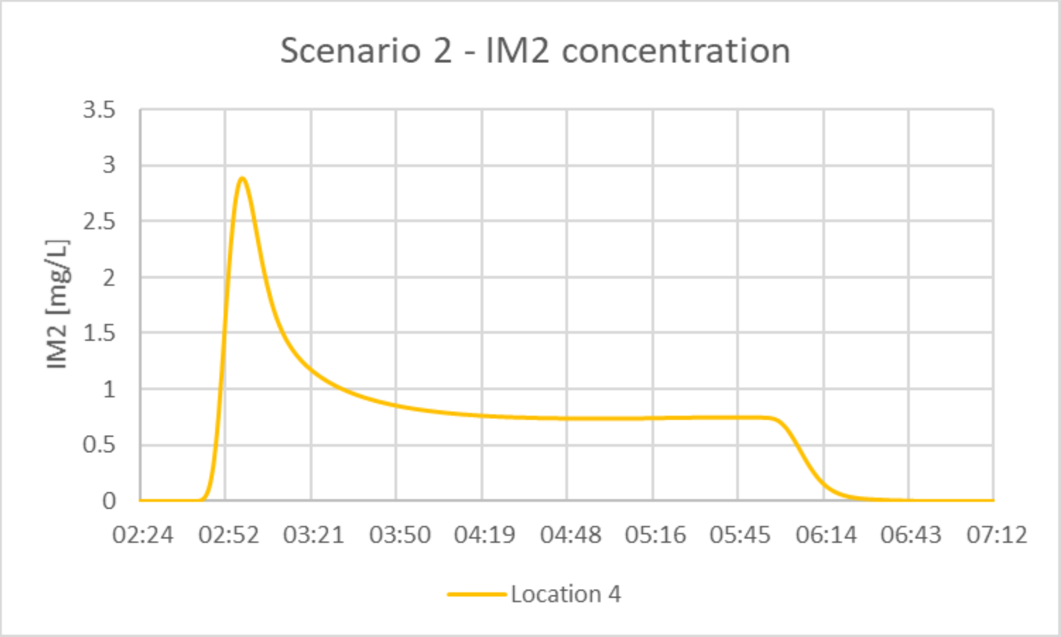


Figure 31: Concentration of IM2 (mg/L) at IM2 in Scenario 2

When the Scenario 2 model results are compared with the baseline model results, the highest peak increase in TSS concentration is 5% (**Figure 32**). This is because the model baseline takes into consideration that the peak suspended sediment concentration at the mouth of Sungei Pang Sua may be higher than what has been observed in the field.

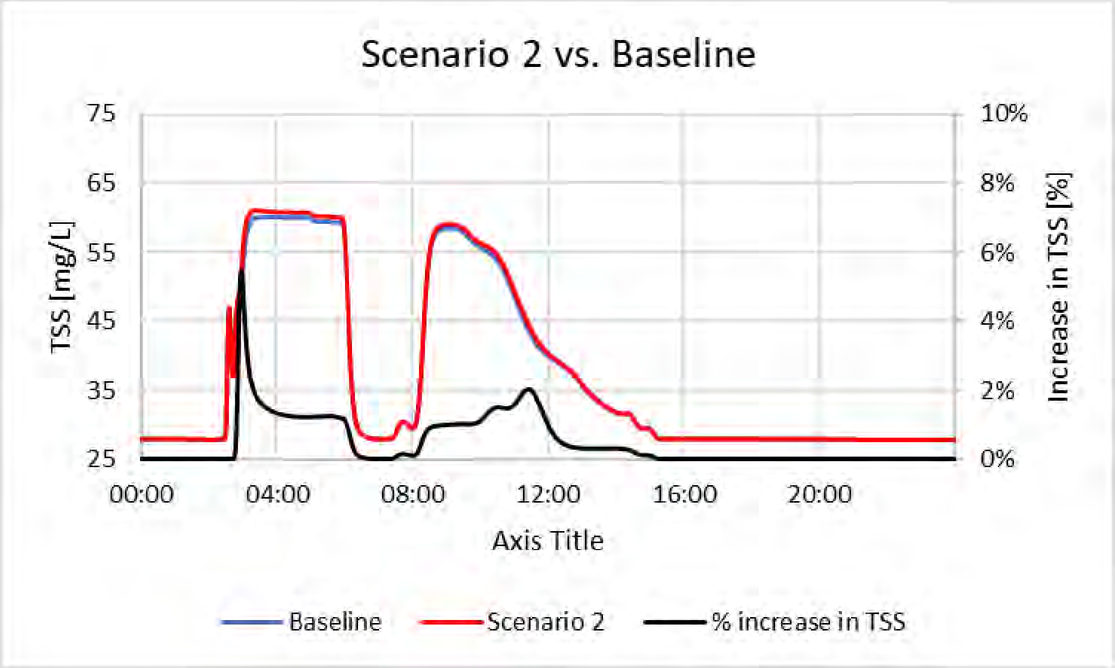


Figure 32: Comparison of TSS concentrations of Scenario 2 with baseline concentration

3.0 IMPACT ASSESSMENT

An impact assessment was conducted after the baseline study. The impact assessment aimed to identify potential impacts that may result from proposed development and to evaluate the significance these impacts have on the various environmental receptors and ecological components (i.e. flora, fauna) within and in the vicinity of the Project area. An impact is thus defined as an entity that alters the integrity and quality of the ecological components. Integrity refers to the “coherence of ecological structure and function, across the whole area, that enables it to sustain the habitats, complex of habitats and/or the levels of populations of the species for which it was classified” (Leicestershire County Council, 1994).

In particular, the impact assessment serves to guide appropriate mitigation methods to ensure impacts are avoided or minimised (CIEEM, 2016).

For this EBS, impacts were assessed, with consideration of the construction methods and design options, using the Impact Significance Assessment Matrix. The potential impacts from and risks associated with the Project activities (construction and operation) were assessed. This was done before and after mitigation of the potential impacts by the project activities (i.e., on residual impacts).

3.1 Impact Significance Assessment Matrix

Identified potential impacts were evaluated based on their significance, which is a measure of the weight that should be given to each impact in decision-making, and determines if management or mitigation measures need to be implemented.

Impacts assessed to be of negligible or minor significance require no additional management or mitigation measures (on the basis that adequate minimum controls are already included in the project design). Negligible and minor impacts are therefore deemed “Insignificant”. Moderate and major impacts are therefore deemed “Significant”. Impacts assessed to be of moderate or major significance require the adoption of management and mitigation measures to minimise or reduce the impact to an “acceptable level”.

An acceptable level is the reduction of a major impact to moderate post-mitigation. In seeking to mitigate moderate impacts, the emphasis is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable. It will not always be practical to reduce moderate impacts to minor in consideration of the cost-ineffectiveness of such approaches (because of diminishing return of impact versus cost). Impact significance will be assessed using the risk-based Impact Significance Matrix (**Table 9**) which considers two factors:

- **Impact Consequence** (**Table 10**): The consequence of an impact is a function of a range of considerations including impact spread, impact duration, impact intensity and nature, legal and guideline compliance. In evaluating the consequence of the biodiversity impacts, the following aspects will be taken into consideration:
- **Receptor Sensitivity** (**Table 11**): Categorises receptors according to their susceptibility to adverse impacts from the project’s construction and operation. It also takes into account the ecological value of the receptor. Species of conservation significance will be considered of high ecological value, species not of conservation significance will be considered of medium ecological value, while non-native species will be considered of low ecological value.
- **Impact Intensity** (**Table 12**): Defines the magnitude of the impact and the status of the impact in relation to regulations, standards, and guidelines.
- **Likelihood of Occurrence** (**Table 13**): The likelihood of the impact occurring during the project construction and operation periods, which takes into account the probability of the event happening as well as the duration of the event. It is estimated based on experience and/or evidence that such an event has previously occurred.

Table 9: Impact Significance assessment matrix

Consequence Likelihood	Imperceptible	Very Low	Low	Medium	High
Unlikely/Remote	Negligible	Negligible	Negligible	Negligible	Negligible
Less likely/Rare	Negligible	Negligible	Minor	Minor	Minor
Possible/Occasional	Negligible	Minor	Minor	Moderate	Moderate
Likely/Regular	Negligible	Minor	Moderate	Moderate	Major
Almost Certain/Continuous	Negligible	Minor	Moderate	Major	Major

Table 10: Impact Consequence matrix

Sensitivity Intensity	Low	Medium	High
Negligible	Imperceptible	Very low	Very low
Low	Very low	Low	Low
Medium	Very low	Medium	Medium
High	Low	High	High

Table 11: Receptor sensitivity classification

Receptor Sensitivity		
Low	**Medium**	**High**
Generally tolerant of and can accommodate physical changes or influences	Moderate to limited capacity to accommodate physical changes or influences	Very limited or no capacity to accommodate physical chemical changes or influences

Table 12: Impact intensity classification

Impact Intensity			
Negligible	**Low**	**Medium**	**High**
No measurable effect from current conditions	<10% change from current conditions	10% change from current conditions	>10% change from current conditions

Table 13: Likelihood classification

Likelihood of Occurrence	Definition
Unlikely/Remote	Not expected to occur during construction and/or operation activities

Likelihood of Occurrence	Definition
Less likely/Rare	Would less likely or rarely occur during construction and/or operation activities
Possible/Occasional	Would possibly or occasionally occur during construction and/or operation activities
Likely/Regular	Would likely occur or would occur on a regular basis during construction and/or operation activities
Almost Certain/Continuous	Would be almost certain to occur or would continuously occur during construction and operation activities

3.2 Impacts to Water Quality Due to Sedimentation

This section describes the potential impact on physical characteristics of water quality from changes in sediment load that may occur during the construction and operation phases of the Project. Although there will be no discharge into Sungei Pang Sua during construction, potential discharges during land clearing and earthworks may affect the TSS quality due to natural drainage patterns during rainfall. Based on the results of the SLS, the impact in sedimentation is Negligible (**Table 14**).

Table 14: Assessed Impact During Construction and Operation Phases – Increased TSS levels in Sungei Pang Sua

Impact	*Reduced Water Quality (Sungei Pang Sua)*				
Likelihood	Unlikely/ Remote	**Less likely/ Rare**	Possible/ Occasional	Likely/ Regular	Almost Certain/ Continuous
	Increase in TSS at Sungei Pang Sua is less likely/rare based on the results of the modelling				
Impact Intensity	Negligible	Low	Medium	**High**	
	Based on the sediment load modelling performed, the highest percentage increase of TSS concentration in Sungei Pang Sua is 19.2% at the mouth of Sungei Pang Sua when compared to the lowest baseline TSS concentration, in the condition where there is low seawater level (mRL). Although the increase of TSS concentration is higher than the 10% of the baseline at the mouth of Sungei Pang Sua, it only lasts for 30 minutes before the TSS concentration drops to less than 10% of the baseline in both scenarios.				
Receptor Sensitivity	Low	**Medium**	High		
	Sungei Pang Sua has a strip of mangrove that is a highly sensitive habitat in Singapore.				
	Imperceptible	Very Low	Low	Medium	**High**

<table>
<tr><th>Impact</th><th colspan="5"><i>Reduced Water Quality (Sungei Pang Sua)</i></th></tr>
<tr><td>Impact Consequence</td><td colspan="5">A high impact intensity and medium receptor sensitivity results in high consequence.</td></tr>
<tr><td rowspan="2">Significance</td><td>Negligible</td><td>Minor</td><td>Moderate</td><td>Major</td><td>Critical</td></tr>
<tr><td colspan="5">A less likely/rare likelihood and high impact consequence results in Minor significance impact.</td></tr>
</table>

The modelling study evaluated the impact on sediment load caused by the development and operation of Kranji AFIP in the vicinity. Based on the modelling study, the proposed Site development will have minor effect on sediment load.

3.3 Mitigation Measures

The EMMP has been drawn to provide a framework for dealing with the risks of the Project development during the construction and operation phases. The EMMP provides control actions to be implemented for management of the impact identified from sediment loading (**Table 15**).

Table 15: Controls and mitigation measures for identified environmental impact

Proposed activity	Description of impact	Significance with current mitigation	Additional mitigation options	Residual significance after additional mitigation
Construction works and operational phase	Increased TSS levels in Sungei Pang Sua	Minor	■ Carry out regular TSS monitoring at discharge points ■ Regular ECM maintenance and inspection to ensure optimum working condition	Negligible

4.0 CONCLUSION

The SLS aimed to show the movement of sediments through Sungei Pang Sua towards Johor Strait and to compare it with a baseline data. Specifically, the SLS aimed to present, through sediment transport modelling, that the total suspended solids (TSS) will not be more than 10% of the baseline at the river mouth or any identified sensitive receptors at the river mouth or along Sungei Pang Sua.

Based on the sediment load modelling performed, the highest percentage increase of TSS concentration in Sungei Pang Sua is 19.2% at the mouth of Sungei Pang Sua when compared to the lowest baseline TSS concentration, in the condition where there is low seawater level (mRL). Although the increase of TSS concentration is higher than the 10% of the baseline at the mouth of Sungei Pang Sua, it only lasts for 30 minutes before the TSS concentration drops to less than 10% of the baseline in both scenarios.

The modelling study evaluated the impact on sediment load caused by the development of Kranji AFIP in the vicinity during construction and operational stages. Land clearing and earthworks during construction and potential discharges from the facilities during Project operation may impact the TSS quality in Sungei Pang Sua. The result of the modelling study is applicable to both construction and operational stages, provided that the rainfall runoff from DP1 and DP2 discharges into Sungei Pang Sua with a maximum concentration of 50 mg/L TSS. The assumed concentration was applied as the worst-case scenario in the model, which is also the maximum allowable discharge limit to a watercourse as per local regulations. Based on the results of the SLS, the impact in sedimentation is Minor without additional mitigation and may reduce to Negligible with EMMP implementation.

Signature Page

Golder Associates (Singapore) Pte Ltd

Mitesh Kumar

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Senior EHS Consultant	*Associate Director*

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APPENDIX A

Method Statement for Cast In-Situ Drainage Works

Source: Huationg

METHOD STATEMENT
FOR
Cast In-situ Drainage Works

Rev.	Date	Description	Prepared	Reviewed
00	01 Jun 2020	MS for Cast In-situ drainage works	Wong Wai Yuen	Chua Ngee Hwee
01	09 Jun 2020	MS for Cast In-situ drainage works	Wong Wai Yuen	Chua Ngee Hwee
02	17 Jun 2020	MS for Cast In-situ drainage works	Wong Wai Yuen	Chua Ngee Hwee

Method Statement for Cast In-situ Drainage Works

Contents

1 Purpose

Proposed drainage system involved in this contract include construction of reinforced concrete (RC) U drain, RC box culvert, RC sump and Trapezoidal drain. This method statement presents the proposed construction sequence, which subject to amendment according to the approved drawing by Consultant.

2 Types of RCU, RCS and RCBC

The type of drain, location and drain size is illustrated in Table 1:

No	Location	Road	Type	Size (mm)
1	B3- island	Road 2	RCBC	600 x 800
2	B5-B6	Road 2	RCBC	1200 x 900
3	E2-island	Road 2	RCBC	600 x 800
4	B7-B2	Road 2	RCBC	1500 x 1300
5	B5	Road 2	RCS	1800 x 1800
6	B6	Road 2	RCS	1800 x 1800
7	B2	Road 2	RCS	2850 x 2250
8	B7	Road 2	RCS	2850 x 2250
9	B3	Kranji Road	RCS	2250 x 900
10	Island near B3	Kranji Road	RCS	900 x 900
11	E2	Kranji Road	RCS	2250 x 900
12	Island near B3	Kranji Road	RCS	900 x 900
13	D2	Future road	RCS	3000 x 2250
14	D3	Future road	RCS	3000 x 2250
15	B1-B2	Road 2	RCU	1200
16	B2-B3	Road 2	RCU	1500
17	B3-B4	Road 2	RCU	1500
18	B1-B5	Road 2	RCU	1200
19	B6-B7	Road 2	RCU	1200
20	B7-E2	Road 2	RCU	1500
21	E2-E1	Kranji Road	RCU	1500
22	B6-C4	Int. driveway	RCU	600
23	B5-C1	Int. driveway	RCU	600
24	B6-C4	Int. driveway	RCU	600
25	C4-C5	Int. driveway	RCU	800
26	C5-C2	Int. driveway	RCU	800
27	B5-C1	Int. driveway	RCU	600
28	C1-C2	Int. driveway	RCU	800
29	D4 end	Future road	RCU	3400
30	A1-A3	Road 1	RCU	900
31	A1-A2	Road 1	RCU	900
32	F1-F2	Kranji Close	RCU	900
33	Island near B3	Kranji Road	RCU	600
34	Island near E2	Kranji Road	RCU	600
35	C2-C3	Future road	Trapezoidal	1600
36	D1-C3	Future road	Trapezoidal	7000
37	C3-D2	Future road	Trapezoidal	7000
38	D3-D4	Future road	Trapezoidal	7000
39	Overall plot	Overall plot	C7	-

Table 1: Summary of RCU, RCBC, RCS and Trapezoidal drain

3 Preparation works for drainage works

The following preparatory works shall be accomplished before commencement of drainage construction works:

- Precondition, Topo survey and Precomputation plan
  - Engage registered surveyor to carry out precondition photographic survey.
  - Engage registered surveyor to carry out topographical survey.
  - Registered surveyor to prepare precomputation plan of drainage alignment.
  - Contractor to get concurrence from SO on precomputation plan of drainage alignment.
- Cable detection and NCE
  - Contractor shall verify at the beginning of the work that there are no existing services running below or across the proposed drains by conducting cable detection.
  - Contractor shall highlight to the SO's rep where there are existing services affecting or would be affected by the proposed drains upon cable detection.
  - Engage LCDW to purchase services plan from authorities and carry out services detection on site.
  - LCDW to apply NCE / NCD from authorities.
  - Trial hole is to be done at area to be excavated for drainage system if necessary.
  - Ensure all the affected services are removed or diverted with acknowledgement of SO, authority or owner of property.
- ERSS for the drainage works
  - Engage PE to design the ERSS required for construction of drains.
  - Submit the ERSS design to SO for review and subsequently submit to BCA.
  - Obtain clearance and PTW from BCA for the commencement of ERSS.
- Contractor shall verify on site that the invert levels of all the exiting drains against the levels as shown in the drawings are in order.
- Drainage diversion (if necessary)
  - Identify if there is any drain to be diverted to facilitate the construction works.
  - Engage PE to design the drain diversion and make submission to PUB, if necessary.
  - Obtain clearance from PUB and SO on the proposed drain diversion before carrying out any physical diversion work.
  - Divert existing drainage system to ensure continuous flow of water before demolition of the existing drainage system, if any.
- Demolition of drain (if any)
  - Demolish existing drain if it happens to obstruct the proposed drainage works.
  - Demolish all the affected structures before commencement of drainage works.
- Ensure the area is free of any form of obstruction before excavating the trench for drainage system. Remove the obstruction with acknowledgement of SO, authority or owner of property before removing any obstruction of site.
- Remove the debris off site.
- If the existing ground is higher than the proposed platform level, excavate the ground to proposed platform level to facilitate the excavation of drain trench in future.

- Mobilize necessary machineries to site such as excavator, excavator with LM certificate and vibratory roller.
- Equipment such as lifting gears, concrete bucket, air compressor and vibrator shall be onsite before commencement of drainage works.
- Material such as steel reinforcement (rebar and wire mesh), ordinary portland cement (OPC), hardcore, formwork, concrete spacer and any other material which deemed to be required to accomplish the drainage works are mobilized to site.
- Provide barricade and waning signage along the excavated drainage trench.

4 Equipment, materials to be used for Drainage Works

Machineries and equipment to be used for the operation are shown as below:

a) CAT 312 / CAT 320
b) Lorry Crane
c) Tipper Truck / Dump Truck
d) 4-tonne Roller
e) 1-tonne Roller
f) 10-tonne Roller
g) Air Compressor
h) Vibrator
i) Concrete Bucket
j) Water Pump
k) Portable Generator
l) Electrical Hand Cutter
m) Hand Drilling Machine
n) Electrical Hand Breaker

Materials to be used for the operation are shown as below:

a) Rebar / Wire Mesh
b) Ordinary Portland Cement (OPC)
c) Hardcore
d) Formwork
e) Concrete Spacer
f) Curing Compound
g) Bonding Agent
h) Expansion Joint
i) Grating with frame
j) Aluminium Rung
k) Sand
l) Geo-textile
m) Geo-composite
n) Neoprene pad
o) Building paper
p) Galvanised rebar (dowel bar for approach slab)
q) Quarry dust
r) Graded granite/ Recycled Concrete Aggregate

5 Procedure of constructing RCU, RCS, RCBC and Trapezoidal drain

Construction of drainage works are categorized in the type of drain as below:

a) Construction of RCU
b) Construction of RCS
c) Construction of RCBC
d) Construction of Trapezoidal drain

5.1 Construction of RCU

a) Setting out of drain alignment
  - Surveyor to identify the drain location on site. The locations are marked on site using timber peg.

b) Excavation of drainage trench
  - Excavator to excavate the drain trench up to the hardcore base level.
  - Ensure the proposed drain area is excavated to sufficient width and depth.
  - Implement earth retaining stability structure (ERSS) when the depth is more than 1.5m. Contractor have to implement the approved ERSS on site to ensure the stability of soil at both sides of drain trench.
  - Cut the ground to form the ERSS profile. All the excavated soil is loaded onto tipper truck and send to approved dumping ground.
  - Barricade the drain trench and safety signage is put up.

c) Preparation of drain base
  - Compact the hardcore base level by using 1-tonne roller
  - On top of the compacted ground, put pegs at reasonable intervals to mark the proposed level of hardcore base.
  - Lay hardcore base and compact it using 1-tonne
  - roller. The hardcore base after compaction shall be the stipulated thickness as of drawings.
  - On top of compacted hardcore base, put pegs at reasonable intervals to mark the proposed level of lean concrete.
  - Casting lean concrete on top of compacted hardcore base and level the lean concrete surface.
  - Surveyor to peg and mark proposed drain centerline on lean concrete.
  - Drain edge line is established and marked on the lean concrete as well.

d) Construction of drain base slab, wall and top slab.
  - Deploy excavator with LM to hoist down the prefabricated rebars for drain base slab, and commence the rebar tying and fabrication of formworks according to approved construction drawing.
  - Request RTO for inspection before casting of base slab. Further to order for concrete from approved concrete plant once the inspection is passed, and complete the concreting of base slab.
  - Dismantle base slab formworks on the following day.
  - Install drain channels (invert level of the drain channels to be checked) and cast benching with mass concrete. The grade of benching is as indicated in construction drawing.

- Steel reinforcement and formwork of drain wall are then installed. Mark the required drain top level.
- Steel reinforcement is as indicated in construction drawing. Request RTO for inspection before closing formwork (external side). Ensure aluminum rung is installed at distance and interval indicated in construction drawing.
- Ensure weep hole is installed at distance and interval indicated in construction drawing as well. The diameter of weep hole is indicated in construction drawing.
- Once drain wall rebar inspection is cleared, proceed to close the remaining formwork.
- Cast concrete of drain wall using appropriate grade. Engine vibrator is used during concreting to ensure evenly distribution of concrete within formwork.
- The level of concrete has to match with the drain top slab (mesh/ rebar anchorage) marked previously.
- Dismantling of internal drain wall formwork on the following day.
- Plaster the drain inner wall to seal up the opening of formwork tie.
- Apply curing compound to the freshly done concrete structure.
- Erection of falsework and formwork for the drain top slab.
- Installation of rebar/ mesh for drain top slab including the grating frame.
- Request RTO for inspection before casting of top slab. Further to order for concrete from approved concrete plant once the inspection is passed, and complete the concreting of top slab.
- Drain top slab to be broom finished; tactile tiles (if any) and expansion joints to be installed before the concrete set.
- Dismantling of external drain wall formwork on the following day.
- Falsework to be maintained for supporting the top slab for 7 days before dismantling.

e) Drain wall treatment and backfilling

- Installation of geo-composite on both side of drain outer wall before backfilling both side of drain with soil.
- The soil backfilled at both sides of drain shall be at least 50mm lower to prevent soil being washed into drain.
- Backfill both sides of completed drain wall with earth and immediately compact the ground using roller.
- Reinstate slope at both sides of drain to required level, alignment and gradient.
- Turf the ground.
- Repeat whole process for next stretch of U drain.

f) Typical work sequence for RCU construction

Generally, RCU construction is consists of setting out and excavation, preparation of drain base, structural works for drain base slab, drain wall and drain top slab and finally the drain wall treatment plus backfilling. The preparation of drain base until the completion of drain top slab is illustrated as Figure 1.

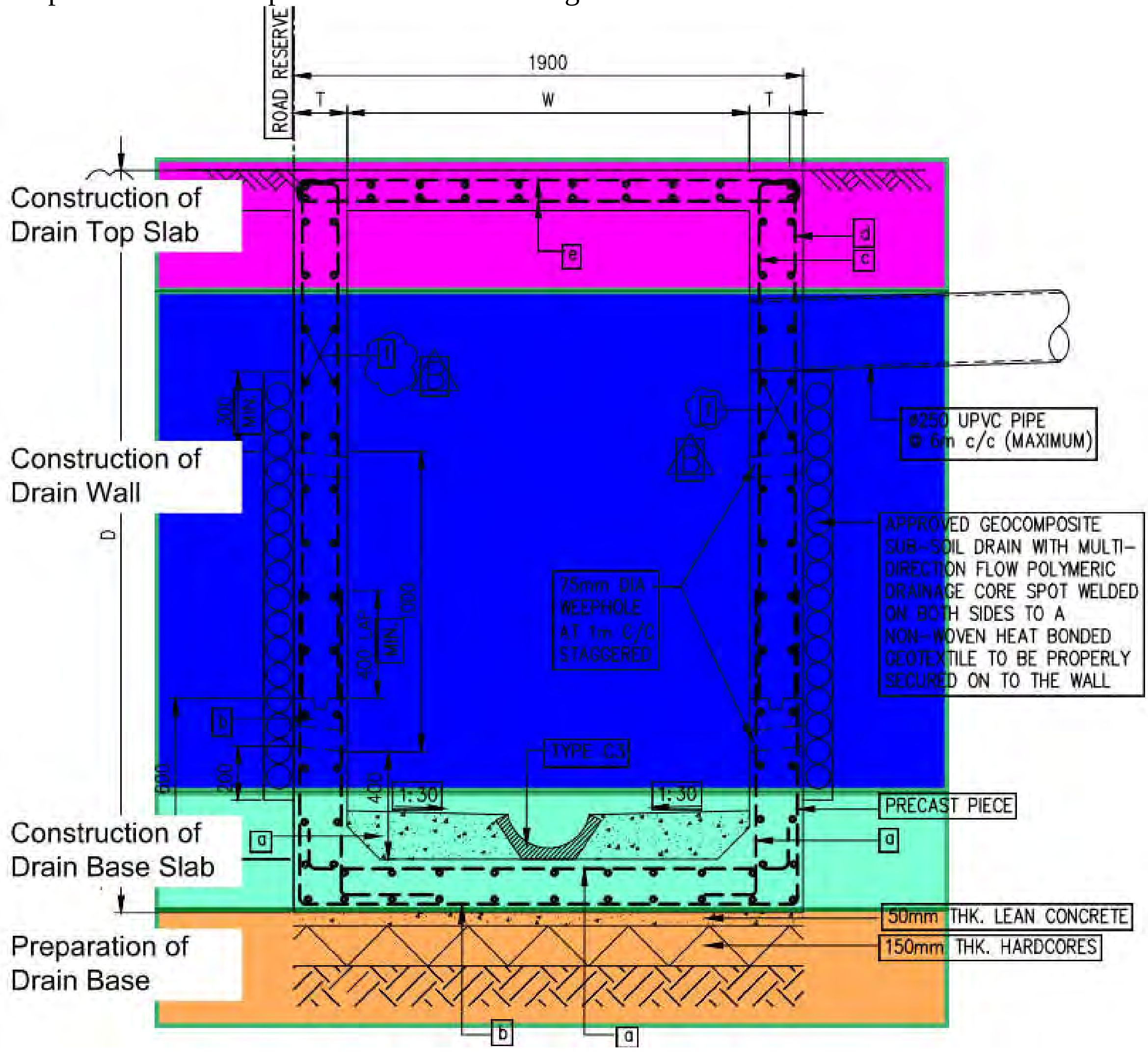


Figure 1: Typical RCU construction work sequence

5.2 Construction of RCS

a) Setting out of sump position
  - Surveyor to mark the center point of proposed RC sump.

b) Excavation of sump
  - Excavator operator to excavate the ground to required level, i.e. the hardcore base level.
  - Ensure the proposed sump area is excavated to sufficient width and depth.
  - The opening excavated shall be large enough for the construction of sump including working space.
  - Supervisor to check the opening size and ditch level.
  - Implement earth retaining stability structure (ERSS) when the depth is more than 1.5m. Contractor have to implement the approved ERSS on site to ensure the stability of soil at all sides of sump ditch.
  - Cut the ground to form the ERSS profile. All the excavated soil is loaded onto tipper truck and send to approved dumping ground.
  - Barricade the sump ditch and safety signage is put up.

c) Preparation of sump base
  - Compact the hardcore base level by using 1-tonne roller
  - On top of the compacted ground, put pegs to mark the proposed level of hardcore base.
  - Lay hardcore base and compact it using 1-tonne roller. The hardcore base after compaction shall be the stipulated thickness as of drawings.
  - On top of compacted hardcore base, put pegs to mark the proposed level of lean concrete.
  - Casting lean concrete on top of compacted hardcore base and level the lean concrete surface.
  - Surveyor to peg and mark proposed sump on lean concrete.

d) Construction of sump base slab, wall and top slab
  - Fabricate rebar and formwork for sump base and wall.
  - Request RTO for inspection before casting of base slab. Further to order for concrete from approved concrete plant once the inspection is passed, and complete the concreting of base slab.
  - Dismantle base slab formworks on the following day; fabricate rebar and formwork for sump wall.
  - Install drain channels and cast benching with mass concrete. The grade of benching is as indicated in construction drawing.
  - Steel reinforcement and formwork of sump wall are then installed. Mark the required sump top level.
  - Steel reinforcement is as indicated in construction drawing. Request RTO for inspection before closing formwork (external side). Ensure aluminum rung is installed as indicated in construction drawing.
  - Install 75mm pvc pipe at 1m c/c staggered for week hole.
  - Once drain wall rebar inspection is cleared, proceed to close the balance formwork.

- Cast concrete of drain wall using appropriate grade. Engine vibrator is used during concreting to ensure evenly distribution of concrete within formwork.
- The level of concrete has to match with the sump top slab (mesh/ rebar anchorage) marked previously.
- Dismantling of internal drain wall formwork on the following day.
- Plaster the drain inner wall to seal up the opening of formwork tie.
- Apply curing compound to the freshly done concrete structure.
- Erection of falsework and formwork for the sump top slab.
- Installation of rebar/ mesh for drain top slab including the grating frame.
- Request RTO for inspection before casting of top slab. Further to order for concrete from approved concrete plant once the inspection is passed, and complete the concreting of top slab.
- Sump top slab to be broom finished; tactile tiles (if any) and expansion joints to be installed before the concrete set.
- Dismantling of external drain wall formwork on the following day.
- Falsework to be maintained for supporting the top slab for 7 days before dismantling.
- Depending on the height of sump wall, it may require more than one operation to cast the sump wall up to top slab soffit level.

e) Sump wall treatment and backfilling

- Installation of geo-composite on both side of drain outer wall before backfilling both side of sump with soil.
- The soil backfilled at both sides of sump shall be at least 50mm lower.
- Backfill both sides of completed sump wall with earth and immediately compact the ground using roller.
- Reinstate slope at both sides of sump to required level, alignment and gradient.
- Turf the ground.
- Repeat whole process for next sump.

f) Typical work sequence for RCS construction
Generally, RCS construction is consists of setting out and excavation, preparation of sump base, structural works for sump base slab, sump wall and sump top slab and finally the sump wall treatment plus backfilling. The preparation of sump base until the completion of sump top slab is illustrated as Figure 2.

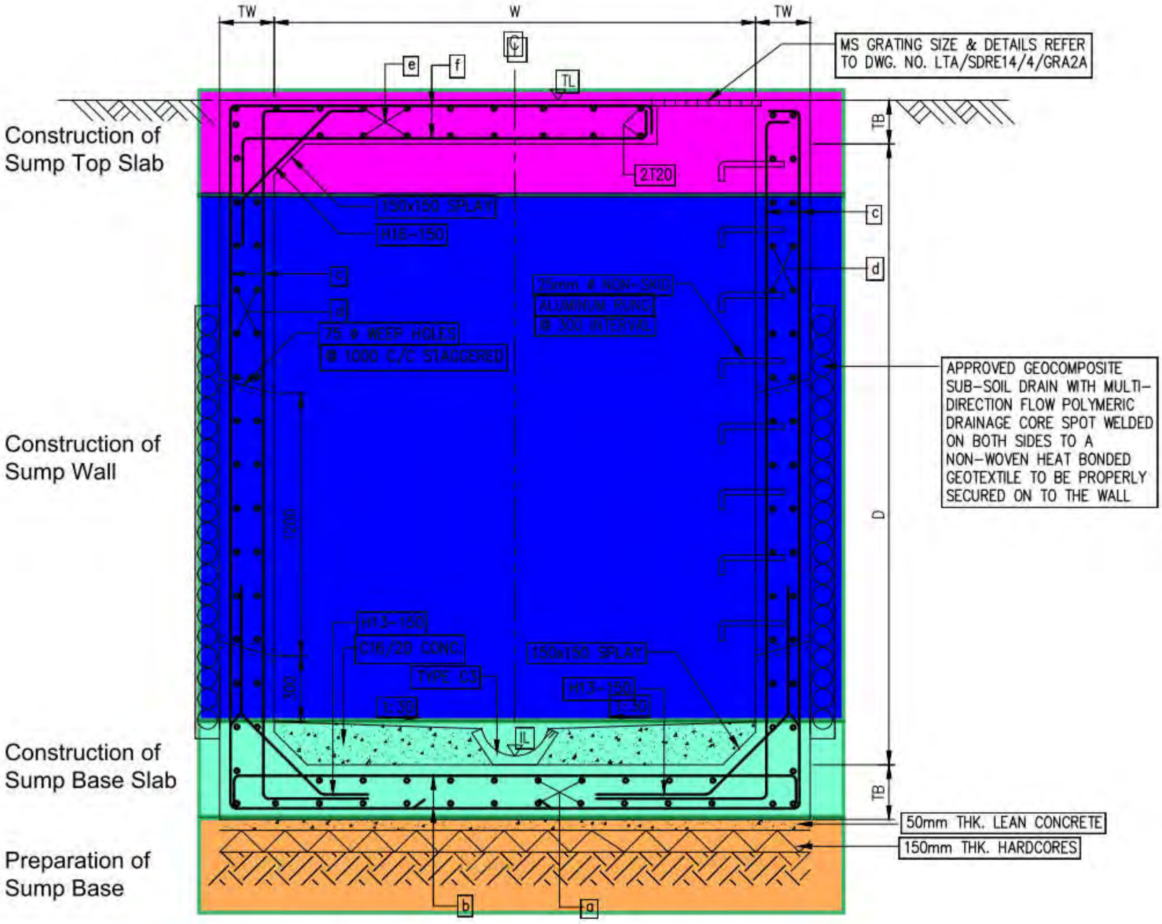


Figure 2: Typical RCS construction work sequence

5.3 Construction of RCBC

a) Setting out of RCBC alignment
  - Surveyor to identify the box culvert location on site. The locations are marked on site using timber peg.

b) Excavation of RCBC
  - Excavator to excavate the box culvert trench up to the hardcore base level.
  - Ensure the proposed box culvert area is excavated to sufficient width and depth.
  - Implement earth retaining stability structure (ERSS) when the depth is more than 1.5m. Contractor have to implement the approved ERSS on site to ensure the stability of soil at both sides of box culvert trench.
  - Cut the ground to form the ERSS profile. All the excavated soil is loaded onto tipper truck and send to approved dumping ground.
  - Barricade the box culvert trench and safety signage is put up.

c) Preparation of RCBC base
  - Compact the hardcore base level by using 1-tonne roller
  - On top of the compacted ground, put pegs at reasonable intervals to mark the proposed level of hardcore base.
  - Lay hardcore base and compact it using 1-tonne roller. The hardcore base after compaction shall be the stipulated thickness as of drawings.
  - On top of compacted hardcore base, put pegs at reasonable intervals to mark the proposed level of lean concrete.
  - Casting lean concrete on top of compacted hardcore base and level the lean concrete surface.
  - Surveyor to peg and mark proposed RCBC centerline on lean concrete.
  - RCBC edge line is established and marked on the lean concrete as well.

d) Construction of RCBC base slab, wall and top slab
  - Deploy excavator with LM to hoist down the prefabricated rebars for box culvert base slab, and commence the rebar tying and fabrication of formworks according to approved construction drawing.
  - Request RTO for inspection before casting of base slab. Further to order for concrete from approved concrete plant once the inspection is passed, and complete the concreting of base slab.
  - Dismantle base slab formworks on the following day.
  - Install drain channels (invert level of the drain channels to be checked) and cast benching with mass concrete. The grade of benching is as indicated in construction drawing.
  - Steel reinforcement and formwork of box culvert wall are then installed. Mark the required box culvert top level.
  - Steel reinforcement is as indicated in construction drawing. Request RTO for inspection before closing formwork (external side).
  - Ensure weep hole is installed at distance and interval indicated in construction drawing as well. The diameter of weep hole is indicated in construction drawing.
  - Once box culvert wall rebar inspection is cleared, proceed to close the remaining formwork.

- Installation of corbel formwork and rebar (box culvert rebar anchorage to be installed as well). Request RTO for inspection before casting box culvert wall and corbel.
- Cast concrete of box culvert wall and corbel by using appropriate grade. Engine vibrator is used during concreting to ensure evenly distribution of concrete within formwork.
- The level of concrete has to match with the corbel top level.
- Dismantling of drain wall formwork (internal and external side of box culvert) on the following day.
- Plaster the drain inner wall to seal up the opening of formwork tie.
- Apply curing compound to the freshly done concrete structure.
- Erection of falsework and formwork for the box culvert top slab.
- Installation of rebar for box culvert top slab, including the galvanized dowel bars.
- Request RTO for inspection before casting of top slab. Further to order for concrete from approved concrete plant once the inspection is passed, and complete the concreting of top slab.
- Dismantling of external box culvert wall formwork on the following day.
- Falsework to be maintained for supporting the top slab for 7 days before dismantling.

e) RCBC wall treatment and backfilling

- Installation of geo-composite on both side of drain outer wall before backfilling both side of sump with soil.
- Backfill both sides of box culvert wall with quarry dusts and compacted it using 10-tonne roller.
- The filling of quarry dusts shall stop at bottom of graded aggregate bottom below the approach slab.
- The alignment of approach slab on compacted quarry dusts is established.
- Excavator operator to top up graded aggregate and the aggregate shall be well compacted by 10-tonne roller. The final thickness of compacted aggregate shall be 250mm.

f) Construction of approach slab

- Installation of geo-textile on top of the compacted graded aggregate, installation of building paper and neoprene pad.
- Installation of rebar and fabrication of formwork for approach slab.
- Request RTO for inspection before casting of approach slab. Further to order for concrete from approved concrete plant once the inspection is passed, and complete the concreting of base slab.
- Use concrete vibrator during concrete casting to ensure the concrete is poured evenly and thoroughly within formwork.
- Dismantling of formwork on the next day.
- Repeat the above steps for construction of next stretch of box culverts.

g) Typical work sequence for RCBC construction

Generally, RCBC construction is consists of setting out and excavation, preparation of box culvert base, structural works for box culvert base slab, box culvert wall and box culvert top slab and finally the box culvert approach slab. The preparation of box culvert base until the completion of box culvert approach slab is illustrated as Figure 3.

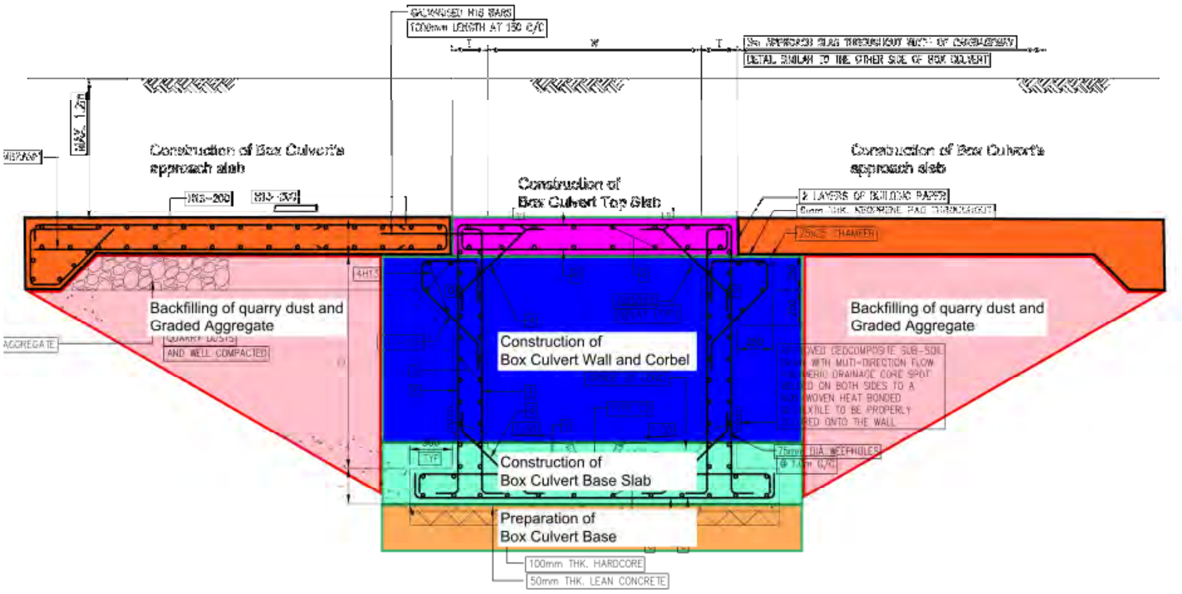


Figure 3: Typical RCBC construction work sequence

5.4 Construction of Trapezoidal drain

a) Setting out of trapezoidal drain alignment
  - Surveyor to identify the drain location on site. The locations are marked on site using timber peg.

b) Excavation of Trapezoidal Drain trench
  - Excavator to excavate the trapezoidal drain trench up to the hardcore base level.
  - Ensure the proposed drain area is excavated to sufficient width and depth.
  - Implement earth retaining stability structure (ERSS) when the depth is more than 1.5m. Contractor have to implement the approved ERSS on site to ensure the stability of soil at both sides of drain trench.
  - Cut the ground to form the ERSS profile. All the excavated soil is loaded onto tipper truck and send to approved dumping ground.
  - Barricade the drain trench and safety signage is put up.

c) Preparation of drain base
  - Compact the hardcore base level by using 1-tonne roller
  - On top of the compacted ground, put pegs at reasonable intervals to mark the proposed level of hardcore base.
  - Lay hardcore base and compact it using 1-tonne roller. The hardcore base after compaction shall be the stipulated thickness as of drawings.
  - On top of compacted hardcore base, put pegs at reasonable intervals to mark the proposed level of lean concrete.
  - Ensure weep hole and geo-textile are installed at distance and interval indicated in construction drawing as well. The diameter of weep hole is indicated in construction drawing.
  - Casting lean concrete on top of compacted hardcore base and level the lean concrete surface.
  - Surveyor to peg and mark proposed drain centerline on lean concrete.
  - Drain edge line is established and marked on the lean concrete as well.

d) Construction of trapezoidal drain concrete lining (without access)
  - Deploy excavator with LM to hoist down the welded mesh (BRC) for drain concrete lining according to approved construction drawing.
  - Install drain channels (invert level of the drain channels to be checked); benching to be cast together with the concrete lining.
  - Request RTO for inspection before casting of concrete lining. Further to order for concrete from approved concrete plant once the inspection is passed, and complete the concreting of concrete lining.

e) Construction of trapezoidal drain concrete lining and slope (with access).
  - Deploy excavator with LM to hoist down the welded mesh (BRC) for drain concrete lining according to approved construction drawing.
  - Steps to be formed by using formwork and secured at both edge of the steps; rebar to be installed as of construction drawings.
  - Install drain channels (invert level of the drain channels to be checked); benching to be cast together with the concrete lining.
  - Request RTO for inspection before casting of concrete lining. Further to order for

concrete from approved concrete plant once the inspection is passed, and complete the concreting of concrete lining.

f) Railing and turfing works
- Installation of Type-B railing as stipulated in the construction drawing.
- The soil to be backfilled and compacted by using 1-tonne roller.
- Reinstate slope at both sides of drain to required level, alignment and gradient.
- Turf the ground.
- Repeat whole process for next stretch of Trapezoidal Drain.

g) Typical work sequence for Trapezoidal Drain construction
Generally, Trapezoidal construction is consisting of setting out and excavation, preparation of drain base, structural works for drain concrete lining and finally the finishing works. The preparation of trapezoidal drain base until the completion of trapezoidal drain is illustrated as Figure 4.

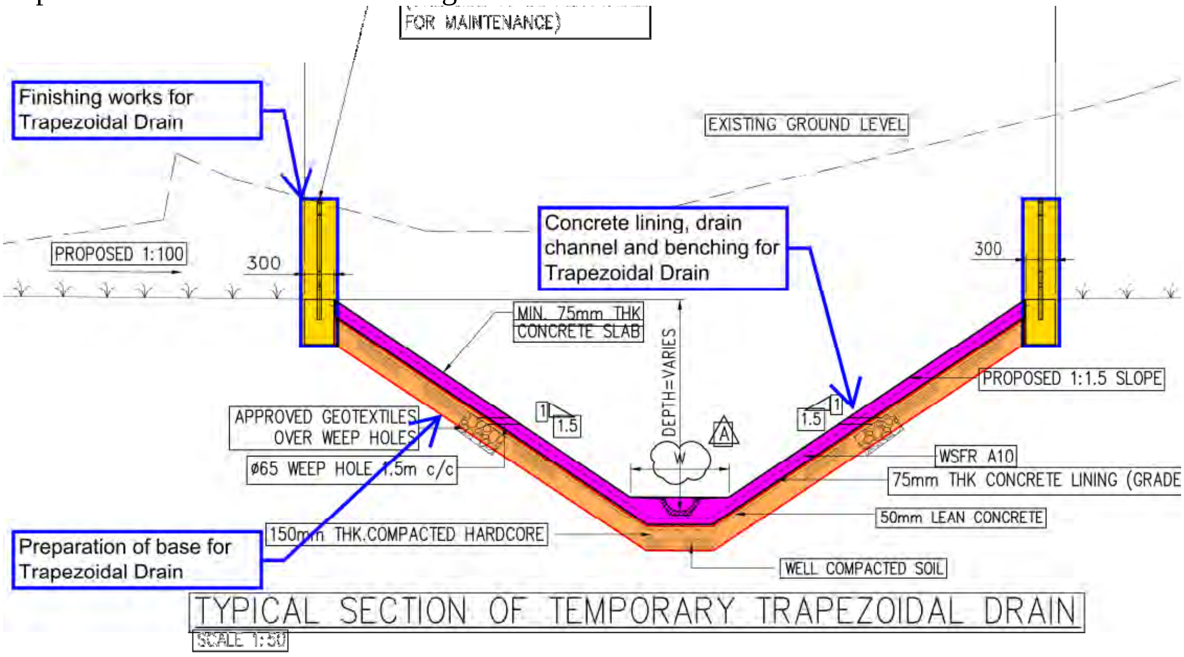


Figure 4: Typical Trapezoidal Drain construction work sequence

5.5 Construction of C7 drain, silt trap and cascade drain

There are C7 drains to be constructed after the plot trimmed into desired profile. Contractor will either fabricate the precast C7R drain or directly purchase from suppliers.

- Contractor shall prepare sufficient steel mould of C7R.
- Precast C7R drain daily with stipulated concrete grade. Request RTO to witness the casting regularly.
- Contractor shall include BRC A5 in precast C7R drain. Refer to Figure 5 for detail of precast C7R drain.

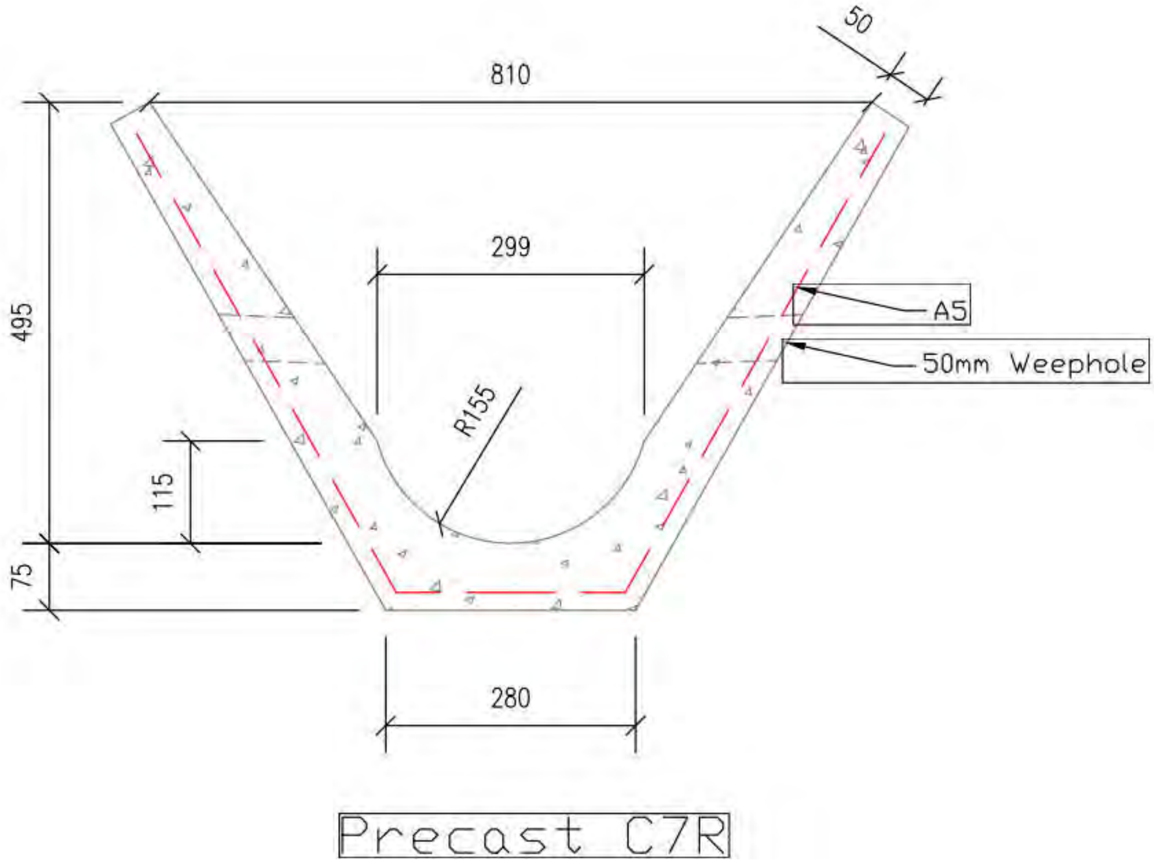


Figure 5: Detail of Precast C7R

C7 drain construction is shown as below:

a) Setting out of C7 drain alignment
   - Surveyor to identify the drain location on site. The locations are marked on site using timber peg.

b) Excavation of C7 trench
   - Supervisor to identify the excavation depth from existing ground level to sand base of precast C7R.
   - Open cut method with 1:1 slope is adopted to excavate the trench.
   - Excavator operator to excavate the ground to desired level.

c) Preparation of drain base
   - Compact the ground using 1-tonne roller.
   - Supervisor to check the level. If the level is higher than desired level, instruct excavator operator to trim ground to desired level; if level is lower than desired level, top up the ground with unwashed sand.
   - Lay 50mm thick sand as of Figure 6.

Figure 6: Laying of sand for C7 drain

   - Compact the sand base again using 1-tonne roller.
   - Ensure the stretch of sand base is in required gradient. The sand base level shall be as precise as possible as it will affect the invert level.

d) Installation of C7 drain

- Excavator with LM certificate is deployed to lift and lay the precast C7R drain on sand base.
- Supervisor to ensure the precast drain is placed correctly on the proposed alignment.
- Seal up the gap between precast drains with 1:3 cement mortar as of Figure 7.

Figure 7: Laying of C7 drain

e) Backfilling for C7 drain line.

- Backfill both side of precast C7R.
- Excavator operator to compact the adjacent slopes of drain, if the drain top level is lower than the platform proposed level.
- The gradient of slope shall be 1:1 from the top of drain wall to the proposed platform level as shown in Figure 8.

Figure 8: Compaction of slope adjacent to C7 drain

- Cast 50mm thick concrete as lining to slope as of Figure 9.

Figure 9: Casting of concrete lining for the C7 drain slope

- Turf the adjacent slopes of drain.
- Repeat the above steps for next stretch of C7R.

6 Drainage that involve over-pumping, demolition or ERSS (other than open cut)

There are several drains which require over-pumping, involve demolition works as well as different type of ERSS (other than open cut). The type of drain and its special arrangement shall be listed in Table 2.

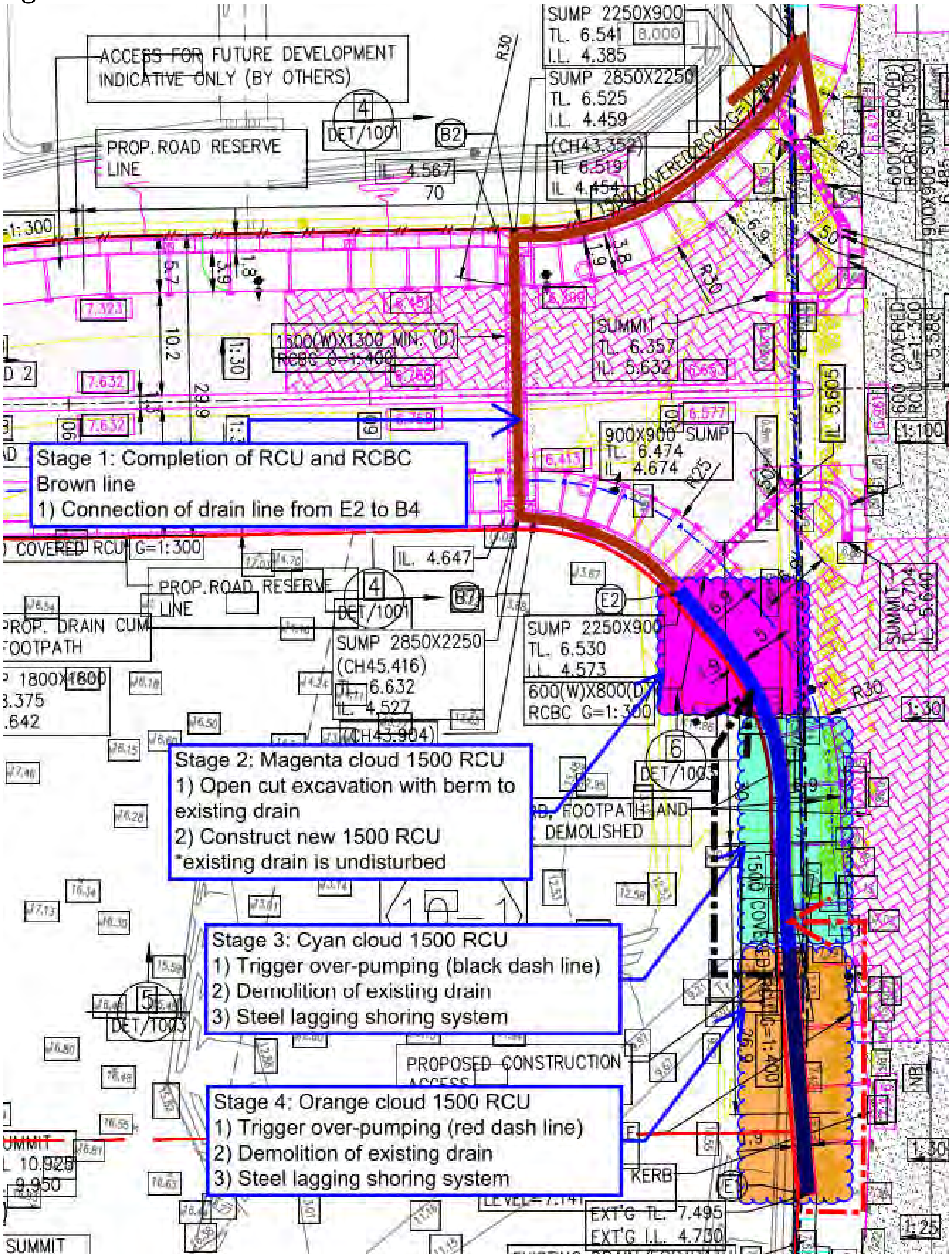
No	Location	Road	Type	Size (mm)	Excavation	Diversion/ Demolition
1	B3- island	Road 2	RCBC	600 x 800	Open cut	NA
2	B5-B6	Road 2	RCBC	1200 x 900	Open cut	NA
3	E2-island	Road 2	RCBC	600 x 800	Open cut	NA
4	B7-B2	Road 2	RCBC	1500 x 1300	Open cut	NA
5	B5	Road 2	RCS	1800 x 1800	Open cut	NA
6	B6	Road 2	RCS	1800 x 1800	Open cut	NA
7	B2	Road 2	RCS	2850 x 2250	Open cut	NA
8	B7	Road 2	RCS	2850 x 2250	Open cut	NA
9	B3	Kranji Road	RCS	2250 x 900	Open cut	NA
10	Island near B3	Kranji Road	RCS	900 x 900	Open cut	NA
11	E2	Kranji Road	RCS	2250 x 900	Open cut	NA
12	Island near B3	Kranji Road	RCS	900 x 900	Open cut	NA
13	D2	Future road	RCS	3000 x 2250	Open cut	NA
14	D3	Future road	RCS	3000 x 2250	Open cut	NA
15	B1-B2	Road 2	RCU	1200	Open cut	NA
16	B2-B3	Road 2	RCU	1500	Open cut	NA
17	B3-B4	Road 2	RCU	1500	Open cut	NA
18	B1-B5	Road 2	RCU	1200	Open cut	NA
19	B6-B7	Road 2	RCU	1200	Open cut	NA
20	B7-E2	Road 2	RCU	1500	Open cut	NA
21	E1-E2	Kranji Road	RCU	1500	Shoring excavation	Over-pumping
22	B6-C4	Int. driveway	RCU	600	Open cut	NA
23	B5-C1	Int. driveway	RCU	600	Open cut	NA
24	B6-C4	Int. driveway	RCU	600	Open cut	NA
25	C4-C5	Int. driveway	RCU	800	Open cut	NA
26	C5-C2	Int. driveway	RCU	800	Open cut	NA
27	B5-C1	Int. driveway	RCU	600	Open cut	NA
28	C1-C2	Int. driveway	RCU	800	Open cut	NA
29	D4 end	Future road	RCU	3400	Open cut	NA
30	A1-A3	Road 1	RCU	900	Open cut	NA
31	A1-A2	Road 1	RCU	900	Open cut	NA
32	F1-F2	Kranji Close	RCU	900	Open cut	Demolition and over-pumping
33	Island near B3	Kranji Road	RCU	600	Open cut	NA
34	Island near E2	Kranji Road	RCU	600	Open cut	NA
35	C2-C3	Future road	Trapezoidal	1600	Open cut	NA
36	D1-C3	Future road	Trapezoidal	7000	Open cut	NA
37	C3-D2	Future road	Trapezoidal	7000	Open cut	NA
38	D3-D4	Future road	Trapezoidal	7000	Open cut	NA
39	Overall plot	Overall plot	C7	-	Open cut	NA

Table 2: Drainage excavation method and requirements

The drainage which involve shoring excavation, over-pumping and demolition will be further explained in following sections.

6.1 Construction of 1500 RCU (E2 to E1)

There is a new 1500 RCU along Kranji Road starting from point E1 to E2 as shown in below Figure 10.



Stage 1: Completion of RCU and RCBC Brown line
1) Connection of drain line from E2 to B4

Stage 2: Magenta cloud 1500 RCU
1) Open cut excavation with berm to existing drain
2) Construct new 1500 RCU
*existing drain is undisturbed

Stage 3: Cyan cloud 1500 RCU
1) Trigger over-pumping (black dash line)
2) Demolition of existing drain
3) Steel lagging shoring system

Stage 4: Orange cloud 1500 RCU
1) Trigger over-pumping (red dash line)
2) Demolition of existing drain
3) Steel lagging shoring system

Figure 10: E2 – E1 drain line construction

Drain line E2 to E1 shall be constructed in stages to ensure the flow of existing drain is maintained. The work sequence in stages shall be listed as below:

- Stage 1: completion of RCBC, RCS, RCU as shown in Brown line (Figure 10)
  - 1500 RCU from E2 to RCS shall be completed
  - RCBC B2 to B7 shall be completed
  - 1500 RCU from B2 to connection of existing at B4 shall be completed
- Stage 2: construction of 1500 RCU at E2 (magenta cloud in Figure 10)
  - Existing drain flow is not disturbed, existing drainage to be maintained.
  - Existing drainage shall be utilized as part of the ERSS.
  - Open cut excavation will be used to excavate until the formation level; lean concrete berm will be cast along the existing drain as shown in Figure 11.

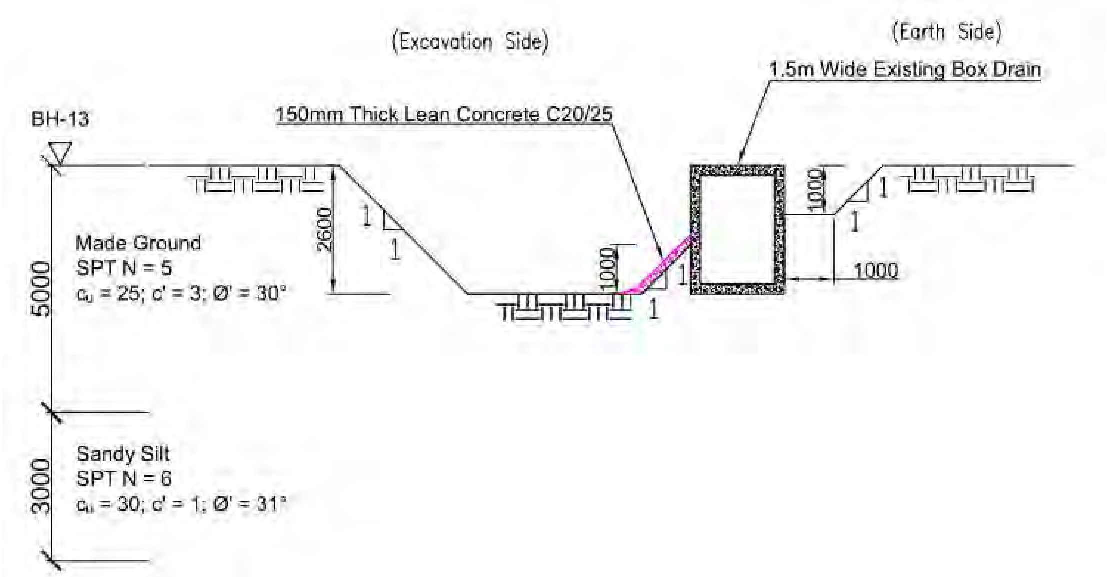


Figure 11: Open cut excavation with lean concrete berm

  - Excavation for the drainage to proceed from inner side of the site.
  - Construct the 1500 RCU drain as mentioned in previous section.
  - Backfilling to the level as shown in approved drainage drawing.

- Stage 3: construction of 1500 RCU towards E1 (cyan cloud in Figure 10)
  - Hoarding to be shifted towards construction site temporary to facilitate the drainage construction.
  - To trigger over-pumping system (black dash line) as shown in Figure 10.
  - Over-pumping system to follow approved ECM scheme as shown in Figure 12)

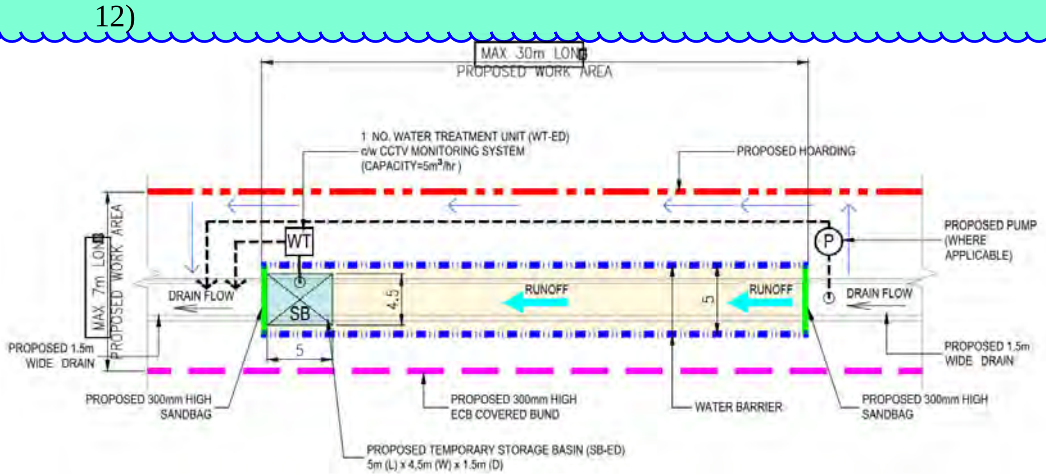


Figure 12: Over-pumping system

  - Once the over-pumping is commissioned, 1500 RCU highlighted in cyan cloud in Figure 10 will be started by demolition of existing drain line.
  - Existing drain will be demolished by using excavator breaker.
  - New drain line will be established.
  - Shoring work will be done prior to any excavation works for drainage.
  - Steel lagging (consists of steel I-beam and 20mm thick steel plate as of Figure 13) will be installed onsite by using excavator.

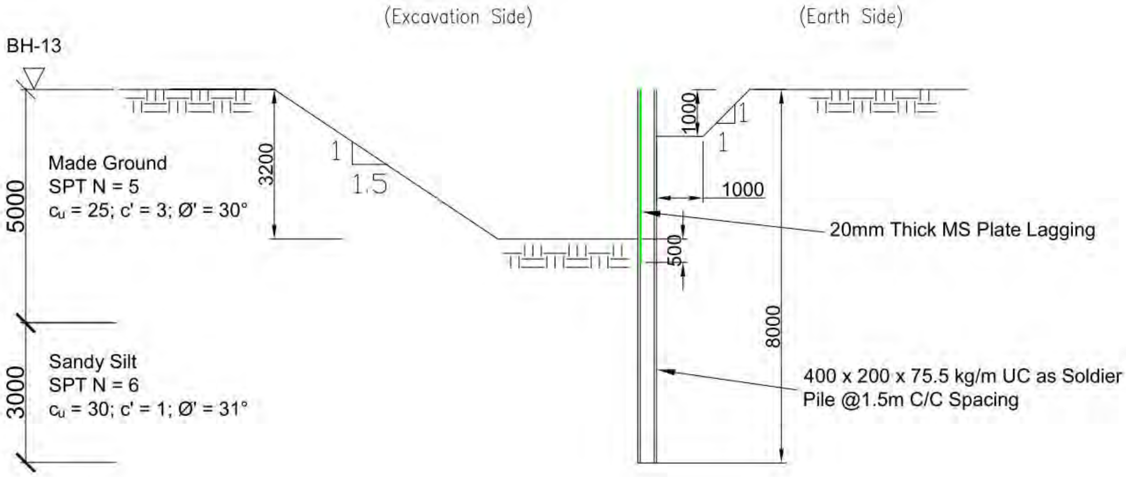


Figure 13: Steel lagging shoring system

  - Excavation for the drainage to proceed from inner side of the site.
  - Construct the 1500 RCU drain as mentioned in previous section.
  - Backfilling to the level as shown in approved drainage drawing.

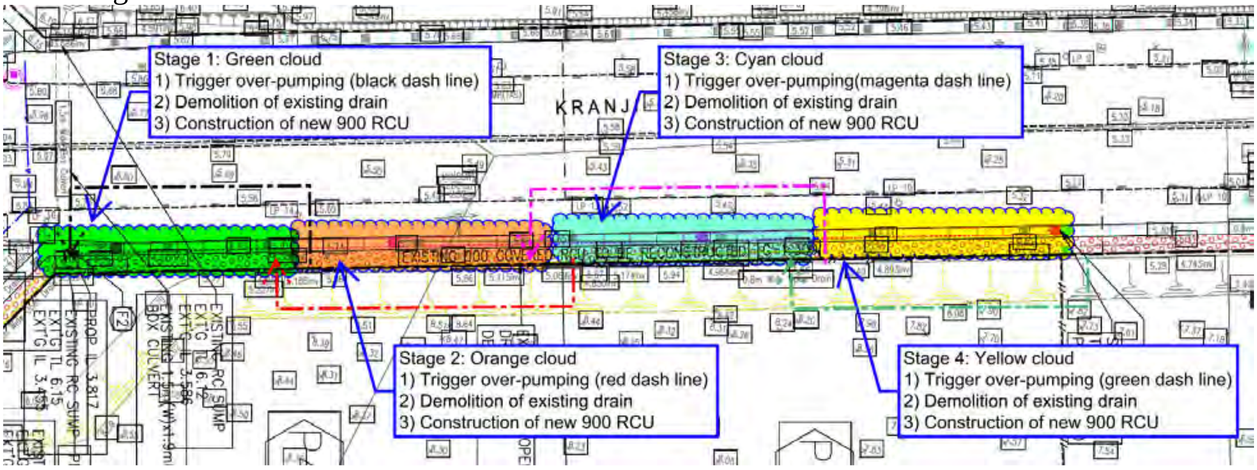
    - Steel beams, steel plates to be extracted for subsequent stretch of shoring works.
    - Hoarding to be reinstated.

- Stage 4: construction of 1500 RCU towards E1 (orange cloud in Figure 10)
    - Hoarding to be shifted towards construction site temporary to facilitate the drainage construction.
    - To trigger over-pumping system (red dash line) as shown in Figure 10.
    - Once the over-pumping is commissioned, 1500 RCU highlighted in orange cloud in Figure 10 will be started by demolition of existing drain line.
    - Existing drain will be demolished by using excavator breaker.
    - New drain line will be established.
    - Shoring work will be done prior to any excavation works for drainage.
    - Steel lagging (consists of steel I-beam and 20mm thick steel plate as of Figure 13) will be installed onsite by using excavator.
    - Excavation for the drainage to proceed from inner side of the site.
    - Construct the 1500 RCU drain as mentioned in previous section.
    - Backfilling to the level as shown in approved drainage drawing.
    - Steel beams, steel plates to be extracted.
    - Hoarding to be reinstated.

- ERSS for drainage works shall follow the approved ERSS drawing as shown in Appendix 1.
- ECM for drainage works shall follow the approved ECM drawing as shown in Appendix 2

6.2 Construction of 900 RCU (F1 to F2)

There is a new 900 RCU along Kranji Close starting from point F1 to F2 as shown in below Figure 14.



Stage 1: Green cloud
1) Trigger over-pumping (black dash line)
2) Demolition of existing drain
3) Construction of new 900 RCU

Stage 2: Orange cloud
1) Trigger over-pumping (red dash line)
2) Demolition of existing drain
3) Construction of new 900 RCU

Stage 3: Cyan cloud
1) Trigger over-pumping(magenta dash line)
2) Demolition of existing drain
3) Construction of new 900 RCU

Stage 4: Yellow cloud
1) Trigger over-pumping (green dash line)
2) Demolition of existing drain
3) Construction of new 900 RCU

Figure 14: F1 – F2 drain line construction

Drain line F2 to F1 shall be constructed in stages to ensure the flow of existing drain is maintained. The work sequence in stages shall be listed as below:

- Stage 1: Construction of 900 RCU (Green cloud in Figure 14)
  - To trigger over-pumping system (Black dash line as shown in Figure 14)
  - Demolition of existing drain by using excavator breaker.
  - Construction of 900 RCU as mentioned in previous section.
- Stage 2: Construction of 900 RCU (Orange cloud in Figure 14)
  - To trigger over-pumping system (Red dash line as shown in Figure 14)
  - Demolition of existing drain by using excavator breaker.
  - Construction of 900 RCU as mentioned in previous section.
- Stage 3: Construction of 900 RCU (Cyan cloud in Figure 14)
  - To trigger over-pumping system (Magenta dash line as shown in Figure 14)
  - Demolition of existing drain by using excavator breaker.
  - Construction of 900 RCU as mentioned in previous section.
- Stage 4: Construction of 900 RCU (Yellow cloud in Figure 14)
  - To trigger over-pumping system (Green dash line as shown in Figure 14)
  - Demolition of existing drain by using excavator breaker.
  - Construction of 900 RCU as mentioned in previous section.
- ERSS for drainage works shall follow the approved ERSS drawing as shown in Appendix 1.
- ECM for drainage works shall follow the approved ECM drawing as shown in Appendix 2

Appendix 1:
ERSS for drainage works

Design Code and Standard References

1.	SS EN 1990: 2008	Basis of structural design
2.	SS EN 1991-1-1: 2008	General actions - densities, self-weight, imposed loads for buildings
3.	SS EN 1992-1-1: 2008	Design of concrete structures
4.	SS EN 1993-1-1: 2008	Design of steel structures
5.	SS EN 1997-1: 2010	Geotechnical design - General rules
6.	SS EN 1997-2: 2010	Geotechnical design - Ground investigation and testing
7.	SS 557: 2010	Code of Practice for Demolition
8.	BCA BC1: 2012	Design guide on use of alternative structural steel to BS 5950 and Eurocode 3
9.	BS EN 1995	Design of timber structures
10.	BS EN 338 (2016)	Structural Timber – Strength Classes
11.	BS EN 14081-1:2005+A1:2011	Timber structures - Strength graded structural timber with rectangular cross section

General Notes for Building Works

1. It is an offence under the building control act to commence and carry out building works without the approved plans and permit to carry out structural works granted by the commissioner of building control.
2. No building works shall commence and be carried out without approved plans and permit to carry out structural works granted by the Commissioner of Building Control.
3. All building works shall be carried out in accordance to BCA approved drawings.
4. The builder/resident engineer (RE)/resident technical officer (RTO)/supervising qualified person QP(S) shall report to the design qualified person QP(D) any building works deviating from BCA approved drawings and shall not allow such works to commence until the deviation(s) and/or material change(s) are approved by the relevant authorities.
5. The builder shall obtain all necessary approvals from all relevant authorities prior to commencement of the proposed works.
6. The builder shall carry out his due diligence at his own costs to detect any existing services and/or possible underground obstruction on site prior to the commencement of works. Affected existing underground services shall be adequately protected during the construction works to prevent any damages.
7. During construction stage, builder is to ensure that the construction sequence will not result in any instability of the proposed building works or affect the structural stability and integrity of any existing structures.
8. All dimensions shown in the drawings shall be in millimetres unless otherwise stated. Do not scale drawing - Only figured dimensions are to be used.
9. All workmanship and materials shall comply to the requirements of the current editions, including amendments of the relevant SS EN design codes, materials standards, execution standards and Authorities requirements.
10. The builder is to obtain Sewerage Interpretation Plan (SIP), Drainage Interpretation Plan (DIP) and Road Interpretation Plan (RIP) from Architect or Relevant Authorities before commencement of works (i.e. piling, excavation etc).
11. For any alteration and addition works, builder must verify on site for any discrepancy and omission of structural members. The builder is deemed to have included all costs relating to rectifying, provision, amongst others, to comply with Engineer's approval.

Notes for Structural Steel Works

1. All structural steel work to be carried out in accordance with the drawings, the specifications, the latest SS EN 1993 Eurocode 3 or equivalent local code of practices wherever applicable.
2. All structural steel shall comply with the requirements of BS EN 10025, BS EN 10210 and BS EN 10219 grade S275. All steel including bolts and nuts shall be Class 1 Steel complying to BC1:2012. Builder is to submit Factory Production Certificate (FPC) and Manufacturer Test Certificates (MTC) or Mill Certificates for BC1: 2012 requirements.

Notes for Earth Retaining and Stabilising System (ERSS) Works

1. No construction works shall be carried out prior to the approval obtained from all relevant authorities.
3. Builder is to ensure that the existing Gas Transmission Pipes (GTP) and any other services are protected during the construction works.
4. All construction materials used shall comply with the latest authorities' requirements and code of practice.
5. If there are any material changes or deviations from the approved plans, approval must be obtained from the relevant authorities prior to carrying out the proposed construction works on site.
6. Builder and/or Site Supervisor(s) are to report to Design QP should the soil conditions observed on site are different from the soil investigation report.
7. Builder and/or Site Supervisor(s) are to report to Design QP if the ERSS design is unable to achieve the intended depth for his assessment and amendment submission if required.
8. Builder and/or Site Supervisors are to stop the construction works immediately and report to Design QP if any visible ground movements and/or structural deformation is observed on site.
9. Excavation site is to be backfilled immediately shall there be water seepage observed during the construction works.
10. There shall be no additional surcharge within 1x excavation depth from the edge of excavation face at all times.
11. Builder shall ensure proper drainage to be provided in close vicinity of the excavation zone to prevent degradation of the ground conditions.
12. The surcharge of 10kPa was adopted for the design of the ERSS system.

CONTIGENCY PLAN

1.1 Alert Level

The contingency plan to be implemented when the ground movement reaches the alert level as set out in the analysis is;

a. Daily monitoring of instrumentation will be implemented to ensure that any ground movements are being recorded and analysed. All reports will be submitted to the Professional Engineer. A reanalysis may also be carried out based on the site situation and prepared for the necessary remedial action should the ground movement escalates to work suspension level.

b. Visual inspection of the surrounding will be carried out so as to pick up any visible tell tale signs of ground movements. The monitoring frequency may be increased to minimum twice daily or even more during the bulk excavation stage.

c. Inspections to the surrounding buildings, common facilities and existing viaduct will be carried out to check the severity of damages. Buildings / houses will also be inspected to ensure the structure stability. Immediate attention and remedial action, if necessary, will be taken for buildings and common facilities to prevent them from further deterioration.

d. Immediate action as recommended by the Professional Engineer will also be carried out on site depending on the cause of the ground movement. Remedial actions such as backfilling to stabilize the movement of the ERSS, or introduction of recharge well (if ground settlement is generated due to dewatering) will be adopted.

1.2 Work Suspension Level

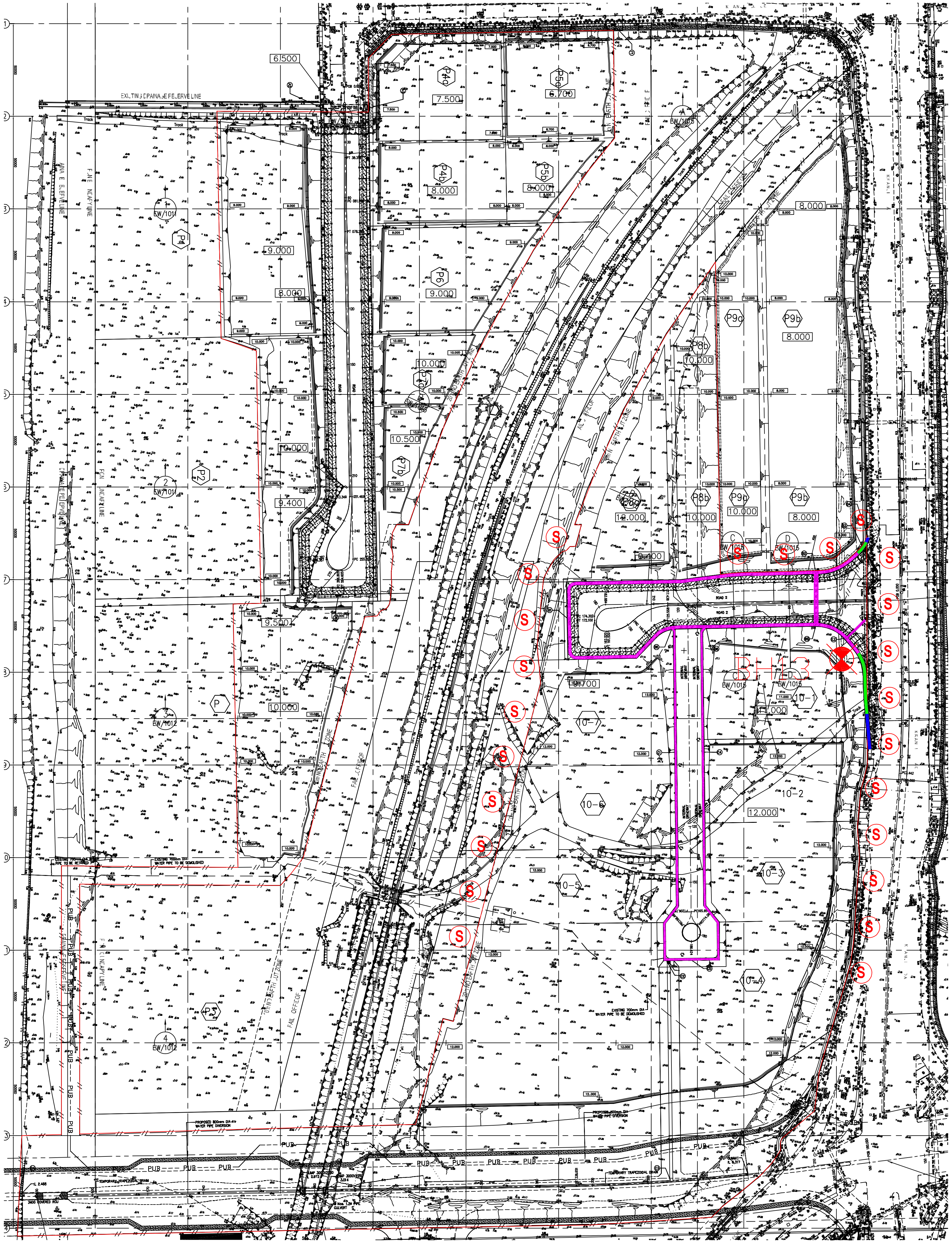
The contingency plan to be implemented when the ground movement reaches the work suspension level as set out in the analysis is;

a. Close monitoring of the ground movement with the aid of instrumentation will be continued daily. Visual inspection will also be carried out.

b. All works affecting the ground stability will be suspended to ensure that the ground condition does not deteriorate. The working area will also be cordoned off to prevent any unauthorized access.

c. The Professional Engineer and Consulting Engineer will be notified immediately of the site condition. A site inspection will then be held immediately to confirm the appropriate remedial action.

d. Additional struts and members will be installed immediately as per the Professional Engineer's design and inspected prior to recommencement of works.



INSTRUMENTATION & LAYOUT PLAN

SCALE: N.T.S

LOCATION PLAN

SCALE: N.T.S

Legend:

- ⊗ Borehole Location
- — Proposed Site Hoarding
- 🟪 Open Cut Excavation Under ST100
- 🟩 Excavation Next to Existing Drain Under ST100
- 🟦 Shoring Excavation Under ST100

Type of Instrumentation	Nos.	Monitoring Frequency	Open Cut Excavation Up to 4m	
			Alert Level	Work Suspension Level
Ⓢ Ground Settlement Marker (Every 25m C/C Spacing from Each Other)	24	Twice Weekly (During Excavation Works) OR Once Weekly (Where no excavation works)	11mm	15mm

NOTES:

1) Frequency of monitoring should be twice a week during the excavation work and once a week when no excavation work is carried out on site.
2) Readings to be commence when instruments are within 30m radius of the excavation works
3) The contractor shall ensure proper protections are provided for the instrumentations. Any damages on the instrumentation shall be repaired immediately and QP shall be informed immediately.

01 Sheet of 03

BUILDING CONSTRUCTION AUTHORITY
APPROVED UNDER SECTION 5 / SECTION 5A OF THE
BUILDING CONTROL ACT (CHAPTER 29)

Project Ref. No.: E2990-00005-2019-ST100
for Commissioner of Building Control

STANDARD CERTIFICATION BY THE QUALIFIED PERSON FOR STRUCTURAL WORKS

1. In accordance with Regulation 9 of The Building Control Regulations, I, VINCENT LIN WENJUN, the Qualified Person for structural works appointed under section 8(1)(a) or 11(1)(d)(i) of the Building Control Act, hereby submit the detailed structural plans and design calculations prepared by me and certify that they have been prepared in accordance with the provisions of the Building Control Regulations, the Building Control Act and any other written law pertaining to buildings and construction for the time being in force.

2. I further certify that these detailed structural plans and design calculations are in reference to Project Ref. No: E2990-00005-2019-ST100

3. Total number of structural plans submitted : 3
and total number of pages of design calculations in this book: 309

VINCENT LIN WENJUN
4794

(QUALIFIED PERSON FOR STRUCTURAL WORKS' SIGNATURE AND STAMP)

29 MAY 2020
DATE

VEngineers
Disclaimer:
This drawing is produced and issued under specific request of our client in connection with the captioned project. It should not be used for any other purposes by any other party without permission from VEngineers. VEngineers accepts no responsibility for the consequences of this drawing being used by any other party for any other purpose(s), or containing any error(s) and/or omission(s) which is due to error(s) and/or omission(s) in the information given to VEngineers by other parties.

29.05.2020	Note for Structural Steel Works
DATE	DESCRIPTION

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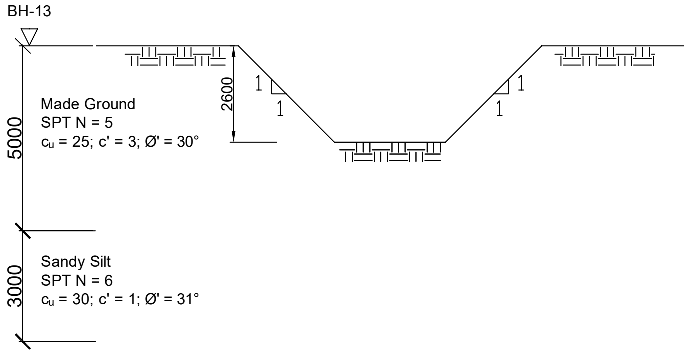
PROJECT TITLE:

EARTHWORKS AND INFRASTRUCTURE AT KRANJI AGRI-FOOD INNOVATION PARK

DRAWING TITLE:

SITE LAYOUT AND
INSTRUMENTATION PLAN

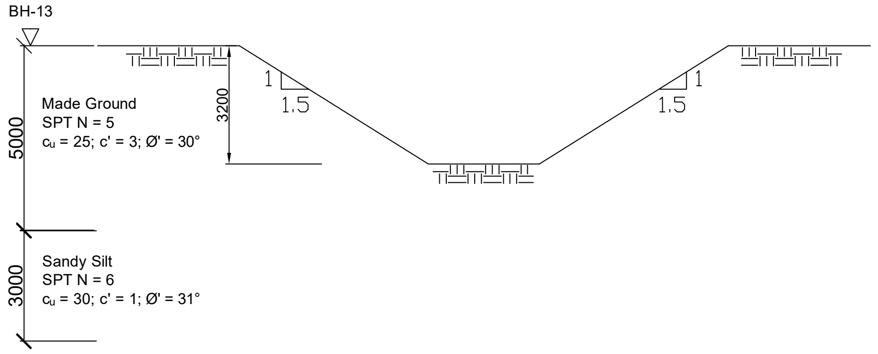
DESIGNED BY: MKN	REVIEWED BY: VL
DRAWN BY: MKN	DATE: 29 MAY 2020
SCALE: AS SHOWN	
DRAWING NO.: 80238_HUATIONG_KRANJI AFIP_ST100_S01	REV: 1



Open Cut Excavation for Construction and Installation of Drainage (Max. Depth =2.6m)
Scale: N.T.S

ERSS Sequence for Construction and Installation of Drainage (Maximum Depth = 2.6m)

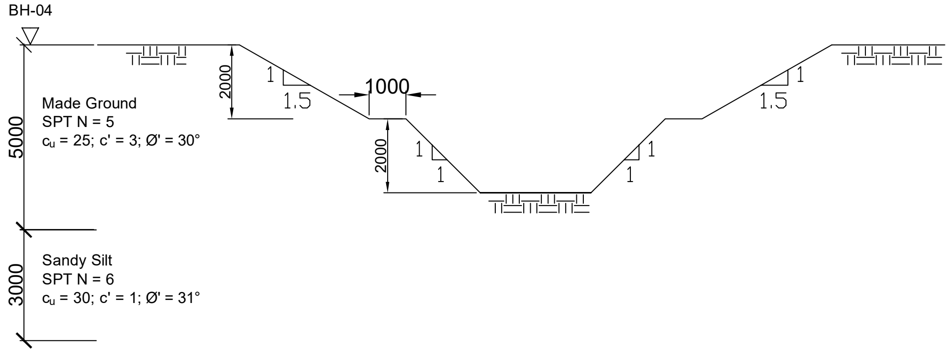
1. Carry out localized open-cut excavation with gradient of 1 : 1 up to maximum depth of 2.6m.
2. Construct and install the drainage.
3. Backfill and compact earth to required platform level.



Open Cut Excavation for Construction and Installation of Drainage (Max. Depth =3.2m)
Scale: N.T.S

ERSS Sequence for Construction and Installation of Drainage (Maximum Depth = 3.2m)

1. Carry out localized open-cut excavation with gradient of 1 : 1.5 up to maximum depth of 3.2m.
2. Construct and install the drainage.
3. Backfill and compact earth to required platform level.



Open Cut Excavation for Construction and Installation of Drainage (Max. Depth =4.0m)
Scale: N.T.S

ERSS Sequence for Construction and Installation of Drainage (Maximum Depth = 4m)

1. Carry out localized open-cut excavation with gradient of 1 : 1.5 up to maximum depth of 2m.
2. Set back 1m on each slope and continue to excavate with gradient of 1:1 up to maximum the depth of 4m from ground surface.
3. Construct and install the drainage.
4. Backfill and compact earth to required platform level.

02 Sheet of 03

BUILDING CONSTRUCTION AUTHORITY
APPROVED UNDER SECTION 5 / SECTION 5A OF THE
BUILDING CONTROL ACT (CHAPTER 29)

Project Ref. No.: A2990-00005-2019-ST100
for Commissioner of Building Control

VINCENT LIN WENJUN
4794

27 APRIL 2020
DATE

(QUALIFIED PERSON FOR STRUCTURAL WORKS' SIGNATURE AND STAMP)

DATE	DESCRIPTION

OWNER:

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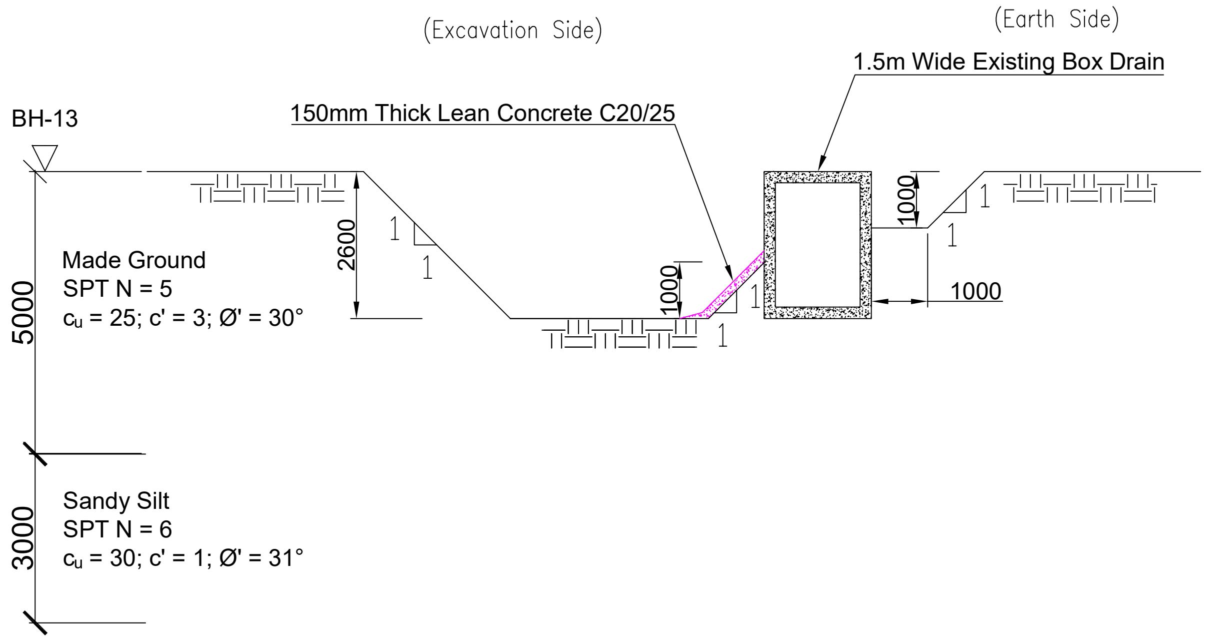
PROJECT TITLE:

EARTHWORKS AND INFRASTRUCTURE AT KRANJI AGRI-FOOD INNOVATION PARK

DRAWING TITLE:

ERSS DETAIL AND CONSTRUCTION SEQUENCE

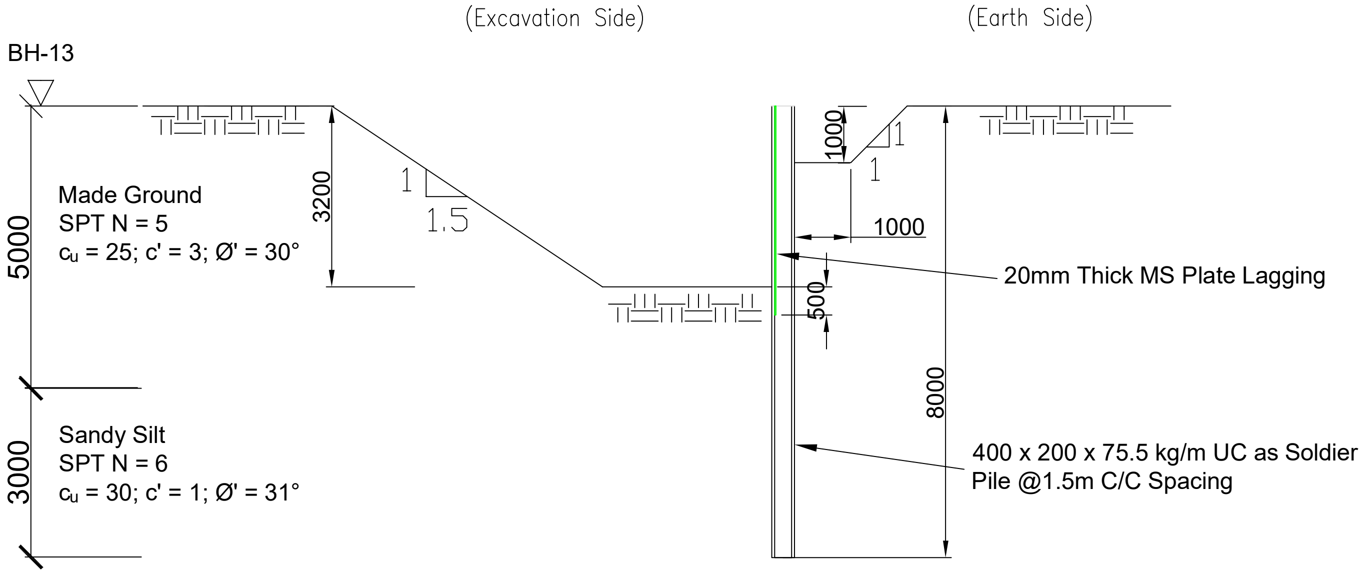
DESIGNED BY: MKN
REVIEWED BY: VL
DRAWN BY: MKN
DATE: 27 APRIL 2020
SCALE: AS SHOWN
DRAWING NO.: 80238_HUATIONG_KRANJI AFIP_ST100_S02
REV: 0



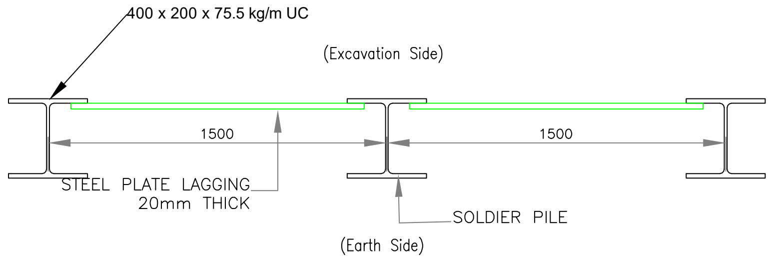
Excavation for Construction and Installation of Drainage Next to Existing Drain (Max. Depth =2.6m)
Scale: N.T.S

ERSS Sequence for Construction and Installation of Drainage Next to Existing Drain (Maximum Depth = 2.6m)

1. Carry out localized open-cut excavation with gradient of 1 : 1 up to maximum depth of 1.0m on earth side of the existing drain.
2. Carry out localized open-cut excavation with gradient of 1:1 up to maximum depth of 2.6m on the excavation side of the existing drain, maintain a soil berm of 1m height and gradient of 1:1.
3. Cast a layer of 150mm thick lean concrete on the slope of soil berm.
4. Construct and install the drainage.
5. Backfill and compact earth to required platform level.



Shoring Excavation for Construction and Installation of Drainage (Max. Depth =3.2m)
Scale: N.T.S



SOLDIER PILE AND STEEL PLATE LAGGING DETAIL

ERSS Sequence for Construction and Installation of Drainage (Maximum Depth = 3.2m)

1. Install the soldier pile and steel plate lagging.
2. Carry out localized excavation with gradient of 1 : 1 up to maximum depth of 1m on earth side of the soldier pile system.
3. Carry out localized excavation with gradient of 1 : 1.5 up to maximum depth of 3.2m on excavation side of the soldier pile system.
4. Construct and install the drainage.
5. Backfill and compact earth to required platform level.
6. Extract the soldier pile and steel plate lagging.

03 Sheet of 03

BUILDING CONSTRUCTION AUTHORITY
APPROVED UNDER SECTION 5 / SECTION 5A OF THE
BUILDING CONTROL ACT (CHAPTER 29)

Project Ref. No.: A2990-00005-2019-ST100
for Commissioner of Building Control

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2. I further certify that these detailed structural plans and design calculations are in reference to Project Ref. No: E2990-00005-2019-ST100

3. Total number of structural plans submitted : 3
and total number of pages of design calculations in this book: 309

CIVIL
VINCENT LIN WENJUN
4794

(QUALIFIED PERSON FOR STRUCTURAL WORKS' SIGNATURE AND STAMP)

27 APRIL 2020
DATE

VEngineers
Disclaimer:

DATE	DESCRIPTION

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PROJECT TITLE:

EARTHWORKS AND INFRASTRUCTURE AT KRANJI AGRI-FOOD INNOVATION PARK

DRAWING TITLE:

ERSS DETAIL AND CONSTRUCTION SEQUENCE

DESIGNED BY: MKN	REVIEWED BY: VL
DRAWN BY: MKN	DATE: 27 APRIL 2020
SCALE: AS SHOWN	
DRAWING NO: 80238_HUATIONG_KRANJI AFIP_ST100_S03	REV: 0

Appendix 2:
ECM for drainage works

VOLUME OF STORM RUNOFF (Q) AT CONSTRUCTION STAGE = $10.9m^3$
TEMP STORAGE BASIN = $15.8m^3$
TOTAL STORAGE VOLUME = $15.8m^3$ > $Q=10.9m^3$, OK

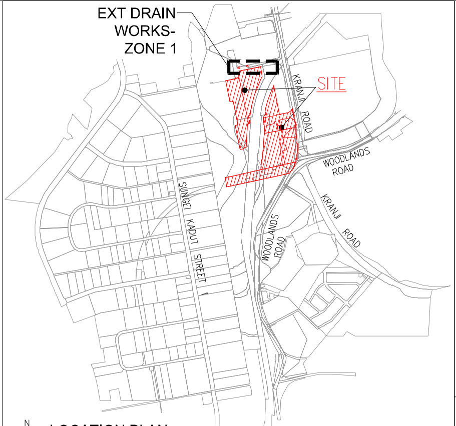
TEMPORARY STORAGE BASIN DIMENSION (SB-ED)								Storm Runoff (m^3)	Water Treatment Tank (WT)
Label	L (m)	W (m)	H (m)	a (m)	b (m)	c (m)	Storage Capacity (m^3)		
SB-ED	5	4.5	1.5	2	1.5	1.5	15.8	10.9	WT-ED=1 No. x $5m^3$/h

REFER TO DWG NO. DT-01 FOR BASIN DETAILS

NOTES:
1. ALL INACTIVE BARE EARTH AREAS WITHIN THE WORK SITE SHALL BE COVERED ALL TIME
2. AILL ACTIVE BARE EARTH AREAS SHALL BE COVERED UP AFTER AND BEFORE RAIN
3. KERB / SILT FENCE AROUND PERIMETER DRAIN TO BE ERECTED TO PREVENT SURFACE RUNOFF FROM CONTACTING THE BARE EARTH AREAS
4. KEEP TURF AND PAVED AREA WHERE POSSIBLE
5. MAXIMUM WORKING AREA WILL BE 30m(L) x 7m(W) = $210m^2$.
6. ONCE 1ST PORTION COMPLETED WILL GO TO NEXT PORTION. EACH PORTION WILL HAVE A MAX. $210m^2$ EXPOSED AREA.
7. PLACE 1 NO. OF WATER PUMP. TO PUMP BLOCKED CLEAN WATER TO PUBLIC DRAIN.
8. ECM TREATMENT SYSTEM 1 NO. FLEXI-M5, CAPACITY = $5m^3$/hrs.

LEGEND

WT	WATER TREATMENT UNIT c/w CCTV AND TSS MONITORING SYSTEM
SB (5 × 4.5)	TEMPORARY STORAGE BASIN
➡	UNTREATED WATER RUNOFF DIRECTION
→	CLEAN WATER RUNOFF DISCHARGE TO EXISTING DRAIN/RIVER
▬ · ▬ ·	PROPOSED HOARDING WITH SEALED BASE
▬ · ▬ ·	PROPOSED 300mm HIGH ECB COVERED BUND
▨	PROPOSED DRAIN
🟩	PROPOSED 300mm HIGH SANDBAG
Ⓟ	PROPOSED PUMP (WHERE APPLICABLE)



LOCATION PLAN
SCALE : 1:10000

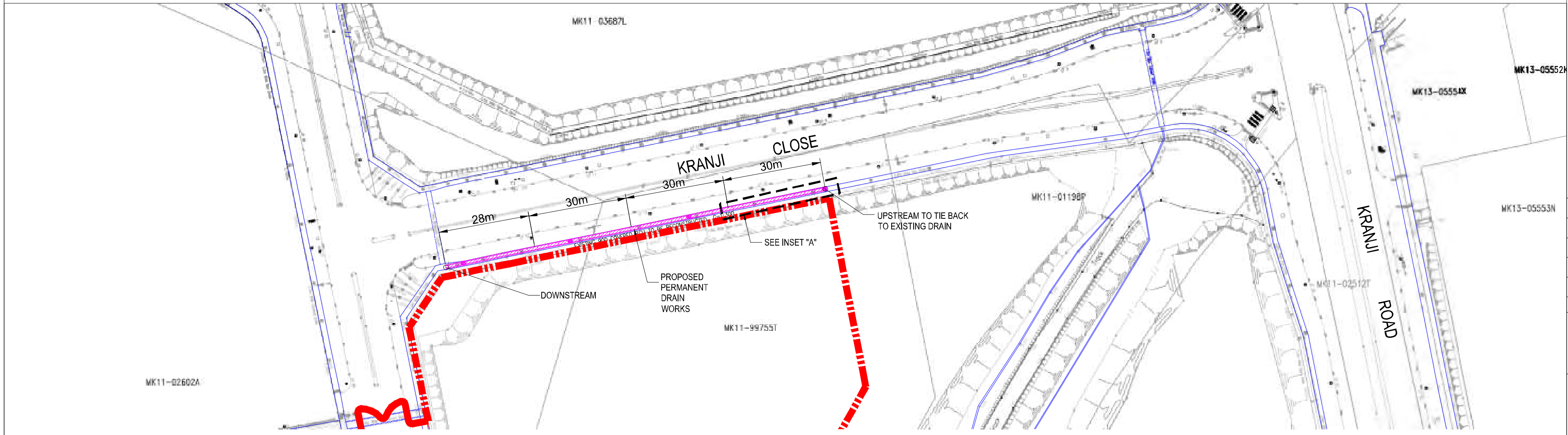
10 sheet of 14

PUBLIC UTILITIES BOARD
Drainage Department

Project Ref. No. : E2990-00005-2019

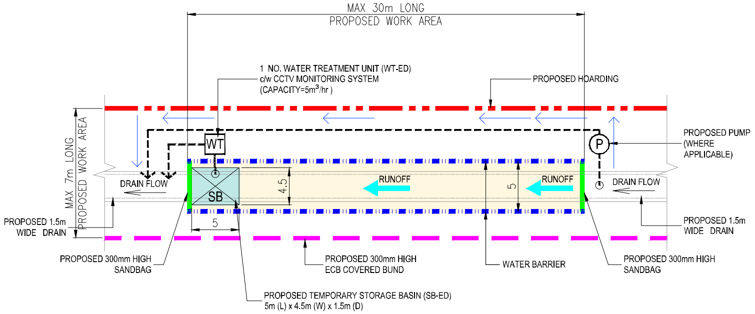
TAN KEH MUI 3708

TAN KEH MUI (Q0153)
QUALIFIED EROSION CONTROL PROFESSIONAL



EARTH CONTROL MEASURE LAYOUT PLAN (EXTERNAL DRAIN WORKS - ZONE 1)

SCALE 1:1250



INSET 'A'
TYPICAL EARTH CONTROL MEASURES PLAN

SCALE 1:200

NO	DESCRIPTION	DATE SIGN
D		
C		
B		
A		

REVISION

DEVELOPER/ LAND OWNER:
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Engineering Planning Division
The JTC Summit
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PROJECT OWNER:

QUALIFIED EROSION CONTROL CONSULTANT:
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TEL: 6353 3392 FAX: 6354 3639

MAIN CONTRACTOR:
Huationg Contractor Pte Ltd
9 Benoi Crescent Singapore 629972
Contact Person: Chua Ngee Hwee
HP: 9069 1350 Email: ngeehwee.chua@huationg.com.sg

PROJECT:
PROPOSED EARTHWORKS AND CONSTRUCTION OF INFRASTRUCTURE AT KRANJI AGRI-FOOD INNOVATION PARK (AFIP) BOUNDED BY KRANJI ROAD AND KRANJI CLOSE

DRAWING TITLE:
EARTH CONTROL MEASURE LAYOUT PLAN
(EXTERNAL DRAIN WORKS - ZONE 1)

DRAWN WL	SCALE AS SHOWN
DESIGNED CCW	DATE MAY 2020
CHECKED CA	APPROVED TKM

FILE NAME : PH-ECM-20044-PL-10-

DRAWING NO : PH/ECM/20044/PL/10
REVISION -

A1

APPENDIX B

Estimated Maximum Sediment Load Calculation

Source: CPG

2. Estimated Maxiumum Sediment Load (based on max allowable 50mg/L)

Kranji AFIP – Drainage Catchment Plan (based on permanent drain flow direction)

Option 1: Sediment Load Estimation based in 1 in 10 years return period (refer to PUB COP):

Rainfall Intensity= Refer to PUB COP,

Assume runoff coefficient=0.45:

Discharge Point 1	Area (ha)	
A1	1.5	
A2	1.7	
A4	0.8	
A5	0.75	
A6	0.76	
A7	0.6	
A8	0.72	
A21	0.2	
TOTAL	7.03	
Peak Runoff, Q	1.802	m^3/s

Discharge Point 2	Area (ha)	
A3	3.8	
A10	2.1	
A10-2	0.44	
A10-3	0.47	
A10-4	2.23	
A10-5	0.74	
A10-6	0.57	
A10-9	0.2	
A19	0.8	
TOTAL	11.35	
Peak Runoff, Q	2.796	m^3/s

Estimated Sediment Load discharge:

Discharge Point 1:

1.802 m3/s x 1000 L/m^3 x 50 mg/L x 10^{-6} kg/mg = 0.0901 kg/s

Discharge Point 2:

2.796 m3/s x 1000 L/m^3 x 50 mg/L x 10^{-6} kg/mg = 0.1398 kg/s

0.2299 kg/s

= 827.64 kg/hr

Option 2: Sediment Load Estimation based on Meteorological Data:

Use rainfall intensity=59.2mm/hr,

Assume runoff coefficient=0.45:

Discharge Point 1	Area (ha)	
A1	1.5	
A2	1.7	
A4	0.8	
A5	0.75	
A6	0.76	
A7	0.6	
A8	0.72	
A21	0.2	
TOTAL	7.03	
Peak Runoff, Q	0.52	m^3/s

Discharge Point 2	Area (ha)	
A3	3.8	
A10	2.1	
A10-2	0.44	
A10-3	0.47	
A10-4	2.23	
A10-5	0.74	
A10-6	0.57	
A10-9	0.2	
A19	0.8	
TOTAL	11.35	
Peak Runoff, Q	0.84	m^3/s

Estimated Sediment Load discharge:

Discharge Point 1:

0.52 m3/s x 1000 L/m^3 x 50 mg/L x 10^{-6} kg/mg = 0.026 kg/s

Discharge Point 2:

0.84 m3/s x 1000 L/m^3 x 50 mg/L x 10^{-6} kg/mg = 0.042 kg/s

0.068 kg/s

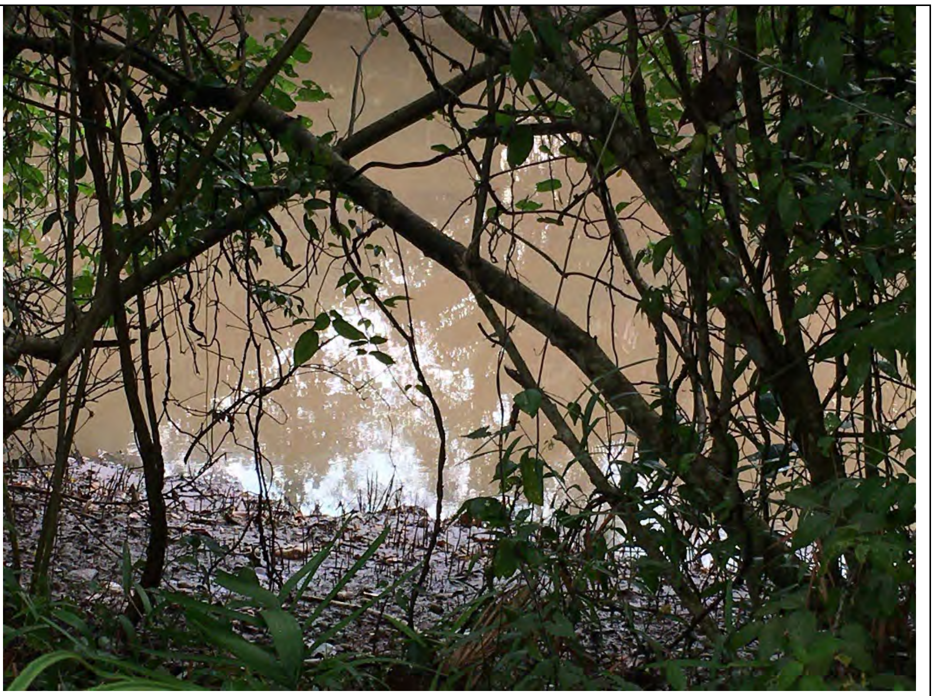
= 244.8 kg/hr

APPENDIX C

Photo Log

Photo No.	**Date:**	
1	23 February 2021	
Description: View of the SP2 during dry weather sampling event.		

Photo No.	**Date:**	
2	23 February 2021	
Description: View of the SP1 during dry weather sampling event. .		

<table>
<tr><td>Photo No.
3</td><td>Date:
12 March 2021</td><td rowspan="2"></td></tr>
<tr><td colspan="2">Description:
View of the SP2 during after rain sampling event.</td></tr>
</table>

<table>
<tr><td>Photo No.
4</td><td>Date:
12 March 2021</td><td rowspan="2"></td></tr>
<tr><td colspan="2">Description:
View of the SP1 during after rain sampling event.</td></tr>
</table>

APPENDIX D

References

Deltares. (2019). SOBEK Manual, 1D/2D modelling suite for integral water solutions.

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APPENDIX E

Chain of Custody Documentation and Laboratory Reports

Amlab
An Interplex Company

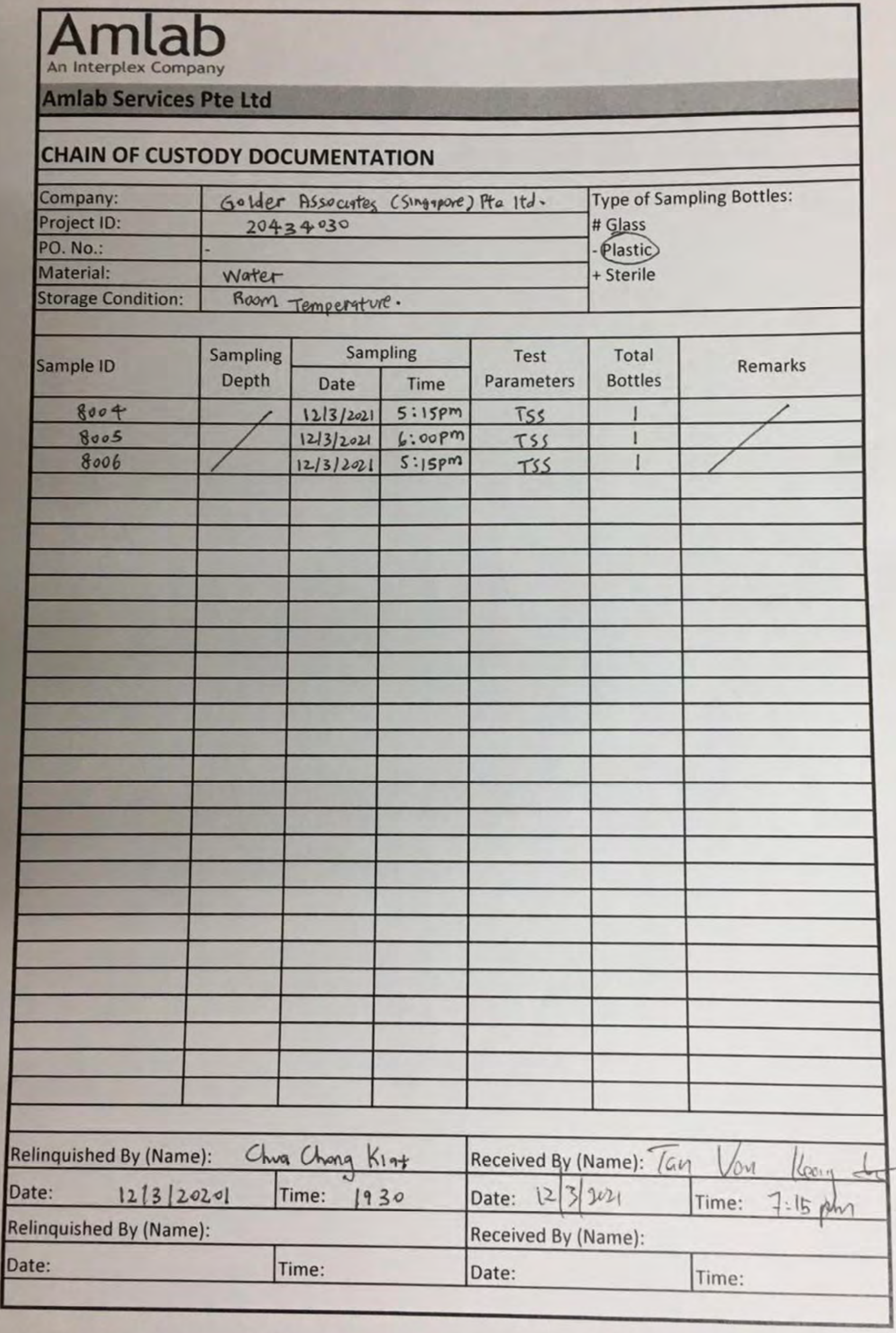
Amlab Services Pte Ltd

CHAIN OF CUSTODY DOCUMENTATION

Company:	Golder Associates	Type of Sampling Bottles: # Glass [✓ Plastic] + Sterile
Project ID:	20434030	
PO. No.:	-	
Material:	Water	
Storage Condition:	Room Temperature	

Sample ID	Sampling Depth	Sampling Date	Sampling Time	Test Parameters	Total Bottles	Remarks
8001	/	23/2/2021	0945	TSS	1	/
8002		23/2/2021	0945	TSS	1	
8003		23/2/2021	1030	TSS	1	
		NOTHING FOUND				

Relinquished By (Name): Chua Chong Kiat		Received By (Name): Jason [illegible]	
Date: 23/2/2021	Time: 11 30	Date: 23/2/2021	Time: 11:30
Relinquished By (Name):		Received By (Name):	
Date:	Time:	Date:	Time:



Amlab
An Interplex Company

Amlab Services Pte Ltd

CHAIN OF CUSTODY DOCUMENTATION

Company: Golder Associates (Singapore) Pte ltd.
Project ID: 20434030
PO. No.: -
Material: Water
Storage Condition: Room Temperature.

Type of Sampling Bottles:
Glass
- [✓ Plastic]
+ Sterile

Sample ID	Sampling Depth	Sampling		Test Parameters	Total Bottles	Remarks
		Date	Time			
8004		12/3/2021	5:15pm	TSS	1	
8005		12/3/2021	6:00pm	TSS	1	
8006		12/3/2021	5:15pm	TSS	1	

Relinquished By (Name): Chua Chong Kiat
Date: 12/3/20201 Time: 1930
Received By (Name): Tan Von Kooing
Date: 12/3/2021 Time: 7:15 pm
Relinquished By (Name):
Date: Time:
Received By (Name):
Date: Time:

AMLAB SERVICES PTE LTD

TEST REPORT

Report No : AL21020892 - 1 / 3
Company Name : Golder Associates Singapore Pte Ltd
Address : 18, Ah Hood Road
#10-51, Hiap Hoe Building
Singapore 329183

Page 1 of 1
Your reference : --
Date Report : 01-Mar-21

Our Reference : --
Date Received : 23-Feb-21
Date Tested : 23-Feb-21 to 26-Feb-21
Sample Description : One (1) water sample was received with following marking:
Project ID: 20434030
8001
Sampling Date: 23/02/2021, Time: 0945

Test Item	Result	Unit	Test Method
Total Suspended Solid	29	mg/l	APHA 2540 D

Note: (1) < = Less than
(2) APHA Method is according to 23rd Edition 2017

William Pang
Deputy General Manager

TEST REPORT

Report No : AL21020892 - 2 / 3
Company Name : Golder Associates Singapore Pte Ltd
Address : 18, Ah Hood Road
#10-51, Hiap Hoe Building
Singapore 329183

Page 1 of 1

Our Reference : --
Your reference : --
Date Received : 23-Feb-21
Date Report : 01-Mar-21
Date Tested : 23-Feb-21 to 26-Feb-21
Sample Description : One (1) water sample was received with following marking:
Project ID: 20434030
8002
Sampling Date: 23/02/2021, Time: 0945

Test Item	Result	Unit	Test Method
Total Suspended Solid	28	mg/l	APHA 2540 D

Note: (1) < = Less than
(2) APHA Method is according to 23rd Edition 2017

WIlliam Pang
Deputy General Manager

TEST REPORT

Report No : AL21020892 - 3 / 3
Company Name : Golder Associates Singapore Pte Ltd
Address : 18, Ah Hood Road
#10-51, Hiap Hoe Building
Singapore 329183

Page 1 of 1

Our Reference : --
Your reference : --
Date Received : 23-Feb-21
Date Report : 01-Mar-21
Date Tested : 23-Feb-21 to 26-Feb-21
Sample Description : One (1) water sample was received with following marking:
Project ID: 20434030
8003
Sampling Date: 23/02/2021, Time: 1030

Test Item	Result	Unit	Test Method
Total Suspended Solid	37	mg/l	APHA 2540 D

Note: (1) < = Less than
(2) APHA Method is according to 23rd Edition 2017

WIlliam Pang
Deputy General Manager

Amlab
An Interplex Company

TEST REPORT

Report No : AL21031229
Company Name : Golder Associates Singapore Pte Ltd
Address : 18, Ah Hood Road
#10-51, Hiap Hoe Building
Singapore 329183

Page 1 of 1
Your reference : --
Date Report : 19-Mar-21

Our Reference : --
Date Received : 12-Mar-21
Date Tested : 12-Mar-21 to 18-Mar-21
Sample Description : Three (3) water samples were received with following marking:
Project ID: 20434030
Sampled Date: 12-Mar -21
(1) 8004
(2) 8005
(3) 8006

Test Item	Result			Unit	Test Method
	(1)	(2)	(3)		
Total Suspended Solid	15	57	18	mg/l	APHA 2540 D

Note: (1) < = Less than
(2) APHA Method is according to 23rd Edition 2017

William Pang
Deputy General Manager

GOLDER
MEMBER OF WSP

golder.com