WORKING PAPER 2J

SOIL EROSION AND SEDIMENTATION ANALYSIS REPORT

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1 IMPACT ASSESSMENT

1.1 Assessment Methodology

Soil erosion is the detachment, entrainment and transport of soil particles from the original place by the agents of erosion such as water, wind and gravity. One of the main causes of soil erosion is water erosion, which is the loss of topsoil due to water. The impact of raindrop loosens the material bonding it together, allowing small fragments to detach. If the rainfall continues, water gathers on the ground, causing water flow on the land surface, known as surface water runoff. This runoff carries the detached soil materials away and deposits them elsewhere. Deposition of the detached soil material is known as sedimentation. Sediment yield refers to the amount of sediment deposit per storm event.

The soil erosion and sediment yield assessments are carried out using Universal Soil Loss Equation (USLE) and Modified Universal Soil Loss Equation (MUSLE) respectively.

The Project site shall consist of 542.2 ha of flat and reclaimed land. Calculation of the soil loss and sediment yield is carried out for five (5) scenarios as described below:

(i) **Pre-development stage** – the existing environment. The Project Site currently consists of 38% idle land and 62% seawater. The idle land is covered with secondary vegetation with mudflat at the foreshore.

(ii) **Pre-bulk grading stage (without erosion and sediment control measures)** – land clearing involves removal of the secondary vegetation. Filling of earth material shall be carried out to increase the platform level from 0m to 8m above m.s.l. Based on the worst case scenario, no erosion and sediment control measures are applied on-site.

(iii) **Pre-bulk grading stage (with erosion and sediment control measures)** – land clearing involves removal of the secondary vegetation. Filling of earth material shall be carried out to increase the platform level from 0 m to 8 m above m.s.l. Erosion and sediment control measures are applied on-site based on the physical activities onsite.

(iv) **Post bulk grading stage (with erosion and sediment control measures)** – Earthwork is completed to achieve the desired platform levels. Construction of the infrastructure facilities and utilities are on-going. Erosion and sediment control measures are applied onsite based on the physical activities.

(v) **Post development stage** – upon operation of the port and industrial area.

The input parameters for USLE and the sources of information are summarized in **Table 1.1**.

Table 1.1: Input Parameters and Reference Source for USLE & MUSLE Calculation

Label	Parameter	Reference Source
R Factor	Rainfall Erosivity Factor	Based on *Guidelines for Erosion and Sediment Control in Malaysia* (DID, 2010).
K Factor	Soil Erodibility Factor	Based on Soil Analysis for the Project site. Borehole data is used to determine K Factor. K Factor is calculated based on Tew Equation as stated in Guidelines for Erosion and Sediment Control in Malaysia (DID, 2010).
LS Factor	Combined index of Slope Length and Slope Steepness	Based on Surveyor's contour plan and Guidelines for Erosion and Sediment Control in Malaysia (DID, 2010).
C Factor	Crop Management Factor	Based on Guidelines for Erosion and Sediment Control in Malaysia (DID, 2010).
P Factor	Soil Conservation Practice Factor	Based on Guidelines for Erosion and Sediment Control in Malaysia (DID, 2010).
V Factor	Runoff Volume	Based on CN Value Method and Urban Stormwater Management Manual for Malaysia 2nd Edition (2012).
Q Factor	Peak Flow	Based on Rational Method and Urban Stormwater Management Manual for Malaysia 2nd Edition (2012).

The Project Site is divided into 20 smaller parcels for detailed calculation of the erosion rates. The parcel demarcation and Borehole locations are shown in **Annex A**.

Details of input data and USLE calculation, MUSLE calculation, and K factor are also provided in **Annex A**.

Topography analysis for various phases of development is carried out using Surfer 17 software. The schematic plots of the analysis are shown in **Annex B**. Changes from the existing elevation and topography to reclaimed and fill land are shown.

1.1.1 Results of Erosion Risk Assessment

Results of the erosion rate and total soil loss during various stages of development are summarised in **Table 1.2** and **Table 1.3** respectively. The maximum soil loss is shown in **Figure 1.1**.

Table 1.2: Erosion Rates of the Project Site during Various Stages of Development

Phase	Erosion Rate (ton ha^{-1} $year^{-1}$)				
	Pre-Development	Pre-Bulk Grading (Without MM*)	Pre-Bulk Grading (With MM*)	Post Bulk Grading (With MM*)	Post Development
1A	0	6.0 – 7.7	2.4 – 3.1	1.5 – 1.9	0.3 – 0.4
1B	0 – 6	52 - 211	2.6 – 84	1.7 – 52	0.4 – 11
1C	0	7.8 – 9.6	3.1 – 3.8	2.0 – 2.4	0.4 – 0.5
2A	0	6.0 – 9.6	2.4 – 3.8	1.5 – 2.4	0.3 – 0.5
2B	0	6.6 – 9.0	2.6 – 3.6	1.7 – 2.2	0.4 – 0.5
2C	0	6.6 – 8.3	2.6 – 3.3	1.7 – 2.1	0.3 – 0.5

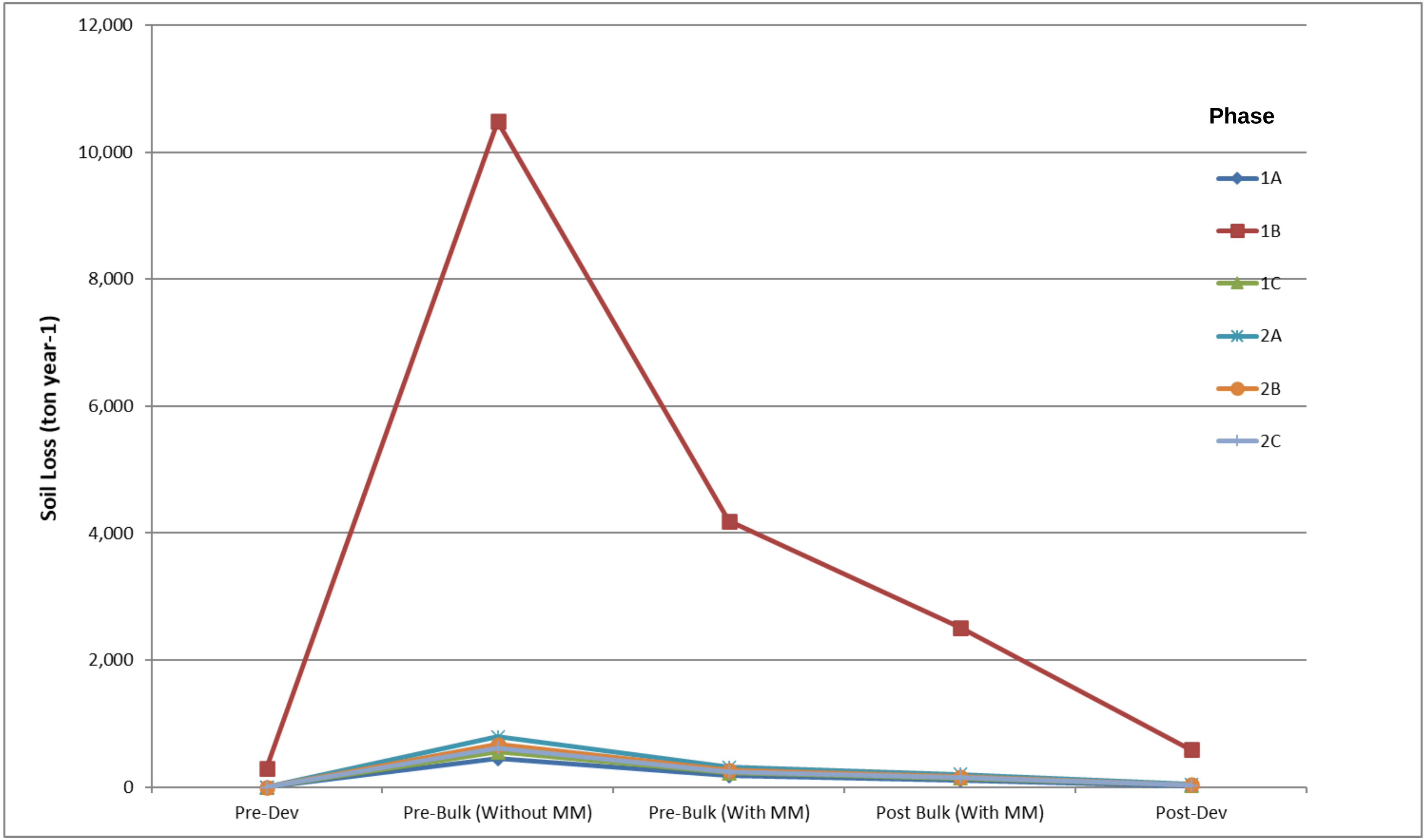
* MM – mitigating measures

Table 1.3: Soil Loss of the Project Site during Various Stages of Development

Phase	Maximum Soil Loss (ton $year^{-1}$)				
	Pre-Development	Pre-Bulk Grading (Without MM*)	Pre-Bulk Grading (With MM*)	Post Bulk Grading (With MM*)	Post Development
1A	0	424 - 452	170 - 181	106 - 113	23 - 25
1B	280 - 299	9,828 – 10,484	3,931- 4,193	2,359 - 2,517	556 - 593
1C	0	521 - 556	209 - 222	130 - 139	28 - 30
2A	0	745- 795	298 - 318	186 - 199	41 - 43
2B	0	632 - 674	253 - 269	158 - 168	34 - 37
2C	0	579 - 618	232 - 247	145 - 154	32 - 34

* MM – mitigating measures

Figure 1.1: Maximum Soil Loss of the Project Site during Various Stages of Development



Pre-development Stage

During pre-development stage, 30% of the Project Site is an idle land with secondary vegetation while 70% is still in water. Results show low erosion rates of 0 – 6 tonnes/ha/year. The total soil loss is estimated to be 280 – 299 tonnes/year.

Pre-bulk Grading Stage (Reclamation/Earthwork)

The construction stage is divided into pre-bulk grading and post bulk grading stage. Pre-bulk grading stage refers to site preparation for earthwork and reclamation. During post bulk grading stage, construction of infrastructure, utilities and jetty is in progress.

Reclamation will be carried out in 2 phases during the pre-bulk grading stage. Phase 1 will be divided into 3 sub-phases while Phase 2 will have another 3 sub-phases. For Phase 1B, the erosion rate is estimated to be 6.6 – 211 ton/ha/year if no erosion and sedimentation control measures are taken during the earthwork filling stage. With Pollution Prevention and Mitigating Measures (P2M2), erosion rates can be reduced to 2.6 – 84 ton/ha/year.

Reclamation for Phases 1A, 1B-9, 1B-10, 1C, 2A-2C will have low erosion impact, with the erosion rates of 6 – 10 ton/ha/year as the fill material is wet sand with larger and heavier particles. In addition, with implementation of P2M2, erosion rates can be reduced to 2 – 3 ton/ha/year.

Post Bulk Grading Stage (Construction)

During post-bulk grading stage, reclamation is completed. Compaction and vertical drains are constructed to facilitate surcharge removal and settling/consolidation of the reclamation material. During this 2-year period, cover crop such as legume and creepers shall be established to minimise erosion risk.

Infrastructure facilities such as road and drainage system, water and electricity supply system as well as the wharf structure shall commence after the 2-year settlement.

Results show increased erosion rate of 1 – 52 tonnes/ha/year. As the construction activities are carried out progressively, the impact is staggered.

Post Development Stage

Once the jetty and industrial building construction is completed, all the temporary site structures shall be removed and the non-built up areas shall be paved. Soil loss during this period is reduced further to 0.3 – 11 tonnes/ha/year.

1.1.2 Results of Sediment Yield Assessment

Sediment yield refers to the total volume or mass of sediment dislodged or deposited from a drainage basin which ends up in the receiving watercourse.

Summary results of the sediment yield assessment for the project development are tabulated in **Table 1.4** and depicted in **Figure 1.2**. Full result of the sediment yield assessment is given in **Annex C.**

Table 1.4: Sediment Yield of the Project Site during Various Stages of Development

Phase	Sediment Yield (ton event^{-1})				
	Pre-Dev	Pre-Bulk (Without MM)	Pre-Bulk (With MM)	Post Bulk (With MM)	Post-Dev
1A	0.00	8.88	3.55	5.71	1.78
1B	4.35	185.20	74.08	116.71	39.31
1C	0.00	10.89	4.36	7.00	2.18
2A	0.00	13.04	5.22	8.38	2.61
2B	0.00	13.67	5.47	8.78	2.74
2C	0.00	15.34	6.13	9.85	3.07

Pre-development Stage

During pre-development stage, the project site is covered with secondary vegetation, mudflat and sea. Results show a low sediment yield of 4 tonnes per storm event.

Construction Stage

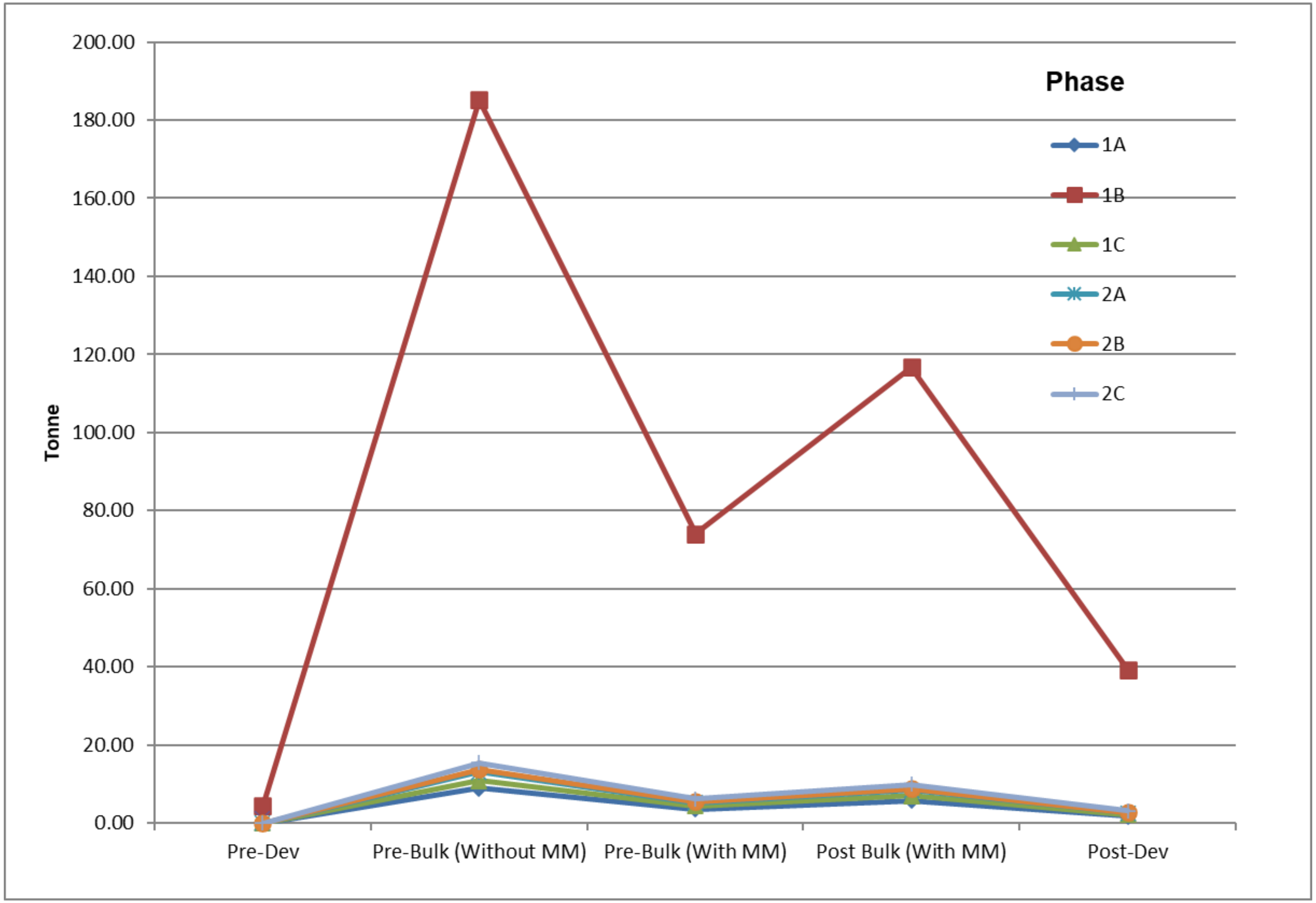
The amount of sediment yield during pre-bulk grading stage without mitigating measures (9 – 185 tonne) is 46 times higher than during pre-development stage (4 tonne). The steep increase in sediment yield will cause siltation to the receiving drain if no mitigating measures are implemented onsite. The resulting impact shall be increased suspended solids and turbidity and reduced sunlight permeability of the runoff. Sedimentation of the silt will eventually discharge to the sea.

Effective sediment control measures such as silt fence, temporary earth drain and sediment basin shall be implemented during the construction stage to ensure no excessive soil material is discharged into the receiving drain. Any eroded soil from the project site shall be allowed to settle out from the runoff before being discharged into the drain. If mitigation measures are implemented before and during earthworks, the sediment yield (4 - 74 tonnes) can be reduced by 60%.

During post bulk grading stage, the sediment yield can be further reduced to 6 - 117 tonne per storm event if mitigation measures are implemented.

Impact of sedimentation is minimised by carrying out construction development in staggered phases.

Figure 1.2: Sediment Yield of the Project Site during Various Stages of Development



Post Development Stage

Upon completion of construction, the erosion rate will be reduced to 2 - 39 tonne per storm event as most of the project site is built-up with building and infrastructure. Non-built up areas shall be paved.

2 MITIGATING MEASURES

Land disturbing Pollution Prevention and Mitigation Measure (LD-P2M2) plans are prepared for the construction stage of each development component as shown in **Figure 2.1** to **Figure 2.9**. To limit the impact of soil erosion and sediment transport to the receiving water, various temporary and permanent erosion control measures shall be implemented onsite.

The work site is located at flat terrain with low erosion risk during the construction stage. Nevertheless, erosion and sediment control practices shall be installed onsite before physical earthwork commences.

2.1 Earthwork and Filling Stage at Phase 1B (Pre-bulk Grading)

1. Minimization of erosion shall be emphasized in every aspect of the construction work and throughout the construction period.

2. Before earthwork commences, Pollution Prevention and Mitigation Measures (P2M2) such as Stabilised Construction Access, Wash Trough, Temporary Earth Drain, Check Dam, Silt Fence, Gross Pollutant Trap and Sediment Basin shall be established onsite.

3. Earthwork (filling) shall be carried out from north to south and east to west directions as per LDP2M2/PBS/001 drawings from R1 to R8.

4. All runoff within the disturbed area shall be channelled to Sediment Basin by Temporary Earth Drain before discharging out of the project site.

5. Check Dam shall be installed at intervals along Temporary Earth Drain.

6. Gross Pollutant Trap shall be installed at the inlet drain of Sediment Basin.

7. Energy dissipater in the form of riprap rocks shall be installed at the discharge outlet of Sediment Basin.

8. Temporary water crossing shall be installed at the intersection of Temporary Earth Drain and internal road.

9. Temporary Stockpile shall be located at least 20 m away from any waterway. The height of Stockpile shall not exceed 1.2m and shall be surrounded by a low bund to control sedimentation.

10. Sediment basins shall be desilted according to the maintenance frequency program stated in the LD-P2M2 report.

11. Only Suspended Solid concentration not exceeding 50 mg/l can be discharged to the receiving watercourse. Other alternative treatment method such as chemical dosing can be carried out to facilitate sediment control.

12. Weekly inspection of all P2M2 shall be carried out. In addition, inspection shall be carried out after every raining episode to check the conditions of all BMPs. Immediate remedial action shall be carried out to repair any damaged P2M2.

13. Nine sediment basins shall be constructed during pre-bulk grading stage to receive runoff from the temporary earth drains. Dimension of the sediment basins are shown in **Table 2.1**.

Table 2.1: Dimension of Sediment Basins at the Project Site

SB	Type	Area (ha)	Volume (m^3)	L_1	W_1	L_B	W_B	y_1	y_2
SB1	Wet	25	10,930	150	50	145	45	0.8	0.8
SB2	Wet	37	15,950	180	60	175	55	0.9	0.8
SB3	Wet	29	12,547	155	55	150	50	0.8	0.8
SB4	Dry	84	12,281	170	60	166	56	0.9	0.7
SB5	Dry	71	10,481	160	55	156	51	0.9	0.7
SB6	Dry	79	11,567	160	60	156	56	0.8	0.7
SB7	Dry	98	14,341	170	70	166	66	0.9	0.7
SB8	Dry	81	11,846	165	60	161	56	0.8	0.7
SB9	Dry	83	11,987	167	60	162	55	1.1	0.7

Note:
L_1 – Top of Water Basin Length (m)
W_1 – Top of Water Basin Width (m)
L_B – Bottom Sediment Storage Zone Length (m)
W_B – Bottom Sediment Storage Zone Width (m)
y_1 – Settling Zone Depth (m)
y_2 – Sediment Storage Depth (m)

2.2 Reclamation Work

1. Reclamation shall be using suitable material from a marine sand source area.

2. The bulk fill material predominantly comprising clean sand, will be placed along the existing shoreline and gradually pushed seaward. The fill will be placed to lie at its natural angle of repose that is expected to be between 1V:4H and 1V:15H depending on the grain size of the sand fill.

3. During placement of sand fill and revetment rock below RL +5.10 mCd, it is likely that a sediment plume will be generated. To minimise sediment plume, the following measures shall be applied:

    i. Using sand fill that has a low silt and clay content,
    ii. Installing silt control barriers at strategic locations,
    iii. Constructing the revetment as soon as possible, and,
    iv. Constructing the revetment from relatively clean rock.

4. In order to minimize erosion damage to the reclamation platform, and the generation of silt plumes, Revetment will be constructed in stages as soon as possible as the reclamation progresses.

5. Reclamation work begins in the northeast corner of CT10 (Phase 1A), and move seaward in a westerly direction (R1 to R8) (refer to LDP2M2/PBS/001 drawing), subsequently Phase 1B from (D10 to D18), and Phase 1C (R1to R3) (refer to LDP2M2/PBS/002 drawing). Thereafter Phase 2A will start from R1 to R6 direction, followed by Phase 2B with the sequence from D1 to D7 (refer to LDP2M2/PBG/005 drawing). Finally Phase 2C will start with the direction of R1 to R8 (refer to LDP2M2/PBG/006 drawing). Placement of the sand fill will need to be completed in several lifts in order to avoid the initiation of slope failures along the seaward edge of the reclamation.

6. The revetment zone comprises a geotextile filter layer, a gravel filter zone, a secondary amour rock layer and a primary armour rock layer. In the inter-tidal region, final trimming of the reclamation fill materials shall be quickly followed by the placement of the geotextile, filter gravel and secondary armour layers so as to provide temporary surface that is resistant to erosion and collapse under tidal action. Placement of primary armour rock shall be undertaken as soon as possible to reduce the risk of erosion and damage due to wave and tidal action.

7. When the platform level has reached RL +5.10 mCd, an 80-metre wide strip of vertical drains (Prefabricated Vertical Drains; PVD) will be installed along the seaward edge of the reclamation for stability purpose and to expedite the ground consolidation.

2.3 Earthwork Filling

1. The existing land mass (Phase 1B) shall be cleared of vegetation. The existing level shall be increased by earthwork filling.

2. Containment Bund made of Geotube shall first be laid to keep the fill material in place more effectively.

3. Filling is undertaken using suitable material from dredging of the berthing area and approach channel.

4. Hoarding and Silt Fence shall be established at the land-based boundary of Phase 1B. Stabilized Construction Access and Wash Trough shall be established at the main entrance.

5. The filled area shall be wetted with water bowser to minimise generation of wind blowing dust.

2.4 Surcharge Removal / Consolidation Period

1. As soon as reclamation of each parcel is completed, Pollution Prevention and Mitigation Measures (P2M2) such as Silt Fence, Temporary Earth Drain, Check Dam, Gross Pollutant Trap and Sediment Basin shall be established onsite.

2. Green Turfing (hand seeding) shall be carried out to provide cover for the bare land during the Surcharge Removal/Consolidation Period (around 2 years). Creeper plants or other varieties suitable for sandy soil shall be used as cover crop.

3. All runoff within the area shall be channelled to Sediment Basin by Temporary Earth Drain before discharging out of the Project site.

4. Check Dam shall be installed at intervals along Temporary Earth Drain.

5. Gross Pollutant Trap shall be installed at the inlet drain of Sediment Basin.

6. Energy dissipater in the form of riprap rocks shall be installed at the discharge outlet of Sediment Basin.

7. Temporary water crossing shall be installed at the intersection of Temporary Earth Drain and temporary internal road.

8. Sediment basins shall be desilted according to the maintenance frequency program stated in the LD-P2M2 report.

9. Only Suspended Solid concentration not exceeding 50 mg/l can be discharged to the receiving watercourse. Other alternative treatment method such as chemical dosing can be carried out to facilitate sediment control.

10. Weekly inspection of all P2M2 shall be carried out. In addition, inspection shall be carried out after every raining episode to check the conditions of all BMPs. Immediate remedial action shall be carried out to repair any damaged P2M2.

2.5 Wharf and Industrial Infrastructure Construction Stage (Post Bulk Grading)

1. During the construction stage, grass cover shall be cleared and disposed offsite as biomass waste.

2. When construction of utilities and wharf at Phase 1 is completed, all temporary P2M2 such as Hoarding, Wash Trough, Temporary Earth Drain, Check Dam, Silt Fence, Temporary Crossing, Gross Pollutant Trap and Sediment Basin shall be removed from the completed area. The disturbed area shall be stabilized with vegetation cover or pavement.

3. Site facilities shall be moved to Phase 2A.

4. Hoarding and all P2M2 shall be established at Phase 2.

5. Only Suspended Solid concentration not exceeding 50 mg/l can be discharged to the receiving watercourse. Other alternative treatment method such as chemical dosing can be carried out to facilitate sediment control.

6. Weekly inspection of all P2M2 shall be carried out. In addition, inspection shall be carried out after every raining episode to check the conditions of all BMPs. Immediate remedial action shall be carried out to repair any damaged P2M2.

7. When construction of utilities and wharf at Phase 2 is completed, all temporary P2M2 such as Hoarding, Wash Trough, Temporary Earth Drain, Check Dam, Silt Fence, Temporary Crossing, Gross Pollutant Trap and Sediment Basin shall be removed from the completed area. The disturbed area shall be stabilized with vegetation cover or pavement.

3. ENVIRONMENTAL MANAGEMENT PLAN

3.1 Environmental Performance Monitoring Committee (EPMC)

As part of the guided self-regulation initiative, an Environmental Performance Monitoring Committee (EPMC) shall be established by Westports Malaysia to monitor the environmental performance and effectiveness of P2M2, and status of regulatory compliance of the project. The tasks of EPMC shall include:

1. To appoint a chairman who is responsible for ensuring the decisions of environmental meetings are responsibly executed.

2. To conduct a meeting at a minimum of once in a quarter and the minutes of the meeting be maintained.

3. An Environmental Officer (EO) shall prepare a Performance Monitoring Document (PMD) which includes the EIA Conditions of Approval (COA) and how to comply through performance monitoring of P2M2.

4. The EO shall execute an environmental performance monitoring (PM) program to monitor and evaluate the effectiveness of the P2M2, inspect, maintain and take corrective actions.

5. To set up a mini laboratory to facilitate the implementation of environmental performance monitoring program. The mini laboratory shall be adequately equipped with portable analytical testing equipment such as in-situ suspended solids meter, turbidity meter, etc.

6. The EO shall establish and maintain the Performance Monitoring logbook for at least 5 years which contains:
   - Checklist of P2M2 list sheet
   - Installation Sheet
   - Photograph folder sheet
   - Corrective Action sheet
   - Performance Monitoring Sheet.

7. The Performance Monitoring Document (PMD) and Performance Monitoring logbook shall be kept at the Project site so that it can be made available for onsite inspection or upon request by the

Department of Environmental inspector. The logbook shall be maintained or updated by weekly or event-based inspections.

8. The EO shall prepare a Performance Monitoring Report (PMR) that discusses the results of the performance monitoring conducted as described in the PMD. The PMR shall include:
   - Data interpretation and assessment of the effectiveness of the P2M2 by making comparison of the performance monitoring parameters with their recommended ranges or standards.
   - Statistical techniques and graphical presentation of the performance monitoring parameters.
   - Photographs of the general site condition, P2M2 and runoff at discharge point.

3.2 Inspection, Monitoring and Maintenance

3.2.1 Inspection and Maintenance

Site inspections shall be conducted to check that all P2M2s installed onsite are properly installed and maintained. In the case of not effective erosion and sedimentation is observed, additional or replacement of P2M2 shall be proposed.

Inspection shall be conducted at the site prior to commencement land clearing activities. Daily visual inspection shall be carried out.

A rain gauge shall be properly maintained onsite to determine if a storm event of 12.5 mm or greater has occurred. Inspection shall also be carried out after every storm event of more than 12.5 mm rainfall.

Maintenance or remedial action shall occur within 7 days of the inspection reported. Major observation and incident of non-compliance shall be recorded in the inspection report. Corrective actions and maintenance shall be recorded in the Performance Monitoring (PM) log book.

Table 3.2.1 summarizes the P2M2 to be implemented during the construction stage.

Table 3.2.2 summarizes the inspection and maintenance checklist during construction stage.

3.2.2 Monitoring

Three (3) types of monitoring shall be carried out throughout the project construction and operational phases, namely:

(a) Compliance monitoring – to assess the overall project compliance and opportunity for optimization and further improvement in environmental management of the project. Compliance monitoring shall be in accordance with the limits stipulated in the EIA Conditions of Approval (COA).
(b) Performance monitoring – to assess expected results in addressing environmental issues as part of Self-Regulation implementation.
(c) Impact monitoring – to observe any deterioration of the surrounding environment.

Table 3.2.3 and **Table 3.2.4** summarise the performance and compliance monitoring requirement during the construction stage respectively.

Table 3.2.1 P2M2 during Construction Stage

Project Activity & Environmental Issues Concerned	Impact	P2M2 to be Implemented
Erosion and sedimentation risk due to large scale land clearing and earthwork.	Wind-blown dust can affect the nearby port and industrial area. Eroded soil may flow into the coastal water, causing increased turbidity and shallow seabed. This in turn disrupts the aquatic ecosystem.	Land clearing and earthwork to be carried out in 2 phases and more sub-phases. All runoff be channelled to Sediment Basin before discharge.
		Geotube is used as containment bund wall at Phase 1B and 2B to contain the fill material.
Silt laden runoff due to the disturbed ground.	Sediment will escape to the coastal water.	Temporary Earth Drain with Check Dam
		Silt Fence
		Sediment Basin with discharge outlet
Tracking of mud by construction equipment when leaving the project site.	Mud escaped out of the project site, causing uncontrolled sediment flow in the public road and drain.	Stabilized Construction Access and Wash Trough
Coastal bank instability after reclamation	Coastal bank erosion, causing shallow sea bed.	Construction of revetment to protect the edges of reclaimed land.
Movement of construction vehicles causes disturbance to temporary and permanent watercourses.	Erosion and sedimentation due to damage of Temporary Earth Drain.	Temporary Water Crossing with Pipe Culvert.
Completed earthwork in some lots/parcels may not be developed immediately.	Soil erosion due to bare land exposed to wind and rain. Dust generate may affect the nearby residents.	Areas not developed yet shall be covered with Turf Grass. The Turf Grass may be removed once construction is ready to commence.
Wharf construction.	Disturbance to coastal water due to piling and structure construction, causing increased turbidity and suspended solids. Bank erosion due to removal of riprap.	Sheet pile to cordon off wharf construction area where necessary.

Table 3.2.2 Site Inspection during Construction Stage

P2M2	Inspection	Maintenance and Remedial Action	Frequency
Stabilized Construction Access	Visual check for any damage to the reinforced paved blocks.	Repair damaged section.	Daily & after 12.5mm of Storm Event
Wash Trough	Visual check for sign of mud on public road	Better house-keeping and training of workers.	
Geotube	Visual check for sign of puncture or damage	Repair damaged section.	
Gross Pollutant Trap	Visual check for accumulation of garbage and debris.	Remove trapped garbage and debris.	
Sediment Basin	Pole check on the reduced sediment basin depth due to silt accumulation.	Desilting shall be carried out before the accumulated silt reaches 50% of the depth.	
Discharge outlet	Visual check for scouring and damage due to erosion.	Repair and make good.	
Temporary Earth Drain	Visual check for damage to the earth drain, rubbish or obstacles that impede the flow.	Repair and make good. Remove rubbish or obstacles from the drain.	
Check Dam	Visual check for any damage to the structure.	Repair and make good.	
Pipe Culvert	Visual check for any damage due to wear and tear.	Replace with new unit.	
Stockpile	Visual check to have proper cover with tarpaulin sheet where necessary. Perimeter low bund surrounding the Stockpile.	Repair and make good. Biomass Stockpile shall be removed from the project site.	
Silt Fence	Visual check for any silt escape out of the project site.	Replace damaged section. Silt fence geotextile shall be installed properly and pegged firmly into the ground.	
Grass Turf	Visual check for remnant bare spot.	Replant.	
Revetment	Visual check for damage due to wave action.	Repair and make good.	

Table 3.2.3 Performance Monitoring

Item	Standard	Equipment/Requirement	Frequency
Sediment Basin	TSS less than 50 mg/l Turbidity less than 250 NTU	Potable TSS meter and Turbidity meter	Daily

Table 3.2.4 Compliance Monitoring

Item	Type of Monitoring	Equipment/Requirement	Frequency
Sediment Basin	TSS less than 50 mg/l Turbidity less than 250 NTU	Grab sample and send to SAMM accredited laboratory.	Monthly
Marine Water Monitoring	pH Value, temperature, DO, Turbidity, salinity, conductivity, COD, BOD_5, TSS, Oil & Grease, NH_3-N, PO4, NO_2, NO_3, Faecal coliform, Enterococci, phenol, TBT, PAH, heavy/trace metals (Cd, Cu, Fe, B, Sn, Pb, Mn, Ni, Zn, Cr^{6+}, Cr^{3+}, Hg, As), Cl_2, CN, S.	Grab sample and send to SAMM accredited laboratory.	Monthly

4. REFERENCES

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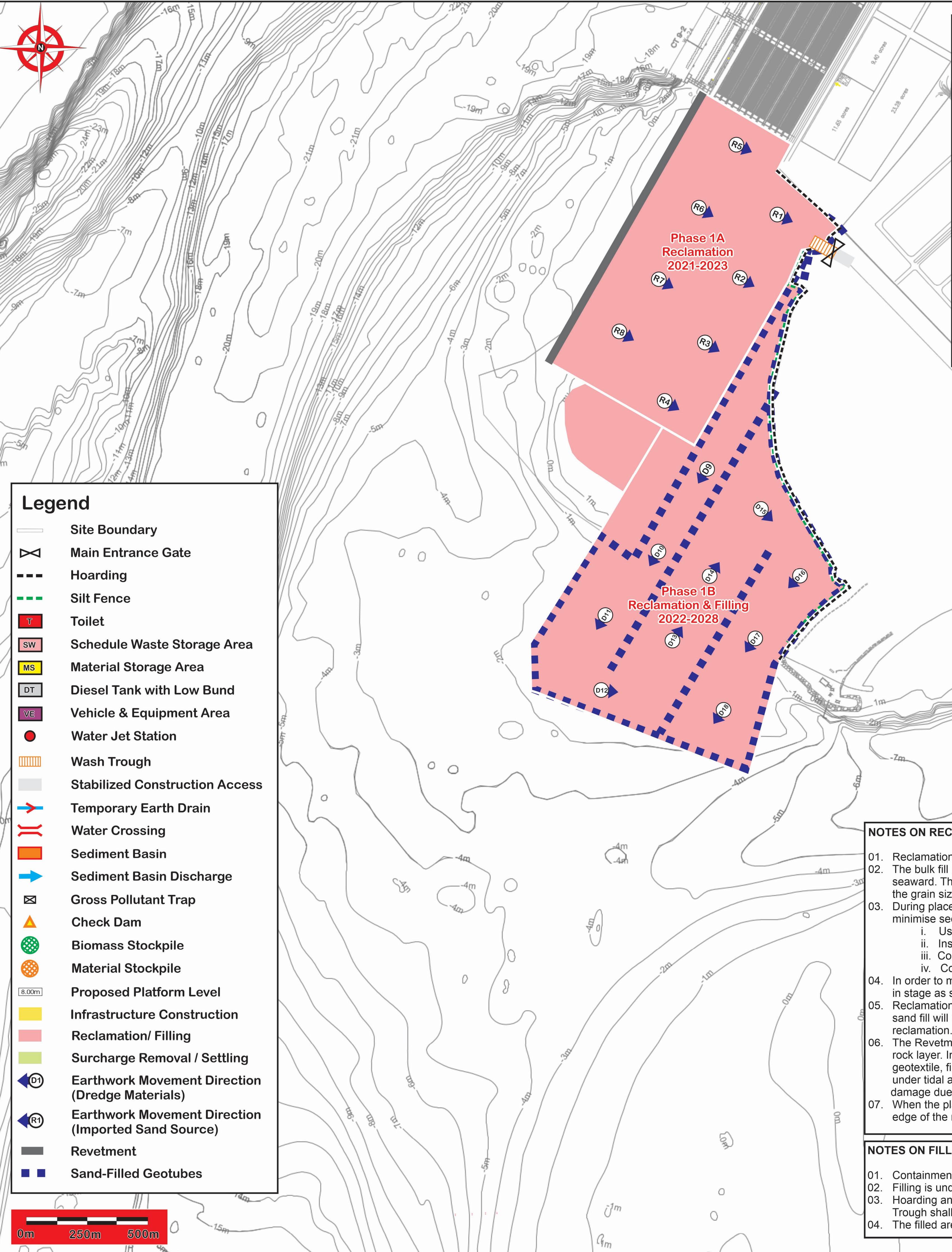
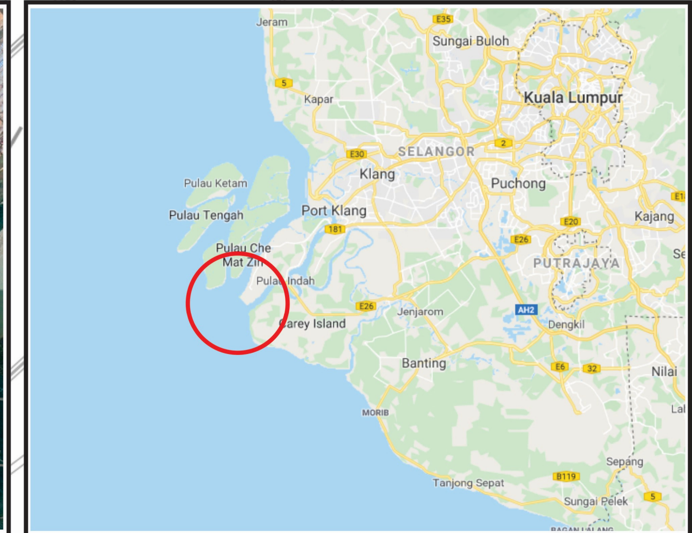


Reclamation
Phase 1A: 2021-2023
Phase 1B: 2022-2028



Location Map

NOTES ON RECLAMATION (PHASE 1A, 2021 - 2023)

01. Reclamation commences at Phase 1A using suitable material from a marine sand source area.
02. The bulk fill material predominantly comprises clean sand, will be placed along the existing shoreline and gradually pushed seaward. The fill will be placed to lie at its natural angle of repose that is expected to be between 1V:4H and 1V:15H depending on the grain size of the sand fill.
03. During placement of sand fill and revetment rock below RL +5.10 mCd, it is likely that a sediment plume will be generated. To minimise sediment plume, the following measures shall be applied:
    i. Using sand fill that has a low silt and clay content,
    ii. Installing floating silt curtains at strategic locations,
    iii. Constructing the revetment as soon as possible, and,
    iv. Constructing the revetment from relatively clean rock.
04. In order to minimize erosion damage to the reclamation platform, and the generation of silt plumes, Revetment will be constructed in stage as soon as possible as the reclamation progresses.
05. Reclamation work begins in the northeast corner of CT10 (Phase 1A), and move seaward in a westerly direction. Placement of the sand fill will need to be completed in several lifts in order to avoid the initiation of slope failures along the seaward edge of the reclamation.
06. The Revetment zone comprises a geotextile filter layer, a gravel filter zone, a secondary amour rock layer and a primary armour rock layer. In the inter-tidal region, final trimming of the reclamation fill materials shall be quickly followed by the placement of the geotextile, filter gravel and secondary armour layers so as to provide temporary surface that is resistent to erosion and collapse under tidal action. Placement of primary armour rock shall be undertaken as soon as possible to reduce the risk of erosion and damage due to wave and tidal action.
07. When the platform level has reached RL +5.10 mCd, an 80-metre wide strip of vertical drains will be installed along the seaward edge of the reclamation for stability purpose.

NOTES ON FILLING (PHASE 1B, 2022 - 2028)

01. Containment Bund made of Geotube shall first be laid to keep the fill material in place more effectively.
02. Filling is undertaken using suitable material from dredging of the berthing area and approach channel.
03. Hoarding and Silt Fence shall be established at the land-based boundary of Phase 1B. Stabilized Construction Access and Wash Trough shall be established at the main entrance.
04. The filled area shall be wetted with water bowser to minimise generation of wind blowing dust.

PROJECT TITLE:

ENVIRONMENTAL IMPACT ASSESSMENT FOR WESTPORTS PHASE II DEVELOPMENT: PROPOSED EXPANSION OF CONTAINER TERMINALCT10-17 AND ITS ASSOCIATED WORKS AT WESTPORTS, PULAU INDAH, SELANGOR DARUL EHSAN

PROJECT PROPONENT

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PREPARED BY:

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CHECKED BY:

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TITLE:

LD-P2M2 FOR PHASE 1A & 1B (RECLAMATION)

DRAWN BY:

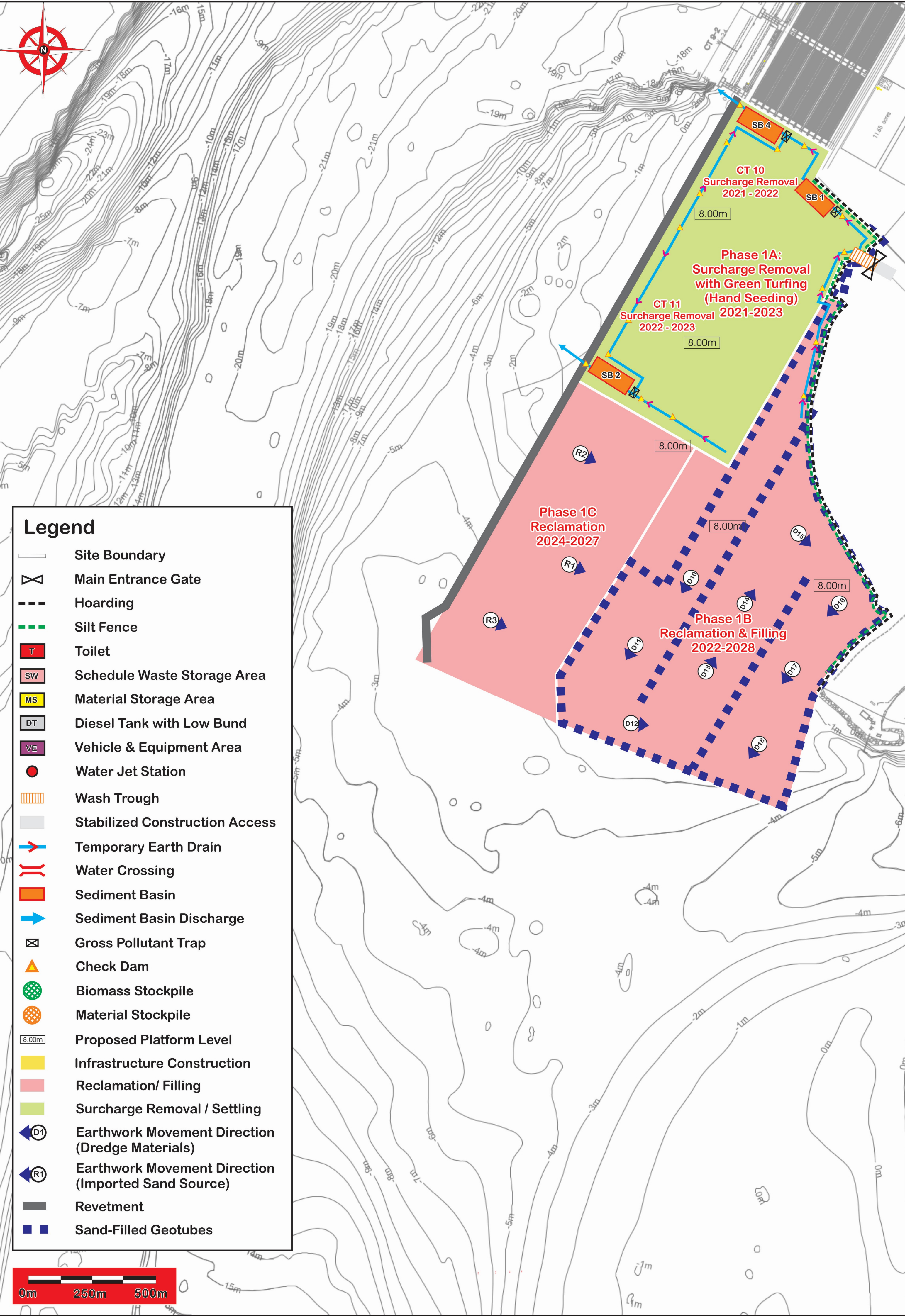
CHEONG HON LOONG
CPESC NO. 7209

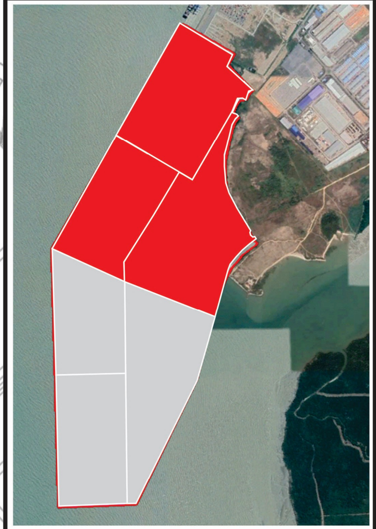
DATE:

SEPTEMBER 2020

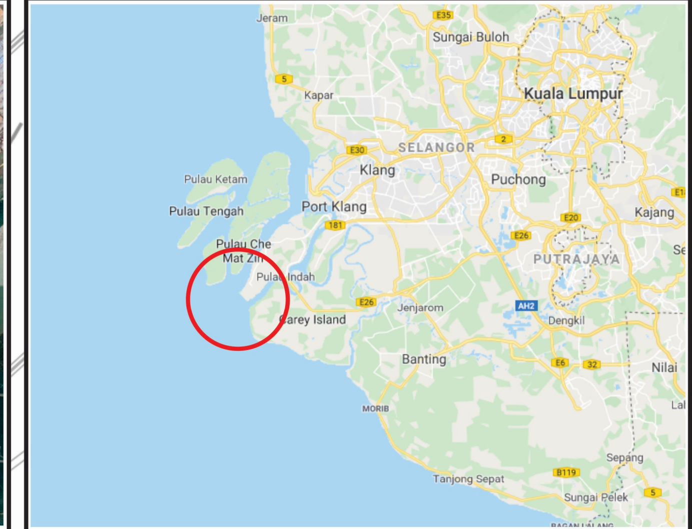
JOB NO: LDP2M2/YSEC/WP/001

DRAWING NO: LDP2M2/PBS/001





Surcharge Removal
Phase 1A: 2021-2023
Reclamation
Phase 1B: 2022-2028
Phase 1C: 2024-2027



Location Map

NOTES ON LAND PREPARATION DURING SURCHARGE REMOVAL PERIOD (PHASE 1A, 2021 - 2023)

01. As soon as reclamation of Phase 1A and filling of Phase 1B are completed, Pollution Prevention and Mitigation Measures (P2M2) such as Silt Fence, Temporary Earth Drain, Check Dam, Gross Pollutant Trap and Sediment Basin shall be established onsite.
02. Green Turfing (hand seeding or hydro-seeding) shall be carried out to provide cover for the bare land during the Surcharge Removal/Consolidation Period (around 2 years). Creeper plants or other varieties suitable for sandy soil shall be used as cover crop.
03. All runoff within the area shall be channelled to Sediment Basin by Temporary Earth Drain before discharging out of the project site.
04. Check Dam shall be installed at intervals along Temporary Earth Drain.
05. Gross Pollutant Trap shall be installed at the inlet drain of Sediment Basin.
06. Energy dissipater in the form of riprap rocks shall be installed at the discharge outlet of Sediment Basin.
07. Temporary water crossing shall be installed at the intersection of Temporary Earth Drain and temporary internal road.
08. Sediment basins shall be desilted according to the maintenance frequency program stated in the LD-P2M2 report.
09. Only Suspended Solid concentration not exceeding 50 mg/l can be discharged to the receiving watercourse. Other alternative treatment method such as chemical dosing can be carried out to facilitate sediment control.
10. Weekly inspection of all P2M2 shall be carried out. In addition, inspection shall be carried out after every raining episode to check the conditions of all BMPs. Immediate remedial action shall be carried out to repair any damaged P2M2.

NOTES ON FILLING (PHASE 1B, 2022 - 2028)

01. Containment Bund made of Geotube shall first be laid to keep the fill material in place more effectively.
02. Filling is undertaken using suitable material from dredging of the berthing area and approach channel.
03. Hoarding and Silt Fence shall be established at the land-based boundary of Phase 1B. Stabilized Construction Access and Wash Trough shall be established at the main entrance.
04. The filled area shall be wetted with water bowser to minimise generation of wind blowing dust.

NOTES ON RECLAMATION (PHASE 1C, 2024 - 2027)

01. Reclamation work at Phase 1C begins in the northwest corner of CT12 and move southerly and westerly direction towards the sea. Placement of the sand fill will need to be completed in several lifts in order to avoid the initiation of slope failures along the seaward edge of the reclamation.
02. In order to minimize erosion damage to the reclamation platform, and the generation of silt plumes, Revetment will be constructed in stage as soon as possible as the reclamation progresses.
03. When the platform level has reached RL +5.10 mCd, an 80-metre wide strip of vertical drains will be installed along the seaward edge of the reclamation for stability reasons.
04. The filled area shall be wetted with water bowser to minimise generation of wind blowing dust.

PROJECT TITLE:

ENVIRONMENTAL IMPACT ASSESSMENT FOR WESTPORTS PHASE II DEVELOPMENT: PROPOSED EXPANSION OF CONTAINER TERMINALCT10-17 AND ITS ASSOCIATED WORKS AT WESTPORTS, PULAU INDAH, SELANGOR DARUL EHSAN

PROJECT PROPONENT

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TITLE:
LD-P2M2 FOR PHASE 1C & 1D (RECLAMATION)

DRAWN BY:
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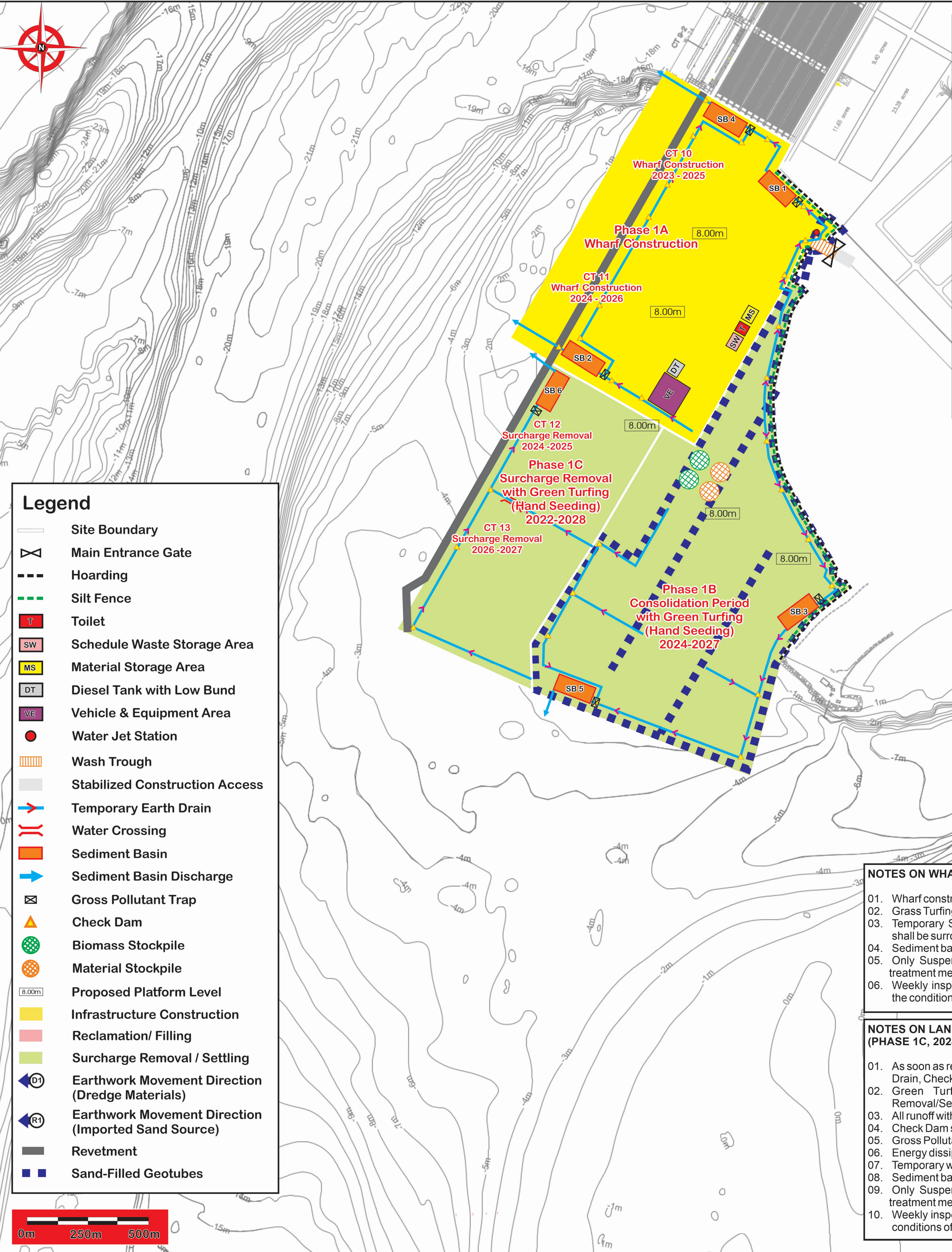
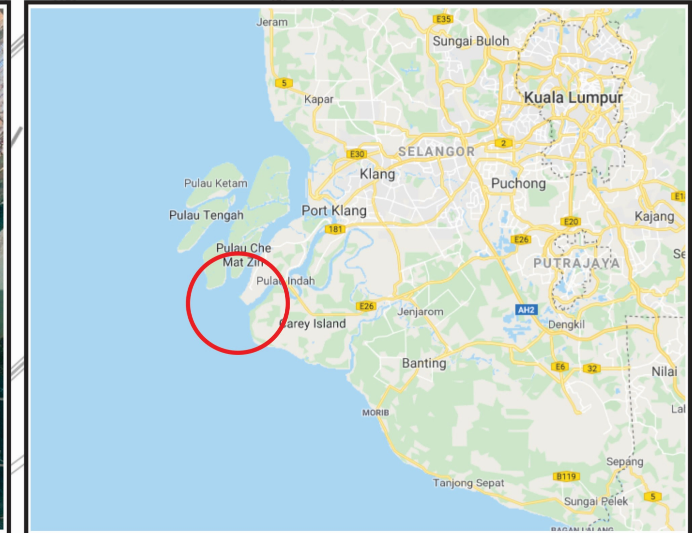
CPESC NO. 7209

DATE:
SEPTEMBER 2020

JOB NO: LDP2M2/YSEC/WP/001
DRAWING NO: LDP2M2/PBS/002



Wharf Construction
Phase 1A: 2023-2026
Consolidation Period
Phase 1B: 2022-2028
Surcharge Removal
Phase 1C: 2024-2027



Location Map

NOTES ON WHARF CONSTRUCTION (PHASE 1A, 2023 -2026)

01. Wharf construction (Phase 1A) and infrastructure construction work (Phase 1B) commence.
02. Grass Turfing shall be removed and stored temporarily at the Biomass Stockpile.
03. Temporary Stockpile shall be located at least 20 m away from any waterway. The height of Stockpile shall not exceed 1.2m and shall be surrounded by a low bund to control sedimentation.
04. Sediment basins shall be desilted according to the maintenance frequency program stated in the LD-P2M2 report.
05. Only Suspended Solid concentration not exceeding 50 mg/l can be discharged to the receiving watercourse. Other alternative treatment method such as chemical dosing can be carried out to facilitate sediment control.
06. Weekly inspection of all P2M2 shall be carried out. In addition, inspection shall be carried out after every raining episode to check the conditions of all BMPs. Immediate remedial action shall be carried out to repair any damaged P2M2.

NOTES ON LAND PREPARATION DURING CONSOLIDATION (PHASE 1B, 2022 - 2028) AND SURCHARGE REMOVAL PERIOD (PHASE 1C, 2024 - 2027)

01. As soon as reclamation of Phase 1B & 1C is completed, Pollution Prevention and Mitigation Measures (P2M2) such as Temporary Earth Drain, Check Dam, Gross Pollutant Trap and Sediment Basin shall be established onsite.
02. Green Turfing (hand seeding) shall be carried out to provide cover for the bare land during the Surcharge Removal/Settling Period (around 2 years). Creeper plants or other varieties suitable for sandy soil shall be used as cover crop.
03. All runoff within the area shall be channelled to Sediment Basin by Temporary Earth Drain before discharging out of the project site.
04. Check Dam shall be installed at intervals along Temporary Earth Drain.
05. Gross Pollutant Trap shall be installed at the inlet drain of Sediment Basin.
06. Energy dissipater in the form of riprap rocks shall be installed at the discharge outlet of Sediment Basin.
07. Temporary water crossing shall be installed at the intersection of Temporary Earth Drain and temporary internal road.
08. Sediment basins shall be desilted according to the maintenance frequency program stated in the LD-P2M2 report.
09. Only Suspended Solid concentration not exceeding 50 mg/l can be discharged to the receiving watercourse. Other alternative treatment method such as chemical dosing can be carried out to facilitate sediment control.
10. Weekly inspection of all P2M2 shall be carried out. In addition, inspection shall be carried out after every raining episode to check the conditions of all BMPs. Immediate remedial action shall be carried out to repair any damaged P2M2.

PROJECT TITLE:

ENVIRONMENTAL IMPACT ASSESSMENT FOR WESTPORTS PHASE II DEVELOPMENT: PROPOSED EXPANSION OF CONTAINER TERMINALCT10-17 AND ITS ASSOCIATED WORKS AT WESTPORTS, PULAU INDAH, SELANGOR DARUL EHSAN

PROJECT PROPONENT

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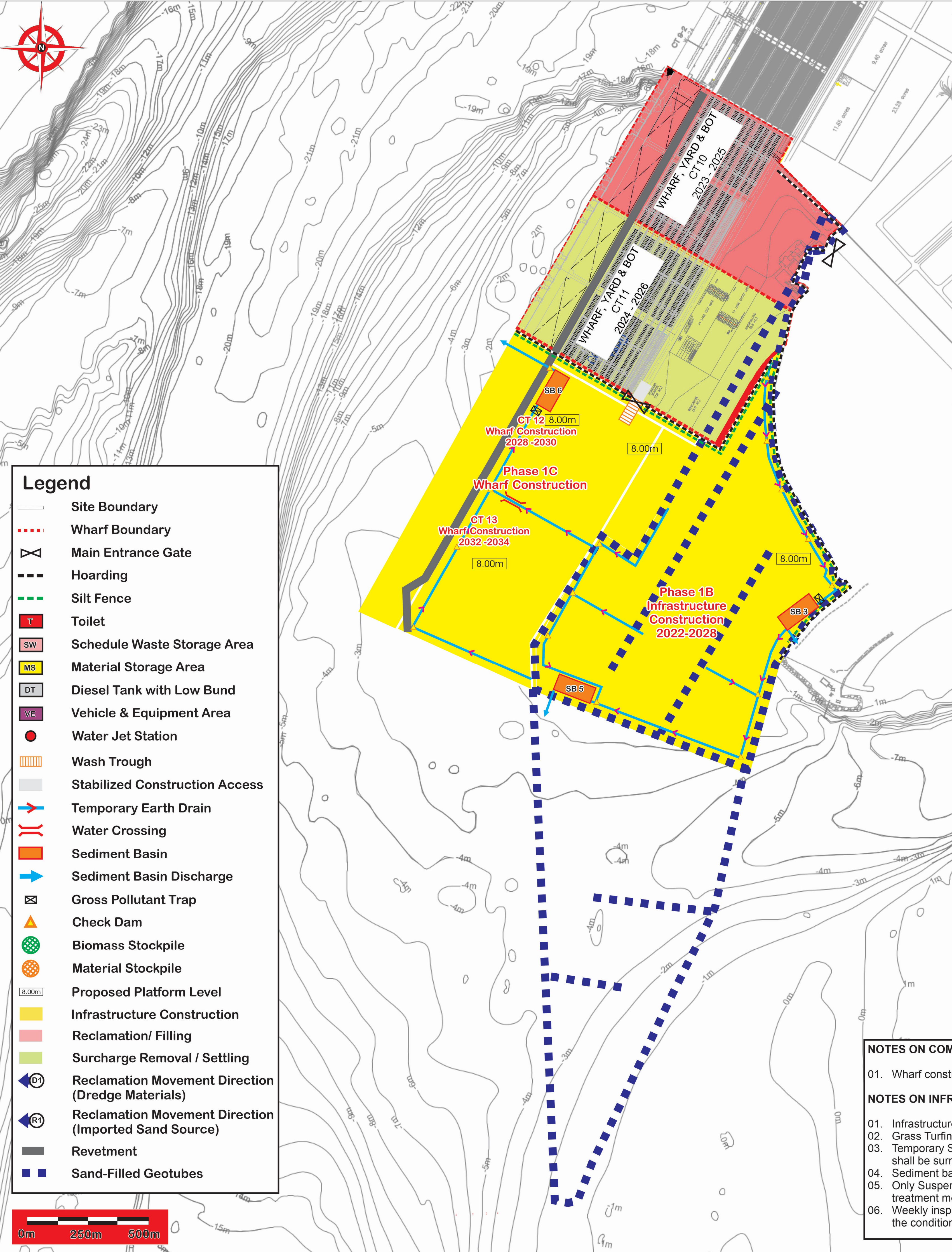
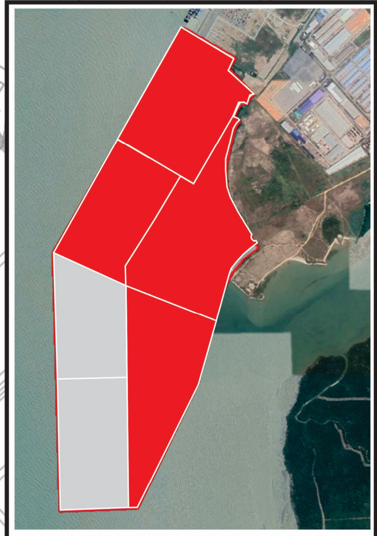
TITLE:
LD-P2M2 FOR PHASE 1D (RECLAMATION)

DRAWN BY:
CHEONG HON LOONG
CPESC NO. 7209

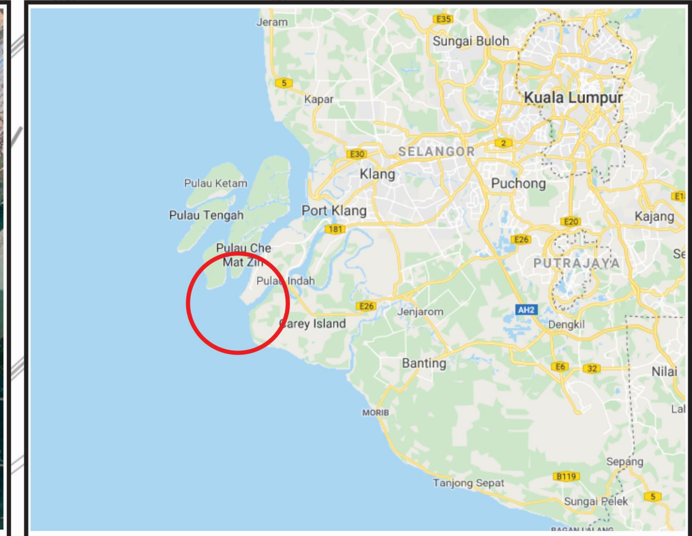
DATE:
SEPTEMBER 2020

JOB NO: LDP2M2/YSEC/WP/001
DRAWING NO: LDP2M2/PBS/003





Wharf Construction
Phase 1A: Completed
Phase 1B: 2028-2034
Infrastructure Construction
Phase 1C: 2022-2028



Location Map

PROJECT TITLE:

ENVIRONMENTAL IMPACT ASSESSMENT FOR WESTPORTS PHASE II DEVELOPMENT: PROPOSED EXPANSION OF CONTAINER TERMINALCT10-17 AND ITS ASSOCIATED WORKS AT WESTPORTS, PULAU INDAH, SELANGOR DARUL EHSAN

PROJECT PROPONENT

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TITLE:

LD-P2M2 FOR PHASE 1B & 1C

DRAWN BY:

CHEONG HON LOONG
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DATE:

SEPTEMBER 2020

JOB NO: LDP2M2/YSEC/WP/001

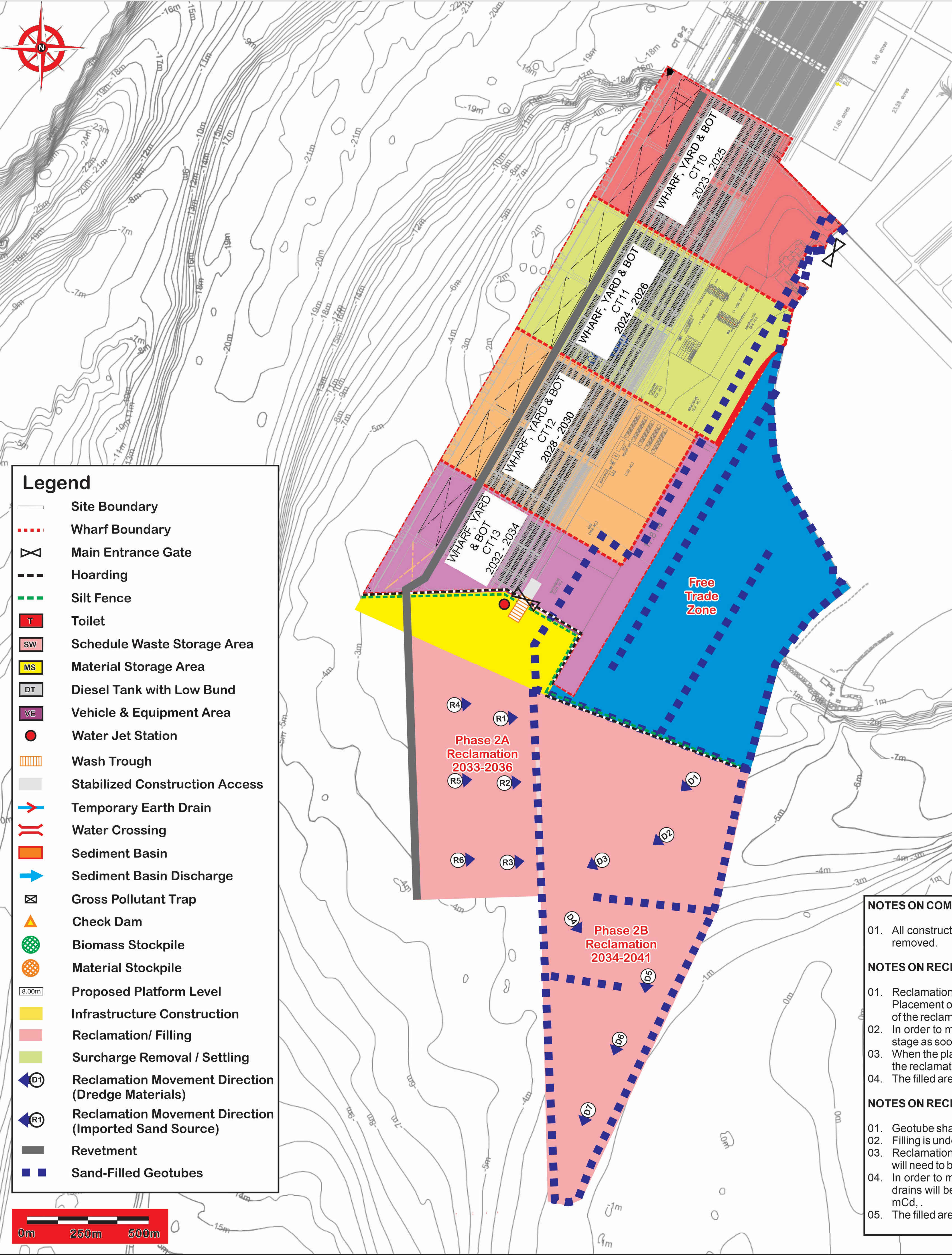
DRAWING NO: LDP2M2/PBS/004

NOTES ON COMPLETION (PHASE 1A, 2027)

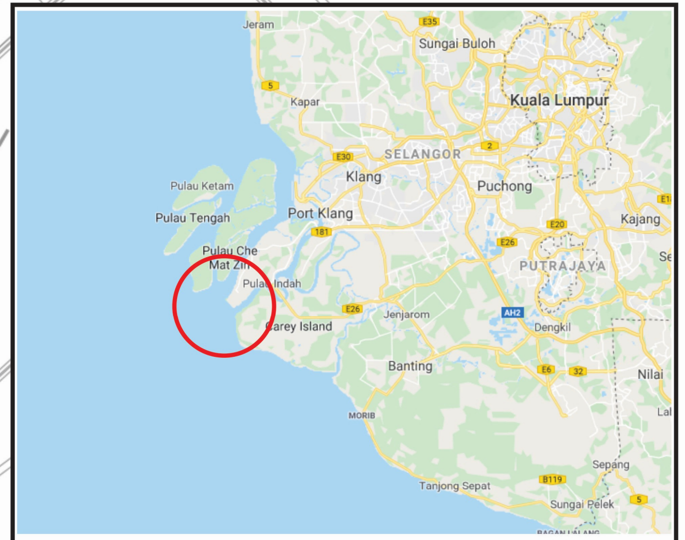
01. Wharf construction at Phase 1A (CT10 and CT11) is completed. All the temporary Pollution Prevention measures in are removed.

NOTES ON INFRASTRUCTURE CONSTRUCTION (PHASE 1B) AND WHARF CONSTRUCTION (PHASE 1C, 2028 - 2034)

01. Infrastructure construction at Phase 1B and wharf construction at Phase 1C commence.
02. Grass Turfing shall be removed and stored temporarily at the Biomass Stockpile.
03. Temporary Stockpile shall be located at least 20 m away from any waterway. The height of Stockpile shall not exceed 1.2m and shall be surrounded by a low bund to control sedimentation.
04. Sediment basins shall be desilted according to the maintenance frequency program stated in the LD-P2M2 report.
05. Only Suspended Solid concentration not exceeding 50 mg/l can be discharged to the receiving watercourse. Other alternative treatment method such as chemical dosing can be carried out to facilitate sediment control.
06. Weekly inspection of all P2M2 shall be carried out. In addition, inspection shall be carried out after every raining episode to check the conditions of all BMPs. Immediate remedial action shall be carried out to repair any damaged P2M2.



Wharf Construction
Phase 1A: Completed
Phase 1B: Completed
Infrastructure Construction
Phase 1C: Completed
Reclamation
Phase 2A: 2033-2036
Phase 2B: 2034-2041



Location Map

PROJECT TITLE:

ENVIRONMENTAL IMPACT ASSESSMENT FOR WESTPORTS PHASE II DEVELOPMENT: PROPOSED EXPANSION OF CONTAINER TERMINALCT10-17 AND ITS ASSOCIATED WORKS AT WESTPORTS, PULAU INDAH, SELANGOR DARUL EHSAN

PROJECT PROPONENT

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TITLE:
LD-P2M2 FOR PHASE 2A (RECLAMATION)

DRAWN BY:
CHEONG HON LOONG
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DATE:
SEPTEMBER 2020

JOB NO: LDP2M2/YSEC/WP/001
DRAWING NO: LDP2M2/PBG/005

NOTES ON COMPLETION (PHASE 1, 2027)

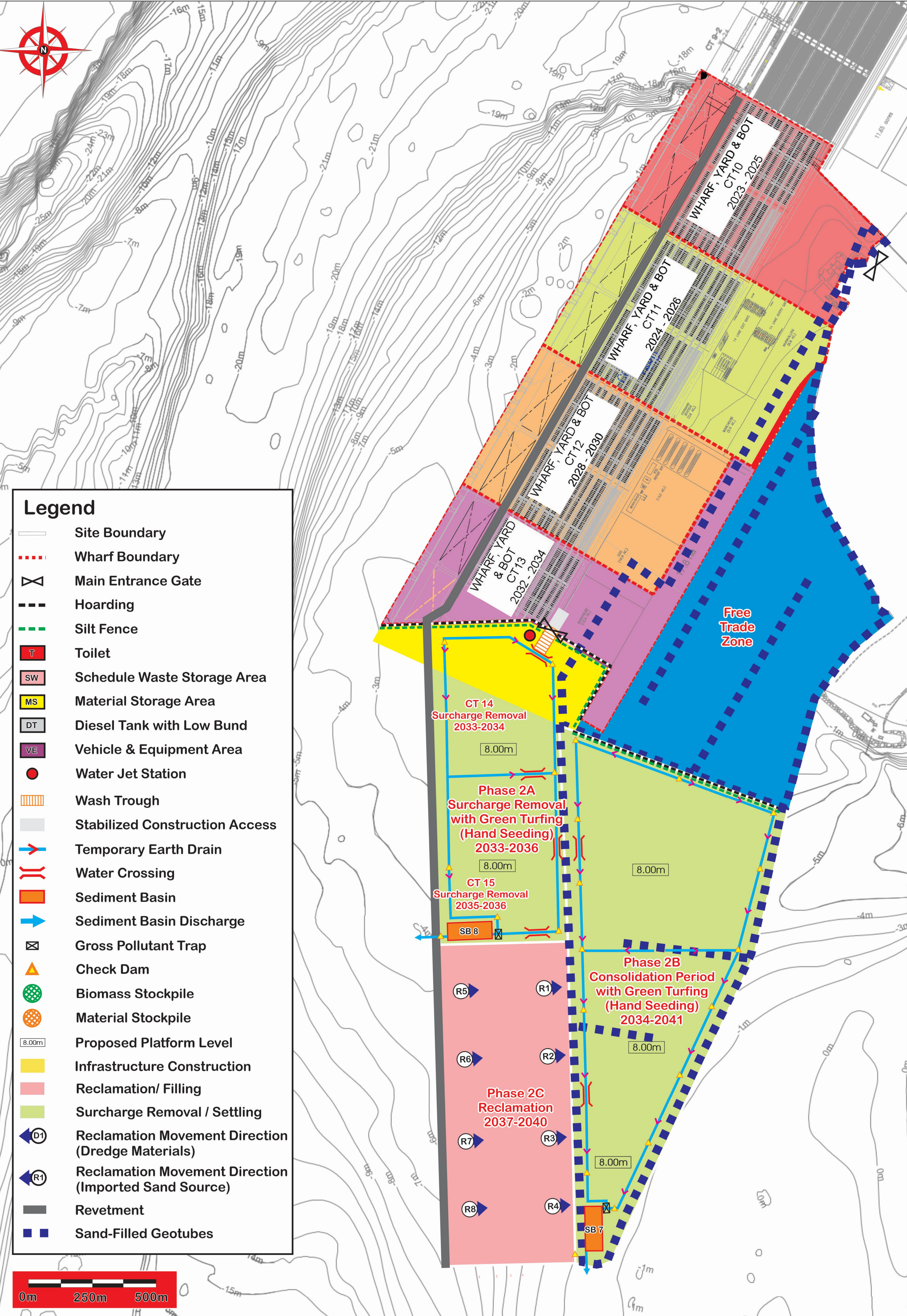
01. All construction at Phase 1 (CT10 to CT13 and Free Trade Zone) is completed. All the temporary Pollution Prevention measures are removed.

NOTES ON RECLAMATION (PHASE 2A, 2033 – 2036)

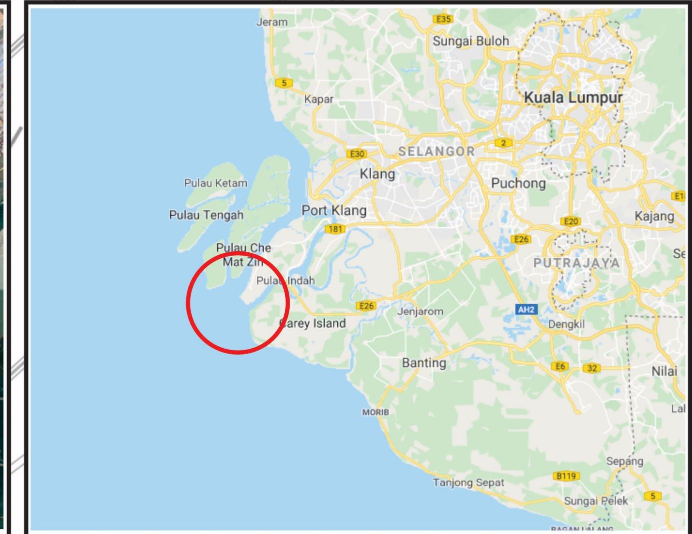
01. Reclamation work at Phase 2A begins in the northwest corner of CT14 and move southerly and westerly direction towards the sea. Placement of the sand fill will need to be completed in several lifts in order to avoid the initiation of slope failures along the seaward edge of the reclamation.
02. In order to minimize erosion damage to the reclamation platform, and the generation of silt plumes, Revetment will be constructed in stage as soon as possible as the reclamation progresses.
03. When the platform level has reached RL +5.10 mCd, an 80-metre wide strip of vertical drains will be installed along the seaward edge of the reclamation for stability reasons.
04. The filled area shall be wetted with water bowser to minimise generation of wind blowing dust.

NOTES ON RECLAMATION (PHASE 2B, 2034 - 2041)

01. Geotube shall be established before reclamation work commences.
02. Filling is undertaken using suitable material from dredging of the berthing area and approach channel.
03. Reclamation work at Phase 2B begins in the northwest corner and move southerly along the Geotube layout. Placement of the sand fill will need to be completed in several lifts in order to avoid the initiation of slope failures along the seaward edge of the reclamation.
04. In order to minimize erosion damage to the reclamation platform and the generation of silt plumes, an 80-metre wide strip of vertical drains will be installed along the seaward edge of the reclamation for stability reasons when the platform level has reached RL +5.10 mCd, .
05. The filled area shall be wetted with water bowser to minimise generation of wind blowing dust.



Wharf Construction
Phase 1A: Completed
Phase 1B: Completed
Infrastructure Construction
Phase 1C: Completed
Consolidation Period
Phase 2A: 2033-2036
Phase 2B: 2034-2041
Reclamation
Phase 2C: 2037-2040



Location Map

NOTES ON LAND PREPARATION DURING SURCHARGE REMOVAL PERIOD (PHASE 2A, 2033 - 2036) AND CONSOLIDATION PERIOD (PHASE 2B, 2034 – 2041)

01. As soon as reclamation of Phase 2A and Phase 2B is completed, Pollution Prevention and Mitigation Measures (P2M2) such as Hoarding, Wash Trough, Silt Fence, Temporary Earth Drain, Check Dam, Gross Pollutant Trap and Sediment Basin shall be established onsite.
02. Green Turfing (hand seeding or hydro-seeding) shall be carried out to provide cover for the bare land during the Surcharge Removal/Consolidation Period (around 2 years). Creeper plants or other varieties suitable for sandy soil shall be used as cover crop.
03. All runoff within the area shall be channelled to Sediment Basin by Temporary Earth Drain before discharging out of the project site.
04. Check Dam shall be installed at intervals along Temporary Earth Drain.
05. Gross Pollutant Trap shall be installed at the inlet drain of Sediment Basin.
06. Energy dissipater in the form of riprap rocks shall be installed at the discharge outlet of Sediment Basin.
07. Temporary water crossing shall be installed at the intersection of Temporary Earth Drain and temporary internal road.
08. Sediment basins shall be desilted according to the maintenance frequency program stated in the LD-P2M2 report.
09. Only Suspended Solid concentration not exceeding 50 mg/l can be discharged to the receiving watercourse. Other alternative treatment method such as chemical dosing can be carried out to facilitate sediment control.
10. Weekly inspection of all P2M2 shall be carried out. In addition, inspection shall be carried out after every raining episode to check the conditions of all BMPs. Immediate remedial action shall be carried out to repair any damaged P2M2.

NOTES ON RECLAMATION (PHASE 2C, 2037 - 2040)

01. Reclamation work at Phase 2C begins in the northwest corner of CT16 and move southerly and westerly direction towards the sea. Placement of the sand fill will need to be completed in several lifts in order to avoid the initiation of slope failures along the seaward edge of the reclamation.
02. In order to minimize erosion damage to the reclamation platform, and the generation of silt plumes, Revetment will be constructed in stage as soon as possible as the reclamation progresses.
03. When the platform level has reached RL +5.10 mCd, an 80-metre wide strip of vertical drains will be installed along the seaward edge of the reclamation for stability reasons.
04. The filled area shall be wetted with water bowser to minimise generation of wind blowing dust.

PROJECT TITLE:

ENVIRONMENTAL IMPACT ASSESSMENT FOR WESTPORTS PHASE II DEVELOPMENT: PROPOSED EXPANSION OF CONTAINER TERMINALCT10-17 AND ITS ASSOCIATED WORKS AT WESTPORTS, PULAU INDAH, SELANGOR DARUL EHSAN

PROJECT PROPONENT

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TITLE:

LD-P2M2 FOR PHASE 2A, 2B, & 2C

DRAWN BY:
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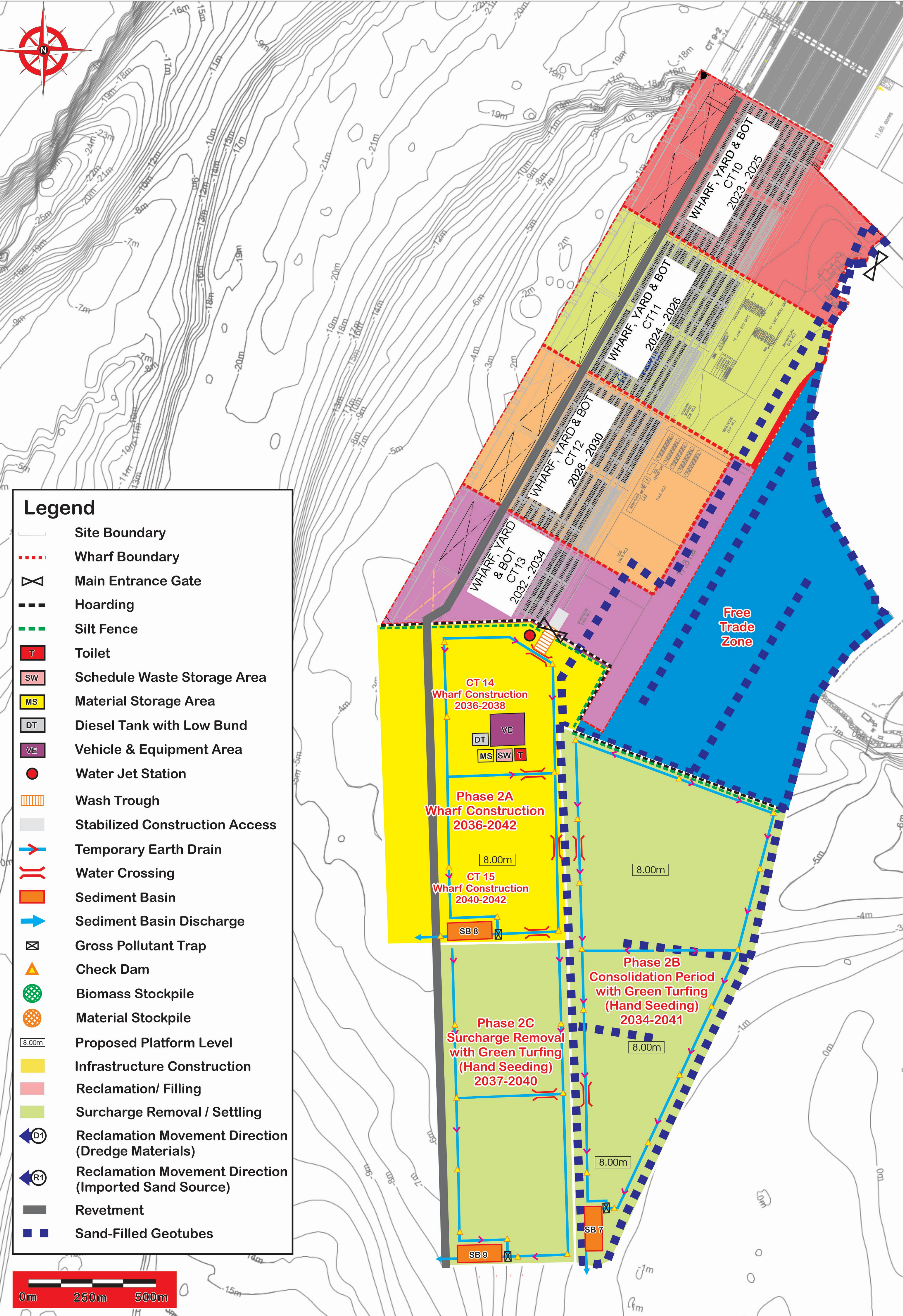
DATE:
SEPTEMBER 2020

JOB NO: LDP2M2/YSEC/WP/001

DRAWING NO: LDP2M2/PBG/006



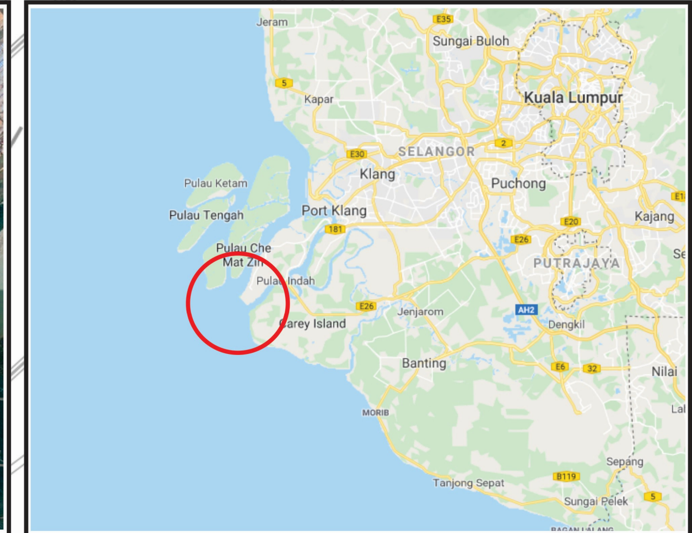
Legend

- Site Boundary
- Wharf Boundary
- Main Entrance Gate
- Hoarding
- Silt Fence
- T Toilet
- SW Schedule Waste Storage Area
- MS Material Storage Area
- DT Diesel Tank with Low Bund
- VE Vehicle & Equipment Area
- Water Jet Station
- Wash Trough
- Stabilized Construction Access
- Temporary Earth Drain
- Water Crossing
- Sediment Basin
- Sediment Basin Discharge
- Gross Pollutant Trap
- Check Dam
- Biomass Stockpile
- Material Stockpile
- 8.00m Proposed Platform Level
- Infrastructure Construction
- Reclamation/ Filling
- Surcharge Removal / Settling
- D1 Reclamation Movement Direction (Dredge Materials)
- R1 Reclamation Movement Direction (Imported Sand Source)
- Revetment
- Sand-Filled Geotubes

Wharf Construction
Phase 2A: 2036-2042

Consolidation Period
Phase 2B: 2034-2041

Surcharge Removal
Phase 2C: 2037-2040



Location Map

NNOTES ON WHARF CONSTRUCTION (PHASE 2A, 2036 - 2042)

01. Wharf construction at Phase 2A commences.
02. Grass Turfing shall be removed and stored temporarily at the Biomass Stockpile.
03. Temporary Stockpile shall be located at least 20 m away from any waterway. The height of Stockpile shall not exceed 1.2m and shall be surrounded by a low bund to control sedimentation.
04. Sediment basins shall be desilted according to the maintenance frequency program stated in the LD-P2M2 report.
05. Only Suspended Solid concentration not exceeding 50 mg/l can be discharged to the receiving watercourse. Other alternative treatment method such as chemical dosing can be carried out to facilitate sediment control.
06. Weekly inspection of all P2M2 shall be carried out. In addition, inspection shall be carried out after every raining episode to check the conditions of all BMPs. Immediate remedial action shall be carried out to repair any damaged P2M2.

NOTES ON LAND PREPARATION DURING CONSOLIDATION PERIOD (PHASE 2B, 2034 – 2041) AND SURCHARGE REMOVAL PERIOD (PHASE 2C, 2037 - 2040)

01. As soon as reclamation of Phase 2B and 2C is completed, Pollution Prevention and Mitigation Measures (P2M2) such as Temporary Earth Drain, Check Dam, Gross Pollutant Trap and Sediment Basin shall be established onsite.
02. Green Turfing (hand seeding) shall be carried out to provide cover for the bare land during the Surcharge Removal/Settling Period (around 2 years). Creeper plants or other varieties suitable for sandy soil shall be used as cover crop.
03. All runoff within the area shall be channelled to Sediment Basin by Temporary Earth Drain before discharging out of the project site.
04. Check Dam shall be installed at intervals along Temporary Earth Drain.
05. Gross Pollutant Trap shall be installed at the inlet drain of Sediment Basin.
06. Energy dissipater in the form of riprap rocks shall be installed at the discharge outlet of Sediment Basin.
07. Temporary water crossing shall be installed at the intersection of Temporary Earth Drain and temporary internal road.
08. Sediment basins shall be desilted according to the maintenance frequency program stated in the LD-P2M2 report.
09. Only Suspended Solid concentration not exceeding 50 mg/l can be discharged to the receiving watercourse. Other alternative treatment method such as chemical dosing can be carried out to facilitate sediment control.
10. Weekly inspection of all P2M2 shall be carried out. In addition, inspection shall be carried out after every raining episode to check the conditions of all BMPs. Immediate remedial action shall be carried out to repair any damaged P2M2.

PROJECT TITLE:

ENVIRONMENTAL IMPACT ASSESSMENT FOR WESTPORTS PHASE II DEVELOPMENT: PROPOSED EXPANSION OF CONTAINER TERMINALCT10-17 AND ITS ASSOCIATED WORKS AT WESTPORTS, PULAU INDAH, SELANGOR DARUL EHSAN

PROJECT PROPONENT

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TITLE:

LD-P2M2 FOR PHASE 2A, 2B, & 2C

DRAWN BY:

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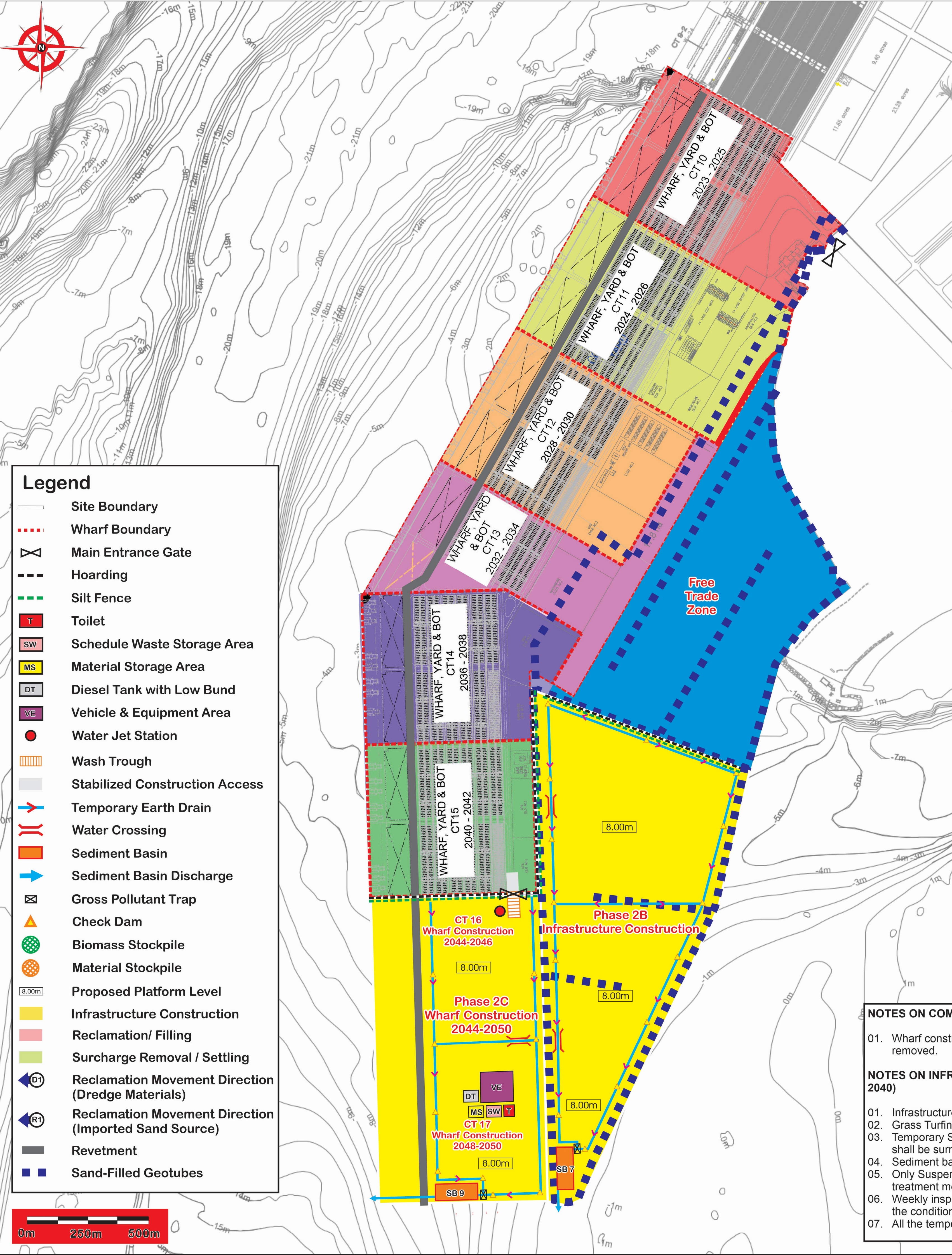
DATE:

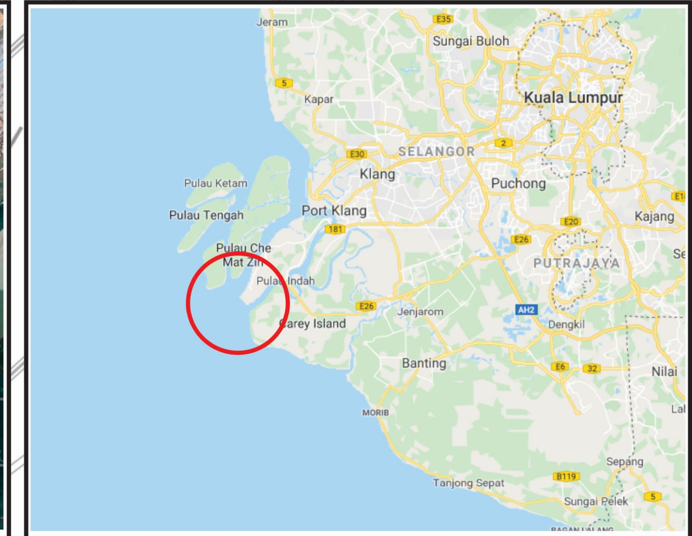
SEPTEMBER 2020

JOB NO:	LDP2M2/YSEC/WP/001
DRAWING NO:	LDP2M2/PBG/007



Wharf Construction
Phase 2A: Completed
Phase 2C: 2044-2050

Infrastructure Construction
Phase 2B



Location Map

NOTES ON COMPLETION (PHASE 2A, 2043)

01. Wharf construction at Phase 2A (CT14 and CT15) is completed. All the temporary Pollution Prevention measures shall be removed.

NOTES ON INFRASTRUCTURE CONSTRUCTION (PHASE 2B, 2034 - 2041) AND WHARF CONSTRUCTION (PHASE 2C, 2037 – 2040)

01. Infrastructure construction at Phase 2B and wharf construction work at Phase 2C commence.
02. Grass Turfing shall be removed and stored temporarily at the Biomass Stockpile.
03. Temporary Stockpile shall be located at least 20 m away from any waterway. The height of Stockpile shall not exceed 1.2m and shall be surrounded by a low bund to control sedimentation.
04. Sediment basins shall be desilted according to the maintenance frequency program stated in the LD-P2M2 report.
05. Only Suspended Solid concentration not exceeding 50 mg/l can be discharged to the receiving watercourse. Other alternative treatment method such as chemical dosing can be carried out to facilitate sediment control.
06. Weekly inspection of all P2M2 shall be carried out. In addition, inspection shall be carried out after every raining episode to check the conditions of all BMPs. Immediate remedial action shall be carried out to repair any damaged P2M2.
07. All the temporary Pollution Prevention measures shall be removed once construction is fully completed.

PROJECT TITLE:

ENVIRONMENTAL IMPACT ASSESSMENT FOR WESTPORTS PHASE II DEVELOPMENT: PROPOSED EXPANSION OF CONTAINER TERMINALCT10-17 AND ITS ASSOCIATED WORKS AT WESTPORTS, PULAU INDAH, SELANGOR DARUL EHSAN

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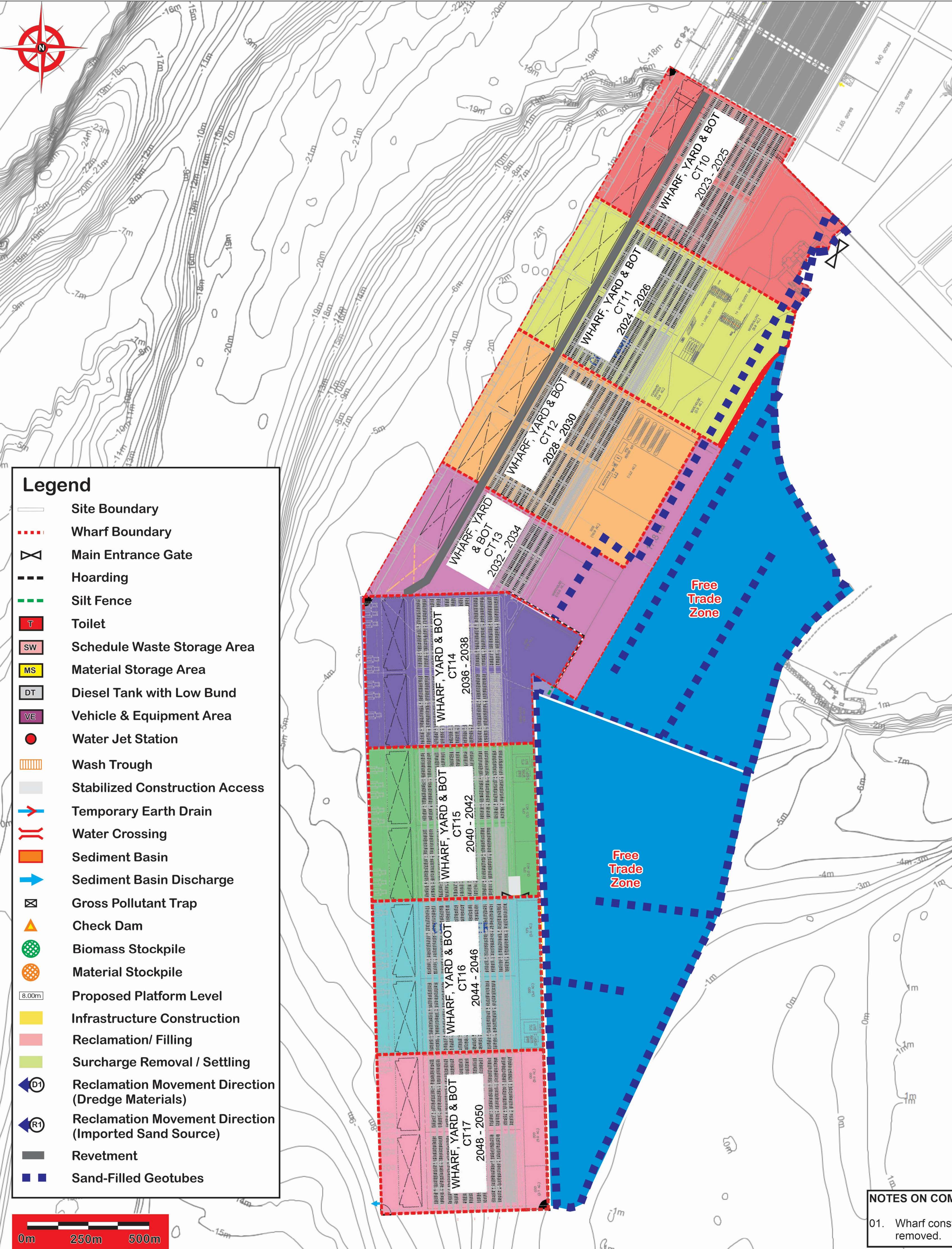
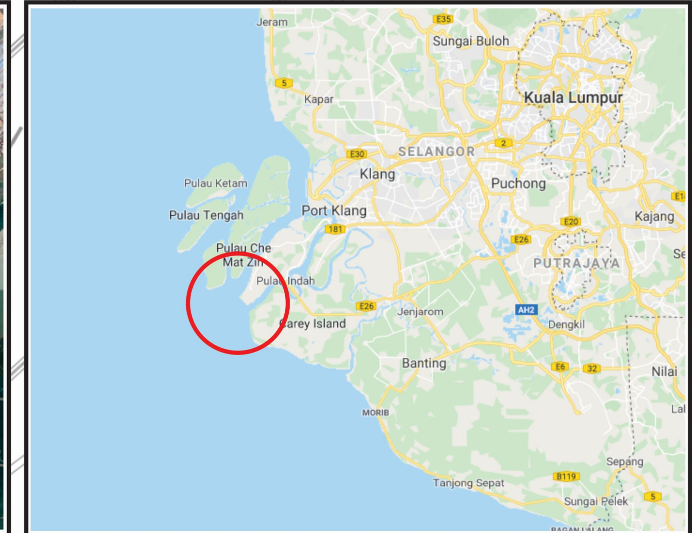
SEPTEMBER 2020

JOB NO: LDP2M2/YSEC/WP/001

DRAWING NO: LDP2M2/PBG/008



Wharf Construction
Phase 2A: Completed
Phase 2C: Completed
Infrastructure Construction
Phase 2B: Completed



Location Map

NOTES ON COMPLETION (PHASE 2C, 2050)

01. Wharf construction at Phase 2C (CT16 andd CT17) is completed. All the temporary Pollution Prevention measures shall be removed.

PROJECT TITLE:

ENVIRONMENTAL IMPACT ASSESSMENT FOR WESTPORTS PHASE II DEVELOPMENT: PROPOSED EXPANSION OF CONTAINER TERMINALCT10-17 AND ITS ASSOCIATED WORKS AT WESTPORTS, PULAU INDAH, SELANGOR DARUL EHSAN

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DATE:
SEPTEMBER 2020

JOB NO:	LDP2M2/YSEC/WP/001
DRAWING NO:	LDP2M2/PBG/010

ANNEX A
INPUT & OUTPUT DATA FOR SOIL EROSION & SEDIMENT YIELD CALCULATIONS

1. INTRODUCTION

The steps involved in the soil erosion and sedimentation assessment for the project development are as follows:

Step	Assessment
1	Calculation of Soil Erosion Rate using the Universal Soil Loss Equation (USLE).
2	Calculation of Sediment Yield using the Modified Universal Soil Loss Equation (MUSLE).

Assumptions made in the soil erosion assessment are as follows:

- Land clearing of the project site is carried out in 2 phases. Phase 1 is further divided into 4 sub-Parcels and Phase 2 in 3 sub-Parcels.
- Eroded soil during this stage will settle locally, with the finer soil particles being carried to the earth drain within the disturbed area, to the sediment basins before discharging to the sea.

2. UNIVERSAL SOIL LOSS EQUATION (USLE)

The **Universal Soil Loss Equation (USLE)** was used in the computation of current and potential erosion as shown below:

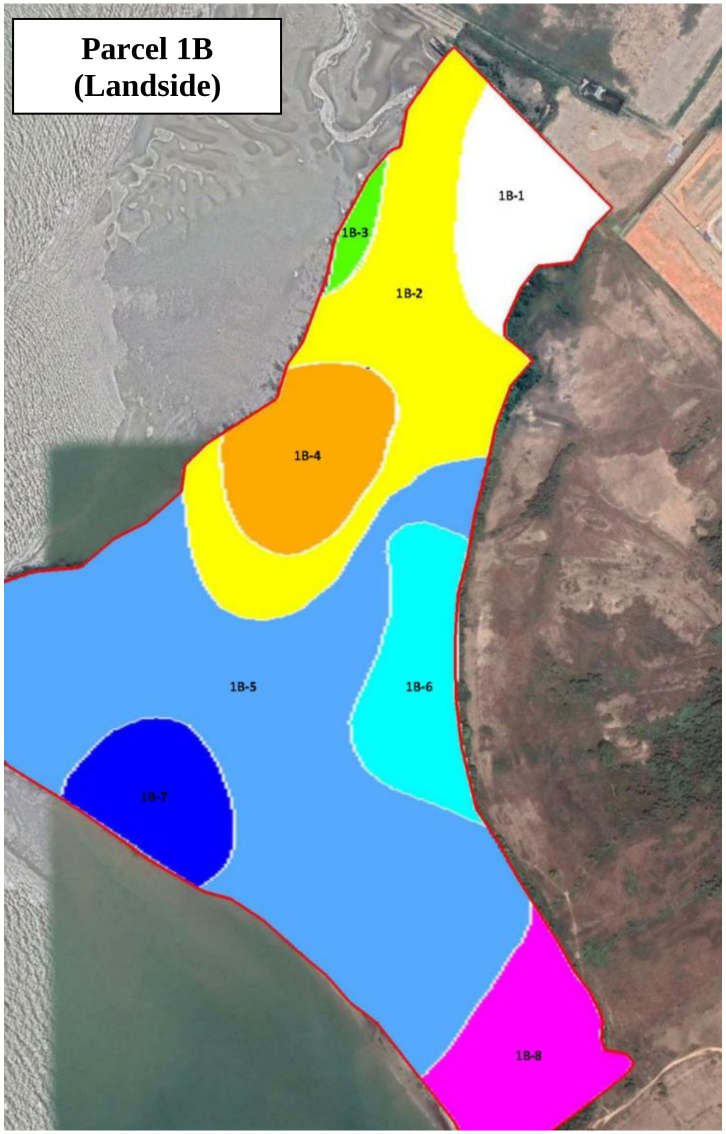
$$A = R.K.L.S.C.P$$

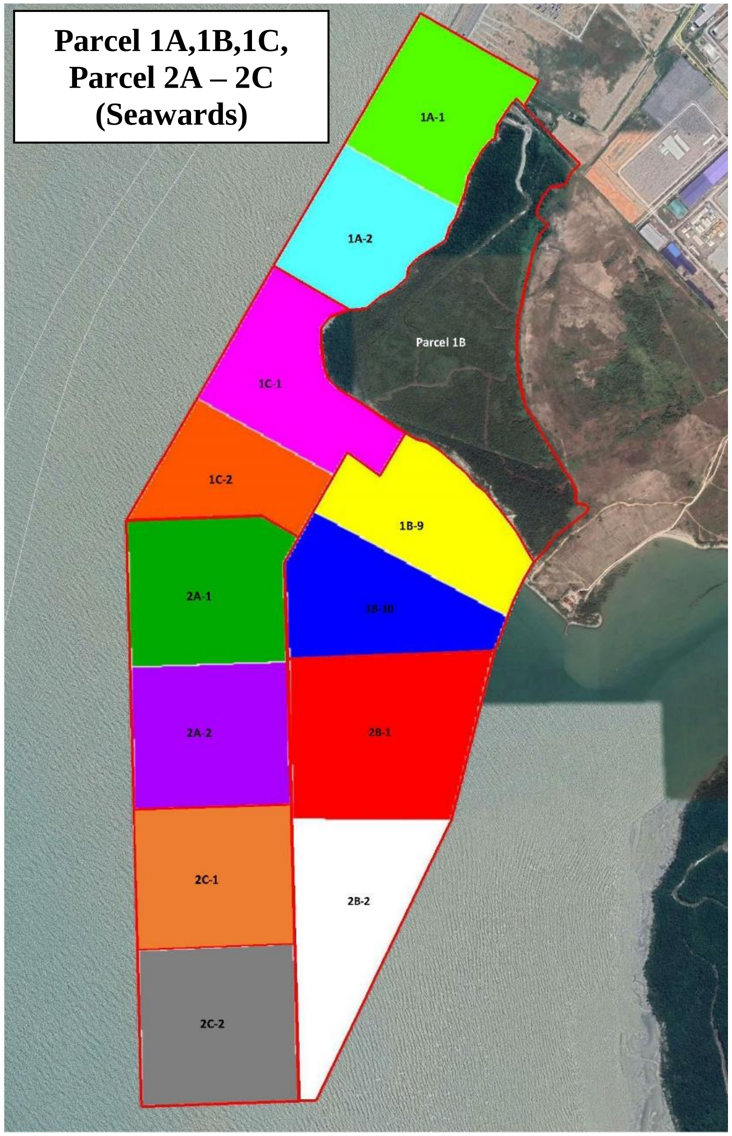
Where A = soil loss in tonne/ha/year
R = rainfall erosivity index ($MJmmha^{-1}h^{-1}$)
K = soil erodibility factor [(tonnes/ha/($MJmmha^{-1}h^{-1}$)]
LS = topographic factor, combination of slope steepness (S, %) and slope length (L, meter)
C = crop management factor, representing the ratio of soil loss under a given crop to that from the bare soil (dimensionless)
P = conservation practice factor, representing measures taken to what it would have been if such conservation measures have not been taken

The values used for the different parameters in the computation are briefly discussed below.

Figure A2.1 shows the break down of the project site into smaller parcels

Figure A2.1 Demarcation of Parcels





2.1 Rainfall Erosivity Index (R)

R Factor is derived from Figure 3.4 Rainfall Erosivity Map for Selangor State, Kuala Lumpur FT and Putrajaya of *Guideline for Erosion and Sediment Control in Malaysia* (DID, 2010).

For Westports, the R Factor is 15,000 – 16,000 MJ.mm/ha.yr.

2.2 Soil Erodibility Factor (K)

K Factor is calculated using Tew Equation from *Guideline for Erosion and Sediment Control in Malaysia* (DID, 2010).

$$K = [1.0 \times 10^{-4} (12 - OM) M^{1.14} + 4.5(s - 3) + 8.0(p - 2)] / (100 \times 7.59)$$

Where:

K	=	Soil Erodibility Factor, (ton/ac.)*(100ft.ton.in/ac.hr) for SI unit (ton/ha)(ha.hr/MJ.mm), the conversion factor is 1/7.59
M	=	(% silt + % very fine sand) x (100 - % clay)
OM	=	% organic matter
S	=	soil structure code
P	=	permeability class

K Factor is derived from Soil Investigation report for Parcel 1B of the project site. Locations of the boreholes are plotted in **Figure A2.1** using Surfer 17 software. Parcel 1A, 1B-9,1B-10, 1C, 2B, & shall be reclaimed with sand. The K-factor used for these sub-Parcels is 0.004, based on Results of the K-Factor are given in **Table A2.1**. The K Factor for each parcel is shown in **Table A2.2**.

(Location of Boreholes at Parcel 1B, n.d.)

Figure A2.1 Location of Boreholes at Parcel 1B

Table A2.1 Soil Test Result for Parcel 1B

		Laboratory Soil Test Results											
Borehole	Depth	OM	Gravel	Sand	Silt	Clay	M	s	p	K	K(SI)	Soil	HSG
	(m)	(%)	(%)	(%)	(%)	(%)					(t.ha.hr/(ha.MJ.mm))	Type	
BH1	0.00m	1.4	0	53	19	28	1368	4	4	0.245	0.032	Sandy Clay Loam	C
BH2	3.00m	1.9	0	46	19	35	1235	4	5	0.319	0.042	Sandy Clay	C-D
BH3	3.00m	1.7	1	75	14.07	9.93	1267	2	2	-0.010	0.004	Sandy Loam	A
BH4	1.50m	1.9	0	64	14	22	1092	4	4	0.234	0.031	Sandy Clay Loam	C
BH5	3.00m	2.2	0	62	16	22	1248	4	4	0.238	0.031	Sandy Clay Loam	C
BH6	3.00m	5.3	0	4	43	53	2021	4	5	0.324	0.043	Silty Clay	C-D
BH7	3.00m	1.1	0	9	32	59	1312	4	6	0.404	0.053	Clay	D
BH8	3.00m	1.1	5	90	3.33	1.67	328	1	1	-0.162	0.004	Sand	A
BH9	3.00m	6.2	0	21	36	43	2052	4	6	0.400	0.053	Clay	D
BH10	3.00m	5.4	0	47	18	35	1170	4	5	0.306	0.040	Sandy Clay	C-D
BH11	3.00m	1.5	0	6	34	60	1360	4	6	0.404	0.053	Clay	D
BH12	3.00m	6.8	0	19	33	48	1716	4	6	0.390	0.051	Clay	D
BH13	3.00m	2.1	0	25	32	43	1824	4	6	0.417	0.055	Clay	D
BH14	3.00m	0.7	0	85	9.32	5.68	879	1	1	-0.144	0.004	Sand	A
BH15	3.00m	2.9	0	8	42	50	2100	4	5	0.341	0.045	Silty Clay	C-D
BH16	3.00m	3.0	0	63	13	24	988	4	4	0.228	0.030	Sandy Clay Loam	C
BH17	3.00m	2.8	0	5	36	59	1476	4	6	0.403	0.053	Clay	D
BH18	3.00m	1.0	0	20	27	53	1269	4	6	0.403	0.053	Clay	D
BH19	3.00m	1.2	0	32	25	43	1425	4	6	0.408	0.054	Clay	D
BH20	3.00m	1.7	0	20	37	43	2109	4	6	0.428	0.056	Clay	D
BH21	3.00m	1.7	0	8	40	52	1920	4	5	0.342	0.045	Silty Clay	C-D
BH22	3.00m	2.5	0	22	34	44	1904	4	6	0.417	0.055	Clay	D
BH23	3.00m	2.7	0	34	22	44	1232	4	6	0.396	0.052	Clay	D
BH24	3.00m	6.9	0	24	32	44	1792	4	6	0.391	0.052	Clay	D
BH25	3.00m	2.4	1	46	22	31	1518	4	4	0.246	0.032	Sandy Clay Loam	C
BH26	3.00m	3.0	0	5	39	56	1716	4	5	0.329	0.043	Silty Clay	C-D
BH27	3.00m	1.2	0	40	25	35	1625	4	4	0.254	0.034	Clay Loam	C
BH28	3.00m	2.9	0	17	32	51	1568	4	6	0.405	0.053	Clay	D
BH29	3.00m	0.6	0	83	10.13	6.87	943	1	2	-0.062	0.004	Loamy Sand	A

		Laboratory Soil Test Results											
Borehole	Depth	OM	Gravel	Sand	Silt	Clay	M	s	p	K	K(SI)	Soil	HSG
	(m)	(%)	(%)	(%)	(%)	(%)					(t.ha.hr/(ha.MJ.mm))	Type	
BH30	3.00m	1.7	0	24	29	47	1537	4	6	0.409	0.054	Clay	D
BH31	3.00m	1.5	0	5	37	58	1554	4	6	0.411	0.054	Clay	D
BH32	3.00m	2.4	0	5	41	54	1886	4	5	0.337	0.044	Silty Clay	C-D
BH33	3.00m	1.5	0	20	33	47	1749	4	6	0.417	0.055	Clay	D
BH34	3.00m	1.1	0	32	29	39	1769	4	4	0.260	0.034	Clay Loam	C
BH35	3.00m	1.1	0	78	12.74	9.26	1155.701	2	2	-0.011	0.004	Sandy Loam	A
BH36	3.00m	2.2	0	17	29	54	1334	4	6	0.401	0.053	Clay	D
BH37	1.50m	0.3	0	89	6.60	4.40	630.96	1	2	-0.072	0.004	Loamy Sand	A
BH38	3.00m	4.2	0	1	37	62	1406	4	6	0.395	0.052	Heavy Clay	D
BH39	1.50m	2.0	0	80	12.29	7.71	1134.418	1	2	-0.060	0.004	Loamy Sand	A
BH40	1.50m	0.4	0	90	6.49	3.51	625.8583	1	1	-0.152	0.004	Sand	A

Remarks
- (light blue) K Value Adjusted
- (yellow) Data % Redistributed
- (red) Highest K Value

Table A2.2 K Factor and Hydrological Soil Group (HSG)

Parcel	K Factor	HSG
1A-1	0.004	A
1A-2	0.004	A
1B-1	0.027	C
1B-2	0.035	C-D
1B-3	0.043	D
1B-4	0.017	B
1B-5	0.045	D
1B-6	0.052	D
1B-7	0.036	C-D
1B-8	0.052	D

Parcel	K Factor	HSG
1B-9	0.004	A
1B-10	0.004	A
1C-1	0.004	A
1C-2	0.004	A
2A-1	0.004	A
2A-2	0.004	A
2B-1	0.004	A
2B-2	0.004	A
2C-1	0.004	A
2C-2	0.004	A

2.3 Topological Factor (LS)

LS Factor is derived from Equation defined by Wischmeier (1975) as given in Equation 3.9 of *Guideline for Erosion and Sediment Control in Malaysia* (DID, 2010).

$$LS = (\lambda / \Psi)^m \times (0.065 + 0.046s + 0.0065s^2)$$

Where λ = sheet flow path length (m)
Ψ = 22.13 (SI units)
S = average slope gradient (%)
M = 0.2 for $s < 1$,
0.3 for $1 \leq s < 3$
0.4 for $3 \leq s < 5$
0.5 for $5 \leq s < 12$ and
0.6 for $s \geq 12\%$

LS factors for Pre-bulk Grading Stage of Parcel 1B are derived from the Surveyor's plan.

Table A2.3 LS Factor for Pre-bulk Grading Stage of Parcel 1B

Slope Gradient	Distance measured on survey plan	Plan to Scale	X	Contour Line			Slope Length	Slope gradient	LS Factor
				Max	Min	Y	(λ)	(S)	
(m)	(mm)	(mm)	(m)	(m)	(m)	(m)	(m)	(%)	
1B-1	**93.70**	1000.00	93.70	7.00	4.000	3.00	93.75	3.20	0.50
1B-2	**106.00**	1000.00	106.00	5.00	3.000	2.00	106.02	1.89	0.28
1B-3	**48**	1000.00	48.20	4.00	3.900	0.10	48.20	0.21	0.09
1B-4	**69**	1000.00	68.70	4.00	3.000	1.00	68.71	1.46	0.20
1B-5	**163**	1000.00	163.00	4.00	3.900	0.10	163.00	0.06	0.10
1B-6	**135**	1000.00	135.00	6.00	4.000	2.00	135.01	1.48	0.25
1B-7	**134**	1000.00	134.00	4.00	3.000	1.00	134.00	0.75	0.15
1B-8	**53**	1000.00	53.30	5.00	4.500	0.50	53.30	0.94	0.14
1B-9	**-**	-	-	-	-	-	-	-	-
1B-10	**-**	-	-	-	-	-	-	-	-

LS factors for Post Bulk Grading Stage of of all Parcels are derived from Surfer 17 software as shown in **Annex B**.

Table A2.4 LS Factor for Post Bulk Grading Stage

Parcel	LS Factor
1A-1	0.12
1A-2	0.10
1B-1	0.20
1B-2	0.10
1B-3	0.25
1B-4	0.15
1B-5	0.14
1B-6	0.25
1B-7	0.15
1B-8	0.14

Parcel	LS Factor
1B-9	0.11
1B-10	0.12
1C-1	0.13
1C-2	0.15
2A-1	0.15
2A-2	0.10
2B-1	0.11
2B-2	0.14
2C-1	0.11
2C-2	0.13

2.4 Crop Management Factor (C)

Plant cover effectively reduces erosion due to the tree canopy which tends to minimize rainfall impact on ground while the roots provide effective binding of the soil, making it more resistant to erosive agents.

2.5 Soil Conservation Practice (P)

Soil conservation practice is important to trap as well as reduce the volume and velocity of surface runoff.

The Crop Management Factor (C) and Soil Cconservation Practice Factor (P) for various stages of development are shown in **Table A2.5.**

Table A2.5 CP Factor for Various Stages of Development

Stage	Vegetative	C Factor	Support Practice	P Factor
Pre-development	Bushes/Shrubs 100% cover	0.03	None	1.00
	Sea	0.01	None	1.00
Pre-bulk Grading (No Ctrl)	Bare Land	1.00	Bare soil	1.00
	Sea	0.01	None	1.00
Pre-bulk Grading (With Ctrl)	Bare Land, rough (offset disk)	0.80	Sediment basin	0.50
	Sea	0.01	None	0.50
Post Bulk	Bare Land, rough (offset disk), wetting	0.50	Sediment basin	0.50
	Sediment Basin	0.01	None	1.00
Post Development	Industrial - medium density, impervious	0.14	Berm drain	0.50

Reference: *Guideline for Erosion and Sediment Control in Malaysia* (DID, 2010).

2.6. Estimated Erosion Rates

A = R*K*LS*CP (USLE)

Table A2.6 Erosion Rate of Project Site during Pre-development Stage

	Parcel	Pre Development Stage											
		R_{min}	R_{max}	K	LS	C	P	A_{min} t ha^{-1} $year^{-1}$	A_{max} t ha^{-1} $year^{-1}$	Area (ac)	Area (ha)	A_{min}-overall t $year^{-1}$	A_{max}-overall t $year^{-1}$
1A	1A-1	15000	16000	0.004	0.00	0.01	1.00	0.0	0.0	83.3	33.7	0	0
	1A-2	15000	16000	0.004	0.00	0.01	1.00	0.0	0.0	74.7	30.2	0	0
	SUB-TOTAL									**158.0**	**63.9**	**0**	**0**
1B	1B-1	15000	16000	0.027	0.50	0.03	1.00	5.9	6.3	15.0	6.1	36	38
	1B-2	15000	16000	0.035	0.28	0.03	1.00	4.4	4.7	40.6	16.4	72	77
	1B-3	15000	16000	0.043	0.09	0.03	1.00	1.7	1.8	2.4	1.0	2	2
	1B-4	15000	16000	0.017	0.20	0.03	1.00	1.6	1.7	16.9	6.8	11	11
	1B-5	15000	16000	0.045	0.10	0.03	1.00	2.0	2.2	98.6	39.9	82	87
	1B-6	15000	16000	0.052	0.25	0.03	1.00	5.9	6.3	16.8	6.8	40	43
	1B-7	15000	16000	0.036	0.15	0.03	1.00	2.4	2.6	13.0	5.3	13	13
	1B-8	15000	16000	0.052	0.14	0.03	1.00	3.1	3.4	19.7	8.0	25	27
	1B-9	15000	16000	0.004	0.00	0.00	0.00	0.0	0.0	86.0	34.8	0	0
	1B-10	15000	16000	0.004	0.00	0.00	0.00	0.0	0.0	90.0	36.4	0	0
	SUB-TOTAL									**399.0**	**161.5**	**280**	**299**

	Parcel	Pre Development Stage											
		R_{min}	R_{max}	K	LS	C	P	A_{min} t ha^{-1} year^{-1}	A_{max} t ha^{-1} year^{-1}	Area (ac)	Area (ha)	A_{min}-overall t year^{-1}	A_{max}-overall t year^{-1}
1C	1C-1	15000	16000	0.004	0.00	0.00	0.00	0.0	0.0	89.0	36.0	0	0
	1C-2	15000	16000	0.004	0.00	0.00	0.00	0.0	0.0	66.0	26.7	0	0
	SUB-TOTAL									**155.0**	**62.7**	**0**	**0**
2A	2A-1	15000	16000	0.004	0.00	0.00	0.00	0.0	0.0	132.0	53.4	0	0
	2A-2	15000	16000	0.004	0.00	0.00	0.00	0.0	0.0	109.0	44.1	0	0
	SUB-TOTAL									**241.0**	**97.5**	**0**	**0**
2B	2B-1	15000	16000	0.004	0.00	0.00	0.00	0.0	0.0	99.0	40.1	0	0
	2B-2	15000	16000	0.004	0.00	0.00	0.00	0.0	0.0	108.0	43.7	0	0
	SUB-TOTAL									**207.0**	**83.8**	**0**	**0**
2C	2C-1	15000	16000	0.004	0.00	0.00	0.00	0.0	0.0	101.0	40.9	0	0
	2C-2	15000	16000	0.004	0.00	0.00	0.00	0.0	0.0	98.0	39.7	0	0
	SUB-TOTAL									**199.0**	**80.5**	0	0

Table A2.7 Erosion Rate during Pre-bulk Grading Stage without Mitigating Measures

	PARCEL	Pre-bulk Grading Stage (Without Mitigating Measures)											
		R_{min}	R_{max}	K	LS	C	P	A_{min} t ha^{-1} $year^{-1}$	A_{max} t ha^{-1} $year^{-1}$	Area (ac)	Area (ha)	A_{min}-overall t $year^{-1}$	A_{max}-overall t $year^{-1}$
1A	1A-1	15000	16000	0.004	0.12	1.00	1.00	7.2	7.7	83.3	33.7	243	259
	1A-2	15000	16000	0.004	0.10	1.00	1.00	6.0	6.4	74.7	30.2	181	193
	SUB-TOTAL									**158.0**	**63.9**	**424**	**452**
1B	1B-1	15000	16000	0.027	0.50	1.00	1.00	197.5	210.7	15.0	6.1	1,199	1,279
	1B-2	15000	16000	0.035	0.28	1.00	1.00	146.9	156.7	40.6	16.4	2,414	2,575
	1B-3	15000	16000	0.043	0.09	1.00	1.00	55.7	59.5	2.4	1.0	54	58
	1B-4	15000	16000	0.017	0.20	1.00	1.00	52.2	55.7	16.9	6.8	357	381
	1B-5	15000	16000	0.045	0.10	1.00	1.00	68.3	72.8	98.6	39.9	2,724	2,906
	1B-6	15000	16000	0.052	0.25	1.00	1.00	195.9	209.0	16.8	6.8	1,332	1,421
	1B-7	15000	16000	0.036	0.15	1.00	1.00	79.7	85.0	13.0	5.3	419	447
	1B-8	15000	16000	0.052	0.14	1.00	1.00	104.9	111.9	19.7	8.0	836	892
	1B-9	15000	16000	0.004	0.11	1.00	1.00	6.6	7.0	86.0	34.8	230	245
	1B-10	15000	16000	0.004	0.12	1.00	1.00	7.2	7.7	90.0	36.4	262	280
	SUB-TOTAL									**399.0**	**161.5**	**9,828.4**	**10,483.6**
1C	1C-1	15000	16000	0.004	0.13	1.00	1.00	7.8	8.3	89.0	36.0	281	300
	1C-2	15000	16000	0.004	0.15	1.00	1.00	9.0	9.6	66.0	26.7	240	256
	SUB-TOTAL									**155.0**	**62.7**	**521**	**556**

	PARCEL	Pre-bulk Grading Stage (Without Mitigating Measures)											
		R_{min}	R_{max}	K	LS	C	P	A_{min} t ha^{-1} $year^{-1}$	A_{max} t ha^{-1} $year^{-1}$	Area (ac)	Area (ha)	A_{min}-overall t $year^{-1}$	A_{max}-overall t $year^{-1}$
2A	2A-1	15000	16000	0.004	0.15	1.00	1.00	9.0	9.6	132.0	53.4	481	513
	2A-2	15000	16000	0.004	0.10	1.00	1.00	6.0	6.4	109.0	44.1	265	282
	SUB-TOTAL									**241.0**	**97.5**	**745**	**795**
2B	2B-1	15000	16000	0.004	0.11	1.00	1.00	6.6	7.0	99.0	40.1	264	282
	2B-2	15000	16000	0.004	0.14	1.00	1.00	8.4	9.0	108.0	43.7	367	392
	SUB-TOTAL									**207.0**	**83.8**	**632**	**674**
2C	2C-1	15000	16000	0.004	0.11	1.00	1.00	6.6	7.0	101.0	40.9	270	288
	2C-2	15000	16000	0.004	0.13	1.00	1.00	7.8	8.3	98.0	39.7	309	330
	SUB-TOTAL									**199.0**	**80.5**	**579**	**618**

Table A2.8 Erosion Rate of Project Site during Pre-bulk Grading Stage with Mitigating Measures

	PARCEL	Pre-bulk Grading Stage (With Mitigating Measures)											
		R_{min}	R_{max}	K	LS	C	P	A_{min} t ha^{-1} year^{-1}	A_{max} t ha^{-1} year^{-1}	Area (ac)	Area (ha)	A_{min}-overall t year^{-1}	A_{max}-overall t year^{-1}
1A	1A-1	15000	16000	0.004	0.12	0.80	0.50	2.9	3.1	83.3	33.7	97	104
	1A-2	15000	16000	0.004	0.10	0.80	0.50	2.4	2.6	74.7	30.2	73	77
	SUB-TOTAL									**158.0**	**63.9**	**170**	**181**
1B	1B-1	15000	16000	0.027	0.50	0.80	0.50	79.0	84.3	15.0	6.1	480	512
	1B-2	15000	16000	0.035	0.28	0.80	0.50	58.8	62.7	40.6	16.4	966	1,030
	1B-3	15000	16000	0.043	0.09	0.80	0.50	22.3	23.8	2.4	1.0	22	23
	1B-4	15000	16000	0.017	0.20	0.80	0.50	20.9	22.3	16.9	6.8	143	152
	1B-5	15000	16000	0.045	0.10	0.80	0.50	27.3	29.1	98.6	39.9	1,090	1,162
	1B-6	15000	16000	0.052	0.25	0.80	0.50	78.4	83.6	16.8	6.8	533	568
	1B-7	15000	16000	0.036	0.15	0.80	0.50	31.9	34.0	13.0	5.3	168	179
	1B-8	15000	16000	0.052	0.14	0.80	0.50	41.9	44.7	19.7	8.0	334	357
	1B-9	15000	16000	0.004	0.11	0.80	0.50	2.6	2.8	86.0	34.8	92	98
	1B-10	15000	16000	0.004	0.12	0.80	0.50	2.9	3.1	90.0	36.4	105	112
	SUB-TOTAL									**399.0**	**161.5**	**3,931.4**	**4,193.4**
1C	1C-1	15000	16000	0.004	0.13	0.80	0.50	3.1	3.3	89.0	36.0	112	120
	1C-2	15000	16000	0.004	0.15	0.80	0.50	3.6	3.8	66.0	26.7	96	103
	SUB-TOTAL									**155.0**	**62.7**	**209**	**222**

	PARCEL	Pre-bulk Grading Stage (With Mitigating Measures)											
		R_{min}	R_{max}	K	LS	C	P	A_{min} t ha^{-1} $year^{-1}$	A_{max} t ha^{-1} $year^{-1}$	Area (ac)	Area (ha)	A_{min}-overall t $year^{-1}$	A_{max}-overall t $year^{-1}$
2A	2A-1	15000	16000	0.004	0.15	0.80	0.50	3.6	3.8	132.0	53.4	192	205
	2A-2	15000	16000	0.004	0.10	0.80	0.50	2.4	2.6	109.0	44.1	106	113
	SUB-TOTAL									**241.0**	**97.5**	**298**	**318**
2B	2B-1	15000	16000	0.004	0.11	0.80	0.50	2.6	2.8	99.0	40.1	106	113
	2B-2	15000	16000	0.004	0.14	0.80	0.50	3.4	3.6	108.0	43.7	147	157
	SUB-TOTAL									**207.0**	**83.8**	**253**	**269**
2C	2C-1	15000	16000	0.004	0.11	0.80	0.50	2.6	2.8	101.0	40.9	108	115
	2C-2	15000	16000	0.004	0.13	0.80	0.50	3.1	3.3	98.0	39.7	124	132
	SUB-TOTAL									**199.0**	**80.5**	**232**	**247**

Table A2.9 Erosion Rate of Project Site during Post Bulk Grading Stage with Mitigating Measures

	PARCEL	Post Bulk Grading Stage (With Mitigating Measures)											
		R_{min}	R_{max}	K	LS	C	P	A_{min} t ha^{-1} $year^{-1}$	A_{max} t ha^{-1} $year^{-1}$	Area (ac)	Area (ha)	A_{min}-overall t $year^{-1}$	A_{max}-overall t $year^{-1}$
1A	1A-1	15000	16000	0.004	0.12	0.50	0.50	1.8	1.9	83.3	33.7	61	65
	1A-2	15000	16000	0.004	0.10	0.50	0.50	1.5	1.6	74.7	30.2	45	48
	SUB-TOTAL									**158.0**	**63.9**	**106**	**113**
1B	1B-1	15000	16000	0.017	0.20	0.50	0.50	13.1	13.9	15.0	6.1	79	85
	1B-2	15000	16000	0.045	0.10	0.50	0.50	17.1	18.2	40.6	16.4	280	299
	1B-3	15000	16000	0.052	0.25	0.50	0.50	49.0	52.2	2.4	1.0	48	51
	1B-4	15000	16000	0.036	0.15	0.50	0.50	19.9	21.3	16.9	6.8	136	145
	1B-5	15000	16000	0.052	0.14	0.50	0.50	26.2	28.0	98.6	39.9	1,046	1,116
	1B-6	15000	16000	0.052	0.25	0.50	0.50	49.0	52.2	16.8	6.8	333	355
	1B-7	15000	16000	0.036	0.15	0.50	0.50	19.9	21.3	13.0	5.3	105	112
	1B-8	15000	16000	0.052	0.14	0.50	0.50	26.2	28.0	19.7	8.0	209	223
	1B-9	15000	16000	0.004	0.11	0.50	0.50	1.7	1.8	86.0	34.8	57	61
	1B-10	15000	16000	0.004	0.12	0.50	0.50	1.8	1.9	90.0	36.4	66	70
	SUB-TOTAL									**399.0**	**161.5**	**2,359.6**	**2,516.9**
1C	1C-1	15000	16000	0.004	0.13	0.50	0.50	2.0	2.1	89.0	36.0	70	75
	1C-2	15000	16000	0.004	0.15	0.50	0.50	2.3	2.4	66.0	26.7	60	64
	SUB-TOTAL									**155.0**	**62.7**	**130**	**139**

	PARCEL	Post Bulk Grading Stage (With Mitigating Measures)											
		R_{min}	R_{max}	K	LS	C	P	A_{min} t ha^{-1} year^{-1}	A_{max} t ha^{-1} year^{-1}	Area (ac)	Area (ha)	A_{min}-overall t year^{-1}	A_{max}-overall t year^{-1}
2A	2A-1	15000	16000	0.004	0.15	0.50	0.50	2.3	2.4	132.0	53.4	120	128
	2A-2	15000	16000	0.004	0.10	0.50	0.50	1.5	1.6	109.0	44.1	66	71
	SUB-TOTAL									**241.0**	**97.5**	**186**	**199**
2B	2B-1	15000	16000	0.004	0.11	0.50	0.50	1.7	1.8	99.0	40.1	66	71
	2B-2	15000	16000	0.004	0.14	0.50	0.50	2.1	2.2	108.0	43.7	92	98
	SUB-TOTAL									**207.0**	**83.8**	**158**	**168**
2C	2C-1	15000	16000	0.004	0.11	0.50	0.50	1.7	1.8	101.0	40.9	67	72
	2C-2	15000	16000	0.004	0.13	0.50	0.50	2.0	2.1	98.0	39.7	77	82
	SUB-TOTAL									**199.0**	**80.5**	**145**	**154**

Table A2.10 Erosion Rate of Project Site during Post Development Stage (Fully Operational)

	PARCEL	Post Development Stage											
		R_{min}	R_{max}	K	LS	C	P	A_{min} t ha^{-1} $year^{-1}$	A_{max} t ha^{-1} $year^{-1}$	Area (ac)	Area (ha)	A_{min}-overall t $year^{-1}$	A_{max}-overall t $year^{-1}$
1A	1A-1	15000	16000	0.004	0.12	0.14	0.40	0.39	0.42	83.30	33.71	13	14
	1A-2	15000	16000	0.004	0.10	0.14	0.40	0.33	0.35	74.70	30.23	10	11
	SUB-TOTAL									**158.00**	**63.94**	**23**	**25**
1B	1B-1	15000	16000	0.036	0.15	0.14	0.40	4.34	4.63	15.00	6.07	26	28
	1B-2	15000	16000	0.052	0.14	0.14	0.40	5.71	6.09	40.60	16.43	94	100
	1B-3	15000	16000	0.052	0.25	0.14	0.40	10.67	11.38	2.40	0.97	10	11
	1B-4	15000	16000	0.036	0.15	0.14	0.40	4.34	4.63	16.90	6.84	30	32
	1B-5	15000	16000	0.052	0.14	0.14	0.40	5.71	6.09	98.60	39.90	228	243
	1B-6	15000	16000	0.052	0.25	0.14	0.40	10.67	11.38	16.80	6.80	73	77
	1B-7	15000	16000	0.036	0.15	0.14	0.40	4.34	4.63	13.00	5.26	23	24
	1B-8	15000	16000	0.052	0.14	0.14	0.40	5.71	6.09	19.70	7.97	46	49
	1B-9	15000	16000	0.004	0.11	0.14	0.40	0.36	0.38	86.00	34.80	13	13
	1B-10	15000	16000	0.004	0.12	0.14	0.40	0.39	0.42	90.00	36.42	14	15
	SUB-TOTAL									**399.00**	**161.48**	**555.64**	**592.69**
1C	1C-1	15000	16000	0.004	0.13	0.14	0.40	0.42	0.45	89.00	36.02	15	16
	1C-2	15000	16000	0.004	0.15	0.14	0.40	0.49	0.52	66.00	26.71	13	14
	SUB-TOTAL									**155.00**	**62.73**	**28**	**30**

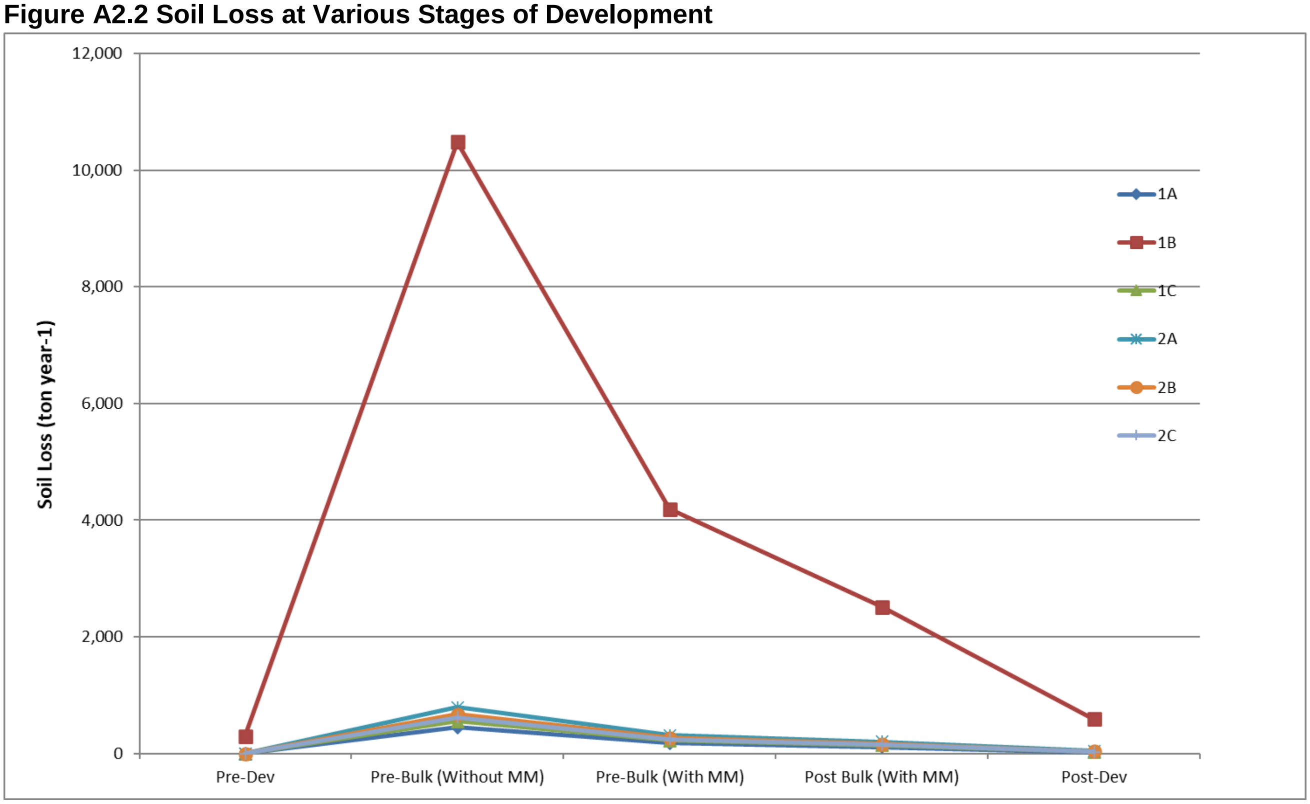
	PARCEL	Post Development Stage											
		R_{min}	R_{max}	K	LS	C	P	A_{min} t ha^{-1} year^{-1}	A_{max} t ha^{-1} year^{-1}	Area (ac)	Area (ha)	A_{min}-overall t year^{-1}	A_{max}-overall t year^{-1}
1D	1D-1	15000	16000	0.004	0.11	0.14	0.40	0.36	0.38	86.00	34.80	13	13
	1D-2	15000	16000	0.004	0.12	0.14	0.40	0.39	0.42	90.00	36.42	14	15
	SUB-TOTAL									**176.00**	**71.23**	**27**	**29**
2A	2A-1	15000	16000	0.004	0.15	0.14	0.40	0.49	0.52	132.00	53.42	26	28
	2A-2	15000	16000	0.004	0.10	0.14	0.40	0.33	0.35	109.00	44.11	14	15
	SUB-TOTAL									**241.00**	**97.53**	**41**	**43**
2B	2B-1	15000	16000	0.004	0.11	0.14	0.40	0.36	0.38	99.00	40.07	14	15
	2B-2	15000	16000	0.004	0.14	0.14	0.40	0.46	0.49	108.00	43.71	20	21
	SUB-TOTAL									**207.00**	**83.77**	**34**	**37**
2C	2C-1	15000	16000	0.004	0.11	0.14	0.40	0.36	0.38	101.00	40.87	15	16
	2C-2	15000	16000	0.004	0.13	0.14	0.40	0.42	0.45	98.00	39.66	17	18
	SUB-TOTAL									199.00	80.54	32	34

Table A2.11 Soil Loss of the Project Site for Various Development Stages

PARCEL	MAXIMUM SOIL LOSS (ton year^{-1})				
	Pre-Development	Pre-Bulk Grading (Without MM*)	Pre-Bulk Grading (With MM*)	Post Bulk Grading (With MM*)	Post Development
1A	0	424 - 452	170 - 181	106 - 113	23 - 25
1B	280 - 299	9,828 – 10,484	3,931- 4,193	2,359 - 2,517	556 - 593
1C	0	521 - 556	209 - 222	130 - 139	28 - 30
2A	0	745 - 795	298- 318	186 - 199	41 - 43
2B	0	632 - 674	253 - 269	158 - 168	34 - 37
2C	0	579 - 618	232 - 247	145 - 154	32 - 34

* MM – mitigating measures

Figure A2.2 Soil Loss at Various Stages of Development



3. MODIFIED UNIVERSAL SOIL LOSS EQUATION (MUSLE)

The **Modified Universal Soil Loss Equation (MUSLE)** was used in the estimation of sediment yield per storm event as shown below:

$$T = 89.6(V*Q_p)^{0.56}\ (K.L.S.C.P)$$

Where T = sediment yield per storm event (tonnes)
V = runoff volume (m^3)
Q = peak discharge (m^3/s)
K = soil erodibility factor [(tonnes/ha/($MJmmha^{-1}h^{-1}$)]
LS = topographic factor, combination of slope steepness (S) and slope length (L). Steepness is in % while length is in meters).
C = crop management factor, representing the ratio of soil loss under a given crop to that from the bare soil (dimensionless)
P = conservation practice factor, representing measures taken to what it would have been if such conservation measures have not been taken.

3.1 Determine Rainfall Intensity (i)

Design storm = 50 mm
Duration of storm = 60 min (assumption)
Intensity of design storm, i = 50 mm/hr

3.2 Determine Peak Flow (Q)

$$Q = \frac{C.\ i.\ A}{360}$$ (Equation 2.3, MSMA 2)

Where Q = Peak flow (m^3/s)
C = Runoff coefficient (Table 2.5, MSMA 2)
i = Average rainfall intensity (mm/hr)
A = Drainage area (ha)

3.3 Determine Runoff Coefficient (C)

Table A3.1 Runoff Coefficient (Table 2.5, MSMA 2)

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

Reference: *Guideline for Erosion and Sediment Control in Malaysia* (DID, 2010).

3.4 Calculation of Peak Flow (Q)

Table A3.2 Peak Flow (Table 2.3, MSMA 2)

Parcel	Q_{pre} Development (m^3/s)	Q_{cons} (m^3/s)	Q_{post} Development (m^3/s)
1A-1	1.405	2.341	4.448
1A-2	1.260	2.099	3.989
1B-1	0.253	0.422	0.801
1B-2	0.685	1.141	2.168
1B-3	0.040	0.067	0.128
1B-4	0.285	0.475	0.902
1B-5	1.663	2.771	5.265
1B-6	0.283	0.472	0.897
1B-7	0.219	0.365	0.694
1B-8	0.332	0.554	1.052
1B-9	1.450	2.417	4.592
1B-10	1.518	2.529	4.806
1C-1	1.501	2.501	4.752
1C-2	1.113	1.855	3.524
2A-1	1.703	2.839	5.393
2A-2	1.653	2.754	5.233
2B-1	1.669	2.782	5.286
2B-2	1.821	3.035	5.767
2C-1	2.226	3.710	7.049
2C-2	1.838	3.063	5.820

3.5 Calculation of Runoff Volume (V)

Table A3.3 Runoff Volume for Pre-development Stage

Parcel	Area (ha)	Land Use	HSG	CN	RO_{pre} mm	V_{pre} m^3
1A-1	33.71	Sea	N/A	N/A	0.00	0
1A-2	30.23	Sea	N/A	N/A	0.00	0
1B-1	6.07	Forest Good Ground Conditions	A	30	8.961	544
1B-2	16.43	Forest Good Ground Conditions	C	70	5.813	955
1B-3	0.97	Forest Good Ground Conditions	D	77	10.957	106
1B-4	6.84	Forest Good Ground Conditions	A	30	8.961	613
1B-5	39.90	Forest Good Ground Conditions	C	70	5.813	2,319
1B-6	6.80	Forest Good Ground Conditions	D	77	10.957	745
1B-7	5.26	Forest Good Ground Conditions	C	70	5.813	306
1B-8	7.97	Forest Good Ground Conditions	D	77	10.957	873
1B-9	34.80	Sea	N/A	N/A	0.00	0
1B-10	36.42	Sea	N/A	N/A	0.00	0
1C-1	36.02	Sea	N/A	N/A	0.00	0
1C-2	26.71	Sea	N/A	N/A	0.00	0
2A-1	40.87	Sea	N/A	N/A	0.00	0
2A-2	39.66	Sea	N/A	N/A	0.00	0
2B-1	40.07	Sea	N/A	N/A	0.00	0
2B-2	43.71	Sea	N/A	N/A	0.00	0
2C-1	53.42	Sea	N/A	N/A	0.00	0
2C-2	44.11	Sea	N/A	N/A	0.00	0

Table A3.4 Runoff Volume for Pre-bulk Grading Stage

Parcels	Area (ha)	Land Use	HSG	CN	RO_{pre} mm	V_{pre} m^3
1A-1	33.71	Bare Land/ Newly Reclaimed Land	A	71	6.433	2,169
1A-2	30.23	Bare Land/ Newly Reclaimed Land	A	71	6.433	1,945
1B-1	6.07	Bare Land/ Newly Graded Land	A	71	6.433	390
1B-2	16.43	Bare Land/ Newly Graded Land	A	71	6.433	1,057
1B-3	0.97	Bare Land/ Newly Graded Land	A	71	6.433	62
1B-4	6.84	Bare Land/ Newly Graded Land	A	71	6.433	440
1B-5	39.90	Bare Land/ Newly Graded Land	A	71	6.433	2,567

Parcels	Area (ha)	Land Use	HSG	CN	RO_{pre} mm	V_{pre} m^3
1B-6	6.80	Bare Land/ Newly Graded Land	A	71	6.433	437
1B-7	5.26	Bare Land/ Newly Graded Land	A	71	6.433	338
1B-8	7.97	Bare Land/ Newly Graded Land	A	71	6.433	513
1B-9	34.80	Bare Land/ Newly Reclaimed Land	A	71	6.433	2,239
1B-10	36.42	Bare Land/ Newly Reclaimed Land	A	71	6.433	2,343
1C-1	36.02	Bare Land/ Newly Reclaimed Land	A	71	6.433	2,317
1C-2	26.71	Bare Land/ Newly Reclaimed Land	A	71	6.433	1,718
2A-1	40.87	Bare Land/ Newly Reclaimed Land	A	71	6.433	2,629
2A-2	39.66	Bare Land/ Newly Reclaimed Land	A	71	6.433	2,551
2B-1	40.07	Bare Land/ Newly Reclaimed Land	A	71	6.433	2,578
2B-2	43.71	Bare Land/ Newly Reclaimed Land	A	71	6.433	2,812
2C-1	53.42	Bare Land/ Newly Reclaimed Land	A	71	6.433	3,437
2C-2	44.11	Bare Land/ Newly Reclaimed Land	A	71	6.433	2,838

Table A3.5 Runoff Volume for Post Bulk Grading Stage

Parcels	Area (ha)	Land Use	HSG	CN	RO_{pre} mm	V_{pre} m^3
1A-1	33.71	Bare Land	A	71	6.433	2,169
1A-2	30.23	Bare Land	A	71	6.433	1,945
1B-1	6.07	Bare Land	A	71	6.433	390
1B-2	16.43	Bare Land	A	71	6.433	1,057
1B-3	0.97	Bare Land	A	71	6.433	62
1B-4	6.84	Bare Land	A	71	6.433	440
1B-5	39.90	Bare Land	A	71	6.433	2,567
1B-6	6.80	Bare Land	A	71	6.433	437
1B-7	5.26	Bare Land	A	71	6.433	338
1B-8	7.97	Bare Land	A	71	6.433	513
1B-9	34.80	Bare Land	A	71	6.433	2,239
1B-10	36.42	Bare Land	A	71	6.433	2,343
1C-1	36.02	Bare Land	A	71	6.433	2,317
1C-2	26.71	Bare Land	A	71	6.433	1,718
2A-1	40.87	Bare Land	A	71	6.433	2,629
2A-2	39.66	Bare Land	A	71	6.433	2,551
2B-1	40.07	Bare Land	A	71	6.433	2,578
2B-2	43.71	Bare Land	A	71	6.433	2,812
2C-1	53.42	Bare Land	A	71	6.433	3,437
2C-2	44.11	Bare Land	A	71	6.433	2,838

Table A3.6 Runoff Volume for Post Development Stage

Parcels	Area (ha)	Land Use	HSG	CN	RO_{pre} mm	V_{pre} m^3
1A-1	33.71	Industry	C	94	34.719	11,704
1A-2	30.23	Industry	C	94	34.719	10,496
1B-1	6.07	Industry	C	94	34.719	2,107
1B-2	16.43	Industry	C	94	34.719	5,704
1B-3	0.97	Industry	C	94	34.719	337
1B-4	6.84	Industry	C	94	34.719	2,375
1B-5	39.90	Industry	C	94	34.719	13,853
1B-6	6.80	Industry	C	94	34.719	2,361
1B-7	5.26	Industry	C	94	34.719	1,826
1B-8	7.97	Industry	C	94	34.719	2,767
1B-9	34.80	Industry	C	94	34.719	12,082
1B-10	36.42	Industry	C	94	34.719	12,645
1C-1	36.02	Industry	C	94	34.719	12,506
1C-2	26.71	Industry	C	94	34.719	9,273
2A-1	40.87	Industry	C	94	34.719	14,190
2A-2	39.66	Industry	C	94	34.719	13,770
2B-1	40.07	Industry	C	94	34.719	13,912
2B-2	43.71	Industry	C	94	34.719	15,176
`2C-1	53.42	Industry	C	94	34.719	18,547
2C-2	44.11	Industry	C	94	34.719	15,315

3.6 Estimated Sediment Yield

Table A3.7 Sediment Yield of the Project Site during Pre-development Stage

Parcel	Pre Development Stage							Yield (tonnes/event)
	K	LS	C	P	V (m^3)	A (ha)	Q_p (m^3/s)	
1A-1	0.004	0.12	0.01	1.00	0	33.7	1.40	0.00
1A-2	0.004	0.10	0.01	1.00	0	30.2	1.26	0.00
SUB-TOTAL						**63.9**		**0.00**
1B-1	0.027	0.50	0.03	1.00	544	6.1	0.25	0.56
1B-2	0.035	0.28	0.03	1.00	955	16.4	0.68	0.99
1B-3	0.043	0.09	0.03	1.00	106	1.0	0.04	0.02
1B-4	0.017	0.20	0.03	1.00	613	6.8	0.28	0.17
1B-5	0.045	0.10	0.03	1.00	2,319	39.9	1.66	1.25
1B-6	0.052	0.25	0.03	1.00	745	6.8	0.28	0.70
1B-7	0.036	0.15	0.03	1.00	306	5.3	0.22	0.15
1B-8	0.052	0.14	0.03	1.00	873	8.0	0.33	0.45
1B-9	0.004	0.11	0.01	1	2,319	34.8	1.45	0.04
1B-10	0.004	0.12	0.01	1	745	36.4	1.52	0.02
SUB-TOTAL						**161.5**		**4.35**
1C-1	0.004	0.13	0.01	1.00	0	36.0	1.50	0.00
1C-2	0.004	0.15	0.01	1.00	0	26.7	1.11	0.00
SUB-TOTAL						**62.7**		**0.00**
2A-1	0.004	0.15	0.01	1.00	0	40.9	1.70	0.00
2A-2	0.004	0.10	0.01	1.00	0	39.7	1.65	0.00
SUB-TOTAL						**80.5**		**0.00**
2B-1	0.004	0.11	0.01	1.00	0	40.1	1.67	0.00
2B-2	0.004	0.14	0.01	1.00	0	43.7	1.82	0.00
SUB-TOTAL						**83.8**		**0.00**
2C-1	0.004	0.11	0.01	1.00	0	53.4	2.23	0.00
2C-2	0.004	0.13	0.01	1.00	0	44.1	1.84	0.00
SUB-TOTAL						**97.5**		**0.00**

Table A3.8 Sediment Yield of the Project Site during Pre-bulk Grading Stage without Mitigating Measures

Parcel	Pre-Bulk Grading Stage (Without Mitigating Measures)							Yield (tonnes/event)
	K	LS	C	P	V (m^3)	A (ha)	Q_p (m^3/s)	
1A-1	0.004	0.12	1.00	1.00	2,169	83.30	2.341	5.11
1A-2	0.004	0.10	1.00	1.00	1,945	74.70	2.099	3.77
SUB-TOTAL						**158.00**		**8.88**
1B-1	0.027	0.50	1.00	1.00	390	6.07	0.422	20.56
1B-2	0.035	0.28	1.00	1.00	1,057	16.43	1.141	46.66
1B-3	0.043	0.09	1.00	1.00	62	0.97	0.067	0.74
1B-4	0.017	0.20	1.00	1.00	440	6.84	0.475	6.21
1B-5	0.045	0.10	1.00	1.00	2,567	39.90	2.771	58.56
1B-6	0.052	0.25	1.00	1.00	437	6.80	0.472	23.16
1B-7	0.036	0.15	1.00	1.00	338	5.26	0.365	7.07
1B-8	0.052	0.14	1.00	1.00	513	7.97	0.554	14.81
1B-9	0.004	0.11	1.00	1.00	2,567	34.80	2.417	5.24
1B-10	0.004	0.12	1.00	1.00	437	36.42	2.529	2.18
SUB-TOTAL						**161.48**		**185.20**
1C-1	0.004	0.13	1.00	1.00	2,317	36.02	2.501	5.97
1C-2	0.004	0.15	1.00	1.00	1,718	26.71	1.855	4.92
SUB-TOTAL						**62.73**		**10.89**
2A-1	0.004	0.15	1.00	1.00	2,629	40.87	2.839	7.93
2A-2	0.004	0.10	1.00	1.00	2,551	39.66	2.754	5.11
SUB-TOTAL						**80.54**		**13.04**
2B-1	0.004	0.11	1.00	1.00	2,578	40.07	2.782	5.69
2B-2	0.004	0.14	1.00	1.00	2,812	43.71	3.035	7.98
SUB-TOTAL						**83.77**		**13.67**
2C-1	0.004	0.11	1.00	1.00	3,437	53.42	3.710	7.85
2C-2	0.004	0.13	1.00	1.00	2,838	44.11	3.063	7.49
SUB-TOTAL						**97.53**		**15.34**

Table A3.9 Sediment Yield of the Project Site during Pre-bulk Grading Stage with Mitigating Measures

Parcel	Pre-Bulk Grading Stage (With Mitigating Measures)							Yield (tonnes/event)
	K	LS	C	P	V (m^3)	A (ha)	Q_p (m^3/s)	
1A-1	0.004	0.12	0.80	0.50	2,169	83.30	2.341	2.05
1A-2	0.004	0.10	0.80	0.50	1,945	74.70	2.099	1.51
SUB-TOTAL						**71.23**		**4.17**
1B-1	0.027	0.50	0.80	0.50	390	6.07	0.422	8.22
1B-2	0.035	0.28	0.80	0.50	1,057	16.43	1.141	18.66
1B-3	0.043	0.09	0.80	0.50	62	0.97	0.067	0.30
1B-4	0.017	0.20	0.80	0.50	440	6.84	0.475	2.48
1B-5	0.045	0.10	0.80	0.50	2,567	39.90	2.771	23.43
1B-6	0.052	0.25	0.80	0.50	437	6.80	0.472	9.26
1B-7	0.036	0.15	0.80	0.50	338	5.26	0.365	2.83
1B-8	0.052	0.14	0.80	0.50	513	7.97	0.554	5.93
1B-9	0.004	0.11	0.80	0.50	2,567	34.80	2.417	2.10
1B-10	0.004	0.12	0.80	0.50	437	36.42	2.529	0.87
SUB-TOTAL						**161.48**		**74.08**
1C-1	0.004	0.13	0.80	0.50	2,317	36.02	2.501	2.39
1C-2	0.004	0.15	0.80	0.50	1,718	26.71	1.855	1.97
SUB-TOTAL						**62.73**		**4.36**
2A-1	0.004	0.15	0.80	0.50	2,629	40.87	2.839	3.17
2A-2	0.004	0.10	0.80	0.50	2,551	39.66	2.754	2.04
SUB-TOTAL						**80.54**		**5.22**
2B-1	0.004	0.11	0.80	0.50	2,578	40.07	2.782	2.28
2B-2	0.004	0.14	0.80	0.50	2,812	43.71	3.035	3.19
SUB-TOTAL						**83.77**		**5.47**
2C-1	0.004	0.11	0.80	0.50	3,437	53.42	3.710	3.14
2C-2	0.004	0.13	0.80	0.50	2,838	44.11	3.063	2.99
SUB-TOTAL						**97.53**		**6.13**

Table A3.10 Sediment Yield of the Project Site during Post Bulk Grading Stage with Mitigating Measures

Parcel	Post Bulk Grading Stage (With Mitigating Measures)							Yield (tonnes/event)
	K	LS	C	P	V (m^3)	A (ha)	Q_p (m^3/s)	
1A-1	0.004	0.12	0.50	0.50	11,704	33.71	2.341	3.29
1A-2	0.004	0.10	0.50	0.50	10,496	30.23	2.099	2.42
SUB-TOTAL						**63.94**		**5.71**
1B-1	0.017	0.20	0.50	0.50	2,107	6.07	0.422	3.49
1B-2	0.045	0.10	0.50	0.50	5,704	16.43	1.141	13.93
1B-3	0.052	0.25	0.50	0.50	337	0.97	0.067	1.68
1B-4	0.036	0.15	0.50	0.50	2,375	6.84	0.475	6.09
1B-5	0.052	0.14	0.50	0.50	13,853	39.90	2.771	57.81
1B-6	0.052	0.25	0.50	0.50	2,361	6.80	0.472	14.88
1B-7	0.036	0.15	0.50	0.50	1,826	5.26	0.365	4.54
1B-8	0.052	0.14	0.50	0.50	2,767	7.97	0.554	9.52
1B-9	0.004	0.11	0.50	0.50	13,853	34.80	2.417	3.37
1B-10	0.004	0.12	0.50	0.50	2,361	36.42	2.529	1.40
SUB-TOTAL						**161.48**		**116.71**
1C-1	0.004	0.13	0.50	0.50	12,506	36.02	2.501	3.83
1C-2	0.004	0.15	0.50	0.50	9,273	26.71	1.855	3.16
SUB-TOTAL						**62.73**		**7.00**
2A-1	0.004	0.15	0.50	0.50	14,190	40.87	2.839	5.10
2A-2	0.004	0.10	0.50	0.50	13,770	39.66	2.754	3.28
SUB-TOTAL						**80.54**		**8.38**
2B-1	0.004	0.11	0.50	0.50	13,912	40.07	2.782	3.65
2B-2	0.004	0.14	0.50	0.50	15,176	43.71	3.035	5.13
SUB-TOTAL						**83.77**		**8.78**
2C-1	0.004	0.11	0.50	0.50	18,547	53.42	3.710	5.04
2C-2	0.004	0.13	0.50	0.50	15,315	44.11	3.063	4.81
SUB-TOTAL						**97.53**		**9.85**

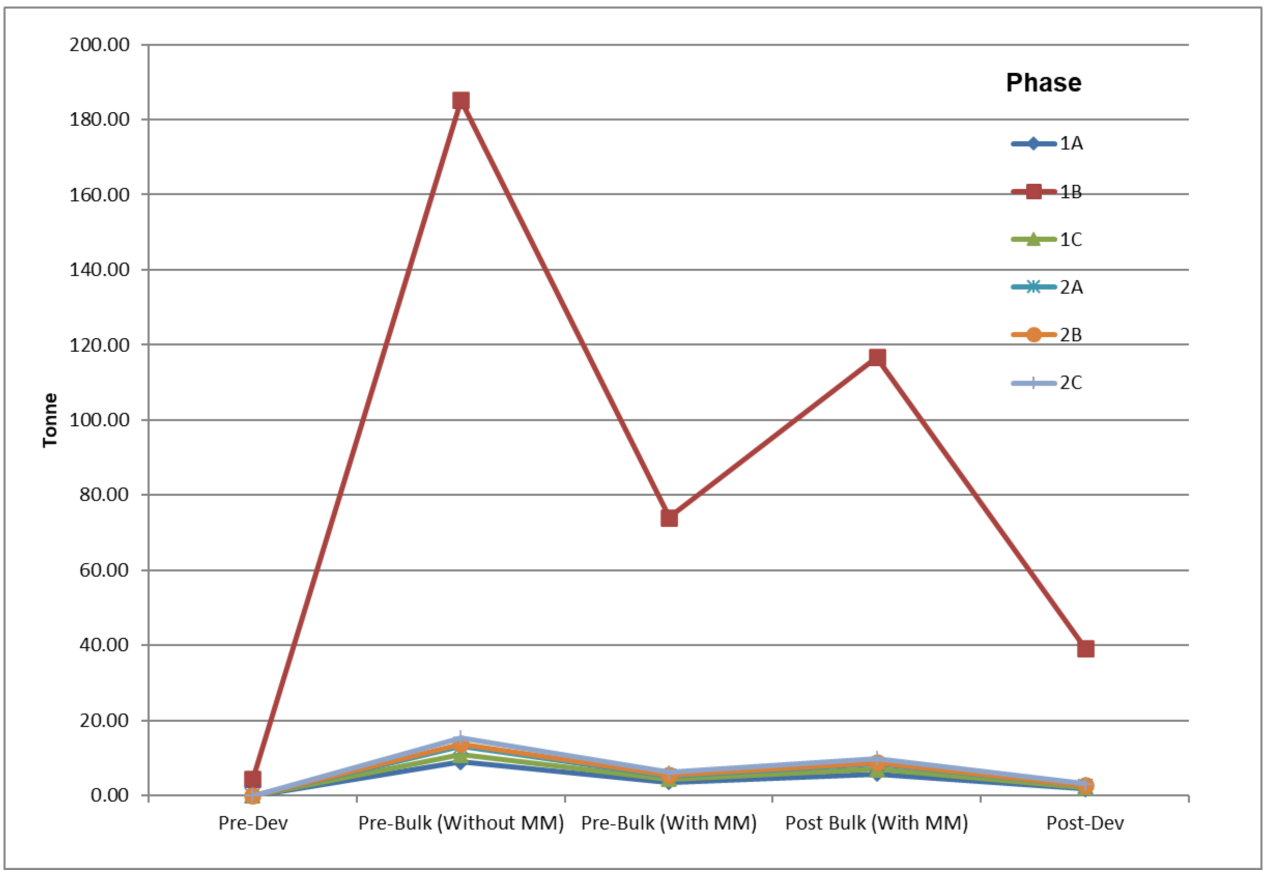
Table A3.11 Sediment Yield of the Project Site during Post Development Stage (Fully Operational)

Parcel	Post Development Stage							Yield (tonnes/event)
	K	LS	C	P	V (m^3)	A (ha)	Q_p (m^3/s)	
1A-1	0.004	0.12	0.14	0.40	11,704	33.71	4.448	1.02
1A-2	0.004	0.10	0.14	0.40	10,496	30.23	3.989	0.76
SUB-TOTAL						**63.94**		**1.78**
1B-1	0.036	0.15	0.14	0.40	2,107	6.07	0.801	1.66
1B-2	0.052	0.14	0.14	0.40	5,704	16.43	2.168	6.68
1B-3	0.052	0.25	0.14	0.40	337	0.97	0.128	0.52
1B-4	0.036	0.15	0.14	0.40	2,375	6.84	0.902	1.90
1B-5	0.052	0.14	0.14	0.40	13,853	39.90	5.265	18.03
1B-6	0.052	0.25	0.14	0.40	2,361	6.80	0.897	4.64
1B-7	0.036	0.15	0.14	0.40	1,826	5.26	0.694	1.42
1B-8	0.052	0.14	0.14	0.40	2,767	7.97	1.052	2.97
1B-9	0.004	0.11	0.14	0.40	13,853	34.80	4.592	1.05
1B-10	0.004	0.12	0.14	0.40	2,361	36.42	4.806	0.44
SUB-TOTAL						**161.48**		**39.31**
1C-1	0.004	0.13	0.14	0.40	12,506	36.02	4.752	1.20
1C-2	0.004	0.15	0.14	0.40	9,273	26.71	3.524	0.99
SUB-TOTAL						**62.73**		**2.18**
2A-1	0.004	0.15	0.14	0.40	14,190	40.87	5.393	1.59
2A-2	0.004	0.10	0.14	0.40	13,770	39.66	5.233	1.02
SUB-TOTAL						**80.54**		**2.61**
2B-1	0.004	0.11	0.14	0.40	13,912	40.07	5.286	1.14
2B-2	0.004	0.14	0.14	0.40	15,176	43.71	5.767	1.60
SUB-TOTAL						**83.77**		**2.74**
2C-1	0.004	0.11	0.14	0.40	18,547	53.42	7.049	1.57
2C-2	0.004	0.13	0.14	0.40	15,315	44.11	5.820	1.50
SUB-TOTAL						**97.53**		**3.07**

Table A3.12 Sediment Yield of the Project Site for Various Development Stages

PARCEL	SEDIMENT YIELD (ton event^{-1})				
	Pre-Dev	Pre-Bulk (Without MM)	Pre-Bulk (With MM)	Post Bulk (With MM)	Post-Dev
1A	0.00	8.88	3.55	5.71	1.78
1B	4.35	185.20	74.08	116.71	39.31
1C	0.00	10.89	4.36	7.00	2.18
2A	0.00	13.04	5.22	8.38	2.61
2B	0.00	13.67	5.47	8.78	2.74
2C	0.00	15.34	6.13	9.85	3.07

Figure A3.1 Sediment Yield at Various Stages of Development



ANNEX B

TOPOGRAPHIC ANALYSIS USING SURFER 17 SOFTWARE

The Reliability, Accuracy and End Result of the Model Using Surfer 17.1.288

Surfer is a full-function 2D and 3-D visualization, contouring and surface modelling package that runs under Microsoft Windows. Surfer is used extensively by geologists, geophysicists, hydrologists, archaeologists, oceanographers, biologists, consultants, engineers and many others across the globe (Golden Surfer, 2020). Surfer is widely used in research such as terrain modelling (Litwin et al., 2013), bathymetric modelling (Pye & Simon, 2015), groundwater modelling (Kumari et al., 2013), watershed (Treloges & Kaen, 2002) and 3-D surface mapping (Koehler, 2004) and water quality model (Anh at al., 2014; Rajesh at al., 2015).

The gridding methods in Surfer define the way in which the XYZ data are interpolated when producing a grid file. All gridding methods require at least three non-collinear data points. The larger the density of grid nodes in the grid, the smoother the map that is created from the grid.

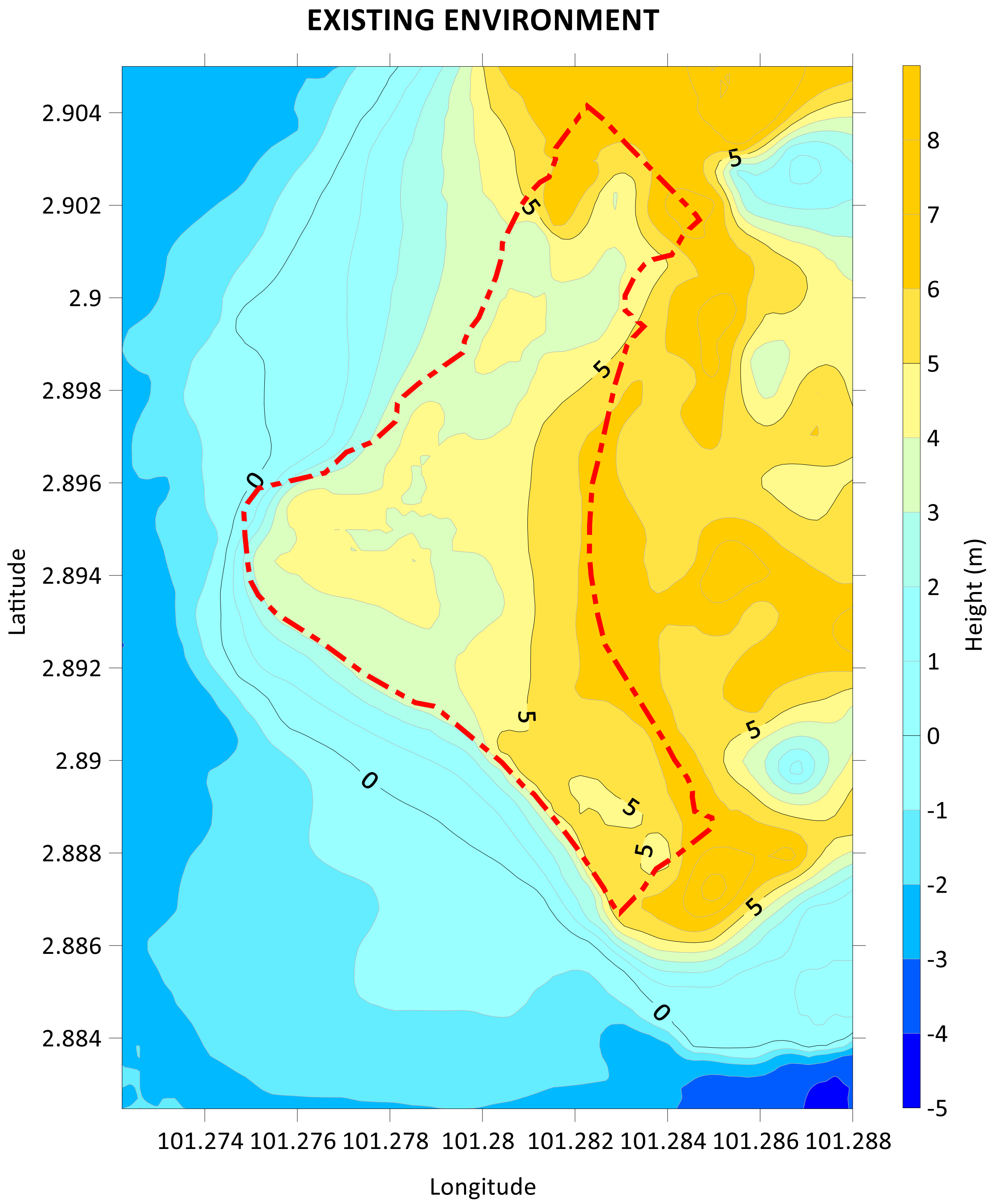
Contour lines and XY lines defining a wireframe are a series of straight-line segments. More X and Y grid nodes in a grid file result in shorter line segments for contours or wireframe maps. This provides a smoother appearance to contour lines on a contour map or smoother appearing wireframe. Under most circumstances, the recommended gridding method is Kriging /polynomial with the default linear variogram. This is the selected default gridding method because it gives good results for most XYZ data sets. The accuracy shown through Surfer interpolation between the interpolated value and observed value indicated not much in variation with coefficient of determination of r2=0.9981 (Yesuf et al., 2012).

Surfer is windows based environmental software representing the highest quality in contour mapping and surface plotting. The gridding methods in Surfer 17 allows to produce accurate contour, surface, wireframe, vector, image, and shaded relief maps from your XYZ data. The data can be randomly dispersed over the map area and Surfer 17's gridding will interpolate the data onto a grid.

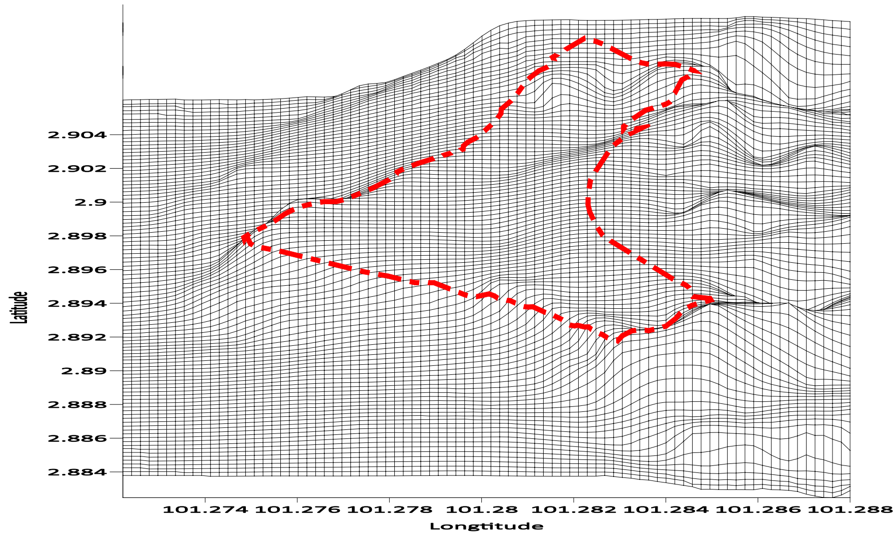
In the analysis, the data from the surveyor bathymetric has been extracted and included exactly into the Surfer 17 based on the GPS coordinate location (XY) and height (Z) value data. The results of the data interpolated had been cross-checked by superimposing the produced map with the actual surveyor bathymetric data.

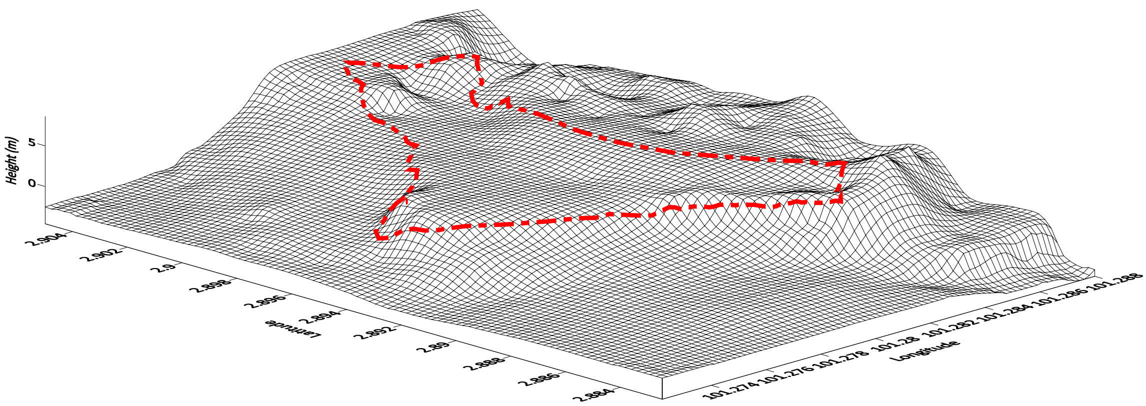
Surfer 17 Output

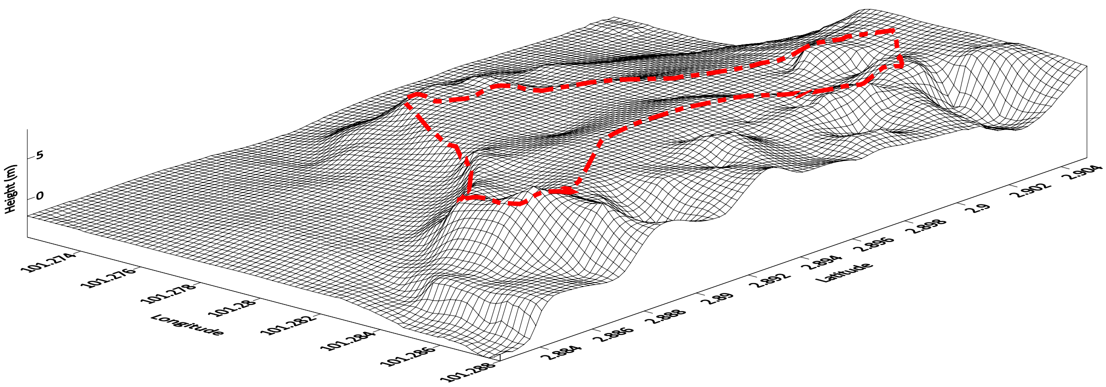
Topography analysis – Existing Environment



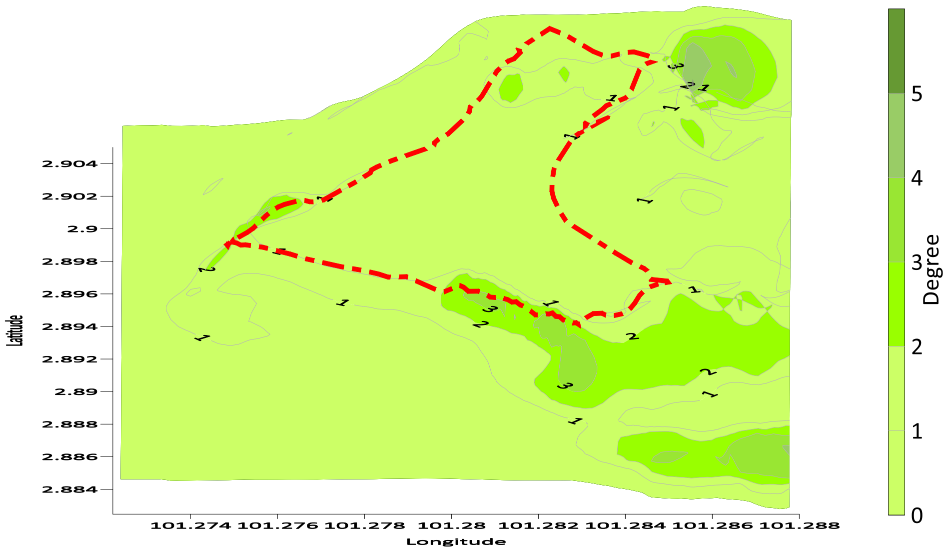
Topography analysis – Existing Environment

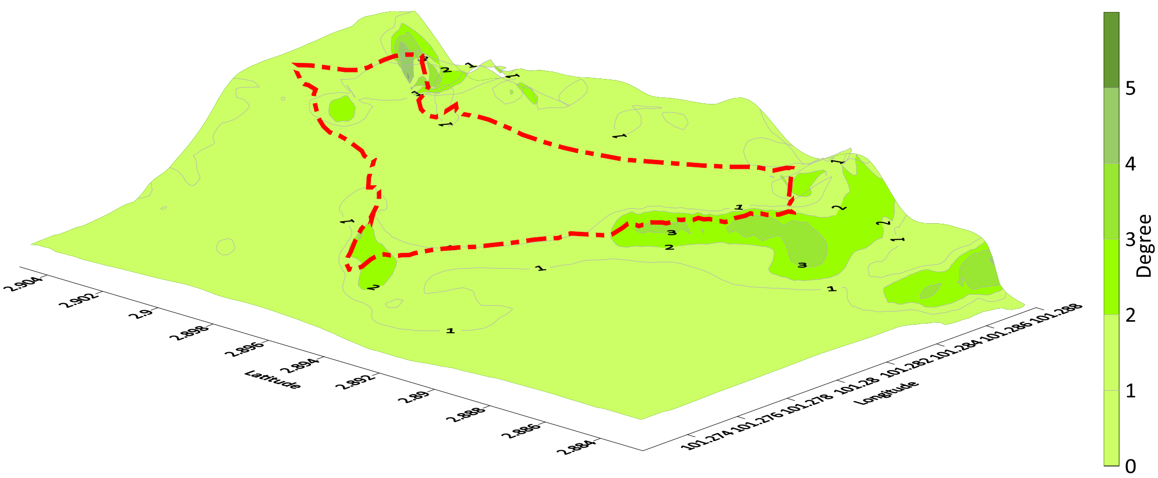


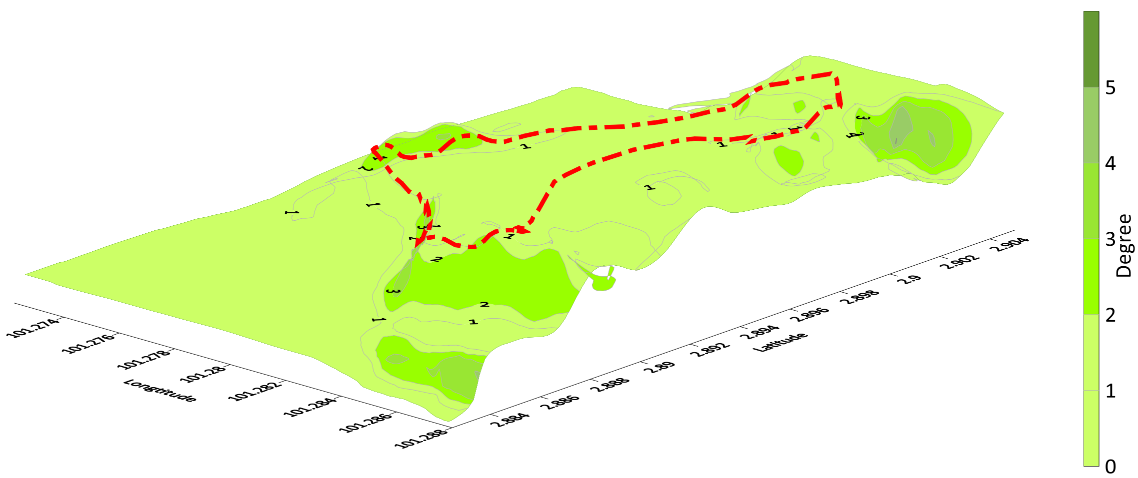




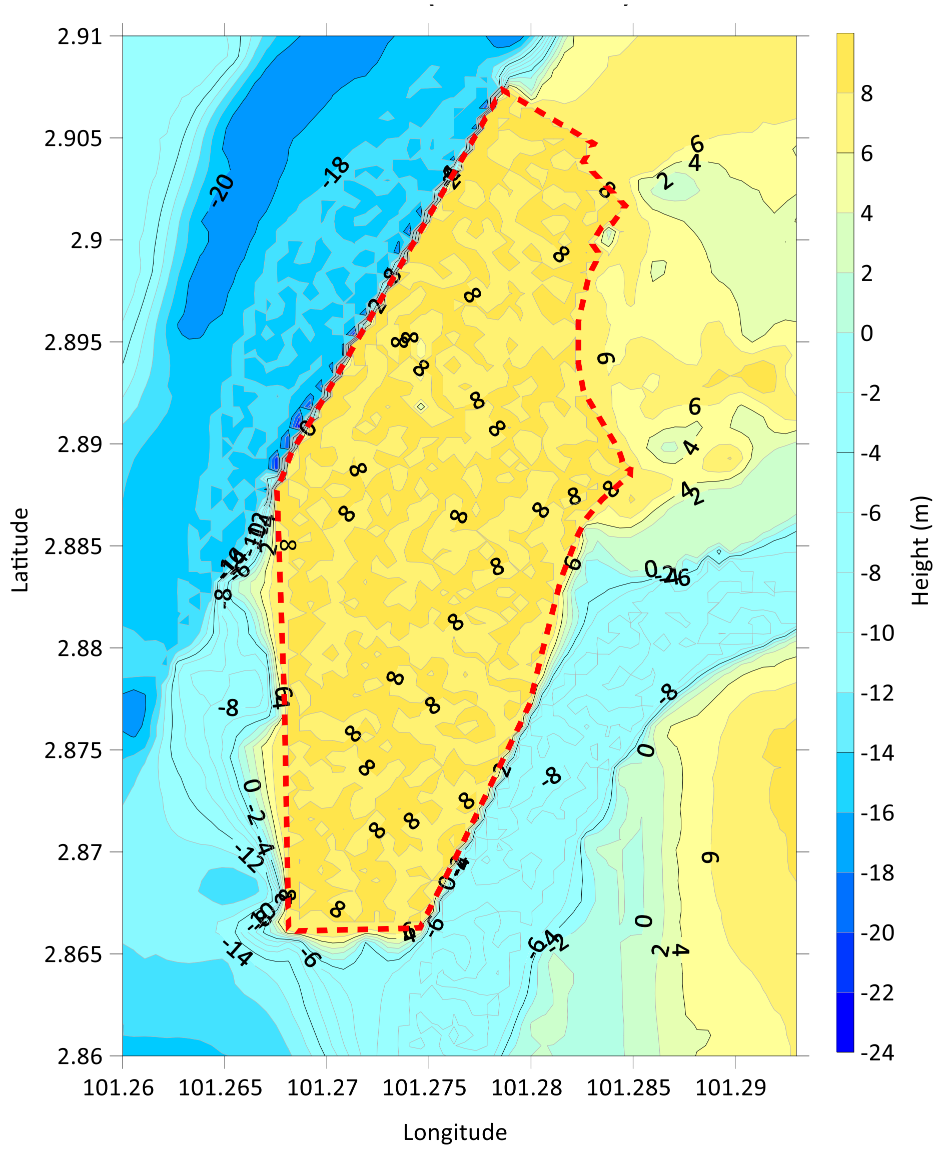
Topography analysis – Existing Environment – Slope

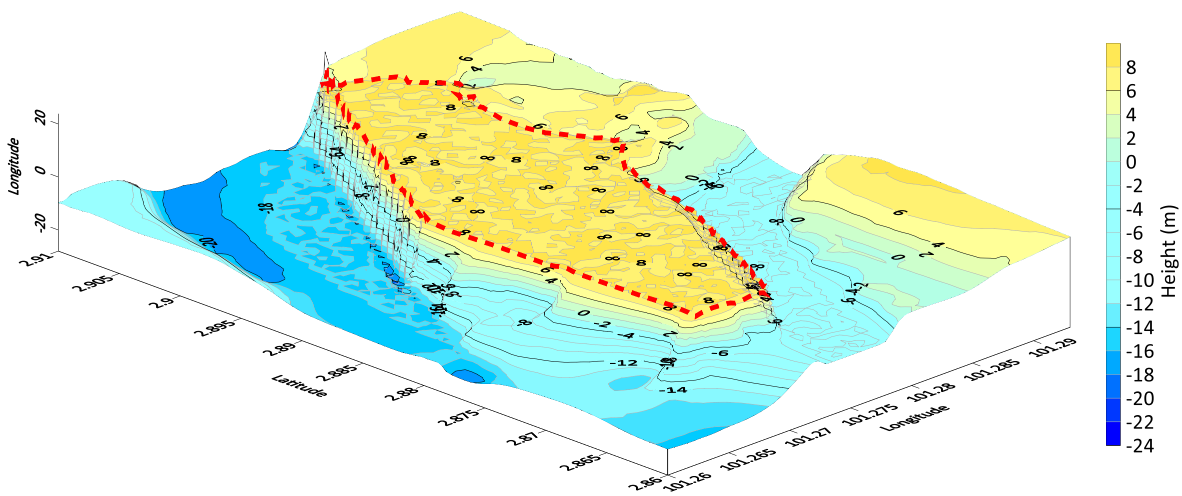




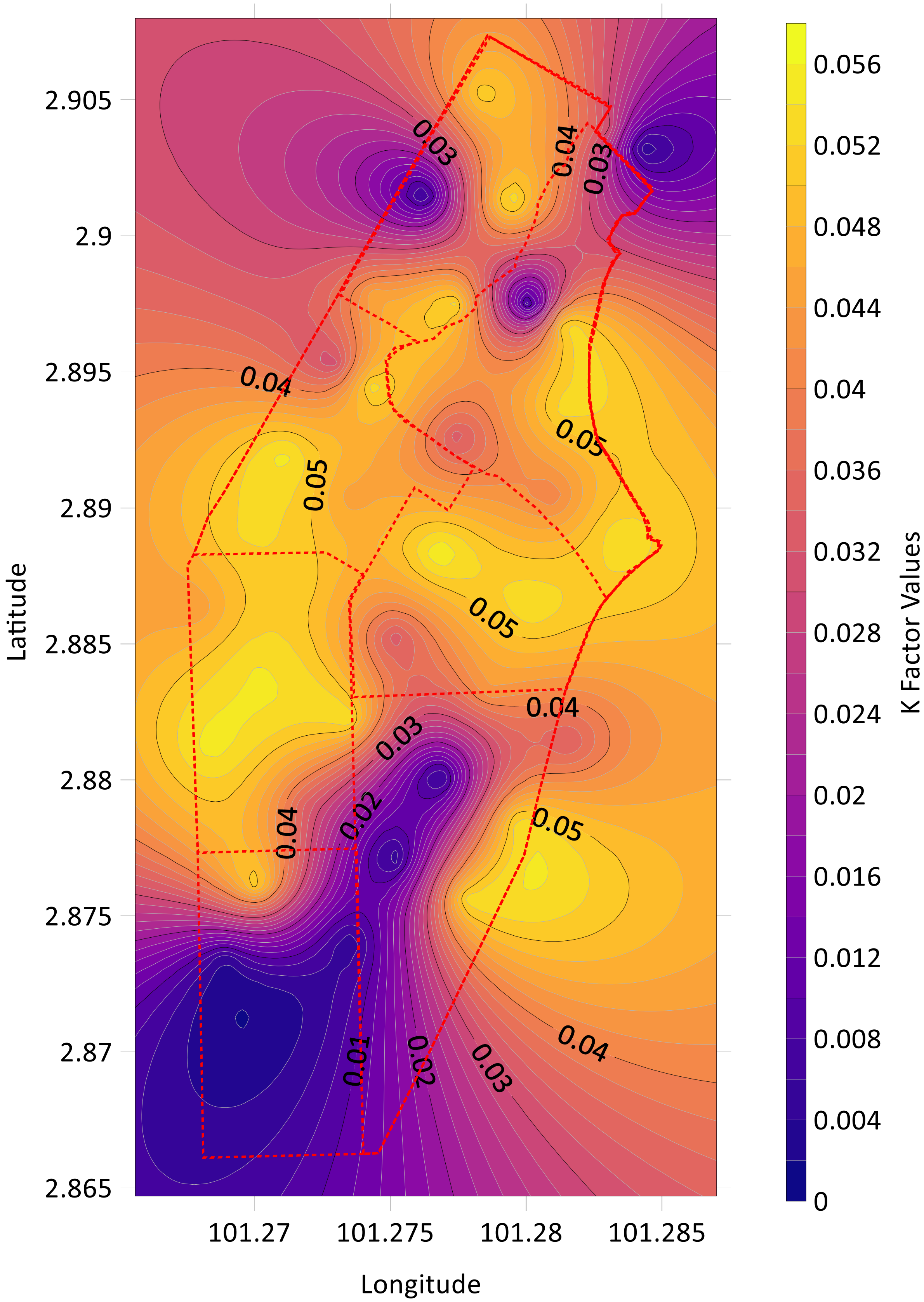


Topography analysis – Project Completion



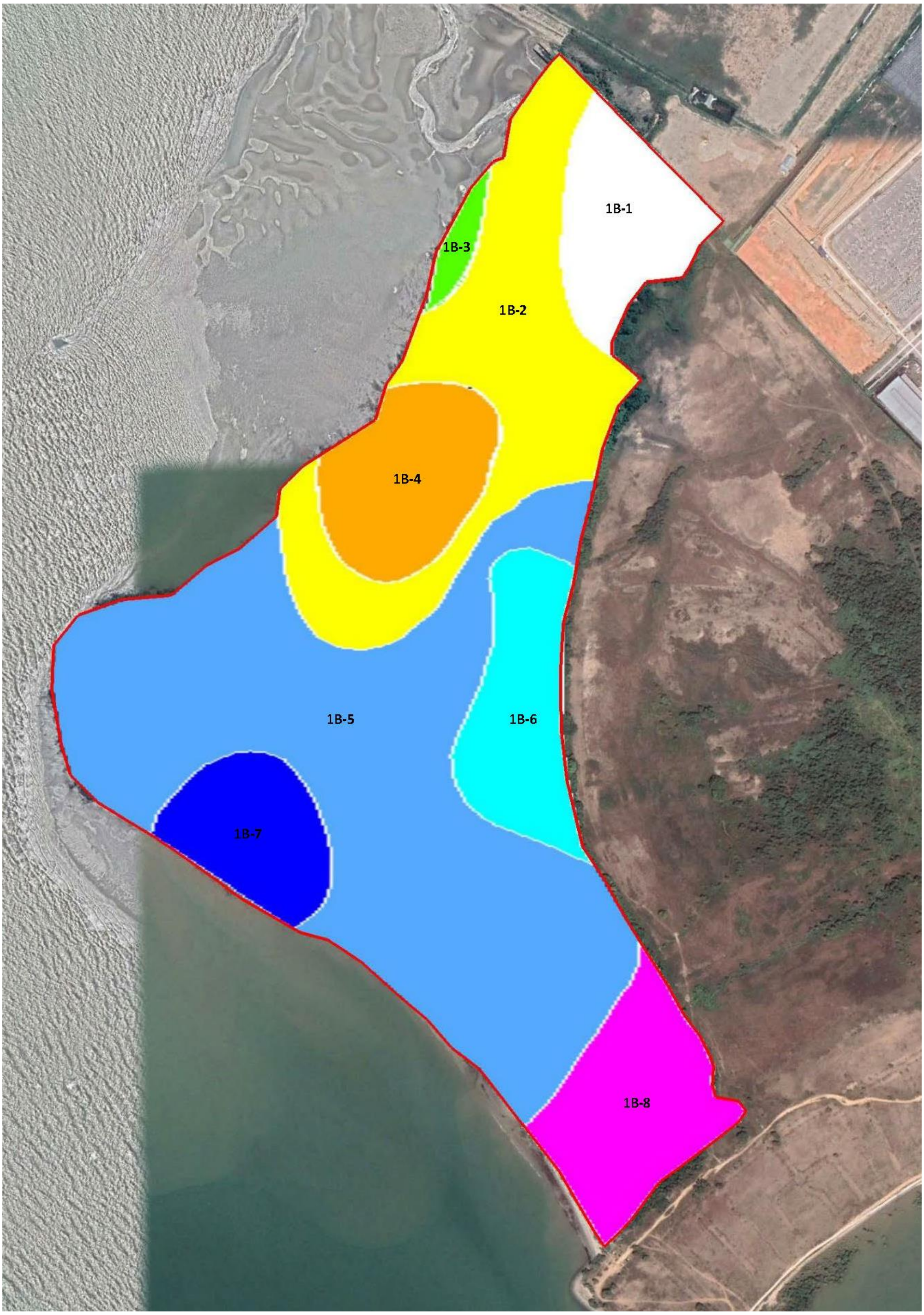


Existing K Factor Mapping – Result based on Soil Investigation Report

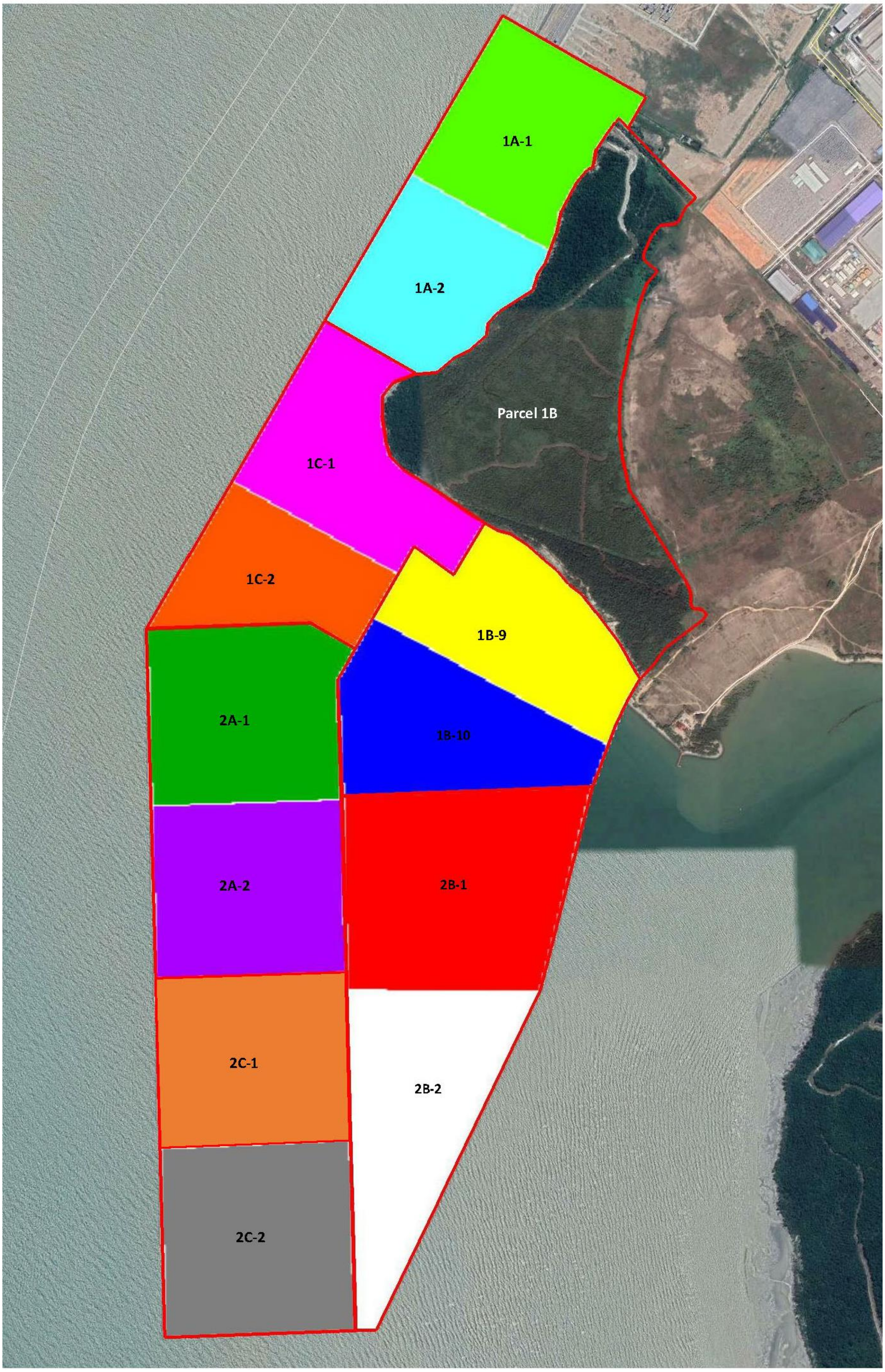


USLE & MULSE Input

Existing K Factor Grouping – For USLE and MULSE calculation



Catchment Divide - For USLE and MULSE calculation


1A-1
1A-2
Parcel 1B
1C-1
1C-2
1B-9
2A-1
1B-10
2A-2
2B-1
2C-1
2B-2
2C-2

ANNEX C
WET & DRY SEDIMENT BASIN SIZING

WET Sediment Basin

SB1

(To MASMA II Guideline)

MSMA 2 ref.

$$t_o = \frac{107.n^{*}.L_o^{1/3}}{S_o^{1/5}}$$

Determine Time of Concentration

Eqn. 14.1 Overlandsheet flow time, t_o = 107 . n . $L^{1/3}$ / √S1/5

Table 14.2 type of surface: Clay

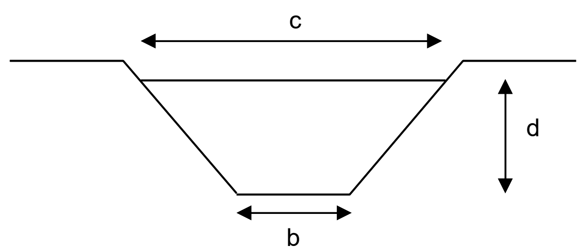
n = 0.03

S = 1 %

L_o = 798 m

t_o = 29.8 min

Drain flow



b =	0.250	m
c =	0.600	m
d =	0.300	m
Full flow section, A =	0.128	m^2
Wetted perimeter, P =	0.945	m
Hydralic radius, R =	0.135	m
Gradient, S =	1 in 25	
% S =	4	
S_d =	0.04	
Manning's n =	0.06	
L_d =	1193	m
$V_d = R^{2/3}$. √S ÷ n =	0.877	m/s
$t_d = L_d / V_d$ =	22.7	min

$Q_d = V_d\, A$ = 0.112 m^3/s

Time of concentration, $\mathbf{t_c} = t_o + t_d$ = 52.4 min

Adopt $\mathbf{t_c}$ = **52.4** min

<u>SEDIMENT BASIN</u>

Sizing of Sediment Basin

Table 12.16	Predominant soil type :	D			(area involving earthworks)
	Area of site :	24.92866	ha		
Table 12.18	Time of concentration	52.44367	minutes		
	Required surface area :	290	m^2/ha =>	**7229.3**	m^2
	Required total volume :	435	m^3/ha =>	**10844.0**	m^3

Sediment Settling Zone

	Required settling zone volume, V_1 =	5422.0 m^3		
	Settling zone depth, y_1 =	**0.76** m		
	Try a settling zone average width, W_1 =	**50.0** m		
	Required settling zone average length, L_1 =	142.7 m		
	say, L_1	**150.0** m		
	Average surface area =	7500.0 m^2		*OK*
Table 12.17	L_1 / y_1 =	197.4	< 200,	*OK*
	L_1 / W_1 =	3.0	> 2,	*OK*

Sediment Storage Zone

Required storage zone volume, V_2 = 5422.0 m^3

Side Slope, Z = 2.0 (H) : 1 (V) Max H =2

Dimension at top of the sediment storage zone,

$W_2 = W_1 - y_1 Z$ 48.48 m

$L_2 = L_1 - y_1 Z$ 148.48 m

Storage zone depth, y_2 = 0.8 m >0.3, *OK*

V2 = 5508.6 m^3 *OK*

<u>Sediment Basin Dimension :</u>

Sediment Storage Zone

$W_B = W_1 - 2 \times Z \times ((y_1/2) + y_2)$ 45.28

$L_B = L_1 - 2 \times Z \times ((y_1/2) + y_2)$ 145.28

Average Section = $W_B \times L_B$ **6578.3** m^2

SB1 **<u>Summary of Sediment Basin Dimension</u>**

Top Water Basin Length	L_1	=	150.00
Top Water Basin Width	W_1	=	50.00
Settling Zone Basin Length	L_2	=	148.48
Settling Zone Basin Width	W_2	=	48.48
Bottom Storage Zone Basin Length	L_B	=	145.28
Bottom Storage Zone Basin Width	W_B	=	45.28
Settling Zone Depth	y_1	=	0.76
Storage Zone Depth	y_2	=	0.80
Area of catchment (ha)		=	24.93
Volume of Sediment Basin (m3)		=	10930.57

WET Sediment Basin

SB2

(To MASMA II Guideline)

MSMA 2 ref.

Determine Time of Concentration

$$t_o = \frac{107 . n^* . L_o^{1/3}}{S_o^{1/5}}$$

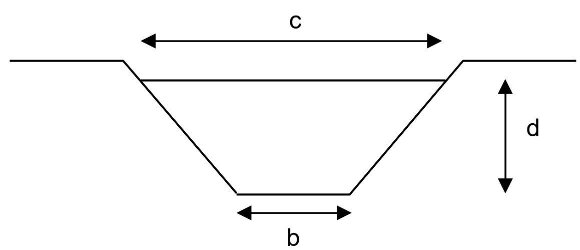
Eqn. 14.1 Overlandsheet flow time, t_o = 107 . n . $L^{1/3}$ / √S1/5

Table 14.2 type of surface: Clay

n =	0.03	
S =	1	%
L_o =	719	m
t_o =	28.8	min

Drain flow

b =	0.250	m
c =	0.600	m
d =	0.300	m
Full flow section, A =	0.128	m^2
Wetted perimeter, P =	0.945	m
Hydralic radius, R =	0.135	m
Gradient, S =	1 in 25	
% S =	4	
S_d =	0.04	
Manning's n =	0.06	
L_d =	667	m
$V_d = R^{2/3}$. √S ÷ n =	0.877	m/s
$t_d = L_d / V_d$ =	12.7	min



$Q_d = V_d\ A$ = 0.112 m^3/s

Time of concentration, $\mathbf{t_c} = t_o + t_d$ = 41.4 min

Adopt $\mathbf{t_c}$ = **41.4** min

<u>SEDIMENT BASIN</u>

Sizing of Sediment Basin

Table 12.16	Predominant soil type :	D		(area involving earthworks)	
	Area of site :	36.58361	ha		
Table 12.18	Time of concentration	41.4317	minutes		
	Required surface area :	290	m^2/ha =>	**10609.2**	m^2
	Required total volume :	435	m^3/ha =>	**15913.9**	m^3

Sediment Settling Zone

	Required settling zone volume, V_1 =	7956.9	m^3		
	Settling zone depth, y_1 =	**0.91**	m		
	Try a settling zone average width, W_1 =	**60.0**	m		
	Required settling zone average length, L_1 =	145.7	m		
	say, L_1	**180.0**	m		
	Average surface area =	10800.0	m^2		*OK*
Table 12.17	L_1 / y_1 =	197.8		< 200,	*OK*
	L_1 / W_1 =	3.0		> 2,	*OK*

Sediment Storage Zone

Required storage zone volume, V_2 =	7956.9	m^3
Side Slope, Z =	2.0	(H) : 1 (V) Max H =2
Dimension at top of the sediment storage zone,		
$W_2 = W_1 - y_1 Z$	58.18	m
$L_2 = L_1 - y_1 Z$	178.18	m
Storage zone depth, y_2 =	0.8	m >0.3, *OK*
V2 =	7992.7	m^3 *OK*

<u>Sediment Basin Dimension :</u>

Sediment Storage Zone

$W_B = W_1 - 2 \times Z \times ((y_1/2) + y_2)$	54.98
$L_B = L_1 - 2 \times Z \times ((y_1/2) + y_2)$	174.98

Average Section = $W_B \times L_B$ **9620.4** m^2

SB2 **<u>Summary of Sediment Basin Dimension</u>**

Top Water Basin Length	L_1	=	180.00
Top Water Basin Width	W_1	=	60.00
Settling Zone Basin Length	L_2	=	178.18
Settling Zone Basin Width	W_2	=	58.18
Bottom Storage Zone Basin Length	L_B	=	174.98
Bottom Storage Zone Basin Width	W_B	=	54.98
Settling Zone Depth	y_1	=	0.91
Storage Zone Depth	y_2	=	0.80
Area of catchment (ha)		=	36.58
Volume of Sediment Basin (m3)		=	15949.65

WET Sediment Basin

SB3

(To MASMA II Guideline)

MSMA 2 ref.

Determine Time of Concentration

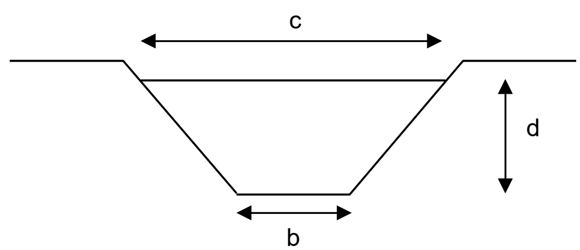
$$t_o = \frac{107.n^* .L_o^{1/3}}{S_o^{1/5}}$$

Eqn. 14.1 Overlandsheet flow time, t_o = 107 . n . $L^{1/3}$ / √S1/5

Table 14.2 type of surface: Clay

n =	0.03	
S =	1	%
L_o =	666	m
t_o =	28.0	min

Drain flow



b =	0.250	m
c =	0.600	m
d =	0.300	m
Full flow section, A =	0.128	m^2
Wetted perimeter, P =	0.945	m
Hydralic radius, R =	0.135	m
Gradient, S =	1 in 25	
% S =	4	
S_d =	0.04	
Manning's n =	0.06	
L_d =	887	m
$V_d = R^{2/3}$. √S ÷ n =	0.877	m/s
$t_d = L_d / V_d$ =	16.9	min

$Q_d = V_d A$ = 0.112 m^3/s

Time of concentration, $\mathbf{t_c} = t_o + t_d$ = 44.9 min

Adopt $\mathbf{t_c}$ = **44.9** min

SEDIMENT BASIN

Sizing of Sediment Basin

Table 12.16	Predominant soil type :	D		(area involving earthworks)	
	Area of site :	28.73271	ha		
Table 12.18	Time of concentration	44.88746	minutes		
	Required surface area :	290	m^2/ha =>	**8332.5**	m^2
	Required total volume :	435	m^3/ha =>	**12498.7**	m^3

Sediment Settling Zone

	Required settling zone volume, V_1 =	6249.4	m^3		
	Settling zone depth, y_1 =	**0.78**	m		
	Try a settling zone average width, W_1 =	**55.0**	m		
	Required settling zone average length, L_1 =	145.7	m		
	say, L_1	**155.0**	m		
	Average surface area =	8525.0	m^2		*OK*
Table 12.17	L_1 / y_1 =	198.7		< 200,	*OK*
	L_1 / W_1 =	2.8		> 2,	*OK*

Sediment Storage Zone

Required storage zone volume, V_2 =	6249.4	m^3
Side Slope, Z =	2.0	(H) : 1 (V) Max H =2
Dimension at top of the sediment storage zone,		
$W_2 = W_1 - y_1 Z$	53.44	m
$L_2 = L_1 - y_1 Z$	153.44	m
Storage zone depth, y_2 =	0.8	m >0.3, *OK*
V2 =	6297.1	m^3 *OK*

<u>Sediment Basin Dimension :</u>

Sediment Storage Zone

$W_B = W_1 - 2 \times Z \times ((y_1 /2)+ y_2)$ 50.24

$L_B = L_1 - 2 \times Z \times ((y_1 /2)+ y_2)$ 150.24

Average Section = $W_B \times L_B$ **7548.1** m^2

SB3 **<u>Summary of Sediment Basin Dimension</u>**

Top Water Basin Length	L_1	=	155.00
Top Water Basin Width	W_1	=	55.00
Settling Zone Basin Length	L_2	=	153.44
Settling Zone Basin Width	W_2	=	53.44
Bottom Storage Zone Basin Length	L_B	=	150.24
Bottom Storage Zone Basin Width	W_B	=	50.24
Settling Zone Depth	y_1	=	0.78
Storage Zone Depth	y_2	=	0.80
Area of catchment (ha)		=	28.73
Volume of Sediment Basin (m3)		=	12546.47

DRY Sediment Basin

SB4

(To MASMA II Guideline)

MSMA 2 ref.

Determine Time of Concentration

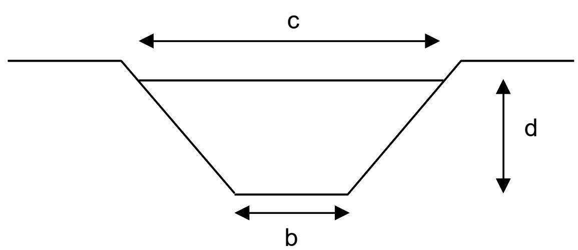
$$t_o = \frac{107.n^{*}.L_o^{1/3}}{S_o^{1/5}}$$

Eqn. 14.1 Overlandsheet flow time, t_o = 107 . n . $L^{1/3}$ / √S1/5

Table 14.2 type of surface: Bare sand with mixture of earth

n =	0.06	
S =	1	%
L_o =	1165	m
t_o =	67.6	min

Drain flow



b =	0.250	m
c =	0.600	m
d =	0.300	m
Full flow section, A =	0.128	m^2
Wetted perimeter, P =	0.945	m
Hydralic radius, R =	0.135	m
Gradient, S =	1 in 25	
% S =	4	
S_d =	0.04	
Manning's n =	0.06	
L_d =	1803	m
$V_d = R^{2/3}$. √S ÷ n =	0.877	m/s
t_d = L_d / V_d =	34.3	min

$Q_d = V_d\ A$ = 0.112 m^3/s

Time of concentration, $\mathbf{t_c}$ = $t_o + t_d$ = 101.8 min

Adopt $\mathbf{t_c}$ = **60.0** min

SEDIMENT BASIN

Sizing of Sediment Basin

Table 12.16	Predominant soil type :	A		(area involving earthworks)
	Area of site :	84.09375	ha	
Table 12.18	Time of concentration	60	minutes	
	Required surface area :	121	m^2/ha =>	**10175.3** m^2
	Required total volume :	145	m^3/ha =>	**12193.6** m^3

Sediment Settling Zone

	Required settling zone volume, V_1 =	6096.8 m^3		
	Settling zone depth, y_1 =	**0.86** m		
	Try a settling zone average width, W_1 =	**60.0** m		
	Required settling zone average length, L_1 =	118.2 m		
	say, L_1	**170.0** m		
	Average surface area =	10200.0 m^2		*OK*
Table 12.17	L_1 / y_1 =	197.7	< 200,	*OK*
	L_1 / W_1 =	2.8	> 2,	*OK*

Sediment Storage Zone

Required storage zone volume, V_2 =	6096.8	m^3
Side Slope, Z =	2.0	(H) : 1 (V) Max H =2
Dimension at top of the sediment storage zone,		
$W_2 = W_1 - y_1 Z$	58.28	m
$L_2 = L_1 - y_1 Z$	168.28	m
Storage zone depth, y_2 =	0.65	m >0.3, *OK*
V2 =	6184.4	m^3 *OK*

Sediment Basin Dimension :

Sediment Storage Zone

$W_B = W_1 - 2 \times Z \times ((y_1 /2)+ y_2)$	55.68
$L_B = L_1 - 2 \times Z \times ((y_1 /2)+ y_2)$	165.68

Average Section = $W_B \times L_B$ **9225.1** m^2

SB4 **Summary of Sediment Basin Dimension**

Top Water Basin Length	L_1	=	170.00
Top Water Basin Width	W_1	=	60.00
Settling Zone Basin Length	L_2	=	168.28
Settling Zone Basin Width	W_2	=	58.28
Bottom Storage Zone Basin Length	L_B	=	165.68
Bottom Storage Zone Basin Width	W_B	=	55.68
Settling Zone Depth	y_1	=	0.86
Storage Zone Depth	y_2	=	0.65
Area of catchment (ha)		=	84.09
Volume of Sediment Basin (m3)		=	12281.24

DRY Sediment Basin

SB5

(To MASMA II Guideline)

MSMA 2 ref.

Determine Time of Concentration

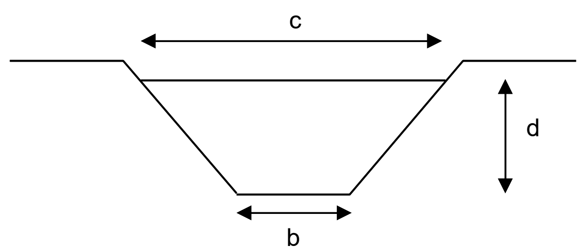
$$t_o = \frac{107.n^{*}.L_o^{1/3}}{S_o^{1/5}}$$

Eqn. 14.1 Overlandsheet flow time, t_o = 107 . n . $L^{1/3}$ / √S1/5

Table 14.2 type of surface: Bare sand with mixture of earth

n =	0.06	
S =	1	%
L_o =	803	m
t_o =	59.7	min

Drain flow



b =	0.250	m
c =	0.600	m
d =	0.300	m
Full flow section, A =	0.128	m^2
Wetted perimeter, P =	0.945	m
Hydralic radius, R =	0.135	m
Gradient, S =	1 in 25	
% S =	4	
S_d =	0.04	
Manning's n =	0.06	
L_d =	1399	m
$V_d = R^{2/3}. \sqrt{S} \div n$ =	0.877	m/s
$t_d = L_d / V_d$ =	26.6	min

$Q_d = V_d\ A$ = 0.112 m^3/s

Time of concentration, $\mathbf{t_c} = t_o + t_d$ = 86.3 min

Adopt $\mathbf{t_c}$ = **60.0** min

SEDIMENT BASIN

Sizing of Sediment Basin

Table 12.16	Predominant soil type :	A		(area involving earthworks)	
	Area of site :	71.22474	ha		
Table 12.18	Time of concentration	60	minutes		
	Required surface area :	121	m^2/ha =>	**8618.2**	m^2
	Required total volume :	145	m^3/ha =>	**10327.6**	m^3

Sediment Settling Zone

	Required settling zone volume, V_1 =	5163.8	m^3		
	Settling zone depth, y_1 =	**0.81**	m		
	Try a settling zone average width, W_1 =	**55.0**	m		
	Required settling zone average length, L_1 =	115.9	m		
	say, L_1	**160.0**	m		
	Average surface area =	8800.0	m^2		*OK*
Table 12.17	L_1 / y_1 =	197.5		< 200,	*OK*
	L_1 / W_1 =	2.9		> 2,	*OK*

Sediment Storage Zone

Required storage zone volume, V_2 =	5163.8	m^3	
Side Slope, Z =	2.0	(H) : 1 (V)	Max H =2
Dimension at top of the sediment storage zone,			
$W_2 = W_1 - y_1 Z$	53.38	m	
$L_2 = L_1 - y_1 Z$	158.38	m	
Storage zone depth, y_2 =	0.65	m	>0.3, *OK*
V2 =	5317.5	m^3	*OK*

<u>Sediment Basin Dimension :</u>

Sediment Storage Zone

$W_B = W_1 - 2 \times Z \times ((y_1 /2)+ y_2)$ 50.78

$L_B = L_1 - 2 \times Z \times ((y_1 /2)+ y_2)$ 155.78

Average Section = $W_B \times L_B$ **7910.5** m^2

SB5 **<u>Summary of Sediment Basin Dimension</u>**

Top Water Basin Length	L_1	=	160.00
Top Water Basin Width	W_1	=	55.00
Settling Zone Basin Length	L_2	=	158.38
Settling Zone Basin Width	W_2	=	53.38
Bottom Storage Zone Basin Length	L_B	=	155.78
Bottom Storage Zone Basin Width	W_B	=	50.78
Settling Zone Depth	y_1	=	0.81
Storage Zone Depth	y_2	=	0.65
Area of catchment (ha)		=	71.22
Volume of Sediment Basin (m3)		=	10481.27

DRY Sediment Basin

SB6

(To MASMA II Guideline)

MSMA 2 ref.

Determine Time of Concentration

$$t_o = \frac{107.n^* . L_o^{1/3}}{S_o^{1/5}}$$

Eqn. 14.1 Overlandsheet flow time, t_o = 107 . n . $L^{1/3}$ / √S1/5

Table 14.2 type of surface: Bare sand with mixture of earth

n = 0.06

S = 1 %

L_o = 803 m

t_o = 59.7 min

Drain flow

b = 0.250 m

c = 0.600 m

d = 0.300 m

Full flow section, A = 0.128 m^2

Wetted perimeter, P = 0.945 m

Hydralic radius, R = 0.135 m

Gradient, S = 1 in 25

% S = 4

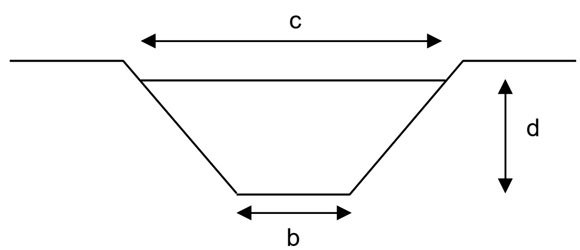
S_d = 0.04

Manning's n = 0.06

L_d = 1399 m

$V_d = R^{2/3}$. √S ÷ n = 0.877 m/s

t_d = L_d / V_d = 26.6 min



$Q_d = V_d\ A$ = 0.112 m^3/s

Time of concentration, $\mathbf{t_c}$ = t_o + t_d = 86.3 min

Adopt $\mathbf{t_c}$ = **60.0** min

SEDIMENT BASIN

Sizing of Sediment Basin

Table 12.16	Predominant soil type :	A			(area involving earthworks)
	Area of site :	79.15658	ha		
Table 12.18	Time of concentration	60	minutes		
	Required surface area :	121	m^2/ha =>	**9577.9**	m^2
	Required total volume :	145	m^3/ha =>	**11477.7**	m^3

Sediment Settling Zone

	Required settling zone volume, V_1 =	5738.9 m^3		
	Settling zone depth, y_1 =	**0.81** m		
	Try a settling zone average width, W_1 =	**60.0** m		
	Required settling zone average length, L_1 =	118.1 m		
	say, L_1	**160.0** m		
	Average surface area =	9600.0 m^2		*OK*
Table 12.17	L_1 / y_1 =	197.5	< 200,	*OK*
	L_1 / W_1 =	2.7	> 2,	*OK*

Sediment Storage Zone

Required storage zone volume, V_2 = 5738.9 m^3

Side Slope, Z = 2.0 (H) : 1 (V) Max H =2

Dimension at top of the sediment storage zone,

$W_2 = W_1 - y_1 Z$ 58.38 m

$L_2 = L_1 - y_1 Z$ 158.38 m

Storage zone depth, y_2 = 0.65 m >0.3, *OK*

V2 = 5828.0 m^3 *OK*

Sediment Basin Dimension :

Sediment Storage Zone

$W_B = W_1 - 2 \times Z \times ((y_1 /2)+ y_2)$ 55.78

$L_B = L_1 - 2 \times Z \times ((y_1 /2)+ y_2)$ 155.78

Average Section = $W_B \times L_B$ **8689.4** m^2

SB6 **Summary of Sediment Basin Dimension**

Top Water Basin Length	L_1	=	160.00
Top Water Basin Width	W_1	=	60.00
Settling Zone Basin Length	L_2	=	158.38
Settling Zone Basin Width	W_2	=	58.38
Bottom Storage Zone Basin Length	L_B	=	155.78
Bottom Storage Zone Basin Width	W_B	=	55.78
Settling Zone Depth	y_1	=	0.81
Storage Zone Depth	y_2	=	0.65
Area of catchment (ha)		=	79.16
Volume of Sediment Basin (m3)		=	11566.83

DRY Sediment Basin

SB7

(To MASMA II Guideline)

MSMA 2 ref.

Determine Time of Concentration

$$t_o = \frac{107.n^{*}.L_o^{1/3}}{S_o^{1/5}}$$

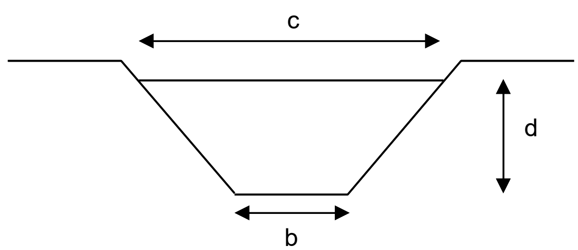
Eqn. 14.1 Overlandsheet flow time, t_o = 107 . n . $L^{1/3}$ / √S1/5

Table 14.2 type of surface: Bare sand with mixture of earth

n =	0.06	
S =	1	%
L_o =	1352	m
t_o =	71.0	min

Drain flow

b =	0.250	m
c =	0.600	m
d =	0.300	m
Full flow section, A =	0.128	m^2
Wetted perimeter, P =	0.945	m
Hydralic radius, R =	0.135	m
Gradient, S =	1 in	25
% S =	4	
S_d =	0.04	
Manning's n =	0.06	
L_d =	2409	m
$V_d = R^{2/3}. \sqrt{S} \div n$ =	0.877	m/s
$t_d = L_d / V_d$ =	45.8	min



$Q_d = V_d\ A$ = 0.112 m^3/s

Time of concentration, $\mathbf{t_c} = t_o + t_d$ = 116.8 min

Adopt $\mathbf{t_c}$ = **60.0** min

<u>**SEDIMENT BASIN**</u>

Sizing of Sediment Basin

Table 12.16	Predominant soil type :	A		(area involving earthworks)
	Area of site :	97.52933	ha	
Table 12.18	Time of concentration	60	minutes	
	Required surface area :	121	m^2/ha =>	**11801.0** m^2
	Required total volume :	145	m^3/ha =>	**14141.8** m^3

Sediment Settling Zone

	Required settling zone volume, V_1 =	7070.9 m^3		
	Settling zone depth, y_1 =	**0.86** m		
	Try a settling zone average width, W_1 =	**70.0** m		
	Required settling zone average length, L_1 =	117.5 m		
	say, L_1	**170.0** m		
	Average surface area =	11900.0 m^2		*OK*
Table 12.17	L_1 / y_1 =	197.7	< 200,	*OK*
	L_1 / W_1 =	2.4	> 2,	*OK*

Sediment Storage Zone

Required storage zone volume, V_2 =	7070.9	m^3
Side Slope, Z =	2.0	(H) : 1 (V) Max H =2
Dimension at top of the sediment storage zone,		
$W_2 = W_1 - y_1 Z$	68.28	m
$L_2 = L_1 - y_1 Z$	168.28	m
Storage zone depth, y_2 =	0.65	m >0.3, *OK*
V2 =	7269.8	m^3 *OK*

Sediment Basin Dimension :

Sediment Storage Zone

$W_B = W_1 - 2 \times Z \times ((y_1 /2)+ y_2)$ 65.68

$L_B = L_1 - 2 \times Z \times ((y_1 /2)+ y_2)$ 165.68

Average Section = $W_B \times L_B$ **10881.9** m^2

SB7 **Summary of Sediment Basin Dimension**

Top Water Basin Length	L_1	=	170.00
Top Water Basin Width	W_1	=	70.00
Settling Zone Basin Length	L_2	=	168.28
Settling Zone Basin Width	W_2	=	68.28
Bottom Storage Zone Basin Length	L_B	=	165.68
Bottom Storage Zone Basin Width	W_B	=	65.68
Settling Zone Depth	y_1	=	0.86
Storage Zone Depth	y_2	=	0.65
Area of catchment (ha)		=	97.53
Volume of Sediment Basin (m3)		=	14340.68

DRY Sediment Basin

SB8

(To MASMA II Guideline)

MSMA 2 ref.

Determine Time of Concentration

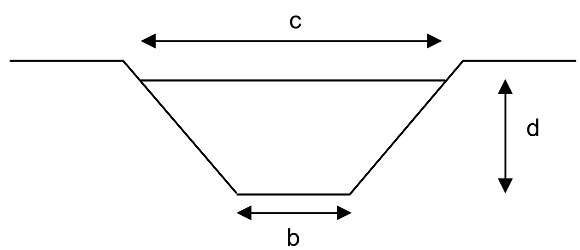
$$t_o = \frac{107.n^{*}.L_o^{1/3}}{S_o^{1/5}}$$

Eqn. 14.1 Overlandsheet flow time, t_o = 107 . n . $L^{1/3}$ / √S1/5

Table 14.2 type of surface: Bare sand with mixture of earth

n =	0.06	
S =	1	%
L_o =	1038	m
t_o =	65.0	min

Drain flow



b =	0.250	m
c =	0.600	m
d =	0.300	m
Full flow section, A =	0.128	m^2
Wetted perimeter, P =	0.945	m
Hydralic radius, R =	0.135	m
Gradient, S =	1 in 25	
% S =	4	
S_d =	0.04	
Manning's n =	0.06	
L_d =	949	m
$V_d = R^{2/3}$. √S ÷ n =	0.877	m/s
$t_d = L_d / V_d$ =	18.0	min

$Q_d = V_d$ A = 0.112 m^3/s

Time of concentration, $\mathbf{t_c} = t_o + t_d$ = 83.0 min

Adopt $\mathbf{t_c}$ = **60.0** min

SEDIMENT BASIN

Sizing of Sediment Basin

Table 12.16	Predominant soil type :	A		(area involving earthworks)	
	Area of site :	80.53251	ha		
Table 12.18	Time of concentration	60	minutes		
	Required surface area :	121	m^2/ha =>	**9744.4**	m^2
	Required total volume :	145	m^3/ha =>	**11677.2**	m^3

Sediment Settling Zone

	Required settling zone volume, V_1 =	5838.6	m^3		
	Settling zone depth, y_1 =	**0.83**	m		
	Try a settling zone average width, W_1 =	**60.0**	m		
	Required settling zone average length, L_1 =	117.2	m		
	say, L_1	**165.0**	m		
	Average surface area =	9900.0	m^2		OK
Table 12.17	L_1 / y_1 =	198.8		< 200,	OK
	L_1 / W_1 =	2.8		> 2,	OK

Sediment Storage Zone

Required storage zone volume, V_2 =	5838.6	m^3	
Side Slope, Z =	2.0	(H) : 1 (V)	Max H =2
Dimension at top of the sediment storage zone,			
$W_2 = W_1 - y_1 Z$	58.34	m	
$L_2 = L_1 - y_1 Z$	163.34	m	
Storage zone depth, y_2 =	0.65	m	>0.3, *OK*
V2 =	6007.8	m^3	*OK*

<u>Sediment Basin Dimension :</u>

Sediment Storage Zone

$W_B = W_1 - 2 \times Z \times ((y_1/2) + y_2)$ 55.74

$L_B = L_1 - 2 \times Z \times ((y_1/2) + y_2)$ 160.74

Average Section = $W_B \times L_B$ **8959.6** m^2

SB8 **<u>Summary of Sediment Basin Dimension</u>**

Top Water Basin Length	L_1	=	165.00
Top Water Basin Width	W_1	=	60.00
Settling Zone Basin Length	L_2	=	163.34
Settling Zone Basin Width	W_2	=	58.34
Bottom Storage Zone Basin Length	L_B	=	160.74
Bottom Storage Zone Basin Width	W_B	=	55.74
Settling Zone Depth	y_1	=	0.83
Storage Zone Depth	y_2	=	0.65
Area of catchment (ha)		=	80.53
Volume of Sediment Basin (m3)		=	11846.40

DRY Sediment Basin

SB9

(To MASMA II Guideline)

MSMA 2 ref.

Determine Time of Concentration

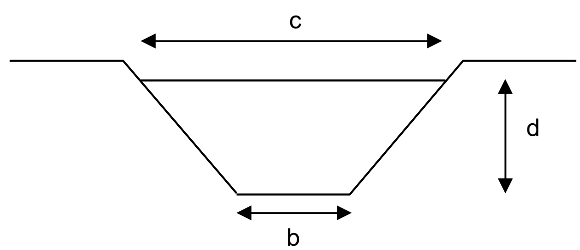
$$t_o = \frac{107.n^*.L_o^{1/3}}{S_o^{1/5}}$$

Eqn. 14.1 Overlandsheet flow time, t_o = 107 . n . $L^{1/3}$ / √S1/5

Table 14.2 type of surface: Bare sand with mixture of earth

n =	0.06	
S =	1	%
L_o =	1340	m
t_o =	70.8	min

Drain flow



b =	0.250	m
c =	0.600	m
d =	0.300	m
Full flow section, A =	0.128	m^2
Wetted perimeter, P =	0.945	m
Hydralic radius, R =	0.135	m
Gradient, S =	1 in 25	
% S =	4	
S_d =	0.04	
Manning's n =	0.06	
L_d =	1289	m
$V_d = R^{2/3}. \sqrt{S} \div n$ =	0.877	m/s
$t_d = L_d / V_d$ =	24.5	min

$Q_d = V_d\,A$ = 0.112 m^3/s

Time of concentration, $\mathbf{t_c} = t_o + t_d$ = 95.3 min

Adopt $\mathbf{t_c}$ = **60.0** min

<u>SEDIMENT BASIN</u>

Sizing of Sediment Basin

Table 12.16	Predominant soil type :	A		(area involving earthworks)
	Area of site :	82.55594	ha	
Table 12.18	Time of concentration	60	minutes	
	Required surface area :	121	m^2/ha =>	**9989.3** m^2
	Required total volume :	145	m^3/ha =>	**11970.6** m^3

Sediment Settling Zone

	Required settling zone volume, V_1 =	5985.3 m^3		
	Settling zone depth, y_1 =	**1.11** m		
	Try a settling zone average width, W_1 =	**60.0** m		
	Required settling zone average length, L_1 =	89.9 m		
	say, L_1	**167.0** m		
	Average surface area =	10020.0 m^2		*OK*
Table 12.17	L_1 / y_1 =	150.5	< 200,	*OK*
	L_1 / W_1 =	2.8	> 2,	*OK*

Sediment Storage Zone

Required storage zone volume, V_2 =	5985.3	m^3	
Side Slope, Z =	2.0	(H) : 1 (V)	Max H =2
Dimension at top of the sediment storage zone,			
$W_2 = W_1 - y_1 Z$	57.78	m	
$L_2 = L_1 - y_1 Z$	164.78	m	
Storage zone depth, y_2 =	0.65	m	>0.3, *OK*
V2 =	6001.7	m^3	*OK*

<u>Sediment Basin Dimension :</u>

Sediment Storage Zone

$W_B = W_1 - 2 \times Z \times ((y_1 /2) + y_2)$ 55.18

$L_B = L_1 - 2 \times Z \times ((y_1 /2) + y_2)$ 162.18

Average Section = $W_B \times L_B$ **8949.1** m^2

SB9 **<u>Summary of Sediment Basin Dimension</u>**

Top Water Basin Length	L_1	=	167.00
Top Water Basin Width	W_1	=	60.00
Settling Zone Basin Length	L_2	=	164.78
Settling Zone Basin Width	W_2	=	57.78
Bottom Storage Zone Basin Length	L_B	=	162.18
Bottom Storage Zone Basin Width	W_B	=	55.18
Settling Zone Depth	y_1	=	1.11
Storage Zone Depth	y_2	=	0.65
Area of catchment (ha)		=	82.56
Volume of Sediment Basin (m3)		=	11986.98