Chapter 3 Existing Environment : Physical Chemical System

3.1 GENERAL

This chapter outlines the existing physical chemical conditions, in qualitative and quantitative manners, prior to commencement of any works at the Project site.

The purpose of describing the existing environmental setting is to establish a credible and reliable baseline data, as a whole, which is an important pre-requisite data for the impact assessment study, modelling and projection for future monitoring works.

3.2 PHYSICAL-CHEMICAL ENVIRONMENT

3.2.1 Topography

From the topographical map issue by The Department of Survey and Mapping Malaysia (JUPEM), Series T735 Sheet 3/113/6 Edition 2 and Edition 3, the Project site is located at the relatively low area with flat undulating ground towards the shoreline.

It is noted that along the coastal strip, there is a rapid rise in the elevation from the edge of the coastline (approximately at high tide level) to about 10 m RL (Reduced Level[1]) within approximately 100 m. From there the ground level is generally maintained between 10 – 20 m along the 1 Km coastal belts except near the headland north of Wiser Bay where elevations of more than 30 m can be found.

The terrace platform is believed to be related to Quaternary sea level changes which is characteristically flat to gently undulating surfaces about 10 – 20 m with remnants of higher terrace to up to 35 m AMSL (Above Mean Sea Level[2]) (Kho, 1968).

[1] ***Reduced Level*** *(RL) the level which has been levelled and tied to a given Land and Survey datum.*

[2] ***Above Mean Sea Level*** *(AMSL) refers to the elevation (on the ground) or altitude (in the air) of any object, relative to the average sea level datum.*

3.2.2 Geology and Soil Conditions

3.2.2.1 Geological Formation

From the 1:500,000 Scale Geological Map of Sarawak, Series T735 Sheet 3/113/6 2nd Edition, it is noted that the bedrock in the area consists of mudstone and sandstone from the late-Pleistocene to the Holocene age, the latter being dominant.

The geological formation where the Project site will be situated, mainly consist of coastal and riverine alluvium with terraces of clay, silt, sand, gravel and layers of peat from Pleistocene-Holocene age.

However, oppose to geological formation observed at the coastal area, sandstone, shale, mudstone, limestone, lignite with some marlstone, siltstone and calcareous sandstone from Oligocene-Miocene age are found towards the southeast direction of the proposed Project. The geological formation for the proposed Project site and its surrounding area is further illustrated in **Figure 3.2.1**.

Among the sedimentary rocks found within the Project site and its surrounding area are such as:-

- **Sandstone,** which is fine to medium grained, thick bedded, flaggy and the common compound found are mica, carbonaceous material and fine granules of pyrite. All gradations from sandstone to sandy shale occur whilst ripple marks, cross-bedding, graded bedding and depositional slump structures are commonly seen. The porosity is fairly high with porosity ranging from 9.2% to 22.7% (Haile, 1962);

- **Shale**, which alternated with thin beds of argillaceous sandstone and sandy shale. Shale successions do not usually exceed 5 m in thickness whilst plant remains and lignite films are ubiquitous. The only macrofossils are imprints of molluscs and a few operculinids (Haile 1962);

- **Limestone and Calcareous Sandstone**; are intercalated in sandstone, usually in lenses of as much as 10 m long and 2 m thick. These rocks usually contain abundant larger foraminifera and lamellibranches. Fine grains, dense varieties also occur and in several places are in contact with discontinuous beds of reworked limestone (Haile, 1962); and,

- **Lignite Material**; is abundant in all rocks except the calcareous ones. Pitch black clayey lignite bands, up to about 2 cm in thickness, occur most commonly in argillaceous sandstone or at the contact of sandstone with shale or sandy shale (Haile 1962).

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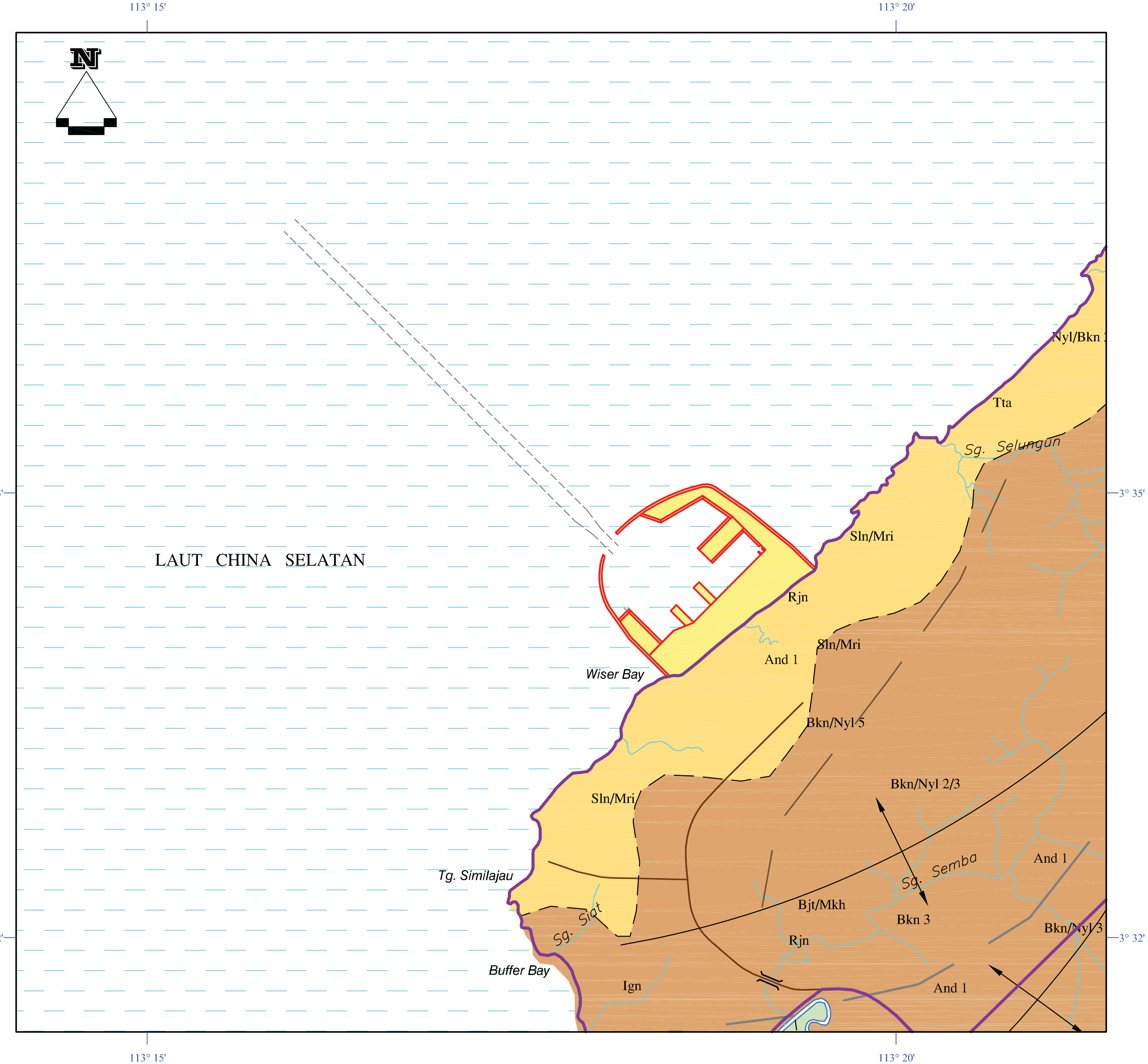
PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED NEW SAMALAJU PORT AT SIMILAJAU,
BINTULU, SARAWAK



LEGEND:

- Project Site And Channel
- Samalaju Industrial Park Boundary
- Main / Coastal Road
- Rivers / Streams

Geologic Symbols

- Chronologic Boundaries
- Formational Boundaries
- Fault
- Anticlinal axis with plunge

Pleistocene-Holocene
Coastal and riverine alluvium, and terraces of clay, silt, sand and gravel with layers of peat.

Oligocene-Miocene
Sandstone, shale, mudstone, limestone, lignite with some marlstone, siltstone and calcareous sandstone.

0 1 2 3 4Km

SCALE IN KILOMETRES (1:75,000) – A4 MEDIUM

SOURCE: Adapted from

SERIES T735 SHEET 3/113/6 EDITION 2-D.O.S. 1968	GEOLOGICAL MAP OF SARAWAK SECOND EDITION, 1992 SCALE 1:500,000

GRID
–The outer ticks indicate the Latitude and Longitude

GEOLOGICAL FORMATION

FIGURE: 3.2.1

D:\ACAD\DRAWINGS\EV103\527\FIG-321.DWG

3.2.2.2 Existing Soil Conditions

From the 1:50,000 Scale, Soil Map of Sarawak, Series T735 Sheet 3/113/6 Edition 2, the proposed Project's platform area is situated on Silantek / Miri soil series and Rajang series at the southwestern and northeastern boundary respectively. These kinds of soils are usually found at flat to gently sloping tidal floodplains with poor fertility. The other common features found in these coastal soils are its high salinity and acidity, making it unsuitable for agricultural purposes.

The most dominant soil series found surrounding the Project site are Bekenu and Nyalau soil series. The summary of the soil characteristics found at the Project site and its surrounding area is further summarized in **Table 3.2.1** and illustrated in **Figure 3.2.2**.

Table 3.2.1 Summary of Soil Characteristics at Project site

Symbol	Series	FAMILY (Group)	Main Characteristics	Terrain	Capability (Limitations)
And	Anderson	ANDERSON • Organic Soils	• >150 cm organic layer	• Level coastal • Lowlands or interior valleys	**Class 5** • Water table • Fertility and inundation
Bjt	Bijat	BIJAT • Gleysols	• Clayey • Alluvial • non-sulphidic • White to grey	• Flat to undulating floodplain or valleys	**Class 3** • Wetness • Inundation
Mkh	Mukah	MUKAH • Organic Soils	• 50-150 cm organic layer over non-sulphidic fine load to clay	• Level coastal lowlands or interior valleys	**Class 4** • Water table • Fertility
Bkn	Bekenu	BEKENU • Red-Yellow Podzolic	• Fine loamy • <20% Gp. III Oxides • Non-calcareous and yellow	• Moderately to very steeply dissected hills	**Class 3 to 5** • Slope • Erosion hazard
Nyl	Nyalau	NYALAU • Red-Yellow Podzolic	• Coarse loamy • Residual • Non-calcareous	• Moderately steep to steep hills	**Class 2 to 5** • Fertility • Slope • Erosion hazard

Symbol	Series	FAMILY (Group)	Main Characteristics	Terrain	Capability (Limitations)
Ign	Igan	IGAN • Organic Soils	• 50-150 cm organic layer over sands • Coarse loam	• Level coastal lowlands or interior valleys	**Class 5** • Water table • Fertility • Inundation
Rjn	Rajang	RAJANG • Thionic Soils	• Clayey • Sulphidic within 50 cm • Strongly saline	• Flat to gently sloping tidal floodplains	**Class 5** • Wetness • Salinity • Acidity
Sln	Silantek	BUSO • Podzols	• Bh horizon • Non-indurated residual	• Gentle dip slopes of cuesta terrain	**Class 4** • Fertility • Moisture deficiency
Mri	Miri	MIRI • Podzols	• Bh horizon indurated	• Flat to undulation terrace summits	**Class 5** • Soil depth • Moisture deficiency
Tta	Tatau	TATAU • Gleysols	• Sandy • Non-sulphidic • Marine origin • Non-saline	• Flat to gently sloping coastal plains	**Class 4** • Fertility • Wetness

Source: Soil Map of Sarawak

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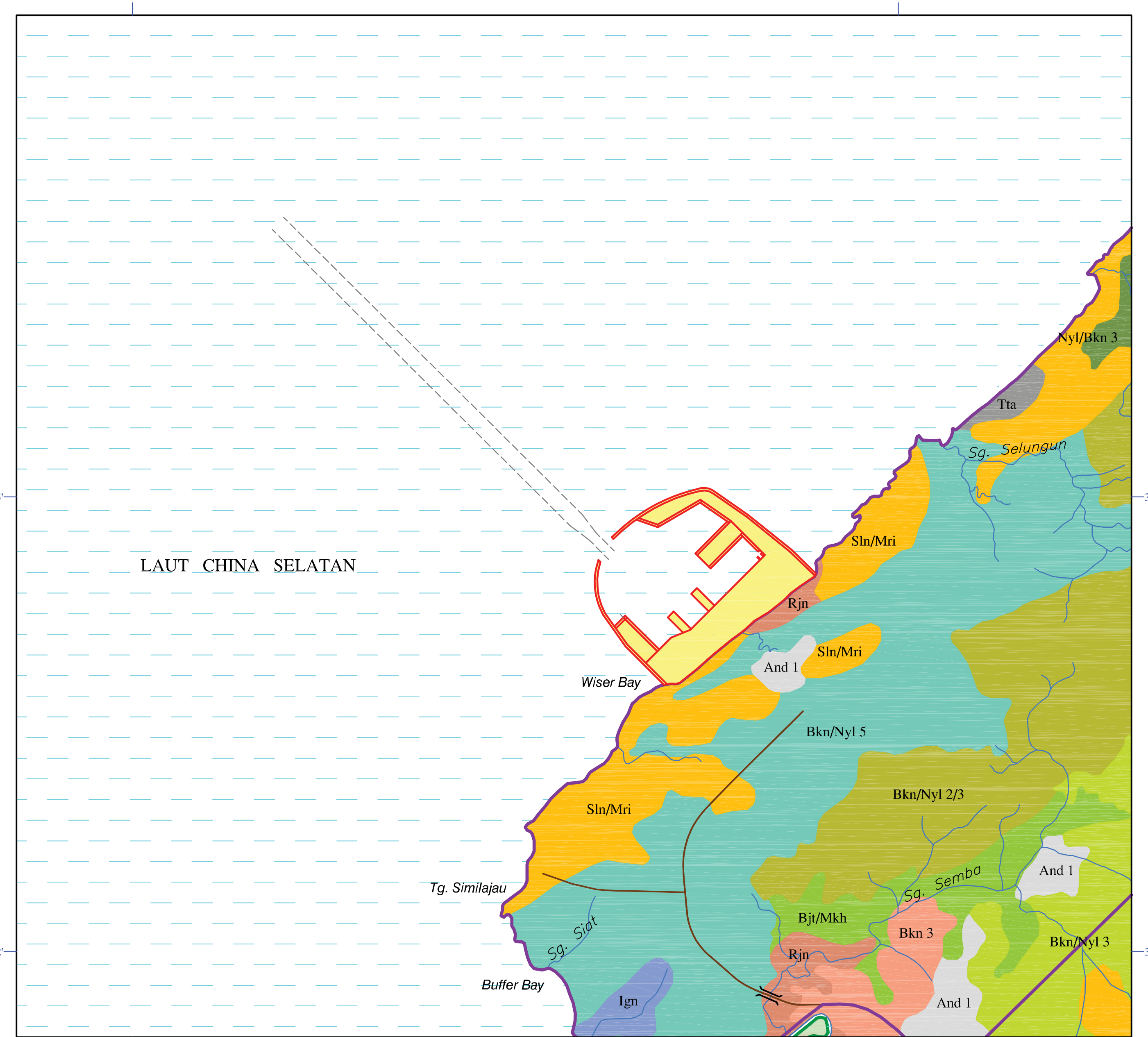
PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED NEW SAMALAJU PORT AT SIMILAJAU,
BINTULU, SARAWAK



LEGEND:

- Project Site And Channel
- Samalaju Industrial Park Boundary
- Similajau National Park Boundary
- Main / Coastal Road
- Rivers / Streams

Key of soil

And 1	Anderson 1	Ign	Igan
Bjt/Mkh	Bijat/Mukah	Nyl/Bkn 3	Nyalau/Bekenu 3
Bkn/Nyl 2/3	Bekenu/Nyalau 2/3	Rjn	Rajang
Bkn/Nyl 5	Bekenu/Nyalau 5	Sln/Mri	Silantek/Miri
Bkn 3	Bekenu 3	Tta	Tatau
Bkn/Nyl 3	Bekenu/Nyalau 3		

N

0 1 2 3 4Km

SCALE IN KILOMETRES (1:75,000) – A4 MEDIUM

SOURCE : Adapted from

SERIES T735
SHEET 3/113/6
EDITION 2-D.O.S. 1968

1:50,000 SOIL MAPS OF SARAWAK
SHEET 3/113/6
FIRST EDITION

GRID
–The outer ticks indicate the Latitude and Longitude

SOIL CHARACTERISTICS

FIGURE: 3.2.2

D:\ACAD\DRAWINGS\EV103\527\FIG-322.DWG

3.2.2.3 Soil Investigation – Boreholes Results Analysis

A total of 18 boreholes were carried out by the previous study within the proposed Project basin and its surrounding area. The locality of the boreholes is as illustrated in **Figure 3.2.3** and the results of the finding is further summarize in **Table 3.2.2**.

The findings of the geotechnical investigation conclude that the sediment properties within and surrounding the proposed Project site are mainly consisting of silt and clay fractions. Only 1 boreholes (MBH6) was carried out within the 6 m CD depth contour and the results are therefore characterized the condition outside of the surf-zone.

Table 3.2.2 Summary of Boreholes Results

Boreholes ID	Boreholes Depth	Description
MBH1	0 – 3.0	Very soft slightly sandy silt
MBH2	0 – 4.3	Very soft to soft silt clay
MBH3	0 – 5.8	Soft to firm silty clay/clayey silt
MBH4	0 – 5.2	Firm clayey silt/silty clay
MBH5	0 – 5.2	Very soft to soft clayey silt/silty clay
MBH6	0 – 5.3	Very soft to soft silty clay
MBH7	0 – 4.0	Very soft tot silty clay
MBH8	0 – 3.5	Very soft tot silty clay
MBH9	0 – 7.0	Very soft slightly sandy clay
MBH10	0 – 2.2	Very soft sandy clay/slightly gravely sandy clay
MBH11	0 – 3.0	Very soft silty clay
MBH12	0 – 2.5	Very soft silty clay
MBH13	0 – 10.0	Soft to firm silty clay/sandy clay
MBH14	0 – 7.2	Very soft/soft sandy clay/sandy clay
MBH15	0 – 5.6	Very soft to soft silt clay/clayey silt
MBH16	0 – 5.5	Soft sandy clay/silt clay
MBH17	0 – 2.6	Very loose silty sand
MBH18	0 – 5.5	Very soft to soft clayey silt/sandy clay

Source: Preliminary Hydraulic Study for Similajau Port Study, Sarawak, DHI 2010.

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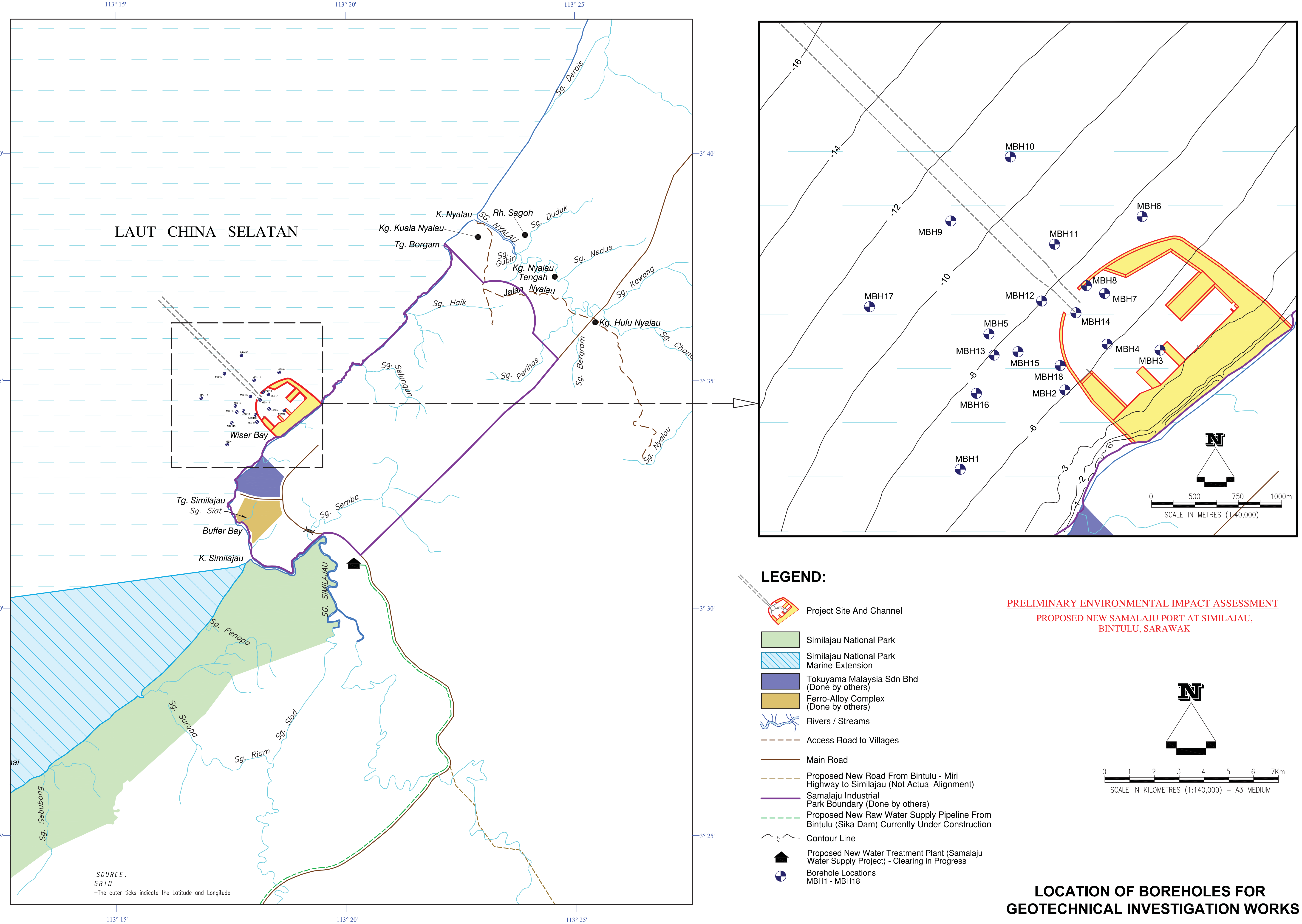


LOCATION OF BOREHOLES FOR GEOTECHNICAL INVESTIGATION WORKS

FIGURE: 3.2.3

D:\ACAD\DRAWINGS\EV103\527\FIG-323.DWG

3.2.3 Meteorology

3.2.3.1 General Climate

The climate surrounding the proposed Project site is largely influenced and governed by the movement of Inter Tropical Convergence Zone (ITCZ) and closely associated with its warm air movement in correlation with the monsoon seasons. There are 2 distinct monsoon regimes in the area, which are, the Northeast Monsoon Season from November to March, and the Southwest Monsoon Season from May to September. The calm period between these 2 monsoon seasons is commonly referred to as the inter-monsoon or transitional period.

The rainfall and evaporation data presented below are sourced from the Kuala Similajau Rainfall Station I.D 3533001 (Latitude: 3°31'40.00"N, Longitude: 113°19'0.38"E) by Drainage and Irrigation Department (DID), which is located approximately 4.23 Km southwest from the proposed Project site. Other meteorological data are obtained from the Bintulu Meteorological Station I.D. 96441 situated at Bintulu Airport (Latitude: 3°10'20.32"N, Longitude: 113° 2'40.56"E), which is situated approximately 53.5 Km southwest from the Project site. The localities of the meteorological stations are as illustrated in **Figure 3.2.16**.

3.2.3.2 Rainfall

Seasonal wind patterns and local topographic features determine the rainfall distribution patterns for the area. Generally, coastal areas will experience higher rainfall in January and much of the rainfall is received during the Northeast Monsoon months of September onwards until March. Based on the observation of rainfall precipitation for the area, minimum rainfall usually occurs from the month of June until August, which coincides with prevailing southwesterly winds. However, rainfall for the inland areas is more evenly distributed throughout the year as they are sheltered from the influence of monsoons by surrounding topographical characteristic.

The rainfall data from Kuala Similajau rainfall station was chosen for this study due to its proximity to the proposed Project site of 4.23 Km, compared to the rainfall data recorded by MMD station located at Bintulu Airport, which is 53.5 Km from the Project site. However, there is limitation for the use of rainfall data from DID station in this study, which is the published rainfall record by DID only available up to year 2003 at the time of report writing.

Based on the nearest rainfall data from DID's Kuala Similajau rainfall station, it is observed that the Similajau basin is experience a total of **2560.0 mm** of rainfall annually. The average mean monthly rainfall for the area is 8.0 mm with the highest monthly mean ever recorded is 17.0 mm in the month of June. The highest monthly rainfall recorded is 100.5 mm in November.

The rainfall data is as tabulated in **Table 3.2.3** and further summarized in **Figure 3.2.4**. The 24 Hours Rainfall Accumulation Estimation produced by Malaysian Meteorological Department (MMD) is as shown in **Figure 3.2.5**.

Table 3.2.3 Rainfall Records of Mean, Maximum and Minimum at Kuala Similajau, Bintulu (2003)

Day	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Day
1	2.5	0.5	3.0	NA	NA	NA	1.0	0.0	6.0	1.5	33.0	26.5	1
2	1.0	0.0	25.5	NA	NA	NA	10.0	0.0	12.5	33.0	0.5	20.0	2
3	26.5	0.0	0.0	NA	NA	NA	80.5	41.0	0.0	6.0	4.0	23.0	3
4	1.5	20.5	0.0	NA	NA	NA	0.0	2.0	0.0	0.5	7.0	4.0	4
5	25.0	0.0	1.0	NA	NA	NA	2.5	0.0	1.0	2.5	100.5	0.5	5
6	0.5	8.5	0.0	NA	NA	NA	0.5	5.0	0.0	1.0	1.0	18.0	6
7	30.0	4.0	0.0	NA	NA	NA	0.0	3.0	0.0	27.0	0.0	0.0	7
8	94.0	4.5	0.0	NA	NA	NA	0.0	0.0	18.5	14.5	1.0	58.0	8
9	19.0	1.0	85.0	NA	NA	NA	0.0	0.5	0.0	29.5	0.0	17.5	9
10	20.0	2.0	2.5	NA	NA	NA	0.0	0.0	5.5	0.0	30.0	47.0	10
11	12.0	1.0	1.5	NA	NA	NA	0.0	0.0	68.0	19.0	2.5	42.5	11
12	32.5	10.0	0.0	NA	NA	NA	0.5	3.5	41.0	29.5	0.0	0.0	12
13	46.5	0.0	0.0	NA	NA	NA	12.0	0.0	0.0	0.0	23.5	31.5	13
14	1.5	0.0	0.0	NA	NA	NA	1.5	44.5	17.0	0.0	0.5	8.5	14
15	0.0	0.0	0.0	NA	NA	NA	0.0	3.5	0.0	0.5	0.0	45.5	15
16	0.0	0.0	0.0	NA	NA	NA	0.0	10.5	1.0	4.0	0.0	31.5	16
17	0.0	0.5	8.0	NA	NA	NA	27.5	10.0	0.0	9.0	14.5	1.0	17
18	2.5	0.0	5.0	NA	NA	NA	6.0	13.5	0.0	18.0	19.0	1.5	18
19	1.0	0.0	0.0	NA	NA	NA	0.0	7.0	4.0	7.5	0.0	0.0	19
20	0.0	0.0	0.5	NA	NA	4.5	0.0	0.0	0.0	0.5	7.5	0.5	20
21	0.0	0.0	53.5	NA	NA	19.5	0.0	0.0	0.0	21.0	1.0	0.0	21

Day	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Day
22	0.0	0.0	29.0	NA	NA	15.5	0.0	0.0	0.0	5.0	1.0	36.0	22
23	0.0	0.0	0.0	NA	NA	82.5	0.0	0.0	3.0	2.5	9.5	31.5	23
24	0.0	4.0	2.0	NA	NA	5.5	0.0	0.0	0.0	3.0	1.0	39.5	24
25	0.0	0.0	NA	NA	NA	11.0	0.0	0.0	18.5	55.5	7.5	0.0	25
26	0.0	0.0	NA	NA	NA	0.5	0.5	1.0	8.0	51.0	87.0	1.5	26
27	4.0	0.0	NA	NA	NA	35.5	0.0	0.0	0.0	0.0	0.5	0.0	27
28	0.0	0.0	NA	NA	NA	11.5	0.0	0.0	0.0	9.0	36.0	0.0	28
29	0.0		NA	NA	NA	0.5	0.5	5.0	0.0	12.0	1.0	0.0	29
30	1.5		NA	NA	NA	0.0	0.0	14.5	0.0	26.0	3.0	0.0	30
31	0.5		NA		NA		0.0	0.0		0.5		0.5	31
Total	322.0	56.5	216.5	0.0	0.0	186.5	143.0	164.5	204.0	389.0	392.0	486.0	Total
Mean	10.4	2.0	9.0	0.0	0.0	17.0	4.6	5.3	6.8	12.5	13.1	15.7	Mean
Maximum	94.0	20.5	85.0	0.0	0.0	82.5	80.5	44.5	68.0	55.5	100.5	58.0	Maximum
Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Minimum

Notes: *All recorded data is continuous and reliable except where the following abbreviation "NA" is used as missing data.*

Source: *Hydrological Yearbook 2003, Drainage and Irrigation Department Sarawak.*

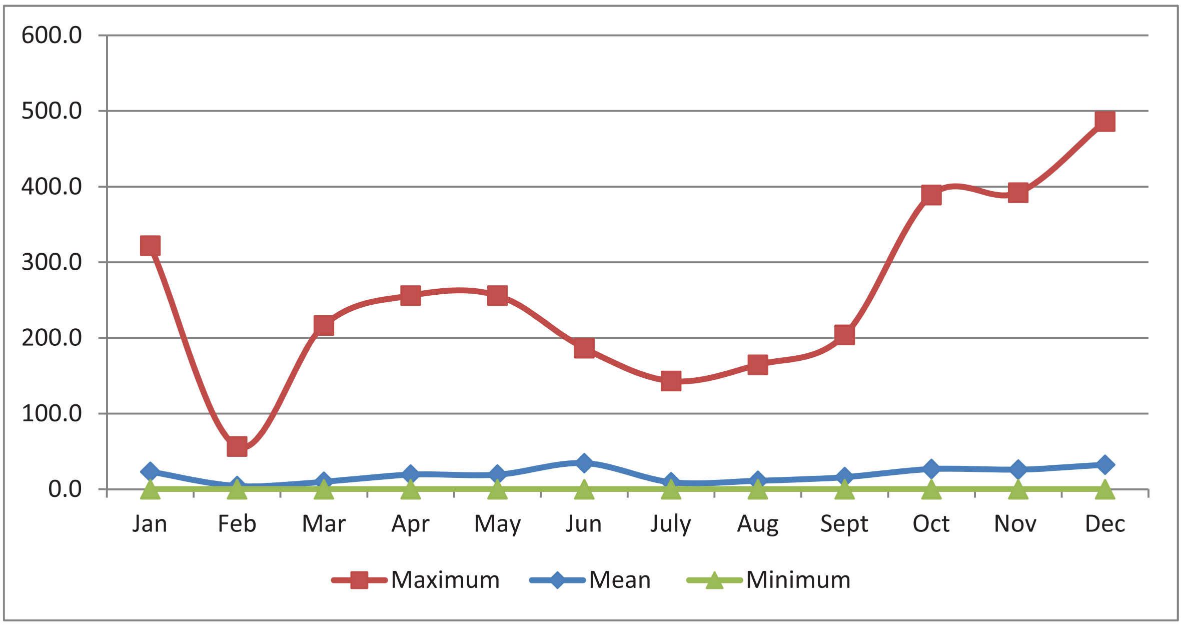
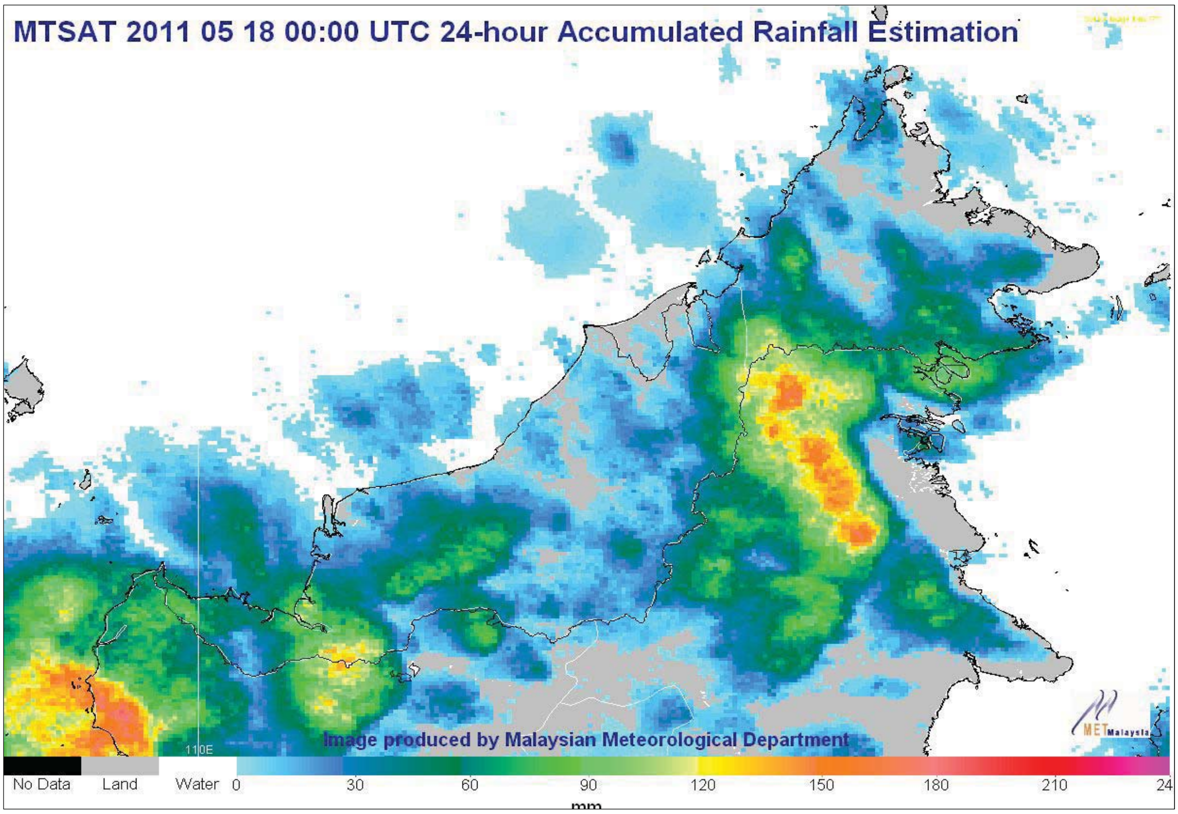


Figure 3.2.4 Summary of Rainfall Data – 2003 at Kuala Similajau Station, DID.



Source: Malaysian Meteorological Department, 2011.

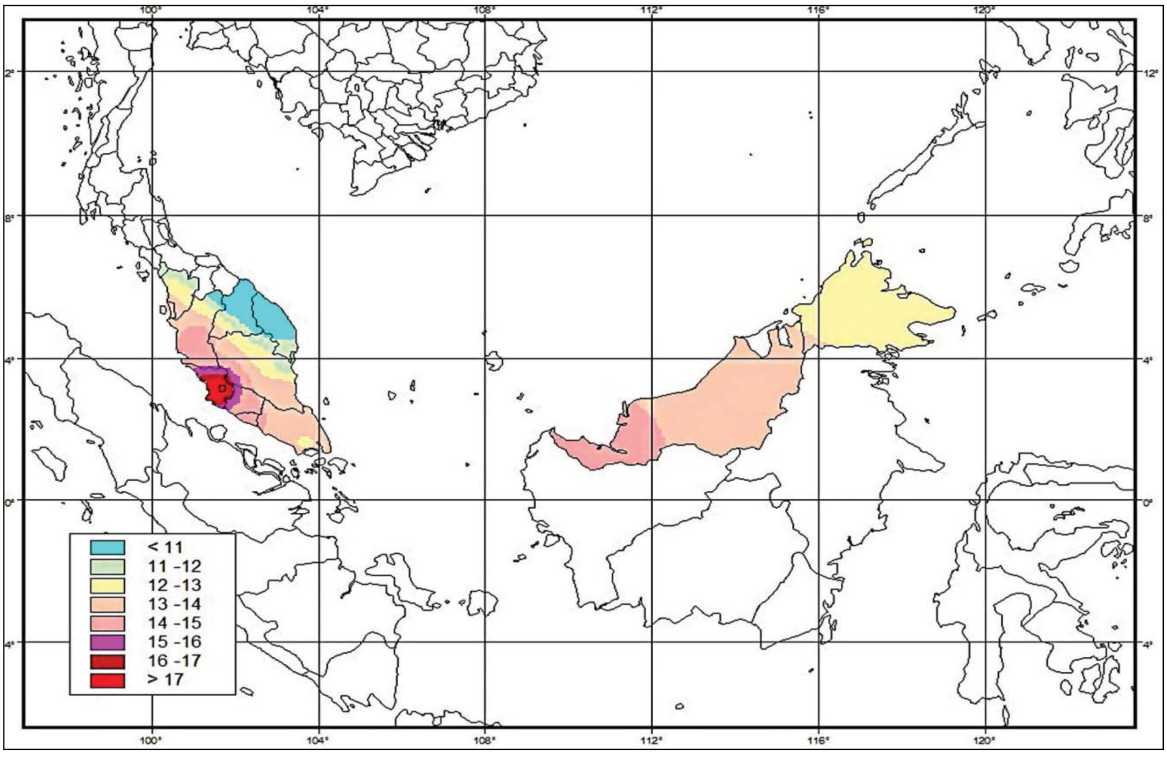
Figure 3.2.5 24-Hours Rainfall Accumulation Estimation

3.2.3.3 Sunshine and Solar Radiation

Being a maritime country close to the equator, Malaysia naturally has abundant sunshine and thus solar radiation. However, it is extremely rare to have a full day with completely clear sky even in periods of severe drought. The cloud cover cuts off a substantial amount of sunshine and solar radiation. On the average, Malaysia receives about 6 hours of sunshine per day. There are, however, seasonal and spatial variations in the amount of sunshine received.

Based on data obtained from Malaysia Meteorological Department (MMD), the mean daily sunshine duration at Bintulu Airport varies from **5.0** to **5.5 hours**. During the hot and drier months of the Southwest monsoon, 7 hours of sunshine is not uncommon. Conversely, in the presence of significant amount of clouds such as during Northwest monsoon is taking its toll, the daily sunshine hours will be reduced to an approximate average of 3 hours. In general, maximum sunshine is evident between the hours of 0830 to 1400.

On average, Bintulu receives an average of **± 14 - 15** mega joule per meter square (MJm^{-2}) of radiation throughout the year (see **Figure 3.2.6**).



Source: Malaysian Meteorological Department.

Figure 3.2.6 Mean Daily Solar Radiation (MJm^{-2})

3.2.3.4 Temperature

The average annual extreme maximum and minimum temperature is approximately 27.3°C and 26.0°C respectively. The average annual mean temperature recorded from 1968 – 2007 (39 years record) is **26.7°C**.

Based on the observation for temperature fluctuation for 39 years record, it can be observed that the month of April until August experience higher temperature. The summary temperature data for 24-hours mean, lowest mean and highest mean is as tabulated in **Table 3.2.5** and further illustrated in **Figure 3.2.7**.

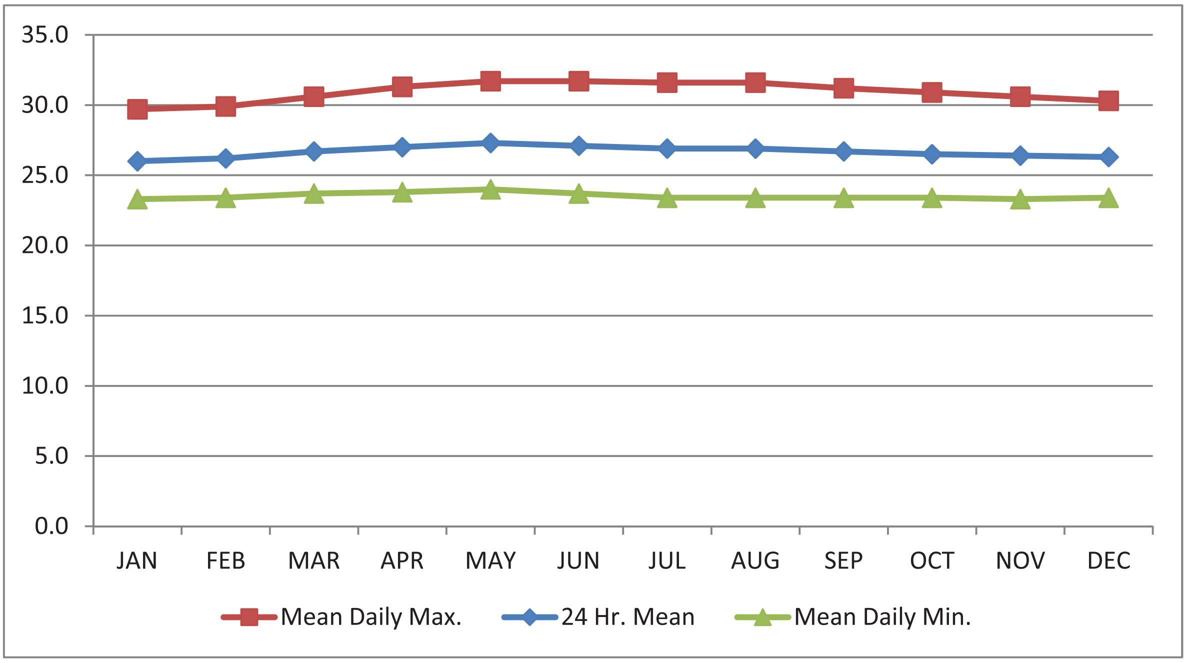
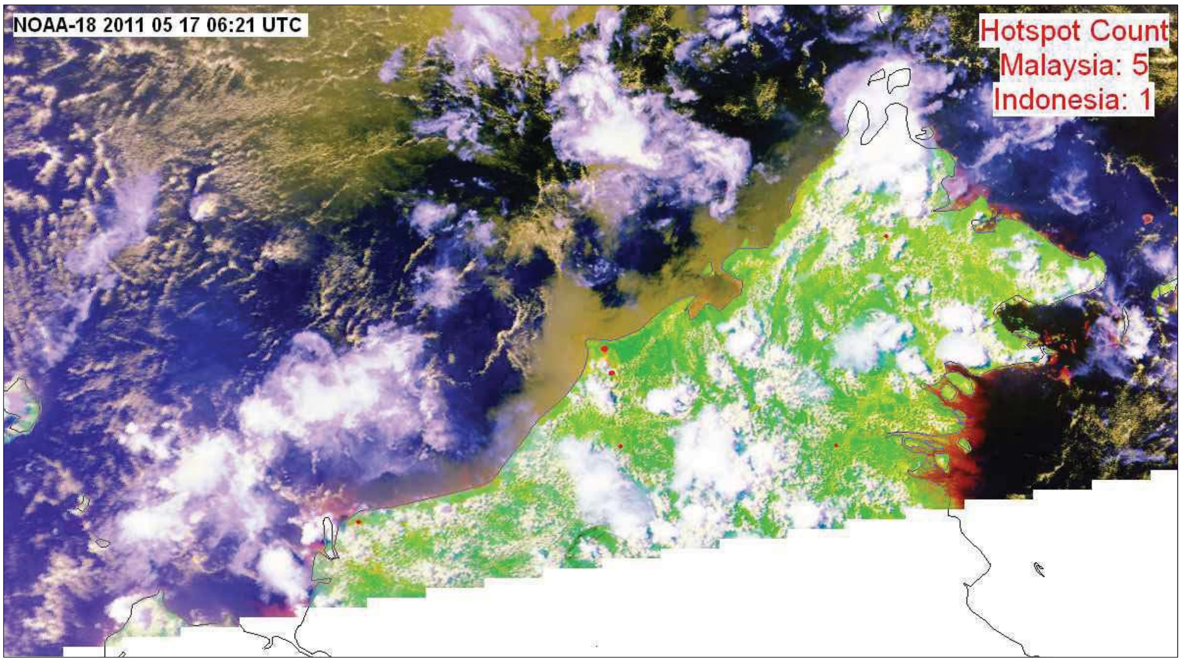


Figure 3.2.7 Summary of 24-Hours Mean, Lowest Mean and Highest Mean (1968-2007)

In addition, a total of 5 hotspot areas are spotted in East Malaysia based on satellite imaginary monitoring by NOAA (National Oceanic and Atmospheric Administration). 3 hotspot areas were detected at Kuala Baram and Lutong area, Miri, 1 hotspot area each at Kuching and Sabah respectively. The hotspot imaginary is as shown in **Figure 3.2.8**.



Source: Malaysian Meteorological Department, May 2011.

Figure 3.2.8 Hotspot Areas Count

3.2.3.5 Relative Humidity

Relative humidity (RH) is the ratio of the current absolute humidity to the highest possible absolute humidity[3] (which depends on the current air temperature). A reading of 100% relative humidity means that the air is over saturated with water vapour and reached its critical point or "*dew point*", creating the possibility of rain. However, it doesn't mean that the relative humidity must be 100% in order for it to rain but it must be 100% for the cloud to form. The relative humidity near the ground could be must lesser.

Based on the 39 years data (1968-2007) for 24-hours mean relative humidity recorded at Bintulu Meteorological Station at Bintulu Airport, it can be observed that the lowest and highest 24-hours relative humidity is 84.2% in August and 87.4% in January respectively and the average mean relative humidity recorded is 85.7%. The 24-hours mean humidity data is as shown in **Table 3.2.6** and further illustrated in **Figure 3.2.9**.

[3] ***Absolute Humidity*** *is the mass of water vapour divided by the mass of dry air in a volume of air at a given temperature. The hotter the air is, the more water it can contain.*

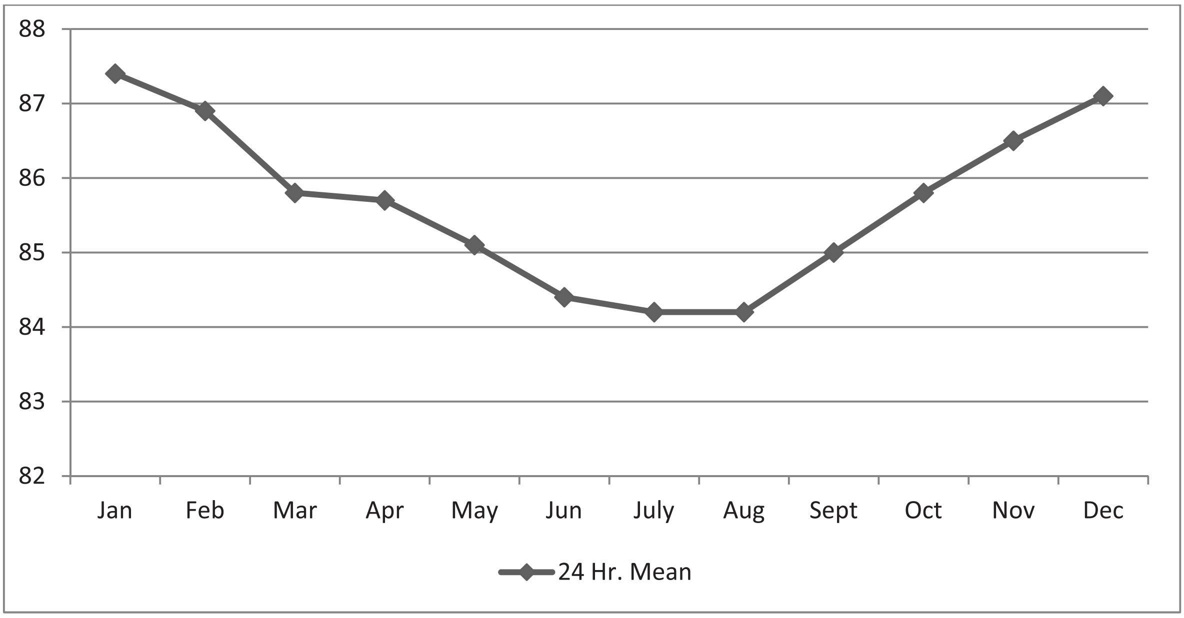


Figure 3.2.9 24 Hours Mean Relative Humidity (%)

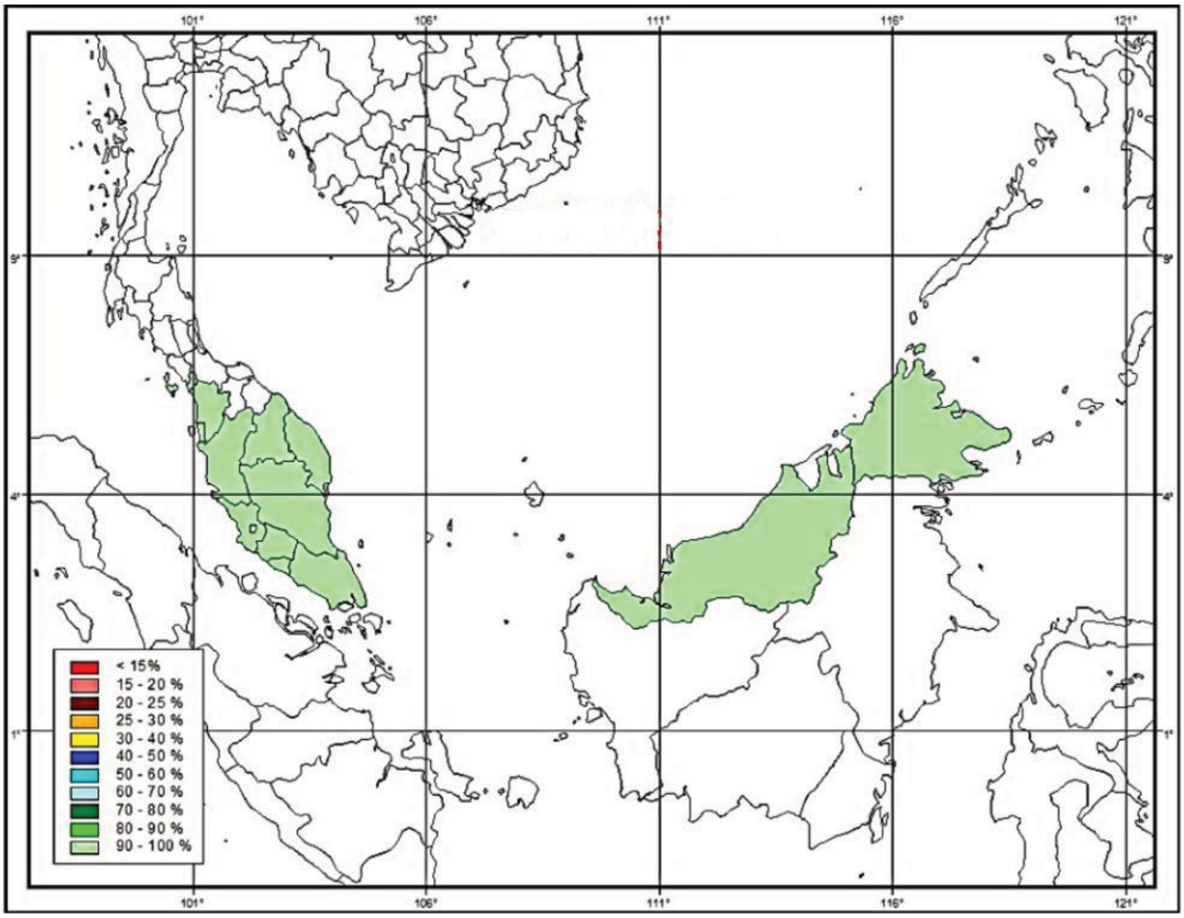
3.2.3.6 Soil Moisture Content

The soil moisture distribution map shown in **Figure 3.2.10** displays the daily distribution of the soil moisture content for East Malaysia on 30th November 2008. Generally, Bintulu experience very wet condition (> 30 %) during the day time with average soil moisture content of the day in most places in Malaysia is between 90 % to 100 % (2008 MMD).

The holding capacity of the soil is assumed to be 30 cm out of the 1 m depth of soil. The field capacity and wilting point are assumed to have the values 0.3 and 0.1 respectively (see **Table 3.2.4**).

Table 3.2.4 Soil Moisture Content

Soil Moisture Content	Conditions
> 30%	Very Wet
25 - 30%	Wet
20 - 25%	Moderate
15 - 20%	Dry
<15%	Very Dry



Source: Malaysian Meteorological Department

Figure 3.2.10 Soil Moisture Distribution Map

Table 3.2.5 24-Hours Mean, Lowest Mean and Highest Mean Temperature (1968 – 2007)

Temperature (°C)	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Annual
24 Hr. Mean	26.0	26.2	26.7	27.0	27.3	27.1	26.9	26.9	26.7	26.5	26.4	26.3	26.7
Mean Daily Max.	29.7	29.9	30.6	31.3	31.7	31.7	31.6	31.6	31.2	30.9	30.6	30.3	30.9
Mean Daily Min.	23.3	23.4	23.7	23.8	24.0	23.7	23.4	23.4	23.4	23.4	23.3	23.4	23.5
Highest Max.	33.5	33.5	34.3	36.0	35.9	35.4	35.5	36.3	35.4	34.6	34.0	34.7	36.3
Year of Highest Max.	2003	1982	2006	1998	2003	2003	2002	2002	1999 2005	1995	1996	1996	2002
Lowest Min.	19.2	19.9	20.3	21.6	21.7	21.1	21.0	21.1	21.1	21.3	21.3	20.8	19.2
Year of Lowest Min.	1972	1976	1974	1968	1976	1985	1976 1982	Sev.	1976	1968	1995	1985	1972

Note: Sev. - Several Occasions

Source: Malaysian Meteorological Department (1968 – 2007)

Table 3.2.6 Relative Humidity (1968 – 2007)

Relative Humidity (%)	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Annual
24 Hr. Mean	87.4	86.9	85.8	85.7	85.1	84.4	84.2	84.2	85.0	85.8	86.5	87.1	85.7

Source: Malaysian Meteorological Department (1968 – 2007)

3.2.3.7 Wind Speed and Directions

The mean surface wind speed observed during the period of 1975 - 2008 shows that they are fairly consistent. Uniform periodic changes can be identified in the wind flow patterns. Based on these changes, wind flow patterns may be classified into the following four seasons:-

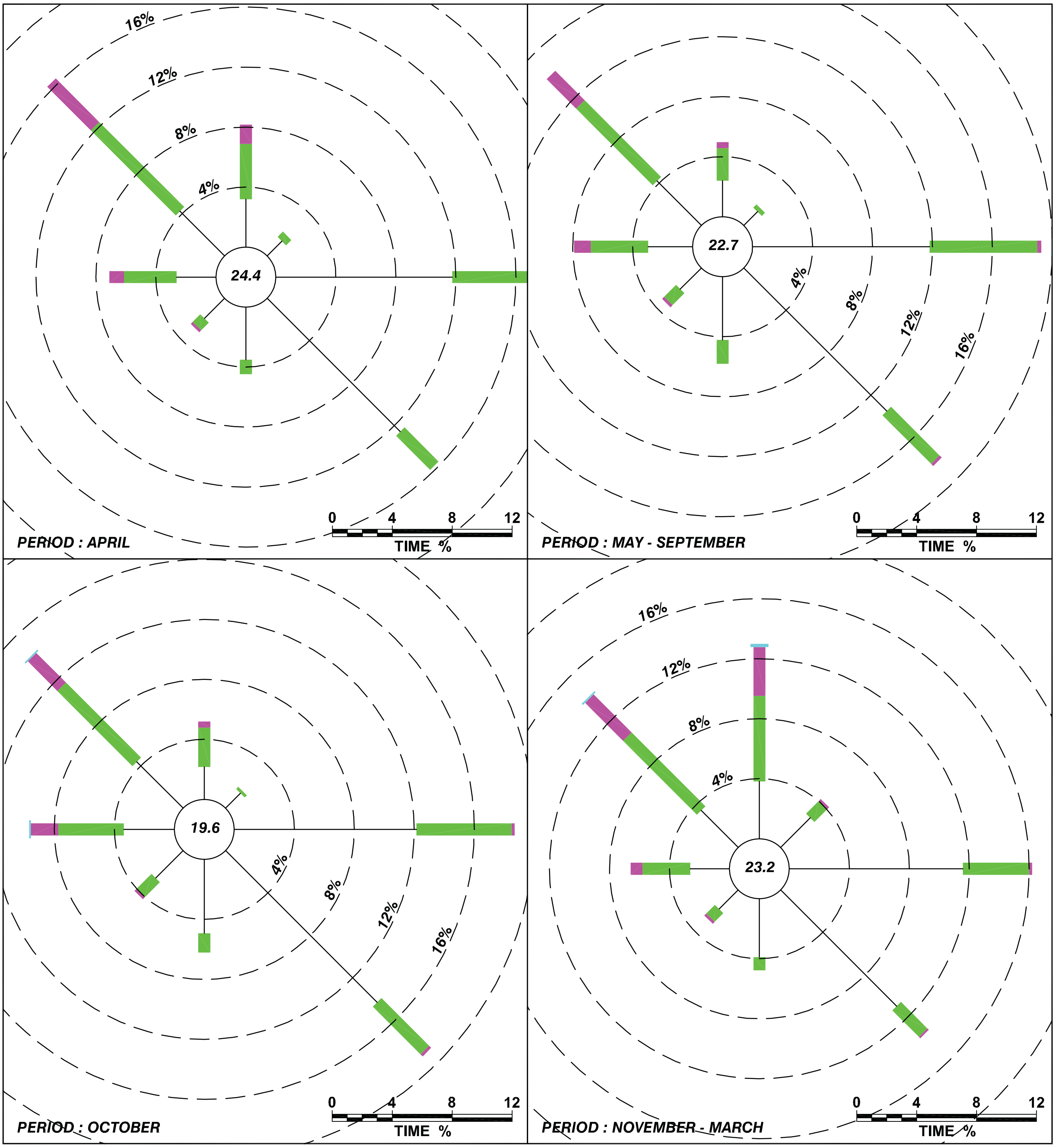
1. Northeast monsoon (November to March);
2. Intermonsoon / transition season (April);
3. Southwest monsoon (May to September); and,
4. Intermonsoon / transition season (October).

The wind flow patterns over Bintulu are partially influenced by the monsoon seasons, namely northeast monsoon season and southwest monsoon season. During the northeast monsoon season from November onwards until March, the sea breeze enforces the prevailing wind resulting in strong northeasterlies with speed of less than 5.5 ms^{-1} and during the southwest monsoon season from May onwards until September, it can be observed that the prevailing wind is much milder blowing from the west and southwest direction with wind speed less than 3.4 ms^{-1}.

Statistically, the registered calm period is **25.2%** throughout the period of 33 years. The seasonal wind velocities and directions recorded from 1975 – 2008 (33 years) are shown in **Figure 3.2.11**[4] and further summarized in **Figure 3.2.12**.

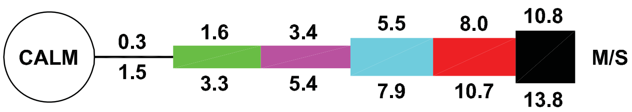
---

[4] The wind rose map shows the frequency of winds blowing from particular directions for a period of years. The length of each "spoke" around the circle is related to the frequency that the wind blows from a particular direction per unit time. Each concentric circle represents a different frequency, emanating from zero at the centre to increasing frequencies at the outer circles.



PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED NEW SAMALAJU PORT AT SIMILAJAU,
BINTULU, SARAWAK



SOURCE: MALAYSIAN METEOROLOGICAL SERVICES DEPT.

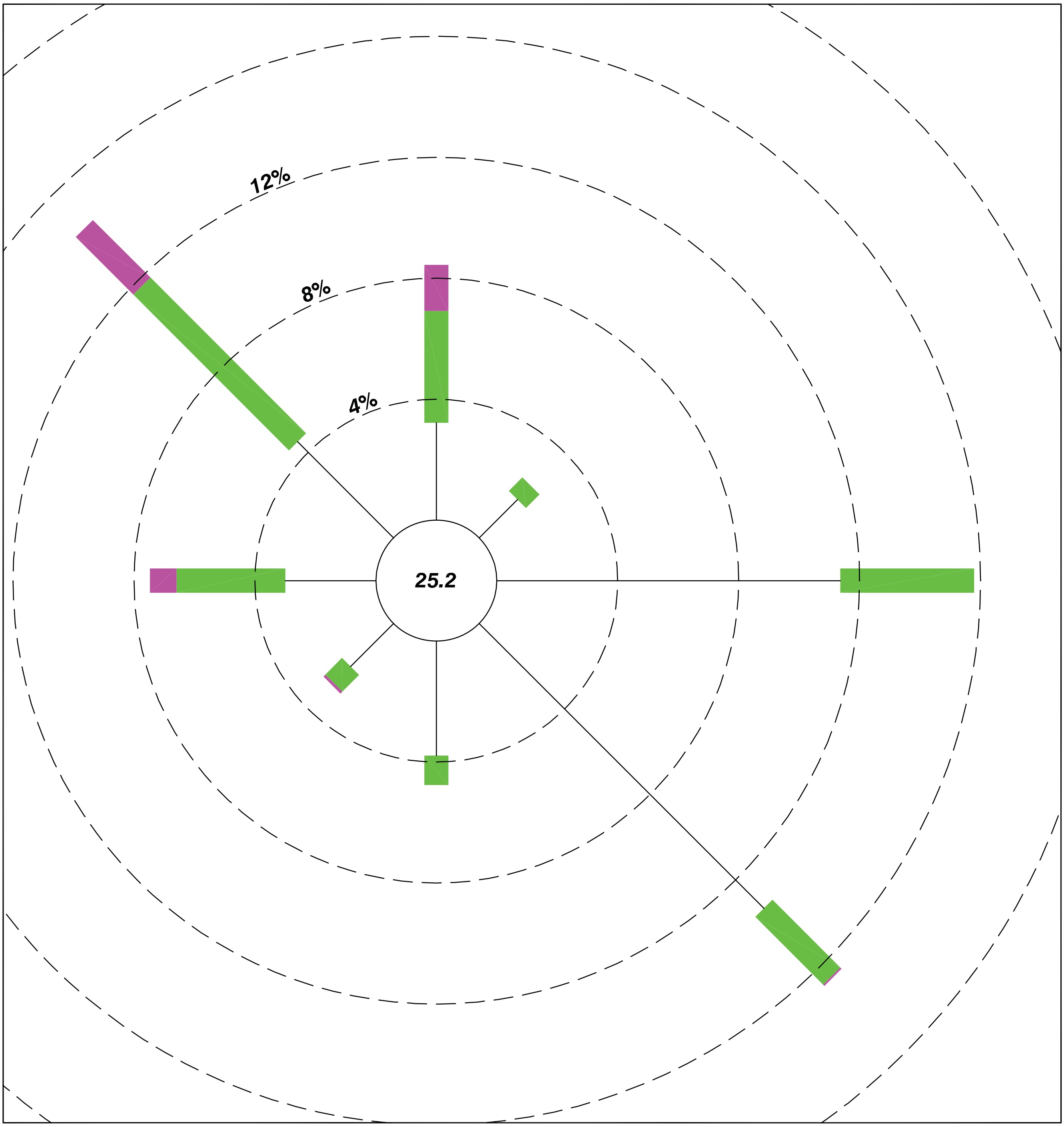
LOCATION : BINTULU
YEAR : 1975-2008
TIME : 24 HOURS

SEASONAL WIND ROSE SUMMARY AT MMD STATION, BINTULU AIRPORT

FIGURE: 3.2.11

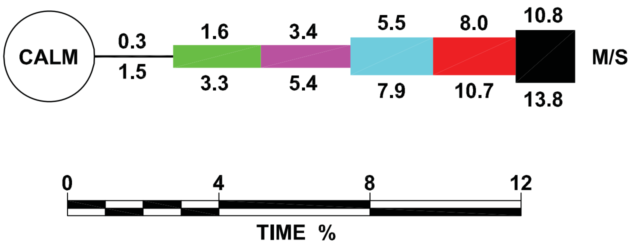
CHEMSAIN KONSULTANT SDN. BHD.

D:\ACAD\DRAWINGS\EV103\527\FIG–3211.DWG



PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED NEW SAMALAJU PORT AT SIMILAJAU,
BINTULU, SARAWAK



SOURCE: MALAYSIAN METEOROLOGICAL SERVICES DEPT.

LOCATION : BINTULU
YEAR : 1975-2008
TIME : 24 HOURS
PERIOD : ANNUAL

SUNNARY OF ANNUAL WIND ROSE AT MMD STATION, BINTULU AIRPORT

FIGURE: 3.2.12

CHEMSAIN KONSULTANT SDN. BHD.

D:\ACAD\DRAWINGS\EV103\527\FIG-3212.DWG

3.2.4 Coastal

3.2.4.1 Offshore and Near Shore Bathymetry

The contours of the Project site are generally parallel with the coastline at the northeast and southwest direction. A number of shoals are found off the coast and the areas with extensive shoals are found off Tanjung (Tg) Similajau extending to Cochrane Bank (Permatang Payung) at the northwest direction.

The foreshore of the proposed Project port's platform area comprises of a narrow beach and cluster of low rocks. The medium gradient beach sloping with some shell fragments, logs and wood debris littered along the beaches.

As for the near shore area, the ground gradient varies from medium to steep sloping rocks. Rock outcrops were found even at the stretch 2 – 6 Km perpendicular to the existing shoreline. A shallow patch of rock outcrops, known as Terumbu Pandan (Mark Reef) located between 9 – 10 m CD contours was observed approximately 3.6 Km from the proposed approach channel to be dredged.

The shoreline is more rocky southwest of the proposed approach channel. To the northeast area from the Project site, the shoreline becomes more rocky from the 600 m north of Kuala Similajau extending 3.2 Km northeast.

3.2.4.2 Wiser Bay

Wiser Bay, also known as Telukan Tubau, is where the proposed Project will be located and dominated by a straight sandy beach of approximately 2 Km. The gentle slope beach extends to about 15 – 20 m seawards during low tide and backed with sandstone cliffs. Other feature that is common in the area is the flat rock ledges that extend to approximately 400 m off the shoreline.

Located to the southwestern end tip of the Wiser Bay, three small streams were observed. They are located a few hundred metres apart. The vegetation observed in the area is mainly Casuarina trees, coastal shrubs, red palm trees and common pitcher plants species. As for the area within the tidal surge zone, the beach consists generally of fine sand with a slope of approximately 1:10 (Vertical:Horizontal). The beach profile is relatively flat with approximate slope of 1:200 below the tidal surge zone. The seabed slope below -5 m is approximately 1:500. The typical profile at Wiser Bay is further illustrated in **Figure 3.2.13**.

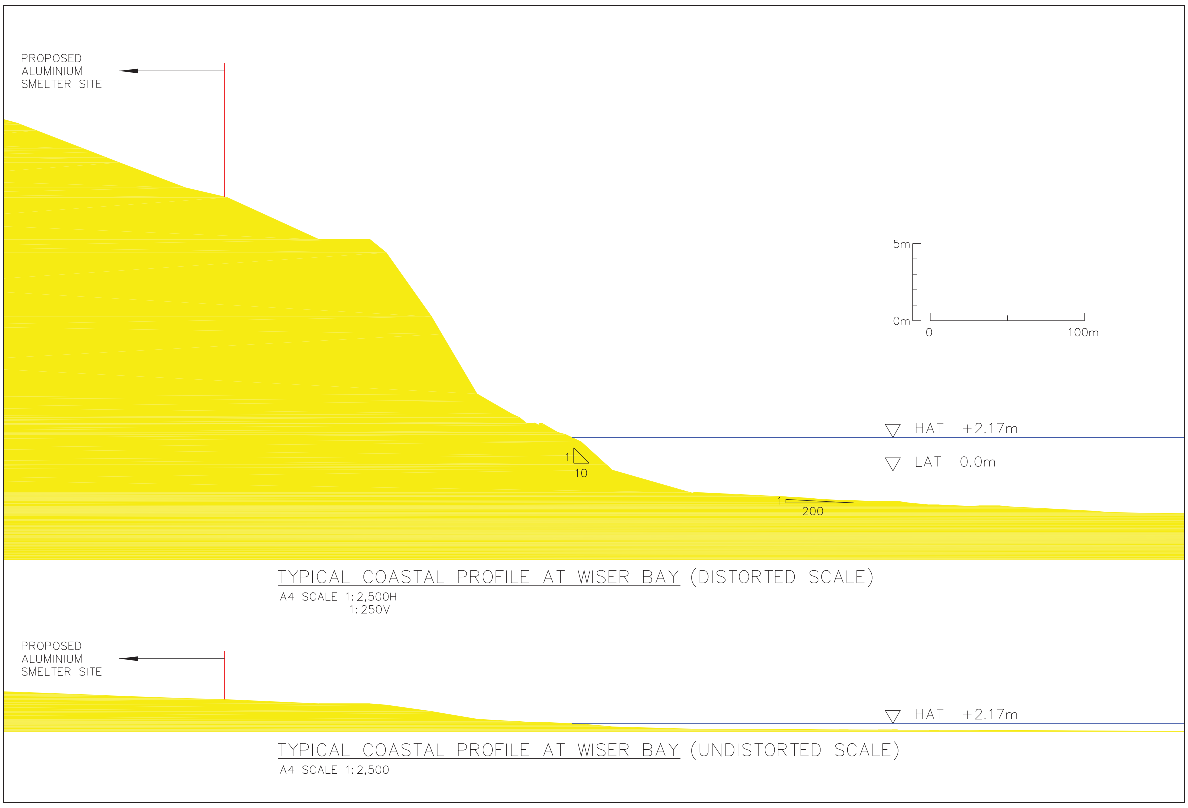


Figure 3.2.13 Typical Coastal Profile at Wiser Bay

3.2.4.3 Similajau Promontory

Similajau Promontory, also locally known as Tg. Similajau, is a cape-like feature and mainly consists of rock outcrops[5] that are perpendicular to the coastline, low cliffs and flat sandy beaches (see **Figure 3.3.1**). It is the nearest promontory to the proposed Project site, located approximately 3.47 Km to the southwest direction

During high tide, the sea water level can submerge the coastal shrub vegetation cover and during low tide, the flat sandy beach area can stretch up to approximately 10 – 20 m seawards. The surge level between ebb and neap tides are considerable high. With the presence of rock outcrop in the area, it poses a hazard to any boat berthing at the area, particularly during strong wave condition.

[5] ***Rock outcrop** is the part of a rock formation that appears above the surface of the surrounding land.*

3.2.4.4 Borgam Promontory

Borgam Promontory, is also locally known as Tg. Borgam, is located approximately 9.36 Km to the northeast of the Project site (see **Figure 3.3.1**). Generally, the landforms found in the area are Sungai (Sg.) Selungun and Sungai (Sg.) Haik, which are relatively flat undulating toward Borgam Promontory with rock outcrops extending toward South China Sea.

3.2.4.5 Coastal Geomorphology

The first 14 Km stretch of the coastal frontage between Tg. Borgam and Tg. Similajau consist a series of rocky outcrops / headlands with concave sandy beached in between. The lengths of sandy beaches range from small pocket beaches of several hundred meters up to 3 Km.

Plate 3.1 Thin layer of sand overlying rocky outcrop.

Plate 3.2 Highly weathered rocky outcrop.

The pocket beach at Tg. Similajau is a short narrow beach with a thin layer of sand overlying the extensive rocky outcrop found in the area. At some portion of the beach, due to the constant wave hitting the shore line, the rocky outcrop forms natural groins fronting the seaward and acts as a natural wave breaker / protection against incoming wave for the area.

Plate 3.3 Natural groins formed nearby the Project site.

Plate 3.4 Terraces of mud / siltstone formation due to weathering process.

As the tidal fluctuates, the exposed rocky outcrops show signs of severe weathering rocks formation, particularly within the tidal surge zone.

3.2.4.6 Coastal Hydrodynamics and Wave Conditions

The offshore wave conditions are very much governed by the monsoon seasonal winds that prevail over the region throughout the year. During the northeast monsoon season, offshore wind is generally between 6 – 10 ms^{-1} blowing from north and northeast directions. However, much lower wind speed were recorded at MMD station at Bintulu Airport, in between 5.5 – 7.9 ms^{-1}, (see **Figure 3.2.11**) due to ***Wind Gradient Effect***[6] as the meteorological station is located further inland and sheltered from direct prevailing wind. During the southwest monsoon season, the offshore wind is not as strong but generally between 5 – 8 ms^{-1} blowing from west and southwest directions, compared to the wind speed recorded further inland of 3.4 – 5.4 ms^{-1}.

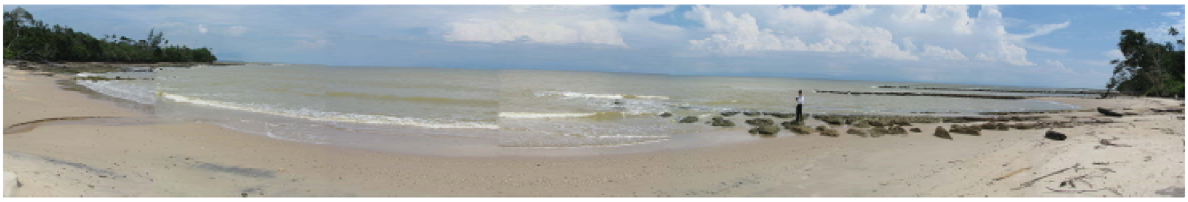
The southwest monsoon winds are generally not destructive in nature compared to northeast monsoon winds, which usually comes with rains and higher water vapour. The southwest monsoon blowing from inland usually carry drier air compared to the denser air blowing from seaward during the northeast monsoon season.

3.2.4.7 Bypass of Sediment at Tg. Similajau, Q_{Bu}:

The existing annual netand gross drifts along the coast north of Tg. Similajau (see **Figure 3.2.15**) were estimated to be approximately **60,000** and **120,000m^3**; respectively. The southerly drift was shown to be mainly due to a surplus from the persistent southerly

[6] ***Wind Gradient Effect*** *is the reduction of wind speed as the wind travel over a city or rough terrain aloft some distance from the source. The wind gradient effect could cause a reduction of 40% to 50% of the geostrophic wind speed.*

transport generated throughout the NE monsoon. The southerly transport induced during the NE-monsoon season is integrated to be approximately **90,000m^3**. The 2D modelling results revealed high transport capacities around the protruding rocky outcrops and headlands for existing conditions and thus indicate full bypass potential here. By studying satellite images and site visit photographic documentation of the coastline adjacent to the headland it is however observed that the coastline retires here and the headland is slightly protruding by 150 m. This indicates that **the actual bypass of sediment is reduced compared to the full bypass potential of 90,000m^3**. It is estimated that the actual annual bypass here is approximately **60,000m^3** corresponding to the net transport on the open coast just up drift of Tg. Similajau. Pictures from the headland area are presented in **Plate 3.5** and **Plate 3.6**.



Upper: Panorama view of pocket beach, Lower: Rocky outcrops.

Figure 3.2.14 Tg. Similajau.

3.2.4.8 Bypass of Sediment at Tg. Sedanai and Tg. Batu Kudu, Q_{Bd}:

The existing net/gross annual drifts along the coast south of Sg. Similajau (see **Figure 3.2.15**) has been estimated to be approximately 60,000/110,000m^3, respectively. The net southerly drifts mainly being due to a surplus from the persistent southerly transport generated throughout the NE monsoon. The southerly transport induced during the NE-monsoon season is calculated (based on average gross and net transport rates) to be approximately 85,000m^3. 2D sediment transport modelling has shown high transport capacities around the rocky outcrops and headlands for existing conditions, indicating a full bypass potential here. The coastlines adjacent to rocky outcrops such as that of Sedanai (see **Figure 3.2.15** and satellite image inset) are only moderately affected by the rocky outcrops. This indicates that the actual bypass of sediment at Tg. Batu Kudu is similar to the full bypass potential of 85,000m^3.

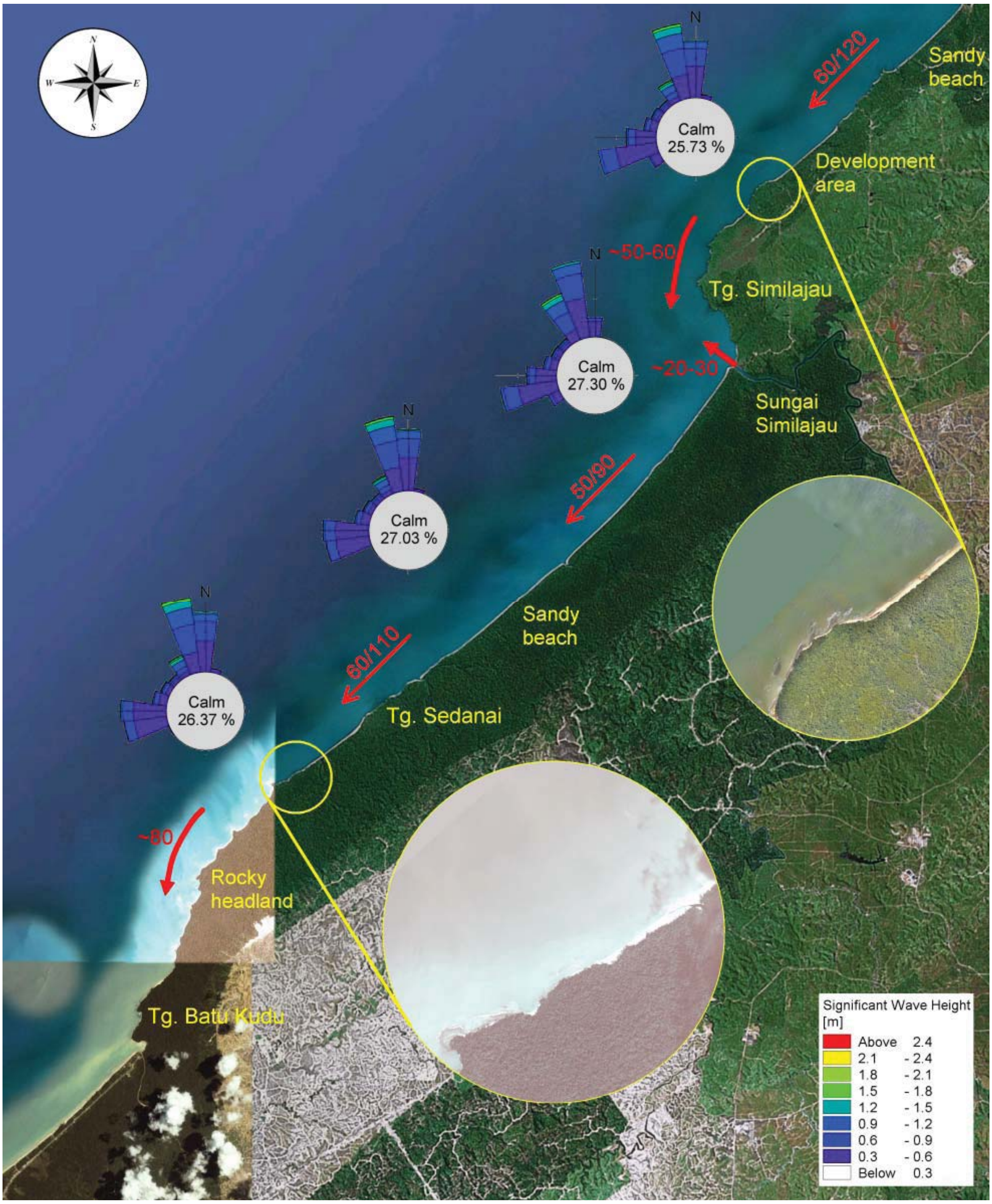


Figure 3.2.15 Similajau coastal cell with littoral drifts and bypass.

3.2.4.9 Sediment Sourced to Coastal Cell from Sg. Similajau, Q_R.

The annual discharged volume of sand from Sg. Similajau to the coastal cell has been estimated to be around **20,000 - 30,000m^3**. The volume has been estimated using two fundamentally different modelling approaches yielding similar annual sediment discharge. The first approach involves an assessment of catchment runoff, with a model based on land use information for the catchment to estimate the total catchment erosion volume. The second approach comprises a 2D sediment transport river model providing detailed sediment transport capacities at the river mouth area from combined river and tidal flow.

3.2.4.10 Similajau Coastal Cell Sediment Budget for Existing Conditions

The annual sediment budget for the existing coastline from Tg. Similajau to Batu Kudu (which includes the national park) can be summarised:

$$\Delta Q = Q_R + Q_{Bu} + Q_{Bd} = 25{,}000m^3 + 55{,}000m^3 - 80{,}000m^3 \cong 0m^3$$

The close-to-zero deficit in the Similajau coastal cell sediment budget indicates that the existing coastline south of Tg. Similajau is stable, which is in line with site observations and satellite images showing no or little erosion here.

3.2.4.11 Initial Similajau Coastal Cell Sediment Budget for Future Conditions:

The port development will entail a deficit in the sediment budget for the Similajau coastal cell caused by full blockage of the updrift sediment bypass, Q_{Bu}, i.e. the sediment feeding the coastal cell from north will terminate. Consequently, the annual sediment budget immediately after the port development will be:

$$\Delta Q = Q_R + Q_{Bu} + Q_{Bd} = 25{,}000m^3 + 0m^3 - 80{,}000m^3 \cong -55{,}000m^3$$

As argued above, a deficit in the sediment budget will starve the Similajau coastline and the coastline will erode as a response to the deficit. The erosion will change the "spiralness" of the bay as also indicated in **Figure 3.2.15**.

The erosion within Similajau coastal cell i.e. along the coastline south of Tg. Similajau to Batu Kudu (which includes the national park coastal stretch) will continue until the bypass rates at the southern boundary of Tg. Butu Kudu reduces to approximately 25,000m^3, equalling the annual amount of material discharged from Sg. Similajau. At such time the annual sediment budget reads:

$$\Delta Q = Q_R + Q_{Bu} + Q_{Bd} = 25{,}000m^3 + 0m^3 - 25{,}000m^3 \cong 0m^3$$

An annual bypass of 25,000m^3 will occur when the coastline has reached an orientation of 325 - 330˚N. The existing orientation of the coastline is 315˚N, i.e. the coastline will become less oblique to the main wave direction.

3.2.4.12 Bintulu Coastal Cell Sediment Budget

If not mitigated, the problems of erosion will migrate south and erosion will eventually occur within the Bintulu coastal cell (see **Figure 3.2.15**) as the sediment bypass around Tg. Batu Kudu will be reduced. Due to a relatively smaller deficit in the sediment budget for the Bintulu coastal cell the erosion rates will be smaller than that of the Similajau coastal cell. Further, the coastline of the Bintulu coastal cell features several rocky outcrops and headlands as shown in **Plate 3.5** and **Plate 3.6**. The impacts of the Similajau port development will end at Bintulu (i.e. at Bintulu port).

	
Plate 3.5 Bintulu Coastal Cell – Facing South	Plate 3.6 Bintulu Coastal Cell – Facing north with Tg. Bt. Kudu protuding

3.2.5 Hydrology and Hydraulics

3.2.5.1 Tides

The tidal regime along the southwest cost of the Project site is usually diurnal type; one high and low tide a day. Generally, spring tides tend to show diurnal nature while neap tides appear semidiurnal. A total of 3 existing tidal stations are identified within the proximity of the Project site, such as, Kpg. Nyalau, Bintulu Port and Bintulu Custom Wharf tidal station. The nearest tidal station to the proposed Project site is Bintulu Port tidal station, which will be adopted for this PEIA study.

The tides information for all 3 tidal stations are as tabulated in **Table 3.2.7** and the locality of the tidal stations are further illustrated in **Figure 3.2.16**.

Table 3.2.7 Tidal Planes at Kpg. Nyalau, Bintulu Port and Bintulu Custom Wharf

Tidal Planes	Kpg Nyalau	Bintulu Port	Bintulu Custom Wharf
	Tidal Level (m)		
Latitude	03° 38'28.4" N	03° 58' 44" N	03° 10' 06.9" N
Longitude	113° 23' 05.5" E	113° 03' 50" E	113° 02' 15.1" E
Source	Marine Dept. (Feb 2004)	JUPEM (1993 – 2003)	Marine Dept. (Jun 2003)
Datum[7]	Chart Datum	Chart Datum	Chart Datum
Type of Tides	Usually diumal	Usually diumal	Usually diumal
Highest Astronomical Tide (HAT)[8]	+2.38	+2.57	+2.82
Mean Higher High Water (MHHW)[9]	+2.04	+2.50	+2.56
Mean High Water (MHW)[10]	+1.78	+2.12	+2.21
Mean Sea Level (MSL)[11]	+1.19	+1.52	+1.63

[7] ***A datum*** *is a base elevation used as a reference from which to reckon heights or depths. A tidal datum is a standard elevation defined by a certain phase of the tide. Tidal datum are used as references to measure local water levels and should not be extended into areas having differing oceanographic characteristics without substantiating measurements.*

[8] ***Highest Astronomical Tide (HAT)*** *is the highest water level that can be predicted to occur under any combination of astronomical conditions.*

[9] ***Mean Higher High Water (MHHW)*** *is the average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch.*

[10] ***Mean High Water (MHW)*** *is the average of all the high water heights observed over the National Tidal Datum Epoch.*

[11] ***Mean Sea Level (MSL)*** *is the arithmetic mean of hourly heights observed over the National Tidal Datum Epoch.*

Tidal Planes	Kpg Nyalau	Bintulu Port	Bintulu Custom Wharf
	Tidal Level (m)		
Mean Low Water (MLW)[12]	+0.60	+0.92	+1.05
Mean Lower Low Water (MLLW)[13]	+0.34	+0.54	+0.70
Lowest Astronomical Tide (LAT)[14]	0.0	0.0	0.0
Land Survey Datum (LSD)	-	+1.38	-

Source: Sarawak Marine Department and JUPEM.

3.2.5.2 River System, Basin Profile and Water Catchment Boundary

The proposed Project site is located at the coastline along the Wiser Bay, also known as Telukan Tubau. The surface runoff water catchment boundary draining the area located further inland to the southwest of the Project site is Similajau Basin, approximately 645 420 804.08 m^2 and located further to the west of the Project site is Suai Basin with an approximate area of 1 882 016 843.30 m^2.

The nearest raw drinking water supply intake point from the proposed Project site is Siod Raw Water Intake Point located approximately 10.36 Km to the south of the Project site. Other identified raw water intake points in the area are further tabulated in **Table 3.2.8** and further illustrated in **Figure 3.2.16**.

Table 3.2.8 Raw Drinking Water Intake Points

Raw drinking water intake point	River	Distance from Project Site	Direction
Siod Raw Water Intake	Sg. Siod	10.36 Km	South
Similajau Raw Water Intake	Sg. Similajau	10.84 Km	South
Kuala Nyalau Raw Water Intake	Sg. Nyalau	12.51 Km	Northwest

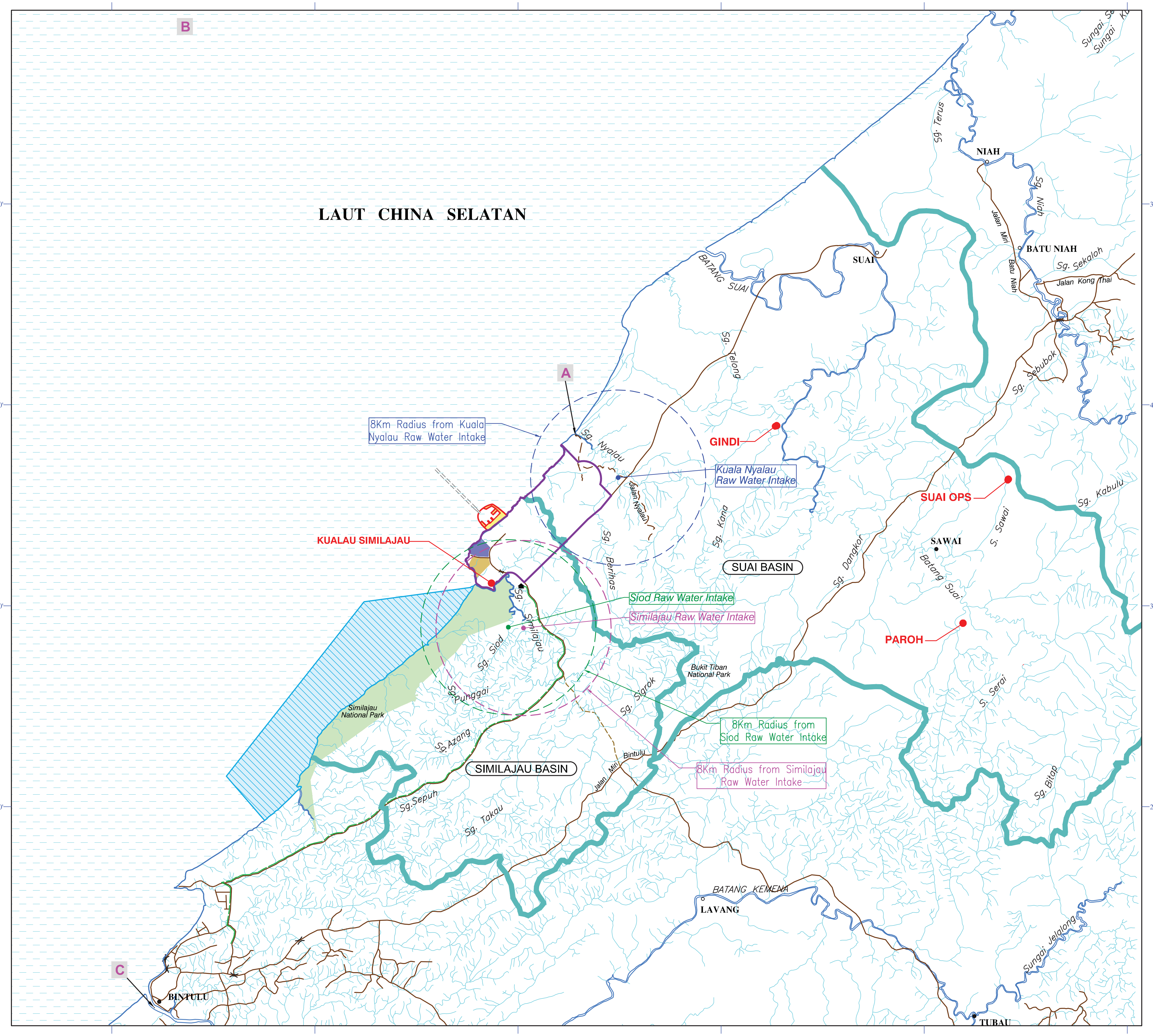
[12] ***Mean Low Water (MLW)*** *is the average of all the low water heights observed over the National Tidal Datum Epoch.*

[13] ***Mean Lower Low Water (MLLW)*** *is the average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch.*

[14] ***Lowest Astronomical Tide (LAT)*** *is the zero value from which all tides are measured.*

PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED NEW SAMALAJU PORT AT SIMILAJAU, BINTULU, SARAWAK



LEGEND:

- Proposed Project
- Samalaju Industrial Park Boundary
- Similajau National Park Boundary
- Main / Coastal Road
- Proposed New Raw Water Supply Pipeline From Bintulu (Sika Dam) Currently Under Construction
- District Boumdary
- Similajau National Park Marine Extension
- Similajau National Park
- Catchment Boundary
- Rivers / Streams
- Proposed New Water Treatment Plant (Samalaju Water Supply Project) - Construction in Progress
- Existing Rainfall Stations

Tidal Planes	A Kpg Nyalau	B Bintulu Port	C Bintulu Custom Wharf
	Tidal Level (m)		
Latitude	03° 38' 28.4" N	03° 58' 44.0" N	03° 10' 06.9" N
Longitude	113° 23' 05.5" E	113° 03' 50.0" E	113° 02 15.1" E

0 3 6 9 12 15 18Km

SCALE IN KILOMETRES (1:350,000) – A3 MEDIUM

SOURCE: Adapted from SERIES T735 SHEET 3/113/6 EDITION 2-D.O.S. 1968 JABATAN PENGAIRAN DAN SALIRAN SARAWAK

GRID
–The outer ticks indicate the Latitude and Longitude

WATER CATCHMENT BASIN BOUNDARY

FIGURE: 3.2.16

D:\ACAD\DRAWINGS\EV103\527\FIG–3216.DWG

3.2.5.3 Plume Modelling Scenarios

Based on six development phases, seven (7) dredge scenarios have been established to cover the main dredging phases. Each of these is combined with two (2) different spill rates (conservative and representative) to provide worst and representative spill in the dredge corridor:-

The dredge scenarios relates to the development phases as given below:-

- **Phase 1**
    - Scenario 1 – no breakwater will be in place; and,
    - Scenario 2 – with breakwater in place.
- **Phase 2**
    - Scenario 3 - dredging of approach channel, outer turning basin and Berth 2 to -15.52m MSL.
- **Phase 3**
    - Scenario 4 – dreading of approach channel, outer turning basin and Berth 2 to a depth of -18.52m MSL.
- **Phase 4**
    - Scenario 5 - dredging of inner channel, inner basin and Berth 3 to a depth of -15.52m MSL, and also construction of Berth.
- **Phase 5**
    - Scenario 6 - final extension of southern breakwater, dredging and reclamation of Berth.
- **Phase 6**
    - Scenario 7 - construction of two jetties (on piles) and dredging of remaining area in the basin to a depth of -15.52m MSL.

3.2.5.3.1 SCENARIO 1

In scenario 1, it is assumed that breakwaters have not been constructed and a CSDs is required for the excavation for breakwater foundation (on water depth approximately -5.5m MSL). A 5000m³ TSHD is required for the dredging of the outer basin and outer approach channel, which will be dredged to -8.5m MSL. The TSHD will commute to the dedicated spoil ground from the dredging area whereas dredged material from the CSDs is assumed to be suitable for reclamation (inner part of profile is potentially sand or sandy material) and therefore will be pumped via pipeline to the reclamation area. The reclamation area is assumed to be protected by bund wall and the overflow will occur from the bund.

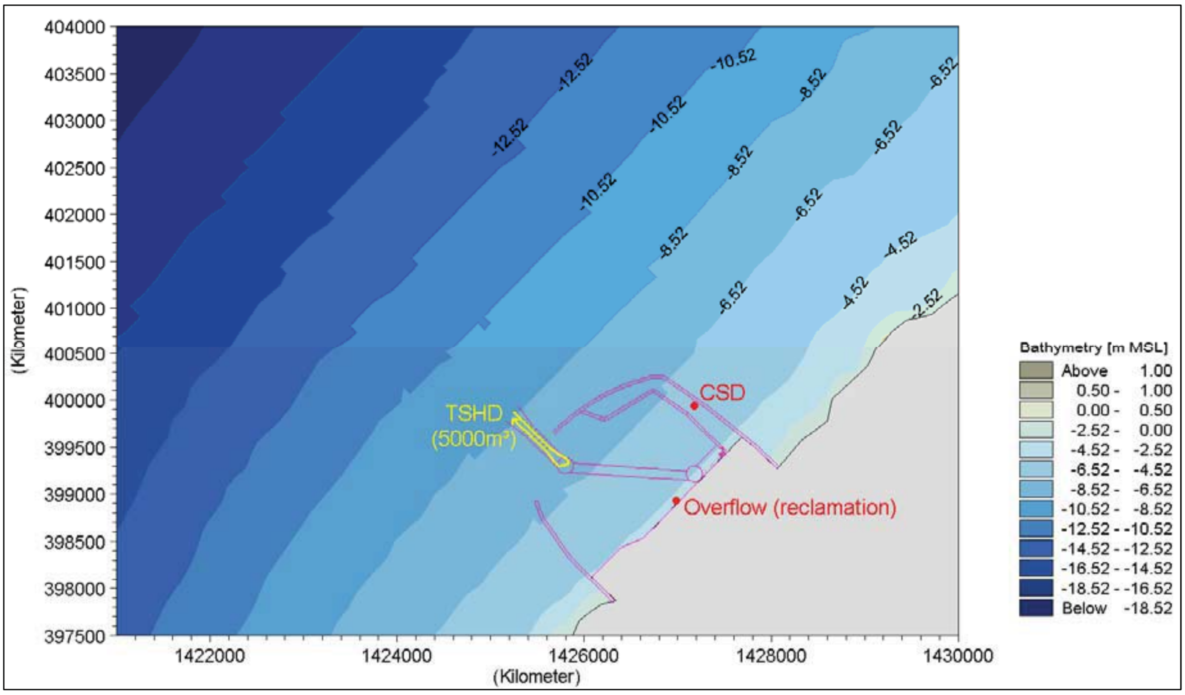


Figure 3.2.17 Dredge Scenario 1 - Phase 1

3.2.5.3.2 SCENARIO 2

Scenario 2 presumes that the breakwaters have been constructed. The CSDs will be dredging along the inner channel and Berth 1 (at water depth of about -6.5m MSL). In this scenario, inner channel and basin, and Berth 1 will be dredged to -8.5m MSL. Dredged material will be pumped to outer reclamation area (attached to the northern breakwater) which is protected by bund limiting the overflow.

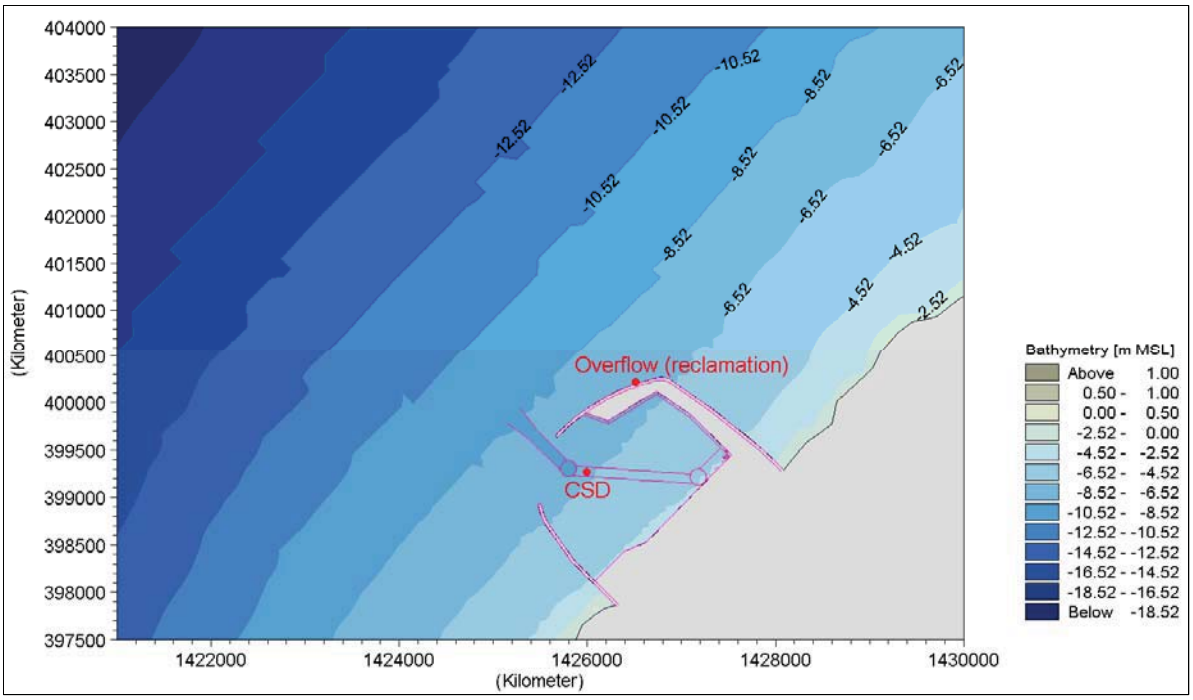


Figure 3.2.18 Dredge scenario 2 – Phase 1

3.2.5.3.3 SCENARIO 3

Scenario 3 is defined based on Phase 2 of the port development, which involves dredging of approach channel, outer turning basin and Berth 2 to -15.5m MSL. Within the port basin area, a CSDs is assumed for the dredging activity at Berth area 2 (at water depth of about -6.5m MSL). Dredged material from CSDs will be loaded on 5000m³ barges and transported to offshore spoil ground. Spills are assumed from both the cutter head and overflow from barges.

A 10000m³ TSHD is assumed to dredge the approach channel and outer turning basin to approximately -15.5m MSL, with overflow from the hopper. The trailer will dispose the dredged material at offshore spoil ground.

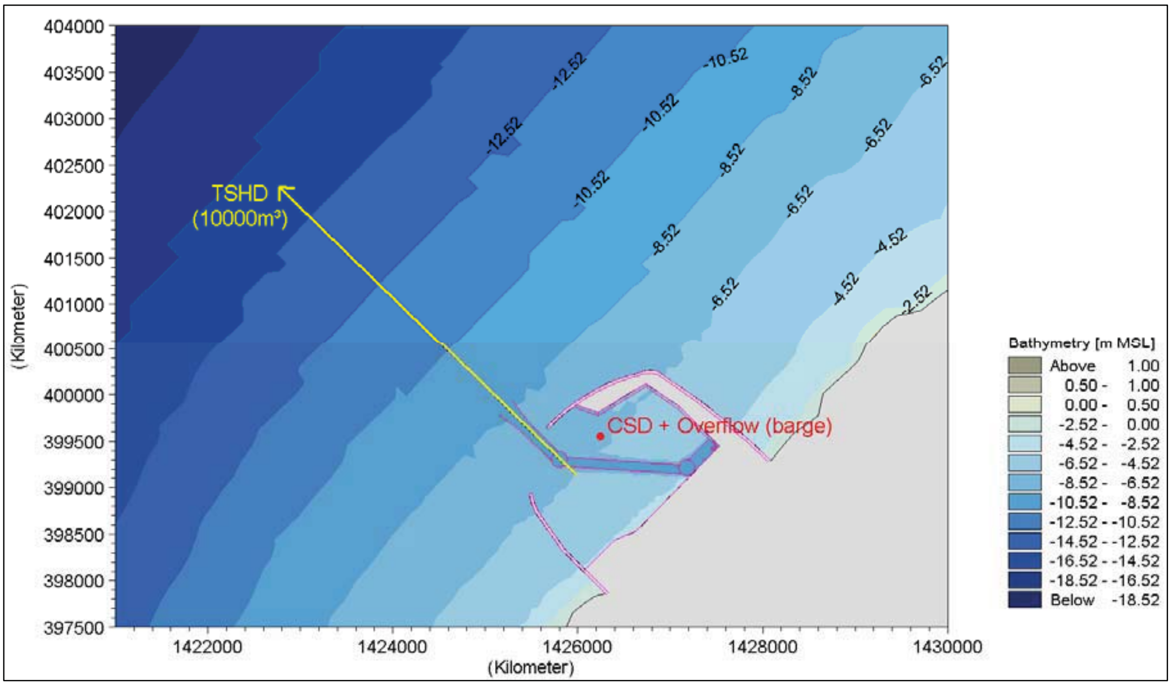


Figure 3.2.19 Dredge scenario 3 – Phase 2

3.2.5.3.4 SCENARIO 4

In this scenario, approach channel, outer turning basin and Berth 2 will be further dredged to a depth of -18.5m MSL. In addition, dredging works at Berth 3 will be initiated. This scenario is defined on basis of port development phase 3.

A CSDs is required for the dredging activity at outer basin, Berth area 2 and 3 (at water depth less than -6.5m MSL). Dredged material from CSDs will be loaded onto a 5000m³ barges and disposed at offshore spoil ground. Spills during dredging works are expected from both the cutter head and overflow from barges.

The remaining approach channel from water depth -13.5m MSL to -18.5m MSL is dredged by a 10000m³ TSHD and is assumed to dredge up to -18.5m MSL. The material will be transported to dedicated offshore spoil ground. Spills are assumed from the overflow from hopper and dumping activity at spoil ground.

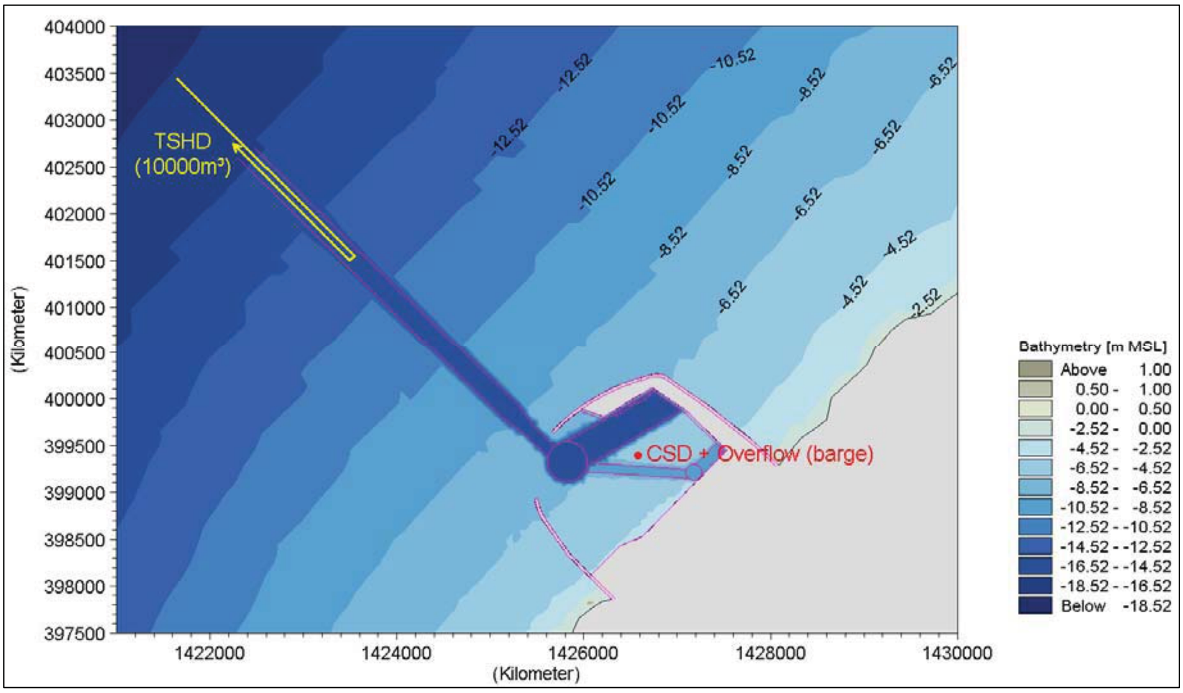


Figure 3.2.20 Dredge scenario 4 – Phase 3

3.2.5.3.5 SCENARIO 5

Scenario 5 is defined based on port development phase 4, which involves dredging of inner channel, inner basin and Berth 3 to a depth of -15.5m MSL, and also construction of Berth area 3.

Assuming a CSDs will be operating at inner channel and inner basin. Dredged material from CSDs will be loaded onto a 5000m³ barges and transported to spoil ground. Spills are expected from both the cutter head and overflow from barges.

A 5000m³ TSHD is assumed for Berth 3, which will be dredged to -18.5m MSL. The TSHD will transport the dredged material to dedicated spoil ground. Spills are assumed from the overflow of hopper and dumping activity at spoil ground.

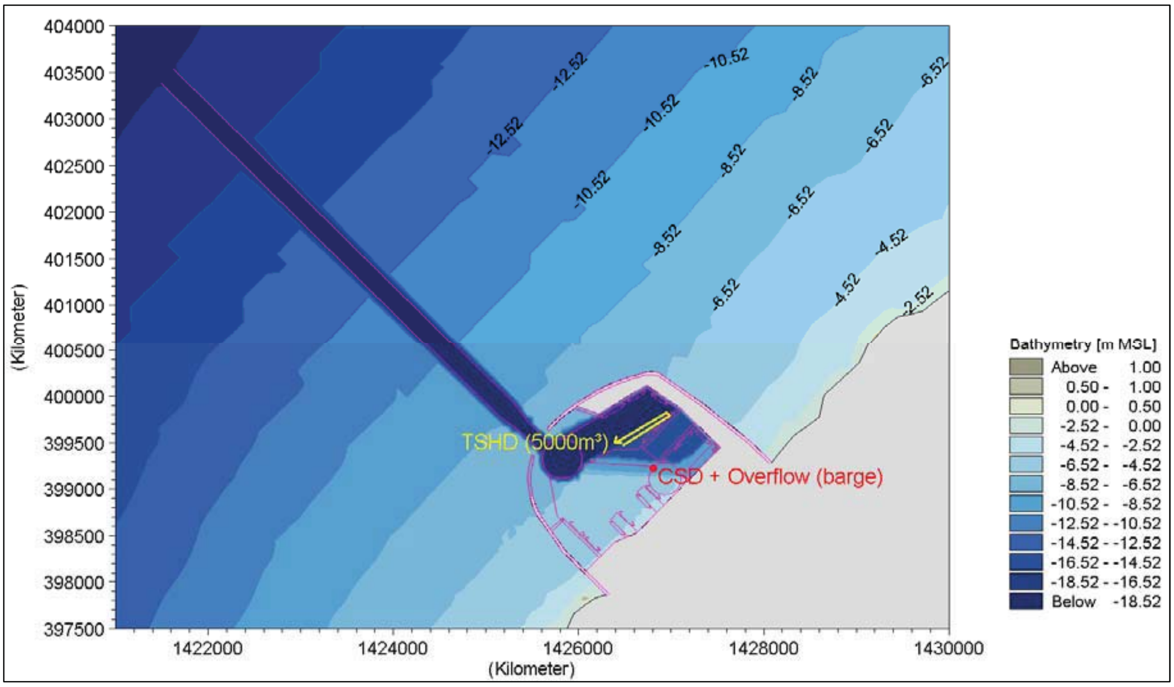


Figure 3.2.21 Dredge scenario 5 – Phase 4

3.2.5.3.6 SCENARIO 6

Development phase 5 emphasises on the development of Berth 4, which includes final extension of southern breakwater, dredging and reclamation of Berth 4.

Assume a CSDs dredging at Berth 4 (on water depth approximately -6.5m MSL). Berth area 4 will be dredged to a depth of -15.5 MSL. Dredged material from CSDs will be loaded on 5000m³ barges and transported to offshore spoil ground. Spills are assumed from the cutter head, overflow of barge and dumping activity at spoil ground.

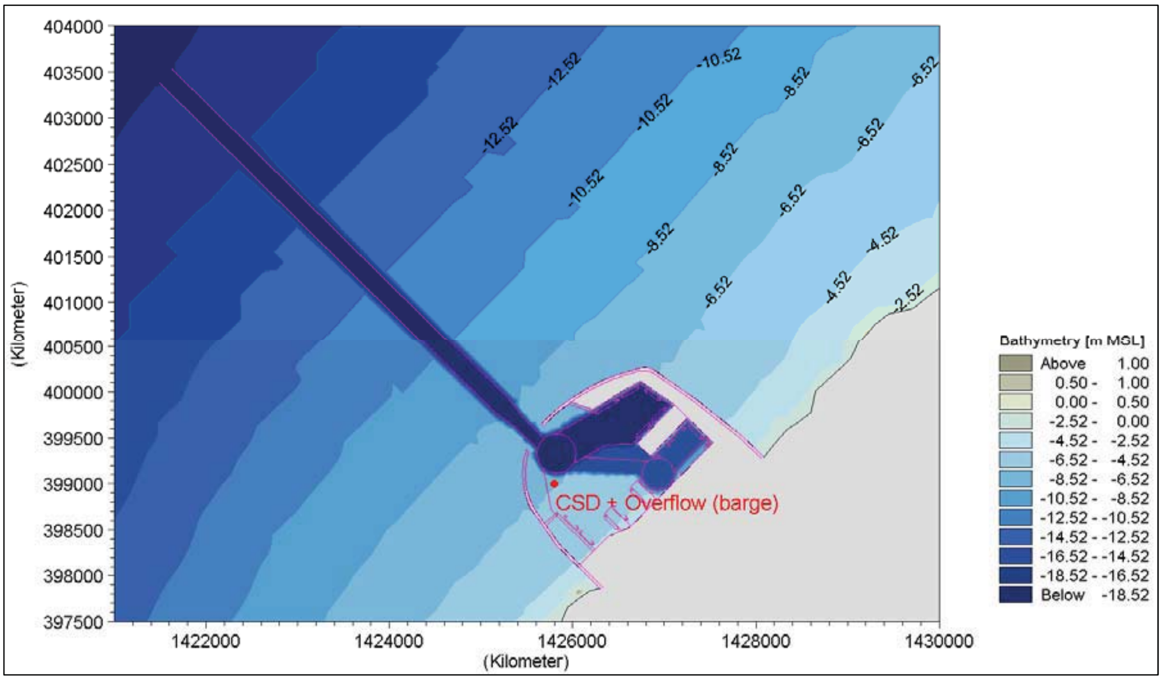


Figure 3.2.22 Dredge scenario 6 – Phase 5

3.2.5.3.7 SCENARIO 7

Scenario 7 is defined based on the final phase, which involves construction of two jetties (on piles) and dredging of remaining area in the basin to a depth of -15.5m MSL.

A CSDs is assumed for the dredging activity at Berth area 4 (on water depth smaller than -6.5m MSL). Dredged material from CSDs will be loaded on 5000m³ barges and transported to offshore spoil ground. Spills are assumed coming from the cutter head, overflow from barges and dumping activity at spoil ground.

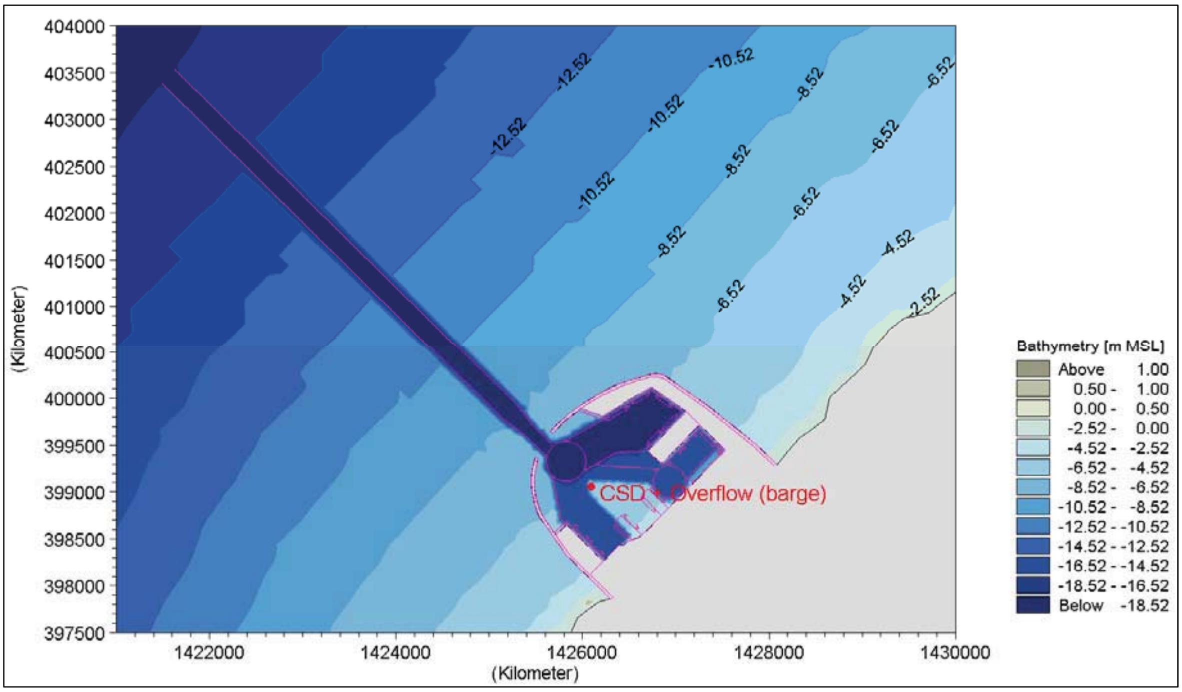


Figure 3.2.23 Dredge scenario 7 – Phase 6

3.2.6 Baseline Sampling

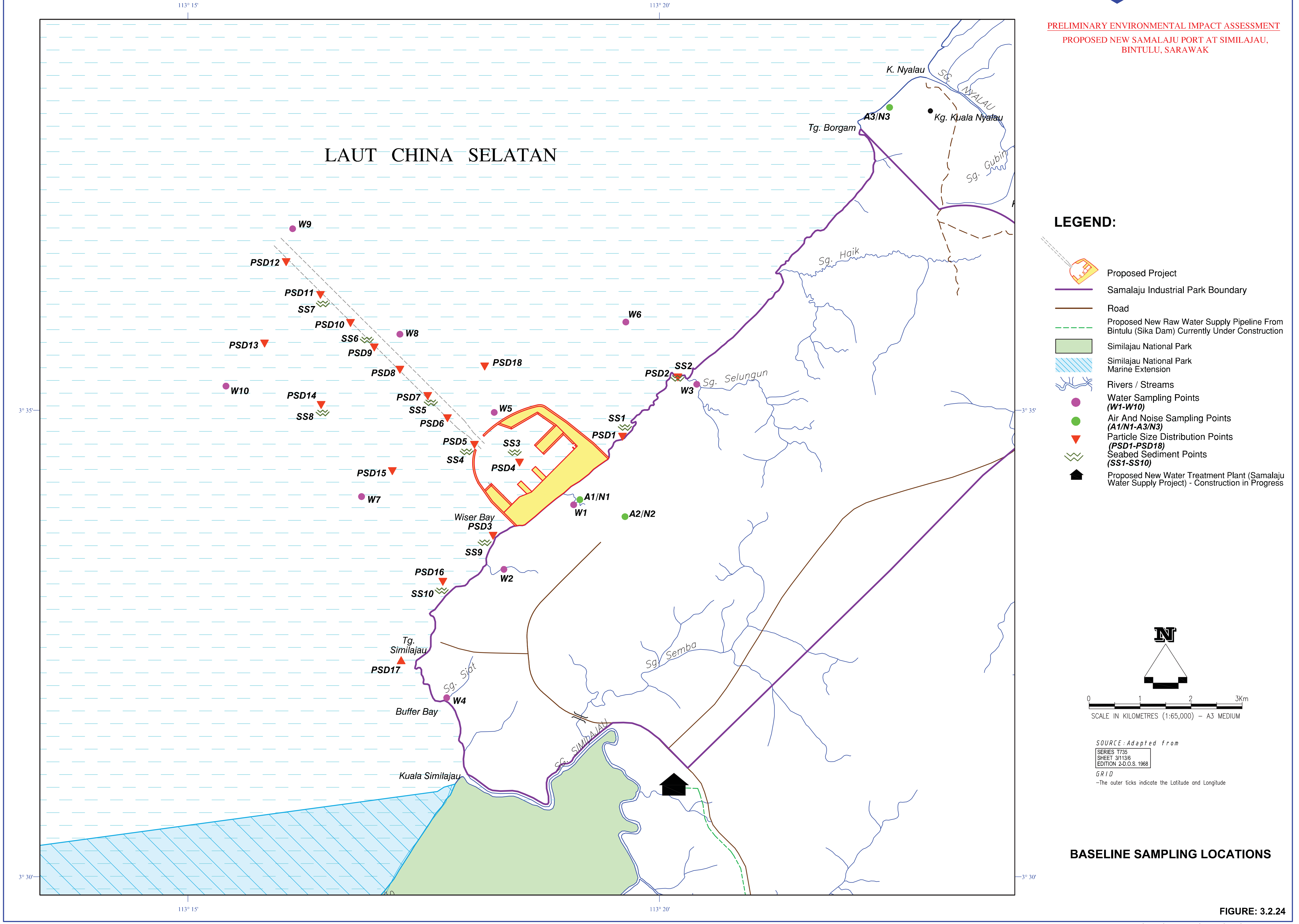
In order to ascertain and characterize the water quality at the proposed Project site and its surrounding area, baseline water quality data has been collected and recorded. Collection of these data involves sampling of river and marine surface water. The sampling locations were carefully chosen and selected to represent the existing natural water quality condition at the area prior to the implementation of the Project and future development of the surrounding area.

3.2.6.1 Surface Water Quality

A total 10 water samples were collected and analysed, consisting of 4 river water samples and 6 marine water samples, from 10 sampling locations within the Project site and its surrounding environment. The details of the river and marine surface water sampling locations are presented in **Table 3.2.9** and its locality is further illustrated in **Figure 3.2.24**.

Table 3.2.9 River and Marine Surface Water Sampling Locations

Sampling I.D.	Latitude	Longitude	Elevation	Type of surface water	Weather condition
W1	3°33'58.00"N	113°19'18.78"E	MSL	River	Fine and cloudy
W2	3°33'17.45"N	113°18'33.89"E	MSL	River	Fine and cloudy
W3	3°35'15.76"N	113°20'36.96"E	MSL	River	Fine and cloudy
W4	3°31'55.29"N	113°17'55.22"E	MSL	River	Fine and cloudy
W5	3°34'57.95"N	113°18'27.87"E	MSL	Marine	Fine and sunny
W6	3°35'55.69"N	113°19'51.81"E	MSL	Marine	Fine and sunny
W7	3°34'4.19"N	113°17'3.24"E	MSL	Marine	Fine and cloudy
W8	3°35'48.11"N	113°17'27.82"E	MSL	Marine	Fine and sunny
W9	3°36'55.76"N	113°16'19.57"E	MSL	Marine	Fine and sunny
W10	3°35'15.07"N	113°16'8.55"E	MSL	Marine	Fine and cloudy



BASELINE SAMPLING LOCATIONS

FIGURE: 3.2.24

The river surface water samples (W1-W4) are then compared with Class IIB of Interim National Water Quality Standard for Malaysia (INWQSM) while the marine water samples (W5-W10) are then compared with Class 2 of Interim Marine Water Quality Standard for Malaysia (IMWQSM).

The Interim Marine Water Quality Standards for Malaysia (IMWQSM) have been used as the benchmark for the marine monitoring program in 1978 for Peninsular Malaysia and in 1985 for Sabah and Sarawak (WEPA, 2011).

The in-situ testing and laboratory results for river surface water samples are tabulated in **Table 3.2.10** whilst the results for marine water samples are shown in **Table 3.2.11** and further appended in **Appendix 3.1**.

Table 3.2.10 Results of in-situ testing and laboratory analysis of river water samples

Parameter(s)	**W1** *26/03/11* *2.50 pm*	**W2** *26/03/11* *5.20 pm*	**W3** *26/03/11* *3.55 pm*	**W4** *26/03/11* *2.05 pm*	**INWQSM Class IIB**[15]
Temperature, °C *(in-situ)*	28.5	28.5	27.5	27.5	NA
pH Value @ 25°C *(in-situ)*	**4.8**	**4.7**	6.9	6.4	6-9
Turbidity, NTU	28	**1,500**	37	**90**	50
Total Suspended Solids, mg/L	24.8	**1,330**	26.0	**86.0**	50
*Total Nitrogen (as N), mg/L	2.87	2.73	1.58	1.92	NA
Dissolved Phosphorus (as P), mg/L	<0.03	0.07	<0.03	0.09	0.2
*Salinity, g/kg	<1	<1	<1	14	NA
Total Lead (as Pb), mg/L	<0.01	0.03	0.02	<0.01	0.05
Total Copper (as Cu), mg/L	<0.02	<0.02	<0.02	<0.02	1
Total Nickel (as Ni), mg/L	<0.02	<0.02	<0.02	<0.02	0.05
Total Cadmium (as Cd), mg/L	0.003	0.005	0.009	0.005	0.01
Total Chromium (as Cr), mg/L	<0.02	<0.02	<0.02	<0.02	NA
Total Mercury (as Hg), mg/L	<0.001	<0.001	<0.001	<0.001	0.001

[15] *Class IIB represents water bodies of good quality. Most existing raw water supply sources come under this category. In practice, no body contact activity is allowed in this water for prevention of probable human pathogens. There is a need to introduce another class for water bodies not used for water supply but of similar quality which may be referred to as **Class IIB.** The determination of **Class IIB** standard is based on criteria for recreational use and protection of sensitive aquatic species*

Parameter(s)	**W1** *26/03/11* *2.50 pm*	**W2** *26/03/11* *5.20 pm*	**W3** *26/03/11* *3.55 pm*	**W4** *26/03/11* *2.05 pm*	**INWQSM Class IIB**[15]
Total Arsenic (as As), mg/L	<0.006	0.009	<0.006	<0.006	0.05
E. coli Count MPN/100 mL, 44.5±0.2°C/24 h	6.8	3.3×10^2	2.3×10^2	33	NA
Note: ***Shaded figures exceeded guideline values.***					

NA : Not Applicable / Not Available

Table 3.2.11 Results of in-situ testing and laboratory analysis of marine water samples

Parameter(s)	**W5** *25/03/11* *11.32 am*	**W6** *25/03/11* *10.55 am*	**W7** *26/03/11* *10.50 am*	**W8** *25/03/11* *11.53 am*	**W9** *25/03/11* *12.08 pm*	**W10** *26/03/11* *11.30 am*	**IMWQSM Class 2**[16]
Temperature, °C *(in-situ)*	27.0	26.5	27.5	27.5	28.0	28.0	≤ 2°C increase over maximum ambient
pH Value @ 25°C *(in-situ)*	7.3	7.5	6.4	7.5	7.5	7.5	NA
Turbidity, NTU	11	27	11	6.9	1.0	3.5	NA
Total Suspended Solids, mg/L	11.2	24.2	7.6	5.2	<5.0	5.8	50mg/L (25 mg/L) or ≤ 10% increase in seasonal average, whichever is lower
*Total Nitrogen (as N), mg/L	1.58	1.51	1.83	1.46	1.50	1.68	NA
Dissolved Phosphorus (as P), mg/L	0.03	0.03	0.10	<0.03	0.04	0.05	NA
*Salinity, g/kg	30	29	28	29	29	29	NA
Total Lead (as Pb), mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.0085
Total Copper (as Cu), mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.0029
Total Nickel (as Ni), mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA
Total Cadmium (as Cd), mg/L	**0.009**	**0.009**	**0.008**	**0.010**	**0.010**	**0.010**	0.002 (0.003)
Total Chromium (as Cr), mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA

[16] ***Class 2*** *beneficial uses for marine life, fisheries, coral reefs, recreational and mariculture.*

Parameter(s)	**W5** *25/03/11* *11.32 am*	**W6** *25/03/11* *10.55 am*	**W7** *26/03/11* *10.50 am*	**W8** *25/03/11* *11.53 am*	**W9** *25/03/11* *12.08 pm*	**W10** *26/03/11* *11.30 am*	**IMWQSM Class 2[16]**
Total Mercury (as Hg), mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.00016 (0.00004)
Total Arsenic (as As), mg/L	<0.006	<0.006	<0.006	<0.006	<0.006	<0.001	0.02 (0.003)*
E. coli Count MPN/100 mL, 44.5±0.2°C/24 h	<1.8 (Not Detected)	<1.8 (Not Detected)	<1.8 (Not Detected)	<1.8 (Not Detected)	<1.8 (Not Detected)	<1.8 (Not Detected)	NA
Note: ***Shaded figures exceeded guideline values.***							

**Interim Marine Water Quality Standard for Malaysia (IMWQSM) in parentheses is for coastal and marine water areas where seafood for human consumption is applicable*

NA : Not Applicable / Not Available

pH

pH is a value which represents the acidity or alkalinity of a solution. The definition for pH is the negative logarithm of the hydrogen-ion concentration,

$$pH = -\log_{10}[H^+]$$

pH is an important water quality parameter as the concentration range suitable for the existence of biological life is quite narrow and critical. For all the 10 water samples tested, only **W1** (pH 4.8) and **W2** (pH 4.7) exceeded the INWQSM Class IIB standard of pH 6-9.

As the water sampling locations, W1 and W2 are detected at the river surface water sample located further inland, the possible occurrence of this condition is most likely due to (**1**) presence of Potential Acid Sulphate Soil (PASS) that usually exist at peat swamp / coastal area and (**2**) sampling points are located within remote river tributaries that has less dilution effects.

Turbidity and Total Suspended Solids (TSS)

Turbidity is a measurement of the light-transmitting properties of water. It is a test used to indicate the relative quantity of waste discharges and the quality of natural waters with respect to colloidal and residual suspended matter. The measurement of turbidity is based on a comparison of the intensity of light scattered by a sample relative to that scattered by a reference suspension under the same conditions.

Total Suspended Solids (TSS) is small solid particles which remain in suspension in water as a colloid or due to the motion of the water. TSS is important as pollutants and pathogens are carried on the surface of particles. The smaller the particle size, the greater the surface area per unit mass of particle, and so the greater the pollutant load that is likely to be carried. The level of turbidity and TSS concentration in the water are closely associated with each other. The increase of TSS level means the increase of suspended solid in water, reduction of light scattered and subsequently increasing the turbidity level.

From the laboratory analysis results, it is observed that the turbidity and the level of TSS at **W2** is 1,500 NTU and 1,330 mg/l and at **W3** is 90 NTU and 86 mg/l, exceeding the INWQSM Class IIB recommended level of 50 NTU and 50 mg/l respectively.

As both the water sample W1 and W2 located midstream, away from coastal wave disturbance, it is most likely the contributing factor to the high level of TSS and turbidity at W2 is due to the sediment runoff from nearby project site clearing works and logging by others and as for W3, it is most likely due to the turbulence created during the transitional of ebb and neap tide.

Plate 3.7 Currently on-going site clearing works by other at water sampling location W2.

Plate 3.8 Visible sediment runoff at water sampling location W2.

Plate 3.9 Water sampling location W3.

Plate 3.10 View from water sampling location W3.

Cadmium (Cd)

Cadmium occurs as a minor component in most zinc ores and therefore is a by-product of zinc production. Cadmium is produced mainly as a by-product from mining, smelting, and refining sulphuric ores of zinc, and, to a lesser degree, lead and copper. Cadmium-containing ores are rare and are found to occur in small quantities. However, traces do naturally occur in phosphate, and have been shown to transmit in food through fertilizer application. Cadmium has many common industrial uses as it is a key component in battery production, is present in cadmium pigments, coatings, and it is a metal that is commonly used in electroplating.

It is also observed that the cadmium level detected at water samples **W5** (0.009 mg/l), **W6** (0.009 mg/l), **W7** (0.008 mg/l), **W8** (0.010 mg/l), **W9** (0.010 mg/l) and **W10** (0.010 mg/l) slightly exceeded the recommended Class 2 IMWQSM level of 0.002 (0.003) mg/l.

3.2.6.2 Ambient Air Quality

The existing ambient air quality level was sampled at 3 locations. The sampling locations were identified based on its proximity of the human settlement to the proposed Project site. The descriptions of sampling locations are presented in **Table 3.2.12** and its locality is further shown in **Figure 3.2.24**.

Table 3.2.12 Ambient air quality and noise level sampling locations

Sampling I.D	Latitude	Longitude	Weather Condition	Description
A1/N1	3°34'2.02"N	113°19'22.37"E	Fine and cloudy	Coastal shoreline along proposed platform area (see **Plate 3.11**).
A2/N2	3°33'51.1"N	113°19'51.1"E	Fine and sunny	Daisy Acres Sdn. Bhd. site office (see **Plate 3.13**).
A3/N3	3°38'12.9"N	113°22'40.1"E	Fine and sunny	Kpg. Kuala Nyalau Community Centre (see **Plate 3.12**)

The ambient air quality levels are then compared with Malaysian Recommended Guidelines for Gaseous Pollutant (MRGGP). The laboratory analysis results for ambient air quality are further shown in **Table 3.2.13**.

Table 3.2.13 Ambient Air Quality Laboratory Analysis Results

Sampling I.D.	Nitrogen Dioxide (NO_2), $\mu g/m^3$	Sulphur Dioxide (SO_2), $\mu g/m^3$	Total Suspended Particulates, $\mu g/m^3$
A1	23.8	<20	95.3
A2	21.2	<20	30.3
A3	17.9	<20	23.4
MRGGP Guidelines	**320**	**500**	**260**

The ambient air quality result shows that for all sampled locations, the existing air quality on-site and its surrounding area are well below the Malaysian Recommended Guidelines for Gaseous Pollutants of **260 $\mu g/m^3$**, for total suspended particulates, **320 $\mu g/m^3$** for nitrogen dioxide and **500 $\mu g/m^3$** for sulphur dioxide respectively. The laboratory analysis results are also appended in **Appendix 3.2**.

Plate 3.11 Ambient Air Sampling A1 along the coastal shoreline of proposed port's platform area.

Plate 3.12 Ambient Air Sampling A3 at Kpg. Kuala Nyalau Community Centre.

Plate 3.13 Ambient Air Sampling A2 at Daisy Acres Sdn. Bhd's site office.

3.2.6.3 Ambient Noise Level

Ambient noise level were measured at 3 sensitive receptors nearest to the proposed Project site, similar to those of the baseline air monitoring, during day and night time. The localities of the sampling points are described in **Table 3.2.12** and the summary of the ambient noise level is as shown in **Table 3.2.14**.

Table 3.2.14 Ambient Noise Level Analysis Results

Sampling I.D.	Result (dB)									
	Day time (7.00am – 10.00pm)					Night time (10.00pm – 7.00am)				
	L_{max}	L_{min}	L_{eq}	L_{10}	L_{90}	L_{max}	L_{min}	L_{eq}	L_{10}	L_{90}
N1	74.1	35.5	46.2	48.3	41.2	77.8	38.6	56.8	57.9	43
N2	69.4	35.6	46.9	48.9	42.1	70.8	34	43	44	37.3
N3	79.2	43.8	54.7	59	46.9	72	44	52	54.5	47.4

Sampling I.D.	Result (dB)									
	Day time (7.00am – 10.00pm)					Night time (10.00pm – 7.00am)				
	L_{max}	L_{min}	L_{eq}	L_{10}	L_{90}	L_{max}	L_{min}	L_{eq}	L_{10}	L_{90}
DOE Limit (L_{eq})	**70**					**60**				
Note: Shaded figures exceed guideline values.										

Ambient noise levels were carried out during day and night time. Day time usually means 7.00am – 10.00pm, while night time means 10.00pm – 7.00am. The measured ambient noise level are then compared against "The Planning Guidelines for Environmental Noise Limits and Control", DOE Limit with maximum permissible sound level (L_{eq}) by receiving land use for planning and new development for *Designated Industrial Zones* of **70 dB** and **60 dB** for day and night time respectively.

From the ambient noise level analysis results, it is observed that the noise level during day and night time are well within the stipulated limit of 70 dB (day time) and 60 dB (night time) for *Designated Industrial Zones* category.

3.2.6.4 Seabed Sediment Sampling

The assessment of sediment quality and its chemical composition is necessary in order to study the impacts of the proposed Project's activities to the marine ecology environment, which are generally related to the upwelling of settled compounds and transportation of contaminants from water column to the benthos. This sediment physicochemical characteristic study will be used to ascertain whether there is significant amount of contaminants generated from the proposed development activities being deposited in the sediment, which then may be transferred and accumulated to the benthic fauna food chain.

Table 3.2.15 Seabed Sediment Sampling Locations

Sampling I.D.	Latitude	Longitude	Elevation	Weather Condition	Plates
SS1	3°34'43.43"N	113°19'49.81"E	MSL	Fine and Cloudy	Plate 3.14
SS2	3°35'20.53"N	113°20'24.83"E	MSL	Fine and Cloudy	Plate 3.15
SS3	3°34'26.05"N	113°18'44.33"E	MSL	Fine and Cloudy	Plate 3.16
SS4	3°34'38.08"N	113°18'15.98"E	MSL	Fine and Cloudy	Plate 3.17
SS5	3°35'9.69"N	113°17'45.35"E	MSL	Fine and Cloudy	Plate 3.18

Sampling I.D.	Latitude	Longitude	Elevation	Weather Condition	Plates
SS6	3°35'41.67"N	113°17'11.94"E	MSL	Fine and Cloudy	Plate 3.19
SS7	3°36'14.19"N	113°16'37.65"E	MSL	Fine and Cloudy	Plate 3.20
SS8	3°35'3.72"N	113°16'38.11"E	MSL	Fine and Cloudy	Plate 3.21
SS9	3°33'40.00"N	113°18'27.61"E	MSL	Fine and Cloudy	Plate 3.22
SS10	3°33'9.37"N	113°17'55.39"E	MSL	Fine and Cloudy	Plate 3.23

The laboratory analysis results for the seabed sediments' chemical composition are as shown in **Table 3.2.16** and then compared with Effect Range-Low standard by National Oceanic and Atmospheric Administration (NOAA) for sediment quality guidelines. The lower 10 percentile data were identified as Effects Range-Low (ERL), and the median as Effects Range-Median (ERM). The laboratory analysis results for the seabed sediments are appended in **Appendix 3.4**.

Plate 3.14 Seabed sediments Sampling Location SS1.

Plate 3.15 View from Seabed sediments Sampling Location SS2.

Plate 3.16 Grab sample of Seabed sediments Sampling Location SS3.

Plate 3.17 Grab sample of Seabed sediments Sampling Location SS4.

	
Plate 3.18 Seabed sediments Sampling Location SS5.	Plate 3.19 Seabed sediments Sampling Location SS6.
	
Plate 3.20 Seabed sediments Sampling Location SS7.	Plate 3.21 Seabed sediments Sampling Location SS8.
	
Plate 3.22 Seabed sediments Sampling Location SS9.	Plate 3.23 Seabed sediments Sampling Location SS10.

Table 3.2.16 Seabed sediments Laboratory Analysis Results

Parameter (s)	SS 1 *25/03/11* *11.08 am*	SS 2 *25/03/11* *10.40 am*	SS 3 *25/03/11* *11.23 am*	SS 4 *25/03/11* *1.20 pm*	SS 5 *25/03/11* *1.09 pm*	SS 6 *25/03/11* *12.49 pm*	SS 7 *25/03/11* *12.33 pm*	SS 8 *25/03/11* *11.10 am*	SS 9 *25/03/11* *10.26 am*	SS 10 *25/03/11* *10.38 am*	NOAA Guidelines	
											ERL	**ERM**
Lead (as Pb), mg/kg	25.2	5.0	13.8	12.6	15.0	15.0	15.8	13.5	12.2	15.2	**46.7**	**218**
Copper (as Cu), mg/kg	9.1	0.6	4.6	5.4	6.4	6.9	7.5	6.8	6.3	7.7	**34**	**270**
Nickel (as Ni), mg/kg	19.5	2.6	11.3	13.6	15.3	16.3	17.1	15.7	14.3	15.9	**20.9**	**51.6**
Cadmium (as Cd), mg/kg	1.0	0.5	0.6	0.7	0.8	0.8	0.9	0.8	0.6	0.7	**1.2**	**9.6**
Chromium (as Cr), mg/kg	14.1	1.2	6.9	8.3	9.0	9.6	9.8	9.2	8.8	12.3	**81**	**370**
Iron (as Fe), mg/kg	**36,000**	**4,680**	**18,200**	**25,700**	**23,600**	**24,800**	**24,500**	**22,100**	**24,000**	**30,700**	**-**	**-**
Manganese (as Mn), mg/kg	**878**	**138**	**427**	**441**	**511**	**519**	**455**	**484**	**620**	**780**	**-**	**-**
Mercury (as Hg), mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	**0.15**	**0.71**
Arsenic (as As), mg/kg	3.1	1.0	1.7	1.4	2.0	1.0	0.8	1.3	1.4	1.3	**8.2**	**70**
Cyanide (as CN), mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**-**	**-**

Based on the laboratory analysis results shown in **Table 3.2.16**, it can be observed that the concentration of Iron (Fe) and Manganese are relatively high for all sediment sample tested. The source of these chemical compounds couldn't be verified at this juncture. However, based on the observation on the land use surrounding the proposed Project site and taking into consideration the proximity of Similajau National Park and its Marine Extension, which limit any human activities within the boundary, it is most likely the high concentration of Iron (Fe) and Manganese occur naturally on-site. This is further supported with the findings from the laboratory analysis results for *Detailed Environmental Impact Assessment (DEIA) for Proposed Integrated Ferro-Alloy Complex (Phase 1) in Samalaju Industrial Park, Bintulu, Sarawak*, which shows high content of Iron in found in sediment samples.

3.2.6.5 Particle Size Distribution

Apart from the seabed sediment samples above, another 18 seabed sediment samples were obtained using a Van Veen grab sampler to determine the percentage of various particle sizes present at the proposed Project's approach channel and its proximity area. Laboratory analyses were carried out using dry sieving methods[17] (sieve analysis) for the identification of Particle Size Distribution. In overall, the results showed that the sediment sizes are generally divided into 4 categories:-

1. Clay - < 0.020 mm;
2. Silt - 0.020 – 0.075 mm;
3. Sand - 0.075 – 2.00 mm; and,
4. Gravel (Coarse Sand) - > 2.00 mm.

Table 3.2.17 Particle Size Distribution Sampling Locations

Sampling I.D.	Latitude	Longitude	Weather Condition	Description
PSD1	3°34'42.74"N	113°19'49.19"E	Fine and Cloudy	Along coastal shoreline northeast from Proposed Project
PSD2	3°35'20.53"N	113°20'24.83"E	Fine and Cloudy	Along coastal shoreline northeast from Proposed Project
PSD3	3°33'39.59"N	113°18'27.26"E	Fine and Sunny	Wiser Bay

[17] ***Sieve Analysis*** *is a simple method of shaking the sample in sieves until the amount retained becomes more or less constant. Alternatively, the sample may be washed through with a non-reacting liquid such as water or blown through with air current.*

Sampling I.D.	Latitude	Longitude	Weather Condition	Description
PSD4	3°34'26.11"N	113°18'43.73"E	Fine and Cloudy	Within proposed turning basin
PSD5	3°34'37.88"N	113°18'15.22"E	Fine and Cloudy	Along proposed approach channel
PSD6	3°34'54.99"N	113°17'58.14"E	Fine and Cloudy	Along proposed approach channel
PSD7	3°35'9.29"N	113°17'45.25"E	Fine and Cloudy	Along proposed approach channel
PSD8	3°35'26.10"N	113°17'27.69"E	Fine and Cloudy	Along proposed approach channel
PSD9	3°35'40.50"N	113°17'11.62"E	Fine and Cloudy	Along proposed approach channel
PSD10	3°35'55.75"N	113°16'56.39"E	Fine and Cloudy	Along proposed approach channel
PSD11	3°36'13.81"N	113°16'37.12"E	Fine and Cloudy	Along proposed approach channel
PSD12	3°36'35.30"N	113°16'15.34"E	Fine and Cloudy	Along proposed approach channel
PSD13	3°35'42.81"N	113°16'1.57"E	Fine and Sunny	Southwest from proposed approach channel
PSD14	3°35'3.59"N	113°16'37.66"E	Fine and Sunny	Southwest from proposed approach channel
PSD15	3°34'20.96"N	113°17'23.03"E	Fine and Sunny	Southwest from proposed approach channel
PSD16	3°33'10.10"N	113°17'55.10"E	Fine and Sunny	Southwest from proposed approach channel
PSD17	3°32'18.60"N	113°17'28.26"E	Fine and Sunny	Tg. Similajau
PSD18	3°35'27.85"N	113°18'21.78"E	Fine and Sunny	Northeast of proposed wave breaker

The particle size distribution (PSD) laboratory results are further shown in **Table 3.2.18** and **Table 3.2.19** and further summarized in **Figure 3.2.25**. Based on the PSD results summarized in **Figure 3.2.25**, it can be observed that the main compositions of sediments on-site are silt (73.17%) followed by clay (17.66%) and fine sand (9.13%). No coarse sand / gravel (>2.00mm) was found in the area. The laboratory results for the PSD are appended in **Appendix 3.5**.

Table 3.2.18 Percentage of Particle Size Distribution Sizes, Sheet 1/2

Parameter(s)	PSD 1 *25/03/11* *11.08 am*	PSD 2 *25/03/11* *10.40 am*	PSD 3 *26/03/11* *10.26 am*	PSD 4 *25/03/11* *11.23 am*	PSD 5 *25/03/11* *1.20 pm*	PSD 6 *25/03/11* *1.11 pm*	PSD 7 *25/03/11* *1.04 pm*	PSD 8 *25/03/11* *12.58 pm*	PSD 9 *25/03/11* *12.49 pm*
Particle Size Distribution									
Coarse Sand, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fine Sand, %	0.7	100	4.9	13.7	6.3	3.0	3.4	1.4	1.1
Silt, %	90.3	0.0	70.1	45.3	71.7	77.0	91.6	95.6	82.9
Clay, %	9.0	0.0	25.0	41.0	22.0	20.0	5.0	3.0	16.0

Table 3.2.19 Percentage of Particle Size Distribution Sizes, Sheet 2/2

Parameter(s)	PSD 10 *25/03/11* *12.40 pm*	PSD 11 *25/03/11* *12.33 pm*	PSD 12 *25/03/11* *12.20 pm*	PSD 13 *26/03/11* *11.20 am*	PSD 14 *26/03/11* *11.10 am*	PSD 15 *26/03/11* *10.58 am*	PSD 16 *26/03/11* *10.38 am*	PSD 17 *26/03/11* *11.55 am*	PSD 18 *25/03/11* *11.42 am*
Particle Size Distribution									
Coarse Sand, %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fine Sand, %	1.4	4.7	13.7	2.0	1.4	5.3	1.1	0.1	0.1
Silt, %	70.3	65.4	66.7	77.0	64.6	88.0	88.0	84.9	87.6
Clay, %	28.3	29.9	19.6	21.0	34.0	6.7	10.0	15.0	12.3

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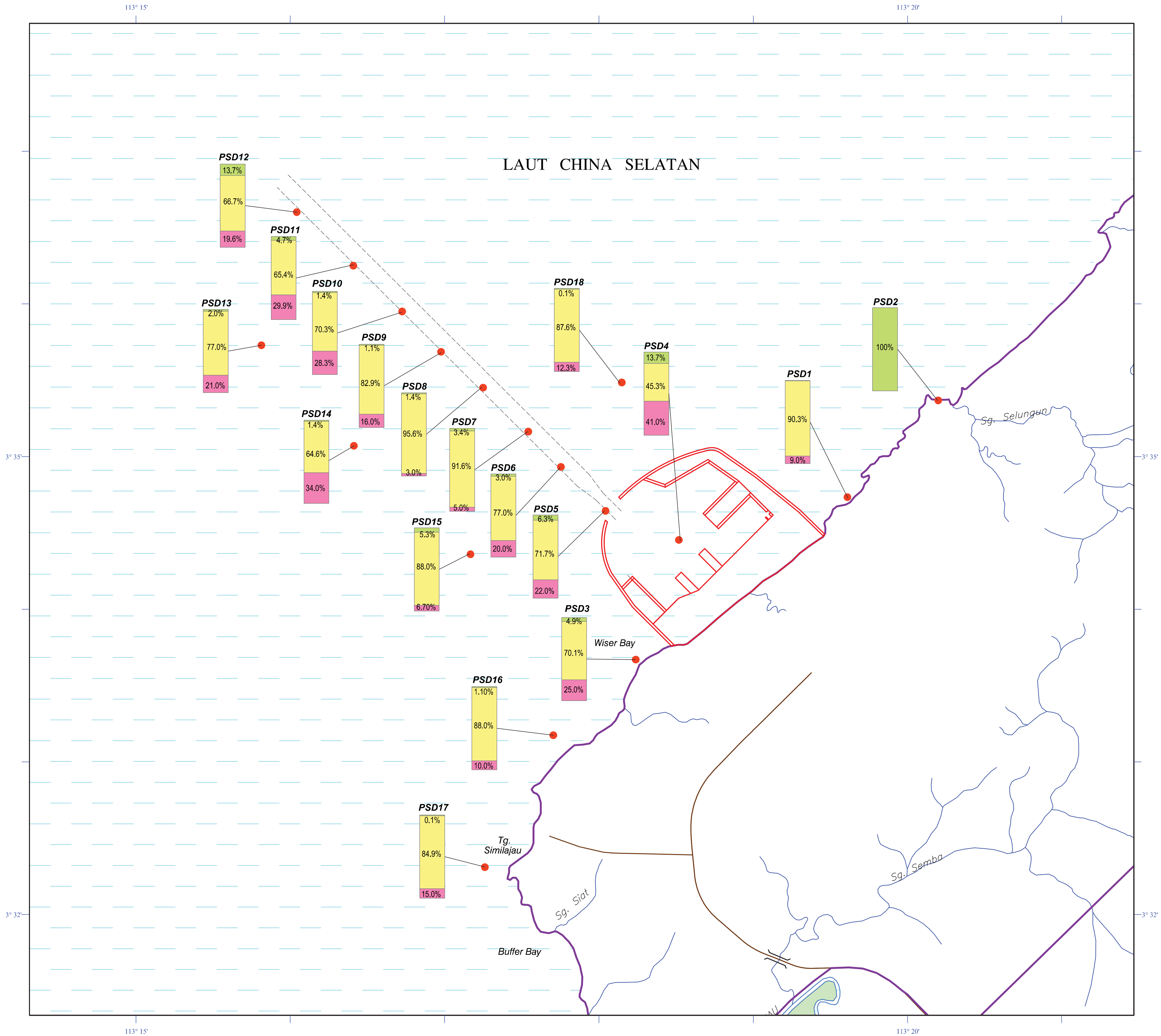
PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED NEW SAMALAJU PORT AT SIMILAJAU, BINTULU, SARAWAK



LEGEND:

- Proposed Project
- Samalaju Industrial Park Boundary
- Road
- Rivers / Streams
- Particle Size Distribution Points *(PSD1-PSD18)*

Parameter (s) Particle Size Distribution	
(grey)	Coarse Sand %
(green)	Fine Sand %
(yellow)	Silt %
(pink)	Clay %

N

0 1 2Km

SCALE IN KILOMETRES (1:45,000) – A3 MEDIUM

SOURCE: Adapted from

SERIES T735
SHEET 3/113/6
EDITION 2-D.O.S. 1968

GRID

–The outer ticks indicate the Latitude and Longitude

SUMMARY OF PARTICLE SIZE DISTRIBUTION RESULTS

FIGURE: 3.2.25

D:\ACAD\DRAWINGS\EV103\527\FIG-3225.DWG

3.3 MARINE TRAFFIC AND NAVIGATIONAL SAFETY

The primary aim of this section is to address the environmental and safety issue associated with the navigational within the exclusive port limit of 12 nautical miles, to and fro the proposed Project; not to be confused with the potential issue arises from the port operation. This section will also assess the possible constrain of other coastal users, access for nearby fishing communities into adjacent area and that are beyond the port exclusive limit.

The locality of the proposed port does not have the qualities of the natural port; whereby it is sheltered and has a deep water channel. The proposed port is located at an exposed flat shoreline and subject to the wrath of northeast monsoon. The proposed approach channel of the port requires frequent capital and maintenance dredging to provide a safe passage for vessel approach.

3.3.1 Existing Marine Traffic and Shipping Lane

During the early stage of the proposed Port construction, there will be an influx of coastal vessel from Bintulu transporting raw material and other heavy machineries required. The expected vessel will be in the form of tugs and barges. Heavy machineries and other raw material are will most likely being transported from Miri or Bintulu respectively. The existing marine traffic recorded from 2005 – 2009 for coastal vessel and foreign vessel is as shown in **Table 3.3.1** and **Table 3.3.2** respectively.

Table 3.3.1 Existing Marine Traffic for Coastal Vessels

Year	Bintulu				Miri			
	Arrivals		Departures		Arrivals		Departures	
	Number	'000 N.R.T	Number	'000 N.R.T	Number	'000 N.R.T	Number	'000 N.R.T
2005	4,890	23,135	4,890	23,135	1,388	3,328	1,388	3,328
2006	4,881	23,013	4,881	23,013	1,401	3,563	1,401	3,563
2007	4,533	22,456	4,533	22,456	1,268	3,090	1,268	3,090
2008	4,504	20,769	4,504	20,769	1,635	3,965	1,635	3,965
2009	4,467	19,654	4,467	19,654	1,593	2,961	1,593	2,961

Source : Sarawak Statistics Yearbook 2010.

It can be observed that the average daily arrival and departure of coastal vessel recorded from 2005 – 2009 for Bintulu Port is higher, 13, while lower number of marine traffic recorded at Miri Port with an average of 4 vessels daily.

Table 3.3.2 Existing Marine Traffic for Foreign Vessels

Year	Bintulu				Miri			
	Arrivals		Departures		Arrivals		Departures	
	Number	'000 N.R.T	Number	'000 N.R.T	Number	'000 N.R.T	Number	'000 N.R.T
2005	2,599	20,003	2,939	20,936	479	2,194	546	2,501
2006	2,646	19,687	2,949	21,005	456	2,472	572	2,743
2007	2,540	19,701	2,753	20,788	483	2,305	584	2,588
2008	2,407	18,147	2,581	18,990	665	3,024	777	3,139
2009	2,440	17,000	2,622	18,205	556	2,059	614	2,124

Source : Sarawak Statistics Yearbook 2010.

As for the marine traffic recorded for foreign vessel, an average of 7 vessels recorded daily for Bintulu Port while Miri Port only receives an average of 2 vessels daily from 2005-2009.

3.3.2 Port Exclusive Zone

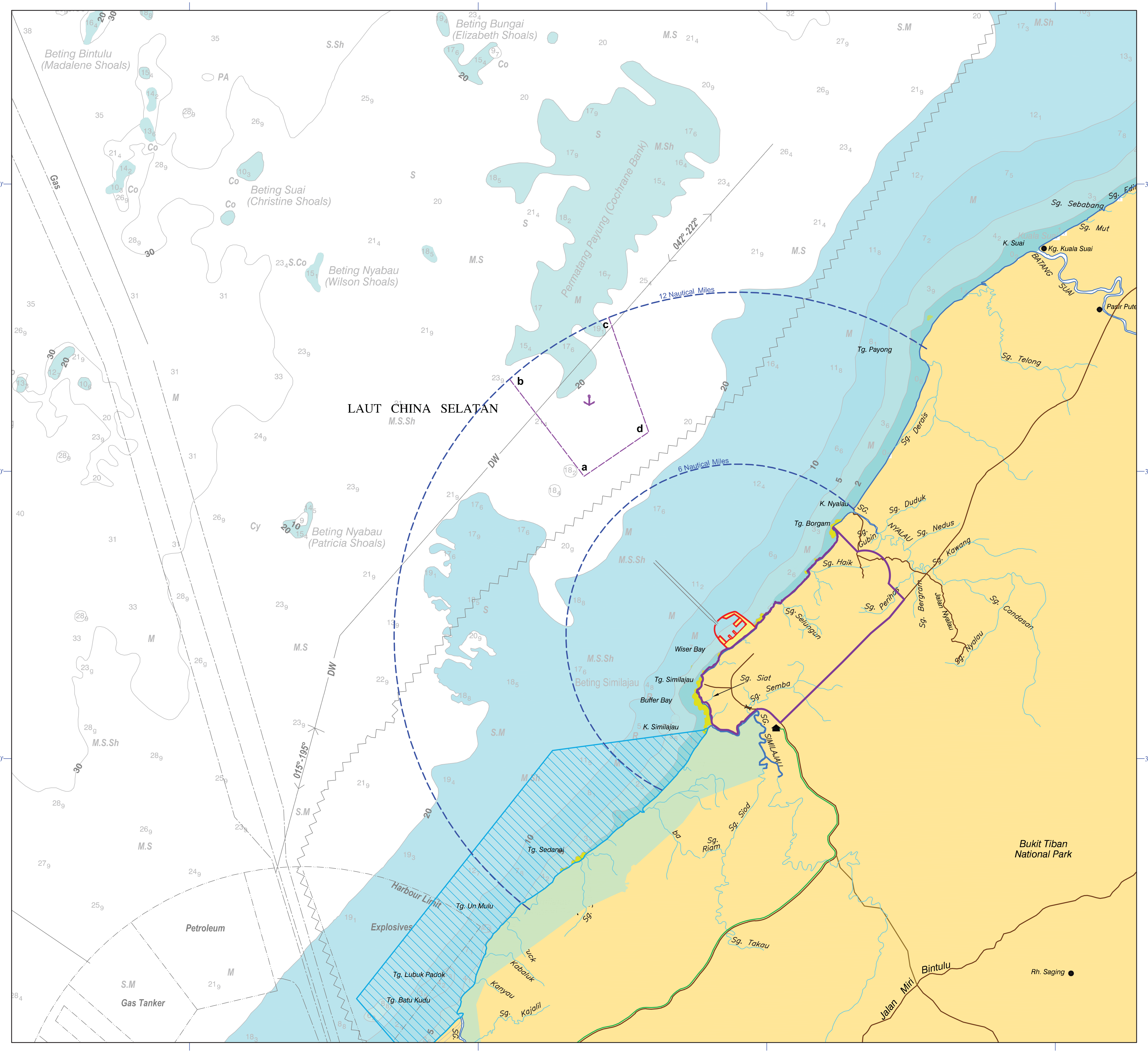
The proposed Project has the port exclusive zone of 12 nautical miles (22.22 Km) from the centre of the proposed Project site extending towards Tg. Payong at northeastern side in the form of an imaginary arc and to the midpoint between Tg. Sedanai and Tg. Batu Kidi at the southwestern side.

The inner port exclusive limit of 6 nautical miles (11.11 Km) will extend from the centre of the proposed Project in the form of the imaginary arc from Sg. Nyalau at the northeastern side towards Tg. Similajau and Tg. Sedanai. The average depth in this area is approximately 20 m MCD.

It is also noted that the proposed Project's 12 nautical miles port exclusive zone is overlapping with the recommended approach vessel route by Sarawak Marine Department. International shipping vessels are expected to encroach into the port's outer limit (12 nautical miles) of the Project's port exclusive zone and likewise, domestic trade vessels might encroach into the port's inner limit (6 nautical miles). The Sarawak admiralty chart and the proposed port exclusive zone are further illustrated in **Figure 3.3.1**.

PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED NEW SAMALAJU PORT AT SIMILAJAU, BINTULU, SARAWAK



LEGEND:

- Proposed Project
- Samalaju Industrial Park Boundary
- Main / Coastal Road
- Proposed New Raw Water Supply Pipeline From Bintulu (Sika Dam) Currently Under Construction
- Similajau National Park
- Similajau National Park Marine Extension
- Rivers / Streams
- Proposed New Water Treatment Plant (Samalaju Water Supply Project) - Construction in Progress
- Nautical mile Radius
- Safty Anchor

N

0 2.5 5 7.5 10 12.5Km

SCALE IN KILOMETRES (1:250,000) – A3 MEDIUM

SOURCE : Adapted from
ADMIRALTY CHART
SAR 6 KUALA IGAN TO TANJUNG PAYONG
SCALE 1:125,000

GRID
–The outer ticks crosses indicate the Latitude and Longitude

PORT EXCLUSIVE ZONE

FIGURE: 3.3.1

D:\ACAD\DRAWINGS\EV103\527\FIG-331.DWG