TERMS OF REFERENCE (TOR)

SPECIAL ENVIRONMENTAL IMPACT ASSESSMENT (SEIA)

for

Proposed Dam Upstream of

Cinta Mata Treatment Plant, Tawau, Sabah

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Security Classification

☒ Open	☐ Restricted	☐ Confidential

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Abbreviations

AMSL	Above Mean Sea Level
BH	Borehole
CFRD	Concrete-Faced Rockfill Dam
CO	Carbon Monoxide
CV	Curriculum Vitae
DID	Department of Irrigation and Drainage
DOE	Department of Environment
ECRD	Earth Core Rockfill Dam
EFD	Zoned Earthfill Dam
EIA	Environmental Impact Assessment
EPD	Environment Protection Department
EMP	Environmental Management Plan
GHG	Greenhouse Has
INWQSM	Interim National Water Quality Standards for Malaysia
IPCC	Inter-Governmental Panel on Climate Change
MLD	Million Litre Per Day
MCM	Million Cubic Metre
NOx	Nitrogen Oxide
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
RCCD	Roller Compacted Concrete Dam
SEIA	Special Environmental Impact Assessment
SESB	Sabah Electricity Sdn Bhd
SOx	Sulphur Oxide
TOR	Terms of Reference
TSP	Total Suspended Particulates
USEPA	United States Environmental Protection Agency
USLE	Universal Soil Loss Equation
WTP	Water Treatment Plant

1.0 INTRODUCTION

1.1 PROJECT TITLE

The title of this Project is "**Proposed Dam Upstream of Cinta Mata Treatment Plant, Tawau, Sabah**". Throughout this Terms of Reference (TOR), it will be referred to as the "Proposed Tawau Dam" or simply the "Project".

1.2 PROJECT INITIATOR

The Project Proponent for this Project is the Sabah State Water Department and the principal contact in respect to this Project is:

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1.3 DESIGN CONSULTANTS

The consultants for the design and engineering aspects for this Project are:

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1.4 ENVIRONMENTAL CONSULTANT

The environmental consultant for this Special Environmental Impact Assessment (SEIA) study is:

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Contact Person: Ir. Brian Chong Sin Hian (Director)

EPD Registration No. : F001
Registration Expiry Date : 30.09.2012

1.4.1 Study Team Members

The list of consultants involved in the preparation of this Special EIA is listed in **Table 1.1** and **Table 1.2**. The detailed Curriculum Vitas (CVs) of the team members are attached in **Annex 1**.

Table 1.1 Special EIA Team Members (Registered with EPD)

No	Personnel	Academic Qualification	Registered Areas	Report Contribution
1.	Lee Kuok Chiang @Terence Reg. No: S0136 Exp: 20.05.13	B. Eng. (Hons) Civil (Env.)	Hydrology	• Study Coordinator • Hydrology Aspect • Erosion & Sediment Control
2.	Ir. Brian S.H. Chong Reg. No: S0002 Exp: 30.09.12	M.Sc. Eng. B. Eng. Civil & Structural	Hydrology Waste Management	• Water Quality • Waste Management
3.	Rebecca T.F. Poong Reg. No: S0008 Exp: 30.09.12	B. Sc. Env Sc.	Land Use	• Land Use • Environmental Management & Technical Review
4.	Jessica Y. Malagkas Reg. No: S0007 Exp: 30.09.12	B. Eng. (Chemical)	Occupational Safety & Health Chemical Engineering	• Occupational Safety & Health • Environmental Monitoring

No	Personnel	Academic Qualification	Registered Areas	Report Contribution
5.	Lim Sze Fook Reg. No: S0005 Exp: 30.09.12	B. Sc. (Hons) Physics	Air Quality	• Air Quality • Microclimate
6.	Geh Poh Khong Reg. No: S0099 Exp: 07.02.13	B.Sc. (Geology)	Geology	• Geology • Soil Erosion • Seismic
7.	Lawrence Fung Reg. No: S0149 Exp: 14.11.12	B. Sc. (Forestry)	Forestry and GIS	• Terrestrial Flora
8.	Eivind Oluf Kofod Reg. No: S0187 Exp: 07.02.13	M. Sc. Forestry	• Terrestrial Flora • Forestry	• Forestry
9.	Peter Chang Reg. No: S0003 Exp: 30.09.12	B. Sc. Marine Biology & Zoology	• Marine Biology, Marine Ecology & Aquaculture	• Terrestrial Fauna

Table 1.2 Special EIA Team Members (Not Registered with EPD)

No	Personnel	Academic Qualification	Report Contribution
1.	Associate Professor Dr. Lee Nyanti @ Janti ak. Chukong	PhD (Aquaculture) M. Sc. (Natural) Resources B. Sc. (Biology)	• Riverine Fauna and Fisheries
2.	Associate Professor Dr. Lim Po Teen	PhD (Fisheries Science) M. Sc. (Marine Science) B. Sc. (Hons) (Marine Sc.)	• Riverine Flora
3.	Jongkar ak Ginang	M. Sc (Science Biology) B. Sc (Environmental Biology)	• Macroinvertebrates
4.	Dr. Paul Porodong	PhD (Kent) M.A Anthropology & Sociology BA. (Hons)	• Social Impact Assessment

No	Personnel	Academic Qualification	Report Contribution
5.	Ir. Lim Sin Poh	M. Eng (Civil) B. Eng. Civil Eng.	• Hydrology • Water Resources Analysis
6.	Associate Professor Ir Zaki Zainuddin	PhD (Env.) Eng. P. Eng. (Chemical) M. Sc. (Env) Eng. B. Eng. (Chemical) (Hons.)	• Water Quality Modelling Study
7.	Pooh Yih Fang	B. Eng. (Civil)	• Traffic Study (Riverine and Land)
8.	Tommy C.Y. Liew	M. Eng. (Hons) Chemical with Env. Eng.	• Assistant Coordinator • Report Compilation & Data Gathering

1.5 LEGAL REQUIREMENT

EIA is a mandatory requirement under the State's Environment Protection Department (EPD) - Environment Protection (Prescribed Activities) (Environmental Impact Assessment) Order 2005.

The proposed dam Project is a prescribed activity which falls under the Environment Protection (Prescribed Activities) (Environmental Impact Assessment) Order 2005, Second Schedule:

Item 8: Power Generation:-

(a) *Dams over 15 meters high and ancillary structures covering an area of 40 hectares or more;*

(b) Artificial lakes or reservoirs with surface area covering 50 hectares or more; or

(c) Diversion of streams, rivers or watercourses.

Apart from that, since there will be involvement of earthwork and aggregates, this Project also falls under:

Item 9: Quarries

(ii) Earth work involving extraction, removal, filling or dumping or earth with a volume of 40,000 cubic metres or more.

EIA for the borrow pits and aggregates supply for the construction of the dam will be assessed separately at a later stage and will be incorporated as part of the tender document for the contractor to get the approval of these EIAs prior to the commencement of the site preparation and construction stage of this Project.

Upon preliminary discussion with the EPD, the proposed Project is likely to fall under the category of a Special EIA due to its scale and sensitivity with Tawau Hill Park located in the near vicinity. This requires a comprehensive and detailed assessment of the primary and key environmental issues and impacts to evaluate the significance of the environmental impacts, and to formulate appropriate mitigation measures and monitoring programme.

1.6 PURPOSE OF TERMS OF REFERENCE (TOR)

The intent of this TOR is to describe the requirements for a Special EIA; to provide the scope of study and also as guidance to the preparation of the Special EIA report. These are to ensure that the study will be in line with the environmental, social and economics requirements. The TOR will be project and site specific, detailing the impact assessment and itemises the potential environmental impacts.

1.7 PURPOSE OF SPECIAL EIA

The main objective of the Special EIA is to ensure that all impacts, direct and indirect, especially the environmental, social and economics associated with the proposed development is fully examined and addressed. Consistent with the objective, the Special EIA report shall be a self-contained and comprehensive document which provides:-

- For the general public, a basic for understanding the proposal, alternatives and preferred solutions, the existing environment and the potential changes to the environment that may occur if the proposal is implemented;

- For decision maker, information for assessing the proposed development and likely impacts of all associated development with respect to the environment, legislative and policy provisions; and

- For the proponent, a comprehensive Environmental Management Plan (EMP) which describes acceptable impacts and environmental management strategies to acceptable performance criteria.

1.8 SPECIAL EIA STUDY GUIDELINES

This Special EIA study and report has been undertaken in accordance to the following guidelines issue by EPD and DOE

1. Handbook for Environmental Impact Assessment (EIA) in Sabah published by Environment Protection Department Sabah (EPD, Nov 2005).

2. A Handbook of EIA Guidelines published by the Department of Environment (DOE, 2007).

3. Environmental Impact Assessment Guidelines for Dams and/or Reservoirs Projects published by the Department of Environment (DOE, Sept 1995).

2.0 BACKGROUND INFORMATION

2.1 STATEMENT OF NEED

2.1.1 Water Demand Projection

Tawau is the major urban centre of the south eastern part of Sabah. The main urban population centre is in the Tawau Municipal area where there is a main port serving the whole region. Tawau town itself is the centre for the State Government's administrative services within the District and has major agricultural and commercial activities. Tawau also serves as the first landing point from neighbouring Kalimantan. Over the years Tawau has expanded rapidly due primarily to the growth of its agricultural industries such as palm oil and cocoa. These industries in turn have attracted a substantial number of investors and migrant workers. Commercial and residential developments have also picked up in tandem with the agricultural development.

The State Government through the Sabah State Water Department (*Jabatan Air Negeri Sabah*) is the water supply management and implementation state agency. The last major water supply treatment plant was commissioned in 1997, namely the Cinta Mata Water Treatment Plant. Over the years, due to unprecedented population growth and rise in industrial activities, the Tawau consumers have faced increasing water supply shortages due to the fact that demand has far exceeded supply. This has given rise to public outcry and adverse publicity for the Government. The existing treatment plants namely Cinta Mata, Jalan Utara, Apas Balung, Merotai and Sebatik have also been frequently compelled to increase their water treatment production volumes beyond the design capacity of the plants in order to meet the demands especially during peak hours.

The Tawau Water Department Divisional Office is frequently faced with problems in providing a reliable distribution of water to the consumers mainly due to the following problems:-

- Unreliable power supply from the power utility;
- Flow recession of surface flows of Sg. Tawau during dry seasons;
- Loss of output from the treatment works due to interconnections to supply areas before reaching the designated reservoirs; and
- Present distribution network is unable to keep pace with the extensive development that is being carried in Tawau.

The proposed dam is required to meet demand up to year 2050 which is estimated at 230 MLD, almost double the supply capacity of the earlier designed dam with an active storage for 12.5 MCM.

2.1.2 Raw Water Resources Review

The existing water supply system in Tawau District is currently served by five (5) water treatment plants. **Figure 2.1** shows the location of the existing water treatment plants in the Tawau District.

Table 2.1 summarizes the existing water treatment plants in operation in Tawau District including their designed and current average productions (based on records from January 2010 to September 2010).

Table 2.1: Existing Design Capacity from 5 Water Treatment Plants

No	Water Treatment Plant (WTP)	Source	Design Capacity (MLD)	Avg. Production (MLD)
1.	Cinta Mata	Sg. Tawau	60.00	71.41
2.	Jalan Utara	Sg. Tawau	50.00	44.17
3.	Apas Balung	Sg. Balung	10.00	7.00
4.	Merotai	Sg. Merotai kanan	5.00	2.69
5.	Sebatik	-	1.00	0.50
		Total	**126.0**	**125.77**

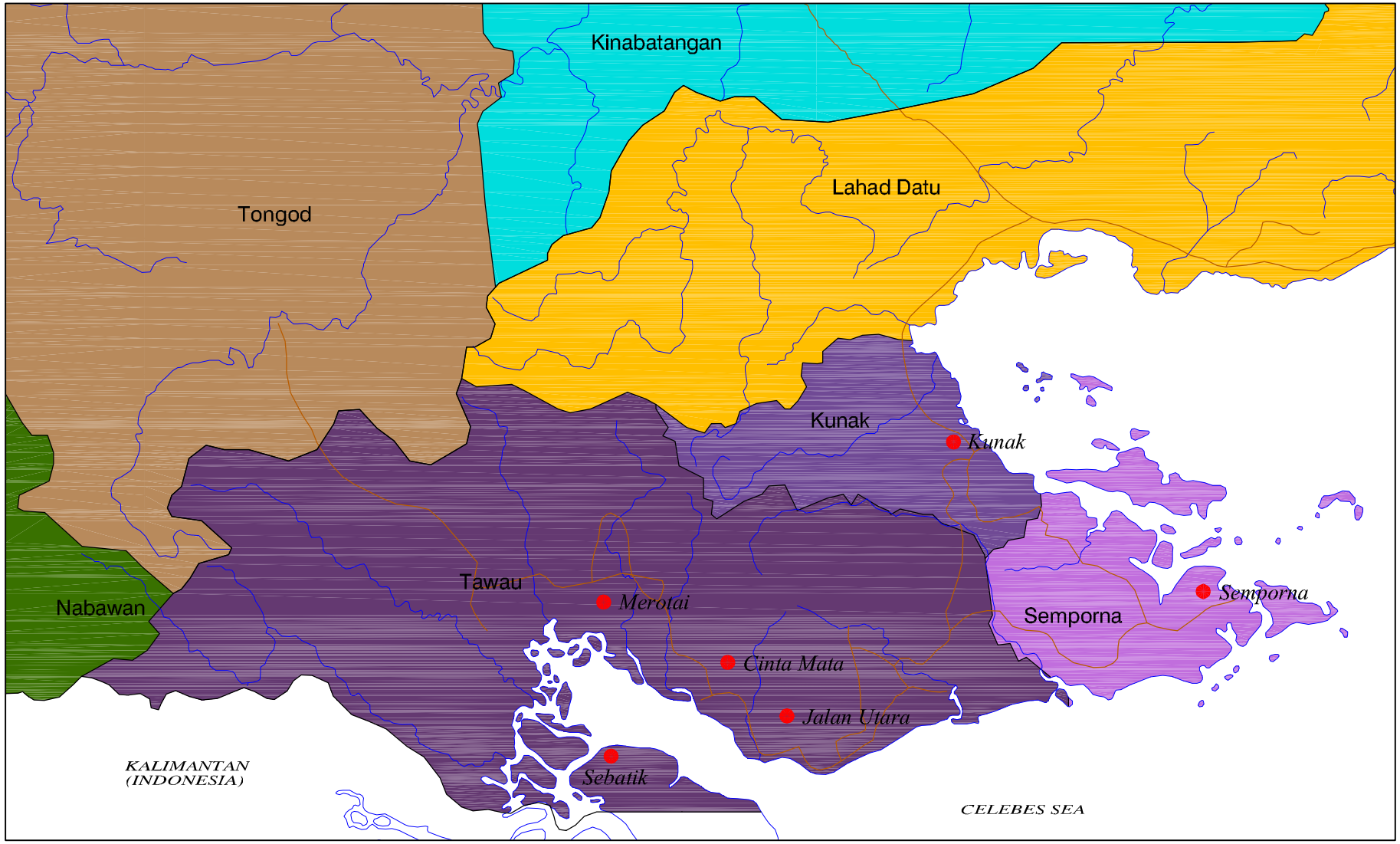
The existing water treatment plants have a total capacity of 126 MLD. It is noted that the water treatment plants in Tawau are currently operating at their total design capacity and that there are frequent water shortages in the division. The Cinta Mata Water Treatment Plant is already operating at about 20% overload as of current.

There are four (4) new water treatment plants under construction presently and are scheduled for completion by end of year 2011 and 2012 as shown in **Table 2.2** below:

Table 2.2: New Water Treatment Plants

Location	Year of Commissioning	Capacity (MLD)
Kalabakan	2011	2
Pulau Sebatik	2011	2.5
Apas Balung	2012	10
Merotai	2012	6
	Total	**20.5**

Two (2) new water treatment plants at Kalabakan (2 MLD) and Pulau Sebatik (2.5 MLD) was commissioned in year 2011. The other two (2) new treatment plants at Apas Balung (10 MLD) and Merotai (6 MLD) will be completed by year 2012.



LEGEND:

- EXISTING WATER TREATMENT PLANTS
- ROADS
- RIVERS / STREAMS

SOURCE : Adapted from
DIRECTOR OF NATIONAL MAPPING, MALAYSIA 1983
RAMPAIAN (MISC.) 80
CETAKAN (ED.) 2 - PPNM
SCALE 1:1,250,000

0 5 10 15 25 35 45Km

SCALE IN KILOMETRES (1:950,000) – A4 MEDIUM

SPECIAL ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED DAM UPSTREAM OF CINTA MATA
TREATMENT PLANT, TAWAU, SABAH

EXISTING WATER TREATMENT PLANTS IN TAWAU DISTRICT

FIGURE: 2.1

D:\ACAD\DRAWINGS\EV403\4150\FIG-21.DWG

2.2 THE PROJECT

2.2.1 Overview of Project

This Project is initiated by the Sabah State Water Department through the State Government under the 10th Malaysia Plan to improve the Tawau Water Supply System to supply treated water to the whole of Tawau District till year 2050 (estimated at 230 MLD). The main objective of the proposed dam is to secure water supply for the whole Tawau District, ensuring a constant and stable supply of water to the communities, be it household or industry.

2.2.2 Project Background

The construction of the dam is proposed back in the 90's which was listed under the 9th Malaysia Plan, but was later rejected due to financial 'incapability' from the Government at that time. The existing design of the Tawau dam was completed about 20 years ago in 1991. The Cinta Mata water treatment plant was constructed in year 1997 adjacent to the proposed dam site. Raw water to the Cinta Mata plant was extracted from Sg. Tawau.

The 1991 designed dam was a concrete-faced rock-fill dam, 42 m in height (above natural ground surface) to create a reservoir with an active storage of 12.5 million cubic meters. It was intended to provide raw water supply of 12.5 MCM to the existing water treatment plants and release an environmental flow of 50 MLD. However, the existing design of the proposed proposed dam is no longer suitable due to the changes to the basic design as described below.

1. Water Demand

Water demand increase and the storage capacity designed are now inadequate. The dam needs to meet the demand to year 2050 (estimated at 230 MLD), which is almost double the supply capacity of the earlier designed dam with an active storage of 125 MLD.

2. Hydrological Data

Hydrological data used for the design of the dam has changed. Additional data over the last 20 years should be used. Also climatic changes over the years since 1991 might render the earlier hydrological analysis invalid or at least the need to be updated.

3. Source of Rockfill Materials

The source of rock-fill materials proposed for the construction of the dam from the Kukusan Hill commercial quarry may not be feasible. The supply of rock from the commercial quarry is expensive compared with 20 years ago. The hauling of large quantity of rock (estimated at 1.5 million m^3) will have serious adverse impacts on traffic in Tawau town and pose potential safety hazards to the public.

4. EIA Requirements

EIA conditions have changed throughout the years. More stringent conditions are now imposed on dam development. The EIA which was completed in 1991 is no longer valid (DOE Reference Number: Ref.AS(S) A50013/202/1(4)). Hence a new EIA has to be prepared and submitted for approval by the approving authority.

5. Condition of Dam Site

The site condition at the dam site has changed. The Cinta Mata Water Treatment Plant (WTP) was constructed adjacent to the dam site. The impact of the dam on the operation of WTP is significant and the design of dam has to take into account the impact on Cinta Mata WTP, particularly risk of contamination due to high sediment load as the existing plant has to continue operation during the construction period of the dam.

6. Catchment Conditions

Catchment conditions have changed as more development has taken place. The impact on the water quality of the reservoir particularly the risk of eutrophication (algae bloom) and manganese after reservoir impoundment has to be investigated and measures to control eutrophication are required.

7. Seismicity Requirements

Seismicity requirements will be more stringent taking into account the frequency and intensity of tremors and earthquake occurred in the recent years, especially in the vicinity of Tawau district.

8. Water Quality of Sg. Tawau

Water quality of Sg. Tawau particularly at Jalan Utara's WTP has deteriorated due to presence of settlements and wastewater pollution along the river leading up to the Jalan Utara's WTP. Piping of water directly from the dam to the Jalan Utara WTP is now considered.

9. Population of Tawau

Tawau town is now more developed and populated. Implication on the long term safety of the dam towards Tawau town is critical. There is zero tolerance on the risk of dam failure.

10. Long Term Sustainability

The Tawau dam site is the only storage site available for development of water sources to meet the demand of Tawau town. The long term sustainability of the Tawau water source is critical to the economic development of Tawau district.

11. Benefit of Dam Project

There is a need to maximize the benefits of the dam project that can be derived from besides water supply, with hydro development, flood mitigation, maintenance of environmental flows. The future development of water resources to meet Tawau's water requirements would be more expensive involving high capital works and operation cost. This is due to the need to transfer water from other river basins.

2.2.3 Project Status

The proposed dam Project is currently still under its inception and scheme review besides preliminary engineering study stage whereby the Project is awarded to Jurutera Perunding Campo to assist Sabah State Water Department in the coordination works such as the reviewing and determining of design options for the dam, reviewing and conducting soil investigation and site survey works, preparation of contract packages and preliminary costing, conducting EIA study, etc.

2.2.4 Land Acquisitions

The proposed dam Project will necessitate land acquisitions for the various components as follows:-

- Inundated Area for the Dam;
- Borrow Quarry Area; and
- Pipeline-from tunnel outlet to Jalan Utara Water Treatment Plant.

Sufficient lands are to be provided for the dam embankment corresponding to the maximum potential dam capacity capable for development on the selected site, the associated spillways necessary for stage development, outlet tunnel, valve station/pumping station and associated pipeline and access roads both within and to the site. Land is to be acquired for the maximum impoundment area and wherever possible the adjacent catchment area desirably extending to the catchment water shed will also be acquired.

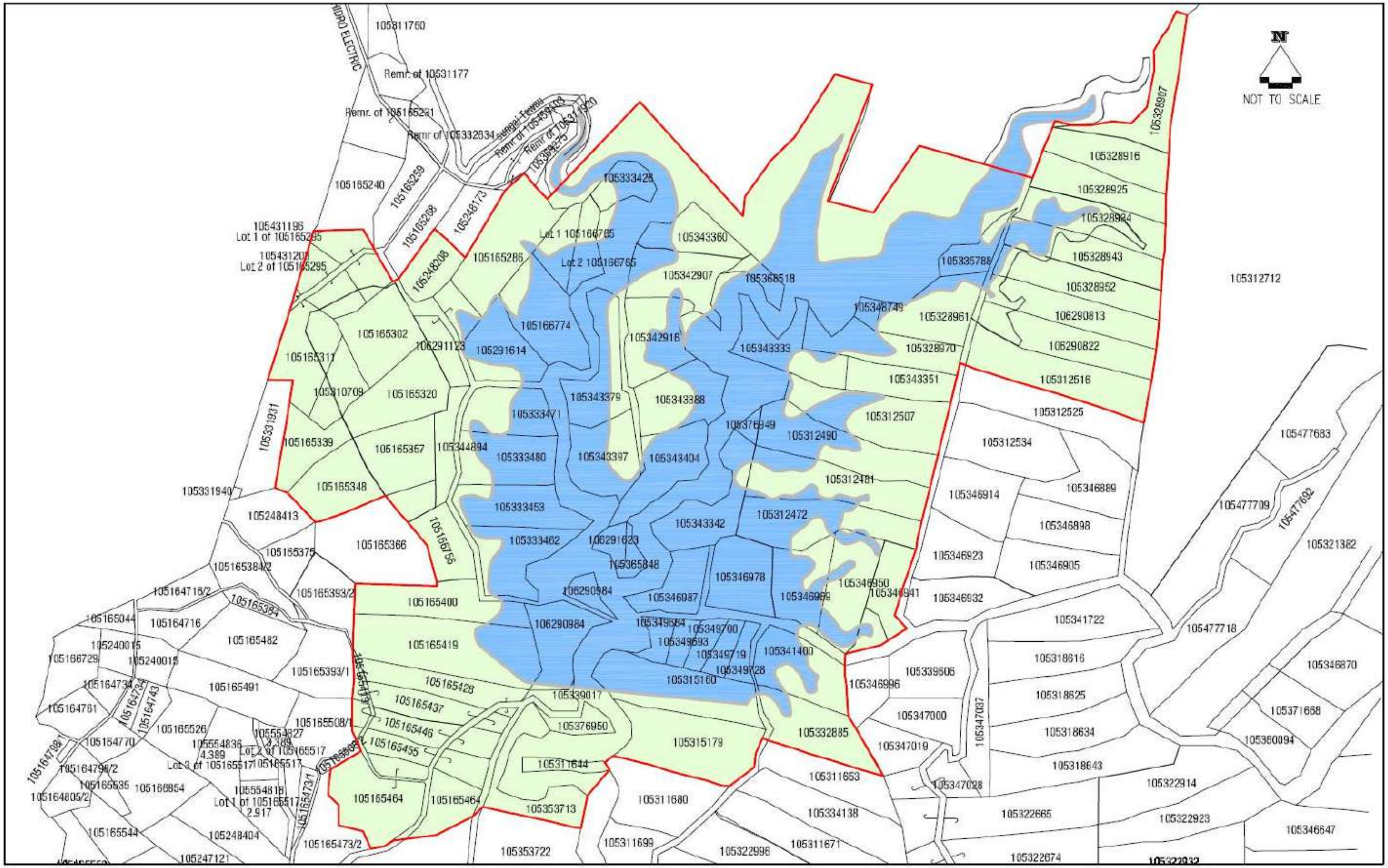
Based on the design elevation of Full Supply Level (FSL) +110m for the proposed dam, an impoundment area of approximately 485 acres will be affected while the total land areas of about 76 lots that need to be acquired will be about 1,000 acres. 56 land lots have been fully acquired (gazetted under Gaz. Not.658/93) by the Sabah State Water Department through State Government for this Project in the 1990s while the rest of the lands are still in the process of being acquired. Some of the land lots are presently occupied and planted with oil palm by small holders. The details of the land acquisition matters will be described further in the SEIA report. Refer to **Figure 2.2** and **Annex 2**) for the lands acquisition.

2.2.5 Project Location

2.2.5.1 Proposed Dam Site

The proposed dam site is located 10 km to the northern side of Tawau town. It is situated between latitudes of 4° 20' N and 4° 21' N and longitudes of 117° 53' E and 117° 54' E. The site can be accessed by the existing road to the existing Cinta Mata WTP (**Plate 1**) which ends at the Tawau Hills Park (**Plate 2**) (refer to **Figure 2.3**).

Tawau Hills Park which belongs to the Sabah Parks is located about 5.5 km northward from the proposed dam site. The affected Sabah Parks boundary for the impoundment is about 500 m away from the proposed dam site. Tawau Hills Park is a gazetted forest reserve (*Tanah Simpanan Taman Negara Bukit Tawau*, gazette No. 110/79) and areas of 73 square miles upstream of Gemok Forest Reserve have been earmarked as water catchment area (*Kawasan Simpanan Air* Sg. Tawau and Sg. Merotai Kanan Plan No. 10124610). It is an important water catchment area for the Tawau district with several rivers such as Sg. Balung, Sg. Kinabutan, Sg. Tawau and Sg. Merotai flowing through the Park.



LEGEND:

- PROPOSED STORAGE AREA
- ACQUIRED LAND

SOURCE: Adapted from
Jurutera Perunding Campo Sdn. Bhd.

SPECIAL ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED DAM UPSTREAM OF CINTA MATA TREATMENT PLANT, TAWAU, SABAH

LAND ACQUISITION FOR THE PROJECT

FIGURE: 2.2

D:\ACAD\DRAWINGS\EV403\4150\TOR\FIG-22.DWG

PROPOSED RIVER DIVERSION
TO CINTA MATA WTP DURING CONSTRUCTION

EXIST. CINTA MATA WATER
TREATMENT PLANT (WTP)

RESERVOIR RO
T.W.L. 102.25m
CAPACITY:
2 x 10 ML.(EXISTING)

TAWAU DAM IMPOUNDMENT

PROPOSED TAWAU DAM

EXIST. RAW WATER
PUMPING STATION

EXIST. 1000mm ø MSCL. PIPE

PROPOSED 900mm DIA. RAW WATER MAIN TO UTARA WTP

RESERVOIR R2
T.W.L. 68.58m
CAPACITY: 30 ML. (EXISTING)

RESERVOIR R1
T.W.L. 68.58m
CAPACITY: 23.5 ML. (EXISTING)

EXIST. UTARA WTP

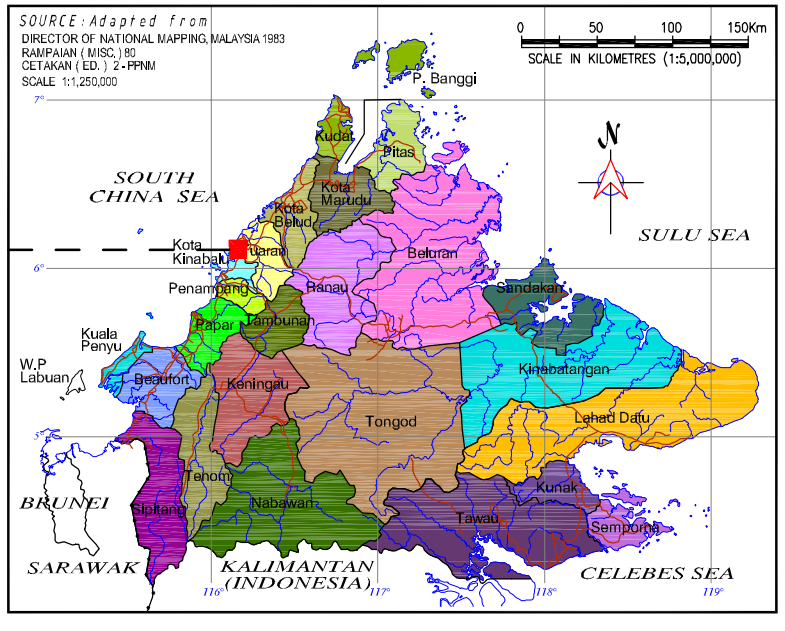
EXIST. 750mm ø MSCL. PIPE

EXIST. 600mm ø MSCL. PIPE

EXIST. 600mm ø MSCL. PIPE

RESERVOIR R3 – (2 TANKS)
T.W.L. 50.00m

Kg. Raja
Kg. Melati
Kg. Pisang
Chinta Mata
Kg. Durian
Kg. Mawar
Kg. Pertama
Kg. Burns
Kg. Bombalai Jambatan
Kg. Mutiara
Kg. Batu Puteh
Kg. Imam
Hutan Rizab Gemok
Kg. Ayer Panas
Kg. Ambar
Kg. Tanjung Batu
S. Tawau
TAWAU
Apas Road
Kg. Kinabutan
Kg. Batu Payong
Laut Sulawesi
KINABUTAN BESAR
Mt. Andrassy
BANDARAYA F.R.
MEMBALUA
Babanga Road
Mark Pang Road
S. Merotai Kecil
S. Bombalai
S. Imam
S. Tabung Batu
S. Tanjung
S. Kinabutan Besar
S. Kinabutan Kecil
S. Apas Kiri
Jalan Utara



LEGEND:

- PROJECT BOUNDARY
- ROAD
- RIVERS / STREAMS
- PROPOSED PIPELINE
- EXISTING PIPELINE
- EXISTING CINTA MATA WATER TREATMENT PLANT
- EXISTING JALAN UTARA WATER TREATMENT PLANT

SOURCE: Adapted from
Juruterа Perunding Campo Sdn. Bhd.
Angkasa Consulting Services Sdn. Bhd.

0 0.5 1.0 1.5 2.0 2.5 3.0Km
SCALE IN KILOMETRES (1:75,000) – A3 MEDIUM

SPECIAL ENVIRONMENTAL IMPACT ASSESSMENT
PROPOSED DAM UPSTREAM OF CINTA MATA
TREATMENT PLANT, TAWAU, SABAH

PROJECT SITE LOCATION

FIGURE: 2.3

D:\ACAD\DRAWINGS\EV403\4150\FIG-23.DWG

2.2.5.2 Sg. Tawau

Sg. Tawau (**Plate 3**) meanders through a narrow shallow valley, and the future impoundment zone consists principally of palm oil and cocoa small holders and shrubs. There are occasional patches of disturbed lowland riverine forest, with a small number of emerging trees. Such habitats consist principally of monoculture crops have been shown to support a surprising diversity of aquatic and terrestrial vertebrate animals.

Downstream of the dam site, the river basin becomes increasingly populated and passes through oil palm plantations, housing areas, light industrial sites and finally a densely populated immigrant shantytown within the town area.

2.2.5.3 Surrounding Land Use

Apart from the existing Cinta Mata water treatment plant that is located within the proposed dam site, the nearest settlement, Kg. Cinta Mata is located 2.5 km away from the proposed dam site. Tanjung Forest Reserve, Gemok Forest Reserve and Mount Andrassy Forest Reserve are located more than 3.5 km to the south west, south east and east, respectively of the Project site. Land use within 10 km radius from the proposed dam site is summarised in **Table 2.3** and **Figure 2.4**.

Table 2.3: Land Use within 10km from the Project Site

No	Land Use	Direction from Project Site	Distance from Proposed Dam Site (m/km)
Within 1 km			
1.	Cinta Mata Water Treatment Plant	South West	400 (0.40)
1 km to 5 km			
2.	Kg. Cinta Mata	North West	2530 (2.53)
3.	*Hutan Rizab Tanjung*/Tanjung Forest Reserve	South East	3200 (3.20)
4.	Kg. Batu Puteh	South West	3750(3.75)
5.	Kg. Durian	West	4300 (4.30)
6.	Bombalai Hill	North west	4500 (4.50)
7.	*Hutan Rizab Gemok*/Gemok Forest Reserve	South West	4550 (4.50)
8.	Mount Andrassy Forest Reserve	East	5000 (5.00)
9.	Kg. Mawar	South West	5000 (5.00)
5 km to 10 km or more			
10.	Kg. Mutiara	South West	5300 (5.30)

No	Land Use	Direction from Project Site	Distance from Proposed Dam Site (m/km)
11.	Tawau Hills Park	North West	5500 (5.50)
12.	Kg. Pisang	North West	5500 (5.50)
13.	Kg. Raja	North West	5800 (5.80)
14.	Kg. Ayer Panas	South	6900 (6.90)
15.	Kg. Imam	South West	7000 (7.00)
16.	Jalan Utara Water Treatment Plant	South West	7300 (7.30)
17.	Kg. Pertama	South West	7200 (7.20)
18.	Kg. Ambar	South West	7580 (7.58)
19.	Kg. Burns	South West	8400 (8.40)

2.2.6 Dam Options

Currently, four (4) types of dam options are being considered:-

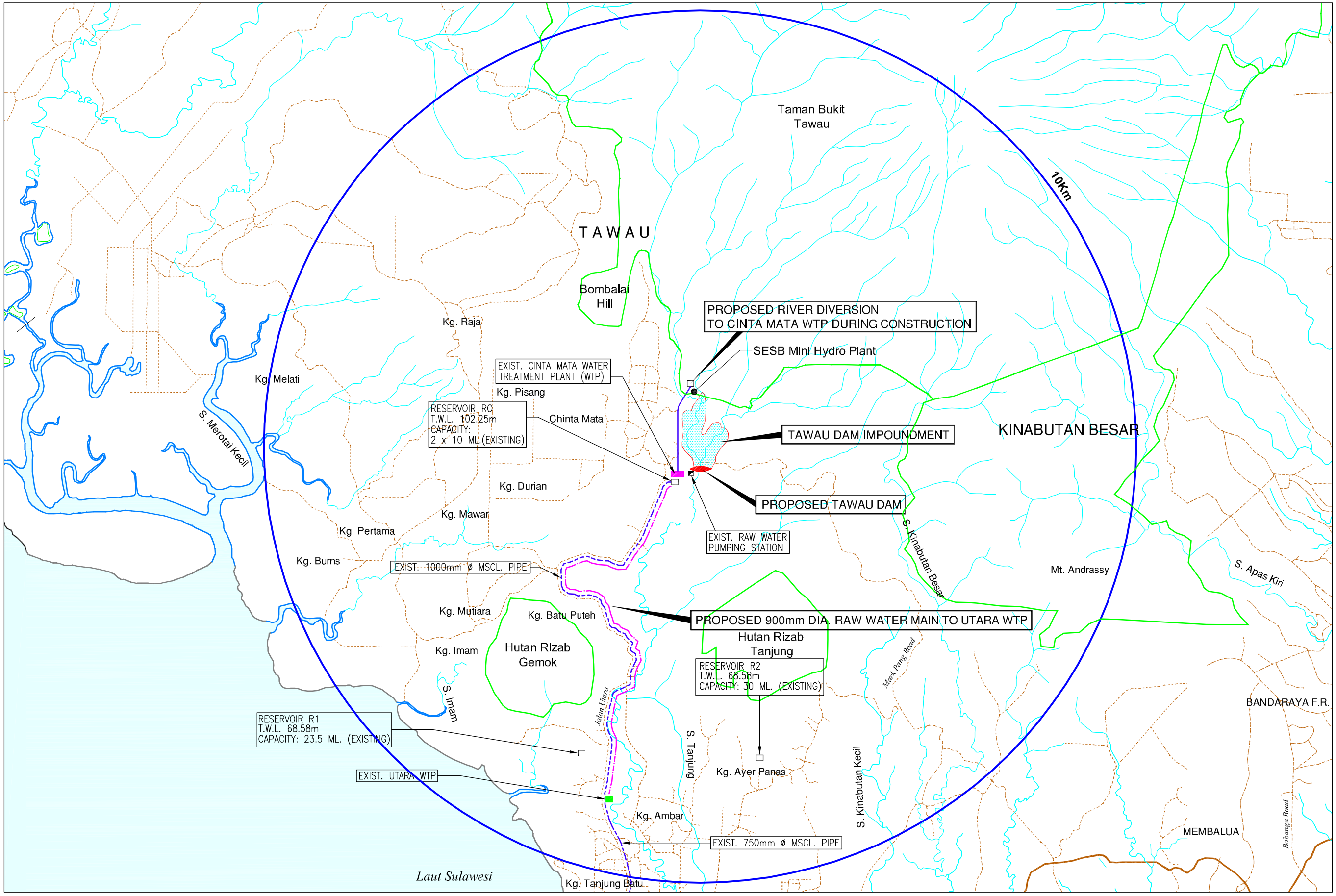
a) Concrete-Faced Rockfill Dam (CFRD);

b) Roller Compacted Concrete Dam (RCCD);

c) Earth Core Rockfill Dam (ECRD); and

d) Zoned Earthfill Dam (EFD).

The details of the type of dams are summarised in **Table 2.4**.



LEGEND:

- PROJECT BOUNDARY
- FOREST RESERVE BOUNDARY
- ROAD
- PROPOSED PIPELINE
- EXISTING PIPELINE
- EXISTING CINTA MATA WATER TREATMENT PLANT
- EXISTING JALAN UTARA WATER TREATMENT PLANT
- RIVERS / STREAMS

N

SOURCE : Adapted from
Jurutera Perunding Campo Sdn. Bhd.
Angkasa Consulting Services Sdn. Bhd.

0 0.5 1.0 1.5 2.0 2.5 3.0 3.5Km

SCALE IN KILOMETRES (1:85,000) – A3 MEDIUM

SPECIAL ENVIRONMENTAL IMPACT ASSESSMENT
PROPOSED DAM UPSTREAM OF CINTA MATA TREATMENT PLANT, TAWAU, SABAH

LAND USE (WITHIN 10KM RADIUS)

FIGURE: 2.4

D:\ACAD\DRAWINGS\EV403\4150\FIG-24.DWG

Table 2.4: Selection of Type of Dams

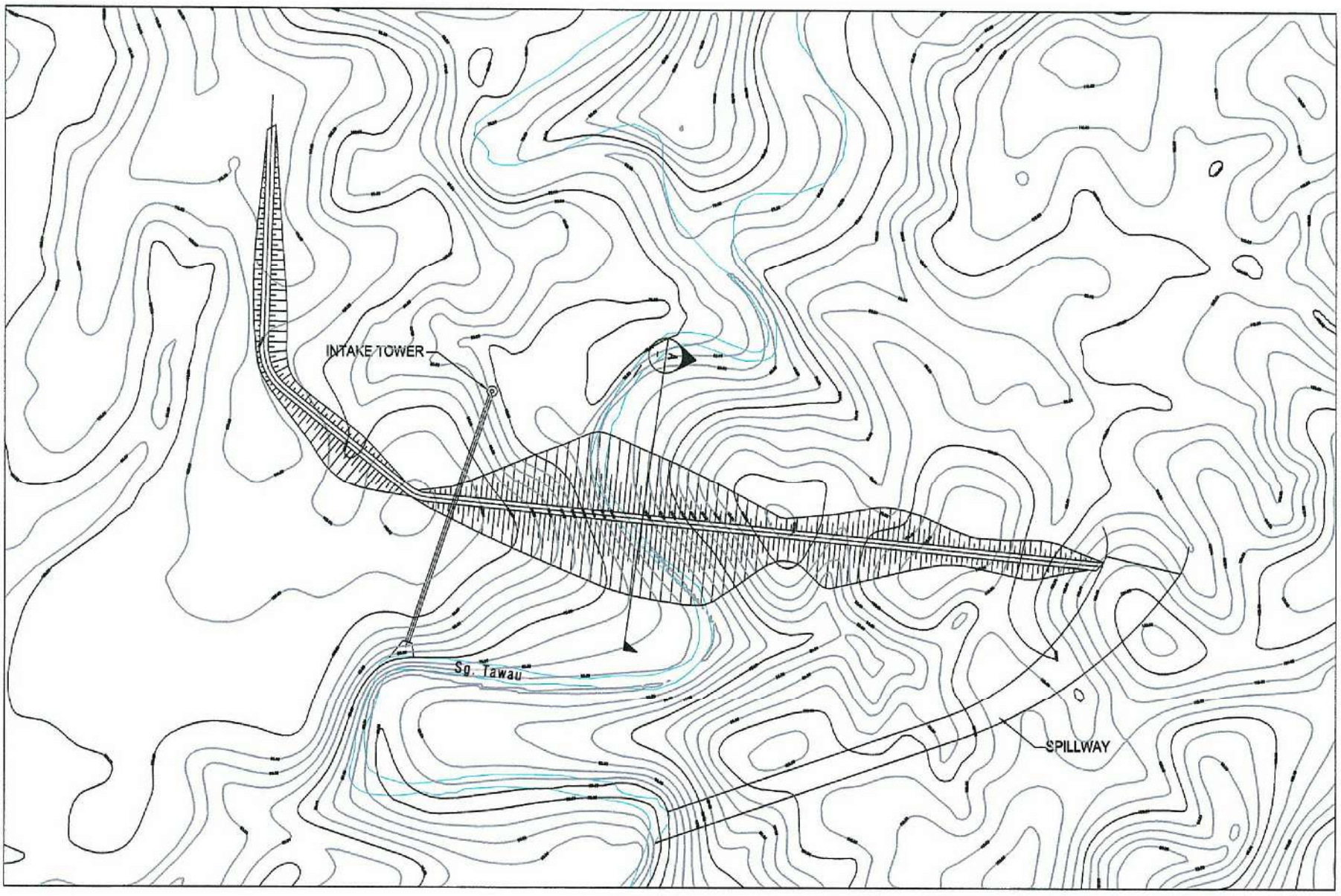
No	Type of Dam	Brief Description	References
1.	Concrete-Faced Rockfill Dam (CFRD)	A CFR dam is a rock-fill dam with concrete slabs on its upstream face. This design offers the concrete slab as an impervious wall to prevent leakage and also a structure without concern for uplift pressure. In addition, the CFR dam design is flexible for topography, faster to construct and less costly than earth-fill dams. Advantages of CFR dam construction include:- • Less problems with wet weather construction since clay borrow areas are not required; • Shorter ancillary works (tunnels, penstocks, spillways) as a result of the steeper embankment slopes; • Easier use of internal haul roads providing greater freedom during construction; • Foundation grouting separated from embankment construction, eliminating delays if difficult foundation problems are encountered; • Relatively small area requiring a high class foundation treatment; • Comparatively simple repair of any leaks that develop during service; • Particularly well suited to multi-stage construction; and • Shorter construction time for smaller embankment volume, minimising the risk of flood damage during construction. • Refer to **Figure 2.5**.	• Aguamilpa, Mexico (1993) • Tianshengqiao, China (1997)
2.	Roller Compacted Concrete (RCC)	The roller-compacted concrete (RCC) dam is a new concept employing an inherently less expensive (leaner) concrete mix to form the core of the dam and allowing further economies through very rapid construction The major advantages of RCC in dam construction include: • More rapid construction; • Effective use of conventional equipment (i.e. trucks, dozers, vibratory, rollers, etc.); • A reduced cost of construction as a sequence of the above; • Thinner layers which lead to increased safety during construction by reducing the differences in levels between placements; • Shorter river diversions during construction;	• Willow Creek Dam, USA (1982) • Santa Cruz Dam, New Mexico (1990)

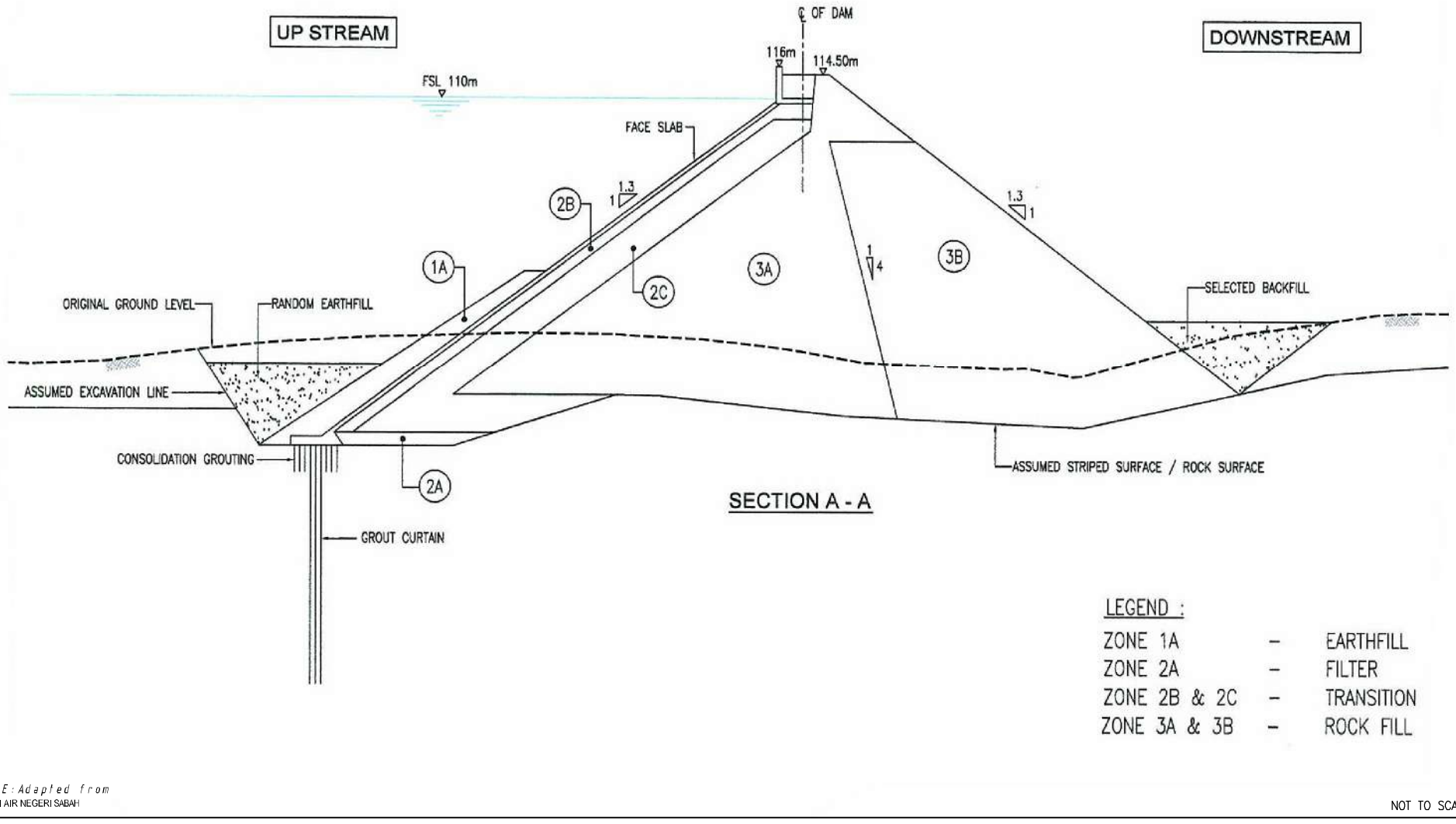
No	Type of Dam	Brief Description	References
		and • The dam is capable of passing floods during construction by overtopping without damage. • Refer to **Figure 2.6**.	
3.	Earth Core Rockfill (ECR)	The earth core rockfill dam consists of a number of components which are the main rockfill, impervious zone and the auxiliary supporting members. The main rockfill provides the structural support for the dam by its weight and internal stability. The impervious zone holds back the water. It is made up of the membrane which holds the water and transition zone which transfers the water load to the rockfill. The membrane may be a thick blanket or core of earth or a thin diaphragm or deck of wood, concrete, steel, asphalt, dry rubble masonry or stone masonry. The auxiliary support members help to sustain the membrane or parts of the main rockfill. These components are similar to the shell, core, and appurtenances of the earth-fill dam and are analysed in a similar way. Refer to **Figure 2.7**.	• Merowe Dam, Sudan (2009)
4.	Zoned Earthfill	A zoned-earth dam has distinct parts or zones of dissimilar material, typically a locally plentiful shell with a watertight clay core. Modern zoned-earth embankments employ filter and drain zones to collect and remove seep water and preserve the integrity of the downstream shell zone. An outdated method of zoned earth dam construction utilized a hydraulic fill to produce a watertight core. Rolled-earth dams may also employ a watertight facing or core in the manner of a rock-fill dam. An interesting type of temporary earth dam occasionally used in high latitudes is the frozen-core dam, in which a coolant is circulated through pipes inside the dam to maintain a watertight region of permafrost within it. Refer to **Figure 2.8**.	• Blue Mesa Dam, USA (1966)

In terms of priority, CFRD is more preferred compared to the other options due to the advantage of the overall stability against seismic risk and lower risk of piping failure. The preliminary comparison of the four (4) dams types are summarized in **Table 2.5**.

Table 2.5: Comparison of Dam Types

No	Factor	CFRD	ECRD	RCCD	EFD
1.	Requirement for dam foundation treatment	Stringent at plinth	Stringent at core zone	Most stringent	Less stringent
2.	Construction Materials Availability at site	All rockfill materials available at site	Rockfill and clay core materials available at site	RCC aggregrates and flyash not available at site	Clay core and random fill materials available at site
3.	Space constraint at downstream area	Dam Crest Below RM 112.00	Dam Crest Below RM 105.00	Dam Crest Below RL 112.00	Dam Crest Below RM 95.00
4.	Impact to Cinta Mata Treatment Plant Water Source	Medium impact	Significant impact	Least impact	Very Significant
5.	Construction Cost	Second Highest	Third Highest	Highest	Lowest
6.	Potential Environmental Impact	Soil erosion and pollution problem	Soil erosion and pollution problem	Impact on road safety due to transportation	Serious soil erosion polluting river
7.	Operational Safety	Safest	Third Safest	Second safest	Least safest
8.	Overall Ranking	First	Second	Third	Fourth





SECTION A - A

LEGEND :

ZONE 1A	–	EARTHFILL
ZONE 2A	–	FILTER
ZONE 2B & 2C	–	TRANSITION
ZONE 3A & 3B	–	ROCK FILL

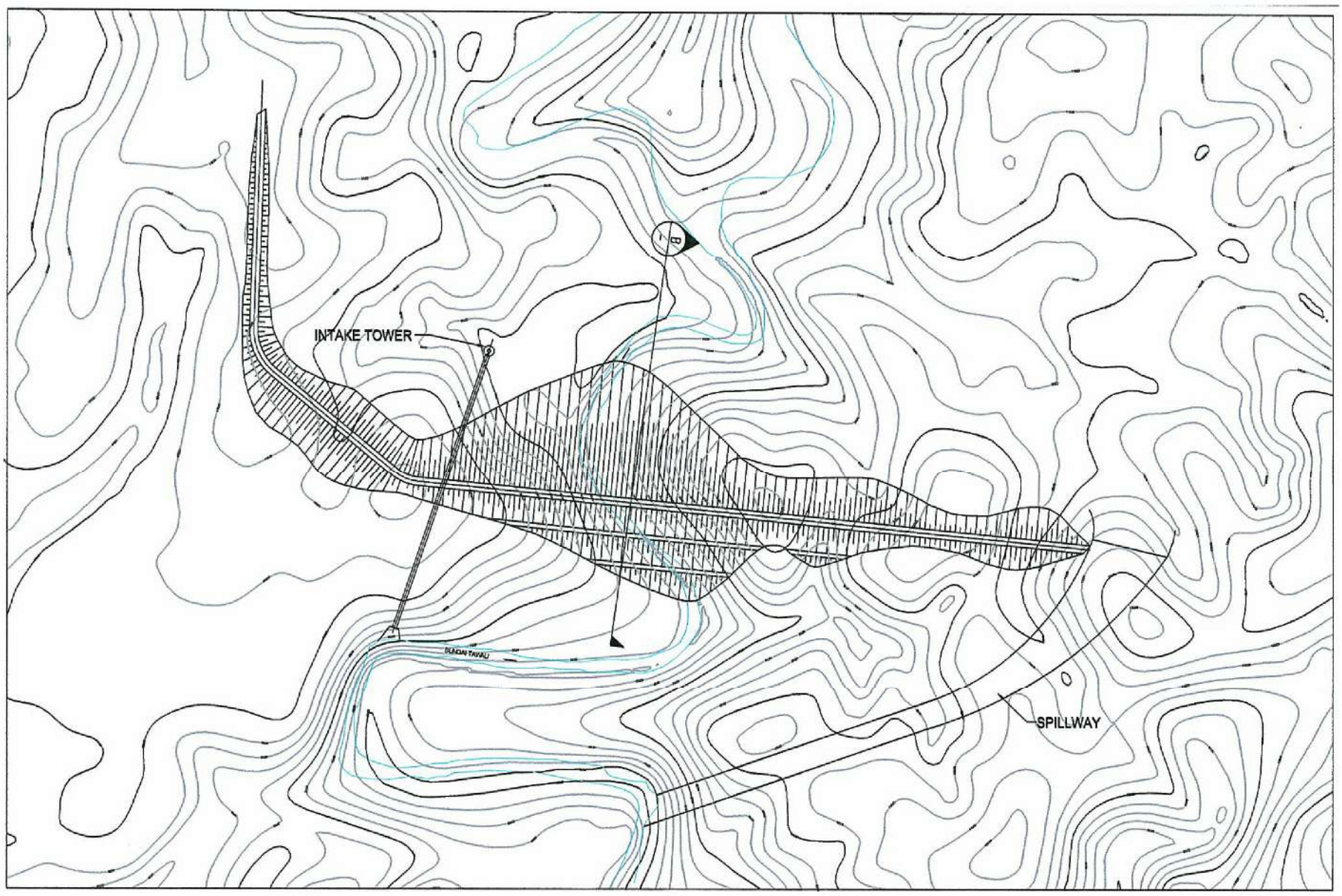
SOURCE : Adapted from
JABATAN AIR NEGERI SABAH

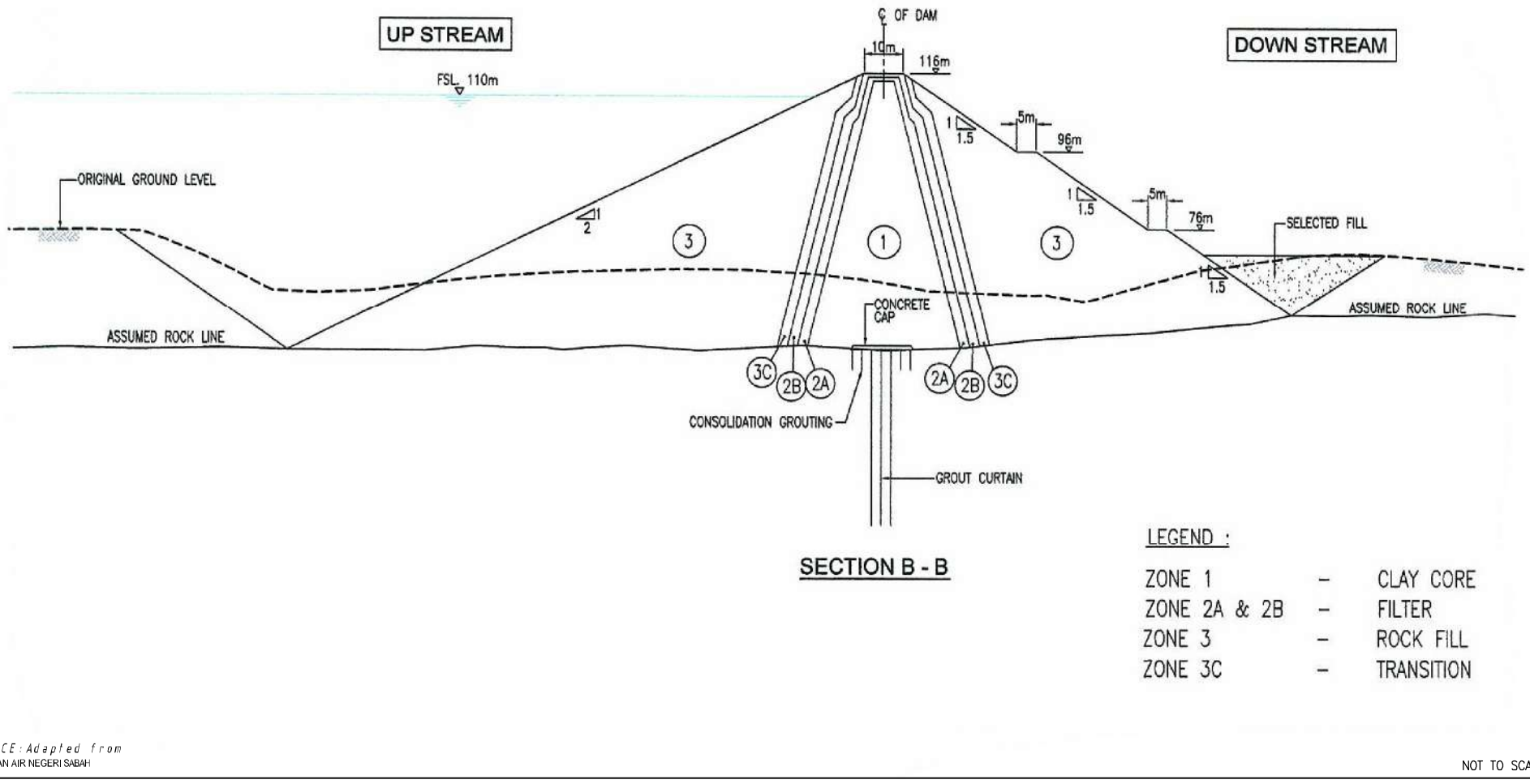
NOT TO SCALE

SPECIAL ENVIRONMENTAL IMPACT ASSESSMENT
PROPOSED DAM UPSTREAM OF CINTA MATA
TREATMENT PLANT, TAWAU, SABAH

LAYOUT AND TYPICAL SECTION OF CONCRETE FACED ROCKFILL DAM

FIGURE: 2.5





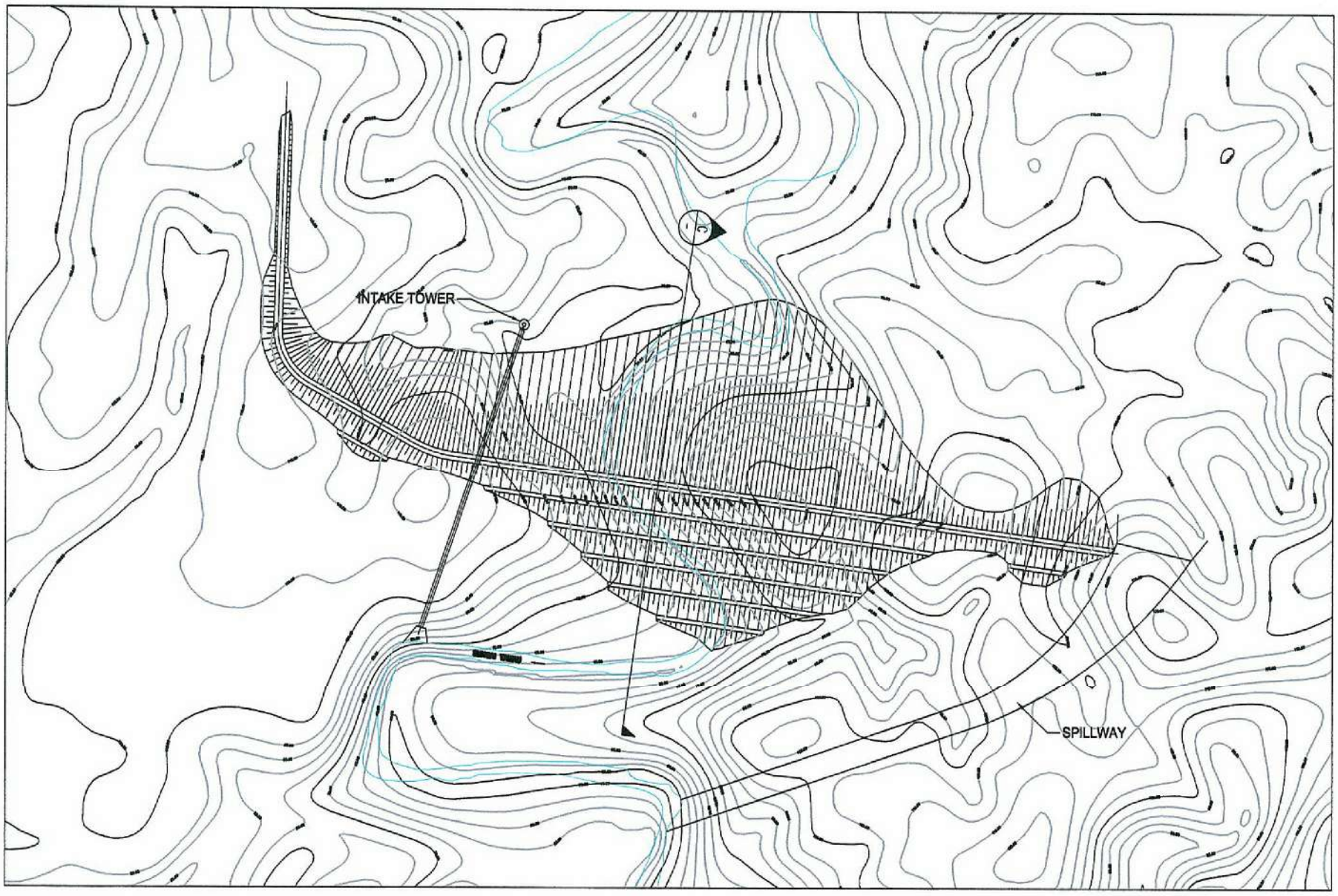
SOURCE : Adapted from
JABATAN AIR NEGERI SABAH

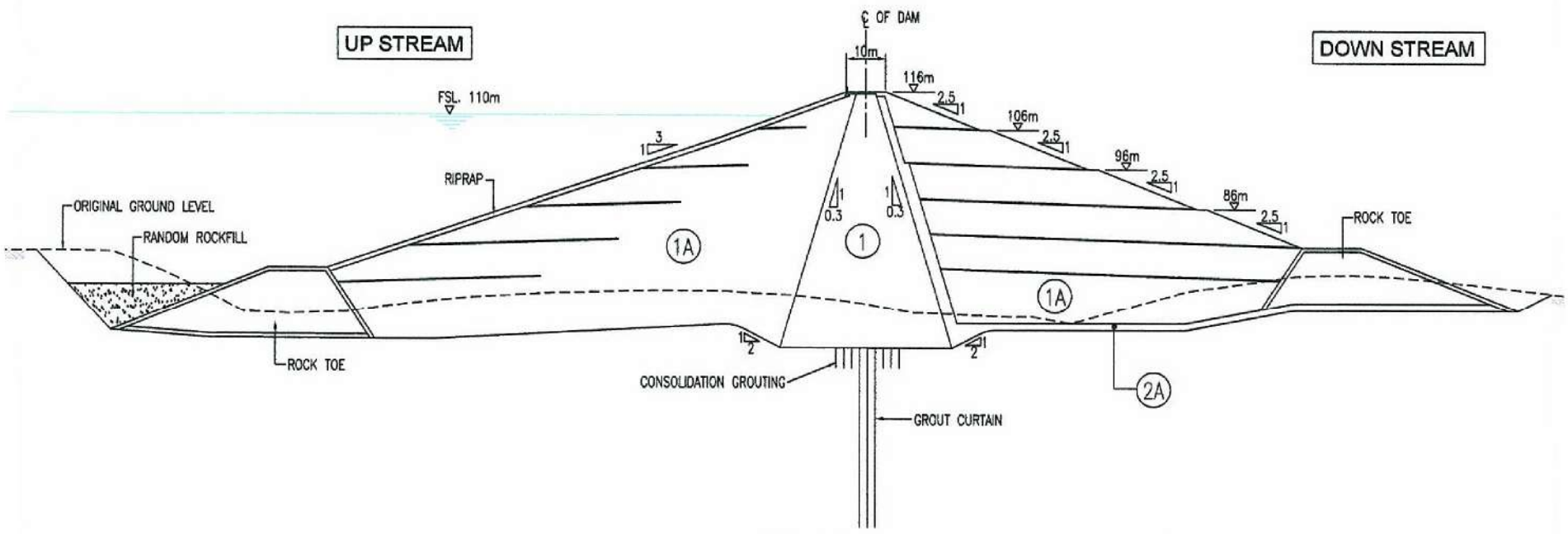
NOT TO SCALE

SPECIAL ENVIRONMENTAL IMPACT ASSESSMENT
PROPOSED DAM UPSTREAM OF CINTA MATA
TREATMENT PLANT, TAWAU, SABAH

LAYOUT AND TYPICAL SECTION OF ROCKFILL CLAY CORE DAM

FIGURE: 2.6





SECTION C - C

LEGEND :

ZONE 1	–	CLAY CORE
ZONE 1A	–	EARTH FILL
ZONE 2A	–	FILTER

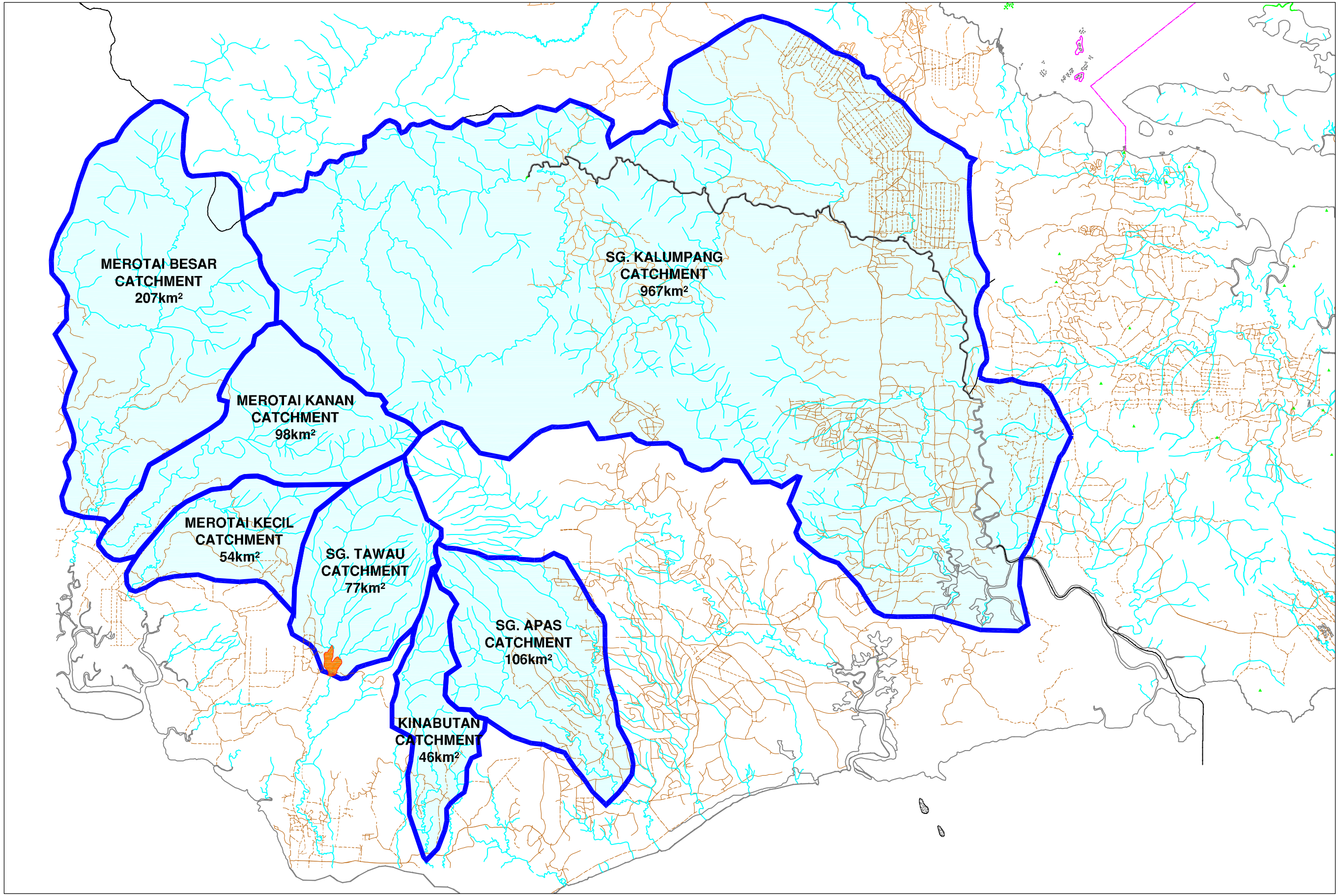
SOURCE : Adapted from
JABATAN AIR NEGERI SABAH

NOT TO SCALE

SPECIAL ENVIRONMENTAL IMPACT ASSESSMENT
PROPOSED DAM UPSTREAM OF CINTA MATA
TREATMENT PLANT, TAWAU, SABAH

LAYOUT AND TYPICAL SECTION OF ZONED EARTHFILL DAM

FIGURE: 2.7



LEGEND:

- PROPOSED DAM SITE
- WATER CATCHMENTS AREA
- ROAD
- RIVERS / STREAMS

SOURCE : Adapted from
Jurutera Perunding Campo Sdn. Bhd.
Angkasa Consulting Services Sdn. Bhd.

0 0.5 1.0 1.5 2.0 2.5 3.0Km

SCALE IN KILOMETRES (1:75,000) – A3 MEDIUM

SPECIAL ENVIRONMENTAL IMPACT ASSESSMENT
PROPOSED DAM UPSTREAM OF CINTA MATA
TREATMENT PLANT, TAWAU, SABAH

WATER CATCHMENT AREAS WITHIN TAWAU AREA

FIGURE: 2.8

D:\ACAD\DRAWINGS\EV403\4150\FIG-28.DWG

2.2.7 Project Components

Major components of the Project are as below:-

a. River diversion works including diversion tunnel, intake tower, upstream and downstream cofferdams, control and closure gates;

b. The dam proper, with estimated height of 116 m to Dam Crest Level;

c. Reservoir;

d. Spillway and its stilling basin;

e. Outlet tunnel;

f. Outlet or valve structure; and

g. Access road to the dam.

The ancillary components associated with the Project are:-

1. Borrow/Quarry Area – two (2) main sources of borrow/quarry areas for rock and earth materials have been considered: within the impoundment area and outside the impoundment area. The details of the proposed quarry/borrow sites shall be discussed in **Section 2.2.8**.

2. Camps and other installation – these include site offices, aggregate system, concrete batching plant, spoil disposal areas, power supply and water supply.

2.2.7.1 Flood Diversion

Flood diversion will consist of three (3) separate elements:

a) A diversion tunnel to handle normal river discharges and small floods;

b) A relatively low upstream cofferdam to divert normal river discharges through the tunnel; and

c) A larger downstream rockfill cofferdam located within the embankment profile, with the downstream face stabilised with reinforcing mesh anchored into the rockfill by anchor bars.

2.2.7.2 Dam

Preliminary studies thus far indicate that a CFR dam would be more viable and economical than the other alternative type of dams. This will be further confirmed and finalised at the submission of the special EIA report later.

2.2.7.3 Reservoir

The reservoir of the proposed dam shall extend along Sg. Tawau and its tributaries in the Sg. Tawau catchment which is approximately 77 km^2. The reservoir will have a branched layout due to the many tributaries within the Sg. Tawau catchment. See **Figure 2.9**.

The reservoir will have a full water supply level of 110 m AMSL. The affected land area for the reservoir is approximately 679 acres. The land acquisition for the Project by Sabah State Water Department can be referred in **Section 2.2.4**.

2.2.7.4 Spillway

The spillway will be located in open cut on a left abutment ridge discharging down a natural slope and entering the river some distance downstream of the dam. The spillway will comprise a control section (i.e. ogee or broad-crested weir) and a short length of concrete line chute terminating in a stilling basin.

Sizing of the basin will be based on the design flood and flood surcharge heights will be set in conjunction with the optimisation of embankment height/spillway width parameters. Consideration will be given to the provision of a service spillway and an ancillary 'fuse plu' type spillway, as an alternative to a single spillway configuration.

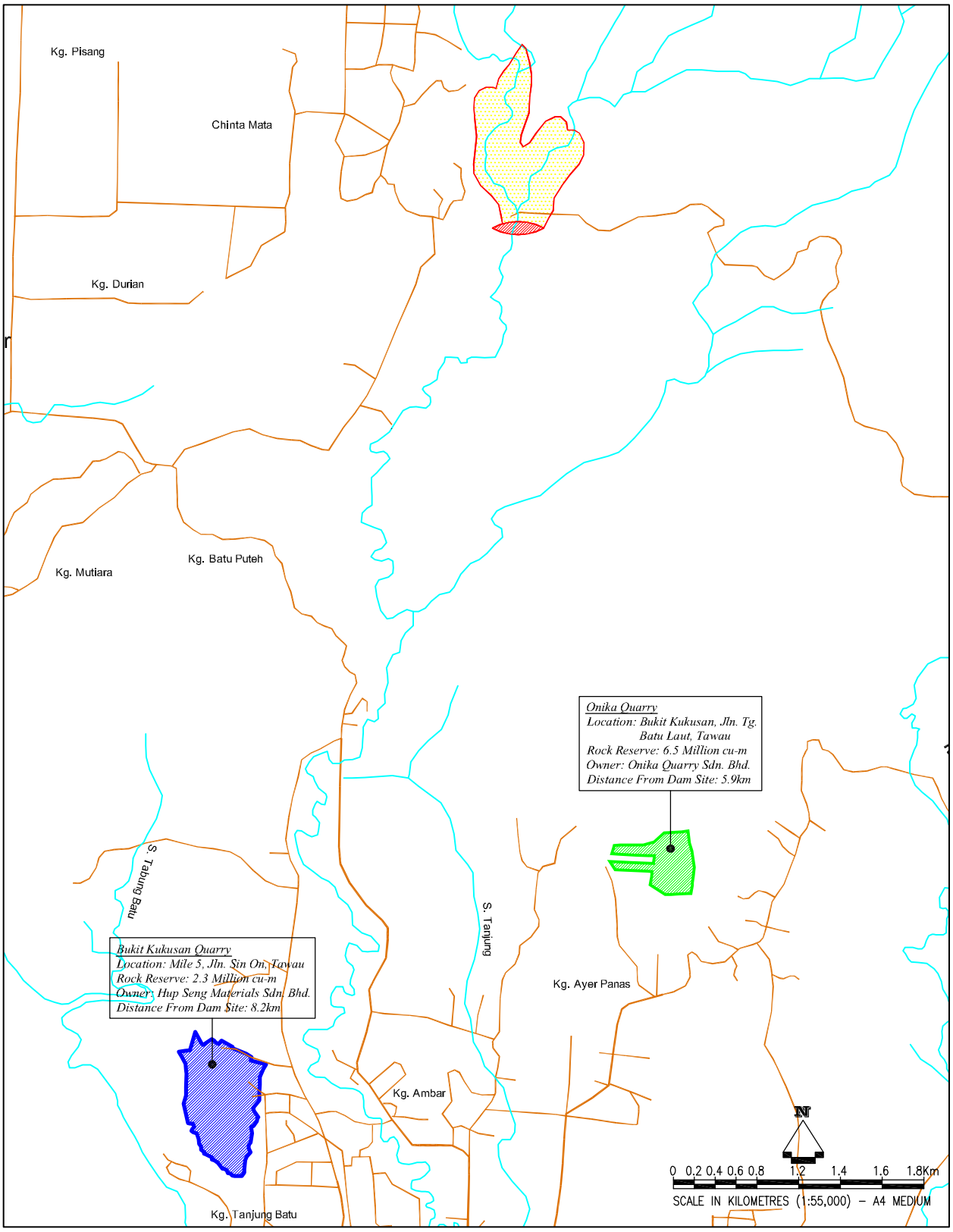
2.2.7.5 Outlet Works

The outlet works to be provided for the Tawau dam will consist of the following:

a) A full height intake lower tower located at the upstream tunnel portal. The tower will have a series of intake ports controlled by a system of shutters and trash-racks. This arrangement will permit water to be withdrawn from any desired level of the storage in order to provide the treatment works with a supply at the best temperature and water quality available.

b) A steel penstock concreted into the downstream half of the diversion tunnel, i.e. downstream of the grout curtain.

c) A large valve chamber at the downstream tunnel portal with a large diameter fixed dispersion cone valve and butterfly valve for discharging directly into the river under emergency storage drawdown conditions. The fixed dispersion cone valve will be housed in a concrete dissipater box to facilitate water energy dissipation.



LEGEND:

- PROPOSED TAWAU DAM
- TAWAU DAM IMPOUNDMENT
- ONIKA QUARRY
- BUKIT KUKUSAN QUARRY
- ROAD
- RIVERS / STREAMS

SOURCE : Adapted from
Jurutera Perunding Campo Sdn. Bhd.
Angkasa Consulting Services Sdn. Bhd.

SPECIAL ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED DAM UPSTREAM OF CINTA MATA TREATMENT PLANT, TAWAU, SABAH

PROPOSED QUARRIES WITHIN TAWAU AREA

FIGURE: 2.9

CHEMSAIN KONSULTANT SDN. BHD.

D:\ACAD\DRAWINGS\EV403\4150\FIG-29.DWG

2.2.7.6 Access Road

Access is available to the proposed Tawau dam site by some 12 km plantation road towards the existing Cinta Mata water treatment plant to the west and the Tawau Hills Park to the north. The standard of these roads is variable and gradually deteriorates as one approach the site. Some 10 km road stretch within the dam site would require upgrading works to some extent.

2.2.8 Borrow/Quarry Areas

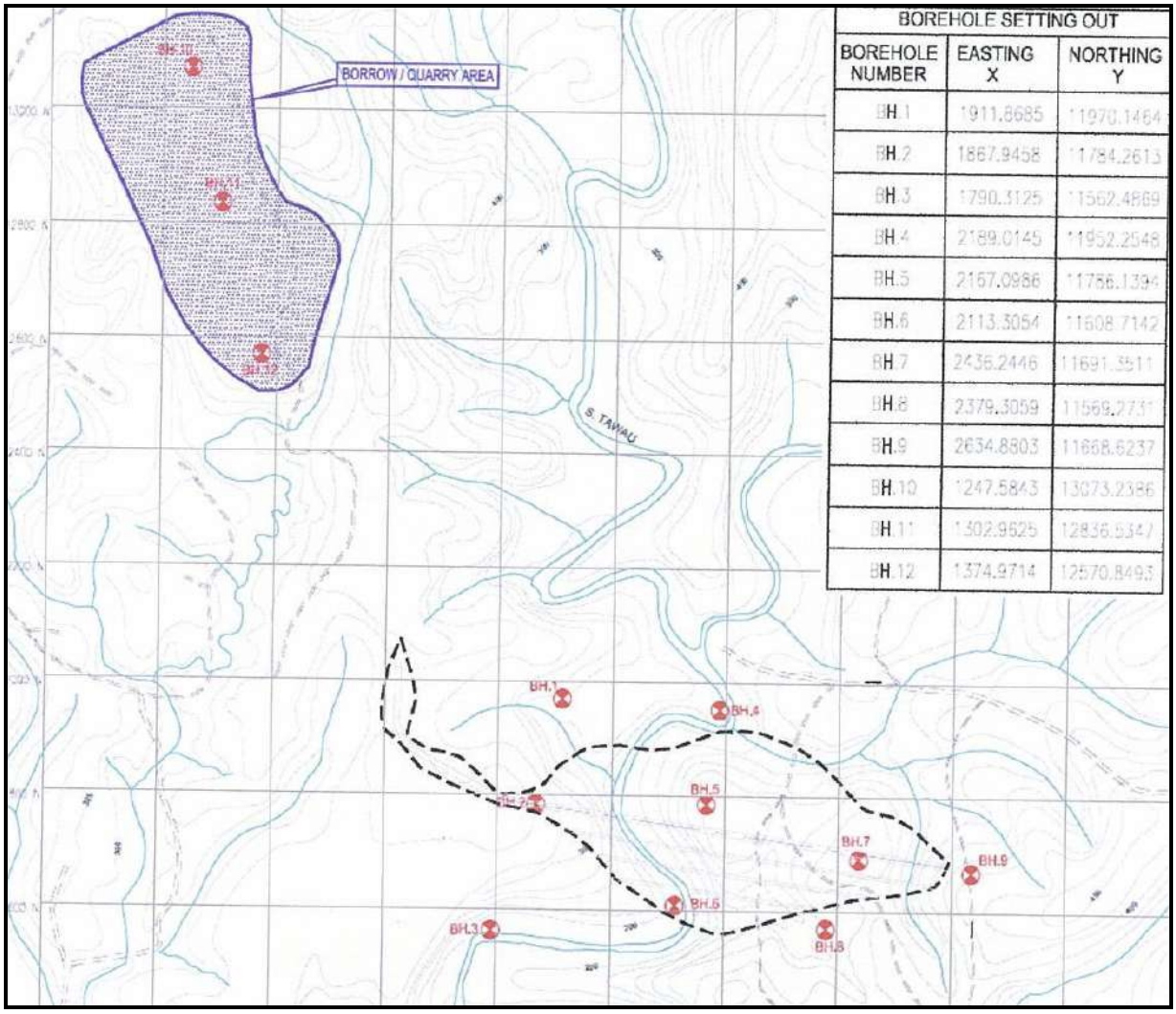
Construction of the dam design options based on **Table 2.4** requires quarry materials and earth borrowed inland materials to be used as source for filling.

Approximately 1.5 million cubic meters of hard rock is required for the rockfill dam option. This requires the establishment of quarries within and near to the dam site as the source of filling for the dam.

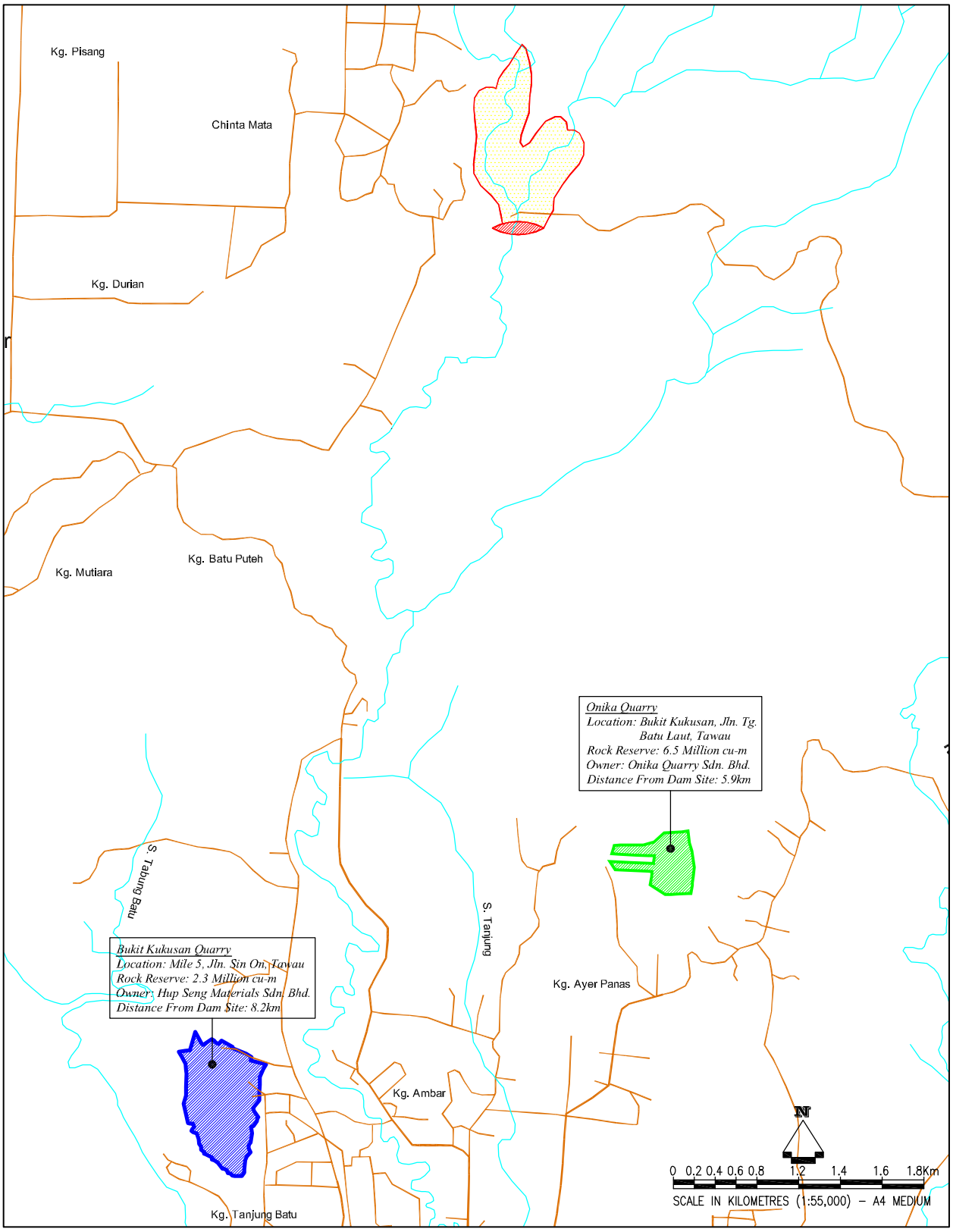
- Within the Project site – One borrow/quarry area is proposed at the northwest direction of the proposed dam site (refer to **Figure 2.10**). Three (3) boreholes (i.e. BH10, BH11 and BH12) were carried out in December 2011. The borrow/quarry area is easily accessible via the existing road to Tawau Hills Park. Approximately 1 million cubic metres of aggregates to be extracted from this quarry while the rest from outside the Project site. Detail of this proposed quarry site will be assessed in a separate EIA report.

- Outside the Project site- Two borrow/quarry sites have been proposed and preferred, i.e. Kukusan Quarry and Onika Quarry (see **Figure 2.11** for the location of the quarries). However, other quarries may also be considered at a later stage. Details of the two (2) quarries are summarised in **Table 2.6** below.

Figure 2.10: Potential Source of Aggregates within the Project Area and Location of Boreholes



BOREHOLE SETTING OUT		
BOREHOLE NUMBER	EASTING X	NORTHING Y
BH.1	1911.8685	11970.1464
BH.2	1867.9458	11784.2613
BH.3	1790.5125	11562.4869
BH.4	2189.0145	11952.2548
BH.5	2167.0886	11756.1394
BH.6	2113.5054	11608.7142
BH.7	2436.2446	11691.3511
BH.8	2379.3059	11569.2731
BH.9	2634.8803	11668.6237
BH.10	1247.5843	13073.2386
BH.11	1302.9525	12836.5347
BH.12	1374.9714	12570.8493



LEGEND:

- PROPOSED TAWAU DAM
- TAWAU DAM IMPOUNDMENT
- ONIKA QUARRY
- BUKIT KUKUSAN QUARRY
- ROAD
- RIVERS / STREAMS

SOURCE : Adapted from
Jurutera Perunding Campo Sdn. Bhd.
Angkasa Consulting Services Sdn. Bhd.

SPECIAL ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED DAM UPSTREAM OF CINTA MATA TREATMENT PLANT, TAWAU, SABAH

PROPOSED QUARRIES WITHIN TAWAU AREA

FIGURE: 2.1.1

CHEMSAIN KONSULTANT SDN. BHD.

D:\ACAD\DRAWINGS\EV403\4150\FIG-211.DWG

Table 2.6: Details of Potential Borrow Areas/Quarries for Proposed Dam

No	Potential Major Quarries in Tawau	
	Kukusan Quarry	**Onika Quarry**
1.	**Location and Project Area**	
•	Location: Bukit Kukusan, Tawau	Location: Mile 5, Jalan Sin On, Tawau
•	Direction: South West	Direction: South East
•	GPS Coordinates: Latitude 04° 16' 46"N'; and Longitude 117° 52' 15" E	GPS Coordinates: Latitude 04° 16' 46"N'; and Longitude 117° 52' 15" E
•	Area: 72.72 acres	Area: 71.68 acres
2.	**Distance from Project Site**	
•	8.2 km	5.9 km
3.	**Estimate Rock Reserve**	
•	23 million cubic meters	6.5 million cubic metres
4.	**Estimated Life Span**	
•	13 years	10
5.	**EIA Status**	
•	Approved	Approved

Apart from that, approximately 4 million cubic meters of earth materials is also required for the filling of the proposed dam. Earth borrow materials will be obtained from the residual excavated soil materials that are generated from bulk earthwork for any development within the Project area, mainly within the range of 10 km radius of the Project site. Detail of this potential earth borrow areas will be assessed in a separate EIA report later.

Due to its proximity, most probably the fill material will be transported via the existing section of the roads leading to the proposed dam site, i.e. Jalan Utara. Although there will be obvious benefits to the costs of the works, there will also be a substantial mitigation of the possible environmental impacts that would undoubtedly arise from the transportation of such large volumes over a relatively short period of time.

Even though the exact borrow areas have not been identified by the Project Proponent at this stage, future selection of any borrow areas should follow the following criteria:

a. Availability of material with acceptable quality;

b. Environmental impact due to extraction and transportation;

c. Cost of material;

d. Cost of extraction;

e. Cost of transportation; and

f. Geotechnical characteristics of the fill material.

2.3 PROJECT ACTIVITIES

The Project activities that will be involved throughout the project development are summarised as follows in **Table 2.7**.

Table 2.7: Project Activities for the Proposed Dam Project

No.	Project Phasing	Project Activities
1.	Preparation / Pre Construction Stage	• Feasibility Study (i.e. Site Investigations)
		• Public Disclosure and Communication
		• Land Acquisition, Tenure and User Rights
		• Funding, Tendering and Design
2.	Construction Stage	• Earthworks, Civil Works and Electro-Mechanical Works
		• River Diversion/ Cofferdam Construction
		• Biomass Disposal
		• Decommissioning of Temporary Structures
3.	Fill Storage/ Impoundment and Commission Stage	• Closing of Diversion Tunnel
		• Removal of Cofferdam Flooding and Filling of Reservoir
		• Releasing Compensation (Environmental) Flow
4.	Operation and Maintenance Stage	• Operation of the Dam
		• Periodic Maintenance

2.4 PROPOSED PROJECT DEVELOPMENT SCHEDULE

The proposed Project schedule is shown in **Figure 3.1** below. The construction of the proposed dam will take about 50 months to complete after it has been awarded.

3.0 SCOPE OF WORKS FOR SPECIAL EIA STUDY

The scope of works for this Special EIA study will cover the following specific subject matters:-

a) Description of the proposed Project including its rationale, concept, components and activities;

b) Description of the existing physic-chemical, biological and human environments including recording the existing river profile and levels;

c) Identification of potential environmental and social impacts and assessment of their significance with indicative costs wherever possible during all stages of Project implementation, including site preparation, diversion works, dam construction, reservoir preparation, rehabilitation/restoration, subsequent operation/maintenance and possible future abandonment.

d) Formulation of abatement and mitigation measures; and

e) Identification of residual impacts and recommendation of monitoring requirements.

3.1 PROJECT DESCRIPTION

Descriptions will made on the proposed site location and size, Project development concept, development components and scheduling, capacity and technologies, operational parameters, site selection criteria or site options, including the 'no project' option and proposed Project activities.

3.1.1 Statement of Need for the Assessment

This Special EIA will provide a comprehensive explanation of the need for, and justification of the proposed dam, including:-

Figure 3.1: Proposed Work Programme for Proposed Tawau Dam Project

	Activities	Month										
		1		2	3	4	5	6	7	8	9	10 to 60
1	**Data Collection**											
	- Engineering Survey Data											
	- Soil Investigation Information											
	- Hydrological Records (streamflow, rainfall, etc.)											
	- Reports related to the Project											
2	**Review of EPD's Requirements and Statutory Requirements**											
	- Environmental Requirements Imposed by EPD											
	- Study of Special EIA Report											
3	**Determination of Reservoir Area and Capacity Curve**											
	- Review of Survey Information											
	- Computation of Stage-Storage Curve											
4	**Hydrological Assessment**											
	- Low Flow Analysis (1:50 year drought)											
	- Flood Analysis											
5	**Geological Assessment**											
	-Assessment on Dam Site's Geological and Foundation Conditions											
6	**Sedimentation Assessment**											
7	**Water Quality Assessment**											
8	**Review Suitability of Proposed Dam Site**											

	Activities	Month										
		1		2	3	4	5	6	7	8	9	10 to 60
	-Assessment of Safety and Constructability											
9	**Identification of Alternate Dam Sites**											
	-Option Study for Dam Sites											
10	**Determination of Optimum Storage Capacity**											
	-Preliminary Estimates for Dam Construction											
	-Comparison of Construction Cost and Storage Yield											
11	**Determination of Firm Yield for Scheme**											
	-Simulation of Reservoir Operation using HecREsim											
12	**Evaluation of Dam Types**											
	-Roller Compacted Concrete (RCC) dam											
	-Zoned Earthfill											
	-Concrete Faced Rockfill Dam (CFRD)											
	-Earth cored Rockfill Dam											
13	**Seismic Study**											
14	**Review Availability and Suitability of Construction Materials**											
15	**Mechanical and Electrical Requirements**											
16	**Preparation of Design Report**											
17	**Design Report Review & Approval**											
												(50 months)
18	**Tendering, Award & Construction**											

- The prime objective of the proposed dam is to meet the future water supply demand in Tawau up to year 2050;

- A comparative analysis of the existing design of the Tawau dam in 1991 and the current review design of the proposed dam; and

- A summary of environmental, economic and social arguments to justify the need for the proposed dam.

It is expected that an update of these assessments, which have been addressed in the previous feasibility study (Sabah State Water Department, 1990) is required. The general statement of need for this Project is mentioned in **Section 2.1** earlier.

3.1.2 Selection of Alternatives / Options

The Special EIA will describe alternatives / options for the proposed dam in Tawau. These alternatives, including the 'no project' option, have been discussed in **Section 2.2.6** and **Section 2.2.7**. Hence, the findings will be further discussed and the choice of preferred options explained.

In addition, it will include a comparison of the adverse and beneficial effects (direct and indirect) used as the basis for selection, and compliance with the principles and objectives of ecologically sustainable development.

It is expected that input from the Project Proponent will be required on this aspect. The alternatives to be discussed will include:-

- Other key alternatives to site selection; and

- Other key alternatives to the dam design and type.

Discussion of the above options will include:

- Adverse and beneficial effects of the alternatives; and

- Comparison of short, medium and long term advantages and disadvantages of the options.

Where appropriate and required, numerical modelling tools and cost benefit analysis will be utilised to assess alternatives.

3.1.3 Description of the Proposed Tawau Dam

All components of the dam scheme (including the reservoir site, dam, etc.) will be described in detail from initial installation to the long term horizon. Emphasis will be given to those components with the most potential for significant short and long term environmental impacts. Underlying assumptions and forecast reliability will also be discussed.

The description will include but not limited to:-

- Location, site, layout and Project including ancillary sites, transport corridors, etc;
- Description of the physical requirements for the proposed dam including:-
  - » Types, total quantities, sources and availability of major construction materials;
  - » Additional infrastructure requirements; and
  - » Off-site infrastructure requirements and community development required to support the construction and operational phases.
- Description of the construction works required, including:
  - » Timing of work programme, duration of construction phase;
  - » Size of construction workforce and accommodation requirements;
  - » Extent of earthmoving, vegetation clearance and other site preparatory works;
  - » Arrangement for disposal of construction wastes during and following construction; and
  - » Arrangements for erosion and sediment control and rehabilitation of construction sites.
- Procedures/processes/technologies to be utilized, and the major plant components associated with operation; and
- Other resource requirements, including infrastructure and public facilities required.

4.0 DESCRIPTION OF EXISTING ENVIRONMENT/ DATA COLLECTION

This section will elaborate the features of the physical, biological and socio-economic environment relevant to the proposed Project and associated infrastructure. A description of the existing environment is required to provide the necessary baseline data for evaluation of the physical, biological and socio-economic impacts and for the formulation of environmental management plan and monitoring programme.

4.1.1 Topographical and Physical Characteristics

Description of the existing topographical and physical characteristics of the Project site will be made from field investigations, secondary sources such as topographical maps from the Lands and Surveys Department, Department of Survey and Mapping Malaysia, aerial photographs and details from previous studies provided by the Project Proponent and their consultants. Findings on terrain analysis, including weathering studies of the Project site and its surrounding areas will be obtained from the Project Proponent to be used for assessing potential soil erosion.

4.1.2 Geology, Geomorphology, Hydrogeology

The Tawau area is underlain mainly by volcanic rocks ranging from basalt to andesite and dacite. Volcanic activity started in Early Miocene and ends with extrusion of basalt in Late Quarternary. The geology of the Tawau dam site is difficult to define from surface outcrops and a comprehensive geological investigation is considered particularly necessary at the site. Some dacite is located in the river bed and massive andesite or basalt is evident on the abutments. A regional geological setting of the Tawau area is shown in **Figure 4.1**.

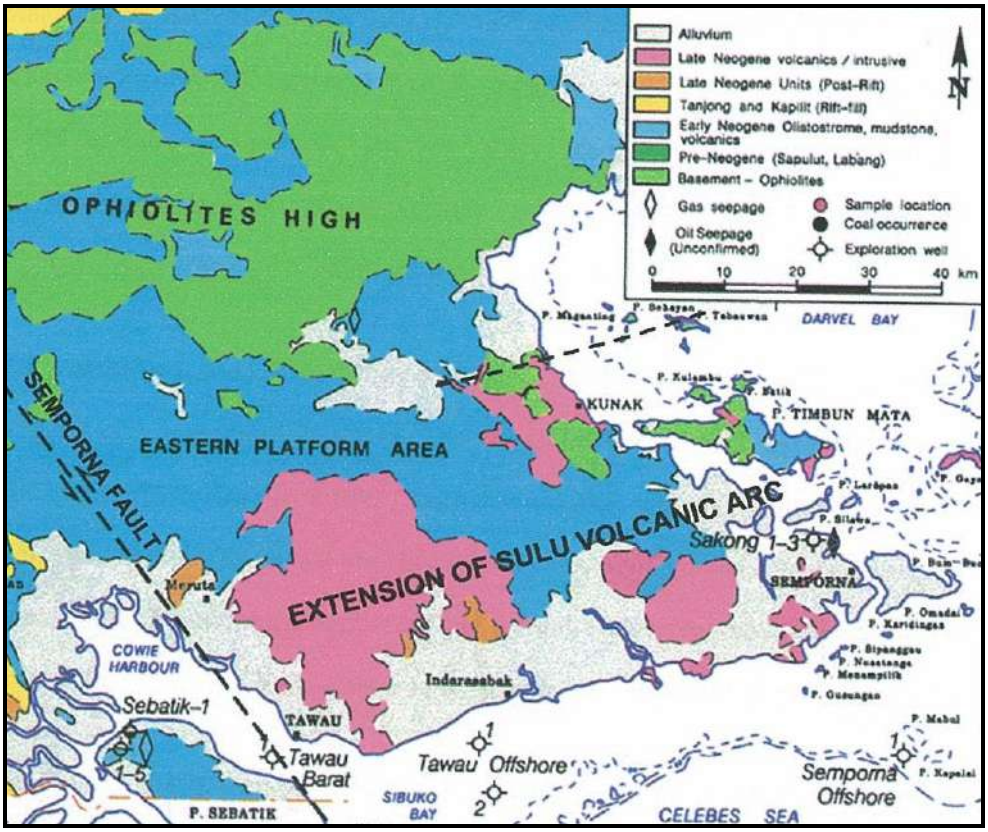


Figure 4.1: Geological Setting of Tawau, Sabah

Existing maps and information combined with satellite imagery and field investigations will be reviewed and analysed to provide a description of the local and regional geology, geomorphology and hydrogeology. Aerial photograph examinations in order to identify general geology and morphology shall be conducted. This includes LANDSAT imageries if available. Some of the imageries may need to be acquired from MACRES in Kuala Lumpur.

Review of the geological features shall be done with particular reference to the followings:

- Identification and evaluation of geological features within the catchment, which may be influenced by the proposed dam;
- General evaluation of the stability and permeability of the site, such as the tightness of the reservoir and the permeability of the dam foundation, by identifying and evaluation of the significance of local faults and joint structures, if any;
- Evaluation of the seismic results collected from the seismic study of this Project and those conducted in earlier reports; and
- Review of the occurrences of mineral resources in the catchment, if any.

4.1.3 Seismicity

The probabilistic method of seismic hazard assessment (PSHA) will be adopted. A desktop PSHA study is proposed to determine the maximum design earthquake for the proposed dam design. The works will include a review of earthquakes and earthquake hazard near the Project area. Data codes developed and under the license of EZ-FRISK (or other software system) shall be used. The results of the PSHA would be in the form of peak ground acceleration (PGA), and response spectra for the proposed dam site for earthquake magnitudes that are 5 and above on the Richter's scale. The recommended design values will be expressed in terms of the annual frequency of exceedance, where graphs are developed for 1, 0.1, 0.001, 1x 10^{-4} and 1x 10^{-5}.

The attenuation relations of NGA (New generation of Attenuation) are mainly for shallow crustal earthquakes in the western United States and similar active tectonic regions. For the Borneon region, shallow sources nearby the dam site are not present and therefore this method will not be used. Earthquakes that occur in the surrounding areas of Borneo are mainly from the subduction zones, and for this case the attenuation relations developed for this condition, such as those by Youngs et al. (1997) or Atkinson and Boore (2007) will be used.

4.1.4 Establishment of Baseline Conditions in the Catchment and River

A combination of data analyses, modelling and expert experience will be used to assess existing river characteristics; in particular the key characteristics of river flow that contribute to hydraulics, flooding and morphological change. This description will form the basis from which the future scenario with the dam can be assessed.

4.1.4.1 Analysis of Rainfall and River Flows

Rainfall records will be analysed to:-

- Describe ambient rainfall conditions;
- Estimate design low flow conditions;
- Estimate design high flow conditions, including Probable Maximum Precipitation (PMP); and
- Incorporate aspects relating to climate change.

Data will be obtained and analysed. Extreme value analysis techniques will be applied to determine design rainfall conditions.

River water levels and discharge will be analysed to determine frequency distributions and design flow conditions (extreme low flows and extreme high flows). It will also be used in the development of the hydrological and hydraulic models, which will supplement this data and provide a more comprehensive description of river flows.

Profiles river cross-section will need to be surveyed in the vicinity of the proposed dam site. Cross sections with intervals of 50 m are proposed over a reasonable reach of Sg. Tawau (about 1.5 km downstream).

Analysis of low flow conditions focuses on low flow duration, magnitude and probability of occurrence (frequency) and will consider the following methods:

1. Procedure for low flow estimates from Malaysian Guidelines (HP 12, DID 1985); and

2. Statistical analysis of discharge measurements/model results.

4.1.4.2 Hydrology

The function of the hydrologic model is to simulate the land phase of the hydrologic cycle. The hydrologic model translates point and spatial rainfall and potential evaporation to runoff for the entire basin, with the primary components of overland flow, interflow and baseflow.

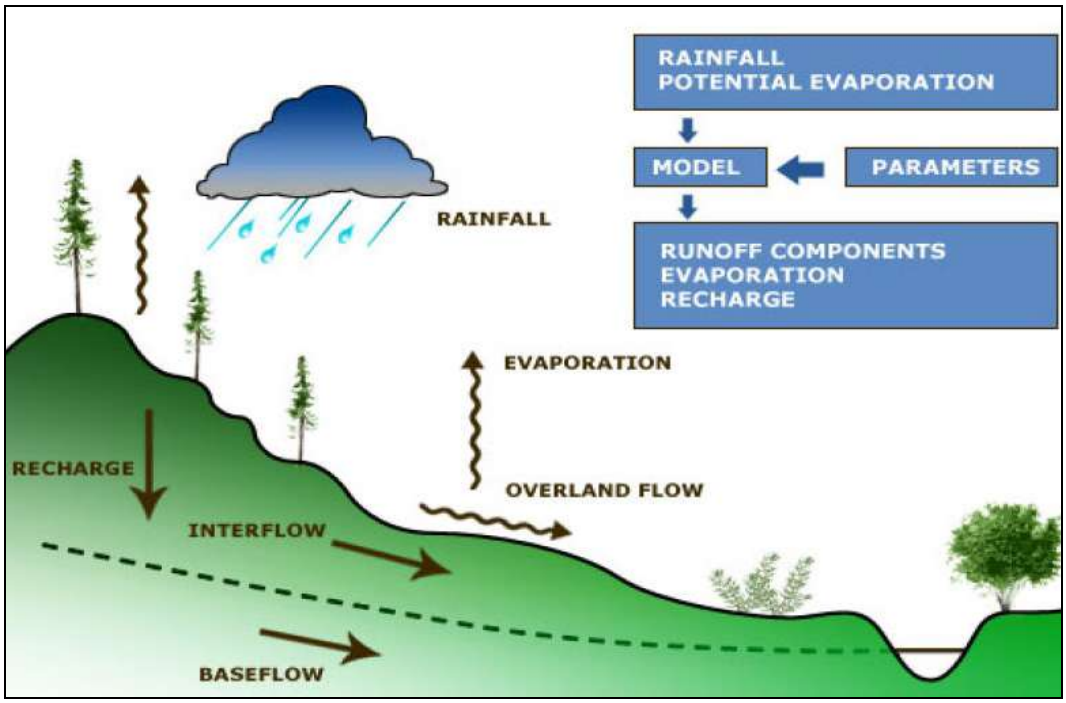


Figure 4.2: Overview of Rainfall/ Runoff Process

The hydrologic model will be based upon a large scale catchment model previously developed for Sg. Tawau. This will take rainfall as input and will predict discharge hydrographs of flood events that will be applied to the hydrodynamic model. The process of runoff is dependent upon the amount of rainfall and the nature of the catchment (land use, vegetation, slope, etc.). Catchment characteristics will be prepared using satellite and topographic data. This will form part of the overall modelling system by linking into the hydrodynamic model. The model is a parametric, lumped, continuous loss model; it can be used to generate continuous time series output of discharge for as long as rainfall data is available.

The model will be used to generate a long term series of runoff (10+ years; as long as the available of rainfall data). Mean annual flows and design low flows will be analysed from these series to provide outputs meaningful and statistically relevant to assessing riverine flow conditions. Future land use and growth changes can be incorporated into the model to predict if future catchment conditions can affect runoff.

4.1.4.3 Hydraulics

A hydraulic model of the river using HEC-HMS will be developed. This is a 1D hydrodynamic model. The geometry for the model will be available river cross-sections, complemented with any additional bathymetric and terrain data.

Boundaries for the model will consist of tidal variations in the ocean and inflows from the hydrologic modelling. Model simulations will be performed over a long-term duration. The model will be calibrated to DID discharge and water levels available at permanent river stations (i.e. Kuhara Station, Ladang Iman Station, etc.). Any other available data, information or comparisons to anecdotal evidence or observations will also be utilised. Emphasis will be made on accurately predicting:

- Low flow conditions - accurately simulating drought conditions;
- High flow conditions - flood events; and
- For dam-break assessment, calibration will be made to a recent, significant flood event and also to the most extreme historical event recorded. While these calibration events will not be of the same intensity as a Probable Maximum Flood (PMF), there are no other floods to compare to. However, less intense flood events are often more difficult to model accurately because predictions in shallower water are more sensitive to the accuracy of the model geometry.

Following calibration, the model will be used to generate a long term record of river discharge and water level. This will provide the basis for determining ambient flow conditions in the river system.

To assess reservoir flow conditions, the HEC-HMS model can be enhanced in specific reaches to include a number of vertical layers in the computation. This feature allows simulations of density / temperature driven currents, which affect stratification in reservoirs.

4.1.4.4 Pollution Sources and Soil Erosion

The assessment considers water quality and sediments from source to departure from the river. This includes generation of pollution and soil erosion in the catchments, its transport via runoff into the river system, its mixing and interactions in the receiving water in the river, and its departure into the sea.

A pollution load and soil erosion risk model for Sg. Tawau catchment will be developed. This model uses identified point and non-point pollution sources and the runoff generated by the catchment model to predict the likely concentrations and types of pollution that is contained

in the runoff. The load assessment considers hydrological, agricultural, population, land cover and land use information to predict the following:

- Quantification of point and diffuse sources of pollution to identify potential affected areas. This includes soil erosion risk;
- Visualize and understand the route followed by pollutants and suspended sediments from the point of generation to the main waterway; and
- Estimation of the pollutant and sediment quantity and concentration that reaches the receiving water body.

4.1.4.5 River Water Quality

The water quality model which will be used is QUAL2E, which was developed by the United States Environmental Protection Agency (USEPA). The QUAL2E model is used for waste load allocations, discharge-permit allocations, and other pollution evaluations. QUAL2E is applicable to well-mixed dendritic streams where the major transport mechanisms of advection and dispersion are only significant along the longitudinal axis of flow for a stream. Streamflow and input of waste loads are considered to be constant i.e. in steady state during the simulation period. The model can also be used to study the assimilative capacities of receiving streams and to identify non-point waste loads (Brown and Barnwell, 1987).

A river is represented in the QUAL2E model as a linked group of streams and tributary reaches that consist of headwaters (the beginning of a stream reach) and sequential strings of completely mixed reactors, which are referred to as computational elements. Within each reach, all the computational elements have the same average depth, stream slope, channel cross-section, and biological/chemical rate constants. The QUAL2E model calculates a flow and mass balance for each computational element.

The forcing function used for estimating transport is the stream discharge, which is assumed to be constant. Stream velocity, cross-sectional area, and depth are computed from streamflow. The QUAL2E model performs dissolved oxygen balance by including major source and sink terms in the mass balance equation. The nitrogen cycle is composed of four compartments: organic nitrogen, ammonia nitrogen, nitrite nitrogen, and nitrate nitrogen. The phosphorus cycle consists of dissolved phosphorus and organic phosphorus. Ultimate carbonaceous biochemical oxygen demand (cBOD) is modeled as a first order degradation process. The major source of dissolved oxygen is algal photosynthesis and atmospheric reaeration.

Besides, water quality modeling for Dissolved Oxygen and Biochemical Oxygen Demand during the impoundment period will also take into consideration the volume of submerged vegetation. This prompts an accurate and consistent estimation of the biomass volume to be inundated by reservoir filling which shall be carefully looked into.

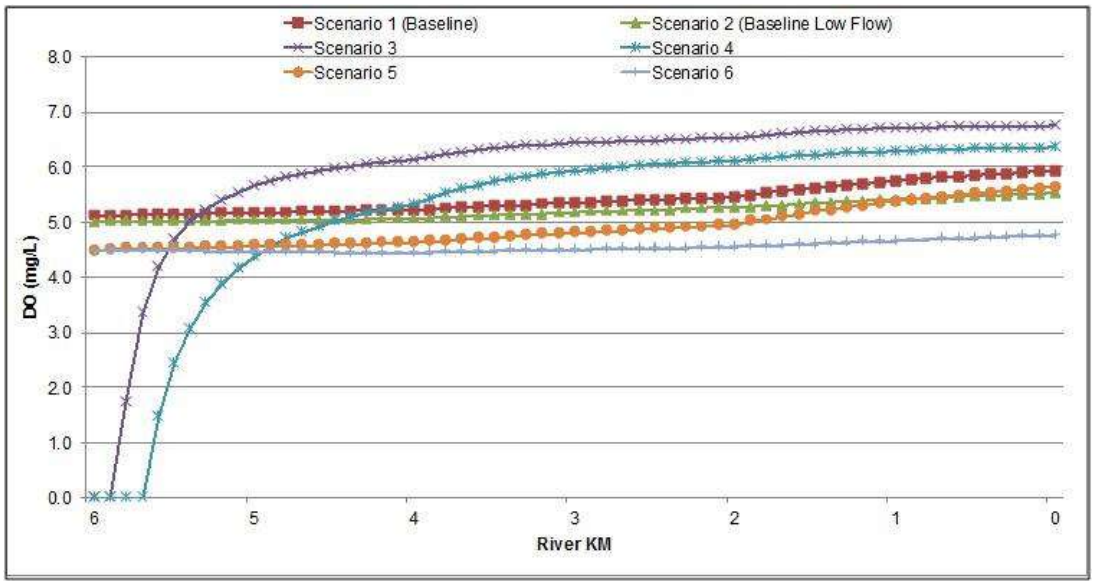


Figure 4.3: Downstream Concentration Spatial Trend of DO

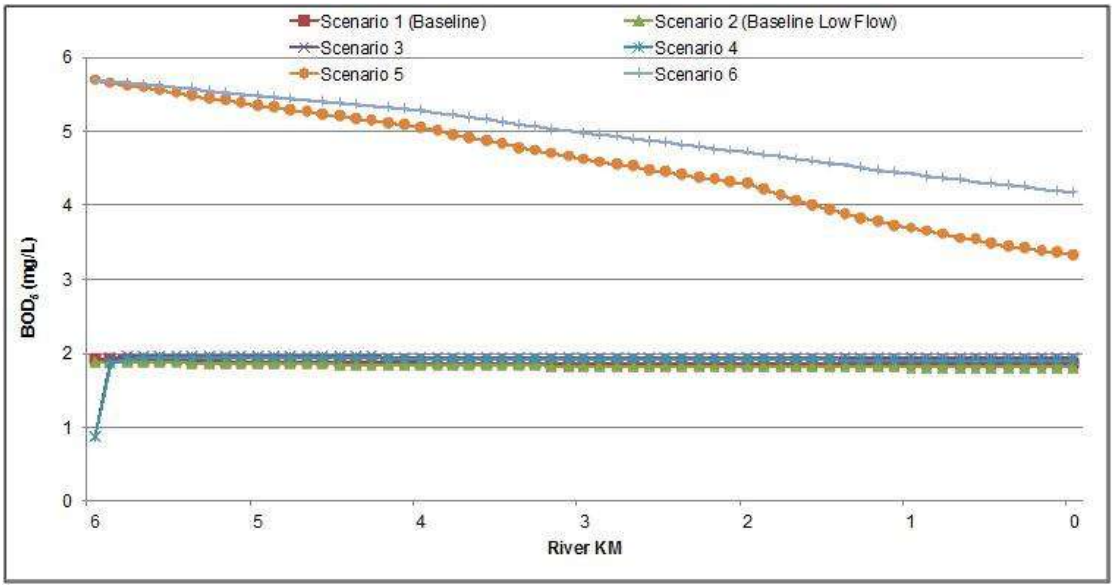


Figure 4.4: Downstream Concentration Spatial Trend of BOD_5

4.1.4.6 River Morphology

The Sediment Transport model simulates non-cohesive transport (both bed load and suspended load components) and cohesive transport. This will use available sediment samples to define sediment characteristics.

The model will be calibrated to any available information relating to the changes in bed formations in the river; a possible aspect in this regard could be accumulated sediments at the upper end of the reservoir.

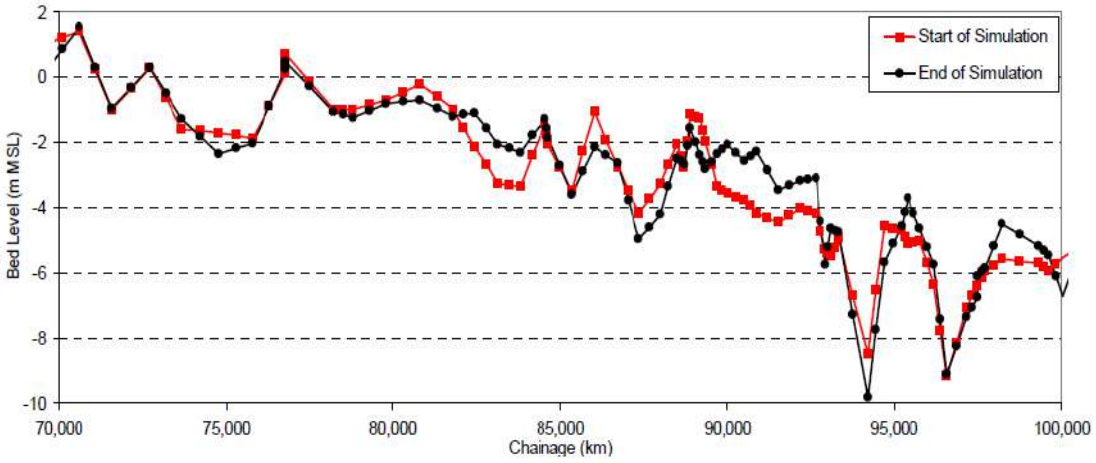


Figure 4.5: Longitudinal profile of bed levels in a river reach subject to morphological changes over a 10 year period

4.1.5 Baseline Environmental Monitoring

Baseline data obtained prior to Project implementation is a good source for formulating future environmental compliance limits/standards for the proposed Project. The following environmental parameters will be determined as environmental baseline data for the special EIA study. These include surface water quality and sediment quality of Sg. Tawau as well as air and noise levels at the surrounding area.

4.1.5.1 Surface Water Quality

Sg. Tawau catchment is about 30 km in length and 8 km in breadth. About 50% of the catchment is mountainous with elevations up to 1,200m AMSL. From the proposed inundation site down to estuary, the river is uniformly formed between 10 to 15 m width with an average velocity of about 0.5 m/s. Therefore, it is essential to have good baseline data for the evaluation of potential impacts due to the proposed development. For this reason, a total of eight (8) samples shall be collected upstream and downstream of the Project site. The proposed surface water sampling locations are shown in **Figure 4.6**.

Table 4.1: Proposed Water Sampling Locations

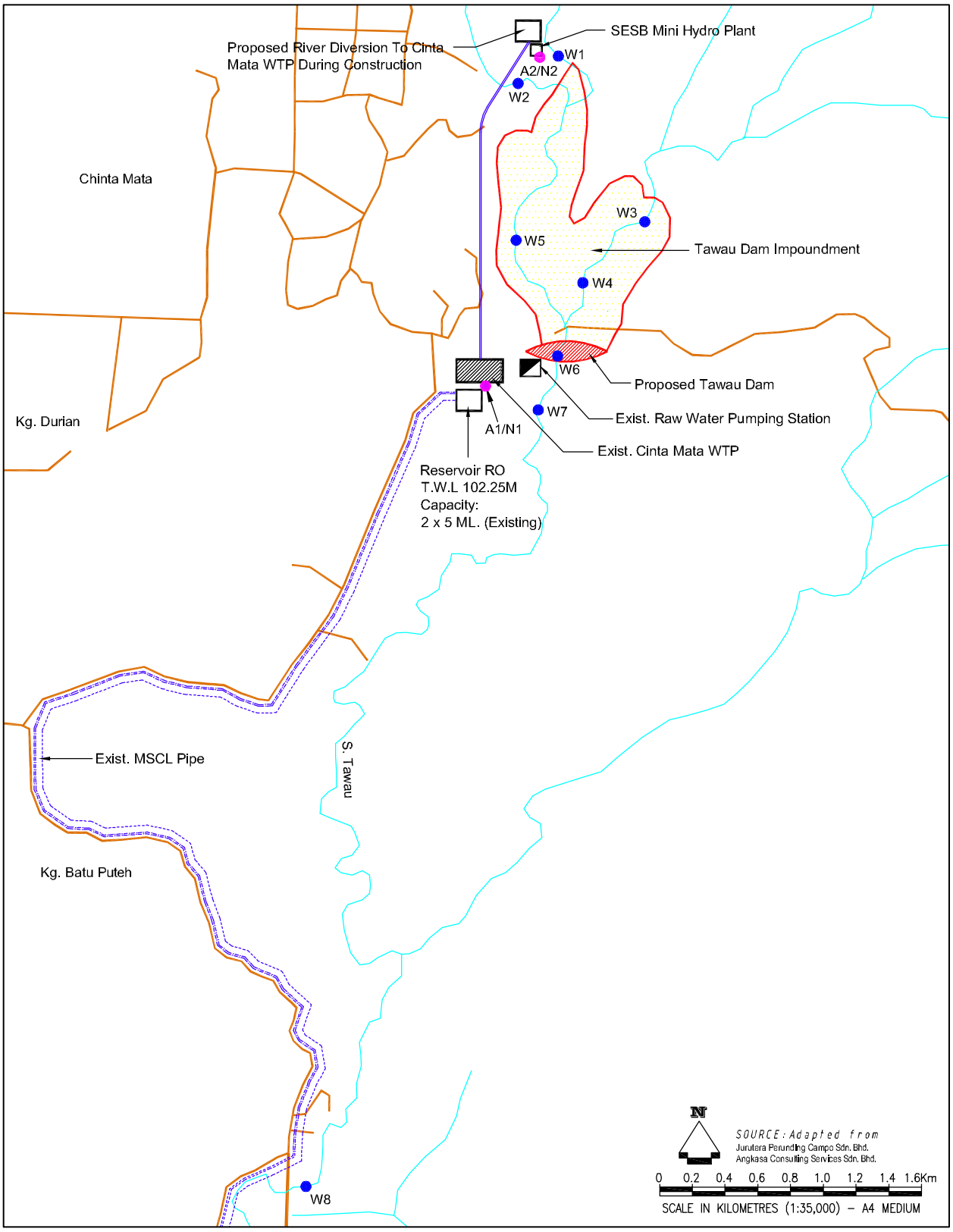
Location	Number of Samples
Upstream of proposed dam site (reservoir)	5
At dam site	1
Downstream of proposed dam site	2
Total	**8**

The Interim National Water Quality Standards for Malaysia (INWQSM) would be used as a guideline in the assessment of river water quality.

Test Parameters

The parameters proposed for the surface water monitoring were determined by considering the potential pollution or change to the parameters as a result of the proposed Project development and operation. Baseline level for these parameters shall be used as comparison with future level when the dam is operated. The proposed parameters are as follows:

Parameters	
• Temperature (in-situ)	• Lead (as Pb)
• pH value (in-situ)	• Manganese (as Mn)
• Dissolved Oxygen (in-situ)	• Total Nitrogen (as N)
• Turbidity (NTU)	• Aluminium (as Al)
• Salinity	• Nickel (as Ni)
• Colour (Hazen)	• Zinc (as Zn)
• Biochemical Oxygen Demand (BOD)	• Boron (as B)
• Chemical Oxygen Demand (COD)	• Iron (as Fe)
• Total Suspended Solids (TSS)	• Potassium (as K)
• Total Dissolved Solids (TDS)	• Phenol
• Conductivity	• Free Chlorine
• Ammoniacal Nitrogen (as NH_3-N)	• Calcium (as Ca)
• Chloride (as Cl^-)	• Sulphide (as S)
• Mercury (as Hg)	• Oil and Grease
• Cadmium (as Cd)	• Total Coliform Count (TCC)
• Chromium (as Cr)	• Faecal Coliform Count (FCC)
• Nitrate-Nitrogen	• Orthophosphorus (as P)
• Organic Phosphorus (as PO_4)	



LEGEND:

- W1-W8 — WATER SAMPLING LOCATIONS
- A1/N1-A2/N2 — AIR AND NOISE SAMPLING LOCATIONS
- ROAD
- RIVERS / STREAMS

SPECIAL ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED DAM UPSTREAM OF CINTA MATA TREATMENT PLANT, TAWAU, SABAH

PROPOSED BASELINE SAMPLING LOCATIONS

FIGURE: 4.6

CHEMSAIN KONSULTANT SDN. BHD.

D:\ACAD\DRAWINGS\EV403\4150\FIG-46.DWG

4.1.5.2 Noise Level Monitoring

Noise monitoring will be carried out to determine baseline noise level which may be useful for future comparison, particularly during construction stage whereby noise generated from use of machinery and equipment could be one of the main concerns to the nearby communities, especially Tawau Hills Park. Measurement should be conducted using Noise Level Meter and measurement shall be taken during day and night referring to the "Planning Guidelines for Environmental Noise Limits and Control in the Environment" published by the DOE. Data obtained shall be recorded in L_{eq}, L_{min} and L_{max} readings. Two (2) noise sampling points have been proposed as shown in **Figure 4.6**.

Table 4.2: Noise and Air Samplings Strategy

Location	Number of Samples
At dam site	1
At nearest receptor	1
Total	**2**

4.1.5.3 Air Quality Monitoring

Air quality will be described based on site investigation and baseline air quality monitoring of the following parameters at the proposed sampling points shall be conducted:

- Total Suspended Particulates (TSP);
- Sulphur Oxide (SO_x);
- Nitrogen Oxide (NO_x); and
- Carbon Monoxide (CO).

Two (2) sampling locations have been proposed and can be referred in **Table 4.2** and **Figure 4.6**.

4.1.6 Biological Environment

Except for Tawau Hills Park area, the vegetation in the Sg. Tawau catchment area is almost entirely derived from human activities. In the mid and lower part of the catchment only three areas of natural vegetation remain: the Bukit Gemok Forest Reserve and Tanjung Forest Reserve.

4.1.6.1 Terrestrial Flora

The area to be inundated and immediate surroundings will be classified into vegetation zones based on land use and natural vegetation types. Inventories to represent each zone will be made in the area to be inundated especially the areas within the Sabah Parks'

boundaries. The inventories will be separated for standing trees >5 cm DBH and for ground vegetation. All species of monocotyledonous and dicotyledonous plants will be included in the inventory. The inventories will reveal presence of high conservation habitats or species, volume of commercial timber, volumes for biomass removal, dry-weight of biomass for greenhouse gas emission calculations.

Specifically, the objectives of the flora component of the study will be:

- Identifying the major or most common forest or vegetation types in and around the proposed Project site;
- Estimating the above-ground biomass content of the major vegetation types that are found within and around the proposed Project site;
- Identifying species of plants (trees, herbs, creepers and so on) which are protected and with significant economic and social importance worthiness of conservation;
- Identifying any potential adverse impact that the Project development and operations may have on important protected species; and
- To proposed mitigating measures, where necessary.

Survey Methodology

a) General Observation

During the plot survey field work, general observations will be made on the community type, condition of the vegetation and dominant species. Surveys will be carried out by vehicle, track and noting of the condition of the forest and plantation area.

b) Station Enumeration

The vegetation survey will be carried out using the Soepadmo (1987) method where an inventory plot will be setup at each identified vegetation types. GPS position where there are signal, at each site will be recorded.

Five (5) stations have been proposed (refer to **Figure 4.7**) and sampling station will be plotted only in the impact area (reservoir area). In every station, a 30 m x 30 m plot will be established to measure, observe and record the flora species within the survey stations.

The plot also will be used to enumerate breast-height (DBH) of each tree. Information such as species name, height and girth of tree shall be recorded. Once data is collected, total plot biomass will be estimated through calculation using formula.

Observations which include presence of traditional medicinal plants, commercially used species and wildlife habitat will also be done.

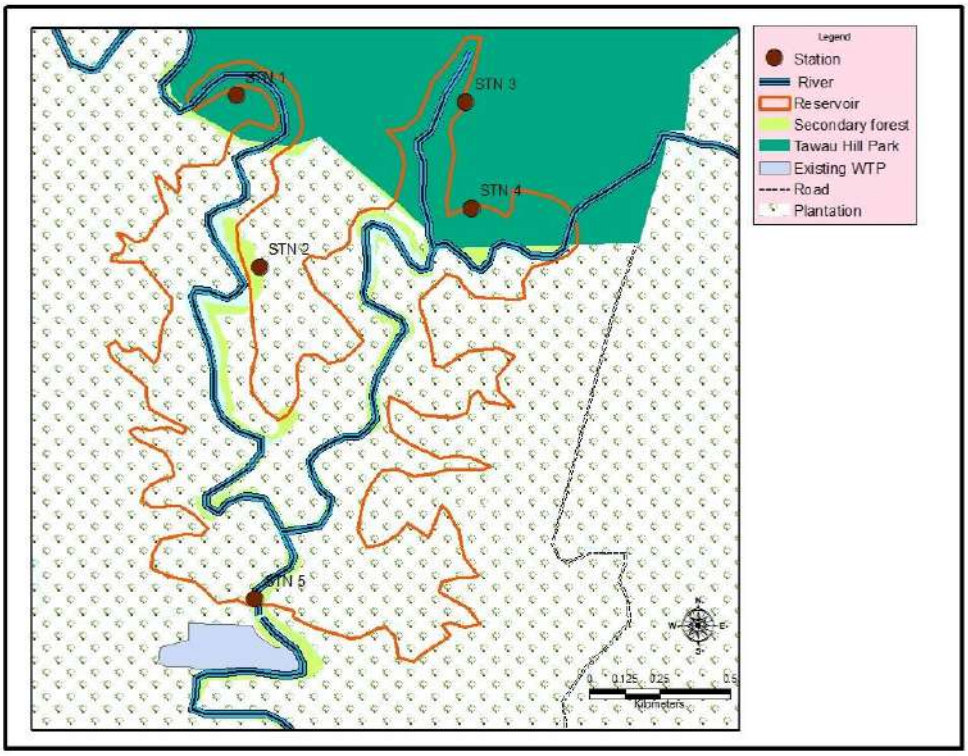


Figure 4.7: Proposed flora sampling stations within the impact area (reservoir area) to measure the vegetation biomass

4.1.6.2 Fauna

Fauna surveys will use the same vegetation zones as the floral studies combined with considerations such as topography and distance to disturbances. The presence of terrestrial mammals will be determined through interviews with local people, literature review and through a search for marks such as tracks, faeces, scratch marks and if possible direct sighting. Avifauna will in addition be detected by sounds and by catching in mist nets. Herpetofauna will be tracked in the field and checked against interviews and literature records. Emphasis will be to determine if there are protected, threatened or endangered species present in the area and to get an impression of the general health of the ecosystem. As the adjacent Tawau Hills Park is rich in wildlife, literature reviews shall be made to ensure the terrestrial fauna at the inundated area is well studied together with Sabah Parks.

a) Small Mammals

The three methods that will be used for this study are (1) 50-100 standard wire or cage traps will be used on line transects for love trapping or terrestrial small mammals, (2) mist netting of volant small mammals (i.e. bats and flying squirrels), three to five sampling points with two station replicates will be set, one in the primary forest and one at the ecotone when such habitat types are available, and (3) opportunistic sampling will be done by spot-lighting, hand-netting, harp traps and direct sighting of animals. Weight and various samples will be collected for later identification.

b) Birds

The two study methods employed are (1) observatory survey of birds that will be conducted at predetermined sites along Sg. Tawau and Sabah Parks boundaries. The birds will be identified either through binoculars or from vocalization. These observational data will supplement the mist netting data, and (2) mist netting will be conducted in several plots in representative areas along Sg. Tawau and its tributaries. At each point, 4 nets will be erected for two consecutive days. The nets will be checked every two hours from 6 am until 6 pm. A bird caught will be weighed, measured and ringed before being released.

c) Herpetofauna

Herpetofauna studies will concentrate on stream frogs. The survey will be done by the standard method of stream transect for adult frogs. After identification, the frogs will be released at the site when it was caught. Any other retiles encountered during the frog, bird and mammal survey will also be recorded.

d) Assessment methodology

Assessment will be made on the potential impacts of the Project development and operations upon terrestrial fauna. Recommendations for minimizing these potential impacts will be formulated.

4.1.6.3 Aquatic Life

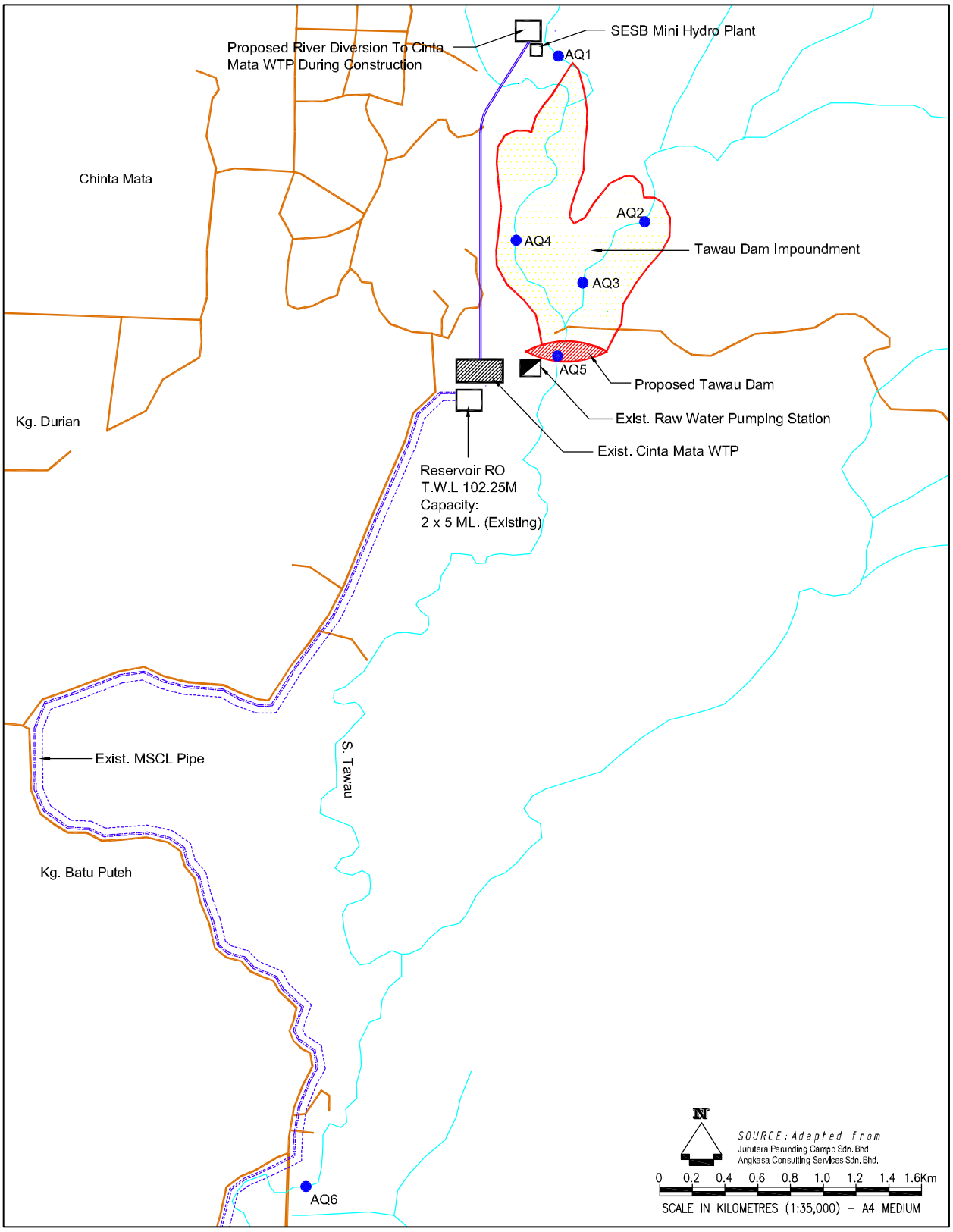
The three major study areas proposed for the aquatic component are aquatic flora, aquatic invertebrates, macrobenthos, fish fauna and riverine fisheries. These components are important mainly due to their interrelationship in the aquatic food web, ecological importance or as sources of food.

For this study, five (5) stations will be selected along Sg. Tawau and its major tributaries. Proposed sampling locations are as follows (refer to **Figure 4.8**):

- One (1) station at downstream of proposed dam site of Sungai Tawau;
- Three (3) stations at the proposed dam site and storage area; and
- One (1) station at upstream of Sg. Tawau or tributary.

However, the actual sites of sampling stations will depend on the accessibility of the area. The sampling will form a baseline against which the health of the river system may be compared before and after the Project is constructed.

The methodologies employed for each of the study station are described below.



LEGEND:

- AQ1-AQ6 **AQUATIC SAMPLING LOCATIONS**
- **ROAD**
- **RIVERS / STREAMS**

SPECIAL ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED DAM UPSTREAM OF CINTA MATA TREATMENT PLANT, TAWAU, SABAH

PROPOSED AQUATIC SAMPLING LOCATIONS

FIGURE: 4.8

a) Aquatic Flora

Aquatic flora refers to phytoplankton and periphyton in general which was found in a river system. Phytoplankton is planktonic algae that live suspended in the water column with little swimming ability. Their distribution is considered to be controlled by physical processes of water such as current and mixing. Periphyton is benthic algae that grow attached to surfaces of rocks or larger plants. Both phytoplankton and periphyton are autotrophic that depends on light and chlorophyll to fix carbon dioxide into organic molecules hence they play an important role in the carbon sink. They are also an important component in food web of the aquatic ecosystem. The ecological study of each component is described below.

- Undertake sampling of phytoplankton, periphyton, and chlorophyll *a* at six (6) selected stations at the proposed sites (refer to **Figure 4.8**);
- Prepare a list of taxa (lowest possible) and relative abundance of the phytoplankton and periphyton found in the study sites;
- Identify potential impact the project may have on the phytoplankton, periphyton, and chlorophyll *a*, and
- Propose mitigation measures to minimize these impacts, where necessary.

Survey Methodology

i. Phytoplantkon composition

Sampling for phytoplankton composition will be carried at six selected stations in Sg. Tawau and its tributaries as described in earlier part. Plankton samples will also be collected using a-20 µm mesh size plankton net or van-dorn water sample for analysis. All samples will be preserved in neutral Lugol's solution and analyzed using a Sedqwick rafter counting chamber under high magnification light microscope (Olympus IX51). Identification will be carried out to the lowest taxa possible with relevant literature.

ii. Chlorophyll a

Water samples for chlorophyll a measurement will be obtained using van-dorn water sampler at subsurface water. One liter of water samples will be filtered using glass fibre filter (GF/F). Total chlorophyll a will be extracted and determined spectrophotometrically. Concentration of chlorophyll a will be determined using the appropriate equations.

iii. Periphyton composition

Periphyton composition will be carried out at same stations as described in earlier part. The stone will be picked randomly from the bed sediments and placed in a tray with a small amount of stream water. Periphyton attached to the stone will be

scraped off using a scalpel and wash onto the tray. Samples will be preserved in neutral Lugol's solution and brought back to the lab for identification. Identification will be carried out to the lowest taxa possible based on Graham and Wilcox (2000) and Biggs and Kilroy (2000).

Assessment Methodology

Assessment will be carried out based on chlorophyll a, taxonomic compositions of phytoplankton and periphyton communities in comparison to similar study on stream ecosystem. The potential impacts of dam construction on the three ecological components will also be assessed.

b) Aquatic MacroInvertebrates

Macroinvertebrates constitute the major organisms in river ecosystem that include aquatic insects (adults and larvae), crabs, shrimps, snails, clams and worms. They are important in contributing to the processing of allochthonous and autochthonous organic carbon thereby influencing periphyton growth, nutrients and food availability for fish and other large animals through their secondary production. Therefore, they are useful candidates for assessment of water pollution and habitat disturbance due to human activities.

For the Special EIA of the proposed dam upstream of Cinta Mata Water Treatment Plant, macroinvertebrate communities will be assessed at three habitat categories, namely (i) not inundated areas, (ii) areas to be inundated, and (iii) below the proposed dam site. The assessment comprises the following activities;

- Undertake sampling of macroinvertebrates at six (6) selected stations at the proposed sites (refer to **Figure 4.8**),
- Prepare a list of taxa (lowest possible) and relative abundance of the macroinvertebrates found in the study sites,
- Identify potential impact the project may have on the macroinvertebrates, and
- Propose mitigation measures to minimize these impacts, where necessary.

Macroinvertebrates Sampling

Macroinvertebrates will be collected by using kick-net (frame size = 40 cm x 32 cm, mesh size = 0.5 mm together with the electro-shocking activity. The shocking area will be covered up to 40 m stretch along the stream depending on the homogeneity of the habitat. The specimens will be put into the plastic bottle containing 85% alcohol and bring back to laboratory for sorting and identification. Identification will be made according to keys available in Yule and Sen (2004).

Statistical Analysis

Data analysis to be performed will include Shannon's diversity index and evenness indices (Ludwig & Reynolds, 1988). Water quality of the rivers studied will be determined biologically using Average Score Per Taxon, ASPT (Mustow, 2002). Shannon's diversity index will be tested for significant difference between stations with modified Zar t-test available in PAST statistical program (Zar, 1999; Hammer et al., 2001).

c) Fish Fauna and Riverine Fisheries

Studies on the fish fauna of Sabah started with the great fauna work on the Indo-Australian fishes by Weber and de Beaufort (1913 – 1922) which include intensive collections and discussion on most of the species found in Sabah. However, to date the work of (2002) is the most comprehensive record of the fish fauna of Sabah. Other studies include those carried out by Roberts (1982), Abdullah Samad (1986), Kong and Inger (1989), Nyanti (1995a, c) and Ahemad & Helena (*in press* a, b).

In Tawau Hills Park, an earlier study on the fish was carried out by Nyanti (1995). A total of 6 families and 18 species were recorded from the area.

The objectives of this study are to:

- Collect, examine and describe the existing status of fish fauna and riverine fisheries in the vicinity of the proposed dam upstream of Cinta Mata Water Treatment Plant,
- Predict the potential significant impact of the dam on fish fauna and riverine fisheries, and
- Propose appropriate mitigating measures for potentially adverse impacts.

Survey Methodology (Fish Fauna)

Fish collection procedures to be employed in this study will focus on a multi habitat approaches, that is, sampling habitats in relative proportion to their local representation, as determined during site reconnaissance. As much as possible, sampling sites will be selected to contain riffle, run and pool habitat. Because all fish sampling gear types are generally considered selective to some degree, various types of sampling gears such as electroshocking, gill nets, cast nets, and hooks and lines will be used in this study (where appropriate).

Fish species will be identified either in situ or in laboratory. Specimens that could not be identified in the field will be preserved in 10% formalin and later transferred to 70% ethanol for identification in the laboratory. Fish identification followed those of Tan (2006), Inger and Chin (2002), Kottelat et al. (1993), Roberts (1989), and Mohsin and Ambak (1983).

The values for diversity index will be calculated for each station following Shannon and Weaver (1963), species evenness following Pielou (1966) and species richness following Margalef (1968).

Survey Methodology (Riverine Fisheries)

Interviews and questionnaires will be carried out with some of the residents at the villages that will be affected by the proposed Project and targeted mainly on the regular local fishermen. This survey will attempt to find out the fishing methods employed, frequency of fishing, targeted fish species, fishing sites and seasons, methods of capture, catch per unit effort, and the importance of riverine fisheries to the local inhabitant.

Assessment Methodology

Assessment will be made on the potential impacts of the Project development and operations upon the existing fish fauna and riverine fisheries. Recommendations for minimizing these potential impacts will be formulated.

4.1.7 Socio Economics

This component describes the impact of the proposed Tawau dam Project on the socio-economic parameters of the people living within and in the surrounding areas of the Project.

The purpose of this study is provide description of the demographic characteristics, socio-economic activities and perceptions of the people living within 5 km radius of the study area to assess the situations, possible impact, including their acceptance and rejection on the Project and recommendations to minimize the adverse socio-economic effects of the Project as well as to maximize the positive contributions of the Project to the people in affected areas.

The scope of this social impact study will cover both the tasks of describing the existing socio-economic conditions and assessing the probable impacts. Description of the socio-economic aspects shall include:

- General demographic characteristics of the population and the sample studied for the district and areas of concern;
- Main economic activities and income level;
- Education level and other skills;
- Land ownership and utilization;
- Utilization of forest and river resources;
- Places of cultural significance and sensitivity;
- Tourism and recreational opportunities; and

- Public infrastructure and other social services.

4.1.7.1 Public Administration and Amenities

This information is mostly available directly from the public authorities in the area. Land traffic count at the Project site will be carried out, primarily to determine the traffic condition during peak hours for both morning and afternoon period. This information will be used for assessment of traffic impacts as a result of the proposed Project.

4.1.7.2 Demography

A survey covering all communities within a distance of 5 km from the reservoir, dam or associated facilities, excluding pipelines, will be performed. The survey will cover i.e. demographic patterns, ethnicity, livelihoods, education, land tenure, land use, use of natural resources. Utilities available in the Project site and surrounding areas will be described based on site inspections and secondary information from the various public and local authorities. This will include power supply, drinking water supply and source and public transportation and communication. The survey will interview a representative sample of the various communities that may be affected by the Project.

4.1.7.3 Stakeholder Engagement and Consultation

This task is a requirement for a Project that is classified as a Special EIA by the EPD. It requires public views to be sought. For this Project, The Consultant shall liaise with the relevant NGOs [normally WWF (World Wide Fund for Nature Malaysia, Sabah branch] and SEPA (Sabah Environment Protection Association) by consulting their views and perceptions on the proposed development.

4.1.7.4 Environmental Health

An assessment of environmental factors affecting the health of local residents will be made as a baseline against which later monitoring may be measured. The assessment will be done through detailed interviews with the target group and through secondary data from public sources.

4.1.7.5 Economic Land Use Activities

Forestry and estate activities in the catchment area will be investigated through information from relevant authorities, interviews with concessionaires, satellite imageries and field visits. The investigations will concentrate on erosion risk and the implications of the reservoir requirements for clean water on the management regimes of the estates and concessions. The use of and compliance with management plans and environmental impact assessments will be assessed. The sufficiency of environmental requirements will be assessed. Similar considerations will be made regarding small scale agriculture or estate crops in the catchment area.

5.0 MAIN ENVIRONMENTAL ISSUES

The typical main issues related to dam construction are listed in **Table 5.1**. However, additional issues may be added upon site assessment when conducting the Special EIA study. A detailed hydrology and hydraulic impact assessment (for design purpose) is not proposed as the Consultant is made to understand that there shall be dam experts and hydrologist engaged to undertake this aspect separately. The findings from the study shall be used to consider issues such as changes in water characteristics, flooding implications, problem of siltation and sedimentation, banks stability and changes in river hydrology wherever applicable.

Table 5.1: List of Main Issues for the Special EIA Study

Item	Issues
1.	**Hydrological and Hydraulic Impacts** These impacts would include water quality impacts and sedimentation. Specific issue would include water management issues such as quantity and timing of the release of water, changes in water characteristics, the disposal of stagnant water or colder water from the lower layers within the dam, releasing for environmental flow purpose, etc.
2.	**Geology and Seismicity** The possible geological effects of the dam by way of increased landslides, seepage or seismic activity which would encompass slope stability and seismicity. The seismic level figure will be recommended by the dam designer. This information will be presented in the final SEIA report.
3.	**Soil Erosion and Sedimentation** Specifically, this issue would be looking into the siltation in the reservoir and the implication of downstream alluvial loss. Also the study will look at the impact of soil erosion due to earthwork in relation to dam construction, road establishment, reservoir preparation, residential camp establishment, etc.
4.	**Air Pollution and Greenhouse Gas (GHG) Emission** Deterioration of air quality due to the exhaust emissions and dust generation during the construction of the dam while greenhouse gas emission due to probable release of carbon dioxide due to the reservoir preparation activities. In addition, the decomposition of the biomass would lead to the release of other GHG such as methane.
5.	**Waste Generation and Management** The issue of waste due to the clearing of debris after construction and restoration of vegetation and site rehabilitation.
6.	**Ecological Impacts** The impacts are reduction in biodiversity and the destruction of wildlife, the effects on habitats (in particular Tawau Hills Park) and the effects on fish spawning.

Item	Issues
7.	**Land and Transport Traffic** The movement of vehicles for the dam construction and the movement of vehicles present its own issues in terms of safety, traffic congestion and right-of ways. These implication will be looked into, especially in areas near the dam, borrow pits and main facilities such as spillway, outlet tunnels, etc.
8.	**River Navigation** The impacts of the dam on the usage of the river as a mode of navigation will be addressed (if any).
9.	**Infrastructure and Utilities** The Project's contribution to local infrastructure development and social facilities will be ascertained as to its significance, positive or otherwise.
10.	**Socio Economics Impacts** This will be a social impact assessment that includes impact of the Project on the economic and social consequences of the housing of the construction work-force and permanent workforce. In addition, potential damage to, or destruction of, archeological or historic sites may be an issue (if any).
11.	**Dam Break** The possible risks and hazards of the dam, including that which may be caused by dam failure, and emergency services and responses.
12.	**Land Use Compatibility** The consistency of the proposal with national, regional, or local planning instruments; the relationship with national parks, wilderness areas, or nature reserves.
13.	**Potential Abandonment** Impact of Dam Decommissioning/ Abandonment

Below are discussions on the main issues that will be studied.

5.1.1 Hydrological and Hydraulic Impacts

Construction and operation of dam will cause changes to the hydrological regime of the main river and its tributaries. The hydrology of the dam catchment in particular, will be assessed with emphasis given to the river systems downstream of the dam.

The following impacts are to be considered:

- Changes in river flows, in particular base flow and environmental flow requirements.
- Changes in river morphology and sediment supply.
- Changes in river water quality.

- Water quality in the reservoir.
- Sedimentation in the reservoir.

The numerical models will be modified to include the dam structure and associated infrastructure. The simulations will be repeated, and then compared. This is the basis of assessment of adverse impacts. Incorporation of dam structures into the models is achieved by inserting control structures. These simulate flow over complex structures, including operational aspects such as spillway closure. Where adverse impacts are identified and require mitigation, the models will be used in the feasibility assessment of mitigation options.

5.1.1.1 Hydrology and Hydraulics

Environmental base flow requirements will be considered using state and international guidelines, including:

- Draft guidelines for the assessment of sustainable levels of water use, Department of Irrigation and Drainage, Sabah, June 2004.
- "The essential of environmental flows", Water and Nature Initiative; Megan Dyson, Ger Bergkamp and John Scalon, IUCN, Gland, Switzerland and Cambridge UK.
- Environmental flow Guidelines, ACT government, 27th May 1999.

Typically, the Department of Irrigation and Drainage requires a minimum compensation flow equivalent to the 90% exceedance flow, based on annual means. This will by the Consultant be taken as a minimum requirement, which will be subjected to review depending upon the ecological conditions in the river system. Consultations with relevant authorities will be made, where necessary to ensure the environmental release flow is of acceptable level.

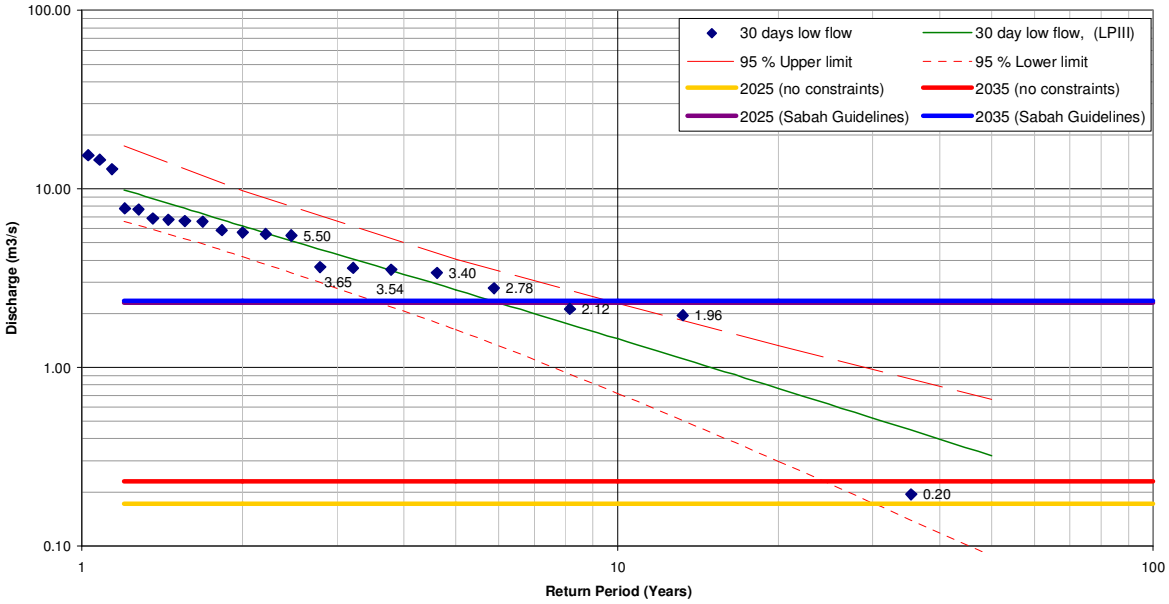


Figure 5.1: Annual low flow conditions, showing annual minimum series (AMS) and design 30 day low flows

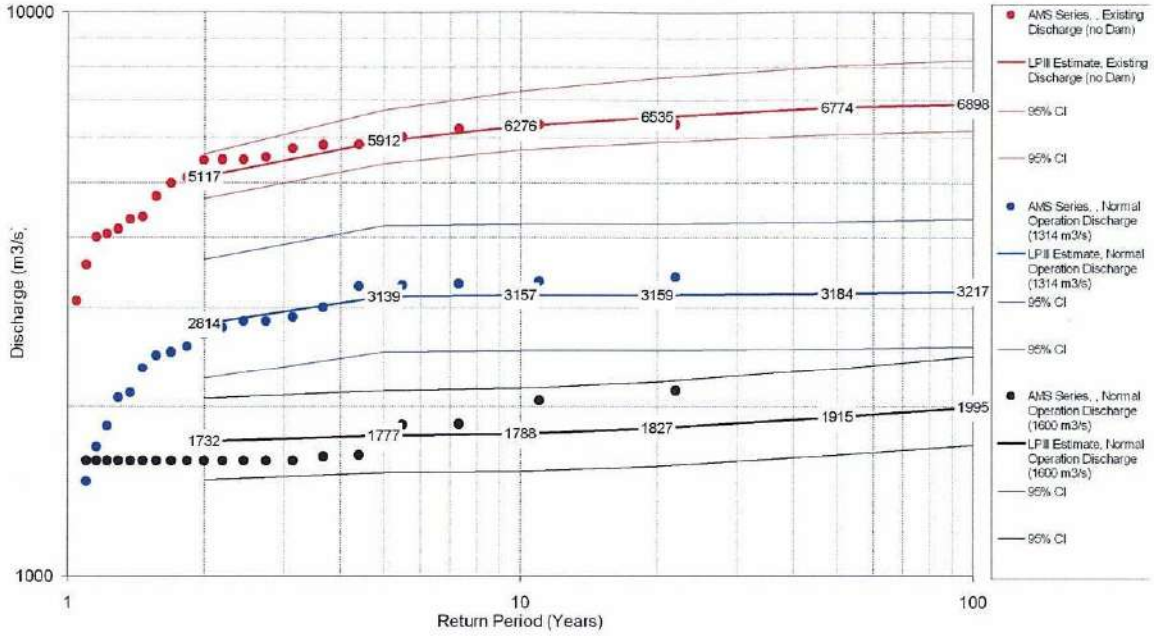


Figure 5.2: Example of analysis of model results, showing changes in design peak flows as a result of dam construction

5.1.1.2 Water Quality

Water would overflow the dam most of the time except on occasions when the flow coming down does not exceed the amount of water abstracted by the existing Cinta Mata Water Treatment Plant.

The possibility of stagnation of water behind the dam with consequent deterioration of water quality should be investigated. The risk of contamination of water upstream whether accidentally or intentionally and the measures to minimize such risk as well as to address any such actual contamination should be looked into.

As mention in **Section 4.1.4.5**, a water quality model (using QUAL2E) shall be set up to predict the change in water quality as a result of the construction of the dam.

The QUAL2E model performs dissolved oxygen balance by including major source and sink terms in the mass balance equation. The nitrogen cycle is composed of four compartments: organic nitrogen, ammonia nitrogen, nitrite nitrogen, and nitrate nitrogen. The phosphorus cycle consists of dissolved phosphorus and organic phosphorus. Ultimate carbonaceous biochemical oxygen demand (cBOD) is modelled as a first order degradation process. The major source of dissolved oxygen is algal photosynthesis and atmospheric re-aeration.

Methodology

The primary impact if any, of the dam operation towards ambient water quality shall be towards the sensitive receptors located downstream of the project site. However, in terms of modelling proceedings, a direct impact is difficult to quantify, as it is correlated to a reduction in carrying capacity due to flow retention without an obvious point source input. Thus, the

modelling scenarios have been oriented towards these conditions, vis-a-vis the resulting water quality of the downstream reaches as a result of flow retention, during the reservoir storage as well discharge during power generation. The following scenarios have been designed to encapsulate these conditions: -

SCENARIO 1: Baseline scenario without the presence of the dam, at normal in-stream flow.

SCENARIO 2: Baseline scenario without the presence of the dam, at low in-stream flow.

SCENARIO 3: Water quality during reservoir storage, at normal in-stream flow.

SCENARIO 4: Water quality during reservoir storage, at low in-stream flow.

SCENARIO 5: Water quality during dam operation at prescribed m^3/s compensational flow, under normal in-stream flow.

SCENARIO 6: Water quality during dam operation at prescribed m^3/s compensational flow during low in-stream flow.

The following **Figure 5.3** shows the typical assessment output of the above scenarios (for Dissolved Oxygen):

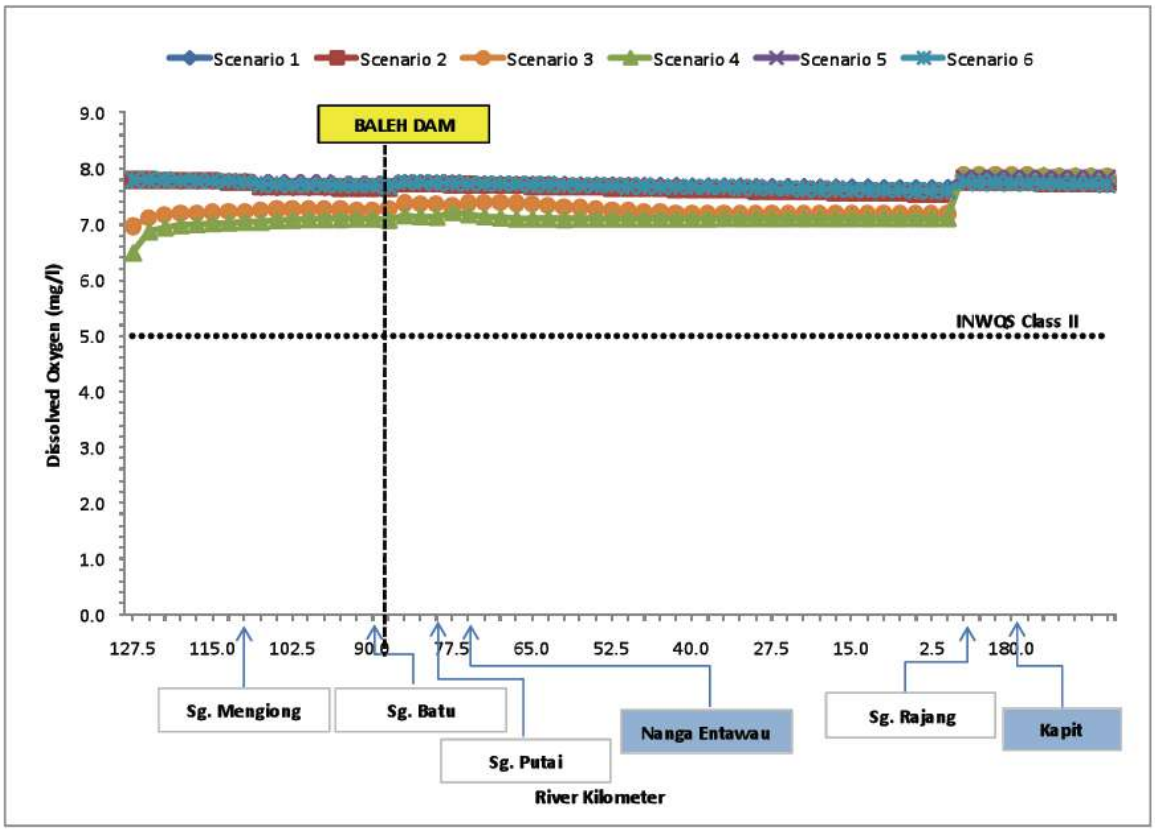


Figure 5.3: Dissolved Oxygen (DO) Downstream Spatial Trend

Potential eutrophic effects as a result of flow retention upstream of the dam shall also be encapsulated in the modeling proceedings, which may in-turn result in diurnal dissolved oxygen depletion from photosynthetic/respirometric processes as well as deterioration in re-aeration capability due to flow inhibition (retention).

5.1.1.3 Flooding

The proposed dam will correspondingly raise upstream water levels so that the sufficient amount of raw water can flow into the new intake at all times. The effects this would have on high/flood flows particularly upstream of the dam need to be assessed. There is a need to confirm whether the upstream increase in water levels is significant or tolerable especially during higher flows when the potential for loss of property and even life is greatest.

Appropriate hydrological modelling software will be utilized to simulate river flow conditions for both before and after construction of the dam in relation to upstream flooding and downstream flooding in the event of dam failure.

5.1.1.4 Sediment

Aspects to be investigated include:

- Soil erosion and risk associated with future land use changes;
- Sediment loads into the reservoir and its consequences; and
- Changes in sediment transport and river morphology.

5.1.2 Geology and Seismicity

The slope near the dam site shall be analysed and a slope gradient map to be compiled. Any potential slope hazard such as unfavourable daylighting joints that affect the slope cut shall be highlighted.

In addition, necessary buffer zone to protect the dam structures and water supply catchment for workers' camp and permanent residential area shall be identified on a map of suitable scale.

Due to the complexity of the geology of the proposed dam site, general review of the natural seismicity of the area shall be conducted. Regional faults in the vicinity will be highlighted, and their possible reactivation will be reviewed. The seismic level figure will be recommended by the dam designer. This information will be presented later in the final report.

5.1.3 Soil Erosion and Sedimentation

Land clearing and site preparation are likely to cause an increase in soil erosion and sedimentation of receiving waters. The likely causes will be preparatory works for the reservoir and access roads to the construction site. The impacts of soil erosion will be made using the Universal Soil Loss Equation (USLE) or other models considered suitable during

the preliminary stages of the analytical work. A Digital Terrain Model (DTM) will be set up for the reservoir area, whereby an erosion risk map will be generated.

During operation, the dam may be expected to cause increased sedimentation upstream due to slower flow velocities and the presence of a "trap" across the river. Flood flows may help re-suspend sediment in the water and will be carried over to the dam. The sediment single gated lock should be able to help control sedimentation in its vicinity to a certain extent through sediment flushing. The rate of possible sedimentation should be quantified to assess its significance.

At the same time, alluvial loss downstream of the dam can happen and should also be quantified.

Sedimentation upstream and alluvial loss downstream has impacts on availability of sand for commercial extraction. This has implications if there are any sand mining operators downstream of the proposed dam site. Sedimentation can also negatively impact on raw water abstraction. Excessive sand could be abstracted leading to more costly operation and maintenance requirements. In serious cases, the intake pump suction inlets could be blocked by accumulated sediment. Significant sedimentation can also affect flood levels.

A sedimentation model will be set up to predict the impacts due to sedimentation/siltation.

5.1.4 Air Pollution and Greenhouse Gas (GHG) Emission

5.1.4.1 Air Pollution

The prediction of impacts due to air pollutants will be made for point and fugitive dust emissions. These will be based on information on pollutant generation and the atmospheric behavior of pollutants. Air pollutants are expected to come from the following sources:

- Dust generated by the loading and unloading of construction material; and
- Gaseous exhausts from vehicles, batching plants and other construction equipment during the dam construction stage.

Prediction of the dispersion of pollutants will be made using the Gaussian Dispersion Model for atmospheric conditions identified for the Project area. Impediments to effective air pollutant dispersion due to natural and man-made structures will be given due consideration in the study. Results of the investigations will be assessed based upon other criteria generally accepted by the DOE for ground level concentrations of air pollutants. The type of air pollution control used in the production process will be addressed. Criteria of health and safety applicable to human population (e.g. impacts of fine particles on the respiratory system) will also be used for the evaluation of impacts.

If the inundated area is heavily wooded and not sufficiently cleared prior to flooding, decomposition will occur. Products of anaerobic decomposition include hydrogen sulphide and methane (which are greenhouse gases). The main gas produced, carbon dioxide, also exacerbates the greenhouse effect thereby contributing to global warming. Mitigating measures to reduce the generation of greenhouse gases will be recommended.

5.1.4.2 GHG Emission

With the proposed dam Project, a significant amount of land area will be cleared and inundated by water. The current vegetation on the land area will either be harvested to produce oil palm or removed for disposal. This will result in the release of stored carbon in the vegetation mainly in the form of carbon dioxide which is a greenhouse gas that causes global warming.

This report will among others discuss the amount of carbon dioxide, a greenhouse gas emitted into the atmosphere resulting from the conversation of mostly oil palm plantation to a lake for water supply. The methodology for the estimation of greenhouse emission will be based on the latest published Revised 1996 Inter-Governmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Has Inventories and follows the latest IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry guidelines (IPCC, 2000).

The IPCC Guidelines for National GHC Inventories are approved internationally are developed through an international process which includes the followings:

- Wide dissemination of drafts and collection of comments from national experts;
- Testing of methods through development of preliminary inventories;
- Country studies which ensure that methods are tested in a wide variety of national contexts;
- Technical and regional workshops; and
- Informal expert groups convened to recommend improvements on specific aspects of the methodology.

5.1.5 Waste Generation and Management

Clearing the reservoir will definitely generate substantial amount of biomass wastes. A comprehensive biomass disposal plan shall be prepared to properly manage these wastes.

The degree of biomass removal to the reservoir will be specified. Reservoir preparation guidelines shall also be included. The most appropriate biomass removal option shall be suggested. Handling, transporting and management of these wastes will also be given due consideration.

The study will also address on the management of used oil, grease, oil filters, batteries, paint, plastic wastes, clinical wastes, domestic and wooden construction wastes.

Appropriate sewerage and sewage treatment system- for base camps during construction period, for work sites and permanent system for operation period will be looked into.

Soil disposal areas for earthworks for diversion tunnels, spillway, dam site, quarry and residential areas shall be identified. Management guidelines for such disposal areas shall be recommended.

Lastly, this study will also incorporate the necessary management measures for logging debris brought downstream to the dam site during high flows both during construction (at diversion inlets) and operational periods (trash racks for intakes). In addition, the necessity to provide log boom for both the cofferdam and main dam shall be examined.

Other wastes such as construction waste, solid waste and sewage from workers are also generated during the construction stage. Handling, transporting and management of these wastes will be given due consideration. A waste management plan will be presented to ensure minimal impact to the surrounding environment.

5.1.6 Ecological Impact

The greatest impact on wildlife will come from loss of habitat resulting from reservoir filling and land-use changes in the watershed. Migratory patterns of wildlife may be disrupted by the reservoir and associated developments. Aquatic fauna, including waterfowls, reptiles and amphibian populations are expected to increase with the reservoir. However, the character of the aquatic ecosystem will change from a riverine to a lacustrine environment with major changes in species and community composition.

The loss of flora and fauna particularly sensitive endemics would mean a loss in biodiversity of local, regional or international conservation importance. In Malaysia, the few remaining tracts of intact pristine dipterocarp forest are particularly at risk from dam projects.

Riverine fisheries usually decline when a dam is constructed due to the changes in river flow, deterioration of water quality, water temperature changes, loss of spawning grounds and barriers to migratory fishes. However, the reservoir may become a rich fishery, sometimes more productive than the previous riverine fishery.

Field investigation will be carried out to ascertain the ecological status of terrestrial and aquatic flora and fauna species found or existed at the proposed dam site, its reservoir, spillway, outlet tunnels and downstream waterways. The study will include a compilation of species list; description of ecological communities and any unique species with conservation value will be recorded. Habitats irreversibly lost shall be compared to the amount of remaining habitats of similar quality in Sabah, i.e. put into a national heredity perspective. Consultation with Tawau Hill Parks will also be carried out and assessed in the SEIA report.

The impacts to nature resources within the Project area affected by the project will be made based on an assessment of the identified resources in the area. The potential impact of the Project development during the different stages of the Project implementation will be presented. Impacts on existing terrestrial ecology and aquatic life due to the presence of the dam will be addressed. Mitigation measures will be proposed for the terrestrial and aquatic biological resources for the impact zones identified. Due consideration will be incorporated for implementation to minimise the ecological impacts and for more effective and practical conservation programmes.

The evaluation will be based on the available literature, habitat maps, vegetation maps, aerial photographs as well as ground truthing to look into the potential wildlife corridors or sanctuaries to protect the wildlife and their possible migrating paths, feeding and nesting grounds in terms of relative security. Rescue plans, if necessary, will be recommended.

The proposed field investigations include transect lines into particular habitats (based on vegetation), habitat characteristics, food availability, roosting, breeding and nesting, refuge areas, species diversity and others. Review of available literature and consultation with local community or residents and camp workers will be carried out to assist with the field investigation.

The Special EIA will examine the distribution of aquatic species and biodiversity through net casting in the upper reaches of the rivers together with available secondary data. In the mid stretches of the river gill nets and traps will be used for the assessment together with cast nets where appropriate. The lower reaches will involve the use of gill nets and any secondary information that may be available. Local communities will also be consulted to obtain awareness and perception on the proposed Project.

5.1.7 Land Traffic

Transportation of construction machinery and materials to the proposed Project site during construction stage is expected to exert additional pressure to the existing traffic volume of Jalan Utara, the main route to the proposed Project site. The impacts on the traffic including the integrity of existing road will be assessed and compared against future traffic generation and the designed capacity of the road system for the area. Should an alternative transportation route be opted, this shall need to be investigated and assessed separately.

Dam management strategies which regulate flow can considerably impair downstream navigation, particularly during the dry season with low flows. In the Malaysian context, this effect is more significant for rural communities in States which are highly dependent on rivers for transportation such as Sabah and Sarawak. In contrast, upstream navigation may be considerably improved. The impacts to river navigation due to the presence of the dam will be investigated.

5.1.8 River Navigation

Most of the time, there may typically exist a significant difference in level between upstream and downstream of the dam, i.e. Sg. Tawau. This would not be passable to river traffic. The river traffic at the near vicinity of the proposed dam site shall be investigated and appropriate measures such as a suitably sized navigation double gated lock taking river craft sizes and site constraints, etc. may need to be taken into consideration. At the same time, safety requirements for river traffic would also need to be looked at.

5.1.9 Infrastructure and Utilities

The proposed dam Project and its ancillary facilities will require infrastructure and utilities to complement its operation. The ability of the existing infrastructure and utilities set up to meet the expected demands of activities during the construction and operation stages will be evaluated.

Suitable measures to alleviate pollution from the batching and crushing plant shall be assessed and appropriate mitigating measures recommended.

5.1.10 Social Economic Implications

From preliminary investigation, it appears that the area to be inundated does not house any permanent inhabitants. But this fact needs to be confirmed. If there are, the inhabitants of areas inundated by the reservoir typically bear the heaviest environmental and social costs. Reservoir filling may results in the forced relocation of those living on the land. The impacts, should there be relocation of residents, will be addressed and mitigation measures to be recommended.

The employment and business opportunities expected to be created by this project will be outlined. It is likely that there will be a shortage of labour, particularly construction workers. An influx of outside workforce (including non-Malaysian) into Tawau is expected. This may give rise to some social problems on current lifestyle of the residential population. Therefore the impacts due to influx of foreign workers on the social aspects of the community and demand for accommodation and basic amenities will be presented. The growth in the population as a whole is likely to occur over the next few years in the surrounding regions as a result of the proposed dam construction. Impacts to land owners, land use and economic activities shall be determined. Mitigating measures will be described to minimise these potential impacts. Land acquisition, if any, must be carried out in accordance with local laws and regulations.

With the assistance of field workers to be engaged by the consultants, the consultants will facilitate the beneficiary participation activities while undertaking socio-economic studies. The specific activities will include the following:

i. Prepare a socio-economic profile that can be used as accurate socio-economic baseline survey data; and

ii. Conduct random social surveys with the nearby communities (normally within 5 km radius) to record the perceptions and concerns of the villagers.

5.1.11 Implication of Regional Activities on the Project

Part of the catchment area is under Sabah Park's boundaries while the rest are covered by oil palm plantations. These activities would have an impact on the proposed Project, in terms of the changes of the physical environment. These shall be looked into during the study.

5.1.12 Impacts on Decommissioning /Abandonment of Dam

The possibility of future abandonment of the completed dam for various reasons should be looked into. The possible causes of abandonment are: downturn of national economy, unforeseen management and technical problems that arise during the implementation of the Project and changes in the government's policy on the nature of the Project.

6.0 IDENTIFICATION AND PREDICTION OF SIGNIFICANT ENVIRONMENTAL IMPACTS

Impact assessment will analyse all Project components in relation to the environmental parameters of the Project area.

The discussion will state:

- The nature of environmental effect (e.g. water pollution and air pollution);
- The source of impact (e.g. site preparation and construction of the dam);
- The nature of impact (e.g. impact on human health and water quality); and
- The action or abatement measures taken to lessen the impact (e.g. silt traps, buffer strips, etc.).

The methodologies used for the prediction of impacts are listed in **Table 6.1**.

Table 6.1: Prediction Methods for Assessment of Impacts

Impacts	Prediction Methods
Soil Erosion, Geology & Minerals	Sediment Delivery Ratio method Computer model which apply the USLE or MUSLE equation, e.g. SWRRB
Surface Water, Hydrology	Hydrological Procedures for urban and rural settings by the Drainage & Irrigation Dept. (DID) – HP4, HP5 and HP11. Also other models for storage, routing, watershed analysis, flood plain hydraulics and urban hydrology developed for local or tropical conditions. Determining flood levels using steady state models, e.g. HECRAS Determining flood levels using unsteady state models, e.g. HEC-HMS Statistical methods, e.g. Flood Frequency method.
Water Quality	Crude estimates of BOD loading in the river system Mathematical or numerical models based on one, two or three-dimensional analysis of pollutant dispersion. Simple models based on mass balance of pollutant, or the Streeter-Phelps Model for simulation of dissolved oxygen profile (i.e. QUAL2E).
Air Quality	Models for air pollutant dispersion based on mass balance or the more advanced Gaussian Plume dispersion model (if needed).
Noise	Mathematical models for prediction of noise at various distances from the source. Models are available for point and line sources.
Ecology	Comparative assessment of conservation status and sensitivity of the habitat, flora and fauna. Ecological models for species diversity and population changes. Relative importance (based on relative density and dominance).
Aesthetics	Analyses of unique (physical, geological, and ecological), scenic values, and comparative assessment with and without Project. Judgmental assessment.
Infrastructure & Utilities	Existing guidelines, factors or criteria for projection of demand for infrastructure and utilities set by various Government authorities. Traffic generation and flow models.

Impacts	Prediction Methods
Socio-economy	Perception rating based on sample assessment of population.
Land use	Map overlay techniques; comparative evaluation against structure/local plans.

Note: Methodologies for assessment tabulated above are not exhaustive but show those commonly used by consultants.

The evaluation of impacts will be made based on established standards and criteria under the Environmental Quality Act, 1974 and its subsidiary legislation. Emission limits with respect to pollutants not defined within the Environmental Quality Act or its subsidiary legislation will be based on values set by the DOE or such other criteria generally accepted by the DOE and EPD (see **Table 6.2**).

Table 6.2: Criteria Used For Impact Evaluation

Impact	Evaluation Criteria	Reference
Soil Erosion and Sedimentation	Guidelines to Control Erosion and Siltation in Malaysia, Local Government Act. May be evaluated against acceptable flood criteria or water quality standards for various uses.	Various sources (e.g. DID criteria for acceptable flood discharge, DOE, Sabah State Water Department) Interim National Water Quality Standards for Malaysia (INWQSM)
Floods (and drainage)	Guidelines and criteria issued by the DID with respect to acceptable flood flow or peak discharges for various catchments.	Guidelines and criteria by DID and other relevant authorities
Water Quality	DOE discharge limit	Environmental Quality (Sewage) Regulations 2009
	Ambient water quality standards for Malaysia.	INWQSM
Ground Water Quality	Based on acceptable International Standards	Malaysian Standard for Water and Packaged Drinking Water, Food Act 1983, Food (Amendment) Regulations 1991
Biodiversity/ Ecology	IUCN and CITES listing of unique and endangered species Endemic species classification Department of Wildlife, Forestry, etc. listings of protected areas, species, etc. Harvesting	IUCN 1996 Protection of Wildlife Act, 1972 Wildlife protection Ordinance (Sabah and Sarawak) Forestry Act, (1984), Guidelines of Forestry Department, FRIM (1997) Wildlife Conservation Enactment
Air Quality	Ambient air quality standards for Malaysia Emission limits	Recommended Malaysian Air Quality Guidelines, 1989. Environmental Quality (Clean Air) Regulations, 1978

Impact	Evaluation Criteria	Reference
Noise	DOE guidelines for siting and zoning of industries WHO recommended noise exposure limits	DOE WHO noise exposure limits.
Transportation	Acceptable level of service for highway affecting traffic flow Acceptable level of service for marine traffic flow	Highway Research Board, 1985
Land Use	Designated land use within specific structure and local plans	Structure and local plans for various local authorities
Socio-Economic	Cost Benefit Analysis (CBA). Historical value and cultural heritage, Archaeology	Museum Department, Forestry Department
Occupational Health	Occupational Health and Safety Act, ILO and other guidelines	Occupational Health and Safety Act 514, 1994, ILO, 1972
Aesthetics	Perceived importance of resources and features by local residents and visitors to the area.	Perception rating based on sample assessment of population/visitors
Infrastructure and Utilities	Criteria and guidelines by respective approving agencies and authorities.	Roads & Water- JKR; Sewerage- local authority, Electricity – SESB; Telecommunications - Telekom Malaysia

7.0 MITIGATION AND ABATEMENT MEASURES

This chapter covers (i) identification of the major mitigation measures for the key environmental impacts, (ii) elaboration on implementation methodologies to be used to help minimise or eliminate the impacts, and (iii) description of other mitigation measures, including secondary rehabilitation measures. Particular attention will be given to impacts mentioned in the previous **Section 6.0**. These recommendations will be made based on discussions with the client and professional judgement based on known applications of technology for the control of pollutants into the environment.

The primary objective of mitigation and control is to ensure that the impacts due to the project implementation are minimised or within acceptable limits so as to render it acceptable to the EPD, DOE, DID and other authorities.

Mitigation will consist of a number of related actions, many of which may consist of no more than ensuring effective management and control of site operations. Mitigation measures can take many forms, including the following:

- Preventive – to be addressed during planning stage and land application including site selection; exclusion of areas identified as having high environmental risks e.g. soil erosion and flooding, provision of buffer zones, and alternatives for routing or development method.

- Control – to be addressed during development and operational stages and related to working practices such as implementing zero burning method instead of open burning, provision of silt traps/sediment basins and establishment of cover crops at cleared areas and steep areas.

- Compensatory – whereby it is recognised that there will be an impact and that some compensation for the loss is to be made. This could include a specific contribution towards local conservation.

8.0 PREPARATION OF PLANS

8.1.1 Environmental Management Plan (EMP)

The environmental management commitments should be integrated into a draft EMP. Guidelines for the preparation of an environmental management plan will be based on the requirements of the EPD as well as DOE. The EMP should aim at facilitating the following:

- Integration of all environmental conditions under different legislation (e.g. requirements under the EPD, DOE, local government requirements) in a readily understandable planning format that addresses a hierarchy of environmental issues e.g. waste management, water pollution and air pollution, etc.);
- Integration of environmental conditions into Project's environmental management system (for ready implementation and due diligence);
- On-going auditing of performance of the development; and
- Linkage of development assessment (i.e. impact assessment study) findings with environmental authorities and development permits.

8.1.2 Environmental Monitoring Plan and Programme

The monitoring programme shall ensure that:

- All the environmental impacts are identified and correctly addressed in the Special EIA;
- The significance of the environmental impacts to the outcome of the Project is accurate; and
- The projected impacts having a high uncertainty are quantified correctly.

Necessary environmental post-project remedial measures are identified and properly addressed and mitigated.

The programme for monitoring will generally identify:

- The scope and type of monitoring required (for e.g. water quality measurement);
- The locations of monitoring stations (this will be identified on map or plan);
- The parameters to be maintained (e.g. dissolved oxygen, if fisheries is important in a river); and
- The frequency of monitoring.

Competent and independent environmental consultants must carry out environmental monitoring and site auditing, in compliance with the EPD's requirement and regulations.

These will form an internal control mechanism to ensure compliance with the environmental requirements.

8.1.3 Dam Break Emergency Action Plan

Although highly unlikely to happen, a dam break can be catastrophic, causing severe devastation in floodplains downstream, both in terms of lives lost and widespread damage to infrastructure and property. The most common cause is extreme inflow events, exceeding the capacity of the spillway, but structural failures have also occurred at inflows less than the design flood. In order to prepare emergency action plans (ERP), revise dam operation strategies, prioritize dam rehabilitation, etc., it is important to assess the consequences of possible dam break in terms of the affected areas, the time available to evacuate people, and the damage which the flood wave will cause. This can be most effectively assessed through model studies and flood mapping.

Overland flow paths and floodplains will be modelled using HEC-RAS and HEC-HMS, with a 2D (or equivalent modeling software) flexible mesh representation of channels and floodplains. Dam failure mechanisms will be modelled in 1D, using structure routines specifically designed to model dam failure. The model will be time dependent, so a dam failure event will be simulated from start to finish. This is a very important feature because storage effects are represented in the model.

Model Establishment

Development of Terrain Map: Topographic information will be collated using GIS techniques to generate a Digital Elevation Model (DEM) of the entire catchment. This will incorporate all relevant information collected (cross-sectional surveys, reservoir bathymetry, spatial topographical analysis, if considered necessary).

Estimation of Hydraulic Roughness: Hydraulic roughness is governed by the nature of the terrain through which water flows. Using satellite imagery (and any other relevant spatial information) combined with observations made during the site visit, a vegetation map of the catchment will be produced. Using this, the Consultant will assign roughness values for various areas, based upon the vegetation type and cover, values recommended in literature, and past experience.

Sediment and Debris data: If considered relevant, the Consultant will perform sensitivity runs to determine what effect debris loading on bridges downstream would have upon flood levels.

Model Applicability to Rapid (Shock) Waves and Dam Break Failure: The numerical schemes, the Consultant proposes to use in this study does not simulate vertical accelerations, which occur during the initial stages of a dam failure[1]. Instead, upwinding in the numerical scheme is applied to allow the model to represent steep water surfaces and,

[1] *Models are available that do have such schemes, but they are typically applicable to the near-field description of water flow in the immediate vicinity of the dam wall / spillway.*

by adjusting the weighting of the friction term, improves the propagation speed of flood waves generated by a dam break. The upwinding is selective (adjusted according to Froude number), so is only applied where needed.

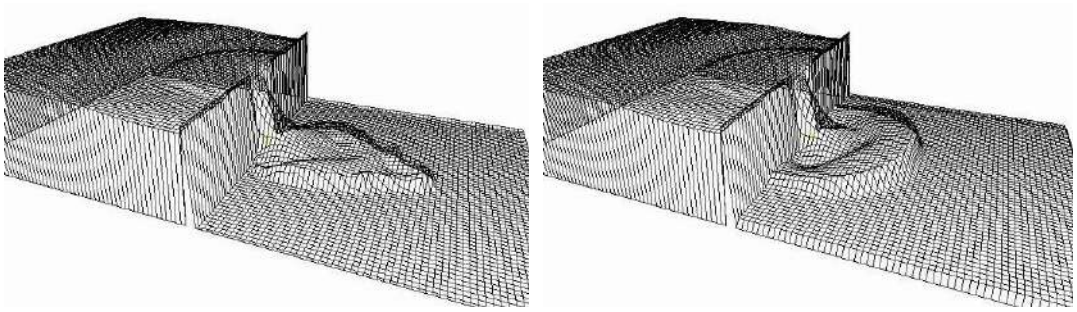


Figure 8.1: Demonstration of model applicability to dambreak; simulation onto an initially dry bed (left) and initially wet bed (right).

Model Calibration and Verification: The combined hydrologic and hydrodynamic model will be calibrated and verified to measurements and observations. The extent of the calibration process will be dependent upon the availability of data; however we will at least calibrate to a recent, significant flood event and also to the most extreme historical event recorded. While these calibration events will not be of the same intensity as a PMF, there are no other floods to compare to. However, less intense flood events are often more difficult to model accurately because predictions in shallower water are more sensitive to the accuracy of the model geometry.

Sensitivity Testing: Due to the unpredictable nature of dam failure and PMFs, the Consultant will perform sensitivity testing to determine which factors have the most significant effects upon model predictions. This will include parameters in the models (rainfall losses, friction, etc.) and in the data (rainfall intensities, temporal patterns, etc.), dam failure mechanisms (rate of collapse, etc.) and potential impacts due to debris (choking of bridges, etc.). Sensitivity testing will provide a measure of the reliability of model predictions and can be incorporated into the assessment.

Dam break scenarios and assessment criteria

Critical aspects for the analysis of a dam break event are:

Failure moment: at a specified time or related to certain hydraulic conditions

Failure mode: breach development, piping failure leading to erosion, or erosion through overtopping. The failure mode has a significant impact on the outflow hydrograph (flood wave). The worst case is instant destruction of the dam, while a gradually developing breach would produce a considerably lower peak discharge

Hydraulic conditions in the river and floodplain downstream

The Consultant will give a recommended list of design scenarios to perform. These will consider:

Initial level of water in reservoirs – the model will dynamically incorporate the volume of water in the reservoirs. Normal reservoir levels and extreme levels will be considered.

Rainfall events – dam failure in combination with extreme rainfall events (PMP and others) will be considered. Also considered will be the risk of a locally extreme event in one sub-catchment in combination with a different extreme event in the remainder of the system.

Breaching mechanism – we will investigate the method of dam failure. This may include instantaneous rupture, breach failure, erosion based failure, piping failure, and embankment failure.

For each design simulation of a dam break scenario, model predictions of hydrologic and hydraulic conditions will be available for the entire catchment and river and drainage system. Assessment criteria (the specific results, analyses or indicators from each simulation that will be used to assess the worst case scenario) will include total inundated area, flood hazard (water depth and velocity) and/or locations of inundation (relative to population, land use, etc.).

Description of flooding conditions and inundation mapping

Predictions from the model are automatically incorporated into a GIS. This conveniently allows the generation of inundation maps and analyses with other spatial data, which will assist in the preparation of the Emergency Action Plan.

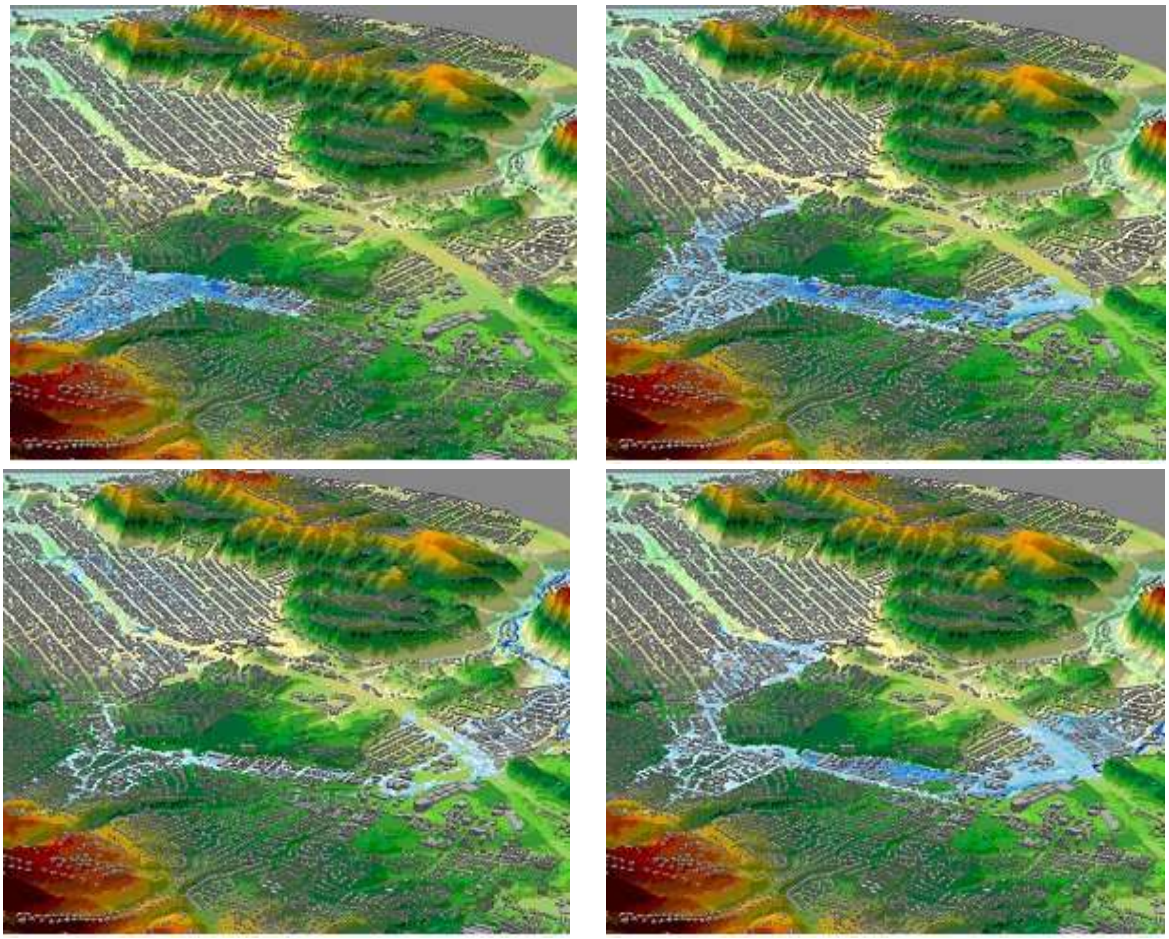


Figure 8.2: Example of a HEC-RAS FLOOD application of dam break. Each picture shows progress of flood event down river system

8.1.4 Abandonment Plan

Project completion / abandonment plan is prepared prior to demobilisation work. In the case of Project abandonment, the potential cause shall be determined and related environmental concerns shall be addressed. Procedures on removal of unwanted and hazardous structures including temporary base camps; rehabilitation and landscaping requirements; appropriate clean-ups and disposal of wastes at the construction site shall be documented and implemented.

8.2 LIAISONS

8.2.1 Liaisons with Relevant Agencies, Authorities and Other Stakeholders

Discussions and meetings will be held with relevant government agencies, particularly with authorities involved in the approval of the Special EIA report such as (but not limited) to the EPD, DOE, Sabah Parks, Water Department, Lands and Surveys Department, Department of Irrigation and Drainage, Sabah Electricity Sdn Bhd (SESB), Fisheries Department, District Office, local community leaders, and so on. The main aim of the meetings would be to

determine the concerns of these departments/agencies/parties so that these can be addressed adequately in the report.

Information, policies and guidelines should also be sourced from these various Government Agencies. Discussions and meetings expected to be necessary with the various Government Agencies are (but not limited to):

a) Environment Protection Department (EPD) – on EIA guidelines and post-project environmental management such as environmental monitoring requirements;

b) Sabah Parks – on the flora and fauna type within the affected area within Tawau Hills Park;

c) Department of Irrigation and Drainage (Water Resources and Management Division) – for hydrological data (if additional information is required) and water catchment areas;

d) Sabah Electricity Sdn Bhd (SESB) – to get the consultation on the existing mini hydro dam along Sg. Tawau;

e) Sabah State Water Department – as the owner of the dam Project, shall also be consulted;

f) Minerals and Geoscience Department – relevant geological information (if additional information is required) and seismic concerns.

g) Forestry Department – encroachment of any forest reserves area (apart from Sabah Park's boundary)

h) District Office and Lands and Surveys Department – for information on land matters and issuance of the appropriate licence, population and other relevant socio-economic data available;

i) Meteorological Department – climate data;

j) Fire and Police Department – on emergency response and safety requirements;

k) Health Department – water supply to downstream users and communicable diseases and vector control;

l) Sabah Museum – to check/ cross-reference all data and information on the flora and fauna found during the field studies and any culturally sensitive areas;

m) Town and Regional Planning Department – to check/ cross-reference district's local plan and zoning; and

n) Public Works Department – for information on road construction and upgrading works.

8.2.2 Project Proponent / Consulting Engineer's Inputs

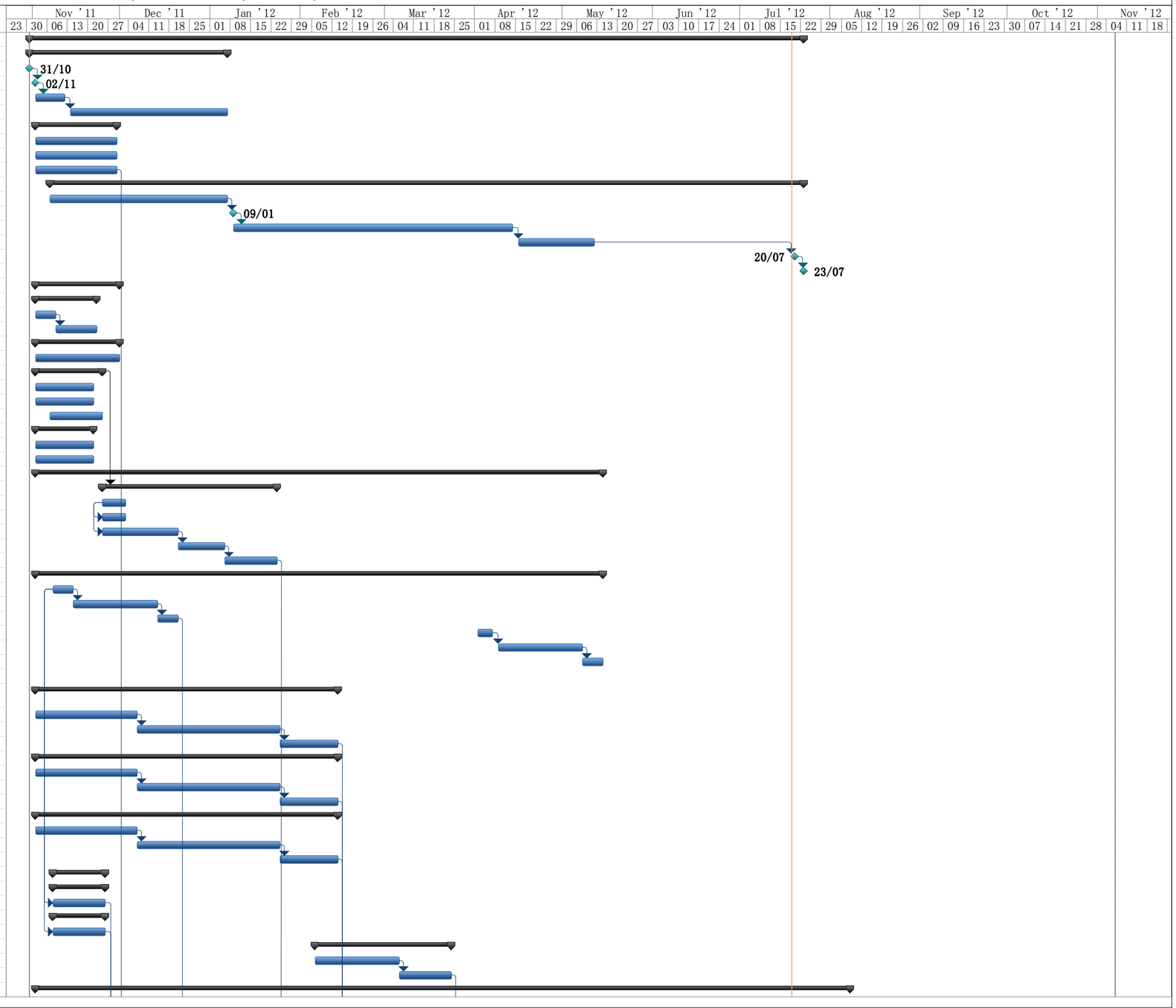
The Project Proponent and the consulting engineers involved in the planning and design of the dam will also play an active role during the Special EIA study by supplying inputs such as the detailed description of the proposed Project concerning the following aspects:

- A concise description of the rational for proposed the Project (i.e. Statement of Need);
- Site location maps (cadastral, contour, etc.);
- Layout plan, design specifications and construction details of the Project;
- Project working paper, if any and implementation schedule;
- Previous studies such as topographic survey, geotechnical/geological studies, hydrological study, etc.;
- Letters from relevant authorities with regards to land matters; and
- Plans for post-construction restoration/rehabilitation of site and management of the dam and water reservoir.

9.0 STUDY SCHEDULE

The projected work programme and schedule for the SEIA study will be as shown in **Figure 9.1**.

ID	Task Name
1	**SCOPING PHASE**
2	**Project Co-ordination**
3	Award of Project and Mobilisation
4	Kick off Meeting
5	Scope Development
6	Information Exchange
7	**Project Description**
8	Project Outline
9	Process Description
10	Utilities/Amenities/Infrastructures
11	**Terms of Reference (TOR)**
12	Preparation of TOR
13	Submission to Project Proponent for Review
14	Review
15	Incorporate TOR Comments
16	Submit to EPD
17	Public Review and Revise
18	**DATA COMPILATION PHASE**
19	**Initial site reconnassiance**
20	Arrange Site Access (Authorities/Land Owners)
21	Preliminary Site Reconnaissance/Survey
22	**Topographical Mapping**
23	Preparation of Base Maps
24	**Desktop Review**
25	Collation of Existing Project Data
26	Collation of Baseline Environmental Data
27	Data Review
28	**Legislation Review**
29	Determine relevant legislation
30	Outline Relevant Environmental Standards
31	**INVESTIGATION PHASE**
32	**Geological and Hydrogeological Review**
33	Collation of Data/Deskstudy
34	Geological Mapping
35	Digitising of Geological Map
36	Geological Interpretation & Report
37	Review of Terrain/Geology/Seismology Reports
38	**Surface Water Sampling**
39	Riverine Water Sampling No.1
40	Laboratory Analysis
41	Preliminary Report
42	Riverine Water Sampling No.2
43	Laboratory Analysis
44	Preliminary Report
45	Ecological Investigations
46	**Terrestrial fauna (inl. Microfauna, invertebrates,amphebia,etc)**
47	Desk Study and Regulatory Consultation
48	Faunal Survey (transext and community survey)
49	Preliminary Reporting
50	**Terrestrial Flora**
51	Desk Study
52	Field survey
53	Preliminary Report
54	**Aquatic Flora and Fauna**
55	Desk Study
56	Field Survey
57	Preliminary Reporting
58	**Air and Noise Study**
59	**Ambient Air Quality Data Collation-Desk Study**
60	Air Quality Monitoring
61	**Ambient Noise Data Collation-Desk Study**
62	Noise Monitoring
63	**Socio-economics Study**
64	Desktop Study & Prepare Questionaire
65	Obtain Official Data
66	**ANALYSIS PHASE**

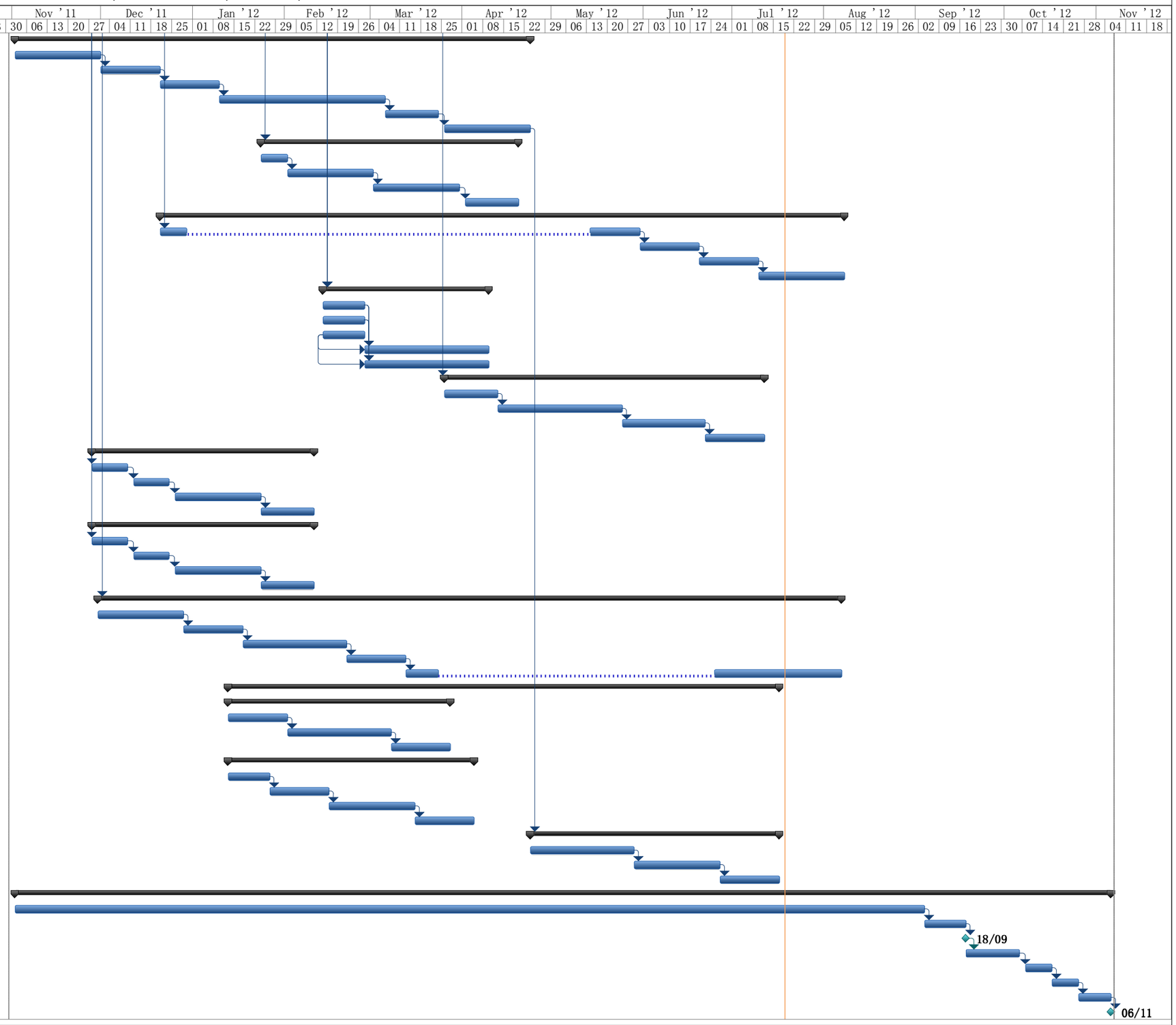


Project: Fig91Special EIA W
Date: Thu 19/07/12

Task	Summary	External Milestone	Inactive Summary	Manual Summary Rollup	Finish-only		
Split	Project Summary	Inactive Task	Manual Task	Manual Summary	Deadline		
Milestone	External Tasks	Inactive Milestone	Duration-only	Start-only	Progress		

Figure 9.1: Work Schedule

ID	Task Name
67	**Hydrology**
68	Collation of Published/Archieved Data
69	Catchment Characteristics
70	Water Balance Study
71	Flood Analysis
72	Preliminary Dam Engineering Analysis (Spillway Exceedance)
73	Reporting & Review
74	**Geological & Hydrogeological Study**
75	Data Analysis
76	Impact Prediction
77	Mitigation measure development & recommendations
78	Finalise report & review
79	**Surface Water Quality**
80	Data Analysis
81	Impact Prediction
82	Mitigiation Measure Development @ Recommendation
83	Outline Erosion & Sediment Control Plan (ESCP)
84	**Ecology**
85	Aquatic Ecologist and Fisheries
86	Flora ecology
87	Microfauna, invertebrates, amphibians and reptiles
88	Impact assessment
89	Finalise report & review
90	**Socio-economics/Lan Use/Aesthetics**
91	Consultation phase
92	Community Questionaire Survey
93	Data Analysis & Evaluation
94	Reporting
95	**Air Pollution (Carbon Sink)**
96	Preliminary Reporting
97	Carbon Sink Calculation
98	Air Quality Impact Assessment/Mitigation
99	Report Review & Finalisation
100	**Noise Pollution**
101	Preliminary reporting
102	Noise impact assessment/mitigation
103	Draft reporting
104	Report review & finalisation
105	**Traffic/Transportation Study**
106	Road Network System Construction
107	Network Analysis
108	Impact Assessment/Mitigation Measures
109	Draft Report
110	Report Review & Finalisation
111	**Waste Management**
112	**Biomass**
113	Generation of Waste
114	Impact Assessment and Mitigation Measures
115	Reporting and review
116	**Wastes (solid, liquid, scheduled waste)**
117	Waste Type and Definition
118	Source & Generation
119	Impact Assessment and Mitigation Measures
120	Reporting & Review
121	**Dam break analysis**
122	Impact Assessment/Mitigation Measures
123	Draft Report
124	Report Review & Finalisation
125	**EIA DOCUMENTATION PHASE**
126	Report Writing & Compilation
127	Report Review & Finalisation
128	Draft Report (to Project Proponent)
129	Report Review & Finalisation
130	Special EIA Documentation
131	Draft Report Review
132	Report Finalisation/Printing
133	Special EIA Report Subnmission to EPD



Project: Fig91Special EIA W
Date: Thu 19/07/12

Task	Summary	External Milestone	Inactive Summary	Manual Summary Rollup	Finish-only		
Split	Project Summary	Inactive Task	Manual Task	Manual Summary	Deadline		
Milestone	External Tasks	Inactive Milestone	Duration-only	Start-only	Progress		

Figure 9.1: Work Schedule

10.0 PLATES

Photos taken during the early site assessment from November 8, 2011 to November 11, 2011 to the Project site and its surrounding areas were attached herewith.

	**Plate 1**: The existing Cinta Mata Water treatment plant in Tawau is operated by Timatch Sdn Bhd which has been recognised as the forerunner in the water industry in Sabah.
	**Plate 2**: Tawau Hills Park which is located about 2 km to the north of the proposed dam site.
	**Plate 3**: Sg. Tawau which traverses along the proposed Project site from the Sg. Tawau catchment area of about 77km^2.

ANNEX 1

CURRICULUM VITAE (CV)S FOR THE STUDY TEAM MEMBERS

ANNEX 1

CURRICULUM VITAE (CV)S FOR THE STUDY TEAM MEMBERS

ANNEX 2

LAND ACQUISITIONS

ANNEX 2

LAND ACQUISITIONS

LANDS ACQUISITION

No	Title No	Area on Title (A) – LTIS	Plan Ref.	Remarks	Gazette Plan
1	105333426	6.090	10123279	Registered.	Gaz. Not. 658/93
2	105343360	9.690	10123800	Registered.	Gaz. Not. 658/93
3	105342907	14.840	10123367	Fully Acquired.	Gaz. Not. 658/93
4	105166774	17.920		Fully Acquired.	Gaz. Not. 658/93
5	L. 16528	22.060		105165286. Registered.	Gaz. Not. 658/93
6	106291614	13.050		Registered.	Gaz. Not. 658/93
7	105343379	15.200	10123800	Registered.	Gaz. Not. 658/93
8	105333471	12.050	10123278	Registered.	Gaz. Not. 658/93
9	105333480	14.570	10123278	Fully Acquired.	Gaz. Not. 658/93
10	105343397	14.750	10123800	Registered.	Gaz. Not. 658/93
11	105333453	14.860	10123751	Registered.	Gaz. Not. 658/93
12	105333462	14.870	10123751	Registered.	Gaz. Not. 658/93
13	106290984	15.520	10123254	Registered.	Gaz. Not. 658/93
14	L. 16540	17.230		105165400. Registered.	Gaz. Not. 658/93
15	L. 16541	30.780		105165419. Registered.	Gaz. Not. 658/93
16	L. 16542	11.760		105165428. Surrendered/Expired.	Gaz. Not. 658/93
17	L. 16543	10.720		105165437. Surrendered/Expired.	Gaz. Not. 658/93
18	L. 16544	10.490		105165446. Surrendered/Expired.	Gaz. Not. 658/93
19	L. 16545	9.200		105165455. Registered.	Gaz. Not. 658/93
20	L. 16546	28.430		105165464. Surrendered/Expired.	Gaz. Not. 658/93
21	105353713	11.940	10124609	Registered.	Gaz. Not. 658/93
22	10531164	3.110	10123028	105311644. Registered.	Gaz. Not. 658/93
23	105315160	22.150	10123938	Registered.	Gaz. Not. 658/93
24	105315179	24.140	10123938	Registered.	Gaz. Not. 658/93
25	105349684	3.410	10123878	Fully Acquired.	Gaz. Not. 658/93
26	105349693	3.170	10123878	Registered.	Gaz. Not. 658/93
27	105349700	3.460	10123878	Registered.	Gaz. Not. 658/93
28	105349719	3.790	10123878	Fully Acquired.	Gaz. Not. 658/93
29	105349728	3.360	10123878	Fully Acquired.	Gaz. Not. 658/93
30	105341400	15.600	10123938	Fully Acquired.	Gaz. Not. 658/93
31	105332885	15.910	10123938	Fully Acquired.	Gaz. Not. 658/93
32	105346987	9.210	10124925	Registered.	Gaz. Not. 658/93
33	105346978	13.400	10124925	Registered.	Gaz. Not. 658/93
34	105346969	12.920	10124925	Fully Acquired.	Gaz. Not. 658/93
35	105291623	2.940	10123800	Should be 106291623. Registered.	Gaz. Not. 658/93
36	105343404	14.320	10123800	Registered.	Gaz. Not. 658/93

No	Title No	Area on Title (A) – LTIS	Plan Ref.	Remarks	Gazette Plan
37	105343342	14.950	10123799	Fully Acquired.	Gaz. Not. 658/93
38	105312472	20.560	10123917	Registered.	Gaz. Not. 658/93
39	105312481	21.180	10123917	Registered.	Gaz. Not. 658/93
40	105376949	1.520	10124062	Registered.	Gaz. Not. 658/93
41	105312490	20.890	10123917	Registered.	Gaz. Not. 658/93
42	105343388	14.860	10123800	Registered.	Gaz. Not. 658/93
43	105342916	14.780	10123367	Registered.	Gaz. Not. 658/93
44	105312507	21.690	10123917	Registered.	Gaz. Not. 658/93
45	105343333	14.700	10123799	Registered.	Gaz. Not. 658/93
46	105328970	14.750	10123980	Registered.	Gaz. Not. 658/93
47	105348749	1.790	10123980	Registered.	Gaz. Not. 658/93
48	105328961	15.160	10123980	Registered.	Gaz. Not. 658/93
49	105368518	3.420	10124031	Registered.	Gaz. Not. 658/93
50	105343351	10.360	10123799	Registered.	Gaz. Not. 658/93
51	105346950	15.200	10124925	Fully Acquired.	Gaz. Not. 658/93
52	105344894	6.290		Registered.	Gaz. Not. 658/93
53	L. 16675	9.870		Registered.	Gaz. Not. 658/93
54	105335788	6.160	10123980	Registered.	
55	Lot 1 of 105166765	6.650	10124772	Registered under 105166765, 13.15Ac.	
56	Lot 2 of 105166765	6.650	10124772	Registered under 105166765, 13.15Ac.	
57	105365848	2.330	10123478	Registered.	
58	105339017	2.610	10123254	Registered.	
59	105376958	3.900	10124062	Surrendered/Expired.	Acquired for Dam & Water Treatment Plant
60	106291123	8.700		Registered.	
61	105328907	13.420	10123980	Registered.	
62	105328934	15.250	10123980	Registered.	
63	105328943	15.010	10123980	Registered.	
64	105328952	15.140	10123980	Registered.	
65	106290813	15.820	10123200	Registered.	
66	106290822	17.690	10123200	Registered.	
67	105346941	11.490	10124925	Registered.	
68	Remr. of 105311920	6.310		Registered as 105311920.	
69	105369275	1.330	10124031	Registered.	
70	105431196	3.38H	10126255	Registered.	
71	105431203	3.38H	10126255	Registered.	
72	105165311	14.780		Registered.	
73	105310709	7.770		Registered.	
74	105165302	15.150		Registered.	
75	105165320	16.890		Registered.	

No	Title No	Area on Title (A) – LTIS	Plan Ref.	Remarks	Gazette Plan
76	105165357	17.920		Registered.	
77	105335788	6.16	10123980	To be acquired	
78	Lot 1 of 105166765	6.65	10124772	To be acquired	
79	Lot 2 of 105166765	6.65	10124772	To be acquired	
80	106291123	8.70	T-2-P-5, 49-NB	To be acquired	
81	105365848	2.33	10123478	To be acquired	
82	105339017	2.61	10123254	To be acquired	
83	105376950	3.90	10124062	To be acquired	
84	105346941	11.49	10124925	To be acquired	
85	105431196	3.38H	10126255	To be acquired	
86	105431203	3.38H	10126255	To be acquired	
87	105165311	14.78	T-2-P-5, 49-NB	To be acquired	
88	105310709	7.77	T-2-P-5, 49-NB	To be acquired	
89	105165302	15.15	T-2-P-5, 49-NB	To be acquired	
90	105165320	16.89	T-2-P-5, 49-NB	To be acquired	
91	105165357	17.92	T-2-P-5, 49-NB	To be acquired	
92	105165339	9.87	T-2-P-5, 49-NB	To be acquired	
93	105165348	13.20	T-2-P-5, 49-NB	To be acquired	
94	Remr. Of 105459103	1,339.9 sq.m.	10125176, 10128027	To be acquired	
95	Remr. Of 105311920	7,191.9 sq.m.	10123035, 10128027	To be acquired	
96	105369275	1.33	10124031	To be acquired	
97	105311939	0.94	10123035	To be acquired	
98	105248208	8.22	T-2-P-5, 49-NB	To be acquired	
99	105328907	13.42	10123980	To be acquired	
100	105328916	13.24	10123980	To be acquired	
101	105328925	13.15	10123980	To be acquired	
102	105328934	15.25	10123980	To be acquired	
103	105328943	15.01	10123980	To be acquired	
104	105328952	15.14	10123980	To be acquired	
105	106290813	15.82	10123200	To be acquired	
106	106290822	17.69	10123200	To be acquired	
107	105312516	21.57	10123917	To be acquired	