DRAFT Environmental and Social Impact Assessment Report

Project Number: 50182-001
May 2018

INO: Riau Natural Gas Power Project
ESIA Vol.5A_Technical Appendices

Prepared by ESC for the Asian Development Bank

Riau 275 MW Gas Combined Cycle Power Plant IPP - ESIA

Medco Ratch Power Riau

ESIA Volume 5: Technical Appendices

AM039100-400-GN-RPT-1014 | V2

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Contents

1. Introduction

ESIA Volume 5 provides Technical Appendices relevant to this ESIA and as referenced within ESIA Volume 1: Introduction, ESIA Volume 2: EIA, ESIA Volume 3: SIA and ESIA Volume 4: ESMP and Framework ESMS. Table 1.1 below provides an overview of the Technical Appendices provided in this Volume and indicates which Volume they are associated with. It should be noted that Appendices may be associated with other more than one Volume of the ESIA and this will be noted within the respective Volume text.

Table 1.1 : ESIA Technical Appendices

ESIA Volume	Technical Appendix	Document Title
ESIA Volume 1: Introduction	Appendix A	Technical Report – Scoping Report
	Appendix B	Technical Report – Detailed Process Description
	Appendix C	ESIA Baseline Survey Terms of Reference (Dry)
	Appendix D	ESIA Baseline Survey Terms of Reference (Wet)
ESIA Volume 2: EIA	Appendix E	Technical Report – Air Quality Impact Assessment
	Appendix F	Technical Report – Noise Impact Assessment
	Appendix G	Technical Report – Water Quality and Freshwater Ecology Assessment
	Appendix H	Technical Report - Occupational Health and Safety & Working Conditions
ESIA Volume 3: SIA	Appendix I	Stakeholder Engagement Plan Including Community Grievance Mechanism
	Appendix J	Chance Find Procedure

Appendix A. Scoping Report

Riau 275 MW Gas Combine Cycle Power Plant IPP Project - ESIA

Medco Ratch Power Riau

Technical Report – Scoping Report

AM039100-400-GN-RPT-1004 | V3

October 2017

Riau 275 MW Gas Combine Cycle Power Plant IPP Project - ESIA

Project no:	AM039100
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V2	14/09/2017	Addressing Further Client Comments	A Kubale	B Clarke	B Clarke
V3	12/10/2017	Addressing ADB Comments	A Kubale	B Clarke	B Clarke

Contents

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs New Zealand Limited (Jacobs) is to provide a Scoping Report which identifies the key issues that need to be addressed in the preparation of the Environmental and Social Impact Assessment (ESIA) in respect to the Riau IPP Project, in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

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Glossary

AMDAL	Analisis Mengenai Dampak Lingkungan
ADB	Asian Development Bank
CEMP	Construction Environmental Management Plan
CEMS	Continuous Environmental Monitoring Station
CCGT	Combined cycle gas turbine
CFPS	Coal fired power station
CPI	Corrugated plate interceptor
EHS	Environmental, Health and Safety
EPFI	Equator Principle Financial Institution
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
GFPP	Gas fired power plant
GT	Gas turbine
H&SP	Health and Safety Plant
ha	Hectare
HHV	High Heating Value
HP	High pressure
HRSG	Heat recovery steam generator
IP	Intermediate pressure
km	Kilometres
m	Metres
aMSL	Above mean sea level
MRPR	Medco Ratch Power Riau
MW	Megawatt
NO_x	Oxides of Nitrogen
OHL	Overhead Line
OPGW	Optical Ground Wire
PPA	Power Purchase Agreement
RoW	Right of way
SAP	Survey Action Plan
SEP	Stakeholder Engagement Plan
ST	Steam turbine
T	Tonnes

1. Introduction

1.1 Background

This Scoping Report supports an Environmental and Social Impact Assessment (ESIA) for the construction and operation of the Riau 275 MW Combined Cycle Gas Fired Power Plant IPP Project (Riau 275 MW GFPP). The Project consists of a 275 MW combined cycle power plant and ancillary facilities, a 40 km long 12-inch gas pipeline, and a switchyard and a 750 m 150 kV transmission line - collectively referred to hereafter as the 'Project'. The Project Sponsors being PT Medco Power Indonesia (MEDCO) and Ratchaburi Electricity Generating Holding PCL (RATCH), have formed PT Medco Ratch Power Riau (MRPR) to build, own and operate the plant under the terms of the Power Purchase Agreement (PPA) which has been agreed with PT Perusahaan Listrik Negara (Persero) ("PLN").

1.2 Project Location

The power plant and ancillary features, switchyard and transmission line is located in the Tenayan Industrial Village (previously known as Sail Village), Tenayan Sub District, Pekanbaru City, Province of Riau.

The power plant is located approximately;

- 10km due east of the city of Pekanbaru in central Sumatra, Indonesia;
- 5km south of the Siak River; and
- 3km south of PLN's existing 2 x 110 MW RIAU Coal Fired Power Station (CFPS).

The power plant and switchyard will be located within the 9 ha of privately owned land currently being used as a palm oil plantation. The site is bounded by palm oil plantations to the west, south and east and Road 45 on the North.

MRPR also proposes to seek gas supply from TGI Perawang Station located north of the power plant in the Siak Regency. The gas will be delivered to the power plant by approximately 40 km of pipeline which will be located within the reserve of existing road.

An outline of the Project area is detailed in Figure 1.1 and an overview of the general area and proposed connections to services is outlined in Figure 1.2.

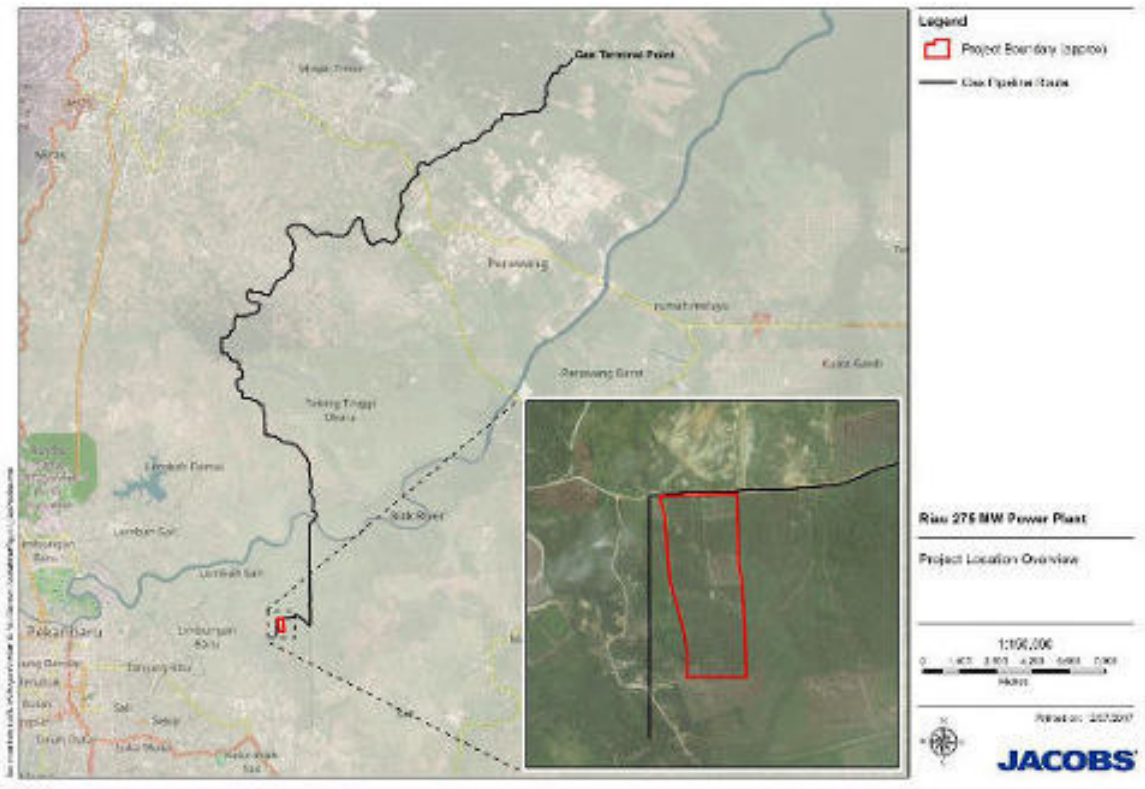


Figure 1.1: Outline of the Project Area

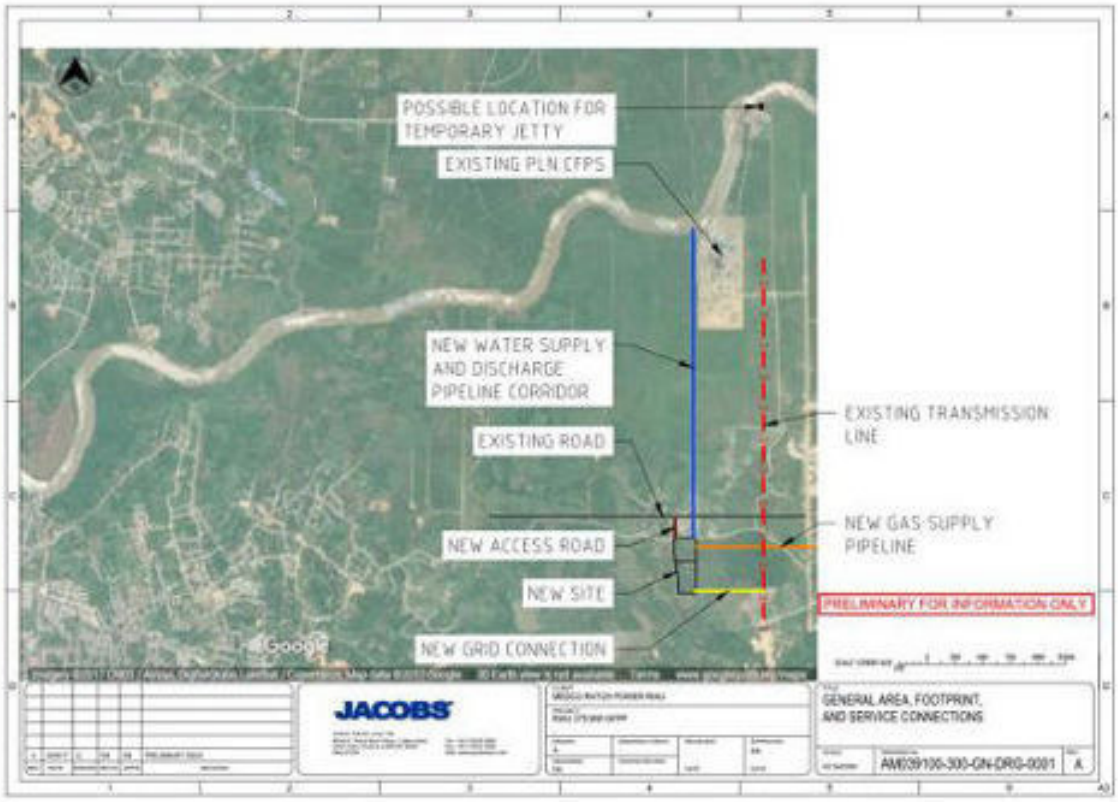


Figure 1.2: Power Plant General Area and Service Connections

1.3 Purpose

This Scoping Report will review existing environmental and social-related studies and information available for the site development and identify key risks to be considered in the ESIA including identifying information gaps for baseline environmental and social studies. The ESIA Scoping Study includes the following:

- Relevant International and National requirements relevant to the proposed development including:
  - Asian Development Bank (ADB) Safeguard Policy Statement 2009[1];
  - Equator Principles
  - International Finance Corporation (IFC) Performance Standards;
  - World Bank Group (WBG) Environmental, Health and Social (EHS) General and Industry Specific Guidelines and
  - Indonesian Regulatory Framework.
- key risks to be addressed by the ESIA investigations;
- information and data gaps to be addressed through the ESIA baseline studies;
- extent and level of further survey required;
- Environmental and Social Impact Scoping Matrix
- a draft Terms of Reference (ToR) for the ESIA baseline studies, including confirming the scale, timing and number of specialist ESIA surveys to be conducted (Appendix B);
- the outcomes of the initial site visit undertaken for the ESIA in June 2017; and
- proposed ESIA assessment methods (and comment on if any changes are proposed to the outline methodology in the SoW).

It should be noted that this Scoping Report has been written with limited information regarding the design of the Project.

1.4 Structure of Report

This Scoping Report is structured as follows:

- Section 2 – Project Overview and Progress
- Section 3 – General Approach to ESIA
- Section 4 – Existing Environment
- Section 5 – Key Environmental and Social Risks

[1] ADB Safeguard Policy Statement 2009 accessed in October 2017 at [https://www.adb.org/site/safeguards/policy-statement]

2. Project Overview and Progress

2.1 Project Description

The Project comprises a 275 MW combined cycle power plant (CCPP), a 40 km long gas supply pipeline which will bring fuel to the site, a 150 kV switchyard and 750 m long transmission line to connect the power plant to the PLN grid. Once constructed, ownership of the switchyard and transmission line will be transferred to PLN. (The switchyard and transmission line connection are collectively known as the Special Facilities.) At the end of the 20 year term of the PPA, PLN will take ownership of the power plant and gas supply pipeline.

The power plant will use gas fuel only and is a 2 x 1 combined cycle plant, designed to deliver up to 275 MW over the 20 year term of the PPA.

Key components of the project will comprise the following:

- Power generated by 2 x 1 combined cycle plant, delivering up to 275 MW;
- River water intake and outlet;
- 2 x 45 m tall, 3.8 m diameter chimneys;
- Wet mechanical draft cooling tower;
- Earthworks to level and raise the power plant platform from approximately 25m above mean sea level (MSL) to 28 m;
- 500 m access road;
- Gas supplied from TGI Gas Station 40 km from the power plant via a 12 inch gas pipeline; and
- a 150 kV switchyard at the plant, with a 750 m double-phi connection to intercept the existing Tenayan – Pasir Putih 150 kV transmission line.

The gas pipeline will be mostly trenched and buried within existing road reserve. Horizontal directional drilling (HDD) will be used to cross the Siak River, with the pipeline anticipated to pass approximately 2 m beneath the river bed. For other small watercourses and crossing of roads, industry standard methodology determined during detailed design will be used.

2.1.1 Water Requirements

The water balance diagram detailed in Appendix E provides an overview of water requirements for the Project including: raw water, treated water and waste water. Raw water is anticipated to be abstracted from the Siak River and treated water discharged back into the river, estimated daily flow rates are as follows:

- Raw Water Abstraction – 368.5 m^3 per hour.
- Treated Water Discharge – 82.5 m^3 per hour.

Following treatment, the combined water discharge from the power plant site is anticipated to have an elevated temperature of between 3-5°C above background. When it reaches the Siak river via the 3 km buried discharge pipeline, the discharged water temperature is likely to be much closer to ambient.

2.2 Project Land Requirements

MRPR plan to construct the power plant and switchyard on a 9 ha plot of land owned by up to eight owners and is currently in procurement process. According to Pekanbaru City's Spatial Plan, the land is in a zone allocated for industrial and warehousing use. There are no dwellings located at the power plant site or along the transmission line so no physical relocation or resettlement of inhabitants will be necessary.

At the time of writing MRPR is still in the process of identifying proposed lands for acquisition, required in relation to the gas pipeline route however no physical relocation or resettlement of inhabitants is anticipated as

the gas and water pipelines will run along the road reserve or within easements which will be agreed with the affected landowners.

The total land requirements for the power plant and switchyard (including temporary laydown areas and offices for the construction workforce) are estimated at approximately 9.1 ha as outlined Table 2.1. Preliminary Site layout plans are provided in the Appendices.

Table 2.1: Riau 275MW GFPP land requirements

Riau 275MW GFPP power plant land area requirements	Approximate Area, ha
Power plant and main plant buildings	1.2
Cooling tower	0.2
Balance of plant area	2.5
Switchyard (150 kV) (part of the Special Facilities to be owned by PLN)	1.5
Total	**5.4**

During construction, there will be further land requirements for the construction workforce including temporary laydown areas and offices. The additional area, estimated at a further 3.7 hectares will be within the site area (total of 9.1 ha).

There will also likely be a need for a temporary jetty to be built on the Siak River, expected to be located close to PLN's 2 x 110 MW CFPS. This will be used for transportation of materials and equipment during the construction phase of the power plant.

In addition, the Project will also have land requirements for a water abstraction point at the Siak River, water supply pipelines to and from the power plant site, the gas supply pipeline, and the 150 kV transmission line, as outlined in Table 2.2 below.

Table 2.2 : Riau 275MW GFPP Land Requirements

Riau 275MW GFPP power plant – Other infrastructure land requirements	Approximate dimensions, m x m	Approximate Area, ha
Water abstraction point	20 x 20	0.006
Water supply and discharge pipeline corridor	2 x 3,000	0.6
Gas supply pipeline	2 x 40,000	8
Transmission Line (including 4 towers)	20 x 750	3
Access road	10 x 500	0.32
Total		**11.926**

2.3 Initial Site Visit

An initial site visit of the Project area was undertaken in June 2017. The Figures outlined below provide an overview of the project area and the current conditions of the power plant site and along the gas pipeline route.

The initial site visit identified that the majority of the area within and surrounding the power plant is made up of plantation area and open scrub land. The road network comprises unmade dirt road and tarmac.

Figure 2.1 : Road and Surrounding Area Across Power Plant Site Area

Figure 2.2 : South of the Siak River, gas pipeline to be installed on left side of the road

Figure 2.3 : North of Siak River, overlooking gas pipeline crossing point

Figure 2.4 : Road entering power plant area

Figure 2.5 : Road along gas pipeline route. Pipeline to be located on right side of the road

Figure 2.6 : Road along gas pipeline route. Pipeline to be located on left side of the road

Figure 2.7 : Perawang TGI Station, fuel supply for Riau power plant

2.4 Project Stages

The Project will span three primary stages, being pre-construction, construction and operation, generally as follows:

- **Pre-construction:** The pre-construction stage involves project development activities, including selection of contractors, field surveys and permitting, and land acquisition works.
- **Construction:** The construction stage will involve land preparation (including site clearance, backfilling and land drainage) followed by construction and commissioning of the power plant, gas pipeline and grid connection.

- **Operation:** The operation stage will involve the full operation of the power plant – first of all over the 20 year term of the PPA and then, as determined by PLN after ownership transfers to PLN.

2.5 Project Timescales

The proposed project timescales for major construction activities are provided in Table 2.3.

Table 2.3: Estimated duration (in months) of activities required for Project construction

Activity	Estimated Duration (months)
Site clearance and levelling	6 months
Gas pipeline construction	12 months
Power plant and switchyard engineering, procurement and construction	24 months
Construction of water pipelines (to and from site)	8 months
Transmission line construction	8 months
Commissioning	8 months

Based on current schedule (see Appendix D) the ESIA and Analisis Mengenai Dampak Lingkungan (AMDAL) will take approximately 10 months. The dates for key for commencement and completion of the ESIA and AMDAL are outlined below:

ESIA

- Scoping – In progress
- Baseline Sampling – In progress – 14th November 2017
- Draft ESIA and Technical Studies – 2nd November 2017 – 5th January 2018
- Framework ESMS and ESMP – 30th November 2017 – 2nd February 2018
- ESIA Exhibit / Approval – 8th January – 27th April 2018

AMDAL & UKL-UPL

- UKL-UPL (gas pipeline and transmission line) – 11th September – 16th January 2018
- KA-ANDAL (power plant) – 4th September – 1st November 2017
- AMDAL Sampling – 12th October – 6th December 2017
- AMDAL and Technical Studies – 2nd November 2017 – 5th January 2018
- ANDAL and RKL-RPL for Power Plant – 30th November 2017 – 2nd April 2018

3. Existing Environment

3.1 Introduction

This section provides an overview of the environmental and social conditions at the proposed site of the Project, using existing information sources and key findings from the initial site visit in June 2017. The findings are listed in Table 3.1 below. A number of information gaps currently exist which will be addressed through the ESIA process.

Table 3.1 : Riau 275MW GFPP Existing Environment

Receptor	Baseline	
	Power Plant and Transmission Line	Gas Pipeline
Climate	Pekanbaru has a tropical climate. The general site climate conditions are provided below. • Ambient air temperature range – 20 °C-37 °C • Design ambient air temperature – 28 °C • Relative humidity range – 40 %-100 % • Design Relative humidity – 80 % • Average annual rainfall - Approximately 3,000 mm - rainy season between November and April • Maximum rainfall - Approximately [136 mm/h] • Average wind speed - Less than 3 m/s, from the north and south • Site elevation - Approximately 25 m aMSL	
Air Quality	The proposed power plant is located 10 km east of Pekanbaru City in a rural area with a number of nearby landowners, the nearest from the power plant site being approximately 450 m to the South. A screening level modelling assessment has been undertaken for the proposed CCGT power station using the AERMOD dispersion model. The intent of the modelling is to predict likely locations of maximum impacts resulting from the discharges in order to select locations for baseline ambient air monitoring of oxides of nitrogen for the project. Figure 3.1 and 3.2 provides results of the screening level modelling assessment. The meteorological data set was developed using the prognostic model TAPM (Version 4.0.4), CSIRO, Australia. This model predicts meteorological parameters for the region based on large-scale synoptic information provided by the Australian Bureau of Meteorology. Meteorological data for the project location was extracted from the model simulation for use with AERMOD. A windrose of the data is detailed in the Figure 3.3 below. Discharge parameters for the power station, including contaminant emission rates, were obtained from the Jacobs Riau 275 MW GFPP Project - Process Description (June 2017). Building downwash effects were not considered under the assumption that the stack heights relative to nearby buildings are such that downwash is not an issue.	

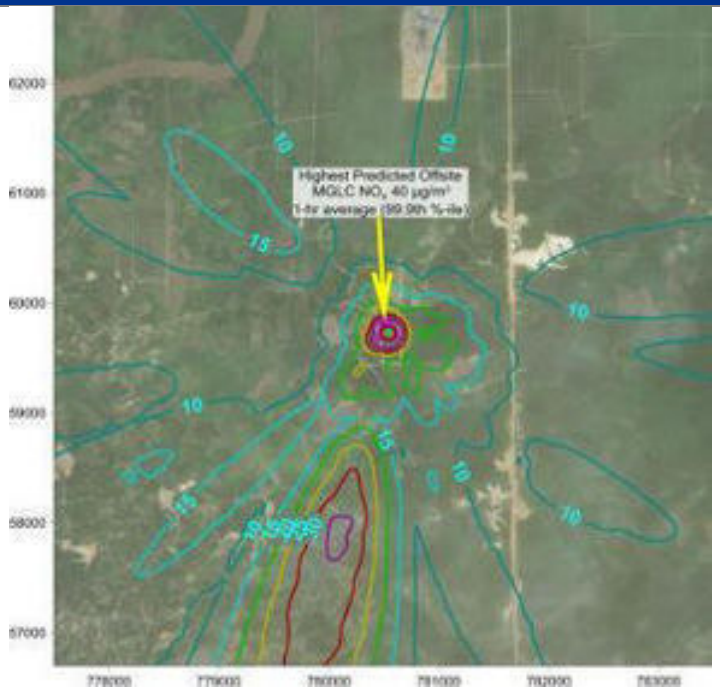
Receptor	Baseline	
	Power Plant and Transmission Line	Gas Pipeline
		

Figure 3.1 : Maximum Predicted NOX Concentrations (1-hour average, 99.9th percentile)

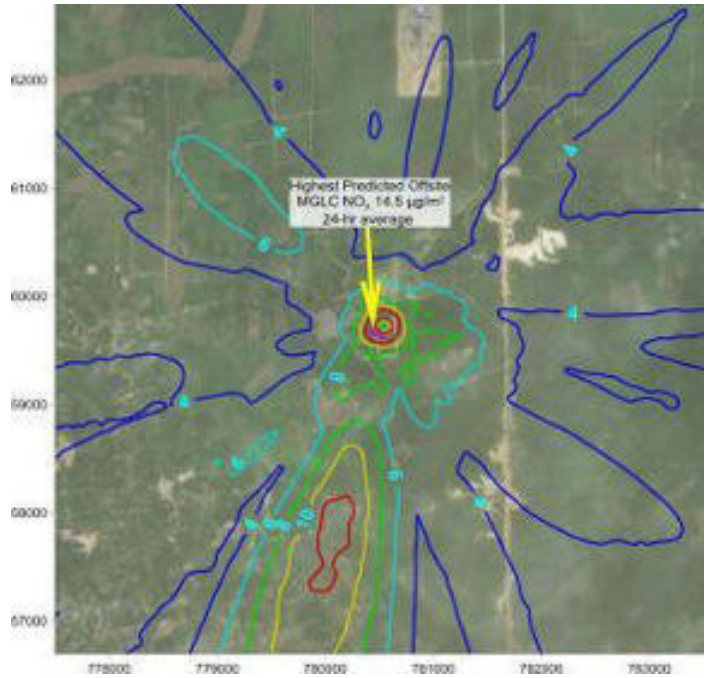
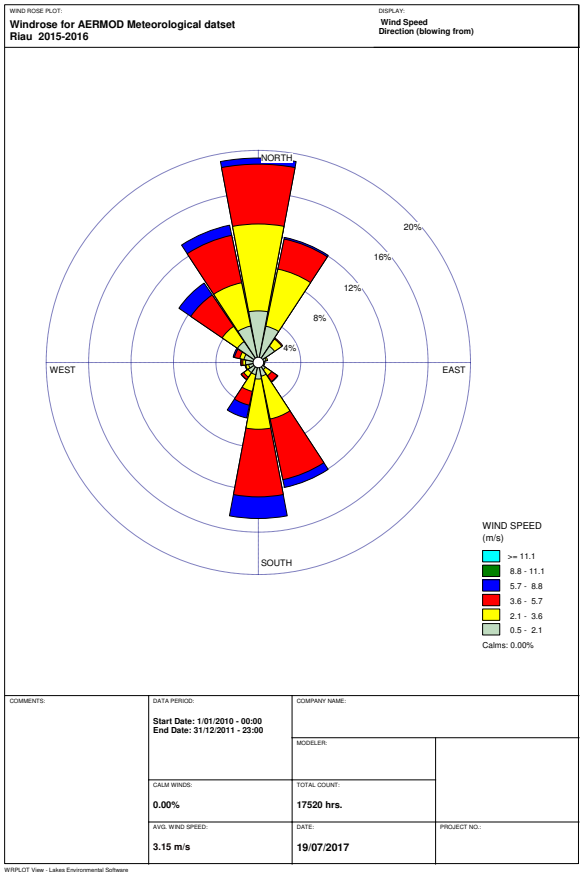
Receptor	Baseline	
	Power Plant and Transmission Line	Gas Pipeline
		

Figure 3.2 : Maximum Predicted NOX Concentrations (24-hour average)

Receptor	Baseline	
	Power Plant and Transmission Line	Gas Pipeline
	 **Figure 3.3 : Windrose for AERMOD meteorological dataset**	
Noise	The proposed power plant is located 10 km east of Pekanbaru City in a rural area with a number of nearby landowners, the nearest from the power plant site being approximately 450m to the South. At the time of writing there was no data available for the existing environment for noise in the region for the power plant / transmission line and the gas pipeline. Ambient noise monitoring will be conducted as part of the ESIA baseline data collection process in accordance with the WBG EHS General Guidelines.	

Receptor	Baseline	
	Power Plant and Transmission Line	Gas Pipeline
Cultural Heritage	There are no sites of cultural significance in the vicinity of the power plant or transmission line.	The gas pipeline will follow existing road that pass approximately four mosques, one school and one community graveyard.
Freshwater Quality and Aquatic Ecology	The Siak River is located an estimated 5k m north of the power plant site and there is another unnamed creek 500 m south of the site. The Siak River to the north is estimated to be 150 m wide and is relatively deep given it is used for the barge transportation of goods for communities and industries.	The gas pipeline route crosses an estimated four minor watercourses and the Siak River.
Landscape and Visual	The topography of the region is fairly uniform at the power plant site and along the gas pipeline route.	
Soils and Geology	The power plant area is situated on minas formation with soils comprising gravel, pebble spreads, sands and clays. The geology on the border of the project area towards the Siak River is made up of young alluvium formation comprising gravels, sands and clays. The gas pipeline route is predominately situated on minas formation with soils comprising gravel, pebble spreads, sands and clays.	
Terrestrial Ecology	There are no protected areas of conservation concern within a 5 km radius of the project area. The majority of the land surrounding the power plant and transmission line comprises palm oil plantations and scrub land.	The majority of the land around the proposed gas pipeline route comprises palm oil plantations and scrub land.
Natural Hazards and Vulnerability to Climate Change	At the time of writing there was no data available for the existing environment for natural hazards and vulnerability to climate change in the region for the power plant / transmission line and the gas pipeline. Ground adjacent to the Siak River is at 10 m aMSL and at the power plant location 20 m aMSL therefore the power plant is not subject to flooding from the river.	
Land Ownership	The power plant is privately owned land and by up to eight owners.	As the gas pipeline is located within the road reserve the land is likely to be state owned however this will be confirmed through the ESIA process.
Land Use	The power plant Project area is currently being used as a palm oil plantation and is privately owned.	The majority of the gas pipeline route will be located within the reserve of existing road.
Social Environment	The nearest community to the power plant is Rejosari and Sail Sub-District, located approximately 2 km south-west from the power plant site. There is no direct route/road from the village to site.	The pipeline route passes through / adjacent to a number of communities. Communities that have been identified within the Stakeholder Engagement Plan (SEP) as likely to be affected by the gas pipeline include; Pinang Sebatang Barat Village (Tualang District), Perawang Barat Villages (Tualang District); Sail Sub-District (Tenayan Raya District) and Tebing Tinggi Okura Sub-District (Rumbai Pesisir District).
Ecosystem Services	At the time of writing data there was no data available for the existing environment for ecosystems services in the region for the power plant / transmission line and the gas pipeline.	
Traffic	Existing traffic is limited due to the rural nature of the surrounding land and limited road connectivity.	Traffic use along the pipeline route is likely to be moderate due to the route running within the reserve of an existing road network that connects nearby rural communities.

4. Stakeholder Engagement and Grievance Mechanism

4.1 Progress to Date

Jacobs have prepared a Stakeholder Engagement Plan (SEP) for the project. The SEP has the following key objectives:

- describes the proposed methods and processes by which local communities, stakeholders and interested parties will be consulted in relation to the Project;
- outlines the means and locations of information disclosure; and
- outlines the grievance mechanism by which stakeholders and/or interested parties can raise their concerns and observations.

4.2 Ongoing Work

As part of the stakeholder process, consultation will be undertaken with members of communities located near to the proposed development area to gather information on existing socio-economic conditions and community and cultural values. This will assist in the development of a socio-economic baseline for communities near to the Project describing key social and economic characteristics, including:

- population and demography, such as age and gender, households and families;
- existing livelihoods, including crops being grown, number of people involved in farming activities;
- existing economic activities undertaken by communities near the project, such as agriculture and palm oil plantation;
- existing land use and tenure arrangements;
- local community values and views on such things as visual and amenity values, cultural/ spiritual values, health, use of existing natural resources; and
- community facilities and features, including historic and cultural sites and existing community facilities.

The Project Sponsor's Senior Manager and/or Community Liaison Officer will both advise the community and key stakeholders that the surveys are to undertaken ahead of time and participate in their oversight with the Jacobs representative that will be on site during all community consultation activities.

5. Key Environmental and Social Risks

5.1 Introduction

An Environmental and Social Impact Scoping Matrix has been developed by Jacobs, which identifies items and activities in the construction and operation of the power plant, transmission line and gas pipeline that could have environmental and social impacts or pose environmental and social risks.

The Environmental and Social Impact Scoping Matrix should be revised following completion of the preparation of the ESIA to take into account any changes to the proposed development site layout or the design as a result of additional mitigating measures identified in the assessment of environmental and social impacts and risks. Any improved level of knowledge on the sensitivity of key elements of the receiving environment based on the baseline surveys should also be incorporated into the revised Environmental and Social Impact Scoping Matrix.

The level of 'Significance' for each of the environmental impacts identified in the Environmental and Social Scoping Matrix was determined by Jacobs' personnel experienced in environmental and social impact assessments of industrial developments using a qualitative approach. The following issues were considered for each discharge or activity (hazard) when determining the level of 'significance' of the impact.

Environmental and social concerns:

- the scale of the resulting impact;
- the severity of the impact;
- the frequency of occurrence of the impact;
- duration of the impact;
- offensiveness of the impact; and
- cumulative impact.

Business concerns included:

- regulatory/legal exposure;
- cost of changing the impact;
- difficulty in changing the impact;
- effect of damage on other processes and activities; and
- effect on public image of the organisation/reputational risk.

The impacts were ranked from low to high significance in terms of their potential for environmental and social impact using the criteria set out below.

Table 5.1: Impact Significance Criteria

Significance Category	Impact Criteria
High	• Significant off-site impact; • Occurs on a relatively frequent basis; • Breaches environmental permits, licences or national standards; • Results in public complaint; and • Is expensive to mitigate.

Significance Category	Impact Criteria
Medium	• has off-site effects minor in nature; • could result in public complaint; • at times may slightly exceed legal consents or standards; and • is regarded as not a good practice.
Low	• may have an off-site effect; • occurs very infrequently; • is within legal requirements, but could still be improved; and • is cheap/relatively easy to mitigate.

5.2 Summary of Key Environmental and Social Risks

The scoping study has identified two potentially 'High' environmental and social impacts that may occur (are detailed below in Table 5.2) and these will be assessed in more detail in the ESIA. The ESIA will also consider environmental and social topics that are of medium and low risk. It should be noted that these potential impacts are based on limited information available at the time of writing and do not consider mitigation/controls that will developed through ongoing detailed design and the ESIA process, see Section 6.2.4.1.

Table 5.2: Summary of Key Potential Environment and Social Risks

Environmental/Social Topic	Key Impacts
Land Ownership and Land Use	Land ownership investigations for the Project are ongoing at the time of writing for the power plant and along the gas pipeline route
Community Health and Safety	Potential adverse impacts to local communities through miss-use / illegal siphoning of gas from the pipeline. Miss-use / illegal siphoning could lead to uncontrolled releases of gas from the pipeline that may combust and therefore harm any individuals/settlements within the nearby area. This is unlikely to occur given the pipeline will be buried for the majority of the route but is a risk that should be considered further during the ESIA and be factored in to community engagement and education programs including emergency response planning.

6. Terms of Reference for ESIA

6.1 Introduction

This section describes the Terms of Reference (TOR) for the general approach to the ESIA. The baseline environmental surveys that are required for the ESIA, and are additional to what is required under the AMDAL process is provided in Appendix B.

6.2 General Approach to ESIA

6.2.1 Introduction

This section provides an overview of the impact assessment methodology applied to the assessment of potential environmental and social impacts arising from the Project. The impact assessment methodology has been developed in accordance with good industry practice, and the potential impacts will be identified in the context of the Project's area of influence, in accordance with Asian Development Bank (ADB) Safeguards and IFC Performance Standard 1 (Assessment and Management of Environmental and Social Risks and Impacts).

6.2.2 Scoping

The Project kick-off meeting was held on 4th May 2017 between representatives of Jacobs and MRPR. Jacobs completed a site visit in June 2017, the results of which will be used in producing a scoping matrix outlining key environmental and social hazards that have High significance.

6.2.3 Establishment of Baseline Conditions

In general, baseline information will be collected from secondary desk-based studies and literature reviews and supplemented with primary data identified in the scoping phase and obtained from site surveys and monitoring, along with consultation with affected communities and correspondence with local stakeholders. For more details reference should be made to Appendix B – Baseline Environmental and Social Data Collection Terms of Reference. At this stage only baseline sampling will be undertaken during the dry season as the proposed power plant site and gas pipeline route is highly modified habitat with low ecological value. If wet season data is deemed necessary this will be discussed and agreed with MRPR and ADB.

6.2.4 Impact Assessment

The prediction of the scale and significance of environmental impacts will be assessed against the established baseline conditions. The assessment criteria will be based on international requirements and good practice involving quantitative analysis and qualitative analysis with professional judgement supported by an impact ranking system to classify the magnitude and significance of the impacts. All activities for the Project will assessed in terms of the significance of the impact on the receiving environment, for example, air quality, noise, ecology, and the significance of the impact of local society, including livelihoods, health, culture and employment. For more details reference should be made to Table 6.1.

Due to the elevation of the project area in relation to the Siak River and minimal raising of ground level at the Project area, quantitative flood risk assessments as set out in the proposal are not deemed necessary however screening of thermal dispersion modelling of water being discharged back into the Siak River will be undertaken.

6.2.4.1 Mitigation

The impact assessment will consider mitigation that is inherently within the design of the Project in order to determine the significance of impacts. If the residual impact including the design mitigation is found to be not acceptable further mitigation measures will then be recommended as necessary to ensure good practices are implemented and in order to reduce any significant potential impacts to an acceptable level, in accordance with ADB Safeguards and IFC Performance Standards. The mitigation hierarchy will be used: avoid, minimise,

restore or remedy, offset, compensate and mitigation measures will be clearly identified and linked to environmental and social management plans.

6.2.4.2 Monitoring

Monitoring is not linked to the impact evaluation but is an important component of the ESIA. Monitoring follow-up actions will be outlined in order to:

- Continue the collection of baseline data throughout construction, operation and later decommissioning.
- Evaluate the success of mitigation measures, or compliance with project standards or requirements.
- Assess whether there are impacts occurring that were not previously predicted.
- In some cases, it may be appropriate to involve local communities in monitoring efforts through participatory monitoring. In all cases, the collection of monitoring data and the dissemination of monitoring results should be transparent and made available to interested project stakeholders.

6.3 Outline of ESIA

The ESIA is anticipated to following the format and layout outlined in Table 6.1 below.

Table 6.1 : Outline Structure of the ESIA

Non-Technical Summary		
Volume 1: Introduction	Introduction	A brief description of the Project, the location and the environmental setting
	Policy, Legal and Administrative Framework	• ADB Safeguard Policy Statement (2009), Equator Principles IFC Performance Standards, WBG General and Industry Specific EHS Guidelines • Indonesian Regulatory Framework • Permits/Licences
	Project Description	• Overview • Site location • Project land requirements • Project schedule • Description of construction, operation and decommissioning activities
	Project Justification and Assessment of Alternatives	• Project justification and site / route selection • Assessments of alternatives including the 'do-nothing' scenario
Volume 2 : Environmental Impact Assessment	Introduction	• Overview
	Impact Assessment Methodology	• Baseline Environmental Conditions and Previous Studies • Spatial and Temporary Scope • Impact Assessment Methodology • Impact Identification • Cumulative Impacts
	Environmental Impact Assessment	Environmental baseline for the following topics: • Climate • Air Quality • Greenhouse Gas Emissions • Noise • Natural Hazards • Hydrology • Water Quality and Freshwater Ecology • Landscape and Visual • Terrestrial Ecology

		• Soils, Geology and Groundwater • Hazardous Substances and Waste • Traffic and Access
		Each of the topics will contain the following: • Assessment of Impacts • Mitigation and Monitoring measures • Assessment of Residual Impacts
		Occupational Health and Safety & Working Conditions
		Cumulative Impacts
		Summary of Environmental Impacts
Volume 3 : Social Impact Assessment	Introduction	Overview
	Legal and Regulatory Framework	• National and International Requirements
	Impact Assessment Methodology	• Data sources • Spatial and Temporary Scope • Impact Assessment Methodology
	Social Impact Assessment	Social baseline for the following topics: • Demographic Overview • Ethnicity and Culture • Religion • Gender • Indigenous People • Ecosystem Services • Economic Profile • Educational Profile • Land Use and Tenure • Poverty, Deprivation and Vulnerable Groups
		Stakeholder Engagement
		Impact Assessment for the following: • Employment • Land Acquisition • Cultural Heritage • Community Health, Safety and Security Impacts • Cumulative Impacts
		Mitigation, Enhancement Measures and Residual Impacts
		Assessment of Residual Impacts
Volume 4 : ESMP, ESMS and Compliance Assessment	Environmental and Social Management Plan (ESMP)	• Construction Mitigation and Monitoring • Operation Mitigation and Monitoring
	Framework Environmental and Social Management System (ESMS)	• Structure of Framework ESMS • Alignment with IFC Performance Standards and ADB Safeguard Policy Statement (2009) • Policies • Roles and Responsibilities • Legal and Other Requirements • Identification of Risks and Impacts • Management Programmes

		• Monitoring and Review • Stakeholder Engagement • Training • Administration
	Compliance Assessment	• Compliance with ADB Safeguard Policy Statement (2009), Equator Principles and IFC Performance Standards

Volume 5: Technical Appendices

Table 6.2: ESIA Terms of Reference

Environmental Topic	Impact Assessment Methodology
Air Quality and Greenhouse Gas Assessment	The ESIA will assess the direct and indirect impacts to air quality from construction and operation including potential dust generation during construction. The assessment will also include greenhouse gases generated by the development and operation of the power plant. The assessment will include: • Evaluation of the current ambient air quality of the area based on baseline sampling results (see Section 8 of Appendix B for details of baseline sampling to be undertaken); • Development of a meteorological data set based on prognostic meteorological data and site specific data from the meteorological station. The TAPM model will be used to fully develop the meteorological data set if no specific data is available • Development of an emission inventory data files for air contaminant sources; and • Conducting air dispersion modelling with AERMOD air dispersion models as area is flat terrain • Evaluation of the level or significance of impact based on the predicted contours produced by the modelling for contaminants by comparison against WHO ambient air guidelines.
Noise	The ESIA will assess potential noise impacts during construction and operation. The assessment will be carried out using the following method: • Noise monitoring will take place as set out in Section 9 of Appendix B. The noise data collected will then be used to establish project noise criteria. • Development of a meteorological data set based on prognostic meteorological data and historic, site specific data from the meteorological station. If no specific data is available TAPM modelling will be used to fully develop the meteorological data set • Development of a sound level inventory for key noise sources and activities of the development • Development of a noise model, including terrain, buildings and a consideration of meteorological conditions using SOUNDPLAN • Prediction of noise levels during construction and operation of the development • Comparison of results from the modelling against evaluation criteria • Evaluation of the level or significance of impact based on the predicted noise levels produced by the modelling.
Cultural Heritage	The ESIA will assess the direct and indirect impacts on cultural heritage assets.
Biodiversity freshwater aquatic assessment	The ESIA will assess the direct and indirect impacts on aquatic flora and fauna values identified through the baseline investigations

Environmental Topic	Impact Assessment Methodology
(including water quality and sediment)	outlined in Section 4 of Appendix B. The following will also be carried out during the ESIA: • Determine whether any critical habitats are impacted; • Assess the potential impact on water quality from soil erosion, transfer of sediment or movement of contaminant; • Conduct screening modelling to determine the dilution rate of contaminants discharged into the river.
Hydrological Assessment	The ESIA will assess the direct and indirect impacts on the hydrological regime using qualitative assessments. The assessment will also include screening of thermal dispersion modelling of water being discharged back into the Siak River.
Groundwater	The ESIA will assess how groundwater will be impacted both during the construction of the Project and operation. Groundwater data collected through baseline sampling outlined in Section 6 of Appendix B will be used to assess any impacts to groundwater quality and the groundwater take on local users.
Landscape and Visual	The ESIA will assess changes to the visual conditions and values of the study area as a result of development infrastructure.
Soils and Geology	The ESIA will assess the potential impacts of soil contamination from the development, including identification of management measures. The baseline sampling will be desk based utilising geotechnical data collected.
Terrestrial Ecology	The ESIA will assess the impacts on the terrestrial flora and fauna values using data collected in the baseline sampling terrestrial ecology fieldwork surveys outlined in Section 5 of Appendix B. The ESIA will compare the proposed footprint of works and associated infrastructure, the duration and nature of construction activities and the lifecycle of the Project and identify the potential impacts on the sensitive characteristics of the habitats and species identified in the baseline study of the surrounding area. Sensitive characteristics include representativeness, intactness, rareness, cohesiveness and other valuable aspects of the habitats (if any), and the rareness or pest status of the species present. The scale of the impact assessment will be determined by the sensitivity of the habitats and species identified in the baseline assessment. The ESIA will determine the scale of impact based on the loss or reduction of habitat, changes to the numbers of species present, changes in community dynamics and the changes to populations of individual species. Impacts may be positive or negative.
Natural Hazards and Vulnerability to Climate Change	The ESIA will undertake a natural hazards assessment will be undertaken which will examine and assess the exposure of the site to natural hazards such as extreme rainfall and drought. The natural hazards assessment will use existing and publically available data within the region in order to define the natural hazards affecting the site under present-day and future climate conditions in order to develop design strategies to appropriately manage the associated risks.
Hazardous Substances and Waste	The ESIA will aim to assess the potential impacts associated with the use of hazardous materials and substances for the development's lifecycle. The ESIA will also assess impacts of waste generated by the development and waste management measures to be

Environmental Topic	Impact Assessment Methodology
	implemented. The ESIA will utilise data currently held on other similar developments to assist in the preparation of a list of potentially hazardous substances used for different phases of the development.
Land Ownership and Land Use	The ESIA will assess changes to and impacts on the use of land (i.e. agricultural uses, community uses) by the development. It will also assess changes to land access arrangements for local people. Data will be collected through consultation which will be undertaken by the social impact assessment team.
Population, Social Environment and Health, Economy	The ESIA will complete an assessment of social impacts on communities near to the development. Matters to be assessed as part of the social impact assessment would be confirmed following the socio and economic surveys outlined in Section 10 of Appendix B. Strategies to avoid, manage or mitigate potential impacts of the development on the existing socio-economic environment and maximise the identified benefits of the development would also be identified.
Traffic	The traffic assessment will be based on traffic survey data collected during baseline investigations of key routes construction vehicles will use to access the site. The ESIA will review the baseline data and assess the impacts associated with the transport of people, materials and equipment to the Project area during construction and operation. The ESIA will also assess any river navigation impacts through construction of temporary jetty and increased river traffic.
Working Conditions and Occupational Health and Safety	The assessment will require review of health and safety procedures that are anticipated to be developed by the EPC (Engineering, Procurement and Construction) Contractor. There will also be review of policies relating to Human Resources and Worker's Rights. The ESIA will assess the adequacy of the proposed controls to prevent major accident scenarios and the level of risk posed on the surrounding development. The proposed health and safety management system will be summarised and the ESIA will outline mitigation, management, and monitoring actions to be included in the ESMP.

6.3.1 Mitigation Measures and Recommendations

Additional mitigation measures to those already included in the design and construction methodology will be recommended to reduce residual impacts to acceptable levels, for example, air quality, ecology or land acquisition. These additional mitigation measures and those included in the design and construction methodology will be summarised and used to develop various management and monitoring procedures (i.e. Environmental and Social Management Plan (ESMP) and Environmental and Social Management System (ESMS)). For clarity, the purpose of each of these key documents is as follows:

- an ESIA identifies and assesses risks and the impacts associated with the Project;
- an ESMP sets out the mitigation and monitoring required to manage the impacts; and
- an ESMS sets out how the mitigation monitoring will be implemented, checked and reviewed.

Appendix A. Environmental and Social Impact Scoping Matrix

Riau 275MW Combined Cycle Gas Fired Power Plant - Environmental and Social Impact Scoping Matrix

											Social Impacts												Natural				Approval	
Plant Items and Operations	**Fresh Water Quality**	**Fresh Water Ecology**	**Terrestrial Ecology**	**Groundwater**	**Ground contam**	**Air Quality**	**Dust**	**Traffic**	**Navigation**	**Noise & vibration**	**Visual**	**River use**	**Fishing (+ve)**	**Fishing (-ve)**	**Loss of access to resources**	**Employment**	**Cultural Heritage**	**Population Movement (-ve)**	**Population Movement (+ve)**	**Resettlement (economic or forced displacement)**	**Loss of production land**	**Public Health**	**Aesthetic**	**Seismic**	**Flooding**	**Climate Change**	**Typhoon**	**AMDAL**	**ESIA**
Stage 1 Preconstruction Phase																												
Land aquistion for Power Plant															L			L		L	L							M
Land Acquisition for Gas Pipeline																				H	H							
Design information																											M	M
Stage 2 Construction of Power Plant & Gas Pipeline																												
Transportation of fill to site					M		M	M		M						M						M						
Earthworks to increase base height to 28m above MSL	L	L	M	L		L	M			M	L				L	L	L			L	L		L	M	M				
Access roads					L		L	L		L	L				L					L									
Transportation of heavy equipment to site via temporary jetty									L			L		L		L							L						
Transport of people and materials to site on daily basis						L	L	M		L						L						L							
Construction of Power Plant			L	L	L	M	M			M	M	M			L		L					L	M						
Construction of gas pipeline			L	L	L	M	M	M		M	M						M												
Crossing of watercourses by the gas pipeline	L	L								L		L		L															
Construction Camp incuding waste and wastewater disposal	L			L	M					L												M							
Construction of Transmission lines			M		L						M				L	L	L					L							
Stage 3. Operation of Power Plant and gas pipeline																												
Discharge of emissions through exhaust and fans (primary air, ID, FD etc)						M																						
Cooling water system (Closed circuit)						M																						
Extraction of water from freshwater environment	M	M								L				M														
Sewage treatment system					L	M				L																		
Discharge of treated wastewater and stormwater to freshwater environment	M	M												M														
miss-use / illegal siphoning of gas from the pipeline.																						H						
Solid waste disposal				L	L																							
Cumulative impacts with existing Riau IPPs (noise, air)						M				M					L			L			L								M

Appendix B. Baseline Environmental and Social Data Collection Terms of Reference

JACOBS

Memorandum

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Subject	Baseline Environmental Data Collection Terms of Reference (TOR)	**Project Name**	Riau 275 MW GFPP Project (Medco Ratch Power Riau)
Attention	NBC, Medco Ratch Power Riau	**Project No.**	AM039100
From	PT Jacobs Indonesia		
Date	05.07.17		

1. Introduction

This Baseline Environmental Data Collection Terms of Reference (TOR) has been developed by PT Jacobs Group Indonesia (PT JGI) to collect sufficient baseline data to quantify the receiving environmental and social baseline status for both the power plant site (including 700m of transmission line) and gas supply pipeline route for the Riau 250 MW CCGT Power Plant Project for the ESIA, and is in addition to the baseline sampling required under Indonesian legislation for the power plant AMDAL and the UKL/UPLs for the gas pipeline and transmission line . The project consists of a 275 MW combined cycle power plant and ancillary facilities, a 40 km long 12-inch gas pipeline, and a switchyard and 150 kV transmission line (750m) - collectively referred to hereafter as the 'Project'.

This TOR should be read in conjunction with the Riau Environmental and Social Impact Assessment (ESIA) – Scoping Report (to be completed), which provides details on the known existing environmental and social site conditions and explains the approach taken to ESIA.

2. Summary Project Description

The Project will be located approximately 10 km due east of Pekanbaru City, approximately 5 km south of the Siak River. The power plant and switchyard will be comfortably accommodated inside the 9 ha of land being procured by the Sponsors. The power plant is a 2 x 1 combined cycle plant, designed to deliver up to 275MW over the 20 year term of the PPA. It will burn gas fuel only. Key components of the project will comprise the following:

- Power generated by 2 x 1 combined cycle plant, delivering up to 275 MW;
- River water intake and outlet;
- Air emissions will be released to the atmosphere via 2 x 45 m tall, 3.8 m diameter chimneys;
- Wet mechanical draft cooling tower;
- Earthworks to level and raise the power plant platform to approximately 28m above mean sea level;
- Gas will be supplied from TGI Gas Station 40 km from the power plant via a 12 inch diameter pipeline; and
- a 150kV switchyard at the plant, with a 750 m double-phi connection to intercept the Tenayan – Pasir Putih 150 kV transmission line (TL).

2.1 Power Plant and Transmission Line

The power plant site is located to the east of Pekanbaru City, in Sail Sub District. The site bounded by palm oil plantation to the west, south and east and Road 45 on the North. The Project Sponsors proposes to construct a 750m long 150kV transmission line to tie in to Tenayan – Pasir Putih 150kV existing transmission line. Four transmission towers will be erected between the power plant and the existing transmission line. The proposed power plant and transmission line sites are shown in Appendix A.

2.2 Gas Pipeline Route

The gas supply line is approximately 46 km long from the PGN Gas Terminal Port at Perawang (Future Line of KP 457 – SV 1401.1 of the Grissik Duri Pipeline – coordinate: 47N 791885 E81526 (UTM Format)) to the gas receiving facility located within the Riau CCGT Power Plant at Tenayan district, Pekanbaru City, Riau Province. The proposed pipeline route is shown in Appendix C.

3. Baseline Sampling

3.1 Introduction

This TOR sets out the baseline survey environmental data that is required to be collected by NBC (hereafter referred to as 'the subconsultant'). It describes:

- The type of data to be collected by the baseline sampling surveys;
- The sampling locations, number of samples, sampling methodology to be followed and frequency of sampling;
- Analysis methods for ecological samples collected;
- Parameters that samples should be analysed for (water, sediment, soil and groundwater samples); and
- Reporting formats for the data collected.

3.2 Requirements of the Subconsultant

The baseline sampling as set out in this ToR will be conducted for the Environmental and Social Impact Assessment (ESIA) for the overall Project adhering to international Asian Development Bank (ADB) International Safeguards and is in additon to the baseline sampling conducted in accordance with Indonesian environmental regulations for the the power plant AMDAL and UKL/UPLs for the transmission line and gas pipeline. The ESIA baseline sampling will be conducted prior to the sampling required for the AMDAL and UKL/UPL.

The subconsultant is required to report on the progress of the baseline data collection surveys to PT JGI. The subconsultant shall provide informal fortnightly progress reporting (email) to PT JGI and monthly face to face meetings with PT JGI's Project Manager during the baseline data collection phase. The progress meetings between the subconsultant and PT JGI during this phase will confirm progress in the data collection, discuss outcomes of consultation undertaken and identify any issues in the collection of the baseline data, thus avoiding schedule/scope creep. For all surveys the raw data that underpins the statistical analysis undertaken as part of the survey should be provided.

Any issues encountered by the subconsultant that prevent the subconsultant undertaking the baseline survey by the method specified in this TOR or where data is not available or cannot be obtained must be advised to PT JGI as soon as the issue comes to the notice of the

subconsultant. PT JGI will then in discussions with the subconsultant and the Project Sponsors determine whether the data is required or an alternative survey method or modification to the proposed survey can be used.

The subconsultant will provide PT JGI with sampling and monitoring methodologies prior to undertaking the baseline data collection for review to ensure JGI's data requirements for the ESIA will be met.

A maximum of three months has been allowed in the ESIA preparation schedule for the undertaking of baseline studies, as the baseline surveys need to be completed before end of September 2017. At this stage we have only aloowed for dry season sampling and based on the findings limited wet season sampling may be required. The TOR may be changed based on environmental and social data currently being collected by the Project Sponsors, which will be made available to PT JGI for this Project.

4. Freshwater Aquatic Survey, including Water Quality

The subconsultant shall conduct a baseline survey to characterise regional freshwater communities and ecology of the Siak River and other water courses in the vicinity of the Project power plant, TL and gas pipeline route that includes:

- Fish;
- Macroinvertebrates;
- Algae and macrophytes;
- Aquatic habitats; and
- Water quality.

Water quality, and ecological (macroinvertebrate and net fishing) sampling of the above water courses is required at locations shown in Appendix B and Appendix D.

4.1 Water Quality Samples

4.1.1 Methodology

Water samples should be collected from the Siak River, an unnamed creek to the south of the proposed power plant site and from four watercourses along the gas pipeline route. Samples will be collected under dry season flow conditions at minimum two sampling locations (one upstream and one downstream). The proposed water quality sample locations are shown in Appendix B (power plant / TL) and Appendix D (gas pipeline route).

Samples will be collected and stored in accordance with the requirements specified in Government Regulation No. 82 Year 2001 regarding Water Quality Management and Pollution Control Class II (as minimum, unless otherwise regulated by local government regulation) and ISO 5667.6:2004 Water quality – Sampling Part: 6 Guidance on sampling of rivers and streams or its equivalent. The sampling will be conducted to determine the physical, chemical and biological parameters of the rivers prior to the power plant development. The parameters that the samples are to be analysed for are set in Table 4.1 below.

For metals the samples jars will be acid preserved. One set of metal samples will be for total metal and the water sample will be placed in the sample container without filtration. Another sample will be collected for soluble metals and the sample will be filtered to remove suspended solids in the field prior to it being placed in the container containing acid preservative. Laboratory analysis of water samples should be carried out in accordance with APHA method.

Organic parameters must be collected in glass jars and that only the first set of samples from each sampling location needs to be analysed for the organic parameters being organochlorine pesticides, Dioxins, Furans, other toxics such as PAH (Polycyclic Aromatic Hydrocarbons), and Polychlorinated Biphenyls (PCB). This would be for the first set of samples collected.

Table 4.1: Analysis Parameters for Water Samples

Parameter		Siak River	Unnamed Creek Connecting power Plant to Siak River	Spot sampling on watercourses crossed by proposed gas pipeline
pH		✓	✓	✓
Total Suspended Solids		✓	✓	✓
BOD		✓	✓	✓
COD		✓	✓	✓
Oil and Grease		✓	✓	✓
Arsenic		✓	✓	✓
Boron		✓	✓	✓
Cadmium		✓	✓	✓
Chromium	Hexavalent	✓	✓	✓
	Total	✓	✓	✓
Copper		✓	✓	✓
Iron		✓	✓	✓
Lead		✓	✓	✓
Mercury		✓	✓	✓
Manganese		✓	✓	✓
Nickel		✓	✓	✓
Zinc		✓	✓	✓
Soluble Heavy Metals (filtered) as per bulleted list above		✓	✓	✓
Ammonia		✓	✓	✓
Fluoride		✓	✓	✓
Total nitrogen		✓	✓	✓
Nitrate		✓	✓	✓
Nitrite		✓	✓	✓
Phosphorus		✓	✓	✓

Parameter	Siak River	Unnamed Creek Connecting power Plant to Siak River	Spot sampling on watercourses crossed by proposed gas pipeline
Total Coliform Bacteria	✓	✓	✓
Organochlorine pesticides	✓	×	×
Dioxins, Furans, other toxics such as PAH (Polyaromatic Hydrocarbons)	✓	×	×
Polychlorinated Biphenyls (PCB)	✓	×	×
Temperature	✓	✓	✓
Conductivity	✓	✓	✓
Turbidity (NTU)	✓	✓	✓

4.1.2 Sampling Frequency and Field Data

As a minimum, water samples should be collected from the identified sampling locations on at least two occasions during the dry season and on one occasion during the wet season (to be confirmed at the end of dry season sampling). Measurements of pH, temperature, dissolved oxygen and conductivity should be recorded in the field at the time the samples are collected. The date and time that the samples were collected and the weather conditions at the time of sampling and for the previous 24 hours should also be noted.

The flow rate of the river at each of the sampling point should be estimated at each sample location. At each sampling point the cross section of the river should be determined along with the velocity of the river at that point. Velocity can be determined by use of flow measuring device or by timing a device floating in the main current of the river between two points marked on the opposite bank. Cross sectional areas will need to be determined, depth and width of the river at the sampling points. Cross sections may be available from the survey of the rivers, which is to be conducted either as part of the baseline data collection by the subconsultant or by the power plant designers. If not they will need to be measured as part of the water sampling programme.

4.2 Freshwater Ecological Sampling

4.2.1 Macro-invertebrate Sampling

Macro-invertebrate sampling will be conducted at one location (unnamed creek near the power plant) and at one location on Siak River, as identified in Section 4.1 and shown in Appendix B. Sediment samples will collected at this location by grab or box corer methods. A total of three samples will collected at this point following a transect across the rivers. The sediment samples will be composited and a sample taken and sent to the laboratory to determine the chemical contaminants present in the sediments.

The benthic fauna will be treated in a standard manner - sieved through 1 mm mesh size, identified to species level and enumerated, weighed and subjected to ABC analyses. Abundance, species diversity and distribution frequency will be determined for each sampling location. The sampling should not be carried out within two weeks of a storm event as this has the potential to flush organisms out of their ecosystems and thereby potentially reducing the number of organisms present.

The sampling should be conducted by a recognised laboratory or university with the facilities to store and count the species. Sampling should be conducted following the guidance provided in the ANZECC Water Quality Guidelines for Fresh and Marine Waters, 2000.

A report will be provided setting out the sampling methodology followed, sample locations, raw data and the analysis of abundance and diversity.

4.2.2 Net Fishing

If appropriate, net fishing will be conducted at the upstream and downstream sampling locations identified for both the Siak River and other watercourses to determine the abundance and diversity of fish species in the rivers prior to the power plant development. Any protected species identified in the survey will need to be clearly identified so that the impact of effluent discharged to rivers from the power plant development can be assessed. The sampling should be conducted by a recognised laboratory or university with experience in conducting similar surveys.

4.3 Reporting

Reports on the baseline data collected by these studies will be prepared by the subconsultant and submitted to PT JGI within one month of the data collection being undertaken.

5. Terrestrial Ecology

The baseline survey will assist in determining the baseline for terrestrial ecosystems and the representative flora and fauna in each of the habitats at the power plant/TL site and the gas pipeline route. As a minimum, flora and fauna samples should be collected from a number of identified sampling locations along the gas pipeline route on at least one occasion during the dry season only. Due to the area being predominantly palm oil plantation and therefore low in biodiversity, it is considered that dry season sampling is only required for terrestrial ecology. Date and time that the samples were collected and the weather conditions at the time of sampling and for the previous 24 hours should be noted.

5.1.1 Site Survey Preparation – All Sites

The task includes review of background information on the locality, field work to survey habitats and species, and reporting of methodologies, results and conclusions. A literature review shall be conducted before carrying out field surveys. This will also include screening of international databases to identify international recognised key biodiversity risks such as designated or protected areas and threatened species. Specific tasks include:

1) Describing and mapping the various terrestrial habitats on the sites. This is to include the fish ponds if any.

2) Within each habitat, use internationally accepted, standard sampling techniques to identify:
   - Habitat type (wetland / agriculture / forest; intact / degraded / modified; man-made; significance of biodiversity – local, national, international). Include information on hydrology, soils or other habitat characteristics that are relevant.
   - Species - including introduced, indigenous, noxious pest or weed, economic value, significance – local, national, international. The significance of species shall be noted in the report.
   - Note the ecological uses of the site for significant faunal species (i.e. feeding, nesting, migrating)

3) Sampling techniques shall be adequate to provide a detailed list of species, abundance, and habitats condition using primarily visual and aural methods. Trapping, handling, specimen collection of species is not expected as part of this study (except for the fish survey, as discussed above).

4) Type of survey will include:
   a) Vegetation / flora;
   b) Avifauna (birds);
   c) Herpetofauna (amphibians and reptiles);
   d) Mammals

5.1.2 Survey methodologies

Vegetation / flora

A preliminary land-use/habitat classification of the study area shall be prepared in GIS by interpretation of satellite imaginary and/or aerial photography. This information shall be used to stratify the vegetation and habitat types for further detailed survey. Stratification is necessary to ensure that the full range of potential habitats and vegetation types are systematically sampled. Stratification shall consider land-use, elevation and vegetation type (shrub, cleared agriculture / plantation / off-stream wetlands).

Power Plant / TL

Habitat classification maps will be ground-truthed through a combination of walked transects through habitat-types to provide further detailed information on vegetation boundaries, floristic diversity and the possible presence of rare and threatened plants.

Walked transect surveys shall aim to record all plant species within the vicinity of the Project. There will be 3-4 transects for the power plant / TL site. Particular attention shall be paid to the dominant, rare, endemic, threatened, protected, invasive species, and the species that are of importance to local communities. Locations of rare or threatened plant species shall be identified using a GPS and data on the size and distribution of the population shall be recorded.

The following general data shall be along each route:

- location using handheld GPS to record coordinates;
- photographs showing habitat structure and any notable plant species;
- habitat types and structure.

Additional habitat conditions data shall be recorded per transect, including the level of modification or disturbance of habitat found per transect and this shall be assessed according to the following grading:

- relatively stable or undisturbed communities (e.g. old growth, unlogged forest);
- late successional or lightly disturbance communities (e.g. old growth mangrove swamp that was selectively logged in recent years);
- mid-successional or moderately to heavily disturbed communities (e.g. young to mature secondary forest); and
- early successional or severely disturbed communities.

Gas Pipeline Route

The gas pipeline route will be driven with all habitats recorded in detail on route. In areas of notable floristic diversity, the site will be assessed in more detail with 100m transects running perpendicular to the road. Notable species will be recorded as above for the power plant / TL site.

Avifauna

Power Plant / TL

The survey shall focus on sampling bird species' richness and abundance located within the range of different habitat strata present. Line transects surveys will be used with a point count method. There will be 3-4 for the power plant / TL site.

Transect surveys and point count surveys involving a 20 minute time-based survey and each transect/point to record all birds seen or heard within a 50 m radius of the census point. Bird surveys shall be conducted within four hours of sunrise to sample peak activity time and surveys shall avoid adverse weather (e.g. high wind or rain). Geographic coordinates shall be recorded at each survey point

Observations on birds shall be done primarily through visual observation and call identification. Nests and important food source/trees for any protected and rare species shall be recorded and captured with GPS. Where possible, surveys will also cover the foreshore area for seabirds.

Gas Pipeline Route

The gas pipeline route will be driven with all habitats recorded in detail on route. In areas of notable potential for avifauna, the site will be assessed in more detail with 100m transects running perpendicular to the road, on the same side as that the pipeline will run. Notable species will be recorded as above for the power plant / TL site.

Herpetofauna

Power Plant / TL

The type and number of reptile and amphibian species shall be recorded during the walked transect surveys. Areas of high concentrations of individuals shall be captured with GPS. Study area and observations of significance shall be photographed.

Gas Pipeline Route

The gas pipeline route will be driven with all habitats recorded in detail on route. In areas of notable potential for herpetofauna, the site will be assessed in more detail with 100m transects running perpendicular to the road, on the same side as that the pipeline will run. Notable species will be recorded as above for the power plant / TL site.

Mammals

Power Plant / TL

The type and number of mammal species shall be recorded during the walked transect surveys. Visual identification of animals, refuges, scat or other signs is expected. It is not deemed necessary to use camera traps in this study.

Gas Pipeline Route

The gas pipeline route will be driven with all habitats recorded in detail on route. In areas of notable potential for mammals, the site will be assessed in more detail with 100m transects running perpendicular to the road, on the same side as that the pipeline will run. Notable species will be recorded as above for the power plant / TL site.

5.1.3 Reporting

Reports delivered by subconsultants shall include the follows:

- Background context, from desk top study.
- Sampling methodology including limitations to methodology (weather, season, timeframe, sampling biases, etc.). Cite references for standard sampling methodologies.
- Results, including species lists and abundance (including indigenous and introduced), observations of refuges / nests etc., significant habitats or species (rare, threatened, noxious etc.), ecosystem uses for key species (nesting, migrating, foraging etc.).
- Conclusions on the significant issues or factors that should be addressed in the environmental impact assessment study, including recommendations for further study work if required.

6. Groundwater Resources (Power Plant Only)

6.1 Collect and Review Background Information

Background information needs to be obtained by the subconsultant on the existing groundwater use and hydrogeological characteristics of the power plant site. Data required to be obtained as part of this assessment includes:

- Determine the location, depth and groundwater levels (both static and pumping levels if available) of existing groundwater /bores and wells within two kilometres of the site.
- Obtain available geological and construction information for bores/wells within two kilometres of the power plant site. Bore construction data may include information on bore casing, well screens, and pump installation, such as depth, diameter, material types, screen slot sizes, and pump specifications.
- Determine the locations of existing groundwater users in nearby villages.
- Advise PT JGI what data is available and whether it is sufficient to prepare hydrogeological maps.
- Prepare hydrogeological maps if there is sufficient data available that show the locations of existing boreholes in relation to the proposed power station and ash disposal site. These maps should clearly identify existing groundwater supply bores, surface geology, groundwater catchment boundary, and hydrogeological features (e.g. springs).
- Determine seasonal fluctuation of the groundwater levels from either existing monitoring data, or undertake regular water level monitoring of accessible bores.
- Arrange and undertake a water sampling programme of three bores/wells within one kilometre of the proposed site to determine baseline water quality of the groundwater system surrounding the project site. Selection of appropriate sampling sites will be undertaken in discussions with PT JGI based on the results of the above review and will target wells which have information on geology, bore construction and yield. It will likely include a borehole drilled on the project site, assuming that this has accessible piezometer installation. A total of three water samples are to be collected once the well volume has

sufficiently purged such that field parameters (pH, total dissolved solids, temperature) have stabilised. The samples are to be analysed for the same parameters as set out in Table 4.1, excluding dioxins.

6.2 Reporting

The subconsultant shall provide the base datasets identified above to PT JGI in appropriate electronic format to enable data manipulation and integration. These data will be used by PT JGI to develop a preliminary conceptual understanding of the hydrogeology of the area surrounding the site. The results of this work will be used to refine the scope and specific requirements for additional investigations and ongoing base data collection to be undertaken.

7. Contaminated Land (Power Plant Only)

Surface soil samples to a depth of 300m are to be collect at the power plant area and analysed for pesticides being organochlorine, organophosphorous and organo nitrous. A total of 10 soil samples on a grid based system shall be collected and analysed.

8. Air Quality

8.1 Ambient Air Quality

The construction activities for both the power plant/TL and the have the potential to adversely impact on the ambient air quality therefore baseline monitoring should be undertaken by the subconsultant at a selection of potentially sensitive sites that could be affected by the construction activities.

The monitoring sites must be located in suitable areas that comply with the guidelines set out in Australian Standard AS 2922 Ambient Air – Guide for the Siting of Sampling Units 1987. The purpose of AS 2922 is to ensure that the location of the sampling site is such that the collected data is representative of that location. The standard has a number of guidelines to facilitate the site location conformity. The guidelines also outline sites to avoid including those that:

- Restrict airflows in the vicinity of the sampling inlet.
- May alter pollutant concentrations by adsorption or absorption.
- Chemical interference with the pollutant being measured may occur.
- Physical interference may produce atypical results.

Consideration is also given to vandalism, adequate access, services and local activities when selecting a site. In addition, for the data to be applicable to human health the sampling inlet should be located near the breathing zone, i.e. around 1 to 2 m above ground level.

Figure 7.1 of AS 2922 documentation and shows the generalised layout and guidelines for a typical sampling site. It is noted that security is an issue in respect to the sampling equipment and local schools, mosques or other relatively secure sites should be used. Discussions should be entered with village chiefs to fine secure sites.

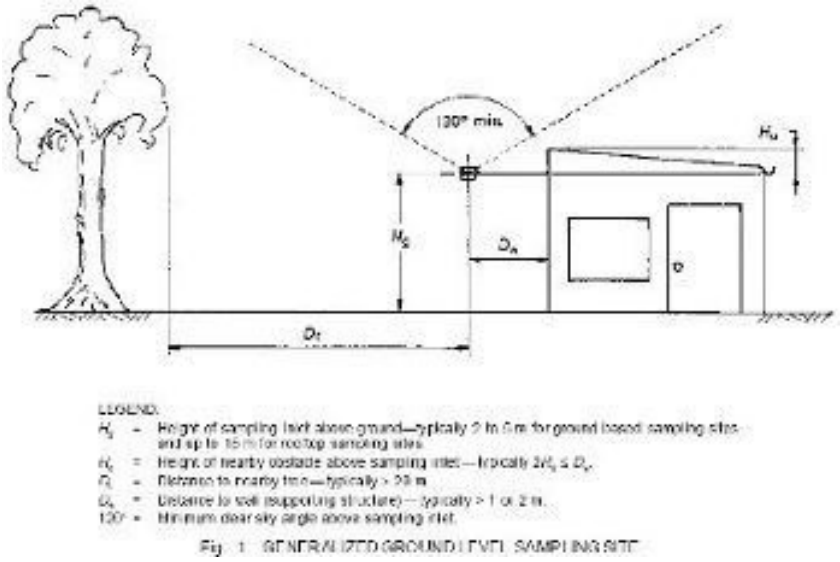


Figure 7.1: Generalised Ground Level Sampling Site

At this initial stage it is proposed that the following monitoring is conducted at the two sites:

- PM10/Total suspended particulate using high volume sampler or low volume method.
- Nitrogen dioxide by either active sampling or by passive diffusion tubes

8.1.1 PM_{10}/PM2.5Total Suspended Particulate

PM10 and PM2.5 will be collected at each of the monitoring sites following Method IO-2.1 Sampling of Ambient Air for PM10 and PM2.5 Using High Volume (HV) Sampler. Ambient air is drawn at a known flow rate through a prepared filter via a PM10 and a PM2.5 inlet, which effectively acts as a hood to prevent precipitation and debris from falling onto the filter. . The sample volume is calculated from the average flow rate and sample duration. The material collected on the filter is determined gravimetrically. Sampling duration is for a 24-hour period.

Sampling would be carried out twice a month for a minimum of three months at each of the monitoring sites.

Subconsultant is to advise which method will be followed and when sampling can commence.

8.1.2 Passive Sampling

Table 7-1 lists the gaseous pollutants to be measured using integrated passive samplers. It also lists a brief description of the reaction occurring in each passive sampler, the analytical method used to measure the reacted product, the sensitivity required, and references for the method discussed. Weather shields have been installed at all sites to protect the passive sampler units.

Table 7.1: Passive Sampling Methods

Pollutant	Reaction & Analysis	Detection Limit
NO_2	Nitrogen (NO_2) is chemiadsorbed onto TEA as nitrite. Nitrite is quantified by visible spectrophotometry. Sampling is selective for gaseous molecules. Any airborne nitrite will not cross the diffusive membrane.	± 2 ppb for 14 day mean

The radiello passive samplers will be exposed for 14 day periods for the three months prior to site works commencing at each of the four monitoring sites. For AMDAL requirements the monitoring will be for one 24 hour period per month.

9. Noise

9.1 Methodology

Construction and operational activities have the potential to adversely impact on the noise environment therefore baseline monitoring should be undertaken by the subconsultant at a selection of noise sensitive sites affected by the activities. These locations must be situated away from existing noise sources such as roads or industry and be representative of the ambient noise environment. Samples will be collected in accordance with the requirements specified in the WBG EHS General ..

Long-term measured background noise levels over a minimum period of 48 hours of good weather should be undertaken to provide information on the background noise environment in the absence of industrial or extraneous noise sources. The subconsultant in their Baseline Noise Report should comment on any current activities near the pipeline sites that may cause a background level of noise and ground vibration (e.g. other industry, railway, major roads, etc.).

The daily variation of background noise levels recorded every 15 minutes at nearby noise sensitive sites should be recorded and reported as mean daily noise levels in the Baseline Noise Report with particular regard to the different periods of the day and night. The survey conditions, meteorology, location and results for each location for the baseline monitoring should also be recorded and included in the Baseline Noise Report. Noise measurements were performed by integrating sound level meter which have facilities L_{TMS}, namely L_{eq} recorded every 5 seconds for 60 minutes measurement. Measurements were taken during the 24-hour activity (L_{SM}). Each measurement should be able to represent a certain time interval with a set of at least four time measurements during the day and three at night time measurements, such as the following example:

- L_1 measured at 07:00 to 08:00 to represent at 06:00 to 9:00
- L2 measured at 10:00 to 11:00 to represent at 09:00 to 11:00
- L3 measured at 15:00 to 16:00 to represent at 14:00 to 17:00
- L4 measured at 20:00 to 21:00 to represent at 17:00. to 22:00
- L5 measured from 23.00 to 24.00 for representing 22.00 to 24.00
- L6 measured at 1:00 to 2:00 for representing 24.00 - 3:00
- L7 measured at 4:00 to 5:00 to represent at 03:00 to 6:00

Where possible, sufficient noise data should be collected to account for variations in seasonal and meteorological conditions. This will provide a baseline for comparison of predicted noise levels as well as information to be used in later studies.

9.2 Sampling locations – Power Plant

The noise sample locations should represent all potentially affected receivers. This will typically be residential properties and excludes unoccupied buildings and should be continuous over at least four days. It should also cover seasonal variations (however as the location is equatorial, this may not be relevant). The sites for noise monitoring are as following (also shown in Appendix B):

1) Rural property to the north (affected by existing PS noise)

2) Rural property to the south (unaffected by existing PS noise)

3) Outskirts of Penkanbaru to the west

4) Outskirts of Penkanbaru to the south

9.3 Sampling locations – Gas Pipeline Route

Noise monitoring along the gas pipeline should be representative of the main noise environments along the route. This monitoring can be a single 15 minute period at each location, however if night works are proposed, monitoring should also be done at night. The sites for noise monitoring are as following (also shown in Appendix D):

1) Outskirts of Penkanbaru close to the proposed pipeline route

2) Rural environment

3) River crossing

4) Outskirts of Jln Koperasi

5) Close to main road (Ji Raya Minas Perawang)

9.4 Reporting

A short Baseline Noise Report will be prepared setting out the above data and provided to PT JGI along with the raw noise monitoring data to enable a noise impact assessment to be prepared. The subconsultant will provide technical details (specification) of the proposed sound level meter to be used, so that PT. JGI can check that it will produce the data required.

10. Social and Economic

10.1 General

The subconsultant will collect data on the current farming activities in the vicinity of the power plant site, TL and gas pipeline route. This includes:

- A breakdown of the crops being grown, number of hectares covered and the annual tonnages harvested and the number of local people who farm or are supported by these fields.
- Demographic data on the number of people involved in the farming activities, where they reside, and age profile.

The subconsultant is required to collect information on:

- Historical settlement of the area and traditional activities;
- Known archaeological sites within two kilometre radius of the gas supply pipeline;
- Traditional and present-day social and tribal structures in the proposed sites;
- Identify and describe of sites of cultural and heritage importance within two kilometre radius of the power plant site, TL and gas pipeline route;
- Determine the values(importance) placed on these sites in terms of local, regional and national significance;
- Identify and record existing activities of cultural and heritage value within two kilometre radius of the power plant site, TL and gas pipeline route;
- Identify potential effects of the proposed power plant site, TL and gas pipeline route on the cultural and heritage sites and values;

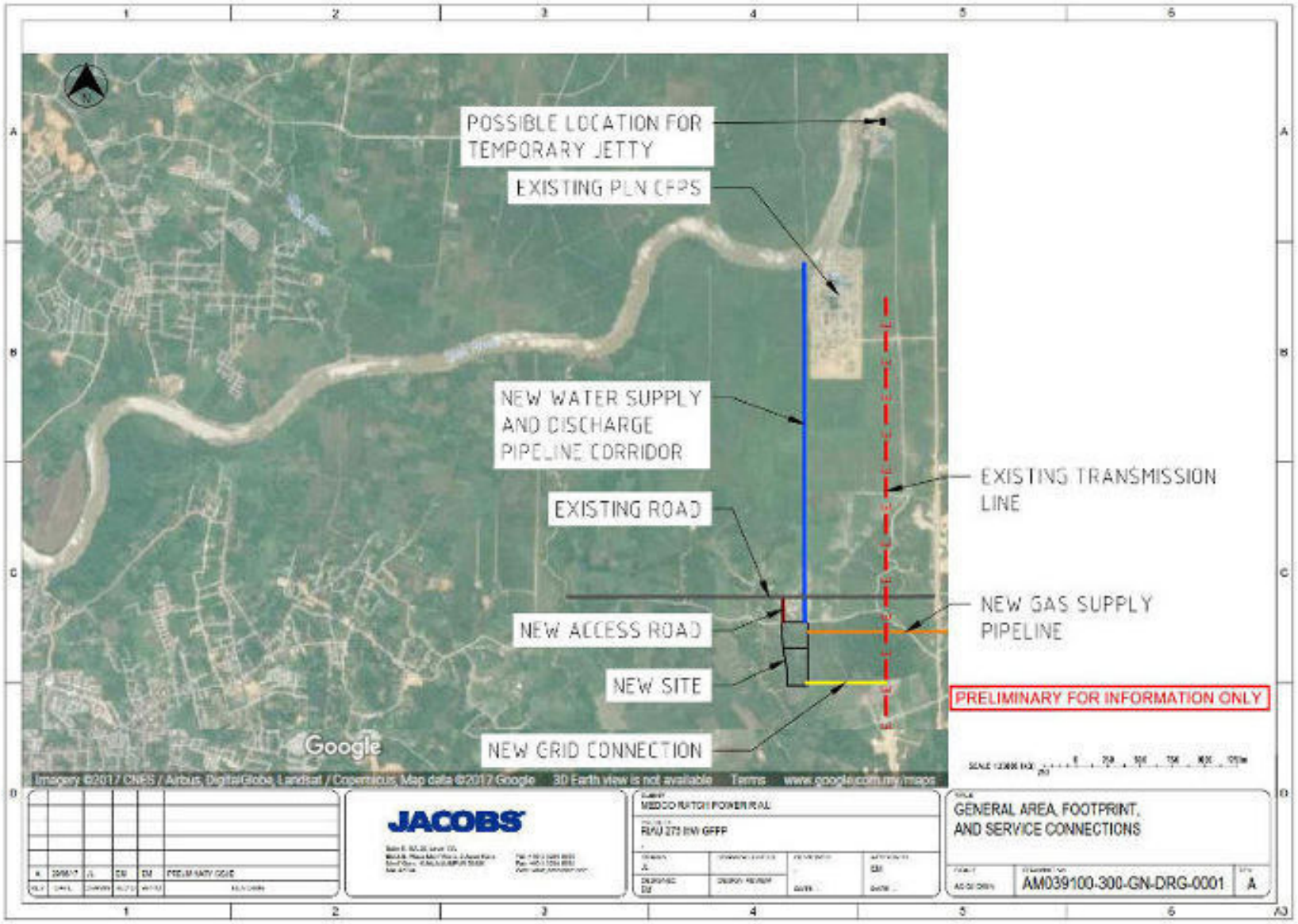
- The views of the key local, regional and national groups, as relevant on the heritage and cultural sites near the site; and
- Provide a report that sets out the methodology used to collect the baseline data and the data collect in respect to cultural activities and heritage sites in the surrounding area.

10.2 Public Health

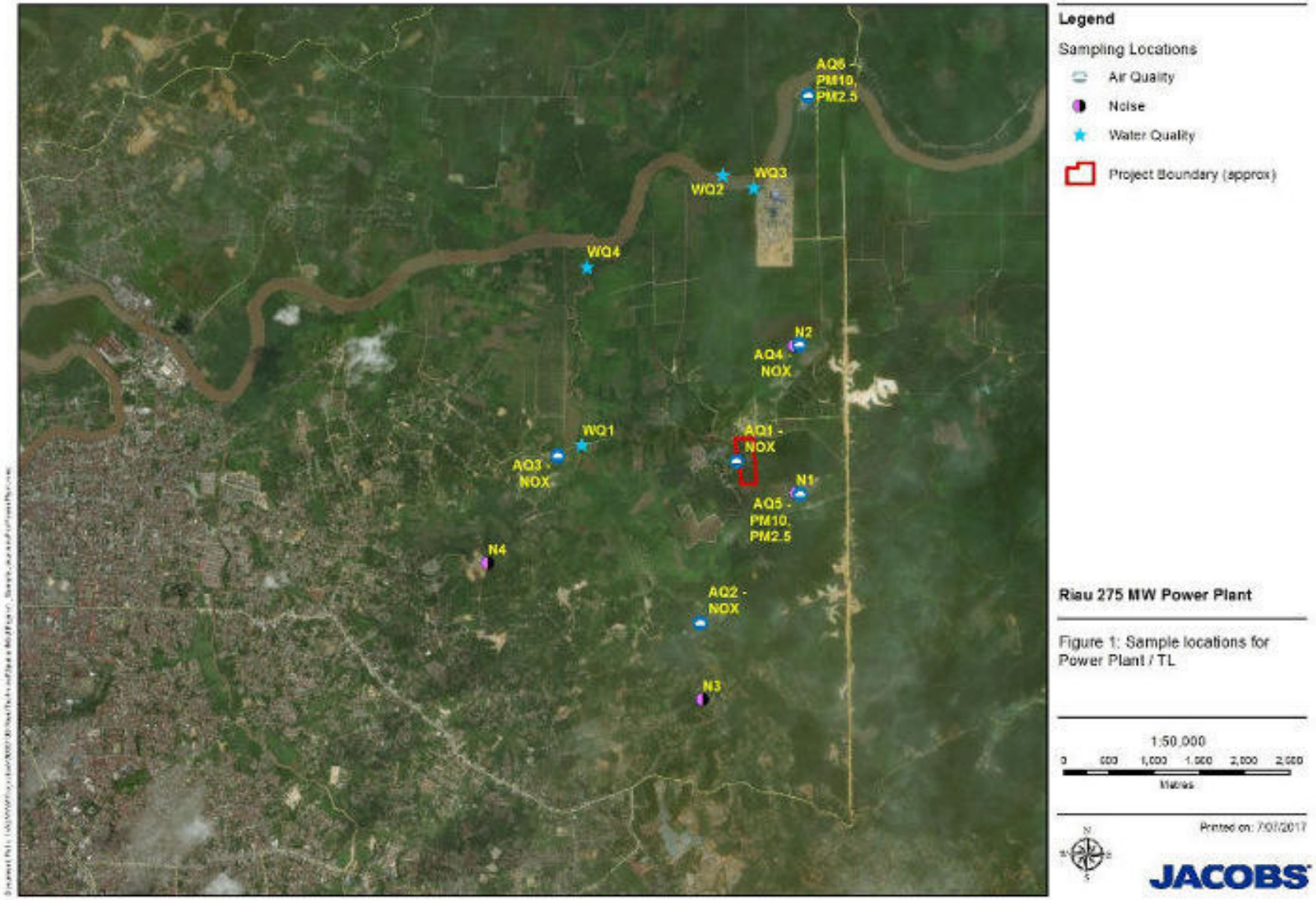
The subconsultant is required to collect information on:

- Historical information of public health in the vicinity of the power plant site, TL and gas pipeline route, to include:
  - Identify and describe of type of public disease on the area;
  - Determine the values (dominance) of the disease on the area;
  - Identify public health facilities to include availability of health worker on the area;
  - Identify potential effects of the proposed transmission line on community public health; and
  - Provide a report that sets out the methodology used to collect the baseline data and the data collect in respect to public health in the surrounding area.

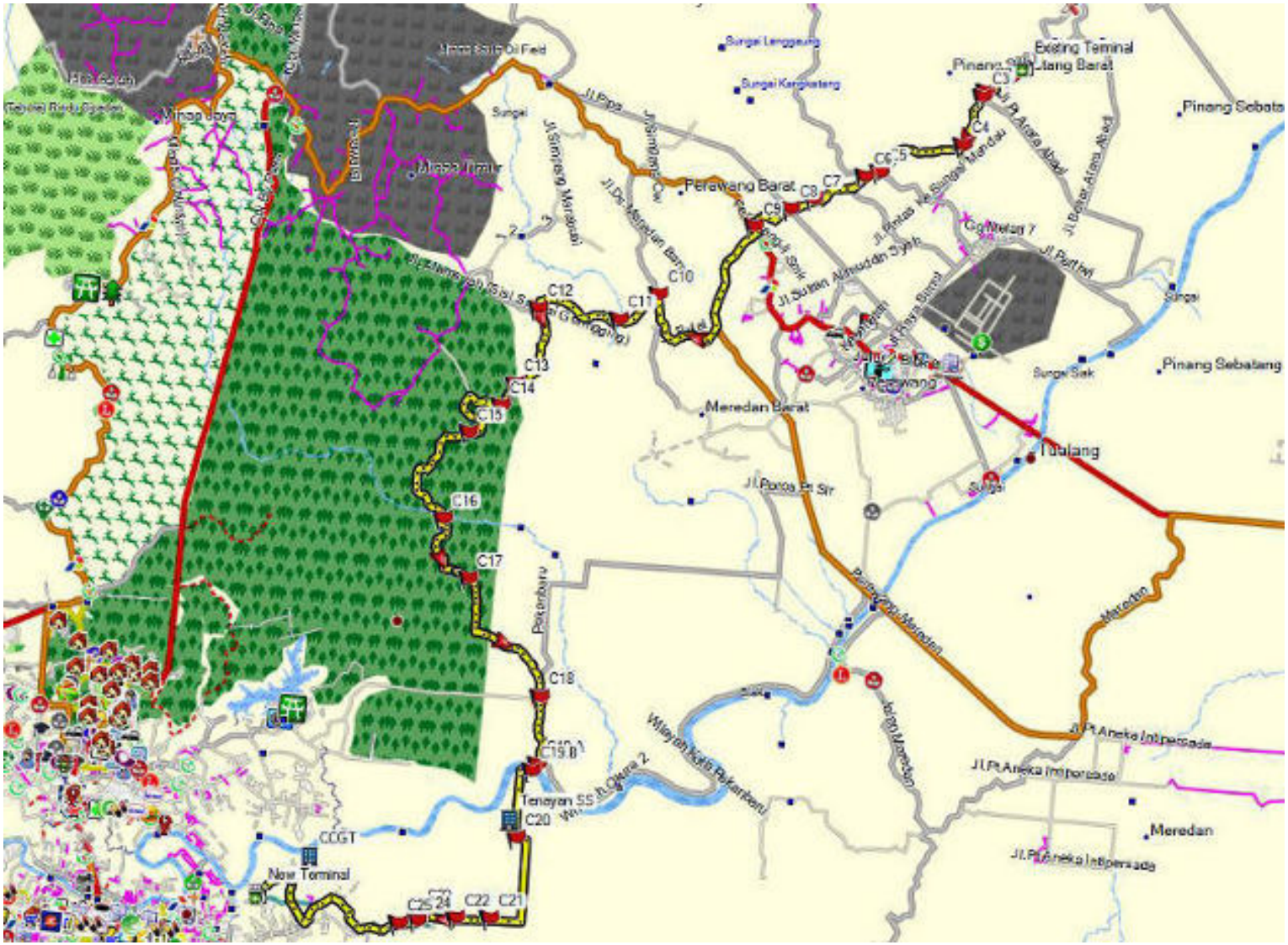
Appendix 1 Proposed Location of Power Plant and Transmission Line



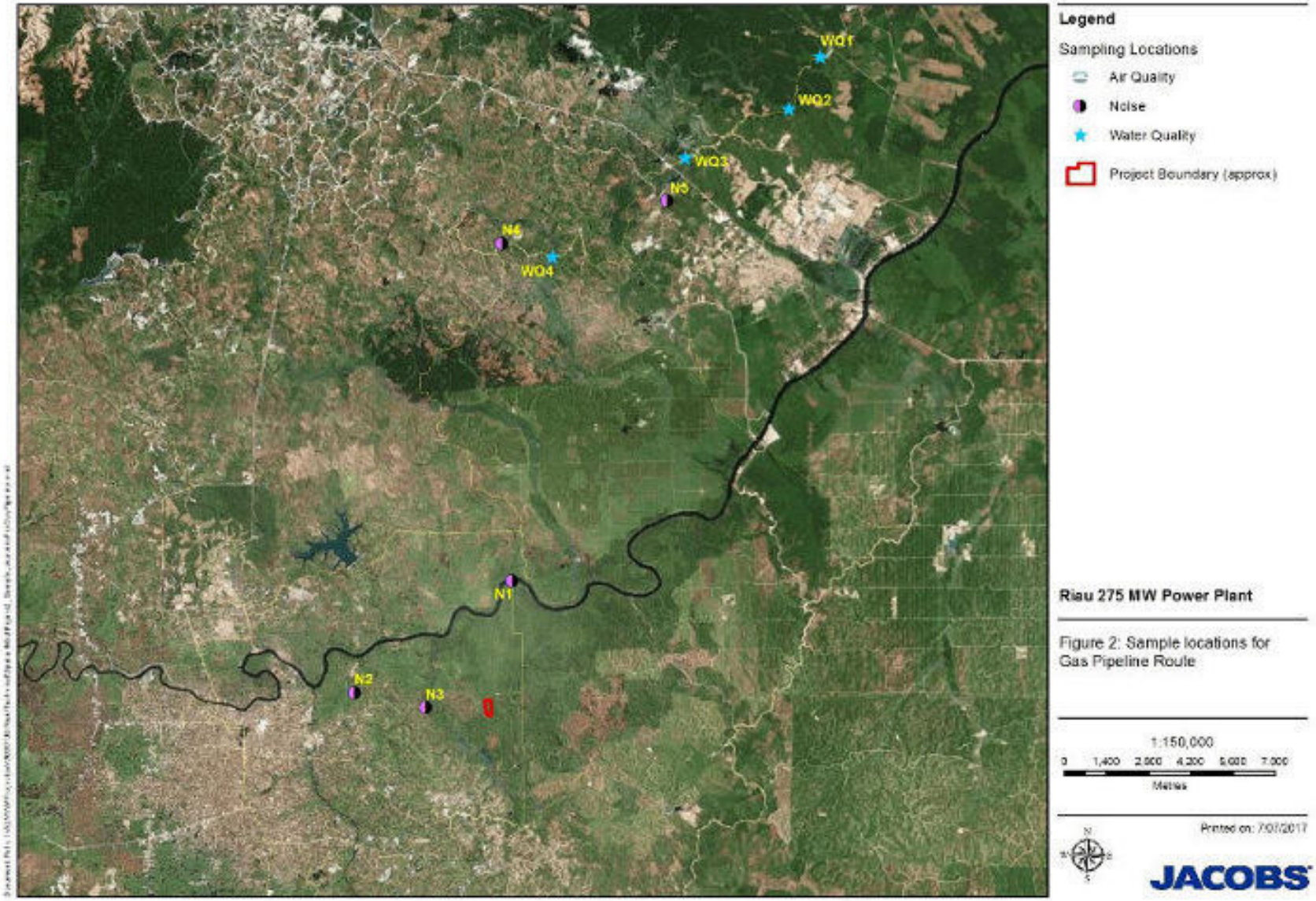
Appendix 2 Proposed Sampling Locations – Power Plant



Appendix 3 Proposed Location of Gas Pipeline Route



Appendix 4 Proposed Sampling Locations – Gas Pipeline



Appendix C. Applicable Legislation, Standards and Guidelines

This section is to set out the requirements that apply to stakeholder engagement for the Project. These are driven by:

- Asian Development Bank (ADB) Safeguard Policy Statement (2009) (Section C.1)
- Principles and procedures specified by the Equator Principles, which integrate the IFC's Social and Environmental Policy and Performance Standards (Section C.2)
- IFC Performance Standards (Section C.3)
- World Bank General and Industry Specific Environmental, Health and Safety Guidelines (Section C.4)
- The Indonesian Regulatory Framework (Section C.5)

C.1 ADB Safeguard Policy Statement (2009)

The ADB Safeguard Policy Statement covers safeguard policies on the following:

- **Environmental** - To ensure the environmental soundness and sustainability of projects and to support the integration of environmental considerations into the project decision-making process.
- **Involuntary Resettlement** - To avoid involuntary resettlement wherever possible; to minimize involuntary resettlement by exploring project and design alternatives; to enhance, or at least restore, the livelihoods of all displaced persons in real terms relative to pre-project levels; and to improve the standards of living of the displaced poor and other vulnerable groups.
- **Indigenous Peoples Safeguards - To** design and implement projects in a way that fosters full respect for Indigenous Peoples' identity, dignity, human rights, livelihood systems, and cultural uniqueness as defined by the Indigenous Peoples themselves so that they (i) receive culturally appropriate social and economic benefits, (ii) do not suffer adverse impacts as a result of projects, and (iii) can participate actively in projects that affect them.

ADB Safeguard Requirements

All three ADB Safeguards require the following in relation to the ESIA:

- **Information disclosure** – i.e. displaying the ESIA or IEE on the Project Sponsor/ADB website.
- **Consultation and participation** - The Project Sponsor will carry out meaningful consultation with affected people and other concerned stakeholders, including civil society, and facilitate their informed participation.
- **Grievance redress mechanism** - borrower/client will establish a mechanism to receive and facilitate resolution of affected peoples' concerns, complaints, and grievances about the project's environmental performance.

C.2 Equator Principles

The Equator Principles are guidelines for financial institutions on managing environmental and social risk in project financing. The key points of the Principles for the purposes of this Project are presented below. The Principles apply to new project financing globally where the total project capital cost exceeds US$10m, and to project finance advisory activities.

Equator Principle Financial Institutions (EPFI) will only provide loans to projects that conform to Principles 1 to 9 as outlined below.

Principle 1 (Review and Categorisation)

> *"When a project is proposed for financing, the EPFI will, as part of its internal social and environmental review and due diligence, categorise it based on the magnitude of its potential environmental and social*

risks and impacts. Such screening is based on the environmental and social categorisation process of the International Finance Corporation (IFC). (Exhibit I)"

Principle 2 (Social and Environmental Assessment)

"For all Category A and Category B Projects, the EPFI will require the client to conduct an Assessment process to address, to the EPFI's satisfaction, the relevant environmental and social risks and impacts of the proposed Project (which may include the illustrative list of issues found in Exhibit II). The Assessment Documentation should propose measures to minimise, mitigate, and offset adverse impacts in a manner relevant and appropriate to the nature and scale of the proposed Project."

Principle 3 (Applicable Social and Environmental Standards)

"For projects located in non-designated countries, the assessment process evaluates compliance with the then applicable IFC Performance Standards on Environmental and Social Sustainability (Performance Standards) and the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines) (Exhibit III).

The Assessment process should, in the first instance, address compliance with relevant host country laws, regulations and permits that pertain to social and environmental issues."

Principle 4 (Environmental and Social Management System and Equator Principles Action Plan)

"For all Category A and Category B Projects, the EPFI will require the client to develop or maintain an Environmental and Social Management System (ESMS).

Further, an Environmental and Social Management Plan (ESMP) will be prepared by the client to address issues raised in the Assessment process and incorporate actions required to comply with the applicable standards. Where the applicable standards are not met to the EPFI's satisfaction, the client and the EPFI will agree an Equator Principles Action Plan (AP). The Equator Principles AP is intended to outline gaps and commitments to meet EPFI requirements in line with the applicable standards."

Principle 5 (Consultation and Disclosure)

"For all Category A and Category B Projects, the EPFI will require the client to demonstrate effective Stakeholder Engagement as an ongoing process in a structured and culturally appropriate manner with Affected Communities and, where relevant, Other Stakeholders. For Projects with potentially significant adverse impacts on Affected Communities, the client will conduct an Informed Consultation and Participation process. The client will tailor its consultation process to: the risks and impacts of the Project; the Project's phase of development; the language preferences of the Affected Communities; their decision-making processes; and the needs of disadvantaged and vulnerable groups. This process should be free from external manipulation, interference, coercion and intimidation.

To facilitate Stakeholder Engagement, the client will, commensurate to the Project's risks and impacts, make the appropriate Assessment Documentation readily available to the Affected Communities, and where relevant Other Stakeholders, in the local language and in a culturally appropriate manner.

The client will take account of, and document, the results of the Stakeholder Engagement process, including any actions agreed resulting from such process. For Projects with environmental or social risks and adverse impacts, disclosure should occur early in the Assessment process, in any event before the Project construction commences, and on an ongoing basis.

EPFIs recognise that indigenous peoples may represent vulnerable segments of project-affected communities. Projects affecting indigenous peoples will be subject to a process of Informed Consultation and Participation, and will need to comply with the rights and protections for indigenous peoples contained in relevant national law, including those laws implementing host country obligations under international law. Consistent with the special circumstances described in IFC Performance Standard 7 (when relevant as

defined in Principle 3), Projects with adverse impacts on indigenous people will require their Free, Prior and Informed Consent (FPIC)."

Principle 6 (Grievance Mechanism)

"For all Category A and, as appropriate, Category B Projects, the EPFI will require the client, as part of the ESMS, to establish a grievance mechanism designed to receive and facilitate resolution of concerns and grievances about the Project's environmental and social performance.

The grievance mechanism is required to be scaled to the risks and impacts of the Project and have Affected Communities as its primary user. It will seek to resolve concerns promptly, using an understandable and transparent consultative process that is culturally appropriate, readily accessible, at no cost, and without retribution to the party that originated the issue or concern. The mechanism should not impede access to judicial or administrative remedies. The client will inform the Affected Communities about the mechanism in the course of the Stakeholder Engagement process. "

Principle 7 (Independent Review)

"For all Category A and, as appropriate, Category B Projects, an Independent Environmental and Social Consultant, not directly associated with the client, will carry out an Independent Review of the Assessment Documentation including the ESMPs, the ESMS, and the Stakeholder Engagement process documentation in order to assist the EPFI's due diligence, and assess Equator Principles compliance."

Principle 8 (Covenant)

"For all Projects, the client will covenant in the financing documentation to comply with all relevant host country environmental and social laws, regulations and permits in all material respects.

Furthermore for all Category A and Category B Projects, the client will covenant the financial documentation:

a) to comply with the ESMPs and Equator Principles AP (where applicable) during the construction and operation of the Project in all material respects; and

b) to provide periodic reports in a format agreed with the EPFI (with the frequency of these reports proportionate to the severity of impacts, or as required by law, but not less than annually), prepared by in-house staff or third party experts, that

i) document compliance with the ESMPs and Equator Principles AP (where applicable), and

ii) provide representation of compliance with relevant local, state and host country environmental and social laws, regulations and permits; and

c) to decommission the facilities, where applicable and appropriate, in accordance with an agreed decommissioning plan.

Where a client is not in compliance with its environmental and social covenants, the EPFI will work with the client on remedial actions to bring the Project back into compliance to the extent feasible. If the client fails to re-establish compliance within an agreed grace period, the EPFI reserves the right to exercise remedies, as considered appropriate."

Principle 9 (Independent Monitoring and Reporting)

"To assess Project compliance with the Equator Principles and ensure ongoing monitoring and reporting after Financial Close and over the life of the loan, the EPFI will, for all Category A and, as appropriate, Category B Projects, require the appointment of an Independent Environmental and Social Consultant, or require that the client retain qualified and experienced external experts to verify its monitoring information which would be shared with the EPFI."

Principle 10 (EPFI Reporting)

"For all Category A and, as appropriate, Category B Projects:

- *The client will ensure that, at a minimum, a summary of the ESIA is accessible and available online.*
- *The client will publicly report GHG emission levels (combined Scope 1 and Scope 2 Emissions) during the operational phase for Projects emitting over 100,000 tonnes of CO2 equivalent annually. Refer to Annex A for detailed requirements on GHG emissions reporting.*

The EPFI will report publicly, at least annually, on transactions that have reached Financial Close and on its Equator Principles implementation processes and experience, taking into account appropriate."

C.3 IFC Performance Standards

The International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability, as of January 2012, define the client's roles and responsibilities for managing their projects and the requirements for receiving and retaining IFC support. They are also relevant to other institutions applying the Equator Principles when making project financing decisions.

The Performance Standards represent the "policy framework" for the ESIA and sustainable social and environmental management for the Project, whereas the IFC EHS Guidelines provide guidance on general and industry good practice as well as recommended numerical limits for emissions to the atmosphere, noise, liquid and solid wastes, hazardous wastes, health and safety, and other aspects of development projects.

Performance Standard 1, Assessment and Management of Environmental and Social Risks and Impacts, establishes the importance of:

- integrated assessment to identify the social and environmental impacts, risks, and opportunities of projects;
- effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and
- the client's management of social and environmental performance throughout the life of the project.

Performance Standards 2 through 8, listed below, establish requirements to avoid, reduce, mitigate or compensate for impacts on people and the environment, and to improve conditions where appropriate.

- Performance Standard 2: Labor and Working Conditions;
- Performance Standard 3: Resource Efficiency and Pollution Prevention;
- Performance Standard 4: Community Health, Safety, and Security
- Performance Standard 5: Land Acquisition and Involuntary Resettlement;
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources;
- Performance Standard 7: Indigenous Peoples; and
- Performance Standard 8: Cultural Heritage.

While all relevant social and environmental risks and potential impacts should be considered as part of the assessment, Performance Standards 2 through 8 describe potential social and environmental impacts that require particular attention in emerging markets. Where social or environmental impacts are anticipated, the client is required to manage them through its Social and Environmental Management System consistent with Performance Standard 1.

C.4 General and Industry Specific EHS Guidelines

In addition to the performance standards, the World Bank Group (WBG) has developed Environmental, Health and Safety (EHS) Guidelines covering both general and industry specific issues. The EHS Guidelines contain the performance levels and measures that are normally acceptable to WBG and are generally considered to be achievable in new facilities at reasonable costs by existing technology. The environmental assessment process may recommend alternative (higher or lower) levels or measures, which, if acceptable to the financiers, become project or site-specific requirements.

In general, when host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

C.5 Indonesian Regulatory Framework

The Indonesian legal system is a hierarchal system, where National Regulations (Acts and National Government Regulations) act as the governing regulation, which are translated into implementing regulations and technical standards at lower levels of the government system (as stated on Law No. 12 of 2011 regarding formation of legislation). The requirements and standards in each regulation must be kept consistent at different levels of the government system, but should there be conflicting standards, the higher level regulation takes precedence.

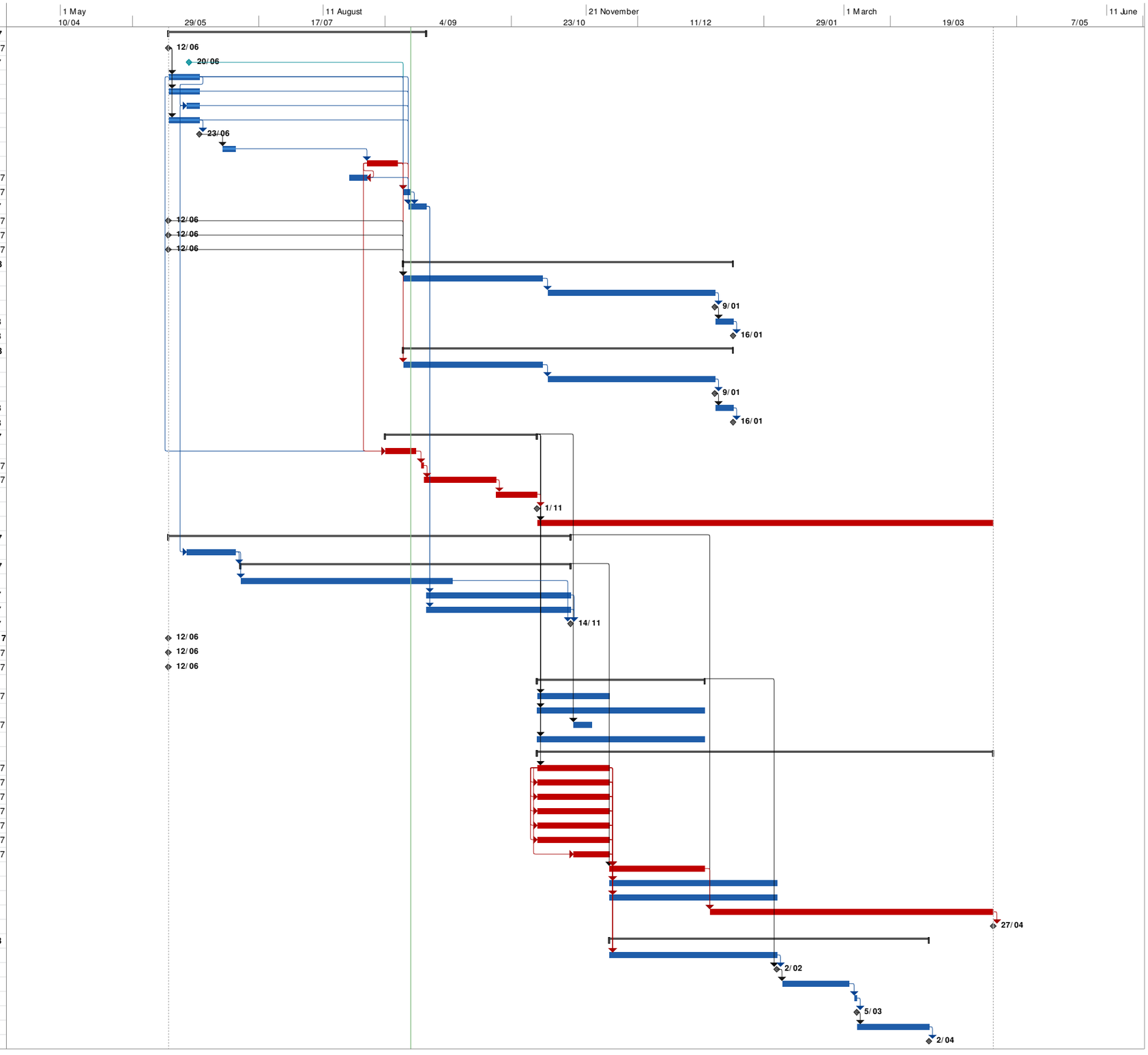
At provincial level, Governor and provincial government can set up local government standards in the form of Governor Decrees and Provincial Local Government Regulations. These regulations apply only within the subject provincial jurisdiction. The Governor and/or provincial local government can set stricter environmental standards than those set at a National level. In such cases, the stricter standards shall be followed.

The various levels of government of Indonesia, including the provincial and local government agencies, that have some jurisdiction or control over the power plant activities, transmission line and gas pipeline include:

- National Level: Ministry of Environment and Forestry (MOEFO);
- Province Level: The Province of Riau; and
- Regency and City Level: Power plant and transmission line - Environmental Agency of Pekanbaru City (DLH – Kota Pekanbaru) and gas pipeline the Siak Regency and Pekanbaru City.

Appendix D. ESIA and AMDAL Schedule

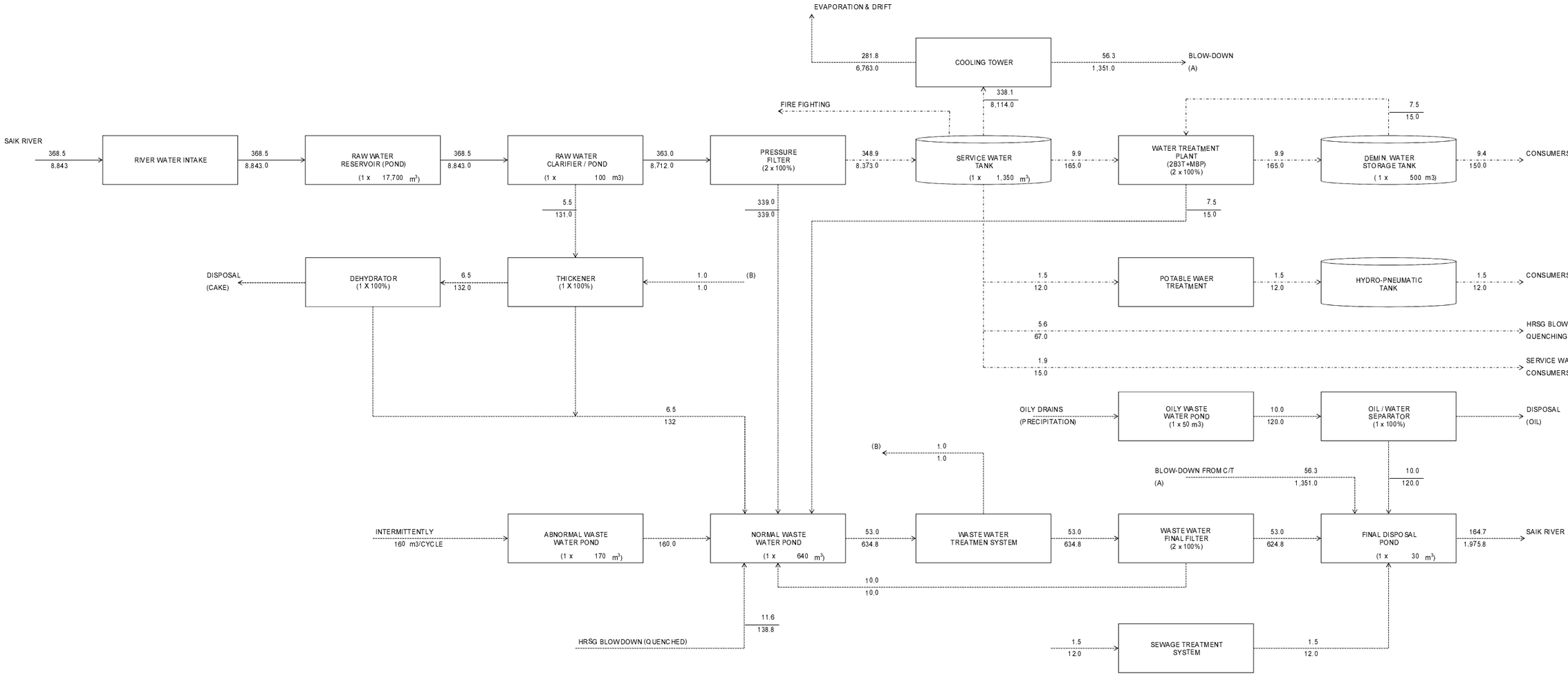
ID	Task Mode	Task Name	Duration	Start	Finish
1		**Phase 1 - Scoping Study**	**67 days**	**Mon 12/06/17**	**Tue 19/09/17**
2		Site Assumed to be Ste 2	0 days	Mon 12/06/17	Mon 12/06/17
3		Site confirmed	0 days	Tue 20/06/17	Tue 20/06/17
4		Review of background information	2 wks	Mon 12/06/17	Fri 23/06/17
5		Draft of Project Description - from OE team	2 wks	Mon 12/06/17	Fri 23/06/17
6		Site visit	1 wk	Mon 19/06/17	Fri 23/06/17
7		Stakeholder mapping	2 wks	Mon 12/06/17	Fri 23/06/17
8		Draft Stakeholder Engagement Plan issued	0 days	Fri 23/06/17	Fri 23/06/17
9		Review stakeholder engagament plan	1 wk	Mon 3/07/17	Fri 7/07/17
10		Initial Community engagement	10 days	Mon 28/08/17	Fri 8/09/17
11		Land acquisition review	1 wk	Mon 21/08/17	Mon 28/08/17
12		Risk assessment	3 days	Mon 11/09/17	Wed 13/09/17
13		Scoping Study report issued	5 days	Wed 13/09/17	Tue 19/09/17
14		Principal Permit in Place	0 days	Mon 12/06/17	Mon 12/06/17
15		Location Permit in Place	0 days	Mon 12/06/17	Mon 12/06/17
16		Spatial Plan Compliance confirmed	0 days	Mon 12/06/17	Mon 12/06/17
17		**UKL-UPL for gas supply pipeline**	**85 days**	**Mon 11/09/17**	**Tue 16/01/18**
18		Preparation of UKL-UPL for gas supply pipeline	2 mons	Mon 11/09/17	Fri 3/11/17
19		Review and submission of UKL-UPL for gas supply	2 mons	Mon 6/11/17	Tue 9/01/18
20		Pipeline UKL/UPL approved	0 days	Tue 9/01/18	Tue 9/01/18
21		Finalise Environmental permit	1 wk	Wed 10/01/18	Tue 16/01/18
22		Environmnetal permit issued	0 days	Tue 16/01/18	Tue 16/01/18
23		**UKL-UPL for 150 kV Transmission Line**	**85 days**	**Mon 11/09/17**	**Tue 16/01/18**
24		Preparation of UKL-UPL for 150 kV transmission line	2 mons	Mon 11/09/17	Fri 3/11/17
25		Review and submission of UKL-UPL for 150 kV	2 mons	Mon 6/11/17	Tue 9/01/18
26		Transmission line UKL/UPL approved	0 days	Tue 9/01/18	Tue 9/01/18
27		Finalise Environmental permit	1 wk	Wed 10/01/18	Tue 16/01/18
28		Environmnetal permit issued	0 days	Tue 16/01/18	Tue 16/01/18
29		**KA ANDAL for Power Plant**	**43 days**	**Mon 4/09/17**	**Wed 1/11/17**
30		Public notification of AMDAL	2 wks	Mon 4/09/17	Fri 15/09/17
31		Public consultation meeting	1 day	Mon 18/09/17	Mon 18/09/17
32		Preparation of KA ANDAL	1 mon	Tue 19/09/17	Mon 16/10/17
33		Presentation and review of KA ANDAL	12 days	Tue 17/10/17	Wed 1/11/17
34		KA Andal approved	0 days	Wed 1/11/17	Wed 1/11/17
35		Community Engagement	6 mons	Thu 2/11/17	Fri 27/04/18
36		**ESIA Sampling**	**107 days**	**Mon 12/06/17**	**Tue 14/11/17**
37		Screening assessment to identify locations to sample	2 wks	Mon 19/06/17	Fri 7/07/17
38		**Dry Season Sampling**	**92 days**	**Mon 10/07/17**	**Tue 14/11/17**
39		Air quality - 1 week / month - two or three times	3 mons	Mon 10/07/17	Fri 29/09/17
40		River Water Sampling	2 mons	Wed 20/09/17	Tue 14/11/17
41		Other sampling - dry season	2 mons	Wed 20/09/17	Tue 14/11/17
42		Determine what wet season sampling required	0 days	Tue 14/11/17	Tue 14/11/17
43		**Wet Season Sampling**	**0 days**	**Mon 12/06/17**	**Mon 12/06/17**
44		As required	0 mons	Mon 12/06/17	Mon 12/06/17
45		As Required	0 mons	Mon 12/06/17	Mon 12/06/17
46		**AMDAL Sampling**	**40 days**	**Thu 2/11/17**	**Fri 5/01/18**
47		Air quality	1 mon	Thu 2/11/17	Wed 29/11/17
48		River Water Sampling	2 mons	Thu 2/11/17	Fri 5/01/18
49		Background noise measurements	1 wk	Thu 16/11/17	Wed 22/11/17
50		Other sampling	2 mons	Thu 2/11/17	Fri 5/01/18
51		**Technical Studies for AMDAL and ESIA**	**120 days**	**Thu 2/11/17**	**Fri 27/04/18**
52		Project Update project description	4 wks	Thu 2/11/17	Wed 29/11/17
53		Technical specialist assessment	4 wks	Thu 2/11/17	Wed 29/11/17
54		Dispersion modelling	1 mon	Thu 2/11/17	Wed 29/11/17
55		Noise Modelling	1 mon	Thu 2/11/17	Wed 29/11/17
56		Social Impact Assessment	1 mon	Thu 2/11/17	Wed 29/11/17
57		Community health, safety, and security	20 days	Thu 2/11/17	Wed 29/11/17
58		Process safety and working conditions	2 wks	Thu 16/11/17	Wed 29/11/17
59		Preparation of Draft ESIA	1 mon	Thu 30/11/17	Fri 5/01/18
60		Develop Framework ESMS	40 days	Thu 30/11/17	Fri 2/02/18
61		Develop ESMP	40 days	Thu 30/11/17	Fri 2/02/18
62		ESIA Exhibit	4 mons	Mon 8/01/18	Fri 27/04/18
63		ESIA Approved	0 days	Fri 27/04/18	Fri 27/04/18
64		**ANDAL & RKL-RPL for Power Plant**	**81 days**	**Thu 30/11/17**	**Mon 2/04/18**
65		Preparation of ANDAL, RKL, RPL	2 mons	Thu 30/11/17	Fri 2/02/18
66		Submission of AMDAL	0 days	Fri 2/02/18	Fri 2/02/18
67		Review by AMDAL Committee	20 days	Mon 5/02/18	Fri 2/03/18
68		AMDAL Hearing	1 day	Mon 5/03/18	Mon 5/03/18
69		Amdal Approved	0 days	Mon 5/03/18	Mon 5/03/18
70		Secure Environmental Permits	1 mon	Tue 6/03/18	Mon 2/04/18
71		Environmental Permit Issued	0 mons	Mon 2/04/18	Mon 2/04/18



Task

Split

Appendix E. Water Balance Diagram



FOR PRELIMINARY

Legends:

Raw Water ——→

Treated Water - - - →

Waste Water (Oily, Sanitary) ——→

Notes:

1. Design Condition : BMCR 100% Load at RSC Conditions (28T, 80% RH, 1.010 bar)
2. The capacity of demineralization is estimated by 2.0 % of steam generation flow at base load
3. The raw water reservoir is sized based on 2 days full load operation.
4. Flow rate = t/h (hourly max.) / t/day (ave.)
5. The details are subject to change as per detail design information.

REV.	DATE	DESCRIPTION	PREPARED	REVIEWED	APPROVED
A	17.Aug.2017	Issued For Proposal	I.S.CHO	-	K.S.LEE

PROJECT :

Riau GFPP(275MW) IPP Project

PT. PERUSAHAAN LISTRIK NEGARA (PERSERO)

MRPR

LOTTE E&C

Title	WATER BALANCE DIAGRAM (RAW WATER RESERVOIR POND) RSC (100% GT Load)
DWG NO.	RIAU-M-WB-001
JOB NO	MULTISCALE / SCALE NONE / REV. A

Appendix B. Detailed Process Description

Riau 275 MW Gas Combined Cycle Power Plant IPP - ESIA

Medco Ratch Power Riau

Technical Report – Process Description

AM039100-400-GN-RPT-1002 | 1

DATE – 17 May 2018

Riau 275 MW Gas Combined Cycle Power Plant IPP - ESIA

Project no:	AM039100
Document title:	Process Description
Document No.:	AM039100-400-GN-RPT-1002
Revision:	1
Date:	17 May 2018
Client name:	Medco Ratch Power Riau
Project manager:	Eamonn Morrissey
Author:	Eamonn Morrissey, Candra Gusri, Gandy Iswara, A Andy, others

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Document history and status

Revision	Date	Description	By	Review	Approved
0	18/04/2018	For ESIA	Jacobs	Bruce Clarke	Eamonn Morrissey
1	17 May 2018	Revised Transmission Line Route	Jacobs	Eamonn Morrissey	Eamonn Morrissey

Contents

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The sole purpose of this report and the associated services performed by Jacobs is to provide the process description for the Project in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

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Abbreviations

AMDAL	Analisis Mengenai Dampak Lingkungan
amsl	Above Mean Sea Level
CEMP	Construction Environmental Management Plan
CEMS	Continuous Environmental Monitoring Station
CCGT	Combined cycle gas turbine
CFPS	Coal fired power station
CPI	Corrugated plate interceptor
CRH	Cold reheat
dB	decibels
EPC	Engineering, procurement and construction
ESIA	Environmental and Social Impact Assessment
GFPP	Gas fired power plant
GT / GTG	Gas turbine / Gas turbine generator
H&SP	Health and Safety Plant
ha	Hectare
HHV	High Heating Value
HP	High pressure
HRSG	Heat recovery steam generator
H&SP	Health and Safety Plan
IP	Intermediate pressure
km	Kilometres
kg/s	Kilograms per second
kV	Kilovolt
L	litre
lp	Low pressure
m	Metres
mg/L	Milligrams per litre
mm	millimetre
m/s	Metres per second
m^3/h	Metres cubed per hour
mAMSL	Meters above mean sea level
MRPR	Medco Ratch Power Riau
MW	Megawatt
NFPA	National fire protection association (of America)
NO_x	Oxides of Nitrogen
OHL	Overhead Line
OPGW	Optical Ground Wire
PLN	Perusahaan Listrik Negara
PPA	Power Purchase Agreement
ppmvd	Part per million by volume, dry

RoW	Right of way
SO_x	Oxides of sulphur, as SO_2
ST / STG	Steam turbine / Steam turbine generator
T	Tonnes
PT TGI	PT Transportasi Gas Indonesia
UKL/UPL	Upaya Pengelolaan Lingkungan dan Upaya Pemantauan Lingkungan
wt/vol	Weight per volume

1. Introduction

1.1 Purpose

This document provides a process description of the construction and operation of the Riau 275MW Combined Cycle Gas Fired Power Plant IPP Project (Riau 275MW GPPP). The project consists of a 275MW combined cycle power plant and ancillary facilities, a 40 km long 12-inch gas pipeline, and a switchyard and 150kV transmission line - collectively comprising the "Project".

This report provides a brief description of the location and environmental setting, followed by key details of the proposed design in respect to construction and operation of the Project. This report is one of several technical reports prepared for the Environmental and Social Impacts Assessment (ESIA) and other permitting work associated with the Project. It is based on preliminary engineering work, including the EPC Contractor's (Lotte E&C) preliminary design of the power plant.

1.2 Background

The Riau 275MW GFPP will be a new, greenfield power station.

The Project Sponsors (being PT Medco Power Indonesia (MEDCO) and Ratchaburi Electricity Generating Holding PCL (RATCH), have formed PT Medco Ratch Power Riau (MRPR) to build, own and operate the plant under the terms of the Power Purchase Agreement (PPA) which has been agreed with PLN.

The key components of the Project include a 275MW combined cycle power plant (CCPP), a 40km long gas supply pipeline which will bring fuel to the site, a 150kV switchyard, and an approximately 750m long transmission line to connect the power plant to the PLN grid. Once constructed, ownership of the switchyard and transmission line collectively known as the Special Facilities will be transferred to PLN. At the end of the 20-year term of the PPA, PLN will take ownership of the power plant and gas supply pipeline.

The Project will be located approximately 10 km due east of Pekanbaru city, approximately 5 km south of the Siak River. The power plant and switchyard well be comfortably accommodated inside the 9 ha of land being procured by MRPR. The power plant is a 2 x 1 combined cycle plant, designed to deliver up to 275MW over the 20-year term of the PPA. It will burn gas fuel only. It will consist of:

- 2 x GE 6F.03 gas turbine (GT) generator sets;
- 2 x supplementary fired heat recovery steam generators (HRSGs);
- 1 x steam turbine (ST) generator set;
- A wet mechanical draft cooling tower;
- Gas reception area; and
- All normal balance of plant systems.

In addition, there will be:

- a 150kV switchyard at the plant, with an approximately 750 m double-phi connection to intercept the Tenayan – Pasir Putih 150 kV transmission line;
- A 40km gas pipeline running from the gas connection point at an offtake location known as SV1401 on the main Grissik-Duri gas pipeline; and
- Water supply and discharge pipelines to and from the Siak River.

2. Location and Environmental Setting

2.1 Site location

The power plant site is located in the Sail Sub District, Tenayan Raya District, Pekanbaru City, and Province of Riau.

The power plant is located approximately

- 10 km due east of the city of Pekanbaru in central Sumatra, Indonesia;
- 3 km south of the Siak River; and
- 2 km south of PLN's 2 x 110MW RIAU Coal Fired Power Station (CFPS).

At the moment, the power plant site is part of a privately owned palm oil plantation. According to Pekanbaru City's Spatial Plan, the land is in a zone allocated for Industrial and Warehousing use.

Drawings in Appendix A show:

- Preliminary, conceptual layout for plant and equipment on the site; and
- The setting of the Site relative to Pekanbaru City and PLN's existing coal fired power station, along with proposed routes for connections to the Grid, existing road, Siak River, and a pipeline corridor between the site and the Siak River.

2.2 Environmental Setting

2.2.1 Climate

Pekanbaru has a tropical climate. The design and general site climate conditions are provided in **Table 1**.

Table 1: General site ambient climate conditions

Parameter	Value
Ambient air temperature range	20°C-37°C
Design ambient air temperature	28°C
Relative humidity range	40%-100%
Design Relative humidity	80%
River water temperature	Approximately 30°C
Average annual rainfall	Approximately 3,000 mm - rainy season between November and April
Maximum rainfall	Approximately 136mm/h
Average wind speed	Less than 3m/s, predominantly from the south or west
Site elevation	Approximately 25 mAMSL

2.2.2 Site Investigation

MRPR has conducted a site investigation of the power plant site. The final report is provided in Appendix C and includes a topographical map and geotechnical characteristics.

2.3 Socio-economic Setting

Riau province has a population of approximately 7 million people, of which approximately one million live in Pekanbaru City.

The majority of the population living close to the power plant site are likely to be involved in the palm oil plantation business, fishing and farming.

The proposed site is currently part of a privately owned palm oil plantation. The palm trees appear to be around 5 – 7 years old.

The closest settlement is around 2 km to the west of the site.

2.4 Project Land Requirements

MRPR plans to build the power plant and switchyard on a 9.1ha plot of land. Land surrounding the site is generally used for palm oil plantations.

There are no dwellings located at the power plant site so no physical relocation or resettlement of inhabitants will be necessary.

The total land requirements for the power plant and switchyard are estimated at approximately 5.4 ha as outlined in Table 2. Preliminary Site layout plans are provided in the Appendix A.

Table 2: Riau 275MW GFPP power plant land requirements

Riau 275MW CCPP power plant land area requirements	Approximate Area, ha
Power plant and main plant buildings (GTGs, HRSGs, STG & Control Room)	1.2
Cooling tower	0.2
Balance of plant area	2.5
Switchyard (150kV) (part of the Special Facilities to be owned by PLN)	1.5
Total	5.4

During construction, there will be further land requirements for laydown areas, offices, and the construction workforce. The additional area estimated at a further 3.7 ha, will be within the site area, as shown on the drawings.

There will also likely be a need for a temporary jetty to be built on or on the banks of the Siak River, expected to be located close to PLN's existing Tenayan Coal Fried Power Station (CFPS).

In addition, the Project will have land requirements for the water abstraction point at the River, water supply pipelines to and from the power plant site, the gas supply pipeline, and the 150kV transmission line, estimated as shown in Table 3.

See Appendix A for details of potential off-site land requirements (excluding the gas pipeline.)

Table 3: Estimated land requirements in addition to the power plant Riau 275MW CCPP power plant – off-site area requirements

Equipment item	Approximate dimensions, m x m	Approximate Area, ha
River water pump house plus local building	50 x 40	0.2
Water supply and discharge pipeline corridor	6 x 3,000	1.8
Gas supply pipeline, though very little, if any, of this will actually need to be acquired by MRPR. Extent is to be confirmed. MRPR may also need to acquire or gain access to some land at the point of connection to the main pipeline. This would be for a valve and pig launching station.	2 x 40,000	8
Transmission Line (including 3 towers not on the main power plant site) – normally via an easement.	25 x 1000	2.5
Transmission line towers (off the main power plant site, straddled by transmission line)	3 x 40 x 40	3 x 0.16 ha
Access road	8 x 400	0.32
Temporary Jetty	100 x 70	0.7

It is not expected that any physical relocation or resettlement of inhabitants will be necessary as:

- There are no dwellings located at the site or along the transmission line, and
- The gas and water pipelines will run along the road reserve or within easements which will be agreed with the affected landowners.

3. Project Schedule

3.1 Project stages

The Project will span three primary stages, being pre-construction, construction and operation, generally as follows:

- **Pre-construction:** The pre-construction stage involves project development activities, including selection of contractors, field surveys and permitting, and land acquisition works.
- **Construction:** The construction stage will involve land preparation (including site clearance, backfilling and land drainage) followed by construction and commissioning of the power plant, gas pipeline and grid interconnection.
- **Operation:** The operation stage will involve the full operation of the power plant – first of all over the 20-year term of the PPA and then, as determined by PLN after ownership transfers to PLN.

3.2 Project Timescales

The proposed project timescales for major construction activities are provided in **Table 4.**

Table 4: Estimated duration (in months) of activities required for Project construction

Activity	Estimated Duration (months)
Site clearance and levelling (may commence before financial close)	6 months
Gas pipeline construction	12 months
Power plant and switchyard engineering, procurement and construction	24 months
Construction of water pipelines (to and from site)	8 months
Transmission line construction	8 months
Commissioning	6 months

The total construction and commissioning time from financial close is to be 30 months.

4. Power Plant Pre-Construction Works

4.1 Introduction

The pre-construction stage involves project development activities, including selection of contractors, field surveys and permitting, and land acquisition works.

4.2 Contractor Selection

MRPR has have already selected the main Contractors, as follows:

Table 5: Estimated duration (in months) of activities required for Project construction

Scope	Contractor
Power Plant, switchyard, transmission line, water supply and discharge structures and pipelines	Lotte Engineering & Construction of South Korea
Gas pipeline	PT Citra Panji Manunggal (CPM) of Indonesia

These contractors will be responsible for identifying and recruiting workers with the appropriate skills and qualifications required for the construction stage of the Project.

Note: peak labour requirements for the construction of the power plant and Special Facilities will be approximately 1,000 people, with the expectation that the local community will be able to provide the bulk of this work-force.

4.3 Field surveys, permitting and land acquisition

In order to collect the data required to finalise the location and design of the Project, MRPR has been conducting field surveys of the site, including topographical survey, geological and geotechnical investigations of the soil.

Additional surveying activities will include those necessary for securing the permits and approvals – AMDAL for the Power Plant, UKL-UPL for the gas pipeline, UKL-UPL for the Switchyard and transmission line, Environmental and Social Impact Assessment (ESIA) for the Project.

Requirements for land acquisition will be identified as part of the process. Land will be acquired for the Power Plant, Switchyard and transmission line. Land for the water intake and pumphouse etc. will be leased. Some land may be needed for the gas pipeline (e.g. at the point of connection to the main gas pipeline at SV1401). Otherwise, the gas pipeline will run along the road reserve, or follow easements to be agreed with any affected landowners.

Nor is it expected that it will be necessary to acquire land for the water supply or wastewater discharge pipelines because it is anticipated that these will either follow road reserves or easements to be agreed with any affected landowners.

5. Power Plant and Transmission Line Construction

5.1 Introduction

The construction phase of the Project is scheduled to last from late early 2018 to the end of 2020.

The following stages are envisaged.

- Site clearance, levelling and general preparation;
- Construction of access road;
- Gas pipeline construction (see later section of this report);
- Power plant and switchyard construction, including construction of water pipelines (to and from site)
- Transmission line construction; and
- Commissioning.

5.2 Site clearance, levelling and general preparation

5.2.1 Site Clearance and levelling

The site area for the Power Plant and Switchyard will need to be cleared of vegetation and any debris prior to levelling. Site clearance works will include felling, trimming, and cutting trees, and disposing of vegetation and debris off-site. Voids and water ponds will be dried and filled with suitable material.

Vegetation, roots, debris, stones, and other materials will be removed from the areas to be stripped by mowing, grubbing, raking, etc.

Topsoil will be stripped from the surface. Excavated topsoil will be transported to and stockpiled in designated topsoil storage areas. Prior to being filled, any sub-grade surfaces will be freed of standing water and unsatisfactory soil materials will be removed. All unnecessary excavated materials will be transported and deposited off-site at an approved facility.

The site will then be levelled. Ideally, the cut and fill will be balanced, to minimise the need to import or export material from the site area. Based on the site topography, preliminary estimates show that if the site elevation is set at 28m, then the cut and fill / backfilling volumes will be reasonably well balanced at approximately 165,000m^3 each.

Notwithstanding this, it is likely that approximately 45,000m^3 of soil will need to be disposed of offsite. At 20m^3 per truck, this will require 2,250 truck movements over approximately 3 months.

5.2.2 Flood Risk

According to investigations for the site originally proposed for the project, it was determined that a site level of 3 mAMSL would be adequate to ensure the site would be above the 100-year return period flood level of the Siak River. The lowest point of the current site for the project is more than 20 mAMSL.

Therefore, the site will not be subject to flooding via the Siak River.

During the engineering stage, the site elevation will be set to ensure stormwater from adjacent properties cannot cause the site to flood and to ensure that stormwater falling on the site does not flood neighbouring land.

5.3 Construction of Access Road

The construction stage includes the development of an access road which will be approximately 500 m long and run from the main road to the north of the Site.

The access road will be a permanently sealed two-lane 8m road.

5.4 Power plant and switchyard construction, including construction of water pipelines (to and from site)

5.4.1 Excavations

A range of excavations will be carried out at the site, primarily:

- Excavation for structures (footings and foundations);
- Excavation of ditches, gutters, and channels;
- Excavation for drainage structures; and
- Trench excavation.

Where excavated material is suitable to be used for fill and backfill, the material will be segregated and transported to a stockpile location at the power plant site. Unless specified or directed otherwise, all unnecessary excavated materials will be transported and deposited outside the power plant site. This material will be disposed in a location not to disturb the environment and which is permitted by municipal authorities.

Soil on site will be deposited and compacted, and the slopes will be trimmed to ensure that the soil is stable and free of surface depressions, and that the slopes drain freely and do not interfere with natural drainage to or from the surrounding area.

5.4.2 Piling

Piling will be undertaken as part of the construction activities. Piling methods will likely include pile driving and bored cast-in-place piling.

Pile driving will be used to pile the main power station foundations. Driving shall be done with fixed leads to hold the pile firmly in position and in axial alignment with the hammer. Piles will be driven continuously and without interruption to or below the calculated tip elevation to reach a driving resistance based on load test results.

Pile driving will not be carried out at night.

Bored, cast-in place piles may be used for lighter structures. With this technique, the pile hole is bored out, a steel cast is placed in the hole and the pile is formed using reinforcing steel and concrete.

Sheet piling may be used to protect shallow excavations which are normally backfilled once the equipment is installed.

5.4.3 Foundations

Reinforced concrete foundations and base building slabs will be prepared prior to the installation of large items of equipment and the erection of buildings. Concrete for the foundations and building slabs will either be batched at the power plant site or brought on to the site in a ready-mixed form by concrete trucks. If batching on site is selected, then sand and cement will be brought to the power plant site and stored in bins and bags next to the batching plant. Water required for concrete batching would be approximately 45m^3/day.

5.4.4 Equipment Installation

Once the foundations are prepared the plant equipment can be installed.

Some equipment will be installed outdoors – e.g. the gas turbine generator sets, the HRSGs, the step-up transformers. Other equipment, including the steam turbine generator set and the condenser, will be installed in purpose built buildings.

The Contractor is likely to pre-fabricate as much of the plant and equipment in factory conditions off-site, in order to minimise site work. For example, the HRSG modules will likely be shipped to site complete, so that site welding requirements are reduced.

Normal construction processes and techniques will be used. In addition to the workers needed or the site preparation and civil works, the workforce will include:

- Steel erectors
- Mechanical fitters
- Pipefitters
- Welders
- Electricians
- Instrumentation technicians
- Crane-drivers
- Scaffolders
- Painters
- Labourers, and
- Support staff.

Specialists will also be necessary from time to e.g. for radiography and other non-destructive testing, and for high voltage work.

5.4.5 Off-site work

Off-site work associated with this stage of the project will include the following:

- The construction of the water intake at the Siak River, as well as the pipeline to take the water from the River to the site. Preliminary details of the proposed structures for this are included in the Appendix A.
- The construction of the water discharge pipeline, which will run alongside the water supply pipeline.
- The construction of a temporary jetty to serve as a berth for ships or barges delivering plant items and construction materials and equipment – e.g. the gas and steam turbines, generators, transformers, HRSG modules. The jetty will be located approximately 4km to the north of the power plant site, close to PLN's 2 x 110 MW coal fired plant. See Appendix A for further details of the possible location and Appendix E for the preliminary Transportation Plan.

Construction of the jetty will involve sheet piling for the "tunnel", while rock and sandbagging will be used for the head area. The tunnel will be dredged where required, the scope of which will depend on the exact location and local depth and conditions. The construction period will be approximately four months. After construction of the

Project is complete and assuming there is no reason for the jetty to remain in place, it will be removed. This will take approximately one month.

The roadway from the temporary Jetty past the CFPS and up to the power plant site is narrow in places and some widening of or improvements to the route may also be required.

5.4.6 Landscaping

After construction and erection work are completed, the power plant site will be landscaped for visual appearance and to limit erosion from surface water during heavy rains. The upper, organic layer of soil temporarily removed and stored during construction, will be used to provide fertile soil for landscaping, where possible.

5.5 Transmission line construction

The construction of the transmission line will likely be labour-intensive with simple hand tools rather than through the use of cranes and/or helicopters.

The major steps are:

- Survey and tower staking;
- Construction of foundations (typically cast in place);
- Erection of towers (i.e. assembly of tower members);
- Conductor, shieldwire, and OPGW stringing;
- Clean up; and
- Testing and commissioning.

Teams can work on separate towers or line sections simultaneously if necessary to reduce the construction schedule. However, this is unlikely to be necessary as the connection is so short.

Smaller vehicles will be used to transport materials (e.g. steel members) to and from each tower location in order to avoid the need for large access tracks or roads.

Inspection, testing, and commissioning will follow PLN's specification requirements.

Further details are included later in this report and the proposed connection route is shown in Appendix A.

5.6 Commissioning

After construction of the power plant is complete, the plant and equipment will be commissioned and set to work. The commissioning process involves:

- Calibrating and setting control and protection devices to ensure the safety of plant, equipment and personnel;
- Energising equipment for the first time;
- Checking individual components work correctly;
- Checking individual systems work correctly;
- Checking that the systems are properly integrated and work together as designed; and

- Testing the plant for compliance with the EPC Contract, including for compliance with the Grid Code and environmental requirements.

5.7 Construction Workforce and Equipment

As mentioned earlier, the labour force is expected to peak at close to 1,000, providing an estimated 10,000 man-months of work. Many of the work force are likely to come from the local community.

See Appendix D for a preliminary labour mobilisation schedule for the construction of the power plant and Special Facilities.

A range of equipment will be used in the construction of the plant. The principal type of equipment to be used includes the items listed in the following table.

Table 6: Construction equipment details

Equipment	Estimated No. units
Backhoe	5
Bulldozer	3
Trailer	2
Dump truck / Mixer truck	28
Cranes	12
Crane barge	1
Pile driver	6
Forklift	7
Welding machines	111
Electricity generators	8

Appendix D also contains further details of the proposed equipment mobilisation schedule.

5.8 HSE precautions during construction

All Contractors involved in the Project will be required to comply with all local health and safety requirements, as well as the requirements of any environmental permits issued for the Project.

Provisions will include developing and then following Construction Environmental Management Plans (CEMPs) and Health and Safety Plans (H&SPs) to reduce the risk of harm to staff, the environment or the local community. This will include drainage and sediment controls.

MRPR will monitor and supervise every contractor to ensure they are fulfilling the rights of workers in accordance with applicable laws and regulations.

Temporary construction offices and facilities for the labour force will be erected close to the Site. This will include areas for

- Food preparation and consumption;
- Ablutions; and
- First aid.

There will also be a prayer room.

There is no plan to construct a worker's camp at or close to the site. Lotte and its subcontractors expect to rent any accommodation necessary to house workers not from the area.

5.9 Construction Phase Noise

The major source of noise emissions will be through heavy machinery such as pile drivers, earthmoving equipment and transport vehicles.

As part of the ESIA and AMDAL process, procedures will be defined to reduce the potential for construction noise to impact on the community. Potential mitigation measures are likely to include

- Restricting hours of work to reduce the possibility of nuisance to neighbours;
- The use of modularisation, and encouraging the EPC Contractor to fabricate as much of the plant offsite as possible – e.g. the HRSG harp sections may be delivered fully assembled, reducing the need for site-work;
- Use of low noise and low vibration equipment to reduce the potential impact of piling operations; and
- Use of silencers during steam blowing exercises.

5.10 Transportation Impacts

The transportation of power station components to site via road could lead to temporary noise impacts on residential areas due to the proximity of the roads to the houses.

A mitigation measure for the transport noise is to transport the equipment to site via barges on the Siak River. This will remove the noise impact on residents in two ways. Firstly, the jetty is further from the residents and any noise would have a lower impact. Secondly, the barges are comparatively less noisy than trucks.

General construction traffic and other deliveries will inevitably come by road from the area surrounding the Plant. In addition to traffic associated with the workforce coming to and from the site, there are likely to be in the order of 10 light trucks and 50 to 60 heavy trucks per day, bringing equipment and material such as concrete, rebar and construction raw materials.

As part of the CEMP, traffic management plans will be developed to minimise any potential impact on nearby residents, including:

- A truck wheel wash facility will be constructed to clean truck wheels prior to exiting the site in order to prevent dust and spoil being transported on to the public road. The wheel wash facility will be used through-out the construction phase of the power plant. The washing facility (pit) will not connect to a drain or watercourse and therefore will not filter the water; it will be manually cleaned out as required.
- Timing of deliveries to avoid peak travel times for residents, and in particular hours when children are scheduled to be going to or returning from school.

See Appendix E for a preliminary Transportation Plan.

6. Plant Operation

6.1 Introduction

The section provides

- A general overview of the power plant process;
- More detailed descriptions of the main power plant components
- A general description of resource requirements and environmental impacts; and
- General information about labour requirement.

6.2 General plant description

The power plant is a 2 x 1 combined cycle plant, designed to deliver up to 275MW over the 20-year term of the PPA. It will burn natural gas fuel only. The plant will consist of:

- 2 x GE 6F.03 gas turbine (GT) generator sets
- 2 x supplementary fired heat recovery steam generators (HRSGs).
- 1 x steam turbine (ST) generator set
- A wet mechanical draft cooling tower
- Normal balance of plant systems will also be provided, including:
  - Gas compression (if required) and conditioning system
  - Demineralised water treatment plant to treat raw water before it is added to the water steam cycle to make up for water lost from the cycle.
  - Closed cycle cooling water system to cool plant and equipment such as lubricating oil coolers, generator coolers, boiler feed pumps
  - Systems to dose and sample the water and steam
  - Compressed air system
  - Fire protection system, in accordance with local requirements with scope and design generally in accordance with NFPA 850
  - Emissions monitoring system
  - Drainage systems
  - Overall plant distributed control system
  - Metering and protection systems
  - Enclosures to house the plant and equipment as required
  - Control room and office space for the O&M staff
  - Black start diesel generators and system
  - HV switchyard.

The Appendix A includes the following conceptual drawings and information, including:

- Conceptual layout

- Water balance
- Single line diagram.

6.3 General process description

In a combined cycle plant, ambient air is filtered and led to the compressor of the gas turbine, where it is compressed. Fuel is added and combusted in the combustors and the hot gas fed to the turbine which drives the generator to generate electricity.

The exhaust gas leaving the turbine may still be in the order of 600°C. In an open cycle (or simple cycle) plant, the exhaust gas flows back to the atmosphere and so a good deal of useful energy is lost. However, in a combined cycle plant, the exhaust gas is fed to a HRSG and is used to generate steam. This is why a combined cycle plant is more efficient than an open cycle plant.

From the HRSG the superheated high pressure (HP) steam is fed to the high pressure section of the steam turbine where it expands before being returned to the HRSG for re-heating. The reheated steam is mixed with intermediate pressure steam also generated in the HRSG and fed to the intermediate pressure section of the steam turbine. Steam leaving this section is fed to the low pressure section of the turbine where it is supplemented with further low pressure steam from the HRSG. All steam exhausts to the condenser where it is condensed to water before returning to the HRSG to be converted to steam once again.

A schematic diagram of the process is provided in the figure below.

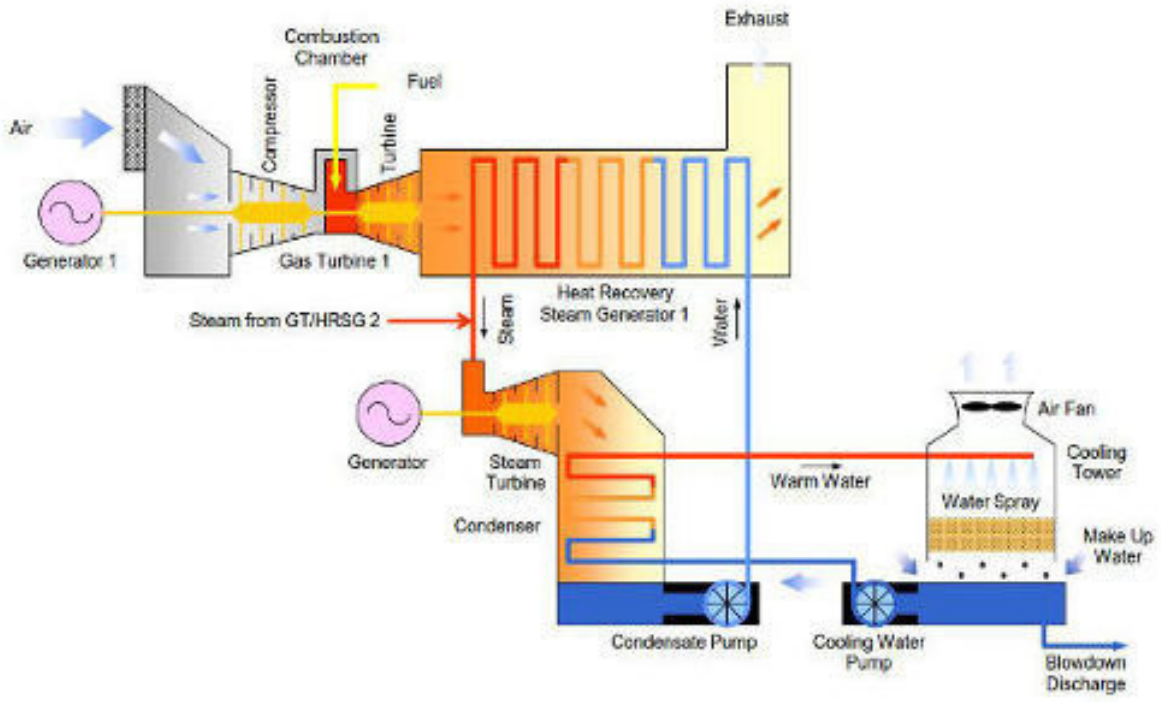

Figure 1: Schematic of General Process

6.4 Gas Turbine Generators

The gas turbine generators will be a 6F.03 model supplied by GE. This is an “F” Class, heavy duty, single shaft, industrial type of gas turbine, of proven design. Each unit will have a capacity of approximately 81MW.

The gas turbines will be equipped with lean-premix dry low NOx combustion systems. No water or diluent injection will be necessary to control NOx emissions.

The turbine generators will be installed outdoors, though within acoustic, ventilated enclosures incorporating fire detection and protection facilities. They will be provided with all associated ancillary and auxiliary equipment and systems for safe, efficient, and reliable operation. They will fire natural gas only.

6.5 Heat Recovery Steam Generator (HRSG)

The HRSGs will be triple pressure with reheat design.

In order to generate additional steam to boost power from the steam turbine from time to time, as desired by PLN, the HRSGs will be fitted with low NOx duct burners.

The HRSGs will include economizer, evaporator, and super-heater tube bank sections with finned tubing, as appropriate, to maximize heat transfer. The thermal cycle will be designed to suit the specific requirements of this Project.

Pressure parts will be designed, manufactured and tested in accordance with "ASME Boiler and Pressure Vessel Code, Section 1, Power Boilers" or equivalent. The HRSG stack height and the flue gas exit temperature will be sufficient to ensure adequate dispersion of the flue gases in accordance with the relevant environmental standards and requirements. At present, a stack height of 45m is anticipated.

The design steam conditions at full load are as follows:

Table 7: HRSG Design Steam Conditions

Parameter	Unit	HP	IP	HRH	LP
Steam pressure at HRSG outlet	Bar	142.0	27.9	22.0	5.3
Steam pressure at steam turbine	Bar	136.7		21.3	4.8
Steam temperature at HRSG outlet	°C	571	298	576	295
Steam temperature at steam turbine	°C	569	314 (CRH)	574	290
Steam flow per HRSG	kg/s	37.7	2	39.5	2

The HRSGs will be installed outdoors.

6.6 Steam Turbine and condenser

Steam from the two HRSGs will be combined, and fed to the steam turbine generator set to generate more electricity. It will be provided with all associated ancillary and auxiliary equipment and systems for safe, efficient, and reliable operation.

The steam turbine will produce approximately 126MW at the design point.

Steam will be condensed in the condenser which will be cooled using water fed from a wet mechanical draught cooling tower.

Preliminary condenser design conditions are:

Table 8: Steam Turbine and condenser details

Parameter	Unit	Value
Steam pressure at inlet	bar	0.0949
Steam temperature	°C	44.8
Steam flow	Kg/s	83.9

Parameter	Unit	Value
Cooling water temperature increase across condenser	°C	10.3
Cooling water flow	Kg/s	4,756

The steam turbine generator and condenser will be installed within a building.

6.7 Major Balance of Plant Systems

6.7.1 Cooling Water Systems

The condenser will be cooled by a closed cycle cooling system with a wet (evaporative) mechanical draught cooling tower.

In a wet tower, the cooling effect is obtained by presenting a large surface of the heated water returning from the condenser to the atmosphere, allowing heat loss to occur predominantly by evaporation. On this project, the mechanical draft tower will comprise a number of "cells" arranged in a line above a basin. The large surface area for the water will be obtained by the use of "fill", likely to consist of a plastic honeycomb or slats installed in each cell. The heated water will descend from upper trays through the fill. Some of it (approximately 2%) will be evaporated, and in the process, the temperature of the remaining water will be reduced. The remaining water will be collected in a concrete basin below, and then pumped back to the condenser to condense steam once again.

The water lost to evaporation and blowdown will have to be replaced, with make-up water extracted from the Siak River.

Ventilation through the fill to allow effective evaporation will be obtained by installing large fans at the top of each cell.

Preliminary cooling tower design parameters are:

Table 9: Cooling Tower parameter details

Parameter	Unit	Value
Cold water temperature (to the condenser)	°C	31.6
Cold water temperature (from the condenser)	°C	41
Water flow	kg/s	5,114

A chemical dosing system will be provided to control the water quality in the cooling water system to prevent fouling, scaling or corrosion. The cooling water treatment will include at least:

- Addition of an acid to the makeup water to reduce the carbonate concentration in the makeup water in order to prevent deposition of calcium carbonate scale particularly on the condenser tubes. Alternatively, the addition of a dispersant along with acid dosing may be used, as long as the dispersant has no adverse impacts on the environment.

- Dosing with organic biocide or NaOCl to control organic growth in the cooling system. A system capable of dosing both continuously and via shock treatment (approximately 20 minutes every 8 hours) will be provided.

Final details will be confirmed once the river water quality and cooling tower design are confirmed.

6.7.2 Gas reception area

The pressure of the gas supplied to the gas turbines must be controlled to be within a set range. On arriving at the site, the gas may be above, within or below the correct range. Therefore, the following facilities will be installed in order to ensure the gas pressure at the gas turbines is correct:

- Gas compressors will be installed, to boost the gas pressure if it is too low. (If it is confirmed that the gas pressure at the supply point (SV1401) will never be so low as require gas compression on site, then these may be removed from the scope of the project.)
- Pressure regulators will be installed to reduce the pressure on occasions when it is too high. Depending on the design, this system may need to incorporate a system to heat the gas before the pressure is reduced. Any such temperature control system is likely to use natural gas to heat water to heat the gas flowing to the plant.

Other equipment in the gas reception area will include:

- An emergency shut down valve, to isolate the plant in the event of a problem (perhaps installed as part of the gas pipeline project);
- A pig receiver station (perhaps installed as part of the gas pipeline project) which will be used to help maintain the cleanliness of the gas pipeline;
- A gas chromatograph to check the composition of the gas arriving at the site; and
- A system to control the pressure of the gas to be used by the HRSG supplementary firing system.

6.7.3 Water treatment

This section describes the process expected to be used for the handling and treatment of the raw water when it arrives on site. Refer to the water balance diagram in Appendix B for further details as well as the preliminary P&ID.

Water will be taken from the Siak River for use in the power generation process.

On arrival at site, the water will enter a raw water reservoir / settling pond, be clarified and filtered, and then stored in a filtered water tank. This initial system shall be sized to store enough water to allow the plant to run at full load for two days without and make-up – approximately 17,700 m^3.

The filtration process will involve dosing with caustic soda and alum.

Preliminary details are as follows:

Table 10: Water treatment details

Parameter	Description / value / comment
Clarification and filtration technologies	Clarifier+ Gravity Filter or Sand filter
Number of streams	Clarifier 50% x 2 Gravity Filter 100% x 2 or Sand filter 100% x 2
Rated capacity of each stream	160m^3/h
Raw Water storage capacity	17,700m^3
Potable Water System	2m^3/h, Activated carbon filter + NaOCl dosing

The raw river water may be dosed with chlorine (as a biocide) in order to prevent biological growth while to water is stored in the raw water reservoir – especially during outages.

Filtered water will be used

- As make-up for the cooling tower (see above);
- As make-up to the demineralised water treatment plant;
- To generate potable water; and
- As a fire water supply.

It is expected that the demineralisation plant will be a conventional ion exchange based plant with a mixed bed polisher.

Preliminary details are as follows:

Table 11: Filtered water details

Parameter	Description / value / comment
Type	Ion Exchanger
Stages of treatment	Activated carbon + 2B3T ion exchange + Mixed Bed Polisher
Number of Streams	2
Rated Capacity of Each Stream	12 m^3/h
Demineralised water storage tank capacity	500 m^3

Preliminary details for the potable water system are as follows:

Table 12: Potable water system details

Parameter	Description / value / comment
Type	Ion Exchanger
Stages of treatment	Activated carbon filtration plus NaOCl dosing
Capacity	2 m^3/h

6.7.4 Water steam cycle chemical treatment

Chemicals will also be used to help control the chemistry of the water and steam in the water/steam cycle. Preliminary details are as follows:

Table 13: Chemical treatment details

Parameter	Description / value / comment
HRSG chemical treatment programme	Ammonia, Phosphate, Carbohydrazide
Ammonia	
Injection point	CEP discharge & HP/IP feed pump suction (provision
Chemical strength	1% wt/vol
Dosage per litre of product water	3 mL/L

Parameter	Description / value / comment
Phosphate	
Injection location	HRSG HP and IP drums
Chemical strength	1% wt/vol
Dosage per litre of product water	3 mL/L
Carbohydrazide or equivalent	
Injection location	Deaerator outlet & provision for dosing at CEP discharge
Chemical strength	1~2% wt/vol
Usage per litre of product water	0.1 mL/L

A sampling system will monitor the quality of the water and steam in the system. The station staff will use the sample results to adjust the dosing systems, so that the chemistry is acceptable while minimising chemical usage.

6.7.5 Wastewater treatment

The plant's onsite wastewater treatment systems will include systems for non-clean stormwater, normal wastewater, abnormal waste water, oily waste water and sanitary water. A preliminary P&ID for the system is included in Appendix B.

The following systems are envisaged:

Table 14: Wastewater treatment details

System / parameter	Description / value / comment
Stormwater	Oily or potentially oily stormwater will drain to the oily water pond where the oil will be separated in a CPI type separator, after which the clean water may be discharged from Site
	The design will avoid or minimise the potential for stormwater to become contaminated with chemicals other than oil. Where this is not possible, stormwater from those areas will be collected and sent to the normal waste water pond.
	Clean stormwater will be collected and either re-used in the process – perhaps in the cooling water system, to reduce make-up water requirements – or discharged from Site with the other effluents.
Oily Drains	Oily drains will be sent to the oil water separator
Process drains – e.g. from the water steam cycle, the demineralisation water treatment plant, blowdown from the cooling tower	Process drains will be sent to the waste water pond for pH adjustment and further treatment before being discharged off site.
Compressor water wash effluents	Effluents from the compressor water washing systems will be collected in a dedicated tank to be emptied via road tanker and disposed of separately.
Sanitary wastewater	These effluents will be treated in a package sewage

System / parameter	Description / value / comment
	treatment plant

6.7.6 Fire Fighting System

The plant fire detection and protection system will be designed in accordance with the local fire codes and the requirements of NFPA 850.

The following systems are envisaged:

Table 15: Firefighting details

System / parameter	Description / value / comment
Deluge systems	GT-Generator Step Up Transformer
	ST- Generator Step Up Transformer
	Main oil tank for Black Start Diesel Generator
	Unit Aux Transformer
Sprinkler systems	Cable room
	Workshop
Gaseous systems	Electronic room
	Control Room
	Switchgear Room
	Gas turbine enclosures

In addition to these systems, there will be

- A ring main with hydrants; and
- Portable fire extinguishers located strategically around the installation.

6.7.7 Lighting

Outdoor artificial lighting including flood lights will be installed at suitable locations. Pole mounted, high pressure sodium vapour lamp fixtures will be used for the approach and work roads. A combination of high pressure sodium vapour, fluorescent, and incandescent fixtures will be used for the turbine hall, HRSG platforms and galleries as necessary. The illumination levels at the various locations will be maintained as stipulated in internationally accepted codes.

A suitable number of lighting panels will be supplied and installed at the convenient locations throughout the Plant. In addition to the normal illumination scheme, an emergency AC and DC lighting scheme will be provided.

Aircraft warning lights will be provided on the chimney stack in accordance with local regulations and/or FAA standards. The uppermost set of lamp fittings will be located as close as practicable to the top of the chimney and further sets of twin lamp fittings will be located on the chimney as required by the applicable regulation / standard.

6.7.8 Security

The site will be enclosed by a security fence. Security guards will be employed undertaking regular security patrols of the boundary fence. A gatehouse will be provided and this will be located on the access road prior to entering the site.

6.8 Labour requirements

The operation of the plant will require approximately 60 full time employees. The expected organisation chart is included in the Appendix G.

Staff will receive comprehensive training during the construction phase – and ongoing training over the lifetime of the Project.

Where possible, labour will be sourced locally.

During scheduled maintenance there will be additional temporary workers on site which can increase the total up to approximately 200.

7. Transmission Line

7.1 Introduction

An approximately 750m long, 150kV overhead line transmission (OHL) will be installed. The line will include 6 transmission towers and will intercept the existing transmission line between Tenayan Switchyard and the Pasir Putih Switchyard via a double phi connection. See Figure 2 below for the for the proposed line route.

To minimize the use of land use between the connection point and plant switchyard, a four circuit transmission line concept will be adopted where possible, so that the loop-in and loop-out to and from the Pasir – Putih line can use the same towers.

The following section provides a description of the route, pre-construction, construction and operation of the transmission line.

7.2 Transmission Line Route

Due to the short length of the proposed transmission line, no route option study will be necessary. The proposed route will be straight forward selected based on the following criteria:

- Maximum 500m wind span, 700m weight span, and 350m basic span;
- Maximising span lengths; and
- Land under spans will be cleared as required to meet conductor clearance to ground requirement.

The transmission line will be connected to existing line by a double phi connection method depicted in the following figure.

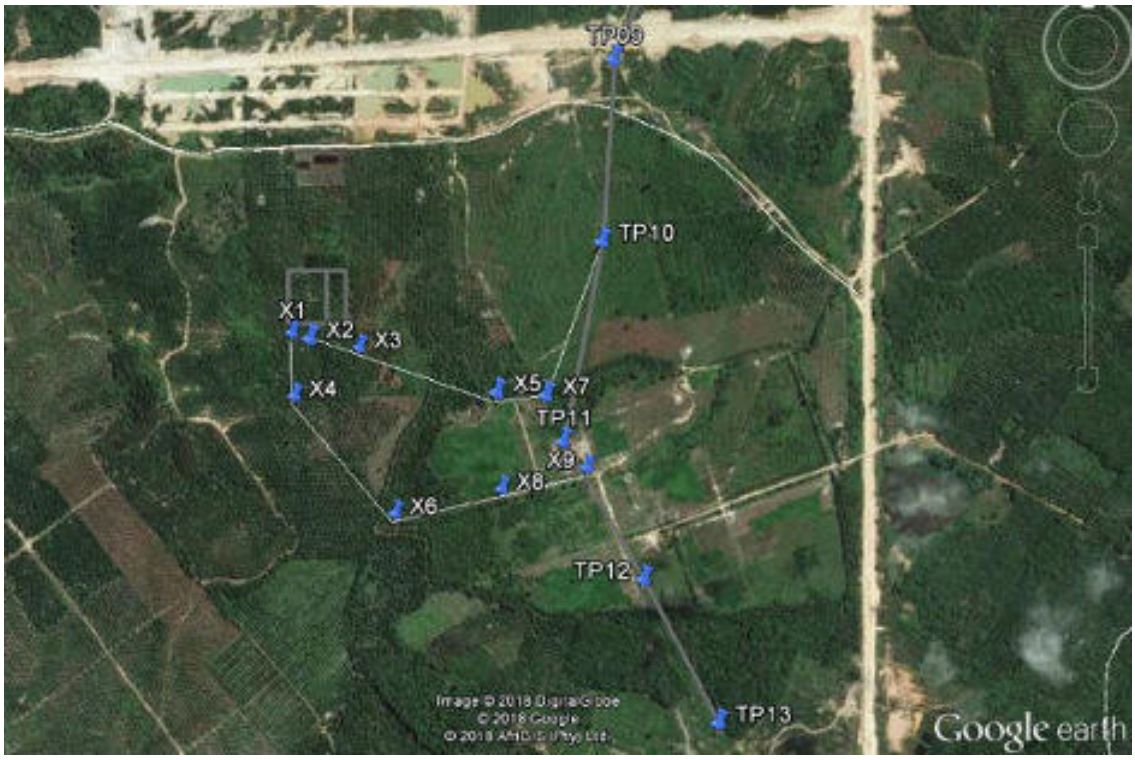

Figure 2: 150kV Double Phi Connection

The land for five of the towers is currently owned by private landowners.

The estimated co-ordinates of the towers and other preliminary details are provided in the following table.

Table 16: Preliminary Details for the Towers

Tower Number	Co-ordinates	Number of circuits	Ownership
X.1	780,523mE 59,576mN	2	MRPR
X.2	780,568mE 59,589mN	2	MRPR
X.3	780,656mE 59,547mN	2	MRPR
X.4	780,527mE 59,452mN	2	MRPR
X.5	780,926mE 59,456mN	2	Private
X.6	780,726mE 59,222mN	2	Private
X.7	781,034mE 59,478mN	2	Private
X.8	780,937mE 59,270mN	2	Private
X.9	781,106mE 59,312mN	2	Private

Notes:

- the route/corridor depicted above is almost finalised. The line will run in this general area. It could be that there may need to be one or two more towers off-site, but they would be in this general area.
- TP.10, TP.11, TP.12, and TP.13 already exist and would be modified as part of the project.

The Right of Way (RoW) for the transmission line will be approximately 25m wide. The towers will require footings covering approximately 40m x 40m each. Tall vegetation will be trimmed in the RoW to obtain the necessary conductor clearance of 8.5m as per SNI 04-6918-2002.

7.3 Pre-Construction and Field Surveys

Prior to construction commencing, field surveys and land acquisition works will be carried out

MRPR will conduct field surveys of the site, including topographical survey, geological and geotechnical investigations of the soil, in order to collect the data required to finalise the location and design of the transmission line. There will also be baseline survey activities for the preparation of the Environmental and Social Impact Assessment (ESIA) and UKL-UPL for the Special Facilities.

There are no settlements or residences along the route.

7.4 Construction

7.4.1 General

The design and construction of the transmission line will take approximately 8 months.

The construction workforce will be approximately 50 and it is expected the bulk will come from the local community. The workforce will include:

- Civil works
- Steel erectors
- Mechanical fitters
- Welders
- Electricians and linesmen
- Instrumentation technicians
- Crane-drivers
- Scaffolders
- Painters
- Labourers, and
- Support staff

The staffing schedule in Appendix D includes the workforce associated with the construction of the transmission line.

Materials required for the construction of the transmission line include the conductors (ACSR 450mm2), earth wire, insulators, and steelwork for the tower sections. Other materials such as sand, stone, portland cement and reinforcement will be required for the foundations.

7.4.2 Erection of Towers

Erection of the lattice towers will occur once the foundations are completely hardened.

Erection is undertaken following the steps:

- Installation of the stub (foot tower) gradually section-by-section;
- Installation of a criss-cross (diagonal) tower; and
- Installation of cross arms on the tower.

The towers will be lattice type, with the following preliminary technical specifications:

- Voltage: 150kV (Max = 170kV);
- Path length: approximately 750m;
- Number of circuits: Quadra circuit;

- Tower type: lattice / tower steel frame;
- High of 4-circuit towers: 40 - 49m;
- Conductor / phase: 4 x 450mm2 ACSR;
- Insulator / insulator: Ceramics
- Carrying capacity: 400MVA / circuit.

In general, the transmission towers consist of the following components:

- Stub: the bottom of the foot of the tower, mounted in conjunction with the installation of the foundation and fastened to the foundation.
- Leg: tower foot which is connected between the stub and the tower body.
- Common body: the bottom of the tower body which is connected between the leg and the top of the tower body (super structure).
- Super structure: tower upper body connected to the common body and the cross arm phase wire and lightning wire.
- Cross arm: the part of the tower which supports the insulators and conductors.

Typical 2-circuit and 4-circuit transmission tower designs are presented in the following Figures.

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A typical 4-Circuit Lattice Tower	**Typical 2-circuit dead-end tower interfaced to the plant gantry**	**Typical 2 circuit lattice tower for intercepting existing line**

Figure 3: Typical 4-circuit and 2-circuit tower designs

7.4.3 Conductor Wire Stringing

Conductor wire drawing activities carried out in the following order:

- Installation of insulators and equipment;

- Stringing of the wire conductors, wire retaining lightning and ground wire; and
- Setting sag and tension.

Stringing the conductor wires between the towers will be carried out using pullies and winches. Stringing is undertaken once the insulators are mounted in place on the towers.

Stringing of conductor wires will be performed per phase, for each bundle there are two (2) wire conductors per phase. The stringing is undertaken for two (2) conductors simultaneously. Because the conductor should not touch the ground, it is necessary to maintain tension (pull so that the conductor is always tense), therefore in addition to the winch machine, it is necessary brake machine that maintains the conductor sag at the correct amount. To obtain the desired tension this is done by pulling the conductor slowly while removing the armature slowly from the conductor drum.

7.4.4 Safety Inspection prior to operation

Once the electrical installation work has been completed, it will be tested before it is operated. The scope of testing activities is as follows:

a. Visual Examination:

- Check the condition of the tower (e.g. everything is in good condition, no parts are rusty, including its nuts and bolts);
- Check the condition of the insulators, (e.g. whether everything is in good condition and clean, nothing is broken or cracked, no deformation); and
- Check the condition of conductors, ground wires and joint sleeves.

b. Construction inspection:

- Examine all components installed and compare them with specifications and regulations.

c. For certain work items that cannot be seen by naked eye, then testing using test equipment or measuring devices will need to be undertaken:

- Testing isolation insulators, insulation resistance between phase to phase and phase insulation resistance between the neutral wire. Test equipment includes Mega Ohm Meter / Megger / Insulation Resistance Tester.
- Ground earthing, using test equipment or measuring devices such as Earth Resistance Tester.

After the inspection and testing activities have been carried out and the lines are certified safe for operation they may be energised for operation.

7.5 Operation

Once constructed and operational, the transmission line will be transferred as an asset for PLN to own to operate. Maintenance activities will be carried out to ensure the line and equipment are functioning properly. Maintenance will also include maintaining the space under the transmission line by trimming any plant growth.

8. Gas Pipeline

8.1 General

The fuel for the project will be dry natural gas. It will be supplied via a 40km long pipeline which will connect to the Grissik-Duri transmission pipeline (operated by PT. TGI) at an offtake location known as SV1401. A custody gas metering facility will be installed by PT. TGI just upstream of the point of interconnection. Downstream of the metering skid, the pipeline size will transfer gas to the plant.

This section of this report addresses the pipeline downstream of the metering point.

Process conditions for the pipeline as follows:

Table 17 : Gas Main Process Parameters

Parameter	Unit	Value
Tie-in point		SV1401
Distance	km	Approximately 40
Gross Heating Value	Btu/SCF	950 - 1250
Diameter	inch	12
Flowrate	MMSCFD	Up to 46
Pipeline design pressure	barg	79.3
Supply pressure at tie-in point	barg	Approximately 50
Delivery Pressure	Barg	Estimated at between 24 and 50

The pipeline will be buried and will mostly follow the existing road. Refer to Appendix F for the proposed route.

The arrival pressure will depend on the pressure of the main pipeline at the delivery point and the flowrate. The flow rate will depend on the level of dispatch of the plant, as determined by PLN.

The pipeline design will be equipped with a pigging facility, mainly intended for piping cleaning and integrity checking. A Pig launcher will be installed at the tie-in point to the Grissik–Duri pipeline, and the receiver will be at the power station site. Sectional valves will be installed to allow pipeline isolation for maintenance or during an emergency.

At the power plant, the gas will enter the gas reception area – described earlier.

8.2 Pipeline Route

The preferred pipeline route is shown in the following figure.[1]

[1] MRPR is currently going through the process of land acquisition / rental, endeavouring to obtain approval from the relevant stakeholders. Thus, minor rerouting may be required in order to avoid permanent damage or land settlement, all in accordance with the prevailing regulations and approvals by MIGAS.

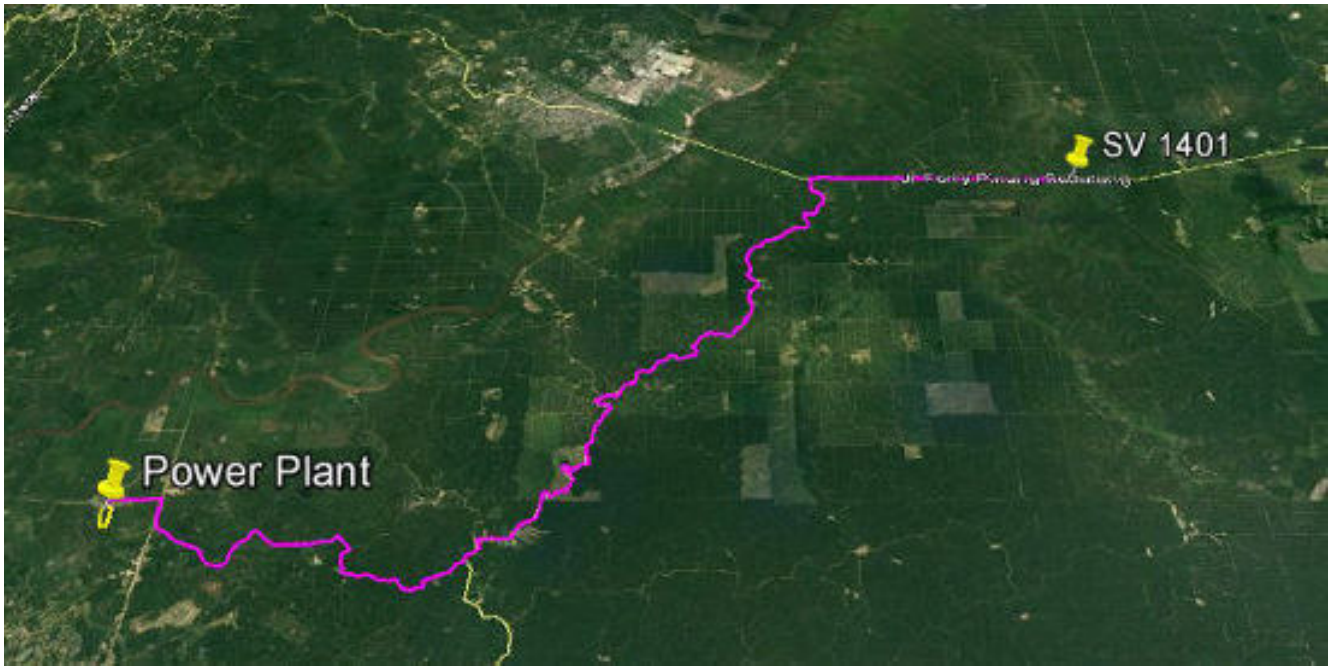

Figure 4: Preferred Gas Pipeline Route

The bulk of the route follows roadways approximately 5 km of which pass close to habited areas. Approximately 8 km is through palm oil plantation land.

During the design stage, the pipeline classification will be determined in accordance with Mining and Energy Ministerial Decree no. 300 (KEPMEN 300) and relevant international guidelines and standards. This process will ensure that there is adequate separation between the pipeline and residents, businesses or other services (e.g. other pipelines for oil, water, gas etc. or power lines) close to the route. Additional safety provisions will be implemented where deemed necessary for public safety.

The pipeline will cross several roads and streams and may run close to or under other existing services (including oil and gas pipelines and power lines). The design will incorporate safeguards in accordance with the regulations and good industrial practice in order to minimise the risk of harm or damage from construction works.

8.3 Construction

8.3.1 Introduction

The pipeline will be installed by CPM, a contractor with substantial experience of this type of work.

The pipeline route extends over a significant area and particular attention will be paid to matters of:

- Maintaining good relations and communication with the communities which could be affected by the work;
- Public safety;
- Traffic control; and
- Environmental protection.

8.3.2 Construction

Construction will involve:

- Preparing the pipeline route by clearing vegetation and grading the immediate area;
- Transporting the pipe sections to the workfront;
- Welding the pipeline sections together, followed by non-destructive testing of the welds to check for flaws. Any flaws will be repaired.
- Digging and preparing the trench for the pipe – with the maximum open trench at any time likely to be 500m;
- Lowering the pipe into the trench;
- Backfilling the trench and compaction; and
- General area reinstatement.

A typical Construction Execution Plan has been provided by CPM and in included in Appendix F for reference.

8.3.3 Tie-ins and final testing

The various sections of pipe will be welded together at what are referred to as tie-ins. These tie-in welds will also undergo non-destructive testing.

Eventually, after the pipeline is complete and has been cleaned, the entire length will undergo a hydro test to check the integrity of the pipeline.

Once complete, the pipeline will be dried and then preserved until the power plant is ready to accept gas.

8.3.4 Construction crew and equipment

The construction team will include:

- Pipefitters
- Welders
- Crane operators and riggers, and
- General labourers.

Construction equipment will include:

- Excavators
- Bulldozers
- Dump trucks
- Cranes
- Welding machines
- Water pumps for temporary drainage systems, and

Appendix F contains further details of the estimated labour requirements and equipment mobilisation schedule.

8.4 Operation

MRPR will operate the pipeline over the term of the PPA.

In general, the pipeline will be in service at all times. The timing of any shutdowns will have to be co-ordinated carefully with the gas supplier and PLN as any shutdown will result in an inability of the power station to operate.

At the end of the PPA, ownership of the pipeline will pass to PLN.

9. Power Plant Resource Requirements

9.1 Natural Gas

The amount of natural gas fuel required from day to day will vary depending on ambient conditions and the level of generation requested by PLN.

Maximum daily fuel demand is estimated as follows:

Table 18: Fuel demand details

Item	Unit	Value
Heat rate at 100% load	Btu/kWh, HHV	6,920
Net output at full load	kW	275,000
Fuel flow per hour at full load	Btu/h	1,903,000,000
CV of fuel, HHV	Btu/scf	1,039
Hours per day	h	24
Use per day	mmscf/d	44

PLN have a nominal target annual net capacity factor (NCF) of 60%. The fuel needed to achieve this annual NCF will depend on the load mix used to deliver the energy. If the 60% AF is achieved using the load mix PLN used during the IPP selection process, then fuel use over the term of the PPA is estimated as follows:

Table 19: Fuel use details

Item	Unit	Value
Capacity at base load	kW	275,000
Hours per normal year	h	8,760
AF	%	0.6
Generation required per year	kWh	1,445,400,000
Average heat rate at evaluation load mix	Btu/kWh, HHV	6,942
Fuel use per year	Btu, HHV	10,033,966,800,000
Fuel use per year	PJ, HHV	10.5
Fuel use over PPA	PJ, HHV	211.7

9.2 Water

9.2.1 General

The plant will extract raw water from the Siak River for use on site. The main water consumption will be for the following:

- Cooling water to cooling towers;
- Demineralised water makeup for the steam cycle;

- Potable water for plant us; and
- Firewater.

The raw water requirements when the plant is at full load are predicted to be approximately 370m^3/h with the predominant usage being for the cooling system. Maximum demand will be in the order of 400m^3/h. Most of the losses from the cooling system will be due to evaporation from the cooling tower. Evaporation losses will vary with steam turbine load and ambient conditions. With the evaporation of water from the cooling water system, the concentration of the salts and impurities in the circulating water increases. In order to control these, additional water is drained from the cooling water system. Such drained water is called blowdown. The blowdown rate depends on the quality of the water and the design of the cooling tower fill. All requirements will be finalised during detailed design.

The following table presents expected demands:

Table 20: Raw water demand details

User	Nominal demand at full load, m^3/h
Cooling tower evaporation and blowdown	340
Water steam cycle	10
Other users and losses	20
Total	370

To minimise make-up requirements, where possible, water will be recycled – for example clean stormwater and some process wastes can go to the cooling tower basin to reduce the need for make-up from the River.

A preliminary water balance / flow diagram for the plant is provided in the Appendix B.

9.2.2 Plant demand in context of Siak River water flow

Daily river flow data for the years 2004 to 2013 have been reviewed and the data yields the following results:

Table 21: Plant demand versus Siak River Flows

Year		2004	2005	2006	2007	2008	2009	2010	2011	2012
Minimum flow	m^3/h	33840	61200	29160	65160	43200	64440	33840	77040	31680
Average flow	m^3/h	259,200	219,600	224,280	270,000	261,000	279,720	250,920	312,480	265,680
Average take required	m^3/h	370								
Take as a % of minimum flow	%	1.09%	0.60%	1.27%	0.57%	0.86%	0.57%	1.09%	0.48%	1.17%
Take as a % of average flow	%	0.14%	0.17%	0.16%	0.14%	0.14%	0.13%	0.15%	0.12%	0.14%

10. Power Plant Environmental Discharges

10.1 Exhaust Stack Emissions

10.1.1 General

Emissions estimates are presented for NOx, CO, SOx, PM, and CO2 as these are the emissions of interest from a gas fired power station.

Table 22: Exhaust Stack Emissions – Per Stack

STACK Emissions	Basis		100% Load
Stacks in service		-	2
NOx	51 mg/Nm^3 = 25 ppmvd, guaranteed by GE /Lotte	g/s per stack	12.1
CO	30 mg/Nm^3 = 23 ppm	g/s per stack	6.5
SOx	30 ppm by weight, sulphur in fuel[2]	g/s per stack	0.47
PM	30mg/Nm^3, allowed by local regulations and guaranteed by GE/Lotte	g/s per stack	7.4
CO_2	Heat Balances, Design Fuel composition, and 52.5 TCO2/TJ, HHV	g/kWh	383
Temperature	Heat Balances	°C	82.4
Exhaust Gas Velocity	Estimated based on 3.8 m diameter stack	m/s	20 m/s

Stack concentrations (mg/Nm^3 and ppm) and are based on 15% O2, dry gas. Each stack will have a continuous emissions monitoring system (CEMS) in order to monitor emissions during plant operation.

All emissions will be within the limits outlined in the IFC/World bank guidelines and within the requirements of the Indonesian regulations.

The following table shows the maximum possible annual emissions, in tonnes/year, based on a Net Capacity Factor (NCF) of 93%.

Table 23: Estimated Maximum Annual CCGT Exhaust Stack Emissions,

STACK Emissions		100% Load and 93% NCF
NOx	t/year	355
CO	t/year	191
SOx	t/year	499
PM, based on PM content in gas	t/year	217
PM, based on PM concentration allowed	t/year	355
CO2	t/year	860,000

[2] Indonesian regulations permit exhaust concentrations of up to 30mg/Nm3. This would increase the emission rate by a factor of approximately 20.

10.1.2 Stack Parameters

The height of the exhaust stack is assumed to be 45m.

The diameter of the exhaust stack is estimated at 3.8m.

The final height and diameter will be determined once the dispersion modelling is completed to make sure that ground level concentrations of the various pollutants do not exceed permitted levels.

10.2 Emissions to air from the cooling tower

There will be emissions to air from the cooling tower, estimated as follows:

Table 24: Emissions to air estimation details

Parameter	Value
Hot humid air	3,000 kg/s of air heated by about 9.7C above ambient at 100% relative humidity
Drift	Less than 1 kg/s

Expected conditions at the top of the cooling tower are:

Table 25: Cooling tower condition details

Parameter	Value
exhaust temperature	35.8°C
exhaust flow	3,800 kg/s
volumetric flow rate	3,500 m^3/s
Exhaust velocity	10.4 m/s
Geometry of cooling tower	73 m long x 18 m wide x 10.1 m high (top deck)
Discharge height	13 m

The cooling towers will be fitted with a drift eliminator. As such, the emission of water droplet from the top of the cooling towers (drift) will be minimal.

However, because the drift droplets will contain the same chemical impurities as the water circulating through the tower (concentrated salts from the incoming supply plus traces of chemicals added for process control) the particulate matter constituent of the drift droplets may be classified as an emission. The magnitude of the drift loss will be influenced by the number and size of droplets produced within the tower, which are determined by the tower fill design, tower design, the air and water patterns, and design of the drift eliminators.

Chemicals used in the cooling tower shall be of a type

- That will have no significant adverse effect on the environment or local community; and
- Which decompose faster than deposited on the surrounding land (and thus do not accumulate)

During the permitting process, these emissions will be modelled.

10.3 Other Air Emissions

The great majority of plant emission to air will be via the exhaust stacks. However, for completeness, the following emissions may also be considered during the permitting process.

- Condenser: Very small quantities from the air ejectors - equivalent to the dissolved gases in the steam cycle make-up -of steam and dissolved air from water.
- Heat: from generator, oil and other cooling systems.
- Steam, gas and air from vents and drains;
- Intermittent steam from emergency relief valves, CO2 if released for fire protection, etc. (although emergencies are not expected to occur).
- Intermittent combustion gases from the Black Start Diesel Generator and the Fire Water Diesel Driven Pump.
- Minor discharges (e.g. SF6 from electrical equipment) during maintenance.

These emissions occur in trace amounts and are generally non harmful. Therefore, further mitigation measures beyond good utility practice are not normally considered necessary.

10.4 Liquid Effluents

10.4.1 General

The power generation process does not produce any hazardous liquid wastes. Preliminary P&IDs for the wastewater treatment system are included in Appendix B.

The primary liquid waste streams will be treated as required before being discharged into the Siak River.

- Clean stormwater will be collected and sent to the cooling tower basin or discharged from site.
- Stormwater which could be contaminated with oil will be collected and sent to a separator, before being discharged to the River.
- Stormwater which could be contaminated with chemicals will be collected and sent to the wastewater treatment plant.
- Effluent from the raw water settling and filtration process will be thickened and dehydrated. The solids will be disposed of off-site via truck. Liquid effluents will be discharged to the wastewater treatment plant.
- Effluents from the water treatment plant (the demineralised water plant) will be discharged to the wastewater treatment plant.
- It should be possible to maintain the chemistry of blowdown from the cooling tower to be within the effluent discharge limits, and so this may not be treated before discharge. In the event any such treatment is necessary, it will be carried out in the wastewater treatment plant.
- Areas storing oils and chemicals will be bunded and drained to an operational wastewater pit for treatment before discharge.
- Compressor water wash water will be collected in a dedicated tank and then trucked off site for disposal.
- The design and chemical treatment regimes will be finalised once adequate river water samples are available.

10.4.2 Effluent Volumes

The following table presents expected discharge volumes.

Table 26: Discharge volume details

User	Nominal discharge at full load, m^3/h
Cooling tower	56
Water steam cycle	2
Other users including losses from water filtration and treatment	22
Total	80

The volume of solids removed in the raw water settling and filtration process will depend on the level suspended solids (TSS) in the incoming water. Based on the samples available (analyses are included in Appendix B) the maximum TSS level in the River was 56mg/l. At an average intake flowrate of $370m^3/h$, approximately 21kg/h of solids will be removed and will have to be disposed of.

10.4.3 Effluent Volumes in context of Siak River water flow

Daily river flow data for the years 2004 to 2013 have been reviewed and the data yields the following results:

Table 27: Estimated Discharge volumes compared with River Water Flow

Year		2004	2005	2006	2007	2008	2009	2010	2011	2012
Minimum flow	m^3/h	33840	61200	29160	65160	43200	64440	33840	77040	31680
Average flow	m^3/h	259200	219600	224280	270000	261000	279720	250920	312480	265680
Average discharge	m^3/h	80								
Discharge as a % of minimum flow	%	0.24%	0.13%	0.27%	0.12%	0.19%	0.12%	0.24%	0.10%	0.25%
Discharge as a % of average flow	%	0.03%	0.04%	0.04%	0.03%	0.03%	0.03%	0.03%	0.03%	0.03%

10.4.4 Effluent quality

The quality of the main effluent – blowdown from the cooling tower - will depend on the

- Incoming water quality. Salts in the original River water will likely be concentrated approximately 6 times.
- Chemicals added to the cooling water system to control biocides, scaling, and (perhaps, if necessary from time to time) deposits.

Water samples have been taken from the river and the results are included in Appendix B. The following table lists the parameters to which discharge limits apply and the relevant limits, lists the maximum incoming value for that parameter based on the samples taken, and predicts the discharge concentration for that parameter, based on the cooling tower operating at 6 cycles of concentration.

No allowance is made for chemicals added in the raw water treatment process or cooling water system dosing. These are normally dosed in small quantities (compared with the circulating water flow rate), and are chosen or controlled so that they cannot cause discharges to exceed environmental limits.

Table 28 Estimated Cooling Tower Blowdown quality based on incoming water quality

Parameter	Unit	Local Standard	IFC/World Bank Guideline	Max incoming	Discharge quality, assuming 6 cycles of concentration
pH value	-	6 - 9	6 - 9	6.88	controlled
Suspended Solids	mg/L	100	50	56	Removed in filtration system
Chromium (Total)	mg/L	0.5	0.5	<0.002	< 0.012
Copper (Cu)	mg/L	1	0.5	<0.01	< 0.06
Zinc (Zn)	mg/L	1	1	0.05	< 0.3
Iron (Fe)	mg/L	3	1	1.168	< 1
Free Chlorine (Cl_2)	mg/L	0.5	0.2		controllable
Oil and grease	mg/L	10	10	2.4	Removed in separator
Phosphate (PO^{4-})**	mg/L	10	silent	0.862	5.172
Lead (Pb)	mg/L	silent	0.5	<0.005	< 0.03
Cadmium (Cd)	mg/L	silent	0.1	<0.002	< 0.012
Mercury (Hg)	mg/L	silent	0.005	<0.0005	< 0.003
Arsenic (As)	mg/L	silent	0.5	<0.005	< 0.03
Temperature	°C	silent	Less than 3°C above ambient water temperature at edge of mixing zone at discharge. This Zone shall be established during permitting.		Raw blowdown temperature will be 31.6 at design case, and temperature will drop between site and river

Note, the measured incoming Iron level exceeds the effluent guideline value. The non-soluble content will be removed by filtration. The soluble content will be removed by aeration, clarifying (coagulation / flocculation / sedimentation) and filtration. It is expected that the iron level entering the cooling tower basin will be between 0.05 ~ 0.10 ppm. Even after concentrating 6 times, the iron content in any discharge will be lower than 1.0 mg/L as Fe, and so will comply with the guidelines. The iron level will be monitored and effluent may be routed to the wastewater treatment system if it happens that the discharge limit will not be met. The wastewater treatment system also has aeration, clarifying and filtration facilities and these would reduce the iron content to meet the specification.

The blowdown will be taken from the cold water stream leaving the cooling tower rather than the hot water stream flowing to it from the plant. The temperature of the blowdown will depend on several factors, most notably:

- The thermal load on the condenser. This which will depend on the steam flow which is a function of the plant output at the time.
- Ambient wet bulb temperature at the time. The ambient wet bulb temperature sets the absolute lower limit for the cold water temperature. The temperature by which the cold water will exceed this is known as the approach and this is normally in the order of 5 to 8°C. For this project, the preliminary design is

based on an approach of approximately 6.3°C. As ambient conditions vary, the wet bulb varies but the approach remains almost constant.

At the design conditions (plant operating at full load, at 28°C and 85% RH) the wet bulb temperature is 25.2°C and it is estimated the blowdown will be 31.5°C. At the hottest ambient conditions (estimated to be 35°C and 50% RH), the wet bulb will drop to 26.2°C and it is estimated the blowdown will be 32.2°C if the plant is operating at full load at the time.

All effluents will be collected and neutralised as required so that the effluent quality will meet the local and IFC / World Bank EHS Guidelines.

10.4.5 Estimated annual water use and discharges

Likely maximum annual water use and discharge volumes are:

Table 29: Annual water use and discharge details

		100% Load and 93% AF
Water Use	m^3/year	2,6000,000
Effluent	m^3/year	650,000

10.5 Noise emissions

10.5.1 General

The power plant will generate noise when in operation. Noise levels from the Project will not exceed the Indonesia and World Bank / IFC noise limits. The noise level in the control room will not exceed 55dB(a). Warning sites will be provided at all entrances to rooms and operating areas where the noise levels exceed 75dB(A). The noise emissions are outlined in the Table below.

Table 30: Noise emissions details

Project location	Allowable Noise emissions
At the plant boundary under normal operation	70dB(A)
1 m from major equipment	85dB(A)
Within central control rooms	55dB(A)

10.5.2 Impact on neighbours

The project site boundary is located approximately 2 km from the nearest residential areas. There is little likelihood of a significant noise impact on these areas from the power station during the operational stage.

In any case, the plant will follow good design and construction practices and implement the mitigation measures including those described below.

The main sources of noise emissions will be the:

- Gas Turbines;
- Gas Compressors (if required);
- HRSG;
- Cooling tower; and

- Transformers

Noise reduction measures in the design will include:

- Silencing of the gas turbine inlets;
- Locating the steam turbine inside a building;
- Limiting noise emissions from any gas compressors, building ventilation fans, transformers etc.;
- Buildings will be lined and cladded as required;
- Safety valves will have silencers fitted, where necessary; and
- Noise sources will be directed away from the most sensitive receptors.

The EPC Contractor will implement measures to achieve the maximum allowable noise levels of 85dBA at 1m from the equipment and 70dBA at the plant boundary.

Noise will be monitored during operation to check that, other than during emergencies, noise emissions are within the acceptable limits, identified below.

Table 31: Noise reduction details

Source of Noise Criteria	Noise Criteria	Day-time	Night-time
		$L_{Aeq1\ hr}$	$L_{Aeq1\ hr}$
World Bank Guidelines	Industrial / Commercial	70 dB(A)	70 dB(A)
	Residential	55 dB(A)	45 dB(A)

10.6 Solid Waste management

The power plant will not produce any bulk solid wastes such as ash or sludge as are generated in a coal fired power station or some industrial processing facilities. Solid wastes are minimal and will generally be as the result of maintenance or housekeeping activities and may include items such as

- Old pipework, steel work, cabling, instrumentation etc., replaced due to upgrades or modifications;
- Consumable items e.g. oil and air filters; and
- Maintenance items, e.g. rags, containers for paints or chemicals etc.

Where possible, items will be recycled. Otherwise, solid wastes will be disposed to a licensed facility nearby.

10.7 Hazardous and toxic substances

According to the Indonesian Government Regulation No. 101 Year 2014 on the Treatment of Hazardous and Toxic Waste, a hazardous substance is a substance, energy, and/or other components that is due to its properties, concentration and/or quantity, either directly or indirectly, can pollute and/or damage the environment, and/or endanger the environment, the health and well-being of human and other living creatures.

The following is a list of typical chemicals and their storage quantities for CCGT plant of this size.

Table 32 - Sample list of Chemicals Stored Onsite for a Typical Combined Cycle Plant

Chemical/Product	Storage Quantity	General Use of Chemical
Sulphuric acid	10,000 L	Demineralisation system
Hydrochloric acid	10,000 L	Demineralisation and cooling water systems
Scale inhibitor	10,000 L	Cooling water systems
Caustic (e.g. NaOH)	10,000 L	Demineralisation system
Turbine oils (e.g. Terrestic 32 or 68, Exxon)	5,000 L	Turbines, pumps, air compressor, lubrication
SAE 15 W - 40 Oil	600 L	Diesel fire pumps
Hydraulic fluid	1,000 L	Steam turbine electrohydraulic fluid
Ammonia (NH_3)		Boiler water treatment
Trisodium Phosphate	100 kg	Boiler water treatment
Sodium Hypochlorite	100 L	Water treatment biocide for raw water and possible for cooling water
Insulating Oil (non PCB)	1,000 L	Transformers
O_2 Scavenger	500 L	Deaerator tanks
Misc. Chemical Reagents for Water Laboratory	50 kg	Water testing lab chemicals
Water Wash Liquid	1,000 L	GT water wash
CO_2	4,000 kg	Fire protection
Miscellaneous oils, reagents, chemicals, thinners etc. used for O&M activities		

The hazardous substances listed are not waste products but chemicals used in the general maintenance of the station.

All chemicals and hazardous substances will be stored in secure locations on site and waste materials will be trucked from site for proper disposal where appropriate.

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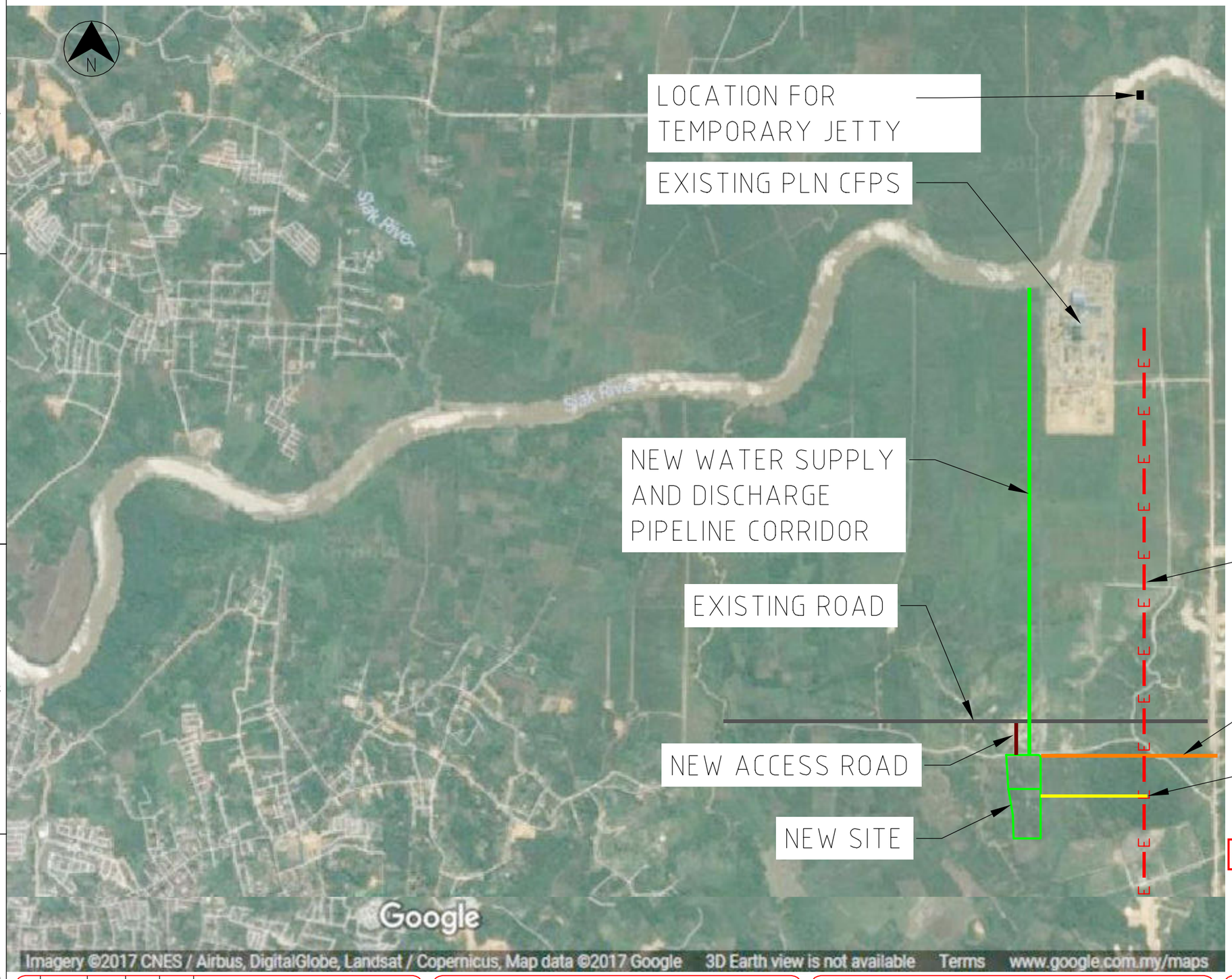
Appendix A. Power Plant Site Location and Layout Drawings



PRELIMINARY FOR INFORMATION ONLY

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D	18/01/18	JL	EM	EM	REVISED WATER PIPELINE
C	08/01/18	JL	EM	EM	REVISED GRID CONNECTION
B	06/12/17	JL	EM	EM	REVISED ISSUE
A	29/06/17	JL	EM	EM	PRELIMINARY ISSUE

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CLIENT
MEDCO RATCH POWER RIAU

PROJECT
RIAU 275 MW GFPP
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DRAWN	DRAWING CHECK	REVIEWED	APPROVED
JL	.	.	EM
DESIGNED	DESIGN REVIEW	DATE .	DATE .
EM	.		

TITLE
GENERAL AREA, FOOTPRINT, AND SERVICE CONNECTIONS

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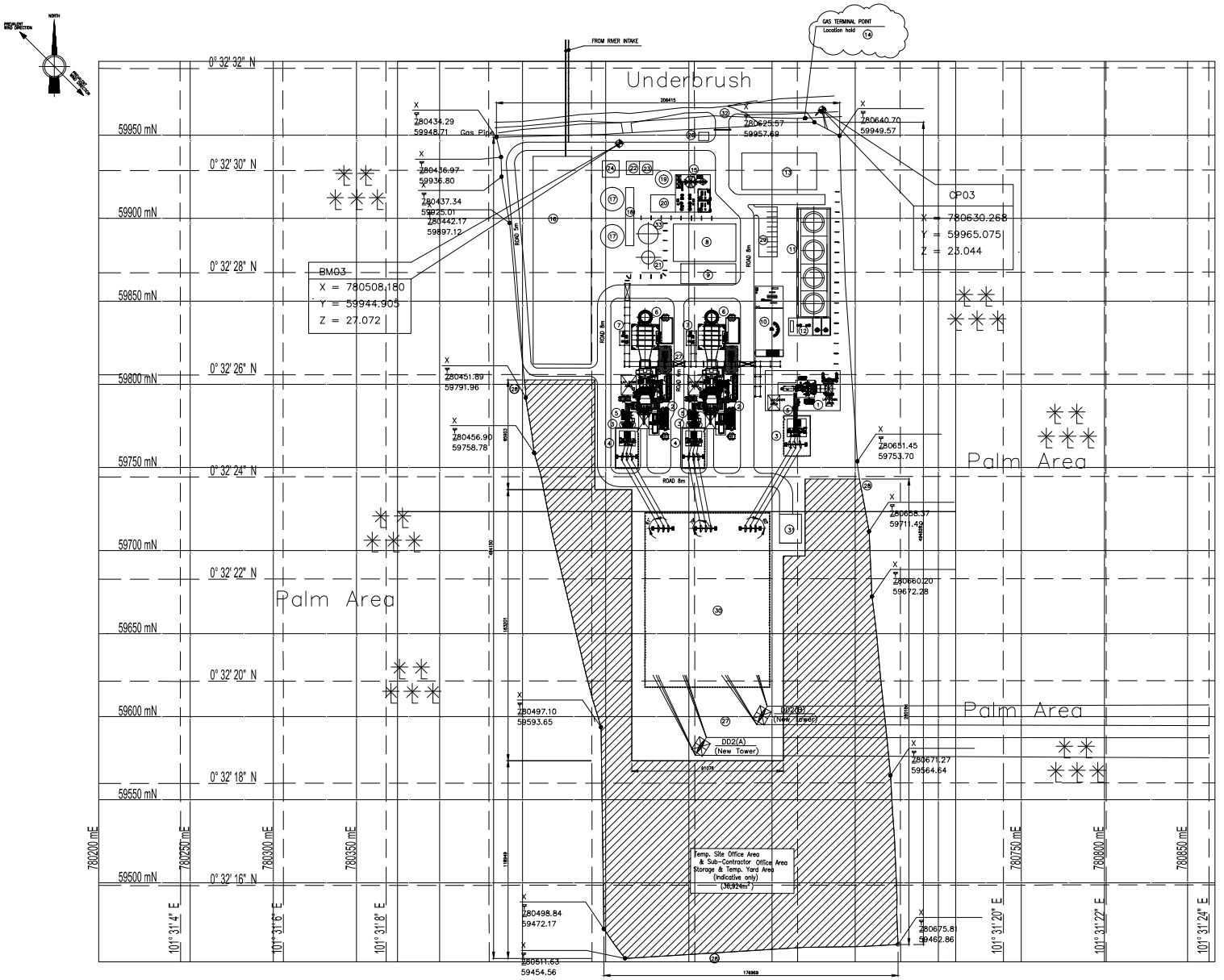
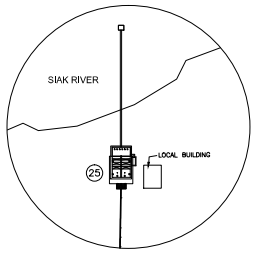




RIVER INTAKE
(NON SCALE)

#	LEGEND:
1	STEAM TURBINE BUILDING
2	GAS TURBINE
3	UNIT AUXILIARY TRANSFORMER
4	GENERATOR STEPUP TRANSFORMER
5	GCB
6	HEAT RECOVERY STEAM GENERATOR
7	HP/IP FEED WATER PUMP SHELTER
8	WORKSHOP/ WAREHOUSE BUILDING
9	BLACK START DIESEL GENERATOR AREA
10	ADMIN. & CENTRAL CONTROL BUILDING
11	COOLING TOWER STRUCTURE
12	CIRCULATING WATER PUMP
13	FUEL GAS CONDITIONING/COMPRESSOR AREA
14	GAS TERMINAL POINT
15	WATER/WASTE WATER TREATMENT PLANT
16	RAW WATER RESERVOIR
17	CLARIFIER
18	CLARIFIED WATER POND
19	SLUDGE DEHYDRATOR
20	WATER TREATMENT PUMP/FIRE WATER PUMP AREA
21	DEMINERALIZED WATER TANK
22	NORMAL WASTE WATER POND
23	ABNORMAL WASTE WATER POND
24	FINAL DISPOSAL POND
25	RIVER WATER INTAKE STRUCTURE/PUMP HOUSE
26	GUARD HOUSE
27	INTERMEDIATE TOWER
28	BOUNDARY FENCE
29	PARKING AREA
30	150kV SUBSTATION
31	SWITCHYARD CONTROL BUILDING
32	ROAD TERMINAL POINT
33	SERVICE WATER TANK

FOR PRELIMINARY

REV.	ISSUE DATE	DESCRIPTION	DRN	DGN	CHK	APP
A	2017.9.29	FOR PRELIMINARY	S.I KIM	Y.K MOON	E.Z SUNG	K.S LEE

PROJECT:
Riau GFPP (275MW) IPP Project

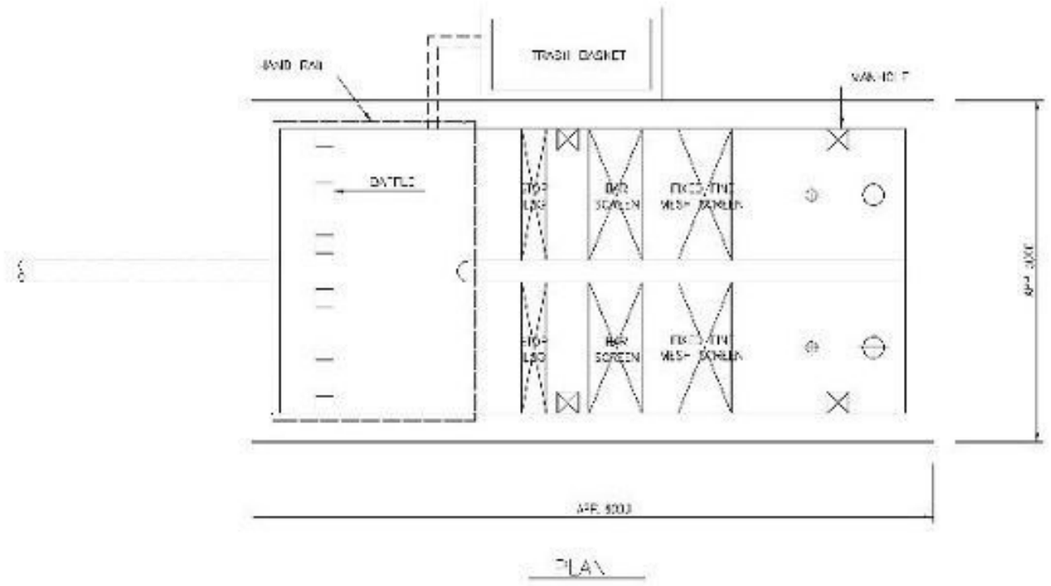
PT. PERUSAHAAN LISTRIK NEGARA (PERSERO)
AGENCY OF THE MINISTRY OF MINES AND ENERGY GOVERNMENT OF THE REPUBLIC OF INDONESIA

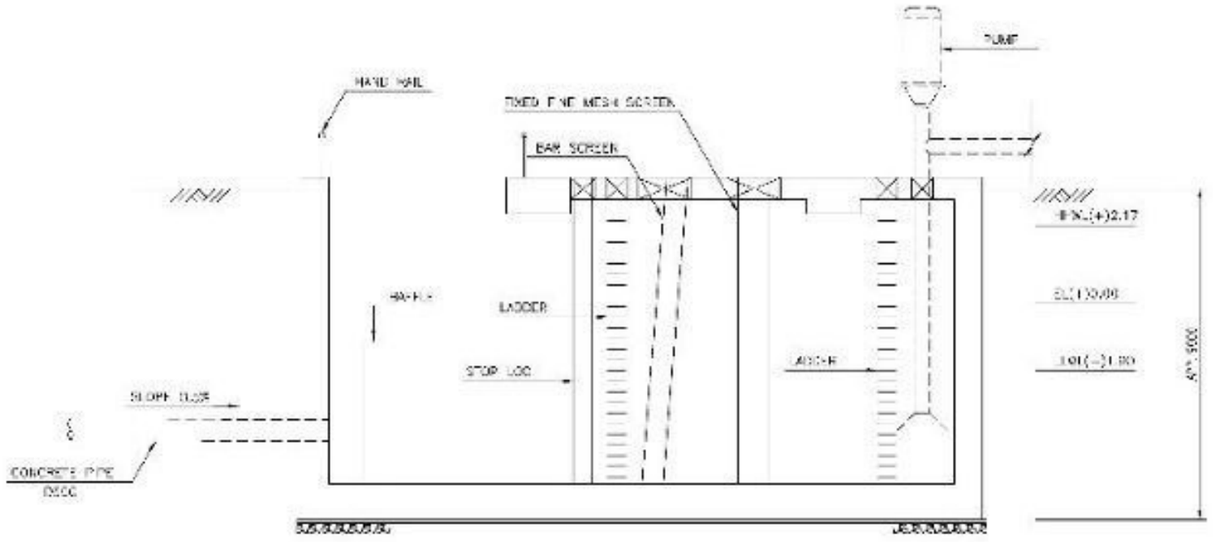
MRPR Mineral Resources Power Plant

LOTTE E&C

TITLE:
PLOT PLAN

SCALE	DRAWING NUMBER	SHEET NO.	REV.
1/850	RIAU-P-PP-001	1/1	A





NOTE

1. DETAIL DESIGN PARAMETERS SHALL BE DETERMINED DURING DETAIL ENGINEERING PHASE

FOR PRELIMINARY

NO.	ISSUE DATE	DESCRIPTION	DES'N	DRAWN	CHK	APP
0		FOR PRELIMINARY	JRH	JOY	CHK	APP

Riau GFPP (250MW) IPP Project

PT. PEMBANGKITAN LISTRIK NEGARA (PERSERO)

MRPR

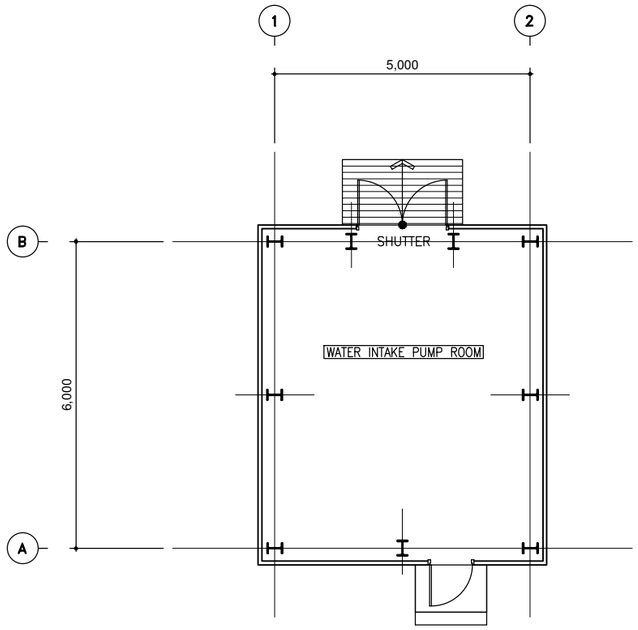
LOTTE E&C

RIVER WATER INTAKE STRUCTURE
PLAN & SECTION

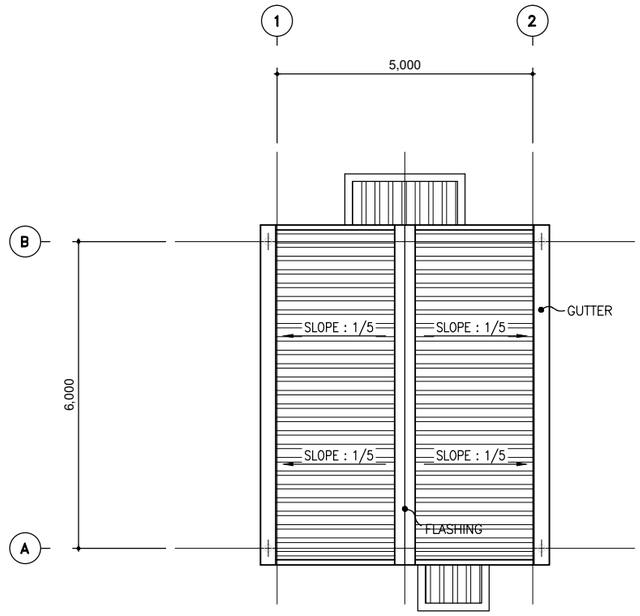
SCALE	DRAWING NO.	SHEET NO.	REV.
NONE	C-001	1/1	0

DWG NO. RIAU – A – WP-001

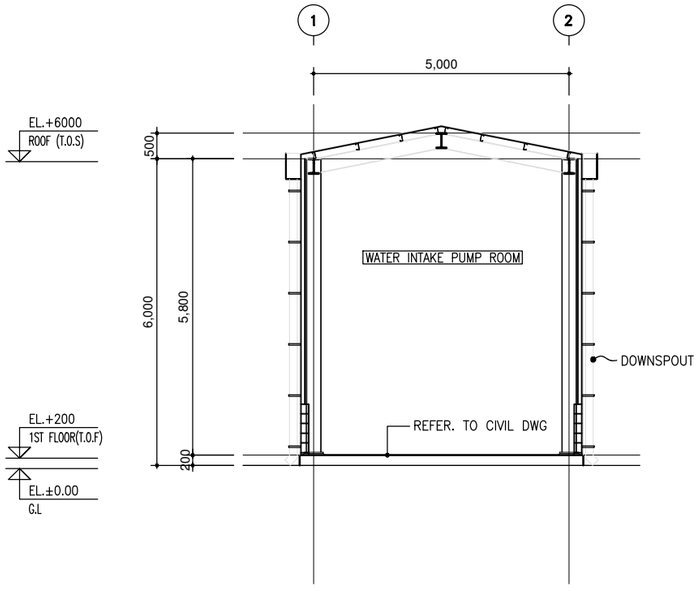
PN



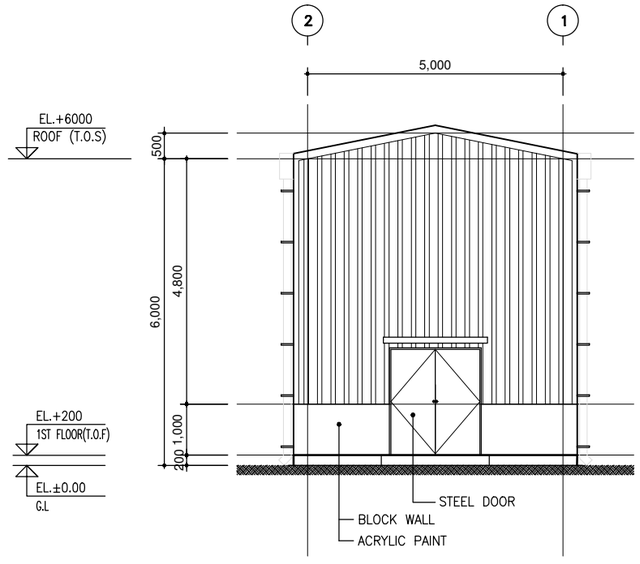
1 1ST FLOOR PLAN



2 ROOF PLAN



3 SECTION



4 ELEVATION (NORTH)

NOTES

1. Detail design parameters shall be determined during detail engineering phase

FOR PRELIMINARY

REV.	ISSUE DATE	DESCRIPTION	DRN	DGN	CHK	APP
A	2017.8.4	FOR PRELIMINARY	S.C.YOON	B.S.KO	K.Y.KIM	K.S.LEE

PROJECT :

Riau GFPP (275MW) IPP Project

PT. PERUSAHAAN LISTRIK NEGARA (PERSERO)

AGENCY OF THE MINISTRY OF MINES AND ENERGY
GOVERMENT OF THE REPUBLIC OF INDONESIA

MRPR
Medco Patch Power Riau

LOTTE E&C

TITLE

WATER INTAKE PUMP HOUSE
FLOOR & ROOF PLAN, SECTION, ELEV.

SCALE	DRAWING NUMBER	SHEET NO.	REV.
-	RIAU – A – WP-001	1/1	A

DWG NO. RIAU-E-SL-001

150kV Transmission Line 1

150kV Transmission Line 1

150kV Transmission Line 2

150kV Transmission Line 2

Gantry & Steel Tower (150kV O.H.L)

LINE TRAP, CVT

150kV, 3Ø, 50Hz, 2500A, 40kA, BUS-1

150kV, 3Ø, 50Hz, 2500A, 40kA, BUS-2

CVT

ES

DS

CT

LA

STEP UP TR. #1
150-11.5kV, 3PH, YNd1
[ ]/[ ] MVA, ONAN/ONAF
%Z=14% @ ONAN
OLTC, ±10%, 1.25% Step

STEP UP TR. #2
150-11.5kV, 3PH, YNd1
[ ]/[ ] MVA, ONAN/ONAF
%Z=14% @ ONAN
OLTC, ±10%, 1.25% Step

STEP UP TR. #3
150-15kV, 3PH, YNd1
[ ]/[ ] MVA, ONAN/ONAF
%Z=14% @ ONAN
OLTC, ±10%, 1.25% Step

IPB 6000A

IPB 1000A

IPB 9000A

VT

GTG-1
11.5kV, 3Ø, 50Hz, 98MVA
PF=0.85 lag

GTG-2
11.5kV, 3Ø, 50Hz, 98MVA
PF=0.85 lag

GEN CB #1 15kV

GEN CB #2 15kV

GEN CB #3 15kV

STG
15kV, 3Ø, 50Hz, 152.5MVA
PF=0.85 lag

VCB 7.2kV 2000A

UNIT AUX. TR GT#1
11.5-6.3kV, Dyn11
NLTC, ±5%
[ ]/[ ]MVA (ONAN/ONAF)
%Z=12% @ ONAN

UNIT AUX. TR GT#2
11.5-6.3kV, Dyn11
NLTC, ±5%
[ ]/[ ]MVA (ONAN/ONAF)
%Z=12% @ ONAN

BLACKSTART D.G
6.3kV
3Ø, 50Hz
1200kW x 4EA
PF=0.8lag

DG

VCB 7.2kV 630A

3PH, 50Hz, 6.3kV, 800A, 40kA

VCB 7.2kV 630A

3PH, 50Hz, 6.3kV, 2000A, 40kA, BUS-1

3PH, 50Hz, 6.3kV, 2000A, 40kA, BUS-2

AUX. TR-1
6.0-0.4kV
Dyn1
[ ]/[ ]MVA(AN/AF)
%Z=8% @ AF (TYP.)

AUX. TR-2
6.0-0.4kV
Dyn1
[ ]/[ ]MVA(AN/AF)
%Z=8% @ AF (TYP.)

AUX. TR-3
6.0-0.4kV
Dyn1
[ ]/[ ]MVA(AN/AF)
%Z=8% @ AF (TYP.)

AUX. TR-4
6.0-0.4kV
Dyn1
[ ]/[ ]MVA(AN/AF)
%Z=8% @ AF (TYP.)

AUX. TR-5
6.0-0.4kV
Dyn1
[ ]/[ ]MVA(AN/AF)
%Z=8% @ AF (TYP.)

AUX. TR-6
6.0-0.4kV
Dyn1
[ ]/[ ]MVA(AN/AF)
%Z=8% @ AF (TYP.)

AUX. TR-7
6.0-0.4kV
Dyn1
[ ]MVA(AN)
%Z=6% @ AN

CABLE

DS

ACB 3200A

ACB 630A

GT#1 SFC

GT#2 SFC

BFP #1, #2

BFP #3, #4

C.W. Pump #2

C.W. Pump #1

Gas Compressor #1

Gas Compressor #2

3PH, 50Hz, 400V, 3200A, 50kA, PDC-1

3PH, 50Hz, 400V, 3200A, 50kA, PDC-2

3PH, 50Hz, 400V, 3200A, 50kA, PDC-3

3PH, 50Hz, 400V, 3200A, 50kA, PDC-4

3PH, 50Hz, 400V, 3200A, 50kA, PDC-5

3PH, 50Hz, 400V, 3200A, 50kA, PDC-6

3PH, 50Hz, 400V, Intake Water MCC

GT MCC #1

ST MCC

GT MCC #2

MOV PDB

MCCB

LTG-TR#1
400-380
/220V
[ ]kVA

LTG-TR #2
400-380
/220V
[ ]kVA

NORMAL LTG PDB

CHARGER 220V DC [ ]A

220V DC BATTERY [ ]AH

220V DC DIST. BOARD -1

220V DC DIST. BOARD -2

INVERTER [ ]KVA

LINE VOLTAGE REGULATOR

STATIC TRANSF SW

MANUAL TRANSF SW

400/230V, AC UPS DIST. BOARD -1

400/230V, AC UPS DIST. BOARD -2

110V DC DIST. BOARD

DC SYSTEM FOR PROTECTION, SWGR, CONTROL

DC SYSTEM FOR GTG #1, 2

INVERTER 30KVA

230V, AC UPS DIST. BOARD

UPS SYSTEM FOR GTG #1, 2

FOR PRELIMINARY

REV.	ISSUE DATE	DESCRIPTION	DRN	DGN	CHK	APP
A	04. AUG '17	FOR PRELIMINARY	K.S LEE	J.H SHIM	E.J SEONG	K.S LEE

PROJECT :

Riau GFPP (275MW) IPP Project

PT. PERUSAHAAN LISTRIK NEGARA (PERSERO)

AGENCY OF THE MINISTRY OF MINES AND ENERGY
GOVERMENT OF THE REPUBLIC OF INDONESIA

MRPR Medco Ratch Power Riau

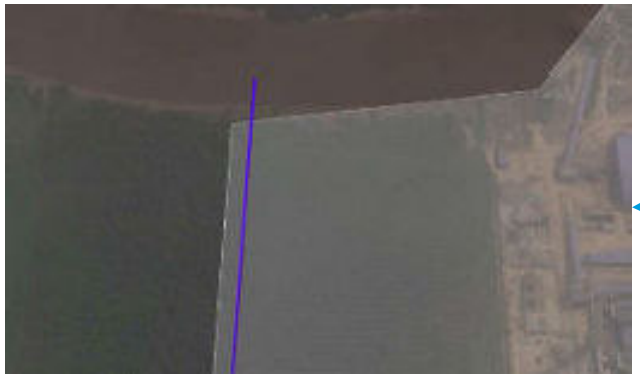
LOTTE E&C

TITLE:

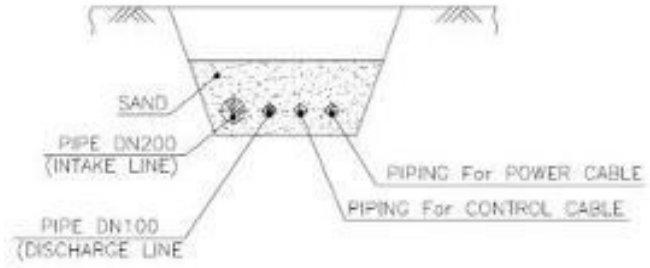
KEY SINGLE LINE DIAGRAM

SCALE	DRAWING NUMBER	SHEET NO.	REV.
NONE	RIAU-E-SL-001	1/1	A

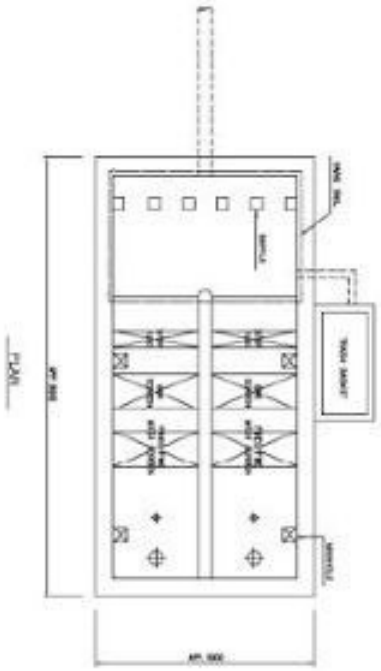
Water Intake Pipeline



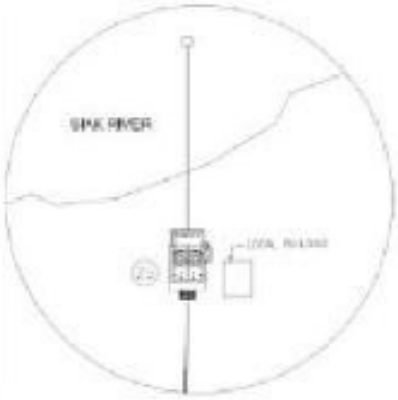
Water Intake Pipeline 3km x 6m width (2m pipe + 4m workway)

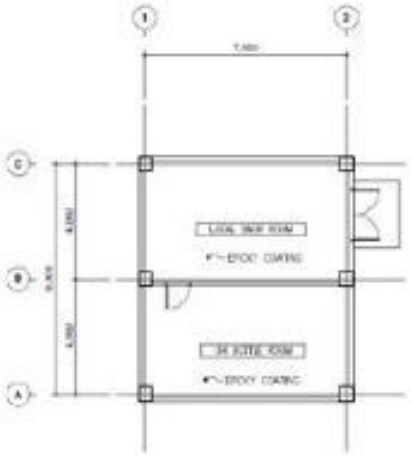


River Water Intake Structure and Water Intake Building



River Water Intake Structure / Underground



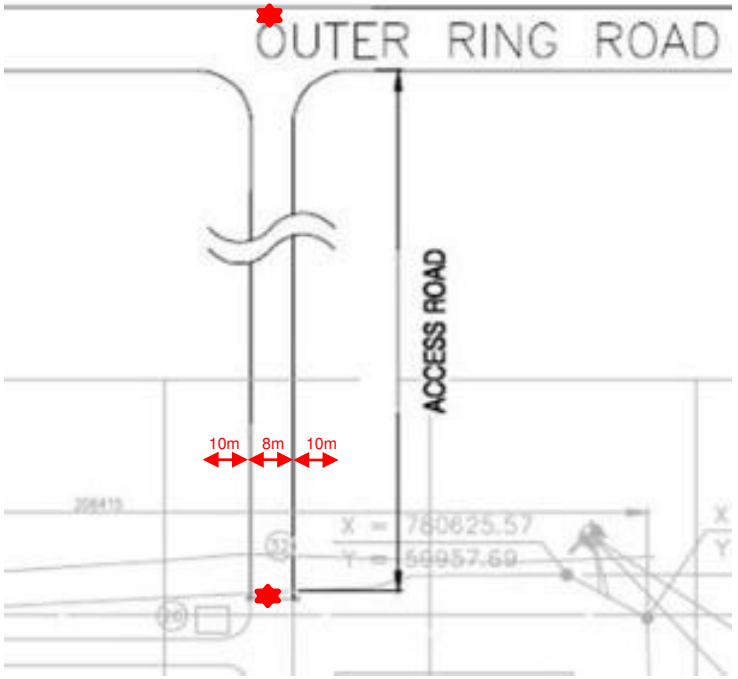


Water Intake Building

Considering interconnection between both structures, Area (50 m x 40 m) is required.

Access Road

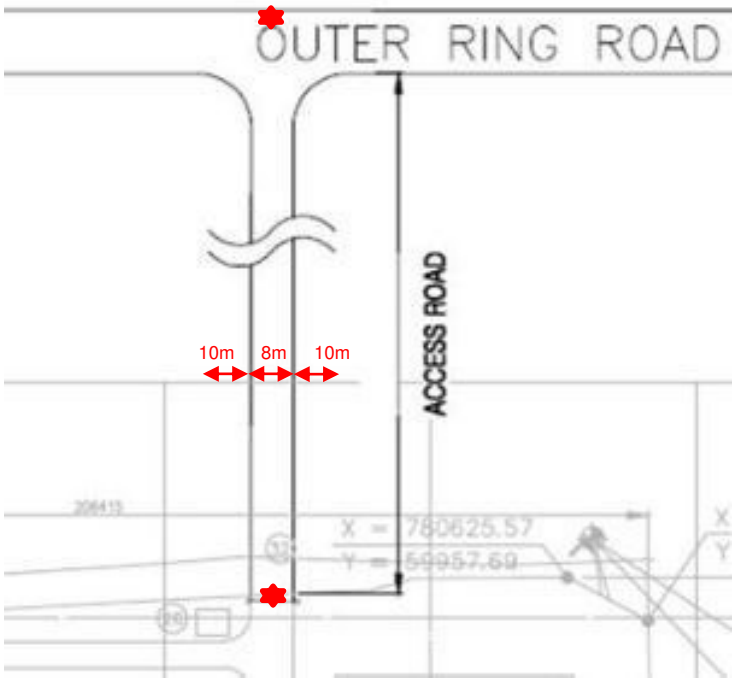
Lokasi	Koordinat
Entrance at site boundary (FGL +28m)	780570.00 m E 59953.00 m N
Outer Ring Road (using google map GL +16m)	780570.00 m E 60153.00 m N



Access Road (two- lane) 28 m x 200 m

8m is paving road and 10mx2(both side) is slope area

LEC - Coordinate for Access Road (move to left)



Access Road (two-lane) 28 m x 200 m

8m is paving road and 10mx2(both side) is slope area

Required area remains unchanged.

Previous Coordinate

Location	Coordinate
Entrance at site boundary (FGL +28m)	780570.00 m E 59953.00 m N
Outer Ring Road (using google map GL +16m)	780570.00 m E 60153.00 m N

Revised Coordinate

Location	Coordinate
Entrance at site boundary (FGL +28m)	780488 m E 59949.00 m N
Outer Ring Road (using google map GL +16m)	780488.00 m E 60149.00 m N

LEC revise access road location by following water intake pipeline. Around **82m to shift** from previous location.

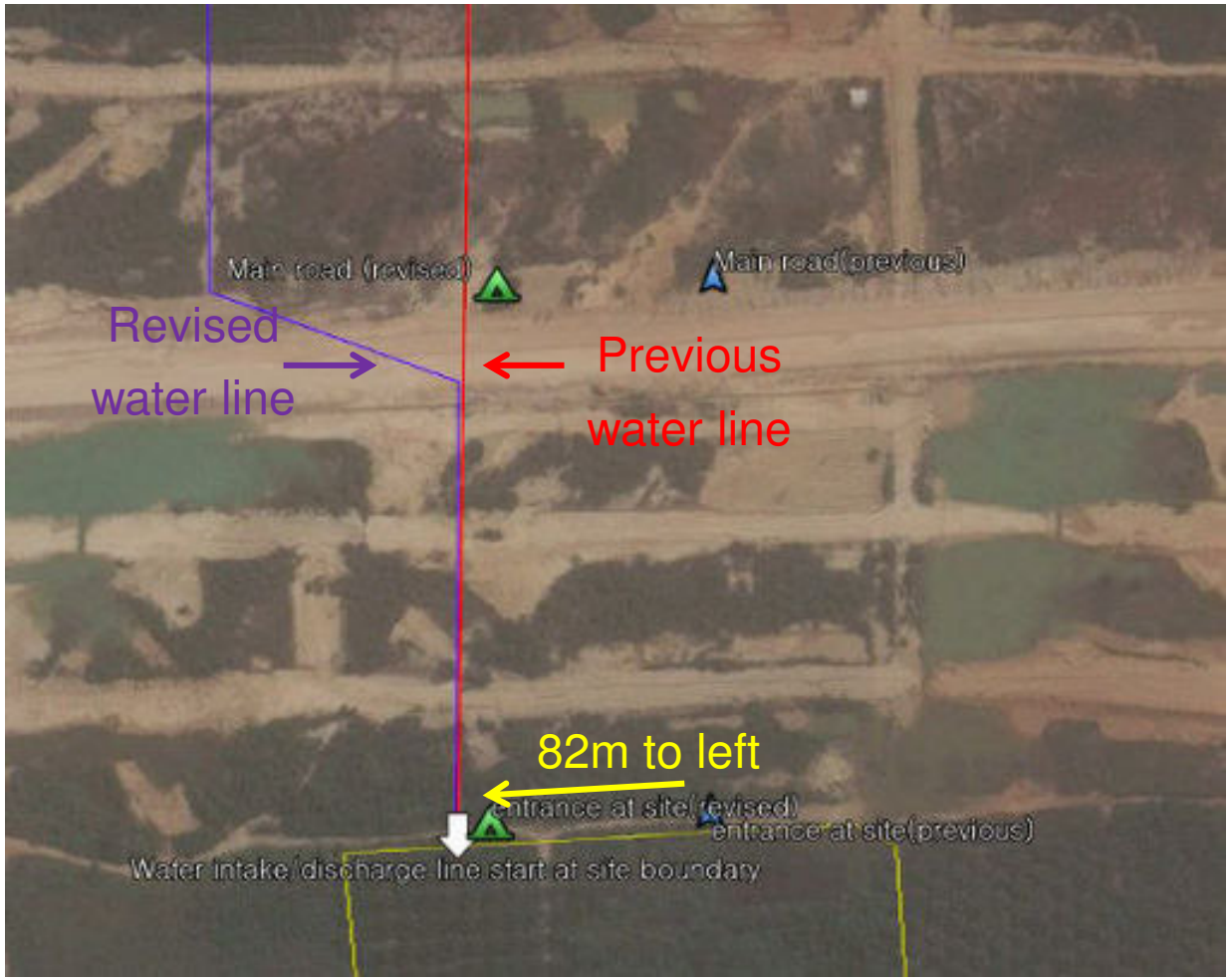
Revised plot plan will be provided later if Owner need to receive it.

LEC - Access Road (move to left)

◆ Location for Water intake pipe line (including discharge pipeline)

Start point at site boundary	Finish point nearby siak river
	
780476.00 m E 59945.00 m N	780357.29 m E 62691.00 m N (This coordinate is suggested by Owner. LEC will follow this location.)

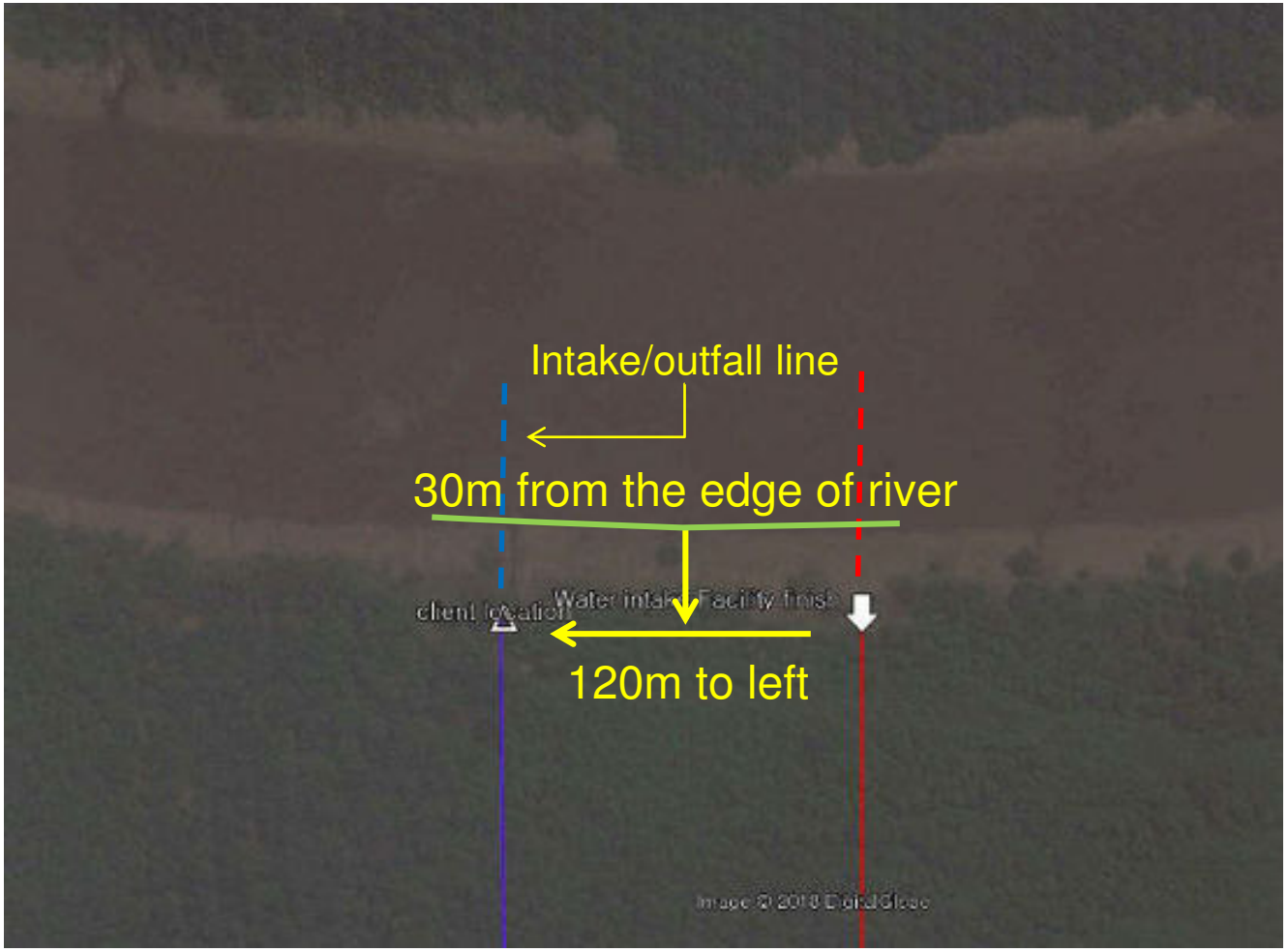
LEC – Revised water intake/discharge pipe line route



→ Revised water intake line (purple)

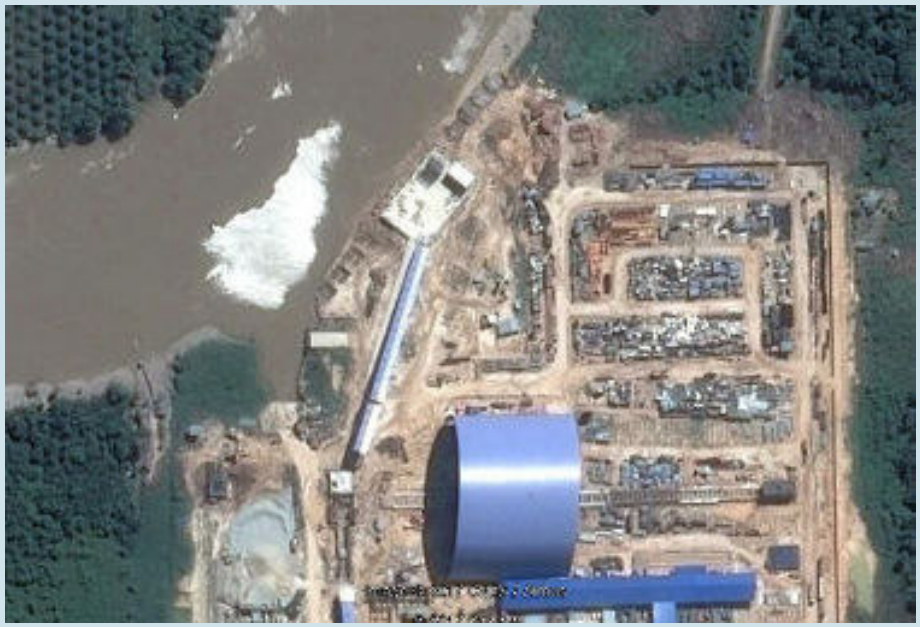
→ Previous water intake line (red)

LEC – Revised water intake facility location



Water intake facility to move around 120m left according to suggestion by Owner. In addition, facility is needed 30m from the edge of river. Required area (50m x 40m) remains unchanged.

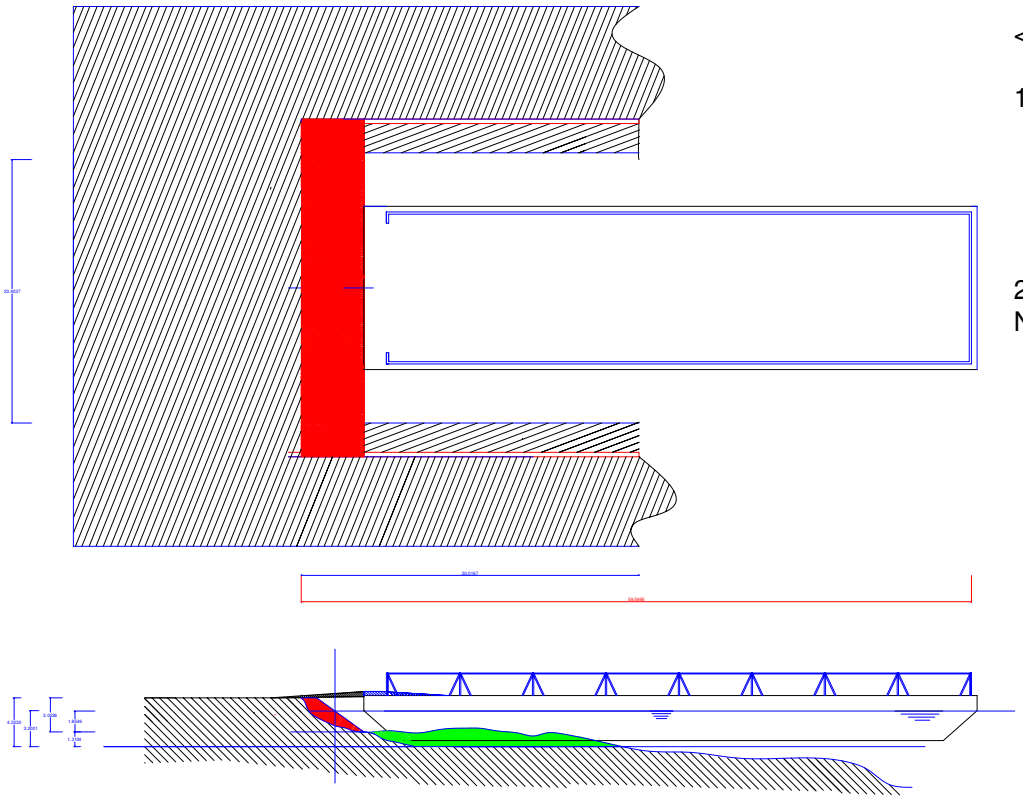
◆ Possible Location for temporary jetty / RoW

Inside Tenayan CFPP	Area adjacent to labor camp in Tenayan
	
To use permanent or temporary jetty in Tenayan CFPP	To build temporary jetty in siak river bank adjacent to Tenayan CFPP Coordinate : 781196.00 m E 63803.00 m N (Location is indicated as above “ ”)

Temp. Jetty / 70 m x 100 m

◆ Temporary Jetty to Site Route / RoW (5.3 km)

◆ Preliminary Temporary Jetty Design



<Permit>

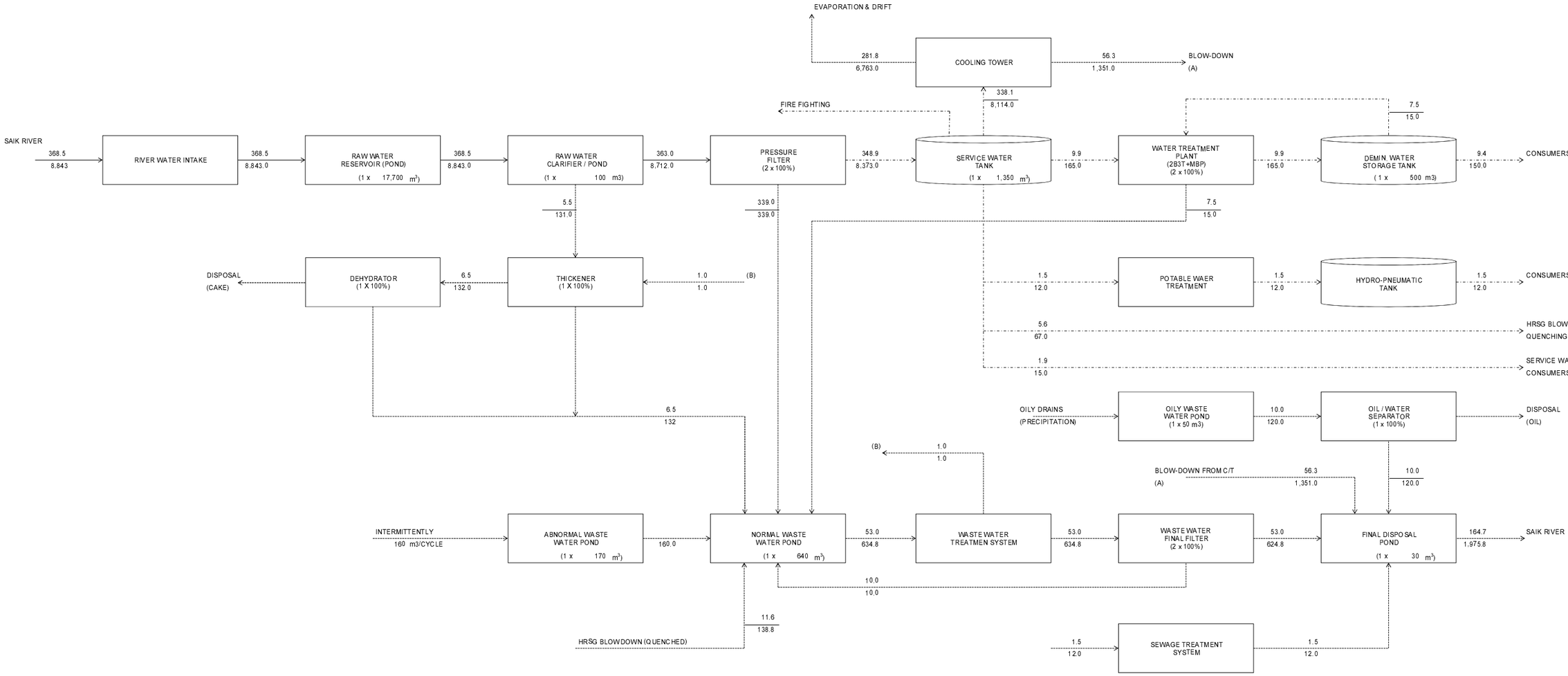
1. Temporary jetty/dredging permit from…
   - Dept. of Transportation
   - Directorate of River transportation
   - Directorate of port and dredging facilities
   - Local port & authorities in Riau

2. Evaluation of safety for environmental impact by local NGO(s) and local leaders

<Description>

For tunnel, sheet pile & wire sling for stud will be installed in both wall of tunnel.
For head (red area), splitstone and sandbag will be installed in river bank.
Dredging will be required subject to siak river condition of river bottom. (green area)
To construct temporary jetty, it takes 3~4 months. (To remove jetty, 1 month to be required)
Temporary jetty`s capacity is upto 270ft barge available.

Appendix B. Water Flow / Balance Diagram and Other Water Related Drawings and Information



FOR PRELIMINARY

Legends:

Raw Water ——→

Treated Water - - - →

Waste Water (Oily, Sanitary) ——→

Notes:

1. Design Condition : BMCR 100% Load at RSC Conditions (28T, 80% RH, 1.010 bar)
2. The capacity of demineralization is estimated by 2.0 % of steam generation flow at base load
3. The raw water reservoir is sized based on 2 days full load operation.
4. Flow rate = t/h (hourly max.) / t/day (ave.)
5. The details are subject to change as per detail design information.

REV.	DATE	DESCRIPTION	PREPARED	REVIEWED	APPROVED
A	17.Aug.2017	Issued For Proposal	I.S.CHO	-	K.S.LEE

PROJECT :

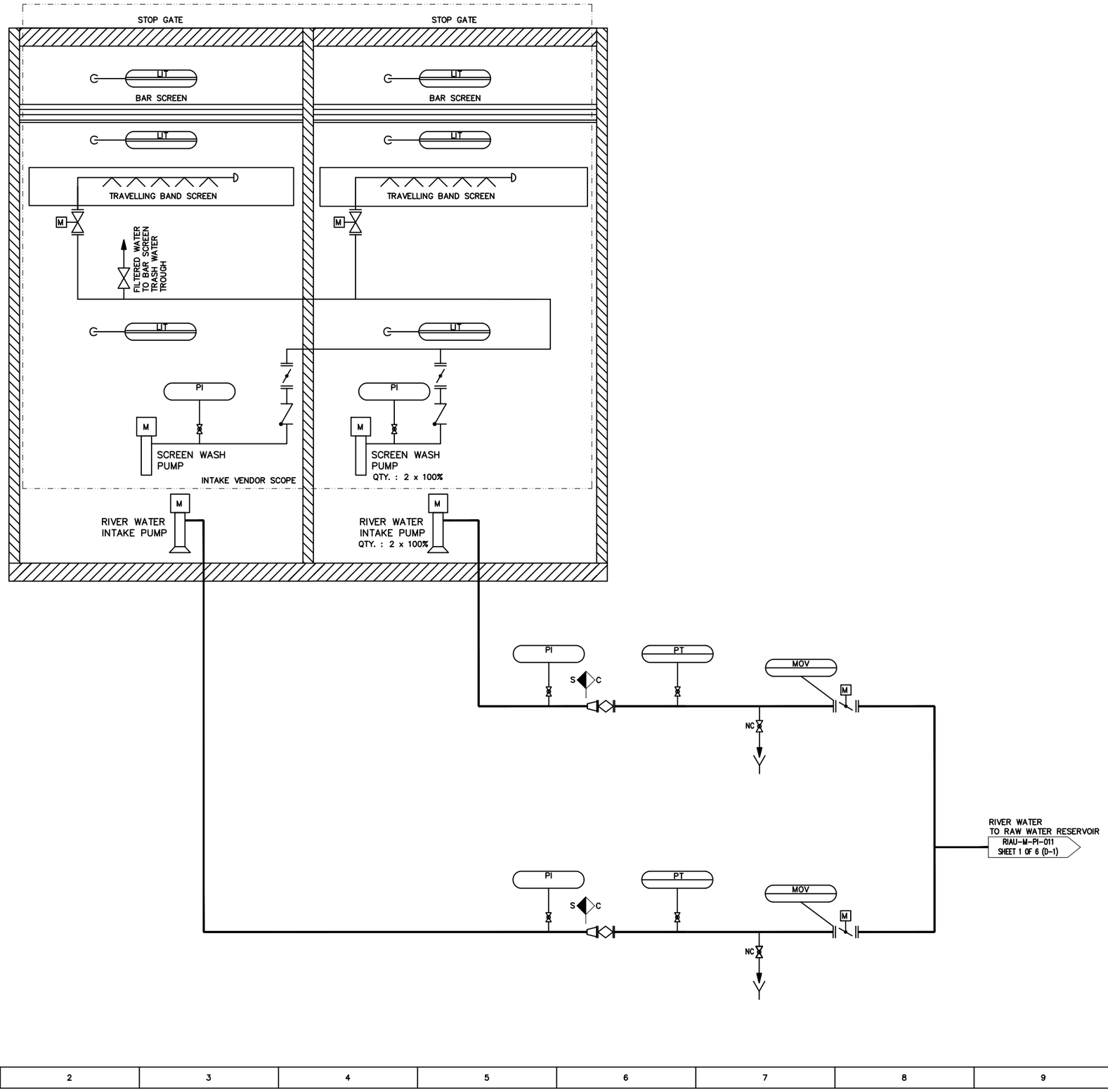
Riau GFPP(275MW) IPP Project

PT. PERUSAHAAN LISTRIK NEGARA (PERSERO)

MRPR

LOTTE E&C

Title	WATER BALANCE DIAGRAM (RAW WATER RESERVOIR POND) RSC (100% GT Load)
DWG NO.	RIAU-M-WB-001
JOB NO	MULTISCALE / SCALE NONE / REV. A



FOR PRELIMINARY

	SIGN.											
	INITIALS											
	REVISIONS											
	SIGN.											
	INITIALS											
	REVISIONS											
A	SIGN.											
	INITIALS											29SEP2017
	REVISIONS	PRELIMINARY										
ISSUE		DRN	DSN	CHD	CV	EL	IC	ME		PE/PM	APPD	DATE
					CLEARED							

PROJECT :

Riau GFPP (275MW) IPP Project

PT. PERUSAHAAN LISTRIK NEGARA (PERSERO)

AGENCY OF THE MINISTRY OF MINES AND ENERGY
GOVERMENT OF THE REPUBLIC OF INDONESIA

MRPR
Medco Ratch Power Riau

LOTTE E&C

TITLE :

P & I DIAGRAM
RIVER WATER INTAKE SYSTEM

SHEET 1 OF 1

OWNER DOCUMENT NUMBER :

SCALE :	DWG NO.	ISSUE
	RIAU-M-PI-015	A

SIZE-A3

NOTE.
1. SCOPE OF SUPPLY
C: EPC CONTRACTOR
V: VENDOR (SUPPLIER)

RAW WATER RESERVOIR
(1 x 100%)

RAW WATER SUPPLY PUMP
(2 x 100%)

RIVER WATER PUMPING FACILITY
RIAU-M-PI-015
SHEET 1 OF 1 (G-9)

INLINE MIXER

CLARIFIER
(1 x 100%)

CLARIFIED WATER POND
(1 x 100%)

CLARIFIED WATER PUMP
(2 x 100%)

SERVICE WATER TANK LIT
RIAU-M-PI-011
SHEET 2 OF 6 (B-1)

PRESSURE FILTER
RIAU-M-PI-011
SHEET 2 OF 6 (C-1)

SLUDGE COLLECTION POND
RIAU-M-PI-013
SHEET 3 OF 3 (D-1)

SLUDGE COLLECTION POND
RIAU-M-PI-013
SHEET 3 OF 3 (D-1)

SLUDGE PUMP FOR CLARIFIER
(2 x 100%)

POLYMER INJECTION PUMP
RIAU-M-PI-013
SHEET 2 OF 3 (C-1)

LINE MIXER (POTABLE WATER)
RIAU-M-PI-011
SHEET 2 OF 6 (H-1)

NaOH STORAGE TANK
RIAU-M-PI-011
SHEET 5 OF 6 (B-1)

HYDRO PNEUMATIC TANK
RIAU-M-PI-011
SHEET 2 OF 6 (F-1)

NaOH UNLOADING PUMP
RIAU-M-PI-011
SHEET 5 OF 6 (B-1)

BIOCIDE (NaOCl)
INJECTION TANK
(1 x 100%)

BIOCIDE (NaOCl)
INJECTION PUMP
(2 x 100%)

BIOCIDE INJECTION PUMP
FOR POTABLE
(2 x 100%)

CAUSTIC SODA (NaOH)
INJECTION TANK
(1 x 100%)

CAUSTIC SODA (NaOH)
INJECTION PUMP
(2 x 100%)

ALUM
INJECTION PUMP
(2 x 100%)

ALUM
INJECTION TANK
(1 x 100%)

FOR PRELIMINARY

	SIGN.										
	INITIALS										
	REVISIONS										
	SIGN.										
	INITIALS										
	REVISIONS										
A	SIGN.										29SEP2017
	INITIALS										
	REVISIONS	PRELIMINARY									

ISSUE		DRN	DSN	CHD	CV	EL	IC	ME	PE/PM	APPD	DATE
					CLEARED						

PROJECT :
Riau GFPP (275MW) IPP Project

PT. PERUSAHAAN LISTRIK NEGARA (PERSERO)
AGENCY OF THE MINISTRY OF MINES AND ENERGY
GOVERMENT OF THE REPUBLIC OF INDONESIA

MRPR
Medco Ratch Power Riau

LOTTE E&C

TITLE :
P & I DIAGRAM
WATER TREATMENT SYSTEM
SHEET 1 OF 6

OWNER DOCUMENT NUMBER :

SCALE :	DWG NO.	ISSUE
	RIAU-M-PI-011	A

SIZE-A3

NOTE
1. SCOPE OF SUPPLY
C: EPC CONTRACTOR
V: VENDOR (SUPPLIER)

LCV & CLARIFIED WATER PUMP
RIAU-M-PI-011
SHEET 1 OF 6 (B-10)

CLARIFIED WATER PUMP
RIAU-M-PI-011
SHEET 1 OF 6 (C-10)

PRESSURE FILTER
(2 x 100%)

SERVICE WATER TANK
(1 x 100%)

PRESSURE FILTER BACKWASH PUMP
(2 x 100%)

FILTERED WATER PUMP
(2 x 100%)

COOLING TOWER MAKEUP PUMP
(2 x 100%)

POTABLE WATER PUMP
(2 x 100%)

POTABLE A/C FILTER
SERVICE, STOP CONTROL

HYDRO-PNEUMATIC TANK
(1 x 100%)

A/C FILTER FOR
POTABLE WATER
(1 x 100%)

SERVICE AIR RECEIVER
RIAU-M-PI-011
SHEET 6 OF 6 (C-1)

CHEMICAL TANK (WWT)
RIAU-M-PI-013
SHEET 1 OF 3 (A-1)

FUME SCRUBBER
RIAU-M-PI-011
SHEET 5 OF 6 (E-1)

ACTIVATED CARBON FILTER
RIAU-M-PI-011
SHEET 3 OF 6 (E-1)

FIRE PUMP SUCTION
LATER

COOLING TOWER BASIN
RIAU-M-PI-017
SHEET 1 OF 3 (C-3)

HRSG B/D QUENCHING
LATER

CHEMICAL TANK (CLARIFIER)
RIAU-M-PI-011
SHEET 1 OF 6 (E-10)

CONTROL/ELECTRICAL BUILDING
LATER

GIS SUB-STATION BUILDING
LATER

WATER TREATMENT BUILDING
LATER

NaOCl INJECTION PUMP (POTABLE)
RIAU-M-PI-011
SHEET 1 OF 6 (E-10)

FOR PRELIMINARY

	SIGN.										
	INITIALS										
	REVISIONS										
	SIGN.										
	INITIALS										
	REVISIONS										
A	SIGN.										29SEP2017
	INITIALS										
	REVISIONS	PRELIMINARY									

ISSUE		DRN	DSN	CHD	CV	EL	IC	ME	PE/PM	APPD	DATE
					CLEARED						

PROJECT :
Riau GFPP (275MW) IPP Project

PT. PERUSAHAAN LISTRIK NEGARA (PERSERO)
AGENCY OF THE MINISTRY OF MINES AND ENERGY
GOVERMENT OF THE REPUBLIC OF INDONESIA

MRPR
Medco Ratch Power Riau

LOTTE E&C

TITLE :
P & I DIAGRAM
WATER TREATMENT SYSTEM
SHEET 2 OF 6

OWNER DOCUMENT NUMBER :

SCALE :
DWG NO. RIAU-M-PI-011
ISSUE A
SIZE-A3

NOTE.
1. SCOPE OF SUPPLY
C: EPC CONTRACTOR
V: VENDOR (SUPPLIER)

FILTERED WATER PUMP
RIAU-M-PI-011
SHEET 2 OF 6 (D-10)

HCl MEASURING TANK
RIAU-M-PI-011
SHEET 5 OF 6 (F-1)

NaOH MEASURING TANK
RIAU-M-PI-011
SHEET 5 OF 6 (E-1)

HCl MEASURING TANK
RIAU-M-PI-011
SHEET 5 OF 6 (G-1)

NaOH MEASURING TANK
RIAU-M-PI-011
SHEET 5 OF 6 (G-1)

REGENERATION PUMP
RIAU-M-PI-011
SHEET 4 OF 6 (C-1)

SERVICE AIR RECEIVER
RIAU-M-PI-011
SHEET 6 OF 6 (C-1)

DEMINERALIZED WATER TANK
RIAU-M-PI-011
SHEET 4 OF 6 (D-1)

TURBO FAN

DEGASIFIER & WATER TANK
(2 x 100%)

ACTIVATED CARBON FILTER
(2 x 100%)

CATION EXCHANGER
(2 x 100%)

DEGASIFIED WATER PUMP
(4 x 50%)

ANION EXCHANGER
(2 x 100%)

MIXED BED POLISHER
(2 x 100%)

FOR PRELIMINARY

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	REVISIONS										
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	INITIALS										
	REVISIONS	PRELIMINARY									
ISSUE		DRN	DSN	CHD	CV	EL	IC	ME	PE/PM	APPD	DATE
					CLEARED						

PROJECT :
Riau GFPP (275MW) IPP Project

PT. PERUSAHAAN LISTRIK NEGARA (PERSERO)
AGENCY OF THE MINISTRY OF MINES AND ENERGY
GOVERMENT OF THE REPUBLIC OF INDONESIA

MRPR
Medco Ratch Power Riau

LOTTE E&C

TITLE :
P & I DIAGRAM
WATER TREATMENT SYSTEM
SHEET 3 OF 6

OWNER DOCUMENT NUMBER :

SCALE :	DWG NO.	ISSUE
	RIAU-M-PI-011	A

SIZE-A3

NOTE.
1. SCOPE OF SUPPLY
C: EPC CONTRACTOR
V: VENDOR (SUPPLIER)

ION EXCHANGER (2B3T+MBP)
RIAU-M-PI-011
SHEET 3 OF 6 (C-10)

MIXED BED POLISHER
RIAU-M-PI-011
SHEET 3 OF 6 (E-10)

LIT
LIA
HH

DEMI. SYSTEM
STOP, START CONTROL

DEMINERALIZED WATER TANK
(1 X 100%)

HS
PI

REGRNERARTION PUMP
(2 X 100%)

DEMI. WATER SUPPLY PUMP
(2 X 100%)

HCl DILUTION WATER
RIAU-M-PI-011
SHEET 5 OF 6 (F-1)

NaOH DILUTION WATER
RIAU-M-PI-011
SHEET 5 OF 6 (C-1)

VACUUM PUMP SEAL WATER
LATER

CHEMICAL DOSING SYSTEM
RIAU-M-PI-013
SHEET 1 OF 2 (B-10)

CONDENSER HOTWELL
RIAU-M-PI-005
SHEET 1 OF 2 (F-3)

LABORATORY ROOM
LATER

CCW HEAD TANK
RIAU-M-PI-008
SHEET 1 OF 1 (B-1)

FOR PRELIMINARY

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	REVISIONS									
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	REVISIONS	PRELIMINARY								
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					CLEARED						

PROJECT :
Riau GFPP (275MW) IPP Project

PT. PERUSAHAAN LISTRIK NEGARA (PERSERO)
AGENCY OF THE MINISTRY OF MINES AND ENERGY
GOVERMENT OF THE REPUBLIC OF INDONESIA

MRPR
Medco Ratch Power Riau

LOTTE E&C

TITLE :
P & I DIAGRAM
WATER TREATMENT SYSTEM
SHEET 4 OF 6

OWNER DOCUMENT NUMBER :

SCALE	:	DWG NO.	ISSUE
		RIAU-M-PI-011	A

SIZE-A3

NOTE.
1. SCOPE OF SUPPLY
C: EPC CONTRACTOR
V: VENDOR (SUPPLIER)

NaOH INJECTION TANK (CLARIFIER)
RIAU-M-PI-011
SHEET 1 OF 6 (E-10)

NaOH INJECTION TANK (CLARIFIER)
RIAU-M-PI-011
SHEET 1 OF 6 (E-10)

NaOH INJECTION TANK FOR WASTE WATER TREAT.
RIAU-M-PI-013
SHEET 1 OF 3 (B-1)

HCl INJECTION TANK FOR WASTE WATER TREAT.
RIAU-M-PI-013
SHEET 1 OF 3 (B-1)

HCl INJECTION TANK FOR WASTE WATER TREAT.
RIAU-M-PI-013
SHEET 1 OF 3 (B-1)

HCl INJ. TANK FOR pH ADJUST
RIAU-M-PI-013
SHEET 1 OF 3 (B-1)

NaOH INJ. TANK FOR pH ADJUST
RIAU-M-PI-013
SHEET 1 OF 3 (D-1)

HCl STORAGE TANK
(1 x 100%)

HCl UNLOADING PUMPS
(2 x 100%)

HCl MEASURING TANK
(1 x 100%)

NaOH MEASURING TANK
(1 x 100%)

NaOH UNLOADING PUMPS
(2 x 100%)

NaOH STORAGE TANK
(1 x 100%)

EYE SHOWER

FUME SCRUBBER

POTABLE WATER SUPPLY
RIAU-M-PI-011
SHEET 2 OF 6 (B-10)

ANION EXCHANGER
RIAU-M-PI-011
SHEET 3 OF 6 (B-10)

CATION EXCHANGER
RIAU-M-PI-011
SHEET 3 OF 6 (B-10)

REGENERATION PUMP
RIAU-M-PI-011
SHEET 4 OF 6 (C-1)

MIXED BED POLISHER
RIAU-M-PI-011
SHEET 3 OF 6 (B-10)

MIXED BED POLISHER
RIAU-M-PI-011
SHEET 3 OF 6 (C-10)

REGENERATION PUMP
RIAU-M-PI-011
SHEET 4 OF 6 (D-1)

HOT WATER GENERATOR
(1 x 100%)

H : POWER OFF
L : POWER ON

FOR PRELIMINARY

	SIGN.										
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PROJECT :

Riau GFPP (275MW) IPP Project

PT. PERUSAHAAN LISTRIK NEGARA (PERSERO)

AGENCY OF THE MINISTRY OF MINES AND ENERGY
GOVERMENT OF THE REPUBLIC OF INDONESIA

MRPR
Medco Ratch Power Riau

LOTTE E&C

TITLE :

P & I DIAGRAM
WATER TREATMENT SYSTEM

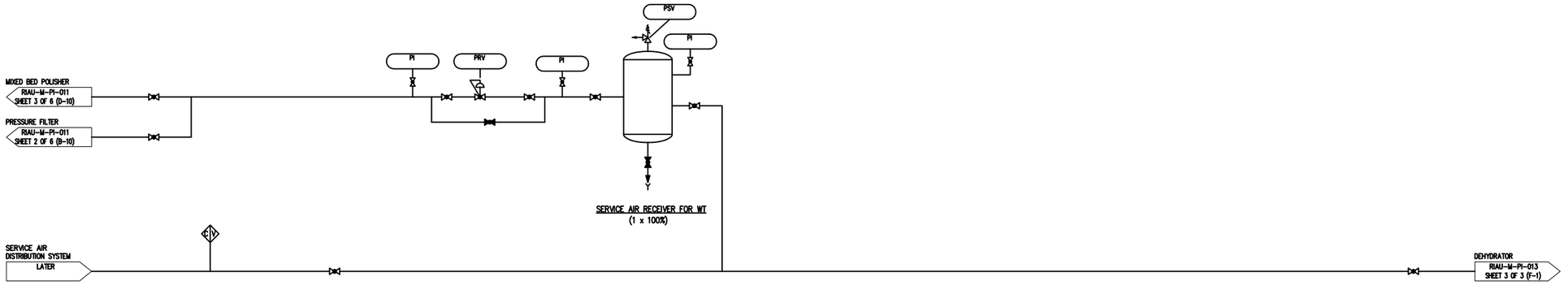
SHEET 5 OF 6

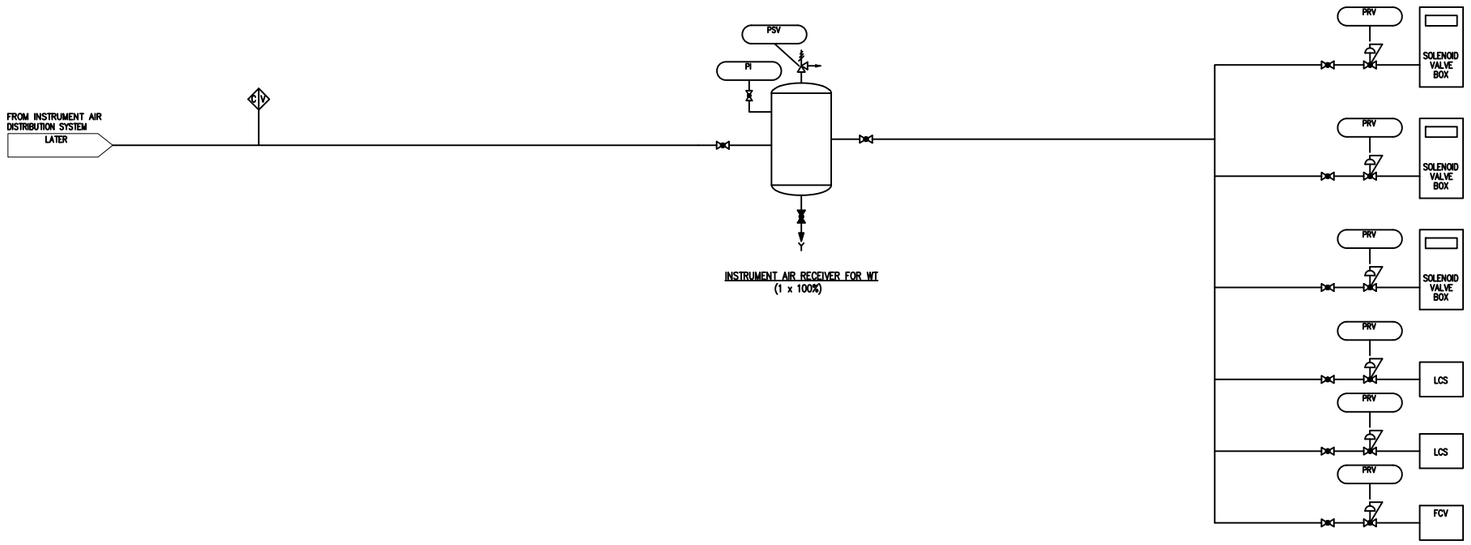
OWNER DOCUMENT NUMBER :

SCALE :	DWG NO.	ISSUE
	RIAU-M-PI-011	A

SIZE-A3

NOTE.
1. SCOPE OF SUPPLY
C: EPC CONTRACTOR
V: VENDOR (SUPPLIER)





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ISSUE		DRN	DSN	CHD	CV	EL	IC	ME			PE/PM	APPD	DATE	
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PROJECT :

Riau GFPP (275MW) IPP Project

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AGENCY OF THE MINISTRY OF MINES AND ENERGY
GOVERMENT OF THE REPUBLIC OF INDONESIA

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LOTTE E&C

TITLE :

P & I DIAGRAM
WATER TREATMENT SYSTEM

SHEET 6 OF 6

OWNER DOCUMENT NUMBER :

SCALE :	DWG NO.	ISSUE
	RIAU-M-PI-011	A

SIZE-A3

POTABLE WATER SUPPLY
RIAU-M-PI-011
SHEET 2 OF 6 (B-10)

HCl UNLOADING PUMP
RIAU-M-PI-011
SHEET 5 OF 6 (C-10)

FUME SCRUBBER
RIAU-M-PI-011
SHEET 5 OF 6 (B-10)

HCl STORAGE TANK
RIAU-M-PI-011
SHEET 5 OF 6 (B-10)

NaOH STORAGE TANK
RIAU-M-PI-011
SHEET 5 OF 6 (B-10)

HRSG CLEANING WASTE
LATER
TEMPORARY PIPE

ROOTS BLOWERS
(2 x 100%)

ABNORMAL WASTEWATER POND
(1 x 100%)

ABNORMAL WASTEWATER PUMP
(2 x 100%)

HCl INJECTION TANK
(1 x 100%)

NaOH INJECTION TANK
(1 x 100%)

HCl INJECTION PUMP
(2 x 100%)

NaOH INJECTION PUMP
(2 x 100%)

ALUM & POLYMER INJECTION TANK
RIAU-M-PI-013
SHEET 2 OF 3 (A-1)

BELT PRESS FILTER
WASHING WATER TANK
RIAU-M-PI-013
SHEET 3 OF 3 (E-1)

pH ADJUST. TANK
RIAU-M-PI-013
SHEET 2 OF 3 (B-1)

pH ADJUST TANK
RIAU-M-PI-013
SHEET 2 OF 3 (C-1)

pH ADJUST TANK
RIAU-M-PI-013
SHEET 2 OF 3 (C-1)

pH ADJUST TANK
RIAU-M-PI-013
SHEET 2 OF 3 (D-1)

NaOH UNLOADING PUMP
RIAU-M-PI-011
SHEET 5 OF 6 (D-10)

BELT FILTER PRESS
FILTERED WATER
RIAU-M-PI-013
SHEET 3 OF 3 (F-1)

pH ADJUST TANK
RIAU-M-PI-013
SHEET 2 OF 3 (D-1)

SLUDGE COLLECTION POND
RIAU-M-PI-013
SHEET 3 OF 3 (D-1)

FINAL DISPOSAL PUMP
RIAU-M-PI-013
SHEET 2 OF 3 (E-1)

OILY WASTE WATER SUMP PIT
RIAU-M-PI-014
SHEET 1 OF 2 (B-10)

HRSG/ST/GT CHEMICAL SUMP
RIAU-M-PI-014
SHEET 1 OF 2 (B-9)

CHEMICAL STORAGE AREA DRAINAGE
LATER

WATER TREATMENT BLDG. DRAINAGE
LATER

NORMAL WASTE WATER POND
(1 x 100%)

NORMAL WASTE WATER PUMP
(2 x 100%)

CPI OIL SEPARATOR
(1 x 100%)

SKIMMED OIL TANK
(1 x 100%)

OILY WASTEWATER PUMP
(2 x 100%)

OILY WASTE WATER POND
(1 x 100%)

FOR PRELIMINARY

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PROJECT :

Riau GFPP (275MW) IPP Project

PT. PERUSAHAAN LISTRIK NEGARA (PERSERO)

AGENCY OF THE MINISTRY OF MINES AND ENERGY
GOVERMENT OF THE REPUBLIC OF INDONESIA

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LOTTE E&C

TITLE : P & I DIAGRAM
WASTE WATER TREATMENT SYSTEM
SHEET 1 OF 3

OWNER DOCUMENT NUMBER :

SCALE :	DWG NO.	ISSUE	SIZE
	RIAU-M-PI-013	A	A3

POTABLE WATER SUPPLY HEADER
RIAU-M-PI-013 SHEET 2 OF 3 (A-10)

HCl INJECTION PUMP
RIAU-M-PI-013 SHEET 1 OF 3 (B-10)
H SIGNAL

NaOH INJECTION PUMP
RIAU-M-PI-013 SHEET 1 OF 3 (C-10)
L SIGNAL

CLARIFIER
RIAU-M-PI-011 SHEET 1 OF 6 (C-10)

HCl INJECTION PUMP
RIAU-M-PI-013 SHEET 1 OF 3 (C-10)

NaOH INJECTION PUMP
RIAU-M-PI-013 SHEET 1 OF 3 (C-10)

NORMAL WASTE WATER PUMP
RIAU-M-PI-013 SHEET 1 OF 3 (D-10)

ALUM INJECTION PUMP
(2 x 100%)

ALUM INJECTION TANK
(1 x 100%)

POLYMER INJECTION PUMP
(2 x 100%)

POLYMER INJECTION TANK(ANION)
(1 x 100%)

POLYMER INJECTION TANK(CATION)
(1 x 100%)

POLYMER INJECTION PUMP
(2 x 100%)

DEHYDRATOR MIXING TANK
RIAU-M-PI-013 SHEET 3 OF 3 (C-1)

pH ADJUSTMENT TANK
(1 x 100%)

COAGULATION TANK
(1 x 100%)

THICKENER
(1 x 100%)

FINAL DISPOSAL POND
(1 x 100%)

FINAL DISPOSAL PUMP
(2 x 100%)

SAMPLING

STORM WATER DRAINAGE
LATER

SLUDGE COLLECTION POND
RIAU-M-PI-013 SHEET 3 OF 3 (D-1)

SLUDGE COLLECTION POND
RIAU-M-PI-013 SHEET 3 OF 3 (D-1)

ABNORMAL WASTEWATER POND
RIAU-M-PI-013 SHEET 1 OF 3 (E-10)

SLUDGE PUMP FOR THICKENER
(2 x 100%)

FOR PRELIMINARY

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ISSUE		DRN	DSN	CHD	CV	EL	IC	ME	PE/PM	APPD	DATE
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PROJECT :

Riau GFPP (275MW) IPP Project

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AGENCY OF THE MINISTRY OF MINES AND ENERGY
GOVERMENT OF THE REPUBLIC OF INDONESIA

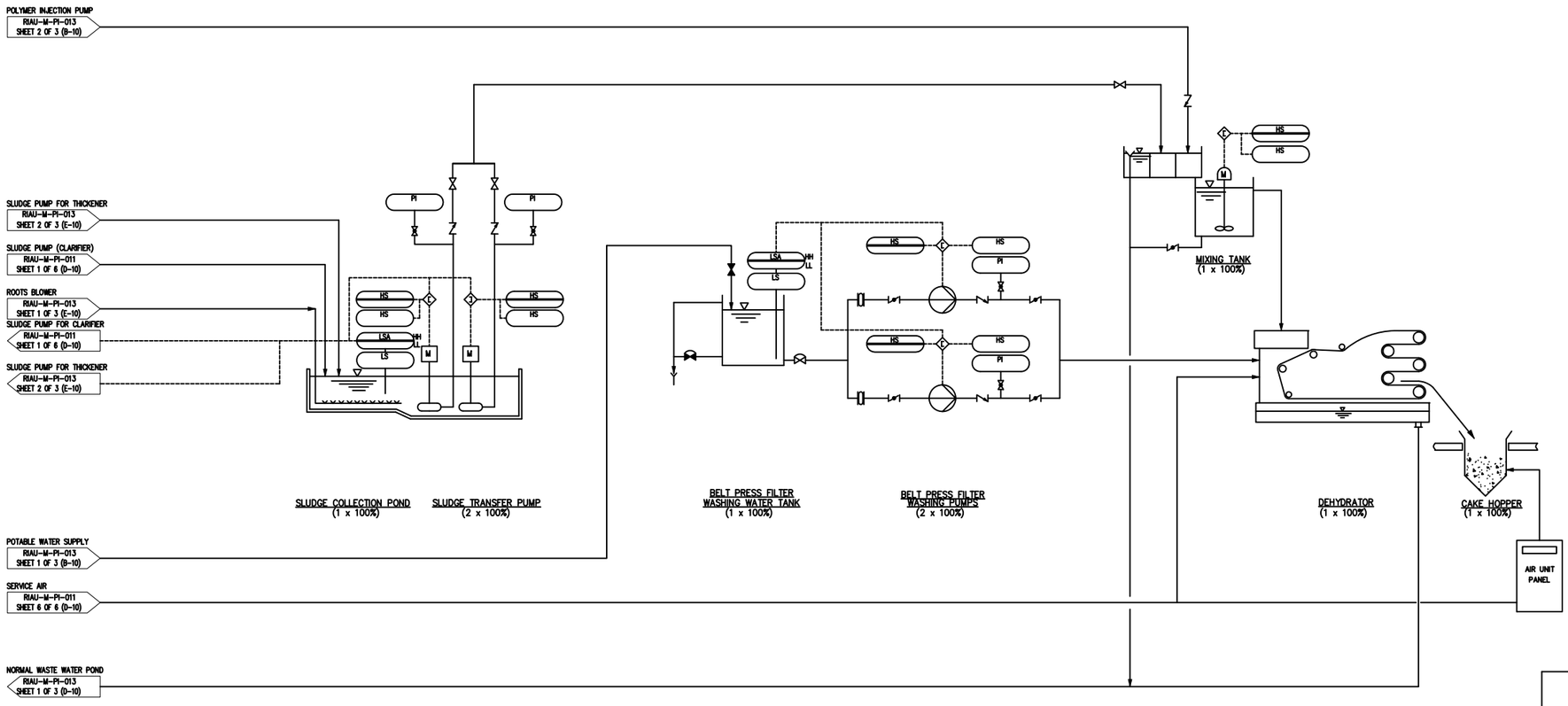
MRPR Medco Ratch Power Riau

LOTTE E&C

TITLE : P & I DIAGRAM
WASTE WATER TREATMENT SYSTEM
SHEET 2 OF 3

OWNER DOCUMENT NUMBER :

SCALE : | DWG NO. RIAU-M-PI-013 | ISSUE A | SIZE-A3



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	REVISIONS	PRELIMINARY									
ISSUE		DRN	DSN	CHD	CV	EL	IC	ME	CLEARED	PE/PM	APPD	DATE

PROJECT :

Riau GFPP (275MW) IPP Project

PT. PERUSAHAAN LISTRIK NEGARA (PERSERO)

AGENCY OF THE MINISTRY OF MINES AND ENERGY
GOVERMENT OF THE REPUBLIC OF INDONESIA

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Medco Ratch Power Riau

LOTTE E&C

TITLE :

P & I DIAGRAM
WASTE WATER TREATMENT SYSTEM

SHEET 3 OF 3

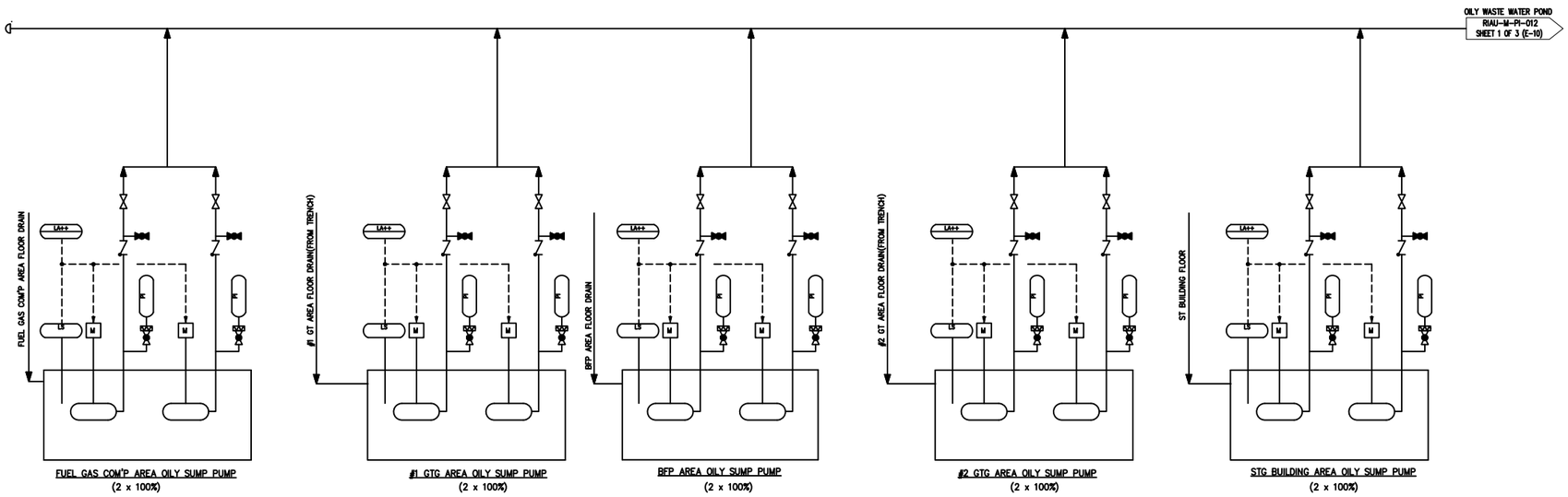
OWNER DOCUMENT NUMBER :

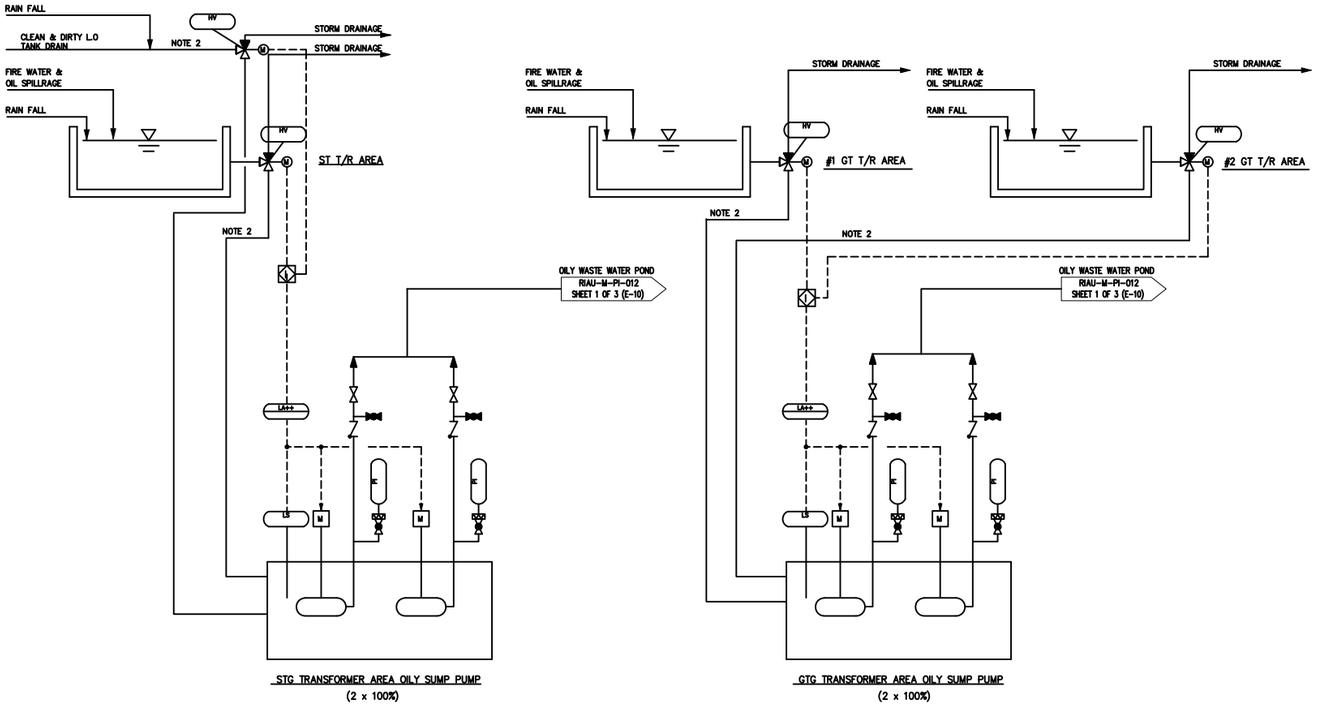
SCALE :	DWG NO.	ISSUE
	RIAU-M-PI-013	A

SIZE-A3

NOTES

1. THE SUMP LOCATION AND NUMBER WILL BE SUBJECT TO FINAL DESIGN.





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PROJECT :

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PT. PERUSAHAAN LISTRIK NEGARA (PERSERO)

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Medco Ratch Power Riau

LOTTE E&C

TITLE : P & I DIAGRAM
WASTE WATER TRANSFER SYSTEM

SHEET 1 OF 2

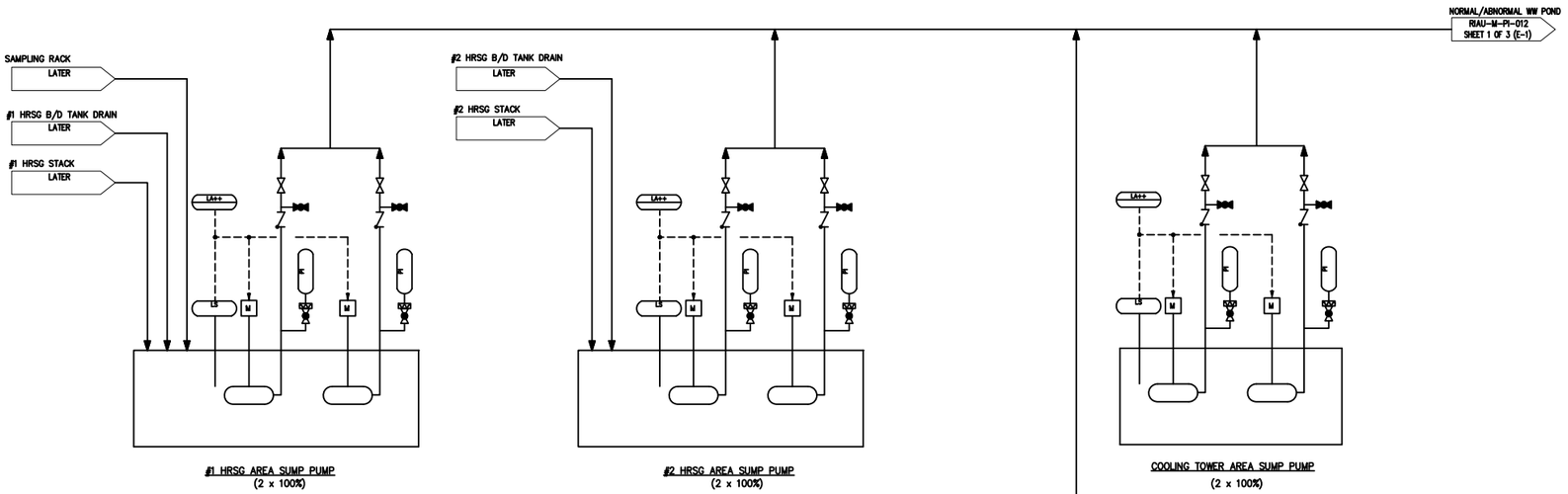
OWNER DOCUMENT NUMBER :

SCALE :	DWG NO.	ISSUE
	RIAU-M-PI-014	A

SIZE-A3

NOTES

1. THE SUMP LOCATION AND NUMBER WILL BE SUBJECT TO FINAL DESIGN.



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ISSUE		DRN	DSN	CHD	CV	EL	IC	ME	CLEARED	PE/PM	APPD	DATE

PROJECT :

Riau GFPP (275MW) IPP Project

PT. PERUSAHAAN LISTRIK NEGARA (PERSERO)

AGENCY OF THE MINISTRY OF MINES AND ENERGY
GOVERMENT OF THE REPUBLIC OF INDONESIA

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LOTTE E&C

TITLE : P & I DIAGRAM
WASTE WATER TRANSFER SYSTEM

SHEET 2 OF 2

OWNER DOCUMENT NUMBER :

SCALE :	DWG NO.	ISSUE
	RIAU-M-PI-014	A

SIZE-A3

{Nomor Sertifikat}
Date: February 25, 2016

Issuing Office:
Jl. Jend. A. Yani No. 79, Pekanbaru 28115, Indonesia
Phone/Facs: +62 761 35881/848709
Email: kkl.pku@sucofindo.co.id

REPORT OF SAMPLING AND ANALYSIS

PRINCIPAL	:	MEDCO POWER INDONESIA, PT. Gd. The Energy Lt. 50 Jl. Jend Sudirman Kav. 52-53 Lot 11A SCBD Senayan Kebayoran Baru Jakarta Selatan DKI – Jakarta Raya
SUBJECT	:	RIVER WATER
RECEIVED DATE	:	15/02/2016
REFERENCE	:	085/PKU-I/B03/2016
SAMPLING LOCATION	:	Sungai Siak Area Pelabuhan Sungai Duku
COORDINATE	:	N 00°32'48.9" E 101°27'57.7"
TESTED FOR	:	Dissolved Solid, Suspended Solid, pH, BOD, COD, Iron, Chloride, Conductivity, Total Hardness, Magnesium, Calcium, Sodium, Silica, Total Coliform (as per client request) *) Comparison of parameter as tested with Government Regulation of Republic Indonesia No.82/2001
SAMPLE DESCRIPTION	:	Sample was drawn by Sucofindo Laboratory at February 10, 2016.
ANALYSIS DATE	:	15/02/2016 to 23/02/2015

Dept. Of Testing, Consultancy and Other Services

PKU.B03.2016.00163

Adi Nuryantono

{Nomor Sertifikat}
Date: February 25, 2016

Issuing Office:
Jl. Jend. A. Yani No. 79. Pekanbaru 28115. Indonesia
Phone/Facs: +62 761 35681/849709
Email: kkl.pku@sucofindo.co.id

Parameter	Unit	Test Result	Water Quality Classification Threshold Limit Value #)				Methods *)
			I	II	III	IV	
Dissolved Solid	mg/L	31.0	1000	1000	1000	2000	2540 C
Suspended Solid	mg/L	14.0	50	50	400	400	2540 D
pH (on site)	-	4.96	6 - 9	6 – 9	6 - 9	5 – 9	4500-H^+-B
BOD_5 days 20 °C	mg/L	16.3	2	3	6	12	5210 B
COD by $K_2Cr_2O_7$	mg/L	54.0	10	25	50	100	5220 B
• Iron Dissolved	mg/L		0.3	-	-	-	3120 B, 3030 E
Chloride	mg/L	5.96	600	-	-	-	4500-Cl^--D
Conductivity	mg/L	44.5	-	-	-	-	
Total Hardness	mg/L	32.0	-	-	-	-	
Magnesium	mg/L	0.071	-	-	-	-	
• Calcium	mg/L		-	-	-	-	
• Sodium	mg/L		-	-	-	-	
• Silica	mg/L		-	-	-	-	
• Total Coliform Per 100 mL			1000	5000	10000	10000	9222 B

*) Standard Methods, 22nd Edition 2012, APHA-AWWA-WEF
#) Requirement means = Threshold limit value of parameter as tested comply with Government Regulation of Republic Indonesia No.82/2001.
• di Subkon ke Lab Cibitung
< = Less than the detection limit indicated

Note :

Requirement means = Threshold limit value of parameter as tested comply with Government Regulation of Republic Indonesia No.82/2001. Water quality clasification specific as 4 (four) class i.e.

- First class (I) : Raw water which can be used for raw drinking water, and / or similar usage.
- Second class (II) : Raw water which can be used for recreation infrastructure, river fishery cultivation, animal husbandry, irrigation and / or similar usage.
- Third class (III) : Raw water which can be used for river fishery cultivation, animal husbandry, irrigation and / or similar usage.
- Fourth class (IV) : Raw water which can be used for irrigation and / or similar usage

Dept. Of Testing, Consultancy and Other Services

PKU.B03.2016.00163

Adi Nuryantono

PT. GEOSERVICES Ltd.
ENVIRONMENTAL LABORATORIES
Jl. Sukajadi No.227, Bandung 40153, Phone : (022) 203 8468-69, Fax (022) 203 0404, email : envdiv@geoservices.co.id

CERTIFICATE OF ANALYSIS

NO : GS.COA.03.2016.031

TESTING FACILITY : BANDUNG

COA 5.8
Terbitan : A
Revisi : 00

JOB NO. : **16/031**
CLIENT : **PT. HEXA INTEGRA ELECTRICA**
DATE RECEIVED : 03 March 2016
SAMPLED BY : Client.
TIME OF ANALYSIS : Commenced 04 March 2016 until 17 March 2016.
TEST METHOD : Waters analyzed in accordance with the procedures published by the American Public Health Association (APHA, 2012), PT. Geoservices Environmental Laboratories WILAB 5.0.

Lab. No : **B 001**
Client ID : **AIR SUNGAI**

Parameter	Unit	Result	Method
Physical			
pH (25°C)		6.0	APHA 4500 H^+ B - 2012
Electrical Conductivity	µS/cm	49	APHA 2510 B - 2012
Turbidity	NTU	17	APHA 2130 B – 2012
Total Suspended Solids (TSS)	mg/L	< 10	APHA 2540 D - 2012
Chemical			
Total Hardness (as $CaCO_3$)	mg/L	10	APHA 2340 B - 2012
Total Alkalinity (as $CaCO_3$)	mg/L	9	APHA 2320 B - 2012
Chloride (Cl)	mg/L	6	APHA 4500 Cl^--C - 2012
Sulfate (SO_4)	mg/L	9	APHA 4500 SO_4 E - 2012
Dissolved Silica (SiO_2)	mg/L	18	APHA 3111 B - 2012
Dissolved Iron (Fe)	mg/L	1.1	APHA 3113 B - 2012
Dissolved Aluminum (Al)	mg/L	3.9	APHA 3113 B - 2012
Dissolved Manganese (Mn)	mg/L	< 0.02	APHA 3111 B - 2012
Dissolved Calcium (Ca)	mg/L	2.8	APHA 3111 D - 2012
Dissolved Magnesium (Mg)	mg/L	0.8	APHA 3111 B - 2012
Dissolved Sodium (Na)	mg/L	3.9	APHA 3111 B - 2012
Dissolved Potassium (K)	mg/L	2.2	APHA 3111 B - 2012
Nitrate (NO_3)	mg/L	1.2	APHA 4500 NO_3E - 2012
Nitrite (NO_2)	mg/L	0.043	APHA 4500 NO_2 B - 2012
Bicarbonate (HCO_3)	mg/L	11	APHA 2320 B - 2012
Carbonate (CO_3)	mg/L	< 1	APHA 2320 B - 2012
Hydroxide (OH)	mg/L	< 1	APHA 2320 B - 2012
Total Phosphate (PO_4) – P	mg/L	0.19	APHA 4500 E - 2012
Chemical Oxygen Demand (COD)	mg/L	27	APHA 5220 D - 2012
Dissolved Oxygen (DO)	mg/L	7	APHA 4500 O - C

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ENVIRONMENTAL LABORATORIES
Jl. Sukajadi No. 227, Bandung 40153, Phone : (022) 203 8468-69, Fax (022) 203 0404, Email : envdiv@geoservices.co.id

CERTIFICATE OF ANALYSIS

NO : GS.COA.03.2016.031

TESTING FACILITY : BANDUNG

COA 5.8
Terbitan : A
Revisi : 00

JOB NO. : **16/031**
CLIENT : **PT. HEXA INTEGRA ELECTRICA**
DATE RECEIVED : 03 March 2016
SAMPLED BY : Client.
TIME OF ANALYSIS : Commenced 04 March 2016 until 17 March 2016.
TEST METHOD : Waters analyzed in accordance with the procedures published by the American Public Health Association (APHA, 2012), PT. Geoservices Environmental Laboratories WILAB 5.0.

Lab. No : **B 001**
Client ID : **AIR SUNGAI**

Parameter	Unit	Result	Method
Physical			
Biochemical Oxygen Demand (BOD)	mg/L	< 1	IK 5 – 6.71
Total Dissolved Solids (TDS)	mg/L	25	IK 5 – 6.2

Bandung, 17 March 2016

Checked
Nengsih
Analyst

Approved Signatory
Lasmijati Kosasih
Laboratory Manager

Additional Siak River water quality information

No.	Analyzed items	Unit	Result
1	Turbidity	NTU	**26.7**
2	Total suspended solids	mg/l	**41.0**
2a	Total dissolved solids	mg/l	**48.2**
3	pH	----	**6.16**
4	Total Hardness	Meq/l	
5	Total Alkalinity: $CaCO_3$	mg/l	
6	Dissolved Silica: SiO_2	mg/l	
7	Iron ($Fe^{+2\ +3}$)	mg/l	**1.168**
8	Aluminum (Al^{+3})	mg/l	
9	Manganese (Mn^{+})	mg/l	**0.067**
10	Calcium (Ca^{+2})	mg/l	
11	Magnesium (Mg^{+2})	mg/l	
12	Sodium & Potassium ($Na^{+\ +\ K+}$)	mg/l	
13	Chloride (Cl^{-})	mg/l	
14	Sulfate (SO_4^{-})	mg/l	**0.022**
15	Nitrate (NO_3^{-})	mg/l	**1.204**
16	Nitrite (NO_2^{-})	mg/l	**0.083**
17	Bicarbonate (HCO_3^{-2})	mg/l	
18	Carbonate (CO_3^{-2})	mg/l	
19	Hydroxide (OH^{-})	mg/l	
20	Phosphate (PO_4^{-3})	mg/l	**0.862**
21	Total Dissolved Solids	mg/l	**48.2**
22	Dissolved Oxygen	mg/l	**5.1**
23	BOD	mg/l	**20.3**
24	COD	mg/l	**81.1**
25	Conductivity	µS/cm	

Source:

Vol. 1: Final Master Plan – Pekanbaru Report of the IndII Wastewater Investment Master Plan - Package III Project 2011 (Data of sample ST 1: Siak I Bridge (Jl. Satrio – Rejosari):

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LABORATORY ANALYSIS REPORT

RESULT OF ANALYSIS

Laboratory Sample Number					OSL1707053-1	OSL1707053-2	OSL1707053-3
Customer Sample Identity					WQ-2 PP Sungai Siak	WQ-3 PP Sungai Siak	WQ-4 PP Anak Sungai Siak (Muara)
Matrix					Surface Water	Surface Water	Surface Water
Date of Sampling					19-07-2017	19-07-2017	19-07-2017
Time of Sampling					12:10 WIB	13:51 WIB	10:[illegible] WIB
Sampling Method					NA [1]	NA [2]	NA [2]
Sampling Point Coordinate					N : 00° 34' 10,1"	N : 00° 34' 01,1"	N : 00° 33' [illegible]"
					E : 101° 30' 47,0"	E : 101° 31' 16,4"	E : 101° 31' [illegible]"
Ambient Temperature					35,7°C	37,6°C	[illegible]°C
Parameter(s) of Analysis	Method	Unit	Detection Limit	Regulation Limit [3]	Result		
Temperature	APHA 22nd edition, Method 2550B (2012)	°C	-	± 3	32,1	31,2	27,[illegible]
pH	SNI 06-6989.11 (2004)	-	-	6 - 9	5,80	6,83	6,[illegible]
Total Suspended Solids (TSS)	SNI 06-6989.3 (2004)	mg/L	1	50	31	56	[illegible]
Conductivity	SNI 06-6989.1 (2004)	µs/cm	1	NA [2]	38	48	[illegible]
Turbidity	APHA 22nd edition, Method 2130 ABE (2012)	NTU	0,5	NA [2]	19,2	30,9	19,[illegible]
Biochemical Oxygen Demand (BOD)	APHA 22nd edition, Method 5210 C (2012)	mg/L	2	3	< 2	< 2	< 2
Chemical Oxygen Demand (COD)	APHA 22nd edition, Method 5220 D (2012)		3	25	13	62	[illegible]
Ammonia (as NH_3-N)	APHA 22nd edition Method 4500 NH3 F (2012)		0,07	(-)	0,26	0,25	0,25
Nitrate (NO_3)	APHA 22nd edition, Method 4500 NO3 E (2012)		0,003	10	0,544	0,545	0,473
Nitrite (NO_2)	APHA 22nd edition, Method 4500 NO2 B (2012)		0,005	0,06	< 0,005	< 0,005	< 0,005
Total Nitrogen	APHA 22nd edition, Method 4500 N (2012)		0,06	NA [2]	2,26	1,56	1,[illegible]
Fluoride (F)	APHA 22nd edition, Method 4500 F D (2012)		0,1	1,5	0,4	0,5	0,4
Phosphorus (P)	APHA 22nd edition, Method 4500 P A, B&E (2012)		0,03	0,2	0,05	< 0,03	0,20
Total Coliform [4]	SNI 3554 (2015)	colony/100mL	-	5000	180	720	220

Note(s):
[1] Subcontracted
[2] Regulation refers to PP 82/2001 class II
[3] Not Applicable or Not Available.

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Organo Science Lab

KAN
Komite Akreditasi Nasional
Laboratorium Pengu
LP - 725 - IDN
0095/LPJ/LABLING-1/LRK/KLH

LABORATORY ANALYSIS REPORT

RESULT OF ANALYSIS

Laboratory Sample Number					OSL1707053-1	OSL1707053-2	OSL1707053-3
Customer Sample Identity					WQ-2 PP Sungai Siak	WQ-3 PP Sungai Siak	WQ-4 PP Anak Sungai Siak (Muara)
Matrix					Surface Water	Surface Water	Surface Water
Date of Sampling					19-07-2017	19-07-2017	19-07-2017
Time of Sampling					12:10 WIB	13:51 WIB	15:55 WIB
Sampling Method					NA [2]	NA [2]	NA [2]
Sampling Point Coordinate					N : 00° 34' 10,1"	N : 00° 34' 01,1"	N : 00° 33' 37,7"
					E : 101° 30' 47,0"	E : 101° 31' 16,4"	E : 101° 30' 16,5"
Ambient Temperature					35,7°C	37,8°C	31,2°C
Parameter(s) of Analysis	Method	Unit	Detection Limit	Regulation Limit [1]	Result		
Oil and Grease	EPA Method 1664, Revision B (2010)	µg/L	1000	1000	1000	2400	1000
Organochlorine Pesticides (OCP)	USEPA SW 846 Method 8270D; 3510C (1996; 1996)		0,4	NA [2]	< 0,4	< 0,4	-
Polychlorinated Biphenyls (PCB)			0,005	NA [2]	< 0,005	< 0,005	-
Polycyclic Aromatic Hydrocarbons (PAHs)			0,04	NA [2]	< 0,04	< 0,04	-
PCDDs [3]	USEPA Method 16136 (GC-HRMS)	pg/L	50	NA [2]	< 50	< 50	-
PCDFs [3]			50	NA [2]	< 50	< 50	-

Note(s):
[3] Subcontracted
[1] Regulation refers to PP 82/2001 class II
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LABORATORY ANALYSIS REPORT

RESULT OF ANALYSIS

Laboratory Sample Number					OSL1707053-1	OSL1707053-2	OSL1707053-3
Customer Sample Identity					WQ-2 PP Sungai Siak	WQ-3 PP Sungai Siak	WQ-4 PP Anak Sungai Siak (Muara)
Matrix					Surface Water	Surface Water	Surface Water
Date of Sampling					19-07-2017	19-07-2017	19-07-2017
Time of Sampling					12.10 WIB	13.51 WIB	14.57 WIB
Sampling Method					NA [3]	NA [3]	NA [3]
Sampling Point Coordinate					N : 00° 34' 10,1"	N : 00° 34' 01,1"	N : 00° 33' 37,7"
					E : 101° 30' 47,0"	E : 101° 31' 16,4"	E : 101° 30' 19,6"
Ambient Temperature					35,7°C	37,6°C	31,4°C
Parameter(s) of Analysis	Method	Unit	Detection Limit	Regulation Limit [3]	Result		
Total Boron (B)	APHA 22nd edition, Method 4500 B C (2012)	mg/L	0,04	NA [3]	1,01	0,52	0,75
Total Mercury (Hg)	USEPA SW 846, Method 7470A (1994)		0,0005	NA [3]	< 0,0005	< 0,0005	< 0,0005
Total Arsenic (As)	USEPA SW 846, Method 7062 (1994); 3005A (1992)		0,005	NA [3]	< 0,005	< 0,005	< 0,005
Total Cadmium (Cd) [2]	USEPA SW 846, Method 7000B (2007); 3005A (1992)		0,002	NA [3]	< 0,002	< 0,002	< 0,002
Total Chromium Hexavalent (Cr^{6+})	USEPA SW 846, Method 7196A (1992)		0,004	NA [3]	< 0,004	< 0,004	< 0,004
Total Chromium (Cr)	USEPA SW 846, Method 7000B (2007); 3005A (1992)		0,02	NA [3]	< 0,02	< 0,02	< 0,02
Total Copper (Cu)			0,01	NA [3]	< 0,01	< 0,01	< 0,01
Total Iron (Fe)			0,009	NA [3]	1,03	0,600	1,29
Total Lead (Pb) [2]			0,005	NA [3]	< 0,005	< 0,005	< 0,005
Total Manganese (Mn)			0,01	NA [3]	< 0,01	0,05	< 0,01
Total Nickel (Ni)			0,01	NA [3]	0,03	< 0,01	< 0,01
Total Zinc (Zn)			0,02	NA [3]	0,02	0,05	< 0,02

Note(s):

[1] This parameter (in the described matrix) / this matrix has not been accredited by KAN

[2] Regulation refers to PP 82/2001 class II.

[3] Not Applicable or Not Available

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LABORATORY ANALYSIS REPORT

RESULT OF ANALYSIS

Laboratory Sample Number					OSL1707053-1	OSL1707053-2	OSL1707053-3
Customer Sample Identity					WQ-2 PP Sungai Siak	WQ-3 PP Sungai Siak	WQ-4 PP Anak Sungai Siak (Muara)
Matrix					Surface Water	Surface Water	Surface Water
Date of Sampling					19-07-2017	19-07-2017	19-07-2017
Time of Sampling					12:10 WIB	13:51 WIB	10:51 WIB
Sampling Method					NA [1]	NA [1]	NA [1]
Sampling Point Coordinate					N : 00° 34' 10,1"	N : 00° 34' 01,1"	N : 00° 33' 37,7"
					E : 101° 30' 47,0"	E : 101° 31' 16,4"	E : 101° 30' 19,9"
Ambient Temperature					36,7°C	37,6°C	31,2°C
Parameter[s] of Analysis	Method	Unit	Detection Limit	Regulation Limit [2]	Result		
Dissolve Boron (B)	APHA 22nd edition, Method 4500-B C (2012)	mgL	0,04	1	0,60	0,50	0,84
Dissolve Mercury (Hg)	USEPA SW 846, Method 7470A (1994)		0,0005	0,002	< 0,0005	< 0,0005	< 0,0005
Dissolve Arsenic (As)	USEPA SW 846, Method 7062 (1994); 3005A (1992)		0,005	1	< 0,005	< 0,005	< 0,005
Dissolve Cadmium (Cd) [1]	USEPA SW 846, Method 7000B (2007); 3005A (1992)		0,002	0,01	< 0,002	< 0,002	< 0,002
Dissolve Chromium Hexavalent (Cr6+)	USEPA SW 846, Method 7196A (1992)		0,004	0,05	< 0,004	< 0,004	< 0,004
Dissolve Chromium (Cr)	USEPA SW 846, Method 7000B (2007); 3005A (1992)		0,02	NA [1]	< 0,02	< 0,02	< 0,02
Dissolve Copper (Cu)			0,01	0,02	< 0,01	< 0,01	< 0,01
Dissolve Iron (Fe)			0,09	-	0,445	0,220	0,520
Dissolve Lead (Pb) [1]			0,005	0,03	< 0,005	< 0,005	< 0,005
Dissolve Manganese (Mn)			0,01	-	< 0,01	< 0,01	< 0,01
Dissolve Nickel (Ni)			0,01	NA [1]	< 0,01	< 0,01	< 0,01
Dissolve Zinc (Zn)			0,02	0,05	< 0,02	< 0,02	< 0,02

Note(s):

[1] This parameter (in the described matrix) of this matrix has not been accredited by KAN

[2] Regulation refers to PP 82/2001 class II.

[3] Not Applicable or Not Available

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Appendix C. Site Investigation

Draft Final Report

Project:

Soil Investigation, Soil Improvement, and Topography Study of Gas Fired Power Plant Project 275 MW In Riau, Indonesia

Tenayan Raya District,
Pekanbaru Regency,
Riau Province

Year 2017

PT WAHANA GUNA MANDIRI
Engineering and Management Consultant

Prepared by : A R Muttaqien Budi Cahyadi Maryodi	**Checked by** / **Date :** Fadhli / 16 June 2017
Distribution : ……. …….	**Approved by** / **Date :** ……. / …. June 2017

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LIST OF APPENDIX

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1. Introduction

1.1 Background

Energy has an important role to support regional development, especially in support of other development sectors. For those reasons, the energy development have targets to provide adequate energy.

In line with the growth of regional development, the demand for energy, particularly electricity will continue to rise. Likewise in the next few years with the transition process of rural communities into urban communities will drive the need for energy.

In order to meet the demand for electricity in accordance with RUPTL 2016-2025 to provide the load demand of Pekanbaru area, especially the management of primary energy, PLN offers private party to build a Gas Engine Power Plant (GFPP) with 275 MW capacity, which is MRPR (Medco Ratch Power Riau).

In preparation of construction the GFPP (275 MW) is necessary to prepare Feasibility Study, Engineering Design, and Tender Documents. Therefore, before the implementation of the necessary physical development, is necessary the study based on primary data (based on survey and investigation) and laboratory test results to determine feasibility of the project.

1.2 Project Location

The selected site is located at Badak Village, Badak Jaya Sub-District, Tenayan Raya District Pekanbaru Regency, province of Riau. The site location can be reached by air plane from Jakarta through Pekanbaru Airport, it takes 1 hour by car or land transportation to reach the project site.

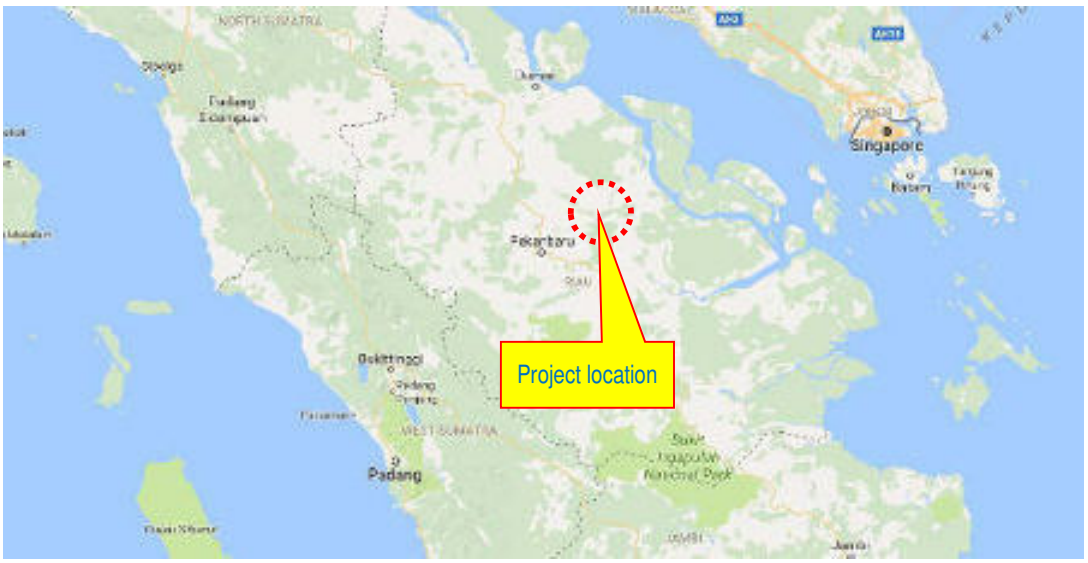


Figure 1-1 *Project Location*

1.3 Scope of Works

The Site Investigation was includes Topographic survey, Geoelectrical survey and modeling, Geotechnical Investigation. A summary of the scope of work for this site investigation typically include the following:

1. Topographic Survey. Performing topographic survey about 9.5 ha area and establishment of 2 units of Benchmark.
2. Leveling measurement to reference Benchmark
3. Performing 3 (three) points of core drilling, with 30 meter depth each and total 90 meter. The investigation includes:
   - Standard penetration test (SPT) every 1.5 meter depth of drilling.
   - Permeability test every 5 meter depth of drilling.
   - Extraction of undisturbed sample (UDS) as much as possible (if required).
   - The core shall be store in core box, one box for 5 meter cores.
4. Geoelectrical measurement about 3 (three) points.
5. Laboratory Analysis of Soil Mechanic with following parameters:
   a. Index Properties :
      - Moisture Content
      - Unit Weight
      - Specific Gravity
      - Grain Size Analysis
      - Atterberg Limits
      - Compaction standard and modified test
      - Amount of material finer than No. 200 Sieve.

   b. Mechanical Properties :
      - Triaxial Compression test
      - Consolidation Test
      - Direct Shear Test
      - Unconfined Compression Test
6. Geotechnical analysis and recommendation shall includes:
   - Design parameter of shallow foundation
   - Design parameter of deep foundation

   Other geotechnical recommendation: Excavation criteria; Recommendation on soil improvement; Coefficient of permeability and Slopes (steepness) of excavation.

1.4 Report Organization

Continuing the first chapter was Introduction aspect, this report is organized in to following section:

- Chapter – 1: Introduction
- Chapter – 2: Topography
- Chapter – 3: Geotechnical Investigation
- Chapter – 4: Comparison of geotechnical analysis with previous study
- Chapter – 5: Conclusion and Recommendation

In an integrated book, this report is complement by following appendices:

- Appendix A: Topography Map
- Appendix B: Description of Benchmark
- Appendix C: Borehole Log

- Appendix D: Photo of Boring Activities and Core Boxes
- Appendix E: Data and Interpretation Curve of Geoelectrical survey
- Appendix F: Result of Soil Mechanic Laboratory
- Appendix G: Result of Groundwater Quality and soil Chemistry
- Appendix H: Photo Documentation

2. Topography

2.1 General

Location of Topography Measurement are at future GFPP 275 MW area (alternative 2), which is slightly hilly. The survey located area at coordinates 0°32'23" N, 101° 31' 13.6" E.

2.2 Survey Methodology

Topographic survey is performed at the study area, cover whole area of future GFPP and surrounding.

a. Standard and Reference

Standard which applied in execution of this work is Indonesian National Standard (SNI) for category Topographic Surveying, as show below :

Table 2-1 *List of topographic surveying standard.*

NO	STANDARD			TITLE
	Code	*Year*	*Standard Items*	
1.	BAKOSURTANAL	-	Standard Survey	Topography Survey and Mapping
2.	SNI 19-6724-2002	2002	Standard Survey	Horizontal Control Network
3.	SNI 19-6988-2004	2004	Standard Survey	Vertical Control Network by Levelling Method

b. Preparation and Secondary Data

Before performing the survey work, it's necessary to prepare and collect secondary data as follows:

- Prepare National Topographic Map by Bakosurtanal (now named as Badan Informasi Geospasial), sheet of Pekanbaru with index number 0816-52 and sheet of Perawang with index number 0816-61. All of the map provided in scale of 1:50.000
- Reference coordinate of existing Benchmarks.
- and other supporting data.

c. Horizontal Control (Traverse) Measurement

Measurement of horizontal control network carried out by closed network traverse. The horizontal measurements connected to reference Benchmarks. Measurement of traverse shall performed by following methods :

- Point of traverse is strived as near with line alignment connecting the Benchmark Existing (reference) at site.

- Apart closeness of between point of traverse is adapted condition of field range from 10 - 50 meter for area relatively leveled off, and about 25 meter for terrain having height difference enough strike.
- Measurement was carried out by measuring instrument Total Station with reading accuracy maximum 5", and measured in one series of reading (forward and backward).
- Measurement of distance every section of traverse done by minimum two times reading (forward-backward).
- Every execution of measurement of polygon always controlled so that be knowable deviation happened and soon given by correction for returned toward alignment which ought to.
- Every point of polygon is marking using wooden peg with dimension ¾" or 30 cm (or other markings) and setup numbering or coding by Surveyor.

d. Vertical Control (Elevation) Measurement

Vertical control measurement aims to give each points of traverse or control points an elevation value.

Elevation measurements performed by the following:

- Elevation measurement should starts and ends from Benchmark.
- Measurement should through the points (peg) of traverse measurement.
- The elevation measurement conducted using waterpass instrument, a TOPCON ATB4 type.
- Elevation measurement for each section carried by double stand with complete reading measurement (yarn top, middle and bottom) and double stands.
- Every step of measurement, maximum distance between instrument and measuring staff is 50 m.
- Before starting and after completion of daily measurement, waterpass instrument should checked its collimation errors.

e. Measurement of Topographic Situation

Measurement of topographic situation carried out to get data of land surface, existing building, house, road, drainage, river and other object that represented situation of intention area.

Measurement of topographic situation shall performed by following methods:

- All detailed measurement should tied to Benchmark or traverse point.
- Measurement of topographic situation carried out to get data of land surface, measurement of situation also done to get data position of natural objects and made in along with the situations residing in measurement area like, house and other building, road, river, powerline (HVTL), plantation boundary, forestry, etc, to be presented as information at situation vector map (topography map)
- All specific utility such as: existing transmission line, PDAM supply pipe, drainage, etc shall identified and drawn in Topography map

- The detailed situation measurement conducted using Total Station

2.3 Reference Coordinate

The existing BM (benchmarks) owned by Regional Government Owned Company (BUMD) was utilized as reference BM. Following are data of reference BM which applied :

- BM name : BM 0
- X value : 783310.000
- Y value : 057048.000
- Z value : 44.690

The reference BM located at BUMD area, about 7 Km from GFPP site.

2.4 Benchmark Installation

For the purposes of topographic, conducted Benchmark manufacture and installation of as many as one pair (two units), consisting of BM-03 and CP-03.

2.5 Horizontal Control (Traverse) Measurement

The traverse measurement was conducted to determine position of distributed reference point which will function as tied point (traverse point). The traverse point will be utilized by detailed situation measurement. Traverse measurement started at BM-03 and finished at CP-03, which also as initial azimuth.

Implementation of horizontal or traverse measurement are as follows :

- Measurement started at reference Benchmark to project site, conducted by geometric loop (closed loop) and connected to reference points BM-03 and CP-03.
- The measurement conducted using Total Station
- Measurement of horizontal angle carried out by one double series (one times of normal and repetition measurement)
- Distance measurement also get from Total Station for each traverse range and finally average distance of each traverse range.

2.6 Vertical Control Measurement

Measurement of vertical control network conducted using levelling (waterpass) method while the route follow horizontal control network (traverse) with closed loop. The measurement connected to BM-0 as starting point of vertical reference (height). The measurement conducted using Waterpass which comply standard and complement by levelling staff. Allowable tolerance of vertical control measurement is under (20√D(km)) mm.

2.7 Measurement of Detailed Situation

The detailed situation measurement intended to get position (coordinate) and height (elevation) of every measured point, which are terrain of ground surface, every object above ground surface. All detailed situation will presented in the Situation Map. The detailed situation measurement conducted by following terms :

- Measurement by Total Station
- Measurement carried out by trigonometry method
- The detailed spot measured with scale of 1:1000 standard, which all detail such as river, road, gully, and 5-10 meter maximum density of ground surface alteration.
- All detailed situation measurement connected to nearest control network point.

2.8 Data Processing and Drawing

Data processing / calculation of control network survey result carried out by bowditch for horizontal control network (traverse), vertical control network and detailed situation calculated by trigonometry method.

The data processing carried out in two (2) steps as follows:

1. Pre data processing directly on site
   This step intended to early make sure the measurement comply with allowable tolerance.
2. Post data processing at office.
   This step conducted by computer based after all measurement completed.
   Data processing of horizontal control network consist of :
   - Calculate arithmetic average angle and arithmetic average distance,
   - Checking angle closure error,
   - Checking linear closure error.

   Data processing of vertical control network consist of :
   - Checking calculation of total distance,
   - Checking height difference,
   - Checking height difference closure error.

Drawing work refers to following terms:

a. Drawing process carried out by computer using AutoCAD Land Development 2009 Software.
b. Detail Situation Map made in 1 : 1000 scale with 1 meter contour interval,
c. The Situation map can produced in A1 paper size
d. Long section drawing made in 1 : 1000 scale of horizontal and 1 : 100 scale of vertical.
e. Cross section drawing made in 1 : 100 scale of horizontal and 1 : 100 scale of vertical.
f. All detail situation, natural or man-made shall plotted in Map / drawing and complement with each symbols, comply with cartography standard as follows :
   - Map Title,
   - Map Index,
   - Legend,
   - Grid lines with 10 Cm interval,
   - Bar scale
   - Sheet guideline and North orientation

Information on date/month/year of measurement implementation and drawing

2.9 Analysis of Topography Survey

Analysis of topography survey result intended to evaluate the quantity and quality of survey implementation compared to terms of reference.

a. Analysis based on Quantity

Based on proposed work quantity, the survey result shall meet the requirement, as follows:

1. Quantity of topography survey consist of:
   a. Preparatory works
   b. Survey / measurement work
   c. Data calculation work
   d. Analysis of survey result
   e. Drawing
   f. Reporting
2. Quantity or total area of survey of Riau GFPP 275 MW is 10 Ha,
3. Total distance of levelling measurement is 5830.7 m

b. Analysis based on Quality

Analysis and checking the horizontal control network result shall refer to allowable tolerance as describes at following table.

Table 2-2 *Analysis of Topography survey*

NO.	ROUTE OF SURVEY	TOTAL DISTANCE (m)	REQUIREMENT	SURVEY RESULT	REMARK
1	BM 0 – BM-03	5,830.7	20mm √D	3.2 mm √D	Passing the requirement

2.10 Survey Result

After whole field activities and office activities completed and produced description of Benchmark, Map, Drawing and other related result. Following table describe summary of survey result while the detail result shows in appendix.

Table 2-3 *Coordinate of installed benchmark.*

Number of BM	X (meters)	Y (meters)	Elevation
BM 03	780508.180	59944.905	27.072
CP 03	780630.268	59965.075	23.044

Table 2-4 *List of survey result*

No.	Survey Result	Number of Sheet	Scale
1	Topography Map	3	1: 2000 & 1: 1000
2	Land Profile of GFPP area	18	1: 2000 & 1: 1000

2.11 Quantity of Cut/ Fill and Recommended Level

On construction projects it is often necessary to modify the existing ground levels to create platforms to build on. Accurately calculating the volumes of soil that must be removed (cut) or added (fill) to create the final ground levels is an essential part of the planning process.

For the GFPP 275 MW project, the cut & fill calculation was made to get a ballace quatity (volume) of cut works and fill works as follows:

- Quantity of Cut/Fill : 165778.75/165343.39 M^3 (remaining cut material: 435.35 M^3)
- Recommended Level : 28.05 m

3. Geotechnical Investigation

3.1 Geology and Geotechnical Site Investigation Methodology

a. Standard and Reference

The Field investigation works was implemented based on common standards and references. The standards and references are shown in Table 3-1 bellow.

Table 3-1 *Applied standard reference of geotechnical investigation.*

NO.	STANDARD			TITLE
	Code	Year	Source	
1	D 1452 – 80	1980	ASTM	Drilling Operation
2	D 1586 - 99	1999	ASTM	Standard Penetration Test (SPT)
3	D-1587 - 00.	2000	ASTM	Undisturbed Sampling
4	D 2487 – 00	2000	ASTM	Classification of Soils for Engineering Purpose
5	D 2488 – 00	2000	ASTM	Description and Identification of Soils (Visual-Manual Procedure)
6		1981	ISRM	Basic Geotechnical Description of Rock Masses
7	D6032-02	2000	ASTM	Rock Quality Designation ("RQD")
8	13-4691	1998	SNI	Preparation of Geological Map
9	13-6185	1999	SNI	Preparation of Geomorphological Map
10	D 2216 – 98	1998	ASTM	Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
11	D 854 – 00	2000	ASTM	Standard Test Method for Specific Gravity of Soil Solids by Water Pycnometer
12	D 422 – 63 (98)	1998	ASTM	Standard Test Method for Particle-Size Analysis of Soils
13	D 2166 – 00	2000	ASTM	Standard Test Method for Unconfined Compressive Strength of Cohesive Soil
14	D 2850 – 95	1995	ASTM	Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils
15	D 4746 – 95	1995	ASTM	Standard Test Method for Consolidated-Undrained Triaxial Compression Test on Cohesive Soils
16	D 2435 – 96	1996	ASTM	Standard Test Method for One-Dimensional Consolidation Properties of Soils
17	D 698 – 00a	2000	ASTM	Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3(600 kN/m^3))
18	D5878 - 08	1998	ASTM	Standard Guides for Using Rock-Mass Classification Systems for Engineering Purposes

b. Core Drilling

The core drilling carried out using drilling machine at each investigation points based on general layout of power plant. The core drilling purposes are to identified the geological and geotechnical condition of sub surface. The Direct Rotary Core Drilling was applied with fresh water as drilling fluids. (ASTM D.2113 - 99). The work implementation shall carried out based on following methods :

1. Location or site of bore hole should be clean up and level to make comfortable work space. The drilling machine are setting up based on its drilling machine *operation manual*,
2. The application of drilling fluids are very important, to assure the cores un-eroded, and cores taken fully recovery and keeps identity of soil/rock.
3. When drilling reach overburden layers or un-stable layers, all potential holes collapse shall be avoid and protect by casing.
4. The ground water table in each bore hole recorded every day during the drilling work implemented and also after drilling complete. Some special condition arise (artesian or water loose) have to recorded also.
5. Prepare the Drilling Daily Report, included:
   - Date of drilling implementation,
   - Location and number of hole,
   - Elevation of water table,
   - Name and type of drilling machine, type of core barrel applied, diameter of bore hole and depth of casing installed,
   - Description of core,
   - Name of Bore Master,
   - Any necessary information about the drilling activities.
6. The core placed into transparent plastic in order to protect it and placed into core box orderly based on drilling depth. On the cover of core box put label or information about:
   - Name / Project Location
   - Number of Bore hole
   - Sequence number of core boxes
   - Depth of drilling of each box.
7. Immediately conduct the core description and continue with log bore preparation. The log bore contains as follows :
   - Date of drilling implementation,
   - Length of core,
   - Rock Quality Designation (RQD),
   - Water table,
   - Rock symbols and its description,
   - Result of on site tests and another necessary/ important description for design needs.

c. Standard Penetration Test (SPT)

The Standard Penetration Test (SPT) was carried out on each holes during drilling activities, based on the USBR specification in Earth Manual Book, ASTM D 1586-99 or SNI 03-4148. It was conduct using Raymond Sampler and Drive Hammer with 140 $\pm$ 2 lb (63,5$\pm$ 1 kg) weight, every stated depth level.

It was recorded every 15 cm penetration of 75 cm falling of hammer. The SPT report consist of :

- Depth of test
- Number of hit for 15 cm penetration

The N-value is total number of hit for 30 cm penetration.

d. Permeability Test and Ground Water Monitoring

The Falling Head Test method was applied for non-permeable soil layers (clay and silt) and Constant Head Test method was applied for permeable soil layers (sand, gravel). The testing

carried out based on BS standard 5930 -1999 and Lugeon Test method based on Earth Manual. Interpretation of the test result was referred to SNI 2436:2008 as shown in following table

Table 3-2 *Permeability level (SNI 2436 : 2008)*

Value of permeability (cm/ sec)	Level of permeability
$> 10^{-2}$	Very high
10^{-2} - 10^{-3}	High
10^{-4} - 10^{-5}	Medium
10^{-6}	Low
$<10^{-6}$	Very low

e. Soil and Ground Water Samples

The undisturbed sample of soil extracted using Shelby Tube Sampler in drilling hole at designed depth and carried out based on ASTM D-1587 - 00. After soil sample trapped in shelby tube, sealed both side of tube paraffin, and then sending to laboratory to analysis of its properties.

The soil sample will process in Soil Mechanic laboratory and some of them will process in chemical soil laboratory. Whereas water sample of bore hole will process in chemical laboratory. The chemical test will focus in corrosive parameter of soil and ground water.

g. Soil Mechanic Test

The soil mechanic laboratory test consists of 2 major parameter, physical (index) properties and mechanical (engineering) properties.

Physical Properties :

- Water content
- Specific Gravity
- Particle-size analysis
- Atterberg Limits
- Unit weight

Mechanical Properties :

- Triaxial Compression Test
- Consolidation Test
- Direct Shear
- Unconfine Compresion Test

3.2 Geological Condition

According to the field geological mapping that have been conducted, the lithology type emerges in the investigation area typically consists of silt and clay. Typically showing massive

to interbeded feature, gently diping of bedding with gently folding area structures commonly found in the area.

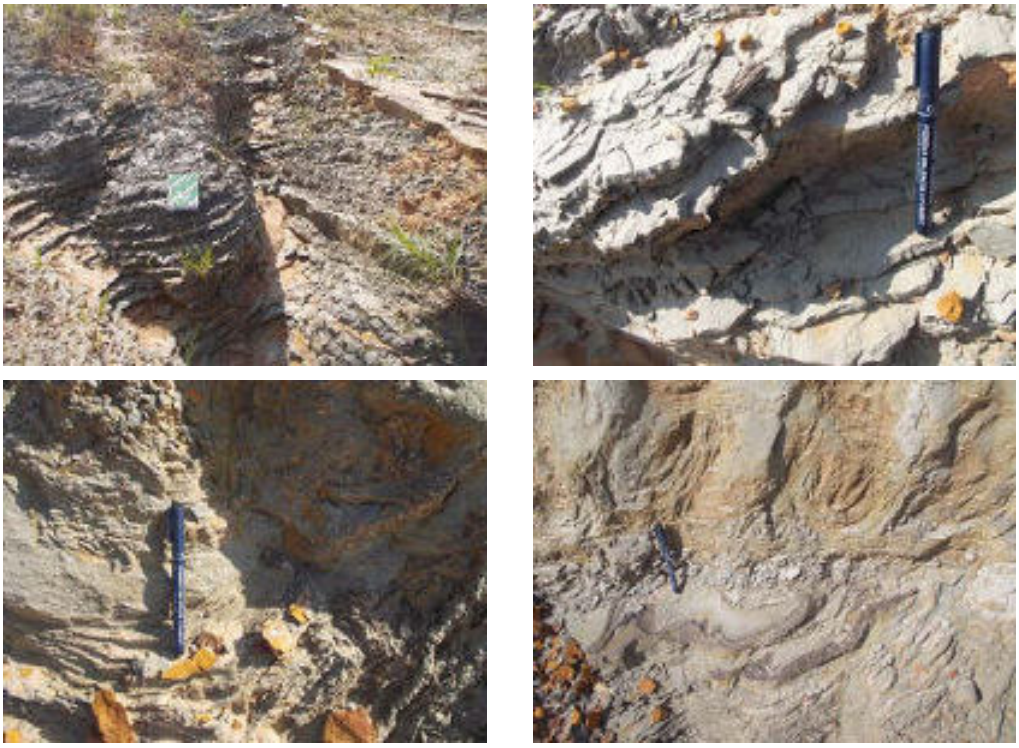


Figure 3-1 *Typical bedrock encountered at investigation.*

According to regional gelogy map of Riau Quadrangle this rock unit is part of Minas formation of Quarternary age (pleistocene) assocciated with gravel and sand deposits which is sometimes interpreted as fluvial origin.

No fault structures encountered in the area, according to regional geology map of Riau Quadrangle (scale 1: 250,000 Clarke. W et al 1982) the nearest large scale fault structure from the area approximately 12 km.

3.3 Core Drilling and Insitu Test

In order to understand the behavior, distribution, geological and geotechnical characteristics of rocks in investigation site. Three drilling locations had had been undertaken. Namely BH-01, BH-02, and BH-03.

Following map shows the layout of soil investigation area, where the drillholes and land boundary situated and the site investigation work is undertaken.

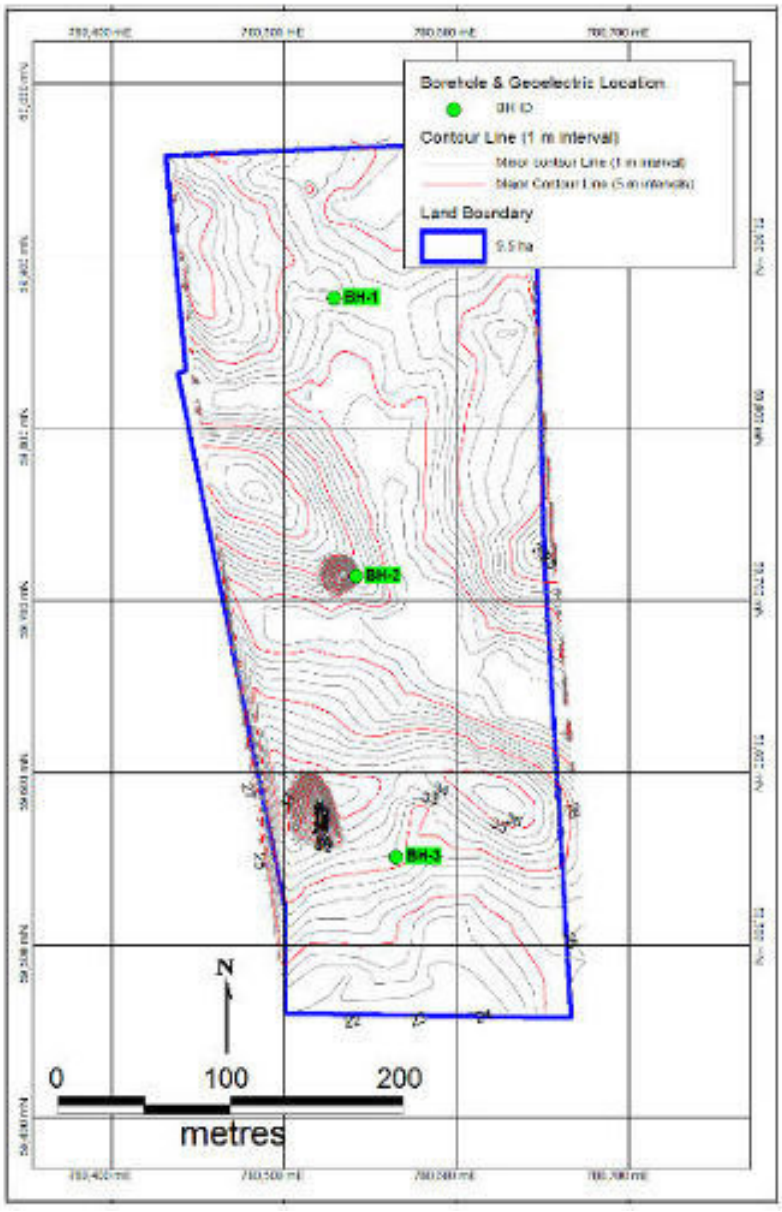


Figure 3-2 *Map layout of soil investigation and geoelectric survey.*

Lithology of site investigation area, according to drilling result consists of consolidated fine grained soil material: silty Clay and Clay. Following table describe soil and rock layer occupying the investigated area.

Table 3-3 *Summary of lithology unit for each borehole location.*

No.	BH-ID	Depth (m)	Lithology	Hardness
1	BH-01	0 – 0.40	clayey SILT	Top Soil (D) soft, dull, blackish brown, clayey SILT, moist, frequent small root encountered.

No.	BH-ID	Depth (m)	Lithology	Hardness
		0.40 – 1.00	silty CLAY	firm - stiff (MW-HW) of light brown - yellowish brown of moist silty CLAY, some fine sand and silt encountered.
		1.00 – 27.00	CLAY	very stiff, (MW-HW) of greyish brown - dark brown CLAY.
		27.00 – 30.00	CLAY	very stiff, (MW-HW) of massive greyish brown - dark brown CLAY.
2	BH-02	0 – 0.60	clayey SILT	Top Soil (D) soft, dull, blackish brown, clayey SILT, moist, frequent small root encount
		0.60 – 3.45	silty CLAY	firm - stiff (MW-HW) of light brown - yellowish brown of moist silty CLAY, some fine sand and silt encountered.
		3.45 – 30.00	CLAY	very stiff, (MW-HW) of massive greyish brown - dark brown lean CLAY.
3	BH-03	0 – 1.20	Clayey SILT	top soil (D), soft of blackish brown clayey SILT, moist, root frequent.
		1.20 - 5.60	Clayey SILT	(MW-HW), soft - firm of light brown - greyish brown silty CLAY. Medium to high plasticity
		5.60 – 30.00	CLAY	(MW), stiff - very stiff of dark grey to light grey massive lean clay with silt. Medium to high plasticity.

In addition to geological description we also undertook the Field Standar Penetration Test (SPT) were performed by 1.5 m interval of testing in regular basis. following tables show field record of SPT data from each borehole.

Table 3-4 *SPT field record of BH-01.*

No	Depth	N1	N2	N3	NSPT (N2+N3)
1	1.50 - 1.95	3	8	10	18
2	3,00 - 3.45	3	10	10	20
3	4.50 - 4.95	5	8	10	18
4	6.00 - 6.45	2	4	2	6
5	7.50 - 7.95	2	6	9	15
6	9.00 - 9.45	5	10	17	27
7	10.50 - 10.95	8	15	18	33
8	12.00 - 12.45	7	20	18	38
9	13.50 - 13.95	5	12	15	27
10	15.00 - 15.45	8	18	18	36
11	16.50 - 16.95	8	18	30	48

No	Depth	N1	N2	N3	NSPT (N2+N3)
12	18.00 - 18.45	5	16	34	50
13	19.50 - 19.95	10	21	30	>50
14	21.00 - 21.45	11	15	32	47
15	22.50 - 22.95	8	26	33	>50
16	24.00 - 24.45	17	28	26	>50
17	25.50 - 25.95	9	26	34	>50
18	27.00 - 27.45	15	40	43	>50
19	28.50 - 28.95	20	35	36	>50
20	30.00 - 30.45	9	24	34	>50

Table 3-5 *SPT field record of BH-02.*

No	Depth	N1	N2	N3	NSPT (N2+N3)
1	1.50 - 1.95	1	1	1	2
2	3.00 - 3.45	2	3	4	7
3	4.50 - 4.95	5	10	12	22
4	6.00 - 6.45	6	10	16	26
5	7.50 - 7.95	7	19	30	49
6	9.00 - 9.45	8	15	34	49
7	10.50 - 10.95	9	18	27	45
8	12.00 - 12.45	10	20	30	50
9	13.50 - 13.95	10	20	44	>50
10	15.00 - 15.45	11	18	33	>50
11	16.50 - 16.95	15	32	38	>50
12	18.00 - 18.45	20	28	25	>50
13	19.50 - 19.95	10	19	30	49
14	21.00 - 21.45	14	29	28	>50
15	22.50 - 22.95	9	28	45	>50
16	24.00 - 24.45	7	12	25	37
17	25.50 - 25.95	10	18	20	38
18	27.00 - 27.45	7	18	40	>50
19	28.50 - 28.95	20	23	35	>50
20	30.00 - 30.45	22	24	36	>50

Table 3-6 *SPT field record of BH-03.*

No	Depth	N1	N2	N3	NSPT (N2+N3)
1	1.50 - 1.95	2	4	6	10

No	Depth	N1	N2	N3	NSPT (N2+N3)
2	3.00 - 3.45	3	3	5	8
3	4.50 - 4.95	2	2	6	8
4	6.00 - 6.45	2	5	6	11
5	7.50 - 7.95	4	8	10	18
6	9.00 - 9.45	6	12	16	28
7	10.50 - 10.95	8	14	20	34
8	12.00 - 12.45	5	10	25	35
9	13.50 - 13.95	11	15	13	28
10	15.00 - 15.45	6	125	18	30
11	16.50 - 16.95	18	25	21	46
12	18.00 - 18.45	6	12	20	32
13	19.50 - 19.95	6	14	23	37
14	21.00 - 21.45	12	20	40	60
15	22.50 - 22.95	8	20	30	50
16	24.00 - 24.45	29	36	36	>50
17	25.50 - 25.95	14	27	50	>50
18	27.00 - 27.45	15	25	30	>50
19	28.50 - 28.95	15	28	31	>50
20	30.00 - 30.45	16	26	39	>50

Following tables described the permeability result obtained from field permeability test, from the test results we might conclude that the permeability value of investigated area ranging from 10^{-5} to 10^{-4} cm/s therefore categorized as medium permeability.

Table 3-7 *Permeability insitu test results.*

No.	BH-ID	Depth (m)	Permeability (cm/sec)
1	**BH-01**	0 – 5	2.22E-04
		2.8 – 10	1.24E-04
		2.8 – 15	7.40E-06
		14.8 – 20	1.17E-06
		19.5 – 25	1.85E-06
		19.3 – 30	2.21E-06

No	BH-ID	Depth (m)	Permeability (cm/sec)
2	**BH-02**	2.95 – 5	2.10E-05
		8.9 – 10	2.31E-05
		14.8 – 15	4.13E-05
		17.8 – 20	1.35E-05
		20.8 – 25	1.82E-06
		20.8 – 30	7.50E-07

3	**BH-03**	2.8 – 5	9.96E-05
		8.8 – 10	4.86E-05

		14.8 – 15	7.43E-05
		17.8 – 20	5.66E-06
		23.9 – 25	5.27E-06
		20.8 – 30	7.50E-07

Documentation of Drilling acitivity BH-01

Documentation of Drilling acitivity BH-02

Documentation of Drilling acitivity BH-03

Figure 3-3 *Documentation of drilling acitivity at investigation area*

3.4 Chemical Properties

During implementation of drilling works, ground water of borehole was taken for water quality laboratory test. Each borehole represented by one groundwater sample obtained after drilling work, one sample taken at 10 meter hole depth and other at 30 meter hole depth. Following table is summary of the laboratory result and the detail result attached in Appendix G.

Table 3-8 *Summary of ground water quality result*

No.	Parameter	Unit	BH-01	BH-02	BH-03
			Depth 28 m	Depth 10 m	Depth 20 m
1	Acidity (as $CaCO_3$)	mg/L ($CaCO_3$)	133	18	104
2	Alkalinity (as $CaCO_3$)	mg/L ($CaCO_3$)	95	328	132
3	Hydrogene Sulphide (H_2S)	mg/L	0.21	28	2
4	Soluble Chloride (Cl)	mg/L	21	31	94
5	Soluble Sulphate (SO_4)	ppm	36	34	104

6	Organic Content	mg/L	366	702	304

Table 3-9 *Summary of Soil Chemistry result*

No.	Parameter	Unit	BH-01	BH-02	BH-03
			Depth 28 m	Depth 10	Depth 20
1	pH	-	7.3	9.62	9.66
2	Acidity	Mg/Kg (CO_3)	64.92	66.05	65.51
3	Alkalinity	mg/Kg (HCO_3)	264.01	266.83	266.59
4	Sulphur Trioxide (SO_3)	ppm	9.62	9.76	9.48
5	Soluble Chloride (Cl)	ppm	67.32	67.19	67.29
6	Soluble Sulphate (SO_4)	ppm	24.01	24.44	24.62
7	Organic Content	%	9.00	9.11	9.17

3.5 Geoelectrical Survey

3.5.1 Implementation of Survey Works

The geoelectric survey work that has been done in is 3 (three) points V.E.S. (Vertical Electrical Sounding), where the placement of dots suspect attention to morphological aspects, geology and aspects of local physical infrastructure located at the location of the investigation. Coordinates of geoelectric points can be seen in Table 3.10, while the layout map of the geoelectric investigation points can be seen in Figure 3.5

Table 3-10 *Summary of ground water quality result.*

Point	X (m)	Y (m)	Z (m)
GL-1	780533.750	59873.540	28.62
GL-2	780544.970	59711.440	28.97
GL-3	780566.520	59551.520	31.05

Implementation of geoelectrical survey at GL-1

Implementation of geoelectrical survey at GL-2

Implementation of geoelectrical survey at GL-3

***Figure 3-4** Implementation of geoelectrical survey at investigation area*

The Geolistrical survey try to penetrate 100 meter of ground consist of 3 (three) points of VES, distributed on future power plant area. Following figure describe lay out of the survey.

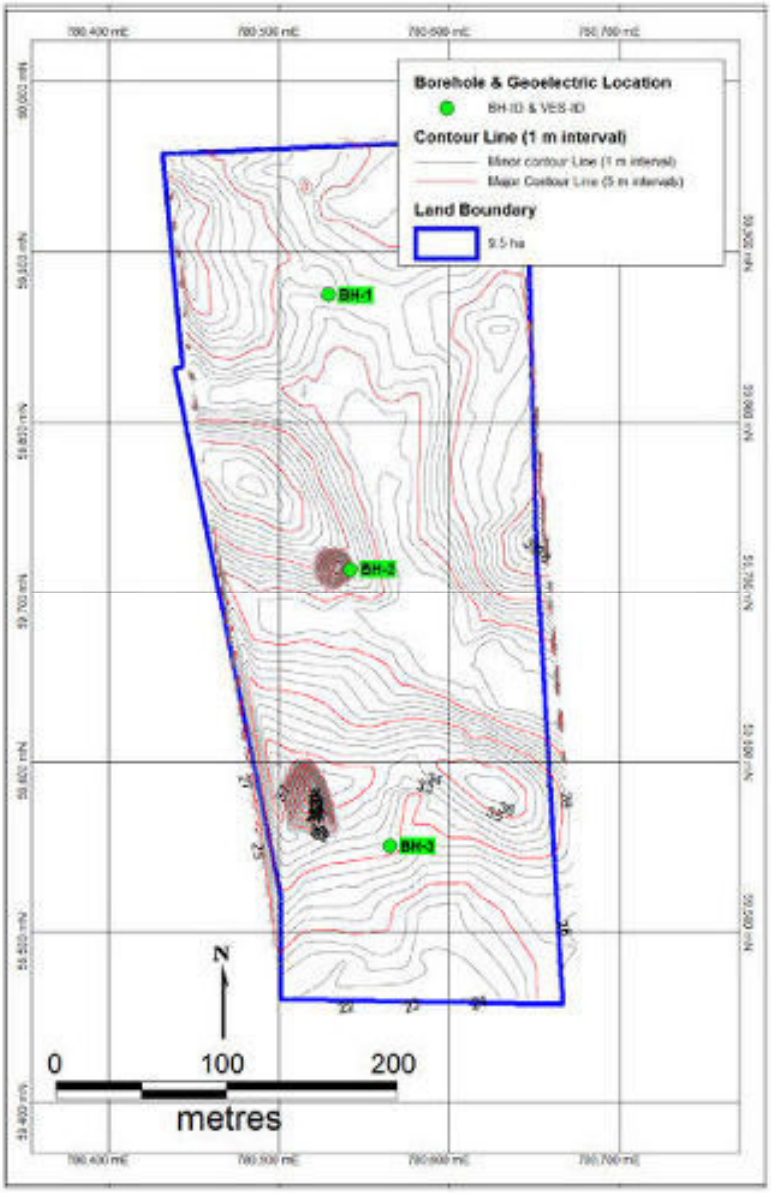


Figure 3-5 *Layout of geoelectrical survey*

3.5.2 Result of Geoelectrical Survey

Based on the results of interpretation of geoelectric data correlated with the drill log data and regional geology sheet Pekanbaru, then the arrangement of layers of soil / rock contained in the area of investigation based on the type of resitivity can be grouped as follows:

1. **The first layer**, interpreted as top soil with a resistivity value of its type ranges from 2100 to 2938 ohm-meters. This unit is found from the local surface to a depth of 1.53 meters with a thickness ranging from 0.64 meters to 1.53 meters.

2. **The second layer**, interpreted as a unit of silty clay, with a resistivity value of the type ranges from 504 to 784 ohm-meter. This layer has a thickness ranging from 2.17 meters to 4.39 meters.
3. **The third layer**, interpreted as a unit of clay, with the resistivity value of the species ranged from 8.7 - 13 ohm-meter. This layer has a thickness ranging from 27.63 to 30.00 meters.
4. **The fourth layer**, interpreted as a unit of clayey sand, with resistivity value of the species ranges from 53 to 79 ohm-meters. This layer has a thickness This layer has a thickness of more than 66 meters

Geological Section Based on Geoelectric Interpretation and Drilling Result (Bor Log) can be seen in Figure 3-6, while Field Data & Interpretation Curve of Geoelectric Survey Results can be seen in Appendix.

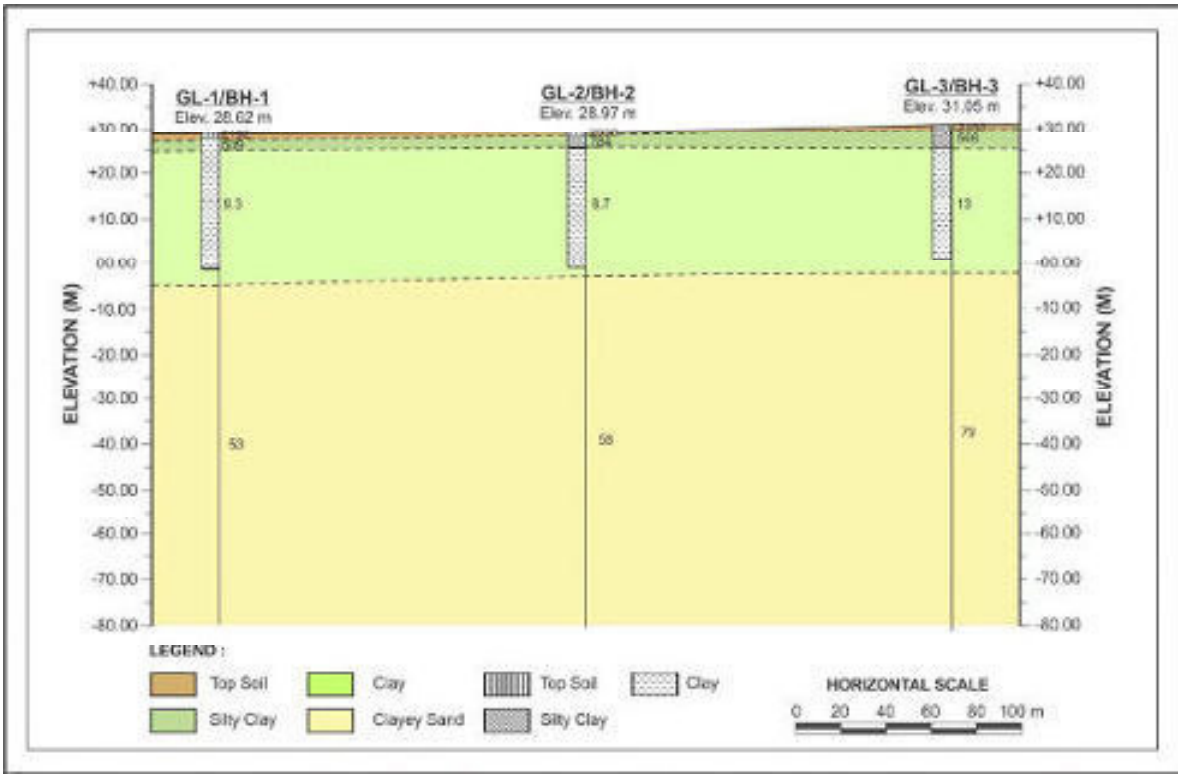


Figure 3-6 *Geological cross section based on geoelectrical data (section GL-1 to GL-3).*

3.6 Geotechnical Investigation and Foundation

3.6.1 Recommendation of Design Parameter

Based on field investigation data which includes 3 boreholes with SPT, the general soil stratification of Gas Fired Power Plant 275 MW Riau area are consist of Clay and Silty Clay soil

type. The strength and consistency of soil layers increased within depth. Ground water level was found between -4.00 to -9.00 m from ground surface elevation.

Soil properties are interpreted from field data as describes in following tables.

Table 3-11 *Parameter design of BH-01.*

PARAMETER DESIGN OF BH-01										
Depth	N-SPT	Soil	γ	Su	c'	ϕ'	Eu	E'	Vs	G max
(m)	(blow/ft)	Type	(kN/m3)	(kPa)	(kPa)	(deg)	(kPa)	(kPa)	(m/s)	(kPa)
0.00	18.00	Clay	19.68	103.02	30.01	20.69	25,108	22,926	209.44	74,677
1.50	18.00	Clay	19.68	113.82	30.01	20.69	27,740	25,329	216.10	79,915
3.00	20.00	Clay	19.68	133.48	33.35	20.69	32,533	29,705	227.19	89,062
4.50	18.00	Clay	18.31	112.41	30.01	21.99	44,566	40,298	222.34	84,995
6.00	6.00	Clay	18.31	38.52	11.50	21.99	15,270	13,807	158.83	41,028
7.50	15.00	Clay	18.31	98.43	25.00	21.99	39,021	35,284	213.25	77,652
9.00	27.00	Clay	18.83	173.45	45.04	21.46	61,259	55,551	257.94	117,249
10.50	33.00	Clay	18.83	215.30	55.06	21.46	76,040	68,955	276.06	135,813
12.00	38.00	Clay	18.83	251.28	63.41	21.46	88,748	80,479	289.78	150,862
13.50	27.00	Clay	18.83	180.67	45.04	21.46	63,812	57,866	261.27	120,549
15.00	36.00	Clay	18.83	243.47	60.07	21.46	85,992	77,980	286.93	147,660
16.50	48.00	Clay	18.76	342.01	80.11	20.76	93,880	85,572	315.00	180,743
18.00	50.00	Clay	18.76	356.26	83.45	20.76	97,792	89,137	319.07	185,830
19.50	50.00	Clay	18.76	356.26	83.45	20.76	97,792	89,137	319.07	185,830
21.00	47.00	Clay	18.76	334.89	78.44	20.76	91,924	83,789	312.93	178,173
22.50	50.00	Clay	18.97	316.33	83.45	22.13	128,083	115,728	319.07	185,830
24.00	50.00	Clay	18.97	316.33	83.45	22.13	128,083	115,728	319.07	185,830
25.50	50.00	Clay	18.97	316.33	83.45	22.13	128,083	115,728	319.07	185,830
27.00	50.00	Clay	19.00	323.05	83.45	22.42	139,079	125,469	319.07	185,830
28.50	50.00	Clay	19.00	323.05	83.45	22.42	139,079	125,469	319.07	185,830
30.00	50.00	Clay	19.00	323.05	83.45	22.42	139,079	125,469	319.07	185,830

Table 3-12 *Parameter design of BH-02.*

PARAMETER DESIGN OF BH-02										
Depth	N-SPT	Soil	γ	Su	c'	ϕ'	Eu	E'	Vs	G max
(m)	(blow/ft)	Type	(kN/m3)	(kPa)	(kPa)	(deg)	(kPa)	(kPa)	(m/s)	(kPa)
0.00	2.00	Clay	18.95	8.61	4.00	28.14	8,247	7,262	105.06	16,761
1.50	2.00	Clay	18.95	9.52	4.00	28.14	9,111	8,024	108.40	17,937
3.00	7.00	Clay	19.00	38.48	13.00	22.13	15,927	14,391	163.39	43,617
4.50	22.00	Clay	19.00	125.44	36.69	22.13	51,924	46,915	236.80	97,422
6.00	26.00	Clay	19.00	120.42	43.37	26.21	95,389	84,561	251.71	111,203
7.50	49.00	Clay	18.34	231.98	81.78	26.21	183,758	162,899	309.26	173,678

PARAMETER DESIGN OF BH-02										
Depth	N-SPT	Soil	γ	Su	c'	ϕ'	Eu	E'	Vs	G max
(m)	(blow/ft)	Type	(kN/m3)	(kPa)	(kPa)	(deg)	(kPa)	(kPa)	(m/s)	(kPa)
9.00	49.00	Clay	18.34	236.24	81.78	26.21	187,128	165,887	311.03	175,838
10.50	45.00	Clay	18.34	236.29	75.10	25.43	171,524	152,529	304.29	167,701
12.00	50.00	Clay	19.82	266.10	83.45	25.43	193,165	171,773	315.86	181,814
13.50	50.00	Clay	19.82	311.48	83.45	22.42	134,650	121,474	317.04	183,289
15.00	50.00	Clay	19.82	314.81	83.45	22.42	136,090	122,773	318.10	184,620
16.50	50.00	Clay	19.82	317.85	83.45	22.42	137,404	123,958	319.07	185,830
18.00	50.00	Clay	19.26	374.95	83.45	20.80	106,753	97,188	319.07	185,830
19.50	49.00	Clay	19.26	367.45	81.78	20.80	104,618	95,244	317.05	183,295
21.00	50.00	Clay	19.18	374.95	83.45	20.80	106,753	97,188	319.07	185,830
22.50	50.00	Clay	19.18	374.95	83.45	20.80	106,753	97,188	319.07	185,830
24.00	37.00	Clay	19.18	291.41	61.74	20.73	77,752	70,913	290.28	151,424
25.50	50.00	Clay	19.18	393.80	83.45	20.73	105,071	95,828	319.07	185,830
27.00	50.00	Clay	19.18	393.80	83.45	20.73	105,071	95,828	319.07	185,830
28.50	50.00	Clay	19.18	393.80	83.45	20.73	105,071	95,828	319.07	185,830
30.00	50.00	Clay	19.18	393.80	83.45	20.73	105,071	95,828	319.07	185,830

Table 3-13 *Parameter design of BH-03.*

PARAMETER DESIGN OF BH-03										
Depth	N-SPT	Soil	γ	Su	c'	ϕ'	Eu	E'	Vs	G max
(m)	(blow/ft)	Type	(kN/m3)	(kPa)	(kPa)	(deg)	(kPa)	(kPa)	(m/s)	(kPa)
0.00	10.00	Clay	19.00	46.81	17.50	22.57	20,904	18,843	174.14	50,073
1.50	10.00	Clay	19.00	51.72	17.50	22.57	23,095	20,819	179.68	53,585
3.00	8.00	Clay	19.00	43.67	14.50	22.57	19,502	17,579	170.38	47,763
4.50	8.00	Clay	18.19	45.30	14.50	22.57	20,229	18,235	172.35	48,968
6.00	11.00	Clay	18.19	64.03	19.00	22.57	28,591	25,773	192.13	61,956
7.50	18.00	Clay	17.71	98.44	30.01	23.93	56,495	50,578	225.81	87,902
9.00	28.00	Clay	17.71	155.94	46.71	23.93	89,493	80,121	260.90	120,184
10.50	34.00	Clay	19.04	193.16	56.73	24.53	122,930	109,748	278.66	138,598
12.00	35.00	Clay	19.04	201.54	58.40	24.53	128,260	114,507	282.40	142,657
13.50	28.00	Clay	19.04	163.16	46.71	24.53	103,835	92,701	264.27	123,568
15.00	30.00	Clay	19.04	176.68	50.05	24.53	112,441	100,384	270.96	130,443
16.50	46.00	Clay	19.04	273.53	76.77	24.53	174,075	155,409	310.82	175,587
18.00	32.00	Clay	18.50	215.43	53.39	20.88	68,100	61,880	277.34	137,189
19.50	37.00	Clay	18.50	249.09	61.74	20.88	78,740	71,549	290.28	151,424
21.00	50.00	Clay	19.14	268.24	83.45	24.12	161,223	144,207	319.07	185,830
22.50	50.00	Clay	19.14	268.24	83.45	24.12	161,223	144,207	319.07	185,830

PARAMETER DESIGN OF BH-03										
Depth	N-SPT	Soil	γ	Su	c'	ϕ'	Eu	E'	Vs	G max
(m)	(blow/ft)	Type	(kN/m3)	(kPa)	(kPa)	(deg)	(kPa)	(kPa)	(m/s)	(kPa)
24.00	50.00	Clay	18.55	349.79	83.45	20.88	109,707	99,687	319.07	185,830
25.50	50.00	Clay	18.55	349.79	83.45	20.88	109,707	99,687	319.07	185,830
27.00	50.00	Clay	18.55	349.79	83.45	20.88	109,707	99,687	319.07	185,830
28.50	50.00	Clay	18.55	349.79	83.45	20.88	109,707	99,687	319.07	185,830
30.00	50.00	Clay	18.55	349.79	83.45	20.88	109,707	99,687	319.07	185,830

3.7.1.5 Embankment Materials

The Gas Fired Power Plant 275 MW Riau area is consist of Clay and Silty Clay soil type with LL = 44.00 – 84.79% and PI = 16.41 – 59.91%, which indicate medium to very high plasticity behaviour. From laboratory data results using Standard Proctor Test at TP-01 and TP-02, we found that the maximum dry density MDD = 1.351 – 1.354 ton/m3 after compacted. The maximum dry unit weight values are too low for compacted soil. These results indicate that the soil absorp water, which also indicate swelling behaviour.

Hence, the soil of TP-01 and TP-02 are not good for embankment materials. Soil with medium to high plasticity has potential tendency to shrink when the water content decreased, and swell when the water content increased. These behaviours will cause cracks within embankment bodies that within time will lead to slopes failure.

3.6.2 Shallow Foundation

Shallow foundation shall be calculated with various factors :

- embedment depth of 0.5 m, 1.0 m, 1.5 m and 2.0 m
- squared base footing size (B, L) of 0.5 m, 1.0 m, 1.5 m, and 2.0 m.
- stripped base footing size (B) of of 0.5 m, 1.0 m, 1.5 m, and 2.0 m.

3.6.2.1 Shallow Foundation Formula Based on SPT

Shallow foundation formula based on SPT data is adopted from Meyerhoff (1965) such as follows:

For B = L ≤ 1.2 m : $Qa = \frac{N_{SPT}}{0.05} Kd$ (unit in kPa)

For B = L > 1.2 m : $Qa = \frac{N_{SPT}}{0.08}\left(\frac{B+0.3}{B}\right)^2 Kd$ (unit in kPa)

Where : $Kd = 1 + 0.33\frac{D}{B} \leq 1.33$

This formula especially used for calculate allowable bearing capacity Qa in terms of 1 inch settlement and not taken the type of foundation (squared or stripped) into account.

Table 3-14 *Bearing capacity of shallow foundation based on SPT of BH-01.*

BH-01					
Depth	**Squared Allowable Bearing Capacity (kN)**				
(m)	**1 x 1**	**1.5 x 1.5**	**2 x 2**	**2.5 x 2.5**	**3 x 3**
0.00	360.00	729.00	1190.25	1764.00	2450.25
0.50	419.40	809.19	1288.45	1880.42	2585.01
1.00	478.80	889.38	1386.64	1996.85	2719.78
1.50	478.80	969.57	1484.84	2113.27	2854.54
2.00	478.80	969.57	1583.03	2229.70	2989.31
Depth	**Stripped Allowable Bearing Capacity (kN/m)**				
(m)	**1 m**	**1.5 m**	**2 m**	**2.5 m**	**3 m**
0.00	360.00	486.00	595.13	705.60	816.75
0.50	419.40	539.46	644.22	752.17	861.67
1.00	478.80	592.92	693.32	798.74	906.59
1.50	478.80	646.38	742.42	845.31	951.51
2.00	478.80	646.38	791.52	891.88	996.44

Table 3-15 *Bearing capacity of shallow foundation based on SPT of BH-02.*

BH-02					
Depth	**Squared Allowable Bearing Capacity (kN)**				
(m)	**1 x 1**	**1.5 x 1.5**	**2 x 2**	**2.5 x 2.5**	**3 x 3**
0.00	40.00	81.00	132.25	196.00	272.25
0.50	46.60	89.91	143.16	208.94	287.22
1.00	53.20	98.82	154.07	221.87	302.20
1.50	53.20	107.73	164.98	234.81	317.17
2.00	53.20	107.73	175.89	247.74	332.15
Depth	**Stripped Allowable Bearing Capacity (kN/m)**				
(m)	**1 m**	**1.5 m**	**2 m**	**2.5 m**	**3 m**
0.00	40.00	54.00	66.13	78.40	90.75
0.50	46.60	59.94	71.58	83.57	95.74
1.00	53.20	65.88	77.04	88.75	100.73
1.50	53.20	71.82	82.49	93.92	105.72
2.00	53.20	71.82	87.95	99.10	110.72

Table 3-16 *Bearing capacity of shallow foundation bsed on SPT of BH-03.*

BH-03					
Depth	Squared Allowable Bearing Capacity (kN)				
(m)	1 x 1	1.5 x 1.5	2 x 2	2.5 x 2.5	3 x 3
0.00	200.00	405.00	661.25	980.00	1361.25
0.50	233.00	449.55	715.80	1044.68	1436.12
1.00	266.00	494.10	770.36	1109.36	1510.99
1.50	266.00	538.65	824.91	1174.04	1585.86
2.00	266.00	538.65	879.46	1238.72	1660.73
Depth	Stripped Allowable Bearing Capacity (kN/m)				
(m)	1 m	1.5 m	2 m	2.5 m	3 m
0.00	200.00	270.00	330.63	392.00	453.75
0.50	233.00	299.70	357.90	417.87	478.71
1.00	266.00	329.40	385.18	443.74	503.66
1.50	266.00	359.10	412.45	469.62	528.62
2.00	266.00	359.10	439.73	495.49	553.58

3.6.3 Deep Foundation

Considering there are many lenses of hard soil layers with inadequate thickness, it is not preferable to use driven piles. Driven piles are prefabricated piles which had limitation of structural axial capacity, hence, if the bearing capacity of the soil is greater than the structural capacity, the piles cannot be driven into the soil layer without any structural damages. Therefore, bored piles is more suitable choice for deep foundation at Gas Fired Power Plant 275 MW Riau area. However, if under any circumstances driven piles should be used, preboring method must be adopted, to help driven piles reach required depth.

Bored piles and driven piles foundation shall be calculated with various factors :

- diameter size (D) of 0.30 m, 0.40 m, 0.50 m, 0.60 m and 0.80 m.
- different locations based on soil investigation points
- depth limitation due to the termination level of boreholes

3.6.3.1 Bored Piles Based on SPT Data

Bored piles based on SPT data shall be calculated as follows :

For cohesive soil

End bearing : $q_p = 9\ Su$

Sleeves friction : $fs = \alpha\ Su$

For granular soil

End bearing : $q_p = 67\ N_{SPT}$

Sleeves friction : $fs = 3.125\ N_{SPT}$

Ultimate bearing capacity : $Qu = qp\ Ap + \Sigma\ fs\ As$

Allowable bearing capacity : $Qa = Qu / SF$

Where :

Su = undrained shear strength
Ap = area of pile base
As = area of pile sleeves
α = adhesion factor based on graph below

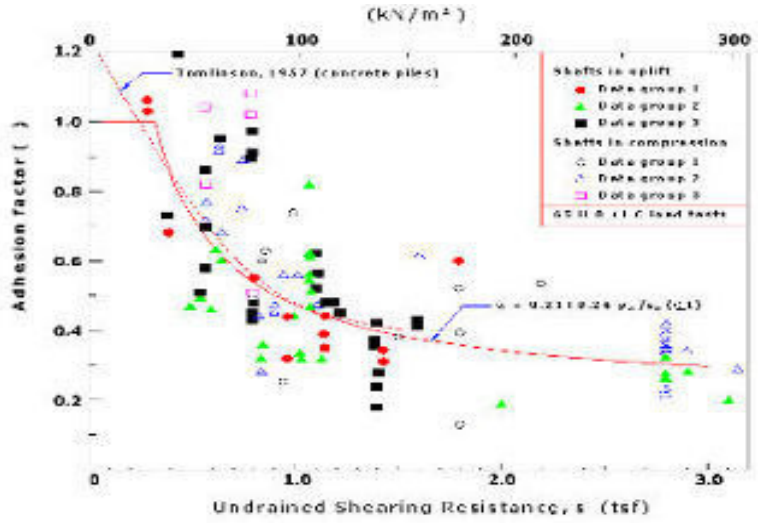


Figure 3-7 *Undraned shearing resistance vs adhesion factor.*

Table 3-17 *Bearing capacity of deep foundation at BH-01 using bored pile based on SPT data.*

Depth	BH-01				
	Allowable Bearing Capacity (kN)				
(m)	D 30	D 40	D 50	D 60	D 80
0.00					
1.50	57.39	89.39	127.82	172.68	281.70
3.00	93.14	139.27	192.95	254.18	399.26
4.50	116.00	167.37	225.10	289.18	436.40
6.00	115.75	158.69	203.80	251.09	352.21
7.50	157.36	220.94	290.08	364.78	530.88
9.00	211.47	301.56	401.46	511.16	759.98
10.50	261.87	373.50	497.30	633.26	941.70

Depth	BH-01				
	Allowable Bearing Capacity (kN)				
(m)	D 30	D 40	D 50	D 60	D 80
12.00	315.52	449.10	596.87	758.86	1125.43
13.50	333.33	464.87	606.62	758.57	1093.13
15.00	392.83	551.30	723.53	909.51	1322.77
16.50	471.89	667.84	883.13	1117.75	1644.98
18.00	530.70	747.88	985.18	1242.63	1817.93
19.50	585.89	821.46	1077.17	1353.01	1965.10
21.00	633.89	883.04	1151.12	1438.13	2068.93
22.50	680.85	943.56	1224.14	1522.61	2173.18
24.00	732.52	1012.46	1310.27	1625.96	2310.98
25.50	784.20	1081.36	1396.39	1729.31	2448.78
27.00	838.20	1154.12	1488.29	1840.73	2600.37
28.50	890.49	1223.84	1575.45	1945.32	2739.82
30.00	942.79	1293.57	1662.61	2049.91	2879.28

Table 3-18 *Bearing capacity of deep foundation at BH-02 using bored pile based on SPT data.*

Depth	BH-02				
	Allowable Bearing Capacity (kN)				
(m)	D 30	D 40	D 50	D 60	D 80
0.00					
1.50	7.80	11.47	15.69	20.44	31.56
3.00	33.70	49.28	67.03	86.96	133.35
4.50	85.62	128.34	178.15	235.05	370.12
6.00	113.54	165.00	223.27	288.34	438.91
7.50	183.98	271.52	372.18	485.96	752.83
9.00	227.64	330.22	446.16	575.44	874.07
10.50	270.24	387.03	517.17	660.67	987.73
12.00	324.10	462.21	615.36	783.55	1165.06
13.50	386.85	551.01	732.78	932.15	1383.71
15.00	439.26	621.26	821.06	1038.66	1527.22
16.50	491.89	691.78	909.64	1145.46	1671.00
18.00	563.07	793.14	1044.41	1316.87	1925.36
19.50	617.23	864.51	1132.56	1421.38	2061.32
21.00	675.80	943.45	1232.30	1542.33	2225.98
22.50	732.46	1019.00	1326.73	1655.65	2377.07
24.00	760.36	1046.75	1349.61	1668.95	2357.03
25.50	844.33	1170.29	1518.50	1888.97	2696.69
27.00	902.26	1247.53	1615.05	2004.84	2851.17

Depth	BH-02				
	Allowable Bearing Capacity (kN)				
(m)	D 30	D 40	D 50	D 60	D 80
28.50	960.19	1324.77	1711.60	2120.70	3005.65
30.00	1018.12	1402.01	1808.15	2236.56	3160.14

Table 3-19 *Bearing capacity of deep foundation at BH-03 using bored pile based on SPT data*

Depth	BH-03				
	Allowable Bearing Capacity (kN)				
(m)	D 30	D 40	D 50	D 60	D 80
0.00					
1.50	33.38	50.36	70.26	93.08	147.49
3.00	50.54	72.33	96.58	123.30	184.15
4.50	70.16	98.67	129.74	163.37	238.31
6.00	96.49	135.89	178.92	225.56	329.69
7.50	131.62	186.62	247.18	313.31	462.26
9.00	179.51	256.98	343.26	438.35	654.98
10.50	225.92	323.06	431.12	550.09	820.80
12.00	265.86	377.26	500.06	634.24	936.78
13.50	290.05	405.17	529.52	663.09	957.90
15.00	328.87	458.46	598.04	747.61	1076.70
16.50	400.66	565.14	745.07	940.47	1377.63
18.00	425.67	591.91	770.33	960.92	1378.63
19.50	478.44	666.08	867.80	1083.59	1557.41
21.00	529.85	736.79	958.89	1196.15	1716.16
22.50	576.39	798.84	1036.45	1289.23	1840.26
24.00	651.83	908.65	1185.24	1481.60	2133.62
25.50	706.54	981.59	1276.41	1591.01	2279.50
27.00	761.24	1054.53	1367.59	1700.42	2425.38
28.50	815.95	1127.47	1458.76	1809.82	2571.26
30.00	870.65	1200.41	1549.94	1919.23	2717.14

3.6.3.2 Driven Piles Based on SPT Data

Driven piles based on SPT data shall be calculated as follows :

For cohesive soil

End bearing : $q_p = 9\ Su$

Sleeves friction : $fs = \alpha\ Su$

For granular soil

End bearing : $q_p = 400\ N_{SPT}$

Sleeves friction : $fs = 2\ N_{SPT}$

Ultimate bearing capacity : $Qu = qp\ Ap + \Sigma\ fs\ As$

Allowable bearing capacity : $Qa = Qu / SF$

Where :

Su = undrained shear strength

Ap = area of pile base

As = area of pile sleeves

α = adhesion factor based on graph below

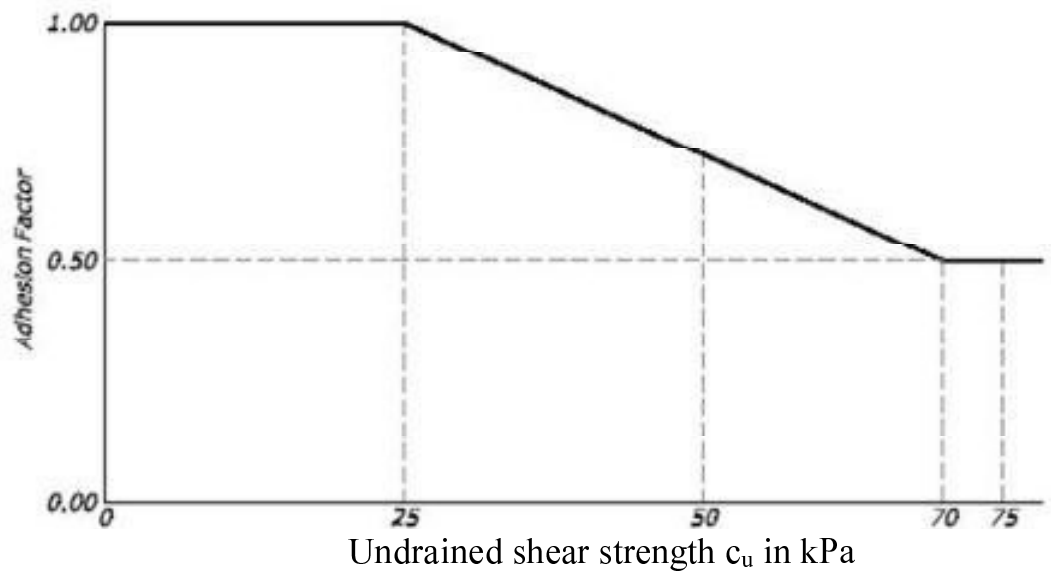


Figure 3-8 *Undrained shear strength vs adhesion factor.*

With preboring method, we can drive the piles until they reach required depth. The result of the calculation are presented in the table below.

3.6.3.3 Driven Pile With Pre-Boring

Since driven piles should be installed using preboring method, it will eliminate the sleeve friction capacity. Hence, the resistance will depend only to end bearing capacity.

Table 3-20 *Bearing capacity of deep foundation using driven pile based on SPT data with pre-boring at BH-01.*

Depth	BH-01				
	Allowable Bearing Capacity (kN)				
(m)	D 30	D 40	D 50	D 60	D 80
0.00					
1.50	61.11	94.35	134.02	180.12	291.63
3.00	103.84	153.54	210.78	275.57	427.79
4.50	130.25	186.37	248.85	317.68	474.40
6.00	130.08	177.79	227.68	279.75	390.41
7.50	173.13	241.97	316.37	396.33	572.94
9.00	241.23	341.24	451.06	570.68	839.33
10.50	312.71	441.29	582.03	734.94	1077.28
12.00	392.88	552.24	725.80	913.57	1331.71
13.50	425.98	588.39	761.02	943.86	1340.17
15.00	510.76	708.53	920.07	1145.36	1637.24
16.50	632.47	881.96	1150.77	1438.92	2073.20
18.00	736.78	1022.64	1328.64	1654.78	2367.46
19.50	837.46	1156.88	1496.44	1856.14	2635.94
21.00	926.66	1273.40	1639.07	2023.67	2849.65
22.50	1011.34	1384.21	1774.96	2183.58	3054.48
24.00	1100.73	1503.40	1923.95	2362.38	3292.87
25.50	1190.13	1622.60	2072.94	2541.17	3531.26
27.00	1283.13	1747.35	2229.84	2730.58	3786.84
28.50	1374.42	1869.08	2381.99	2913.17	4030.29
30.00	1465.71	1990.80	2534.15	3095.75	4273.74

Table 3-21 *Bearing capacity of deep foundation using driven pile based on SPT data with pre-boring at BH-02.*

BH-02				
Allowable Bearing Capacity (kN)				
D 30	D 40	D 50	D 60	D 80
7.80	11.47	15.69	20.44	31.56
33.77	49.38	67.16	87.12	133.56
91.34	135.97	187.69	246.50	385.38
124.10	179.07	240.86	309.45	467.05
218.03	316.93	428.94	554.06	843.64
285.87	407.86	543.21	691.91	1029.36
352.66	496.92	654.54	825.51	1207.52

BH-02				
Allowable Bearing Capacity (kN)				
D 30	D 40	D 50	D 60	D 80
435.44	610.66	800.93	1006.24	1461.97
535.01	748.55	979.70	1228.46	1778.78
624.82	868.68	1130.33	1409.78	2022.05
715.42	989.82	1282.19	1592.52	2267.08
835.90	1156.92	1499.13	1862.53	2652.90
937.83	1291.98	1666.90	2062.58	2916.25
1045.70	1436.65	1848.79	2282.13	3212.37
1151.66	1577.93	2025.39	2494.05	3494.93
1212.77	1649.96	2103.63	2573.77	3563.45
1350.09	1844.64	2361.45	2900.51	4045.40
1461.38	1993.02	2546.92	3123.08	4342.17
1572.67	2141.41	2732.40	3345.66	4638.93
1683.96	2289.79	2917.88	3568.23	4935.70

Table 3-22 *Bearing capacity of deep foundation using driven pile based on SPT data with pre-boring at BH-03.*

BH-03				
Allowable Bearing Capacity (kN)				
D 30	D 40	D 50	D 60	D 80
33.94	51.10	71.19	94.20	148.98
51.64	73.80	98.41	125.50	187.09
71.97	101.09	132.76	166.99	243.14
97.24	136.90	180.17	227.06	331.70
133.82	189.55	250.84	317.71	468.12
192.51	274.30	364.91	464.34	689.63
256.56	363.92	482.19	611.38	902.52
315.65	443.65	583.04	733.82	1069.55
352.00	487.77	632.77	786.99	1123.09
405.37	560.46	725.54	900.61	1280.70
507.30	707.32	922.79	1153.73	1661.99
553.40	762.22	983.21	1216.38	1719.25
632.35	871.29	1124.31	1391.41	1967.84
713.03	981.03	1264.19	1562.51	2204.64
788.84	1082.10	1390.53	1714.12	2406.79
908.43	1250.77	1612.89	1994.78	2817.87
1007.28	1382.58	1777.64	2192.48	3081.47

BH-03				
Allowable Bearing Capacity (kN)				
D 30	D 40	D 50	D 60	D 80
1106.13	1514.38	1942.39	2390.18	3345.07
1204.98	1646.18	2107.14	2587.88	3608.67
1303.83	1777.98	2271.90	2785.58	3872.27

3.6.3.4 Driven Pile Without Pre-Boring

Without pre-boring method, the piles cannot be driven deep into the soil without being damaged, considering there is a limit on structural capacity of pile axial load.

Hence to prevent pile damage during installation, driven piling can be applied directly without pre-boring, with appropriate allowable bearing capacity described as follows:

Table 3-23 *Bearing capacity of deep foundation using driven pile based on SPT without pre-boring at BH-01.*

Depth	BH-01				
	Ultimate Bearing Capacity (kN)				
(m)	D 30	D 40	D 50	D 60	D 80
0.00					
1.50	61.11	94.35	134.02	180.12	291.63
3.00	103.84	153.54	210.78	275.57	427.79
4.50	130.25	186.37	248.85	317.68	474.40
6.00	130.08	177.79	227.68	279.75	390.41
7.50	173.13	241.97	316.37	396.33	572.94
9.00	241.23	341.24	451.06	570.68	839.33
10.50	312.71	441.29	582.03	734.94	1077.28
12.00		552.24	725.80	913.57	1331.71
13.50				943.86	1340.17
15.00					1637.24
16.50					2073.20
18.00					

Table 3-24 *Bearing capacity of deep foundation using driven pile based on SPT without pre-boring at BH-02.*

BH-02				
Ultimate Bearing Capacity (kN)				
D 30	D 40	D 50	D 60	D 80

7.80	11.47	15.69	20.44	31.56
33.77	49.38	67.16	87.12	133.56
91.34	135.97	187.69	246.50	385.38
124.10	179.07	240.86	309.45	467.05
218.03	316.93	428.94	554.06	843.64
285.87	407.86	543.21	691.91	1029.36
		654.54	825.51	1207.52
			1006.24	1461.97
				1778.78

Table 3-25 *Bearing capacity of deep foundation using driven pile based on SPT without pre-boring at BH-03.*

BH-03				
Ultimate Bearing Capacity (kN)				
D 30	**D 40**	**D 50**	**D 60**	**D 80**
33.94	51.10	71.19	94.20	148.98
51.64	73.80	98.41	125.50	187.09
71.97	101.09	132.76	166.99	243.14
97.24	136.90	180.17	227.06	331.70
133.82	189.55	250.84	317.71	468.12
192.51	274.30	364.91	464.34	689.63
256.56	363.92	482.19	611.38	902.52
315.65	443.65	583.04	733.82	1069.55
	487.77	632.77	786.99	1123.09
		725.54	900.61	1280.70
			1153.73	1661.99
				1719.25

3.6.4 Settlement

Guidance on tolerable settlements can be found in engineering textbooks, such as *Soil Mechanics in Engineering Practice* (Terzaghi and Peck), *Foundation Analysis and Design* (Bowles) and *Foundation Engineering* (Hanson, Peck and Thornburn). As a rule, these references indicate that a total settlement of 1 inch (25 mm) is acceptable for the majority of structures, while other structures can tolerate even greater settlements without distress. On the other hand, a more restrictive settlement criterion can be necessary based on the needs of a specific structure. Current engineering practice is often based on an allowable total

settlement of 1 inch (25 mm) with the objective of controlling the differential settlements to $^3/_4$ inch (19 mm) or less.

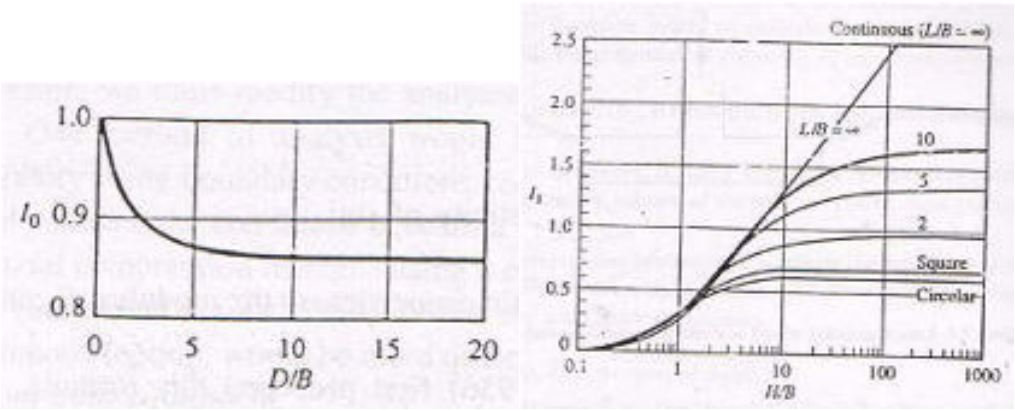
There are two kind of settlements that taken into account : immediate settlement which take places during 0 – 14 days after the load of structure being applied due to the shear distortion, and long term settlement, also known as consolidation settlement which take a long time to occur. The third kind of settlement, secondary settlement, usually considered negligible and not significant. On this analyses, we are going to calculate the maximum load that make the foundations settled at 1 inch.

Immediate settlement caused by distorsion of soil due to load and occur immediately after load being applied till 7 days afterward.

$$Si = \frac{qBI_0I_1}{E}$$

Where :

q = P / A = total applied load from upper structure
B = width of foundation base
I_0 = influence factor due to the depth of embedment
I_1 = influence factor due to the dimension of the base
E = soil modulus elasticity



The results of 1 inch settlement due to maximum load are presented below. Hence, for the safety of design, we recommend to use the lower value, which is the allowable bearing settlement.

3.7.4.1 Immediate Settlement

Immediate settlement caused by distorsion of soil due to load and occur immediately after load being applied till 7 days afterward.

$$Si = \frac{qBI_0I_1}{E}$$

Where :

q = P / A = total applied load from upper structure
B = width of foundation base
I_0 = influence factor due to the depth of embedment
I_1 = influence factor due to the dimension of the base

E = soil modulus elasticity

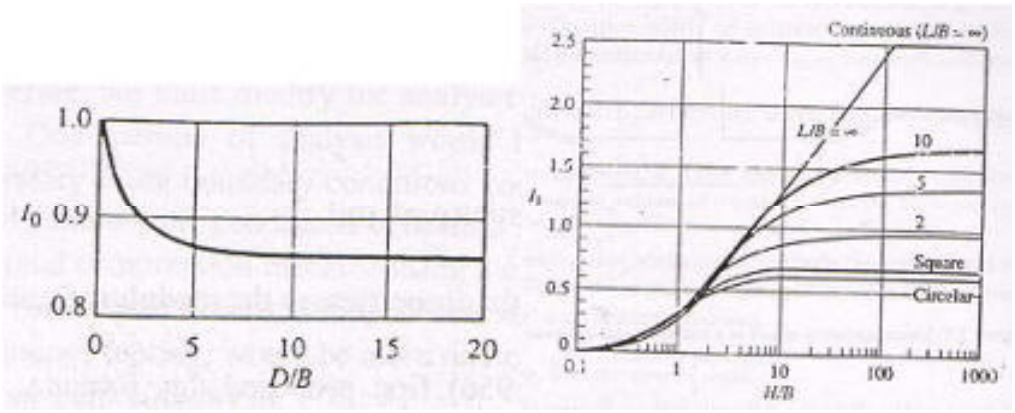


Figure 3-9 *Immediate settlement curve.*

The results of 1 inch settlement due to maximum load are presented below. Hence, for the safety of design, we recommend to use the lower value, which is the allowable bearing settlement.

Table 3-26 *Allowable bearing settlement of BH-01.*

BH-01				
Squared Foundation			Stripped Foundation	
Foundation Size		Max Load	Foundation Size	Max Load
B (m)	L (m)	(kN)	B (m)	(kN)
1.00	1.00	730.00	1.00	312.00
1.50	1.50	1070.00	1.50	355.00
2.00	2.00	1470.00	2.00	390.00
2.50	2.50	1840.00	2.50	415.00
3.00	3.00	2210.00	3.00	440.00

Table 3-27 *Allowable bearing settlement of BH-02.*

BH-02				
Squared Foundation			Stripped Foundation	
Foundation Size		Max Load	Foundation Size	Max Load
B (m)	L (m)	(kN)	B (m)	(kN)
1.00	1.00	265.00	1.00	150.00
1.50	1.50	407.00	1.50	182.00
2.00	2.00	585.00	2.00	210.00
2.50	2.50	770.00	2.50	234.00
3.00	3.00	970.00	3.00	255.00

Table 3-28 *Allowable bearing settlement of BH-03.*

BH-03				
Squared Foundation			Stripped Foundation	
Foundation Size		Max Load	Foundation Size	Max Load
B (m)	L (m)	(kN)	B (m)	(kN)
1.00	1.00	600.00	1.00	268.00
1.50	1.50	870.00	1.50	307.00
2.00	2.00	1190.00	2.00	338.00
2.50	2.50	1500.00	2.50	365.00
3.00	3.00	1800.00	3.00	388.00

3.6.5 Slope Stability

For open cut excavation requirements, we also provide the calculation of slope stability with various depth and various slope inclination.

The recommendation of minimum safety factor adopted from JM Duncan and AL Buchignani (UC Berkeley, 1974) are as follows:

Recommendation of Minimum Factor of Safety

No		Cost and consequences of slope failure	Uncertainties of Predicting Soil Strength	
			Small	Large
1	a	If the cost of repairment equal to construction cost	1.25	1.50
	b	If there are no risks of structures and human life		
2	a	If the cost of repairment larger than construction cost	1.50	2.00
	b	If there are risks of structures and human life		

The calculation of slope stability safety factor is as follows :

$$SF = \frac{1}{\tan\alpha}\left\{\frac{c'}{\gamma H}\sec^2\alpha + \tan\phi'\left(1 - r_u\sec^2\alpha\right)\right\}$$

Where :

α = slope inclination of excavation

c' = soil cohesion

γ = soil unit weight

H = depth of excavation

r_u = U / W sec α = ratio of pore water pressure with weight of soil

U = γ_w H_w = pore water pressure

γ_w = 9.81 kN/m^3 water unit weight

H_w = height of ground water level

W = weight of soil

Following tables show the safety factor of each borehole location regarding to the degree of slope inclination.

Table 3-29 *Safety factor for 75 degrees inclination.*

Depth	SAFETY FACTOR FOR 75 DEGREES INCLINATION		
(m)	BH-01	BH-02	BH-03
1.00	3.43	0.80	2.26
2.00	1.90	0.55	1.34
3.00	1.51	0.76	0.92
4.00	1.22	1.35	0.80
5.00	0.66	1.34	0.82
6.00	0.86	1.16	1.01
7.00	1.08	1.76	1.20
8.00	1.12	1.57	1.20
9.00	1.14	1.33	1.14
10.00	0.87	1.22	0.95

Table 3-30 *Safety factor for 60 degrees inclination.*

Depth	SAFETY FACTOR FOR 60 DEGREES INCLINATION		
(m)	BH-01	BH-02	BH-03
1.00	3.74	0.96	2.37
2.00	1.98	0.75	1.30
3.00	1.52	0.86	0.83
4.00	1.18	1.37	0.68
5.00	0.52	1.41	0.70
6.00	0.76	1.25	0.91
7.00	1.02	1.77	1.13
8.00	1.07	1.61	1.12
9.00	1.09	1.39	1.05
10.00	0.78	1.29	0.83

Table 3-31 *Safety factor for 45 degrees inclination.*

Depth	SAFETY FACTOR FOR 45 DEGREES INCLINATION		
(m)	BH-01	BH-02	BH-03
1.00	4.18	0.99	2.85
2.00	2.41	0.57	1.78
3.00	1.96	1.02	1.31
4.00	1.65	2.04	1.16
5.00	0.99	1.96	1.18
6.00	1.23	1.65	1.42
7.00	1.47	2.68	1.64
8.00	1.53	2.36	1.65
9.00	1.55	1.95	1.58
10.00	1.23	1.77	1.36

Table 3-32 *Safety factor for 30 degrees inclination.*

Depth	SAFETY FACTOR FOR 30 DEGREES INCLINATION		
(m)	BH-01	BH-02	BH-03
1.00	6.20	1.41	3.80
2.00	3.15	1.17	1.95
3.00	2.36	1.23	1.13
4.00	1.66	1.82	0.87
5.00	0.59	1.91	0.91
6.00	0.99	1.73	1.25
7.00	1.46	2.32	1.63
8.00	1.56	2.14	1.61
9.00	1.59	1.87	1.49
10.00	1.06	1.77	1.10

Table 3-33 *Safety factor for 15 degrees inclination.*

Depth	SAFETY FACTOR FOR 15 DEGREES INCLINATION		
(m)	BH-01	BH-02	BH-03
1.00	7.51	2.84	5.24
2.00	4.46	2.42	3.39
3.00	3.67	2.43	2.57
4.00	3.15	3.45	2.31
5.00	2.01	3.66	2.35
6.00	2.42	3.36	2.79
7.00	2.83	4.38	3.16
8.00	2.93	4.07	3.19
9.00	2.96	3.59	3.07
10.00	2.42	3.41	2.68

3.6.6 Liquefaction

Liquefaction usually occur at soil layers with these criteria :

- Saturated fine sand layer with no cohesion
- Saturated cohesive layer with LL < 35 % and clay content below 15%.

Since the soil classification at Gas Fired Power Plant 275 MW Riau area is consist of Clay and Silty Clay soil type with LL = 44.00 – 84.79%, we can conclude that liquefaction will not occur at GFPP 275 MW Riau area.

4. Comparison to Location Alternative 1

Comparing the soil investigation results recently at Alternative-2 (Alt-2) area to soil investigation results conducted earlier which located at Alternative-1 (Alt-1) (studied on April 2016), we came into conclusions as follow:

4.1 Soil Type and Stratification

At Alt-2 location, the soil types are dominated by Silt (50% average), follow by Clay (25% average) and Sand (25% average), which can be named as Clayey Silt with Sand. These soil types are consistent until depth of boring termination (30 meters).

At Alt-1 location, the same types of soil (Clayey Silt with Sand) also found at the top layer with thickness of 8 – 14 meter. Below Clayey Silt with Sand layer, we found medium to very dense sand layer until depth of boring termination (24 - 26 meters). While at Alt-2 location, no sand layer was found until termination depth.

4.2 Soil Plasticity Behaviour

Clayey Silt with Sand soil type at Alt-2 location can be categorized as medium to very high plasticity behaviour, with LL = 47.56 – 84.76% and PI = 29.42 – 59.91%. The Clayey Silt with Sand soil type at Alt-1 location also showed the same behaviour, with LL = 69.52 – 108.20% and PI = 39.30 – 80.61%, slightly higher than Alt-2 location.

4.3 Soil Strength and Stifness

At Alt-2 location, we already found firm to stiff soil at surface layer (N-SPT = 7 – 20), and the strength and stiffness of soil are increasing with depth. The only exception is at BH-02 area, where soft soil layer (N-SPT = 2) with thickness of 2 meter was found.

At Alt-1 location, the soil showed the same tendency, the strength and stiffness are increasing with depth. Soft soil layer as at BH-02 area Alt-2 location was found with thickness of 5 – 7 m.

To summarize, both Alt-2 and Alt-1 location has the same type of soil. The differences are the soil at Alt-1 location has thicker soft layer (5 – 7 meters) and underlaid by medium to very dense sand layer. While at Alt-2 location, the soft soil is much thinner (2 meters) and no sand layer was found until the termination of boring depth.

5. Conclusion and Recommendation

Based on geotechnical drilling had been conducted we might conclude the stratigraphy of the soil layer in investigation area by as follows:

- Top Soil consists of clayey SILT layer with thickness approximately 0.4 – 1.2 m and locally up to 5.6 m.
- Silty CLAY, is a soil layer underlying top soil layer with thickness approximately 0.6 – 2.85 m.
- CLAY layer, the lower most layer up to end of drilling depth, approximately 24 – 29 m thick relative to the end of drilling depth.

From geoelectrical survey, based on the resistivity range, we interpret the discontinuity that might reflect the soil layer boundary in subsurface by as follows:

- 1st layer with resistivity value ranging from 2100 – 2938 ohm m, with thickness ranging from 0.64 up to 1.53 m. This layer interpreted as top soil cover.
- 2nd layer with rasistivity value ranging from 504 – 784 ohm m, with thickness ranging from 2.7 up to 4.39. This 2nd layer interpreted as silty Clay unit.
- 3rd layer with resistivity value ranging from 8.7 up to 13 ohm m, with thickness ranging from 27.63 m up to 30 m. This layer interpreted as Clay unit.
- 4th layer with resistivity value ranging from 53 up to 79 ohm m, with thickness approximately more than 66 m. this layer is underlie below drilling depth and interpreted as clayey SAND unit.

Geotechnical analysis is undertaken to understand the geotechnical aspect of investigation area in terms of the bearing capacity of subsurface material regarding to shallow and deep foundation, the settlement analysis, slope stability assesment during construction work, and liquefaction potential.

Detail design parameters from geotechnical aspect that had been deduced from geotechnical analysis can be seen in table 3.11 to 3.13.

The bearing capacity of soil for **shallow foundation** at **BH-01** location is summarized as follows (the detailed result can be seen in table 3.14):

- For 1 x 1 m, 1.5 x 1.5 m, 2 x 2 m, 2.5 x 2.5 m, and 3 x 3 m of **squarred foundation** allowable bearing capacity to support load to the ground of **1 m depth** of foundation respectivley are 478.8 kN (47,8 ton), 889.38 kN (88.9 ton), 1386.64 kN (138.6 ton), 1996.85 kN (199.6 ton), and 2719.78 kN (271.9 ton).
- For 1 x 1 m, 1.5 x 1.5 m, 2 x 2 m, 2.5 x 2.5 m, and 3 x 3 m of **squarred foundation** allowable bearing capacity to support load to the ground of **2 m depth** of foundation respectivley are 478.80 kN (47.8 ton), 969.57 kN (96.9 ton), 1583.03 kN (158.3 ton), 2229.70 kN (229.9 ton), 2989.31 kN (298.9 ton).
- For 1 m, 1.5 m, 2 m, 2.5 m, and 3 m of **stripped foundation** allowable bearing capacity to support load to the ground of **1 m depth** of foundation respectivley are 478.80 kN (47.8 ton), 592.92 kN (59.9 ton), 693.32 kN (69.3 ton), 798.74 kN (79.8 ton), 906.59 kN (90.6 ton).
- For 1 m, 1.5 m, 2 m, 2.5 m, and 3 m of **stripped foundation** allowable bearing capacity to support load to the ground of **2 m depth** of foundation respectivley are 478.80 kN (47.8 ton), 646.38 kN (64.6 ton), 791.52 kN (79.1 ton), 891.88 kN (89.1 ton), 996.44 kN (99.6 ton).

The bearing capacity of soil for **shallow foundation** at **BH-02** location is summarized as follows (the detailed result can be seen in table 3.15):

- For 1 x 1 m, 1.5 x 1.5 m, 2 x 2 m, 2.5 x 2.5 m, and 3 x 3 m of **squarred foundation** allowable bearing capacity to support load to the ground of **1 m depth** of foundation respectivley are 53.20 kN (5,3 ton), 98.82 kN (9.8 ton), 154.07 kN (15.4 ton), 221.87 kN (22.1 ton), and 302.20 kN (30.2 ton).
- For 1 x 1 m, 1.5 x 1.5 m, 2 x 2 m, 2.5 x 2.5 m, and 3 x 3 m of **squarred foundation** allowable bearing capacity to support load to the ground of **2 m depth** of foundation respectivley are 53.20 kN (5.3 ton), 107.73 kN (10.7 ton), 175.89 kN (17.5 ton), 247.74 kN (24.7 ton), 332.15 kN (33.2 ton).
- For 1 m, 1.5 m, 2 m, 2.5 m, and 3 m of **stripped foundation** allowable bearing capacity to support load to the ground of **1 m depth** of foundation respectivley are 53.20 kN (5.3 ton), 65.88 kN (6.5 ton), 77.04 kN (7.7 ton), 88.75 kN (8.8 ton), 100.73 kN (10.1 ton).
- For 1 m, 1.5 m, 2 m, 2.5 m, and 3 m of **stripped foundation** allowable bearing capacity to support load to the ground of **2 m depth** of foundation respectivley are 53.20 kN (5.3 ton), 71.82 kN (7.1 ton), 87.95 kN (8.7 ton), 99.10 kN (9.9 ton), 110.72 kN (11.1 ton).

The bearing capacity of soil for **shallow foundation** at **BH-03** location is summarized as follows (the detailed result can be seen in table 3.16):

- For 1 x 1 m, 1.5 x 1.5 m, 2 x 2 m, 2.5 x 2.5 m, and 3 x 3 m of **squarred foundation** allowable bearing capacity to support load to the ground of **1 m depth** of foundation respectivley are 266.00 kN (26,6 ton), 494.10kN (49.4 ton), 770.36 kN (77 ton), 1109.36 kN (110.9 ton), and 1510.99 kN (30.2 ton).
- For 1 x 1 m, 1.5 x 1.5 m, 2 x 2 m, 2.5 x 2.5 m, and 3 x 3 m of **squarred foundation** allowable bearing capacity to support load to the ground of **2 m depth** of foundation respectivley are 266.00 kN (26.6 ton), 538.65 kN (53.8 ton), 879.46 kN (87.9 ton), 1238.72 kN (12.3 ton), 1660.73 kN (16.6 ton).
- For 1 m, 1.5 m, 2 m, 2.5 m, and 3 m of **stripped foundation** allowable bearing capacity to support load to the ground of **1 m depth** of foundation respectivley are 266.00 kN (26.6 ton), 329.40 kN (32.9 ton), 385.18 kN (38.5 ton), 443.74 kN (44.3 ton), 503.66 kN (50.3 ton).
- For 1 m, 1.5 m, 2 m, 2.5 m, and 3 m of **stripped foundation** allowable bearing capacity to support load to the ground of **2 m depth** of foundation respectivley are 266.00 kN (26.6 ton), 359.10 kN (35.9 ton), 439.73 kN (43.9 ton), 495.49 kN (49.5 ton), 553.58 kN (55.3 ton).

For deep foundation we provided two bearing capacity of soil regarding to the foundation type both bored pile and driven pile type. In addition to driven pile we also provided the bearing capacity with pre-boring and without pre-boring. All the bearing capacity had been calculated with respect to depth and the diameter of pile collumn. The detail bearing capacity of deep foundation can be seen in section 3.6.3.

One of the purpose of slope stability analysis is to provide the factor of safety of the slope. We have provided the factor of safety for the slope with respect to the slope angle (inclination) for artificial slope during construction and excavation. For this stage, every selected slope angle with factor of safety can be seen in section 3.6.5 with different factor of safety determination is provided with respect to the depth of excavation during construction work. In particular the detailed factor of safety for given slope inclination can be seen in table 3.29 to table 3.33.

Since the soil layer and lithology unit predominantly consists of cohesive soil layer of Silt and Clay, therefore the potential of soil liquefaction relatively very low. As mentioned at the beginning of section 3.6.6, the criteria for soil material that might undergoing liquefaction are for non-cohessive and cohessive soil with liquid limit (LL) <35%, while based on laboratory data the liquid limit of soil properties in investigation area is > 35% (47.56 – 84.76%), therefore we assume the liquefaction will probably not occurred.

To get a ballace quatity/volume of cut/fill works, it's recommended the design level at 28.05 m. Quantity of Cut/Fill are 165778.75/165343.39 M^3, withremaining cut material are 435.35 M^3.

APPENDIX A

Topography Map