# Environmental and Social Impact Assessment Report

Project Number: 50182-001
November 2018

# INO: Riau Natural Gas Power Project
# ESIA Vol.2
# Environmental Impact Assessment (Part A)

Prepared by ESC for the Asian Development Bank

# Riau 275 MW Gas Combined Cycle Power Plant IPP - ESIA

Medco Ratch Power Riau

## ESIA Volume 2: Environmental Impact Assessment

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## Document history and status

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## Contents

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# Glossary

| Acronym | Term | Definition |
|---|---|---|
| ESIA | Environmental and Social Impact Assessment | The ESIA is a comprehensive document of a Project's potential environmental and social risks and impacts. An ESIA is usually prepared for greenfield developments or large expansions with specifically identified physical elements, aspects, and facilities that are likely to generate significant environmental or social impacts. |
| ESMP | Environmental and Social Management Plan | Summarises the client's commitments to address and mitigate risks and impacts identified as part of the Assessment, through avoidance, minimisation, and compensation/offset. This may range from a brief description of routine mitigation measures to a series of more comprehensive management plans (e.g. water management plan, waste management plan, resettlement action plan, indigenous peoples plan, emergency preparedness and response plan, decommissioning plan). |
| ESMS | Environmental and Social Management System | The ESMS is the overarching environmental, social, health and safety management system which may be applicable at a corporate or Project level. The system is designed to identify, assess and manage risks and impacts in respect to the Project on an ongoing basis. |
| | Legal and regulatory framework | The national legal and institutional framework applicable to the project should be defined. This should also include any additional lender requirements and any international agreements or conventions that may also apply. |
| | Project Description | A project description considers all project phases from pre-construction, construction, operation and decommissioning and is as detailed as possible in order to identify the environmental aspects resulting from project activities. A summary of the project description is provided in ESIA Volume 1: Introduction. |

# List of Abbreviations

| Abbreviation | Description |
|---|---|
| AoI | Area of Influence |
| aMSL | Above mean sea level |
| ADB | Asian Development Bank |
| AEP | Annual exceedance probability |
| ALARP | As low as reasonably practicable |
| AMDAL | Analisis Mengenai Dampak Lingkungan |
| ASTER | Advanced Spaceborne Thermal Emissions and Reflection Radiometer |
| BAP | Biodiversity Action Plan |
| BGL | Below Ground Level |
| BOD | Biochemical Oxygen Demand |
| CEMS | Continuous Emissions Monitoring System |
| CCPP | Combined Cycle Power Plant |
| CFPP | Coal Fired Power Plant |
| COD | Chemical Oxygen Demand |
| dBA | Decibel A-weighting |
| DMU | Discrete Management Unit |
| EHS | Environmental, Health and Safety |
| EIA | Environmental Impact Assessment |
| ENSO | El Niño Southern Oscillation |
| EPC | Engineering, Procurement and Construction |
| EPFI | Equator Principle Financial Institutions |
| ESCP | Erosion and Sediment Control Plan |
| ESIA | Environmental and Social Impact Assessment |
| ESMP | Environmental and Social Management Plan |
| ESMS | Environmental and Social Management System |
| GEV | Generalised Extreme Value |
| GHG | Greenhouse Gas |
| GIIP | Good International Industry Practice |
| GWP | Global Warming Potential |
| Ha | Hectares |
| HFCs | Hydrofluoro Carbons |
| HRSG | Heat Recovery Steam Generator |
| HSE | Health, Safety and Environment |
| IFC | International Finance Corporation |
| ILO | International Labour Organisation |
| IPCC | Intergovernmental Panel on Climate Change |
| IUCN | International Union for Conservation of Nature |
| KBA | Key Biodiversity Area |
| km | Kilometres |

| Abbreviation | Description |
|---|---|
| m | Metres |
| MfE | Ministry for the Environment |
| MGLC | Maximum ground level concentrations |
| MoE | Ministry of Environment |
| MRPR | Medco Ratch Power Riau |
| MW | Megawatt |
| NBC | Nusa Buana Cipta |
| NCA | Noise Catchment Areas |
| NTS | Non-Technical Summary |
| OCP | Organochlorine Pesticides |
| OPP | Organophosphorus Pesticides |
| OHS | Occupational Health and Safety |
| PFCs | Perfluoro carbons |
| PLN | PT Perusahaan Listrik Negara (Persero) |
| $PM_{10}$ | Particulate Matter less than ten microns |
| $PM_{2.5}$ | Particulate Matter less than 2.5 microns |
| PPE | Personal Protective Equipment |
| QRA | Qualitative Risk Assessment |
| RoW | Right of Way |
| RSL | Regional Screening Levels |
| SDS | Safety Data Sheet |
| SOP | Standard Operating Procedure |
| SWL | Sound power level |
| T | Tonnes |
| TJ | Terrajoule |
| ToR | Terms of Reference |
| TSP | Total Suspended Particulate |
| TDS | Total Dissolved Solids |
| TSS | Total Suspended Solids |
| VPH | Vehicles per hour |
| VSR | Visually Sensitive Receptor |
| WBG | World Bank Group |
| WHO | World Health Organisation |
| ZTVI | Zone of Theoretical Visual Impact |

# 1. Introduction

## 1.1 Overview

The Environmental and Social Impact Assessment (ESIA) Volume 2: Environmental Impact Assessment (EIA) provides an assessment of the potential impacts of the Project on environmental receptors, makes mitigation and monitoring recommendations and provides an assessment of residual impacts. This introduction section provides an overview of the ESIA process.

The ESIA process and how related environmental and social assessments are applied is summarised in Figure 1.1. For social impacts, reference should be made to the ESIA Volume 3: Social Impact Assessment.

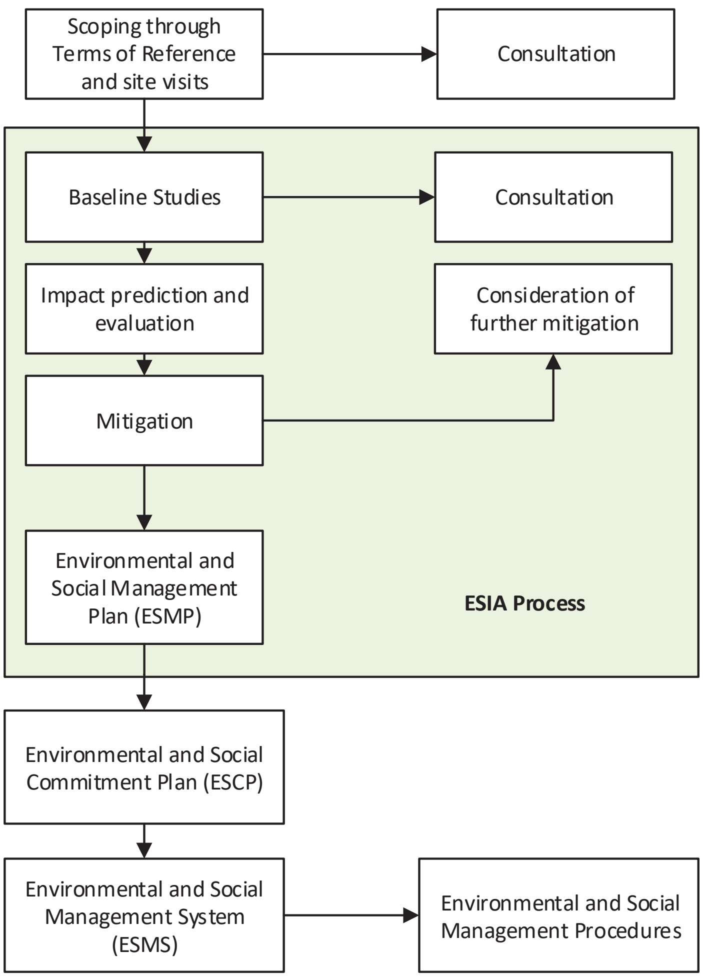


**Figure 1.1 : General Overview of the ESIA Process**

## 1.2 Spatial and Temporal Scope

The area of influence (AoI) constitutes the spatial extent of the ESIA as outlined in Figure 1.2 below. The AoI encompasses all areas directly and indirectly affected by Project components, which are primarily contained within the power plant site, along the transmission line route and along the gas pipeline route. For each environmental topic, the spatial and temporal scope will vary and this will be discussed in detail in the methodologies for each.

The study period is a time limit that will be used in predicting and undertaking an impact evaluation as part of the impact assessment. The period is used as a basis to determine if there are any changes to the environmental baseline resulting from the Project activities.

For this impact assessment temporary vs permanent impacts are considered as follows:

- Permanent impacts relate to permanent above ground infrastructure which includes:
  - Power plant, transmission line, water intake structure, access road and gas metering facility
- Temporary impacts relate to construction activities relating to below ground infrastructure and areas which are used during construction only. These areas include:
  - Gas pipeline working corridor of 6 m, water intake and discharge pipeline working corridor of 6 m and temporary jetty.

Table 1.1 and Table 1.2 gives a summary of permanent and temporary footprints from these features and an overview of temporary vs permanent impacts are detailed in Figure 1.3 below.

**Table 1.1 : Summary of Permanent Project Footprint**

| Project Infrastructure | Dimension (m) | Footprint (ha) |
|---|---|---|
| Power plant (plant buildings, cooling tower, balance of plant area and switchyard) | - | 5.4 |
| Transmission Line Towers | 4 x 40 x 40 | 0.64 |
| Water intake structure | 50 x 40 | 0.2 |
| Gas metering facility | 15 x 30 | 0.045 |
| Access Road | 8 x 400 | 0.32 |
| **Total** | | **6.605** |

**Table 1.2 : Summary of Temporary Project Footprint**

| Project Infrastructure | Dimension (m) | Footprint (ha) |
|---|---|---|
| Water intake and discharge pipeline | 6 x 3,000 | 1.8 |
| Gas pipeline | 6 x 40,000 | 24 |
| Temporary jetty | 100 x 70 | 0.7 |
| **Total** | | **26.5** |

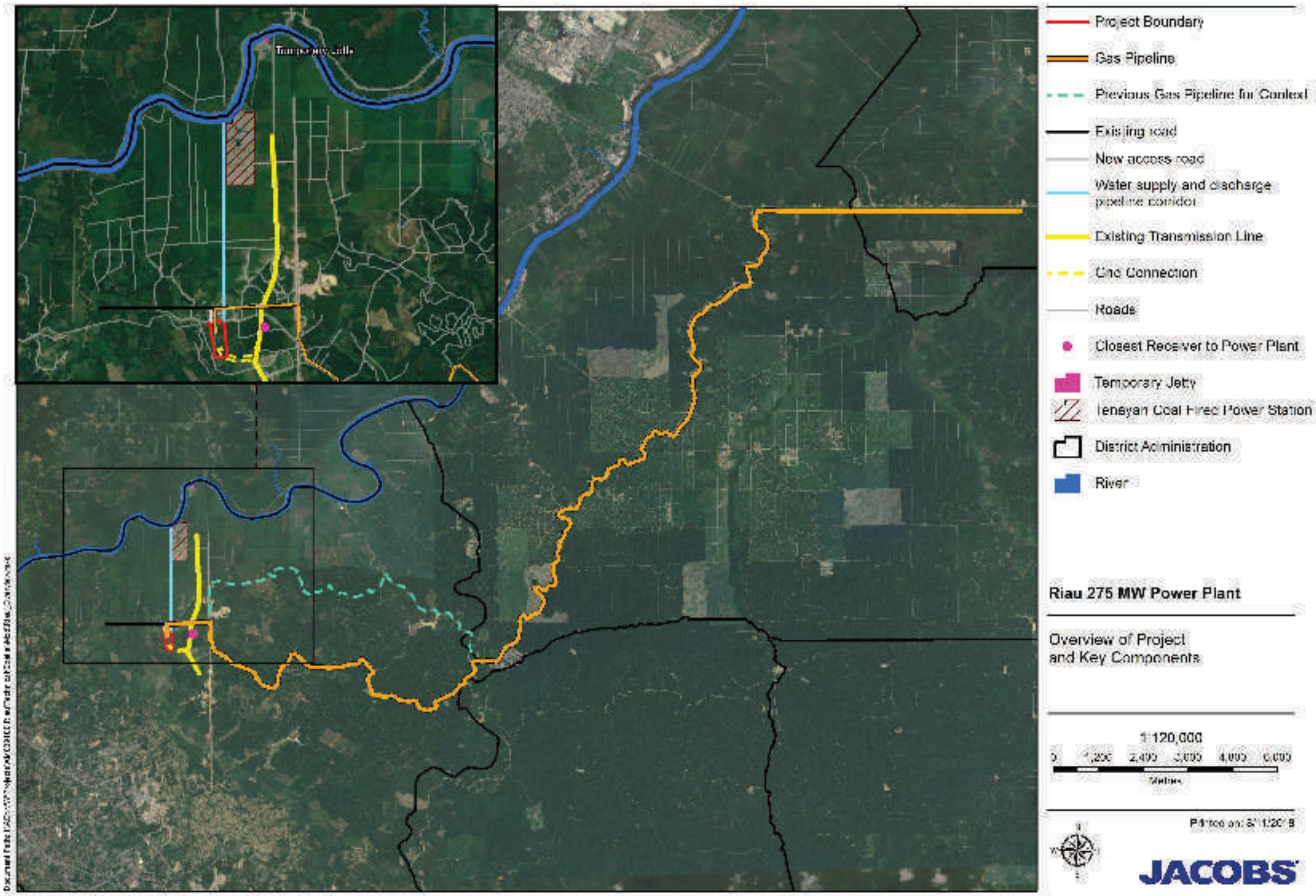


Figure 1.2 : Spatial Scope of the Project

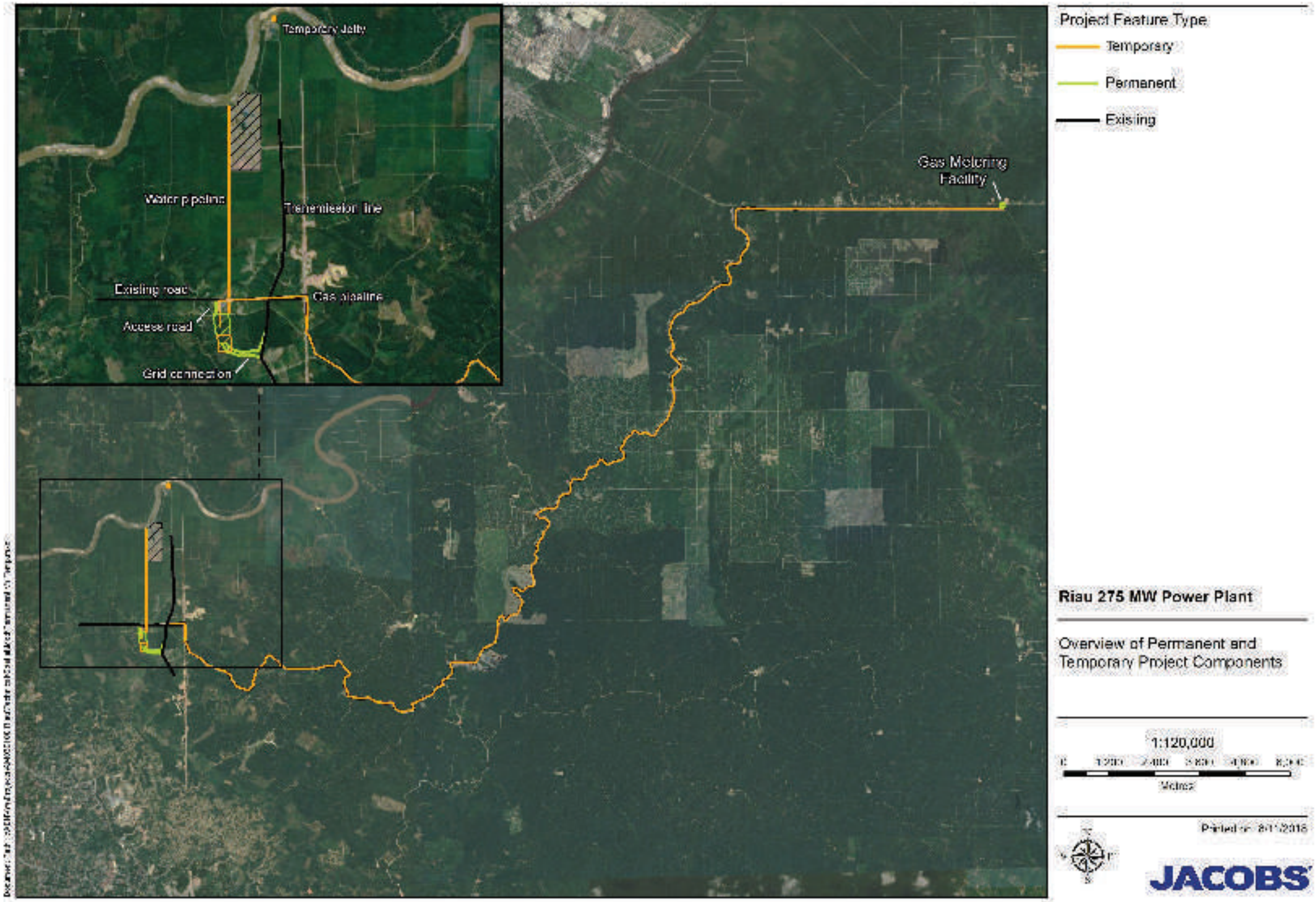


Figure 1.3 : Overview of Temporary vs Permanent Impacts

## 1.3 Baseline Environmental Conditions

Environmental scoping was completed at an early stage to identify development activities that would require attention in the ESIA. The Scoping Report includes the Terms of Reference (ToR) for the ESIA and the ToR for the baseline sampling, the report is located in the ESIA Volume 5: Technical Appendices.

Baseline data collection refers to the collection of background data in support of the environmental assessment. Ideally baseline data should be collected prior to development of a project, but often this is not possible. Baseline data collection can also occur throughout the life of a project as part of ongoing monitoring of environmental and social conditions.

ADB Environmental Safeguards guidance on identification of environmental baseline data states that it "*…describes relevant physical, biological, and socioeconomic conditions within the study area. It also looks at current and proposed development activities within the project's area of influence, including those not directly connected to the project. It indicates the accuracy, reliability, and sources of the data."*

Baseline information used for this ESIA has utilised primary data collected through on-site surveys by Jacobs environmental and social sub-consultant Nusa Buana Cipta (NBC), between June and September 2017 (dry season) and January to February 2018 (wet season).

In addition, the Project benefits from having environmental studies collected for environmental assessments associated with the Analisis Mengenai Dampak Lingkungan (AMDAL) for PT Perusahaan Listrik Negara (Persero) (PLN) existing 2 x 110 MW Tenayan Coal Fired Power Plant (CFPP). Other publically available studies and data sources have been used as secondary supporting information in this volume.

It should be noted that at the time of baseline surveys being conducted the preferred gas pipeline route was the 'Alternate Route 1 and Alternate Route 2 as shown in Figure 1.2 above. Following completion of baseline surveys two sections of the gas pipeline route was changed by MRPR and is now referred to as the 'Preferred Gas Pipeline Route'. The 10 km section of gas pipeline route that has replaced Alternate Route 2 predominantly consists of palm oil plantation. The 7 km section of gas pipeline that has replaced Alternate Route 1 is 6 m south of an existing oil pipeline which runs adjacent to existing road reserve. The two routes have similar environment and landscape characteristics and therefore the baseline sampling undertaken to date is considered to be representative of the preferred gas pipeline route.

## 1.4 Structure of Volume 2

This ESIA Volume 2: EIA is structured in the following way:

- Section 2 – Methodology
- Section 3 – Environmental Baseline
- Section 4 – Air Quality (Impact Assessment)
- Section 5 – Greenhouse Gas Emissions (Impact Assessment)
- Section 6 – Soils, Geology and Groundwater (Impact Assessment)
- Section 7 – Hydrology (Impact Assessment)
- Section 8 – Water Quality and Freshwater Ecology (Impact Assessment)
- Section 9 – Landscape and Visual (Impact Assessment)
- Section 10 – Natural Hazards and Vulnerability to Climate Change (Impact Assessment)
- Section 11 – Noise (Impact Assessment)
- Section 12 – Terrestrial Ecology (Impact Assessment)
- Section 13 – Traffic (Impact Assessment)
- Section 14 – Hazardous Substances and Waste (Impact Assessment)

- Section 15 – Working Conditions and Occupational Health and Safety
- Section 16 – Gas Pipeline Qualitative Risk Assessment
- Section 17 – Assessment of Cumulative Impacts
- Section 18 – Summary of Environmental Impact Assessment
- Section 19 – References

# 2. Methodology

## 2.1 Introduction

The impact assessment methodology applies to the assessment of potential environmental impacts arising from the Project. The impact assessment methodology has been developed in accordance with good industry practice and the potential impacts have been identified in the context of the Project's AoI, in accordance with International Finance Corporation (IFC) Performance Standard 1 (Assessment and Management of Environmental and Social Risks and Impacts) and Asian Development Bank (ADB) Environmental Safeguards.

## 2.2 Impact Assessment

The impact assessment predicts and assesses the Project's likely positive and negative impacts, in quantitative terms to the extent possible. For each of the environmental aspects, the assessment determined the sensitivity of the receiving environment and identifies impacts and assesses the magnitude and overall significance of environmental impacts. An ESIA will always contain a degree of subjectivity, as it is based on the value judgment of various specialists and ESIA practitioners. The evaluation of significance is thus contingent upon values, professional judgement, and dependent upon the environmental context. Ultimately, impact significance involves a process of determining the acceptability of a predicted impact.

### 2.2.1 Defining Impact

There are a number of ways that impacts may be described and quantified. An impact is essentially any change to a resource or receptor brought about by the presence of the proposed project component, project discharge or by the execution of a proposed project related activity. The assessment of the significance of impacts and determination of residual impacts takes account of any inherent mitigation measures incorporated into the Project by the nature of its design.

In broad terms, impact significance can be characterised as the product of the degree of change predicted (the magnitude of impact) and the value of the receptor/resource that is subjected to that change (sensitivity of receptor). For each impact the likely magnitude of the impact and the sensitivity of the receptor are defined. Generic criteria for the definition of magnitude and sensitivity are summarised below.

### 2.2.2 Direct vs Indirect Impacts

A direct impact, or first order impact, is any change to the environment, whether adverse or beneficial, wholly or partially, resulting directly from an environmental aspect related to the project. An indirect impact may affect an environmental, social or economic component through a second order impact resulting from a direct impact. For example, removal of vegetation may lead to increased soil erosion (direct impact) which causes an indirect impact on aquatic ecosystems through sedimentation (indirect impact).

### 2.2.3 Magnitude Criteria

The assessment of impact magnitude is undertaken by categorising identified impacts of the Project as beneficial or adverse. Then impacts are categorised as 'Major', 'Moderate', 'Minor' or 'Negligible' based on consideration of parameters such as:

- Duration of the impact – ranging from 'well into operation' to 'temporary with no detectable impact'.
- Spatial extent of the impact – for instance, within the site boundary, within district, regionally, nationally, and internationally.
- Reversibility – ranging from 'permanent thus requiring significant intervention to return to baseline' to 'no change'.
- Likelihood – ranging from 'occurring regularly under typical conditions' to 'unlikely to occur'.
- Compliance with legal standards and established professional criteria – ranging from 'substantially exceeds national standards or international guidance' to 'meets the standards' (i.e. impacts are not predicted to

exceed the relevant standards) presents generic criteria for determining impact magnitude (for adverse impacts). Each detailed assessment will define impact magnitude in relation to its environmental or social aspect.

- Any other impact characteristics of relevance.

Table 2.1 below presents generic criteria for determining impact magnitude (for adverse impacts). Each detailed assessment will define impact magnitude in relation to its environmental or social aspect.

**Table 2.1 : General Criteria for Determining Impact Magnitude**

| Category | Description |
|---|---|
| Major | Fundamental change to the specific conditions assessed resulting in long term or permanent change, typically widespread in nature and requiring significant intervention to return to baseline; would violate national standards or Good International Industry Practice (GIIP) without mitigation. |
| Moderate | Detectable change to the specific conditions assessed resulting in non-fundamental temporary or permanent change. |
| Minor | Detectable but small change to the specific conditions assessed. |
| Negligible | No perceptible change to the specific conditions assessed. |

### 2.2.4 Sensitivity Criteria

Sensitivity is specific to each aspect and the environmental resource or population affected, with criteria developed from baseline information. Using the baseline information, the sensitivity of the receptor is determined factoring in proximity, number exposed, vulnerability and the presence of receptors on site or the surrounding area. Generic criteria for determining sensitivity of receptors are outlined in Table 2.2 below. Each detailed assessment will define sensitivity in relation to its environmental or social aspect.

**Table 2.2 : General Criteria for Determining Impact Sensitivity**

| Category | Description |
|---|---|
| High | Receptor (human, physical or biological) with little or no capacity to absorb proposed changes |
| Medium | Receptor with little capacity to absorb proposed changes |
| Low | Receptor with some capacity to absorb proposed changes |
| Negligible | Receptor with good capacity to absorb proposed changes |

### 2.2.5 Impact Evaluation

The determination of impact significance involves making a judgment about the importance of project impacts. This is typically done at two levels:

- The significance of project impacts factoring in the mitigation inherently within the design of the project; and
- The significance of project impacts following the implementation of additional mitigation measures.

The impacts are evaluated taking into account the interaction between the magnitude and sensitivity criteria as presented in the impact evaluation matrix in Table 2.3 below.

Table 2.3 : Impact Matrix

| | | Magnitude | | | |
|---|---|---|---|---|---|
| | | Major | Moderate | Minor | Negligible |
| Sensitivity | High | Major | Major | Moderate | Negligible |
| | Medium | Major | Moderate | Minor | Negligible |
| | Low | Moderate | Minor | Negligible | Negligible |
| | Negligible | Minor | Negligible | Negligible | Negligible |

The objective of the ESIA is to identify the likely significant impacts on the environment and people of the project. In this impact assessment, impacts determined to be 'Moderate' or 'Major' are deemed significant. Consequently, impacts determined to be 'Minor' or 'Negligible' are not significant.

## 2.3 Mitigation

Mitigation measures are actions taken to avoid or minimise negative environmental or social impacts. Mitigation includes those embedded within the design (as already considered as part of the impact evaluation) and any additional mitigation required thereafter. Additional mitigation will be implemented to reduce significant impacts to an acceptable level, this is referred to as the residual impact. The mitigation hierarchy should be followed: avoid, minimise, restore or remedy, offset, compensate. Mitigation measures should be clearly identified and linked to environmental and social management plans.

## 2.4 Monitoring

Monitoring is not linked to the impact evaluation but is an important component of the ESIA. Monitoring and follow-up actions should be completed to:

- Continue the collection of environmental and social 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; and
- 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.

## 2.5 Residual Impacts

Those impacts that remain once mitigation has been put in place will be described as residual impacts, using Table 2.3 set out above.

## 2.6 Cumulative Impacts

The assessment of cumulative impacts will consider the combination of multiple impacts that may result when:

- The Project is considered alongside other existing facilities within similar discharges;
- The Project is alongside other existing or proposed projects in the same geographic area or similar development timetable; and
- Impacts identified in different environmental and social aspects of the ESIA combine to affect a specific receptor.

The assessment of cumulative impacts will identify where particular resources or receptors would experience significant adverse or beneficial impacts as a result of a combination of projects (inter-project cumulative impacts). In order to determine the full combined impact of the development, potential impacts during construction and operation phases have been assessed where relevant.

# 3. Environmental Baseline

## 3.1 Introduction

This section provides a summary of baseline information known to date for the existing physical and biological environment, using available information and the methodology outlined in Section 2 above. This data will be used to quantify the sensitivity of the receiving environment to the proposed Project.

## 3.2 Climate

An assessment of 33 years of rainfall data from 1980-2013 was undertaken by NBC. The average annual rainfall over the last five years was ~2,472 mm/year. The greatest rainfall depth occurs through the months of October to December and March/April (>200 mm/month). Rainfall during these months can effectively double the monthly total when compared to 'dry' months, such as June to September.

From 2000 to 2013, the average rainy days per month ranges from 5-10, with wetter months having a greater amount of wet (rainy) days. This fluctuates widely each year, with some of the wetter months experiencing up to 25 rainy days on occasion.

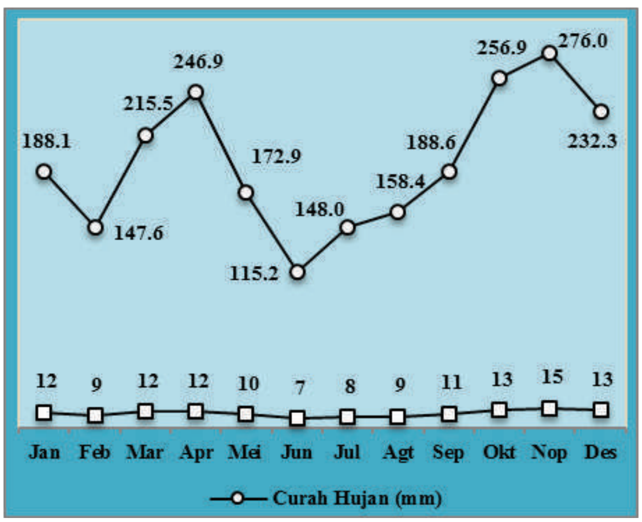


**Figure 3.1 : Average Monthly Rainfall (mm) and Rainy Days at the Public Work Office in Senapelan District (Pekanbaru City) between 1980-2013**

Temperature remains relatively constant throughout the year, with monthly minimums between 20-24°C and maximums up to 35°C. The average temperature from the most recent data (2015) ranges between 31.7 to 33.6°C, with a mean of 32.6°C.

### 3.2.1 Meteorology

The air quality assessment (ESIA Volume 5, Appendix E – Air Quality Technical Assessment) has identified meteorological conditions typically associated with the proposed location of the Project. The prevailing weather patterns affect how noise propagates from the source to the receiver locations and provide potential for noise enhancing conditions to be present. Similarly, local weather conditions can also reduce noise impacts where wind directions are generally directed from receiver to the source (i.e. sound propagation towards sensitive receivers is hindered).

Wind is generally light, but the area is subject to monsoonal weather with high winds during the wet months. The predominant wind direction varies throughout the year, with southerly winds occurring primarily during the dry season and northerly winds during the rainy season. The average wind speed is less than 3 m/s.

The wind rose shown in Figure 3.2 has been generated from data collected at an ambient air monitoring site in Pekanbaru for 2010 to 2015. A photograph of the monitoring station, provided as Figure 3.6, indicates that the site is in close vicinity to one or more tall buildings which may influence the winds measured at the site. The meteorological data shows winds predominantly from the north-western and north-eastern sectors, and from the south-southeast. Calm conditions, which are a wind speed of less than 0.5 m/s, are predicted to occur for 27% of the time and the average wind speed for the data period is 0.54 m/s. The very low wind speeds as well as the absence of winds from the north suggest that that winds are measured at a low height above ground level, and are affected by local structures, trees, etc.

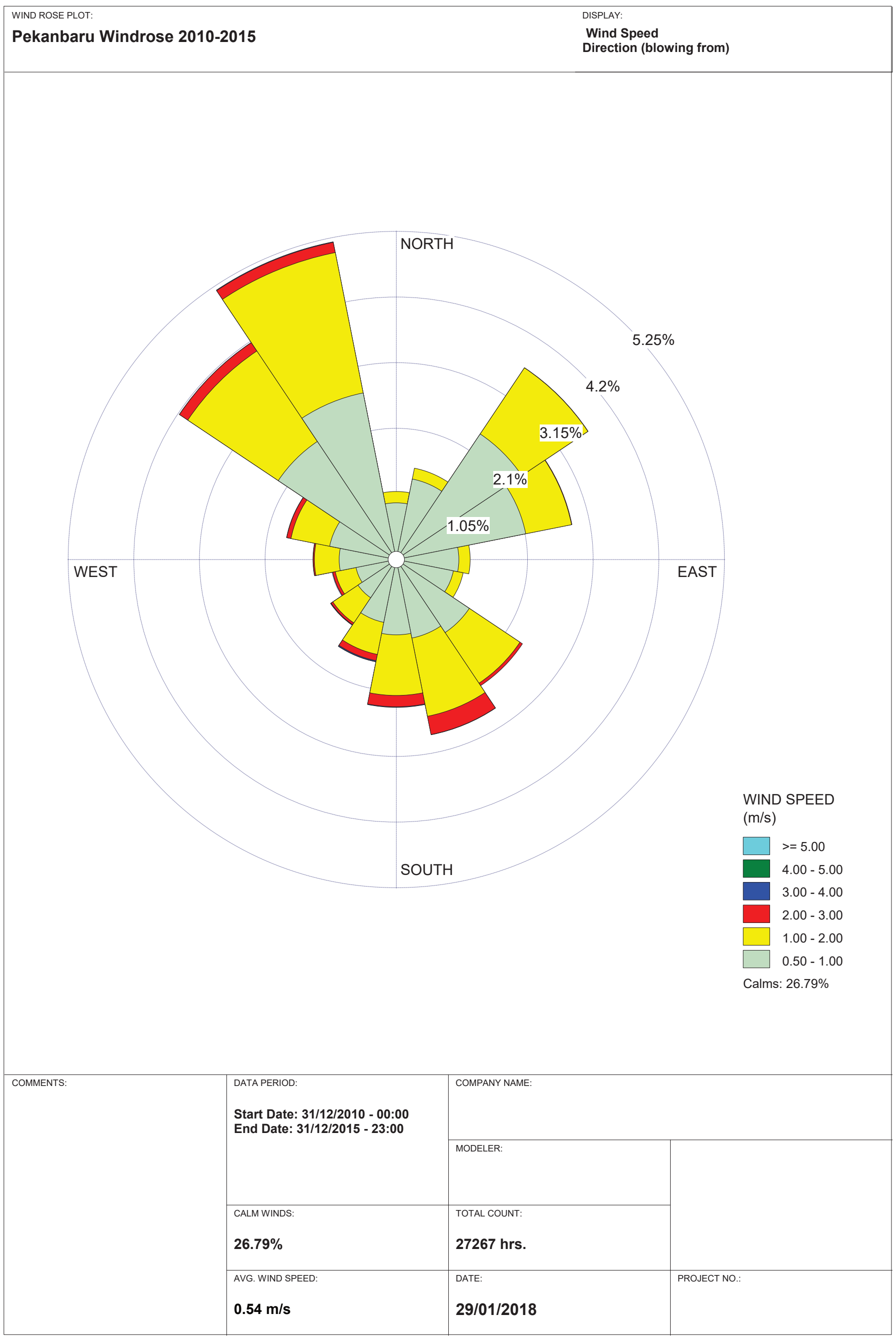


**Figure 3.2 : Windrose of Data Collected at Pekanbaru (Years 2010 – 2015)**

## 3.3 Air Quality

Energy production, industrial and household discharges from fuel combustion, and vehicular traffic are the primary anthropogenic contributors to air pollution in the Project area. The main pollutants identified of interest are particulate matter (as Total Suspended Particulate (TSP), $PM_{10}$ and $PM_{2.5}$), CO, $NO_2$, and $SO_2$.

The Project area primarily consists of palm oil plantations for several kilometres in all directions, with limited residential land use. The main population centre in the area is Pekanbaru City, the nearest residential areas to the power plant site are located more than 3 km to the west of the plant site. The main source of industrial pollution in the local area is therefore the Tenayan CFPP located 2 km to the north of the site.

The scale of residential and industrial activity in the Project area is relatively low.

### 3.3.1 Ambient Air Monitoring Data

Ambient air quality monitoring has been undertaken by Jacobs at locations representing the existing air quality around the power plant and the pipeline route. Monitoring data has also been sourced to represent the existing air quality in the city of Pekanbaru.

Baseline Monitoring for the Project Area (Power Plant)

Baseline ambient monitoring data has been collected in association with the Projects at six monitoring sites near the Project area. Sampling locations were selected in order to get a general representation of ambient air within the receiving environment around the Project area. In addition, sampling locations were also selected to minimise security risks. Two rounds of sampling have been undertaken, one during July 2017 for the dry season, and one during January-February 2018 for the wet season. The number of samples and monitoring sites for each season are detailed in Table 3.1 and 3.2 below.

**Table 3.1 : Ambient Air Baseline Monitoring – Dry Season**

| Contaminant | Number of monitoring sites | Total number of samples |
|---|---|---|
| $SO_2$, $O_3$, NO2, TSP, Pb, HC, CO | 10 | 10 |
| TSP, $PM_{10}$, $PM_{2.5}$ | 2 | 8 |
| Passive $NO_2$ | 4 | 8 |

**Table 3.2 : Ambient Air Baseline Monitoring – Wet Season**

| Contaminant | Number of monitoring sites | Total number of samples |
|---|---|---|
| Power Plant | | |
| $SO_2$, $O_3$, $NO_2$, TSP, Pb, HC, CO | 3 | 3 |
| $PM_{10}$, $PM_{2.5}$ | 3 | 6 |
| Gas Pipeline | | |
| TSP, $PM_{10}$, $PM_{2.5}$ | 2 | 4 |
| Passive $NO_2$ | 4 | 4 |

A map showing the sampling locations is provided as Figure 3.3. The parameters monitored and sampling times conducted at the four sites included:

- Total suspended particulate using high volume sampler (24-hour sampling period per monitoring event) in accordance with Indonesian Standard Method SNI 19-7119.3-2005;
- $PM_{10}$ using low volume sampler fitted with a $PM_{10}$ sampling head (24-hour sampling period per monitoring event) in accordance with Indonesian Standard Method SNI 19-7119.15 (2016);

- $PM_{2.5}$ using low volume sampler fitted with a $PM_{10}$ sampling head (24-hour sampling period per monitoring event) in accordance with Indonesian Standard Method SNI 19-7119.14 (2016);
- Nitrogen dioxide ($NO_2$) by active sampling (1-hour sampling period) in accordance with Indonesian Standard Method SNI 19-7119.2-2005, and passive sampling (14-day sampling period per monitoring event) in accordance with NIOSH Standard 6700 (1998);
- Sulphur dioxide ($SO_2$) by active sampling (1-hour sampling period per monitoring event) in accordance with Indonesian Standard Method SNI 19-7119.7-2005;
- Ozone ($O_3$) by active sampling (1-hour sampling period per monitoring event) in accordance with Indonesian Standard Method SNI 19-7119.8-2005;
- Total non-methane hydrocarbons (TNMHC) by active sampling (30-minute sampling period) in accordance with Indonesian Standard Method SNI 19-7119.13-2005; and
- Lead (Pb) by active sampling (1-hour average) in accordance with Indonesian Standard Method SNI 19-7119.4-2005.

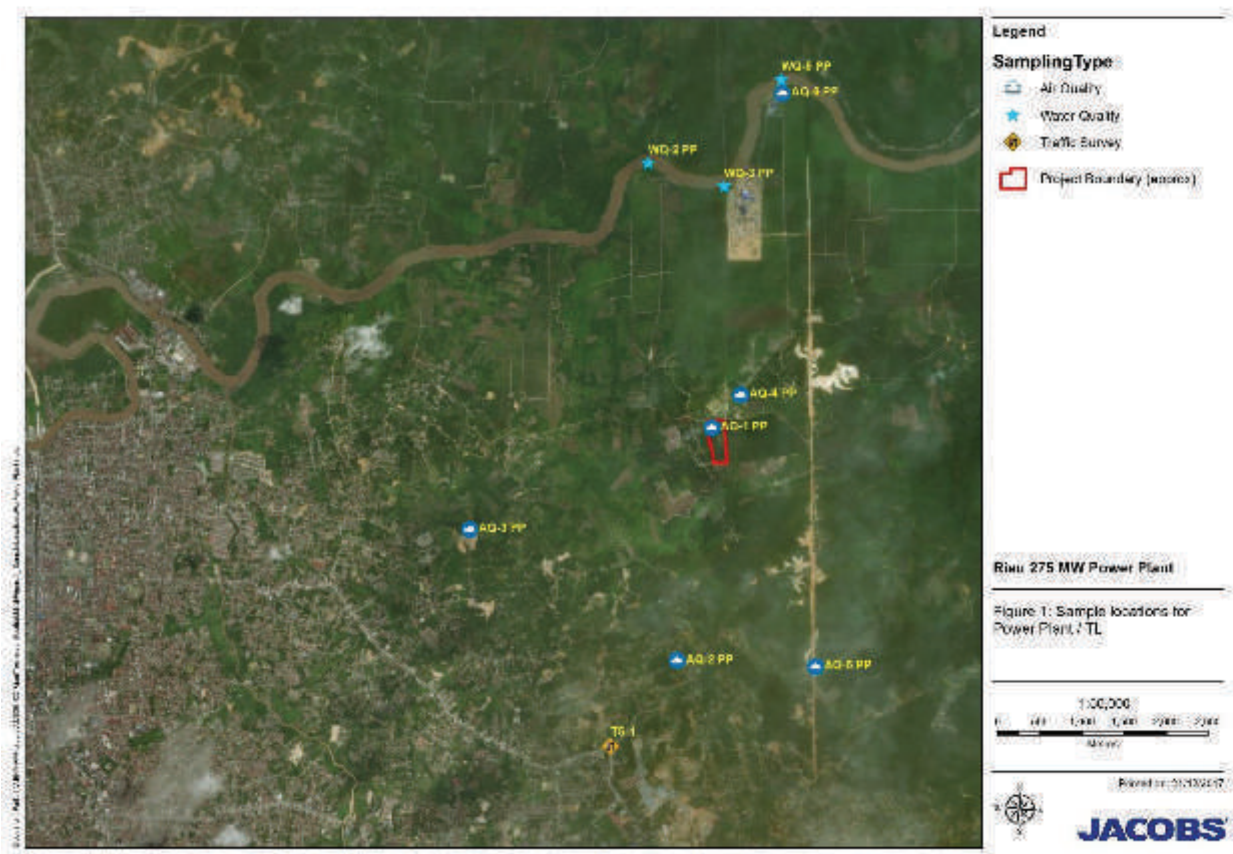


**Figure 3.3 : Baseline Sampling Locations for Riau CCPP Power Plant**

A summary of the baseline air quality monitoring results for the dry and wet season are provided respectively in Table 3.3 and Table 3.4 below.

**Table 3.3 : Baseline Ambient Air Monitoring Results, July 2017 (Dry Season)**

| Contaminant | Range of Measured Concentrations (µg/m³) | | | | | | Overall Average (µg/m³) | Indonesian Air Quality Standard (µg/m³) | WHO Air Quality Guidelines (µg/m³) |
|---|---|---|---|---|---|---|---|---|---|
| | AQ-1 | AQ-2 | AQ-3 | AQ-4 | AQ-5 | AQ-6 | | | |
| $SO_2$ (1-hr avg) | <34 | <34 | <34 | <34 | <34 | <34 | <34 | *900* | *500* |
| $O_3$ (1-hr avg) | <30 | <30 | <30 | <30 | <30 | <30 | <30 | *235* | *n/a* |
| $NO_2$ (1-hr avg) | <17 | <17 | <17 | <17 | <17 | <17 | <17 | *400* | *200* |
| $NO_2$ (14 day average) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | *n/a* | *n/a* |
| CO (1-hr avg) | 0 | 1200 | 0 | 0 | 0 | 0 | 200 | *30000* | *n/a* |
| TNMHC (30-minute avg) | 1.0 | 1.0 | 0.7 | 1.6 | 1.6 | 1.3 | 1.2 | *160* | *n/a* |
| TSP (1-hr avg) | 49 | 92 | 54 | 6 | 55-317 (avg 136) | 36-141 (avg 69) | 95 | *230* | *n/a* |
| $PM_{10}$ (24-hr avg) | n/a | n/a | n/a | n/a | 20-66 (avg 45) | 9-42 (avg 25) | 38 | *150* | *50* |
| $PM_{2.5}$ (24-hr avg) | n/a | n/a | n/a | n/a | 11-31 (avg 21) | <2-22 (avg 11) | *16* | *65* | *25* |
| Pb (1-hr avg) | <0.06 | <0.06 | <0.06 | <0.06 | <0.06 | <0.06 | <0.06 | *2* | *n/a* |

Note: < refers to the detection limit of the sampling method
N/A refers to not applicable and is used where sampling was not undertaken

**Table 3.4 : Baseline Ambient Air Monitoring Results, January-February 2018 (Wet Season)**

| Contaminant | Range of Measured Concentrations (µg/m³) | | | | | | Overall Average (µg/m³) | Indonesian Air Quality Standard (µg/m³) | WHO Air Quality Guidelines (µg/m³) |
|---|---|---|---|---|---|---|---|---|---|
| | AQ-1 | AQ-2 | AQ-3 | AQ-4 | AQ-5 | AQ-6 | | | |
| $NO_2$ (1-hr avg) | <17 | <17 | <17 | <17 | n/a | <17 | *<17* | *400* | *200* |
| $PM_{10}$ (24-hr avg) | n/a | n/a | n/a | n/a | 10-53 | 13-43 | 30 | *150* | *50* |
| $PM_{2.5}$ (24-hr avg) | n/a | n/a | n/a | n/a | 5-20 | 17-23 | *16* | *65* | *25* |

Note: < refers to the detection limit of the sampling method
N/A refers to not applicable and is used where sampling was not undertaken

The ambient monitoring undertaken shows that the ambient air concentrations measured are influenced to some degree by human activity, with concentrations being above what would be typically observed in a rural area. Generally ambient air quality in the project area is good, with ambient air concentrations of contaminants being consistently below the national and international guidelines.

With the exception of particulate matter, the air quality at the sites was determined to be of good quality, with $SO_2$, $NO_2$, CO and ozone ambient air concentrations being relatively low, and well below the Indonesian Ambient Air Standards and the World Health Organisation (WHO) Ambient Air Guidelines. Particulate matter concentrations are higher and at times exceeding the WHO 24-hour guideline value of 50 µg/m³ for $PM_{10}$ and 25 µg/m³ for $PM_{2.5}$, though are consistently below the Indonesian ambient air standards. It is likely that the occasionally high TSP measurements are a result of the monitors being placed in locations of cleared and unsealed land where dust can be easily mobilised by wind or vehicular traffic. This is demonstrated in the photograph of air quality sampling site AQ-5, shown as in Figure 3.4, which had the highest TSP reading of 317 µg/m³ as a 24-hour average. Measurements of particulate matter taken elsewhere in the area were generally lower, and likely to be more representative of actual conditions during the plant operation. However, the dusty nature of the disturbed soil does indicate the need for good practice dust management procedures during the construction phase of the Project.

**Figure 3.4 : Air Quality Sampling Location AQ-5**

Passive sampling for $NO_2$ was also undertaken at four of the baseline monitoring sites (AQ-1, AQ-2, AQ-3 and AQ-4). Passive samplers were deployed for a 14-day sampling duration at each site for three months over the dry season and for six weeks over the wet season. As with the manual sampling, concentrations of $NO_2$ at each of the sites were also determined to be below the method detection limit (equivalent to an ambient air concentration of around 0.01 µg/m$^3$).

Ambient Air Quality Monitoring Along the Gas Pipeline Route

Ambient monitoring data has also been collected along the gas pipeline route, at four locations. A map of these locations is provided as Figure 3.5, and the results are provided in Table 3.5 below. Since sampling was undertaken a section of the gas pipeline route has changed and this is also shown in Figure 3.5 below. Monitoring results along the pipeline route were similar to those in the main Project area, with all contaminants measured below Indonesian Ambient Air Standards and WHO Ambient Air Guidelines.

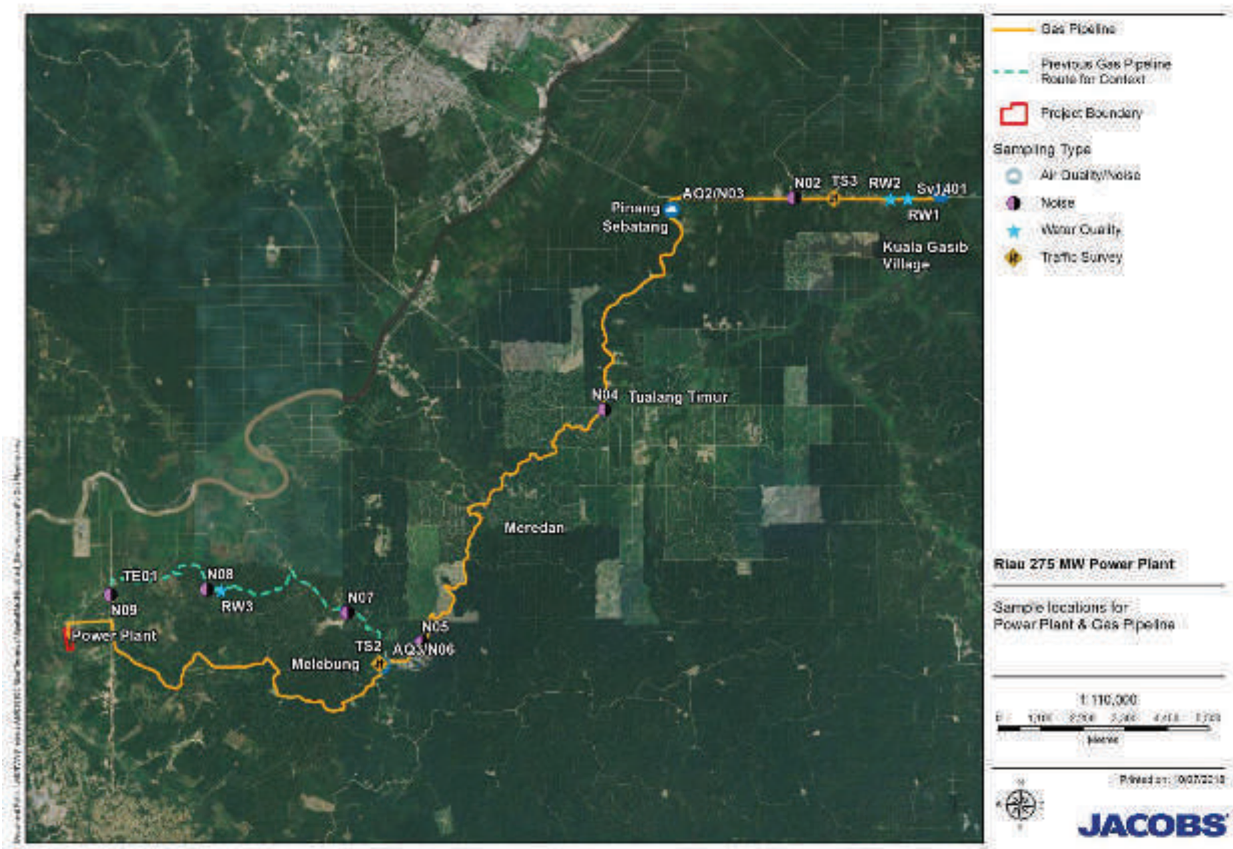


**Figure 3.5 : Baseline Sampling Locations for Riau CCPP Gas Pipeline Route**

**Table 3.5 :Baseline Ambient Air Monitoring Results Along Gas Pipeline Route, January-February 2018 (Wet Season)**

| Contaminant | Measured Concentrations ($\mu g/m^3$) | | | Overall Average ($\mu g/m^3$) | Indonesian Air Quality Standard ($\mu g/m^3$) | WHO Air Quality Guidelines ($\mu g/m^3$) |
|---|---|---|---|---|---|---|
| | AQ-1 | AQ-2 | AQ-3 | | | |
| $SO_2$ (1-hr avg) | <33 | <33 | <33 | <33 | *900* | *500* |
| $O_3$ (1-hr avg) | <34 | <34 | 69 | <46 | *235* | *n/a* |
| $NO_2$ (1-hr avg) | <17 | <17 | <17 | <17 | *400* | *200* |
| CO (1-hr avg) | <114 | <114 | <114 | <114 | *30000* | *n/a* |
| TNMHC (30-minute avg) | <1.6 | <1.6 | <1.6 | <1.6 | *160* | *n/a* |
| TSP (1-hr avg) | 88 | 81 | 71 | 80 | *230* | *n/a* |
| $PM_{10}$ (24-hr avg) | 12-34 | 56 | 26-38 | 26 | *150* | *50* |
| $PM_{2.5}$ (24-hr avg) | 10-23 | 24 | 14-21 | *16* | *65* | *25* |
| Pb (1-hr avg) | <0.06 | <0.06 | <0.06 | <0.06 | *2* | *n/a* |

Note: < refers to the detection limit of the sampling method

Pekanbaru City Continuous Ambient Monitoring

To supplement the manual and passive ambient air sampling undertaken for the Project, Jacobs has sourced continuous ambient air monitoring data from the city of Pekanbaru, which maintains an ambient monitoring station approximately 9 km west of the Project. This data is reproduced in Table 3.6.

A photograph of the Pekanbaru monitoring site is shown as Figure 3.6, with Figure 3.7 showing the location of this station (labelled as PEF2) in relation to the Project. Data collected at this site consists of half-hourly measurements of NO, $NO_2$, $O_3$, $SO_2$ and $PM_{10}$, measured from 2011 to 2015. This data provides a good indication of existing ambient air quality in the Pekanbaru airshed, including any short-term and seasonal variations that could be expected to occur at the power plant site.

It is expected that contaminant concentrations at the urban Pekanbaru City monitoring location would be higher than that in the Project area, due to higher levels of traffic in the City as compared to the Project site which will result in elevated levels of $NO_X$. This assumption is supported by the baseline monitoring undertaken as part of the air quality assessment described above, which measured lower concentrations of contaminants in the Project area compared to those measured in Pekanbaru.

**Figure 3.6 : Photograph of PEF-2 Ambient Air Monitoring Site in Pekanbaru**


**Figure 3.7 : Location Map of PEF-2 Ambient Monitoring Site in Pekanbaru in Relation to the Project**

**Table 3.6 : Summary of Ambient Monitoring Data Collected at Pekanbaru, 2011 - 2015**

| Statistic | $NO_2$ (µg/m$^3$) | | Ozone (µg/m$^3$) | $PM_{10}$ (µg/m$^3$) | $SO_2$ (µg/m$^3$) | |
|---|---|---|---|---|---|---|
| | 1-hour avg | 24-hour avg | 1-hr avg | 24-hr avg | 1-hour avg | 24-hour avg |
| average | 10 | | 59 | 48 | 67 | |
| median | 6.8 | 6.9 | 45 | 25 | 59 | 61 |
| 70th | 14 | 12 | 88 | 37 | 84 | 85 |
| 95th | 30 | 24 | 166 | 174 | 176 | 153 |
| 99th | 45 | 30 | 233 | 424 | 259 | 254 |
| 99.9th | 115 | 46 | 312 | 562 | 341 | 305 |
| Indonesian Air Quality Standards | 400 | 150 | 235 | 150 | 900 | 364 |
| WHO Ambient Air Guidelines | 200 | n/a | n/a | 50 | n/a | 20 |

The continuous monitoring data in Pekanbaru indicates that the ambient air quality is relatively good with respect to $NO_2$. The concentrations measured over the 2011-2015 period are generally (excluding outliers) less than 25% of the Indonesian 1-hour average ambient air standard of 400 ug/m$^3$, and less than 15% of the 24-hour average standard of 150 µg/m$^3$. Concentrations of $PM_{10}$ and $SO_2$ are significantly higher than those observed in the Project area during the baseline air quality monitoring. This is in part due to the more urban nature of the Pekanbaru site, which includes discharges from traffic (including road dust and fuel combustion) and domestic fires etc. It may also be attributed to the longer, continuous nature of the monitoring which is able to capture high pollution events such as that caused by regional-scale agricultural burning and forest fires.

Analysis of $PM_{10}$ concentrations measured during the 2011-2015 period, as shown in Figure 3.8 below, shows the concentrations to be highly variable over the course of a year, with significantly elevated concentrations occurring during the June to October dry season when open agricultural burning and forest fires are common throughout the region. These sources contribute to a regional haze which is not attributable to individual industrial sources. The 2015 fire season has been noted as being the worst year for haze on record in Pekanbaru, resulting in widespread mobilisation of the population to combat brush fires. Since then government intervention has greatly reduced the incidence of these fires, and the regional haze problem has been less of a problem.

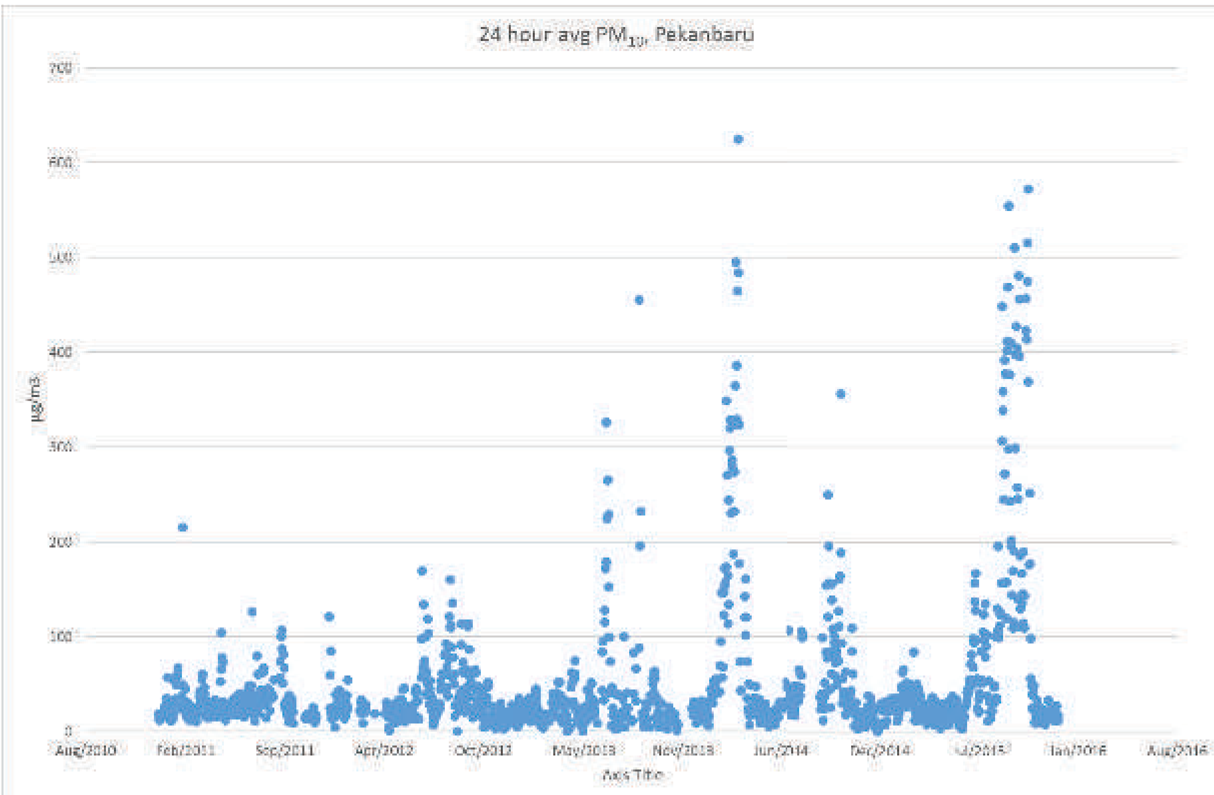


**Figure 3.8 : 24-hour Average $PM_{10}$ Concentrations as Measured at Pekanbaru, 2011-2015**

Elevated concentrations of $SO_2$ are assumed to be the result of elevated sulphur content of fuels used for transportation and other industrial sources burning fuels containing sulphur in the area where the continuous ambient air monitoring was undertaken. Given the low level of traffic and other industrial sources in the Project area, the concentrations of $SO_2$ are also expected to be much lower.

## 3.4 Soils, Geology and Groundwater

### 3.4.1 Geology and Soils

The following description of the geology and soils at the power plant site and along the proposed gas pipeline route is based on a detailed geotechnical study (refer to ESIA Volume 5, Appendix B – Process Description) and a document describing the hydrogeology of the power plant. It is noted that the aforementioned documents focus on the power plant site. Therefore, there is limited information describing the geology and soils along the proposed gas pipeline route, though geological and hydrogeological maps indicate that the geology and soils are likely to be similar to those observed at the power plant.

Regional scale geological maps indicate that the geological unit beneath the power plant and gas pipeline route is part of the Minas formation (Rihardika, 2017). The Minas formation is comprised of very fine sandy siltstone that is well sorted, brittle, and poorly cemented. Borehole records obtained from the general vicinity of the power plant are generally consistent with the above description near the ground surface.

The general area that the power plant and proposed gas pipeline route is located in undulating land that is prone to landslides and general surface erosion. The erosion is primarily due to heavy rainfall events and poorly consolidated soils, typically silt and clay. The Project area (power plant, water and wastewater pipelines and gas pipeline) and the general surrounding area is not within peat land, see Figure 3.9 below.

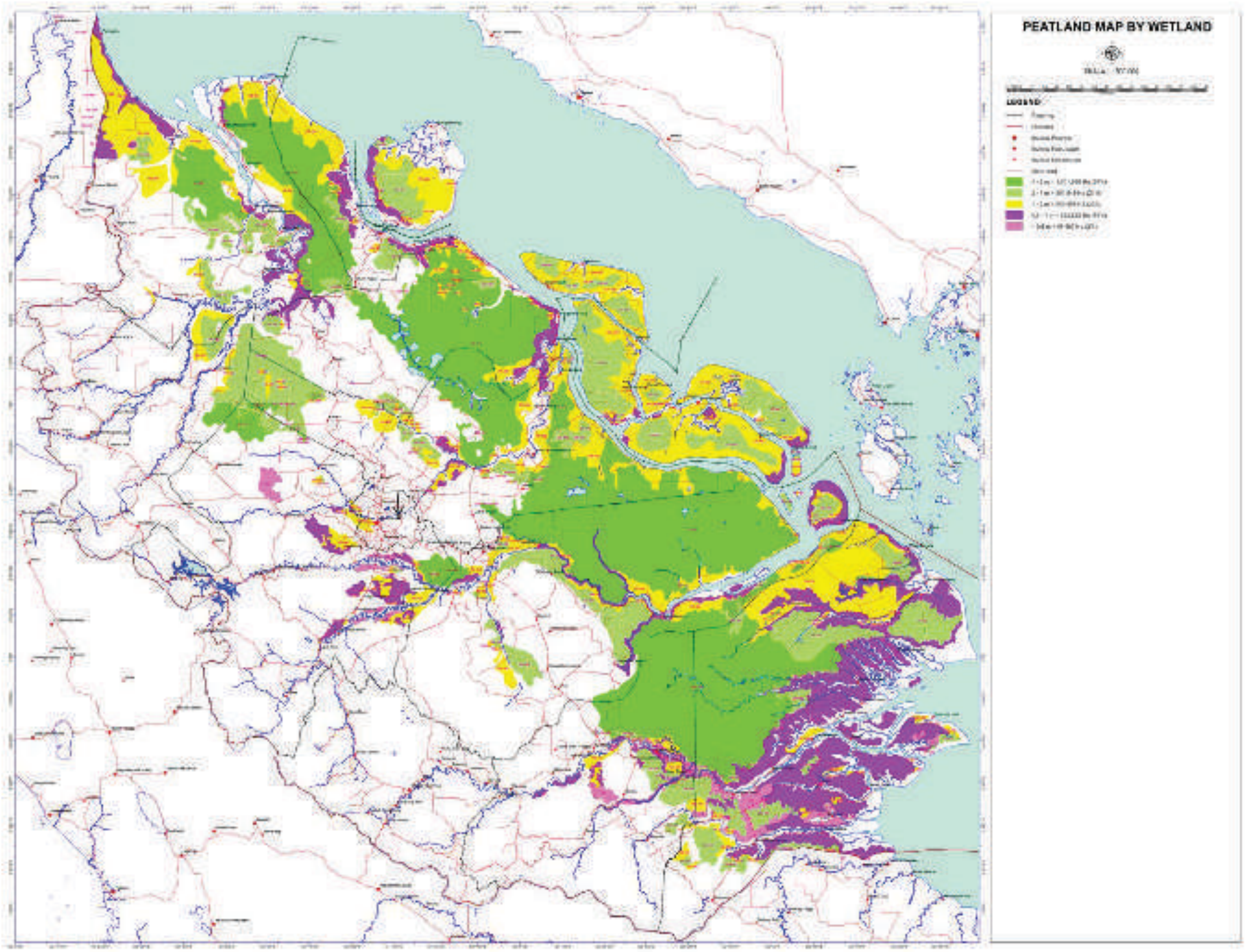


**Figure 3.9 : Map Showing Peat Land**

At the site, the geology has been interpreted from boreholes and resistivity survey collected as part of baseline studies for the proposed plant. Three boreholes were drilled to a depth of 30 m below ground level (BGL) within the proposed footprint of the site and the logs are summarised below in Table 3.7.

**Table 3.7 : Summary of Lithology Identified in Boreholes Within the Power Plant**

| Borehole | Depth (m) | Lithology |
|---|---|---|
| BH-01 | 0 – 0.40 | Clayey SILT |
| | 0.40 – 1.00 | Silty CLAY |
| | 1.00 – 27.00 | CLAY |
| | 27.00 – 30.00 | CLAY |
| BH-02 | 0 – 0.60 | Clayey SILT |
| | 0.60 – 3.45 | Silty CLAY |
| | 3.45 – 30.00 | CLAY |
| BH-03 | 0 -1.20 | Clayey SILT |
| | 1.20 – 5.60 | Clayey SILT |
| | 5.60 – 30.00 | CLAY |

The location of each borehole is shown in Figure 3.10 below.

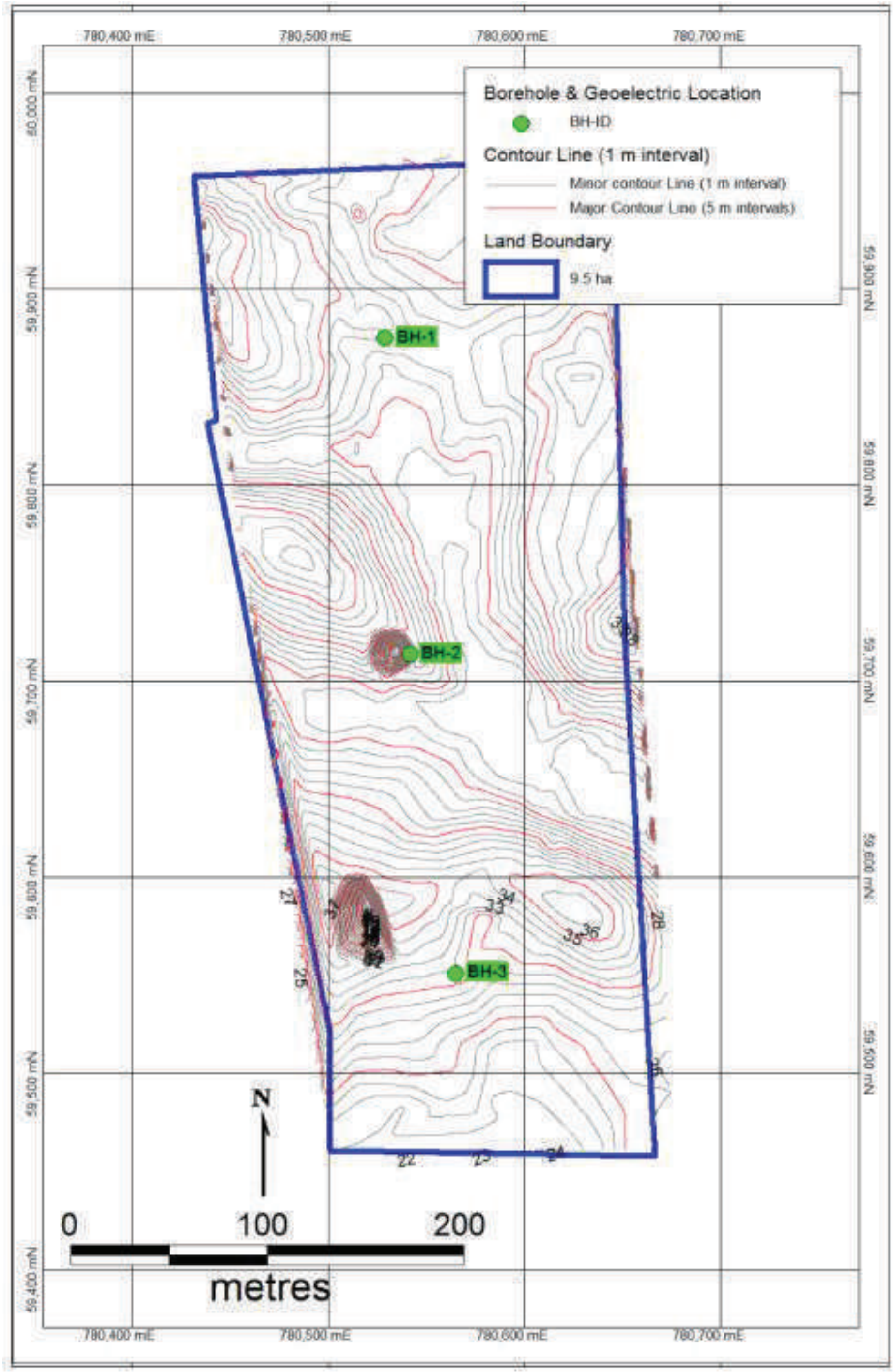


**Figure 3.10 : Location of Boreholes Drilled Within the Power Plant Site**

The logs presented above indicate the presence of clay layer of considerable thickness between 1 and 5 m below the ground surface. Results from a resistivity survey undertaken as part of a geotechnical study (ESIA Volume 5, Appendix B – Process Description) are consistent with these observations. The results of the resistivity survey identified four geological units that are as follows:

- First layer comprised of topsoil ranging in thickness from 0.64 to 1.53 m;
- Second layer comprised of silty clay ranging in thickness from 2.17 to 4.39 m;

- Third layer comprised of clay ranging in thickness from 27.63 to 30.00 m; and
- Fourth layer comprised clayey sand with a thickness of greater than 66.00 m.

A cross-section showing the results of the resistivity survey is also shown below in Figure 3.11.

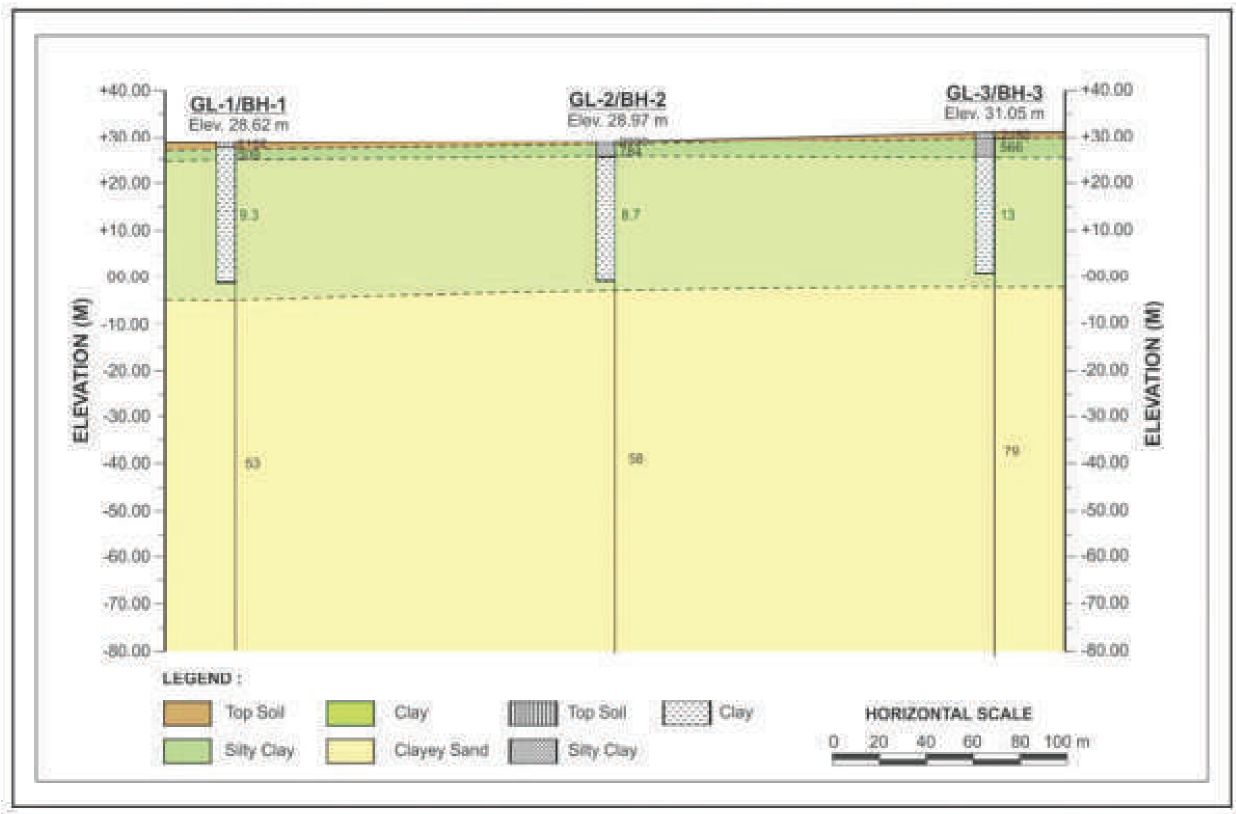


**Figure 3.11 : Cross-Section Showing Results of Resistivity Survey**

In summary, site-specific information collected at the power plant is generally consistent with regional geological maps near the ground surface and a significant clay layer was identified via site-specific studies between one and five metres below the ground surface.

### 3.4.2 Groundwater

Groundwater is defined by Freeze and Cherry (1979) as water found beneath the water table in soils and geological formations that are fully saturated.

Based on the above data the site appears to have two distinct aquifers, or water bearing horizons. The first, which is shown on the regional hydrogeological map is a shallow unconfined aquifer system that is perched on top of the regional extensive clay layer described above. This aquifer is shallow, and typically less than 5 m from the ground surface. Groundwater flow in this shallow aquifer will be controlled by topography (i.e. follows the fall of the land) but in general is to the west. According to the hydrogeological map (Rihardika, 2017) this sandstone has a hydraulic conductivity of between $10^{-6}$ and $10^{-8}$ cm/s which is consistent with literature values of sand and silty sand.

Based on the water level measured in local wells around the plant there appears to also be a deep aquifer unit located beneath the clay layer around 30 m below ground level. No further information on the hydraulic parameters of this unit is available.

Due to the undulating nature of the site, the shallow groundwater table is likely to be highly variable, with the shallowest levels encountered in the depressions or lower lying areas, and deeper groundwater levels on the slopes of the small hillocks on site.

### 3.4.3 Local boreholes and wells

Surveys undertaken for the ESIA identified a number of wells in close proximity to the proposed plant and pipeline. There are 20 wells within 1.5 km of the power plant and a further 18 wells within 100 m of the proposed gas pipeline route (see Figure 3.12 and Figure 3.13).

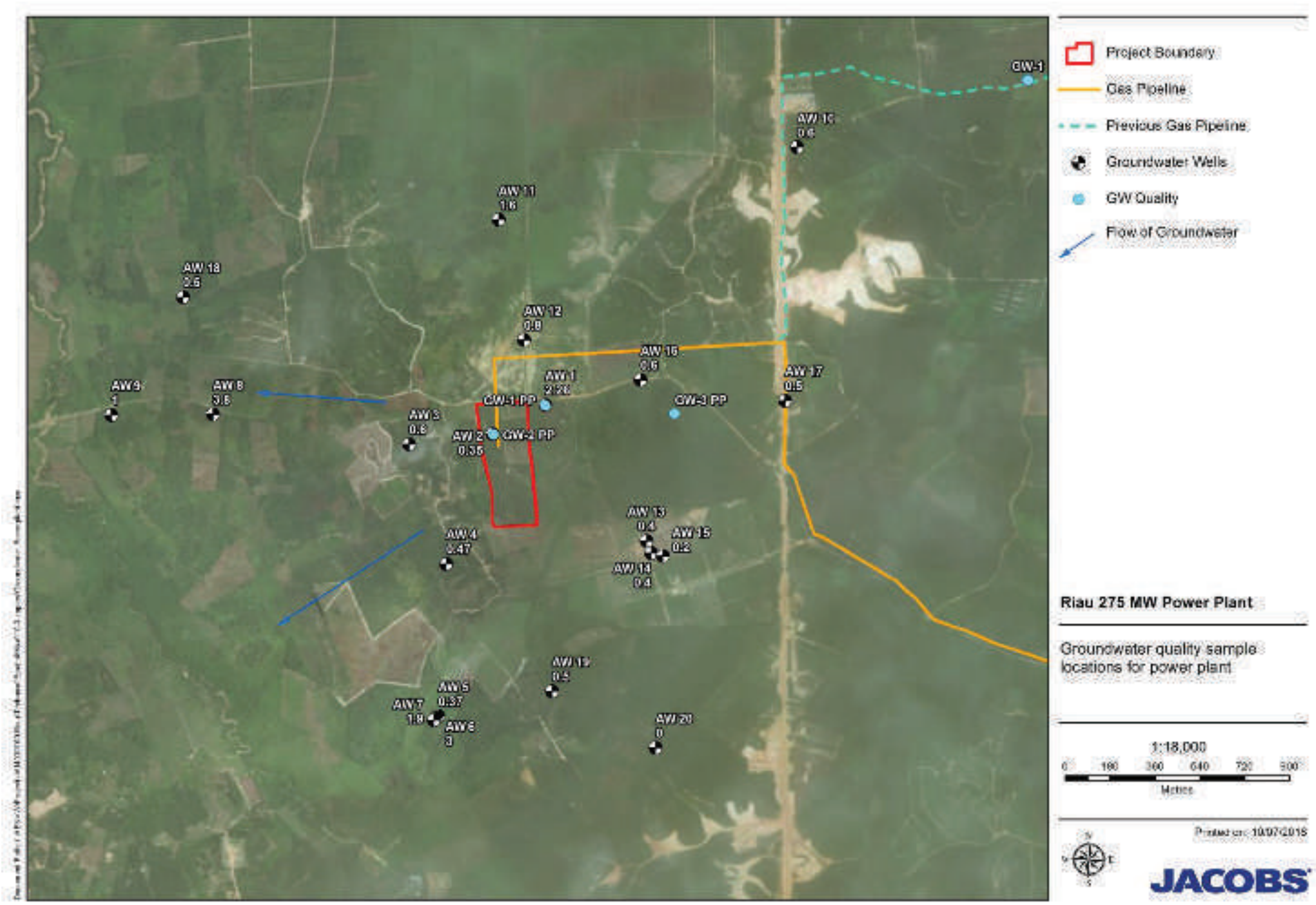


Figure 3.12 : Location of Groundwater Sampling Wells and Neighbouring Wells Within 1.5 km of the Power Plant

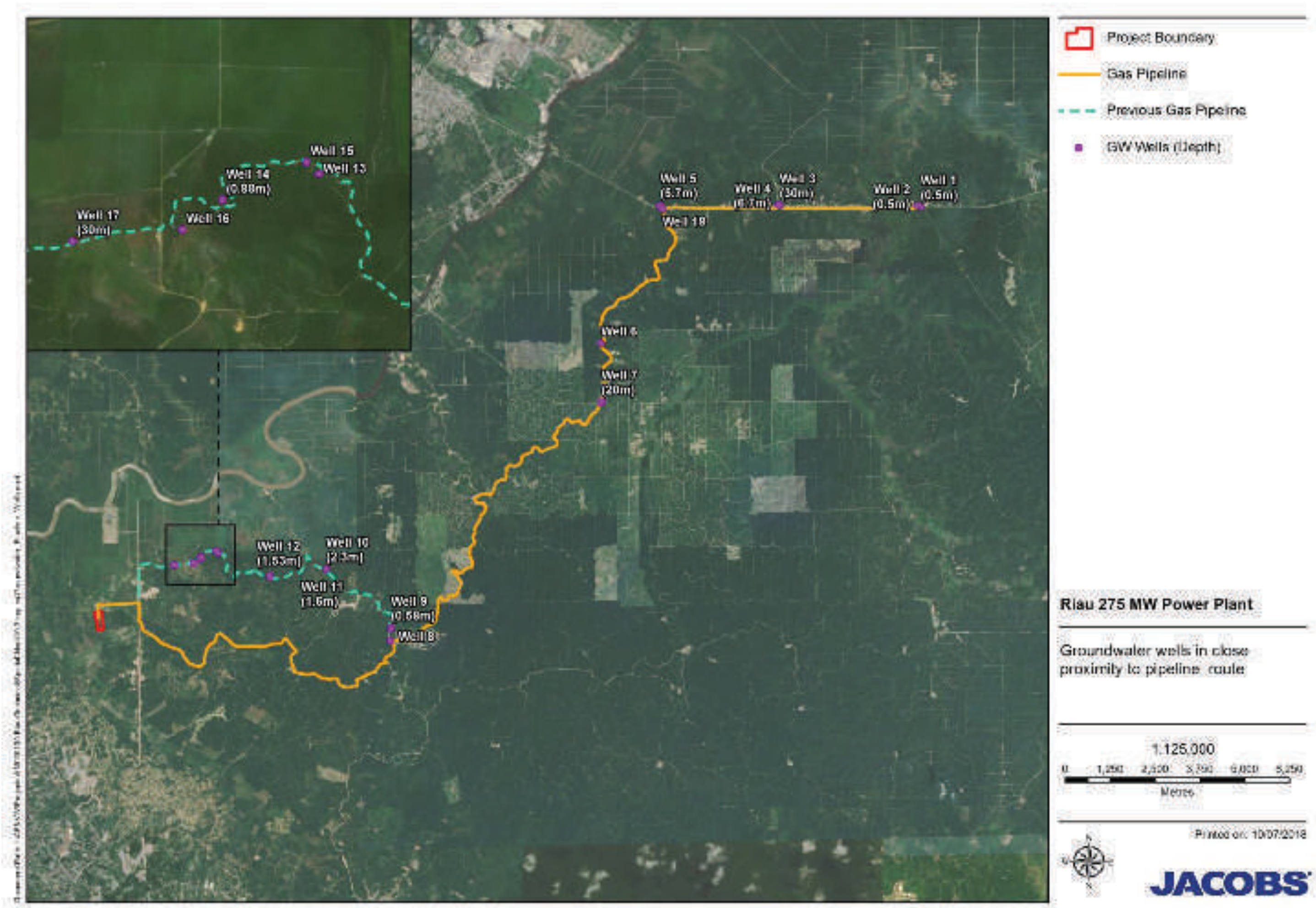


**Figure 3.13 : Location of Wells Within Close Proximity to the Proposed Gas Pipeline Route**

Groundwater levels range from close to ground surface to 3.8 m BGL as shown in Table 3.8.

**Table 3.8 : Summary of Water Levels in Wells in Close Proximity to the Power Plant**

| Well | Well elevation (m aMSL) | Water level (m aMSL) | Water level (m BGL) | Approx. distance to project boundary (m) |
|---|---|---|---|---|
| AW1 | 20 | 17.74 | 2.26 | 70 |
| AW2 | 27 | 26.65 | 0.35 | Within project boundary |
| AW3 | 19 | 18.4 | 0.6 | 285 |
| AW4 | 29 | 28.53 | 0.47 | 245 |
| AW5 | 18 | 17.63 | 0.37 | 795 |
| AW6 | 18 | 15 | 3 | 805 |
| AW7 | 17 | 15.1 | 1.9 | 815 |
| AW8 | 10 | 6.2 | 3.8 | 1,060 |
| AW9 | 7 | 6 | 1 | 1,465 |
| AW10 | 23 | 22.4 | 0.6 | 1,500 |
| AW11 | 14 | 12.4 | 1.6 | 735 |
| AW12 | 13 | 12.2 | 0.8 | 250 |
| AW13 | 19 | 18.6 | 0.4 | 445 |
| AW14 | 20 | 19.6 | 0.4 | 475 |
| AW15 | 21 | 20.8 | 0.2 | 525 |
| AW16 | 32 | 31.4 | 0.6 | 465 |
| AW17 | 25 | 24.5 | 0.5 | 1,035 |
| AW18 | 6 | 5.5 | 0.5 | 1,255 |
| AW19 | 21 | 20.5 | 0.5 | 670 |
| AW20 | 25 | 25 | 0 | 1,015 |

Notes:
Well depths have not been provided
m aMSL = metres above mean sea level
m BGL = metres below ground level
It is assumed that the well within the project boundary will be decommissioned in accordance with appropriate regulatory standards

Based on the baseline field observations, these wells are likely to be used for domestic purposes and/or irrigation of palm oil plantations. In relation to groundwater quality, visual, olfactory and taste observations have been made on the 20 wells within 1.5 km of the power plant. Unfortunately, the depths of these wells were not recorded during the survey however based on the water levels observed it is assumed that they are all screened in the shallow unconfined aquifer. The observations noted the following:

- The majority of wells produced clear water, though some wells had muddy water;
- The majority of wells had water that tasted like acid; and
- No odour was identified at the majority of wells.

With regard to the 18 wells within 100 m of the gas pipeline (Figure 3.13), well depths range from 0.5 to 60 m, as shown in Table 3.9 below. Unfortunately, groundwater levels for these wells were not recorded. These wells are also likely to be used for domestic purposes and/or irrigation of palm oil plantations. No visual, olfactory or taste observations have been made on these wells.

**Table 3.9 : Summary of Water Levels in Wells in Close Proximity to the Gas Pipeline**

| Well | Depth (m) | Approx. distance to proposed gas pipeline route (m) |
|---|---|---|
| 1 | 5 | 10 |
| 2 | 38 | 20 |
| 3 | 20 | 70 |
| 4 | 10 | 90 |
| 5 | 80 | 30 |
| 6 | 60 | 35 |
| 7 | 53 | 30 |
| 8 | 30 | 15 |
| 9 | 80 | 70 |
| 20 | 24 | 40 |
| 11 | 3 | 45 |
| 12 | 2 | 10 |
| 13 | 20 | 15 |
| 14 | 15 | 10 |
| 15 | 1,2 | 75 |
| 16 | 1 | 100 |
| 17 | 0.50 | 15 |
| 18 | 7 | 100 |

A limited number of groundwater quality analyses have been completed on the 20 wells within 1.5 km of the power plant and the 18 wells with 100 m of the proposed gas pipeline route.

### 3.4.4 Soil Sampling

Ten soil samples were collected at the power plant during baseline surveys. The locations of the soil samples are shown in Figure 3.14. Sample location were selected on a random basis to give a representative baseline of existing contaminant concentrations at the site given no industrial activities have occurred at the site.


**Figure 3.14 : Location of Soil Samples at the Power Plant**

These soils samples were analysed for organochlorine pesticides (OCP), organophosphorus pesticides (OPP), carbaryl (sevin) and carbofuran (furadan). This analytical suite was chosen because of the current use of the land as a palm oil plantation.

Results of the soil sampling are shown in Table 3.10. The results were compared against the Regional Screening Levels (RSLs) for the Protection of Human Health at Industrial Sites to identify the risk to human health as a result of excavation of the soil. Where multiple values were potentially relevant for a particular contaminant group (e.g. Total OCP), the lowest value was taken, as exceeding that value may result in adverse impacts on human health if not managed appropriately.

In summary, all soil samples were below detection limits for all analyses, indicating that the soils in the vicinity of the power plant are not contaminated from the use of pesticides.

**Table 3.10 : Soil Sampling Results**

| Sample | Total Organochlorine Pesticides (OCPs) (mg/kg) | Total Organophosphorus Pesticides (OPPs) (mg/kg) | Carbaryl (Sevin) (mg/kg) | Carbofuran (Furada) (mg/kg) |
|---|---|---|---|---|
| Detection Limit | 0.2 | 2 | 0.01 | 0.02 |
| Regulation Limit | NA | NA | - | - |
| Assessment Guidelines[1] | 8.5[2] | 7.9[3] | 82,000 | 4,100 |

| Sample | Total Organochlorine Pesticides (OCPs) (mg/kg) | Total Organophosphorus Pesticides (OPPs) (mg/kg) | Carbaryl (Sevin) (mg/kg) | Carbofuran (Furada) (mg/kg) |
|---|---|---|---|---|
| L-1 PP | < 0.2 | < 2 | < 0.01 | < 0.02 |
| L-2 PP | < 0.2 | < 2 | < 0.01 | < 0.02 |
| L-3 PP | < 0.2 | < 2 | < 0.01 | < 0.02 |
| L-4 PP | < 0.2 | < 2 | < 0.01 | < 0.02 |
| L-5 PP | < 0.2 | < 2 | < 0.01 | < 0.02 |
| L-6 PP | < 0.2 | < 2 | < 0.01 | < 0.02 |
| L-7 PP | < 0.2 | < 2 | < 0.01 | < 0.02 |
| L-8 PP | < 0.2 | < 2 | < 0.01 | < 0.02 |
| L-9 PP | < 0.2 | < 2 | < 0.01 | < 0.02 |
| L-10 PP | < 0.2 | < 2 | < 0.01 | < 0.02 |

Notes:
1. Sourced from Regional Screening Level for Chemical Contaminants at Industrial Sites – Industrial Soil (May 2018).
2 . No guideline value for total OCPS, and therefore used DTT, an OCP, as replacement guideline value.
3. No guideline value for total OPPs, and therefore used Dichlorvos, an OPP, as replacement guideline value.

### 3.4.5 Groundwater Quality Sampling

Groundwater quality samples were collected from three groundwater monitoring wells, one of which is within the boundary of the power plant (GW-2 PP), while the remaining two (GW-1 PP and GW-3 PP) were located immediately to the east of the power plant. The rationale for sampling these wells is that they are deeper wells tapping into the deep aquifer, thus providing an indication of groundwater quality, as opposed to the shallow unconfined aquifer comprising perched groundwater which is likely to be impacted by surface activities. The location of the groundwater samples and neighbouring wells are shown above in Figure 3.12.

Samples collected from the three groundwater wells were analysed for a range in chemical, bacterial and organic parameters. Results from the groundwater samples are shown in Table 3.11. The results show that with the exception of pH at GW-2 PP and GW-3 PP and total coliforms at GW-1 PP, groundwater quality is compliant with Indonesian Regulation PP 82/2001 Class II. The low pH values to the east of the site are likely a result existing land uses in the area and the presence of organic acids (e.g. humic acid). The high total coliform count within the site is likely a result of the wellhead being compromised to some degree, thus allowing surface runoff to enter the well. In addition, the total cadmium concentration at GW-2 PP of 0.012 mg/L was the only analyte which exceeded World Health Organisation (WHO) drinking water guidelines.

Overall, the results indicate that groundwater is generally of good quality and subjected to limited contamination, likely a result of existing land uses and surface runoff, and therefore activities in the area that may impact groundwater quality should be carefully managed.

**Table 3.11 : Groundwater Quality Results**

| Analytes | Unit | Detection Limit | Regulation Limit[1] | WHO Drinking Water Guidelines[2] | GW-1 PP | GW-2 PP | GW-3 PP |
|---|---|---|---|---|---|---|---|
| **Physical** | | | | | | | |
| Temperature | ℃ | - | ±3 | NA | 27 | 27.8 | 28.1 |
| Total Dissolved Solids (TDS) | mg/L | 4 | 1000 | NA | 39 | < 4 | 60 |

| Analytes | Unit | Detection Limit | Regulation Limit[1] | WHO Drinking Water Guidelines[2] | GW-1 PP | GW-2 PP | GW-3 PP |
|---|---|---|---|---|---|---|---|
| Total Suspended Solids (TSS) | mg/L | 1 | 50 | NA | 7 | < 1 | < 1 |
| Conductivity | µs/cm | 1 | NA³ | NA | 46 | < 1 | 90 |
| Turbidity | NTU | 0.5 | NA³ | NA | 9.71 | 3.07 | 2.43 |
| **Chemical** | | | | | | | |
| pH | - | - | 6 – 9 | NA | 6.67 | **4.58** | **4.66** |
| Biochemical Oxygen Demand (BOD) | mg/L | 2 | 3 | NA | < 2 | < 2 | < 2 |
| Chemical Oxygen Demand (COD) | mg/L | 3 | 25 | NA | < 3 | < 3 | < 3 |
| Ammonia (as $NH_3$-N) | mg/L | 0.07 | (-) | NA | 0.10 | 0.19 | < 0.07 |
| Nitrate ($NO_3$) | mg/L | 0.003 | 10 | 11.3 | 0.034 | 0.060 | 0.822 |
| Nitrite ($NO_2$) | mg/L | 0.005 | 0.06 | 1.9 | < 0.005 | < 0.005 | < 0.005 |
| Total Nitrogen | mg/L | 0.06 | NA | NA | 0.10 | 0.25 | 1.81 |
| Fluoride (F) | mg/L | 0.1 | 1.5 | 1.5 | < 0.1 | 0.2 | 0.2 |
| Phophorus (P) | mg/L | 0.03 | 0.2 | NA | < 0.03 | < 0.03 | < 0.03 |
| Oil and Grease | µg/L | 1000 | 1000 | NA | < 1,000 | < 1,000 | < 1,000 |
| Total Boron (B) | mg/L | 0.04 | NA | 2.4 | 0.62 | 0.65 | 0.86 |
| Total Mercury (Hg) | mg/L | 0.0005 | NA | 0.006 | < 0.0005 | < 0.0005 | < 0.0005 |
| Total Arsenic (As) | mg/L | 0.005 | NA | 0.01 | < 0.005 | < 0.005 | < 0.005 |
| Total Cadmium (Cd)[2] | mg/L | 0.002 | NA | 0.003 | < 0.002 | **0.012** | 0.002 |
| Total Chromium Hexavalent ($Cr^{6+}$) | mg/L | 0.004 | NA | NA | < 0.004 | < 0.004 | < 0.004 |
| Total Chromium (Cr) | mg/L | 0.02 | NA | 0.05 | < 0.02 | < 0.02 | < 0.02 |
| Total Copper (Cu) | mg/L | 0.01 | NA | 2 | < 0.01 | < 0.01 | < 0.01 |
| Total Iron (Fe) | mg/L | 0.09 | NA | NA | 0.30 | 0.10 | <0 .09 |
| Total Lead (Pb)[2] | mg/L | 0.005 | NA | 0.01 | < 0.005 | < 0.005 | < 0.005 |
| Total Manganese (Mn) | mg/L | 0.01 | NA | NA | < 0.01 | < 0.01 | < 0.01 |
| Total Nickel (Ni) | mg/L | 0.01 | NA | 0.07 | < 0.01 | < 0.01 | < 0.01 |
| Total Zinc (Zn) | mg/L | 0.02 | NA | NA | < 0.02 | < 0.02 | < 0.02 |
| Dissolved Boron (B) | mg/L | 0.04 | 1 | 2.4 | < 0.04 | 0.31 | 0.51 |
| Dissolved Mercury (Hg) | mg/L | 0.0005 | 0.002 | 0.006 | < 0.0005 | < 0.0005 | < 0.0005 |
| Dissolved Arsenic (As) | mg/L | 0.005 | 1 | 0.01 | < 0.005 | < 0.005 | < 0.005 |
| Dissolved Cadmium (Cd)[2] | mg/L | 0.002 | 0.01 | 0.003 | < 0.002 | < 0.002 | < 0.002 |
| Dissolved Chromium Hexavalent ($Cr^{6+}$) | mg/L | 0.004 | 0.05 | NA | < 0.004 | < 0.004 | < 0.004 |
| Dissolved Chromium | mg/L | 0.02 | NA³ | NA | < 0.02 | < 0.02 | < 0.02 |
| Dissolved Copper (Cu) | mg/L | 0.01 | 0.02 | 2 | < 0.01 | < 0.01 | < 0.01 |
| Dissolved Iron (Fe) | mg/L | 0.09 | (-) | NA | 0.24 | <0.09 | <0.09 |
| Dissolved Lead (Pb)[3] | mg/L | 0.005 | 0.03 | 0.01 | < 0.005 | < 0.005 | < 0.005 |
| Dissolved Manganese (Mn) | mg/L | 0.01 | (-) | NA | < 0.01 | < 0.01 | < 0.01 |
| Dissolved Nickel (Ni) | mg/L | 0.01 | NA | 0.07 | < 0.01 | < 0.01 | < 0.01 |

| Analytes | Unit | Detection Limit | Regulation Limit[1] | WHO Drinking Water Guidelines[2] | GW-1 PP | GW-2 PP | GW-3 PP |
|---|---|---|---|---|---|---|---|
| Dissolved Zinc (Zn) | mg/L | 0.02 | 0.05 | NA | < 0.02 | < 0.02 | < 0.02 |
| **Microbiology** | | | | | | | |
| Total Coliforms | colony/100mL | - | 5,000 | NA | **20,000** | 740 | 12 |
| **Organics** | | | | | | | |
| Organochlorine Pesticides (OCP) | µg/L | 0.4 | NA | NA | < 0.4 | < 0.4 | < 0.4 |
| Polychlorinated Biphenyils (PCB) | µg/L | 0.005 | NA | NA | < 0.005 | < 0.005 | < 0.005 |
| Polycyclic Aromatic Hydrocarbon (PAHs) | µg/L | 0.04 | NA | NA | < 0.04 | < 0.04 | < 0.04 |

Notes:

**Bold text** indicates exceedance of Indonesian Regulation PP 82/2001 Class II

**Bold text** indicates exceedance of WHO Drinking Water Guidelines

[1] Indonesian Regulation PP 82/2001 Class II

[2] WHO Drinking Water Guidelines (2017) – Assumed WHO guidelines apply to both total and dissolved concentrations for all metals, unless otherwise stated

[3] Parameter in the described matrix has not been accredited by KAN

### 3.4.6 Sampling – Gas Pipeline

Four soil samples were collected along the length of the gas pipeline route. The locations of the soil samples are shown in Figure 3.15.

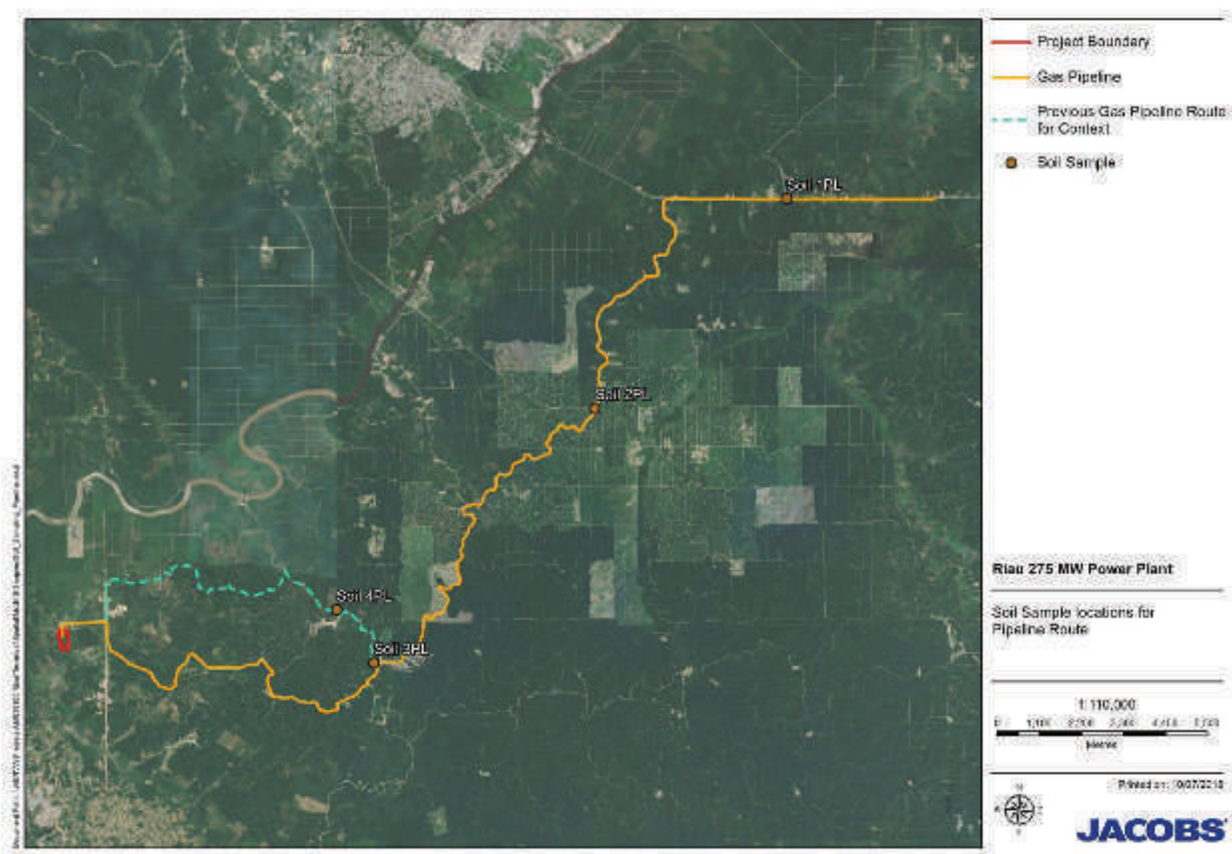

**Figure 3.15 : Location of Soil Samples Along the Gas Pipeline**

The collected soils samples were analysed and results listed in Table 3.12. The results were compared against the Regional Screening Levels (RSLs) for the Protection of Human Health at Industrial Sites for industrial sites to identify the risk to human health as a result of excavation of the soil. It is noted that these guidelines contain both carcinogenic and non-carcinogenic values in relation to particular contaminants, of which values may be different (e.g., carcinogenic screen level value for Mirex in relation to ingestion (0.018 mg/kg) is different to the non-carcinogenic screen value for Mirex in relation to ingestion (2,300 mg/kg)). Where multiple values were potentially relevant for a particular contaminant, the lowest value was taken as exceeding that value may result in adverse impacts on human health if not managed appropriately.

In summary, while contaminants were observed in the soil samples, they were generally at low levels and there were no exceedances of RSLs in relation to the protection of human health. This indicates that no measures are required to protect human health during construction works along the pipeline.

**Table 3.12 : Soil Sampling Results**

| Parameter | Unit | Limit of Reporting | Regional Screening Levels (Protection of Human Health)[1] | Soil 1 PL | Soil 2 PL | Soil 3 PL | Soil 4 PL |
|---|---|---|---|---|---|---|---|
| **Metals & Cations** | | | | | | | |
| Mercury | mg/kg | 0.05 | 46[2] | 0.06 | 0.07 | 0.08 | 0.06 |
| Arsenic | mg/kg | 1.00 | 3 | < 1.00 | 2.27 | 1.63 | 2.79 |
| Boron | mg/kg | 5.00 | 230,000[3] | < 5.00 | < 5.00 | < 5.00 | < 5.00 |
| Cadmium | mg/kg | 1.00 | NA | < 1.00 | < 1.00 | < 1.00 | < 1.00 |
| Chromium | mg/kg | 1.00 | NA | 12.8 | 17.000 | 14.0 | 14.5 |
| Copper | mg/kg | 1.00 | 47,000 | 1.1 | 1.13 | < 1.00 | < 1.00 |
| Iron | mg/kg | 5.00 | 820,000 | 7,930 | 15,000 | 7,630 | 6,810 |
| Lead | mg/kg | 1.00 | 800[4] | 2.55 | 4.59 | 2.34 | 2.02 |
| Manganese | mg/kg | 1.00 | 26,000 | 8.84 | 6.38 | 8.46 | 4.10 |
| Nickel | mg/kg | 1.00 | 8,100[5] | 1.4 | 1.21 | 1.08 | < 1.00 |
| Zinc | mg/kg | 5.00 | 350,000 | 5.96 | < 5.00 | < 5.00 | < 5.00 |
| **Polyaromatics Aromatic Hydrocarbons (PAHs)** | | | | | | | |
| Total PAHs | mg/kg | 1.0 | 6,000[6] | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| **Polychlorinated Biphenyls (PCBs)** | | | | | | | |
| Total Polychlorinated Biphenyls | mg/kg | 0.25 | 0.94[7] | < 0.25 | < 0.25 | < 0.25 | < 0.25 |
| **Organochlorine Pesticides (OCPs)** | | | | | | | |
| Trans-Chlordane | mg/kg | 0.5 | NA | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cis-Chlordane | mg/kg | 0.5 | NA | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Endosulfan 1 | mg/kg | 0.5 | 7,000[8] | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Dieldrin | mg/kg | 0.5 | 0.14 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Endosulfan 2 | mg/kg | 0.5 | 7,000[8] | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 4.4'-DDT | mg/kg | 1.0 | 8.5 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Mirex | mg/kg | 0.001 | 0.17 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |

| Parameter | Unit | Limit of Reporting | Regional Screening Levels (Protection of Human Health)[1] | Soil 1 PL | Soil 2 PL | Soil 3 PL | Soil 4 PL |
|---|---|---|---|---|---|---|---|

Notes:

[1] Sourced from Regional Screening Level for Chemical Contaminants at Industrial Sites – Industrial Soil (May 2018)

[2] Mercury (elemental)

[3] Boron & Borates only

[4] Lead and Compounds

[5] Nickel Acetate

[6] Total Petroleum Hydrocarbons (Aromatic (Medium)

[7] Polychlorinated Biphenyls (high risk)

[8] Endosulfan

### 3.4.7 Groundwater Sampling

Groundwater samples were collected from seven groundwater monitoring wells along the length of the gas pipeline route. The location of the groundwater samples and neighbouring wells are shown in Figure 3.16 and detailed in Table 3.13.

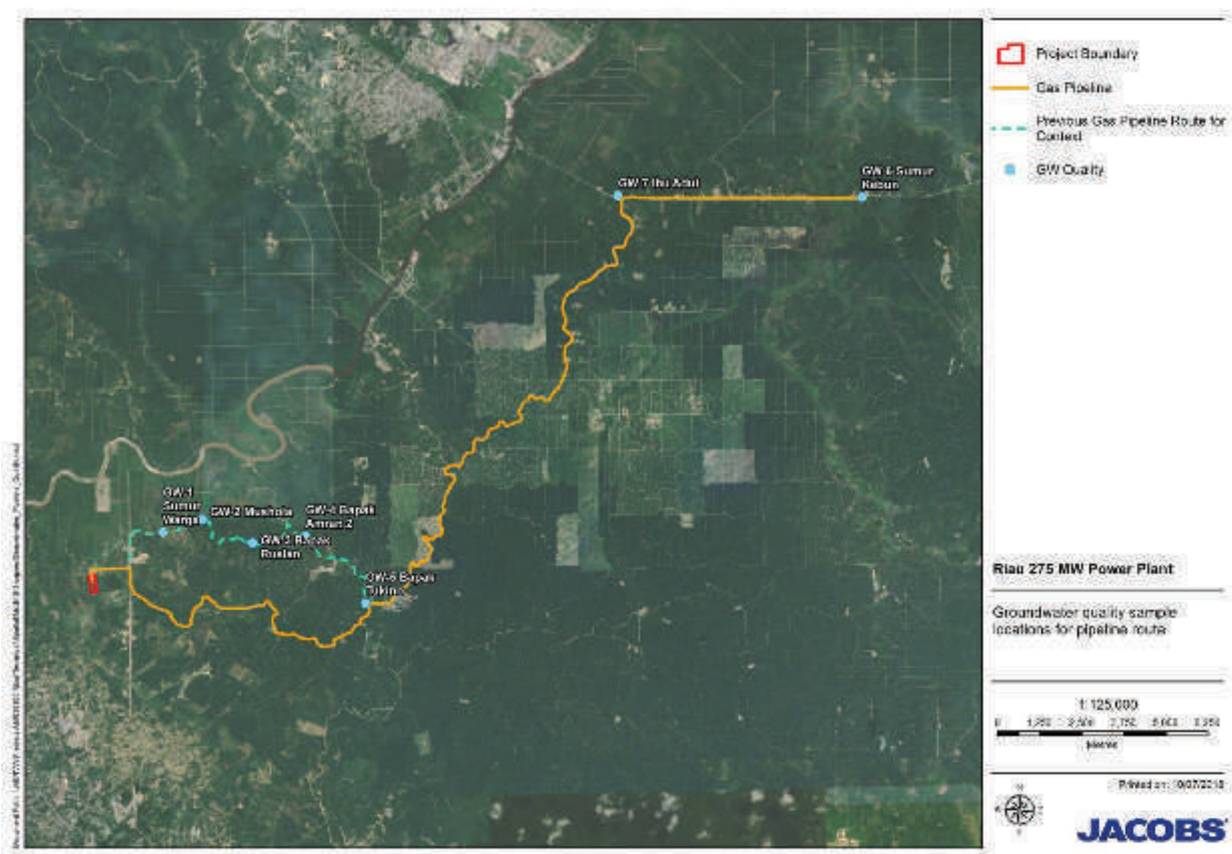


**Figure 3.16 : Location of Groundwater Sampling Wells Along the Gas Pipeline Route**

Samples collected from the seven groundwater wells were analysed for a range of analytes and results from the groundwater samples are shown in Table 3.13. The results show that these were a small number of exceedances of the relevant regulations. These exceedances are as follows:

- Acceptable range for pH in Indonesian Regulation PP 82/2001 Class II is 6 to 9. pH at GW-1 Sumur Warga, GW-5 Bapak Tukino, and GW-7 Ibu Adui all fell outside the acceptable range;
- Biochemical oxygen demand and chemical oxygen demand concentrations were 4.7 and 141 mg/L at GW-6 Sumur Kebun, respectively, thus exceeding Indonesian Regulation PP 82/2001 Class II of 3 and 25 mg/L, respectively;
- The total boron concentration at GW-2 Mushola of 4.87 mg/L exceeded WHO Drinking Water Guidelines of 2.4 mg/L; and
- Total coliform counts in GW-6 Sumur Kebun and GW-7 Ibu Adui were 49 and 5 cfu/100 mL, respectively. These counts did not exceed Indonesian Regulation PP 82/2001 Class II but do indicate localised sources of contamination or inadequate well protection.

The limited contamination is potentially a result of localised activities impacting groundwater in specific wells or site-specific hydrogeological conditions.

**Table 3.13 : Groundwater Quality Results**

| Analytes | Unit | Detection Limit | Regulation Limit[1] | WHO Drinking Water Guidelines[2] | GW-1 | GW-2 | GW-3 | GW-4 | GW-5 | GW-6 | GW-7 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | - | - | 6 – 9 | NA | **4.21** | 7.0 | 6.26 | 6.8 | **4.44** | 6.27 | **4.97** |
| Total Suspended Solids (TSS) | mg/L | 1 | 50 | NA | 1 | < 1 | < 1 | < 1 | 6 | 26 | < 1 |
| Biochemical Oxygen Demand (BOD) | mg/L | 2 | 3 | NA | < 2 | < 2 | < 2 | < 2 | < 2 | **4.7** | < 2 |
| Chemical Oxygen Demand (COD) | mg/L | 5 | 25 | NA | < 5 | < 5 | < 5 | 8 | < 5 | **141** | < 5 |
| Oil & Grease | mg/L | 1 | NA | NA | < 1,000 | < 1,000 | < 1,000 | < 1,000 | < 1,000 | 9 | < 1,000 |
| Arsenic (As) | mg/L | 0.02 | NA | 0.01 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| Boron (B) | mg/L | 0.04 | NA | 2.4 | < 0.04 | **4.87** | < 0.04 | 2.22 | 2.08 | 0.38 | 0.36 |
| Cadmium (Cd) | mg/L | 0.002 | NA | 0.003 | < 0.002 | < 0.002 | < 0.002 | < 0.002 | < 0.002 | < 0.002 | < 0.02 |
| Chromium (Cr) | mg/L | 0.02 | NA | 0.05 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| Chromium Hexavalent ($Cr^{6+}$) | mg/L | 0.004 | NA | NA | < 0.004 | < 0.004 | < 0.004 | < 0.004 | < 0.004 | 0.006 | < 0.004 |
| Copper (Cu) | mg/L | 0.02 | NA | 2 | < 0.02 | 0.06 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| Iron (Fe) | mg/L | 0.02 | NA | NA | 0.05 | < 0.02 | < 0.02 | 0.03 | 0.03 | 0.43 | < 0.02 |
| Lead (Pb) | mg/L | 0.02 | NA | 0.01 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| Mercury (Hg) | mg/L | 0.00005 | NA | 6 | < 0.00005 | < 0.00005 | < 0.00005 | < 0.00005 | < 0.00005 | < 0.00005 | < 0.00005 |
| Manganese (Mn) | mg/L | 0.02 | NA | NA | < 0.02 | 0.04 | < 0.02 | 0.02 | < 0.02 | < 0.02 | < 0.02 |
| Nickel (Ni) | mg/L | 0.02 | NA | 0.07 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| Zinc (Zn) | mg/L | - | NA | NA | 0.08 | 0.36 | 0.09 | 0.10 | 0.13 | 0.05 | 0.07 |
| Ammonia (as $NH_3$-N) | mg/L | 0.07 | NA | NA | < 0.07 | < 0.07 | < 0.07 | < 0.07 | < 0.07 | < 0.07 | < 0.07 |
| Fluoride (F) | mg/L | 0.1 | 1.5 | 1.5 | < 0.1 | < 0.1 | 0.2 | 0.2 | < 0.1 | 0.4 | 0.1 |
| Total Nitrogen | mg/L | - | NA | NA | 1.35 | 1.19 | 1.94 | 1.33 | 1.04 | 0.89 | 1.21 |
| Nitrate ($NO_3$) | mg/L | 0.003 | 10 | 11.3 | < 0.003 | 0.136 | 0.540 | 0.28 | 0.206 | < 0.003 | 0.604 |
| Nitrite ($NO_2$) | mg/L | 0.005 | 0.06 | 1.9 | < 0.005 | 0.008 | 0.007 | 0.012 | < 0.005 | 0.017 | 0.007 |
| Phophorus (P) | mg/L | 0.03 | 0.2 | NA | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | 0.04 |

| Analytes | Unit | Detection Limit | Regulation Limit[1] | WHO Drinking Water Guidelines[2] | GW-1 | GW-2 | GW-3 | GW-4 | GW-5 | GW-6 | GW-7 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | ℃ | - | ±3 | NA | 27.5 | 28.4 | 26.5 | 27.1 | 26.7 | 27.5 | 27.4 |
| Conductivity | µs/cm | - | NA | NA | 11.3 | 109 | 119 | 76.2 | 16.6 | 67.1 | 65.5 |
| Turbidity | NTU | 0.5 | NA | NA | 2.94 | < 0.5 | 1.78 | 3.12 | 0.46 | 12.2 | 0.25 |
| Dissolved Arsenic (As) | mg/L | 0.02 | 1 | 0.01 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| Dissolved Boron (B) | mg/L | 0.04 | 1 | 2.4 | < 0.04 | 0.68 | < 0.04 | < 0.04 | < 0.04 | 0.29 | 0.19 |
| Dissolved Cadmium (Cd) | mg/L | 0.002 | 0.01 | 0.003 | < 0.002 | < 0.002 | < 0.002 | < 0.002 | < 0.002 | < 0.002 | < 0.002 |
| Dissolved Chromium | mg/L | 0.02 | NA | NA | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| Dissolved Chromium Hexavalent ($Cr^{6+}$) | mg/L | 0.004 | 0.05 | NA | < 0.004 | < 0.004 | < 0.004 | < 0.004 | < 0.004 | < 0.004 | < 0.004 |
| Dissolved Copper (Cu) | mg/L | 0.02 | 0.02 | 2 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| Dissolved Iron (Fe) | mg/L | 0.02 | NA | NA | 0.03 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | 0.03 | < 0.02 |
| Dissolved Lead (Pb) | mg/L | 0.02 | 0.03 | 0.01 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| Dissolved Mercury | mg/L | 0.00005 | 0.002 | 6 | < 0.00005 | < 0.00005 | < 0.00005 | < 0.00005 | < 0.00005 | < 0.00005 | < 0.00005 |
| Dissolved Manganese (Mn) | mg/L | 0.02 | NA | NA | < 0.02 | 0.04 | < 0.02 | 0.04 | < 0.02 | < 0.02 | < 0.02 |
| Dissolved Nickel (Ni) | mg/L | 0.02 | NA | 0.07 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| Dissolved Zinc (Zn) | mg/L | 0.02 | 0.05 | NA | < 0.02 | 0.29 | 0.03 | < 0.02 | < 0.02 | < 0.02 | 0.02 |
| Total Dissolved Solids (TDS)[3] | mg/L | - | 1000 | NA | 105 | 11 | 33 | 12 | 41 | 9 | 15 |
| Total Coliform | Cfu/100 mL | 1 | 5000 | NA | < 1 | < 1 | < 1 | < 1 | <1 | 49 | 5 |

Notes:

GW-1 = GW-1 Sumur Warga

GW-2 = GW-2 Mushola

GW-3 = GW-3 Bapak Ruslan

GW-4 = Bapak Amran 2

GW-5 = Bapak Tukino

GW-6 = GW-6 Sumur Kebun

GW-7 = GW-7 Ibu Adui

| Analytes | Unit | Detection Limit | Regulation Limit[1] | WHO Drinking Water Guidelines[2] | GW-1 | GW-2 | GW-3 | GW-4 | GW-5 | GW-6 | GW-7 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Bold text** indicates exceedance of Indonesian Regulation PP 82/2001 Class II | | | | | | | | | | | |
| **Bold text** indicates exceedance of WHO Drinking Water Guidelines | | | | | | | | | | | |
| [1] Indonesian Regulation PP 82/2001 Class II | | | | | | | | | | | |
| [2] WHO Drinking Water Guidelines (2017) – Assumed WHO guidelines apply to both total and dissolved concentrations for all metals, unless otherwise stated | | | | | | | | | | | |
| [3] Parameter in the described matrix has not been accredited by KAN | | | | | | | | | | | |

### 3.4.8 Acid Sulphate Soils

In general acid sulphate soils (ASS) are associated with coastal environments in waterlogged soils, Riau is approximately 80 km from the coast and situated in an area of variable topography as opposed to flat land near the coast. The Cirebon Project in Indonesia, located on the coast identified ASS as present. Mean soluble sulphate concentrations in groundwater at Cirebon was reported by Soilens (2015) as 2,977 ppm compared to Riau, where a mean concentration of 58 ppm was recorded in the site investigation report (see Volume 5: Technical Appendices). The two orders of magnitude lower concentrations at Riau are determined to not be at a level that would produce ASS. pH levels in soils samples at Riau ranged from 7.3 to 9.66 which falls outside the range that would typically observed in ASS although it is noted that these samples were taken between 10 – 30 m below ground level and so do not provide a clear representation of pH values of shallow soil. However, based on data collected and comparing to sites which have been identified as having ASS, the Riau Project is not considered to be at risk of ASS.

## 3.5 Hydrology

### 3.5.1 Siak River Field Surveys

Field surveys were taken on the Siak River in 2017 as part of the baseline studies by PT NBC. Three cross sections were taken 1) upstream, 2) midstream and 3) downstream of the Project location, these indicated that the river width ranged from 121-125 m, and had a maximum depth of 12.8 m. River flow velocities during these assessments ranged from 0.8–1.0 m/s. The temperature of the river varied between 27.9 and 32.1°C.

### 3.5.2 Tidal Influences

The Riau CCPP intake and discharge point is ~136 km from the coast. Examination of the Siak River (see Section 7.1.1) daily flow time series is not useful for the purposes of identifying sub-daily tidal variations. Local reports from Pekanbaru City upstream of the project site indicate the Siak River is tidal in regards to water level fluctuations, but there is no tidal current at the site. The average tidal range is ~2.2 m at spring tide and 0.6 m at neap tide. Water level fluctuation within the river channel has the range of 1.5–2.2 m at Pekanbaru and maintains a semi-diurnal characteristic (JICA, 2018).

Examination of a global digital elevation model (version 2) and contours developed from an Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) dataset indicate the river bank is ~ 10 m aMSL while the planned Riau CCPP location ranges from 20-30 m aMSL. This is further confirmed in Figure 3.17, although there is no datum or surveying reference for this topographic map to indicate how the elevations were defined.

The ASTER dataset has a vertical accuracy of ~17 m at the 95% confidence level, meaning the flat nature of this location makes it difficult to infer contours and topographic changes without local LIDAR or ground surveying, and therefore should be used cautiously.

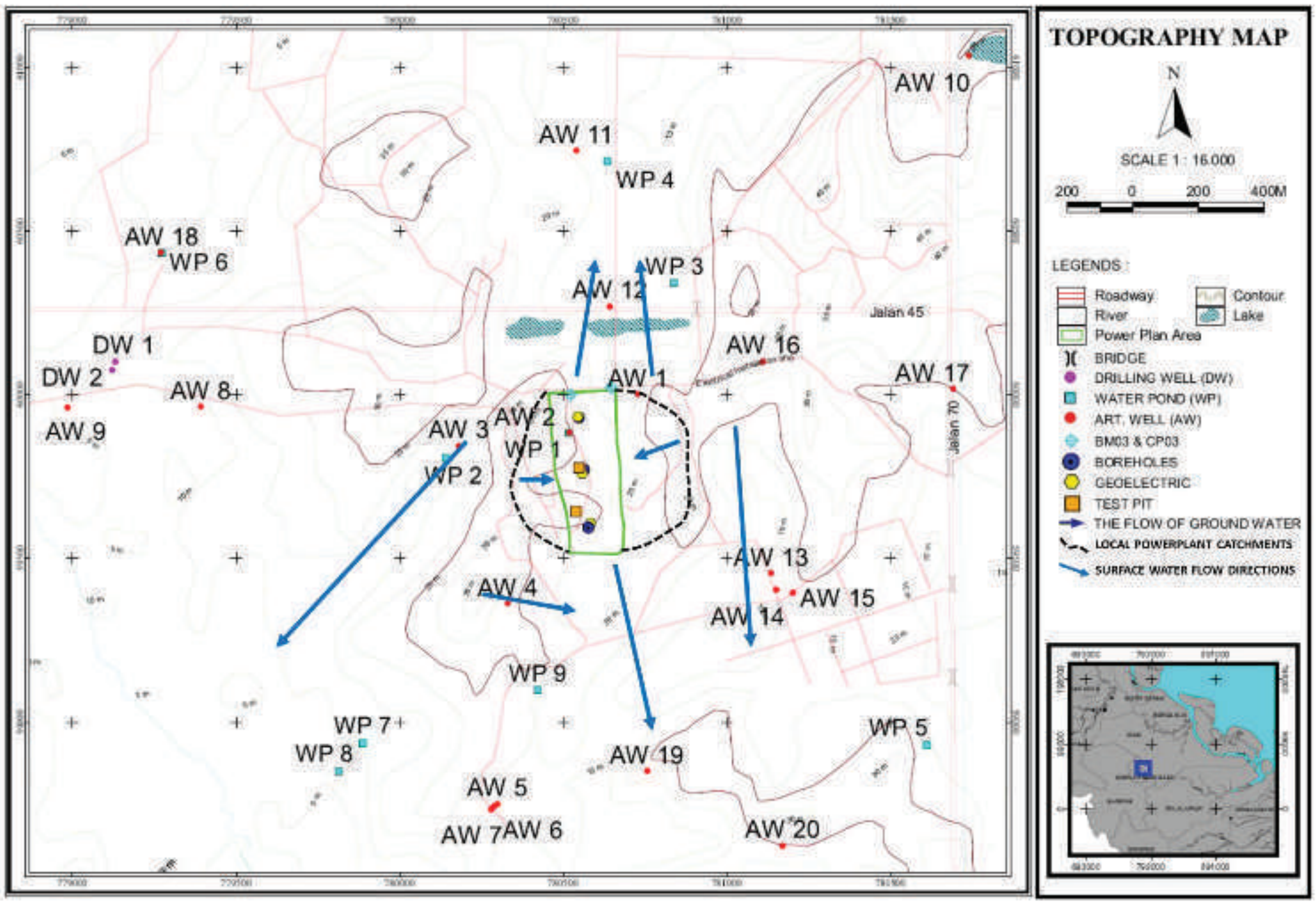


**Figure 3.17 : Topographic Map of the Power Plant Location (1:16000 scale). The Power Plant is Indicated by the Green Line, Dashed Black Lines Indicate Local Surface Water Catchments**

## 3.6 Water Quality and Freshwater Ecology

The project area contains the Siak River as the main watercourse. This is a large river draining north-east from the project area. In the general project vicinity, the river is approximately 125 m wide. The river at this location is over 100 km from the sea at an elevation of 10 m aMSL. Based on available monitoring and ecology data and published data in Yuliati (2017) the river would be freshwater at this location and well above any saline water intrusion through tidal influence. The river water level within the project area has however been observed to fluctuate due to tidal influences but is anticipated to be a result of freshwater backing up above the saline reach of the tide.

The Siak River is located approximately 3 km north of the power plant location. The water supply for the power plant will be sourced from this river and cooling water blowdown and other effluents will be discharged back to the river. A temporary jetty for the unloading of equipment for the construction of the power plant will also be constructed in the Siak River. Baseline data has been gathered to characterise the quality of the Siak River in both wet and dry season conditions. The Tenayan River is a tributary of the Siak River and is located to the west of the project location. No other permanent watercourses occur within the power plant (including transmission line, new road, water supply/discharge pipeline) project area.

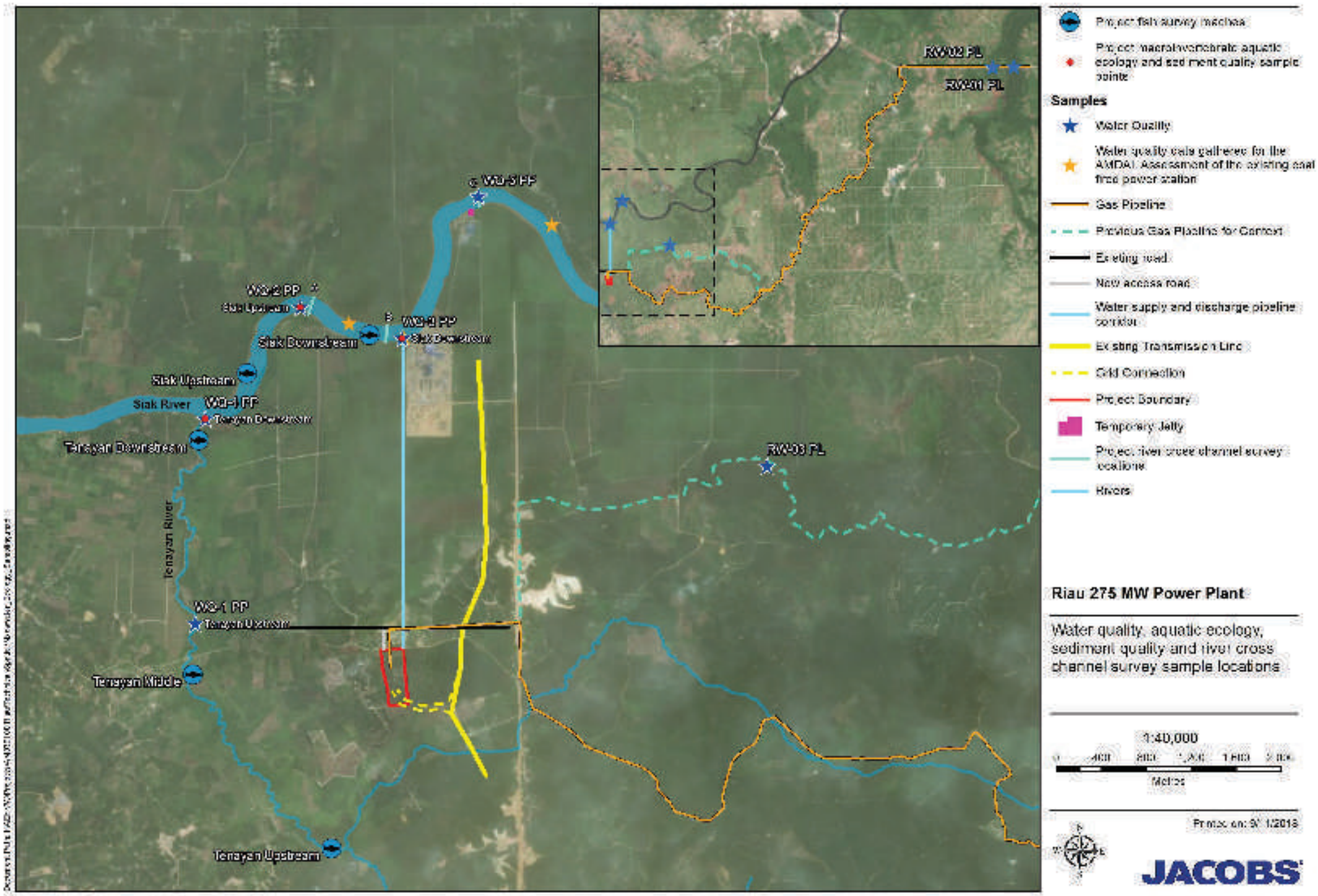


Figure 3.18 : Water Quality, Freshwater Ecology, Sediment Quality and River Cross Channel Survey Sample Locations

### 3.6.1 River Morphology and Use

The Siak River is a large river approximately 125 m wide and at the proposed location of the intake and temporary jetty is at an elevation of approximately 10 m aMSL. Yuliati *et. al.* (2017) note that it is one of the four main rivers in Riau Province and it is the deepest river in Indonesia. It is characterised as a blackwater river that contains humic acid compounds from the leaching of surrounding soils. The river is over 100 km from the sea so is not expected to be tidally influenced at this location especially with no saltwater ingress. Yuliati *et. al.* (2017) studied the tidal influence on water quality in the river and concluded that the maximum point of saline impact on the water was located well downstream (over 80 km) from the power plant and over 40 km from the end of the pipeline route This is also reflected in the fish species that have been found which are mostly freshwater only species. There is evidence of tidal influence on the water levels in proximity to the project area with the freshwater backing up in the river and this impact was observed by Yuliati *et. al.* (2017) as far upstream as Pekanbaru above the project area. Both the Siak River and Tenayan River are used as a source of fish for food by locals.

Yuliati *et. al.* (2017) note that the Siak River is a national strategic river used for navigation, transportation, fishing and a source of raw water for industries. The river is frequently used for transportation by a range of commercial boats and tankers. These boats carry people and cargo up and down the river using various jetties and structures along the river to load and offload people and products. In proximity to the Project there is a jetty associated with the existing Tenayan CFPP and then upstream in Pekanbaru, the largest town on the river, there are a large number of wharfs, jetties and terminals which demonstrate the frequency and regular use of the river for transport.

The Siak River has a gentle grade and is a wide deep channel. The banks contain a range of mud banks and trees/shrubby vegetation (see Figure 3.19, Figure 3.20 and Figure 3.21). The water is visually turbid and brown. Three cross sections have been taken across the river with widths ranging from 121 to 125 m and maximum depths from 10.8 to 12.8 m. Therefore, the river is similar upstream and downstream of the proposed Project area.

**Figure 3.19 : Siak River in Proximity to Water Quality Sample Sites**

Figure 3.20 : Siak River at Location of Cross Section C-C1

Figure 3.21 : Siak River at Location of Proposed Temporary Jetty

The Tenayan River is smaller than the Siak River being approximately 10 m wide in the vicinity of the upstream sample point and 15 m at the downstream point near its confluence with the Siak River. The river is generally brown and turbid (Figure 3.22) with some bankside tree/shrubby vegetation in a thin strip along the river. The wider area beyond the river bank is generally palm oil plantation.

**Figure 3.22 : Tenayan River at Downstream Sample Point**

The main watercourse that will be crossed by the pipeline route is the Gasib River.  Monitoring site RW-02 is located on the main stem of this at the proposed crossing point (Figure 3.23).  At this location the river was measured in February 2018 as being 18 m wide and 2.6 m deep at high tide during a cross sectional survey. The river is generally flat and slow flowing.

Monitoring site RW-01 is located on a tributary of the Gasib River close to RW-01 (Figure 3.24).  This is a similarly flat and slow flowing area and was measured at high tide as being 9 m wide and 1.9 m deep.

**Figure 3.23 : Gasib River at RW-02 Sample Point and Location of Proposed Gas Pipeline Crossing**

Figure 3.24 : Gasib River at RW-02 Sample Point and Location of Proposed Gas Pipeline Crossing

### 3.6.2 Physical and Chemical Properties - Power Plant Vicinity, Siak and Tenayan Rivers

Water quality samples and field observations were gathered from the survey locations. Some sites were sampled in wet and dry seasons and some in one season. In general sites on the power pipeline route were only sampled in the wet season due to the route location being decided later than the power plant location. The Siak River sites were generally sampled in both dry and wet seasons.

Yuliati *et. al.* (2017) noted concerns about the decline in the water quality of the Siak River due to inputs of domestic and industrial waste and reports of health effects on domestic users of the water and decreases in fish populations. Putri (2011) also noted the polluted nature of the river and concerns over its health that have resulted in the government initiating a policy to control pollution in the river with a resulting suite of programmes aiming to improve the water quality.

Yuliati *et. al.* (2017) assessed the quality of water in the lower Siak River (Palas Village in Pekanbaru City for 180 km downstream to the mouth) This data was gathered over 8 months in 2015 and 2016 from 8 sites distributed both upstream and downstream of the proposed power plant with a focus on understanding the differences in water quality at high and low tide. The nearest sites to the project location were approximately 30km upstream and downstream of the proposed jetty and water intake/discharge locations. Sufficient data was gathered to report on the range of water quality observed at each location. The Siak River is characterised as a blackwater river (Baun *et. al.* 2007) with high levels of dissolved organic carbon and low dissolved oxygen levels controlled in part by the influence of the tides. Their study compared the water quality to an index that identifies the pollution status of waterbodies by comparison to an established range of water quality in other relevant rivers. The following was concluded from their analysis of the water quality data:

- The pH of the black water was low in line with that found by other researchers;
- Total suspended solids were variable and elevated but generally below guidelines;
- Salinity levels in the lower river were influenced by the tide but this saline impact was not observed further upstream;
- Dissolved oxygen was low due to the high dissolved organic carbon;
- BOD and COD were observed to be elevated and likely to be sourced from industrial and other discharges;

- For nutrients, ammonia and nitrite concentrations were generally above guidelines and nitrate and phosphorous within guidelines;
- Total coliforms and oil and grease were generally within the guidelines; and
- For metals, cadmium and mercury were within guidelines and lead often elevated above the guidelines.

The overall conclusion of Yuliati *et. al.* (2017) was that the Siak River water quality was heavily polluted at all states of the tide. The data gathered for this project indicates the following:

- The water is warm, with generally elevated suspended solids and high turbidity in both wet and dry season with suspended solid concentrations higher in dry season;
- pH and DO were low in accordance with the results discussed above;
- Where guideline values exist concentrations of most parameters were within guideline values;
- Many parameters were below detection limits including most metals and organic parameters indicating reasonable water quality;
- Iron concentrations were elevated above guidelines and it is noted that in the dry season data only boron concentrations were elevated above what may be typical in rivers;
- The chemical oxygen demand was often elevated indicated organic enrichment of the water. BOD was not generally elevated in this data in contrast to published results. Faecal contamination was evident but not always above guidelines and higher in dry season conditions;
- Nutrient concentrations were generally below guidelines where they existed with some elevation of nitrogen observed above what may be expected in good quality rivers; and
- Oil and grease were elevated in the Siak River but not the Tenayan River in data gathered for this project. This may result from the regular boat traffic on the river.

Overall while there were differences in some parameters between the wet and dry season data a similar pattern of water quality emerged with most parameters being within guidelines where they existed, and iron, pH and oil and grease concentrations being elevated in both seasons. Suspended solids concentrations were higher in the dry season. Therefore, where data has only been gathered for this study in one season at certain locations (usually the wet season for the Gasib River and others the pipeline route crosses) that data will be broadly representative of general water quality throughout the two seasons but likely to under represent the suspended solid concentrations and therefore turbidity.

Data gathered in 2010 presents a broadly similar picture with elevated suspended solids, iron, high oxygen demand and highly elevated microbial contaminants. Therefore, the data gathered for this project is broadly in accordance with that gathered for other projects and discussed in published reports. Overall the rivers appear to have a high sediment load and turbidity, low dissolved oxygen and pH and some elevated metals and nutrients and a higher oxygen demand. The physical and chemical results from baseline sampling was compared to the guidelines outlined in the Government Regulation No. 82 Year 2001 regarding Water Quality Management and Pollution Control Class II. For the tabulated results please refer to the Technical Report - Water Quality and Freshwater Ecology contained in Volume 5: Technical Appendices.

### 3.6.3 Macroinvertebrates

For the dry season sampling, three surface sediment samples were taken from three separate locations, two on the Siak River and one on the downstream end of the Tenayan River. No differentiation between sites can be made. The results indicate that there was a limited number of taxa with mainly worms, snails and clams being found (Figure 3.25 and Figure 3.26). These are more tolerant of degraded conditions and disturbance.

Figure 3.25 : Example of Benthic Macroinvertebrate Species Identified

Figure 3.26 : Example of Benthic Macroinvertebrate Species Identified

Samples were taken from the Siak River and the three rivers along the pipeline route in the wet season. These sites were analysed independently without compositing. Results indicate that:

- The macroinvertebrate populations in the Siak River are impoverished with low numbers of taxa and low diversity (WQ 02, 03 and 05). All three sites are impoverished with the site in proximity to the proposed jetty having the poorest macroinvertebrate ecology.
- The results indicate slightly fewer taxa than in the composite sample previously analysed however in general both indicated poor macroinvertebrate ecology.
- The two sites on the Gasib River (RW-01 and RW-02) and the results from the Pasir River (RW-03B) have greater number of taxa and better diversity than the Siak River. The tributary of the Gasib River (RW-01) and the Pasir River RW-03B have the best macroinvertebrate ecology with examples of pollution intolerant species such as mayflies and the largest diversity of any sites.
- The unnamed creek located along the gas pipeline route in an area of palm plantations had a very poor diversity with mostly midge larvae present. These are indicative of a very disturbed poor habitat area and/or of poor water quality.

### 3.6.4 Fish

Fish species have been identified in both the Siak and Tenayan for dry season surveys and for wet season surveys. Overall 9 types of fish were identified in the dry season and 25 in wet season surveys.

The dry season results show that the Siak River had a greater diversity of fish species than the Tenayan River and in greater numbers. There was little difference between the upstream and downstream sites on the Siak River in terms of either species or density. On the Tenayan River there were few fish identified with none in the middle reach. The fish identified to species level were generally species that are found in freshwater systems only and were all native to this area and other areas throughout Asia.

In the wet season there was a greater number of species identified with a similar pattern of distribution with the greatest diversity of species being found in the Siak River. The smaller watercourses including the Tenayan River and Gasib River had lower numbers of fish species.

Aryani (2015) reports on fish populations within the Kampar Kanan River in Riau Province. This river is a tributary of the Kampar River, itself the next major waterbody to the south of the Siak River. The study location in Aryani (2015) is approximately 80 km south-west of the project area. The study identified the occurrence of 36 fish species belonging to 7 orders, 15 families and 23 genera. Among the collected species, order Cypriniformes was most dominant which is similar to the data gathered for this project. Iskandar and Dahiyat (2012) assessed potential fish populations in the Siak River based on interview methods. This identified 36 species in the Siak River with many thought to be becoming less frequently found than in the past. These papers indicate that the fishing methods, monitoring sites and analysis methods used in this study have provided results broadly in line with published information in terms of numbers, types and sensitivity of species potentially in the area.

The threat status of the fish identified has been identified with reference to the International Union for Conservation of Nature (IUCN) Red list of threatened species status. This is only possible where fish were identified to species level. One species is identified as near threatened and was found within the Siak River upstream of the proposed water intake and discharge. This is Kryptopterus minor (Siamese Glass Catfish) which is native to Indonesia, Cambodia, Malaysia, Thailand and Vietnam. It was classed as Near Threatened due to inferred population declines arising from the impact of harvesting for the ornamental fish trade and the loss and degradation of suitable habitat, especially peatland and lowland forest covered streams. The remaining species were mostly classed as of least concern or not evaluated. For the tabulated results please refer to the Technical Report - Water Quality and Freshwater Ecology contained in Volume 5: Technical Appendices.

It is noted that no assessment of fish populations has been undertaken downstream of all project activities that may impact the Siak River. At present the furthest downstream fisheries sample is from above the temporary jetty. It is recommended that prior to and during construction of the power plant further monitoring is undertaken downstream of all proposed project activities as well as the sites included in this ESIA to assess fish populations downstream of the site, compare these to other locations and provide data to assess changes over time.

A fisher folk survey has been undertaken for the project in September 2018. This gathered information from the Okura Villagers regarding their use of the Siak River and included fish species caught. The full report is detailed in ESIA Volume 5 – Technical Appendices – Appendix S. The species identified in that survey have been compared to the data gathered in the project surveys.

Table 3.14 presents data on fish species commonly caught by local fisherfolk that has been gathered for this project from the Fisher folk survey at Okura Village. This surveyed villagers who use the river upstream, downstream and in the vicinity of the proposed project. Table 3.14 identifies whether the fish identified by fisherfolk were also documented by the physical survey. Where identification was able to be made to species level two additional species were identified, an eel and giant freshwater prawn. Both of these are classed as least concern.

The fish data observed through baseline surveys and presented in the full report and Table 3.14 below outline the range of species identified through both physical surveys and discussion with local fisherfolk and this has been compared to published information as an indication of whether the survey results reflect the species that may be expected. The results appear to be broadly in line with published information in terms of numbers, types and sensitivity of species potentially in the area.

This work has only assessed fish presence within the river/project area without detailed consideration of the lifecycle stages, migratory patterns and/or particular habitat requirements for those fish. This is based on the assumptions that any potential water quality impacts could impact on any lifestage and that the footprint of physical project works (intake structure, pipeline crossings and temporary jetty) are minimal when considered in a wider river environment so are likely to have a negligible impact on the overall spawning success or feeding of the species in the river even if a small amount of particular spawning habitat of feeding grounds was lost at the structure locations.

**Table 3 14 : Fish species identified through fisher folk survey at Okura Village.**

| Item | Local fish name | Other Common Name | Family (Latin) | Species (Latin) | Common Name | Identified in Project Sampling | Status |
|---|---|---|---|---|---|---|---|
| 1 | Juara | Patin Juaro | *Pangasiidae* | *Pangasius polyranodon* | - | Yes | NE |
| 2 | Pantau | Pantau | *Cyprinidae* | *Rasbora spp.* | - | Can't be determined as spp. level – a Rasbora spp. was identified. | |
| 3 | Paweh | Paweh, nilem | *Cyprinidae* | *Osteochilus hasseltii, Osteochilus vittatus (synonym)* | - | Yes | LC |
| 4 | Tilan | Tilan kapar | *Mastacembelidae* | *Mastacembalus maculatus* | Buff-backed spiny eel | No | LC |
| 5 | Temingal | - | - | - | - | Can't be determined, no species with same local name identified. | |
| 6 | Olang | - | - | - | - | Can't be determined, no species with same local name identified. | |
| 7 | Sepungkah | - | *Ambassidae* | *Parambassis siamensis* | Glass fish | Yes | LC |
| 8 | Baung | Baung | *Bagridae* | *Hemibagrus nemurus* | - | Yes | LC |
| 9 | Shrimp | Udang / Udang galah | *Palaemonidae* | *Macrobrachium rosenbergii* | Giant freshwater prawn | No | LC |
| 10 | Patin | Patin | *Pangasidae* | *Helocophagus spp.* | Catfish | Can't be determined as spp. Level. | |
| 11 | Asau | - | - | - | - | Can't be determined, no species with same local name identified. | |

Notes: [1]Status is based upon the IUCN Red List of threatened species status as reported in http://www.iucnredlist.org/search and http://www.iucnredlist.org/details/180650/0 and http://www.fishbase.org/summary/14215. Key: NE - Not Evaluated; DD - Data Deficient; LC – Least Concern; NT – Near Threatened, VU – Vulnerable; EN – Endangered; CR – Critically Endangered; EW – Extinct in the wild; EX – Extinct.

### 3.6.5 Sediment Quality

Sediment samples were gathered using grab or corer box methods. In a similar manner to the macroinvertebrate samples the three samples from the three sites in the dry weather sampling were composited into one sample for analysis. This data could only be of use to provide a general indication of the current quality of the environment and has not been included in the report as the wet weather sediment sampling methods are considered to be more robust. Sampling undertaken in the wet season were not composited between sites allowing this data to better indicate the range of sediment quality in the various areas potentially impacted by the project. Analysis was undertaken for heavy metal and organic contaminants. Laboratory analysis was undertaken in accordance with USEPA 3050 and APHA 3120 B methods.

No relevant Indonesian sediment quality guidelines exist for comparison. Therefore, the ANZECC (2000) Guidelines were used to establish relevant sediment guidelines to characterise the environmental quality of the river sediments. The sample results had no parameters above guidelines indicating generally good sediment quality. Water quality data analysed above has indicated from available literature that lead, iron and boron could be in elevated concentrations with other metals below guideline concentrations. Therefore, these individual samples appear to be representative of the overall water quality as they do not show notable elevation of metals. The results for organic contaminants were below the laboratory detection limits, however it should be noted that the detection limits were generally above the trigger levels therefore it cannot be concluded that organic contaminants are not present in concentrations that may impact on the ecological values of the waterways. For the tabulated results please refer to the Technical Report - Water Quality and Freshwater Ecology contained in Volume 5: Technical Appendices.

### 3.6.6 Baseline Water Quality and Freshwater Ecology Summary

Overall water quality is average from an ecological perspective with concentrations of many parameters being within environmental guidelines. However, there was low dissolved oxygen, low pH and high suspended sediment, turbidity levels and iron and some impacts of oil and grease and high oxygen demand. These are likely to be having controls on some of the ecological values of the river as they would impact upon more sensitive macroinvertebrate and fish species. Published reports including Yuliati (2017) note the poor water quality of the river and the fact that this is likely to be leading to impoverished fish populations. Sediment quality indicates little enrichment by metals or hydrocarbons. All river studies had broadly similar water quality. Macroinvertebrate populations in the Siak and Tenayan Rivers were generally fairly impoverished with a reasonably small range of taxa present and those that were are considered to be pollution/disturbance tolerant. A range of fish species were present, especially in the Siak River which are broadly in line with the expected numbers of species for the region. One near threatened species was present at the site upstream of the proposed intake and discharge. The data did not identify any clear differences between the upstream and downstream Siak River sample locations in dry or wet season sampling. The main difference observed between the Siak and Tenayan Rivers was the greater number of fish species observed in the Siak River. The Siak River is the primary watercourse that would be potentially impacted by project activities.

The Gasib and Pasir Rivers at the location of the proposed pipeline crossings had broadly similar water quality to the Siak and Tenayan Rivers and generally a more diverse macroinvertebrate ecology but more impoverished fishery population.

In general, this data indicates that the receiving environments are not pristine and are likely to be degraded to some extent by existing surrounding and upstream land uses and use of the rivers. Utilising the criteria within the ESIA methodology it is considered that overall the water quality and ecology of the Siak River, Gasib River, Pasir River and unnamed creek that the pipeline crosses are of low sensitivity as receptors have some capacity to absorb the project changes. This is due to the existing water quality having some capacity for change and the existing ecology already being degraded and comprising mainly more tolerant species. The presence of one near threatened fish species could indicate that the upstream site on the Siak River may be of medium sensitivity as the fish population has little capacity to absorb changes. This location is upstream of the Project area so is unlikely to be impacted by any of the proposed project activities. For the tabulated results please refer to the Technical Report - Water Quality and Freshwater Ecology contained in Volume 5: Technical Appendices.

## 3.7 Landscape and Visual

### 3.7.1 Visual Context

The following section provides a summary of the visual setting for the Project in order to determine the likely visual impacts of the development, aided by the use of 3-D modelling techniques, to provide a comparison of the existing environment and impression of the site post power plant construction.

### 3.7.2 The Power Plant

The Project site is located approximately 10 km east of Pekanbaru city, approximately 5 km south of the Siak River. The power plant and switchyard will be located within a 9.1 ha area of land being procured for the development by the Project sponsor Medco Ratch Power Riau (MRPR).

The habitat types present at the power plant location include; mixed garden species; palm plantation; open areas; former cultivation areas; small rubber plantations and areas of secondary growth. There are no dwellings located on the site. The project location within a wider geographical context is shown in Figure 3.27 below.


**Figure 3.27 : Project Location**

**Figure 3.28 : Palm Oil Plantation Within Project Site (Source: Tenayan Environmental and Social Baseline Study Report)**

## 3.8 Natural Hazards and Vulnerability to Climate Change

### 3.8.1 Earthquakes

Indonesia is located in a tectonically active area being surrounded by three major tectonic plates. Indonesia overall is therefore considered an earthquake prone region. Seismic history in Indonesia, including Riau Province, is shown in Figure 3.29 below. Figure 3.29 shows the occurrence of past significant earthquakes around Sumatra that have been recorded between 1650 – 2018. The majority of these earthquakes are concentrated along the southern and western edge Indonesia and not in the vicinity of the project site. There is no submarine trench north of the Island of Sumatra and very few significant earthquakes are expected north or immediately east of Riau Province. The main hazards associated with earthquakes are shaking and liquefaction.


**Figure 3.29 : Seismic History in Indonesia (NGD/WDS, 2018)**

### 3.8.2 Tsunami

Due to being located in a seismically active area Indonesia has a history of Tsunami's. Most notably, the 20 December 2004 tsunami caused as a result of a large earthquake within the Indian Ocean and resulting in 150,000+ casualties most on the western side of Sumatra. Tsunami observations from 1650 – 2018 in the vicinity of Sumatra are shown in Figure 3.30 below which indicates tsunamis are concentrated along the western and southern trenches in the areas of high seismic activity. There are no recorded observations of a tsunami to the north of Riau.


**Figure 3.30 : Tsunami History in Indonesia (NGD/WDS, 2018)**

Due to this being a tectonically active region Indonesia contains a number of active volcanoes. The volcanos are concentrated along plate subduction zones to the south and west of Indonesia. Figure 3.31 below shows the location of significant volcanic eruptions in Indonesia from 1650 – 2018, noting that there has been no volcanic activity in the immediate vicinity of the project site. The main hazards associated with volcanic eruptions are lahar, lava and airfall deposits.

The nearest active volcano to the Riau CCPP site is Marapi being approximately 165 km to the south-west of the project site. Marapi is a stratovolcano rising 2,000 m above the Bukittinggi plain in the Padang Highlands and more than 50 eruptions, of small to moderate explosive activity, have been recorded since the end of the 18th century (SIGVP, 2018). No lava flows have been reported outside the summit crater.

Figure 3.31 : Volcanic Eruption History in Indonesia (NGD/WDS, 2018)

### 3.8.3 Forest Fires

Sumatra and the Riau Province are generally vulnerable to forest fires. Rather than being naturally caused, the forest fires are often caused by people undertaking clearance of vegetation via the slash and burn technique to create productive land, despite it being illegal. When this occurs during dry weather conditions, the blazes often become out of control and threaten villages and public health from smoke inhalation and require evacuations. El Niño Southern Oscillation (ENSO) climate conditions causes dryer weather and increases the risk of uncontrolled forest fires and burning peatlands.

### 3.8.4 Flooding

Heavy rainfall and associated flood events are a common natural hazard within Indonesia. Settlements built in low lying areas and in close proximity to rivers are particularly at risk of flood water inundation. As recently as December 2017 the Siak River flooded parts of Pekanbaru affecting in 3,567 households or 10,887 people (The Jakarta Post, 2018). See Hydrology baseline in Section 7 for further information on flood risk.

### 3.8.5 Landslides

Landslides are a common natural hazard throughout Indonesia with landslides occurring every year and causing loss of life, damage to property and productive land. The risk of a landslide occurring generally increases in steeper areas that receive high rainfall, with the risk exacerbated by forest clearance and the monsoon season between October and April. The landslide risk in the Riau region is classified as Low to Very Low in the vicinity of Pekanbaru (refer to Figure 3.32).

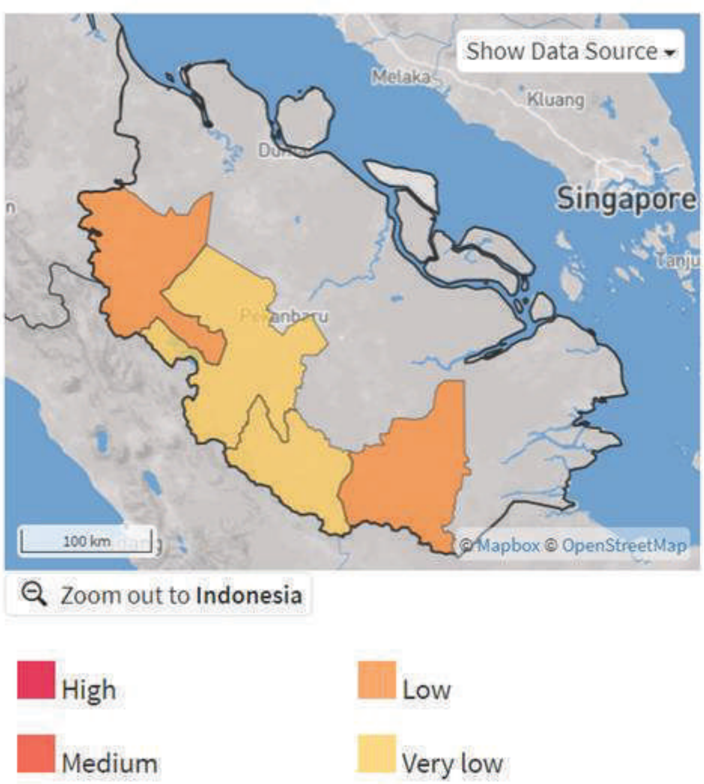

Figure 3.32 : Landslide Hazard Risk (Source: ThinkHazard, 2018(a))

### 3.8.6 Vulnerability to Climate Change

Climate change, namely sea level rise, has the potential to have widespread impacts on island nations such as Indonesia in the future, with low lying coastal areas to be most affected. The power plant site is located approximately 125 km inland and is approximately 17 m aMSL. As such, sea level rise will not pose a risk to the project site.

### 3.8.7 Tropical Cyclones

Indonesia is often subject to tropical cyclones which form over the warm oceanic waters near the equator. Tropical cyclones can result in high winds, storm surges, heavy rainfall, flooding and landslides. Coastal regions are most vulnerable to the impacts from tropical cyclones due to them deriving their energy from warm water, and weakening relatively quickly when they track over land. The risk of a tropical cyclone impacting the Riau region is identified as being 'Very Low' (refer to Figure 3.33) with the majority of cyclones impacting the southern and eastern areas of Indonesia (ThinkHazard, 2018). Indonesia experiences tropical cyclones ranging in intensity from category 1 to the largest category 5 cyclones.

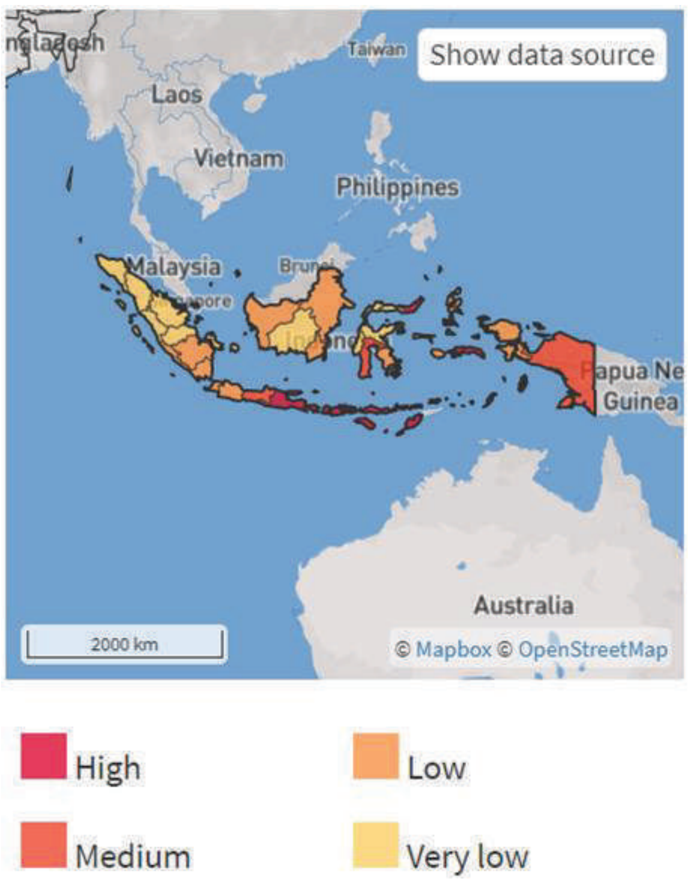


Figure 3.33 : Tropical Cyclone Risk Indonesia (Source: ThinkHazard, 2018(b))

## 3.9 Noise

### 3.9.1 Acoustic Character of Surrounding Area

Noise levels were measured at locations representative of the nearest built up areas over several days during September and October 2017 and January (dry season) to February 2018 (wet season). Noise monitoring was conducted in accordance with Indonesian Standards (State Minister of Environment Decree No 48) and the monitoring period was extended to a minimum of 48 hours continuously at the power plant site in accordance with WBG EHS Guidelines. The ambient noise levels were recorded continuously for a one-hour period during representative time intervals and comments against identifiable noise influences were noted during the noise survey. Typically, the noise sources in the area were as follows:

**Day time – Residential Areas**

- Noise from traffic activity;
- Residential noise (children, talking, televisions, radios);
- Birds; and
- Dogs.

**Night time – Residential Areas**

- Noise from traffic activity;
- Dominant noise from crickets and other nocturnal insects;
- Generators;
- Crickets; and
- Occasional birds.

Monitoring locations are presented visually in Figure 3.34 below and the results are provided in Table 3.14.

### 3.9.2 Noise Catchment Areas

The area surrounding the proposed Riau CCPP has been divided into Noise Catchment Areas (NCAs). These areas have been presented in Table 3.15 and graphically in Figure 3.34 and have been defined according to the likely noise environment in the area.

**Table 3.15 : Description of NCAs**

| Noise Catchment Area | Description |
|---|---|
| NCA 1 | The immediate vicinity of the Riau CCPP |
| NCA 2 | Semi-rural receivers on the eastern outskirts of Pekanbaru |
| NCA 3 | Suburban receivers in eastern Pekanbaru |
| NCA 4 | Palm oil plantations |
| NCA 5 | Township near the intersection of Jl Baru Bakal and Jl Pemda |
| NCA 6 | Properties along Jl Ferry Pinang Sebatang |

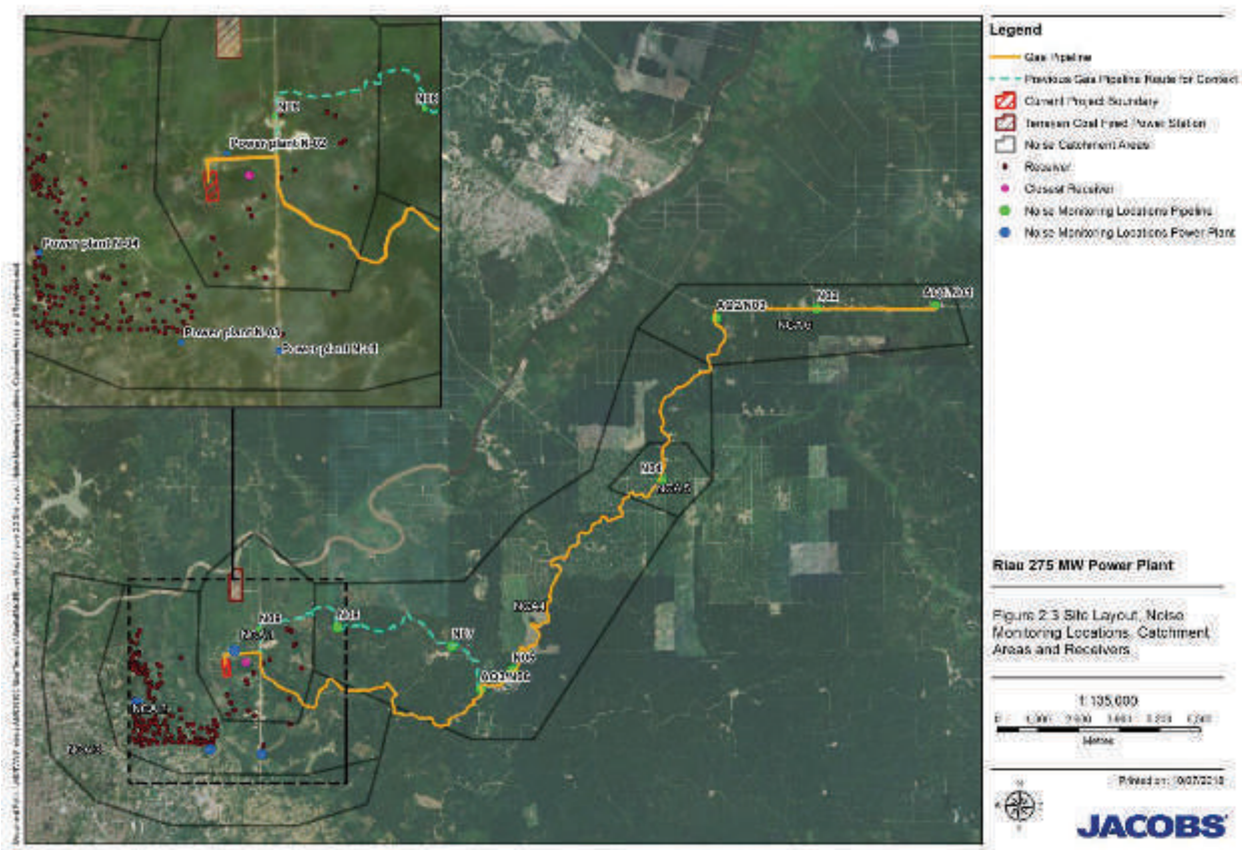


**Figure 3.34 : Site Layout Noise Monitoring Locations and Catchment Areas and Receivers**

### 3.9.3 Monitoring Results

The results of monitoring at each location are summarised in Table 3.16 below. Noise monitoring was carried out at each site during periods where noise impacts may be experienced. For the gas pipeline route, noise impacts may be associated with daytime construction work only, while at for receivers potentially affected by power station noise, results are presented for each time interval of the 24-hour monitoring period and for the overall Ls (Daytime), Lm (Night time) and Lsm (24 hour) periods.

At the four locations (PS01, PS02, PS03 and PS04) around the power station, attended monitoring was undertaken in intervals covering continuous 48-hour periods. The monitoring was completed at different dates for each of the four locations, though all of the monitoring was undertaken in the second half of 2017.

**Table 3.16 : Noise Monitoring Results**

| Study area | Location | NCA | Monitored noise level (LAeq period) | | | | | | | Overall noise level | | | World Bank Parameters | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L1 | L2 | L3 | L4 | L5 | L6 | L7 | Ls | Lm | Lsm | Day | Night |
| | | | 6am-9am | 9am-11am | 2pm-5pm | 5pm-10pm | 10pm-12am | 12am-3am | 3am-6am | | | | (7:00 to 22:00) | (22:00 to 7:00) |
| Pipeline | PL01 | 6 | - | 57 | - | - | - | - | - | - | - | - | - | - |
| | PL 02 | 6 | - | 62 | - | - | - | - | - | - | - | - | - | - |
| | PL03 | 6 | - | 71 | - | - | - | - | - | - | - | - | - | - |
| | PL 04 | 5 | - | 67 | - | - | - | - | - | - | - | - | - | - |

| Study area | Location | NCA | Monitored noise level (LAeq period) | | | | | | | Overall noise level | | | World Bank Parameters | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L1 | L2 | L3 | L4 | L5 | L6 | L7 | Ls | Lm | Lsm | Day | Night |
| | | | 6am-9am | 9am-11am | 2pm-5pm | 5pm-10pm | 10pm-12am | 12am-3am | 3am-6am | | | | (7:00 to 22:00) | (22:00 to 7:00) |
| | PL 05 | 4 | - | 72* | - | - | - | - | - | - | - | - | - | - |
| | PL06 | 4 | - | 62 | - | - | - | - | - | - | - | - | - | - |
| | PL 07 | 4 | - | 53 | - | - | - | - | - | - | - | - | - | - |
| | PL 08 | 4 | - | 37 | - | - | - | - | - | - | - | - | - | - |
| | PL 09 | 1 | - | 45 | - | - | - | - | - | - | - | - | - | - |
| Power station | PS 01 | 2 | 61 | 50 | 58 | 49 | 52 | 47 | 44 | 56 | 49 | 55 | 54 | 55 |
| | PS 02 | 1 | 61 | 53 | 62 | 57 | 59 | 62 | 61 | 59 | 61* | 59 | 60 | 59 |
| | PS 03 | 2 | 58 | 57 | 60 | 62 | 59 | 56 | 51 | 59 | 56 | 58 | 58 | 58 |
| | PS 04 | 2 | 54 | 57 | 56 | 43 | 46 | 41 | 46 | 53 | 45 | 51 | 49 | 51 |

* These results appear to be unrealistically high and may indicate interference from a localised noise source

Audio recording at proposed power plant sites indicated that existing background noise levels were influenced by birds, local traffic and residential noise (including diesel generators) during daytime and evening hours and crickets during night time hours. Background noise levels along the pipeline route are controlled by the proximity of the monitoring site to local roads and the local density of residential properties.

World Bank Group EHS General Guidelines covering noise limits are discussed in Section 11.1, however in summary they outline recommended goals for noise levels measured outside a dwelling. For residential properties, these noise levels are described as 55 dB(A) during daytime hours and 45 dB(A) during the night.

Review of the monitoring results shown in Table 3.16 shows that this noise level is currently exceeded during daytime hours at receivers PL01 – PL06 and PS02 / PS03. Night time noise monitoring was carried out at the four sites potentially impacted by operational noise. This testing showed that existing noise levels during night time hours are currently exceeded at all four locations.

### 3.9.4 Topography

The local topography and terrain is important in the consideration of noise propagation to other locations adjacent to the site. In the area of interest around the proposed power plant, the land is generally flat, with regular, low rolling hills.

The terrain is typically thickly vegetated with palm oil plantations and interspersed with small dirt roads. Over these large distances, acoustic absorption through these plantations may be significant and land usage has been accounted for in the modelling of noise impacts for the proposal.

## 3.10 Terrestrial Ecology

### 3.10.1 Introduction

The terrestrial ecology data was collected on two occasions to encompass the dry and wet seasons to allow an objective assessment of the value of the habitat within the project area for terrestrial ecology.

### 3.10.2 Dry Season Survey

**Habitats**

Three survey plots (20 x 100 m) were set up adjacent to the power plant site. The surveys could not be conducted on the actual site because the Project sponsors, MRPR, could not gain access to that land prior to completion of the land acquisition process. The actual areas surveyed were selected as they are determined to be representative of the receiving environment within the power plant site. The plots were located to provide a representation of the ecosystems present within the construction site area as set out in Table 3.17. Within each survey plot data was collected as follows:

- 20 10 x 10 m sub plots were surveyed for trees; and
- 20 5 x 5 m sub plots surveyed for saplings.

In each sub plot the trees and saplings were identified, a voucher specimen was taken and the relative frequency (FN), relative dominance (DN), relative density (KN), and important value index (INP) were calculated by using Curtis (1959) method (Dombois-Ellenberg 1974). Trees and Saplings INP were obtained from the sum of FN, DN, and KN. The species diversity index (H ') and the species evenness index (E) in the plot were calculated by Shannon method (Magurran, 1988).

**Table 3.17 : Locations, Co-ordinates, Administrative areas, and Land Coverage of Each Sample Plot**

| Location | Co-ordinate | Village | District | Regency | Land Use |
|---|---|---|---|---|---|
| TR1 | 00°32’28” LU;<br>101°31’11” BT | Industri Tenayan | Tenayan Raya | Pekanbaru | Palm Plantation |
| TR2 | 00°32’07 LU;<br>101°31’31” BT | Industri Tenayan | Tenayan Raya | Pekanbaru | Palm Plantation |
| TR3 | 00°32’25,2” LU;<br>101°31’10,1” BT | Industri Tenayan | Tenayan Raya | Pekanbaru | Palm Plantation<br>Shrubs |

*Note: Co-ordinate used is an approximation for TR2*

### Fauna

The transmission line and area to the north of the proposed Riau CCPP site were surveyed between 19th July and 1st August 2017 by recording the birds, herpetofauna and mammals observed while walking three transects. The location of the transects is set out in Table 3.18 and shown in Figure 3.35 below.

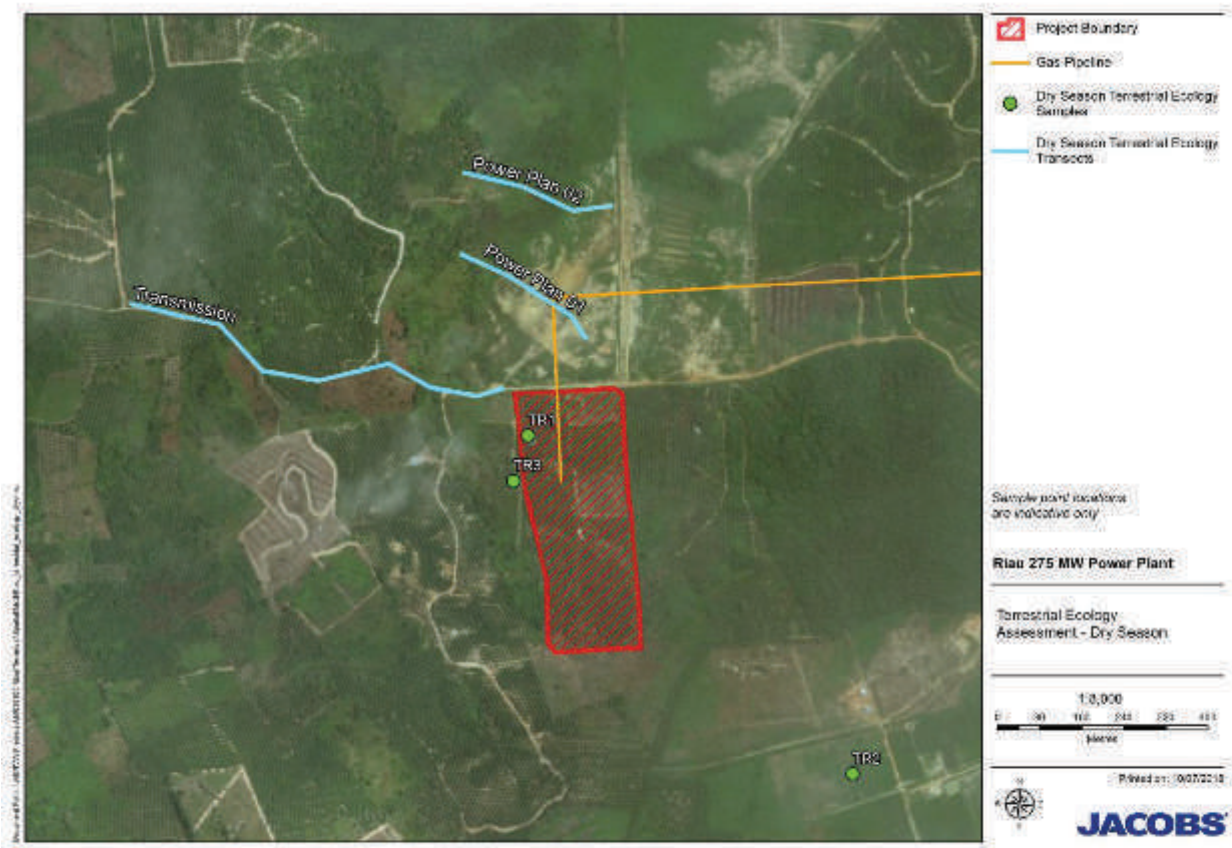


**Figure 3.35 : Location of Transects**

The bird surveys were carried out within four hours of sunrise and included census points along the transect line. At each census point a 20-minute survey to count all bird species visible and heard within a 50 m radius was carried out. The surveys for herpetofauna and mammals were conducted by recording any species or evidence of species observed long the transect.

**Table 3.18 : Line Transect Co-ordinates**

| No. | Transect ID. | Co-ordinate Start | | Co-ordinate End | | Length of Transect (m) |
|---|---|---|---|---|---|---|
| | | Latitude | Longitude | Latitude | Longitude | |
| 1 | Transmission Line | 0°32'30.98" U | 101°31'9.52" T | 0°32'36.22" U | 101°30'46.44" T | 700 |
| 1 | Power Plan 01 | 0°32'34.00" U | 101°31'14.61" T | 0°32'39.32" U | 101°31'6.79" T | 300 |
| 2 | Power Plan 02 | 0°32'42.28" U | 101°31'16.20" T | 0°32'44.37" U | 101°31'6.98" T | 300 |

### 3.10.3 Wet Season Survey

The Project area was surveyed at the locations shown in Table 3.19, Table 3. and Figure 3.36 between the 22nd and 31st January 2018.

**Table 3.19 : Location of Wet Season Vegetation Survey Transects**

| Location | Code/ref | Administration area |
|---|---|---|
| **1. Gas Pipeline Route** | | |
| **1.1 side of paved highway** | | |

| Location | Code/ref | Administration area |
|---|---|---|
| Section 1 (1-5 km) | 1.1.1a | Ds. Kuala Gasib, Kec. Koto Gasib, Siak Regency |
| | 1.1.1b | Ds. Kuala Gasib, Kec. Koto Gasib, Siak Regency |
| Section 2 (6-10 km) | 1.1.2a | Ds. Pinang Sebatang, Kec. Tualang, Siak Regency |
| | 1.1.2b | Ds. Pinang Sebatang, Kec. Tualang, Siak Regency |
| Section 3 (11-15 km) | 1.1.3 | Ds. Tualang Timur, Kec. Tualang, Siak Regency |
| Section 4 (16-20 km) | 1.1.4 | Ds. Tualang Timur, Kec. Tualang, Siak Regency |
| Section 5 (21-25 km) | 1.1.5 | Ds. Meredan, Kec. Tualang, Siak Regency |
| **1.2 side of unpaved highway** | | |
| Section1 (1-5 km) | 1.2.1a | Kelurahan Mlebung, Kec. Tenayan Raya, Pekanbaru City |
| | 1.2.1b | Kelurahan Mlebung, Kec. Tenayan Raya, Pekanbaru City |
| Section 2 (6-10 km) | 1.2.2a | Kelurahan Mlebung, Kec. Tenayan Raya, Pekanbaru City |
| | 1.2.2b | Kelurahan Mlebung, Kec. Tenayan Raya, Pekanbaru City |
| Section 3 (11-15 km) | 1.2.3a | Kelurahan Mlebung, Kec. Tenayan Raya, Pekanbaru City |
| | 1.2.3b | Kelurahan Mlebung, Kec. Tenayan Raya, Pekanbaru City |
| **2 CCPP site and water pipe footprint** | | |
| **2.1 CCPP site footprint** | | |
| Power plant | 2.1a | Kelurahan Mlebung, Kec. Tenayan Raya, Pekanbaru City |
| Power plant | 2.1b | Kelurahan Mlebung, Kec. Tenayan Raya, Pekanbaru City |
| Power plant | 2.1c | Kelurahan Mlebung, Kec. Tenayan Raya, Pekanbaru City |
| Transmission line | 2.2 | Kelurahan Mlebung, Kec. Tenayan Raya, Pekanbaru City |
| **3. Water pipeline** | | |
| Sample site 1 | 3.1 | Kelurahan Mlebung, Kec. Tenayan Raya, Pekanbaru City |
| Sample site 2 | 3.2 | Kelurahan Mlebung, Kec. Tenayan Raya, Pekanbaru City |

**Table 3.20 : Location of Wet Season Fauna Survey Transects**

| Location | Code / ref | Data collected (direct and indirect evidence) |
|---|---|---|
| Transects on gas pipeline route at road section | TR1 - TR5 | Birds, Reptiles, Mammals |
| Transect on gas pipeline route at unpaved section | UP1 - UP3 | Birds, Reptiles, Mammals |
| Transect on CCPP site and surrounding area | PS1 - PS3 | Birds, Reptiles, Mammals |
| Transect on water pipeline route | WI1 - WI2 | Birds, Reptiles, Mammals |
| Listening point 1 to 8 at gas pipeline route | LP1 - LP8 | Amphibians |
| Listening point at CCPP and surrounding area | LQ1 - LQ2 | Amphibians |
| Listening points at water pipeline route | WL1 - WL2 | Amphibians |

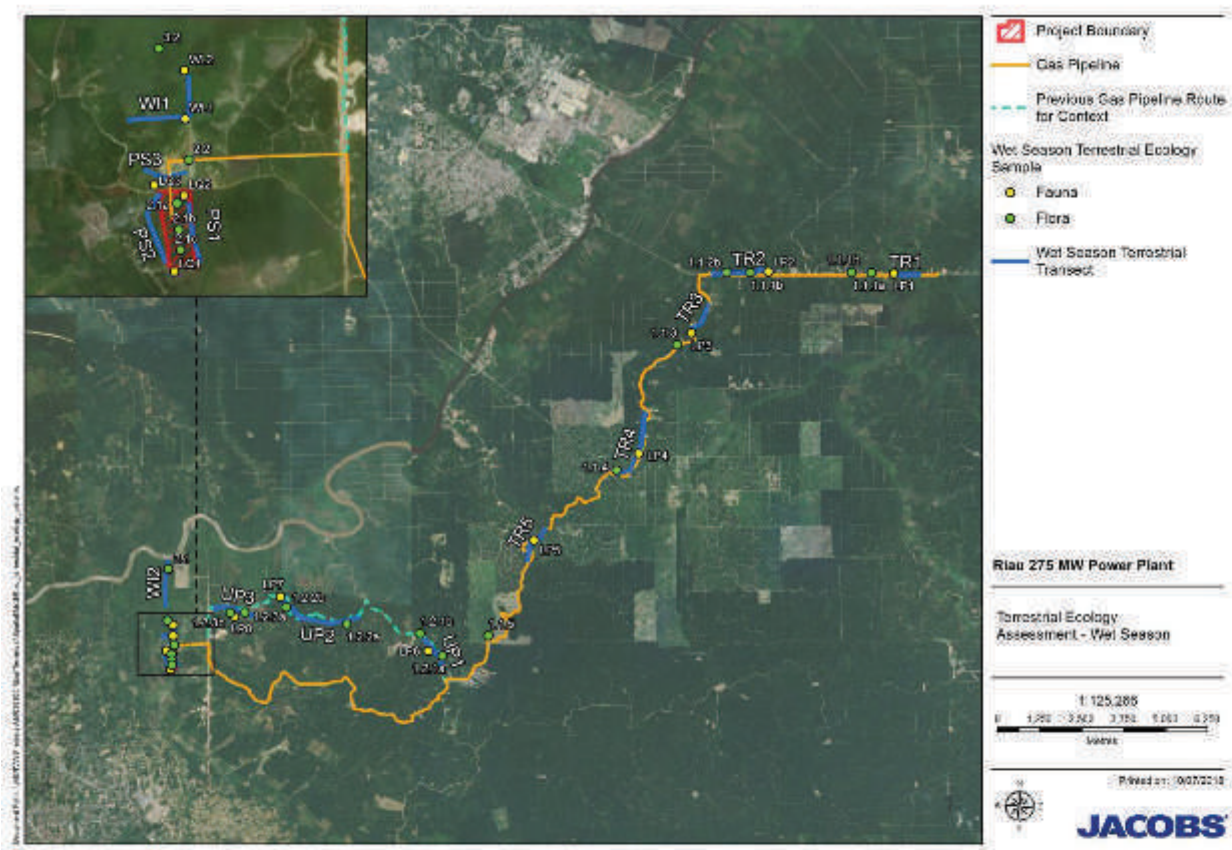


**Figure 3.36 : Location of wet season transects**

## Results

Detailed results of the wet season survey work completed at the Riau CCPP site and along the proposed gas pipeline are set out within the results section below. Figure 3.37 below provides an overview of the land use in the Project area. It should be noted that a buffer area around the Project features has been included and this relates to detailed data as presented in the legend shown at the top left of Figure 3.37. Beyond this buffer area a second layer of data is provided to show the general land use of the region and this data corresponds to the legend at the bottom of Figure 3.37.

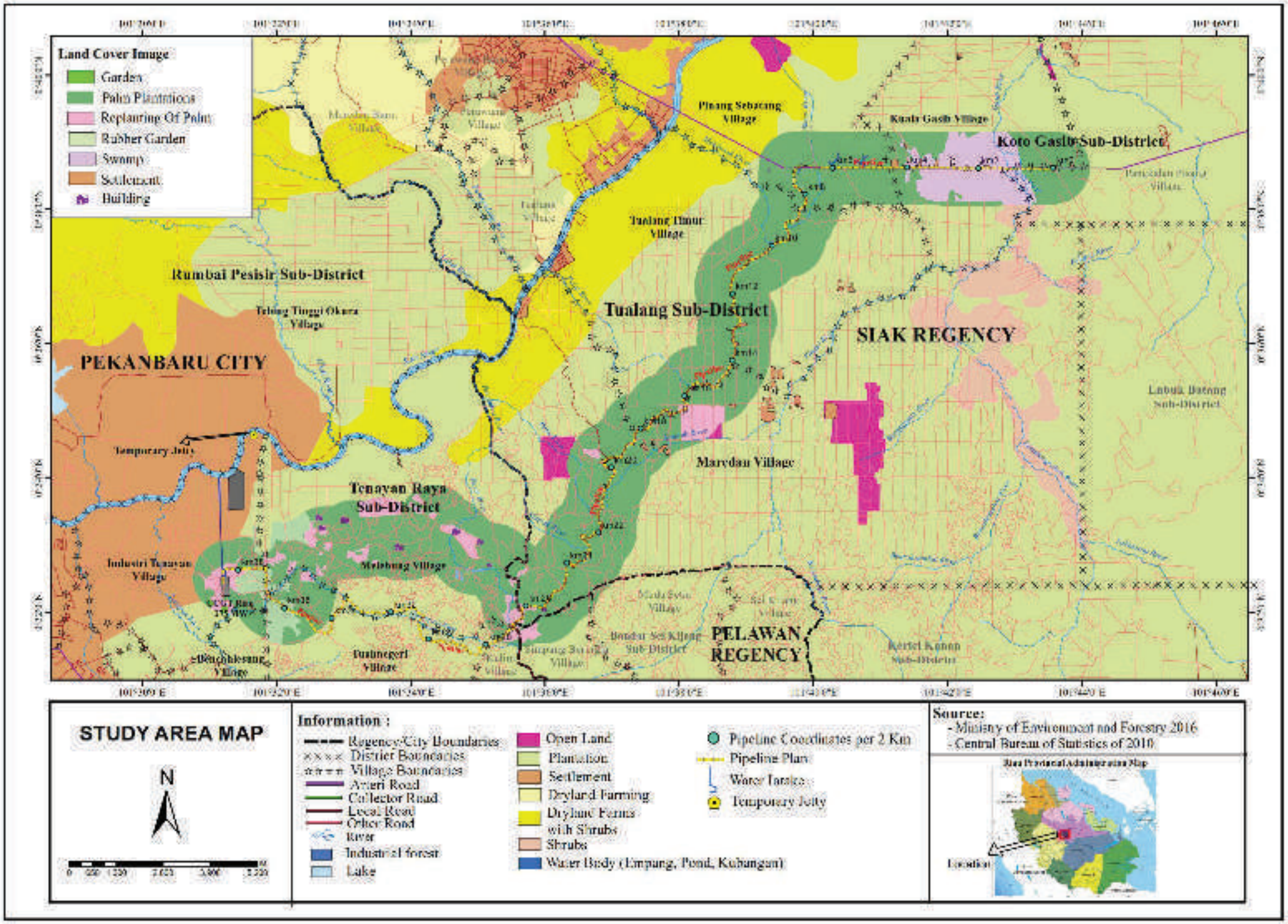


Figure 3.37 : Land Uses within the Project Area

### 3.10.4 Habitats

#### 3.10.4.1 Dry Season Sampling

The habitat covering the Riau CCPP site was primarily palm oil plantation. TR1 and TR2 were well maintained African oil palm (*Elaeis guineensis*) plantations (Figure 3.38), while TR3 was unmaintained and included a greater proportion of other species (Figure 3.39). Table 3.21 provides a summary of the species recorded in each of the plots and illustrates the dominance of the African oil palm in all three plots.

**Table 3.21 : Important Values Index (INP ≥10%) the Main Types of Trees and Saplings for Each Plot on the Riau CCPP Site**

| No. | Species Name | IUCN Status | Tree | | | Sapling | | |
|---|---|---|---|---|---|---|---|---|
| | | | TR-1 | TR-2 | TR-3 | TR-1 | TR-2 | TR-3 |
| 1 | *Acacia mangium* | Not Evaluated | - | 8.0 | 40.6 | - | - | 17.0 |
| 2 | *Alstonia angustiloba* | Not Evaluated | - | - | 16.2 | - | - | 26.6 |
| 3 | *Aporosa arborea* | Not Evaluated | - | - | - | - | - | 11.6 |
| 4 | *Archidendron ellipticum* | (Least concern) | - | - | - | - | - | 21.4 |
| 5 | *Archidendron jiringa* | Not Evaluated | - | 13.2 | - | - | - | - |
| 6 | *Artocarpus dadak* | Not Evaluated | - | - | - | - | - | 15.1 |
| 7 | *Artocarpus elasticus* | Not Evaluated | - | - | 16.5 | - | - | 31.6 |
| 8 | *Artocarpus integer* | Not Evaluated | - | - | - | - | - | 26.9 |
| 9 | *Elaeis guineensis* | (Least Concern) | 292.5 | 278.8 | 210.5 | - | - | 10.1 |
| 10 | *Ficus variegata* | Not Evaluated | - | - | - | - | - | 14.8 |
| 11 | *Nephelium rubescens* | Not Evaluated | - | - | - | - | - | 13.5 |
| 12 | *Paropsia vareciformis* | Not Evaluated | - | - | - | - | - | 21.3 |
| **Total number of species recorded in plot** | | | **1** | **3** | **4** | **0** | **0** | **11** |

**Figure 3.38 : Oil Palm Plantation Within TR1**

**Figure 3.39 : Unmaintained Oil Palm Plantation Within TR3**

#### 3.10.4.2 Wet Season Sampling

The detailed list of species recorded at each of the sample sites as set out in Table 3.22 provides a summary of the numbers of species recorded at each sample site and an indication of the predominant habitat type.

**Table 3.22 : Summary of the Wet Season Flora Survey**

| Code/ref | Habitat type | No. of Sapling species recorded | No of mature tree species recorded | Species with IUCN status recorded |
|---|---|---|---|---|
| **1. Gas pipeline route** | | | | |
| 1.1.1a | Secondary swamp forest | 7 | 3 | *Alstonia spatulata Blume* (Least concern) |
| 1.1.1b | Secondary swamp forest | 10 | 19 | *Maranthes corymbosa Blume* (Least concern) |
| 1.1.2a | Swamps adjacent to Lake Abdullah | 25 | 10 | *Elaeis guineensis Jack.* (Least concern)<br>*Nephelium lappaceum L* (Least concern) |
| 1.1.2b | Rubber and palm oil plantations, mixed with natural species | 22 | 13 | *Elaeis guineensis Jack*. (Least concern) |
| 1.1.3 | Secondary forest | 32 | 21 | *Afzelia rhomboidea (Blanco) S. Vidal* (Vulnerable) |
| 1.1.4 | Rubber plantation | 15 | 22 | *Afzelia rhomboidea (Blanco) S. Vidal* (Vulnerable)<br>*Nephelium lappaceum L* (Least concern) |
| 1.1.5 | Oil palm and secondary forest | 30 | 19 | *Anisoptera marginata Korth.* (Endangered)<br>*Anisophyllea disticha (Jack) Baill*. (Least concern)<br>*Elaeis guineensis Jack*. (Least concern) |
| 1.2.1a | Rubber plantation | 2 | 1 | |
| 1.2.1b | Jabon plantation (burrflower tree) | 3 | 2 | |
| 1.2.2a | Palm oil plantation | 0 | 1 | *Elaeis guineensis Jack.* (Least concern) |
| 1.2.2b | Palm oil plantation | 0 | 1 | *Elaeis guineensis Jack.* (Least concern) |
| 1.2.3a | Palm oil and Jabon plantation | 0 | 2 | *Elaeis guineensis Jack.* (Least concern) |
| 1.2.3b | Palm oil plantation | 0 | 1 | *Elaeis guineensis Jack.* (Least concern) |
| 2.2 | Bush/scrub | 18 | 8 | *Afzelia rhomboidea (Blanco) S. Vidal* (Vulnerable) |
| **2.1 CCPP site footprint** | | | | |
| 2.1a | Palm oil plantation | 0 | 4 | *Elaeis guineensis Jack.* (Least concern) |
| 2.1b | Palm oil plantation | 0 | 1 | *Elaeis guineensis Jack.* (Least concern) |
| 2.1c | Palm oil plantation | 0 | 1 | *Elaeis guineensis Jack.* (Least concern) |
| **3. Water pipeline** | | | | |
| 3.1 | Rubber plantation and scrub | 30 | 13 | *Nephelium lappaceum L* (Least concern)<br>Santiria apiculata A.W. Benn (Least concern) |
| 3.2 | *Acacia mangium* stands | 15 | 1 | *Afzelia rhomboidea (Blanco) S. Vidal* (Vulnerable) |

The sample results indicated that the majority of the species recorded are not included within the IUCN conservation status framework. The sample transect that included species that have been assessed by IUCN are highlighted in Table 3.22 along with the species and conservation status.

The areas that appear to have the greatest species diversity were alongside the gas pipeline route (Transects 1.1.1 to 1.1.5) and the water pipeline route (3.1 and 3.2). These areas generally contain predominately oil palm, rubber and timber/lumber species. However, there are discrete areas where oil palm has been unmanaged for a number of years (potentially decades) and is characterised by native dense vegetation although plantation species are still noted. It should also be noted that the observation of Anisoptera marginata Korth was located 50 m down a slope on the other side of the road from the gas pipeline in an area of dense vegetation which is bounded by oil palm plantation and therefore outside of the project footprint. The sample sites within Riau

CCPP site and along the gas pipeline route adjacent to the unpaved roads were either oil palm or jabon plantation and had very limited species diversity.

The wet season data was collected over the wider project area and based on a comparison of what was collected within the Riau CCPP site during the wet and dry season is considered to provide an appropriate representation of the habitats present.

### 3.10.5 Fauna

#### 3.10.5.1 Dry Season Sampling (Power Plant)

The species observed during the survey visits are set out in Table 3.23, Table 3.24 and Table 3.25. The majority of species recorded had an IUCN conservation status of Least Concern. Two species with Near Threatened conservation status were recorded, a long tailed parakeet (*Psittacula longicauda)* and a silvery lutung (*Trachypithecus cristatus).* Both of these species are considered by IUCN as Near Threatened because of the extensive habitat loss (deforestation) that has occurred within their range.

The species recorded reflect the habitat type, freshwater swamp forest, that was naturally occurring in the locality and has now been cleared to establish oil palm plantations. It is considered likely that these species have shown some resilience to this habitat change and have managed to adapt to some extent to the modified environment. The adaptation is predominantly in discrete areas of unmanaged oil palm plantation where over many year (potentially decades) natural regrowth has occurred to the extent that the majority of the discrete area is native vegetation with some plantation species still occurring. These areas are considered to be low grade Natural Habitat and indicative of a disturbed habitat.

The following key applies to all of the following results tables:

<u>Conservation Status IUCN</u>

LC Least Concern

NT Near Threatened

VU Vulnerable

EN Endangered

CR Critically Endangered

<u>Protection: PP No. 7 Tahun 1999</u>

DL Protected

<u>Abundance</u>

1 One encounter

J Seldom found (2-5 times encounter)

TU Not common (6-10 times encounter)

U Commonly found (11-20 times encounter)

M Abundance (> 20 times encounter)

**Table 3.23 : Bird Species Recorded During the Transect Visits**

| Scientific name | Common name | IUCN conservation status | PP-7/1999 | Abundance |
|---|---|---|---|---|
| *Spilopelia chinensis* | Spotted dove | LC | | M |
| *Geopelia striata* | Zebra dove | LC | | M |
| *Pycnonotus goiavier* | Yellow-vented bulbul | LC | | M |
| *Pycnonotus aurigaster* | Sooty-headed bulbul | LC | | M |
| *Parus major* | Great tit | LC | | U |
| *Orthotomus atrogularis* | Dark-necked tailorbird | LC | | U |
| *Prinia flaviventris* | Yellow-bellied prinia | LC | | U |
| *Dicaeum trochileum* | Scarlet-headed flowerpecker | LC | | U |
| *Lonchura striata* | White-rumped munia | LC | | U |
| *Lonchura leucogastra* | White-bellied munia | LC | | U |
| *Lonchura malacca* | Tricoloured munia | LC | | U |
| *Spilornis cheela* | Crested serpent eagle | LC | DL | TU |
| *Amaurornis phoenicurus* | White-breasted waterhen | LC | | TU |

| Scientific name | Common name | IUCN conservation status | PP-7/1999 | Abundance |
|---|---|---|---|---|
| *Centropus sinensis* | Greater coucal | LC | | TU |
| *Centropus bengalensis* | Lesser coucal | LC | | TU |
| *Caprimulgus affinis* | Savanna nightjar | LC | | TU |
| *Halcyon smyrnensis* | White-throated kingfisher | LC | DL | TU |
| *Todiramphus chloris* | Collared kingfisher | LC | DL | TU |
| *Orthotomus ruficeps* | Ashy tailorbird | LC | | TU |
| *Prinia familiaris* | Bar-winged prinia | LC | | TU |
| *Rhipidura perlata* | Spotted fantail | LC | | TU |
| *Cinnyris jugularis* | Olive-backed sunbird | LC | DL | TU |
| *Lonchura maja* | White-headed munia | LC | | TU |
| *Nisaetus cirrhatus* | Changeable hawk-eagle | LC | DL | J |
| *Treron vernans* | Pink-necked green pigeon | LC | | J |
| *Psittacula longicauda* | Long-tailed parakeet | NT | DL | J |
| *Cacomantis merulinus* | Plaintive cuckoo | LC | | J |
| *Cacomantis sepulcralis* | Rusty-breasted cuckoo | LC | | J |
| *Surniculus lugubris* | Square-tailed drongo cuckoo | LC | | J |
| *Caprimulgus macrurus* | Large-tailed nightjar | LC | | J |
| *Collocalia fuciphaga* | Edible-nest swiftlet | LC | | J |
| *Collocalia esculenta* | Glossy swiftlet | LC | | J |
| *Alcedo atthis* | Common kingfisher | LC | DL | J |
| *Dendrocopos moluccensis* | Sunda pygmy woodpecker | LC | | J |
| *Hirundo tahitica* | Pacific swallow | LC | | J |
| *Lalage nigra* | Pied triller | LC | | J |
| *Corvus enca* | Slender-billed crow | LC | | J |
| *Gerygone sulphurea* | Golden-bellied gerygone | LC | | J |
| *Rhipidura javanica* | Malaysian pied fantail | LC | | J |
| *Anthreptes malacensis* | Brown-throated sunbird | LC | DL | J |
| *Dicaeum trigonostigma* | Orange-bellied flowerpecker | LC | | J |
| *Zosterops palpebrosus* | Oriental white-eye | LC | | J |

The bird species encountered included a number of species listed on PP No. 7 Tahun 1999. All of the species were considered to have a conservation status of Least Concern (IUCN, n.d.) except the long-tailed parakeet which is Near Threatened (IUCN, n.d.) but was seldom recorded during the survey.

**Table 3.24 : Herpetofauna Recorded Along the Transects and Known in Surrounding Area**

| Scientific name | Common name | IUCN conservation status | Abundance |
|---|---|---|---|
| **Amphibians** | | | |
| *Pulchrana glandulosa* | Rough-sided frog | LC | M |
| *Fejervarya limnocharis* | Indian cricket frog | LC | U |

| Scientific name | Common name | IUCN conservation status | Abundance |
|---|---|---|---|
| *Fejervarya cancrivora* | Crab eating frog | LC | U |
| *Hylarana erythraea* | Common green frog | LC | U |
| *Ingerophrynus melanostictus* | Crested toad | LC | TU |
| **Reptiles** | | | |
| *Varanus salvator* | Asian water monitor | LC | Commonly encountered in the Siak River |
| *Eutropis multifasciata* | Many-striped skink | - | Commonly |
| *Naja sumatrana* | Equatorial spitting cobra | LC | Rarely |
| *Dendrelaphis haasi* | Haas's bronzeback tree snake | LC | Rarely |
| *Dendragama boulengeri* | Boulenger's tree agama | - | Rarely |

All of the herpetofauna species encountered during the survey work where considered to be of least concern (IUCN, n.d.) and generally associated with the wetter parts of the survey area, particularly closer to the Siak River.

**Table 3.25 : Mammals Recorded Along the Transects and Known in the Surrounding Area**

| Scientific name | Common name | IUCN conservation status | Abundance |
|---|---|---|---|
| *Callosciurus notatus* | Plantain Squirrel | LC | U |
| *Trachypithecus cristatus* | Silvery Lutung | NT | TU |

The power station site and transmission line survey transects only recorded two mammal species. The silvery lutung is considered to be Near Threatened by IUCN because of extensive habitat loss within its range although it does appear to be able to adapt to some extent to living within modified areas. The plantain squirrel was commonly recorded within survey area and is considered to be adaptable and in some areas an agricultural pest (IUCN, n.d.).

### 3.10.5.2 Wet Season Sampling (Power Plant, Water Pipeline and Gas Pipeline)

Table 3.26, Table 3.27, Table 3.28 and Table 3.29 provide a summary of the fauna recorded at each sample site.

### Birds

**Table 3.26 : Summary of the Abundance, Diversity and Conservation Status of Bird Species Recorded During the Wet Season Sampling**

| Location | Number of bird species recorded (species diversity) | Total number of individuals recorded (abundance) | IUCN status – number of species | | | No. of species listed on PP-7/1999 |
|---|---|---|---|---|---|---|
| | | | Least concern | Near Threatened | Vulnerable | |
| **Gas Pipeline Route** | | | | | | |
| TR1 | 78 | 572 | 74 | 2 | 2 | 12 |
| TR2 | 80 | 604 | 75 | 4 | 1 | 12 |
| TR3 | 72 | 411 | 67 | 3 | 2 | 12 |

| Location | Number of bird species recorded (species diversity) | Total number of individuals recorded (abundance) | IUCN status – number of species | | | No. of species listed on PP-7/1999 |
|---|---|---|---|---|---|---|
| | | | Least concern | Near Threatened | Vulnerable | |
| TR4 | 73 | 487 | 68 | 3 | 2 | 10 |
| TR5 | 64 | 189 | 61 | 2 | 1 | 10 |
| UP1 | 47 | 86 | 46 | 1 | - | 7 |
| UP2 | 32 | 218 | 31 | 1 | - | 8 |
| UP3 | 54 | 218 | 52 | 1 | 1 | 8 |
| **Riau CCPP site** | | | | | | |
| PS1 | 48 | 160 | 48 | - | - | 9 |
| PS2 | 37 | 108 | 37 | - | - | 7 |
| PS3 | 44 | 125 | 41 | 3 | - | 7 |
| **Water pipeline route** | | | | | | |
| WI1 | 70 | 289 | 67 | 2 | 1 | 11 |
| WI2 | 60 | 181 | 57 | 2 | 1 | 10 |

The diversity of bird species was greatest along the transects covering the gas pipeline and water pipeline routes and this coincides with the areas of habitat that are not dominated by oil palm plantation. The IUCN Vulnerable species recorded were black partridge (*Melanoperdix niger)* and Sunda-blue flycatcher (*Cyornis caerulatus*). The IUCN list that key threats to both these species is rapid habitat loss through de-forestation.

Within the Riau CCPP site, the dry and wet season data for birds recorded was relatively similar in terms of the number and types of species recorded.

### Herpetofauna

**Table 3.27 : Summary of the Amphibian Species Recorded During the Wet Season Sampling**

| SCIENTIFIC NAME | COMMON NAME | IUCN | Listening Point | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gas pipeline route | | | | | | | | Riau CCPP site | | | Water pipeline | |
| | | | LP1 | LP2 | LP3 | LP4 | LP5 | LP6 | LP7 | LP8 | LQ1 | LQ2 | LQ3 | WL1 | WL2 |
| *Fejervarya limnocharis* | *Indian cricket frog* | LC | 23 | 19 | 7 | 18 | 14 | 10 | 19 | 15 | 5 | 2 | 4 | 8 | 5 |
| *Fejervarya cancrivora* | *Crab-eating frog* | LC | 15 | 17 | 5 | 8 | 7 | 11 | 6 | 8 | 1 | 1 | 1 | 2 | 1 |
| *Pulchrana glandulosa* | *Rough sided frog* | LC | 37 | 25 | 11 | 12 | 16 | 16 | 4 | 8 | 3 | 2 | 2 | 5 | 6 |
| *Hylarana erythraea* | *Common green frog* | LC | 18 | 10 | 12 | 9 | 14 | 26 | 21 | 21 | 9 | 6 | 12 | 13 | 11 |
| *Ingerophrynus melanostictus* | *Crested toad* | LC | 9 | 5 | 2 | 7 | 5 | 5 | 6 | 5 | 1 | 1 | 1 | 2 | 1 |
| **Number of individuals recorded (abundance)** | | | **102** | **76** | **37** | **54** | **56** | **68** | **56** | **57** | **19** | **12** | **20** | **30** | **24** |
| **Number of species recorded (diversity)** | | | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** |

The amphibian species recorded were common to all of the sample sites and the same species were recorded in both the wet and dry season surveys. The abundance of individuals is likely to be linked to the habitat types present close to the listening point and therefore indicates that the areas with a greater abundance of species are likely to have more wet habitats present.

Table 3.28 : Summary of the Reptile Species Recorded During the Wet Season Sampling

| SCIENTIFIC NAME | COMMON NAME | IUCN | Location | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gas pipeline route | | | | | | | | Riau CCPP site | | | Water pipeline | |
| | | | TR1 | TR2 | TR3 | TR4 | TR5 | UP1 | UP2 | UP3 | PS1 | PS2 | PS3 | WI1 | WI2 |
| *Aphaniotis fusca* | *Earless agamid* | LC | 1 | 1 | 1 | 2 | 1 | | | | | | 1 | 1 | |
| *Bronchocela cristatella* | *Green crested lizard* | LC | 2 | 3 | 1 | 2 | 1 | | | 1 | | | | 1 | 1 |
| *Dendragama boulengeri* | *Boulenger's tree agama* | | | 1 | 1 | 1 | 1 | | | | | | | 1 | |
| *Dendrelaphis haasi* | *Haas's bronzeback tree snake* | LC | | 1 | 1 | | | | | | | | | | |
| *Eutropis multifasciata* | *Many-striped skink* | LC | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | | | |
| *Eutropis novemcarinata* | *Nine-keeled skink* | LC | | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | |
| *Lygosoma (quadrupes)* sp. | *Writhing skinks* | | | 1 | 1 | 1 | 1 | | | | | | 1 | 1 | |
| Naja sumatrana | Equitorial spitting cobra | LC | | | | 1 | | | 1 | | | | | | |
| *Tytthoscincus temmincki* | *Temmincki lizard* | | 1 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | |
| *Varanus bengalensis* | *Bengal monitor* | LC | | 1 | 1 | 1 | 1 | | 1 | | | | | 1 | |
| *Varanus salvator* | *Asian water monitor* | LC | 2 | 2 | 1 | | | | | | 1 | | 1 | 2 | 3 |
| **Number of individuals recorded (abundance)** | | | **9** | **14** | **11** | **12** | **9** | **2** | **4** | **2** | **3** | **2** | **4** | **9** | **4** |
| **Number of species recorded (diversity)** | | | **5** | **10** | **10** | **9** | **8** | **2** | **4** | **2** | **3** | **2** | **4** | **8** | **2** |

The reptile species recorded all had a least concern conservation status or had not been assessed by the IUCN (IUCN, n.d.). The species diversity varied across the sample sites with the lower values generally associated with the areas of plantation. The wet season survey data for the Riau CCPP site was similar to that recorded during the dry season.

## Mammals

Table 3.29 : Summary of the Mammal Species Recorded During the Wet Season Sampling

| Scientific name | Common name | IUCN | Location | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gas pipeline route | | | | | | | | Riau CCPP site | | | Water pipeline | |
| | | | TR1 | TR2 | TR3 | TR4 | TR5 | UP1 | UP2 | UP3 | PS1 | PS2 | PS3 | WI1 | WI2 |
| *Callosciurus notatus* | *Plantain squirrel* | LC | 1 | 2 | 3 | 3 | 1 | 1 | | | 1 | | | | |
| *Helarctos malayanus* | *Sun bear* | VU | | | 1 | | | | | | | | | | |
| *Hylobates agilis* | *Agile gibbon*** | EN | | | 5 | | | | | | | | | | |
| *Macaca fascicularis* | *Crab eating macaque* | LC | 17 | 5 | 12 | | | | | | | | | 10 | 27 |
| *Macaca nemestrina* | *Southern pig-tailed macaque* | VU | | | 15 | 12 | 1 | | | | | | | 21 | 9 |
| *Manis javanica* | *Sunda pangolin** | CR | | | 1 | 1 | 1 | | | | | | | | |
| *Rusa unicolor* | *Sambar deer* | VU | | | 1 | | | | | | | | | | |
| *Sus scrofa* | *Wild boar* | LC | | 3 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | |
| *Trachypithecus cristatus* | *Silvery lutung* | NT | | | 17 | 8 | | | | | | | | 12 | 8 |
| *Tragulus kanchil* | *Lesser mouse-deer* | LC | | | 1 | 1 | 1 | | | | | | | | |
| **Number of individuals recorded (abundance)** | | | **18** | **10** | **57** | **26** | **5** | **2** | **1** | **1** | **1** | **0** | **1** | **44** | **44** |

| Scientific name | Common name | IUCN | Location | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gas pipeline route | | | | | | | | Riau CCPP site | | | Water pipeline | |
| | | | TR1 | TR2 | TR3 | TR4 | TR5 | UP1 | UP2 | UP3 | PS1 | PS2 | PS3 | WI1 | WI2 |
| **Number of species recorded (diversity)** | | | 2 | 3 | 10 | 6 | 5 | 2 | 1 | 1 | 1 | 0 | 1 | 4 | 3 |

*Note: All three records were indirect evidence identified as leftovers

**Note: Records were comprised of direct evidence (three visual sightings) and indirect evidence (two calls)

The survey results included both direct and indirect evidence for the species. The mammal species most abundant through the study area were the two macaque species and the silvery lutung. The diversity of species was highest at site TR3 which appears to coincide with an area of secondary forest that also had a relatively diverse number of mature and sapling trees.

Two IUCN Vulnerable species, one IUCN Endangered and one IUCN Critically Endangered species were recorded. The sunda pangolin is considered Critically Endangered by the IUCN (IUCN, n.d.) due to high levels of hunting and poaching for its meat and scales. The key threats to the agile gibbon are habitat loss, primarily as a result of deforestation (IUCN, n.d.). The two Vulnerable species recorded are all considered to have decreasing populations across their range as a result of habitat loss and hunting (IUCN, n.d.).

Further baseline surveys undertaken in June 2018 found no further evidence of the sunda pangolin at TR3, TR4 or TR5. Figures 3.40, 3.41 and 3.42 below provide an overview of the areas along TR3, TR4 and TR5 where secondary evidence of the sunda pangolin was noted.

**Figure 3.40 : Area at TR3 Where Secondary Evidence of Sunda Pangolin Noted**

Figure 3.41 : Area at TR4 Where Secondary Evidence of Sunda Pangolin Noted

Figure 3.42 : Area at TR5 Where Secondary Evidence of Sunda Pangolin Noted

The baseline survey undertaken in June 2018 also confirmed that the agile gibbons are only noted at TR3 and comprise up to two to three family groups with a total of 12 individuals. It should be noted that the area where agile gibbon is noted is located in a small patch of dense vegetation 100 m from the edge of the road and on the other side of the road from the gas pipeline, see Figure 3.45 for overview of area size. There are no observed vegetation links via a canopy that would allow the agile gibbons to move from the area of vegetation to the gas pipeline. Figure 3.44 area 2 below shows the discrete area where the agile gibbon has been noted. Site photos recorded of this area of vegetation is noted in Figure 3.43 below.

**Figure 3.43 : Area of Vegetation at TR3 where Agile Gibbon has been Noted**

The Riau CCPP site itself recorded limited mammal interest during the wet season sampling and the this the same as recorded in the dry season.

### 3.10.6 Baseline Summary

There are no legally protected areas of conservation concern or areas of conservation interest within a 5 km radius of the Project area. Sumatra is listed as one of the World Wide Fund (WWF) Critical Regions of the World (WWF), n.d.). The nearest Important Bird Areas (Birdlife International, 2018) are between 50 and 100 km north, south and east of the project area. The Tesso Nilo National Park is approximately 75 km south of the project area. There are no UNESCO heritage sites within 100 km of the Project area. The nearest is over 300 km to the south of the Project area. The nearest Key Biodiversity Area (KBA) is approximately 50 km from the nearest Project feature (the start of the gas pipeline).

Discussion on Natural Habitat and Critical Habitat is discussed later in Section 3.10.8.

The power station site and transmission line was dominated by oil palm plantation and the data collected did not include any IUCN Red Listed Threatened species of flora or fauna (Vulnerable, Threatened, Endangered or Critically Endangered).

The water pipeline route passes through *Acacia mangium* production forest plantation stands and rubber plantation with scrub. Direct evidence of a number of IUCN Red Listed Vulnerable species were recorded: legume/tree species (*Afzelia rhomboidea*), Black partridge (*Melanoperdix niger*), Sunda blue flycatcher (*Cyornis caerulatus)* and Southern pig-tailed macaque.

The gas pipeline route could be classified in to two main types:

- the route along unpaved roads (26-40 km) was dominated by oil palm plantation with a record of the IUCN Red Listed (Vulnerable) Black partridge in transect UP3.
- the route along the paved roads 0-26 km had more varied habitats recorded including secondary forest, secondary swamp forest and rubber/ oil palm plantations with records (direct and indirect evidence) of a number of IUCN Red Listed Threatened species:
  - IUCN Vulnerable: legume/tree species (*Afzelia rhomboidea*), black partridge, sunda blue flycatcher, sambar deer, sun bear and southern pig-tailed macaque;
  - IUCN Endangered: *Anisoptera marginata* and agile gibbon (direct and indirect evidence found at TR3); and
  - IUCN Critically Endangered: sunda pangolin (direct evidence found at TR3, TR4 and TR5).

### 3.10.7 Land Classes

As outlined in Figure 3.37 there are a number of land classes within the Project area that were identified during baseline surveys. The description of these land classes are provided in Table 3.30 below.

**Table 3.30 : Descriptions of Land Classes within the Project Area**

| Land Class | Description |
|---|---|
| Native Regrowth Forest | Discrete areas of the Project area contain areas of oil palm plantation that have not been managed for many years and have been left to naturally regrow. The number of years unmanaged is not known but based on level of growth it is determined to be a decade or more. Although the area is still a mix of native and non-native growth, the area is predominantly dense native vegetation of moderate quality. |
| Oil Palm and Rubber Plantation | Areas containing a dominance of oil palm and rubber plantation. The Project area is characterised by these plantations. |
| Road / Settlements | A number of settlements are adjacent to the road which the gas pipeline predominantly follows (within the road reserve). In areas away from settlements, the road is characterised by a band of grass / scrub either side. |

### 3.10.8 Habitat Assessment

Habitats can be defined as Modified, Natural or Critical under the ADB Safeguard Policy Statement and IFC Performance Standard 6. The definitions of these habitats are detailed below.

#### ADB Safeguard Policy Statement

Under the ADB Safeguard Policy Statement habitats can be defined as:

- Modified Habitat: Areas where natural habitat has been altered, often through the introduction of alien species of plants and animals, such as in agricultural areas;
- Natural Habitat: Land and water areas where the biological communities are formed largely by native plant and animal species, and where human activity has not essentially modified the area's primary ecological functions.
- Critical Habitat: Critical habitat includes areas with high biodiversity value, including:
  - habitat required for the survival of critically endangered or endangered species;
  - areas having special significance for endemic or restricted range species;
  - sites that are critical for the survival of migratory species;
  - areas supporting globally significant concentrations of numbers of individuals of congregatory species;
  - areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services; and
  - areas having biodiversity of significant social, economic, or cultural importance to local communities.

  Critical habitats include those areas either legally protected or officially proposed for protection, such as areas that meet the criteria of the World Conservation Union classification, the Ramsar List of Wetlands of International Importance, and the United Nations Educational, Scientific, and Cultural Organization's world natural heritage sites.

#### IFC Performance Standard 6

Under the IFC Performance Standard 6 habitats can be defined as:

- Modified Habitat: Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological function and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands.

- Natural Habitat: Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition; and
- Critical Habitat: Critical habitats are areas with high biodiversity value, including:
  - (i) habitat of significant importance to Critically Endangered and/or Endangered species;
  - (ii) habitat of significant importance to endemic and/or restricted-range species;
  - (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species;
  - (iv) highly threatened and/or unique ecosystems; and/or
  - (v) areas associated with key evolutionary processes.

Based on the terrestrial ecology surveys undertaken to date and discussed in Section 3.10.7, the Project area comprises predominantly oil palm plantations along with lumber and rubber. Based on this and the results of the baseline surveys the habitat within the project area can be considered to be Modified Habitat. It should also be noted that the oil palm plantations operate on a rotational basis, being cut down and replanted approximately every 15 years, and therefore the receiving environment undergoes ongoing modification. In some very discrete areas there is a mix of unmanaged plantation areas that have native regrowth, these areas contain dense native vegetation that can be considered to be low grade Natural Habitat. The areas of low grade Natural Habitat previously palm oil plantation have been unmanaged for years (potentially decades based on level of vegetation growth). These areas are considered to be low grade due to the mix of native species that have adapted within an area of non-native species and although these discrete areas are generally now characterised by native species they are indicative of a young and relatively disturbed habitat. As these areas are not part of the land to be acquired by MRPR and therefore outside of their control, it is possible that these areas may also be cleared for future plantation use in although landowner intentions are not known. Figure 3.44 below provides an overview of areas of Modified and Natural Habitat within the Project area. The 1 km buffer around the Project area gives a total of 8,793 ha. Of this 8,666.5 ha is determined to be Modified Habitat and 118.5 ha (1%) is determined to be low grade Natural Habitat.

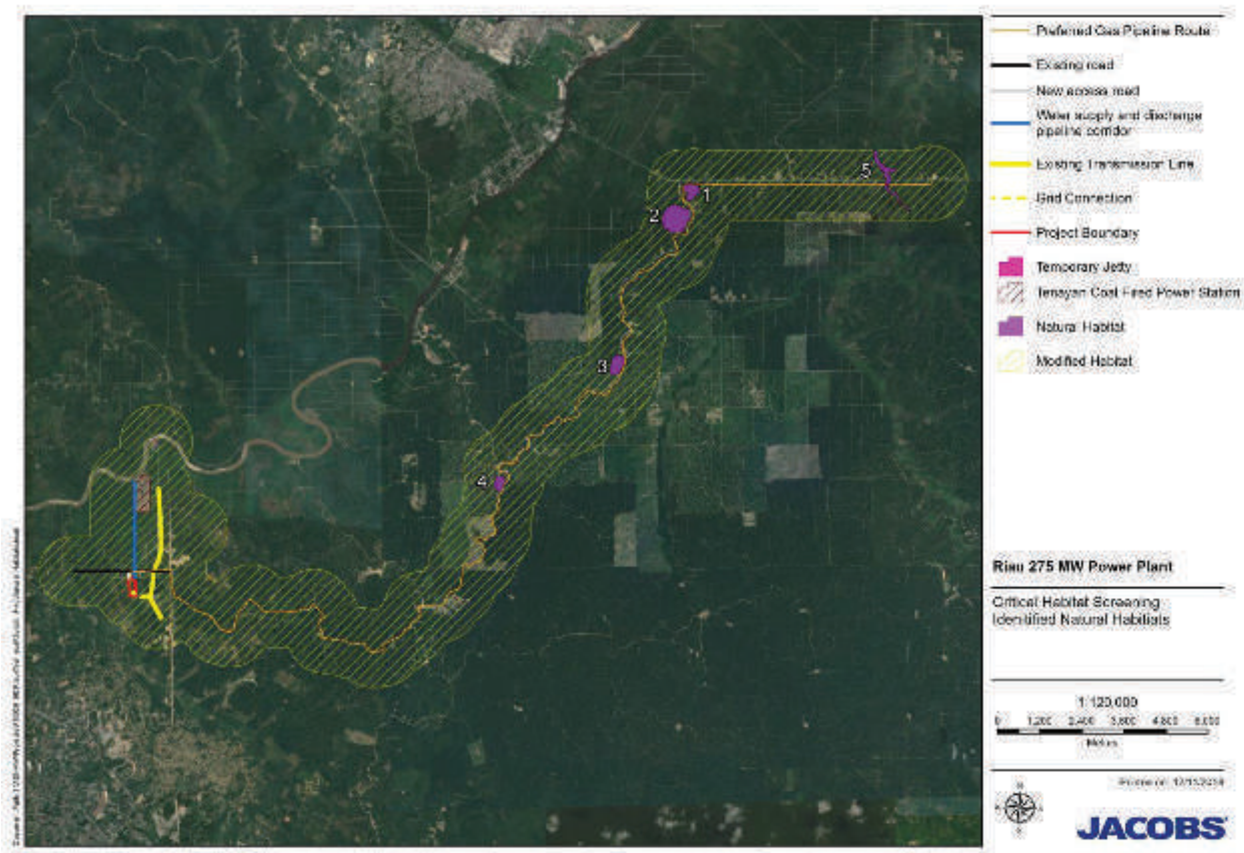


**Figure 3.44 : Modified and Natural Habitat within the Project Area**

The survey results show that the area contains a range of species including IUCN Red Listed Threatened species (Vulnerable, Endangered or Critically Endangered). The occurrence of these species is directly linked to the areas of natural habitat noted and therefore may form Critical Habitat. However, under the IFC Performance Standards and ADB Safeguard Policy Statement, a Modified Habitat may also comprise Critical Habitat. To determine whether Critical Habitat is present, a screening assessment is required, this is detailed in the following sections.

### 3.10.9 Critical Habitat Screening Assessment

The Critical Habitat Screening Assessment process was undertaken in accordance with IFC in Performance Standard 6 and associated Guidance Note and the ADB Safeguard Policy Statement.

#### 3.10.9.1 Discrete Management Unit

The IFC Performance Standard 6 requires a project to ‘determine a sensible ecological or political boundary that defines the area of habitat to be considered for the Critical Habitat assessment. Referred to as a Discrete Management Unit (DMU), this is an area with a ‘definable boundary within which the biological communities and/or management issues have more in common with each other than they do with those in adjacent areas’.

DMUs do not imply management control or responsibility by the Project, and often include areas outside of their control. The DMU also does not indicate Project footprint or impacted area, and in most cases is larger than either of these. This ensures impacts on biodiversity values in the larger landscape are adequately considered.

For the Project, the DMU has been defined based on the sunda pangolin (IUCN Critically Endangered) and agile gibbon (IUCN Endangered) which has been noted in the Project area. Sunda pangolins are understood to be wide ranging species that are found across all of Sumatra. The species has a diverse range of habitats from primary and secondary forest, including lowland dipterocarp forest to cultivated areas including gardens and oil palm and rubber plantations. It is also noted as being found near human settlements. As such the DMU boundary has been set on this basis with boundaries defined based on the Siak River and Pekanbaru City to the west and south. To the east and north boundaries of the S. Pingai, S.Pelajau, S. Inas and S. Gasip Rivers have been used. The agile gibbon (IUCN Endangered) is found only in one of the discrete areas of Natural Habitat identified (see Figure 3.45). The agile gibbon is generally found in primary or secondary forest and the low grade natural habitat used by a small family of agile gibbons on site is outside the Project footprint and will not be impacted.

The DMUs for this Project is outlined in Figure 3.45 below.

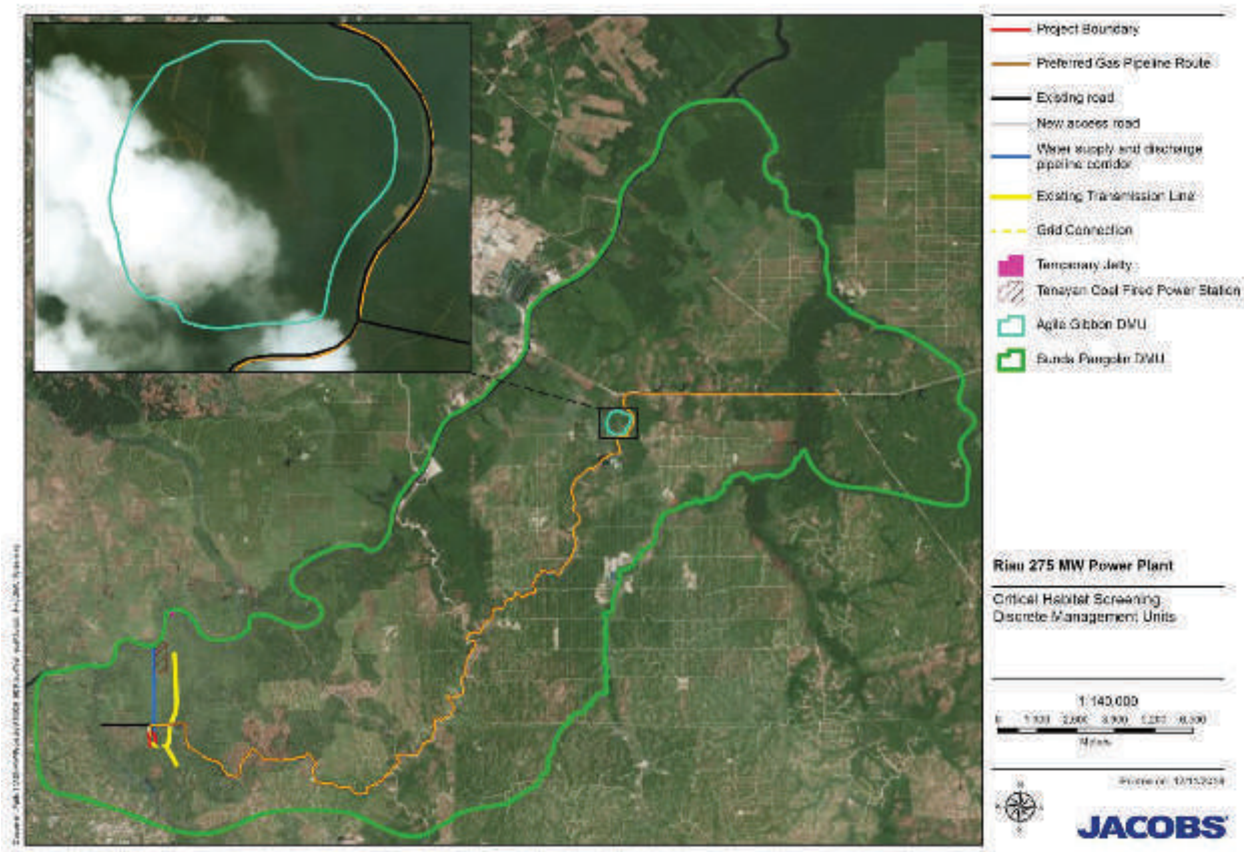


**Figure 3.45 : Discrete Management Unit for Sunda Pangolin**

#### 3.10.9.2 Criterion for Critical Habitat

The Critical Habitat assessment comprised an analysis of biodiversity values within the Project area and DMU, habitats of high biodiversity value and species of conservation concern e.g. sunda pangolin and agile gibbon. This involved GIS analysis, desk-based data collection and baseline surveys during dry and wet season.

Critical Habitat criteria are defined in IFC Guidance Note 6, paragraphs GN 69 to GN 97. Table 3.31 below provides a breakdown of the Critical Habitat criteria from Criterion 1 to 5.

ADB criteria for Critical Habitat is as described in Section 3.10.8.

**Table 3.31 : IFC Critical Habitat Criteria**

| Criteria | Tier 1 | Tier 2 |
|---|---|---|
| Criterion 1: Critically Endangered (CR) / Endangered (EN) Species | (a) Habitat required to sustain ≥ 10 percent of the global population of a CR or EN species/subspecies where there are known, regular occurrences of the species and where that habitat could be considered a discrete management unit for that species.<br><br>(b) Habitat with known, regular occurrences of CR or EN species where that habitat is one of 10 or fewer discrete management sites globally for that species. | (c) Habitat that supports the regular occurrence of a single individual of a CR species and/or habitat containing regionally- important concentrations of a Red-listed EN species where that habitat could be considered a discrete management unit for that species/subspecies.<br><br>(d) Habitat of significant importance to CR or EN species that are wide ranging and/or whose population distribution is not well understood and where the loss of such a habitat could potentially impact the long-term survivability of the species.<br><br>(e) As appropriate, habitat containing nationally/regionally important concentrations of an EN, CR or equivalent national/regional listing. |
| Criterion 2: Habitat of Significant Importance to Endemic and / or Restricted-Range Species | (a) Habitat known to sustain ≥ 95 percent of the global population of an endemic or restricted-range species where that habitat could be considered a discrete management unit for that species (e.g., a single-site endemic). | (b) Habitat known to sustain ≥ 1 percent but < 95 percent of the global population of an endemic or restricted-range species where that habitat could be considered a discrete management unit for that species, where data are available and/or based on expert judgment. |
| Criterion 3: Habitat Supporting Globally Significant Concentration of Migratory Species and / or Congregatory Species | (a) Habitat known to sustain, on a cyclical or otherwise regular basis, ≥ 95 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle where that habitat could be considered a discrete management unit for that species. | (b) Habitat known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent but < 95 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle and where that habitat could be considered a discrete management unit for that species, where adequate data are available and/or based on expert judgment.<br><br>(c) For birds, habitat that meets BirdLife International's Criterion A4 for congregations and/or Ramsar Criteria 5 or 6 for Identifying Wetlands of International Importance.<br><br>(d) For species with large but clumped distributions, a provisional threshold is set at ≥5 percent of the global population for both terrestrial and marine species.<br><br>(e) Source sites that contribute ≥ 1 percent of the global population of recruits. |
| Criterion 4: Highly Threatened and / or Unique Ecosystems | Criterion 4 has no tiered system although recent publication (Keith et al, 2013) may introduce this. This criterion must include one of the following<br>a) the ecosystem is at risk of significantly decreasing in area or quality;<br>b) has a small spatial extent; and /or<br>c) Contains unique assemblages of species including assemblages or concentrations of biome-restricted species. Highly threatened or unique ecosystems are defined by a combination of factors which may include long-term trend, rarity, ecological condition, and threat. | |

| Criteria | Tier 1 | Tier 2 |
|---|---|---|
| Criterion 5: Areas Associated with Key Evolutionary Processes | The criterion is defined by:<br>a) the physical features of a landscape that might be associated with particular evolutionary processes; and/or<br>b) Sub-populations of species that are phylogenetically or morphogenetically distinct and may be of special conservation concern given their distinct evolutionary history. The latter includes evolutionarily significant units and evolutionarily distinct and globally endangered species. | |
| Notes:<br>• No Tier system is in place for Criterion 4 and 5. | | |

#### 3.10.9.3 Critical Habitat Candidate Species

For this Critical Habitat assessment, species noted during desktop review, baseline surveys as being IUCN Critically Endangered and Endangered and potentially present in the Project area have been considered. Other species of concern noted in the baseline surveys are IUCN Vulnerable species include the following:

- IUCN Vulnerable: (legume/tree species) (*Afzelia rhomboidea*), black partridge (*Melanoperdix niger*), sunda blue flycatcher (*Cyornis caerulatus)* and southern pig-tailed macaque (*Macaca nemestrina*), sun bear (*Helarctos malayanus*) and sambar deer (*Rusa unicolor*).

These species along with the IUCN Endangered species, Anisoptera marginata Korth, are not considered within the Critical Habitat assessment as screening of these species against IFC and ADB Critical Habitat criterion found that their status and context within the project area in terms of population abundance did not trigger further assessment. The species considered for this Critical Habitat Assessment are as follows:

- Sunda pangolin; and
- Agile Gibbon.

Further information on these species have been collected through desktop reviews of available literature and through discussions with species specialists. It should be noted the available literature on these species is limited and with respect to the sunda pangolin focus predominantly on their threats rather than natural occurrence in the wild. The desktop review used the following reports:

- Challender D., Nguyen Van T., Shepherd C., Krishnasamy K., Wang A., Lee B., Fletcher L., Heng S., Seah Han Ming J., Olsson A., Nguyen The Truong A., Nguyen Van Q., Chung Y., (2014). *Manis javanica*, Sunda Pangolin IUCN Assessment.
- Pantel S., Chin S.Y., (2008). Proceedings of the Workshop on Trade and Conservation of Pangolins Native to South and Southeast Asia.
- Gomez L., Leupen B.T.C., Krishnasamy K., Heinrich S., (2017). Mapping Indonesian Pangolin Seizures (2010 – 2015).
- Geissmann T., Nijman V., (2008). *Hylobates agilis*, Agile Gibbon IUCN Assessment

**Consultation with Species Specialists**

Specialists also consulted as part of this Critical Habitat Screening Assessment include the following:

- Professor Gono Semiadi. Research Centre for Biology – Indonesian Institute of Sciences. Expertise in Mammalia & Wildlife Management (refer to CV in ESIA Volume 5 Technical Appendices - Appendix N).
- Guritno Djanubudiman. NBC mammal specialist. Bachelor degree in Biology ESIA Volume 5 Technical Appendices - Appendix N.
- Suprayogo Soemarno. NBC plant specialist. Master's degree in science. Expertise in tropical forest ecology ESIA Volume 5 Technical Appendices - Appendix N.
- Alwi. Local sunda pangolin specialist.
- Sarah Heinrich – PhD student studying sunda pangolin at the School of Biological Sciences and Centre for Conservation Science & Technology at the University of Adelaide.

**Response:** "*Unfortunately, there are no studies on exact population numbers/locations in Sumatra yet, but we are currently working on an updated IUCN Redlist assessment, which will be published later this year or early 2019.*

*As for home ranges, there are studies suggesting quite a big home range for male Sunda pangolins (~40 ha), and ~7 ha for females. Female home ranges are also probably dependant on natal dens (i.e. trees and tree hollows). Sunda pangolins are semi-arboreal and are usually found in lowland areas, and here typically forests, but there is anecdotal evidence that they use wetland and riverine ecosystems as well. They have also been observed living in modified habitats (e.g., plantations), although it's unclear at the moment if they can actually thrive in plantations, or whether they are simply losing habitat and trying to cope with it somehow by moving into these plantations. It is believed that they can generally adapt to different habitat types, provided they have enough prey and resting places (e.g., fallen tree logs, hollows, burrows etc). There aren't many ecological studies yet on pangolins…"*

- Dan Challender – Postdoctoral Research Associate – Oxford Martin Programme on the Illegal Wildlife Trade, University of Oxford. Chair, IUCN SSC Pangolin Specialist Group.

  **Response**: …"*The Sunda pangolin M. javanica does appear to be something of a habitat generalist. It occurs in tropical and sub-tropical forests but also appears in artificial and degraded landscapes including oil palm and rubber plantations as well as gardens. The extent to which there is any habitat preference has not really been tested in any meaningful manner. It could have some preferences but we don't really know at the moment…. in Singapore they are known to use water culverts to move around sometimes and ledges in underpasses etc so if you're thinking about connectivity or ability to move between suitable habitat that could be one option.*

  *Home range size estimates are below:*

  *36.4 – 90.7 ha, ♂ (n = 4), Singapore*

  *6.97 ha, ♀ (n = 1), Singapore*"

- Dr Susan Cheyne – Associate Lecturer MSc Primate Conservation, Oxford Brookes University. co-director of the Borneo Nature Foundation. Vice-chair of the IUCN Primate Specialist Group Section on Small Apes.

  **Response**: "*Average home range for 1 family group of agile gibbon is 35-45 ha. Large canopy gaps will mean the area needed for the gibbon group will be larger. Group home ranges will overlap by ~10%.*

  *Actual size of forest needed to maintain a viable population of gibbons over 50 years into the future for this species is ~ 60 km$^2$ minimum with connectivity/corridor to other forests. Large canopy gaps (roads etc) can be mitigated by canopy bridges (not just a single rope, I can send designs if needed). Power lines should be insulated as gibbons can use them to travel and may get electrocuted. Gibbons will very rarely come to the ground so the key is avoiding isolating them. Translocation would be a last (and expensive) option*."

Based on consultation discussion, the agile gibbon population is not viable with young likely to be more resilient than adults in managing disturbance from existing source such as the nearby highway and properties. With so many individuals and family groups in one place, this may lead to aggression and conflict and potentially dispersion of individuals to outside the habitat area. The young when old enough may also leave the family group which may result in movement out of the current habitat area.

#### 3.10.9.4 IFC Critical Habitat Triggers

Table 3.32 outlines the Critical Habitat triggers for Criterion 1 to 3 with respect to these species.

**Table 3.32 : Summary of Potential Critical Habitat Species**

| Species | Common Name | IUCN Listing | Criterion 1 | Criterion 2 | Criterion 3 | Observation Type and Locations | Species Information | Criterion Rationale |
|---|---|---|---|---|---|---|---|---|
| *Manis javanica* | Sunda Pangolin | CR | X | | | Secondary evidence through baseline surveys. | This species suffers from high levels of poaching for meat and scales. The species is widely distributed across Southeast Asia including southern China, Peninsular Malaysia, Cambodia, Vietnam, Myanmar, Sumatra, Java, Borneo and has been recorded from sea level up to 1,700 m AMSL. There is virtually no information available on population level of any species of Asian Pangolin and no comprehensive population estimates. The species has a diverse range of habitats from primary and secondary forest, including lowland dipterocarp forest to cultivated areas including gardens and oil palm and rubber plantations. It is also noted as being found near human settlements. The home range of these species is estimated at 6.97 ha based on the IUCN Assessment (IUCN 2014) although based on consultation, males may have home ranges of 40 ha or more. They are typically nocturnal animals that feed on ants and termites. | Sunda pangolin was observed through secondary evidence (destroyed termite nests) on three transects (TR3, TR4 and TR5) during baseline surveys. Field surveys and desktop data have noted that the Project area and wider region is heavily degraded and is predominantly made up of oil palm and rubber plantations.<br>Given the wide distribution and diverse range of habitats it is likely that sunda pangolin may be found in the region and Project area. Further surveys in June 2018 found no further direct or indirect evidence of sunda pangolin in the transects previously noted as having indirect evidence of them. Discussions with a local specialist and mammal specialist (who were also present on site) in June 2018 confirmed the regular occurrence of sunda pangolin in the area based on knowledge of suitable habitat and regional occurrence of the species, in particular the Natural Habitat around the swamp (Natural Habitat Area 1 in Figure 3.44). It has also been noted that sunda pangolin tend to nest in areas of dense vegetation normally on the banks of a steep slope but may travel one to two kilometres to forage for food within plantation areas. As such the other areas of Natural Habitat can also be considered to be suitable nesting habitats for the sunda pangolin.<br>Given the regular occurrence of the species and its wide ranging nature, Critical Habitat is likely triggered under Criterion 1, Tier 2 in relation to the regular occurrence of a Critically Endangered Species within the DMU for sunda pangolin. |
| *Hylobates agilis* | Agile Gibbon | EN | | | | Primary and secondary evidence through | This species suffers from a continued habitat loss and illegal trade for the pet market. Threats are primarily associated with Sumatra where the decline is most rapid. The species is found in Sumatra (southeast of Lake Toba and the Singkil River), Peninsular Malaysia and South | Agile gibbon was noted on one transect (TR3) during baseline surveys. The records comprised three individuals sighted, and two other individuals heard through calls. |

| Species | Common Name | IUCN Listing | Criterion 1 | Criterion 2 | Criterion 3 | Observation Type and Locations | Species Information | Criterion Rationale |
|---|---|---|---|---|---|---|---|---|
| | | | | | | baseline surveys. | Thailand. Population estimates across Sumatra are unknown. The species occurs at highest densities in dipterocarp-dominated forests but can also be found from swamps and lowland forests to hill, submontane and montane forests. They have an average home range size of 29 ha although based on consultation responses it could range up to 45 ha for one family group. The expansion of oil palm plantations is noted as a major cause of forest loss in Sumatra and therefore is closely associated with habitat loss for this species. | Further baseline surveys undertaken in June 2018 identified four agile gibbons at TR3, with one individual a juvenile. Based on advice by the NBC mammal specialist it is suggested that this area comprises 2 / 3 family groups totalling 10-12 individuals. The TR3 transect is also noted as an area of Natural Habitat (see Figure 3.44 area 2).<br>The area of Natural Habitat is 55 ha which is a small area for 2 / 3 family groups comprising 12 individuals. Areas of forest needed to maintain a viable population is 60 $km^2$ (6,000 ha). As such this population of agile gibbon is not considered viable. In addition, this is a small population size not considered to be a regionally importance concentration and particularly when comparing with other areas of Sumatra which have been noted to contains populations in excess of 4,000 individuals (Geissmann T., Nijman V., (2008)). As such Criterion 1 to 3 is not determined to be triggered for this species however, they will be treated as species of concern for mitigation. |

### Critical Habitat Criterion 1 – 3

The results of the Critical Habitat Screening assessment as outlined in Table 3.31 above identified that one species (sunda pangolin) triggers Critical Habitat under Criterion 1 Tier 2. Secondary indirect evidence of this species was noted on three transects during baseline surveys and from the desktop assessment undertaken is noted as being found across Sumatra in a diverse range of habitats including palm oil and rubber plantations such as those found in the Project area. Further discussions with local specialist and mammal specialist noted that sunda pangolin is commonly found in the area particularly within the areas of Natural Habitat noted in Figure 3.44.

It can therefore be concluded that the sunda pangolin triggers Critical Habitat under Criterion 1 Tier 2 for the sunda pangolin DMU in relation to the regular occurrence of a Critically Endangered species. The Agile Gibbon is determined to not trigger Critical Habitat under Criterion 1 – 3.

### Critical Habitat Criterion 4

IFC Performance Standard 6 describes this Criterion to be highly threatened or unique ecosystems including:

- that are at risk of significantly decreasing in area or quality;
- with a small spatial extent; and
- containing unique assemblages of species including assemblages or concentrations of biome-restricted species.

Highly threatened or unique ecosystems are defined by a combination of factors which may include long-term trend, rarity, ecological condition, and threat. Within the Project area and DMUs, there are not suitable habitat that fall under this criterion as the landscape has almost exclusively been converted to oil palm and rubber plantations and is therefore heavily modified.

### Critical Habitat Criterion 5

Criterion 5 has no tiered system although IFC Performance Standard 6 describes this Criterion to be one of the following:

- Physical features of a landscape that might be associated with particular evolutionary processes; and/or
- Subpopulations of species that are phylogenetically or morphogenetically distinct and may be of special conservation concern given their distinct evolutionary history.

There are no physical features within the Project area and DMUs that are known to be associated with evolutionary processes. The baseline surveys did not identify any species subpopulations known to be phylogenetically or morphogenetically distinct. As a result, it is determined that the Project area and DMUs is not important in the conservation of Key Evolutionary Processes.

### Other Recognised High Biodiversity Values

In addition, consideration should also be given to the IFC examples of high biodiversity values that may give rise to Critical Habitat. These examples are detailed in Table 3.33 below and a description of whether these values are triggered by the Project area and DMUs.

**Table 3.33 : IFC High Biodiversity Values**

| IFC High Biodiversity Values | Description |
|---|---|
| Areas required for the reintroduction of CR and EN species and refuge sites for these species (habitat used during periods of stress (e.g. flood, drought or fire)). | The Project area is dominated by oil palm and rubber plantations and therefore not suitable as refuge areas for species. |
| Ecosystems of known special significance to CR and EN species for climate adaptation purposes | The Project area is dominated by oil palm and rubber plantations and is not therefore considered to have ecosystems of significance for CR and EN species. |

| IFC High Biodiversity Values | Description |
|---|---|
| Concentrations of Vulnerable (VU) species in cases where there is uncertainty regarding the listing, and the actual status of the species may be EN or CR. | No VU species with uncertain IUCN listing is noted as being present within the Project area. |
| Areas of primary / old growth / pristine forests and/or other areas with especially high levels of species diversity. | The Project area is dominated by oil palm and rubber plantations and does not support or contain high levels of species diversity. |
| Landscape and ecological processes (e.g. water catchments, area critical erosion control, disturbance regimes (e.g. fire, flood) required for maintaining critical habitat. | The Project area does not comprise any landscape processes that support the presence of critical habitat. The Project area is undulating in topography with predominantly plantation growth. Some very discrete ecological areas have been noted as supporting Critical Habitat as discussed earlier in this section. |
| Habitat necessary for the survival of keystone species. | The Project area is predominantly oil palm and rubber plantations and therefore does not comprise habitat necessary for the survival of keystone species. |
| Areas of high scientific value such as those containing concentrations of species new and/or little known to science. | The Project area is predominantly oil palm and rubber plantations and therefore does not comprise an area of high scientific value. |
| Areas that meet the criteria of the IUCN's Protected Area Management Categories Ia, Ib and II, although areas that meet criteria for Management Categories III-VI may also qualify depending on the biodiversity values inherent to those sites. | The Project area is not within a IUCN Protected Area. |
| UNESCO Natural World Heritage Sites that are recognised for their Global Outstanding Value. | There are no UNESCO heritage sites within 100 km of the Project area. The nearest is over 300 km to the south of the Project area. |
| The majority of Key Biodiversity Area (KBAs) which encompass *inter alia* Ramsar Sites, Important Bird Area (IBA), Important Plant Areas (IPA) and Alliance for Zero Extinction Sites (AZE). | The Project and DMUs are not within a KBA. The nearest KBA area is approximately 50 km from the nearest Project feature (the start of the gas pipeline). |
| Areas determined to be irreplaceable or of high priority / significance based on systematic conservation planning techniques carried out at the landscape and/or regional scale by governmental bodies, recognised academic institutions and/or other relevant qualified organisations (including internationally recognised NGOs) | The Project area has been allocated either as an industrial zone or as land to be used for oil palm plantations and therefore is not considered to be an area that is irreplaceable or of high priority for conservation. |
| Areas identified by the client as High Conservation Value (HCV) using internationally recognised standards, where criteria used to designate such areas is consistent with the high biodiversity values listed in paragraph 16 of IFC Performance Standard 6. | Project area is predominantly oil palm and rubber plantations and is not identified by the client as a HCV area due to it not containing areas of outstanding or critical importance for biodiversity. |

In consideration of these values and the IFC definition of Critical Habitat being:

- habitat of significant importance to Critically Endangered and Endangered species;
- habitat of significant importance to endemic and/or restricted range species; and
- habitat supporting globally significant concentrations of migratory species and/or congregatory species.

#### 3.10.9.5 ADB Critical Habitat Triggers

Table 3.34 below provides an assessment of the ADB Critical Habitat triggers against the Project.

**Table 3.34: ADB Critical Habitat Triggers**

| ADB Triggers | Description | Triggered |
|---|---|---|
| Habitat required for the survival of critically endangered or endangered species | The Project and wider area is characterised by oil palm plantation which may be used by sunda pangolin (IUCN Critically Endangered) for foraging. Although the habitat is not considered important for the survival of these species and given the fact the sunda pangolin is generally found across all areas of Sumatra the Project area does not constitute habitat that versus habitat outside of the project area is important for the survival of the species. However, based on the regular occurrence of this species in the region and across Sumatra, the sunda pangolin DMU boundary for this Project is determined to be Critical Habitat for this species.<br>The agile gibbon (IUCN Endangered) is found only in one of the discrete areas of natural habitat identified (area 2, see Figure 3.44). The agile gibbon is generally found in primary or secondary forest and the low grade natural habitat used by a small family of agile gibbons on site is outside the Project footprint and will not be impacted. As such this is not determined to trigger Critical Habitat. | Yes for sunda pangolin |
| Areas with special significance for endemic or restricted-range species | The project area is characterised by oil palm and rubber plantation which is considered to be modified habitat. The discrete areas of low grade natural habitat support species such as the sunda pangolin and agile gibbon. However, this is not considered to have specific significance for endemic or restricted range species. No other locally endemic or range restricted species were found in the Project area. | No |
| Sites that are critical for the survival of migratory species | As above the project area is characterised by oil palm plantation is not considered suitable for the survival of any migratory species. | No |
| Areas supporting globally significant concentrations or numbers of individuals of congregatory species | The baseline surveys and secondary data review found no species noted as a congregatory species. Based on the presence of wide areas of oil palm and rubber plantation, the Project area is considered to support globally significant concentrations or individuals of congregatory species. | No |
| Areas with unique assemblages of species that are associated with key evolutionary processes or provide key ecosystem services | Areas with unique ecosystem or assemblages of species are defined by a combination of factors which may include long-term trend, rarity, ecological condition, and threat. Within the Project area and DMUs, there are not suitable habitat or species that fall under this criterion as the landscape has almost exclusively been converted to oil palm and rubber plantations and is therefore heavily modified.<br>There are also no physical features or species within the Project area and DMUs that are known to be associated with evolutionary processes or ecosystem services. The baseline surveys did not identify any species subpopulations known to be phylogenetically or morphogenetically distinct. As a result, it is determined that the Project area and DMUs is not important in the conservation of Key Evolutionary Processes. | No |
| Areas with biodiversity that has significant social, cultural or economic importance to local communities | There are no areas with the Project AoI that contain biodiversity with significant social, cultural or economic importance to the local communities. The Sialang trees which are historically important to the Malay Batin and were used to collect Sialang honey. In present day the majority of the Sialang trees have been cut down for production plantation forest. There are only two trees known to remain and are located on the banks of the Siak River in Industri Tenayan. It is understood that these trees are located outside of the Project area. | No |

#### 3.10.9.6 Conclusion

The Critical Habitat Screening Assessment found that Criterion 1 Tier 2 of the IFC Critical Habitat criteria is triggered due to the presence of Critically Endangered species, sunda pangolin within the sunda pangolin DMU boundary. Under the ADB criteria Critical Habitat is also triggered due to the presence of the sunda pangolin within the sunda pangolin DMU boundary. Any impacts and appropriate mitigations applicable to the Critical Habitat is discussed further in Section 12.

Although the area of habitat where the agile gibbons are located is avoided by the Project and Critical Habitat is not triggered for this species, mitigation and management measures will be implemented to avoid and minimise any potential disturbance to this Endangered species during constriction.

Table 3.35 set out below outlines the ADB and IFC criteria required for a Project to be able to proceed within Critical Habitat and how the Project meets these criteria.

**Table 3.35: ADB and IFC Criteria Required for a Project Located in Critical Habitat**

| ADB Criteria and IFC Criteria | Project Justification |
|---|---|
| **ADB Criteria** | |
| There are no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function. | Critical Habitat is triggered based on presence of sunda pangolin rather than suitable habitat values being identified. Impacts are discussed further in Section 12 including management / mitigation measures to ensure no measurable adverse impacts on the sunda pangolin. |
| The project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised. | Impacts are discussed further in Section 12 including management / mitigation measures to ensure there are no reductions in the population of the sunda pangolin or other species of concern noted as being present. |
| Any lesser impacts are mitigated in accordance with para. 27 –<br>Para 27. Mitigation measures will be designed to achieve at least no net loss of biodiversity. They may include a combination of actions, such as post-project restoration of habitats, offset of losses through the creation or effective conservation of ecologically comparable areas that are managed for biodiversity while respecting the ongoing use of such biodiversity by Indigenous Peoples or traditional communities, and compensation to direct users of biodiversity. | Impacts are discussed further in Section 12 including management / mitigation measures |
| **IFC Criteria** | |
| No other viable alternatives within the region exist for development of the project on modified or natural habitats that are not critical. | Critical Habitat is triggered based on presence of the Sunda Pangolin. The species is found across all of Sumatra. As noted in Figure 3.44, the majority of the Project is located in Modified Habitat with discrete patches of Natural Habitat. |
| The project does not lead to measurable adverse impacts on those biodiversity values for which the critical habitat was designated, and on the ecological processes supporting those biodiversity values. | Critical Habitat is triggered based on presence of sunda pangolin rather than suitable habitat values being identified. Impacts are discussed further in Section 12 including management / mitigation measures to ensure no measurable adverse impacts on the sunda pangolin. |

| ADB Criteria and IFC Criteria | Project Justification |
|---|---|
| The project does not lead to a net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time. | Impacts are discussed further in Section 12 including management / mitigation measures to ensure there are no reductions in the population of the sunda pangolin or other species of concern noted as being present. |
| A robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the client's management program | A Biodiversity Action Plan (BAP) as described further in Section 12 has been prepared for the Project – see ESIA Volume 5 – Technical Appendices. |

## 3.11 Traffic

### 3.11.1 Main Road

The main north-south highway extending along the spine of Sumatra (named Jl. Lintas Timur Sumatra) runs approximately 5 km south-west of the site and through the city of Pekanbaru (Figure 3.46).


**Figure 3.46 : Map Showing Sumatra Highway Network and the Route from the Ports of Belawan and Dumai to the Site**

It extends 2,500 km along the length of the eastern side of Sumatra from Pelabuhan Bakauheni in the far south to Banda Aceh in the north connecting the cities of Palembang, Jambi, Pekanbaru and Medan. In rural areas, the highway typically has a six-metre-wide two lane paved carriageway with no passing lanes, roadside barriers, sealed shoulders or median barriers. There is significant ribbon development scattered along the highway including retailing, residential and commercial activity. This route will be used to transport material and equipment from Belawan Port and Dumai Port to the site.

### 3.11.2 Local Roads

The existing road network immediately surrounding the site is shown in Figure 3.47 below.


**Figure 3.47 : Map Showing Road Network Around the Power Plant Site**

Immediately surrounding the site there is a network of dirt roads accessing palm oil plantations, many of which would be unsuitable for construction traffic as they are of poor quality and are too narrow. There are currently no useable road links for trucks to the east and west of the site.

A wide and straight dirt road runs from the settlement in the south to the existing coal fired power station on the Siak River to the north. For the proposed power plant, this road provides access for land transport to the Main Road (Jl. Lintas Timur Sumatra). To the north, it extends to the site of the proposed jetty, potentially allowing access for materials transported via river barges. Sections of this road are currently being paved in asphalt.

Between the dirt road to the power plant and the Main Road are narrow sealed roads Jl. Hangtuah and Jl. Badak Ujung which run through a residential area. Parts of Jl Badak Ujung have recently been sealed. The seal is approximately 5.5 m wide.

There are two significant intersections which road transport would pass through when travelling between the proposed power plant and the Main Road. They are the Jl Hantuah / Jl Badak Ujung intersection and the intersection of Jl. Hangtauh with the Main Road.

The layout of both intersections are typical of designs commonly found on arterial roads within Indonesia. The intersection of Jl Hantuah and Jl Badak Ujung is an uncontrolled T-intersection with an unpaved triangular shaped island in the middle of the intersection. The intersection between Jl. Hangtauh and Jl. Lintas Timur Sumatra (the Main Road) is a wide unmarked T-intersection.

The wide open design of these intersections with little signage or road marking provides little guidance to drivers on how the designer intended they should be used. Potentially this could lead to safety issues.

### 3.11.3 Pedestrian Network

On roads in the vicinity of the proposed power plant and the propose gas pipeline, there is no pedestrian infrastructure including footpaths. As in much of Indonesia, people typically walk along the road shoulder.

### 3.11.4 Cycling Network

There is no cycling infrastructure around the site or in the settlement to the south of the power plant.

### 3.11.5 Public Transport

There is little information available on public transport services in the settlement to the south of the power plant due to the informal nature of the public transport sector in Indonesia. However, it is likely that privately owned minibuses (Angkot) and motor cycle taxi's (Ojek) serve the settlement.

### 3.11.6 Road Traffic Counts

Traffic counts were undertaken on the 25th of January, 27th of January and 1st of February 2018 (all work days). The locations where the counts were taken are shown in the map below (Figure 3.48).

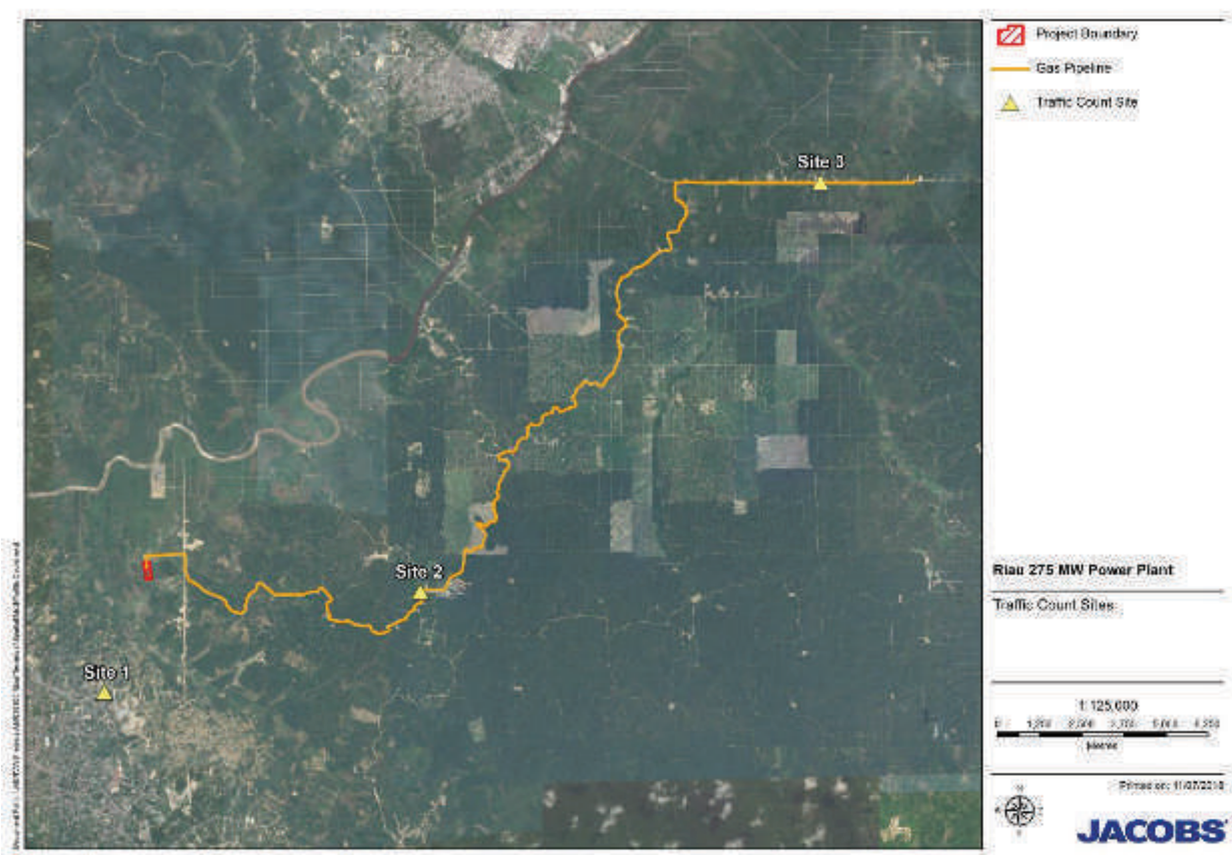

**Figure 3.48 : Map Showing Location of Traffic Counts**

Traffic counts were undertaken over the following periods:

- Morning Period – 7-9 am (two hours);
- Midday Period – 11 am-1 pm (two hours); and
- Afternoon Period – 2 pm-7 pm (five hours);

Both directions of flow were counted. The counts were classified into car, taxi / minivan, large bus, light truck, heavy truck, motorbike, bicycle, and Tuk tuk.

The first location where traffic counts were undertaken is the intersection of Jl. Hangtuah and Jl. Badak Ujung roads. This road will be used by construction traffic travelling from the Main Road to the power plant site. The results of the survey are shown in Figure 3.49.

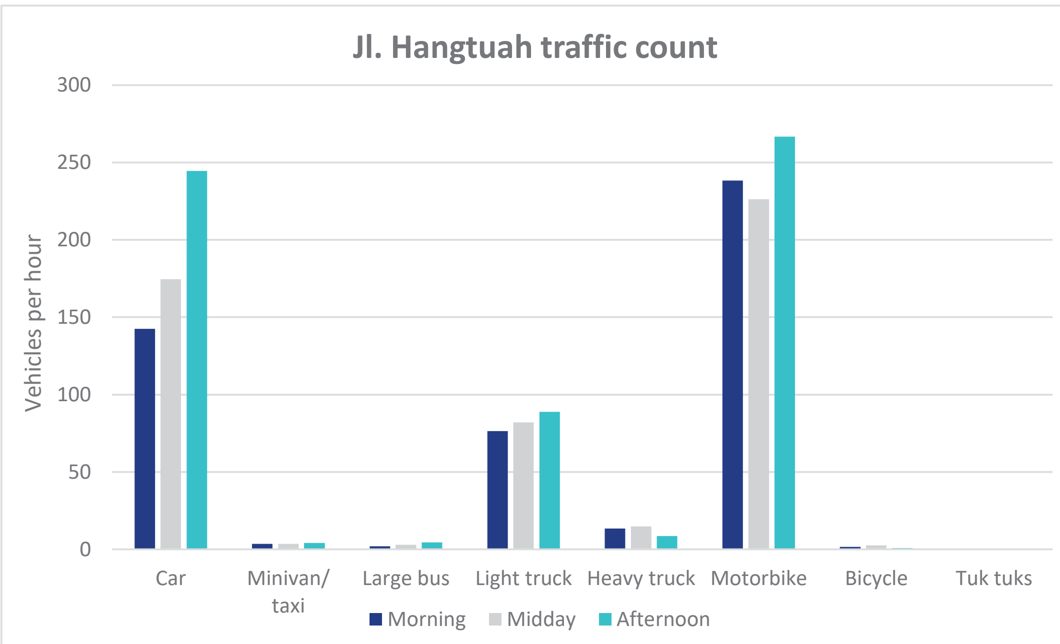


**Figure 3.49 : Graph Showing Traffic Counts for Location One: Jl. Hangtuah**

The figure shows motorbikes were the most common vehicle counted on Jl Hangtuah with cars being the second most common and light trucks coming in third. The number of minivans/ taxi's, large buses, bicycles and tuk tuks observed was very low and light trucks greatly outnumbered large trucks.

Counts were highest in the afternoon when flows were around 619 vehicles per hour (vph). The second location that traffic counts were undertaken is half way along Jl. Lintas Maredan – Simpang Beringin at the intersection with an unnamed palm oil plantation road (Figure 3.50). This road will be used by traffic travelling to the pipeline construction site. Movement on this road will also need to be managed through temporary traffic controls during the construction of the 40 km long gas pipeline.

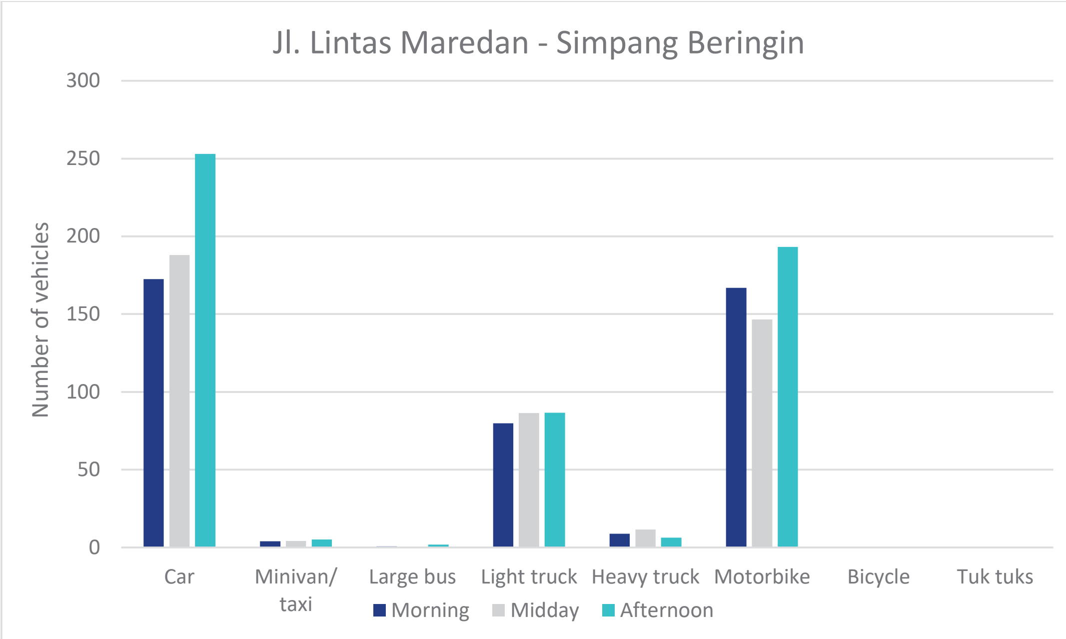


**Figure 3.50 : Graph Showing Traffic Counts for Location Two: Jl. Lintas Maredan – Simpang Beringin**

The figure shows cars and motorbikes are the most common vehicles at this location with a mode split of roughly 40% cars, 40% motorbikes and 20% trucks. Counts were highest in the afternoon when flows were around 433 vph.

The third location that traffic counts were undertaken is half way along Jl. Perawang – Siak (Figure 3.51). This road will also be used by traffic travelling to the pipeline construction site. Movement on this road will also need to be managed through tempoary traffic management during the construction of the 40 km long gas pipeline.

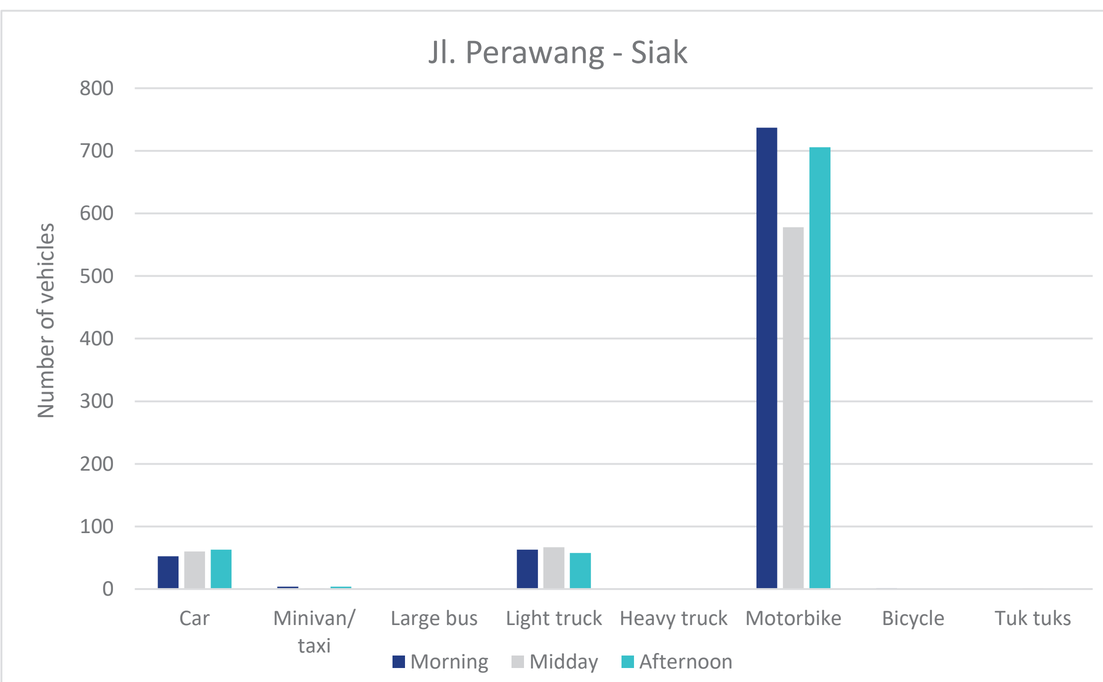


**Figure 3.51 : Graph Showing Traffic Counts for Location Three: Jl. Perwang – Siak**

At this location motorbikes, are by far the most common vehicle with flows of around 740 vph compared with only 60 vph for cars and 60 vph for light trucks. The highest flow was 858 vph, and unlike the other sites where flows were slightly higher in the afternoon, at this site the highest flow occurred in the morning.

### 3.11.7 River Traffic Count

A count of the boats using the Siak River was undertaken on the 24th of February 2018 between 8am and 6pm at the location of the proposed temporary jetty. This count was undertaken to gain an understanding of how much traffic was using the river and whether there was likely to be an impact from using the river to transport overweight loads to the site. The results of the survey are shown in Figure 3.52.

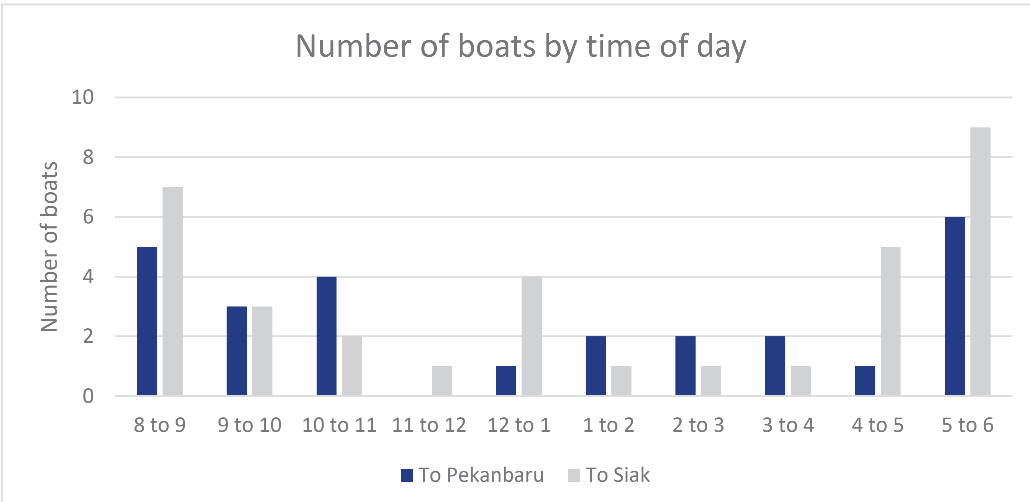


**Figure 3.52 : Graph Showing the Number of Boats by Time of Day that were Counted on the Siak River**

The figure shows the early morning and late afternoon were the busiest times for river traffic, with flows at these times being more than twice as flows during the middle of the day.  The peak flow was 14 boats per hour, which occurred between 4:00pm and 6:00pm. Overall there were 26 boats that went up river to Pekanbaru and 34 boats that went down river to Siak during the 10-hour survey period. Figure 3.53 shows the category of boat survey.

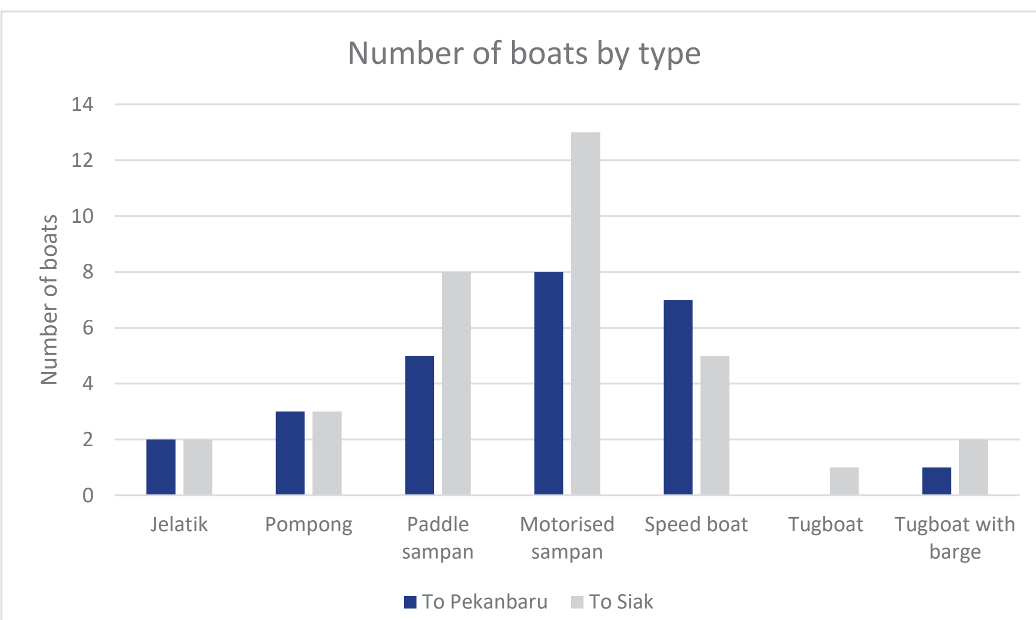

**Figure 3.53 : Graph Showing the Number of Boats by Type that was Counted on the Siak River**

Boats were grouped into seven categorises which are jelatik (medium sized wooden boat), pompong (small wooden boat with v shape haul), paddle sampan (small flat bottom wooden boat which is moved by paddling), motorised sampan (small flat bottom wooden boat with a motor), speed boat, tugboat and tugboat with barge.

Small boats (pompon, sampan and speed boats) were the most common type of boats on the Siak River making up 52 out of 60 boats counted (Figure 3.46). There was one tugboat and three tugboats with barges that would likely be going to and from the port of Pekanbaru.

### 3.11.8 Crash Analysis

No specific crash data is available for the roads around the proposed power plant or in the city of Pekanbaru as this information is not collected in a comprehensive manner.

For this reason, consideration has been given to road safety in Indonesia as a whole as it would seem likely that crash patterns in the local area would be similar to those for Indonesia as a whole.

It is estimated that there are 32,000 road crash fatalities in Indonesia per year, or around 90 fatalities per day (Australian Aid). This puts the fatality rate per capita at about 14 fatalities per 100,000 people. By comparison, Sweden, which is one of safest countries in the world, has a fatality rate of below 3 (Australian Aid).

Motorcyclists and pedestrians make up the substantial majority of road fatalities in Indonesia with 50-60% of fatalities being motorcyclists and 20-30% being pedestrians.

The fatality rate in Indonesia is possibly attributable to a mixture of factors including:

- The interaction of motorbikes, trucks and pedestrians within the carriageway;
- Overloading of trucks and motorbikes;
- Ribbon development along main roads;
- The overall standard and condition of roading infrastructure; and
- Road user behaviour.

The roads in the vicinity of the proposed power plant are typical of those within Indonesia and so it is expected that their safety, and the factors associated with road safety are likely to be similar to other roads within the country.