Environmental and Social Impact Assessment Report (ESIA) – Part 5

Project Number: 51112-001
August 2018

INO: Jawa-1 LNG to Power Project

Prepared by ERM for PT Jawa Satu Power (JSP)

PLTGU Jawa 1 Independent Power Project

ANNEX D
AIR QUALITY ASSESSMENT

Prepared for:

PT Jawa Satu Power (JSP)

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1 INTRODUCTION

1.1 OVERVIEW

The PLTGU Jawa-1 Project (hereafter referred to as 'the Project') involves the development of a 1,760MW Combined Cycle Gas Turbine (CCGT) Power Plant, a Liquefied Natural Gas (LNG) Floating Storage and Regasification Unit (FSRU) and 500kV power transmission lines and a Substation.

Emissions to air from the Project have the potential for adverse effects on human health, agricultural and sensitive ecology. This air quality impact assessment assesses these potential impacts against relevant air quality standards, objectives and guidelines where relevant.

The assessment of potential air quality impacts associated with the Project considers:

- sources, nature and quantity of emissions to air;
- a qualitative assessment of construction and decommissioning phase impacts;
- a detailed quantitative assessment of process emissions;
- an assessment of potential impacts on relevant sensitive receptors; and
- mitigation measures to reduce the impacts where necessary.

2 LEGAL FRAMEWORK AND BEST PRACTICE

2.1 OVERVIEW

The International Finance Corporation (IFC) Environmental, Health and Safety (EHS) guidelines are considered throughout the assessment and provide the overarching guidance and principles for undertaking the assessment. The key documents considered are:

- IFC General EHS Guidelines: Air Emissions and Ambient Air Quality (1);
- IFC General EHS Guidelines: Construction and Decommissioning (2);
- IFC EHS Guidelines for Thermal Power Plants (3);
- IFC EHS Guidelines for Liquefied Natural Gas (LNG) Facilities (4); and
- IFC EHS Guidelines for Shipping (5).

Where necessary, other internationally recognised sources of information are referred to including guidelines from: the World Health Organisation (WHO); the European Union (EU); United States Environmental Protection Agency (USEPA); the Australian National Pollution Inventory (NPi); and/or various guidelines and methodologies from the Department of Environment and Rural Affairs (DEFRA) and reputable air quality institutes and working groups such as the Institute of Air Quality Management (IAQM).

(1) International Finance Corporation (IFC) (2007) Environmental, Health and Safety Guidelines, General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality [Online] Available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines [Accessed 06 February 2018]

(2) International Finance Corporation (IFC) (2007) Environmental, Health and Safety Guidelines, General EHS Guidelines: Construction and Decommissioning [Online] Available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines [Accessed 06 February 2018]

(3) International Finance Corporation (IFC) (2007) Environmental, Health and Safety Guidelines for Thermal Power Plants [Online] Available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines [Accessed 06 February 2018]

(4) International Finance Corporation (IFC) (2017) Environmental, Health and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities [Online] Available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines [Accessed 06 February 2018]

(5) International Finance Corporation (IFC) (2007) Environmental, Health and Safety Guidelines for Shipping [Online] Available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines [Accessed 06 February 2018]

2.2 *AIR QUALITY STANDARDS AND GUIDELINES*

2.2.1 *International Finance Corporation - Human Health*

The IFC's General EHS guidelines for air emissions and ambient air quality state that:

- *Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines, or other internationally recognised source; and*

- *Emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards. As a general rule, this Guideline suggests 25 percent of the applicable air quality standards to allow additional, future sustainable development in the same airshed.*

Indonesia has established ambient air quality standards which are published in the Government *Regulation of the Republic of Indonesia Number 41 (1999)* regarding Air Pollution Control (PP41/1999) and are presented below in **Table 2.1**. Where relevant the World Health Organisation (WHO) [(1)] guideline values are also presented for comparison. The WHO does not specify these guideline values as air quality standards *per se.* and state that *"considerations such as prevailing exposure levels, technical feasibility, source control measures, abatement strategies, and social, economic and cultural conditions should also be taken into account, and in certain circumstances there may be valid reasons to pursue policies that will result in pollutant concentrations above or below the specified guideline values".*

In accordance with the IFC guidelines the Indonesian air quality standards will be used for comparison of baseline data and predicted impacts in this air quality impact assessment.

([1]) World Health Organisation (WHO) (2000) Air Quality Guidelines for Europe, Second Edition [Online] Available at: http://www.euro.who.int/__data/assets/pdf_file/0005/74732/E71922.pdf?ua=1 [Accessed 22 May 2018]

Table 2.1 Ambient Air Quality Standards and Guidelines

Parameter	Averaging Period	Indonesian Air Quality Standard (µg/m³)	WHO Air Quality Guideline Value (µg/m³)
Nitrogen Dioxide (NO2)	1-hour	400	200 (guideline)
	24-hour	150	n/a
	Annual	100	40 (guideline)
Sulphur dioxide (SO_2)	1-hour	900	n/a
	24-hour	365	125 (Interim target-1) 50 (Interim target-2) 20 (guideline)
	Annual	60	n/a
Carbon Monoxide (CO)	1-hour	30,000	30,000
	24-hour	10,000	n/a
Total Suspended Particulate (TSP)	24-hour	230	n/a
	Annual	90	n/a
Particulate Matter (PM_{10})	24-hour	150	150 (Interim target-1) 100 (Interim target-2) 75 (Interim target-3) 50 (guideline)
Particulate Matter ($PM_{2.5}$)	24-hour	65	75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) 25 (guideline)
	Annual	15	35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) 10 (guideline)
Ozone (O_3)	1-hour	50	n/a
	Annual	235	n/a
Lead (Pb)	24-hour	2	n/a
	Annual	1	0.5
Hydrocarbons (HC)	3-hours	160	n/a
Total Fluorides (F)	24-hour	3	n/a
	90 days	0.5	n/a
Chlorine and Chlorine dioxide	24-hour	150	n/a

2.2.2 *International Finance Corporation - Ecology and Agriculture*

The IFC's General EHS guidelines for air emissions and ambient air quality (1) states that:

"Facilities or projects located within or next to areas established as ecologically sensitive (e.g. national parks), should ensure that any increase in pollution levels is as

(1) International Finance Corporation (IFC) (2007) Environmental, Health and Safety Guidelines, General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality [Online] Available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines [Accessed 06 February 2018]

small as feasible, and amounts to a fraction of the applicable short term and annual average air quality guidelines or standards as established in the project specific environmental assessment."

In terms of potential impacts to ecology and agriculture, local assessment criteria do not exist and the IFC do not set standards or guidelines for the protection of vegetation, however, guidelines and standards from the WHO and the EU exist and are therefore used to inform the assessment where necessary.

Air quality critical levels for the protection of sensitive ecological areas and agriculture adopted in this air quality impact assessment are presented below in **Table 2.2**. The critical level is the concentration in the atmosphere above which direct adverse effects on ecological receptors, such as plants or ecosystems may occur. These critical levels will be used for comparison against predicted impacts in this air quality impact assessment.

Table 2.2 Air Quality Critical Levels used for the Assessment of Impacts on Sensitive Ecological and Agricultural Receptors

Substance	Averaging Period	Critical Levels ($\mu g/m^3$)(1,2)
Nitrogen Oxides (NO_x)	Annual mean	30
Sulphur dioxide (SO_2)	Annual Mean	20

(1) World Health Organisation (WHO) Air Quality Guidelines for Europe, 2nd edition (2000) [Online] Available at: http://www.euro.who.int/__data/assets/pdf_file/0005/74732/E71922.pdf [Accessed 01 February 2018]

(2) Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on Ambient Air Quality and Cleaner Air for Europe Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0050&from=EN [Accessed 01 February 2018]

2.2.3 Guideline Air Emission Levels

International Finance Corporation

The IFC EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by using existing technology at reasonable costs. The IFC Performance Standard for 'Resource Efficiency and Pollution Prevention' (1) states that:

"when host country regulations differ from the levels and measures presented in the World Bank Group EHS Guidelines, projects are required to achieve whichever is the more stringent. If less stringent levels or measures than those provided in the EHS

(1) International Finance Corporation (IFC) (2012) Resource Efficiency and Pollution Prevention [Online] Available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/performance-standards/ps3 [Accessed 01 February 2017]

Guidelines are appropriate in view of specific project circumstances, a full and detailed justification must be provided for any proposed alternatives through the environmental and social risks and impacts identification and assessment process. This justification must demonstrate that the choice for any alternate performance levels is consistent with the objectives of this performance standard."

The relevant emission limits as per the IFC EHS Guidelines for natural gas fired thermal power plants greater than 50 megawatt thermal input (MWth) are presented in **Table 2.3**.

Table 2.3 ***International Finance Corporation (IFC) Air Emissions Guidelines for Combustion Turbine (>50MWth)***

Combustion Technology / Fuel	Particulate Matter (PM)	Sulphur Dioxide (SO_2)	Nitrogen Oxides (NO_x)	Dry Gas, Excess O_2 content (%)
	in mg/Nm³ or as indicated			
	NDA(1) / DA(2)	NDA(1) / DA(2)	NDA(1) / DA(2)	
Natural Gas (all turbine types of unit >50MWth(3))	n/a	n/a	51 (25ppm)	15%

(1) Non-degraded airshed
(2) Degraded airshed
(3) Megawatt thermal input

Indonesian Regulation on Emission of Thermal Power Industry

Indonesia has established industry specific emission limit guidelines for gas fired power plants published in the Indonesian *Regulation of the Minister of Living Environment Number 21 (2008).* These guideline values are presented below in **Table 2.4**.

Table 2.4 ***Environmental Ministry Regulation No. 21 Year (2008) Emission Limits for Gas Fired Power Plant***

Combustion Technology / Fuel	Particulate Matter (PM)	Sulphur Dioxide (SO_2)	Nitrogen Oxides (NO_x)
Gas	30	150	320

(1) The gas volume is measured in standard state (25 ° C and atmospheric pressure 1).
(2) All parameters were corrected with O_2 by 15% in dry state

Applicable Emission Limits

In accordance with the IFC performance standards the NO_x emission guidelines advocated by the IFC should take precedence as it is more stringent that the local emission limits for gas fired power plants. On this basis the CCGT power plant should be designed so that NO_x emission concentrations do not exceed 51mg/Nm³.

The impact on air quality resulting in emissions of SO_2 and PM from the CCGT power plant have been scoped out of this air quality impact assessment and this is discussed in more detail in **Section 3.9**.

2.2.4 *Stack Height*

The IFC EHS guideline for ambient air quality and air emissions set out the Good International Industry Practice (GIIP) general approach for determining the stack height so as to avoid downwash from nearby structures. The guidance also provides information on the structures which should be considered. The guidance specifically states that the GIIP approach is recommended in order to "*to avoid excessive ground level concentrations due to downwash, wakes, and eddy effects, and to ensure reasonable diffusion to minimize impacts.*"

In order to assess whether any nearby structures would result in excessive ground level concentrations due to building downwash, relevant buildings were included in the dispersion model as discussed in more detail in **Table 5.21.** Furthermore, a variety of stack heights were considered including 60m (base case), 65m, 70m, 75m and 82m (GIIP stack height).

The modelling results were compared to the Indonesian air quality standards (**Table 2.1**) to evaluate the stack height required to avoid excessive offsite ground level concentrations due to the operation of the CCGT power plant. The assessment is presented in **Section 5.4**.

3 SCREENING ASSESSMENT

3.1 OVERVIEW

This section presents the findings of a preliminary qualitative screening assessment undertaken to identify Project activities, processes and emissions which require consideration within the scope of the detailed air quality impact assessment presented in **Section 5**.

3.2 ON SITE CONSTRUCTION PLANT

During the construction phase of the Project there will be a requirement for mobile and non-mobile plant, including, for example, bulldozers, loaders, excavators, mobile cranes, pile machines, graders, scrappers, pile driver excavators, dump trucks, and generators, etc. Elevated ambient concentrations of nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and particulate matter ($PM_{2.5}$ and PM_{10} (1)) from the exhaust emissions are expected. The Institute of Air Quality Management (IAQM) (2) states that:

"exhaust emissions from on-site plant (also known as non-road mobile machinery or NRMM) and site traffic suggests that they are unlikely to make a significant impact on local air quality, and in the vast majority of cases they will not need to be quantitatively assessed. For site plant and on-site traffic, consideration should be given to the number of plant/vehicles and their operating hours and locations to assess whether a significant effect is likely to occur."

The detailed construction schedule including locations of individual sources in any given period of time is not known. Emissions to air from onsite mobile and non-mobile plant will be intermittent and spatially variable throughout the construction phase period as different activities take precedence. The impacts to air quality will be highly dependable on the operating time of individual mobile and non-mobile plant, meteorological conditions and the relative distance to sensitive receptors. On this basis it is recognised that a representative and accurate dispersion model is difficult to define.

(1) TSP shall mean particulate matter with an aerodynamic diameter no greater than 30 µg: PM_{10} shall mean particulate matter with an aerodynamic diameter no greater than 10µg; and $PM_{2.5}$ shall mean particulate matter with an aerodynamic diameter no greater than 2.5µg. Definitions from United States Environmental Protection Agency (USEPA) (1995) AP-42 Section 13.2 Fugitive Dust Sources [Online] Available at: https://www3.epa.gov/ttnchie1/ap42/ch13/ [Accessed 06 February 2018]

(2) Institute of Air Quality Management (IAQM) (2014) Guidance on the Assessment of Dust from Demolition and Construction [Online] Available at: http://iaqm.co.uk/guidance/ [Accessed 06 February 2018]

Instead, whilst it is acknowledged that exhaust emissions will have some impact on air quality, the assumption is that with the implementation of internationally recognised good practice air quality management measures for land based vehicles and equipment such as those presented in the IFC EHS Guidelines for Air Emissions and Ambient Air Quality (1), impacts to relevant sensitive receptors in the study area due to exhaust emissions from diesel powered vehicles and equipment used on site are considered negligible and are therefore not considered further.

3.3 GENERAL CONSTRUCTION ACTIVITIES

Elevated ambient concentrations of TSP and PM_{10} from earthwork activities, construction of the Project infrastructure, and trackout of dusty materials onto the public road network has the potential to cause impacts on sensitive receptors in the vicinity of the named activities if not managed accordingly. Dust deposition and/or visible dust plumes arising from construction sites can also cause nuisance affecting local amenities and quality of life. Dust emissions can vary substantially from day to day and will depend on the level of activity, the specific operations being undertaken and the meteorological conditions at the time of release. Given the complexity and specific nature of fugitive dust emissions, the potential impacts to air quality from construction related activities could lead to significant adverse impacts on air quality and have therefore been given further consideration in **Section 5.2** this air quality impact assessment.

3.4 OFFSITE TRAFFIC

The Project will generate additional traffic on the local road network during construction and operation phase as a result of worker vehicles and vehicles delivering materials to site and removing residual products. The Institute of Air Quality Management (IAQM) states that:

"For site traffic on the public highway, if it cannot be scoped out (for example by using the EPUK's criteria), then it should be assessed using the same methodology and significance criteria as operational traffic impacts."

The Environmental Protection UK (EPUK) (2) indicative criterion to proceed with a detailed air quality impact assessment is as follows:

(1) International Finance Corporation (IFC) (2007) Environmental, Health and Safety Guidelines, General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality [Online] Available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines [Accessed 06 February 2018]

(2) Guidance from the Environmental Protection UK and Institute of Air Quality Management (IAQM) (2017) Land-Use Planning & Development Control: Planning for Air Quality [Online]

- daily traffic flows increase by more than 500 vehicles/day; and/or
- heavy goods vehicles (HGV) flows increase by more than 100 vehicles/day.

During the construction phase it is expected that more than 40,000 vehicles will be utilised for material transportation required for the construction of the CCGT. This includes the mobilisation of vehicles to transport 57,000 m^3 of infill soil for levelling of the CCGT site. Based on an 8 m^3 (>3.5t) dump truck capacity this is estimated to be approximately 200 dump truck trips/day to the CCGT site. Transportation of the 57,000 m^3 construction materials for the CCGT requires an estimated 27,360 trips or 76 truck trips/day over the construction period. For the Cibatu substation site, approximately 15,000 truck trips are required for the site levelling, equating to 120 truck trips/day. For jetty construction, the transportation of infill material to site, small equipment and construction materials is estimated to require approximately 14 truck trips/day. Construction of the transmission towers will require a total of approximately 1,000 trips per year to transport materials such as steel piece, cement, sand and gravel.

Although the exact traffic route(s) and specific traffic flow increases on each route are unknown, the above information indicates that traffic flows during the construction phase of the project may exceed the EPUK criterion on certain roads. The potential impacts to air quality from exhaust emissions from offsite traffic therefore requires further consideration within the detailed air quality impact assessment and is presented in **Section 5.3**.

The specific increase in traffic flows during the operation phase is not known, however vehicle journeys during the operation phase are expected to be substantially less than during the construction phase and primarily associated with the workforce employed at the plant and some occasional deliveries etc. The change in traffic flows during the operation phase are not expected to exceed the EPUK screening criteria thus impacts to air quality are considered negligible and not considered further.

3.5 UNPAVED ACCESS ROADS

Elevated ambient concentrations of TSP and PM_{10} from vehicles operating on unpaved access roads has the potential to cause impacts on sensitive receptors within several hundred meters from the road. Dust deposition and/or visible dust plumes arising from unpaved roads can cause nuisance affecting local amenities and quality of life.

Available at: http://www.iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf [Accessed 06 February 2018]

The main existing access road to the power plant site is paved, therefore dust emissions are not considered likely. It is understood that new access roads will be constructed for main access to the power plant and within the plant area itself. There will also be a new access road to connect the power plant to the jetty and intake pumping station area. It is expected that these roads will be paved therefore dust emissions are not considered likely.

The access to the construction areas associated with the transmission lines will be via existing main roads where possible. The exact route and proximity to sensitive receptors has not been defined, however it is expected that with the implementation of standard good practice mitigation measures, dust from unpaved roads can be controlled and reduced to an acceptable level throughout the duration of the construction phase.

The likely impacts from dust emissions and suggested mitigation is discussed in detail in **Section 5.2** of this air quality impact assessment. The relevant control measures should be applied to unpaved access roads associated with the Project throughout the construction and operation phase where necessary.

3.6 SHIPPING

The Project will generate additional ships during the construction and operation phase. Exhaust emissions of NO_x, NO_2, SO_2, $PM_{2.5}$ and PM_{10} from these ships has the potential to adversely impact ambient air quality. Research from UK technical guidance document TG (16) [(1)] recommends that a detailed assessment is only required for large ports, defined as more than 5,000 movements per year, and where there is relevant public exposure within 1km of berthing and manoeuvring.

During the construction and operation phase it is not known how many ship movements will be required exactly, but it is expected that the emission will be intermittent, short term and transient in nature; and the number of ship movements will not exceed 5,000. It is further expected that the international good practice recommendations to prevent, minimise and control exhaust emissions from ships presented in the IFC EHS Guidelines for Shipping [(2)] will be implemented the construction and operation phase. On this basis the

(1) Department for Environment Food and Rural Affairs (DEFRA) Local Air Quality Management Technical Guidance (TG16) (2016) [Online] Available at: https://laqm.defra.gov.uk/documents/LAQM-TG16-April-16-v1.pdf [Accessed 06 February 2018]

(2) International Finance Corporation (IFC) (2007) Environmental, Health and Safety Guidelines for Shipping [Online] Available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines [Accessed 06 February 2018]

potential impacts of shipping emissions are considered negligible and have not been considered further.

3.7 *FLOATING STORAGE AND REGASIFICATION UNIT (FSRU)*

The FSRU will be equipped with three Wartsila 8L34DF and one Wartsila 6L34DF dual fuel generators required for normal operational activities (1). The generators will operate using liquefied natural gas (LNG) boil-off gas (BOG) during normal operation and will comply with the International Maritime Organisation (IMO) Tier 3 NO_x emission standards. The generators will also have the capacity to operate using diesel oil should the supply of BOG be interrupted. In diesel mode the generators are IMO Tier 2 compliant.

During normal operating conditions three sets of main generator engines will be in operation, with one on standby. The mass emission rates from the generators operating in gas mode are presented in **Table 3.1**. This information has been provided by the FSRU builders for the purpose of this impact assessment. The interruption of BOG supply to the generators is considered infrequent therefore the operation in diesel mode has not been considered.

Table 3.1 FSRU Duel-Fuel Generator Information Operating on Liquefied Natural Gas (LNG) Boil Off Gas (BOG)

Parameter[1]	**Unit**	**Generator Information**		
Description		No.1 Main Generator Engine	No.2 Main Generator Engine	No.4 Main Generator Engine
Stack height	m	~51	~51	~51
Exhaust gas pipe diameter	m	0.660	0.660	0.610
Mass flow rate [2]	kg/h	18289	18289	13725
Emission temperature [2][3]	C	252	252	244
Mass Emission Rates				
NO_x	kg/hr	3.7	3.7	2.8
PM	kg/hr	0.029	0.029	0.022
SO_2	kg/hr	Negligible	Negligible	Negligible

(1) During normal operating condition (considering regas. capacity of 300 mmscfd), 3 sets of main generator engines are operating. The other fuel consumption equipment are not operating (e.g., auxiliary boilers, GCU).
(2) Based on ISO condition and gas mode
(3) Exhaust gas temperature after economiser

(1) Wartsila 34DF Product Guide [Online] Available at: https://cdn.wartsila.com/docs/default-source/product-files/engines/df-engine/product-guide-o-e-w34df.pdf?sfvrsn=6 [Accessed 29 May 2018]

Exhaust emissions of NO_x, SO_2, and PM has the potential to adversely impact ambient air quality. The IFC EHS Guidelines for Air Emissions and Ambient Air Quality (1) states that:

"significant sources of point emissions are considered to be a general source which contribute a net emission increase of one or more of the following pollutants within a given airshed: PM_{10}: 50 tons per year (tpy); NO_x: 500 tpy; SO_2: 500 tpy."

Based on the Project information provided in **Table 3.1**, the estimated net emission increase of NO_2 and PM is 32.4tpy and <1tpy respectively when considering a regasification capacity of 300 million standard cubic feet per day (mmscfd). The SO_2 emission to air from LNG BOG combustion is considered negligible. The mass emission rates for NO_x, PM and SO_2 are therefore well below the IFC criteria and can therefore be considered not significant. Furthermore, the FSRU will be located 8km from the shore and any sensitive receptor locations. The evidence presented suggests that the potential impacts on ambient air quality at sensitive receptors will be negligible and have not been considered further.

3.8 *ONSHORE RECEIVING FACILITY (ORF)*

During the operation phase of the Project there will be a 70 m high pressure cold gas vent located at the ORF. The purpose of the vent is to safely dispose of hydrocarbon to atmosphere under maintenance and emergency relief. The composition of the vented gas is presented in **Table 3.2**. The gas is 'sweet' meaning it is largely free of acidic gases such as carbon dioxide (CO_2) and hydrogen sulphide (H_2S) and consists primarily of methane (CH_4). Methane is relatively non-toxic and has no ambient air quality standard associated with it. It is noted that some small quantities of other hydrocarbons exist in the feed gas, however these are very small and considered unlikely to have an adverse impact on ambient air quality given the height of the stack and the occasional and short term nature of venting. Furthermore, the vent stack will be designed to account for the hydrocarbon lower explosive limits (LELs) acceptable on the facility and will have sufficient velocity to mix air with gas to maintain the mixed concentration below the flammable limit. It is expected that this design will effectively mix and disperse the gas into the atmosphere and impacts on air quality at ground level will be negligible. On this basis the potential impacts on air quality from the cold gas vent are considered negligible and have not been considered further.

(1) International Finance Corporation (IFC) (2007) Environmental, Health and Safety Guidelines, General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality [Online] Available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines [Accessed 06 February 2018

Table 3.2 Feed Gas Composition

Component	Typical Value (% Mol)	Min/Max value (% Mol)
Oxygen	0.00	Max 0.2%
Nitrogen	0.35	Max 1%
Carbon Dioxide	0.00	Max 3%
Methane	96.66	Min 85%
Ethane	2.30	Max 8%
Propane	0.47	Max 4%
i-Butane	0.09	Max 2%
n-Butane	0.11	Max 2%
i-Pentane	0.02	Max 0.1%
n-Pentane	0.00	Max 0.2%
HHV (BTU/SCF)	1036	1000 to 1150

3.9 COMBINED CYCLE GAS TURBINE (CCGT) POWER PLANT

The combustion of natural gas in the 1,760MW thermal power plant has the potential to impact air quality at sensitive receptors across a wide area depending on operating conditions and meteorological conditions. The European Commission[1] Best Available Techniques (BAT) Reference Document for Large Combustion Plants specifies that the emissions from the combustion of natural gas are principally NO_x and CO with mostly negligible dust and SO_2 emissions. The document further states that dust and SO_2 emissions are not an environmental concern under normal and controlled combustion conditions.

The combustion of natural gas in the CCGT power plant and the subsequent NO_x and CO emissions to air are considered the main focus of this air quality impact assessment and is given further detailed consideration in **Section 5.4**.

3.10 DIESEL ENGINE-GENERATORS

The Project will be equipped with twelve 2MWel (24MWel total) diesel powered engine-generators required to start-up the main power plant (i.e. black start) and for safe shutdown in the event of loss of main power supply from the Jawa-Bali 500 kV grid. Information sourced directly from PLN, Indonesia's government owned electricity corporation, indicates that since its establishment, the Jawa-Bali 500 kV grid has experienced one complete black out in 1997, and a partial black out in 2005. The occurrence of a blackout is therefore considered a rare occurrence and the use of the diesel generators is

(1) European Commission (2017) Best Available Techniques (BAT) Reference Document for Large Combustion Plants [Online] Available at: http://eippcb.jrc.ec.europa.eu/reference/BREF/LCP/JRC107769_LCP_bref2017.pdf [Accessed 06 February 2018]

considered an emergency/unplanned event in the context of this impact assessment.

The exhaust emissions to air from the generators can result in elevated ambient concentrations of NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$ and subsequent short term impacts on ambient air quality. Although the generators are expected to be used infrequently and for a limited duration, the short term impacts on air quality can be significant while in operation. The likely impacts have been considered in more detail in **Section 6** of this air quality impact assessment.

3.11 COOLING TOWERS

The Project will be equipped with two wet cooling tower systems necessary for the normal operation of the power station. The system will utilise sea water and will dissipate large heat loads to the atmosphere. Due to the direct contact between the cooling water and the air passing through it, small amounts of water are lost as liquid drift. The liquid drift evaporates to a solid salt crystal when the water in the drift evaporates. The deposition of salt (Sodium Chloride (NaCl)) on the surrounding agriculture can have an adverse impact on crop production. The assessment of NaCl deposition and its effect on agriculture has been considered in in **Section 5.5.**

3.12 DECOMMISSIONING

The decommissioning of the proposed Project will likely include deconstruction of structures and buildings and include similar activities and impacts as during the construction phase. It is assumed that mitigation and management implemented during construction will be similarly applied during decommissioning; therefore decommissioning impacts are not assessed further.

4 RECEIVING ENVIRONMENT

4.1 OVERVIEW

A critical part of the air quality impact assessment is to establish the state of the existing environment (referred to as the baseline). This section presents the air quality baseline conditions, relevant sensitive receptors meteorological conditions in the study area. This section is informed by air quality surveys undertaken by ERM to collect primary environmental data for the EIA.

4.2 STUDY AREA AND IDENTIFICATION OF SENSITIVE RECEPTORS

Taking into account relevant guidance documents, the nature of activities during the construction and operation phases, and the relative locations of sensitive receptors, a study area of 350m (human) and 50m (ecology) (see **Figure 4.1** to **Figure 4.4**) and 10km (see **Figure 4.5**) around the Project has been established for the construction (refer to **Section 5.2**) and operation phase (refer to **Section 5.4**, **Section 5.5**, and **Section 6**) respectively. The study areas have been determined so that all potentially impacted sensitive receptors closest to the Project activities during both construction and operation phase have been identified.

For the purpose of this impact assessment sensitive receptors are split into two categories as follows:

- Human – these are locations where people are present in the long term, and include villages and towns, isolated dwellings, schools, hospitals, clinics and government offices. The relevant pollutants of interest for sensitive human receptors are dust, $PM_{2.5}$, PM_{10}, NO_2 and SO_2.

- Ecological – these are locations where there are local, national or internationally protected habitats. The relevant pollutants of interest for sensitive ecological receptors are dust, SO_2 and NO_x. This receptor type will also include agricultural areas (i.e. paddy fields).

To provide an indication of the potentially impacted receptors during the construction and operation phase, the residential and ecological areas within 350m and 50m from the onshore pipeline, CCGT power plant and Cibatu Substation site have been identified (**Figure 4.1** - **Figure 4.4**), and a number of representative air sensitive receptors have been plotted within 10km of the CCGT power plant (**Figure 4.5**). The latter have been selected to represent larger settlements in the study area and will be included in the dispersion model to understand the likely impacts on air quality at those specific locations (see **Section 5.4**). Air Sensitive receptors within 350m of the transmission tower construction sites are also considered and part of this impact assessment however given the spatial extent of the transmission lines these have not been presented in a figure.

Within the study area there are a number of ecological receptors including paddy fields and protected mangrove forests. These areas will therefore be given consideration in the air quality impact assessment where necessary. For more information on the ecology of the area refer to **Chapter 7** of the ESIA.

Figure 4.1 Construction Phase Study Area and Representative Human Receptors (CCGT & Onshore Pipeline)

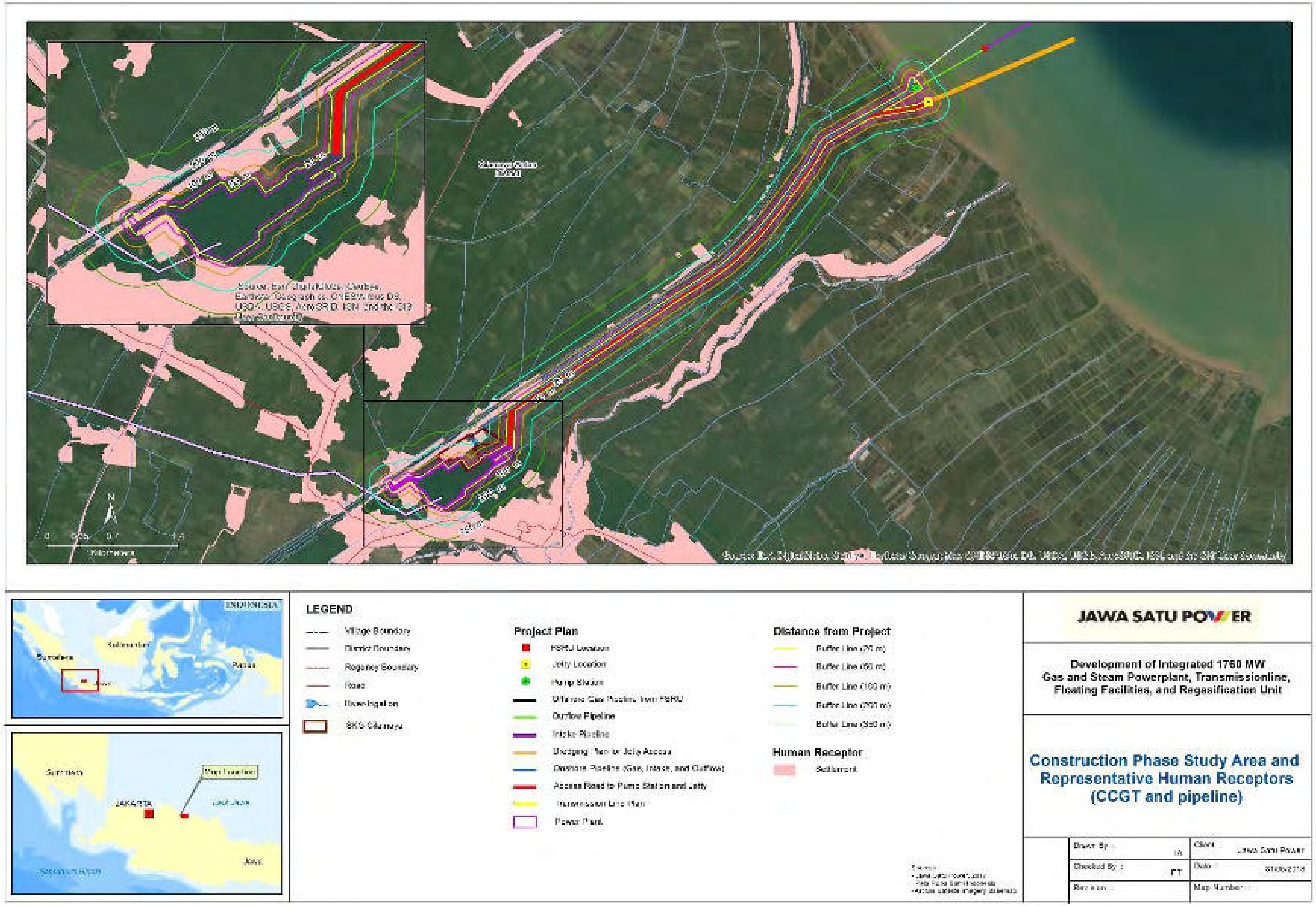


Figure 4.2 Construction Phase Study Area and Representative Ecological Receptors (CCGT & Onshore Pipeline)

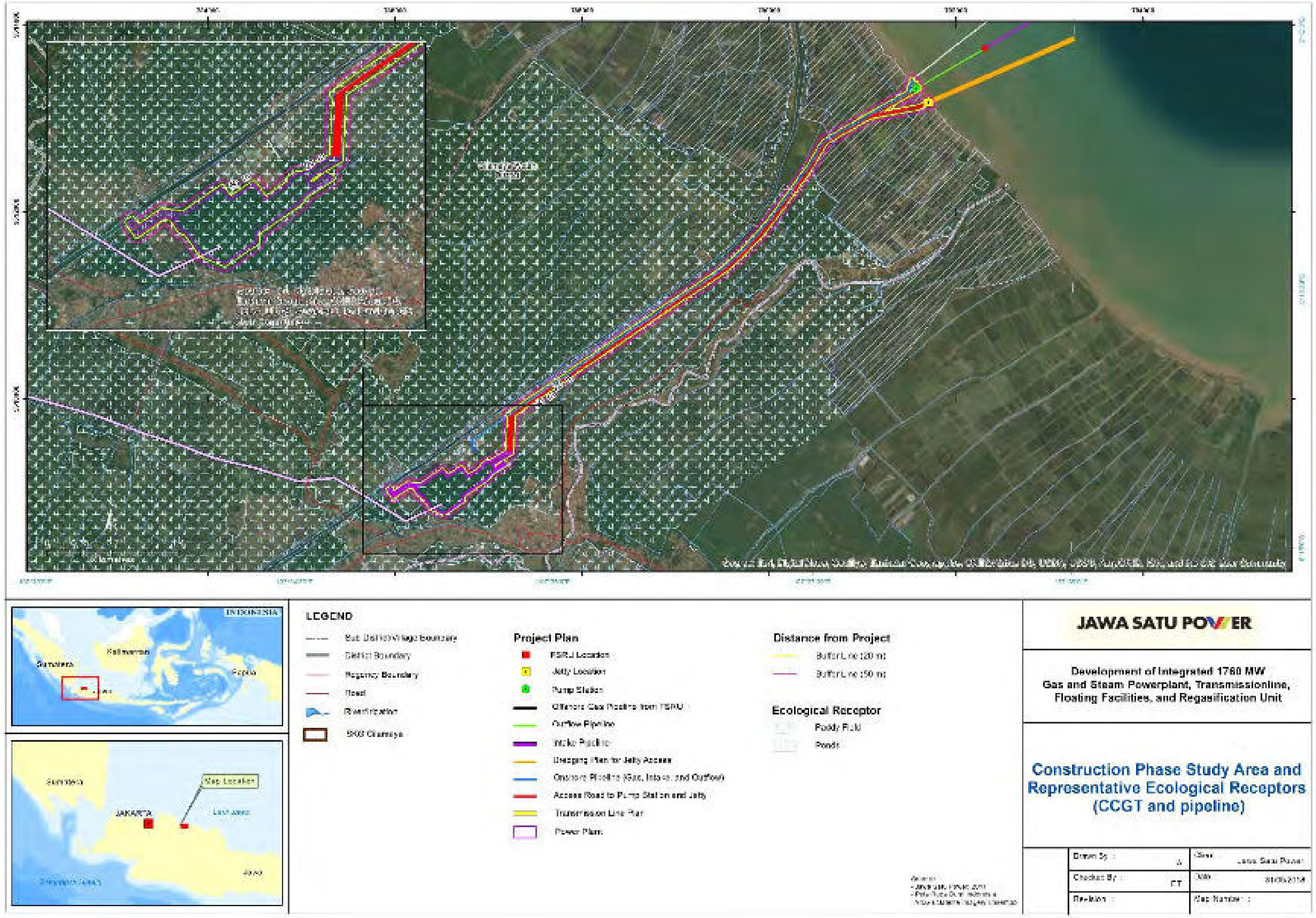


Figure 4.3 Construction Phase Study Area and Representative Human Receptors (Cibatu Substation)

Figure 4.4 Construction Phase Study Area and Representative Ecological Receptors (Cibatu Substation)

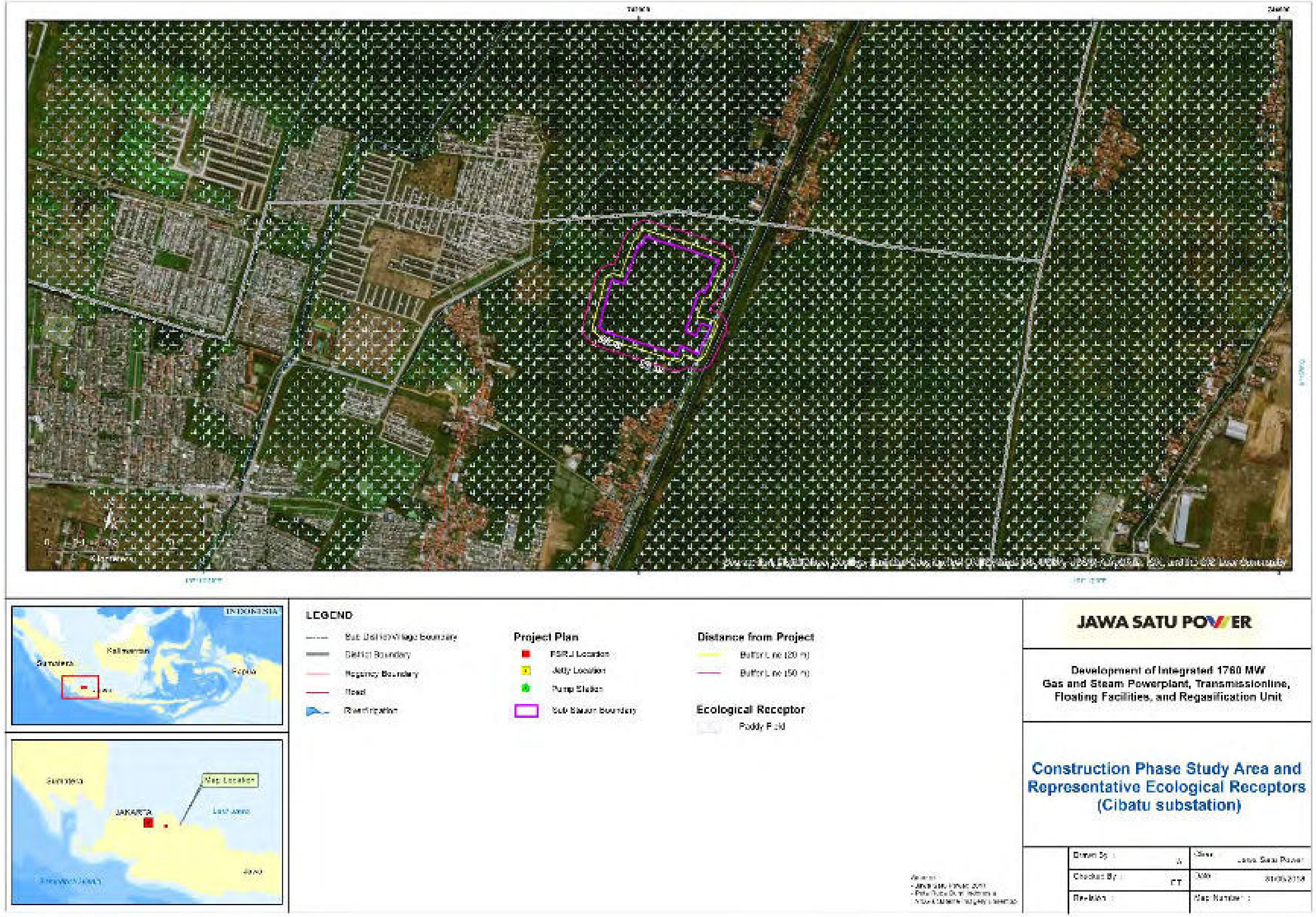


Figure 4.5 Operation Phase Study Area and Representative Human Receptors (CCGT)

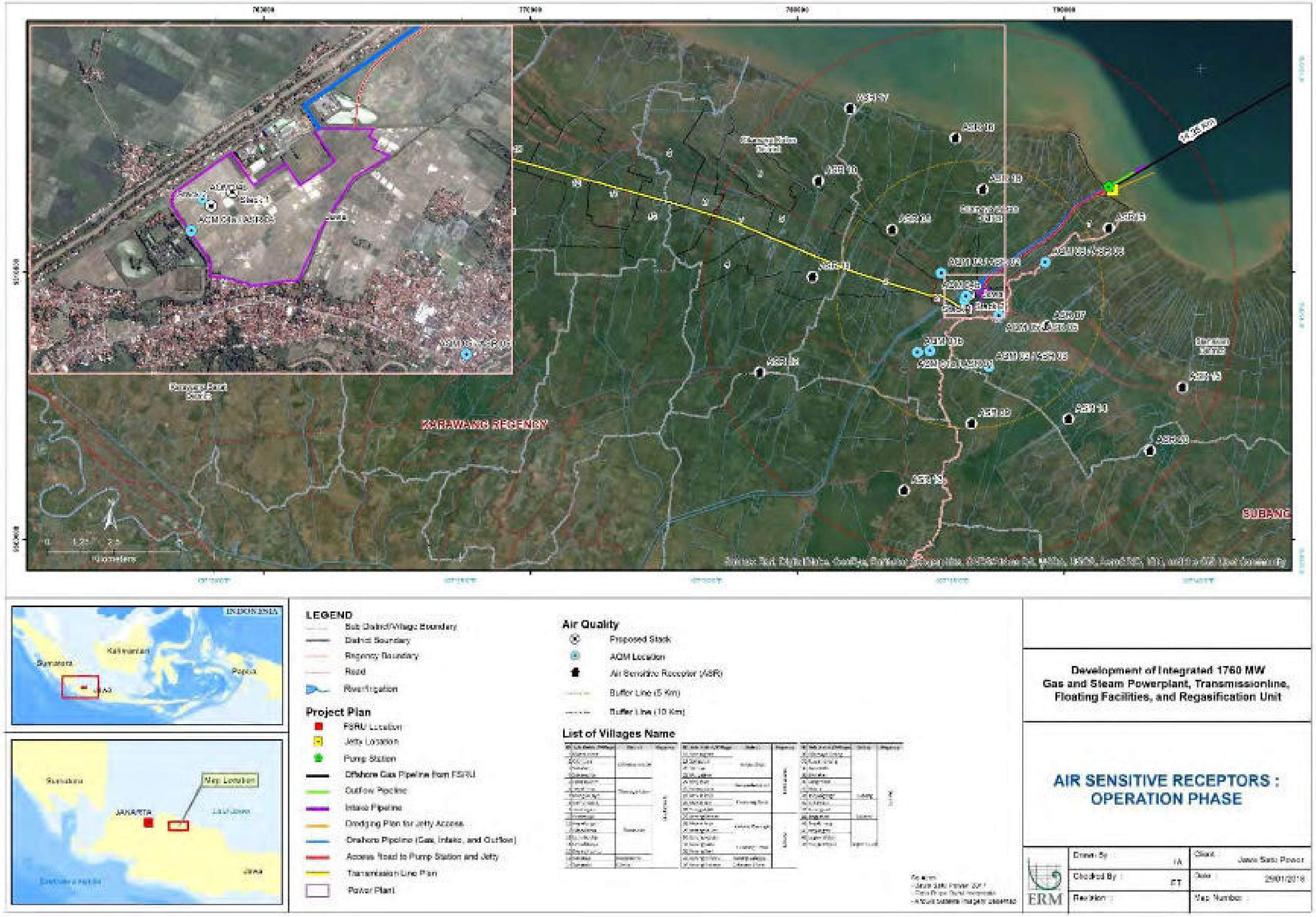
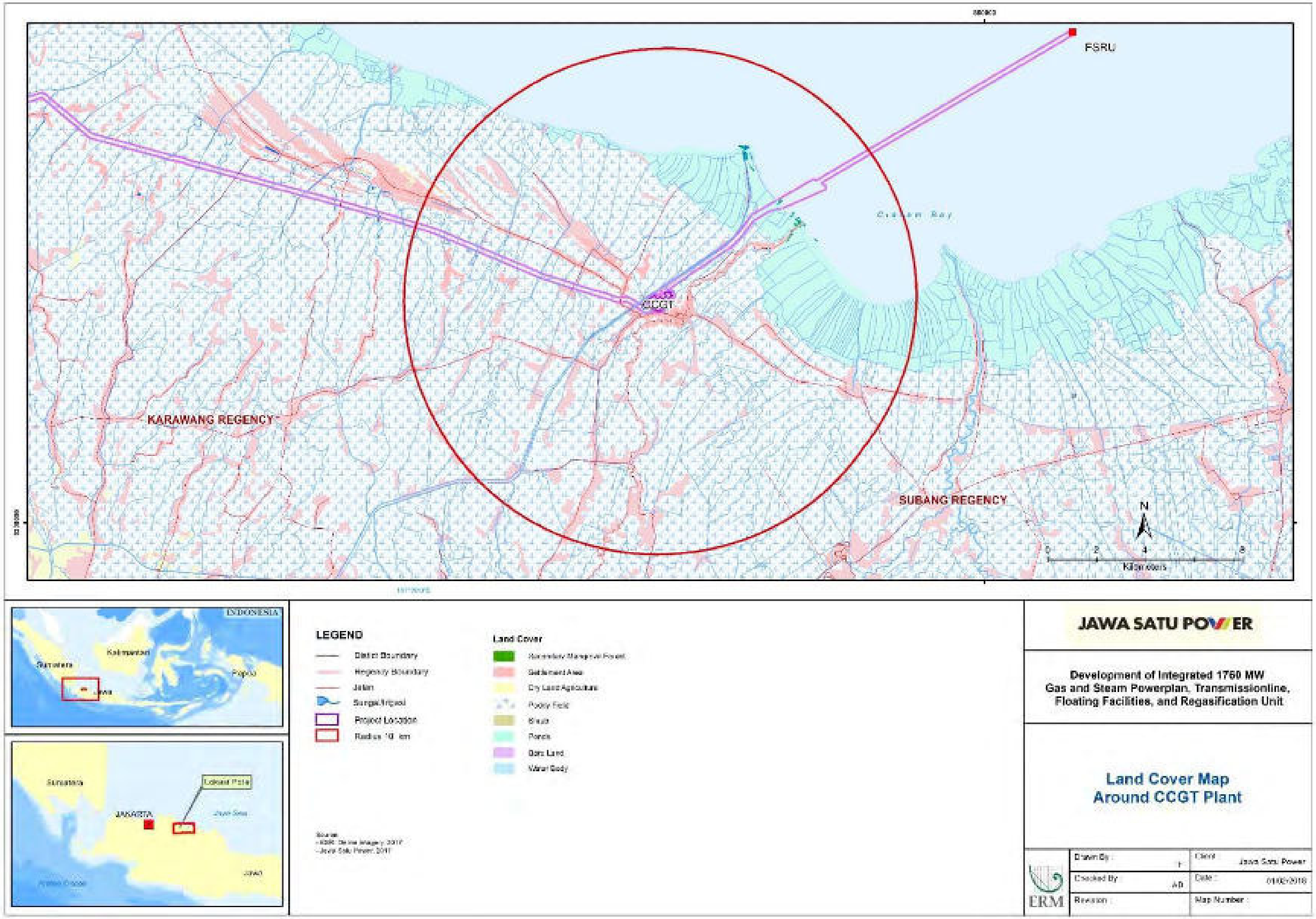


Figure 4.6 Operation Phase Study Area and Representative Ecological Receptors (CCGT)



4.3 AIR QUALITY BASELINE

4.3.1 Overview

In accordance with IFC guidelines (1), measurement of existing air quality is required for emissions associated with the Project processes over time that have potential to impact the surrounding land use.

As discussed in **Section 3**, the primary focus of the air quality impact assessment relates to emissions of NO_x and CO from power generation at the CCGT power plant. A project specific monitoring survey was undertaken at six locations in the vicinity of the proposed power plant site to provide an indication of ambient concentrations of NO_2 in the study area and to inform the air quality impact assessment. Ambient ozone (O_3) concentrations were also monitored to inform the NO_x to NO_2 conversion process in the atmosphere which is discussed in more detail in **Section 5.4**. Monitoring of CO was not undertaken as ambient concentrations of CO are typically well below the relevant air quality standards for the protection of human health and monitoring is not therefore not considered necessary.

This air quality impact assessment is informed by a 24 week Radiello diffusion tube survey and a 12 week continuous and real time monitoring survey conducted with two AQS Urban Air Quality Monitors (AQS1).

The baseline assessment methods, monitoring locations and findings are discussed in more detail in the following sections.

4.3.2 Baseline Monitoring Methods

Ambient concentrations of NO_2 and O_3 were measured using Radiello diffusion tubes and the Aeroqual AQS Urban Air Quality Monitor (AQS-1).

Radiello Diffusion Tubes

A radiello diffusion tube is a passive sampler that consist of a small radial diffusive body made of porous polypropylene in which the cartridge with adsorbent is positioned. Radiello diffusion tubes were selected to monitor ambient NO_2 concentrations for the following reasons:

- Tubes are inexpensive, lightweight, robust, easy to deploy and non-intrusive;
- No power source is required making them ideal in remote project locations;

(1) International Finance Corporation (IFC) (2007) Environmental, Health and Safety Guidelines, General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality [Online] Available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines [Accessed 05 February 2018]

- Can be located at several sites around the project location increasing the spatial variability of the assessment.

Aeroqual AQS Urban Air Quality Monitor (AQS1)

The AQS1 is a real time continuous air quality monitoring system capable of simultaneously monitoring concentrations of NO_2 and O_3 in the ambient air and logging information on a minute by minute basis. The AQS-1 was selected for the following primary reasons:

- It can operate using solar panel and batteries allowing flexibility when locating the monitor on site;
- In head to head tests with traditional United States Environmental Protection Agency (USEPA) approved analyzers, the AQS has shown r2 correlations as high as 0.98;
- The monitor has a sensor for monitoring O_3. Whilst not emitted from the combustion process an understanding of baseline O_3 is important in determining how much of the emitted NO will be converted to NO_2; and
- The monitor is relatively lightweight, portable and easily deployed.

4.3.3 *Monitoring Locations and Duration*

A total of six air quality monitoring sites were established at locations in the vicinity of the Project. Diffusion tubes were deployed at all six locations for two monitoring periods extending over a total of 24 weeks from the 10th August 2017 to the 03rd April 2018. The AQS1 monitor system was deployed at two locations for 12 weeks from the 08th January 2018 to the 02nd April 2018.

Monitoring locations were initially selected using aerial photography, local available knowledge about villages, accessibility and security to determine the most suitable locations. The final decision on locations was then made while in the field to determine the most suitable and representative locations for monitoring equipment to be deployed. The locations were generally chosen to determine the background concentration levels in areas of high population density where feasible i.e. where sensitive receptors are located.

Information regarding the monitoring locations and duration of monitoring are presented in **Table 4.1**; aerial mapping showing the location of the monitoring sites relative to the Project site is presented in **Figure 4.7** and the images of the sites are presented in **Figure 4.8** to **Figure 4.15**.

Table 4.1 Air Quality Monitoring Summary

Site	Land-use	Location		Method	Duration	Period	Measured Substances
		Latitude	Longitude				
AQM1a	Residential	6°15'45.62"S	107°34'31.31"E	Passive	12 weeks	10/08/2017 – 06/11/2017	NO_2
AQM1b	Residential	6°15'47.29"S	107°34'16.07"E	Passive	12 weeks	09/01/2018 – 03/04/2018	NO_2
				Active	12 weeks	08/01/2018 – 02/04/2018	NO_2 and O_3
AQM2	Residential	6°14'10.68"S	107°34'44.96"E	Passive	24 weeks	10/08/2017 – 06/11/2017 & 09/01/2018 – 03/04/2018	NO_2
AQM3	Residential	6°16'4.94"S	107°35'43.62"E	Passive	24 weeks	10/08/2017 – 06/11/2017 & 09/01/2018 – 03/04/2018	NO_2
AQM4a	Fenceline	6°14'43.79"S	107°35'13.24"E	Passive	12 weeks	10/08/2017 – 06/11/2017	NO_2
AQM4b	Fenceline	6°14'38.84"S	107°35'14.94"E	Passive	12 weeks	09/01/2018 – 03/04/2018	NO_2
				Active	12 weeks	08/01/2018 – 02/04/2018	NO_2 and O_3
AQM5	Residential	6°15'2.42"S	107°35'55.24"E	Passive	24 weeks	10/08/2017 – 06/11/2017 & 09/01/2018 – 03/04/2018	NO_2
AQM6	Residential	6°13'56.72"S	107°36'51.19"E	Passive	24 weeks	10/08/2017 – 06/11/2017 & 09/01/2018 – 03/04/2018	NO_2

Figure 4.7 Air Quality Monitoring Locations

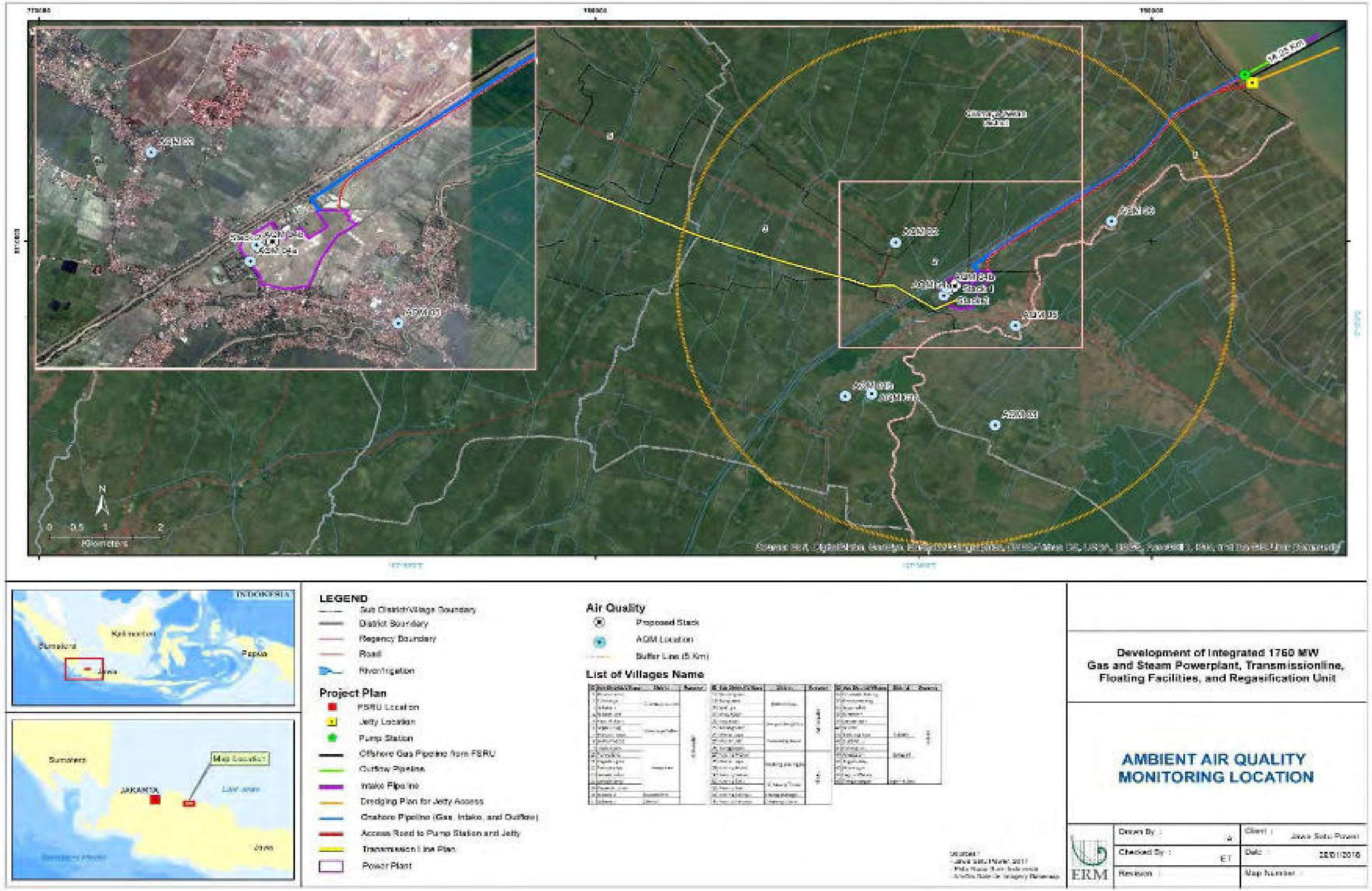


Figure 4.8 Air Quality Monitoring Site (AQM) 1a

Figure 4.9 Air Quality Monitoring Site (AQM) 1b

Figure 4.10 Air Quality Monitoring Site 2

Figure 4.11 Air Quality Monitoring Site 3

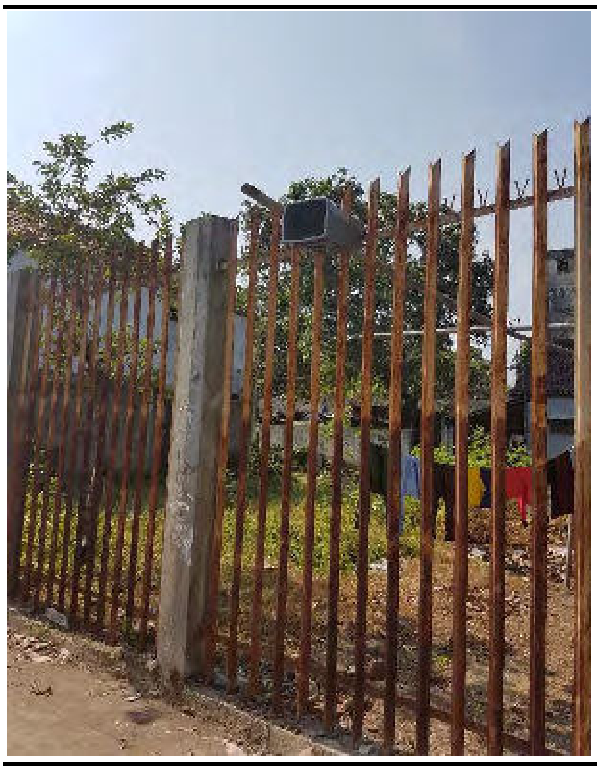


Figure 4.12 Air Quality Monitoring Site 4a

Figure 4.13 Air Quality Monitoring Site 4b

Figure 4.14 Air Quality Monitoring Site 5

Figure 4.15 Air Quality Monitoring Site 6

4.3.4 *AQS1 Servicing and Calibration*

The AQS-1 monitoring systems were factory calibrated prior to deployment. Both monitoring systems were subsequently serviced in accordance with the manufactures specifications on the 8th February 2018. During the onsite service the gas sample inlet filter was replaced and the flow rates were checked using a TetraCal volumetric air flow calibrator. Where necessary the flow rates were adjusted to 0.16LPM as per manufacturer specification. A second site service was undertaken on the 9th March to replace the gas sample inlet filters, however a technical issue with the flowmeter meant the flow rates could not be confirmed.

Following the completion of the 12 week monitoring campaign the results from the AQS1 monitors were compared to the diffusion tube results. The evidence suggested that the AQS1 monitors were potentially overestimating NO_2 concentrations. This was subsequently confirmed by the manufacturer following additional analysis of the data and monitor function.

On the 23rd May 2018 an onsite calibration was performed by an Aeroqual technician under the supervision of ERM. Due to time constraints and availability the NO_2 calibration gas necessary to perform the NO_2 span calibration could not be acquired. Instead, a gas dilution calibrator with zero air generator was used to perform a zero (baseline calibration), and an O_3 generator to test the O_3 response were used in combination to test and validate the baseline of the O_3 module; the baseline of the O_x module; O_3 span response of the O_3 module; and the O_3 span response of the O_x module. Based on the data from the calibration check it was possible to correct the historical NO_2 monitoring data for the full 12 weeks monitoring period at both locations. At AQM1b (AQS1-657) the O_3 gain and offset were adjusted and the NO_2 corrected. At AQM4b (AQS1-658) only the NO_2 was corrected with no adjustments necessary for O_3. All adjustment were completed as per the manufacturer's specifications. The results based on the calibrated data set are summarised and discussed in the following section.

4.3.5 *Baseline Results and Summary*

Radiello Diffusion Tubes

The NO_2 monitoring data from the air quality survey undertaken by ERM and supported by a specialist sub-contractor from the 10th August 2017 to the 20th November 2017 and again from the 09th January 2018 to the 03rd April 2018 is presented below in **Table 4.2** and has indicatively been used to represent annual average background concentrations of NO_2 in the study area.

The baseline information also needs to be interpreted for short term periods to compare against the short term air quality standards presented in **Table 2.1**. The United Kingdom Department for Environment, Food and Rural Affairs

(DEFRA) [1] recommends that the short term (i.e. the one hour average) baseline is derived by multiplying the long term by a factor of two. Furthermore, DEFRA sets out conversion factors for converting between the one hour and 24 hour periods. These conversions have been undertaken to provide baseline concentrations for comparison against the short term air quality standards and the results from applying this methodology are presented in **Table 4.2, Table 4.3** and **Table 4.4.**

A review of the baseline data against the relevant air quality standards indicates the following:

- The indicative annual mean baseline concentration is below the relevant air quality standard for the protection of human health at all monitoring locations. The highest indicative annual average is 7.93µg/m^3 at AQM5, 8% of the relevant air quality standard.

- The maximum indicative 1-hour average concentration is below the relevant air quality standard for the protection of human health at all monitoring locations. The highest indicative maximum 1-hour average is 35.2µg/m^3 at AQM5, 8.8% of the relevant air quality standard.

- The maximum indicative 24-hour average concentration is below the relevant air quality standard for the protection of human health at all monitoring locations. The highest maximum indicative 24-hour average is 20.7µg/m^3 at AQM5, 13.8% of the relevant air quality standard.

The results from the diffusion tube monitoring survey indicate that the ambient NO_2 concentrations at all sites are below the relevant air quality standards. The receiving airshed can therefore be classified as non-degraded.

(1) Department for Environment, Food and Rural Affairs (DEFRA) (2016) Air emissions risk assessment for your environmental permit [Online] Available from: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit [Accessed 14 December 2017]

Table 4.2 Indicative Annual Mean NO_2 Background Concentrations Estimated from Weekly Diffusion Tube Results

Monitoring Period	Date on	Date off	Season	AQM1a	AQM1b	AQM2	AQM3	AQM4a	AQM4b	AQM5	AQM6
				NO_2 µg/m³							
Week 1	10/08/17	17/08/17	Inter-monsoon	6.00	-	8.60	6.32	6.28	-	8.15	5.02
Week 2	17/08/17	24/08/17	Inter-monsoon	6.49	-	6.60	5.79	5.53	-	7.04	4.21
Week 3	28/08/17	04/09/17	Inter-monsoon	6.28	-	8.03	6.36	5.98	-	8.52	4.80
Week 4	04/09/17	11/09/17	Inter-monsoon	7.17	-	7.77	7.15	7.69	-	8.82	6.00
Week 5	11/09/17	18/09/17	Inter-monsoon	7.41	-	7.86	8.01	8.03	-	9.42	6.30
Week 6	18/09/17	25/09/17	Inter-monsoon	7.71	-	11.42	11.6	8.77	-	13.0	8.03
Week 7	25/09/17	02/10/17	Monsoon	6.37	-	9.61	8.23	9.16	-	9.81	5.17
Week 8	02/10/17	09/10/17	Monsoon	8.95	-	7.20	7.80	11.4	-	13.5	8.65
Week 9	09/10/17	16/10/17	Monsoon	8.14	-	6.99	8.31	11.0	-	17.6	7.20
Week 10	16/10/17	23/10/17	Monsoon	3.57	-	3.95	3.38	3.52	-	5.38	2.14
Week 11	23/11/17	30/11/17	Monsoon	2.78	-	3.68	4.89	2.91	-	6.22	2.52
Week 12	30/11/17	06/11/17	Monsoon	3.31	-	2.95	4.31	3.03	-	5.45	2.27
Week 13	09/01/18	16/01/18	Monsoon	-	1.81(1)	2.20	1.48	-	1.97(1)	2.29	2.54
Week 14	16/01/18	23/01/18	Monsoon	-	4.91(1)	7.95	3.76	-	5.77(1)	6.64	5.87
Week 15	23/01/18	30/01/18	Monsoon	-	7.80(1)	8.97	6.37	-	6.73(1)	8.89	5.96
Week 16	30/01/18	06/02/18	Monsoon	-	6.67(1)	12.9	3.53	-	3.18(1)	5.79	4.32
Week 17	06/02/18	13/02/18	Monsoon	-	5.24(1)	6.50	2.76	-	3.80(1)	4.40	3.12
Week 18	13/02/18	20/02/18	Monsoon	-	4.17(1)	7.44	2.67	-	3.18(1)	4.25	5.73
Week 19	20/02/18	27/02/18	Monsoon	-	6.50(1)	7.03	4.96	-	5.06(1)	5.36	4.40
Week 20	27/02/18	06/03/18	Monsoon	-	4.70(1)	8.03	3.50	-	2.16(1)	6.34	3.25
Week 21	06/03/18	13/03/18	Monsoon	-	4.83(1)	7.95	6.45	-	4.66(1)	8.67	0.86
Week 22	13/03/18	20/03/18	Monsoon	-	3.85(1)	4.79	5.73	-	4.02(1)	6.92	0.59
Week 23	20/03/18	27/03/18	Monsoon	-	4.47(1)	9.40	6.07	-	5.26(1)	7.31	1.00
Week 24	27/03/18	03/04/18	Monsoon	-	5.96(1)	9.06	5.81	-	6.34(1)	8.16	3.27
24 Week Average Concentration (2)				5.36		6.85	5.56	5.37		7.93	3.97
Annual Air Quality Standard(3)				100							

(1) Median value from triplicate diffusion tube

(2) Used as an indication of the annual average concentration at each monitoring site

(3) Indonesia (PP41/1999) Ambient Air Quality Standards

Table 4.3 *Maximum Indicative 1-Hour NO_2 Background Concentrations Estimated from Weekly Diffusion Tube Results*

Monitoring Period	Date on	Date off	Season	AQM1a (1)	AQM1b (1)	AQM2 (1)	AQM3 (1)	AQM4a (1)	AQM4b (1)	AQM5 (1)	AQM6 (1)
				NO_2 µg/m³							
Week 1	10/08/17	17/08/17	Inter-monsoon	12.0	-	17.2	12.6	12.6	-	16.3	10.0
Week 2	17/08/17	24/08/17	Inter-monsoon	13.0	-	13.2	11.6	11.1	-	14.1	8.42
Week 3	28/08/17	04/09/17	Inter-monsoon	12.6	-	16.1	12.7	12.0	-	17.0	9.60
Week 4	04/09/17	11/09/17	Inter-monsoon	14.3	-	15.5	14.3	15.4	-	17.6	12.0
Week 5	11/09/17	18/09/17	Inter-monsoon	14.8	-	15.7	16.0	16.1	-	18.8	12.6
Week 6	18/09/17	25/09/17	Inter-monsoon	15.4	-	22.8	23.1	17.5	-	26.0	16.1
Week 7	25/09/17	02/10/17	Monsoon	12.7	-	19.2	16.5	18.3	-	19.6	10.3
Week 8	02/10/17	09/10/17	Monsoon	17.9	-	14.4	15.6	22.8	-	27.0	17.3
Week 9	09/10/17	16/10/17	Monsoon	16.3	-	14.0	16.6	22.1	-	35.2	14.4
Week 10	16/10/17	23/10/17	Monsoon	7.14	-	7.90	6.77	7.03	-	10.8	4.29
Week 11	23/11/17	30/11/17	Monsoon	5.56	-	7.37	9.78	5.83	-	12.4	5.04
Week 12	30/11/17	06/11/17	Monsoon	6.62	-	5.90	8.61	6.05	-	10.9	4.55
Week 13	09/01/18	16/01/18	Monsoon	-	3.62	4.40	2.95	-	3.95	4.59	5.08
Week 14	16/01/18	23/01/18	Monsoon	-	9.81	15.9	7.52	-	11.5	13.3	11.7
Week 15	23/01/18	30/01/18	Monsoon	-	15.6	17.9	12.7	-	13.5	17.8	11.9
Week 16	30/01/18	06/02/18	Monsoon	-	13.3	25.8	7.06	-	6.36	11.6	8.64
Week 17	06/02/18	13/02/18	Monsoon	-	10.5	13.0	5.52	-	7.60	8.80	6.24
Week 18	13/02/18	20/02/18	Monsoon	-	8.35	14.9	5.34	-	6.35	8.50	11.5
Week 19	20/02/18	27/02/18	Monsoon	-	13.0	14.1	9.93	-	10.1	10.7	8.80
Week 20	27/02/18	06/03/18	Monsoon	-	9.40	16.1	6.99	-	4.32	12.7	6.50
Week 21	06/03/18	13/03/18	Monsoon	-	9.66	15.9	12.9	-	9.32	17.3	1.71
Week 22	13/03/18	20/03/18	Monsoon	-	7.71	9.59	11.5	-	8.05	13.8	1.17
Week 23	20/03/18	27/03/18	Monsoon	-	8.95	18.8	12.1	-	10.5	14.6	2.01
Week 24	27/03/18	03/04/18	Monsoon	-	11.9	18.1	11.6	-	12.7	16.3	6.54
Maximum 1-Hour Concentration (2)				17.9		25.8	23.1	22.8		35.2	17.3
Annual Air Quality Standard (3)				400							

(1) The results at each monitoring site are based on multiplying the 1-week average value from the diffusion tube data set presented in *Table 4.2* by a factor of two

(2) The indicative maximum 1 hour average concentration at each monitoring site

(3) Indonesia (PP41/1999) Ambient Air Quality Standards

Table 4.4 ***Maximum Indicative 24-Hour NO_2 Background Concentrations Estimated from Weekly Diffusion Tube Results***

Monitoring Period	Date on	Date off	Season	AQM1a (1)	AQM1b (1)	AQM2 (1)	AQM3 (1)	AQM4a (1)	AQM4b (1)	AQM5 (1)	AQM6 (1)
				NO_2 µg/m³							
Week 1	10/08/17	17/08/17	Inter-monsoon	7.08	-	10.1	7.46	7.41	-	9.62	5.92
Week 2	17/08/17	24/08/17	Inter-monsoon	7.66	-	7.79	6.83	6.53	-	8.3	4.97
Week 3	28/08/17	04/09/17	Inter-monsoon	7.41	-	9.48	7.50	7.06	-	10.1	5.66
Week 4	04/09/17	11/09/17	Inter-monsoon	8.46	-	9.17	8.44	9.07	-	10.4	7.08
Week 5	11/09/17	18/09/17	Inter-monsoon	8.74	-	9.3	9.5	9.5	-	11.1	7.43
Week 6	18/09/17	25/09/17	Inter-monsoon	9.10	-	13.5	13.65	10.3	-	15.3	9.48
Week 7	25/09/17	02/10/17	Monsoon	7.52	-	11.3	9.7	10.8	-	11.6	6.10
Week 8	02/10/17	09/10/17	Monsoon	10.6	-	8.50	9.21	13.4	-	15.9	10.2
Week 9	09/10/17	16/10/17	Monsoon	9.61	-	8.25	9.81	13.0	-	20.7	8.50
Week 10	16/10/17	23/10/17	Monsoon	4.21	-	4.66	3.99	4.15	-	6.34	2.53
Week 11	23/11/17	30/11/17	Monsoon	3.28	-	4.35	5.77	3.44	-	7.34	2.97
Week 12	30/11/17	06/11/17	Monsoon	3.90	-	3.48	5.08	3.57	-	6.43	2.68
Week 13	09/01/18	16/01/18	Monsoon	-	2.13	2.60	1.74	-	2.33	2.71	2.99
Week 14	16/01/18	23/01/18	Monsoon	-	5.79	9.38	4.44	-	6.81	7.83	6.92
Week 15	23/01/18	30/01/18	Monsoon	-	9.20	10.6	7.52	-	7.94	10.5	7.03
Week 16	30/01/18	06/02/18	Monsoon	-	7.87	15.2	4.17	-	3.75	6.83	5.10
Week 17	06/02/18	13/02/18	Monsoon	-	6.18	7.67	3.26	-	4.48	5.19	3.68
Week 18	13/02/18	20/02/18	Monsoon	-	4.92	8.78	3.15	-	3.75	5.01	6.77
Week 19	20/02/18	27/02/18	Monsoon	-	7.68	8.30	5.86	-	5.97	6.32	5.19
Week 20	27/02/18	06/03/18	Monsoon	-	5.55	9.47	4.13	-	2.55	7.48	3.84
Week 21	06/03/18	13/03/18	Monsoon	-	5.70	9.38	7.61	-	5.50	10.3	1.01
Week 22	13/03/18	20/03/18	Monsoon	-	4.55	5.66	6.77	-	4.75	8.16	0.69
Week 23	20/03/18	27/03/18	Monsoon	-	5.28	11.1	7.17	-	6.21	8.63	1.18
Week 24	27/03/18	03/04/18	Monsoon	-	7.03	10.7	6.85	-	7.48	9.63	3.86
Maximum 24-Hour Concentration (2)				10.6		15.2	13.7	13.4		20.7	10.2
Annual Air Quality Standard (3)				150							

(1) The 24-hour average concentrations have been derived by multiplying the concentrations in *Table 4.3* by a factor of 0.59

(2) The indicative maximum 24 hour average concentration at each monitoring site

(3) Indonesia (PP41/1999) Ambient Air Quality Standards

Aeroqual AQS Urban Air Quality Monitor (AQS-1)

The maximum 1-hour and 24-hour average NO_2 and O_3 concentrations collected using the AQS1 monitoring system from the 08th January 2018 to the 05th April 2018 are presented below in **Table 4.5** and **Table 4.6**. The twelve week average has also been presented to provide an indication of the long term background concentrations at each site and to provide a comparison to the annual average air quality standard. A review of the NO_2 baseline data against the relevant air quality standards indicates the following:

- The indicative annual mean baseline concentration is below the relevant air quality standard for the protection of human health at both monitoring locations. The highest indicative annual average is 12.2μg/m^3 at AQM1b, 12% of the relevant air quality standard.
- The maximum 1-hour average concentration is below the relevant air quality standard for the protection of human health at both monitoring locations. The highest maximum 1-hour average is 66.9μg/m^3 at AQM1b, 17% of the relevant air quality standard.
- The maximum 24-hour average concentration is below the relevant air quality standard for the protection of human health at both monitoring locations. The highest maximum 24-hour average is 27.7μg/m^3 at AQM1b, 18% of the relevant air quality standard.

The results from the survey indicate that the ambient NO_2 concentrations at both sites are below the relevant air quality standards when considering the highest 1-hour and 24-hour period. Furthermore, although not directly comparable, the 12-week average is below the long term air quality standard. The receiving airshed can therefore be classified as non-degraded for the purpose of this air quality impact assessment.

The O_3 data will not be used for comparison to the air quality standards, rather it has been used to determine the NO_x to NO_2 conversion of modelled NO_2 predictions in **Section 5.4** and **Section 6.**

Table 4.5 AQS1 - NO_2 Monitoring Summary

Monitoring Site	Maximum 1-hour	Maximum 24-hour	12-week Average (1)
	NO_2 μg/m^3		
AQM1b (AQS657)	66.9	27.7	12.2
AQM4b (AQS-658)	61.7	21.5	8.44
Air Quality Standard (2)	*400*	*150*	*100*

(1) Indicative of long term average and compared to annual average air quality standard
(2) Indonesia (PP41/1999) Ambient Air Quality Standards

Table 4.6 AQS1 - O_3 Monitoring Summary

Monitoring Site	Maximum 1-hour (1)	Maximum 24-hour (1)	12-Week Average (1) (2)
	O_3 μg/m³		
AQM1b (AQS657)	235	68.5	34.3
AQM4b (AQS-658)	264	83.3	42.0

(1) Data has been used to determine NO_x to NO_2 conversion rates in *Section 5.4* and *Section 6*
(2) Indicative of long term average and compared to annual average air quality standard

Table 4.7 AQS1 - O_3 Maximum 1-Hour Values

Time	AQM1b(1)	AQM4b(1)	Max Value(2)
	O_3 (ppb)		
00:00	30.0	32.3	32.3
01:00	22.1	27.0	27.0
02:00	38.5	38.5	38.5
03:00	32.8	38.6	38.6
04:00	25.9	31.0	31.0
05:00	24.2	25.5	25.5
06:00	33.0	33.4	33.4
07:00	30.2	33.9	33.9
08:00	30.4	35.8	35.8
09:00	45.8	51.0	51.0
10:00	63.4	70.5	70.5
11:00	77.8	92.4	92.4
12:00	101	116	116
13:00	95	105	105
14:00	100	110	110
15:00	100	137	137
16:00	122	135	135
17:00	74.6	85.1	85.1
18:00	64.8	74.9	74.9
19:00	41.8	48.1	48.1
20:00	41.5	44.8	44.8
21:00	42.5	46.2	46.2
22:00	35.5	39.3	39.3
23:00	31.0	32.2	32.2

(1) The maximum O_3 value (ppb) for each hour throughout the 12 week monitoring period
(2) Data is used to inform the detailed dispersion modelling assessment presented in **Section 5.4** and **Section 6**.

4.4 CLIMATOLOGY

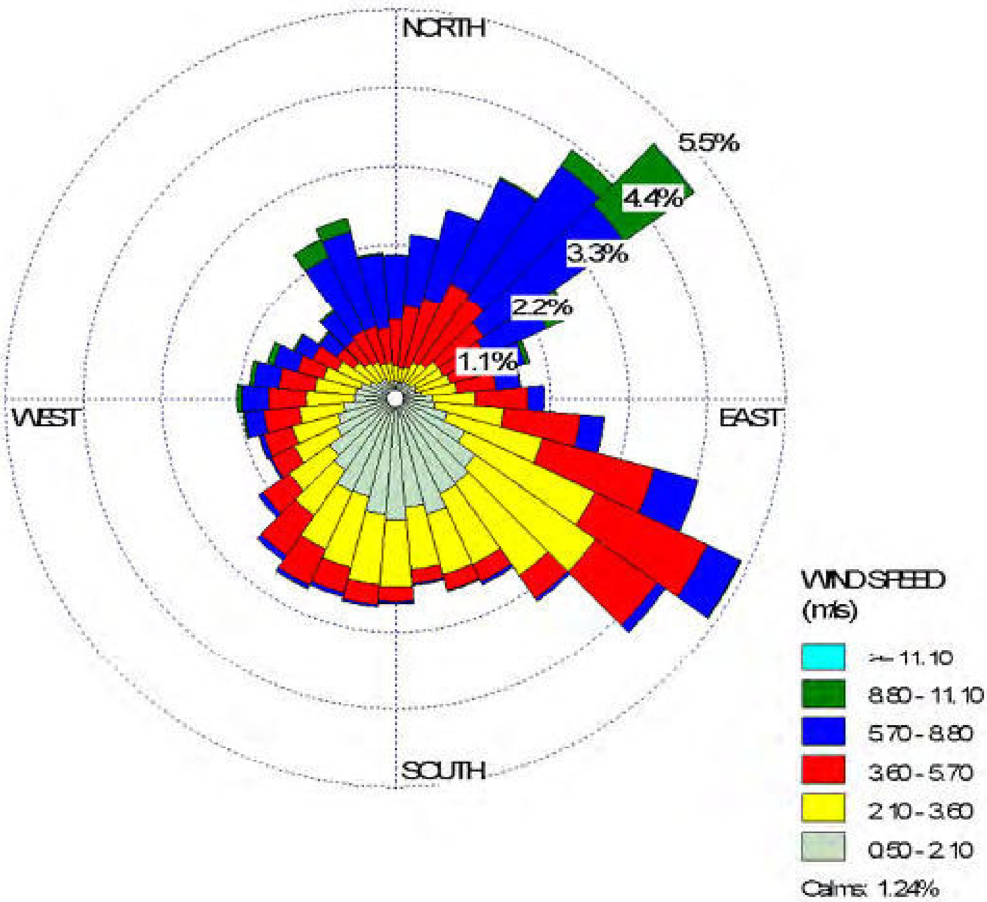
Meteorological data representative of the study area is crucial for supporting the detailed dispersion model assessment (see **Section 5.4** and **Section 6).** Following IFC recommendations, data is required for five (5) years in order to capture year on year variability. In order to fully define the meteorology, hourly sequential meteorological data is required for:

- wind speed;
- wind direction;
- precipitation;

- relative humidity;
- temperature; and
- cloud cover.

There are no meteorological stations in the vicinity of the Project that capture all these parameters or have sufficient data availability. Therefore five years of meteorological data (2013 - 2017) were modelled using the Weather Research and Forecasting Model (WRF) centred on the CCGT power plant location. The WRF model is a next-generation mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting needs. The model is extensively validated using actual observations to ensure the best possible accuracy and precision. The wind rose generated using the AERMOD meteorological pre-processor AERMET is presented in **Figure 4.16**.

Figure 4.16 Wind Rose (2013 – 2017)



5 IMPACT ASSESSMENT AND MITIGATION

5.1 OVERVIEW

The air quality impact assessment approach utilises qualitative and quantitative methods, including detailed air dispersion modelling, to assess potential impacts to sensitive receptors from the key emission sources identified in **Section 3**. Where appropriate, the assessment considers existing air quality baseline conditions and assesses predicted impacts at sensitive receptors by comparing them to the relevant air quality standards presented in **Section 2.2.**

The main sources of emissions associated with the proposed Project which require further more detailed assessment have been identified as follows:

- Construction activities: These activities are specifically associated with earthworks, the construction of the Project infrastructure, and track-out (carrying and contamination) of materials onto public roads leading to increased ambient concentrations of TSP and PM_{10}.
- Offsite construction traffic: The use of vehicles on the public road network during the construction phase resulting in elevated concentrations of NO_2 and PM_{10}; and
- Operation of the CCGT power plant: The continuous operation of two Combined Cycle Gas Turbines (CCGT) used for power generation during the normal operation of the Project resulting in elevated ambient concentrations of NO_2 and CO.

5.2 IMPACTS TO AIR QUALITY FROM DUST EMISSIONS DURING CONSTRUCTION

5.2.1 *Overview*

As discussed in **Section 3.3,** the activities associated with the construction phase of the Project have the potential to generate TSP and particulate matter (PM_{10}). These activities include ground excavation, material transfer, material stockpiling, construction of the main infrastructure including the power plant, ORF and transmission lines, and trackout of dusty materials and dirt onto the public road network. Fugitive dust has the potential to cause impacts on sensitive receptors in the vicinity of the above named activities if not managed accordingly. Dust emissions can vary substantially from day to day and will depend on the level of activity, the specific operations being undertaken and the meteorological conditions.

The following section qualitatively addresses the potential impacts on human health and ecology as well as potential nuisance concerns from dust emissions associated with construction phase activities. Where activities are considered likely to result in generation of dust with potential to impact ambient air quality and/or local amenities and quality of life, mitigation has been identified so that those impacts are reduced to an acceptable level. For the purpose of the impact assessment, the construction phase activities have been grouped into three categories including earthworks, construction and trackout.

5.2.2 *Assessment Methodology*

The Institute of Air Quality Management (IAQM) [(1)] provide specific guidance for defining the dust impact risk from construction sites based on the scale and nature of the works which determines the potential dust emissions magnitude; and the sensitivity of the receiving area. The IAQM guidance has been used as the main reference document for determining the potential risk of impact from the anticipated construction works in order to determine the level of site specific mitigation that should be applied. The premise of the guidance is that with the implementation of effective site specific mitigation and management measures, the environmental effect will not be significant in most cases.

The potential dust impact risk from the different project components and activities and the specific mitigation measures which are required have been considered. The construction of the FSRU and Jetty have been screened out on the basis that no dust will be generated in the marine environment and no sensitive receptors exist within 350m.

Where necessary professional judgement has been used to estimate the impact magnitude from the different project components and activities.

Determining the Magnitude of the Impact

The IAQM define the potential dust emissions magnitude based on the scale of the anticipated works and is classified as small, medium or large. The criteria for estimating the magnitude of dust impacts from earthworks, construction and track-out as per the IAQM guidance note is presented in **Table 5.1** and has been used to inform this impact assessment.

Determining the Sensitivity of the Area

The IAQM define the sensitivity of the area based on receptor type and the number of receptors within a certain distance from the source. Residential properties, schools, hospitals are classified as high sensitivity to dust soiling and health effects. Locations where there are particularly important plant species where the dust sensitivity is uncertain or unknown (i.e. rice paddy) are classified as medium sensitivity. The criteria for estimating the sensitivity of the area to dust soiling effects on people and property; human health impacts

(1) Institute of Air Quality Management (IAQM) (2014) Guidance on the Assessment of Dust from Demolition and Construction [Online] Available at: http://iaqm.co.uk/guidance/ [Accessed 05 February 2018]

from PM_{10}; and impacts to ecology from dust deposition as per the IAQM guidance is presented in **Table 5.2**, **Table 5.3** and **Table 5.4** respectively**.** The guidance provides screening criteria of 350m and 50m from the construction site and access road respectively beyond which impacts are not considered likely.

Determining the Risk of Impact

The impact magnitude is combined with the sensitivity of the area to determine the risk of the impact with no mitigation applied. The matrices in **Table 5.5** and **Table 5.6** and **Table 5.7** provide the approach for defining the impact risk due to earthworks, construction and track-out respectively. The findings from this risk assessment inform the level of mitigation which is necessary to reduce impacts to an acceptable level.

Table 5.1 *Dust Emission Magnitude*

Activity	Impact Magnitude		
	Small	Medium	Large
Earthworks	Total site area <2 ,500m², soil type with large grain size (e.g. sand), <5 heavy earth moving vehicles active at any one time, formation of bunds <4m in height, total material moved <20,000 tonnes, earthworks during wetter months	Total site area 2,500 m² – 10,000 m², moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 4 m - 8 m in height, total material moved 20,000 tonnes – 100,000 tonnes	Total site area >10,000 m², potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >8 m in height, total material moved >100,000 tonnes
Construction	Total building volume <25,000m³, construction material with low potential for dust release (e.g. metal cladding or timber).	Total building volume 25,000m³ – 100,000m³, potentially dusty construction material (e.g. concrete), on site concrete batching;	Total building volume >100, 000m³, on site concrete batching, sandblasting
Trackout	<10 HDV (>3.5t) outward movements in any one day, surface material with low potential for dust release, unpaved road length <50 m.	10-50 HDV (>3.5t) outward movements in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50 m – 100 m	>50 HDV (>3.5t) outward movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length >100m

Table 5.2 *Sensitivity of the Area to Dust Soiling Effects on People and Property*

Receptor Sensitivity	Number of Receptors	Distance from the Source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Note: For trackout the distances should be measured from the side of the roads used by construction traffic. Without site specific mitigation, trackout may occur from roads up to 500 m from large sites, 200 m from medium sites and 50 m from small sites, as measured from the site exit. The impact declines with distance from the site, and it is only necessary to consider trackout impacts up to 50 m from the edge of the road.

Table 5.3 Sensitivity of the Area to Human Health Impacts

Receptor Sensitivity	Annual Mean PM_{10} concentration	Number of Receptors	Distance from the Source (m)				
			<20	<50	<100	<200	<350
High	>32 µg/m³	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	28-32 µg/m³	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	24-28 µg/m³	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<24 µg/m³	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	>32 µg/m³	>10	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	28-32 µg/m³	>10	Medium	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	24-28 µg/m³	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	<24 µg/m³	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Low	-	>=1	Low	Low	Low	Low	Low

Note: For trackout the distances should be measured from the side of the roads used by construction traffic. Without site specific mitigation, trackout may occur from roads up to 500 m from large sites, 200 m from medium sites and 50 m from small sites, as measured from the site exit. The impact declines with distance from the site, and it is only necessary to consider trackout impacts up to 50 m from the edge of the road.

Table 5.4 Sensitivity of the Area to Ecological Impacts

Sensitivity of Area	Distance from the Source (m)	
	<20	<50
High	High	Medium
Medium	Medium	Low
Low	Low	Low

Table 5.5 Risk of Dust Impacts – Earthworks

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table 5.6 Risk of Dust Impacts – Construction

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table 5.7 Risk of Dust Impacts - Trackout

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

5.2.3 *Construction Phase Impacts from the Combined Cycle Gas Turbine Power Plant (pre mitigation)*

Earthworks

The CCGT Power Plant will be developed on a 21 ha parcel of land and earthworks will be carried out to raise the power plant platform to 4.0m above mean sea level (msl). The site is currently at 2.5m above msl, requiring the site to be raised by 1.5m from the current level, with a predicted 310,000 m^3 of soil needed for backfilling purposes. The IAQM consider the dust impact magnitude to be **large** for a site which requires >100,000m^3 of material to be handled (see **Table 5.1)**.

The exact locations of earthwork activities are not known. Instead, the sensitivity of the area has been determined based on the number and distance of residential receptors from the power plant site boundary assuming that earthwork activities will be occurring throughout the area during the construction phase. A review of aerial imagery indicates that there are between 10 and 100 residential dwellings within 20m of the CCGT power plant boundary (see **Figure 4.1**). On this basis the sensitivity of the area is considered to be **high** to dust soiling affects (see **Table 5.2**). The annual mean PM_{10} concentration is not known, however as a worst case assumption the sensitivity of the area to health impacts is assumed to be **high** (see **Table 5.3**).

Paddy fields exist to the immediate north and east of the power plant site boundary. The distance from the boundary is less than 20m and on this basis the sensitivity of the paddy fields to dust soiling from earthwork activities is **medium**.

Construction

The power plant complex will consist of five main buildings supported by other infrastructure. The main buildings include the Onshore Receiving Facilities (ORF), two turbine buildings, Heat Recovery Steam Generator (HRSG), Control and Electrical building (CEB), Cooling Towers, administration building and a workshop/warehouse building. The Project estimates that 57,000m^3 of construction materials will be required and as such is considered to have a **medium** impact magnitude (see **Table 5.1)**.

The exact locations of construction activities are not known. Instead, the sensitivity of the area has been determined based on the number and distance of receptors from the power plant site boundary assuming that construction activities will be occurring throughout the entire area during the construction phase. A review of aerial imagery indicates that there are between 10 and 100 residential dwellings within 50m of the CCGT power plant boundary (see **Figure 4.1**). On this basis the sensitivity of the area is considered to be **medium** to dust soiling affects (see **Table 5.2**). The annual mean PM_{10}

concentration is not known, however as a worst case assumption the sensitivity of the area to health impacts is assumed to be **high** (see **Table 5.3**).

Paddy fields exist to the immediate north and east of the power plant site boundary. The distance from the boundary is less than 20m and on this basis the sensitivity of the paddy fields to dust soiling from earthwork activities is **medium** (see **Table 5.4**).

Track out

During the construction activities at the power plant site, approximately 40,000 vehicles are expected to be utilised for material transportation of the 315,000 m^3 of infill soil for levelling of the CCGT site. Based on an 8 m^3 (>3.5t) dump truck capacity this is estimated to be approximately 200 dump truck trips/day to the CCGT site. Transportation of the 57,000 m^3 construction materials for the CCGT requires an estimated 27,360 trips or 76 truck trips/day over the construction period. The impact magnitude with regard to trackout is therefore considered **large** (see **Table 5.1**).

The IAQM specify that without site specific mitigation, track out may occur on roads up to 500m from large sites and impacts are expected up to 50m from the edge of the road. A review of aerial imagery indicates that there are >100 residential dwellings within the specified screening criteria (see **Figure 4.1**). On this basis the sensitivity of the area is considered to be **high** to dust soiling affects (see **Table 5.2**). The annual mean PM_{10} concentration is not known, however as a worst case assumption the sensitivity of the area to health impacts is assumed to be **high** (see **Table 5.3**).

There are no ecologically sensitive receptors up to 500m from the site and within 50m from the edge of the site access road. On this basis the sensitivity of the area to ecological impacts from track out is **negligible** (see **Table 5.4**).

Summary of Dust Risk

The summary of the risk associated with the construction of the combined cycle gas turbine (CCGT) power plant is presented in **Table 5.8.** The risk has been determined based on the matrices presented in **Table 5.5**, **Table 5.6** and **Table 5.7**.

Table 5.8 Summary of Dust Risk

Potential Impact	Risk		
	Earthworks	Construction	Track out
Dust Soiling	High	Medium	High
Human Health	High	Medium	High
Ecological	Medium	Medium	Negligible

5.2.4 *Construction Phase Impacts from the Onshore Pipeline (pre mitigation)*

Earthworks

The proposed onshore pipelines will include three (3) main pipelines i.e. the seawater supply pipe, the waste water discharge pipe and the 20-inch gas supply pipeline. The total length of pipeline will be approximately 7.6km from the landfall point to the CCGT power plant. The right of way (ROW) for pipeline installation will be cleared and will be graded to same level using bulldozers and/or excavators. All roots and stumps shall be removed by grubbing, digging or such other means. All unwanted stumps, roots and other vegetation shall be disposed outside the boundaries of worksite. Prior to excavating in work area, all topsoil shall be stripped, stored and topsoil which is deemed to be unsuitable shall be disposed of offsite. The exact amount of material moved or number of vehicles operating at once during the onshore pipeline installation is not known. As a conservative assumption the impact magnitude from the installation of the onshore pipeline is considered **medium** (see **Table 5.1)**.

The exact locations of earthwork activities are not known. Instead, the sensitivity of the area has been determined based on the number and distance of residential receptors from the ROW boundary assuming that earthwork activities will be occurring throughout the area during the construction phase. A review of aerial imagery indicates that there are between 10 and 100 residential dwellings within 50m of the ROW. On this basis the sensitivity of the area is considered to be **medium** to dust soiling affects (see **Table 5.2**). The annual mean PM_{10} concentration is not known, however as a worst case assumption the sensitivity of the area to health impacts is assumed to be **high** (see **Table 5.3**).

Paddy fields exist along the length of the pipeline ROW. The distance from the boundary is less than 20m and on this basis the sensitivity of the area to ecological impacts from earthwork activities is **medium** (see **Table 5.4**).

Construction

There are no construction activities *per se* associated with the installation of the onshore pipeline. Dust impacts from the construction of the pipeline are considered negligible and have not been considered further.

Track out

The access road for the onshore pipeline installation will use the same public road as that for CCGT access and jetty construction. Pipelines from the laydown area will be transported using trailer trucks to pipeline ROW. For jetty construction, the transportation of infill material to site, small equipment and construction materials is estimated to require approximately 14 truck trips/day. An additional 400 trips per year will be required for mobilization of +/- 1640 joint pipes, pulleys and welding equipment required for the construction of the seawater supply and waste water discharge pipeline and gas pipeline. The impact magnitude with regard to trackout is therefore considered **large** (see **Table 5.1**).

Aerial imagery indicates that there are potentially between 10 and 100 residential receptors within 500m of the site entrance and within 20m of the road side. On this basis the sensitivity of the area is considered to be **high** to dust soiling affects (see **Table 5.2**). The annual mean PM_{10} concentration is not known, however as a worst case assumption the sensitivity of the area to health impacts is assumed to be **high** (see **Table 5.3**).

There are no paddy fields within 500m of the pipeline ROW site entrance and within 50m from the edge of the site access road. On this basis the sensitivity of the area to ecological impacts from track out is **negligible** (see **Table 5.4**).

Summary of Dust Risk

The summary of the risk associated with the installation of the onshore pipeline is presented in **Table 5.9.** The risk has been determined based on the matrices presented in **Table 5.5**, **Table 5.6** and **Table 5.7**.

Table 5.9 Summary of Dust Risk

Potential Impact	Risk		
	Earthworks	Construction	Track out
Dust Soiling	Medium	Negligible	High
Human Health	Medium	Negligible	High
Ecological	Medium	Negligible	Negligible

5.2.5 *Construction Phase Impacts from the Cibatu Substation (pre mitigation)*

Earthworks

This impact assessment associated with the earthworks within the proposed Cibatu substation site assumes that the total volume of soil for site elevation will be 125,000 m^3 with additional construction material with low potential for dust release (e.g. metal cladding or timber). Given the volume of soil handling the impact magnitude is considered **large** (see **Table 5.1)**.

On the basis that all residential properties are located > 100m from the substation boundary (see **Figure 4.3**) the sensitivity of the area to dust soiling is classified as **low** (see **Table 5.2**). The annual mean PM_{10} concentration is not known, however on the basis that properties are located >100m from the substation the sensitivity of the area to health impacts is assumed to be **low** (see **Table 5.3**).

Paddy fields exist in close proximity substation (see **Figure 4.4**). The distance from the boundary is less than 20m and on this basis the sensitivity of the area to dust soiling from earthwork activities is **medium** (see **Table 5.4**).

Construction

This impact assessment of the proposed Cibatu substation assumes that the total building volume will be <25,000 m^3 and construction material with low potential for dust release (e.g. metal cladding or timber). On this basis the impact magnitude is considered **small** (see **Table 5.1**).

On the basis that all residential properties are located > 100m from the substation boundary (see **Figure 4.3**) the sensitivity of the area to dust soiling is classified as **low** (see **Table 5.2**). The annual mean PM_{10} concentration is not known, however on the basis that properties are located >100m from the substation the sensitivity of the area to health impacts is assumed to be **low** (see **Table 5.3**).

Paddy fields exist in close proximity substation (see **Figure 4.4**). The distance from the boundary is less than 20m and on this basis the sensitivity of the area to ecological impacts from earthwork activities is **medium** (see **Table 5.4**).

Track out

For the Cibatu substation site, approximately 15,000 truck trips are required for the site levelling, equating to 120 truck trips/day. The impact magnitude with regard to trackout is therefore considered **large** (see **Table 5.1**).

Aerial imagery indicates that there are potentially between 10 and 100 residential receptors within 500m of the site entrance and within 20m of the road side. On this basis the sensitivity of the area is considered to be **high** to dust soiling affects (see **Table 5.2**). The annual mean PM_{10} concentration is not known, however as a worst case assumption the sensitivity of the area to health impacts is assumed to be **high** (see **Table 5.3**).

Paddy fields exist within 500m of the site entrance and within 20m of the road side. On this basis the sensitivity of the area to ecological impacts from earthwork activities is **medium** (see **Table 5.4**).

Summary of Dust Risk

The summary of the risk associated with the construction of the Cibatu Substation is presented in **Table 5.10.** The risk has been determined based on the matrices presented in **Table 5.5**, **Table 5.6** and **Table 5.7**.

Table 5.10 Summary of Dust Risk

Potential Impact	Risk		
	Earthworks	Construction	Track out
Dust Soiling	Low	Negligible	High
Human Health	Low	Negligible	High
Ecological	Medium	Low	Medium

5.2.6 *Construction Phase Impacts from the Transmission Lines (pre mitigation)*

Earthworks

The actual land area required for each transmission line tower will depend on the nature of the tower and will range from 784m² to 1,7642m². The IAQM consider the dust impact magnitude to be **small** for a site less than 2,500m² (see **Table 5.1)**.

The aerial imagery indicates that there are potentially between 1 and 10 residential receptors located <50m from a tower footing boundary thus the sensitivity of the area to dust soiling is considered **low** (see **Table 5.2**). The annual mean PM_{10} concentration is not known, however on the basis that there are between 1 and 10 properties located <50m from the substation the sensitivity of the area to health impacts is considered **medium** as a worst case (see **Table 5.3**).

Paddy fields exist in close proximity to the tower footings. The distance from the boundary is less than 20m and on this basis the sensitivity of the area to dust soiling from earthwork activities is **medium** (see **Table 5.4**).

Construction

The transmission line tower foundations will be made of iron framework casted with casted concrete consist of sand, coral and cement. The project predicts that ± 14,150 cement sacks, ± 1,179m³ sand and ± 1,769m³ gravels will be required for the construction. Approximately ± 2,463 tons of steel material will be required to construct the towers. Given the quantity and type of materials, the impact magnitude from the construction of the transmission lines is considered **small** (see **Table 5.1**).

The aerial imagery indicates that there are potentially between 1 and 10 residential receptors located <50m from a tower footing boundary thus the sensitivity of the area to dust soiling is considered **low** (see **Table 6.2**). The annual mean PM_{10} concentration is not known, however on the basis that there are between 1 and 10 properties located <50m from the substation boundary the sensitivity of the area to health impacts is considered **medium** as a worst case (see **Table 5.3**).

Paddy fields exist in close proximity to the tower footings. The distance from the boundary is less than 20m and on this basis the sensitivity of the area to dust soiling from earthwork activities is **medium** (see **Table 5.4**).

Trackout

Construction of the transmission towers will require a total of approximately 1,000 trips per year to transport materials such as steel piece, cement, sand and gravel. The movements will be coordinated from a deposition camp that is yet to be selected but will be local to the tower installation sites, relocating along the transmission line route as required. The individual transportation activities will therefore be localised to each tower location with small numbers of trucks required to transport the materials to the nearest access road for hand carry to each installation site. The impact magnitude from this Project infrastructure is therefore considered **small** (see **Table 5.1**).

The deposition camp and site entrance to each tower footing is currently unknown. On the basis that the camps will be located in relatively rural areas local to the tower installation sites it assumed unlikely that a substantial number of residential receptors will exist within 50m of the road edge and within 200m of the site entrance (assuming a medium site) therefore the sensitivity of the area to dust soiling is considered **low.** Similarly it is assumed that the the sensitivity of the area to health impacts is considered **low** (see **Table 5.3**).

While the site access to each tower footing is unknown the proximity to paddy fields is expected to be less than 20m from the road edge and within 200m of the site access therefore the sensitivity of the area to dust soiling is considered **medium** (see **Table 5.4**).

Summary of Dust Risk

The summary of the risk associated with the construction of the transmission lines is presented in **Table 5.11.** The risk has been determined based on the matrices presented in **Table 5.5**, **Table 5.6** and **Table 5.7**.

Table 5.11 Summary of Dust Risk

Potential Impact	Risk		
	Earthworks	Construction	Track out
Dust Soiling	Negligible	Negligible	Negligible
Human Health	Low	Low	Negligible
Ecological	Low	Low	Low

5.2.7 *Summary of Impacts from Dust Emissions during Construction (pre mitigation)*

A summary of the impact magnitude and impact significance pre-mitigation during the construction phase is presented below in **Table 5.12.**

Table 5.12 Summary of Impacts during Construction (pre-mitigation)

Project Component	Activity	Impact	Impact Magnitude	Sensitivity of Area	Impact Significance
CCGT Power Plant	Earthworks	Dust Soiling	Large	Medium	High
		Human Health	Large	High	High
		Ecological	Large	Medium	Medium
	Construction	Dust Soiling	Medium	Medium	Medium
		Human Health	Medium	High	Medium
		Ecological	Medium	Medium	Medium
	Trackout	Dust Soiling	Large	High	High
		Human Health	Large	High	High
		Ecological	Large	Negligible	Negligible

Project Component	Activity	Impact	Impact Magnitude	Sensitivity of Area	Impact Significance
Onshore Pipeline	Earthworks	Dust Soiling	Medium	Medium	Medium
		Human Health	Medium	High	Medium
		Ecological	Medium	Medium	Medium
	Construction	Dust Soiling	Negligible	Negligible	Negligible
		Human Health	Negligible	Negligible	Negligible
		Ecological	Negligible	Negligible	Negligible
	Trackout	Dust Soiling	Large	High	High
		Human Health	Large	High	High
		Ecological	Large	Negligible	Negligible
Cibatu Substation	Earthworks	Dust Soiling	Large	Low	Low
		Human Health	Large	Low	Low
		Ecological	Large	Medium	Medium
	Construction	Dust Soiling	Small	Low	Negligible
		Human Health	Small	Low	Negligible
		Ecological	Small	Medium	Low
	Trackout	Dust Soiling	Large	High	High
		Human Health	Large	High	High
		Ecological	Large	Medium	Medium
Transmission Towers	Earthworks	Dust Soiling	Small	Low	Negligible
		Human Health	Small	Medium	Low
		Ecological	Small	Medium	Low
	Construction	Dust Soiling	Small	Low	Negligible
		Human Health	Small	Medium	Low
		Ecological	Small	Medium	Low
	Trackout	Dust Soiling	Small	Low	Negligible
		Human Health	Small	Low	Negligible
		Ecological	Small	Medium	Low

5.2.8 *Recommended Mitigation, Management and / or Monitoring Measures*

At all construction sites a series of specific project component mitigation measures for earthworks, construction and trackout are required and are presented in **Table 5.13**. Where the assessment predicts negligible impacts no site specific mitigation measures are proposed.

Table 5.13 Proposed Mitigation Measures

Project Component	Activity	Mitigation
All construction sites	Construction	1. Develop and Implement a Dust Management Plan (DMP). The DMP will contain the measures outlined in this document and a plan for implementation. 2. Regular site inspections will be performed to monitor compliance with the DMP. All inspection results will be recorded and corrective actions taken where mitigation and management measures are not being implemented effectively. 3. Daily onsite and offsite inspections will be undertaken to visually assess the dust emissions from earthwork and construction activities, and from vehicles exiting the construction sites. Results from the inspection will be recorded and appropriate measures such as those presented in this table will be taken to reduce emissions where necessary. 4. All dust and air quality complaints will be recorded, the cause identified and appropriate mitigation measures such as those presented in this table will be implemented to reduce dust emissions in a timely manner. 5. The frequency of site inspections will be increased when activities with a high potential to produce dust are being carried out and during prolonged dry and windy conditions. 6. Use of site watering to suppress wind and physical disturbance dust generation. 7. Only cutting, grinding, or sawing equipment fitted with suitable dust suppression techniques such as water sprays will be used. 8. All chutes, conveyors and skips will be covered at all times. 9. Drop heights from conveyors, loading shovels and hoppers will be minimised 10. Ensure an adequate water supply on site for effective dust suppression and mitigation.
CCGT Power Plant	Earthworks	1. Re-vegetate earthworks and exposed areas including stockpiles to stabilise the surfaces as soon as is practicable. 2. Use hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable. 3. Only remove the top cover in small and specific areas during the construction phase and not all at once. 4. Stockpiles will be places as far as reasonably practicable from air sensitive receptor locations. 5. The design of stockpiles will be optimised to retain a low profile with no sharp changes in shape. 6. Real time PM_{10} monitoring will be undertaken at two fenceline locations. Monitoring will commence 3-months prior to the earthwork phase commencing.

Project Component	Activity	Mitigation
	Construction	1. The construction site will be planned so that machinery and dust causing activities are located away from air sensitive receptors as far as possible 2. Wind breaks will be erected around the construction site at least the height of any stockpile on site. 3. All sand and aggregates will be stored in bunded areas and are not allowed to dry out unless specifically required. 4. Deliveries of cement and other fine powders will be delivered in enclosed tankers and stored in silos with suitable emission controls to prevent escape of material and overfilling during delivery.
	Trackout	1. Ensure that all vehicles entering and leaving the site are covered to avoid fugitive emissions during transport. 2. Inspect on-site haul roads for integrity and instigate the necessary repairs to the surfaces as soon as reasonable practicable. 3. Implement a wheel washing system. 4. Regularly dampen/clean the site access and local roads to remove any materials tracked out of the site. 5. Access gates will be located at least 10m away from air sensitive receptors where possible.
Onshore Pipeline	Earthworks	1. Re-vegetate earthworks and exposed areas including stockpiles to stabilise the surfaces as soon as is practicable. 2. Use hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable. 3. Only remove the top cover in small and specific areas during the construction phase and not all at once. 4. Stockpiles will be places as far as reasonably practicable from air sensitive receptor locations. 5. The design of stockpiles will be optimised to retain a low profile with no sharp changes in shape.
	Trackout	1 Ensure that all vehicles entering and leaving the site are covered to avoid fugitive emissions during transport. 2. Inspect on-site haul roads for integrity and instigate the necessary repairs to the surfaces as soon as reasonable practicable. 3. Implement a wheel washing system. 4. Regularly dampen/clean the site access and local roads to remove any materials tracked out of the site. 5. Access gates will be located at least 10m away from air sensitive receptors where possible.
Cibatu Substation	Earthworks	1. Re-vegetate earthworks and exposed areas including stockpiles to stabilise the surfaces as soon as is practicable. 2. Use hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable. 3. Only remove the top cover in small and specific areas during the construction phase and not all at once. 4. Stockpiles will be places as far as reasonably practicable from air sensitive receptor locations. 5. The design of stockpiles will be optimised to retain a low profile with no sharp changes in shape.

Project Component	Activity	Mitigation
	Construction	1. All sand and aggregates will be stored in bunded areas and are not allowed to dry out unless specifically required.
	Trackout	1. Ensure that all vehicles entering and leaving the site are covered to avoid fugitive emissions during transport. 2. Inspect on-site haul roads for integrity and instigate the necessary repairs to the surfaces as soon as reasonable practicable. 3. Implement a wheel washing system. 4. Regularly dampen/clean the site access and local roads to remove any materials tracked out of the site. 5. Access gates will be located at least 10m away from air sensitive receptors where possible.
Transmission Line Towers	Construction	1. All sand and aggregates will be stored in bunded areas and are not allowed to dry out unless specifically required.
	Trackout	1. Ensure that all vehicles entering and leaving the site are covered to avoid fugitive emissions during transport. 2. Implement a wheel washing system.

5.2.9 *Residual Impacts (post mitigation)*

The IAQM guidance suggest that when correctly applying and actively managing the mitigating controls outlined in **Table 5.13**, the impacts to receptors located within 350m downwind of any construction activity are not likely to be significant for the large majority of the time. However, due to the nature of construction activities, the scale and duration of the construction phase, and the possibility of extreme weather conditions, it is possible that communities may experience occasional, short term dust annoyance. The IAQM states that "*the likely scale of this would not normally be considered sufficient to change the conclusion that with mitigation the effects will be 'not significant'*. On this basis it can be concluded that construction phase activities are likely to result in a **Minor** impact at worst post mitigation.

5.3 IMPACTS TO AIR QUALITY FROM OFFSITE TRAFFIC DURING CONSTRUCTION

5.3.1 *Overview*

As identified in **Section 3.4**, exhaust emissions from increased offsite traffic required during the construction phase could potentially lead to impacts on air quality at sensitive receptors in the study area. The potential impact to sensitive receptors has been assessed initially using a semi-quantitative assessment method based upon the formulae presented in the UK Highways Agency Design Manual for Roads and Bridges (DMRB) [(1)].

5.3.2 *Assessment Methodology*

DMRB sets out a number of formulae to determine the process contribution (PC), in µg/m^3 (atmospheric concentration) per g/km/hr (emission), of a stream of traffic to pollutant concentrations at a distance *d* from the road centre. These formulae are based upon modelling of a generic road and represent decreasing impacts with increasing distance from the roadside. In terms of NO_2 and PM_{10}, impacts are assumed to be negligible at distances >200m.

The DMRB formulae are as follows:

- For distances 5m and less:
  - Process Contribution (PC) = 0.063541 µg/m3 per g/km.hr *(Equation 1)*
- For distances (d) of 5m – 168m:

(1) Design Manual for Roads and Bridges (2007) Volume 11, Section 3, Part 1 Air Quality [Online] Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section3/ha20707.pdf [Accessed 06 February 2018]

- Process Contribution (PC) = 0.17887 + 0.00024 d – (0.295776 / d) + (0.2596/d2) – 0.0421 ln(d) µg/m3 per g/km.hr *(Equation 2)*

- For distances (d) of 168m – 200m:
  - Process Contribution (PC) = 0.0017675 – (0.0000276173 * (d-168)) µg/m3 per g/km.hr *(Equation 3)*

To calculate the PC for both PM_{10} and NO_x, the equation for expressing pollutant emission rates as a function of average vehicle speed takes the standard form where *E* is the emission rate expressed in g/km; *v* is the average speed of the vehicle in km/hr; and *a* to *j* and *x* are coefficients.

The equation is expressed as follows:

E = (a + b.v + c.v2 + d.ve + f.ln(v) + g.v3 + h/v + i/v2 + j/v3).x (Equation 4)

For the purpose of this assessment, emissions function coefficients in *Equation 4* have been based on EURO Tier 1 emission standards for HGV as specified in DMRB and presented in **Table 5.14** for reference. Concentrations of SO_2 from traffic are considered negligible when using this methodology. The average speed of the vehicles is assumed to be a constant 40km per hour.

5.3.3 *Traffic Related Impacts (pre-mitigation)*

The DMRB methodology has been used to determine the PC of NO_x/NO_2 and PM_{10} at 5m, 20m, 50m, 100m and 200m from the road side to determine the potential magnitude of the impact at air sensitive receptors located along access roads used by construction traffic during the construction phase.

Given that the exact number of vehicle movements on any given road during the construction period are not precisely known, a conservative value of 1,000 and 10,000 additional heavy good vehicle (HGV) movements per day has been used to understand the likely impacts on ambient air quality. The results from the screening assessment are presented below in **Table 5.15** and **Table 5.16**.

These results are comparable to the annual mean AQS as presented in **Table 2.1**. To compare against the short term AQS, the process contributions have conservatively been multiplied by a factor of two as per the DEFRA (1) recommendation. The results indicate that the concentration of NO_2 and PM_{10} is well below the relevant air quality standard at all distances from the road when considering the most conservative value of 10,000 HGV movements per day.

(1) Department for Environment, Food and Rural Affairs (DEFRA) (2016) Air emissions risk assessment for your environmental permit [Online] Available from: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit [Accessed 14 December 2017]

Table 5.14 Emission Function Coefficients for Total Oxides of Nitrogen and Particulate Matter

Legislation Class	Substance	Engine Size or Vehicle Configuration	Coefficients							Valid Speed Range (km/hr)
			a	b,c,d,e,f	g	h	i	j	x	
HGV – Euro 1	NO_x	Rigid	4.4	0	1.87x10-6	126	0	-805	1	5-100
	PM		0.0896	0	5.16x10-8	7.43	0	0	1	

Table 5.15 Process Contribution from Construction Traffic Vehicle Exhausts (1,000 AADT)

Pollutant	HGV per day	Speed (km/hr)	Emission Rate(*E*) (g/km/hr)	Process Contribution (PC) µg/m³				
				5m	20m	50m	100m	200m
NO_X	1000	40	319	20.3	13.9	6.50	1.93	0.282
NO_2(1)				6.29	4.57	2.36	0.770	0.118
PM_{10}			11.6	0.738	0.504	0.236	0.0704	0.0103

(1) To calculate NO_2 from the calculated NO_x PC is as follows: NO_2 road = NO_x road [(-0.068 ln (NO_x total) + 0.53)] *(DMRB (2007) Volume 11, Section 3, Part 1 - Air Quality)*

Table 5.16 Process Contribution from Construction Traffic Vehicle Exhausts (10,000 AADT)

Pollutant	HGV per day	Speed (km/hr)	Emission Rate(*E*) (g/km/hr)	Process Contribution (PC) µg/m³				
				5m	20m	50m	100m	200m
NO_X	10,000	40	3190	203	139	65.0	19.3	2.82
NO_2(1)				33.9	26.6	15.7	6.05	1.10
PM_{10}			116	7.38	5.04	2.36	0.704	0.103

(2) To calculate NO_2 from the calculated NO_x PC is as follows: NO_2 road = NO_x road [(-0.068 ln (NO_x total) + 0.53)] *(DMRB (2007) Volume 11, Section 3, Part 1 - Air Quality)*

5.3.4 *Recommended Mitigation, Management and / or Monitoring Measures*

Based on the findings of the assessment presented in **Section 5.3.3** no additional mitigation or management is necessary. It is expected, however, that good practice procedures such as those outline in the IFC EHS Guidelines for Air Emissions and Ambient Air Quality (1) are implemented. These include:

- Replacing old vehicles with new, more fuel efficient alternatives;
- Converting high use vehicles to cleaner fuels, where feasible; and
- Implementing a regular vehicle maintenance and repair program.

5.3.5 *Residual Impacts (post mitigation)*

The impacts to air quality from exhaust emissions due to offsite traffic during the construction phase of the Project are expected to be well below the relevant air quality standards at all distances from the road. The significance of the impact is considered minor adverse at worst when considering the overly conservative assumption that an additional 10,000 HGV movements per day will be generated by the Project. In practice this amount of HGVs is not likely and the impact to air quality is expected to be negligible.

5.4 *Impacts to Air Quality from the CCGT Power Plant During Operation*

5.4.1 *Overview*

As discussed in **Section 3.9**, the CCGT power plant has the potential to impact air quality at sensitive receptors across a wide area depending on specific design parameters and meteorological conditions. The potential impacts to air quality from the CCGT power plant were therefore quantified using detailed dispersion modelling.

5.4.2 *Assessment Methodology*

Magnitude and Significance of Impacts

There is no Project specific approach for determining the magnitude and the significance of impacts during the operation phase of the Project. This air quality impact assessment, therefore, makes specific consideration to the guidance set out by the IFC when defining the magnitude and significance of impacts to air quality.

(1) International Finance Corporation (IFC) (2007) Environmental, Health and Safety Guidelines, General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality [Online] Available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines [Accessed 06 February 2018]

The *magnitudes* of impacts during the operation phase were quantified using detailed dispersion modelling. The magnitude of the impact was ascertained by means of comparison to the Indonesian air quality standards and is based upon whether or not the impacts result in air quality standards being exceeded or contribute a substantial proportion of airborne pollutants in the local airshed. Magnitude is based on both the 'Project Contribution (PC)'; this is the impact arising solely from project related emissions, and the Predicted Environmental Concentration (PEC); this is the PC added to the existing baseline.

In order to determine the *significance* of those impacts, consideration is then required to the sensitivity of the area in question, based on sensitivity of human health and ecology within the study area. Examples of receptor type and sensitivity for the purpose of this air quality impact assessment are presented in **Table 5.17**.

In general, the approach assumes that sensitivity within the general study area is 'Medium' for human health and ecological receptors. There are a small number of specific cases where the sensitivity may be defined as 'High'; these include hospitals, for example, where there are intensive care units or high dependency wards, or internationally designated sites e.g. RAMSAR. Under no circumstances is the sensitivity for human health described as 'Low'.

Table 5.17 Receptor Sensitivity

Receptor Sensitivity	Human Health	Ecology
High	• Hospitals; • Schools; and • Retirement homes	• Internationally Designated Sites
Medium	• General Population	• Nationally Designated Site
Low	n/a	• Locally Designated Sites (Areas of specific ecological interest not subject to statutory protection) • Agriculture

The IFC make a differentiation in the significance of impacts, based upon the existing baseline. Essentially, this is whether air quality guidelines or standards are exceeded or not due to baseline concentrations.

The IFC General EHS Guidelines state:

"Projects with significant sources of air emissions, and potential for significant impacts to ambient air quality, should prevent or minimise impacts by ensuring that:

- *Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines, or other internationally recognised sources.*

- *Emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards. As a general rule, this Guideline suggests 25 percent of the applicable air quality standards to allow additional, future sustainable development in the same airshed [i.e. in an undegraded airshed]".*

And:

"An airshed should be considered as having poor air quality [degraded] if nationally legislated air quality standards or WHO Air Quality Guidelines are exceeded significantly".

The IFC guidelines further state:

"Facilities or projects located within poor quality airsheds, and within or next to areas established as ecologically sensitive (e.g. national parks), should ensure that any increase in pollution levels is as small as feasible, and amounts to a fraction of the applicable short-term and annual average air quality guidelines or standards as established in the project-specific environmental assessment."

The significance of impacts is therefore defined in terms of the magnitude of impacts (i.e. the PC), the sensitivity of the receptors, and whether the baseline pollution concentrations are above or below the air quality standards. Using this approach, the significance criteria for air quality have been defined. Based upon these considerations the magnitude and significance of impacts for non-degraded and degraded airsheds has been derived and presented in **Table 5.18** and **Table 5.19** respectively.

Table 5.18 Magnitude Criteria for Assessment of Air Pollutants

Magnitude of impact	Non-degraded airshed (i.e. baseline < AQS)	Degraded airshed (i.e. baseline > AQS)
Negligible	PC <25% of AQS	PC <10% of AQS
Small	PC between 25% and 50% of AQS and PEC <100% of AQS	PC between 10% and 30% of AQS
Medium	PC between 50% and 100% of AQS, and PEC <100% AQS; or PC between 25% and 50% of AQS, and PEC >100% of AQS	PC between 30% and 50% of AQS
Large	PC > 100% of AQS; or PC > 50% of AQS, and PEC >100% of AQS	PC > 50% of AQS

PC: Process Contribution
PEC: Predicted Environmental Concentration
AQS: Air Quality Standard/Guideline

Table 5.19 Determination of Significance

Impact Magnitude	Receptor Sensitivity		
	Low	Medium	High
Negligible	Negligible	Negligible	Negligible
Small	Negligible	Minor	Moderate
Medium	Minor	Moderate	Major
Large	Moderate	Major	Major

Selection of Modelling Scenarios

A base case modelling scenario was considered to include a stack height of 60m and a NO_x emission rate based on the IFC NO_x emission limit value and turbine NO_x concentration manufacture guaranteed of 51mg/Nm^3 (refer to **Section 5.4.3**). The resulting ground level concentrations indicate that the maximum 1-hour PC results in minor impact on air quality and therefore exceeded 25% of the NO_2 1-hour Indonesian air quality standard and is not compliant with the relevant criteria outlined in **Section 2.2**. In order to facilitate the decision making process, this air quality impact assessment presents the findings from a number of additional modelling scenarios based on varying stack heights and reduced NO_x concentration. This approach has been undertaken to determine the Project design which is necessary to achieve compliance with the air quality criteria discussed in **Section 2.2**.

A summary of the modelling scenarios is presented in **Table 5.20**.

Table 5.20 Modelling Scenarios

Modelling Scenario (1)(2)(3)	Stack Height (m)	Substances Modelled	Emission Concentration (mg/Nm^3)
Scenario 1a (Base Case)	60	NO_x	51
		CO	50
Scenario 1b	60	NO_x	40
Scenario 2a	65	NO_x	51
Scenario 2b	65	NO_x	40
Scenario 3a	70	NO_x	51
Scenario 3b	70	NO_x	40
Scenario 4a	75	NO_x	51
Scenario 4b	75	NO_x	40
Scenario 5a	82 (4)	NO_x	51
Scenario 5b	82 (4)	NO_x	40

(1) Scenario 1a (base case) considers a stack height of 60m, a guaranteed NO_x emission concentration of 51 mg/Nm^3 and CO emission concentration of 50mg/Nm^3. The NO_x emission concentration is also reflective of the IFC emission limit for natural gas fired combustion turbines > 50MWth (see **Table 2.3**).

(2) Scenario 2a, 3a, 4a and 5a consider increasing stack height while maintaining the GE 9HA.02 gas turbine NO_x emission rate at a guaranteed concentration of 51 mg/Nm^3.

(3) Scenario 1b, 2b, 3b, 4b and 5b consider increasing stack height with both GE 9HA.02 turbines operating at the expected base load NO_x emission level of 40mg/Nm^3. While the contractual guarantees from General Electric (GE) are for a maximum of 51 mg/Nm^3 NO_x, the two 9HA.02 gas turbines are not expected to operate at this limit during normal operation. Furthermore, the turbines will be fitted with GEs Dry Low NO_x (DLN2.6e) combustion system which will result in lower NO_x emissions. The applicability of this NO_x emission level is supported by the European Commission Best Available Techniques (BAT) Reference Document for Large Combustion Plants which presents evidence of new CCGT power plants (>50MWth) achieving a NO_x emission level between 15 and 40 mg/Nm^3 as a daily average and between 10 and 30 mg/Nm^3 as an annual average when applying BAT (i.e. dry low-NOx burners). (European Commission Best Available Techniques (BAT) Reference Document for Large Combustion Plants (2017) [Online] Available at: http://eippcb.jrc.ec.europa.eu/reference/BREF/LCP/JRC107769_LCP_bref2017.pdf)

(4) Good International Industry Practice (GIIP) stack height requirement

Dispersion Modelling

The air quality impact assessment approach uses air dispersion modelling to assess potential impacts to sensitive receptors from the stack emissions from the CCGT power plant.

The dispersion model used in the assessment was the USEPA AERMOD dispersion model version 16216r. AERMOD is a state of the art detailed dispersion model that can be used to represent complex multiple emission sources and predict air quality at receptor locations taking into account meteorology. The model is widely recognised for use in this type of application, including by the IFC, US EPA, UK Environment Agency and state based EPA's throughout Australia.

At each of the representative human air sensitive receptors the maximum PC and the PEC for each substance of interest is presented and the significance of the impact defined using the approach outlined in **Section 4.** In addition, the maximum PC and PEC at any point on the receptor grid outside of the power plant site boundary has been identified and the significance defined. The results of the assessment comprise the maximum PC and PEC predicted over a period of five years from 2013 to 2017 on the receptor grid.

The modelling scenarios and methodology, including receptor grid spacing, meteorological data information, NO_x to NO_2 conversion and the treatment of buildings, land use and terrain is presented in **Table 5.21** and the emission inventory is presented in **Table 5.22**.

Table 5.21 Detailed Modelling Methodology

Modelling Component	Information/Method/Approach
Interpretation of the worst case offsite ground level concentration	The assessment presents the 100th percentile (absolute highest 1-hour and 24-hour) modelled concentration found anywhere on the receptor grid as a worst case approach. It is noted, however, that the modelled 1-hour ground level concentrations at any given grid point or sensitive receptor have the potential to be highly skewed. The absolute worst hour may have a concentration twice that of the second-worst hour, and 10 times that of the ninth-highest hour, however the ninth-highest hour may only be fractionally above the tenth-highest hour. Consequently a modelling result taken as a peak value (100th percentile) in comparison to ambient air quality criteria is greatly sensitive to modelling uncertainty as a result of extreme, rare and transient meteorological conditions. To mitigate modelling uncertainty, the use of the 9th highest or 99.9 percentile is considered. This approach of reducing the impact of modelling uncertainty on the presentation of the predicted 1-hour average concentration is adopted across multiple jurisdictions around the world including Victoria in Australia (1), Alberta in Canada (2) and the New Zealand Ministry for the Environment (3). For averaging periods longer than an hour, the modelling uncertainty is reduced as the averaging process over multiple hours reduces the peak 1-hour values, and longer averaging periods are therefore not subject to the same modelling uncertainty. Consequently, for criteria with averaging periods of 1-hour, the 9th highest (99.9th percentile) value has also been reported to reduce modelling uncertainty. Use of the 9th highest 1-hour average value means that from the model predictions, results for 8751 hours of the year are equal to or lower than the value presented. For averaging periods greater than 1-hour the maximum predicted (100th percentile) concentration only has reported.
Defining Sources	The representation of emission sources in AERMOD was based on the nature of the source being considered. As discussed, the substances of interest are from the combustion of natural gas resulting in emissions to the atmosphere through two stationary stacks. The sources were therefore modelled as point sources.
Defining Emissions	The scenarios assume continuous emissions throughout one entire year comprising of 365 days. Stack parameters and emission rates were defined for each substance with the potential to have adverse impacts on air quality during normal operation. The emission inventory is presented in **Table 5.22.**
Receptor Grid	The dispersion model uses a nested grid extending up to 10 km from the stack locations to determine the maximum process contribution in the study area and the process contribution arising at representative air sensitive receivers and in each air sensitive receiver classification. The receptor spacing varies with distance

Modelling Component	Information/Method/Approach
	from the point source locations in order to provide sufficiently dense receptors close to the site, and suitable spatial coverage further afield. The spacing of receptors is as follows: • 50 meter spacing from 0 to 500 meters; • 100 meter spacing from 500 to 1,000 meters; • 200 meter spacing from 1,000 to 2,000 meters; • 400 meter spacing from 2,000 meters to 4,000 meters; and • 500 meter spacing from 4,000 meters to 10,000 meters. Furthermore, specific receptor points were included in the model to reflect the locations of representative air sensitive receivers (refer to **Figure 4.5**)
Meteorological Data	The meteorological data used in the model must be reflective of the local conditions. There is very little meteorological data available for Indonesia therefore five (5) years of meteorological data was modelled using the Weather Research and Forecasting Model (WRF) using a 4km x 4km resolution (see **Section 4.4**).
Conversion of NO_x to NO_2	The USEPA's Tier 3 screening method (Ozone Limiting Method (OLM)) in AERMOD was used to convert the modelled NO_x concentrations to NO_2 for comparison to the air quality standards. (4) Atmospheric O_3 fluctuates throughout the day and it is unlikely that the maximum measured O_3 values will correspond with the maximum NO_x concentrations at receptors. It is also overly conservative to apply the maximum monitored O_3 value to determine the NO_x to NO_2 conversion throughout the study area and for every hour of the year. On this basis, and to further refine the impact assessment, the maximum 1-hour O_3 value for each hour of the day was extracted from the data collected during the monitoring period and included as a 'HROFDY' file within the AERMOD set up (see **Table 4.7**). The AERMOD Tier 3 screening method requires that the NO_2/NO_x in-stack ratio (ISR) is defined. Information to inform this process was extracted from the USEPA NO_2/NO_x ISR database (5). A review of the available information for natural gas fired turbines indicates an average ISR of 0.17 and this value was therefore used to inform the dispersion model.
Buildings	When air flow passes over buildings, a phenomenon known as building downwash occurs where the air is entrained in the lee of the building and drawn down to ground level. This effect can bring the plume from the stack down to ground level quicker than would otherwise be the case, and therefore increase the ground level concentration relative to a case where there are no buildings. The USEPA (6) suggest that emissions from stacks greater than 2.5 times the height of the highest nearby structure would escape building influences on

Modelling Component	Information/Method/Approach
	dispersion. On this basis only nearby buildings which are higher than 24m require consideration in the assessment. The buildings included in the dispersion model included the gas and steam turbine halls (H = 25m); the heat recovery steam generator (HRSG) buildings (H = 45m); and the main electrical building (H = 20m). The representation of the buildings within AERMOD can be seen in **Figure 5.1** and were modelled to account for building downwash.
Land Use	The land use and terrain around the Project will affect dispersion. Airflow over the ground is disturbed by protuberances into the air, for example buildings, trees and vegetation. The surface roughness length is a representation of the disruption of airflow close to the ground due to these obstructions. In this case, the land use type in the study area is primarily cultivated land. The AERMOD pre-processor AERSURFACE was used to define the land use characteristics around the project site.
Terrain	Hills, mountains and valleys can affect dispersion by directing the plume. The terrain pre-processor AERMAP using the Shuttle Radar Topographic Mission (SRTM) 90 x 90m imagery was run to provide information on the a) base elevation of each receptor and source defined in the model; and b) the terrain height that has the greatest influence on dispersion for each individual receptor, otherwise known as the hill height scale. Both the base elevation and hill height scale were incorporated into AERMOD. The terrain throughout the study area is generally flat (simple terrain) therefore it is unlikely that terrain has much effect on the meteorology conditions within the study area.

(1) Environmental Protection Agency Victoria (2013) Guidance notes for using the regulatory air pollution model AERMOD in Victoria [Online] Available at: https://www.epa.vic.gov.au/~/media/Publications/1551.pdfhttp://www.mfe.govt.nz/sites/default/files/atmospheric-dispersion-modelling-jun04.pdf [Accessed 30 June 2018];

(2) Alberta Government (2013) Air Quality Model Guideline [Online] Available at: http://aep.alberta.ca/air/air-quality-modelling/documents/AirQualityModelGuideline-Oct1-2013.pdf [Accessed 06 February 2018]

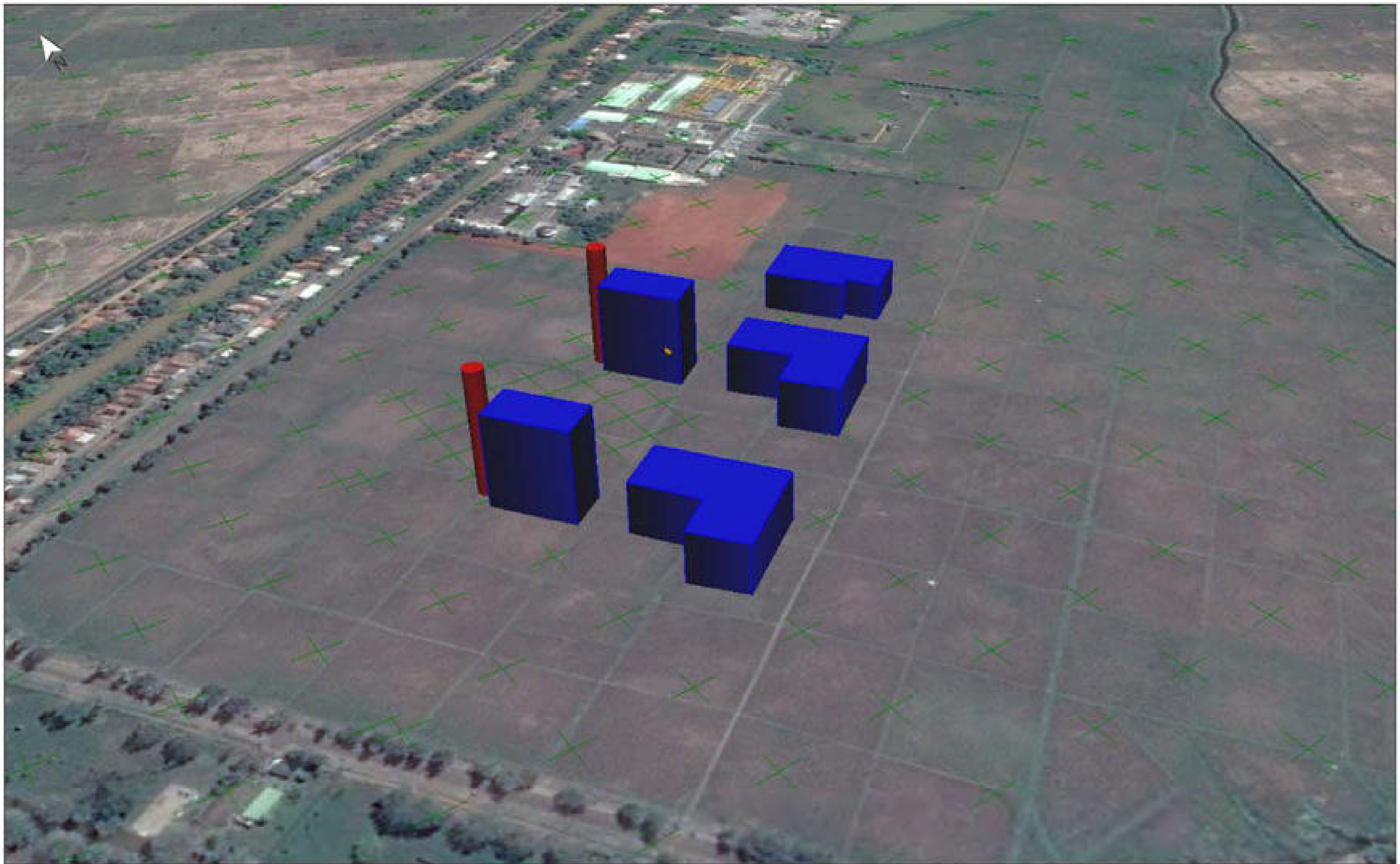
(3) New Zealand Ministry for the Environment (2004) Good Practice Guide for Atmospheric Dispersion Modelling [Online] Available at: http://www.mfe.govt.nz/sites/default/files/atmospheric-dispersion-modelling-jun04.pdf [Accessed 06 February 2018];

(4) United States Environmental Protection Agency (2014) Clarification on the Use of AERMOD Dispersion Modeling for Demonstrating Compliance with the NO_2 National Ambient Air Quality Standard [Online] Available at: https://www3.epa.gov/scram001/guidance/clarification/NO2_Clarification_Memo-20140930.pdf [Accessed 30 May 2018]

(5) United States Environmental Protection Agency (USEPA) NO_2/NO_x In-Stack Ratio (ISR) Database Available at: https://www3.epa.gov/ttn/scram/no2_isr_database.htm [Accessed 30 May 2018]

(6) United States Environmental Protection Agency (USEPA) (1985) Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) [Online] Available at: https://www3.epa.gov/scram001/guidance/guide/gep.pdf [Accessed 06 February 2018]

Figure 5.1 Building Representation in AERMOD



Building Representation in AERMOD

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DATE: 07/02/2018

Environmental Resources Management
ERM

Table 5.22 Emission Inventory for CCGT Power Plant

	Unit	Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5	
		a	b	a	b	a	b	a	b	a	b
Actual Stack Conditions											
Stack Location	Lat/Long	Stack 1: 6°14'37.84"S 107°35'19.58"E Stack 2: 6°14'40.04"S 107°35'16.25"E									
Stack height	m	60	60	65	65	70	70	75	75	82	82
Stack diameter	m	9.44									
Exit Temperature	k	340									
Emission Velocity	m/s	15.2									
Actual oxygen (O_2) content (dry)	%	10.7									
Actual moisture (H_2O) content (wet)	%	13.2									
Actual volume flow rate	Am^3/s	1067									
Reference Conditions (1)											
Temperature	K	273.15									
Oxygen content (dry gas)	%	15									
Moisture content (dry gas)	%	0									
Normalised Volume Flow Rate (2)											
Normalised volume flow rate	Nm^3/s	1283									
Emission Concentrations											
Oxides of Nitrogen (NO_x) (1)	mg/Nm^3	51	40	51	40	51	40	51	40	51	40
Carbon Monoxide (CO)	mg/Nm^3	50	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*
Emission Rates											
Oxides of Nitrogen (NO_x)	g/s	65.4	51.3	65.4	51.3	65.4	51.3	65.4	51.3	65.4	51.3
Carbon Monoxide (CO)	g/s	64.2	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*

(1) International Finance Corporation (IFC) (2008) Environmental, Health and Safety Guidelines for Thermal Power Plants [Online] Available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/our+approach/risk+management/ehsguidelines [Accessed 05 February 2018].

(2) Calculated using the Environment Agency (2013) Pollution Inventory Reporting – Combustion Activities Guidance Note [online] Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/296994/LIT_7825_e97f48.pdf [Accessed 05 February 2018]

5.4.3 *Scenario 1a (Base Case): Impacts to Air Quality (pre-mitigation)*

The significance of impacts are discussed in this section for the relevant substances and averaging periods. Where the findings are considered negligible throughout the study area no further analysis or discussion is provided in this air quality impact assessment. This approach has been taken on the basis that additional modelling scenarios incorporating additional mitigation will only improve the results resulting in a reduced impact on air quality relative to the base case scenario.

- Nitrogen Dioxide (NO_2) 1-Hour Maximum (100th percentile)
    - The modelling results presented in **Table 5.23** indicate that the maximum offsite PC based on the absolute highest modelled value (100th percentile) is 136µg/m^3 which exceeds 25% of the relevant air quality standard (400µg/m^3). The PEC (179µg/m^3) is below the air quality standard. On this basis the impact to air quality is considered Minor. A contour map showing the PC and PEC is presented in **Figure 5.2** and **Figure 5.3** respectively. Further analysis is necessary and is presented in **Section 5.4.4** and **Section 5.4.5**.
- Nitrogen Dioxide (NO_2) 1-Hour Maximum (99.9th percentile)
    - The modelling results presented in **Table 5.24** indicate that the maximum offsite PC based on the 99.9th percentile 1-hour value is 112µg/m^3 and exceeds 25% of the relevant air quality standard (400µg/m^3). The PEC (179µg/m^3) is below the air quality standard. On this basis the impact to air quality is considered Minor. A contour map showing the PC and PEC is presented in **Figure 5.4** and **Figure 5.5.** Further analysis is necessary and is presented in **Section 5.4.4** and **Section 5.4.5**.
- Nitrogen Dioxide (NO_2) 24-Hour Maximum
    - The modelling results presented in **Table 5.25** indicate that the maximum offsite PC (35.1µg/m^3) and the maximum offsite PEC (62.8µg/m^3) is less than 25% and 100% of the relevant air quality standard (150µg/m^3) respectively throughout the study area. On this basis the impacts to air quality are Negligible. A contour map showing the PC and PEC is presented in **Figure 5.6** and **Figure 5.7**. No further assessment is considered necessary.
- Nitrogen Dioxide (NO_2) Annual Average
    - The modelling results presented in **Table 5.26** indicate that the maximum offsite PC (8.22µg/m^3) and the maximum offsite PEC (20.5µg/m^3) is less than 25% and 100% of the relevant air quality standard (100µg/m^3) respectively throughout the study area. On this

basis the impacts to air quality are Negligible. A contour map showing the PC and PEC is presented in **Figure 5.8** and **Figure 5.9**. No further assessment is considered necessary.

- Carbon Monoxide (CO) 1-Hour Maximum (100th percentile)
  - The modelling results presented in **Table 5.27** indicate that the maximum offsite PC based on the absolute highest modelled value (100th percentile) is 149µg/m^3 and is less than 25% of the relevant air quality standard (30,000µg/m^3) throughout the study area. On this basis the impacts to air quality are Negligible. A contour map showing the PC is presented in **Figure 5.10.**
- Carbon Monoxide (CO) 1-Hour Maximum (99.9th percentile)
  - The modelling results presented in **Table 5.28** indicate that the maximum offsite PC based on the 99.9th percentile 1-hour value is 122µg/m^3 and is less than 25% of the relevant air quality standard (30,000µg/m^3) throughout the study area. On this basis the impacts to air quality are Negligible. A contour map showing the PC is presented in **Figure 5.11.** No further assessment is considered necessary.
- Carbon Monoxide (CO) 24-Hour Maximum
  - The modelling results presented in **Table 5.29** indicate that the maximum offsite PC (38.2µg/m^3) is less than 25% of the relevant air quality standard throughout the study area. On this basis the impacts to air quality are Negligible. A contour map showing the PC is presented in **Figure 5.12.** No further assessment is considered necessary.
- Oxides of Nitrogen (NO_x) Annual Average
  - The modelling results presented in **Table 5.30** indicate that the maximum offsite PC (9.14µg/m^3) exceeds 25% of the relevant standard (30µg/m^3). On this basis the impact to air quality is considered Minor. It is noted, however, that in the coastal areas where protected mangrove have been identified, and in areas where paddy fields are present around the site boundary, the impacts to air quality are Negligible (i.e. PC less than 25% of air quality standard) (see **Figure 5.13**). On this basis no further assessment is considered necessary.

Table 5.23 Scenario 1a: Nitrogen Dioxide (NO_2) 1-Hour Maximum – 100 Percentile (Human Health)

Site	Baseline (µg/m³)	AQS[(1)] (µg/m³)	Airshed classification	PC[(2)] (µg/m³)	PC/AQS (%)	PEC[(3)] (µg/m³)	PEC/AQS (%)	Impact Significance
Maximum concentration [(4)]	66.9 [(5)]	400	ND [(6)]	136	34%	203	51%	Minor
ASR1				40.8	10%	108	27%	Negligible
ASR2				56.8	14%	124	31%	Negligible
ASR3				42.3	11%	109	27%	Negligible
ASR4				98.0	25%	165	41%	Negligible
ASR5				56.0	14%	123	31%	Negligible
ASR6				46.0	11%	113	28%	Negligible
ASR7				44.1	11%	111	28%	Negligible
ASR8				42.7	11%	110	27%	Negligible
ASR9				31.9	8.0%	98.7	25%	Negligible
ASR10				36.2	9.0%	103	26%	Negligible
ASR11				35.1	8.8%	102	25%	Negligible
ASR12				29.6	7.4%	96.5	24%	Negligible
ASR13				25.1	6.3%	92.0	23%	Negligible
ASR14				33.0	8.2%	100	25%	Negligible
ASR15				29.5	7.4%	96.4	24%	Negligible
ASR16				38.3	9.6%	105	26%	Negligible
ASR17				32.2	8.1%	99.1	25%	Negligible
ASR18				39.1	9.8%	106	26%	Negligible
ASR19				36.3	9.1%	103	26%	Negligible
ASR20				26.9	6.7%	93.8	23%	Negligible

(1) Air Quality Standard *(Regulation of the Republic of Indonesia Number 41 (1999))*

(2) Process Contribution

(3) Predicted Environmental Contribution

(4) The maximum ground level concentration outside of the Power Plant site boundary

(5) The maximum 1-hour average concentration was measured at AQM1b using the AQS1 real time air quality monitor (see **Table 4.5**). This was used as the 1-hour average baseline across all sites as a worst case approach.

(6) Non-degraded (Baseline < AQS)

Table 5.24 Scenario 1a: Nitrogen Dioxide (NO_2) 1-Hour Maximum – 99.9 Percentile (Human Health)

Site	Baseline (µg/m³)	AQS[1] (µg/m³)	Airshed classification	PC[2] (µg/m³)	PC/AQS (%)	PEC[3] (µg/m³)	PEC/AQS (%)	Impact Significance
Maximum concentration [4]				112	28%	179	45%	Minor
ASR1				21.5	5.4%	88.3	22%	Negligible
ASR2				40.5	10%	107	27%	Negligible
ASR3				21.3	5.3%	88.1	22%	Negligible
ASR4				48.3	12%	115	29%	Negligible
ASR5				45.8	11%	113	28%	Negligible
ASR6				23.9	6.0%	90.8	23%	Negligible
ASR7				19.6	4.9%	86.5	22%	Negligible
ASR8				28.5	7.1%	95.4	24%	Negligible
ASR9				14.1	3.5%	80.9	20%	Negligible
ASR10	66.9 [5]	400	ND [6]	21.3	5.3%	88.1	22%	Negligible
ASR11				20.2	5.1%	87.1	22%	Negligible
ASR12				13.4	3.3%	80.2	20%	Negligible
ASR13				10.9	2.7%	77.8	19%	Negligible
ASR14				12.1	3.0%	78.9	20%	Negligible
ASR15				11.4	2.8%	78.3	20%	Negligible
ASR16				19.5	4.9%	86.4	22%	Negligible
ASR17				18.4	4.6%	85.2	21%	Negligible
ASR18				23.7	5.9%	90.6	23%	Negligible
ASR19				18.7	4.7%	85.5	21%	Negligible
ASR20				9.49	2.4%	76.4	19%	Negligible

(1) Air Quality Standard *(Regulation of the Republic of Indonesia Number 41 (1999))*
(2) Process Contribution
(3) Predicted Environmental Contribution
(4) The maximum ground level concentration outside of the Power Plant site boundary
(5) The maximum 1-hour average concentration was measured at AQM1b using the AQS1 real time air quality monitor (see **Table 4.5**). This was used as the 1-hour average baseline across all sites as a worst case approach.
(6) Non-degraded (Baseline < AQS)

Table 5.25 Scenario 1a: Nitrogen Dioxide (NO_2) 24-Hour Maximum – 100 Percentile (Human Health)

Site	Baseline (µg/m³)	AQS[1] (µg/m³)	Airshed classification	PC[2] (µg/m³)	PC/AQS (%)	PEC[3] (µg/m³)	PEC/AQS (%)	Impact Significance
Maximum concentration [4]	27.7 [5]	150	ND [6]	35.1	23%	62.8	42%	Negligible
ASR1				6.99	4.7%	34.7	23%	Negligible
ASR2				7.98	5.3%	35.7	24%	Negligible
ASR3				6.20	4.1%	33.9	23%	Negligible
ASR4				11.1	7.4%	38.9	26%	Negligible
ASR5				13.2	8.8%	40.9	27%	Negligible
ASR6				3.32	2.2%	31.0	21%	Negligible
ASR7				5.45	3.6%	33.2	22%	Negligible
ASR8				3.05	2.0%	30.8	21%	Negligible
ASR9				4.05	2.7%	31.8	21%	Negligible
ASR10				4.33	2.9%	32.1	21%	Negligible
ASR11				2.09	1.4%	29.8	20%	Negligible
ASR12				2.85	1.9%	30.6	20%	Negligible
ASR13				2.54	1.7%	30.3	20%	Negligible
ASR14				2.87	1.9%	30.6	20%	Negligible
ASR15				1.87	1.2%	29.6	20%	Negligible
ASR16				2.40	1.6%	30.1	20%	Negligible
ASR17				2.24	1.5%	30.0	20%	Negligible
ASR18				3.35	2.2%	31.1	21%	Negligible
ASR19				2.67	1.8%	30.4	20%	Negligible
ASR20				1.96	1.3%	29.7	20%	Negligible

(1) Air Quality Standard *(Regulation of the Republic of Indonesia Number 41 (1999))*

(2) Process Contribution

(3) Predicted Environmental Contribution

(4) The maximum ground level concentration outside of the Power Plant site boundary

(5) The maximum 24-hour average concentration was measured at AQM1b using the AQS1 real time air quality monitor (see **Table 4.5**). This was used as the 24-hour average baseline concentration across all sites as a worst case approach.

(6) Non-degraded (Baseline < AQS)

Table 5.26 Scenario 1: Nitrogen Dioxide (NO_2) Annual Average (Human Health)

Site	Baseline (µg/m³)	AQS[1] (µg/m³)	Airshed classification	PC[2] (µg/m³)	PC/AQS (%)	PEC[3] (µg/m³)	PEC/AQS (%)	Impact Significance
Maximum concentration [4]	12.2 [5]	100	ND [6]	8.22	8.2%	20.5	20%	Negligible
ASR1				2.12	2.1%	14.4	14%	Negligible
ASR2				0.869	<1%	13.1	13%	Negligible
ASR3				1.10	1.1%	13.3	13%	Negligible
ASR4				3.03	3.0%	15.3	15%	Negligible
ASR5				0.872	<1%	13.1	13%	Negligible
ASR6				0.384	<1%	12.6	13%	Negligible
ASR7				0.445	<1%	12.7	13%	Negligible
ASR8				0.467	<1%	12.7	13%	Negligible
ASR9				0.535	<1%	12.8	13%	Negligible
ASR10				0.356	<1%	12.6	13%	Negligible
ASR11				0.337	<1%	12.6	13%	Negligible
ASR12				0.290	<1%	12.5	13%	Negligible
ASR13				0.473	<1%	12.7	13%	Negligible
ASR14				0.312	<1%	12.6	13%	Negligible
ASR15				0.172	<1%	12.4	12%	Negligible
ASR16				0.220	<1%	12.5	12%	Negligible
ASR17				0.237	<1%	12.5	12%	Negligible
ASR18				0.244	<1%	12.5	12%	Negligible
ASR19				0.361	<1%	12.6	13%	Negligible
ASR20				0.164	<1%	12.4	12%	Negligible

(1) Air Quality Standard *(Regulation of the Republic of Indonesia Number 41 (1999))*
(2) Process Contribution
(3) Predicted Environmental Contribution
(4) The maximum ground level concentration outside of the Power Plant site boundary
(5) The maximum derived annual average concentration was measured at AQM1b using the AQS1 real time air quality monitor (see **Table 4.5**). This was used as the annual average baseline concentration across all sites as a worst case approach
(6) Non-degraded (Baseline < AQS)

Table 5.27 Scenario 1: Carbon Monoxide (CO) 1-Hour Maximum – 100 Percentile (Human Health)

Site	Baseline (µg/m³)	AQS[1] (µg/m³)	Airshed classification	PC[2] (µg/m³)	PC/AQS (%)	PEC[3] (µg/m³)	PEC/AQS (%)	Impact Significance
Maximum concentration [4]	n.a [5]	30,000	ND [6]	149	<1%	149	<1%	Negligible
ASR1				44.5	<1%	44.5	<1%	Negligible
ASR2				62.0	<1%	62.0	<1%	Negligible
ASR3				46.2	<1%	46.2	<1%	Negligible
ASR4				107	<1%	107	<1%	Negligible
ASR5				61.1	<1%	61.1	<1%	Negligible
ASR6				50.1	<1%	50.1	<1%	Negligible
ASR7				48.1	<1%	48.1	<1%	Negligible
ASR8				46.6	<1%	46.6	<1%	Negligible
ASR9				34.8	<1%	34.8	<1%	Negligible
ASR10				39.5	<1%	39.5	<1%	Negligible
ASR11				38.3	<1%	38.3	<1%	Negligible
ASR12				32.3	<1%	32.3	<1%	Negligible
ASR13				27.4	<1%	27.4	<1%	Negligible
ASR14				36.0	<1%	36.0	<1%	Negligible
ASR15				32.2	<1%	32.2	<1%	Negligible
ASR16				41.7	<1%	41.7	<1%	Negligible
ASR17				35.2	<1%	35.2	<1%	Negligible
ASR18				42.7	<1%	42.7	<1%	Negligible
ASR19				39.5	<1%	39.5	<1%	Negligible
ASR20				29.3	<1%	29.3	<1%	Negligible

(1) Air Quality Standard *(Regulation of the Republic of Indonesia Number 41 (1999))*
(2) Process Contribution
(3) Predicted Environmental Contribution
(4) The maximum ground level concentration anywhere on the modelled receptor grid
(5) No quantitative baseline information was collected on the basis that ambient concentrations are typically low and project contributions negligible
(6) Non-degraded (Baseline < AQS)

Table 5.28 Scenario 1: Carbon Monoxide (CO) 1-Hour Maximum – 99.9 Percentile (Human Health)

Site	Baseline (μg/m³)	AQS(1) (μg/m³)	Airshed classification	PC(2) (μg/m³)	PC/AQS (%)	PEC(3) (μg/m³)	PEC/AQS (%)	Impact Significance
Maximum concentration (4)	n.a (5)	30,000	ND (6)	122	<1%	122	<1%	Negligible
ASR1				23.4	<1%	23.4	<1%	Negligible
ASR2				44.2	<1%	44.2	<1%	Negligible
ASR3				23.2	<1%	23.2	<1%	Negligible
ASR4				52.7	<1%	52.7	<1%	Negligible
ASR5				49.9	<1%	49.9	<1%	Negligible
ASR6				26.1	<1%	26.1	<1%	Negligible
ASR7				21.4	<1%	21.4	<1%	Negligible
ASR8				31.1	<1%	31.1	<1%	Negligible
ASR9				15.3	<1%	15.3	<1%	Negligible
ASR10				23.2	<1%	23.2	<1%	Negligible
ASR11				22.1	<1%	22.1	<1%	Negligible
ASR12				14.6	<1%	14.6	<1%	Negligible
ASR13				11.9	<1%	11.9	<1%	Negligible
ASR14				13.2	<1%	13.2	<1%	Negligible
ASR15				12.4	<1%	12.4	<1%	Negligible
ASR16				21.3	<1%	21.3	<1%	Negligible
ASR17				20.0	<1%	20.0	<1%	Negligible
ASR18				25.8	<1%	25.8	<1%	Negligible
ASR19				20.3	<1%	20.3	<1%	Negligible
ASR20				10.3	<1%	10.3	<1%	Negligible

(1) Air Quality Standard *(Regulation of the Republic of Indonesia Number 41 (1999))*
(2) Process Contribution
(3) Predicted Environmental Contribution
(4) The maximum ground level concentration anywhere on the modelled receptor grid
(5) No quantitative baseline information was collected on the basis that ambient concentrations are typically low and project contributions negligible
(6) Non-degraded (Baseline < AQS)

Table 5.29 Scenario 1: Carbon Monoxide (CO) 24-Hour Maximum – 100 Percentile (Human Health)

Site	Baseline (µg/m³)	AQS[1] (µg/m³)	Airshed classification	PC[2] (µg/m³)	PC/AQS (%)	PEC[3] (µg/m³)	PEC/AQS (%)	Impact Significance
Maximum concentration [4]	n/a [5]	10,000	ND [6]	38.2	<1%	38.2	<1%	Negligible
ASR1				7.62	<1%	7.62	<1%	Negligible
ASR2				8.70	<1%	8.70	<1%	Negligible
ASR3				6.76	<1%	6.76	<1%	Negligible
ASR4				12.1	<1%	12.1	<1%	Negligible
ASR5				14.4	<1%	14.4	<1%	Negligible
ASR6				3.62	<1%	3.62	<1%	Negligible
ASR7				5.94	<1%	5.94	<1%	Negligible
ASR8				3.33	<1%	3.33	<1%	Negligible
ASR9				4.41	<1%	4.41	<1%	Negligible
ASR10				4.72	<1%	4.72	<1%	Negligible
ASR11				2.27	<1%	2.27	<1%	Negligible
ASR12				3.11	<1%	3.11	<1%	Negligible
ASR13				2.77	<1%	2.77	<1%	Negligible
ASR14				3.13	<1%	3.13	<1%	Negligible
ASR15				2.04	<1%	2.04	<1%	Negligible
ASR16				2.61	<1%	2.61	<1%	Negligible
ASR17				2.45	<1%	2.45	<1%	Negligible
ASR18				3.66	<1%	3.66	<1%	Negligible
ASR19				2.91	<1%	2.91	<1%	Negligible
ASR20				2.14	<1%	2.14	<1%	Negligible

(1) Air Quality Standard *(Regulation of the Republic of Indonesia Number 41 (1999))*
(2) Process Contribution
(3) Predicted Environmental Contribution
(4) The maximum ground level concentration anywhere on the modelled receptor grid
(5) No quantitative baseline information was collected on the basis that ambient concentrations are typically low and project contributions negligible
(6) Non-degraded (Baseline < AQS)

Table 5.30 Scenario 1: Oxides of Nitrogen (NO_x) – Annual Average (Ecology)

Receptor	Baseline(µg/m³)	Airshed classification	AQS [1] (µg/m³)	PC[2] (µg/m³)	PC / AQS (%)	PEC[3] (µg/m³)	PEC/AQS (%)	Impact Significance
Maximum [4]	n/a	ND [6]	30	9.14	30%	9.14	30%	Minor

(1) WHO/EU Critical Level for the Protection of Vegetation
(2) Process Contribution
(3) Predicted Environmental Contribution
(4) The maximum ground level concentration found anywhere on the grid
(5) NO_x baseline not available
(6) Assumed non-degraded (Baseline < AQS)

Figure 5.2 Scenario 1a: Nitrogen Dioxide (NO_2) 1-Hour Maximum Process Contribution (PC) – 100 Percentile (Human Health)

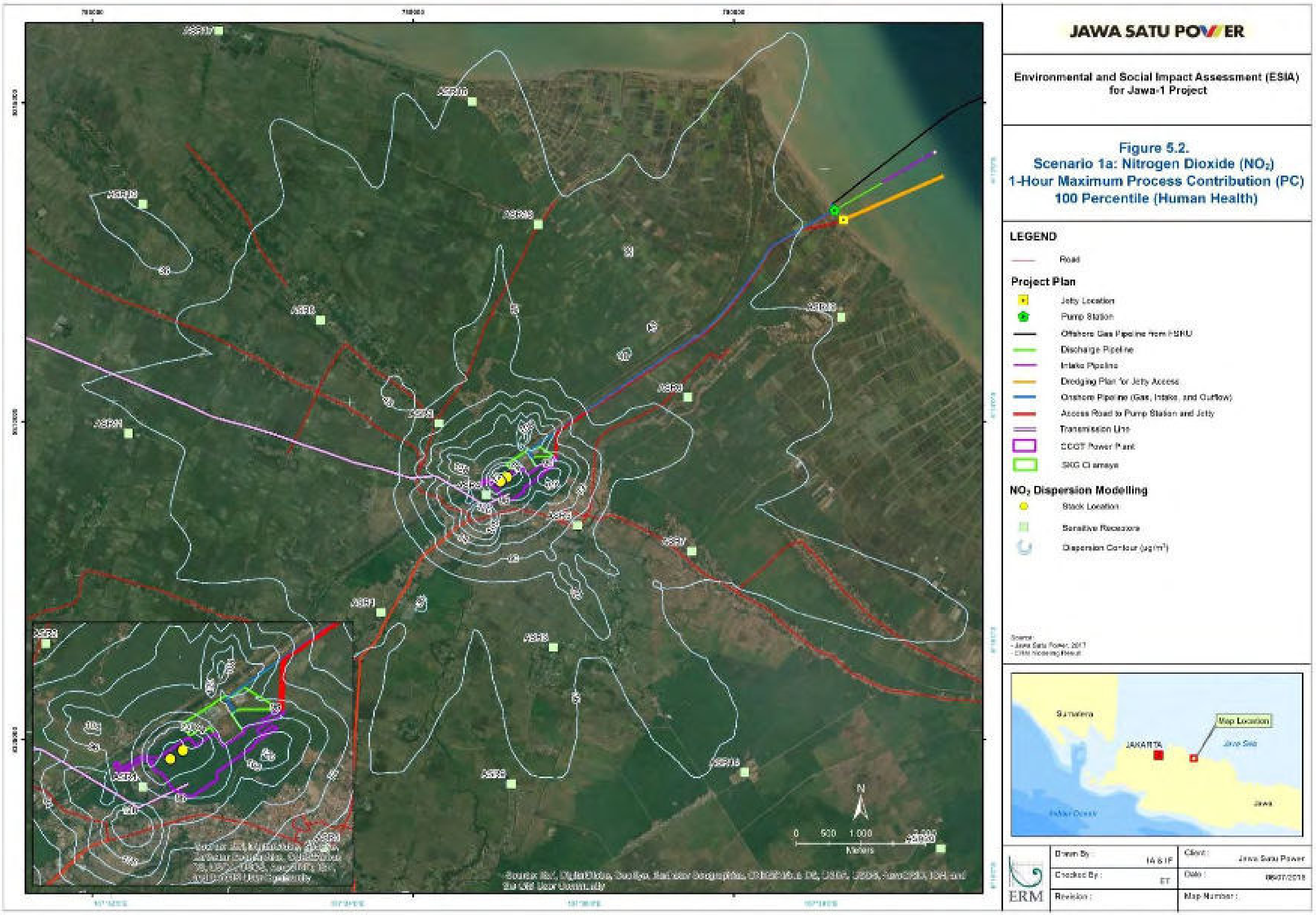


Figure 5.3 Scenario 1a: Nitrogen Dioxide (NO_2) 1-Hour Maximum Predicted Environmental Concentration (PEC) – 100 Percentile (Human Health)

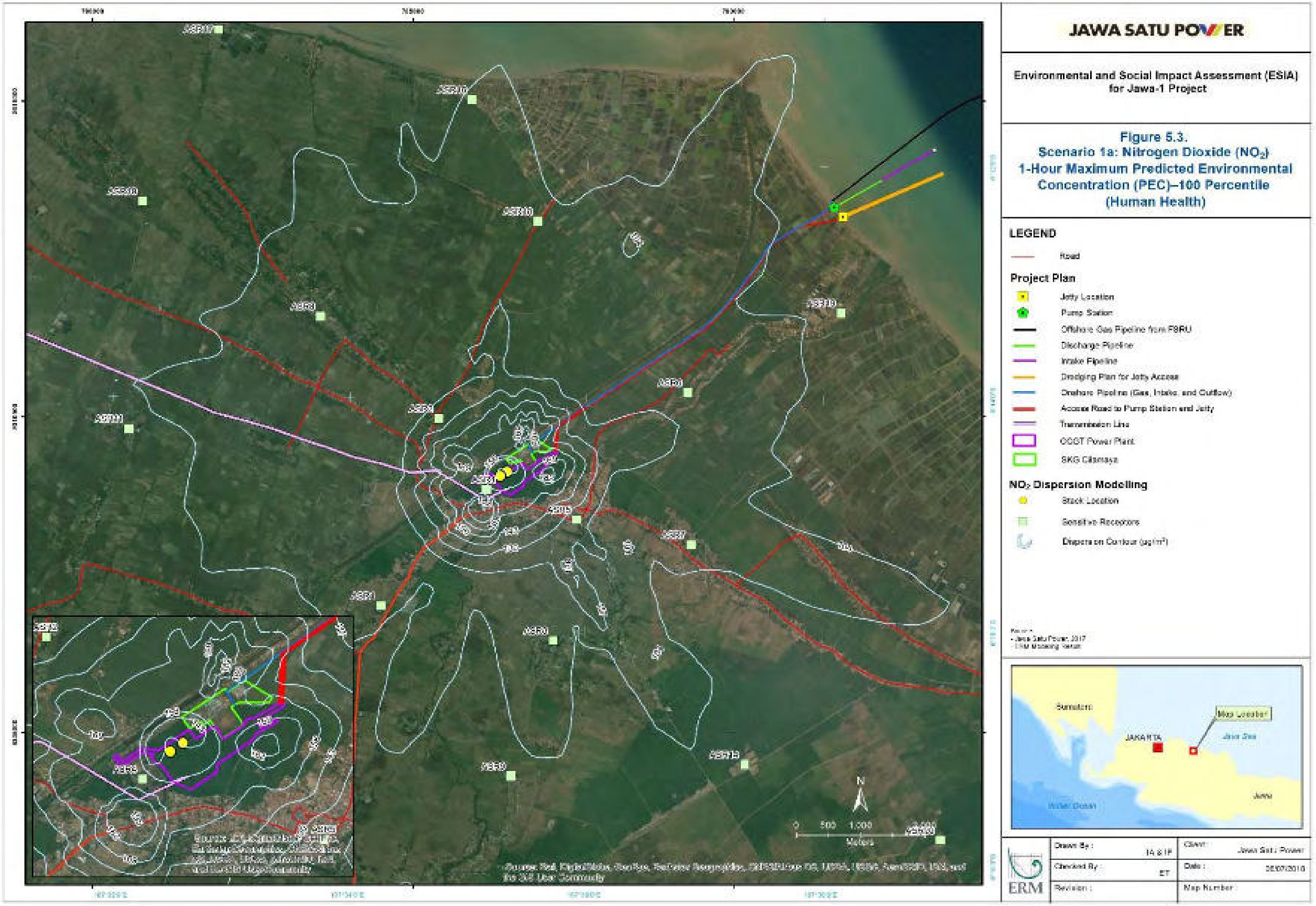


Figure 5.4 Scenario 1a: Nitrogen Dioxide (NO_2) 1-Hour Maximum Process Contribution (PC) – 99.9 Percentile (Human Health)

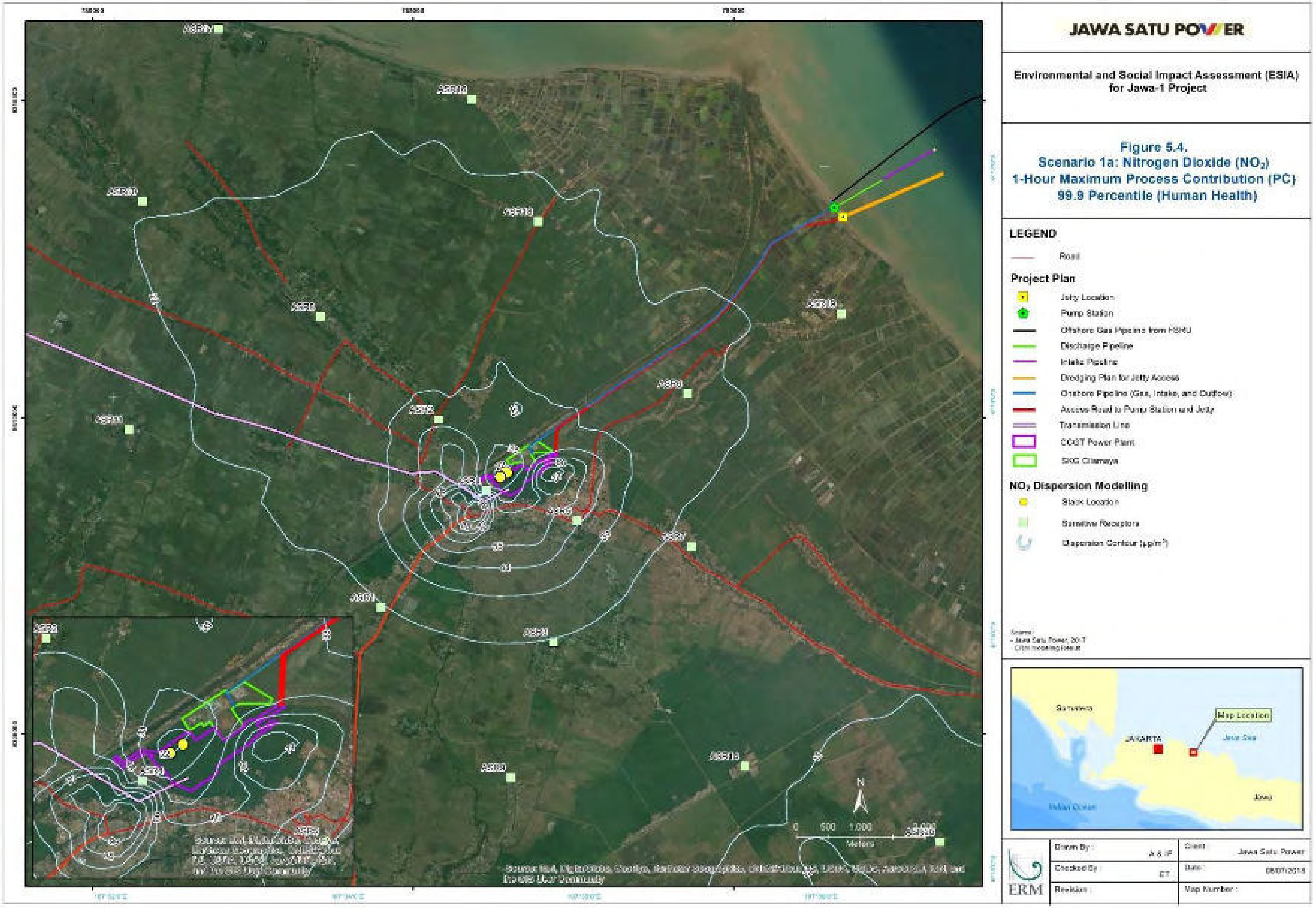


Figure 5.5 *Scenario 1a: Nitrogen Dioxide (NO_2) 1-Hour Maximum Predicted Environmental Concentration (PEC) – 99.9 Percentile (Human Health)*

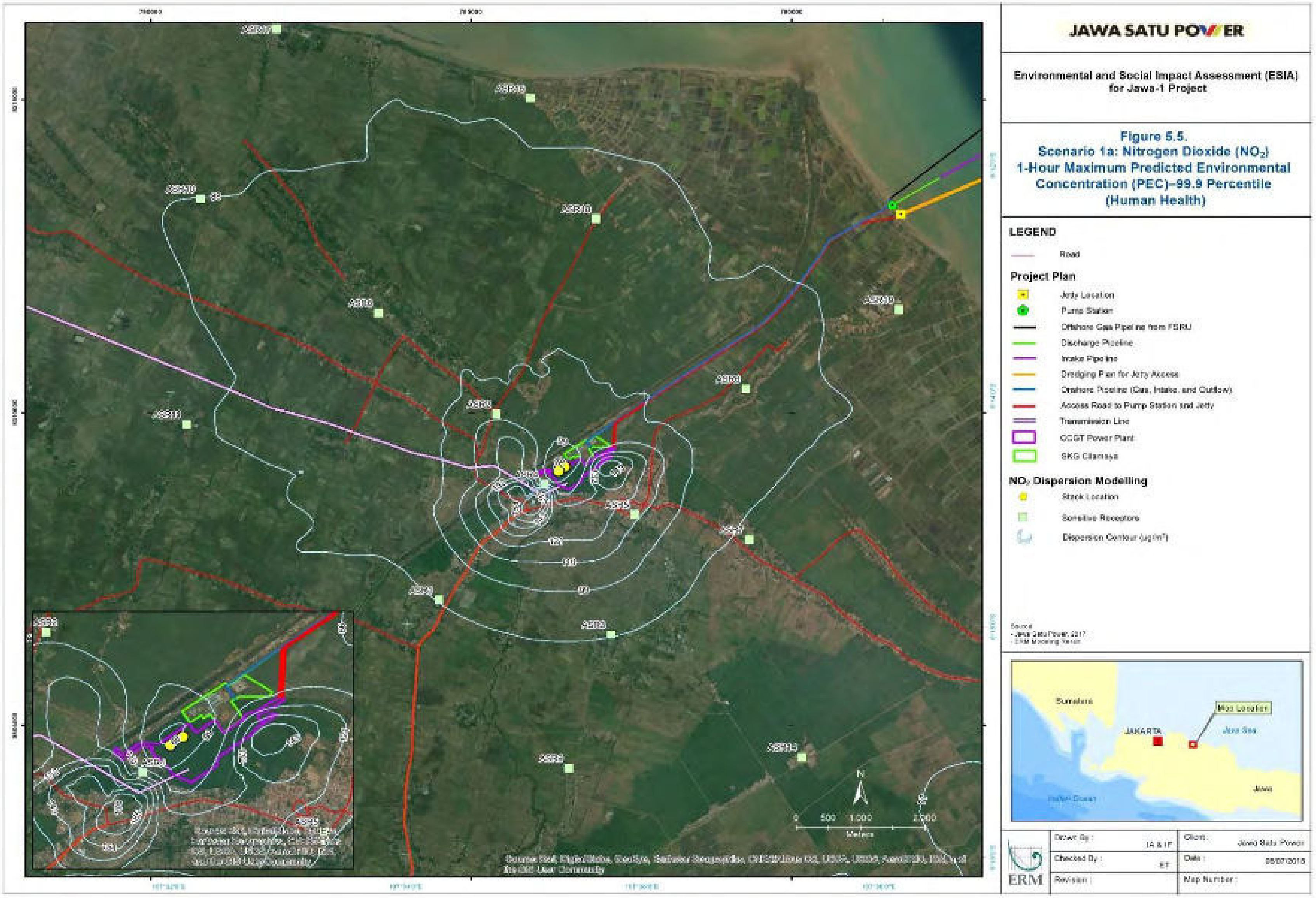


Figure 5.6 Scenario 1a: Nitrogen Dioxide (NO_2) 24-Hour Maximum Process Contribution (PC) – 100th Percentile (Human Health)

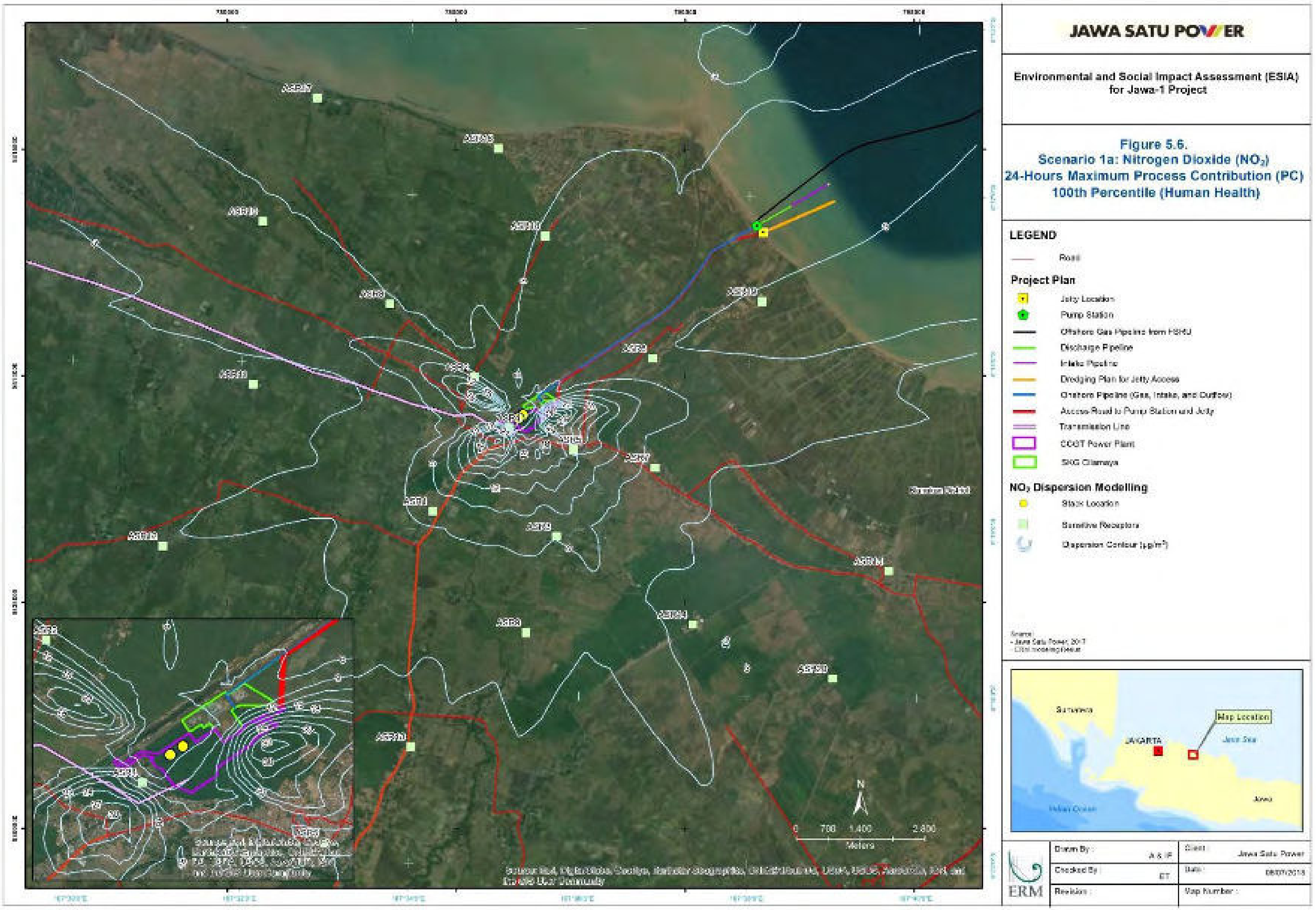


Figure 5.7 Scenario 1a: Nitrogen Dioxide (NO_2) 24-Hour Maximum Predicted Environmental Concentration (PEC) – 100th Percentile (Human Health)

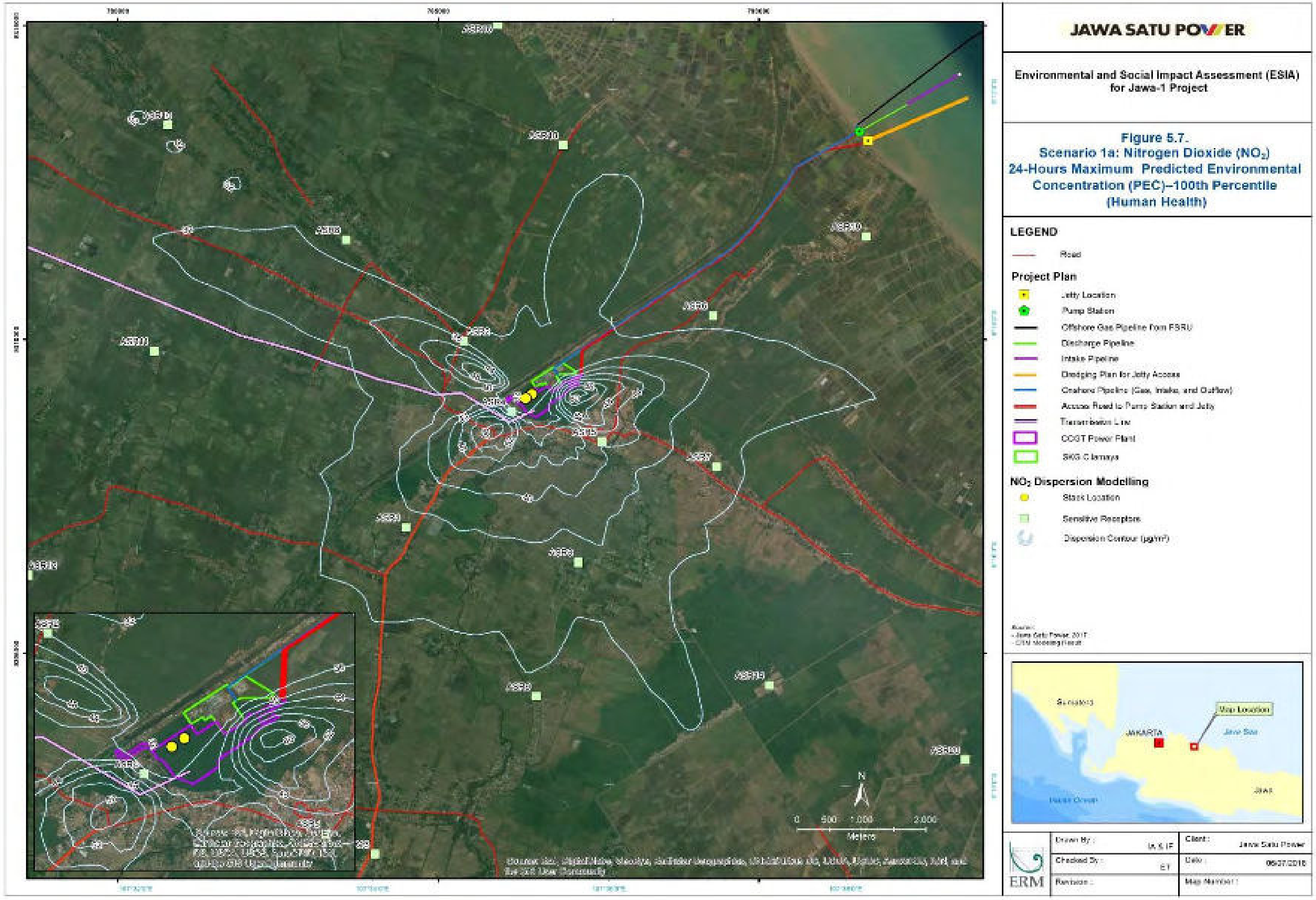


Figure 5.8 Scenario 1a: Nitrogen Dioxide (NO_2) Annual Average Process Contribution (PC) (Human Health)

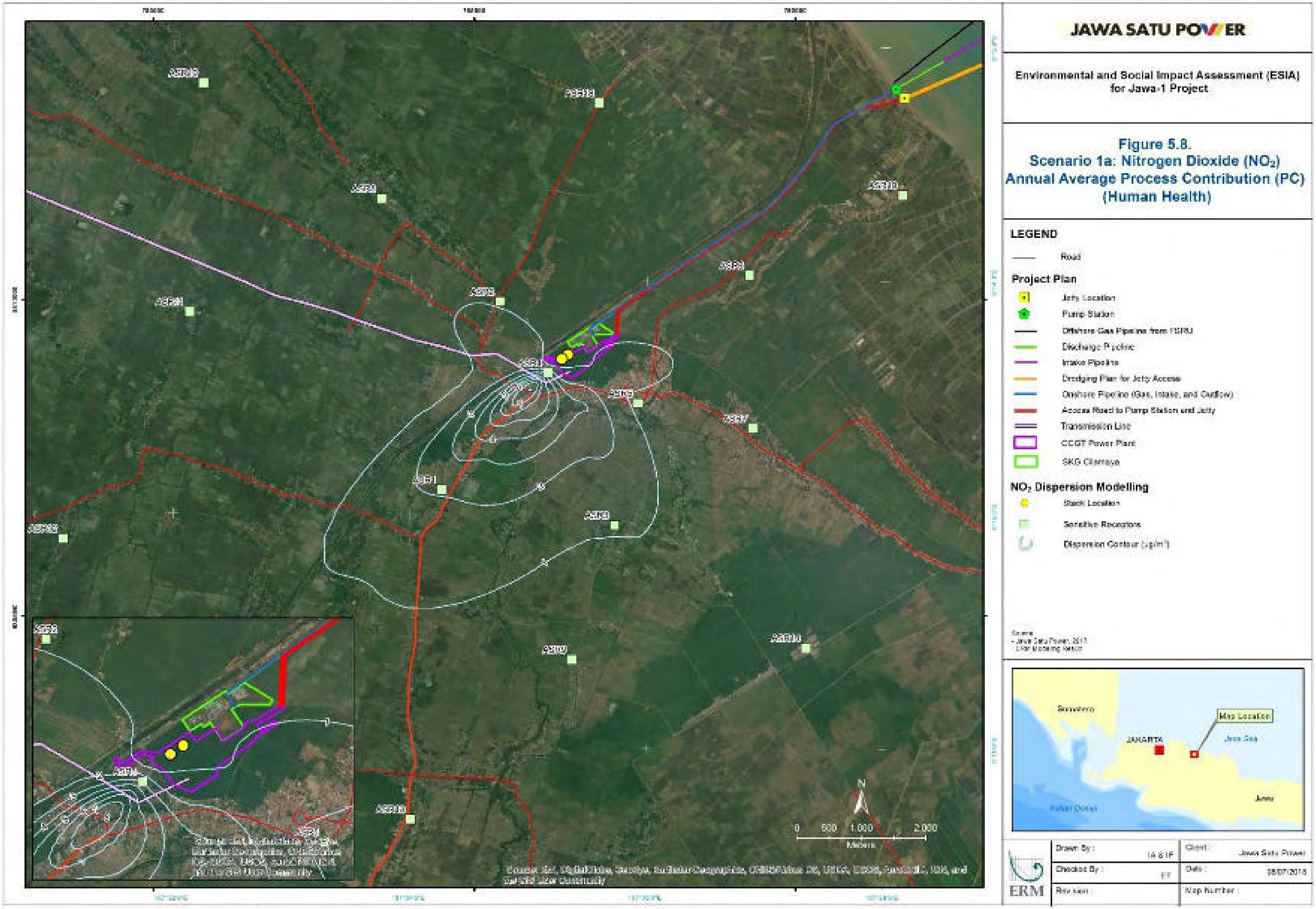


Figure 5.9 *Scenario 1a: Nitrogen Dioxide (NO_2) Annual Average Predicted Environmental Concentration (PEC) (Human Health)*

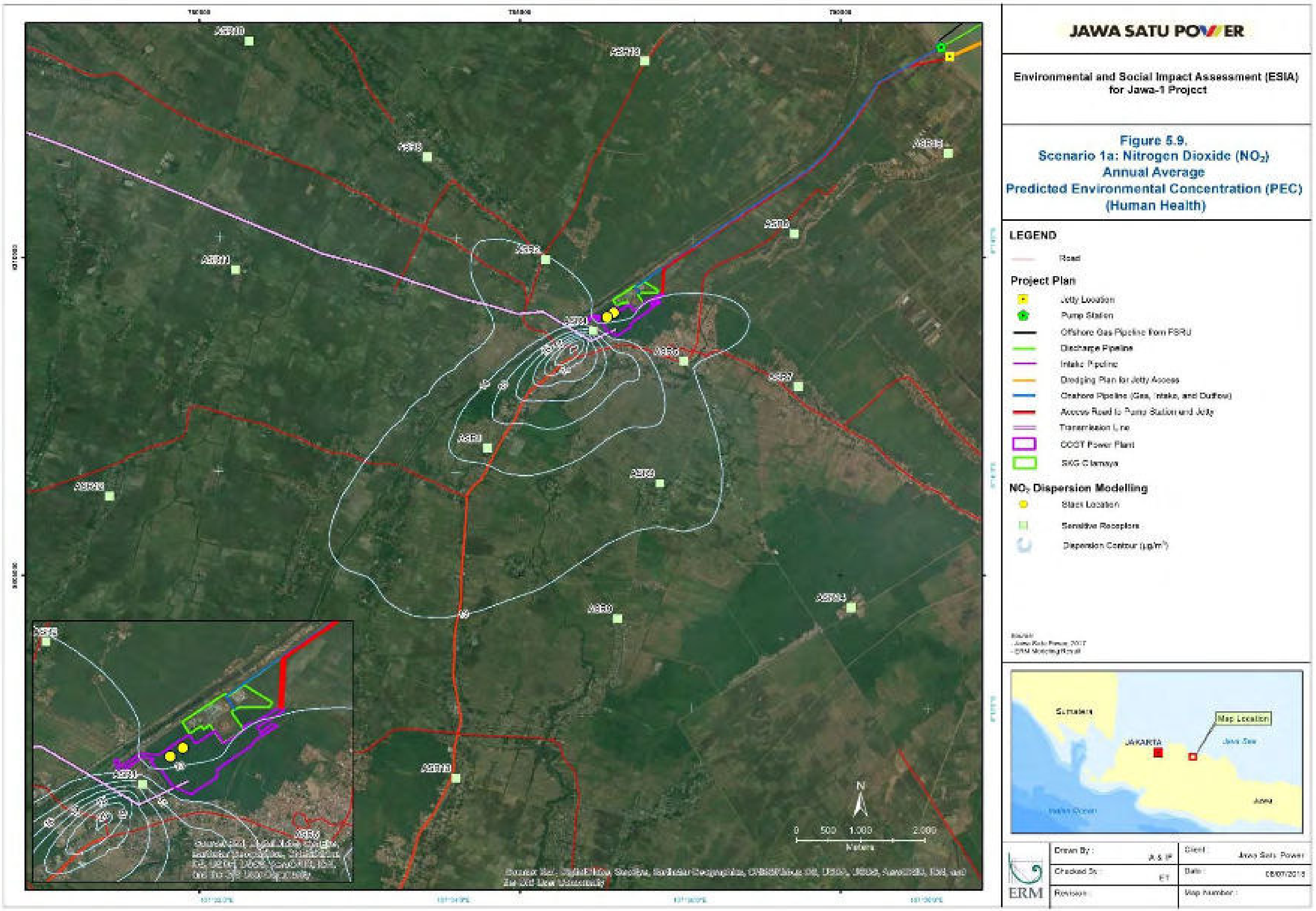


Figure 5.10 Scenario 1a: Carbon Monoxide (CO) 1-Hour Maximum Process Contribution (PC) – 100 Percentile (Human Health)

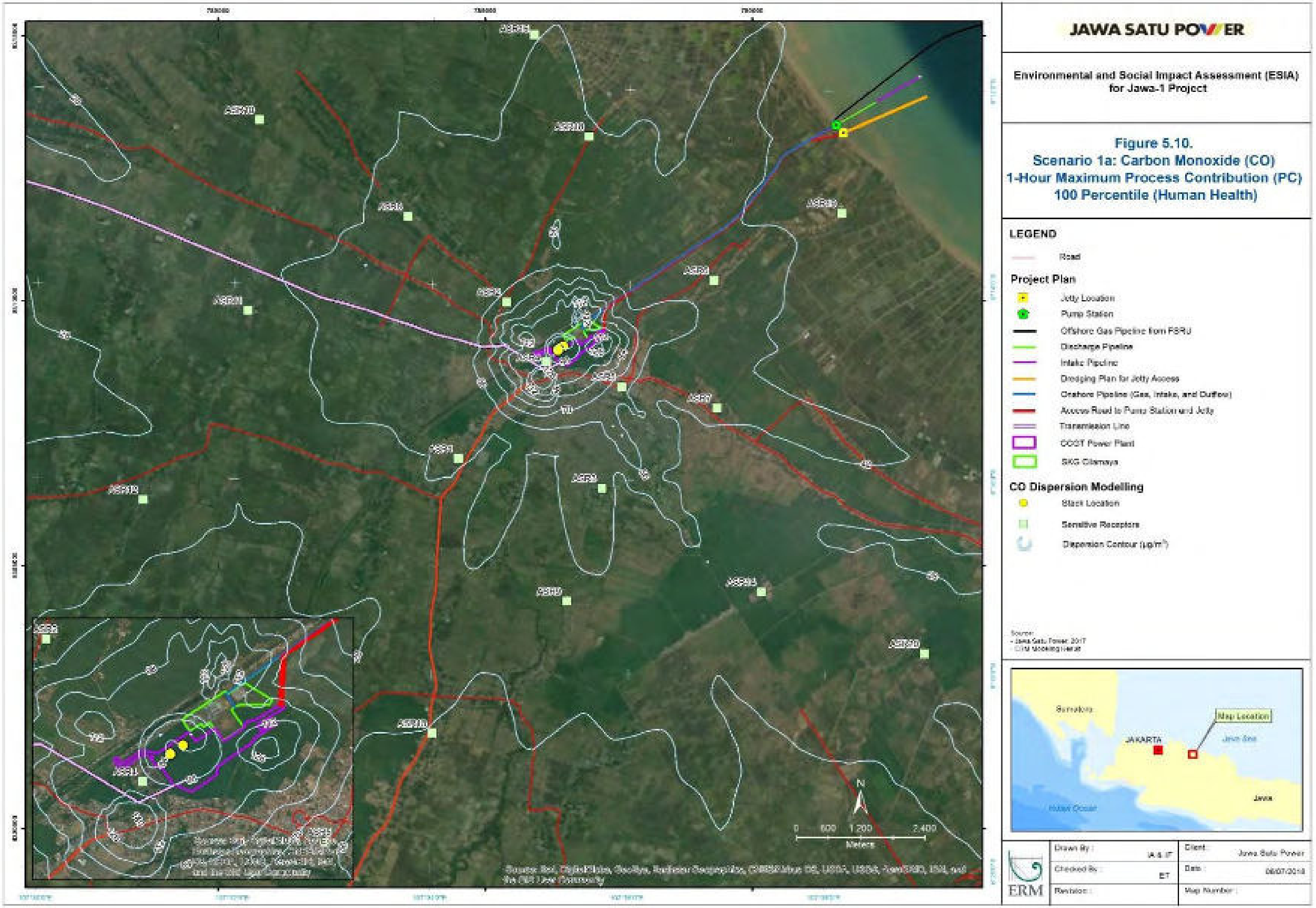


Figure 5.11 Scenario 1a: Carbon Monoxide (CO) 1-Hour Maximum Process Contribution (PC) – 99.9 Percentile (Human Health)

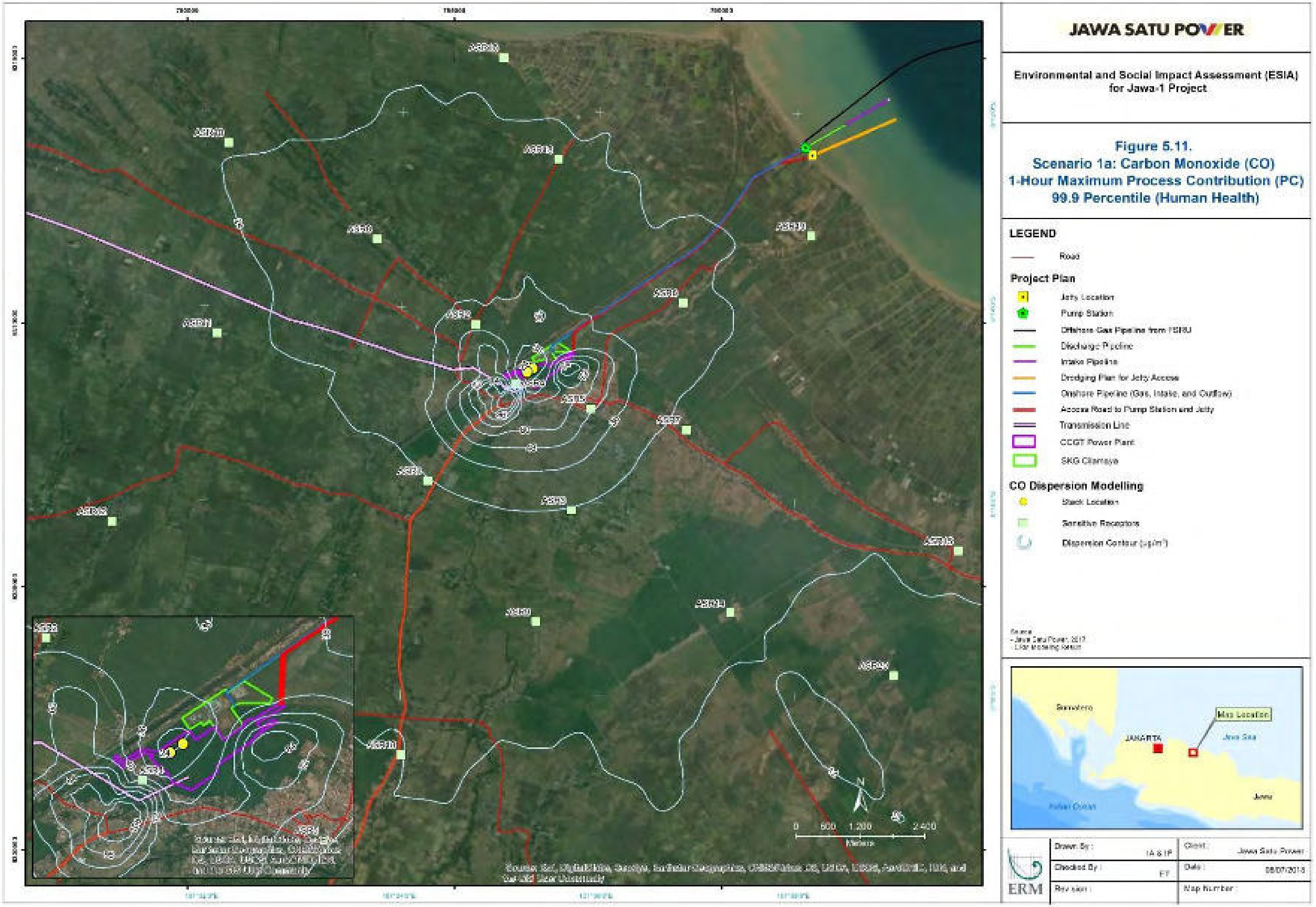


Figure 5.12 Scenario 1a: Carbon Monoxide (CO) 24-Hour Maximum Process Contribution (PC) – 100th Percentile (Human Health)

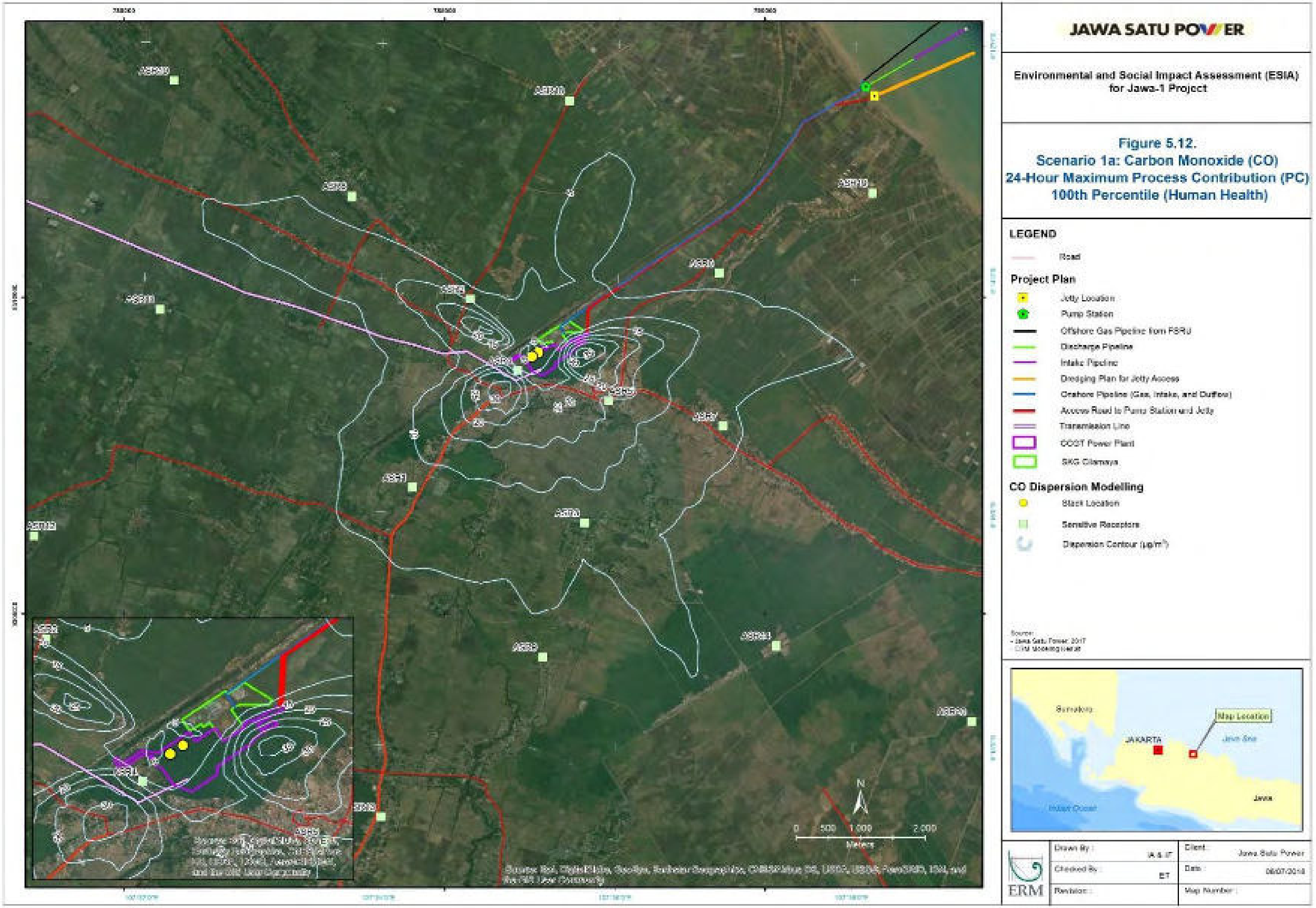
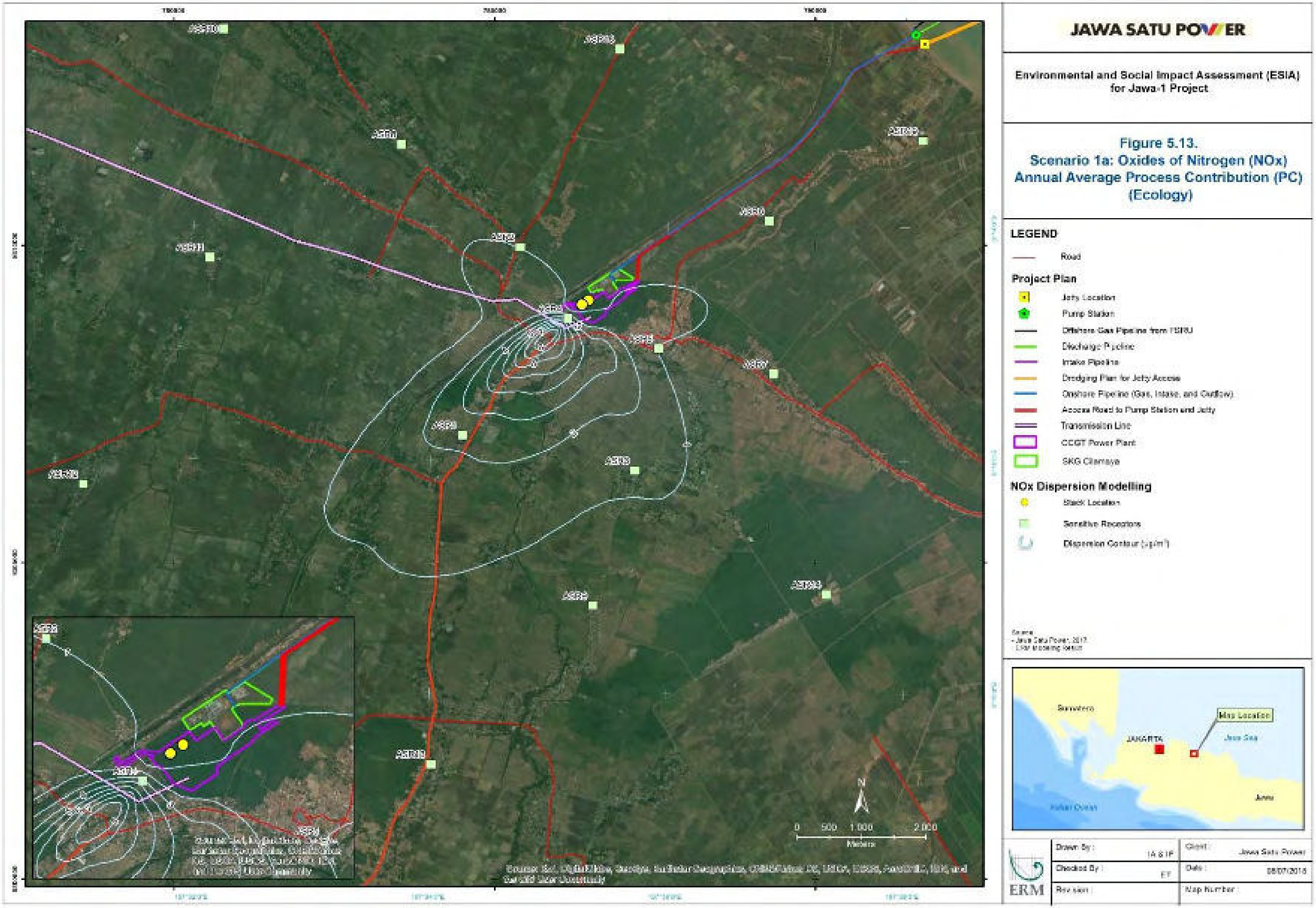


Figure 5.13 Scenario 1a: Oxides of Nitrogen (NO_x) Annual Average Process Contribution (PC) (Ecology)



5.4.4 *Stack Height Analysis*

The assessment of impacts on air quality presented in **Section 5.4.3** concludes that the offsite NO_2 1-hour ground level concentration resulting from the operation of the CCGT power plant exceed 25% of the Indonesian air quality standard. As a result of this finding, a number of additional modelling scenarios were investigated to determine the stack height necessary to reduce the NO_2 1-hour maximum ground level concentration and achieve compliance to the criteria discussed in **Section 2.2**. The stack height analysis presented in this section is undertaken on the basis that the turbines will continuously operate at the IFC NO_x emission limit value and turbine manufacturer guarantee of 51mg/Nm^3.

As discussed in **Table 5.21, t**he maximum offsite PC and PEC and the resulting impact significance based on the absolute highest 1-hour concentration (100th percentile) and the 9th highest 1-hour concertation (99.9th percentile) are presented and discussed.

Modelling at the 100th Percentile

The absolute highest 1-hour (100th percentile) maximum NO_2 ground level concentration for each of the modelling scenarios is presented in **Table 5.31**. The modelling results indicate that the ground level concentrations exceed 25% of the Indonesian 1-hour air quality standard when considering a 60m and 65m stack height design. The NO_2 1-hour ground level concentrations are expected to be at or below 25% of the standard at all sensitive receptor locations when considering a stack height of 70m.

It is noted, however, that the maximum 1-hour ground level concentrations resulting from a 70m, 75m and 82m stack height design are within a range of 0.4µg/m^3 which is not considered consistent with a 12m stack height increase. This evidence suggests that the absolute highest 1-hour modelled concentration (100th percentile) is possibly influenced by an unusual meteorological condition and is potentially overestimating the impact on air quality as discussed in **Table 5.21**.

Table 5.31 Maximum Offsite Ground Level Concentrations: Nitrogen Dioxide (NO_2) 1-Hour Maximum – 100 Percentile (Human Health)

Scenario	Stack Height	NO_x Concentration (mg/Nm³)	Maximum PC(1)	PC/AQS (%)	PEC(2)(3)	PEC/AQS (%)	Impact Significance
			µg/m³				
Scenario 1a	60	51	136	34%	203	51%	Minor
Scenario 2a	65	51	107	27%	174	44%	Minor
Scenario 3a	70	51	101	25%	168	42%	Negligible
Scenario 4a	75	51	101	25%	168	42%	Negligible
Scenario 5a	82	51	100	25%	167	42%	Negligible

(1) Process Contribution
(2) Predicted Environmental Concentration
(3) The maximum 1-hour average concentration of 66.9µg/m³ (see **Table 4.5**) was used as the 1-hour average baseline across the entire modelling domain a worst case approach.

Modelling at the 99.9th Percentile

The ninth highest 1-hour (99.9th percentile) maximum NO_2 ground level concentration for each of the modelling scenarios is presented in **Table 5.32.** The modelling results indicate that the ground level concentrations exceed 25% of the Indonesian 1-hour air quality standard when considering a 60m stack height design. The NO_2 1-hour ground level concentrations are expected to be at or below 25% of the standard at all sensitive receptor locations when considering a stack height of 65m.

In comparison to the modelling results at the 100th percentile, the maximum ground level concentration modelled at the 99.9th percentile decreases from 65.9µg/m³ to 50.7µg/m³ with a stack height increase of 12m. This observed decrease is considered more consistent relative to the increase in stack height.

This findings further supports the justification for the use of the 99.9th percentile for increasing modelling certainty as discussed in **Table 5.21**. Based on the 99.9th percentile a stack height of 65m is required to comply with criteria presented in **Section 2.2**.

Table 5.32 ***Maximum Offsite Ground Level Concentrations: Nitrogen Dioxide (NO_2) 1-Hour Maximum – 99.9 Percentile (Human Health)***

Scenario	Stack Height	NO_x Concentration (mg/Nm³	Maximum PC(1)	PC/AQS (%)	PEC(2)(3)	PEC/AQS (%)	Impact Significance
			µg/m³				
Scenario 1a	60	51	112	28%	179	45%	Minor
Scenario 2a	65	51	88.4	22%	155	39%	Negligible
Scenario 3a	70	51	65.9	16%	133	33%	Negligible
Scenario 4a	75	51	58.8	15%	126	31%	Negligible
Scenario 5a	82	51	50.7	13%	118	29%	Negligible

(1) Process Contribution
(2) Predicted Environmental Concentration
(3) The maximum 1-hour average concentration of 66.9µg/m³ (see **Table 4.5**) was used as the 1-hour average baseline across the entire modelling domain a worst case approach.

5.4.5 *Stack Height and Nitrogen Oxide (NO_x) Emission Concentration Analysis*

As discussed in **Table 5.20**, while the contractual NO_x emission guarantees from General Electric (GE) are for a maximum of 51 mg/Nm³, the two 9HA.02 gas turbines are expected to operate at 40mg/Nm³ during base load operation. While this is not currently guaranteed, additional analysis is provided to determine the stack height necessary in the event that a reduced NO_x concentration can be guaranteed by the Project. The maximum offsite PC and PEC and the resulting impact significance for the absolute highest 1-hour concentration (100th percentile) and the 9th highest 1-hour concertation (99.9th percentile) are discussed.

Modelling at the 100th Percentile

The absolute highest 1-hour (100th percentile) maximum NO_2 ground level concentration for each of the modelling scenarios is presented in **Table 5.33**. The modelling results indicate that the ground level concentrations exceed 25% of the Indonesian 1-hour air quality standard when considering a 60m stack height design. The NO_2 1-hour ground level concentrations are expected to be at or below 25% of the Indonesian standard at all sensitive receptor locations when considering a stack height of 65m.

Similar to the discussion presented in **Section 5.4.4**, it is noted that the maximum 1-hour ground level concentrations resulting from a 70m, 75m and 82m stack height design are within a range of 0.4µg/m³ which is not considered consistent with a 12m stack height increase. This evidence suggests that the absolute highest 1-hour modelled concentration (100th percentile) is possibly influenced by an unusual meteorological condition and is potentially overestimating the impact on air quality as discussed in **Table 5.21**.

Table 5.33 ***Maximum Offsite Ground Level Concentrations: Nitrogen Dioxide (NO_2) 1-Hour Maximum – 100 Percentile (Human Health)***

Scenario	**Stack Height**	**NO_x Concentration (mg/Nm^3)**	**Maximum PC(1)**	**PC/AQS (%)**	**PEC(2)(3)**	**PEC/AQS (%)**	**Impact Significance**
			µg/m³				
Scenario 1b	60	40	107	27%	174	43%	Minor
Scenario 2b	65	40	84.0	21%	151	38%	Negligible
Scenario 3b	70	40	79.2	20%	146	37%	Negligible
Scenario 4b	75	40	79.0	20%	146	36%	Negligible
Scenario 5b	82	40	78.8	20%	146	36%	Negligible

(1) Process Contribution
(2) Predicted Environmental Concentration
(3) The maximum 1-hour average concentration of 66.9µg/m³ (see **Table 4.5**) was used as the 1-hour average baseline across the entire modelling domain a worst case approach.

Modelling at the 99.9th Percentile

The ninth highest 1-hour (99.9th percentile) maximum NO_2 ground level concentration for each of the modelling scenarios is presented in **Table 5.34.** The modelling results indicate that the NO_2 1-hour ground level concentrations are expected to be at or below 25% of the standard at all sensitive receptor locations when considering a stack height of 60m.

In comparison to the modelling results at the 100th percentile, the maximum ground level concentration modelled at the 99.9th percentile decreases from 65.9µg/m³ to 50.7µg/m³ with a stack height increase of 12m. This observed decrease is considered consistent relative to the increase in stack height.

This findings further supports the justification for the use of the 99.9th percentile for increasing modelling certainty as discussed in **Table 5.21**. Based on the 99.9th percentile a stack height of 60m is required to comply with the assessment criteria presented in **Section 2.2**.

Table 5.34 ***Maximum Offsite Ground Level Concentrations: Nitrogen Dioxide (NO_2) 1-Hour Maximum – 99.9 Percentile (Human Health)***

Scenario	**Stack Height**	**NO_x Concentration (mg/Nm^3)**	**Maximum PC(1)**	**PC/AQS (%)**	**PEC(2)(3)**	**PEC/AQS (%)**	**Impact Significance**
			µg/m³				
Scenario 1b	60	40	87.9	22%	155	39%	Negligible
Scenario 2b	65	40	69.3	17%	136	34%	Negligible
Scenario 3b	70	40	51.7	13%	119	30%	Negligible
Scenario 4b	75	40	46.2	12%	113	28%	Negligible
Scenario 5b	82	40	39.8	10%	107	27%	Negligible

(1) Process Contribution
(2) Predicted Environmental Concentration
(3) The maximum 1-hour average concentration of 66.9µg/m³ (see **Table 4.5**) was used as the 1-hour average baseline across the entire modelling domain a worst case approach.

5.4.6 *Summary of Results*

The results of the base case scenario presented in **Section 5.4.3** indicate that **Minor** impacts to air quality are expected at worst when considering the NO_2 1-hour air quality standard. This minor impact is a result of the 1-hour PC exceeding 25% of the Indonesian air quality standard. All other PCs with regard to the 24-hour and annual average air quality standards are considered negligible (i.e. less than 25% of the relevant standard). The PEC for all substances and averaging periods are below the relevant Indonesian air quality standards and considered acceptable. The assessment therefore concludes that additional mitigation is necessary so that the maximum 1-hour NO_2 PCs are reduced to less than or equal to 25% of the standard to allow for future sustainable development in the same airshed.

The assessment has therefore considered a number of additional modelling scenarios which specifically focus on assessing the offsite NO_2 ground level concentration relative to the 1-hour air quality standard. The outcome of the modelling scenarios in terms of mitigation and monitoring measures varies depending on whether the absolute highest 1-hour ground level concentration (100^{th} percentile) or the 9^{th} highest ground level concentration (99.9^{th} percentile) is applied.

Based on the evidence documented in **Table 5.21** and in **Section 5.4.4** and **Section 5.4.5**, the use of the 99.9^{th} percentile for 1-hour modelling is likely to improve the certainty of the modelling results which will subsequently improve the certainty regarding the impact significance and mitigation measures required to achieve compliance with the air quality criteria presented in **Section 2.2**.

5.4.7 *Recommended Mitigation, Management and / or Monitoring Measures*

The mitigation options relative to the base case design and informed by the discussion and the results presented in **Table 5.32** and **Table 5.34** and, are as follows:

- Stack height increase from 60m to 65m; or
- NO_x emission concentration guaranteed reduction from 51mg/Nm^3 to 40mg/Nm^3.

In addition to the abovementioned mitigation measures the following good practice monitoring measures are required in accordance with the IFC guidelines:

- Implementation of continuous stack emission monitoring throughout the operational lifetime of the Project to confirm that the NO_x emission concentration from the turbines do not exceed the Projects guaranteed levels;

- Annual stack emission testing of NO_x emissions will be undertaken to counter check the performance of the emission monitoring system;
- Installation of two continuous ambient NO_2 air quality and meteorological monitoring systems. One monitoring system will be positioned in the area where the maximum short-term ground level concentrations have been predicted based on detailed dispersion modelling. The second monitoring system will be located in an area representative of the true background so a differentiation can be made between background and potential impacts to air quality from the Project. The effectiveness of the monitoring program will be reviewed regularly.

5.4.8 Residual Impacts (post mitigation)

The residual impacts from the operation of the CCGT power plant is likely to be negligible when incorporating the mitigating options discussed in **Section 5.4.7**.

5.5 IMPACTS FROM COOLING TOWERS

5.5.1 Overview

As identified in **Section 3.11**, the cooling tower systems have the potential to increase salt deposition on the surrounding area and have adverse impacts on agriculture, project infrastructure and urban developments. The potential salt deposition rates from the cooling towers were quantified using detailed dispersion modelling and the findings are presented in the following section.

5.5.2 Assessment Threshold

Impacts from salt deposition may cause reductions in agricultural yield through leaf damage (leaf necrosis) however the IFC and WHO do not provide standards or guidelines on which to base an assessment.

Research indicates that many species have thresholds for visible leaf damage in the range of 10-20 kilogram/hectare/month (kg/ha/mo) of NaCl during the growing season. Threshold values vary depending on rainfall frequency, humidity, and the specific sensitivity of the species. Generally it's been found that deposition rates reaching or exceeding 10kg/ha/mo in any month throughout the growing season can lead to leaf damage in many species of plant (1).

A research paper, published in 1980 (2), presents the findings from the Chalk Point Cooling Tower Study undertaken from 1973 to 1979. The Agronomy and Botany Departments of The University of Maryland (UM) designed and implemented a program of vegetation and soil monitoring at several sites near the plant. The research concludes that no identifiable, detrimental effects on the plant species were apparent and tests of undisturbed soil at the revealed no significant changes in key parameters such as soil acidity (pH), extractable sodium and chloride, and electrical conductivity.

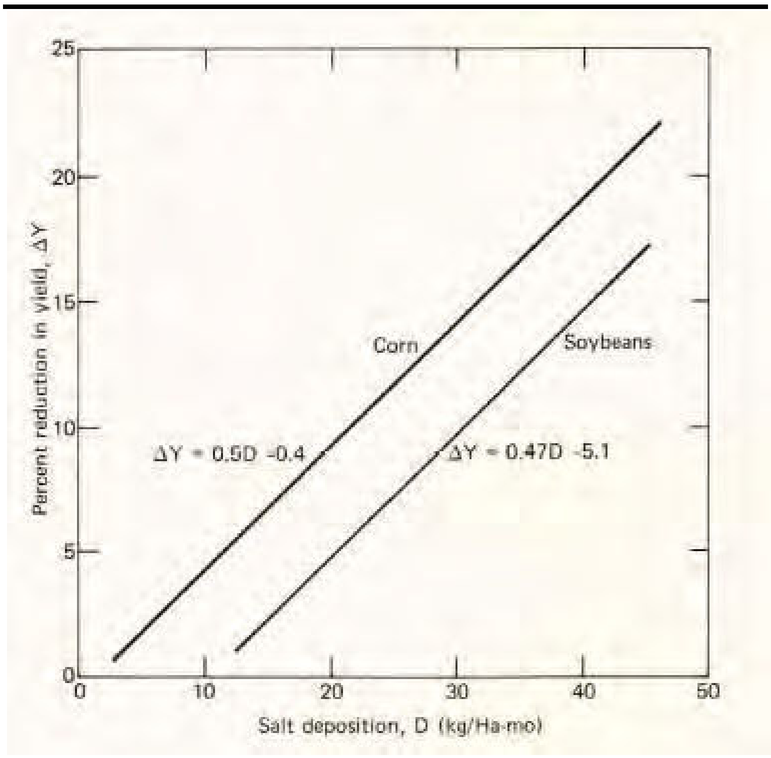
The impact of salt drift on crop yield reduction (corn and soybean) as determined by the UM agronomist using regression methods with controlled salt-spray test data is presented in **Figure 5.14.** While no specific assessment was undertaken for rice it is assumed that the percent reduction in yield will be similar. This is supported by the United States Department of Agriculture (3) who provide a list of salt tolerant crops according to three criteria including: the ability of the crop to survive on saline soils; yield of the crop on saline soils; and the relative yield of the crop on a saline soil as compared with its yield on a non-saline soil under similar growing conditions. The study indicates that both rice and corn have a medium tolerance to salt.

(1) United States Nuclear Regulatory Commission (1999) Environmental Standard Review Plan. *Office of Nuclear Reactor Regulation* [Online] Available at: https://www.nirs.org/wp-content/uploads/nukerelapse/levy/exhe6bacchus.pdf [Accessed 09 March 2018]

(2) Environmental Impact of Salt Drift from a Natural Draft Cooling Tower (1980) [Online] available at: http://www.jhuapl.edu/techdigest/views/pdfs/V01_N2_1980/V1_N2_1980_Moon.pdf [Accessed 15 May 2018]

(3) United States Department of Agriculture (2016) U.S. Salinity Laboratory: Riverside, CA. Crop Selection for Saline Soils [Online] Available at: https://www.ars.usda.gov/pacific-west-area/riverside-ca/us-salinity-laboratory/docs/crop-selection-for-saline-soils/ [Accessed 15 May 2018]

Figure 5.14 Impact of Salt Drift on Crop Yield Reductions



Source: 6J. A. Armbruster, "Response of Corn (Zea Mays L.) and Soybeans (Glycine May L. Merr) to Saline Aerosol Drift from Brackish Water Cooling Towers," Ph.D. Dissertation, University of Maryland, Department of Agronomy (1979).

5.5.3 Assessment Methodology

The USEPA AERMOD dispersion model version 16216r was used to predict the maximum deposition rates of NaCl averaged over a one month period in the study area. Both dry and wet deposition rates were modelled and the cumulative impact assessed. The same meteorological data set, receptor grid spacing, land use and terrain as that presented in **Section 5.4** was used for the assessment. Five (5) years of hourly sequential meteorological data was used so that inter annual variability was incorporated into the model and the highest one month average of any of the five meteorological years was used to define the impact significance as a worst case.

The amount of total particulate matter (TPM) released to the atmosphere was calculated using the following formula [(1)]:

- TPM [g/h] = Total Dissolved Solids (TDS) [ppmw] x Drift Loss [%] / 100% x Circulating Water Rate [m^3/hr]

([1]) Government of Canada (2015) Wet cooling tower particulate matter emission: guide to reporting [Online] Available at: https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/report/sector-specific-tools-calculate-emissions/wet-cooling-tower-particulate-guide.html [Accessed 07 March 2018]

The location of each cooling tower fan is presented in **Table 5.35.** Each fan was treated as a point source and modelled using the information presented in **Table 5.36.**

Table 5.35 Cooling Tower Fan Locations

Fan Number	Modelled Point Source Location (Lat/Long)
1	6°14'38.54"S, 107°35'29.57"E
2	6°14'38.24"S, 107°35'30.02"E
3	6°14'37.98"S, 107°35'30.44"E
4	6°14'37.65"S, 107°35'30.86"E
5	6°14'37.39"S, 107°35'31.29"E
6	6°14'37.10"S, 107°35'31.74"E
7	6°14'36.80"S, 107°35'32.16"E
8	6°14'36.51"S, 107°35'32.58"E
9	6°14'36.21"S, 107°35'33.00"E
10	6°14'35.92"S, 107°35'33.46"E
11	6°14'35.62"S, 107°35'33.88"E
12	6°14'35.33"S, 107°35'34.30"E
13	6°14'35.03"S, 107°35'34.72"E
14	6°14'34.74"S, 107°35'35.17"E
15	6°14'34.44"S, 107°35'35.59"E
16	6°14'34.15"S, 107°35'36.02"E
17	6°14'38.99"S, 107°35'29.90"E
18	6°14'38.70"S, 107°35'30.32"E
19	6°14'38.40"S, 107°35'30.74"E
20	6°14'38.11"S, 107°35'31.19"E
21	6°14'37.81"S, 107°35'31.61"E
22	6°14'37.52"S, 107°35'32.03"E
23	6°14'37.22"S, 107°35'32.45"E
24	6°14'36.93"S, 107°35'32.88"E
25	6°14'36.63"S, 107°35'33.33"E
26	6°14'36.34"S, 107°35'33.75"E
27	6°14'36.04"S, 107°35'34.17"E
28	6°14'35.75"S, 107°35'34.59"E
29	6°14'35.45"S, 107°35'35.05"E
30	6°14'35.16"S, 107°35'35.47"E
31	6°14'34.86"S, 107°35'35.89"E
32	6°14'34.57"S, 107°35'36.31"E

Table 5.36 Cooling Tower and Modelling Information

Item	Data	Unit
Number of cooling towers	2	-
Cells/fans per cooling tower	16	-
Total cells/fans	32	-
Cooling tower structure height	18.7	m
Cell/fan diameter	9.75	m
Exit velocity	8.73	m/s
Exit temperature	37.8	C
Circulating rate	54478	m^3/hr
	907603 (1)	lpm
Total dissolved solids (TDS)	44,100	mg/l

Item	Data	Unit
Design drift	0.0005	%
	4.54	lpm
	200127	mg/min
	3.34	g/s
	0.208	g/s/PM_{10}/cell
Operating hours	8760	hours
Sodium Chloride (NaCl) Particle Density	2.165	g/cm^3
(1) 1 cubic meter / hour = 16.7lpm		

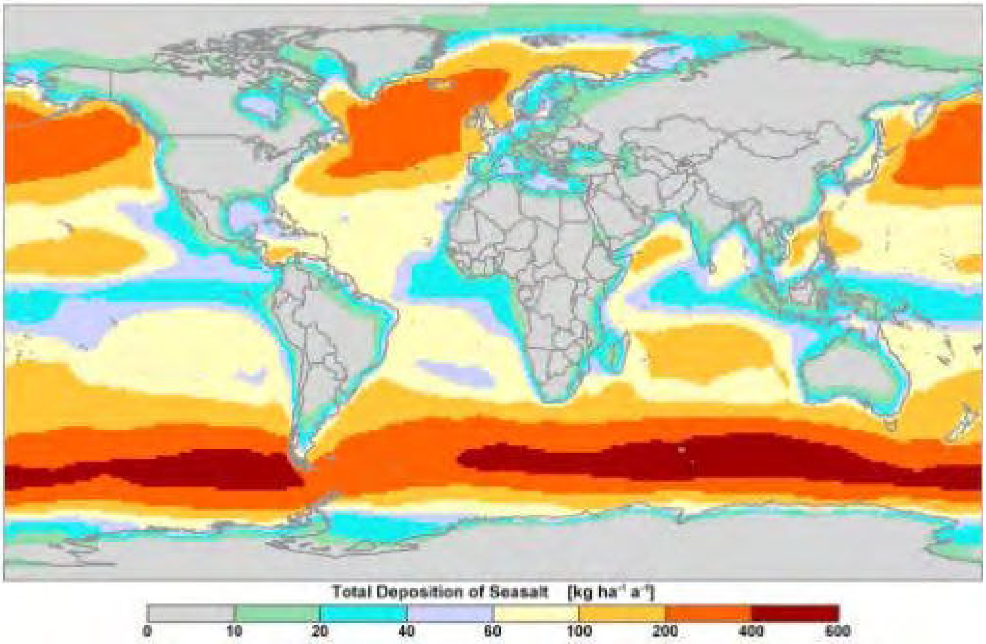
5.5.4 *Impacts to Environment and Infrastructure (pre mitigation)*

Salt water bodies are the dominant global source of airborne salt particles. The coastal location of the Project would suggest that the existing vegetation is already exposed to salt deposition from the natural injection of sea water droplets into the atmosphere. Research indicates that global sea salt deposition rates can reach 400-600kg/ha/a (refer to **Figure 5.15** [(1)]) however these extreme values are primarily found in the northern and southern most oceans. Total deposition in continental areas has been researched and the evidence suggests that salt deposition rates at the Project site are likely to be between 20 and 40kg/ha/a. For the purpose of this impact assessment, the median value of 30kg/ha/a has been adopted as a baseline.

The modelling results based on the emissions inventory detailed in **Table 5.36** is presented in **Figure 5.16.** The modelling results indicate that salt deposition rates from the Project will not exceed 10kg/ha/mo. Based on the expected existing conditions at the site, and on the basis that the assessment threshold will not be exceeded, adverse impacts to agriculture due to the Project are considered **Negligible**.

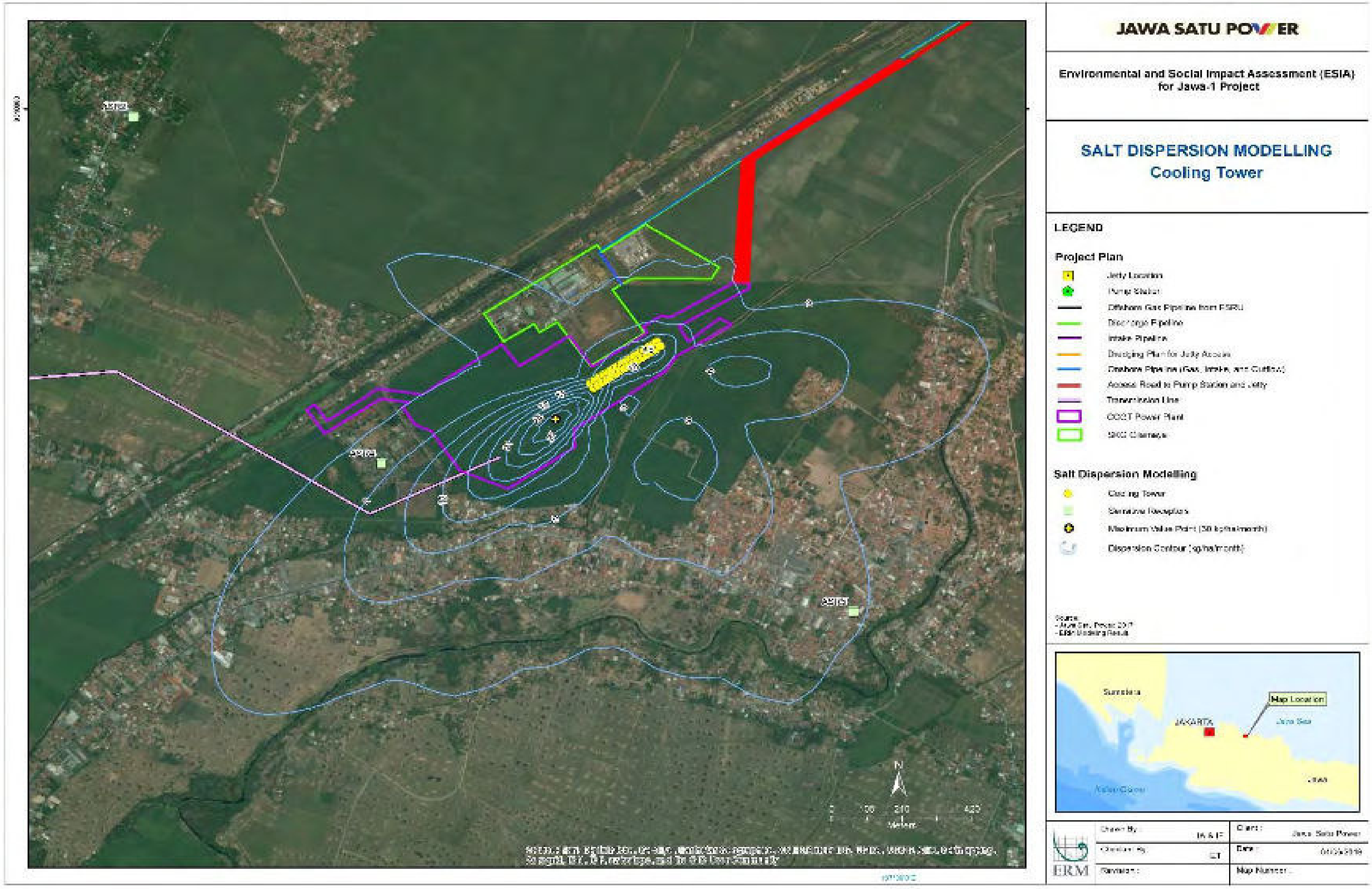
(1) Robert Vet et al (2014) A global assessment of precipitation chemistry and deposition of sulfur, nitrogen, sea salt, base cations, organic acids, acidity and pH, and phosphorus. *Atmospheric Environment.* [Online] Available at: https://www.sciencedirect.com/science/article/pii/S1352231013008133 [Accessed 7 March 2018]

Figure 5.15 Global Sea Salt Deposition



Source: Robert Vet et al (2014) A global assessment of precipitation chemistry and deposition of sulfur, nitrogen, sea salt, base cations, organic acids, acidity and pH, and phosphorus. Atmospheric Environment. [Online] Available at: https://www.sciencedirect.com/science/article/pii/S1352231013008133 [Accessed 7 March 2018]

Figure 5.16 Predicted Salt Deposition Rates from Cooling Towers – Total (Wet and Dry) Deposition Rate (kg/ha/mo)



5.5.5 *Recommended Mitigation, Management and/or Monitoring Measures*

Based on the finding presented in **Section 5.5.4** no additional mitigation is considered necessary in terms of reducing the impacts on surrounding agriculture.

Impacts from salt on urban development as well as machinery and equipment within the Project area may occur due to salt corrosion, mainly within the dry season. It is therefore recommended that all exposed surfaces be coated or painted to reduce corrosion from salt deposition. Regular maintenance of exposed surfaces is also required.

5.5.6 *Residual Impacts (post mitigation)*

The residual impacts due to the continuous operation of the cooling towers are expected to be **Negligible**.

6 UNPLANNED AND NON-ROUTINE EVENTS

6.1 IMPACTS TO AIR QUALITY FROM BLACK START / EMERGENCY DIESEL ENGINE-GENERATORS

6.1.1 Overview

As identified and discussed in **Section 3.10**, the combustion of diesel in engine-generators used for black start and shut down has the potential to adversely impact air quality at sensitive receptors. Impacts to air quality can occur across a wide area depending on operating conditions and meteorological conditions.

The operation of the diesel engine-generators is considered a non-routine event as it will only occur in the event of loss of main power supply from the Jawa-Bali 500 kV grid. The likelihood of this occurring is rare, with the last complete blackout occurring in 1997 (see **Section 3.10**).

The potential impacts to air quality from the operation of the diesel engine-generators were quantified using detailed dispersion modelling.

6.1.2 Assessment Methodology

Selection of Modelling Scenarios

The power plant will typically use power from the main grid for black start and for emergency shutdown. The diesel engine generators are therefore only required when the main electrical grid is down and unable to provide power to the power plant. It is considered extremely unlikely that the requirement to use the generators will coincide with main grid failure. As a conservative assumption, however, it is expected that a black-start may occur once in any given year and take seventy minutes, and an emergency condition would occur six times in any given year and occur for two hours. The assessment scenarios on this basis are as follows:

- **Scenario 1 (Black start):** It is understood that for a black start, the use of all twelve engines will be required for a 70 minute period. The power requirements from the generators during this start-up period will fluctuate based on the balance of plant (BoP) and the start-up frequency converted (SFC) system requirements. The expected startup will require 11MW from 0-45 minutes to supply BoP, 23.7MW from 45-61 to power the SFC, and 11MW from 61-70 to continue running the BoP until the plant is fully operational. To account for this startup profile in the model, five generators producing 2.2MW each (i.e. 11MW total) have been modelled to account for 0-45 minutes, and twelve generators producing 2.2MW each (i.e. 26.4MW total) have been modelled to account for 45 – 60 minutes. The results at each point on the receptor grid have been added together and compared to the 1-hour air quality standard. The operation of five generators between 61-70 minutes has not been considered as the worst case one hour has already been assessed.

- **Scenario 2 (Shutdown):** It is understood that one of the twelve diesel powered engine-generators will be required in case of a station black out and/or for the safe shutdown of the power plant in the event of loss of main supply. The likely impact on air quality from one of the twelve diesel engine-generator sets (Generator No. 1) running at full power has therefore been undertaken. The assessment assumes that the engine-generator may operate for two hours, six times a year as a worst case. The results are compared to the relevant 1-hour air quality standard.

Dispersion Modelling

The dispersion model used in the assessment was the USEPA AERMOD dispersion model version 16216r (refer to **Section 5.4.2**).

Detailed dispersion modelling was used to predict concentrations of emitted substances at ground level locations outside the Project site boundary. Five (5) years of hourly sequential meteorological data was used so that inter annual variability was incorporated into the model.

The results of the assessment comprise the maximum process contribution predicted over a period of five years from 2013 to 2017 on the receptor grid. At each of the representative human air sensitive receptors the maximum PC and the PEC for each substance of interest is presented and the significance of the impact defined using the same approach outlined in **Section 5.2.2.** In addition, the maximum PC and PEC at any point on the receptor grid outside of the power plant site boundary has been identified and the significance defined.

The modelling scenarios and methodology is presented in **Table 6.1** and the engine locations and emission inventory is presented in **Table 6.2** and **Table 6.3** respectively.

Table 6.1 Detailed Modelling Methodology

Modelling Component	Method/Approach
Interpretation of the worst case offsite ground level concentration	The assessment presents the 100th percentile (absolute highest 1-hour and 24-hour) modelled concentration found anywhere on the receptor grid as a worst case approach. It is noted, however, that the modelled 1-hour ground level concentrations at any given grid point or sensitive receptor have the potential to be highly skewed. The absolute worst hour may have a concentration twice that of the second-worst hour, and 10 times that of the ninth-highest hour, however the ninth-highest hour may only be fractionally above the tenth-highest hour. Consequently a modelling result taken as a peak value (100th percentile) in comparison to ambient air quality criteria is greatly sensitive to modelling uncertainty as a result of extreme, rare and transient meteorological conditions. To mitigate modelling uncertainty, the use of the 9th highest or 99.9 percentile is considered. The approach of reducing the impact of modelling uncertainty on the presentation of the predicted 1-hour average concentration is adopted across multiple jurisdictions around the world including Victoria in Australia (1), Alberta in Canada (2) and the New Zealand Ministry for the Environment (3). For averaging periods longer than an hour, the modelling uncertainty is reduced as the averaging process over multiple hours reduces the peak 1-hour values, and longer averaging periods are therefore not subject to the same modelling uncertainty. Consequently, for criteria with averaging periods of 1-hour, the 9th highest (99.9th percentile) value has also been reported to reduce modelling uncertainty. Use of the 9th highest 1-hour average value means that from the model predictions, results for 8751 hours of the year are equal to or lower than the value presented. For averaging periods greater than 1-hour the maximum predicted (100th percentile) concentration only has reported.
Defining Sources	The representation of emission sources in AERMOD was based on the nature of the source being considered. As discussed, the substances of interest are from the combustion of diesel oil resulting in emissions to the atmosphere through a number of stationary stacks. The sources were therefore modelled as point sources.
Defining Emissions	Stack parameters and emission rates for both modelling scenarios were defined for each substance with the potential to have adverse impacts on air quality while the generators are operational. The emission inventory for the project is presented in **Table 6.3** and is based on the diesel engine-generator information provided by engine manufacturer MTU for engine type 20V4000G23 6ETC. Only the short term (1-hour) impacts on air quality have been assessed. There is no 1-hour Indonesian or WHO air quality standard or guideline for PM therefore no assessment of impacts has been considered.

Modelling Component	Method/Approach
Receptor Grid	The dispersion model uses a nested grid extending up to 10 km from the stack locations to determine the maximum process contribution in the study area and the process contribution arising at representative air sensitive receivers and in each air sensitive receiver classification. The receptor spacing varies with distance from the point source locations in order to provide sufficiently dense receptors close to the site, and suitable spatial coverage further afield. The spacing of receptors is as follows: • 50 meter spacing from 0 to 500 meters; • 100 meter spacing from 500 to 1,000 meters; • 200 meter spacing from 1,000 to 2,000 meters; • 400 meter spacing from 2,000 meters to 4,000 meters; and • 500 meter spacing from 4,000 meters to 10,000 meters. Furthermore, specific receptor points were included in the model to reflect the locations of representative air sensitive receivers (refer to **Figure 4.5**).
Meteorological Data	The meteorological data used in the model must be reflective of the local conditions. There is very little meteorological data available for Indonesia therefore five (5) years of meteorological data was modelled using the Weather Research and Forecasting Model (WRF) using a 4km x 4km resolution (see **Section 4.4**).
Conversion of NO_x to NO_2	The USEPA's Tier 3 screening method (Ozone Limiting Method (OLM)) in AERMOD was used to convert the modelled NO_x concentrations to NO_2 for comparison to the air quality standards. [(4)] Atmospheric O_3 fluctuates throughout the day and it is unlikely that the maximum measured O_3 values will correspond with the maximum NO_x concentrations at receptors. It is also overly conservative to apply the maximum monitored O_3 value to determine the NO_x to NO_2 conversion throughout the study area and for every hour of the year. On this basis, and to further refine the impact assessment, the maximum 1-hour O_3 value for each hour of the day was extracted from the data collected during the monitoring period and an 'HROFDY' file was included within the AERMOD set up (see **Table 4.7**). The AERMOD Tier 3 screening method requires that the NO_2/NO_x in-stack ratio (ISR) is defined. Information to inform this process was extracted from the USEPA NO_2/NO_x ISR database [(5)]. A review of the available information for diesel generators indicates an average ISR of 0.05. A value of 0.1 was therefore used to inform the dispersion model as a conservative value.
Buildings	No building information was included in the dispersion model.

Modelling Component	Method/Approach
Land Use	The land use and terrain around the Project will affect dispersion. Airflow over the ground is disturbed by protuberances into the air, for example buildings, trees and vegetation. The surface roughness length is a representation of the disruption of airflow close to the ground due to these obstructions. In this case, the land use type in the study area is primarily cultivated land. The AERMOD pre-processor AERSURFACE was used to define the land use characteristics around the project site.
Terrain	Hills, mountains and valleys can affect dispersion by directing the plume. The terrain pre-processor AERMAP using the Shuttle Radar Topographic Mission (SRTM) 90 x 90m imagery was run to provide information on the a) base elevation of each receptor and source defined in the model; and b) the terrain height that has the greatest influence on dispersion for each individual receptor, otherwise known as the hill height scale. Both the base elevation and hill height scale were incorporated into AERMOD. The terrain throughout the study area is generally flat (simple terrain) therefore it is unlikely that terrain has much effect on the meteorology conditions within the study area.

(1) New Zealand Ministry for the Environment (2004) Good Practice Guide for Atmospheric Dispersion Modelling [Online] Available at: http://www.mfe.govt.nz/sites/default/files/atmospheric-dispersion-modelling-jun04.pdf [Accessed 06 February 2018];

(2) Alberta Government (2013) Air Quality Model Guideline [Online] Available at: http://aep.alberta.ca/air/air-quality-modelling/documents/AirQualityModelGuideline-Oct1-2013.pdf [Accessed 06 February 2018]

(3) New South Wales Environment Protection Agency (EPA) (2005) Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales [Online] Available at: http://www.environment.nsw.gov.au/resources/air/ammodelling05361.pdf [Accessed 06 February 2018]

(4) United States Environmental Protection Agency (USEPA) (2015) Technical Support Document (TSD) for NO2 Related AERMOD Modifications [Online] Available at: https://www3.epa.gov/scram001/11thmodconf/AERMOD_NO2_changes_TSD.pdf [Accessed 06 February 2018]

Table 6.2 Generator Locations

Generator Number	Modelled Stack Location (Lat/Long)
1	6°14'42.11"S 107°35'24.12"E
2	6°14'41.98"S 107°35'24.29"E
3	6°14'41.85"S 107°35'24.45"E
4	6°14'41.75"S 107°35'24.64"E
5	6°14'41.62"S 107°35'24.80"E
6	6°14'41.49"S 107°35'24.97"E
7	6°14'41.39"S 107°35'25.16"E
8	6°14'41.26"S 107°35'25.32"E
9	6°14'41.16"S 107°35'25.52"E
10	6°14'41.03"S 107°35'25.68"E
11	6°14'40.90"S 107°35'25.84"E
12	6°14'40.80"S 107°35'26.04"E

Table 6.3 Emission Inventory for Diesel Engine Generators

Parameter	Unit	Generator 1 – 12 (1)
Stack height	m	9
Stack Diameter	m	0.478
Exit Velocity	m/s	40.1
Volume Flow Rate	m^3/s	7.20
Exit Temperature	k	813
Power Output	kW	2200
NO_x Emission rate	g/kWh	10.4
	g/s	6.4
SO_2 Emission rate(2)	g/kWh	2
	g/s	1.2

(1) Data provided by engine manufacturer MTU for engine model 20V4000G23 6ETC
(2) SO_2 emission rate is based on an expected fuel sulphur content of 0.5%.

6.1.3 *Scenario 1: Impacts to Air Quality (pre-mitigation)*

The significance of the modelled impacts on ambient air quality are as follows:

- Nitrogen Dioxide (NO_2) 1-Hour Maximum (100^{th} percentile)
  - The modelling results presented in **Table 6.4** indicate that the maximum offsite PC and PEC is 268µg/m^3 and 335µg/m^3 respectively and is less than 100% of the relevant air quality standard (400µg/m^3) throughout the study area. On this basis the impacts to air quality is **Moderate.** A contour figure showing the PC and PEC is presented in **Figure 6.1 and Figure 6.2.**
- Nitrogen Dioxide (NO_2) 1-Hour Maximum (99.9^{th} percentile)
  - The modelling results presented in **Table 6.5** indicate that the maximum offsite PC and PEC is 204µg/m^3 and 271µg/m^3 respectively and is less than 100% of the relevant air quality standard (400µg/m^3) throughout the study area. On this basis the impacts to air quality is **Moderate.** A contour figure showing the PC and PEC is presented in **Figure 6.3 and Figure 6.4.**
- Sulphur Dioxide (SO_2) 1-Hour Maximum (100^{th} percentile)
  - The modelling results presented in **Table 6.6** indicate that the maximum offsite PC is 312µg/m^3 and is less than 50% of the relevant air quality standard (900µg/m^3) throughout the study area. On this basis the impacts to air quality are **Minor.** A contour figure showing the PC is presented in **Figure 6.5.**
- Sulphur Dioxide (SO_2) 1-Hour Maximum (99.9^{th} percentile)
  - The modelling results presented in **Table 6.7** indicate that the maximum offsite PC is 199µg/m^3 and is less than 25% of the relevant air quality standard (900µg/m^3) throughout the study area. On this basis the impacts to air quality are **Negligible.** A contour figure showing the PC is presented in **Figure 6.6.**

Table 6.4 Scenario 1: Nitrogen Dioxide (NO_2) 1-Hour Maximum – 100 Percentile

Site	Baseline (µg/m³)	AQS[1] (µg/m³)	Airshed classification	PC[2][3] (µg/m³)	PC/AQS (%)	PEC[4] (µg/m³)	PEC/AQS (%)	Impact Significance
Maximum concentration [5]	66.9. [6]	400	ND [7]	268	67%	335	84%	Moderate
ASR1				102	25%	169	42%	Minor
ASR2				152	38%	219	55%	Minor
ASR3				116	29%	183	46%	Minor
ASR4				191	48%	258	65%	Minor
ASR5				157	39%	223	56%	Minor
ASR6				113	28%	180	45%	Minor
ASR7				137	34%	204	51%	Minor
ASR8				145	36%	212	53%	Minor
ASR9				97.1	24%	164	41%	Negligible
ASR10				97.3	24%	164	41%	Negligible
ASR11				88.5	22%	155	39%	Negligible
ASR12				89.8	22%	157	39%	Negligible
ASR13				76.7	19%	144	36%	Negligible
ASR14				93.6	23%	160	40%	Negligible
ASR15				70.2	18%	137	34%	Negligible
ASR16				100	25%	167	42%	Minor
ASR17				98.7	25%	166	41%	Negligible
ASR18				95.8	24%	163	41%	Negligible
ASR19				94.0	24%	161	40%	Negligible
ASR20				75.6	19%	142	36%	Negligible

(1) Air Quality Standard *(Regulation of the Republic of Indonesia Number 41 (1999))*
(2) Process Contribution
(3) This value is the sum of the process contribution from 5 generators operating at 2.2MW (total 11MW) for 45 minutes and 12 generators operating at 2.2MW (total 26.4MW) for 15minutes.
(4) Predicted Environmental Contribution
(5) The maximum ground level concentration outside of the Power Plant site boundary
(6) The maximum 1-hour average concentration was measured at AQM1b using the AQS1 real time air quality monitor (see **Table 4.5**). This was used as the 1-hour average baseline across all sites as a worst case approach.
(7) Non-degraded (Baseline < AQS)

Table 6.5 *Scenario 1: Nitrogen Dioxide (NO_2) 1-Hour Maximum – 99.9 Percentile*

Site	Baseline (µg/m³)	AQS[1] (µg/m³)	Airshed classification	PC[2][3] (µg/m³)	PC/AQS (%)	PEC[4] (µg/m³)	PEC/AQS (%)	Impact Significance
Maximum concentration [5]	66.9. [6]	400	ND [7]	204	51%	271	68%	Moderate
ASR1				64.9	16%	132	33%	Negligible
ASR2				123	31%	190	47%	Minor
ASR3				56.8	14%	124	31%	Negligible
ASR4				168	42%	235	59%	Minor
ASR5				103	26%	170	43%	Minor
ASR6				73.0	18%	140	35%	Negligible
ASR7				91.2	23%	158	40%	Negligible
ASR8				90.4	23%	157	39%	Negligible
ASR9				21.1	5.3%	88.0	22%	Negligible
ASR10				67.0	17%	134	33%	Negligible
ASR11				64.5	16%	131	33%	Negligible
ASR12				41.3	10%	108	27%	Negligible
ASR13				15.7	3.9%	82.6	21%	Negligible
ASR14				48.2	12%	115	29%	Negligible
ASR15				47.7	12%	115	29%	Negligible
ASR16				55.8	14%	123	31%	Negligible
ASR17				60.1	15%	127	32%	Negligible
ASR18				55.9	14%	123	31%	Negligible
ASR19				56.3	14%	123	31%	Negligible
ASR20				35.3	8.8%	102	26%	Negligible

(1) Air Quality Standard *(Regulation of the Republic of Indonesia Number 41 (1999))*
(2) Process Contribution
(3) This value is the sum of the process contribution from 5 generators operating at 2.2MW (total 11MW) for 45 minutes and 12 generators operating at 2.2MW (total 26.4MW) for 15minutes.
(4) Predicted Environmental Contribution
(5) The maximum ground level concentration outside of the Power Plant site boundary
(6) The maximum 1-hour average concentration was measured at AQM1b using the AQS1 real time air quality monitor (see **Table 4.5**). This was used as the 1-hour average baseline across all sites as a worst case approach.
(7) Non-degraded (Baseline < AQS)

Table 6.6 Scenario 1: Sulphur Dioxide (SO_2) 1-Hour Maximum - 100 Percentile

Site	Baseline (μg/m³)	AQS[1] (μg/m³)	Airshed classification	PC[2][3] (μg/m³)	PC/AQS (%)	PEC[4] (μg/m³)	PEC/AQS (%)	Impact Significance
Maximum concentration [5]	n/a [6]	900	ND [7]	312	35%	312	35%	Minor
ASR1				32.1	3.6%	32.1	3.6%	Negligible
ASR2				77.6	8.6%	77.6	8.6%	Negligible
ASR3				29.4	3.3%	29.4	3.3%	Negligible
ASR4				168	19%	168	19%	Negligible
ASR5				62.5	6.9%	62.5	6.9%	Negligible
ASR6				28.9	3.2%	28.9	3.2%	Negligible
ASR7				30.0	3.3%	30.0	3.3%	Negligible
ASR8				31.7	3.5%	31.7	3.5%	Negligible
ASR9				20.4	2.3%	20.4	2.3%	Negligible
ASR10				25.9	2.9%	25.9	2.9%	Negligible
ASR11				21.2	2.4%	21.2	2.4%	Negligible
ASR12				19.7	2.2%	19.7	2.2%	Negligible
ASR13				16.1	1.8%	16.1	1.8%	Negligible
ASR14				26.3	2.9%	26.3	2.9%	Negligible
ASR15				15.4	1.7%	15.4	1.7%	Negligible
ASR16				33.8	3.8%	33.8	3.8%	Negligible
ASR17				25.4	2.8%	25.4	2.8%	Negligible
ASR18				29.7	3.3%	29.7	3.3%	Negligible
ASR19				28.1	3.1%	28.1	3.1%	Negligible
ASR20				16.0	1.8%	16.0	1.8%	Negligible

(1) Air Quality Standard *(Regulation of the Republic of Indonesia Number 41 (1999))*
(2) Process Contribution
(3) This value is the sum of the process contribution from five generators operating at 2.2MW (total 11MW) for 45-minutes and twelve generators operating at 2.2MW (total 26.4MW) for 15-minutes
(4) Predicted Environmental Contribution
(5) The maximum ground level concentration outside of the Power Plant site boundary
(6) Background SO_2 concentrations were not quantified for the purpose of this 'unplanned' assessment scenario
(7) Assumed non-degraded (Baseline < AQS)

Table 6.7 Scenario 1: Sulphur Dioxide (SO_2) 1-Hour Maximum - 99.9 Percentile

Site	Baseline (µg/m³)	AQS(1) (µg/m³)	Airshed classification	PC(2)(3) (µg/m³)	PC/AQS (%)	PEC(4) (µg/m³)	PEC/AQS (%)	Impact Significance
Maximum concentration (5)	n/a (6)	900	ND (7)	199	22%	199	22%	Negligible
ASR1				14.0	1.6%	14.0	1.6%	Negligible
ASR2				42.4	4.7%	42.4	4.7%	Negligible
ASR3				12.5	1.4%	12.5	1.4%	Negligible
ASR4				125	14%	125	14%	Negligible
ASR5				45.6	5.1%	45.6	5.1%	Negligible
ASR6				21.4	2.4%	21.4	2.4%	Negligible
ASR7				25.2	2.8%	25.2	2.8%	Negligible
ASR8				22.7	2.5%	22.7	2.5%	Negligible
ASR9				4.42	<1%	4.4	<1%	Negligible
ASR10				15.5	1.7%	15.5	1.7%	Negligible
ASR11				13.9	1.5%	13.9	1.5%	Negligible
ASR12				8.65	1.0%	8.7	1.0%	Negligible
ASR13				3.29	<1%	3.29	<1%	Negligible
ASR14				10.1	1.1%	10.1	1.1%	Negligible
ASR15				10.1	1.1%	10.1	1.1%	Negligible
ASR16				12.8	1.4%	12.8	1.4%	Negligible
ASR17				14.2	1.6%	14.2	1.6%	Negligible
ASR18				14.5	1.6%	14.5	1.6%	Negligible
ASR19				13.1	1.5%	13.1	1.5%	Negligible
ASR20				7.40	<1%	7.4	<1%	Negligible

(1) Air Quality Standard *(Regulation of the Republic of Indonesia Number 41 (1999))*
(2) Process Contribution
(3) This value is the sum of the process contribution from five generators operating at 2.2MW (total 11MW) for 45-minutes and twelve generators operating at 2.2MW (total 26.4MW) for 15-minutes
(4) Predicted Environmental Contribution
(5) The maximum ground level concentration outside of the Power Plant site boundary
(6) Background SO_2 concentrations were not quantified for the purpose of this 'unplanned' assessment scenario
(7) Assumed non-degraded (Baseline < AQS)

Figure 6.1 Scenario 1: Nitrogen Dioxide (NO_2) 1-Hour Maximum Process Contribution (PC) – 100 Percentile (Human Health)

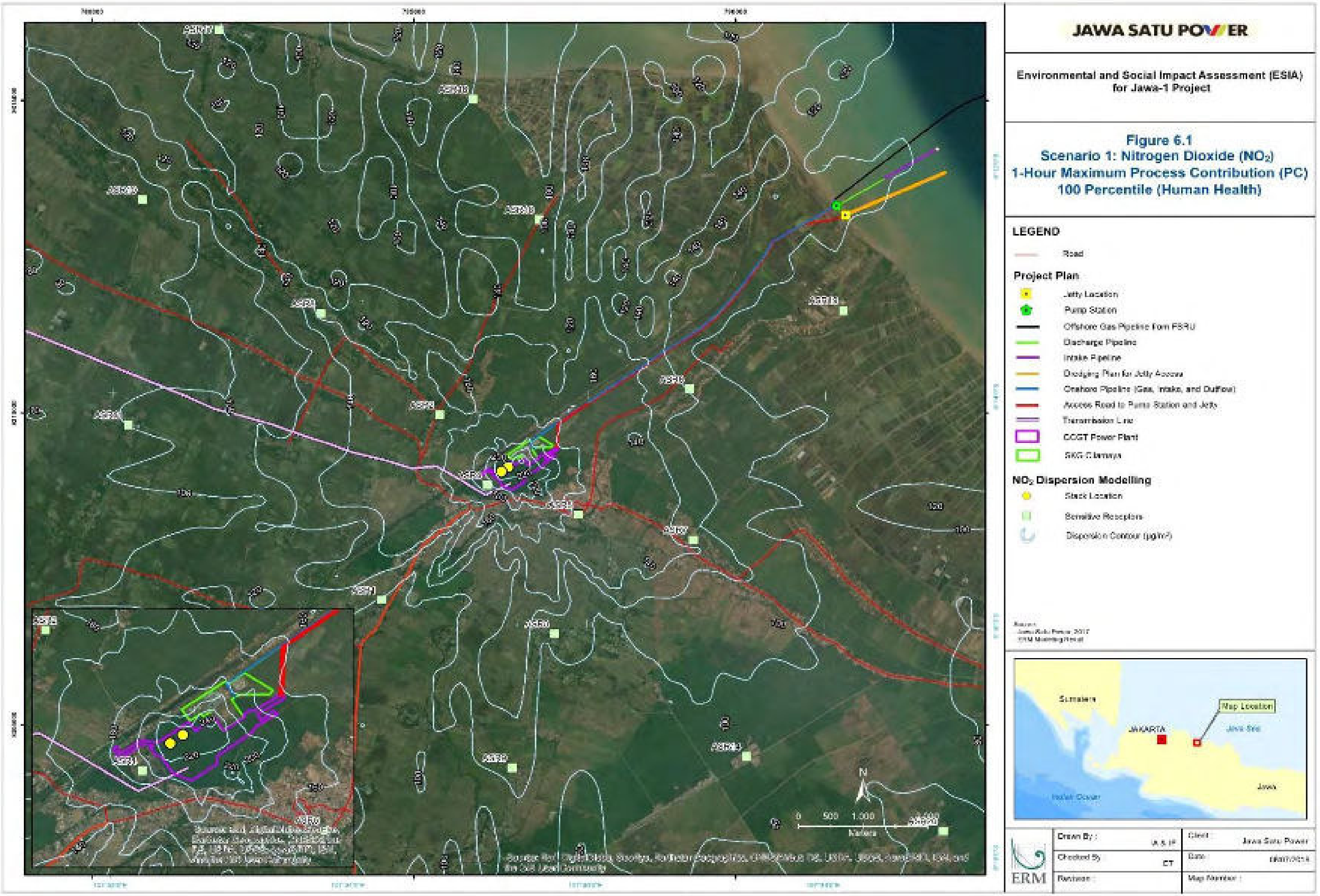


Figure 6.2 *Scenario 1: Nitrogen Dioxide (NO_2) 1-Hour Maximum Predicted Environmental Concentration (PEC) –100 Percentile (Human Health)*

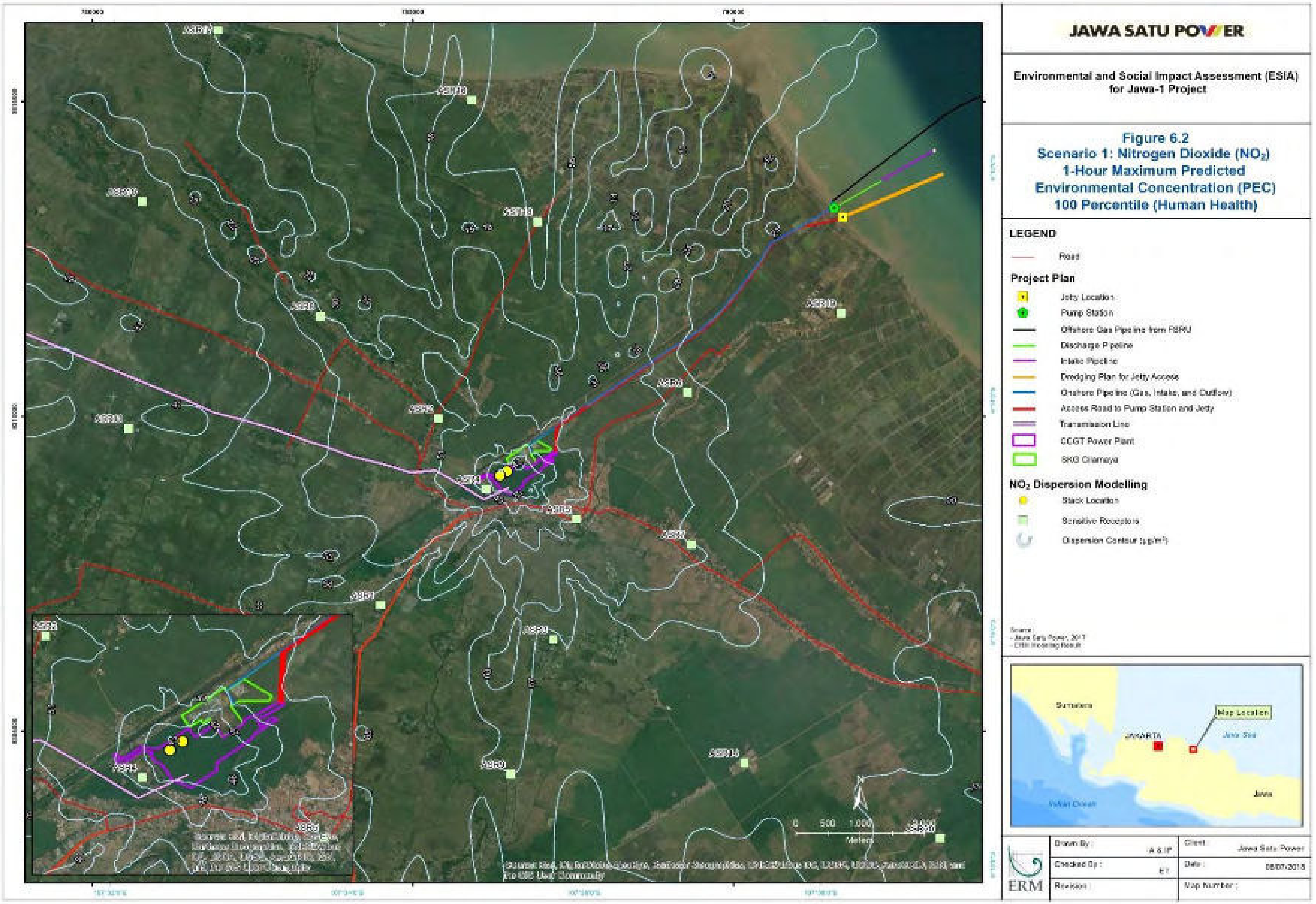


Figure 6.3 Scenario 1: Nitrogen Dioxide (NO_2) 1-Hour Maximum Process Contribution (PC) – 99.9 Percentile (Human Health)

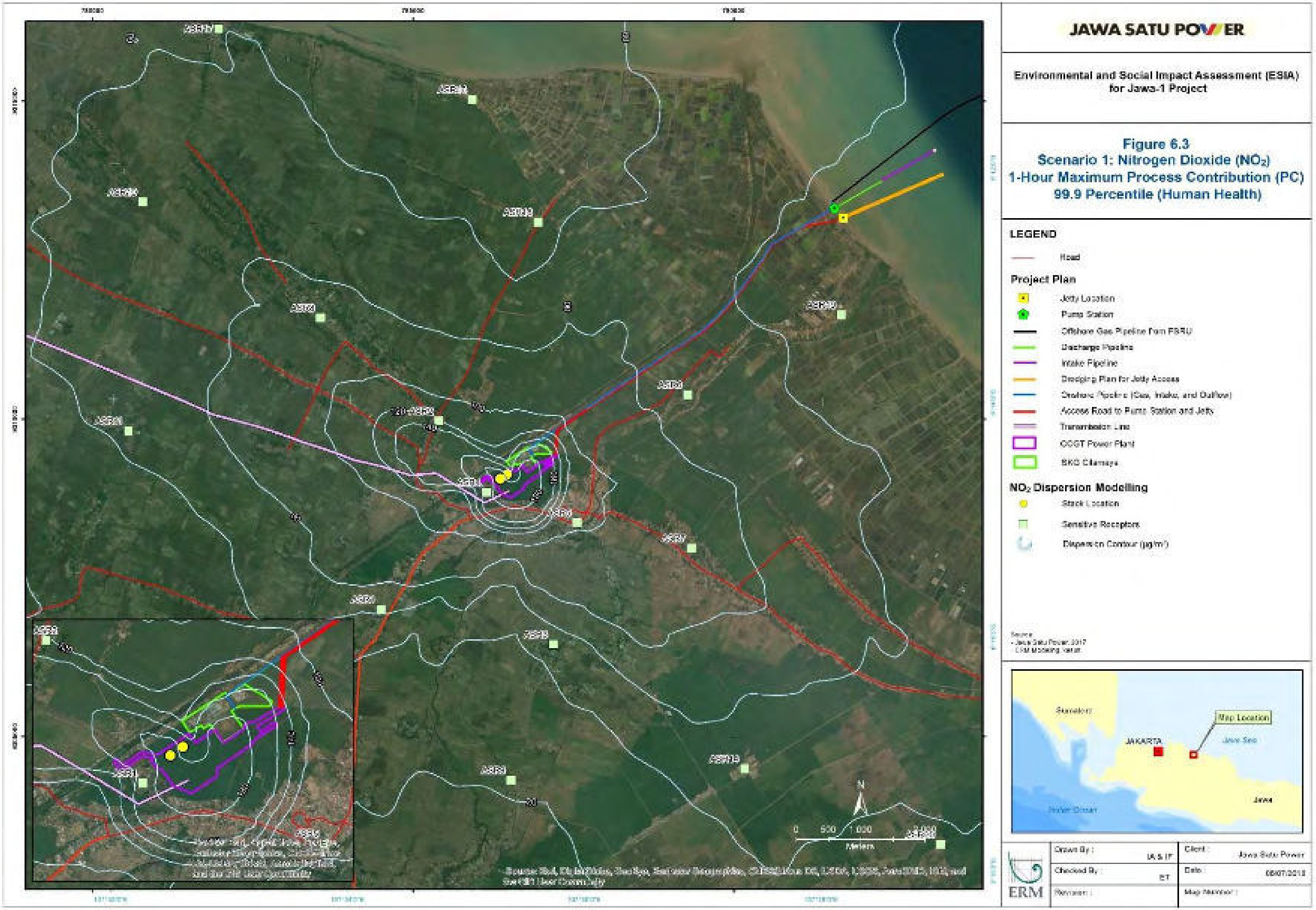


Figure 6.4 Scenario 1: Nitrogen Dioxide (NO_2) 1-Hour Maximum Predicted Environmental Concentration (PEC) – 99.9 Percentile (Human Health)

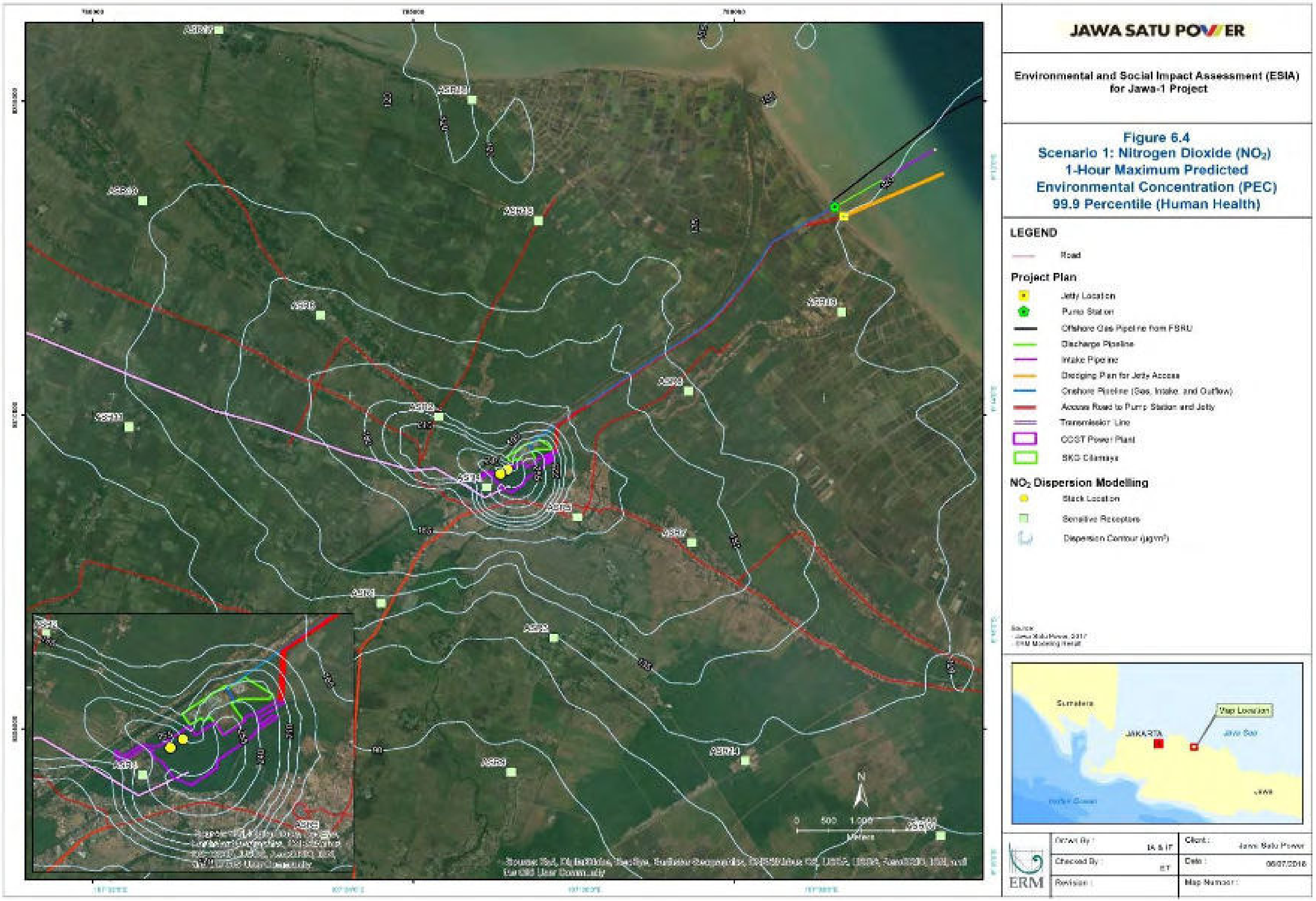


Figure 6.5 Scenario 1: Sulphur Dioxide (SO_2) 1-Hour Maximum Process Contribution (PC) – 100 Percentile (Human Health)

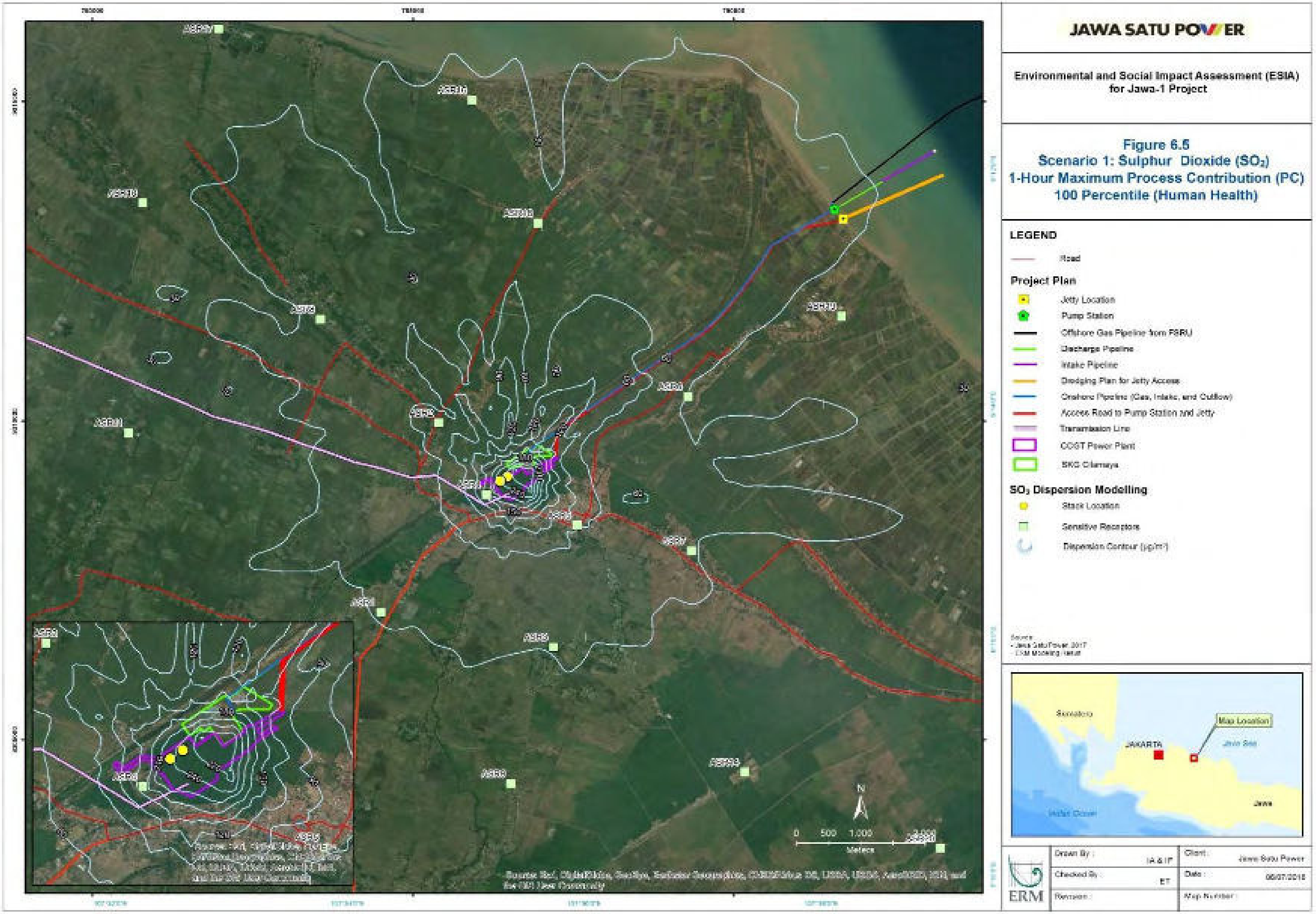
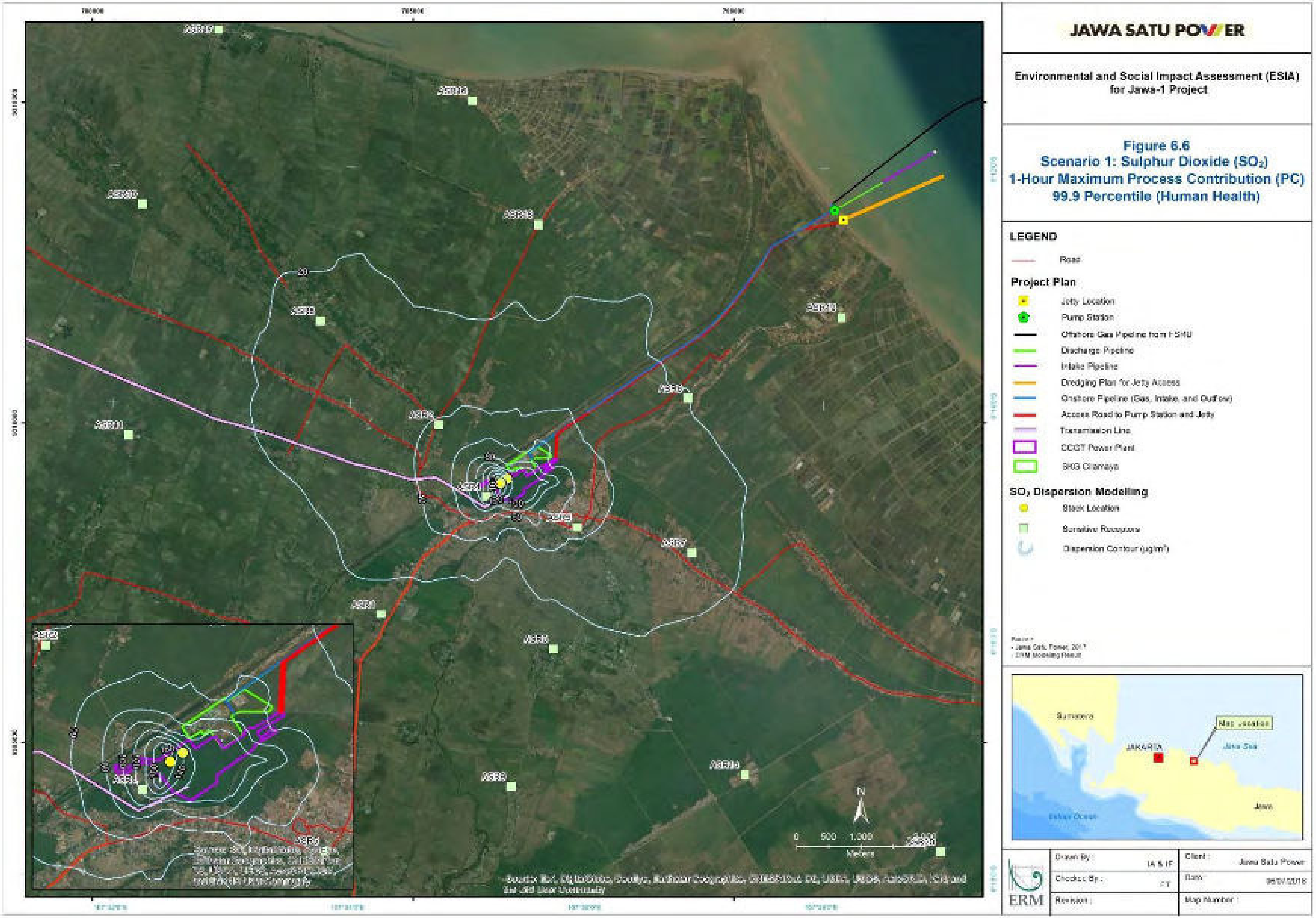


Figure 6.6 Scenario 1: Sulphur Dioxide (SO_2) 1-Hour Maximum Process Contribution (PC) – 99.9 Percentile (Human Health)



6.1.4 *Scenario 1: Recommended Mitigation, Management and / or Monitoring Measures*

The findings indicate that a **Moderate** adverse impacts to air quality from NO_x emissions are expected at worst due to the operation of the diesel generators during a black start event. Impacts to air quality from SO_2 emissions are considered Minor at worst based on the absolute highest 1-hour (100th percentile) concentration. It should be noted that no assessment of PM has been undertaken as no 1-hour ambient air quality standard exists in Indonesia or in the WHO guidelines.

Given that the impacts to air quality are moderate, it is suggested that the following mitigation and management measures are implemented to reduce the likelihood of unacceptable impacts on air quality during a black start:

- The simultaneous operation of all twelve diesel engine-generators will only occur when required and for the amount of time necessary to black start the power plant. The operator will endeavour to reduce this time period as much as is feasible to minimise the likelihood of unacceptable impacts on air quality;

- All engine-generators will be routinely checked and maintained in accordance with the manufactures specifications. This routine maintenance will ensure that the operational performance of the engine-generator is maintained at a high level throughout the operational lifetime of the Project;

- Diesel fuel with a maximum sulphur content of 0.5% will be used at all times.

6.1.5 *Scenario 1: Residual Impacts (post-mitigation)*

With the implementation of the suggested mitigation and management measures discussed in **Section 6.1.4** it is considered likely that the significance of the NO_2 and SO_2 PC at ground level will be **Moderate** and **Small** respectively at offsite locations within the study area. Given the nature of the event (i.e. short term and infrequent) this impact is considered acceptable given that no exceedances of the air quality standards have been reported.

6.1.6 *Scenario 2: Impacts to Air Quality (pre-mitigation)*

The significance of the modelled impacts on ambient air quality are as follows:

- Nitrogen Dioxide (NO_2) 1-hour Maximum (100th percentile)
    - The modelling results presented in **Table 6.8** indicate that the maximum offsite PC and PEC is 245µg/m^3 and 312µg/m^3 respectively which are less than 100% of the relevant air quality standard (400µg/m^3) throughout the study area. On this basis the impacts to air quality are

Moderate. A contour figure showing the PC and PEC is presented in **Figure 6.7** and **Figure 6.8**.

- Nitrogen Dioxide (NO_2) 1-hour Maximum (99.9th percentile)
  - The modelling results presented in **Table 6.9** indicate that the maximum offsite PC and PEC is 153µg/m³ and 220µg/m³ which is less than 50% and 100% of the relevant air quality standard (400µg/m³) respectively throughout the study area. On this basis the impacts to air quality are **Minor.** A contour figure showing the PC and PEC is presented in **Figure 6.9 and Figure 6.10.**
- Sulphur Dioxide (SO_2) 1-hour Maximum (100th percentile)
  - The modelling results presented in **Table 6.10** indicate that the maximum offsite PC (56.3µg/m³) is less than 25% of the relevant air quality standard (900µg/m³) throughout the study area. On this basis the impacts to air quality are **Negligible.** A contour figure showing the PC is presented in **Figure 6.11.**
- Sulphur Dioxide (SO_2) 1-hour Maximum (99.9th percentile)
  - The modelling results presented in **Table 6.11** indicate that the maximum offsite PC (32.4µg/m³) is less than 25% of the relevant air quality standard (900µg/m³) throughout the study area. On this basis the impacts to air quality are **Negligible.** A contour figure showing the PC is presented in **Figure 6.12.**

Table 6.8 *Scenario 2: Nitrogen Dioxide (NO_2) 1-Hour Maximum – 100 Percentile (Generators 1 Only at 100% Load)*

Site	Baseline (µg/m³)	AQS(1) (µg/m³)	Airshed classification	PC(2) (µg/m³)	PC/AQS (%)	PEC(3) (µg/m³)	PEC/AQS (%)	Impact Significance
Maximum concentration (4)	66.9 (5)	400	ND (6)	245	61%	312	78%	Moderate
ASR1				22.9	5.7%	89.8	22%	Negligible
ASR2				55.1	14%	122	31%	Negligible
ASR3				22.5	5.6%	89.4	22%	Negligible
ASR4				123	31%	190	47%	Minor
ASR5				44.0	11%	111	28%	Negligible
ASR6				20.4	5.1%	87.3	22%	Negligible
ASR7				20.8	5.2%	87.7	22%	Negligible
ASR8				22.6	5.6%	89.5	22%	Negligible
ASR9				15.2	3.8%	82.1	21%	Negligible
ASR10				19.1	4.8%	86.0	21%	Negligible
ASR11				15.6	3.9%	82.5	21%	Negligible
ASR12				14.0	3.5%	80.8	20%	Negligible
ASR13				11.6	2.9%	78.4	20%	Negligible
ASR14				18.6	4.7%	85.5	21%	Negligible
ASR15				10.7	2.7%	77.6	19%	Negligible
ASR16				25.0	6.2%	91.9	23%	Negligible
ASR17				18.6	4.7%	85.5	21%	Negligible
ASR18				21.0	5.3%	87.9	22%	Negligible
ASR19				19.8	5.0%	86.7	22%	Negligible
ASR20				11.3	2.8%	78.2	20%	Negligible

(1) Air Quality Standard *(Regulation of the Republic of Indonesia Number 41 (1999))*
(2) Process Contribution
(3) Predicted Environmental Contribution
(4) The maximum ground level concentration anywhere on the receptor grid
(5) The maximum 1-hour average concentration was measured at AQM1b using the AQS1 real time air quality monitor (see **Table 4.5**). This was used as the 1-hour average baseline across all sites as a worst case approach.
(6) Non-degraded (Baseline < AQS)

Table 6.9 Scenario 2: Nitrogen Dioxide (NO_2) 1-Hour Maximum – 99.9 Percentile (Generators 1 Only at 100% Load)

Site	Baseline (µg/m³)	AQS[(1)] (µg/m³)	Airshed classification	PC[(2)] (µg/m³)	PC/AQS (%)	PEC[(3)] (µg/m³)	PEC/AQS (%)	Impact Significance
Maximum concentration [(4)]	66.9 [(5)]	400	ND [(6)]	153	38%	220	55%	Minor
ASR1				10.2	2.5%	77.1	19%	Negligible
ASR2				30.2	7.5%	97.0	24%	Negligible
ASR3				8.85	2.2%	75.7	19%	Negligible
ASR4				96.3	24%	163	41%	Negligible
ASR5				32.8	8.2%	100	25%	Negligible
ASR6				14.9	3.7%	81.8	20%	Negligible
ASR7				17.5	4.4%	84.4	21%	Negligible
ASR8				16.1	4.0%	83.0	21%	Negligible
ASR9				3.15	<1%	70.0	18%	Negligible
ASR10				11.0	2.7%	77.8	19%	Negligible
ASR11				10.2	2.5%	77.0	19%	Negligible
ASR12				6.01	1.5%	72.9	18%	Negligible
ASR13				2.29	<1%	69.2	17%	Negligible
ASR14				7.16	1.8%	74.0	19%	Negligible
ASR15				7.31	1.8%	74.2	19%	Negligible
ASR16				9.15	2.3%	76.0	19%	Negligible
ASR17				10.0	2.5%	76.9	19%	Negligible
ASR18				10.4	2.6%	77.2	19%	Negligible
ASR19				9.16	2.3%	76.0	19%	Negligible
ASR20				5.31	1.3%	72.2	18%	Negligible

(1) Air Quality Standard *(Regulation of the Republic of Indonesia Number 41 (1999))*
(2) Process Contribution
(3) Predicted Environmental Contribution
(4) The maximum ground level concentration anywhere on the receptor grid
(5) The maximum 1-hour average concentration was measured at AQM1b using the AQS1 real time air quality monitor (see **Table 4.5**). This was used as the 1-hour average baseline across all sites as a worst case approach.
(6) Non-degraded (Baseline < AQS)

Table 6.10 Scenario 2: Sulphur Dioxide (SO_2) 1-Hour Maximum - 100 Percentile (Generators 1 Only at 100% Load)

Site	Baseline (μg/m³)	AQS[(1)] (μg/m³)	Airshed classification	PC[(2)] (μg/m³)	PC/AQS (%)	PEC[(3)] (μg/m³)	PEC/AQS (%)	Impact Significance
Maximum concentration [(4)]	n/a [(5)]	900	ND [(6)]	56.3	6.3%	56.3	6.3%	Negligible
ASR1				4.82	<1%	4.82	<1%	Negligible
ASR2				11.5	1.3%	11.5	1.3%	Negligible
ASR3				4.74	<1%	4.74	<1%	Negligible
ASR4				25.7	2.9%	25.7	2.9%	Negligible
ASR5				9.20	1.0%	9.20	1.0%	Negligible
ASR6				4.26	<1%	4.26	<1%	Negligible
ASR7				4.34	<1%	4.34	<1%	Negligible
ASR8				4.68	<1%	4.68	<1%	Negligible
ASR9				3.20	<1%	3.20	<1%	Negligible
ASR10				3.92	<1%	3.92	<1%	Negligible
ASR11				3.23	<1%	3.23	<1%	Negligible
ASR12				2.95	<1%	2.95	<1%	Negligible
ASR13				2.43	<1%	2.43	<1%	Negligible
ASR14				3.92	<1%	3.92	<1%	Negligible
ASR15				2.23	<1%	2.23	<1%	Negligible
ASR16				5.18	<1%	5.18	<1%	Negligible
ASR17				3.84	<1%	3.84	<1%	Negligible
ASR18				4.39	<1%	4.39	<1%	Negligible
ASR19				4.07	<1%	4.07	<1%	Negligible
ASR20				2.38	<1%	2.38	<1%	Negligible

(1) Air Quality Standard *(Regulation of the Republic of Indonesia Number 41 (1999))*
(2) Process Contribution
(3) Predicted Environmental Contribution
(4) The maximum ground level concentration anywhere on the receptor grid
(5) Background SO_2 concentrations were not quantified for the purpose of this 'unplanned' assessment scenario
(6) Assumed non-degraded (Baseline < AQS)

Table 6.11 Scenario 2: Sulphur Dioxide (SO_2) 1-Hour Maximum – 99.9 Percentile (Generators 1 Only at 100% Load)

Site	Baseline (µg/m³)	AQS[1] (µg/m³)	Airshed classification	PC[2] (µg/m³)	PC/AQS (%)	PEC[3] (µg/m³)	PEC/AQS (%)	Impact Significance
Maximum concentration [4]	n/a [5]	900	ND [6]	32.4	3.6%	32.4	3.6%	Negligible
ASR1				2.12	<1%	2.12	<1%	Negligible
ASR2				6.32	<1%	6.32	<1%	Negligible
ASR3				1.86	<1%	1.86	<1%	Negligible
ASR4				20.2	2.2%	20.2	2.2%	Negligible
ASR5				6.89	<1%	6.89	<1%	Negligible
ASR6				3.11	<1%	3.11	<1%	Negligible
ASR7				3.66	<1%	3.66	<1%	Negligible
ASR8				3.34	<1%	3.34	<1%	Negligible
ASR9				0.647	<1%	0.647	<1%	Negligible
ASR10				2.27	<1%	2.27	<1%	Negligible
ASR11				2.11	<1%	2.11	<1%	Negligible
ASR12				1.27	<1%	1.27	<1%	Negligible
ASR13				0.480	<1%	0.480	<1%	Negligible
ASR14				1.51	<1%	1.51	<1%	Negligible
ASR15				1.52	<1%	1.52	<1%	Negligible
ASR16				1.89	<1%	1.89	<1%	Negligible
ASR17				2.07	<1%	2.07	<1%	Negligible
ASR18				2.16	<1%	2.16	<1%	Negligible
ASR19				1.91	<1%	1.91	<1%	Negligible
ASR20				1.11	<1%	1.11	<1%	Negligible

(1) Air Quality Standard *(Regulation of the Republic of Indonesia Number 41 (1999))*
(2) Process Contribution
(3) Predicted Environmental Contribution
(4) The maximum ground level concentration anywhere on the receptor grid
(5) Background SO_2 concentrations were not quantified for the purpose of this 'unplanned' assessment scenario
(6) Assumed non-degraded (Baseline < AQS)

Figure 6.7 Scenario 2: Nitrogen Dioxide (NO_2) 1-Hour Maximum Process Contribution (PC) – 100 Percentile (Human Health)

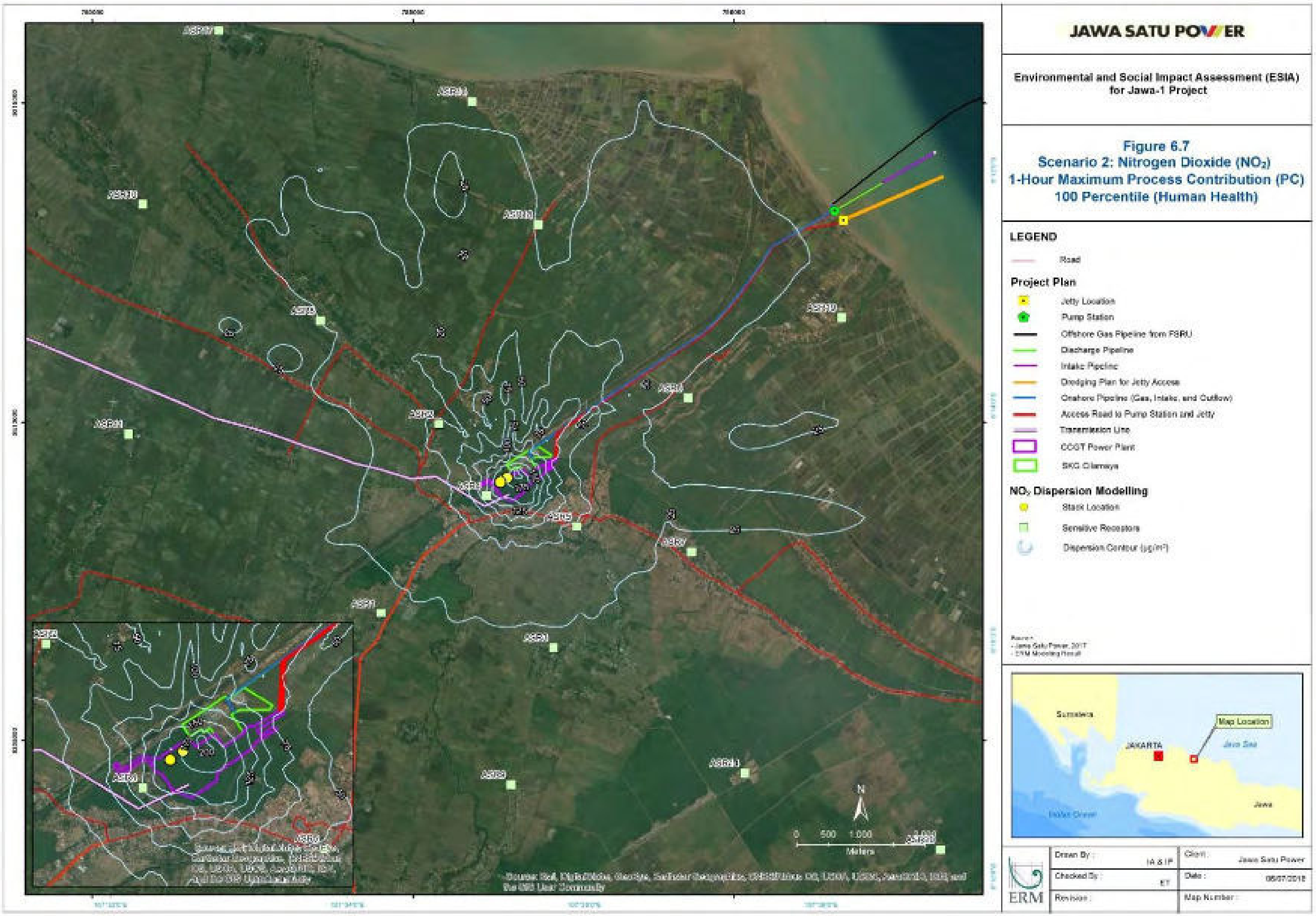


Figure 6.8 Scenario 2: Nitrogen Dioxide (NO_2) 1-Hour Maximum Predicted Environmental Concentration (PEC) – 100 Percentile (Human Health)

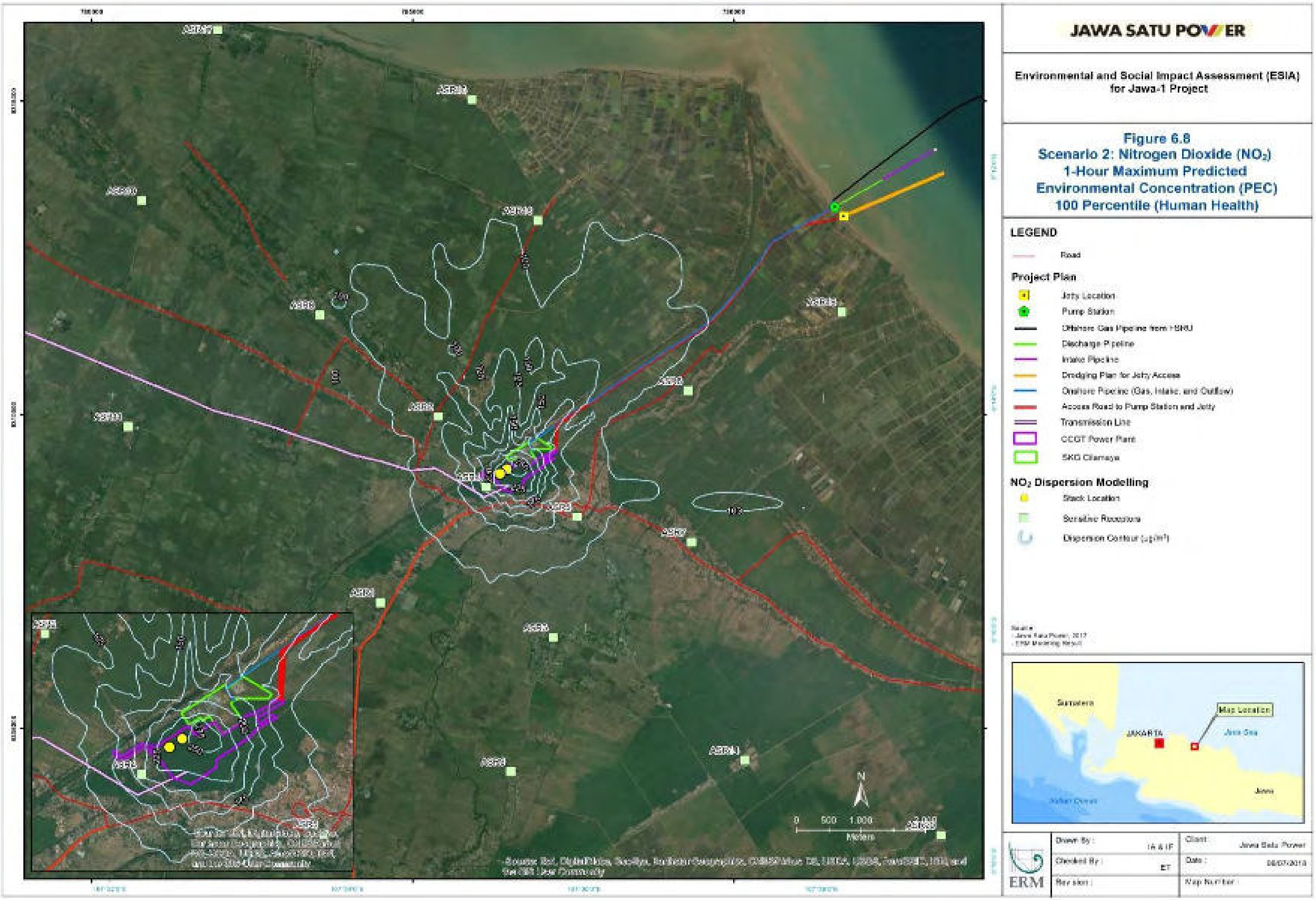


Figure 6.9 Scenario 2: Nitrogen Dioxide (NO_2) 1-Hour Maximum Process Contribution (PC) – 99.9 Percentile (Human Health)

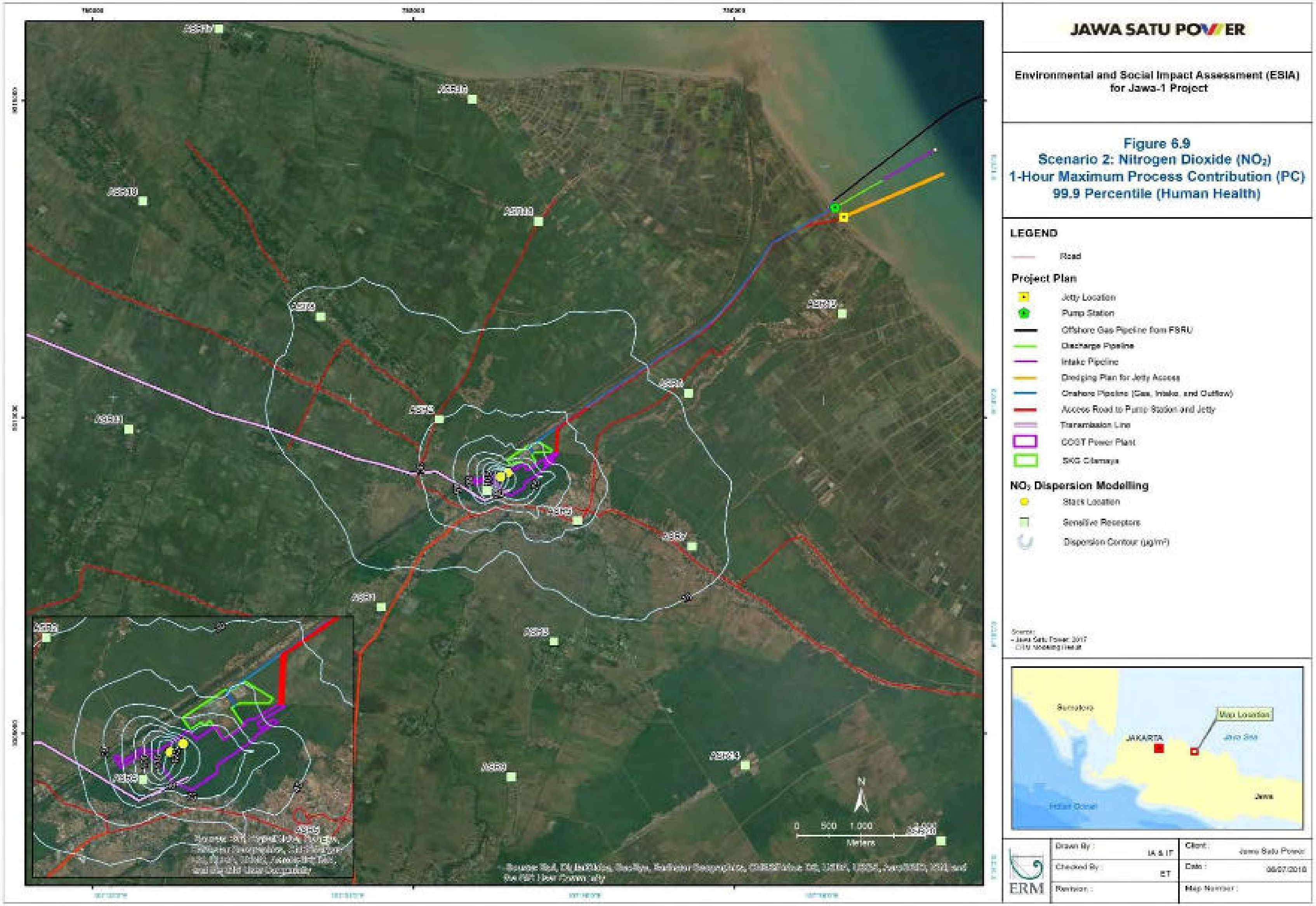


Figure 6.10 Scenario 2: Nitrogen Dioxide (NO_2) 1-Hour Maximum Predicted Environmental Concentration (PEC) – 99.9 Percentile (Human Health)

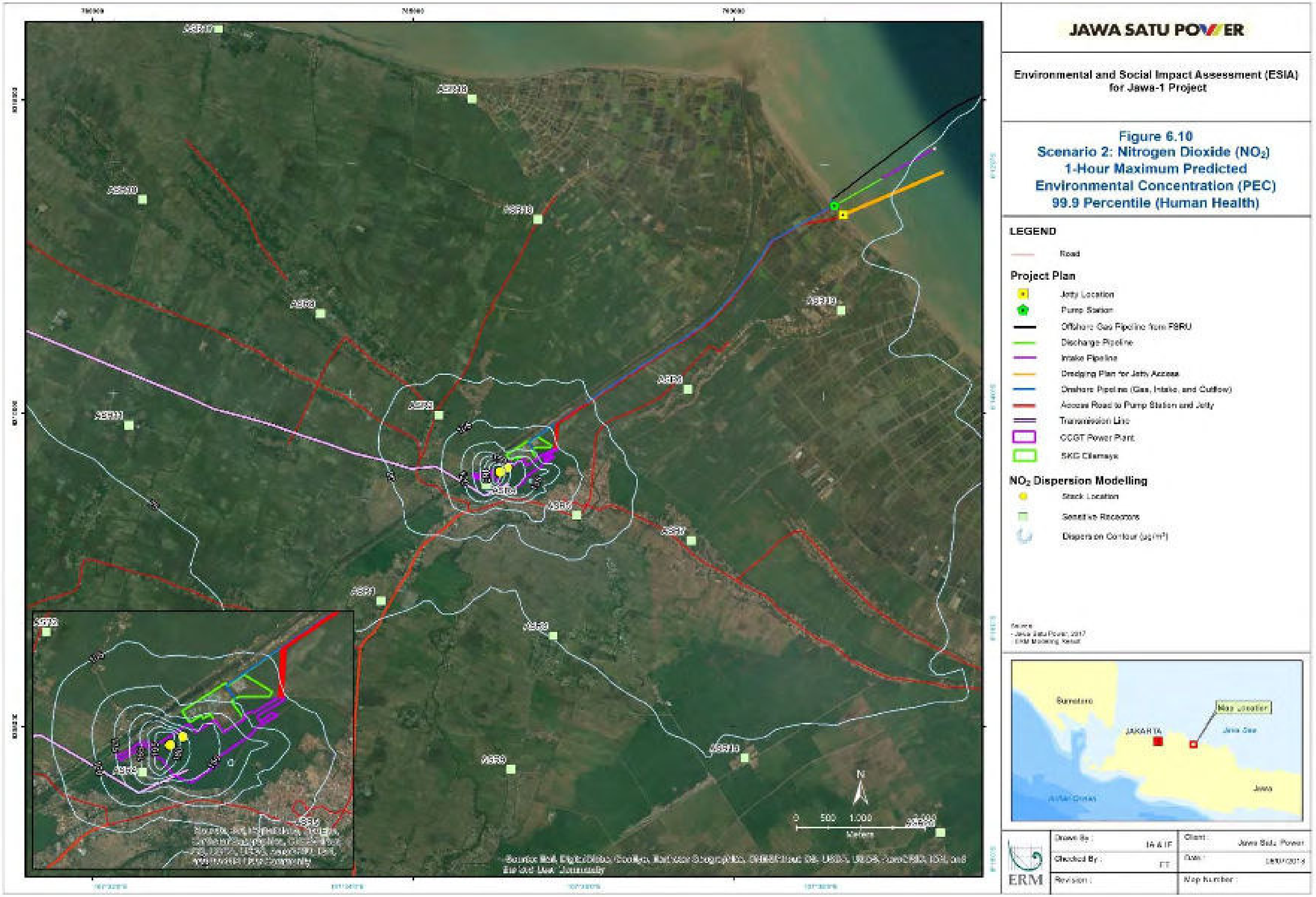


Figure 6.11 Scenario 2: Sulphur Dioxide (SO_2) 1-Hour Maximum Process Contribution (PC) – 100 Percentile (Human Health)

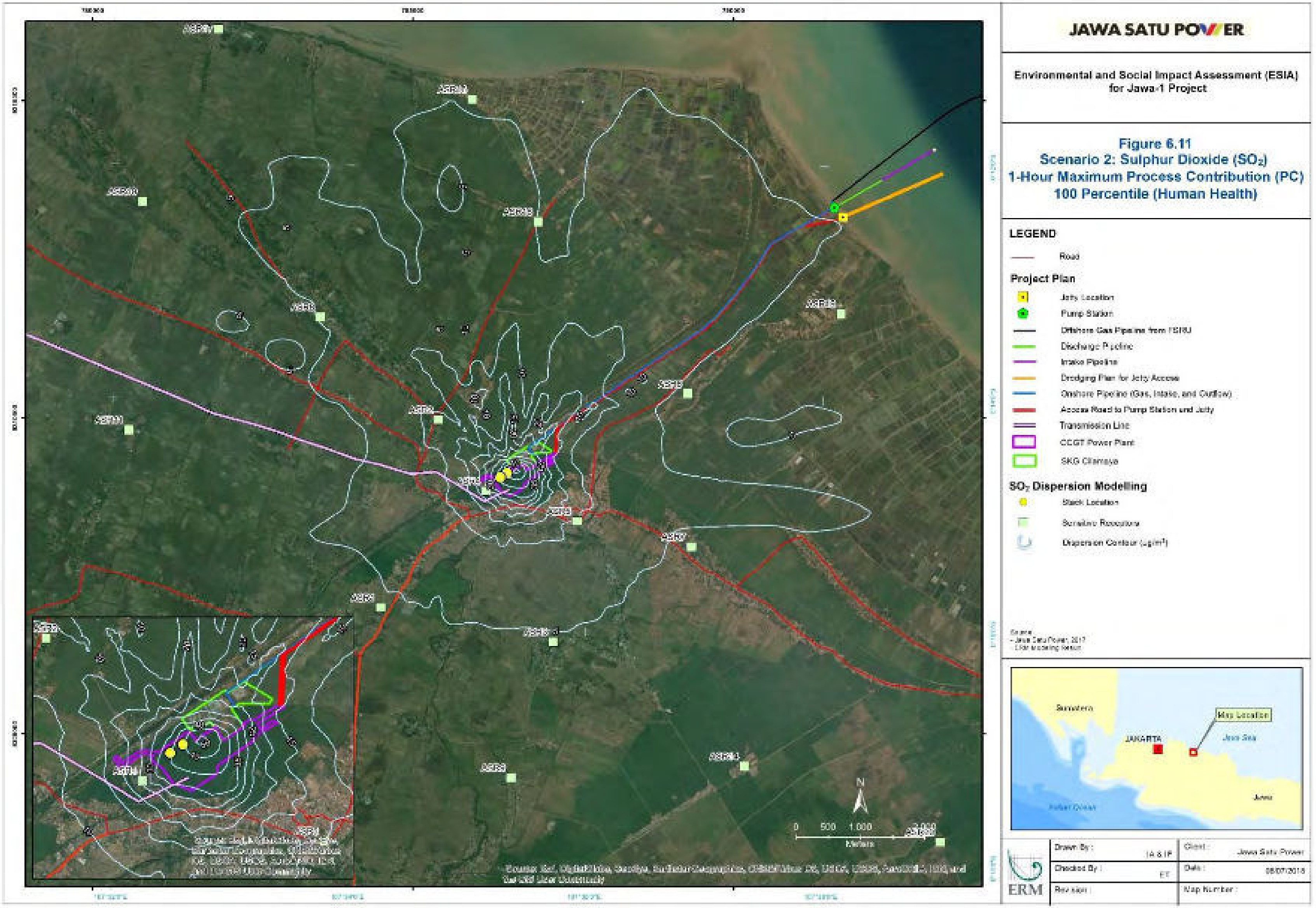
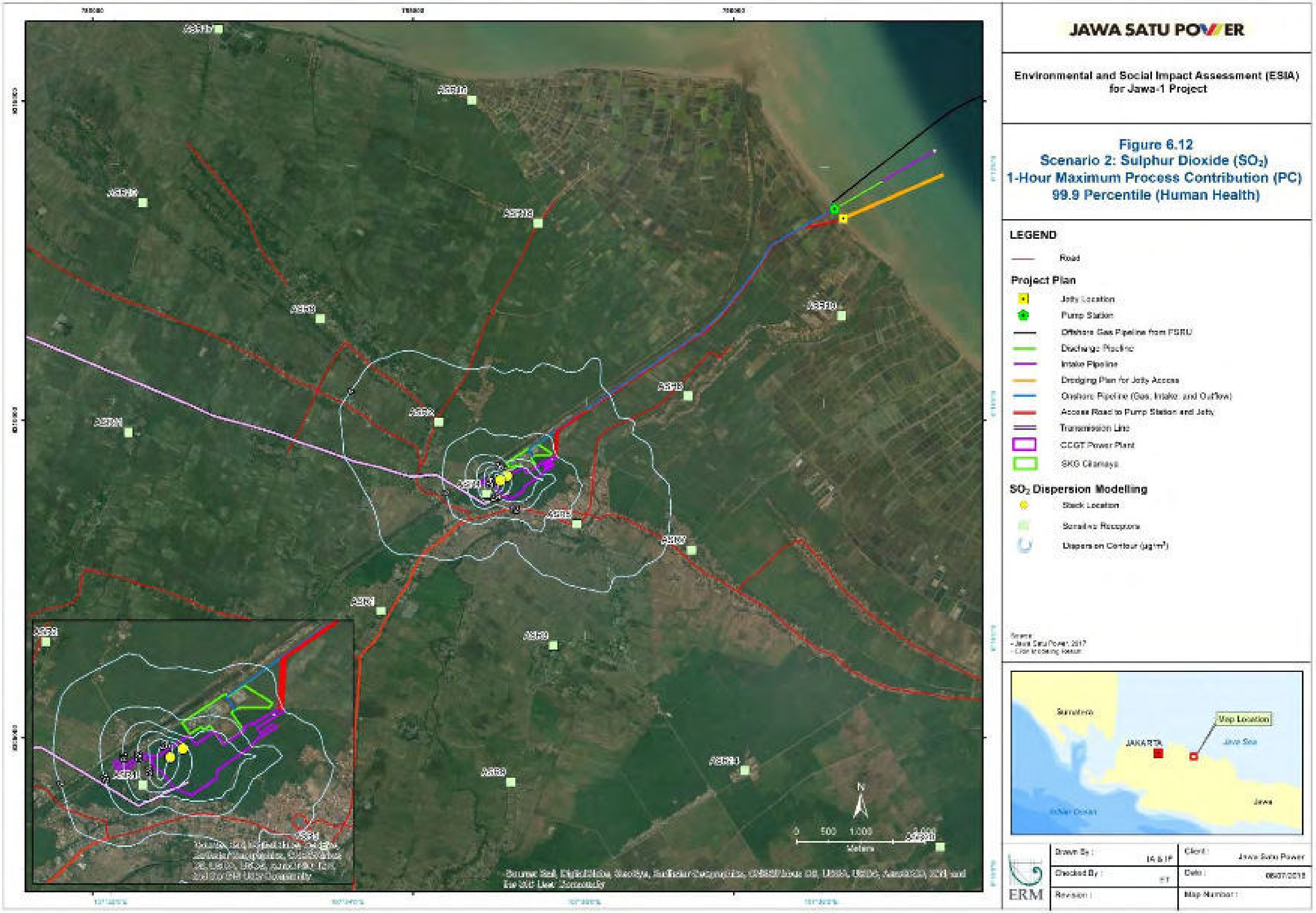


Figure 6.12 Scenario 2: Sulphur Dioxide (SO_2) 1-Hour Maximum Process Contribution (PC) – 99.9 Percentile (Human Health)



6.1.7 Scenario 2: Recommended Mitigation, Management and / or Monitoring Measures

The findings from the air quality impact assessment indicate that **Moderate** adverse impacts to air quality are expected at worst due to the operation of one diesel fired engine-generator operating at full load when emergency power is required for the safe shutdown of the power plant in the event of loss of main supply. The suggested mitigation, management and monitoring is presented in **Section 6.1.4**.

6.1.8 Scenario 2: Residual Impacts (post-mitigation)

The residual impacts are likely to be **Moderate** adverse at worst throughout the study area. Given the nature of the event (i.e. short term and infrequent) this impact is considered acceptable given that no exceedances of the air quality standards have been reported.

7 CUMULATIVE IMPACTS AND MITIGATION

7.1 INTRODUCTION

The IFC Performance Standard 1 (Paragraph 5) defines the broader Project area to include *"… areas potentially impacted by cumulative impacts from further planned development of the Project, any existing project or condition, and other project-related developments that are realistically defined at the time the Social and Environmental Assessment is undertaken."*

In addition, the IFC Performance Standard 1 (Paragraph 6) states that the *"… assessment will also consider potential trans-boundary effects, such as pollution of air, or use or pollution of international waterways, as well as global impacts, such as the emission of greenhouse gases."*

Cumulative impacts are those impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the proposed Project. Cumulative impacts are therefore generally impacts that act with others in such a way that the sum is greater than the parts. This is, however, not always the case – sometimes they will simply be the sum of the parts, but that sum becomes significant.

This chapter considers the cumulative impacts that would result from the combination of the Project and other actual or proposed future developments in the broader Project Area.

7.2 IDENTIFIED CUMULATIVE IMPACTS

Within the study area it is primarily the operation of a flare at the SKG Pertamina Gas facility located immediately to the north east of the Project site that could lead to cumulative impacts on air quality at sensitive receptor locations. It should be noted, however, that during normal operation the flare will combust only small quantities of gas to maintain a pilot light and emissions to air are considered small. Although the flaring rates and periods of flaring at the facility are not known, it is considered acceptable to assume that emission form the flare will have been captured within the baseline assessment presented in **Section 4.3** and as such have already been assessed within this air quality impact assessment.

8 CONCLUSION AND RECOMMENDATIONS

The proposed Project has the potential to adversely impact on ambient air quality throughout its lifetime from construction through operation and decommissioning. This air quality impact assessment identifies those emissions which are potentially significant and then quantifies the impact so that suitable mitigation and/or recommendations can be identified where required.

8.1 CONSTRUCTION PHASE

During the construction phase of the Project, the potential impacts to air quality are primarily associated with dust and PM_{10} from earthwork activities, construction of the Project infrastructure, and trackout of dusty materials onto the public road network. Without the correct implementation of mitigation, the significance of the impacts associated with these activities can be major adverse at sensitive receptor locations within 350m of construction activities. Emissions from mobile and non-mobile plant as well increased traffic movements on the public road network have also been considered, however these are expected to be negligible.

Based on the predicted impacts during the construction phase, site specific mitigation measures have been identified. These measures are intended to minimise the potential impacts associated with the construction activities where necessary. Based on the correct implementation of the mitigation measures, the residual impacts are expected to be negligible for the majority of the time. However, due to the nature of construction activities, the scale and duration of the construction phase, and the possibility of extreme weather conditions, it is possible that communities may experience occasional, short term dust annoyance. Therefore, although the proposed mitigation is designed to reduce dust emissions as far as possible, it is recognised that in reality this will not necessarily be feasible all of the time and there may be short term minor adverse impacts during the construction phase.

8.2 OPERATION PHASE

The potential impacts to ambient air quality from the CCGT and diesel fired engine-generators were assessed quantitatively through the use of the dispersion model AERMOD.

The assessment indicates that during the continuous operation of the CCGT power plant incorporating a stack height of 60m and operating at the IFC NO_x emission limit guideline of $51mg/Nm^3$, the NO_2 PC will exceed 25% of the 1-hour Indonesian air quality standard. On this basis a number of additional modelling scenarios were considered and mitigation options presented including increasing stack height and/or reducing NO_x concentrations. In addition, good practice management and monitoring measures are advised, including continuous emissions monitoring, annual stack testing and continuous ambient air quality monitoring at two offsite locations. The residual impact on air quality is expected to be negligible with the implementation of additional mitigation and monitoring throughout the operation phase.

With regard to the diesel fired engine-generators required for black start and emergency power for the safe shutdown of the power plant, the assessment considers two 'unplanned event' scenarios. Both assessment scenarios considered only the short term (1-hour) impacts as such events are only expected periodically and for short periods of time.

The assessment indicates that moderate adverse impacts to air quality are expected during a black start event requiring the use of all twelve generators. The use of one engine-generator at full and continuous loading for safe shutdown procedures is also expected to have moderate adverse impacts on air quality at worst. It is suggested that all engine-generators should be routinely checked and serviced so that their operational performance is maintained throughout the operational lifetime of the Project. Diesel fuel with a sulphur content of 0.5% should be used at all times.

Salt deposition from the cooling towers is unlikely to exceed the threshold above which leaf damage in most species has been found. No additional mitigation is therefore proposed.