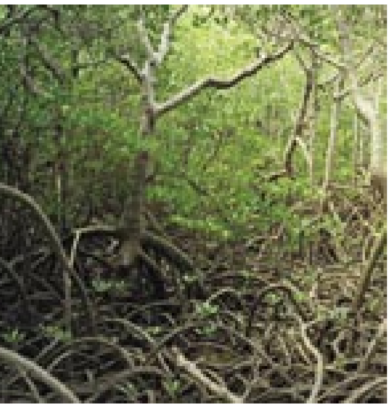
Section 6

Waste and Emissions Inventory

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6. Waste and Emissions Inventory

6.1 Waste and Emissions Management Principles

The construction, operation and decommissioning phases of the Blacktip Project will result in the generation of solid and liquid wastes and emissions. The volumes and characteristics of waste and emissions generated will vary considerably throughout the different phases of the project. The variations in volumes and characteristics will require specific waste and emissions reduction measures, which will have minimisation as a central theme.

Waste and emissions management will be undertaken according to Woodside's Environmental Standards and Aspirations document (Woodside 2003c) and relevant Woodside guidelines and legislative requirements. The management process will give priority to developing production systems and equipment in an efficient manner to minimise resource use and waste generation, including gaseous emissions.

The prevention and minimisation of hazardous waste materials through pre-qualification, tendering and contracting processes will also be a major focus of waste management.

Other objectives of waste and emissions management are to:

- Identify opportunities to prevent and/or reduce waste generation from the proposed development through design and operation standards and by working with contractors and suppliers.
- Identify opportunities to re-use, recycle or reprocess waste generated during all phases of the proposed development.
- Reduce the amount and toxicity of waste requiring disposal.
- Avoid undesirable safety and environmental effects through inappropriate handling, storage, transportation or disposal.
- Identify and eliminate hazards to human health and the environment to ALARP.
- Utilise certified waste transporters and disposal facilities for ultimate waste disposal if other options are not practicable.
- Document waste management information, including inventory, disposal, waste characteristics and procedures.

These objectives, and the treatment and disposal of all waste and emissions will be incorporated into project-specific Environmental Management Plans for both terrestrial and marine based project aspects (**Section 15**). The plans will incorporate regulatory requirements within Western Australian, Northern Territory and Commonwealth jurisdictions and will span construction, commissioning, operation and decommissioning phases.

Specific impacts and management measures for terrestrial and marine-based components are discussed in **Sections 11** and **12**.

6.2 Waste Inventory

Waste will be generated in varying amounts throughout all phases of the Blacktip Project, although it is expected that the majority of waste will be generated during drilling, construction, installation and commissioning.

During the life of the project waste will arise from three main waste streams:

1) non-hazardous solid waste stream including:
   - construction;
   - domestic;
   - green waste.
2) liquid waste stream including:
   - sanitary wastewater and greywater;
   - hydrotest water.
3) hazardous waste stream.

6.2.1 Construction Phase

Some of the main waste streams that are likely to be generated during construction, and their sources, are summarised in **Table 6-1**.

Table 6-1 Main Construction Waste Stream Sources

Construction Activity/Source	Waste Type
Construction Camp	Sanitary wastewater and greywater Sewage Cooking oil Putrescibles and packaging
Mechanical Workshop	Lube oil and grease Used oil spill kits Rags and cotton waste Oil filters and replacement parts Coolant Batteries Solvents, primers and rust-proofing agents Tyres Washdown liquid collected in oily water pits
General Plant Construction	Soil and rock fragments for example excavated or surplus soil not suitable for reuse Packaging and empty containers for example plastic, cardboard, paper, pallets and metals Scrap or damaged building materials for example plasterboard, timber or metals off-cuts, pipe and electrical off-cuts, welding slag Concrete and paving materials for example surplus or damaged
Pipeline Construction	As defined below

Construction Activity/Source	Waste Type
Clearing and Grading	Fuel spillages Fluid leaks Tyres and consumables from plant and vehicles
Pipe Stringing	As per clearing and grading, and: Rope rings used to separate pipes on the truck
Pipe Welding	As per clearing and grading, and: Pipe pup offcuts Slag from welding Personal protection equipment items, for example gloves, glasses and dust masks Welding items, for example grinding disks, electrode stubs and packets Chemicals for developing x-rays and gamma rays
Joint Coating	As per clearing and grading, and: Garnet for blasting operation Joint coating tins Excess coating Masking tape
Trenching	As per clearing and grading, and: Replacement parts, for example trencher teeth and belts
Lowering in	As per clearing and grading, and: Wooden skids Broken foam pillows
Padding and Backfill	As per clearing and grading
ROW reinstatement/rehabilitation	Seed bags Fuel spillages Fluid leaks Tyres and consumables from plant and vehicles Fencing wire and wooden post off-cuts
Cathodic Protection Installation	As per clearing and grading, and: Excess coke breeze and nylon mesh weaved bags; Packaging for anodes and cables Epoxy cable sealing kits Cad-weld charges Cable cut-offs
Vehicle Washdown	Oily water Chemically contaminated water
Other Construction Waste	Sanitary waste Domestic waste

6.2.1.1 Non-Hazardous Solid Waste

Construction Waste: The quantity of solid construction waste cannot be defined at this stage, as it is highly dependent on the in situ ground conditions and will vary throughout the construction period. Most construction waste can be classified as inert material, and as a result much of it will be reused where at all possible. It is envisaged that the waste stream will typically consist of:

- soil, for example excavated or surplus soil not suitable for pipeline bedding or cover;
- rock fragments, for example if blasting is required shallow rock that is not suitable for reuse;
- concrete, for example surplus remaining after concrete pours at the plant site;
- packaging materials for example plastic, cardboard, paper, pallets and metals;
- pipe off-cuts and reinforcing steel at the plant site;
- damaged products, for example plasterboard, bricks, tiles at plant site;
- timber scraps at the plant site;
- paving materials at the plant site;
- metal at the plant site;
- electrical off-cuts at the plant site;
- waste tyres along the pipeline corridor and at the plant site.

Solid Domestic Waste: Domestic waste will typically consist of:

- putrescibles
- packaging

Offshore: All waste such as packaging will be contained in clearly marked containers on board the laybarge or other support vessels (**Section 11.20**). In accordance with MARPOL regulations and relevant regulatory authority requirements plastics, plastic products of any kind, domestic waste (for example cans, glass, paper or other waste from living areas,) and maintenance waste (for example rags, deck sweepings, oil soaks) will not be disposed of overboard, but disposed or recycled at appropriate waste facilities onshore, most likely at Darwin. No burning of waste will be permitted.

Putrescible food waste will be macerated prior to discharge to the ocean in accordance with all MARPOL and all other relevant legislation. No putrescible waste will be discharged within 12 nautical miles of any land.

Onshore: During construction the greatest quantities of domestic waste will be generated from the construction camps. Some domestic waste will also be generated along the pipeline corridor. Sewage water will be treated and disposed of using an approved treatment system which will be an above ground proprietary package membrane reactor. Sludge will be tankered off site as required.

The main source of domestic waste will be from the mess facilities (dining area etc) at the camps. Packaging waste (for example bottles, cardboard, aluminium cans and plastic) will also be generated. The exact quantities of waste are not known at this stage and will be dependent on the numbers of personnel involved and the approach taken for construction.

Green Waste: Green organic waste, for example vegetation, shrubs and trees may be generated as the plant and pipeline corridor is cleared in preparation for plant construction and pipe laying. The expected volume cannot be confirmed as the density of vegetation varies along the corridor and as much of it as possible will be respread during rehabilitation. A number of options will be assessed for use of the remaining green waste. For example, there may be business opportunities for the harvest of cycads and other saleable species that will be cleared during site preparation. Furthermore, trees cleared during site preparation could be processed for firewood. Otherwise, green waste is likely to be burned if it cannot be reused.

6.2.1.2 Liquid Waste

The liquid waste streams that will be generated during construction and installation are summarised in **Table 6-2**.

- **Table 6-2 Construction Liquid Waste Stream Discharges**

Source of Emissions	Description of Emissions	EIS Section
Laydown areas and onshore accommodation/mess facilities	Stormwater Drainage Greywater Sanitary wastewater	**12.5**
Jack-up, laybarge and support vessels	Deck drainage Cooling water Greywater and black water/sewage	**11.20**
Drilling	Drill cuttings Drilling muds	**11.8**

During construction liquid waste will mainly consist of:

- sanitary wastewater
- grey water

The sanitary wastewater stream will comprise both grey water and sewage. Wastewater volumes generated at the construction camp are assumed to total between 200 and 250 L of water per person per day. This amounts to a weekly wastewater loading of approximately 230 kL/week, assuming the camp is fully occupied at 130 people. Sewage will be treated and disposed of in accordance with statutory regulations, as detailed in **Section 12.5**.

The gas plant site will be sealed with a drainage management system to allow the segregation of clean water from potentially dirty water. The drainage system will collect and convey all pant drainage streams to an appropriate disposal location. This will be done in such a way as to protect personnel, plant and equipment, and to avoid pollution. The system design philosophy is based on maximum segregation of sources to minimise contamination and subsequent clean-up problems. Clean surface water will drain offsite, potentially contaminated stormwater will be mixed with the PW, treated and discharged via the PW pipeline. Water not suitable for treatment in the PW treatment system, for example contaminated via chemical spills, will be contained and moved offsite for treatment before disposal. The volume of this type of water is anticipated to be very low due to the minimal use of chemicals on the site.

The Jack-up, laybarge, support vessels and wellhead platform will have deck drainage systems. Deck drainage will consist mainly of clean rainwater, which will generally be directed overboard. Further detail is provided in **Section 4.8.8**.

Offshore, sanitary wastewater will be generated by personnel housed on vessels. The effluent will be disposed of in accordance with MARPOL regulations. A sewerage system for both black and grey water will be contained on board and will service the entire crew. Further detail is provided in **Section 4.8.9**.

Drilling muds and cuttings management are discussed separately in **Sections 4** and **11** of this report.

6.2.1.3 Hazardous Waste

Waste materials that are harmful to the environment or health are considered hazardous and treated separately to inert waste. Hazardous waste will mainly be generated offshore and onshore during drilling, installation and construction phases of the proposed development and will include:

- recovered solvents;
- excess or spent chemicals/solvents;
- paints;
- oil contaminated materials for example sorbents, filters and rags;
- acids for example batteries;
- hydrocarbons for example lubricating oils, fuel;
- herbicides.

Hydrocarbons will most likely be found in areas where rotating equipment and lube oil systems, liquid fuel or waste oil storage areas, refuelling areas and vehicle washdown areas are located.

Offshore deck drainage water from dirty or oily areas on the Jack-up will be directed to sumps, which will be connected to oily water collection and treatment systems. Once separated the oil and grease will be reprocessed or stored in suitable containers ahead of transfer ashore for recycling. In the event of an oil or chemical spill on the drill rig, a system will be in place to block the overboard drains and divert the spill to the sump and prevent this material from entering the sea.

Onshore hazardous waste will be segregated from other waste and disposed of onshore, by recycling, incineration or contained landfill, in accordance with relevant legislation and guidelines. Details of hazardous waste will be compiled, including type, amount and disposal method, to track final destinations and identify opportunities for improvement.

Some biological waste from first aid facilities may also be generated.

More detailed information regarding hazardous waste can be found in **Sections 4.8.8** and **12.3**.

6.2.2 Commissioning Phase

Solid, liquid and hazardous waste is expected to be generated during commissioning (**Table 6-3**). Much of the waste generated will be similar in type and volume to that produced during construction; however, there will be a large volume of liquid waste in the form of hydrotest water from dewatering of the pipeline during commissioning.

- **Table 6-3 Commissioning Solid and Liquid Waste Sources**

Source of Emissions	Emissions Type
Pipeline Dewatering	Discharge of hydrotest water Pipeline dust and dirt from inside pipeline Wet and muddy foam pigs
Commissioning	Fuel spillages Fluid leaks Tyres and consumables from plant and vehicles Worn plastic pigs

Dewatering of the hydrotest water is the major commissioning activity that is expected to generate liquid waste. As described in detail in **Section 4.6.3**, an estimated 17,000 m^3 of treated seawater will be discharged to the marine environment. A further 6,000 m^3 of hydrotest water will require discharge from the condensate tanks and gas plant pipework.

6.2.3 Operation and Maintenance Phase

As the offshore facilities will be unmanned, waste will generally only be generated offshore and along the onshore pipeline corridor during general maintenance or repair routines. However, some process-derived waste will be generated from the gas plant during normal operations.

6.2.3.1 Non-Hazardous Solid Waste

As the gas plant will be minimally manned (two personnel) only a very small amount of construction and domestic waste will be generated onshore during operation, whilst domestic waste produced offshore during maintenance periods will also be minimal as the wellhead platform will be unmanned. Maintenance waste will be similar to that produced during construction but in very minor quantities. Only minor quantities of green waste will arise from general gas plant housekeeping.

6.2.3.2 Liquid Waste

Operational volumes of sanitary wastewater and greywater will be minor, both offshore and at the onshore gas plant, as they will be either unmanned or minimally manned. However, the largest volume of liquid waste will arise from the Produced Water Treatment Facility, which will discharge a maximum of 7800 bpd of PW approximately 3 km offshore. **Table 6-4** summarises the expected waste streams.

- **Table 6-4 Production and Operations Liquid Waste Streams**

Source of Emissions	**Description of Emissions**
Accommodation facilities	Greywater and Sewage
PW treatment	A maximum of 7800 bpd treated PW
Onshore contaminated water	Wastewater/washdown water to be treated and disposed of as per treated PW (**Section 4.8.8**)

6.2.3.3 Hazardous Waste

Approximately 150 m^3 of silica gel will be required at the gas plant for adsorbing water and condensate from the gas stream. Silica gel can withstand high temperatures and pressures and is a porous preparation of silicon dioxide (SiO_2) (which also forms quartz and sand). It is planned to replace the silica gel every three years because it degrades over time and hence becomes less effective.

Two options are being considered for silica gel replacement:

1) All the used material will be removed from the site for appropriate disposal/recycling by the vendor, and the system will be replenished with new silica.
2) The used silica will be sieved to remove waste material for example hydrocarbons, and the system will be topped up with new silica. The waste material will be taken offsite for disposal/recycling by the vendor.

Besides silica gel only minor quantities of hazardous waste will be associated with the offshore facilities and gas plant during operation and maintenance. This will include oils, used batteries and diesel fuel.

Hazardous waste will most likely be returned to Darwin, or a facility elsewhere, that can appropriately handle hazardous waste.

6.3 Atmospheric Emissions

A summary of the atmospheric emissions that will be generated during the various phases of the Blacktip Project is provided below. The sources of these emissions are also identified.

6.3.1 Greenhouse Gases

Greenhouse Gas Emissions Sources: The Blacktip Project will allow carbon intensive liquid fuels currently used by prospective customers to be phased out and replaced with natural gas, which is more efficient and produces less greenhouse gases and other particulate pollutants than alternative fossil based fuels for the same energy demand profile. Greenhouse gas emissions associated with the project should be viewed in the context of the project providing an overall benefit in terms of greenhouse gas production and less emissions than other fossil based fuels.

Greenhouse gas emissions from the proposed Blacktip Project will be associated with:

- combustion of fuel gas
- combustion of liquid fuels
- combustion of gas in the flare
- combustion during well cleanup
- venting of gas
- fugitive emissions

The major greenhouse gas emissions associated with the Blacktip Project will be carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) and these will be mostly associated with the production phase. Emissions will also result from fuel used in construction equipment, supply vessels, and drilling rigs, as well as during well cleanup and commissioning but these contributors are small in relation to the emissions associated with the production phase.

Wherever possible gas will be used as a fuel source within the Blacktip Project. A major source of greenhouse gas emissions will be combustion of fuel gas used to drive the gas compression system located at the onshore gas plant. This gas compression unit is required to assist in transporting the gas through the Trans Territory Pipeline and requires approximately 12 MW of power, while power requirements for the gas process itself are approximately 1000 kW. Other items of plant associated with greenhouse gas emissions will include the lighting, telemetry and control valve systems at the wellhead platform, requiring approximately 4.5 kW of power.

Combustion of liquid fuel used in backup power supplies and emergency equipment, and gas in the flare will result in the discharge of additional greenhouse gases. The diesel-fired equipment is required to cater for periods when gas is not available. The flare system is in place to remove hydrocarbons from the gas plant in the case of a process upset or an emergency. Flaring of gas from the plant may also be required, infrequently, during maintenance activities at the plant. However, because the maintenance is planned, flare characteristics can to some extent be controlled. It is normal practice for a pilot flare to be kept alight at all times, ensuring that any gas sent to the flare system will be ignited.

Another possibility for significant greenhouse gas release from the Blacktip Project is an emergency affecting the integrity of the gas pipelines from the wellhead platform to the onshore plant and from the plant to the customer. The likelihood of a failure of either pipeline is remote due to its location and design. This will be further assessed during the risk assessment to be undertaken during detailed design. In the event of a failure of either pipeline, gas would either slowly or suddenly be released at very high pressures. This gas release would represent a significant increase in the Blacktip Project greenhouse gas emissions. If the gas ignited, CO_2 would be generated, rather than direct venting of methane, resulting in a smaller but still significant emission. Such an event would constitute a significant release; however, it should be emphasised that the likelihood of such an event is remote.

Emissions Forecasting Methodology: Prediction of the greenhouse gas emissions that are likely to be associated with the project has been undertaken using the methodologies developed by the Exploration and Production Forum (now referred to as the International Association of Oil and Gas Producers, OGP) for oil and gas exploration and production facilities. This methodology uses a tier system to estimate emissions. The tier 2/3 methodology has been adopted to forecast greenhouse gas emissions for the Blacktip Project. This system essentially uses available project information (for example approximate fuel demand) with industry average 'factors' (for example tonnes NOx per tonne gas fuel burnt in a gas turbine) to determine project emissions (for example NOx in tonnes per annum). The methodology used in this forecast is similar to those quoted by the National Greenhouse Gas Inventory Committee and Greenhouse Challenge Program. Fugitive emissions have been calculated using data from American Petroleum Institute (API) 4859 (API 1993).

Construction Phase Greenhouse Gas Emissions: Greenhouse gases will be generated during the construction and installation processes as a result of diesel consumed in mobile plant and vehicles. Based on an estimate of 5,000 m^3 of diesel used during construction approximately 15,000 tonnes of CO_2 will be produced, this is compared to approximately 90,000 tonnes per year during the operations phase of the project.

Operation Phase Greenhouse Gas Emissions: **Table 6-5** provides estimates of the greenhouse gas emissions associated with the operation and production phase of the proposed Blacktip Project by source and by individual greenhouse gas.

- **Table 6-5 Operation Phase Gas Emissions and Sources**

Emission Source	CO_2 Emissions (t/a)	CH_4 (t/a)	N_2O (t/a)	Total Greenhouse Gas CO_2-e (t/a)
Gas Plant – Compression	65,148	11.2	5.9	67,201
Gas Plant – Power	5,429	0.9	0.5	5,600
Gas Plant – Flare	11,401	93.3	0.4	13,477
Gas Plant – Other	0	0.5	0	10.5
Wellhead Platform	60	0.6	0.0	75
Wellhead Platform - Fugitive emissions	0	1.5	0	31.5
Gas Plant – Fugitive emissions	0	15	0	315
Total	82,038	123.3	7.1	86,710

For the purposes of assessment the emissions from the proposed Blacktip Project are estimated as 90,000 tonnes CO_2-e per annum. It should be noted that during commissioning and the early phase of production the quantity of greenhouse gas released due to flaring will be significantly higher than during normal steady state operations.

6.3.2 Other Combustion Products

In addition to greenhouse gases, combustion of gaseous or liquid fuels results in the discharge of oxides of nitrogen (NO_x) and oxides of sulfur (SO_x). **Table 6-6** shows the emissions of these gases by source during the operation phase.

- **Table 6-6 Additional Combustion Product Emission Sources**

Emission Source	NO_x Emissions (t/a)	SO_x Emissions (t/a)
Gas Plant - Compression	266	0.3
Gas Plant - Power	22	0.02
Gas Plant Flare	15	0.05
Wellhead Platform	3.5	None
Total	306.5	0.37

6.3.3 Other Atmospheric Emissions & Pollutants

Non-Methane Hydrocarbons (NMHCs): These include heavier hydrocarbons such as ethane and propane. A very small volume of NMHCs will be released from the condensate storage tank, due to displacement of vapours when condensate is pumped into the tank or from the tank during diurnal temperature variations and when the condensate is loaded into the export tankers. However, the installation of floating roofs on the onshore condensate tanks will significantly reduce the volume of NMHCs released. NMHCs will also be associated with incomplete combustion. Expected emissions of NMHCs from the Blacktip Project are shown in **Table 6-7** by source.

- **Table 6-7 Non-Methane Hydrocarbon Emission Sources**

Emission Source	NMHCs Emissions t/a
Gas Plant – Compression	1.4
Gas Plant – Power	0.1
Gas Plant – Flare	70
Gas Plant – Other	5
Wellhead Platform	0.1
Tanker Emissions	44
Total	131.6

No additional gaseous emissions are expected to be generated by the project.

Ozone Depleting Substances: Ozone depleting substances (ODSs) have been associated with refrigeration systems, air conditioning, insulation materials, fire fighting agents, passive fire protection, cleaners for electrical equipment, aerosol propellants and other uses. The use of ODSs has been generally phased out over the past fifteen years. ODSs will not be installed in or used in the manufacture or installation of any systems associated with the Blacktip Project. Where alternatives to ODSs are required, the global warming potential of the substitute will be considered, with no or low global warming potential substitutes considered preferable.

Some contracted construction vessels and drilling rigs may still have ODSs on board (such as fire fighting agents or refrigerants), which may be released in an emergency. However, contractor conditions, detailed in **Section 12.6**, will control the use of ODSs by contractors.

6.3.4 Odour

Typically, the two main sources of odour from gas plants are hydrogen sulphide (H_2S) and mercaptans. Plants that supply domestic reticulation are required to add an odourant (mercaptans) to give the natural gas a distinctive and unpleasant odour. This is designed as a safety precaution to prevent any unnoticed build up of gas in the atmosphere.

The Blacktip Gas Plant, an industrial plant, will not add mercaptans but will use more effective gas detection methods that do not rely on smell. Whilst the Blacktip Gas Plant will not add any mercaptans to the gas, small trace elements of mercaptans and hydrogen sulphide may naturally occur in the gas at the following measured concentrations, namely.

- hydrogen sulphide (H_2S)- 3ppm (v)
- mercaptan - <0.5 ppm (v)

It is possible that mercaptans will not be present in the gas as during the well test, levels were found to be below apparatus detection levels.

Preliminary literature reviews (Lenntech 2004; Atia 2004) indicate that for H_2S the lowest detectible odour is 0.0005 ppm (v); recognisable at 0.005 ppm (v); and an offensive odour occurs above 3 ppm (v).

Under normal operating conditions there should be no odour emanating from the plant. However, under upset conditions when there is the potential for gas to escape from the plant preliminary dispersion calculations indicate that for even a fairly substantial leak of 0.1 kg/s, in calm conditions, H_2S levels would be below 0.0005 ppm (v) within 350 m of the source. Beyond 350 m there should not be any odour impact due to H_2S.

Mercaptans are compounds formed from hydrocarbon and sulphur. There are many different types of mercaptan with different odour levels. Based on the conservative assumption that Blacktip gas contains 0.5 ppm (v), then 350 m from the source mercaptan levels would be 0.00008 ppm (v).

If the Blacktip gas contains mercaptans then the most likely species would be ethyl and methyl mercaptan. At 350 m from the source, concentrations would be half the detectable limit and 1/3 the recognition limit.

Based on these very conservative calculations, the conclusion is that odours should not extend beyond the plant boundary.

6.3.5 Dust Emissions

Dust will be generated during the construction phase of the project. Dust may be generated by construction activities such as the clearing of vegetation, movement of vehicles, earthworks, the formation of soil stockpiles and exposed surfaces. Dust emissions have the potential to affect the health of workers, to impact on vegetation and amenity, and to lead to the loss of topsoil.

Dust can potentially present a hazard at the proposed plant and along the pipeline ROW principally due to reduced visibility for vehicle drivers, dust inhalation to the workforce, effects on welding and damage to equipment. Dust is a hazard on access tracks, mainly due to reduced visibility and the risk of floating and skidding on thicker layers of bulldust. This also presents a hazard to the public if the track is not exclusive to the project.

Quantities of dust generated cannot be determined. Impacts and management measures are discussed in **Section 12.6.4** of this report.

6.4 Noise

Noise is expected to be emitted to varying degrees during construction of the plant and pipelines, gas plant operation, routine maintenance and emergency flaring. At this stage of the development it is only possible to predict typical noise levels. A noise assessment was undertaken by Air Noise Environment (ANE) and the complete findings are included in **Appendix A**, **Volume 2** of this EIS. The assessment identified noise levels from distinct phases of the project namely construction, operation and maintenance.

6.4.1 Sensitive Receptors

Two groups of sensitive receptors were identified during the desktop noise assessment. These two groups were recognised as the closest residents to the project location representing those who could potentially be most affected by increased noise levels. These groups are as follows:

- Wadeye township, which has approximately 2,500 residents located 12 km to the east of the plant site.
- Tchindi Aboriginal Camping Ground, which is used by an undefined number of the local community on an ad hoc basis for camping, fishing etc. This camping ground is located approximately 2.5 km to the south west of the plant site, and south of the pipeline landfall location.

6.4.2 Background Noise Levels

Noise monitoring was undertaken to determine the background noise levels in the project area. The monitoring locations were selected to capture locations where the predominant impact would be from noise emissions. Monitoring was undertaken at the gas plant site itself and also at Wadeye township. The gas plant location is representative of the noise levels at the Tchindi Camping Ground, and Wadeye township representative of the noise levels in the community, both identified as sensitive receptors.

At the gas plant there will a considerable amount of noise during construction; a minimum level of noise during general day to day operations; but potentially a large noise from flaring during planned and emergency maintenance. Wadeye township was also deemed a significant monitoring location because of the increased volume of construction related traffic that will potentially pass by the town during the construction phase. However, this potential source of noise is unlikely given the proposal to direct traffic away from the town by constructing a new access road between the airstrip and the project area. During operation, noise from traffic will be minimal.

The results of ambient noise monitoring at both the gas plant site and Wadeye township concluded that the areas are generally quiet and typical of a rural/rural residential community.

In summary the Average L_{A90} (the noise level exceeded 90% of the time) was measured as follows:

- 34 dB(A) during day time at the proposed gas plant site (the maximum average (L_{AMAX}) was 64 dB(A));
- 28–30 dB(A) during evening and night-time at the proposed gas plant site (the maximum average (L_{AMAX}) was 43–47 dB(A));
- 40–43 dB(A) during day time, evening and night-time at Wadeye township (the maximum average (L_{AMAX}) was 67–70 dB(A)).

Table 6-8 gives typical sound pressure levels so that comparisons can be made between background noise levels and predicted noise levels during construction and operation and explains what these levels equate to in real terms.

- **Table 6-8 Typical Sound Pressure Levels for Comparison Purposes**

Sound Pressure Level (dB)	Typical Environment	Average Subjective Description
140	30 m from jet aircraft	Intolerable
130	Pneumatic chipping and riveting (operator's position)	
120	Boiler shop (maximum levels)	
110	Chainsaw	Very noisy
100	Disco	
90	Heavy lorries at 6 m	
80	Kerbside of busy road	Noisy
70	Loud radio	
60	Restaurant	
50	Conversational speech at 1 m	Quiet
40	Residential area at night	
30	Quiet bedroom at night	
20	Background in TV and recording studios	Very quiet
10		
0	Threshold of hearing	

6.4.3 Construction Phase Emissions

Offshore: Construction and installation activities for the offshore components of the project are not possible to model as the exact equipment and vessels that will be used are currently not known. However, a number of studies have been undertaken on noise emissions in the marine environment and these are discussed below.

Naturally occurring noise levels in the ocean as a result of wind and wave activity may range from around 90 dB re 1µPa under very calm, low wind conditions to 110 dB re 1µPa under windy conditions (Woodside 2002b).

During drilling, installation and commissioning there will be noise emissions from the Jack-up (including drilling and flaring), support vessels, installation vessels (including the pipelay barge and trenching plough) and helicopters.

During production noise sources will be limited to irregular helicopter and support vessel trips, infrequent (less than four per year) tanker visits and low level noises associated with platform operations for example noise from electrical generators and gas flow through pipelines.

At the Jack-up, noise will be emitted from the drill pipes and onboard machinery. McCauley (1998) measured the underwater noise emitted from a Jack-up in the Timor Sea and found the broadband noise level to be approximately 146 dB re 1 µPa when not actively drilling and 169 dB re 1 µPa during drilling operations. He also found underwater broadband noise of approximately 182 dB re 1 µPa from a rig support vessel holding station (by strong forward and reverse thrusts from the engines and bow thrusters for short periods of time) which were detected up to 30 km away.

Onshore: Noise modelling considered noise emissions from three distinct components of the construction phase of the project namely shore crossing construction, onshore pipeline construction and gas plant construction. Typical source noise levels are attributed to each of the proposed construction plant to calculate a total sound power level for each of the main activities (for example trenching, rehabilitation) and hence for each main construction component.

A noise model (ENM) was used to assess this information based on a worse case meteorological scenario. The result is a prediction of what the noise levels will be at the nearest sensitive receptors (ie at Wadeye township and the Tchindi Camping Ground).

Generally, the recommended criteria for noise levels during construction at sensitive receptors are 5dB(A) greater than the existing background noise level. These criteria are designed to preserve the acoustic amenity of nearby receptors. The predicted noise levels (L_{A10}) for the main construction components at the sensitive receptors are as follows:

- shore crossing construction - generally 20–29 dB (A);
- onshore pipeline construction - generally 23–36 dB (A);
- onshore gas Plant construction - generally 23–33 dB (A).

Adding 5 dB(A) to the background noise levels detailed in **Section 6.4.2**, the accepted noise levels at the Tchindi Camping Ground for day, evening and night time operations are: 39, 35 and 31 dB(A), respectively; and correspondingly at Wadeye 49, 47 and 43 dB(A). All construction activities carried out during day time (7 am–6 pm) will therefore comply with the recommended criteria for construction activities at surrounding receptors.

Evening (6 pm–10 pm) and night time (10 pm–7 am) work will sometimes not comply. The activities that are predicted to breach the recommended construction criteria include clearing/grading and trench dredging along the pipeline route or at the gas plant. Management measures will be implemented to reduce any impacts from these activities, as discussed in **Section 12**.

Blasting is highly unlikely to be required and is discussed separately in **Section 6.5**.

6.4.4 Operation Phase Emissions

Offshore: During operation the wellhead platform will be unmanned and will have only a minimal amount of equipment generating noise. The noise from the wellhead platform will be much less than noise from the Jack-up during drilling and installation, and is consequently not expected to cause impacts on the marine environment.

Trading tankers visiting the condensate export mooring to load condensate will also generate noise, which will be generated both above and below the water surface. Levels of noise may be similar to the levels generated by rig support vessels, especially if tugboats are used to position the tanker. At the onshore facilities, process equipment, flaring and occasional maintenance visits from helicopters will generate noise that may be heard offshore, but is expected to be slight and should not affect marine fauna.

Onshore: Noise will be generated onshore during the operation phase of the project, with most noise being emitted from the gas plant site itself. Operational equipment (all of which does not necessarily operate on a continuous basis) that may result in noise emissions include:

- power generation equipment;
- process pumps;
- air coolers;
- control valves;
- slugcatchers;
- hp/lp flare tips;
- export compressor;
- relief/blowdown valves;
- condensate loading pumps;
- instrument air compressor;
- standby diesel power generation.

A very small pilot flare will operate continuously during normal operations for safety reasons, which will have negligible noise emissions.

Schedule 2 of the *Draft Waste Management and Pollution Control (Environmental Noise) Regulation* contains recommended criteria for operational noise at sensitive receptors. The maximum noise levels are defined according to the nature of the noise receiving area. The Blacktip Project area is categorised as ‘Area 4’ which is defined as:

> ‘An area of noise-sensitive premises that is within 15 m of a building used for noise sensitive purposes on the premises, where the building is more than 100 m from a road carrying more than 10,000 vehicles per day or a significant business district.’

In accordance with the Environmental Noise Regulation criteria during day time hours (ie from 7 am to 7 pm, Mon to Sat) 65 dB (A) is never to be exceeded at the sensitive receptor; whereas 45 and 55 dB (A) can be exceeded 10% and 1% of the time, respectively. Criteria are also established for Sundays, evenings and night time which are generally more stringent.

During normal operations noise levels at the plant boundary will not exceed 82 dB(A). Based on the modelling assessment undertaken, the noise level is predicted to be 25dB approximately 2.5 km from the plant boundary at the Tchindi Camping Ground. The noise level will be significantly less than this 10 km away at the Wadeye township.

This indicates that expected emission levels during operations are unlikely to be significant due to the buffer distances to potentially sensitive receptors, and will comply with day time criteria and the more stringent evening and night time criteria for receptor locations. Furthermore, internal noise levels, specifically with regard to the on-site accommodation will comply with AS 2107:2000 'Recommended Design Sound Levels and Reverberation Times for Building Interiors'.

6.4.5 Maintenance & Emergency Flaring

Offshore: Maintenance vessels, helicopters and support vessels will generate noise whilst travelling offshore, but to a lesser extent and infrequently, as travel to and from the wellhead platform will only be required for maintenance of the wellhead platform.

Onshore: As described in detail in **Section 4.7.3.2** an emergency flare system will be provided in line with normal design practice. The flare system will be designed to provide a safe means of rapidly disposing of pressurised gas. The flare system will fulfil two major functions:

- depressurisation of process equipment in the event of an emergency (for example fire or gas detection within the plant);
- depressurisation of process equipment prior to maintenance.

The approximate noise levels, which are also dependent on the level of planned maintenance and the emergency situation cannot be confirmed until detailed design progresses but the level will not exceed 115 dB(A) at the plant boundary.

The noise modelling undertaken concluded that the noise levels for maintenance operations are expected to be less than 47 dB(A) at the Tchindi Camping Ground and less than 20 dB(A) at Wadeye which are within the recommended 'Area 4' day time, evening and night time criteria. It is recognised that the noise levels may be audible at the Tchindi Camping Ground which is closer to the proposed gas plant site. Appropriate management measures are included in **Section 12.7**.

6.5 Vibration

Vibrations may be caused by mechanical equipment such as generators, vehicles and earth-moving equipment, likely to operate during the construction phase. The vibrational energy produced from these sources cannot be quantified.

Blasting would only occur in the nearshore area during trenching of the pipeline, although it is unlikely to be required based on recent geotechnical investigations.

If blasting does occur a Blasting Management Plan will be developed, approved by regulatory authorities and implemented. Impacts and management measures are discussed in **Section 12.8**.

6.6 Light

Light will be generated during construction, installation and commissioning by various offshore and onshore vessels and vehicles, as well as from the onshore accommodation camp. During operation, the wellhead platform will have safety and navigation lights, and light will be generated onshore from the gas plant and ancillary systems.

Light spill has the potential to impact on local fauna, in particular the ability of lighting to attract or distract fauna. Furthermore, light spill can also be of nuisance to nearby residents and recreational users.

With the Blacktip gas field being situated approximately 90 km from the nearest coast there are currently no sources of artificial light in the area. The only source of offshore lighting would be the occasional ship passing through the Gulf.

Onshore, the nearest permanent light source to the gas plant would be the Wadeye township which is located 10 km east of the plant site.

6.6.1 Construction Phase

In accordance with safety regulations, lights on the drilling rigs and pipelay barges will be kept alight 24 hours per day. Lights will also be required on the vessels and beach during construction of the shore crossing.

Onshore construction activities will occur 24 hours per day, 7 days per week. Construction will be confined to the dry season when access is available via road and site conditions are preferable. Most of the construction activities will occur at the gas plant site, which is away from the shore. Safety considerations will require that construction site is well lit. The construction site lighting will be designed to minimise light spill and potential impact of local fauna.

6.6.2 Operation and Maintenance

During operation, lighting on the unmanned wellhead platform will be kept to minimum safety and navigation requirements.

Extensive lighting for industrial plants is mandatory for general safety, therefore, the gas plant will be well lit and a potential source of light spill. The light spill generated from the plant will depend upon the actual light source (wavelength and intensity), location/placement of light fittings and the method of switching the lighting.

There will be short periods (15–30 minutes) during commissioning/start up, or in the event of an emergency when the emergency flare will be triggered.

During planned maintenance activities flaring of gas is sometimes required to make equipment safe so that it can be inspected. Flaring in this case would occur quarterly or annually and could last up to 24 hours. During these periods, light intensity produced by the flare will be far greater than that for the pilot light (which is continually lit) and the flare may be visible during the night from the beaches adjacent to the shore crossing.

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