14

# Terrestrial Noise

An assessment of noise and vibration effects for the construction and operational phases of the Project has been conducted and is provided as **Appendix L**. This chapter provides a summary of the key findings.

## 14.1 Existing Environment

### 14.1.1 Noise Sensitive Locations

A review of aerial photographs of the study area has identified six noise sensitive residential receptor groups and a school, which were considered to be potentially affected by noise from the proposed activities at the subject site. As Berrimah Farm has been flagged for residential development, this location has additionally been considered in this assessment. These locations are summarised in Table 14-1.

**Table 14-1 Noise Sensitive Locations**

| Location and Land Use | Approx Distance from EAW | Direction from EAW |
|---|---|---|
| A - Darwin (Government House)[1] | 4 km | WNW |
| B - Darwin (Waterfront Precinct)[1] | 4 km | WNW |
| C - East Darwin, Stuart Park[2] | 5 km | NW |
| D – Bayview[2] | 6 km | NNW |
| E - Kormilda College[3] | 4 km | NNE |
| F - Berrimah Farm[2] | 4 km | NNE |
| G – Palmerston[2] | 6 km | E |

**Notes:** 1. Considered as Urban Receptor
2. Considered as Suburban Receptor
3. School

### 14.1.2 Existing Baseline Noise Monitoring

For the purpose of establishing appropriate noise criteria for the Project, the following documents have been reviewed with regard to baseline noise monitoring which has been previously undertaken in the vicinity of the study area:

- SVT Engineering Consultants, 2009, *ICHTYS Gas Field Development Project, Onshore Airborne Noise Study*, prepared for INPEX Browse Ltd, Perth Western Australia
- SVT Engineering Consultants, 2004, *Darwin Wharf Precinct Redevelopment, Noise Assessment*, prepared for URS Australia Pty Ltd
- GHD Consultants, 2006, *Quarantine Waste Treatment Facility*, Public Environmental Report
- ConocoPhillips, 2006, *Annual Environmental Performance Report, Darwin Liquefied Natural Gas Plant*, Environmental Protection Licence (EPL-LNG01).

Table 14-2 provides a summary of the reported background ($L_{A90}$ - the noise level exceeded for 90% of the measurement period) and ambient ($L_{A10}$ - the noise level exceeded for 10% of the measurement period) noise levels at representative locations to the identified noise sensitive receptors. Table 14-3 provides a summary of the adopted $L_{A90}$ levels for Locations A – G.

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**Table 14-2: Summary of Existing Noise Monitoring Results in Vicinity of EAW**

| Project/ Location | Report Date | $L_{A90}$ dB(A) – Background Level | | | $L_{A10}$ dB(A) – Ambient Level | | |
|---|---|---|---|---|---|---|---|
| | | Day | Evening | Night | Day | Evening | Night |
| Ichthys Gas Field Development EIS / O'Ferrals Road, Bayview [Represents Location D] | 2008 | 32 | 32 | 33 | 45 | 44 | 42 |
| Ichthys Gas Field Development EIS Constance Ct, Palmerston [Represents Location G] | 2008 | 39 | 39 | 32 | 53 | 50 | 44 |
| Darwin LNG / Fairway Waters, Durack / Palmerston [Represents Location G] | 2005 | 40 – 47 | | | n/a | n/a | n/a |
| Darwin LNG / Fairway Waters, Durack / Palmerston [Represents Location G] | 2006 | 42 | n/a | 36 | n/a | n/a | n/a |
| Darwin LNG / Darwin CBD [Represents Locations A / B] | 2005 | 39 – 46 | | | n/a | n/a | n/a |
| Darwin LNG / Darwin CBD [Represents Locations A / B] | 2006 | 47 | n/a | 38 | n/a | n/a | n/a |
| Darwin Wharf Precinct Redevelopment / Darwin CBD (Near waterfront) [Represents Location B] | 2004 | 45 – 51 | | 40 | n/a | n/a | n/a |
| Quarantine Waste Treatment Facility / Government House, Darwin CBD [Represents Location A] | 2006 | 43 | 38 | 42 | n/a | n/a | n/a |
| Quarantine Waste Treatment Facility / Kormilda College [Represents Location E] | 2006 | 45 | 46 | 39 | n/a | n/a | n/a |
| Quarantine Waste Treatment Facility EAW (Before development) | 2006 | 31 | 32 | 31 | n/a | n/a | n/a |

**Table 14-3: Summary of Adopted $L_{A90}$ Levels for Locations A – G**

| Project/ Location | $L_{A90}$ dB(A) | | |
|---|---|---|---|
| | Day | Evening | Night |
| A - Darwin (Government House)[1] | 43 | 38 | 38** |
| B - Darwin (Waterfront Precinct)[2] | 45 | 40* | 40 |
| C - East Darwin, Stuart Park[3] | 32 | 32 | 32* |
| D - Bayview[4] | 32 | 32 | 32** |
| E - Kormilda College[5] | 45 | 45* | 39 |
| F - Berrimah Farm[6] | 45 | 45* | 39 |
| G - Palmerston[7] | 39 | 39 | 32 |

Notes:

1. Based on Quarantine Waste Treatment Facility Noise Assessment Report, 2006;
2. Based on Darwin Wharf Precint Redevelopment Report, 2004 (Evening level not reported, therefore assumed same as night-time level);
3. Based on Ichthys Gas Field Development EIS Report, 2008 (Assumed same as Location D);
4. Based on Ichthys Gas Field Development EIS Report, 2008;
5. Based on Quarantine Waste Treatment Facility Noise Assessment Report, 2006;
6. Based on Quarantine Waste Treatment Facility Noise Assessment Report, 2006 (Assumed same as Location E);
7. Based on ICHTHYS Gas Field Development EIS Report, 2008

* where the evening background noise level has been reported as higher than daytime background noise level, the daytime level (the lower of the two reported levels) has been adopted for the purposes of this assessment;

** where the night-time background noise level has been reported as higher than evening background noise level, the evening level (the lower of the two reported levels) has been adopted for the purposes of this assessment.

## 14.2 Potential Impacts

### 14.2.1 Project Assessment Criteria

Whilst specific noise and vibration guidelines are not available for the NT, URS recommends consideration to the following regulations and guidelines.

#### *NSW Interim Construction Noise Guideline (ICNG)*

Table 14-4 sets out the nominated construction noise management levels, as determined under the NSW ICNG process, based on the background noise levels presented in Table 14-3. It is expected that noise generating construction activities would only occur within recommended standard hours.

#### *NSW Industrial Noise Policy (INP)*

The applicable project-specific noise levels as determined under the NSW INP process are outlined in Table 14-5. As the wharf will continue to operate at any time, the target project-specific noise level is the night-time level. For the purpose of this assessment, the night-time noise level is considered the controlling noise goal because compliance with that target leads to compliance at all other times.

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**Table 14-4: Construction Noise Management Levels**

| Receptors | Nominated Construction Noise Management Levels Within Recommended Standard Hours: 7am – 6pm: Mon – Fri 8am – 1pm: Sat | | Nominated Construction Noise Management Levels Outside Recommended Standard Hours: 6pm – 7am: Mon – Fri 1pm – 12am: Sat All day: Sundays and Public Holidays | |
|---|---|---|---|---|
| | Noise Affected Management Level $L_{Aeq,15min}$ dB(A) | Highly Noise Affected Management Level $L_{Aeq,15min}$ dB(A) | Noise Affected Management Level $L_{Aeq,15min}$ dB(A) | Highly Noise Affected Management Level $L_{Aeq,15min}$ dB(A) |
| A - Darwin (Government House) | 53 | 75 | 43 | n/a |
| B - Darwin (Waterfront Precinct) | 55 | 75 | 45 | n/a |
| C - East Darwin, Stuart Park | 42 | 75 | 37 | n/a |
| D - Bayview | 42 | 75 | 37 | n/a |
| E - Kormilda College | 55 | 75 | 50 | n/a |
| F - Berrimah Farm | 55 | 75 | 50 | n/a |
| G - Palmerston | 49 | 75 | 44 | n/a |

Notes: $L_{Aeq}$ - equivalent noise level - the constant sound pressure level equivalent in sound energy to the varying sounds over the measurement period

**Table 14-5: Project-Specific Noise Levels**

| Receptors | $L_{Aeq,15min}$ dB(A) | | |
|---|---|---|---|
| | Day | Evening | Night |
| A – Darwin (Government House) | 48 | 43 | 43 |
| B – Darwin (Waterfront Precinct) | 50 | 45 | 45 |
| C – East Darwin, Stuart Park | 37 | 37 | 37 |
| D – Bayview | 37 | 37 | 37 |
| E – Kormilda College | 50 | 50 | 44 |
| F – Berrimah Farm | 50 | 45 | 40 |
| G – Palmerston | 44 | 44 | 37 |

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### *Sleep Disturbance Criteria – WHO Guidelines*

In the event that instantaneous, short-duration, high-level noise events occur during night-time hours (10pm – 7am), consideration should be given to the potential for the disturbance of sleep within residences.

Since EAW also operates during night-time period, an assessment of sleep disturbance for the potentially affected residential locations has also been considered in this study.

The INP does not specifically address sleep disturbance from high noise level events. Reference can be made to the WHO (World Health Organisation) *Guidelines for Community Noise* (1999). The guideline recommends that the noise levels outside bedroom windows and inside bedrooms should be limited to $L_{Amax}$ 60 dB(A) and $L_{Amax}$ 45 dB(A), respectively. These limits have been determined taking into consideration the allowed maximum noise levels inside bedrooms to prevent sleep disturbance caused by noise impacts during night-time hours (10pm – 7am).

The 60 dB(A) limit is assessed outdoors at the most exposed side of residential premises. Sleep disturbance thresholds are also determined by factors including noise character and pitch, perceived personal danger, degree of habituation, age, illness or fatigue and the point in time when the noise occurs during the sleep period. For example, noisy events are generally less disturbing to people if confined to the earlier period of the evening when it is still possible to retrieve deep sleep.

### *Off-Site Traffic Noise Criteria*

Criteria for off site road traffic noise are specified in the NSW *Environmental Criteria for Road Traffic Noise* (ECRTN). The criteria applicable are summarised in Table 14-6. The site falls under the ECRTN category of 'Land use developments with potential to create additional traffic on existing freeways/arterials'.

Regular vehicle movement to access the wharf is considered as an industrial noise source and is assessed in accordance with the INP.

**Table 14-6: Environmental Criteria for Road Traffic Noise**

| Type of Development | Day $L_{Aeq,15hr}$ dB(A) | Night $L_{Aeq,9hr}$ dB(A) | Where criteria are already exceeded |
|---|---|---|---|
| Land use developments with potential to create additional traffic on existing freeways/arterials | 60 | 55 | Where feasible, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating time of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments.<br>In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB. |
| Notes: Day: 7am – 10pm / Night: 10pm – 7am | | | |

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## *Rail Noise Criteria*

Operational rail noise has been assessed against the airborne rail traffic noise trigger levels set out in the NSW *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects (NSW IGANRIP)*; these guideline levels are presented in Table 14-7.

**Table 14-7: Environmental Criteria for Rail Noise**

| Receptors | Day $L_{Aeq, 15hr}$ dB(A) | Night $L_{Aeq, 9hr}$ dB(A) | $L_{Amax}$ dB(A) | $L_{Aeq, 1hr}$ dB(A) |
|---|---|---|---|---|
| Residences | 65 | 60 | 85 | n/a |
| Schools and Educational Institutions (Internal) | n/a | n/a | n/a | 45 |
| Notes: Day: 7am – 10pm / Night: 10pm – 7am | | | | |

## *Vibration Criteria*

In the absence of specific NT guidelines addressing vibration issues, consideration was given to the following publications:

- NSW *Assessing Vibration: A Technical Guideline* (NSW DECC, 2006)
- British Standard BS6472:1992 *Guide to Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80 Hz)*
- British Standard BS7385-2:1993 *Evaluation and Measurement for Vibration in Buildings, Part 2 - Guide to Damage Levels from Ground Borne Vibration.*

The above standards are typically adopted by industry in Australia for the assessment of construction and operational vibration impacts.

## *Effect of Vibration on Structures*

Transient and continuous vibration guidelines to ensure a minimal risk of cosmetic damage to residential and other acoustically sensitive buildings are presented in Table 14-8. These guide values are conservative, as the actual degree of tolerance of a building depends on the structural characteristics and frequency spectrum of the vibration. In the case of continuous vibration, BS7385-2:1993 recommends that targets outlined below be reduced to 50 %.

**Table 14-8: Vibration Guidelines for Cosmetic Damage**

| Vibration Type | Peak Particle Velocity | | |
|---|---|---|---|
| | Reinforced or framed structures Industrial and heavy commercial buildings | Unreinforced or light framed structures Residential or light commercial type buildings | |
| Transient Vibration | 50 mm/s at 4 Hz and Above | 15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz | 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above |
| Continuous Vibration | 25 mm/s at 4 Hz and Above | 7.5 mm/s at 4 Hz increasing to 10 mm/s at 15 Hz | 10 mm/s at 15 Hz increasing to 25 mm/s at 40 Hz and above |
| Source: BS7385 – 2:1993 Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to damage levels from groundbourne vibration | | | |

### *Human Comfort*

Acceptable values of human exposure to continuous and impulsive vibration are dependent on the time of day and the activity taking place in the occupied space.

When assessing intermittent vibration, the Vibration Dose Value (VDV) is used as a reference. Due to the nature of the works proposed, intermittent vibration dose criteria have been considered for the purposes of this assessment. The VDV accumulates the vibration energy received over the daytime and night-time periods.

Acceptable VDVs, as sourced from BS 6472:1992 and outlined in NSW *Assessing Vibration: A Technical Guideline*, are presented in Table 14-9.

**Table 14-9: Acceptable Vibration Dose Values for Intermittent Vibration (m/s1.75)**

| Location | Daytime* | | Night-time* | |
|---|---|---|---|---|
| | Preferred Value | Maximum Value | Preferred Value | Maximum Value |
| Critical areas** | 0.10 | 0.20 | 0.10 | 0.20 |
| Residences | 0.20 | 0.40 | 0.13 | 0.26 |
| Offices, schools, educational institutions and places of worship | 0.40 | 0.80 | 0.40 | 0.80 |
| Workshops | 0.80 | 1.60 | 0.80 | 1.60 |
| Notes: * Daytime is 7am to 10pm and Night-time is 10pm to 7am; ** Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These goals are only indicative, and there may be need to assess intermittent values against the continuous or impulsive goals for critical areas | | | | |

When assessing continuous vibration, weighted root-mean-squared (RMS) acceleration in the 1-80 Hz range is used as a reference. Acceptable weighted RMS acceleration levels, as sourced from BS 6472:1992 and outlined in the Technical Guideline, is presented in Table 14-10. The VDV accumulates the vibration energy received over the daytime and night-time periods.

**Table 14-10: Preferred and Maximum Weighted RMS Values for Continuous Vibration Acceleration**

| Location | Assessment Period | Preferred Values | | Maximum Values | |
|---|---|---|---|---|---|
| | | z-axis | x- and y -axis | z-axis | x- and y -axis |
| Critical areas** | Day or night-time* | 0.005 | 0.0036 | 0.010 | 0.0072 |
| Residences | Daytime* | 0.010 | 0.0071 | 0.020 | 0.014 |
| Residences | Night-time* | 0.007 | 0.005 | 0.014 | 0.010 |
| Offices, schools, educational institutions and places of worship | Day or night-time* | 0.020 | 0.014 | 0.040 | 0.010 |
| Workshops | Day or night-time* | 0.040 | 0.029 | 0.080 | 0.058 |
| Notes: | * Daytime is 7am to 10pm and Night-time is 10pm to 7am<br>** Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These goals are only indicative, and there may be need to assess intermittent values against the continuous or impulsive goals for critical areas | | | | |

### 14.2.2 Noise Modelling Methodology

Noise levels during construction of the EAW expansion and operation of the expanded wharf have been predicted using an acoustic computer model created in SoundPLAN Version 7.0. This program is used and recognised in Australia and internationally. This program is also considered by the NSW INP as a preferred computer noise model (Section 6.2 – Noise Prediction).

The noise model was constructed to quantify the noise emission levels of the current EAW operation and to predict cumulative noise levels from the expansion by calculating the contribution of each noise source. The noise model took into account:

- sound power levels of each source
- noise sensitive locations
- screening effects due to topography
- meteorological effects and attenuation due to distance, and
- ground and atmospheric absorption.

### 14.2.3 Construction Phase Noise

During the construction phase elevated noise levels can be expected at locations close to the works areas, but given the setback distances to the closest receptors, noise nuisance or annoyance would be expected to be limited.

The assumed working hours of the construction workforce for each component of construction are 7am to 6pm, potentially up to seven days a week. It is assumed that only minor activities, such as vehicle refuelling and maintenance, will occur outside of these designated work hours.

For the purposes of this assessment, noise impacts have been calculated based on assumed equipment schedules (details provided in **Appendix K**). Sound power levels in octave frequency bands for these sources have been obtained from the British Standard BS5228. Each of the identified items of equipment for each stage has conservatively been assumed to operate continually and simultaneously.

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The Stage 1 construction phase is predicted to generate the highest noise levels. This construction stage has been modelled with both the exclusion and inclusion of the piling activity. Modelling results for these conditions are respectively presented in Table 14-11 and Table 14-2.

As presented in Table 14-11, modelling results indicate that the conservatively assumed construction activities excluding piling would comply with the nominated daytime, evening and night-time construction noise limits at all identified sensitive receptor locations.

It is noted, as presented in Table 14-2, that piling has potential to exceed the nominated evening and night-time noise limit at Receptors A – D, particularly under adverse meteorological conditions. It would not be expected, however, that piling would occur outside of recommended hours (7am – 6pm, Monday – Friday and 8am – 1pm, Saturday).

**Table 14-11: Stage 1 (Worst Case) Construction Noise Modelling Results (Excluding Piling)**

| Receptor Location | Predicted Noise Levels ($L_{Aeq}$) dB(A) | | | | | | | | Construction Noise Management Levels $L_{Aeq,15min}$ dB(A) | | | Exceedance | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Neutral Met Modelling Scenarios | | | | Adverse Met Modelling Scenarios | | | | D | E | N | D | E | N |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | | | | |
| A | 29 | 30 | 29 | 30 | 35 | 36 | 35 | 36 | 53 | 43 | 43 | No | No | No |
| B | 32 | 33 | 32 | 33 | 37 | 38 | 37 | 39 | 55 | 45 | 45 | No | No | No |
| C | 27 | 28 | 27 | 28 | 31 | 33 | 31 | 33 | 42 | 37 | 37 | No | No | No |
| D | 24 | 25 | 24 | 25 | 29 | 30 | 29 | 30 | 42 | 37 | 37 | No | No | No |
| E | 21 | 22 | 21 | 22 | 26 | 27 | 26 | 27 | 35 (Internal) | | | No | No | No |
| F | 23 | 24 | 23 | 24 | 27 | 29 | 27 | 29 | 55 | 50 | 50 | No | No | No |
| G | 22 | 23 | 22 | 23 | 26 | 28 | 26 | 28 | 49 | 44 | 44 | No | No | No |

Notes:
Scenario 1: Daytime, dry season, neutral meteorological conditions, temperature 33°C, relative humidity 20%
Scenario 2: Night-time, dry season, neutral meteorological conditions, temperature 22°C, relative humidity 20%
Scenario 3: Daytime, wet season, neutral meteorological conditions, temperature 33°C, relative humidity 80%
Scenario 4: Night-time, wet season, neutral meteorological conditions, temperature 22°C, relative humidity 80%
Scenario 5: Daytime, dry season, adverse meteorological conditions, temperature 33°C, relative humidity 20%
Scenario 6: Night-time, dry season, adverse meteorological conditions, temperature 22°C, relative humidity 20%
Scenario 7: Daytime, wet season, adverse meteorological conditions, temperature 33°C, relative humidity 80%
Scenario 8: Night-time, wet season, adverse meteorological conditions, temperature 22°C, relative humidity 80%

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**Table 14-12: Stage 1 (Worst Case) Construction Noise Modelling Results (Including Piling)**

| Receptor Location | Predicted Noise Levels ($L_{Aeq}$) dB(A) | | | | | | | | Construction Noise Management Levels $L_{Aeq,15min}$ dB(A) | | | Exceedance | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Neutral Met Modelling Scenarios | | | | Adverse Met Modelling Scenarios | | | | D | E | N | D | E | N |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | | | | |
| A | 42 | **44** | 42 | **44** | **47** | **51** | **47** | **51** | 53 | 43 | 43 | No | **Yes** | **Yes** |
| B | 44 | **46** | 44 | **46** | **49** | **52** | **49** | **53** | 55 | 45 | 45 | No | **Yes** | **Yes** |
| C | 36 | **39** | 36 | **39** | **41** | **45** | **41** | **45** | 42 | 37 | 37 | No | **Yes** | **Yes** |
| D | 35 | 37 | 35 | 37 | **39** | **43** | **39** | **43** | 42 | 37 | 37 | No | **Yes** | **Yes** |
| E | 29 | 31 | 29 | 31 | 32 | 37 | 32 | 37 | 35 (Internal) | | | No | No | No |
| F | 30 | 32 | 30 | 32 | 33 | 38 | 33 | 38 | 55 | 50 | 50 | No | No | No |
| G | 29 | 32 | 29 | 32 | 33 | 37 | 33 | 38 | 49 | 44 | 44 | No | No | No |

Notes: Results in bold represent the exceedance of the respective noise limit.
Scenario 1: Daytime, dry season, neutral meteorological conditions, temperature 33°C, relative humidity 20%
Scenario 2: Night-time, dry season, neutral meteorological conditions, temperature 22°C, relative humidity 20%
Scenario 3: Daytime, wet season, neutral meteorological conditions, temperature 33°C, relative humidity 80%
Scenario 4: Night-time, wet season, neutral meteorological conditions, temperature 22°C, relative humidity 80%
Scenario 5: Daytime, dry season, adverse meteorological conditions, temperature 33°C, relative humidity 20%
Scenario 6: Night-time, dry season, adverse meteorological conditions, temperature 22°C, relative humidity 20%
Scenario 7: Daytime, wet season, adverse meteorological conditions, temperature 33°C, relative humidity 80%
Scenario 8: Night-time, wet season, adverse meteorological conditions, temperature 22°C, relative humidity 80%

### 14.2.4 Operational Phase Noise

For the purposes of assessment, all plant was conservatively assumed to operate 24 hours per day, seven days a week. Minor equipment and on-site light vehicles were not considered in the assessment as they would have no material influence on the predicted noise levels.

A summary of the noise modelling results is presented in Table 14-13. The modelling results indicate that the operation of the expanded EAW would comply with the nominated project-specific noise levels at all identified sensitive receptor locations.

Predicted noise contours for operations, under adverse meteorological conditions are provided in **Appendix L.**

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**Table 14-13: Operational Noise Modelling Results**

| Receptor Location | Predicted Noise Levels ($L_{Aeq}$) dB(A) | | | | | | | | Project-Specific Noise Levels (PSNL) $L_{Aeq,15min}$ dB(A) | | | Exceedance | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Neutral Met Modelling Scenarios | | | | Adverse Met Modelling Scenarios | | | | D | E | N | D | E | N |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | | | | |
| A | 31 | 32 | 31 | 33 | 37 | 38 | 37 | 38 | 48 | 43 | 43 | No | No | No |
| B | 34 | 35 | 34 | 35 | 39 | 40 | 39 | 41 | 50 | 45 | 45 | No | No | No |
| C | 27 | 29 | 27 | 29 | 32 | 34 | 32 | 34 | 37 | 37 | 37 | No | No | No |
| D | 26 | 27 | 26 | 27 | 31 | 32 | 31 | 32 | 37 | 37 | 37 | No | No | No |
| E | 21 | 22 | 21 | 23 | 26 | 28 | 26 | 28 | 35 (internal) | | | No | No | No |
| F | 23 | 24 | 23 | 24 | 28 | 29 | 28 | 30 | 50 | 45 | 40 | No | No | No |
| G | 20 | 22 | 20 | 22 | 26 | 27 | 26 | 28 | 44 | 44 | 37 | No | No | No |

Notes:
Scenario 1: Daytime, dry season, neutral meteorological conditions, temperature 33°C, relative humidity 20%
Scenario 2: Night-time, dry season, neutral meteorological conditions, temperature 22°C, relative humidity 20%
Scenario 3: Daytime, wet season, neutral meteorological conditions, temperature 33°C, relative humidity 80%
Scenario 4: Night-time, wet season, neutral meteorological conditions, temperature 22°C, relative humidity 80%
Scenario 5: Daytime, dry season, adverse meteorological conditions, temperature 33°C, relative humidity 20%
Scenario 6: Night-time, dry season, adverse meteorological conditions, temperature 22°C, relative humidity 20%
Scenario 7: Daytime, wet season, adverse meteorological conditions, temperature 33°C, relative humidity 80%
Scenario 8: Night-time, wet season, adverse meteorological conditions, temperature 22°C, relative humidity 80%

### 14.2.5 Sleep Disturbance

Provided that piling does not occur during the night-time period, it is predicted that all construction works can be carried out without giving rise to sleep disturbance at any of the identified residential receptor locations, with predicted construction noise levels significantly below the 60 dB(A) $L_{Amax}$ WHO guideline sleep disturbance criterion.

EAW operations are predicted to comply with the WHO criterion and not give rise to sleep disturbance at the identified locations.

### 14.2.6 Off-Site Traffic Noise

A qualitative off-site road traffic assessment has been undertaken based on information gathered from the *Territory 2030 Strategic Plan (*NTG, 2009), the Ichthys Gas Field Development Traffic Impact Assessment (INPEX 2010) and the Quarantine Waste Treatment Facility Environmental Report (GHD Consultants. 2006).

Berrimah Road will be the route to be used by all trucks and other vehicle movements associated with the EAW operations and construction. The Traffic Impact Assessment undertaken for Ichthys Gas Field Development (INPEX 2010) provides AADT (Annual Average Daily Traffic) figures for two demarked sections of the road as detailed in Table 14-14.

**Table 14-14: 2007 AADTs on Berrimah Road (Ichthys Gas Field Development Traffic Impact Assessment)**

| Berrimah Road Section | 2007 AADT | % Commercial Vehicles | Speed Limit |
|---|---|---|---|
| Tiger Brennan Drive to Wishart Road Section | Approximately 8000 to 10000 | 28% commercial vehicles | 80 km/h |
| Wishart Road to EAW Entry Gate Section | approximately 4000 | | 60 km/h |

The 2030 Masterplan provides forecasted import and export tonnage figures at EAW for various sectors (general cargo import/export, live stock export, bulk liquids, rig tender supplies, motor vehicles import). URS has carried out a qualitative estimation of the growth in number of trucks based on these figures, and would expect a growth in the region of 150 % to 200 % by 2020. Whilst a 200 % growth in the number of trucks associated with the activities at EAW represents a substantial increase, the actual vehicle numbers are very low (estimated to be less than 200) when compared with the existing volume of traffic along Berrimah Road.

With consideration to future traffic growth, traffic volumes from operation and development of EAW would be expected to be less than 5% of the total traffic already present along Berrimah Road, and therefore would have a negligible influence on existing road traffic noise levels.

### 14.2.7 Rail Noise and Vibration

With respect to the identified residential receptor groups, a review of recent aerial photographs indicates that most receptors are located more than 100 m from the rail corridor. The Rural Residential zoned area, which is yet to be fully developed at the western end of Stockwhip Drive (in the Palmerston receptor group) would be expected to be the worst potentially affected by rail noise and vibration, should any such effect arise.

Aerial photographs indicate that currently only two dwellings exist within this area, located on the eastern side of Birdie Road, respectively at some 30 m and 70 m from the existing railway line. There also appears to be scope for future dwellings to be located within similar distances from the rail corridor on the northern side of Stockwhip Drive.

It is understood that there are currently about 40 train movements per week (20 northbound and 20 southbound) servicing the EAW terminal. Out of these 20 each way movements, 17 carry bulk minerals for export via EAW.

The Nordic Rail Traffic Noise Prediction Method (Kilde 1984) has been used to estimate the level of noise at the closest receptors assuming 8 trains, each 1 km long, travelling at 80 km spread out evenly over a 24-hour period.

At the closest receptors, the noise levels set out in Table 14-15 are predicted.

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**Table 14-15: Predicted Rail Noise Levels**

| | Day $L_{Aeq, 15hr}$ dB(A) | Night $L_{Aeq, 9hr}$ dB(A) | $L_{Amax}$ dB(A) |
|---|---|---|---|
| Rail Noise Level Criteria (IGANRIP, NSW DECCW, 2007) | 65 | 60 | 85 |
| Predicted Rail Noise Levels | Up to 62 | Up to 60 | Up to 82 |
| Notes: Day: 7am – 10pm / Night: 10pm – 7am | | | |

The predicted levels in Table 14-15 demonstrate compliance with the nominated rail noise criteria.

At the time of preparing this assessment, predicted rail volumes due to the wharf expansion were not available. It is noted that future rail traffic is dependent primarily on mining development on the NT and also SA, which in turn is contingent on many factors. Based on the predicted noise levels and the assumptions made in determining these, it is considered that compliance with the nominated limits would likely be maintained, provided that night-time train movements do not increase.

Given the proximity of the closest of the identified receptors to the rail alignment, there is potential for vibration effects on these receptors due to existing train movements. It is noted, however, that the vibration levels received and extent of impacts that may occur, if any, will be dependent on a number of factors including axial loading, condition and maintenance of the tracks and local ground conditions. It is considered unlikely that the increase in train movements associated with the EAW expansion would materially increase any vibration impacts beyond existing levels.

Measures to mitigate any vibration impacts, if necessary, include track maintenance, inclusion of resilient elements beneath the rails in local areas; and/or operational controls such as limiting night-time movements and restricting speed local to residential areas.

Through a combination of these measures, it is expected that rail movements associated with EAW would comply with the vibration criteria set out in Section 14.2.1.

### 14.2.8 Construction Phase Vibration

Given the setback distances from the proposed construction areas, no construction vibration impacts are predicted at sensitive receptor locations. The predicted ground vibration levels would be acceptable at all identified receptor locations in relation to both human disturbance and structural damage impacts.

### 14.2.9 Operational Phase Vibration

The operational noise sources would not be expected to give rise to vibration impacts, with predicted ground vibration levels at all identified receptor locations considered to be acceptable in relation to both human disturbance and structural damage impacts.

### 14.2.10 Summary of Potential Noise and Vibration Impacts

The following provides a summary of the outcomes of the assessment of potential noise impacts:

- **Operation:** Noise levels generated by the proposed operation are predicted to be within the established noise objectives at all sensitive receptor locations under all meteorological conditions.
- **Construction Noise:** Noise levels generated by general construction activities are predicted to be within the established management noise levels at all sensitive receptor locations under all meteorological conditions. Piling has the potential to cause exceedances of the night-time management noise level under adverse meteorological conditions at the closest receptors. This construction activity will be confined to the daytime period (0700 – 1800), and therefore, compliance with the nominated construction noise limits is predicted.
- **Sleep Disturbance:** Predicted noise levels are expected to be within the sleep disturbance noise limit for all receptors.
- **Vibration:** Given the setback distances to receptors from the wharf, no construction or operational vibration impacts are predicted. The predicted ground vibration levels would be acceptable at all identified receptor locations in relation to both human disturbance and structural damage impacts.
- **Off-Site Traffic Noise:** Whilst a substantial growth in traffic volume is predicted due to the EAW expansion, when compared with the existing volume of traffic along Berrimah Road, the actual vehicle numbers are relatively low. With consideration to future traffic growth, traffic volumes from operation and development of EAW would be expected to have a negligible influence on road traffic noise levels on the surrounding arterial network.
- **Rail Noise:** At the time of preparing this DEIS, predicted rail volumes due to the wharf expansion were not available. Rail noise levels at the closest residential receptor locations have been predicted based on existing rail volumes. Based on the predicted levels and the assumptions made in determining these, it is considered that compliance with the nominated limits would likely be maintained provided that night-time train movements do not increase. As noted above, future rail traffic is dependent primarily on mining development on the NT and also SA, which in turn is contingent on many factors; more detailed information is required in order to undertake a more robust rail noise study.
- **Rail Vibration:** Given the proximity of the closest of the identified receptors to the rail alignment there is potential for vibration effects on these receptors due to existing train movements. It is noted, however, that the vibration levels received and extent of impacts that may occur, if any, will be dependent on a number of factors. It is considered unlikely that the increase in train movements associated with the EAW expansion would materially increase any vibration impacts beyond existing levels. It is noted that future rail traffic is dependent primarily on mining development on the NT and also SA, which in turn is contingent on many factors; more detailed information is required in order to undertake a more robust rail vibration study.

## 14.3 Management of Impacts

The management of terrestrial noise and vibration impacts will be contained within the:

- CEMP to be developed for the construction phase of the project; and
- EAW EMP, which will be updated after the conclusion of the EIS process, for the ongoing operation of the expanded EAW facility.

## 14.4 Objectives and Standards

The objectives for terrestrial noise and vibration management are to prevent adverse noise and vibration impacts on the community during the construction and operational phases of the Project.

Whilst specific noise and vibration guidelines are not available for the NT, URS recommends consideration to the following regulations and guidelines:

- NSW *Interim Construction Noise Guideline* (ICNG, NSW DECC, 2009)
- NSW *Assessing Vibration – A Technical Guideline* (NSW DEC, 2006)
- NSW *Industrial Noise Policy* (INP, NSW EPA 2000) with consideration of the Industrial Noise Policy Application Notes (NSW DEC, 2006)
- The World Health Organization – *Guideline for Community Noise* (1999)
- NSW *Environmental Criteria for Road Traffic Noise* (ECRTN, NSW EPA 1999)
- NSW *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects*; (IGANRIP, NSW DECCW, 2007).

## 14.5 Management Requirements

The terrestrial noise and vibration management requirements for the construction phase of the project would be incorporated within plans and procedures included within the CEMP. The potential key management controls for construction include:

- Where practicable carrying out all construction works using noisiest equipment or plant items within the day-time period. Piling should not be carried out after 6pm. (Note: It is not planned that pile driving would be undertaken at night. However, night-time pile driving could be required in event of program delays or other factors out of control of the contractor.)
- Scheduling construction to minimise multiple use of the noisiest equipment or plant items where practicable.
- Strategic positioning of plant items and maintenance work areas to reduce the noise emission to noise sensitive receptors, where possible.
- Ensuring machinery engine covers are closed, equipment is well maintained and silencers/mufflers are used.
- On-going maintenance for major items of construction equipment that are significant contributors to construction noise levels.
- Awareness training for staff and contractors in environmental noise issues including:
  - minimising the use of horn signals, and maintaining these signals to a low volume. Consider alternative methods of communication;
  - avoiding any unnecessary noise when carrying out manual operations and when operating plant; and
  - switching off any equipment not in use for extended periods.
- Restricting the entry and departure of heavy vehicles to and from site to the nominated construction hours.
- Community consultation with local residents and building owners to assist in the alleviation of community concerns.
- Maintaining a suitable complaints register. Should noise complaints be received, undertake noise monitoring at the locations concerned, and implement reasonable and feasible measures to reduce noise impacts. Advise complainants of the outcome of any complaints investigation.

Operational management is currently covered by the EAW EMP (Coffey, 2010). This document does not currently include any operational noise management principles.

The following key management controls for operational noise will be implemented:

- The proponent will maintain all plant and equipment in good working order to ensure compliance with the noise criteria.
- The proponent will site and design noise generating plant to comply with the applicable noise criteria at all nearby residential receptor locations.
- The proponent will develop a noise monitoring program, making results of this monitoring available to the relevant authority upon request.
- In the event of any exceedance of the established noise criteria, the proponent will take immediate action to investigate and remedy the situation.
- The proponent will develop a complaints handling protocol to respond to any complaints in relation to noise and/or vibration and investigate these, where necessary, and advise complainants of the outcome of any complaints investigation.
- The proponent will monitor any adverse impact from site going vehicles movements on the public road network through on-going consultation with neighbouring residents. In the event of off-site vehicle noise adversely impacting neighbouring residents, opportunities to reduce the impact through management controls will be investigated.

## 14.6 Monitoring and Reporting

Periodic noise monitoring throughout the construction phase of the project would be incorporated and undertaken as part of the CEMP.

Short term attended noise monitoring will be undertaken as outlined below at the following location:

- Receptor B (Darwin - Waterfront Precinct) or representative location;

Additionally, the following location (or representative locations) will be considered for periodic noise monitoring:

- Receptor A - Darwin (Government House);
- Receptor C - East Darwin, Stuart Park;
- Receptor D – Bayview;
- Receptor E - Kormilda College;
- Receptor F - Berrimah Farm; and
- Receptor G – Palmerston.

All noise monitoring will be carried out in accordance with the requirements of the *Environmental Protection Act 1994*, the *Environmental Protection (Noise) Policy 2008*, *Environmental Protection Regulation 2008*, NSW Industrial Noise Policy (EPA 2000) and AS1055:1997 *Acoustics – Description and Measurement of Environmental Noise*. All noise monitoring instruments will comply with AS IEC 61672.1 – 2004 *Electroacoustics – Sound level meters – Specifications*. All instruments will have valid and current calibration certificates traceable to a NATA certified laboratory.

The instrument(s) will be set to statistically process and store measured $L_{Aeq}$, $L_{A10}$, $L_{A50}$, $L_{A90}$, $L_{A1}$ and $L_{Amax}$ noise levels over 15 minute measurement intervals with the measuring microphone(s) set at 1.2 – 1.5 m above ground level. Calibration of the systems will be regularly verified.

Attended noise measurements will be conducted quarterly during active construction hours, if applicable, during day, evening and night-time periods over a 48-hour period. Additionally, attended noise monitoring will be carried out promptly at other sensitive receptor location(s) in response to any substantiated complaint(s).

In the event of a community member registering a complaint regarding excessive noise levels, a two-phase response regime will be implemented:

- First complaint: EAW personnel will visit complainant's property to carry out subjective evaluation of the noise and undertake a preliminary noise monitoring assessment, in order to determine if an exceedance of the construction noise criteria had occurred.
- Second complaint: Site Response - An acoustic professional will visit the area where the complaint was registered for a 48-hour period to undertake a robust noise monitoring assessment to appropriately assess any impacts.

## 14.7 Commitments

- *The CEMP to be developed prior to construction would include a Construction Noise Environmental Management Plan (CNEMP).*
- *Noise monitoring will be carried out in accordance with the requirements of the NSW Industrial Noise Policy (EPA 2000) and AS1055:1997 Acoustics – Description and Measurement of Environmental Noise.*
- *The project will implement corrective action resulting from complaints investigations as required.*
- *The project will investigate all substantiated noise and vibration related complaints.*

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