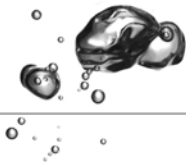


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12. Noise and Vibration

12.1 Introduction

This chapter provides an assessment of the potential noise and vibration impacts of the proposed Emu Swamp Dam Project. There are two options for the Project: an Urban Water Supply Dam (5,000 ML) and a Combined Urban and Irrigation Dam (10,500 ML).

The noise and vibration impacts assessment includes:

- describing of the existing environment of the Project area based on baseline noise monitoring results;
- establishing construction and operational noise guidelines for the Project using relevant legislation and EPA noise policies and guidelines;
- noise propagation modelling to predict the potential noise impacts at nearest sensitive receivers during construction of the dam;
- qualitative assessment of operational noise impacts of the project;
- blasting noise impact assessment; and
- mitigation measures.

12.2 Existing Environment

This section identifies nearest sensitive receivers and describes the existing noise and vibration environment for the Project.

12.2.1 Sensitive Receivers

The potential noise and vibration sensitive receivers for the Project include:

- rural residential dwellings located near the proposed dam wall site;
- residential dwellings located adjacent to the proposed urban pipeline and pumping stations; and
- residential dwellings located adjacent to the proposed irrigation pipeline and pumping stations;

The nearest noise sensitive receivers were identified from aerial photography and site visits to the project area.

The proposed construction works area are presented in **Figure 3-6**. The nearest sensitive receiver to the dam wall construction site is located approximately 100 m from the construction works area. Another seven residences are located within a distance of 1 km from the construction site and works area. The location of nearest sensitive receivers to the construction area is presented in **Figure 12-1**.

The distance between the proposed pipelines and the noise sensitive receivers in most areas is relatively large (>500 m) except in two small pockets of areas where the distance between the noise sensitive receivers and the proposed pipelines is approximately 30m.

There are 4 potential locations for pump stations as shown in **Figure 3-5**. These 4 locations are listed below and the approximate distance to the nearest sensitive receiver:

- near dam wall (900 m);
- on Old Caves Road (near the New England Hwy intersection) (approximately 200 m);
- on Church Road (near the Ellwood Road intersection) (approximately 200 m); and
- on Cannon Creek Road (near the Barkers Lane intersection) (200 m).

12.2.2 Existing Noise Levels

The noise environment was measured at sensitive receivers near both the proposed construction area and at the location of the proposed pumping stations for the Irrigation Pipeline. The sites were selected as being representative of the receiving environment that may be influenced by the construction of Emu Swamp Dam, Stalling Lane Access, the Urban Pipeline and the Irrigation Pipeline.

Attended and unattended background noise monitoring was undertaken in accordance with the *Noise Measurement Manual* (EPA 2000).

When measuring noise levels the use of statistical descriptors is necessary to understand and describe how variations in the noise environment occur over any given period. A list of common descriptors used in the noise assessment as well as their meaning is given below

- L_{A10} – For a specified time interval, means the A-weighted sound pressure level that is equalled or exceeded for 10% of the interval
- L_{A90} – For a specified time interval, means the A-weighted sound pressure level that is equalled or exceeded for 90% of the interval
- L_{Aeq} – For a specified time interval, means the time average A-weighted sound pressure level for the interval
- L_{Amax} – For a specified time interval, means the highest momentary sound pressure level from a single noise event

12.2.2.1 Project Construction Area

Unattended monitoring was undertaken at three locations near the proposed dam construction area. These locations are presented in **Figure 12-1**. Unattended noise monitoring was undertaken from 3rd to 10th August 2007. The noise loggers used for the unattended noise monitoring surveys were Acoustic Research Laboratories Model EL315 and Brüel & Kjær Type 2238 Logging Sound Level Meters. The unattended noise monitoring was performed over a 15 minute intervals, continuously over a period of 1 week at each measurement location. The calibration of the noise loggers was checked before and after the monitoring period and the drift was less than 0.5 dB(A).

Weather conditions during the monitoring periods were fine with light winds and mostly clear skies. The main noise sources during the monitoring period were birds, insects and rustling leaves. Based on experience of monitoring in similar environments in similar environments, noise levels during summer may be louder due to insect noise.

The unattended noise monitoring results are summarised in **Table 12-1**. The noise monitoring results are presently graphically in **Appendix F**.

■ **Table 12-1 Summary of Unattended Noise Monitoring Results**

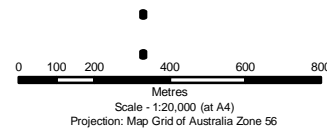
Address	Time	L_{Aeq} Average dB(A)	L_{A10} Average dB(A)	L_{A90} Average dB(A)	L_{A90} 10 th Percentile dB(A)
376 Fletcher Rd	Day	42	43	34	29
	Evening	32	34	28	27
	Night	30	30	27	26
147 Emu Swamp Rd	Day	41	42	31	25
	Evening	27	30	23	22
	Night	29	30	23	22
246 Emu Swamp Rd	Day	41	42	31	28
	Evening	31	30	26	26
	Night	28	29	26	26



Legend

- Full Supply Level 734.5m AHD
- Full Supply Level 738m AHD

- # Noise Monitoring Location
- ! Residence



EMU SWAMP DAM EIS

Emu Swamp Dam Site

**Figure 12-1
Noise Monitoring Locations
Around the Dam Wall**

The measured night time background noise level (L_{A90}) at 376 Fletcher Road, 147 Emu Swamp Road and 246 Emu Swamp Road were 26dB(A), 22 dB(A) and 26dB(A), respectively. These levels were equivalent to the lowest measurement range of the B&K 2238 noise monitor (22 dB(A)) and ARL 315 noise monitor (26dB(A)). In a rural area, the L_{A90} noise levels during the evening and night time period may indeed be lower than the levels recorded by the noise monitors.

Furthermore, the noise environment at the three monitoring locations are similar and the night time background noise level (L_{A90}) at the three monitoring locations should be similar. The 4 dB(A) difference between the night time background noise level (L_{A90}) of the three locations was probably due to the limitation of the instruments.

12.2.2.2 Irrigation Pumping Stations

Attended monitoring was also undertaken at locations representative of the receiving environment that may be influenced by the irrigation pumping stations.

Attended monitoring was undertaken over 15-minute intervals using a Rion NA-27 SLM. The calibration of the instruments was checked before and after the monitoring period and the drift was less than 0.5 dB(A).

The results of attended monitoring and a summary of dominant noise sources observed at the time of the survey are presented in **Table 12-2**.

■ **Table 12-2 Attended Noise Monitoring Data**

Site	Start Time	Finish Time	L_{Aeq}	L_{A1}	L_{A90}	Comments
Aerodrome Road	11:30 am	11:45	55.9	66.2	46.9	Infrequent noise from traffic, and a horse and wind noise.
Barkers Lane	12:10 pm	12:25	53.4	62.8	47.3	Noise from birds and wind noise.

12.3 Noise and Vibration Assessment Guidelines

This section of the report presents the relevant Queensland legislation for construction and operational noise control. The construction noise level goals have been developed for the day and night time works as a means of assisting with the management of potential impacts.

In establishing construction and operational noise level goals the following legislative and guideline documents have been reviewed:

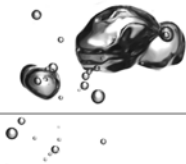
- *Environmental Protection Act 1994*;
- *Environmental Protection (Noise) Policy 1997*;
- *Environmental Protection Regulation 1998* and associated Nuisance Laws;
- *Ecoaccess Guideline - Planning for Noise Control Guideline* (EPA 2004); and
- *Ecoaccess Guideline - Noise and Vibration from Blasting* (EPA 2006).

12.3.1 Environmental Protection Act 1994

Environmental noise control in Queensland is governed under the *Environmental Protection Act 1994* (EP Act) and subordinate legislation, which aims to strike a balance between protecting the amenity of sensitive receivers and allowing industrial, commercial and development activities to occur in an ecologically sustainable manner.

12.3.2 Environmental Protection (Noise) Policy 1997

The *Environmental Protection (Noise) Policy 1997* (EPP (Noise)), provides guidance in achieving the object of the EP Act by identifying (Section 10) the environmental values to be enhanced or protected as follows:



The environmental values to be enhanced or protected under the EPP Noise are the qualities of the acoustic environment that are conducive to:

- a) the wellbeing of the community or a part of the community, including its social and economic amenity; or
- b) the well being of an individual, including the individual's opportunity to have sleep, relaxation and conversation without unreasonable interference from intrusive noise.

Section 11 of the EPP Noise also provides a numerical value to determine an acoustic quality objective as follows:

- 1) *The "acoustic quality objective" is the objective of achieving an ambient level of L_{Aeq} 55 dB(A) or less for most of Queensland's population living in residential areas.*
- 2) *It is intended that the acoustic quality objective be achieved as part of progressively achieving the object of this policy over the long term.*
- 3) *It is not intended that, in achieving the acoustic quality objective, any part of the existing acoustic environment be allowed to significantly deteriorate.*
- 4) *For subsection (1), the ambient level in a residential area is measured over 24 hours as the long-term L_{Aeq} outside a dwelling in the area.*

12.3.3 Environmental Protection Regulation 1998

Construction Noise

The EP Act and the EPP (Noise) provide a guide to the control of noise emissions from activities. Further to this the Environmental Protection Regulation 1998 (amended 2006) categorises noise offences (Division 4, Subdivision 1 under Offences, 6W Building work) as follows:

A builder or building contractor must not carry out building work on a building site in a way that makes or causes audible noise to be made from the building work:

- a) *on a Sunday or public holiday, at any time; or*
- b) *on a Saturday or business day, before 6.30am or after 6.30pm*

However non-adherence to these times is not an offence where the activity being undertaken is an Environmentally Relevant Activity (ERA) or where a development approval has been granted to undertake operations outside of these hours..

In summary, for an activity such as construction, even if the works take place over extended periods, the EPA does not provide specific guidelines for the assessment of noise impacts. The only guideline is the generalised noise emission level taken from Section 11 part 1 of the EPP (Noise) for an acoustic quality objective of L_{Aeq} 24 hour 55 dB(A) ambient level in residential areas.

Operational Noise

Noise sources associated with the operation of the Project would require consideration of noise limits for the potential future recreational uses adjacent to the inundation area and the use of regulated items associated with maintenance activities. An outline of noise level limits and time restrictions for the operation of regulated devices from the *Environmental Protection Regulation 1998 (amended 2006)*, which may be used as a guide for minimising the potential for nuisance noise associated with the operational maintenance activities, is provided in **Table 12-7**.

■ **Table 12-3 Operational Noise Limits and Time Restrictions for Various Activities**

Plant Item	Time Restriction	Limit on Audible Noise	Source
Regulated Devices	7am - 7pm, Mon – Sat	50 dB(A)	6X EPR, 1998
	8am – 7pm, Sun & Public Holidays	the greater of 40 dB(A) or background + 5	

Source: Environmental Protection Regulation 1998

The *Planning for Noise Control Guideline* (EPA 2004) would be used to develop operational noise level limits for the pump station as outlined below.

12.3.4 Ecoaccess Guideline - Planning for Noise Control Guideline (2004)

Environmentally Relevant Activities

The *Planning for Noise Control Guideline* (EPA 2004) provides a framework for the assessment and management of noise emissions from Environmentally Relevant Activities. The purpose of the guideline is to limit noise from specific sources so that speech interference, community annoyance or sleep disturbance impacts are minimised.

Environmentally Relevant Activities (ERAs) such as rock crushing, screening and concrete batching, and quarrying would require a Development Approval to operate. Where ERAs are proposed, a detailed, noise impact assessment is required.

The assessment framework outlined in the *Planning for Noise Control Guideline* (EPA 2004) would be applied to set noise conditions for ERAs associated with the Project. The assessments would be undertaken as part of the subsequent development approval process for each ERA. Thus, a detailed assessment of applicable noise level goals for the operation of concrete batching plants, crushing, quarrying and screening facilities will be undertaken once particular contractors have been commissioned and as part of the subsequent ERA process. However, the potential contribution of these activities to the overall construction noise associated with the Project has been considered as part of the EIS.

The approach outlined in the *Planning for Noise Control Guideline* (EPA 2004) is considered suitable for protecting against amenity or intrusive noise impacts from the proposed pump stations.

The maximum planning noise level (PNL) from specific noise sources within an area should be restricted to the levels specified in **Table 12-4**, which will help protect against intrusive noise impacts.

■ **Table 12-4 Estimated maximum values of planning noise levels (PNL) for proposed noise sources for different areas containing residences (EPA 2004)**

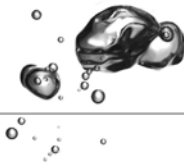
Noise area category	Description of neighbourhood	PNL - Maximum L_{Aeq} (1 hour)		
		Day	Evening	Night
Z1	Very rural, purely residential. Less than 40 vehicles an hour	40	35	30
Z2	Negligible transportation. Less than 80 vehicles an hour	50	45	40
Z3	Low-density transportation. Less than 200 vehicles an hour	55	50	45

Note: Day: 7am – 6pm; Evening: 6pm – 10pm; Night: 10pm – 7am. On Sundays and public holidays, daytime is defined as 8am – 6pm.

Noise category Z1 would generally be the most applicable to receivers within proximity to the proposed pumping stations. Night time noise goals will be the controlling criteria for noise emissions from the pump stations (given that this is the quietest time of day).

Following the procedure outlined in the *Planning for Noise Control Guideline* (EPA 2004) would result in a planning noise level around $L_{Aeq,1hour}$ 30 dB(A) for the pumping stations.





The operational noise level goals for the pumping stations would be developed following the finalisation of sites and would be further investigated as part of the detailed design. This noise level goal has been used to provide an indication of the likelihood for amenity impacts in this EIS.

Sleep Disturbance

Noise affects people’s ability to gain the appropriate amount and type of sleep needed for maintenance of good health. The influence of sleep from noise is discussed in *The health effects of environmental noise – other than hearing loss* (enHealth Council, 2004).

The *Planning for Noise Control Guideline* (EPA 2004) provides assessment criteria for sleep disturbance. This guideline recommends that maximum instantaneous internal noise levels in sleeping areas should not exceed approximately 45 dB(A) more than 10 to 15 times per night. The corresponding external maximum noise levels (L_{Amax}), which should protect at least 90% of the population (i.e a probability of only 10% awakenings) are presented in **Table 12-5**. These levels differ according to window types and whether windows are open or closed.

■ **Table 12-5 L_{Amax} Sleep Disturbance Goals**

Window type and setting	External L_{Amax} Noise Level (dB(A)) #
Wide open	47
Partially closed	52
Single glazed, closed	62
Thermal double glazed, closed	67

Assumes typical noise reduction of 5 dB(A) across a wide open window, 7 dB(A) across partially closed, 20 dB(A) single glazed, closed and 25 dB(A) thermal double glazed and closed.

A nominal external night time construction noise level assessment criterion for instantaneous noise sources of L_{Amax} 52 dB(A), for partially closed windows, is proposed for the Project in order to assist with the assessment and management of night time construction noise impacts.

12.3.5 Ecoaccess Guideline – Noise and Vibration from Blasting (2006)

The Ecoaccess guideline, Noise and Vibration from Blasting (EPA 2006) provides assessment criteria for blasting noise and vibration as follows.

Noise

Blasting activities must be carried out in such a manner that if blasting noise should propagate to a noise sensitive place, then the air blast overpressure:

- a) Must be not more than 115 dB(linear) peak for nine out of any ten consecutive blasts initiated, regardless of the interval between blasts; and
- b) Must not exceed 120 dB(linear) peak for any blast.

Vibration

Blasting operations must be carried out in such a manner that if ground vibration should propagate to a noise sensitive place, the ground borne vibration:

- a) Must not exceed a peak particle velocity (PPV) of 5 mm/s for nine out of any ten consecutive blasts initiated, regardless of the interval between blasts; and
- b) Must not exceed a PPV of 10 mm/s for any blast.

These levels would be applicable to any blasting undertaken as part of the Project construction works.

12.3.6 Rationale of the Construction Noise Criteria for this project

Construction noise levels are not typically set for daytime construction projects in Queensland. The Project will be constructed for between 14 to 16 months and has the potential for nuisance impacts at residences close to the construction area. Noise emissions during construction should be controlled through the adoption of Project noise criteria to protect the acoustic amenity of the local community.

Given the absence of any specific construction noise criteria in Queensland, the ambient acoustic objective of L_{Aeq} 55 dB(A) in the EPP(Noise) has been adopted for daytime construction activities.

12.3.7 Summary of Noise and Vibration Goals

Construction Noise

For this project the following time periods have been adopted for reference purposes:

- Daytime: 6 am to 6pm
- Evening: 6pm to 10pm
- Night: 10pm to 7am

The construction noise criteria have been adopted as follows:

- Sleep disturbance criteria L_{Amax} 52 dB(A) during the night time period
- The acoustic quality objective of $L_{Aeq}(24hr)$ 55dB(A) from EPP(Noise) during the daytime and evening period. On the basis there are 12 hours during daytime and 4 hours during the evening, the construction noise criteria for daytime and evening are $L_{Aeq}(12hr)$ 55dB(A) and $L_{Aeq}(4hr)$ 55dB(A) , respectively

The Project construction and vibration noise criteria at the noise sensitive receivers are presented in **Table 12-6**.

■ Table 12-6 Project Construction Noise and Vibration Goals

Project goals	Day	Evening	Night time
Construction Noise	55 dB(A) L_{Aeq} 12 Hr	55 dB(A) L_{Aeq} 4 Hr	L_{Amax} 52 dB(A)
Construction Blasting ¹			
Noise / Overpressure	115 dB(Lin) peak (9/10) 120 dB(Lin) peak	N/A	N/A
Vibration	5 mm/s PPV (9/10) 10 mm/s PPV (Max)	N/A	N/A

¹ Blasting will only occur during daytime hours.

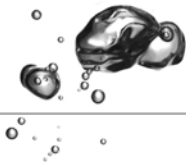
Operational Noise

The Project operational noise criteria at the noise sensitive receivers are presented in **Table 12-7**.

■ Table 12-7 Operational Noise Limits and Time Restrictions for Various Activities

Plant Item	Time Restriction	Limit on Audible Noise	Source
Regulated Devices	7 am - 7 pm, Mon – Sat 8 am – 7 pm, Sun & Public Holidays	50 dB(A) the greater of 40 dB(A) or background + 5 dB	6X EPR, 1998

Source: Environmental Protection Regulation 1998



12.4 Noise and Vibration Impact Assessment

This section provides an assessment of the potential noise and vibration impact of the proposed Emu Swamp Dam Project. It includes assessment of:

- noise from construction of Emu Swamp Dam;
- noise from construction of the Urban and Irrigation Pipelines;
- noise and vibration from blasting;
- haulage trucks on roads;
- operational noise; and
- the potential effects of noise on local wildlife/fauna.

Emission of low frequency noise (noise with components below 200 Hz) is not considered in this assessment given the temporary nature of the works and the fact that the construction activities would not typically include significant sources of low frequency noise. Low frequency noise assessment is usually only undertaken for long term continuous industrial noise source which would operate during day or night. Low frequency noise would be considered for the rock crushing, concrete batching and screening facilities as part of the Development Approvals for these plants.

12.4.1 Dam Construction Noise Impact Assessment

Potential noise impacts associated with the construction of the dam include:

- the noise generated by equipment utilised in the construction of the dam wall, blasting in the proposed dam wall construction area.
- haulage of quarried material to the dam wall site.
- site preparation including vegetation removal.
- construction of infrastructure including pipelines and the Stalling Lane Access.

12.4.1.1 Overview of Construction Activities

Dam Wall

There are two potential options for the Emu Swamp Dam:

- an Urban Water Supply Dam; and
- a Combined Urban and Irrigation Dam.

Construction activities are similar for both dam options and those with the potential to generate noise impacts include:

- site establishment;
- quarrying operations;
- crushing of rock for aggregate;
- sand screening operations;
- concrete batching operations;
- haulage of material onsite;
- excavation;
- construction of the dam wall, and
- clearing of the inundation areas;

The construction period for the Urban Water Supply Dam and the Combined Urban and Irrigation Dam is approximately 14 months and 16 months respectively. It is proposed that the intensity of construction activities will be the same for both dam options. The timelines for the both project options are presented in **Section 3** of the EIS.

Normal working hours will be over a 10 hour period per day between 6am to 6pm from Monday to Saturday. Crushing, screening, operation of the RCC batch plant and concrete laying of the RCC wall will operate at night for a period of 3 to 4 months.

The RCC batch plant and laying of the RCC wall is likely to be 2 x 10 hour shifts per day, 7 days a week. Limited night time works are required during this phase to enable the concrete laying process.

Crushing and screening activities are anticipated to be over a 20 hour period per day based on 2 x 10 hour shifts per day, 6 days a week (Monday to Saturday). A maintenance shift will operate outside these working hours but activity levels will be much lower than day time hours to minimise the potential for noise impacts from to night time works.

The assessment outlined in the following section addresses the potential for night time noise impacts and identifies possible mitigation measures

Stalling Lane Access

Construction of Stalling Lane Access will involve clearing, sediment control, drainage, rock excavation, embankment construction and paving of gravel.

12.4.1.2 Noise Modelling

A three dimensional noise model was developed using SoundPLAN 6.4 software to predict the construction noise levels. The CONCAWE noise propagation algorithms and method has been used in this study and is suited for the requirements of construction projects

Several assessment scenarios have been modelled to determine the construction noise impact at noise sensitive receiver locations.

Modelling Scenarios

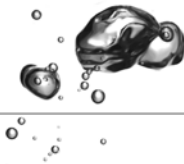
Noise levels from the construction of the dam wall will vary depending on the types of equipment and processes used during construction activities.

The construction activities and level of intensity will be the same for the Urban Water Supply Dam and the Combined Urban and Irrigation Dam. The Combined Urban and Irrigation Dam will have a longer construction period. On site construction equipment will be the same for both the Urban Water Supply Dam and the Combined Urban and Irrigation Dam. The predicted construction noise levels will therefore be similar for both dam options.

The typical noise levels and 'worse case' scenarios (ie. highest noise levels generated), during the construction of the dam wall during the daytime and night time have been selected and modelled.

The computer modelling has been based on the assumption that not all of the proposed construction equipment will be operating at maximum engine speed or load. Some equipment may not be operational or may be in idle mode at various times during the working day.

There were four modelling scenarios as part of the assessment. Details for each modelling scenario is presented in **Table 12-8**. The machinery and equipment associated with construction activity is provided in **Section 3** of the EIS.



■ **Table 12-8 Description of Noise Modelling Scenarios for Construction**

Modelling Scenario	Construction Activities	Time (Day /Night)
Scenario 1	Dam Foundation Preparation, Concrete Batch Plant, Crushing Plant, Screening Plant and Quarry	Day
Scenario 2	Concrete Batch Plant, Crushing Plant, and Screening Plant	Night
Scenario 3	Concrete Batch Plant, RCC Wall Construction, and Pump Station	Day
Scenario 4	Concrete Batch Plant, RCC Wall Construction	Night

12.4.1.3 Meteorological conditions

Noise propagation is influenced by the rural locality and the topography of the surrounding area by way of shielding and interaction with low level air flows. The development of nocturnal cold air and downslope drainage flows and surface based temperature inversions (where cold dense air located near the surface of the earth is overlaid by warmer, less dense air), particularly under calm night time conditions, influences noise levels experienced at nearby sensitive places. Atmospheric temperature inversions can enhance the propagation of noise and result in noise impacts at receiver locations which would otherwise not experience noise from an operation.

The noise levels at noise sensitive receivers can increase by up to 10 dB(A) under adverse meteorological conditions (such as temperature inversions or varying wind speeds and direction) and decrease up to 7 to 10 dB(A) under unfavourable propagation conditions.

The *Planning for Noise Control Guideline* (EPA 2004) provides guidance for determining whether adverse meteorological conditions are likely to have a significant impact on the propagation of noise from the Project and therefore, whether or not meteorological condition require consideration as part of the impact assessment investigation. When establishing appropriate planning noise limits for projects, the occurrence of adverse weather conditions should be considered as part of the assessment if:

- 1) Temperature inversion conditions occur for 30% of the time during the winter night and evening hours (between 6pm and 7am). This corresponds to approximately 2 nights per week during the winter months; or
- 2) Wind speeds below 3 m/s blowing from the source to the receiver (any time throughout the year) occur for 30% of the time during any day, evening or night time assessment period.

A review of the wind roses from the air quality chapter reveals the predominant wind direction is north-easterly wind and the predominant wind direction has been incorporated into the noise modelling. However, most of the noise sensitive receivers are located to the east of the construction site while the nearest noise sensitive receiver is located directly to the south of the construction site. Therefore, the construction noise impact would be lower during a north-easterly wind as compared to a calm condition.

Adverse meteorological conditions during daytime and night time have been considered in this assessment. For the daytime, noise levels have been predicted for a neutral normal lapse (average) condition with no wind and for a normal lapse condition with a 3 m/s north easterly wind. For the night time, noise levels have been predicted for a temperature inversion condition with no wind and a neutral normal lapse (average) condition with no wind. The modelled scenarios are shown below.

■ **Table 12-9 Modelling scenarios under different meteorological conditions**

Time Period	Wind speed and direction	Air Stability Class*
Day	No Wind	Neutral, D
Day	3 m/s NE	Neutral, D
Night	No Wind	Neutral, D
Night	No Wind	Stable, F

*Pasquill-Gifford stability class

12.4.1.4 Modelling Results

The predicted noise levels at the eight noise sensitive receivers during different stages of dam wall construction are summarised in **Table 12-10**.

■ **Table 12-10 Summary of Predicted Noise Levels at Sensitive Receivers**

Receiver	Predicted Noise Level (dB(A))							
	Scen1	Scen1	Scen2	Scen2	Scen3	Scen3	Scen4	Scen4
R1	50	54	42	46	52	53	54	58
R2	44	49	38	43	44	49	46	50
R3	41	47	38	43	42	46	43	47
R4	39	42	37	42	37	37	39	42
R5	33	38	32	37	30	34	32	36
R6	41	38	43	47	32	27	34	38
R7	41	38	43	47	32	27	33	38
R8	40	36	41	46	30	25	32	36
Met condition	No wind Class D	3 m/s NE class D	No wind Class D	No wind Class F	No wind Class D	3 m/s NE class D	No wind Class D	No wind Class F
Construction Noise Goal	L _{Aeq} 55dB(A)	L _{Aeq} 55dB(A)	L _{Amax} 52dB(A)	L _{Amax} 52dB(A)	L _{Aeq} 55dB(A)	L _{Aeq} 55dB(A)	L _{Amax} 52dB(A)	L _{Amax} 52dB(A)

The noise modelling results have also been presented as colour noise contour maps overlaid on aerial photographs. For scenarios 1 and 3, the predicted noise levels are presented in terms of an average hourly L_{Aeq} noise level and are compared with the proposed L_{Aeq} 55dB(A) criterion for the day and evening periods. For night time activities (scenarios 2 and 4), the predicted noise levels are presented in terms of the L_{Amax} noise level and these are compared to the proposed night time L_{Amax} 52dB(A) criterion.

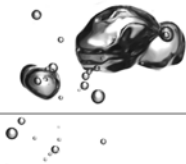
Scenario 1

Scenario 1 represents activities during RCC dam foundation and excavation, concrete batching plant, crushing and screening, quarrying. **Figure 12-2** and **Figure 12-3** show that the noise levels under both calm (no wind) and 3 m/s north-easterly wind are predicted to comply with the proposed L_{Aeq} 55dB(A) noise criterion at all the noise sensitive receivers outside the inundation area.

Scenario 2

Scenario 2 represents night time activities during concrete batching plant, crushing and screening. **Figure 12-4** and **Figure 12-5** show the noise levels under both calm (no wind) with stability class D and calm (no wind) with stability class F are predicted to comply with the proposed L_{Amax} 52dB(A) noise criterion at all the noise sensitive receivers outside the inundation area





Scenario 3

Scenario 3 represents the night time activities during RCC dam construction and the operation of a RCC batch plant. **Figure 12-6** and **Figure 12-7** show that the noise levels under both calm (no wind) and 3 m/s north-easterly wind are predicted to comply with the proposed L_{Aeq} 55 dB(A) noise criterion at all the noise sensitive receivers outside the inundation area.

Scenario 4

Scenario 4 represents night time activities during concrete batching plant and construction of the Left Half RCC Wall Construction. The closest noise sensitive receiver during these works is located at 376 Fletcher Road. **Figure 12-8** and **Figure 12-9** show the noise levels under both calm (no wind) with stability class D and calm (no wind) with stability class F are predicted to be L_{Amax} 57 dB(A) and L_{Amax} 58 dB(A), respectively. These predicted levels exceed the proposed L_{Amax} 52 dB(A) noise criterion by up to 6 dB(A).

Proposed mitigation measures to address this exceedance are discussed in the following section.

At other noise sensitive receivers outside the inundation area, the construction noise levels are predicted to comply with the proposed L_{Amax} 52 dB(A) noise criterion.

12.4.1.5 Discussion

Modelling results show all construction activities during the daytime period under both calm (no wind) and 3 m/s northeasterly wind range between 25 and 53 dB(A) at the noise sensitive receivers and will comply with the proposed L_{Aeq} 55 dB(A) noise criterion at all the noise sensitive receivers outside the inundation area.

During the night time period, noise levels from the construction of the Right Half RCC Wall are predicted to range between 32 and 46 dB(A) at the noise sensitive receivers and will comply with the sleep disturbance criterion of L_{Amax} 52 dB(A). However, during the construction of the Left Half RCC Wall, the sleep disturbance criterion of L_{Amax} 52 dB(A) will be exceeded by 2 dB(A) under neutral weather condition (Class D) and up to 6dB(A) during temperature inversion (Class F) at the closest noise sensitive receiver which may cause sleep disturbance at the closest noise sensitive receiver. At the other seven noise sensitive receivers outside the inundation area, the construction noise levels are predicted to comply with the noise criteria. To reduce the internal noise level to meet the sleep disturbance criterion, noise mitigation measures would be required.

The modelling for each scenario includes the location and number of construction equipment on site for the various activities. However these scenarios are static representations of what may occur over the duration of the works. The predicted noise levels will be verified with compliance monitoring during the construction activities.

Due to the rural nature of the Project area and the low ambient noise environment, construction noise may be audible at the sensitive receivers even if there is compliance with the noise criteria.

In summary, noise levels from the construction of the dam wall will comply with all noise criteria at all noise sensitive receivers during daytime construction activities. During the Left Half RCC Wall construction, the sleep disturbance criterion will be exceeded by up to 6dB(A) at the closest noise sensitive receiver. Noise management and mitigation measures for the Project are addressed further in **Section 12.5**.

12.4.2 Vegetation Clearing in the inundation area

Vegetation in the inundation area will be cleared as part of the Project. Noise emanating from the vegetation clearing machinery may affect the surrounding noise sensitive receivers. Machinery associated with this activity however, will move from one area to another as vegetation is progressively cleared, meaning that potential noise impacts will only be temporary (short-term) at any one location. Stanthorpe Shire Council (SSC) will endeavour to prevent or mitigate against any potential noise impacts through consultation with affected landholders.

12.4.3 Pipeline Construction Noise Impact Assessment

There are two potential pipelines associated with the Project; the 23 km for the Urban Pipeline and 120 km for the Irrigation Pipeline. Both pipelines will be constructed largely in road reserves and by a combination of methods that will be determined by various constraints including other services, vegetation communities, road requirements, access, topography, geology, safety and environment.

The proposed Urban Pipeline construction may be either above ground or below ground.

12.4.3.1 Overview of Construction Activities

The construction of the pipeline will involve a combination of buried and above ground pipe. The preference will be for buried pipelines but until detailed surveys and design is undertaken it will not be possible to define which sections are buried and which are to be above ground.

The key activities with potential to generate air borne noise include:

- clearing;
- trench excavation including drilling and blasting in rock (where required) for buried pipes;
- concrete pedestal construction for above ground pipes (where required);
- directional drilling for road, rail and creek crossings;
- trench backfilling/surface reinstatement;
- building construction of pump stations, valve chambers etc; and
- pump, electrics and telemetry installation.

12.4.3.2 Preliminary Impact Assessment

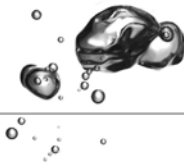
A detailed construction and earthworks schedule is not available at this stage. A conceptual description of the likely activities and typical phases of construction works has thus been used as the basis for this assessment of potential impacts on nearby receivers. The machinery and equipment associated with the construction of the pipelines is provided in **Section 3** of the EIS.

The distance between the proposed pipelines and most sensitive receivers in most areas is relatively large (>500 m) and the potential for noise impacts from construction would be low. However, the distance between the proposed pipelines and the noise sensitive receivers is only 30m in two areas. and the noise levels from the construction of the pipeline may affect the nearby noise sensitive receivers.

Construction activities will move from one area to another as the construction of the pipeline progresses. The construction noise impacts at sensitive receiver will only occur on temporary basis. Ongoing consultation with affected landholders during construction of the Urban and Irrigation Pipeline will help to mitigate against any potential noise impacts. Noise control measures outlined in **Section 12.5** will also be implemented for the duration of construction period.

12.4.4 Blasting Noise and Vibration Impact Assessment

Construction materials will be sourced from a quarry area to be established in the inundation area for the proposed Emu Swamp Dam.



As outlined in **Section 12.2.1**, the nearest receivers are located approximately 100 m from the construction works area.

Blasting will occur approximately 500 m from the nearest dwellings. Vibration impacts from earthmoving and construction activities are unlikely to occur over these relatively large distances and have not been considered further. Noise and vibration from blasting has the potential to impact receivers over these distances, and had been assessed below.

Blasting calculations for airblast overpressure and ground vibration have been based on the prediction method described in Appendix J of AS 2187.2 (2006) *Explosives - Storage and use Part 2: Use of explosives*.

The airblast overpressure predictions have been based on parameters given in Section J7.2 of AS 2187.2 (2006) for confined blasting. Airblast overpressure can increase rapidly if blasts are poorly confined and hence a 10 dB safety factor has been applied to blasting impact predictions. The areas of airblast impact have therefore been calculated based on a limit of 105 dB (linear).

The peak particle vibration has been based on the formula given in Section J7.3 of AS 2187.2 (2006) for the average peak particle velocity.

At this stage, information available about blasting includes Blasting medium (ANFO), total amount of explosives to be used for the project (80 tonnes) and blasting frequency, which is to be 3 blasts per week. Specific details of blast patterns are currently unavailable and hence the assessment of potential impacts has been carried out for a large range of charge sizes.

The prediction method according to the AS 2187.2 (2006) does not consider the effect of topographic shielding or meteorological conditions. Results should therefore be used only as a guide for the identification of potential impacts from blasting. Topographic shielding, meteorological conditions, exact locations of the blast and accurate measurements of local wind profiles would need to be considered by the construction contractor as an input into blast design, to ensure that the blasting criteria will be met.

The distances required to achieve airblast overpressure and vibration criteria for various charge sizes are listed in **Table 12-11**. The results presented in **Table 12-11**, show that for charge sizes less than or equal to 500 kg the effective charge mass per delay, the airblast overpressure will be the determining factor in achieving the criteria. It is noted that a 500 kg effective charge mass per delay is a significant charge mass, and is unlikely to actually be used for blasting for the Project.

■ **Table 12-11 Predicted distances to achieve airblast overpressure and ground vibration criteria for various charge sizes**

Effective charge mass per delay (kg)	Distance to achieve Airblast overpressure < 105 dB(lin) (m)	Distance to achieve Peak particle velocity < 5 mm/s (m)
5	409	67
25	699	149
50	881	210
100	1110	298
200	1398	421
500	1898	666

The impact of blasting operations at the proposed quarry near the proposed dam wall will be minimal provided that blast sizes are carefully controlled. With a separation distance of 500 m between the blasting site and the nearest sensitive receiver and charge masses per delay of 5 kg or less, the criteria are expected to be met.

Section 12.5 provides information on general blasting mitigation measures as recommended by AS 2187.2 (2006). However, the blasting contractor will be required to provide a detailed management plan for these impacts prior to commencement of work in the quarry.

12.4.5 Noise Impact of Trucks During Construction

Construction traffic to and from the site will use the New England Highway and Fletcher Road. It is not intended to use Emu Swamp Road for construction access. Materials deliveries and collections will mostly be by semi-trailer or B-double trucks.

Generation of heavy traffic is discussed in **Section 13** of the EIS. During construction traffic is estimated to be 30 heavy vehicle movements per day over a 12 hour construction period. This frequency is unlikely to result in exceedance of road traffic noise guidelines. It is recognised that the existing traffic on Fletcher Road consists of a small number of light vehicles, A Traffic Management Plan will address safety and amenity impacts from this traffic.

12.4.6 Operational Noise Impact Assessment

This section provides an overview of the potential noise impacts at sensitive receivers resulting from the operation of the Project.

Pumping Stations, Fish Transfer Station and Pipeline Pumping Stations

The closest noise sensitive receiver is located more than 500 m from the pumping station and fish transfer station at the dam. Due to the large distance between the noise source and the noise sensitive receiver, the operational noise impacts from the pumping station and fish transfer station at the dam are expected to be minimal. There are three other pumping stations on the Irrigation Pipeline with locations shown on **Figure 3-5**. The pipeline pumping stations are located in rural areas and are around 200 m from noise sensitive receivers. The operational noise impacts from the pipeline pumping stations are expected to be minimal. However this will be considered further as part of the detailed design. The design of the pumping station will ensure noise impacts are minimised.

Recreational Use

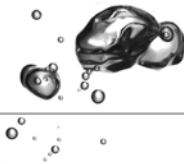
Possible recreational uses following completion of construction may include:

- picnic areas, shelters, BBQs and playground equipment;
- boat ramp;
- jet skis and power boats.

In order to mitigate the potential noise impacts from recreation activities, management procedures controlling their use including operating hour and speed limit etc. would be included as part of operational environmental management plans for the area. Control of the use of recreational areas for jet skis and power boats would be administered by SSC and management plans would be developed prior to the approval of such uses. Management measures are recommended in **Table 12-13**.

12.4.7 Effects of Noise on Local Wildlife/Fauna

The amount of information available on the effects of general construction noise on Australian wildlife/fauna is relatively sparse. However, extensive studies undertaken in the US suggest that long term exposure of fauna to noise may have a minimal effect on the behaviour and the habitat of some wildlife (Larkin *et al* 1996). Noise affects wildlife differently from humans and the effects can vary from serious to non-existent in different species and situations. Risk of hearing damage can occur if fauna are close to a construction blast, for example, but the likelihood of this is small given that blast zones would be within the construction site and the fauna tend to move away from humans and their activities.



Direct physiological effects of noise on fauna are difficult to measure in the field and a lot of the impacts are observed by behavioural changes. For repeated construction noise, some form of habituation may occur and the animals may simply maintain activities in their natural habitat after an initial period of acclimatisation. It is only when this does not occur and when the noise causes a decrease of survivability and reproduction as a result of a retreat away from favourable habitats due to the noise that an issue of concern may arise.

Another potential noise impact is interference with communication between wildlife when high noise levels are sustained over a long period. This is unlikely to occur due to the behavioural modifications outlined above (human activities would tend to cause relocation).

It is generally unlikely that the noise due to the construction of the Emu Swamp Dam or subsequent operational activities will have a lasting or major impact on the native fauna. However, if a rare or threatened species is identified in the vicinity of the Project, precautionary measures may include:

- a preconstruction survey of native habitat to identify the extent of the habitat and approximate colony size;
- periodic monitoring of the colony; and
- a post construction survey to identify any impacts and possible remedial measures where required.

12.5 Mitigation Measures

This section provides a number of recommendations so noise and vibration impacts are kept to a practical minimum.

12.5.1 Construction Noise Mitigation

Construction activities will generally be carried out in accordance with the construction noise control guidelines described in AS 2436:1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites* and the recommendations presented in **Table 12-12**.

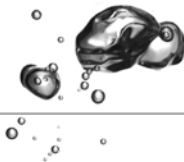
This impact assessment highlights the potential for construction noise and vibration impacts at residences near to the Project.

SSC recognises that management of noise is a critical component of the Project and will require ongoing consideration and community engagement for the duration of the Project. This section summarises noise management procedures which will be adopted by the Project to manage noise impacts on sensitive receivers. These measures will be incorporated into detailed construction noise and vibration management plan, to be implemented by the construction contractor.

The noise impact assessment predicted that noise levels from the construction of the dam wall will comply with all noise criteria at all noise sensitive receivers during daytime construction activities. However, night time works during the Left Half RCC Wall construction are predicted to exceed the sleep disturbance criterion. If monitoring shows that noise levels are exceeding the noise criteria, SSC will consider the temporary relocation of affected persons or other solutions.

■ **Table 12-12 Construction Noise and Vibration Mitigation Measures**

Control Strategy	Description
Construction hours	<p>As far as practicable, general construction activities (excluding RCC Wall Construction) will be in accordance with the EPP (Noise).</p> <p>Due to the nature of using RCC, these operations will occur on a continuous 24 hour basis. During this time communication with potentially affected residents will be carried out.</p>
General Noise Management Practices and scheduling of activities	<p>In general, construction works and consideration of quiet work practices would be carried out in accordance with AS 2436:1981 <i>Guide to noise control on construction, maintenance and demolition sites</i>.</p> <p>Prior to the commencement of site works, the community would be informed of the upcoming activities and likely duration.</p> <p>The construction programme would continue to be developed in consultation with the local community to schedule noisier activities (such as blasting) during least sensitive times of the day.</p> <p>Rock breaking, rock hammering, blasting and any other activities which result in impulsive or tonal noise generation would only to be conducted during normal operational hours.</p> <p>Appropriate selection of construction processes / methodologies and equipment which minimise the generation of noise would be further considered during the development of the project schedule.</p> <p>Employ respite periods for particularly noisy activities where possible.</p> <p>Maintain a site activity log, recording the type of activities occurring during various times of the day to assist with the retrospective investigation of community complaints relating to noise complaints.</p>
Maximise Shielding and Distance to Receivers	<p>Maximise the offset distance between noisy plant and continuous operations (generators, compressors, crushers etc) and nearby noise sensitive receivers or ensure plant are screened utilising:</p> <ul style="list-style-type: none"> ■ purpose built barriers; ■ materials stockpiles; ■ site sheds, buildings or other structures; or ■ natural topographical barriers. <p>Where possible, carry out loading and unloading of materials and equipment in areas as far away from noise sensitive areas as possible.</p>
Plant and Equipment	<p>Equipment having directional noise characteristics (emits noise strongly in a particular direction) would be oriented such that noise is directed away from sensitive areas.</p> <p>Avoid the coincidence of noisy plant working at the same time close together adjacent to sensitive receivers.</p> <p>Acoustic enclosures or localised noise screens could be incorporated around fixed plant or over individual pieces of equipment as appropriate based on acoustic assessment for Crusher and screening plant and the concrete batch plant.</p> <p>All mechanical plant should be silenced by best practical means using current control technology and in accordance with manufacturers' specifications, and maintained appropriately.</p> <p>Plant with the lowest noise rating which meets the requirement of the task should be selected.</p> <p>Where possible for works in close proximity to sensitive receivers, use electric motors in preference to diesel motors.</p> <p>Where reversing alarms are to be used, their acoustic range should be limited to the immediate danger area. Traditional 'beeper' alarms for mobile equipment could be replaced with:</p> <ul style="list-style-type: none"> ■ "Smart alarms" that adjust their volume depending on the ambient level of noise. These are particularly useful during operations in quieter areas, where other noise on the site is less, or when works take place during quieter periods such as night time and early morning; and ■ "Broadband" or "quacker" alarms. These emit a less annoying sound and are more directional (meaning the sound is focused to the area of concern); and are less likely to travel to noise sensitive areas. Enclose noisy equipment as much as possible, depending on the nature of the equipment, access and ventilation requirements. <p>Where practicable, metal surfaces subject to impacts from heavy objects (such as rock dropping into empty truck trays, or metal grates on road ramps etc) should be lined with rubber</p>



Control Strategy	Description
	<p>impact protection to minimise impact noise.</p> <p>Ensure that tailgates on trucks are securely fitted to avoid unnecessary “clanging” noise, particularly during movement of empty trucks.</p> <p>Where using pneumatic equipment, select silenced compressors or use quieter hydraulic equipment .</p> <p>Conduct regular inspections and effective maintenance of both stationary and mobile plant and equipment (including mufflers, enclosures etc).</p> <p>Equipment not being utilised as part of the work should not be left standing with engines running for extended periods.</p>
Blasting	<p>Blasting will be designed and managed by a blasting contractor, who would control blast overpressure and vibration in accordance with the project limits, through a detailed management plan. The plan must address AS 2187 (2006) <i>Explosives-Storage and Use Part 2: Use of explosives</i>, and would include the following types of measures to minimise impacts:</p> <ul style="list-style-type: none"> ■ Airblast overpressure and ground vibration can be reduced by: ■ reducing maximum instantaneous charge of each blast; ■ changing drilling patterns, burden, blast hole diameter, deck loading, location, spacing and orientation of blast holes or using a combination of appropriate delays; and ■ where possible, orienting faces so that they do not face directly towards residences and keeping face heights to a minimum. <p>Consider weather forecasts in the ongoing management of blast impacts (allowing for the effects of adverse wind on the propagation of air blast to surrounding areas).</p>
Construction Traffic Noise	<p>Establish designated access route/s to the site and inform drivers of these routes, parking lots and acceptable delivery times.</p> <p>Undertake regular site road maintenance (and inspections) to minimise impact noises from trucks travelling over irregularities in the road surface (such as pot-holes, washouts or ruts).</p> <p>Limit vehicle speeds in critical areas both on and off site.</p> <p>Allow for one-way traffic flow through the site to minimise the use of reversing alarms as much as possible and minimise traffic delays.</p> <p>The use of ‘smart’, reversing alarms.</p> <p>Limiting excessive acceleration from site exits.</p> <p>Ensure that vehicles required within compounds do not “queue” outside the worksite close to residential areas. This particularly applies in the commencement of shift during morning hours, where sleep disturbance issues may arise.</p> <p>Entry and departure of heavy vehicles to and from the site are restricted to the standard daytime construction times.</p>
Noise Monitoring	<p>Due to the varying nature of the construction activities to be undertaken throughout the project the effectiveness of the construction noise mitigation measures and management procedures would be reviewed regularly. Ongoing monitoring and review of the site noise management practices would be undertaken:</p> <ul style="list-style-type: none"> ■ at the commencement of construction activities; ■ in response to a valid community complaint regarding construction noise; or ■ where review of upcoming construction schedule indicates a high likelihood for impact at nearest sensitive receiver locations. <p>The purpose of monitoring is as a proactive management tool to assist with:</p> <ul style="list-style-type: none"> ■ investigating the likely sources of construction noise impact; ■ quantifying the extent of likely impact (through comparison with the project noise level goals); ■ identifying the need for further controls or modified site noise management practices; and ■ establishing the effectiveness of noise mitigation implemented.
Blast Overpressure Monitoring	<p>Blast overpressure and vibration monitoring is initially to be undertaken for trial blasts at several key residential locations to identify site specific details and make adjustments to the blasting parameters and programme.</p> <p>This monitoring should also be undertaken on a monthly basis under changing temperature and meteorological conditions to ensure blasting levels remain within the criteria.</p>

12.5.2 Operational Noise Mitigation and Management

The operational noise assessment has identified the potential noise impacts associated with dam maintenance, pump stations, the water treatment plant and potential future recreational uses associated with the Project. Significant nuisance noise generated during operation is unlikely provided future design of mechanical plant considers noise control. **Table 12-13** provides a summary of recommended management measures to be considered in the detailed design and operational management of the Project.

■ **Table 12-13 Operational Mitigation and Management Measures**

Noise source	Options for Mitigation
Dam Facilities	Motors associated with the pump station and fish transfer station would be designed with consideration to noise emissions. Mitigation options may include: <ul style="list-style-type: none"> ■ enclosures; ■ acoustically line plant rooms; ■ barriers; ■ locating plant in sites which maximise shielding provided by topography, buildings or structures associated with the Project
Pump Station	Perform further investigation into the potential for noise impact (including sleep disturbance) during detailed design and incorporate acoustic treatment as required to maintain appropriate noise levels at nearest sensitive receivers.
Maintenance	Restrict use of regulated devices (grass cutting, electrical power tools etc)
Recreational Use	In further considering the potential recreational uses adjacent to the inundation area consider the potential for noise nuisance from the use of motorised boats and bikes; Management plans controlling the use of power boats or jet skis may include: <ul style="list-style-type: none"> ■ Restricting the number of power boats or jet skis permitted at any time; ■ Limiting the operational hours of the recreational area; ■ Careful selection of boat ramp to maximise distance to nearest sensitive places and maximise shielding provided by surrounding topography; and ■ Limiting the speed of power boats or jet skis in certain areas.

12.6 Summary and Conclusions

Noise levels from the construction of the dam wall will comply with the noise criteria at all sensitive receivers for the day. During the construction of the Left Half RCC Wall, the sleep disturbance criterion will be exceeded at the closest sensitive receiver. Noise mitigation and management measures have been recommended to minimise the potential impacts of construction noise at nearest sensitive receivers. Consultation and communication throughout construction will further assist in the management of construction noise.

There is low potential for noise impacts from the construction of the Urban and Irrigation Pipeline due to the relatively large distances between the proposed pipelines and the noise sensitive receivers in most areas.