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19. NOISE AND VIBRATION

This section addresses Section 3.7 of the ToR. The noise and vibration impact assessment includes the following:

- establish the existing noise and vibration amenity of the Project area including identification of the nearest sensitive receivers;
- develop construction and operational noise goals for the Project using relevant legislation and guidelines;
- predict the potential noise and vibration impacts at the nearest sensitive receivers during construction of the dam and pipeline using noise propagation modelling and assessment;
- assess the potential operational noise impacts of the Project using qualitative process; and
- discuss mitigation measures.

The assessment of potential noise and vibration impacts includes construction of the dam, pipeline, and associated infrastructure, blasting, clay borrow operations, haulage of material and goods to construction sites, inundation and buffer preparation works and changes to traffic type and volume.

19.1. Description of environmental values

19.1.1. Regulatory framework

In establishing construction and operational noise goals for the Project, the following Queensland legislative and guideline documents have been reviewed. These documents have been used in adopting project specific noise and vibration goals that are presented in Section 19.1.6.

- *Environmental Protection Act 1994*;
- *Environmental Protection (Noise) Policy 2008*;
- Ecoaccess Guideline - Planning for Noise Control Guideline (2004);
- Ecoaccess Guideline - Noise and Vibration from Blasting (2006);
- Draft Ecoaccess Guideline – Assessment of low frequency noise (2004); and
- *Environmental Protection Regulation 2008*.

19.1.1.1. 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.

19.1.1.2. Environmental Protection (Noise) Policy 2008

The purpose of the *Environmental Protection (Noise) Policy 2008* (EPP Noise) is to achieve the object of the EP Act in relation to the acoustic environment.

The environmental values to be enhanced or protected under this policy are:

- the qualities of the acoustic environment that are conducive to protecting the health and biodiversity of ecosystems; and
- the qualities of the acoustic environment that are conducive to human health and wellbeing, including by ensuring a suitable acoustic environment for individuals to do any of the following:
  - sleep;
  - study or learn;
  - be involved in recreation, including relaxation and conversation; and
  - the qualities of the acoustic environment that are conducive to protecting the amenity of the community.

To the extent that is reasonable to do so, noise must be dealt with in the following order of preference:

a) avoid;

b) minimise, firstly by orientating the activity to minimise noise and secondly by using the best available technology; and

c) manage;

To the extent that it is reasonable to do so, noise from an activity must not be:

a) for noise that is continuous noise measured by $L_{A90,T}$ more than nil dB(A) greater than the existing acoustic environment measured by $L_{A90,T}$; or

b) for noise that varies over time measured by $L_{Aeq,adj,T}$—more than 5 dB(A) greater than the existing acoustic environment measured by $L_{A90,T}$.

Table 19-1 presents the Schedule 1 – Acoustic quality objectives of the EPP Noise which are prescribed for enhancing or protecting the environmental values. All sensitive receptor types listed in Schedule 1 have been presented here for reference, although not all sensitive receptor types are located close to the Project area.

Table 19-1 Schedule 1 Acoustic quality objectives

Sensitive receptor	Time of day	Acoustic Quality objectives measured at the receptor in dB(A)			Environmental value
		$L_{Aeq,adj,1hr}$	$L_{A10,adj,1hr}$	$L_{A1,adj,1hr}$	
Dwelling (for outdoors)	Daytime and evening	50	55	65	Health and wellbeing
Dwelling (for indoors)	Daytime and evening	35	40	45	Health and wellbeing
	Night-time	30	35	40	Health and wellbeing, in relation to the ability to sleep

Sensitive receptor	Time of day	Acoustic Quality objectives measured at the receptor in dB(A)			Environmental value
		$L_{Aeq,adj,1hr}$	$L_{A10,adj,1hr}$	$L_{A1,adj,1hr}$	
Library and educational institution (including a school, college and university) (for indoors)	When open for business or when classes are being offered	35			Health and wellbeing
Childcare centre or kindergarten (for indoors)	When open for business, other than when the children usually sleep	35			Health and wellbeing
Childcare centre or kindergarten (for indoors)	When the children usually sleep	30			Health and wellbeing, in relation to the ability to sleep
School or playground (for outdoors)	When the children usually play outside	55			Health and wellbeing, and community amenity
Hospital, surgery or other medical Institution (for indoors)	Visiting hours	35			Health and wellbeing
Hospital, surgery or other medical institution (for indoors)	Anytime, other than visiting hours	30			Health and wellbeing, in relation to the ability to sleep
Commercial and retail activity (for indoors)	When the activity is open for business	45			Health and wellbeing, in relation to the ability to converse
Protected area, or an area identified under a conservation plan under the *Nature Conservation Act 1992* as a critical habitat or an area of major interest	Anytime	The level of noise that preserves the amenity of the existing area or place			Health and biodiversity of ecosystems
Marine park under the *Marine Parks Act 2004*	Anytime	The level of noise that preserves the amenity of the existing marine park			Health and biodiversity of ecosystems
Park or garden that is open to the public (whether or not on payment of an amount) for use other than for sport or organised entertainment	Anytime	The level of noise that preserves the amenity of the existing park or garden			Community amenity

With the exception of the pipeline, which will be built partially near residential areas, most Noise Sensitive Receivers (NSRs) surrounding the Project are located in rural areas.

19.1.1.3. Ecoaccess guideline - planning for noise control guideline (2004)

The *Planning for Noise Control Guideline* (EPA 2004) provides a framework for the assessment of operational noise emitted from industrial, commercial and mining operations, and is intended for noise planning purposes. The guideline is aimed at addressing the control and prevention of three aspects:

- preventing background noise creep (noise levels creeping higher and higher over time);
- containing and minimising variable noise; and
- avoiding sleep disturbance.

The approach outlined in the Planning for Noise Control Guideline (EPA 2004) is considered suitable for protecting the existing noise amenity and minimising intrusive noise impacts from operational noise sources such as pump stations.

The guideline uses two different methods of determining limits to be imposed on how much noise is emitted from a Project, and adopts the lesser of the two results as noise goals: (a) Preventing background noise creep from steady, continuously operating machinery such as ventilation fans and (b) protect noise impacts from variable noise levels and short-term noise events.

The first method compares existing background noise to noise levels considered suitable for different land uses (recommended 'background noise planning levels' shown in Table 19-2). The resulting 'background noise planning level' is converted to an $L_{eq,1h}$ dB(A)level, and further adjusted for any tonal and impulsive characteristics to give a 'planning noise level' (PNL) of $L_{r,1hour}$ dB(A).

Table 19-2 Recommended outdoor background noise planning levels

Receiver land use	**Receiver area dominant land use* (description for neighbourhood)**	**Background noise level, min $L_{90,1hour}$ dB(A)**		
		Day (7 am to 6 pm)	**Evening (6 pm to 10 pm)**	**Night (10 pm to 7 am)**
Purely residential	Very rural	35	30	25
	Rural residential, church, hospital	40	35	30
	Shop or commercial office	45	40	35
Residential area on a busy road or near an industrial area or commercial area	Residential, church, hospital, school	45	40	36
	Shop or commercial office	50	45	40
	Light industry	55	50	45
Passive recreation area	Picnic grounds, public beaches, bush walks, public gardens, etc	35	35	35

*Dominant land use is defined as a radius of 200 m from the receiver location under consideration.

The relevant operational noise criterion is a Planning Noise Level (PNL). The PNL is calculated by determining a Rated Background Level (RBL) (min $L_{A90,1hour}$) which is then modified based on existing noise levels, tonality and impulsiveness.

The second method aims to protect noise impacts such as speech interference, community annoyance and to some extent sleep disturbance from variable noise levels and short-term noise events. It compares the noise contribution from existing operations to a maximum hourly equivalent 'noise planning level' suitable to the area. For the purposes of this assessment only 'planning noise levels' would be applicable as any noise from dam and pipeline operations are expected to be steady and continuous.

19.1.1.4. Ecoaccess guideline – noise and vibration from blasting (2006)

For this project, blasting is expected to occur during the early stages of the dam construction.

The applicable document to assess the noise and vibration impact of blasting and air-blast overpressure is the EPA's Ecoaccess *Noise and vibration from blasting* and Australian Standard AS2187.2 – 2006 *'Explosives – Storage and Use. Part 2: Use of Explosives*'. The purpose of this document is to provide recommended levels of air-blast overpressure, ground vibration peak particle velocity (PPV) and allowable times for blasting activities.

Section J7 of AS2187.2 – 2006 provides formulae to estimate the air blast overpressure and ground vibration associated with blasting activities and they were used for this project

The Ecoaccess guideline contains blast emissions criteria and times of blasting as follows:

1) Blasting noise criteria

> *"Blasting activities must be carried out in such a manner that if blasting noise should propagate to a noise sensitive place, then*
>
> *a) the airblast overpressure must not be more than 115 dB(linear) peak for nine out of any 10 consecutive blasts initiated, regardless of the interval between blasts; and*
>
> *b) the airblast overpressure must not exceed 120 dB(linear) peak for any blast"*

2) Blasting Vibration Criteria

> *"Blasting operations must be carried out in such a manner that if ground vibration should propagate to a noise-sensitive place:*
>
> *a) the ground-borne vibration must not exceed a peak particle velocity of 5mm per second for nine out of any 10 consecutive blasts initiated, regardless of the interval between blasts; and*
>
> *b) the ground-borne vibration must not exceed a peak particle velocity of 10mm per second for any blast."*

3) Times of blasting

> *"Blasting should generally only be permitted during the hours of 9am to 3pm, Monday to Friday, and from 9am to 1pm on Saturdays. Blasting should not generally take place on Sundays or public holidays.*
>
> *Blasting outside these recommended times should be approved only where:*

a) *blasting during the preferred times is clearly impracticable (in such situations blasts should be limited in number and stricter airblast overpressure and ground vibration limits should apply; or*

b) *there is no likelihood of persons in a noise-sensitive place being affected because of the remote location of the blast site."*

4) Weather effects

"When a temperature inversion or a heavy low cloud cover is present, values of airblast overpressure will be higher than normal in surrounding areas. Accordingly, blasting should be avoided if predicted values of airblast overpressure in noise-sensitive places exceed acceptable levels. If this is not practicable, blasting should be scheduled to minimise noise annoyance. An appropriate period is generally between 11am and 1pm. Similarly, blasting should be avoided at times when strong winds are blowing from the blasting site towards noise sensitive places."

19.1.1.5. Assessment of Low Frequency Noise Guideline (Draft)

The draft *Assessment of Low Frequency Noise Guideline* (EPA 2004) is applicable to low frequency noise (frequency less than 200 Hz) emitted from industrial premises, commercial premises, mining and extractive operations. The intent of the guideline is to accurately assess annoyance and discomfort caused by low frequency noise within sensitive receiver locations such as within dwellings.

Sources of high level low frequency noise having content less than 200 Hz may include boilers, pumps, transformers, cooling fans, compressors, oil and gas burners, electrical installations, diesel engines, asynchronous motors, ventilation and air conditioning equipment, wind turbulence and large chimney resonance.

Where a noise impact exhibits unbalanced frequency spectra, the overall sound pressure level inside residences should not exceed an unweighted 50 dB(Lin) to avoid complaints of low frequency noise annoyance. If the dB(Lin) measurement exceeds the dB(A) measurement by more than 15 dB, a one-third octave band measurement in the frequency range 10 to 200 Hz should be carried out.

The draft guideline has been used to assess low frequency noise impacts at sensitive receivers from the pump stations.

19.1.2. Methodology

Noise monitoring was conducted to quantify the existing ambient noise environment surrounding the subject site, and will be used to determine the noise limits for the Project.

Ambient noise levels were measured with noise loggers at four representative locations between 20 October and 3 November 2008. The noise logger locations were selected to be near NSR's. The residences / areas represented by each noise logger are indicated in Table 19-3. These areas are expected to represent the potentially noise affected areas that surround the Project site, as well as the township of Taroom.

Figure 19-1 shows the approximate locations of the four noise-logging locations in relation to the proposed Project water storage.

Noise monitoring was conducted in accordance with Australian Standard AS1055.1-1997 *Acoustics – Description and Measurement of Environmental Noise*.

Table 19-3 Residences represented by each noise logger location

Closest Noise Sensitive Receiver	Logger Location	Closest activity and approximate distance	Notes on noise logging locations
NSR 2	"Boggomoss" – Lot 3 on LE232	Dam site establishment and construction at 8.0 km Road works (Glebe Weir Rd) at 500 m	Properties to the north of the water storage and Dam wall, adjacent to Glebe Weir Road and the Precipice National Park. The NSR is located in a rural area, with existing ambient noise levels typical of such an area. Dominant noise sources were from animals and natural sounds such as wind rustling leaves. The logger was positioned approximately 20 m from Glebe Weir Road. This road is carries minimal traffic volumes.
NSR 10	"Moorang" – Lot 12 on FT7	Roadworks (Cracow Rd) at 1.7 km Pipeline Construction at 3.2 km	Properties to the south of the water storage and Dam wall and in the vicinity of Cracow Road. The NSR is located in a rural area, with existing ambient noise levels typical of such an area. Dominant noise sources were from animals and natural sounds such as wind rustling leaves. Farming equipment is also expected to contribute to the noise levels measured at the site.
NSR 8	"Riverview" – Lot 182 on SP147005	Roadworks (Brodies Rd) at 1 km	Properties to the west of the Project, not including those bounded by the Leichhardt Highway. The NSR is located in a rural area, with existing ambient noise levels typical of such an area. The dominant noise source during the site visit was from domestic dogs barking inside a kennel.
NSR 31	Taroom Hospital - Miller Street, Taroom.	Away from construction activities	The township of Taroom. The Taroom Hospital is located near the corner of Miller Street and Yaldwyn Street. The existing ambient noise environment consisted of animal noises such as bird and rooster calls as well as noise from surrounding residential properties. Occasional cars passing by were observed during the site visit.

19.1.3. Dam and surrounds

This section describes the existing noise environment in the dam area and surrounds, and presents results from noise monitoring.

19.1.3.1. Sensitive receivers

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

- residential dwellings surrounding the proposed dam site;
- residential dwellings located along the first stage of the proposed water supply pipeline route, balancing storage and pumping stations;
- residential dwellings near to road upgrade / construction areas;
- residential dwellings located along transport routes to be utilised during construction; and

- Precipice National Park: The Precipice National Park is located to the northeast of the proposed dam site. The National Park is protected under the *Nature Conservation Act 1992* and is therefore considered a noise sensitive receiver under EPA guidelines.

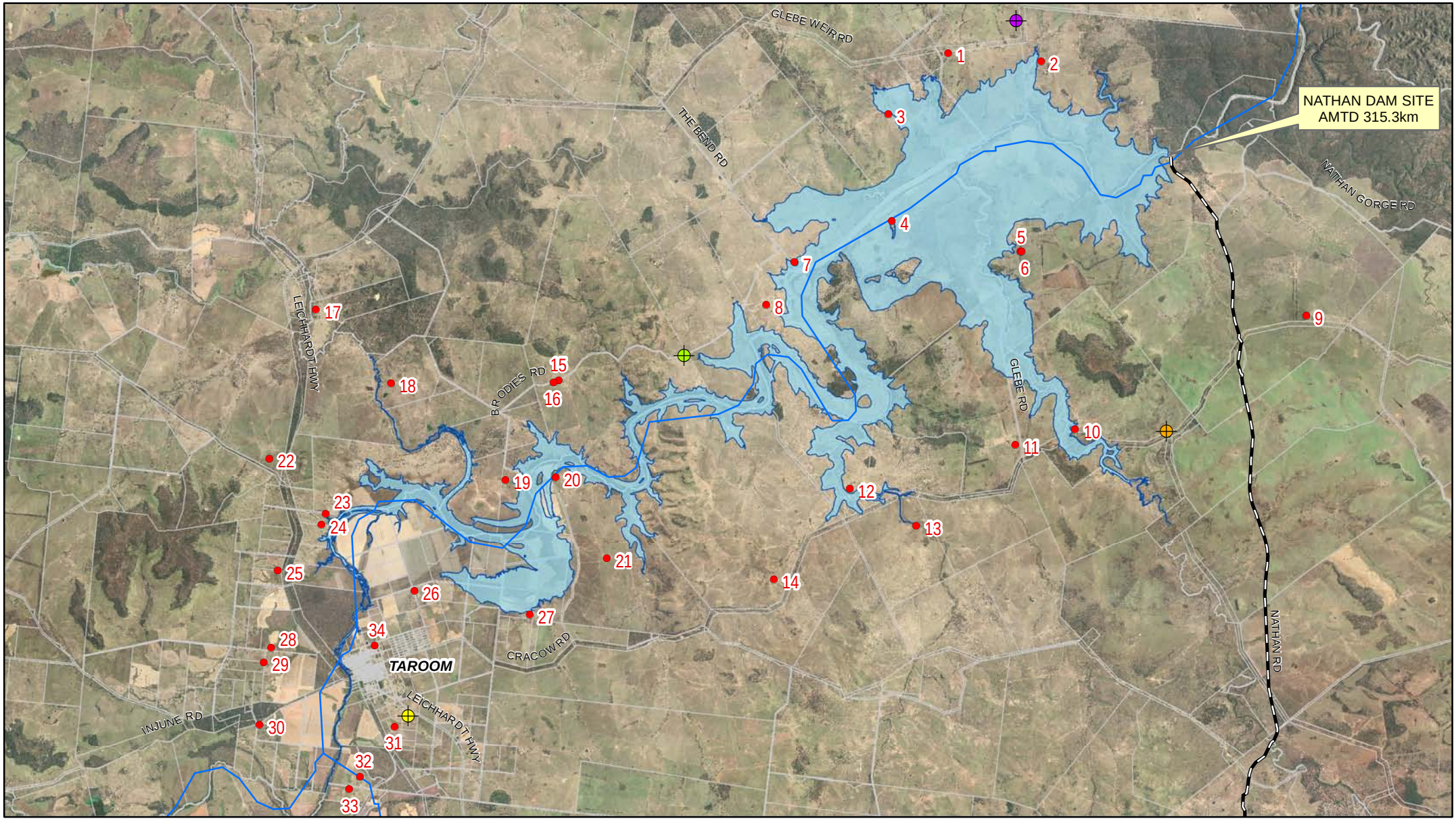
Noise logging has been conducted to represent the potentially most affected sensitive receivers as outlined above and will be used for assessment purposes.

Table 19-14 shows a list of sensitive receivers and Figure 19-1 shows their location on a map.

Table 19-4 Noise sensitive receivers surrounding the Nathan Dam site and the relevant noise generating construction activities

Noise Sensitive Receiver	Approximate location		Closest Noise Generating Activity	Approximate distance to nearest noise and/or vibration generating activity
	East	North		
1	201430	7184250	Road upgrades - Glebe Weir Road	130 m
2	205051	7183480	Road upgrades - Glebe Weir Road	1.5 km
3	198900	7181812	Road upgrades - Glebe Weir Road	2.2 km
4	199041	7177788	Receiver inside flooding area	-
5	204269	7176153	Site establishment and construction	7 km
6	204507	7176132	Site establishment and construction	7 km
7	195427	7176003	Road upgrades - Broadies Road & the bend Road	1.8 km (NSR may be inundated)
8	194280	7174478	Road upgrades - Broadies Road	800 m
9	215498	7174156	Site establishment and construction Pipeline construction	8.4 km 2.9 km
10	206243	7169577	Road upgrades - Cracow Road	200 m (NSR may be inundated)
11	203638	7169096	Road upgrades - Cracow Road	1 km
12	197504	7167353	Road upgrades - Southern rec area access & Cracow Road (Bentley Creek)	900 m (NSR may be inundated)
13	200005	7165737	Road upgrades - Cracow Rd (Bentley Creek)	1.5 km
14	194267	7163713	Road upgrades - Southern rec area access	2.8 km
15	186098	7171409	Road upgrades – Bundulla Road	3.3 km
16	185953	7171378	Road upgrades – Bundulla Road	3.3 km
17	176707	7174126	Receiver is distant from relevant activities	-
18	179654	7171375	Distant relevant activities	-
19	183911	7167508	Road upgrades – Bundulla Road	450 m
20	186089	7167535	Road upgrades – Bundulla Road	200 m (NSR may be inundated)
21-34	187717	7164502	Receiver is distant from relevant activities	-

Note: the location of clearing activities is not known. This activity has been assessed on a distance to comply basis and therefore it is not indicated in **Table 19-4**. Accordingly, all potential sensitive receivers have been included, even those that are distant from all other activities.



LEGEND

Noise Logging Locations

- Taroom Hospital
- Riverview
- Boggomoss
- Moorang
- Sensitive Receivers
- Proposed Pipeline
- Major Watercourse
- Full Supply Level (183.5m AHD)
- Cadastre

Projection: GDA94 Zone 56

Figure 19-1

0 1.25 2.5 5 Kilometres

N

Scale 1:200,000 (at A4)

SKM SunWater Making Water Work

NATHAN DAM AND PIPELINES EIS

Identified Noise Sensitive Receivers (NSRs)

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19.1.3.2. Ambient noise levels

The noise logging results used as representative noise values at NSRs are presented in Table 19-5.

Table 19-5 Noise logging results used as representative noise values at NSRs (free field), dB(A)

Noise Descriptor	Time period	Logger ID			
		Boggomoss NSR 2	Moorang NSR 10	Riverview NSR 8	Taroom NSR 31
$L_{A10,18hrs}$	6am to 12 midnight	43.3	43.2	45.0	51.4
$L_{Aeq,24hrs}$	24 hours	42.2	41.8	45.5	51.0
$L_{Aeq,1hr}$	Maximum 1 hour, 24 hours	46.0	46.4	51.5	57.1
$L_{Aeq, (Av. Day)}$	Average day period – 7am to 6pm	43.3	41.8	41.4	52.1
$L_{Aeq, (Av. Evening)}$	Average evening period – 6pm to 10pm	42.7	43.5	48.6	53.1
$L_{Aeq, (Av. Night)}$	Average night period – 10pm to 7am	40.3	39.8	44.1	46.4
$L_{A10, (Av. Day)}$	Average day period – 7am to 6pm	43.9	42.5	42.4	52.4
$L_{A10, (Av. Evening)}$	Average evening period – 6pm to 10pm	43.6	43.2	49.7	50.2
$L_{A10, (Av. Night)}$	Average night period – 10pm to 7am	36.2	39.7	42.4	44.8
$L_{A90, (Av. Day)}$	Average day period – 7am to 6pm	30.2	29.0	31.4	41.6
$L_{A90, (Av. Evening)}$	Average evening period – 6pm to 10pm	34.8	36.2	42.7	41.9
$L_{A90, (Av. Night)}$	Average night period – 10pm to 7am	29.1	30.1	28.7	36.6

The noise logging results have been used to determine the RBL, which is presented in Table 19-6. This is discussed in Section 19.1.1.3. The RBL is used to determine the noise criteria for the operational stage of the Project.

Table 19-6 Rated Background Levels (RBL) for each noise logging location

Noise Descriptor	Time period	Logger ID			
		Boggomoss NSR 2	Moorang NSR 10	Riverview NSR 8	Taroom NSR 31
RBL, (Day)	Day Period – 7am to 6pm	27	26	34	38
RBL, (Evening)	Evening Period – 6pm to 10pm	30	30	34	37
RBL, (Night)	Night Period – 10pm to 7am	25	26	20	33

The meteorological conditions present during the noise logging period have been considered to determine the influence of weather on the recorded noise levels. All rain and wind affected data has been excluded from the noise logging results. In accordance with AS1055-1997, data was considered to be wind affected if the maximum wind gust exceeded 5 m/s any day containing four hours total.

Recorded meteorological data for the Taroom Weather Station (ID 035070, located at Lat –25.64, Lon 49.80, Height 199 m) was obtained from the Bureau of Meteorology. The station is located approximately 32 km southwest (SW) of the proposed dam wall. Data for the Taroom Weather Station has been used for assessment purposes.

19.1.3.3. Ambient vibration levels

There were no significant vibration sources in the Project area that are likely to influence ambient vibration levels at sensitive receiver locations.

19.1.4. Pipeline

19.1.4.1. Ambient noise levels

Given the length of the pipeline (260 km) it is not feasible to determine the exact characteristics of ambient noise levels along its entire length. It is expected that in rural areas with negligible transportation, noise levels will be represented by the noise levels measured near NSR 8 (Moorang). In areas with medium or dense transportation or some commerce or industry the noise levels will be represented by Noise Category R3 or R4 of Appendix A from AS1055.2-1997 – *Acoustics- Description and Measurement of Environmental Noise*, as shown in Table 19-7.

Table 19-7 Estimated average background sound pressure levels ($L_{A90,T}$) for areas containing residences in Australia

Noise area category (Notes 1 and 2)	Description of neighbourhood	Average background A-weighted sound pressure level, $L_{A90,T}$					
		Monday to Saturday			Sundays and public holidays		
		0700-1800	1800-2200	2200-0700	0900-1800	1800-2200	2200-0900
R1	Areas with negligible transportation	40	35	30	40	35	30
R2	Areas with low density transportation	45	40	35	45	40	35
R3	Areas with medium density transportation or some commerce or industry	50	45	40	50	45	40
R4	Areas with dense transportation or some commerce or industry	55	50	45	55	50	45
R5 (See Note 3)	Areas with very dense transportation or in commercial districts or bordering industrial districts	60	55	50	60	55	50
R6 (See Note 3)	Areas with extremely dense transportation or within predominantly industrial districts	65	60	55	65	60	55

NOTES:

1. The division into noise area categories is necessary in order to accommodate existing sound levels encountered at residential sites in predominantly commercial or industrial districts, or in areas located close to main land transport routes, i.e. road and rail.

2. The noise area category most appropriate should be selected irrespective of metropolitan or rural zoning and will vary from location to location.

3. Some industrial and commercial sites are not predominant sources of high background sound levels.

19.1.4.2. Ambient vibration levels

There were no significant vibration sources in the Project area that are likely to influence ambient vibration levels at sensitive receiver locations.

19.1.5. Associated infrastructure

The construction of the following associated infrastructure has the potential to generate noise impacts at sensitive receivers.

- road construction and road upgrades; and
- clay extraction activities

Ambient noise levels discussed for the dam and surrounds (Section 19.1.3.2) are also relevant for the road construction and upgrades and quarrying (clay borrow areas).

Given the distance of potential vibration sources to receivers no vibration impacts are expected from these activities onto sensitive receivers.

19.1.6. Project noise and vibration goals

19.1.6.1. Construction noise and vibration goals

With the exception of the pipeline, which will be built partially near residential areas, most NSRs surrounding the Project are located in rural areas. The EPP Noise dwelling (outdoors) acoustic quality objective of 50 dB(A) $L_{Aeq,1hr}$ has been applied as the noise criteria (for construction noise) in lieu of any specific guidelines for construction noise.

19.1.6.2. Operational noise and vibration goals

In order to assess the operational noise from the Project, the RBL and PNL were determined for each of four noise logging locations.

The *Planning for Noise Control* document provides recommended RBLs based on the surrounding land use to prevent background noise levels from progressively increasing over time with the introduction of new commerce or industry. The RBLs have been derived from the noise monitoring results, and correspond to the median of the 90th percentile of the background (L_{A90}) noise levels for each daytime, evening and night period. The recommended RBLs for each of the noise sensitive receivers, based on the dominant land use of each site are presented in Table 19-8.

Table 19-8 Recommended outdoor background noise planning levels for each noise sensitive receiver

Location	Receiver Land Use	Receiver Area Dominant Land Use	Day	Evening	Night
Boggomoss NSR 2	Purely Residential	Rural	35	30	25
Moorang NSR 10	Purely Residential	Rural	35	30	25
Riverview NSR 8	Purely Residential	Rural	35	30	25
Taroom NSR 31	Residential on a busy road or near an industrial area or commercial area	Residential, church, hospital, school	45	40	35

Note: The dominant land use is defined by a radius of 200 m from the receiver location under consideration.

In order to prevent background creep, the noise criteria are adjusted where the RBLs approach the recommended levels listed in Table 19-8. The adjustments to the recommended RBLs are presented in Table 19-9.

Table 19-9 Adjustments to recommended RBL to prevent background creep from occurring

Existing background level at residential receiver	Recommended $L_{A90,1hr}$
>Recommended RBL	Background – 10 dB(A)
=Recommended RBL	Recommended RBL – 10 dB(A)
Recommended RBL - 1	Recommended RBL – 9 dB(A)
Recommended RBL - 2	Recommended RBL – 5 dB(A)
Recommended RBL - 3	Recommended RBL – 3 dB(A)
Recommended RBL - 4	Recommended RBL – 2 dB(A)
Recommended RBL - 5	Recommended RBL – 2 dB(A)
<Recommended RBL - 5	Background + 5 dB(A)

Note: It may not be possible to maintain background levels in rural areas below 25 dB(A) as developments occur. In such cases a threshold background level of 25 dB(A) is to be used.

Based on the RBLs obtained through the noise logging data, and adjustments to prevent the occurrence of background creep, the adjusted RBLs (i.e. RBL,adj) are presented in Table 19-10.

Table 19-10 Adjusted RBLs for the prevention of background creep

Noise Sensitive Receiver	Recommended RBL,adj in dB(A)		
	Day	Evening	Night
Boggomoss - NSR 2	32	25*	25*
Moorang - NSR 10	31	25*	25*
Riverview - NSR 8	26	25*	25*
Taroom - NSR 31	43	37	30

*: Threshold background level of 25 dB(A) used.

The rating level $L_{Ar,T}$ is the equivalent continuous A-weighted sound pressure level $L_{Aeq,T}$, adjusted for tonality and impulsiveness as outlined in the EPA's Ecoaccess guideline *Planning for noise control.* It is set to 3dB(A) above the RBL,adj presented in Table 19-10 provided it does not exceed the PNL guidelines presented in *Table 3* of *Planning for noise control*.

The applicable noise criteria for the operational phases of the Project for each of the noise logging locations are listed in Table 19-11. The noise criteria have been derived using Equation 1 and Equation 2, on the basis that the noise sources will not be noticeably tonal at the surrounding noise sensitive receivers.

Table 19-11 Applicable noise criteria for the operations of the Project

Location	Applicable PNL ($L_{Ar,T}$), dB(A)		
	Day	Evening	Night
Boggomoss - NSR 2	35	28	28
Moorang - NSR 10	34	28	28
Riverview - NSR 8	29	28	28
Taroom - NSR 31	46	40	33

19.2. Potential impacts and mitigation measures

19.2.1. Methodology

Noise and vibration impacts from the construction and operation of the Project have been assessed in this section. Construction noise levels were predicted using SoundPLAN software, which is accepted by local councils and DERM.

The calculation method selected for the construction and operational noise prediction is the CONCAWE method, because of its capability of incorporating meteorological effects in noise calculations for large distances. The worst-case propagation conditions have been used in the noise model.

The noise emissions of the highest noise generating activities of the dam and pipeline construction and road upgrades have been modelled.

The closest NSR to the Project site (Dam) is located approximately 6.0 km to the northwest. Other NSRs are considered relevant, as they will be close to pre-construction activities.

19.2.2. Dam and surrounds – construction phase

The following stages in the dam construction are expected to generate the highest noise levels given the high number of noise sources or their closeness to NSRs:

- site establishment;
- dam construction; and
- clearing of the water storage.

19.2.2.1. Noise impacts

Table 19-12 details the modelled dam construction stages and their associated noise sources, based on the information provided in the Project description.

Table 19-12 Dam construction stages and associated noise sources

Work Item	Anticipated Plant Requirement	SWL in dB(A)
Access road construction and upgrading	2 x excavators	107 (Excavator); 109.5 (beeper)
	2 x backhoe	107 (backhoe); 109.5 (beeper)
	3 x water trucks	112
	3 x 825 compactors	107.5
	3 x graders	119.6
	3 x tip trucks	108.3
	1 x bitumen truck	84
	1 x tractor broom	80
	5 x twin cab 4x4	Not used
Clearing	3 x A variety of excavators with attachments including tree grabs, hooks, mulchers	107 (Excavator); 109.5 (beeper)
	2 x Horizontal tub grinders	119.6
	2 x Broad acre mulchers	80
	4 x Tippers and semi-tippers	79.1
	2 x Transport vehicles	Not used
Site establishment	4 x broad-acre mulchers	80
	2 x excavators (tree pullers, mulchers, pincers)	107 (Excavator); 109.5 (beeper)
	2 x horizontal tub-grinders	119.6
	3 x 6x6 dump trucks	114.4
	1 x RCC batch plants containing:	
	1 x Wheeled loader	108
	2 x Concrete pump + Concrete mixer truck idling	103.1
	2 x Concrete pump + Concrete mixer truck pumping	109.8
	2 x 20KW Water pumps	93.1
	1 x concrete batch plant containing:	108
	1 x Wheeled loader	103.1
	1 x Concrete pump + Concrete mixer truck idling	109.8
	1 x Concrete pump + Concrete mixer truck pumping	93.1
	3 x 20KW Water pumps	110.4 (Dozer); 109.5 (beeper)
	2 x dozers	107 (Excavator); 109.5 (beeper)
	2 x excavators	119.6
	1 x grader	119.6
	3 x scrapers	114.4
	4 x 6x6 dump trucks	107.5
	1 x compactors	112
	2 x water carts	

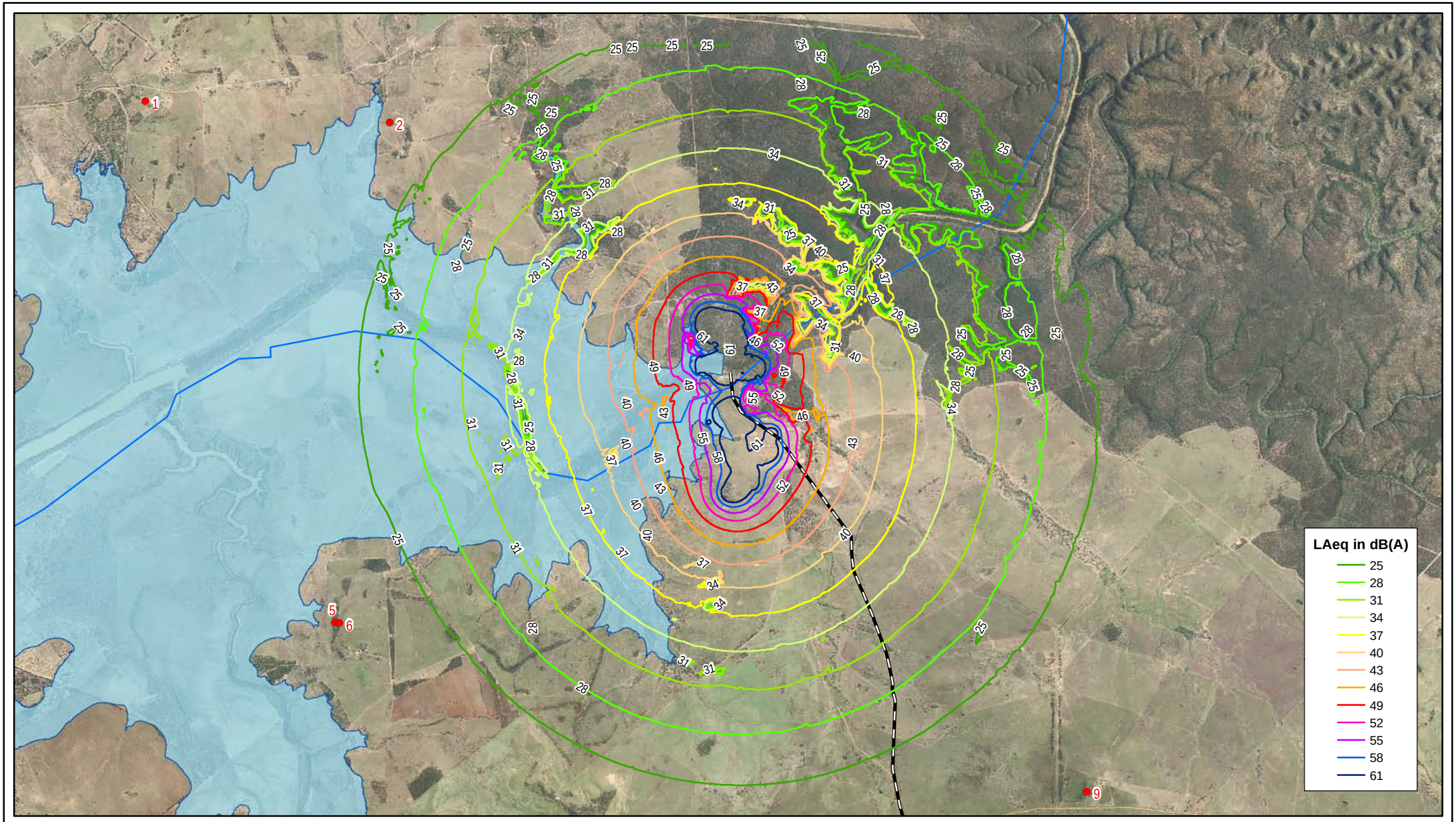
Work Item	Anticipated Plant Requirement	SWL in dB(A)
Dam construction	2 x drill rigs	*
	2 x excavators	107 (Excavator); 109.5 (beeper)
	2 x large dump trucks	114.4
	2 x water carts	112
	3 x scrapers	119.6
	3 x 6x6 dump trucks	114.4
	2 x large dump trucks	114.4
	2 x water trucks	112
	2 x graders	119.6
	2 x compressors	*
	1 x de-sanding plant	*
	3 x pumps	93.1
	1 x recycle water plant	*
	1 x concrete pumps	93.1
	1 x batch plant and associated equipment	*
	1 x crane	88.9
	1 x grout curtain testing equipment	*
	1 x grout mixer	*
	1 x pressure grouting equipment	*
	1 x grout delivery plant	*
	2 x 966 loaders	108

* Sound power levels could not be obtained for these noise sources. However, noise predictions for the site establishment scenario (with similar noise sources to the dam construction) show that the noise levels will be significantly below the noise criteria. We expect that these noise sources will have similar noise emissions to those from the Site Establishment stage. Therefore the noise emissions from the unmodelled sources would not be sufficient to cause an exceedance of the criteria

Site establishment

Figure 19-2 shows a noise contour map for the site establishment operations. The noise contour map was calculated for all applicable noise sources from Table 19-12 and the worst-case noise propagation conditions and worst-case weather conditions.

Figure 19-2 shows the closest current NSRs to the construction site. The closest NSRs at the time of construction will be NSR 2, NSR 5 and NSR 6, the closest being at approximately 6 km from the site. The predicted noise level at NSR 2 is approximately 23 dB(A). Therefore no noise impacts are expected for the operation of heavy machinery at site during site establishment operations.



LEGEND

- Sensitive Receivers
- Proposed Pipeline
- Major Watercourse
- Full Supply Level (183.5m AHD)

Projection: GDA94 Zone 56

Figure 19-2

0 0.5 1 2
Kilometres

N

Scale 1:75,000 (at A4)

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NATHAN DAM AND PIPELINES EIS

Site establishment noise contour map

I:\QENV2\Projects\QE40192\400 - Nathan - Spatial\ArcMXD\Figures\190_Noise_Vibration\Figure_19-2_Site_Establishment_Noise_Contours_v2.mxd Produced: 14/06/2011

- Dam construction

The dam construction activities are similar to the site establishment activities in the number of machines and in the type of machines to be used. Predicted noise levels at NSR 2 (the closest to the dam site) are approximately 23 dB(A) for the Site establishment operations. We note that for a 10 dB(A) increase in noise level to occur at these receivers (which would still be below the EPP (Noise) 2008 acoustic quality objectives), the number of machines must increase tenfold. Therefore no noise impacts are expected for the dam construction stage at all NSRs.

- Vegetation clearing

Figure 19-3 shows typical LA_{eq} noise contours produced by clearing activities at 1.8 m above natural terrain. Noise contours were calculated from the noise sources listed in Table 19-12 (which form part of the Project description) to determine the approximate distance at which the EPP (Noise) 2008 50 dB(A) $LA_{eq,1h}$ Acoustic Quality objective would be achieved. The noise sources are spread over a 500m distance (it has been assumed that all applicable noise sources from Table 19-12 operate in the same area). This figure shows that the 50 dB(A) target would be exceeded should operations be located within 580 m from any NSRs. If this were the case, an Environmental Management Plan (Section 29.9.15) should be implemented to manage any potential noise impacts.

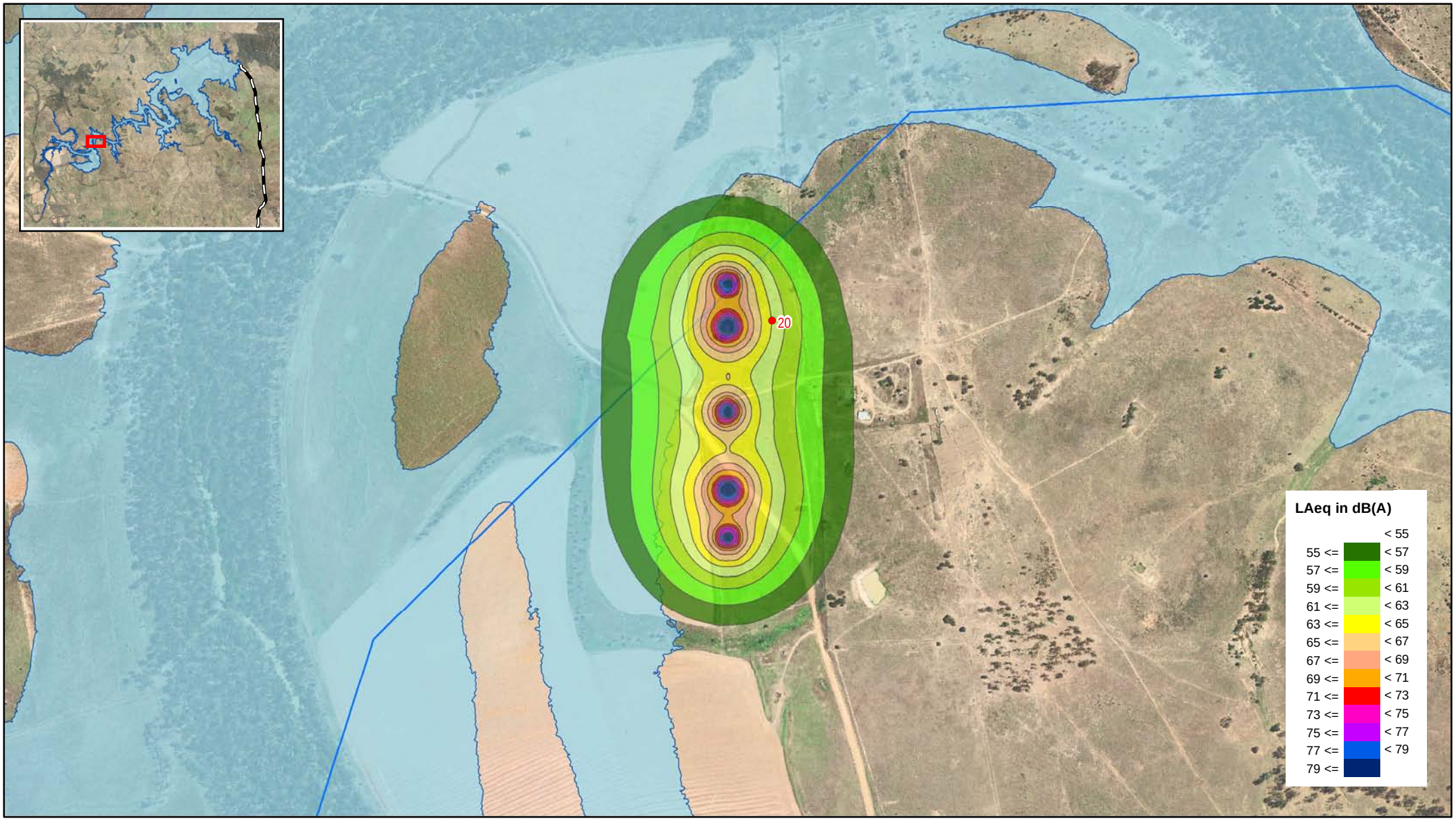
19.2.2.2. Blasting impacts

The main source of vibration from dam construction activities is likely to be the use of explosives for the excavation of the diversion channel. Estimation of vibration and overpressure levels for a range of different charge masses has been used to assess potential blasting impacts at sensitive receivers.

The guidelines including limits and calculation methods for air blast overpressure and ground vibration associated with blasting activities have been outlined in Section 19.1.1.4.

Adopting this approach, the explosive charge mass that would produce a maximum air blast overpressure limit of 115 dB(L) at the nearest residence to the blast site has been estimated. The closest residences to the most likely blasting site are NSR10 and NSR 11, which are located approximately 6.0 km from the dam site.

Figure 19-4 presents the explosive charge mass in kilograms required to produce an air blast overpressure of 115 dB(L) at the closets NSRs. The constant 'K_a' in the blast noise formula is not known (Section 19.1.1.4). Therefore a range of explosive charge masses 'Q' has been used in calculations for a range of common site constants 'K_a'. The lowest mass for each site constant is used in the assessment.



LEGEND

- Sensitive Receivers
- Proposed Pipeline
- Major Watercourse
- Full Supply Level (183.5m AHD)

Projection: GDA94 Zone 56

Figure 19-3

0 50 100 200
Metres

N

Scale 1:10,000 (at A4)

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NATHAN DAM AND PIPELINES EIS

Typical $L_{Aeq.1hr}$ noise levels produced by clearing operations

I:\QENV2\Projects\QE40192\400 - Nathan - Spatial\ArcMXD\Figures\190_Noise_Vibration\Figure_19-3_LAeq1hr_NoiseContours_ClearingOps.mxd Produced: 14/06/2011

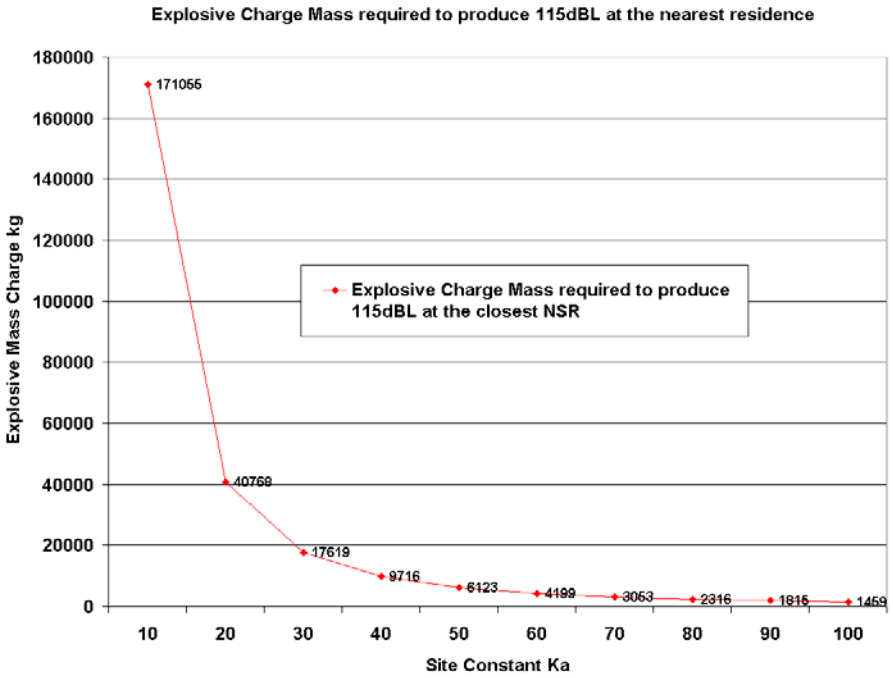


Figure 19-4 Explosive mass charge required to produce 115 dBL at the closest NSRs with varying site constants

Formulae from the guidelines and standards detailed in Section 19.1.1.4 were used to assess ground vibration. It was found that the Effective Charge Mass per Delay to reach the ground vibration velocity limit of 5 mm/s PPV at the nearest residence is approximately 40,633 kg. It should be noted that even a 500 kg effective charge mass per delay is a significant charge mass, and is unlikely to be used. As the nearest sensitive receivers will be more than 6 km distant and the vibration goal of 5 mm/s and airblast overpressure goal of 115 dB(Lin) (m) are achieved within 1750 m at this charge, no vibration or airblast overpressure impacts are expected from blasting at the dam site.

There is no likelihood of persons in a noise sensitive place being affected by blasting activity because of the remote location of the site. Therefore restrictive time constraints on blasting activity are not considered appropriate.

19.2.3. Dam and surrounds - operations phase impacts

As the dam is not gated the only sources of noise or vibration during operations relate to release of water from the outlet structure or traffic associated with maintenance vehicles or use of the recreation areas. None of these sources would be expected to cause noise or vibration impacts.

19.2.4. Pipeline - construction

For this project it is envisaged that there will be up to four pipe laying fronts. Each front would only open as much trench per day as could be laid in a day.

Pipeline installation is expected to generate the highest noise levels.

Noise emissions have been modelled for this stage.

Table 19-13 shows the noise sources used in the noise model as extracted from the Project Description. For noise modelling purposes, the number of machines for the pipeline installation stage was divided by three to allow for the different construction fronts.

Table 19-13 Anticipated pipeline plant requirements

Stage	Noise sources involved	SWL in dB(A)
Pipeline Installation	12 x excavators (4 used in model)	107 (Excavator); 109.5 (beeper)
	4 x Loaders (2 used in model)	108
	2 x welding equipment	Not used
	Graders (3 used in model)	119.6
	4 x water trucks (2 used in model)	112
	2 x dozers (1 used in model)	110.4 (Dozer); 109.5 (beeper)
	4 x compactors (2 used in model)	107.5

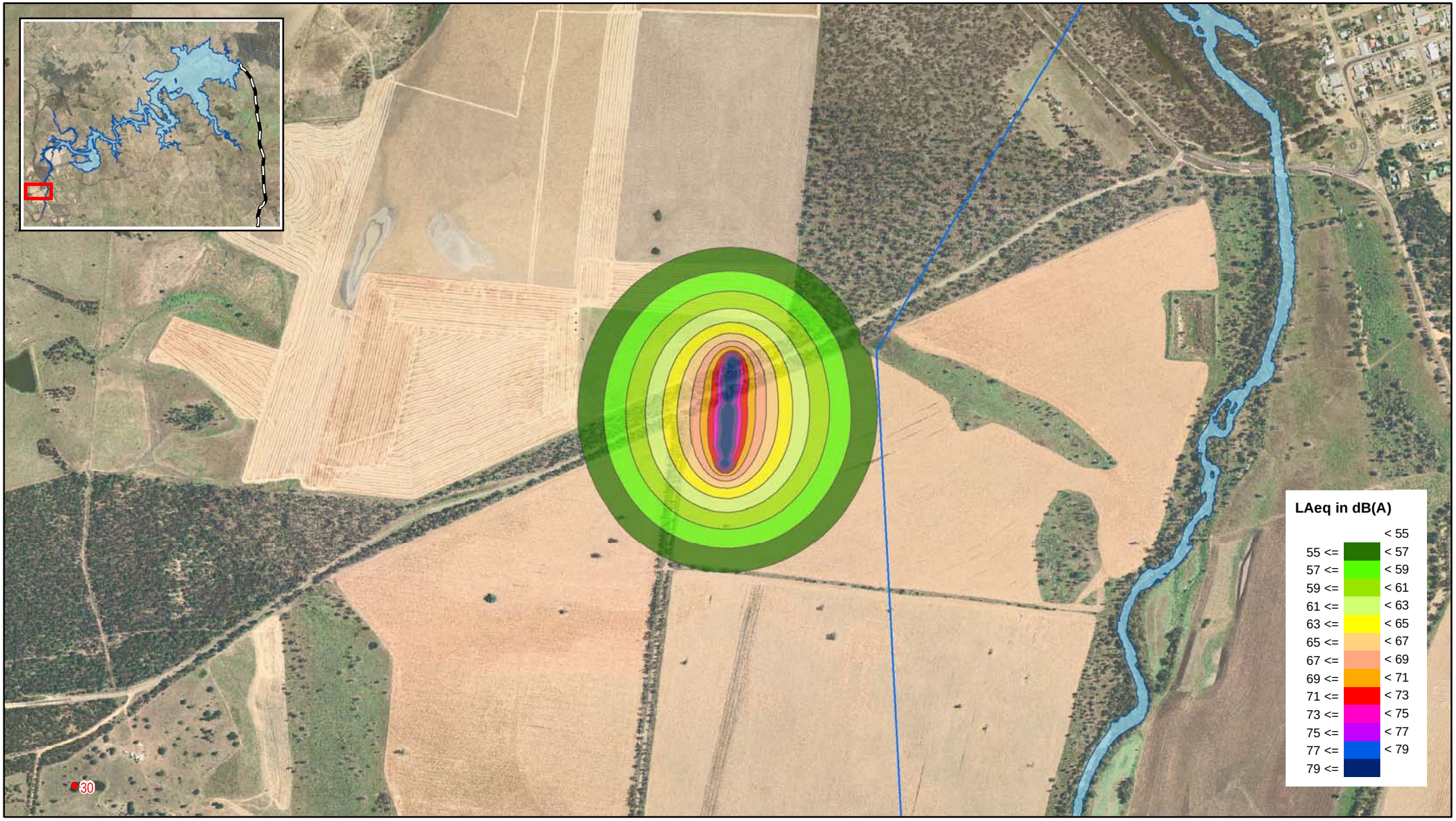
19.2.4.1. Pipeline installation noise impacts

As it is not feasible to model the pipeline construction over its entire length, noise contours were computed to determine typical noise emissions. The noise sources were placed in a 300 m line in the computer model to replicate the trenching/pipelining/backfilling process. Noise contours were calculated to determine the approximate distance at which the EPP (Noise) 2008 50 dB(A) $LA_{eq,1h}$ Acoustic Quality Objective would be achieved. Noise contours were calculated at 1.8 m above natural terrain.

Figure 19-5 shows that the 50 dB(A) target would be exceeded should operations be located approximately within 870 m of any NSRs. If this were the case, an Environmental Management Plan must be implemented to manage any potential noise impact. However, we note that unlike the construction of the dam, pipeline installation moves along the easement and it is of temporary nature relative to any one location. Hence the noise impacts would be of short duration. There will be an increased number of people impacted by construction of the pipeline when it passes towns however this impact will also be of short duration.

19.2.4.2. Vibration impacts

Blasting is not expected to be required to lay the pipeline and therefore was not assessed. If areas of blasting are identified during the detailed design phase, the distance/charge/ground constants based limits derived for dam construction blasting (Figure 17-4) would apply.



LEGEND

- Sensitive Receivers
- Proposed Pipeline
- Major Watercourse
- Full Supply Level (183.5m AHD)

Projection: GDA94 Zone 56

Figure 19-5

0 100 200 400
Metres

N

Scale 1:15,000 (at A4)

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NATHAN DAM AND PIPELINES EIS

Typical $L_{Aeq.1hr}$ noise levels produced by the pipeline installation operations

I:\QENV2\Projects\QE40192\400 - Nathan - Spatial\ArcMXD\Figures\190_Noise_Vibration\Figure_19-5_LAeq1hr_NoiseContours_Pipeline_InstallationOps.mxd Produced: 14/06/2011

19.2.5. Pipeline - operation

The highest noise contributions from the operation of the pipeline will be from the four pumping stations and power supply facilities that will be installed at the dam and along the pipeline corridor.

The pipeline will generally operate automatically. Water level sensors at each balancing storage station will detect a drop in water level and will activate the pump station to start automatically.

The pump stations will have to comply with the planning noise levels for the night time period as shown in Table 19-11 for noise logging locations Boggomoss, Moorang and Riverview, i.e. an $L_{Ar,T}$ equal to 28 dB(A) at the closest NSRs. Two additional pump stations will be built approximately 38 km from the dam, and another approximately 119 km from the dam. As they will be installed in rural areas noise limits from Table 19-11 would apply.

Noise emissions from pumping stations have been modelled using the equipment and sound powers in Table 19-14.

Table 19-14 Pump operation equipment and sound powers used in noise modelling

Stage	Noise sources involved	SWL in dB(A)
Pipeline Operation	1 x Pump	106
	1 x Generator	129

Figure 19-6 shows a typical LAr,T noise contour produced by pumping station operation. This figure shows that the 28 dB(A) $L_{Ar,T}$ target would be exceeded should operations be located within 6 km of any NSRs.

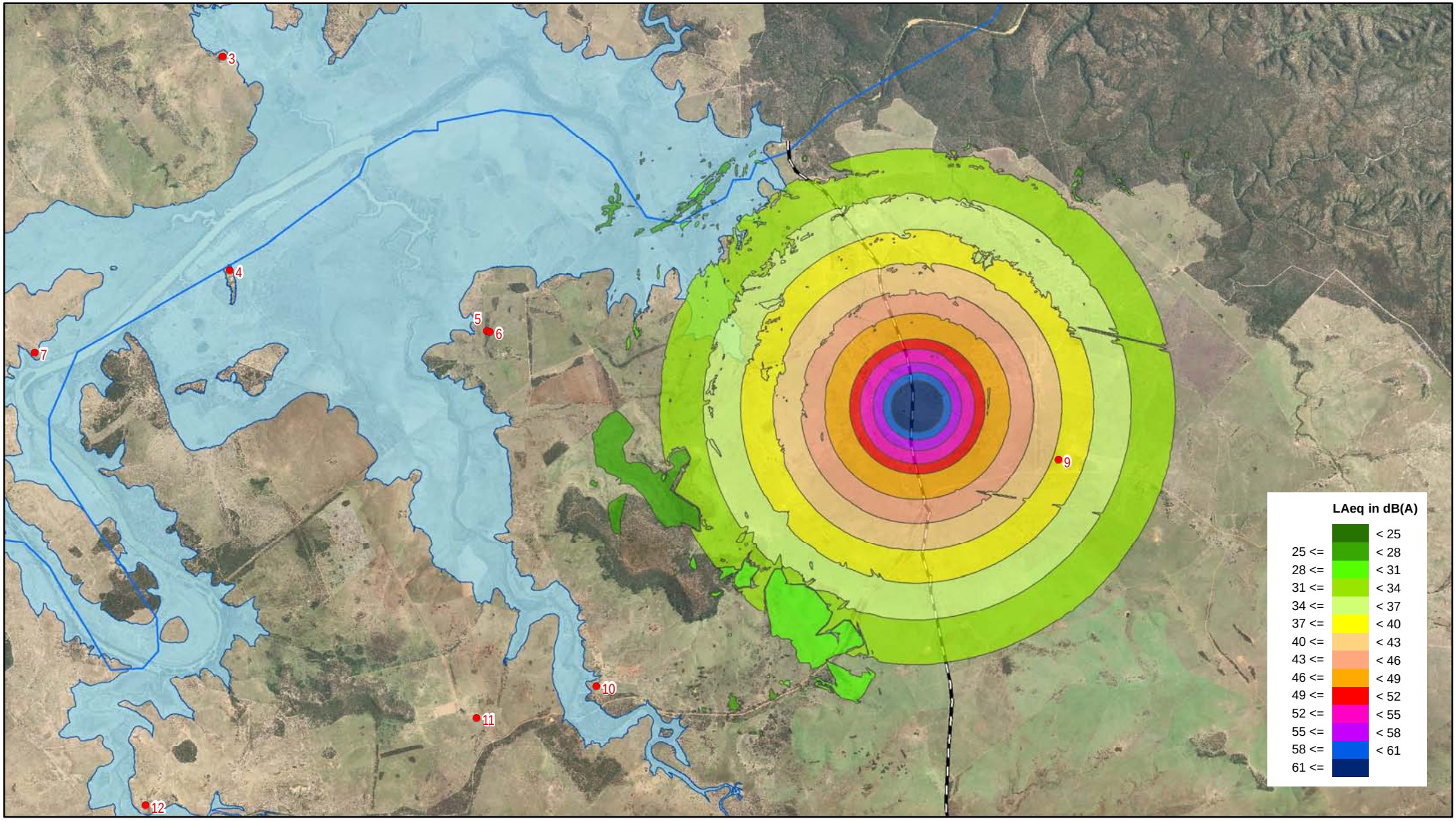
19.2.5.1. Low frequency noise impacts

The pumps and generator have the potential to cause adverse low frequency noise impacts. As per the draft *Assessment of Low Frequency Noise Guideline* (EPA 2004), low frequency noise has the potential to cause noise impacts if the unweighted dB(Lin) exceeds 50 dB. Figure 19-7 shows the predicted unweighted noise levels produced by the pumping stations.

Comparing the $L_{Ar,T}$ noise levels (Figure 19-6) and the unweighted noise levels (Figure 19-7), the 28 dB $L_{Ar,T}$ noise limit is stricter than the 50 dB unweighted noise limit. Therefore, the 28 dB $L_{Ar,T}$ noise limit only is used for this assessment.

It is recommended that the location of these stations be chosen such that they are more than 6 km from noise sensitive receivers, or noise mitigation strategies be employed. Noise mitigation measures could include constructing enclosures for the pumps and their associated power generators and selecting low noise equipment. If enclosures are adopted, they should include silencers at the air intakes and outlets. These elements should also be oriented away from the NSRs.

If pumping stations are to be located within 6 km of any noise sensitive receivers, it is recommended that detailed noise modelling be conducted, with the proposed mitigation measures included.



LEGEND

- Sensitive Receivers
- Proposed Pipeline
- Major Watercourse
- Full Supply Level (183.5m AHD)

Projection: GDA94 Zone 56

Figure 19-6

0 0.5 1 2
Kilometres

N

Scale 1:100,000 (at A4)

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NATHAN DAM AND PIPELINES EIS

Typical predicted pump station noise levels - a weighted

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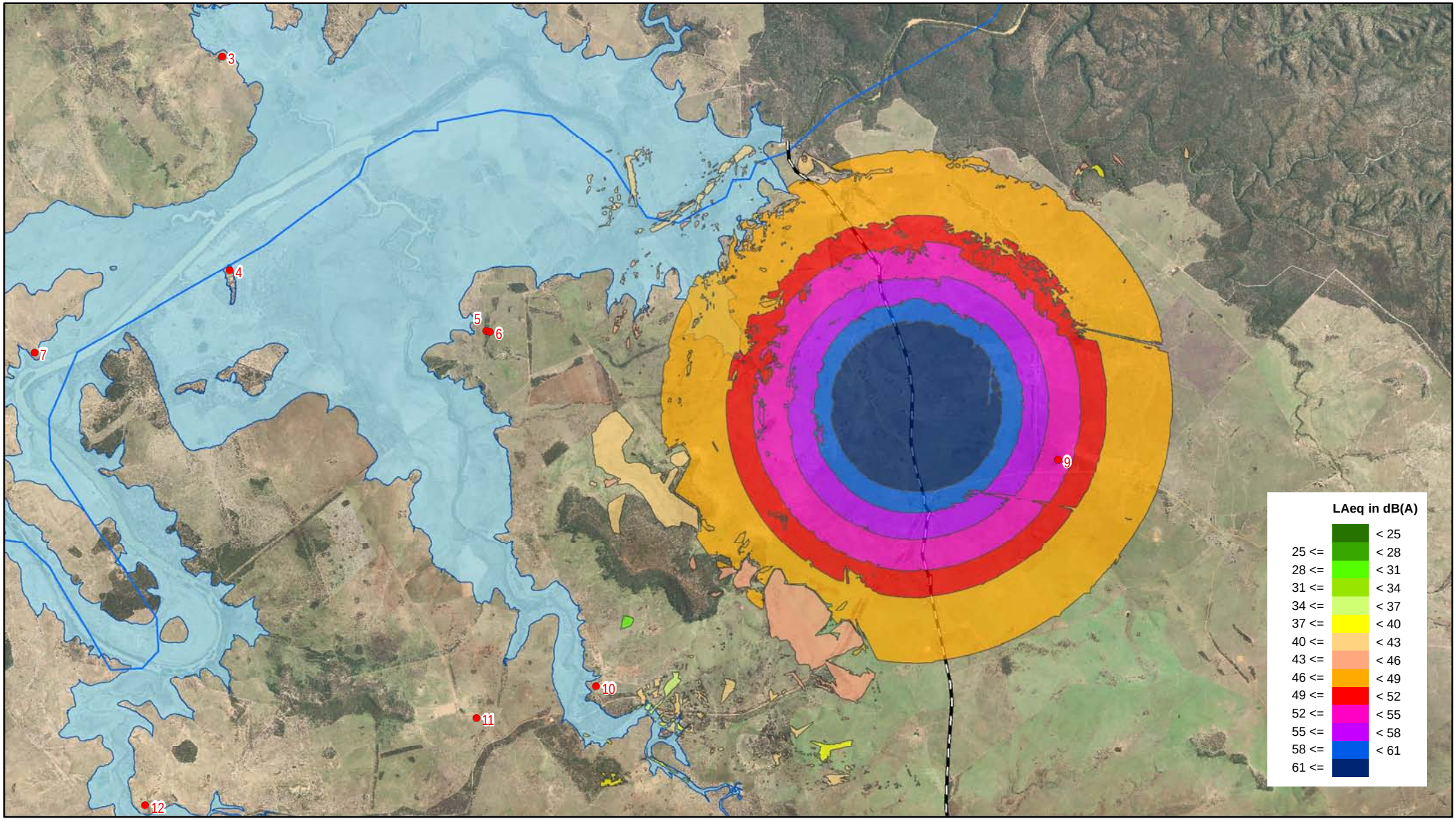

LEGEND

- Sensitive Receivers
- Proposed Pipeline
- Major Watercourse
- Full Supply Level (183.5m AHD)

Projection: GDA94 Zone 56

Figure 19-7

0 0.5 1 2
Kilometres

N

Scale 1:100,000 (at A4)

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NATHAN DAM AND PIPELINES EIS

Typical predicted pump station noise levels - linear weighted

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19.2.5.2. Vibration impacts

No vibration sources are expected from the operation of the pipeline.

19.2.6. Associated infrastructure – road upgrades

19.2.6.1. Noise impacts

Figure 19-8 shows the location of the proposed road works (green) and the closest NSRs. It is expected that the construction of the following road upgrades could produce noise impacts onto NSRs:

- Glebe Weir Road – Upgrade of existing two lane sealed road (24 km). NSR potentially affected is NSR1; and
- Cracow Road (Cockatoo Creek) – Road raised (length 2 km), culverts installed and a 200 m long bridge. NSR potentially affected is NSR10.

NSR 19 and NSR 20 are close to the proposed road works for Bundulla Road. Only turning circles will be constructed as this section of road will be closed. Given the minor amount of work required and the short time expected to be required for this, this road upgrade has not been assessed.

Figure 19-9 shows the predicted noise levels at the NSRs relevant to road construction and upgrades activities. Figure 19-5 shows a typical $LA_{eq,1hr}$ noise contour produced by road works (noise contours were calculated to determine the approximate distance at which the EPP (Noise) 2008 50dB(A) $LA_{eq,1hr}$ Acoustic Quality Objective would be achieved. The noise sources are spread over a 500 m distance (it has been assumed that all applicable noise sources from Table 19-12 operate in the same area). This figure shows that the 50 dB(A) target would be exceeded should operations be located within approximately 880 m of any NSRs. This is the case for NSR 1 and NSR 10, where an environmental Management Plan should be implemented to manage any potential noise impact.

We note that road upgrades are a beneficial asset for residences near them and are of a temporary nature. Hence their noise impacts may be low.

Table 19-15 Road upgrades noise levels at the closest NSRs

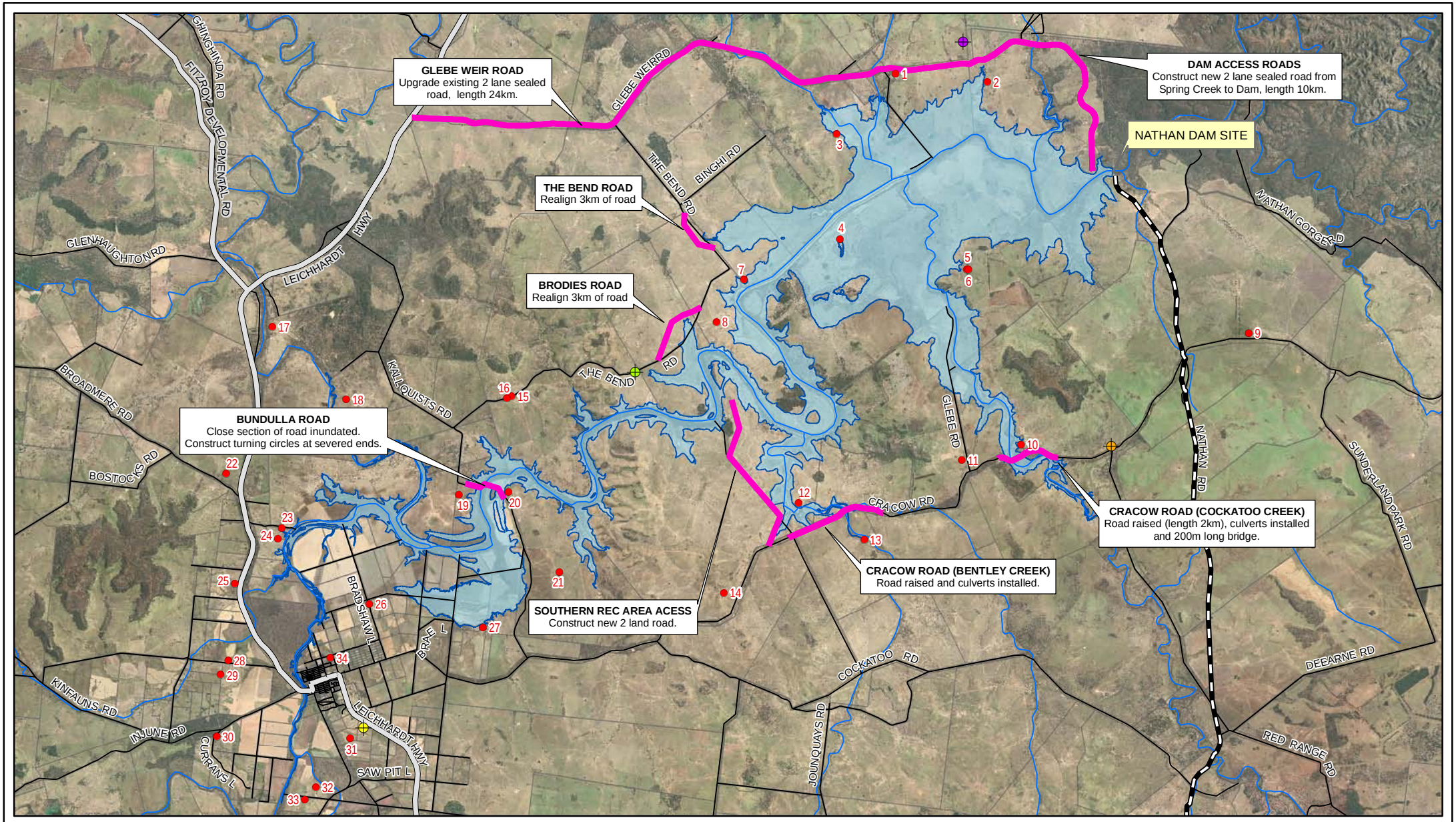
Noise sensitive receiver	Approximate distance to road works	Access roads upgrading approximate noise levels
		$L_{Aeq,1hr}$
NSR 1	200 m	64-66
NSR 10	240 m	62-64

19.2.6.2. Low frequency noise impacts

It is considered that low frequency noise from road construction activities will not be a problem at residences if the buffer distances discussed above are maintained. Where potential problems do occur then noise mitigation measures will be implemented as described in Section 29.9.15 of the EMP.

19.2.6.3. Vibration impacts

For the road construction and operation of associated infrastructure, no vibration impacts are expected.



LEGEND

- Towns
- Sensitive Receivers

Noise Logging Locations

- Taroom Hospital
- Riverview
- Boggomoss
- Moorang

- Proposed Pipeline
- Watercourses
- State Controlled Roads
- Local Roads

- Full Supply Level (183.5 m AHD)
- Cadastre

Projection: GDA94 Zone 56

Figure 19-8

0 1.25 2.5 5
Kilometres

N

Scale 1:200,000 (at A4)

SKM SunWater Making Water Work

NATHAN DAM AND PIPELINES EIS

Proposed road works and approximate location of NSRs

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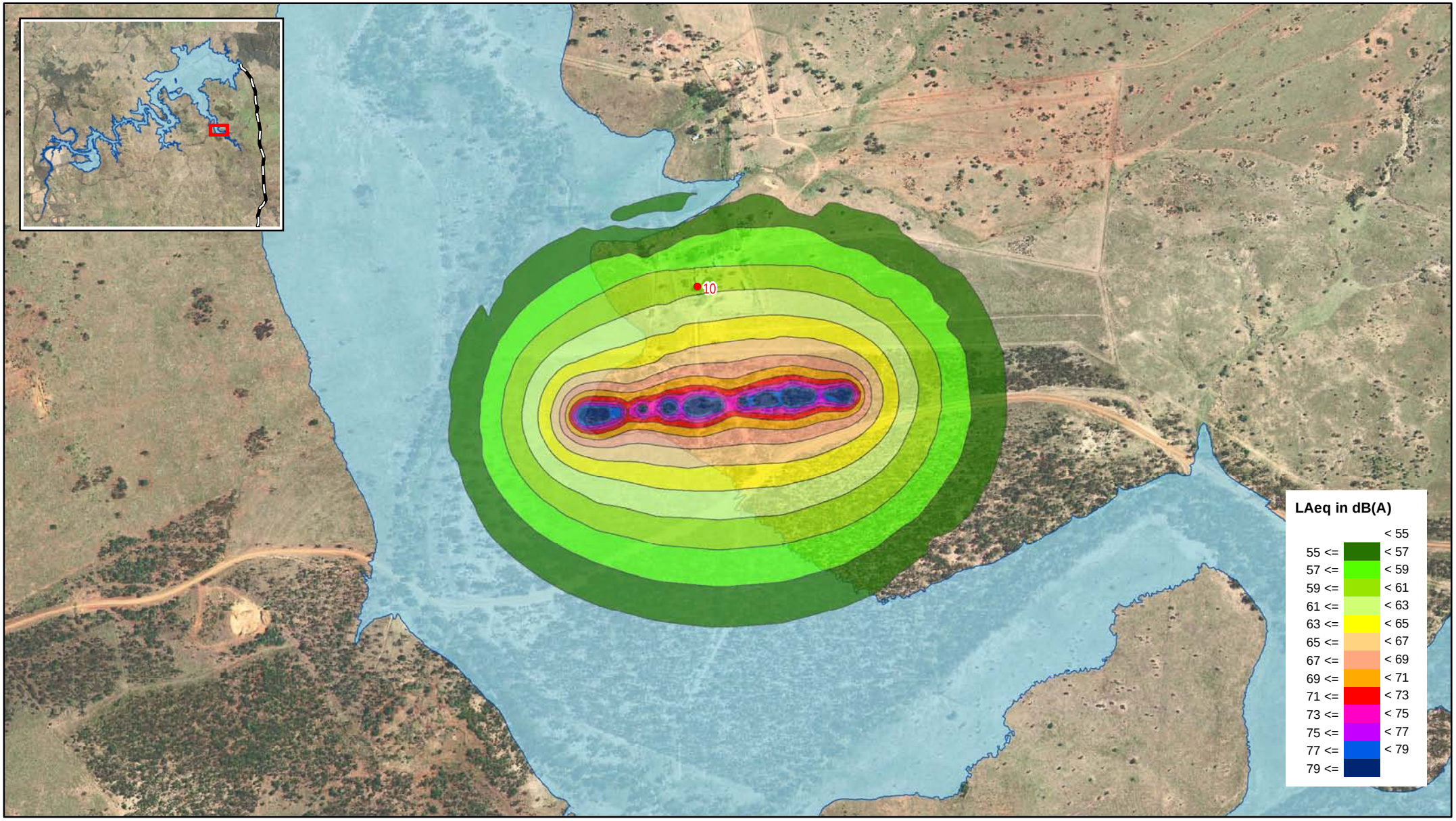

LEGEND

- Sensitive Receivers
- Proposed Pipeline
- Major Watercourse
- Full Supply Level (183.5m AHD)

Projection: GDA94 Zone 56

Figure 19-9

0 50 100 200
Metres

N

Scale 1:10,000 (at A4)

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NATHAN DAM AND PIPELINES EIS

Typical $L_{Aeq.1hr}$ noise levels produced by roads upgrades

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19.2.7. Associated infrastructure – extraction activities

The noise and vibration modelling was undertaken prior to a significant reduction in the proposed clay borrow areas. All borrow areas are now contained within FSL and as such are now further from sensitive receivers than as modelled. Accordingly, noise and vibration impacts from resource extraction presented here are an over-estimate of the potential impacts.

19.2.7.1. Noise impacts

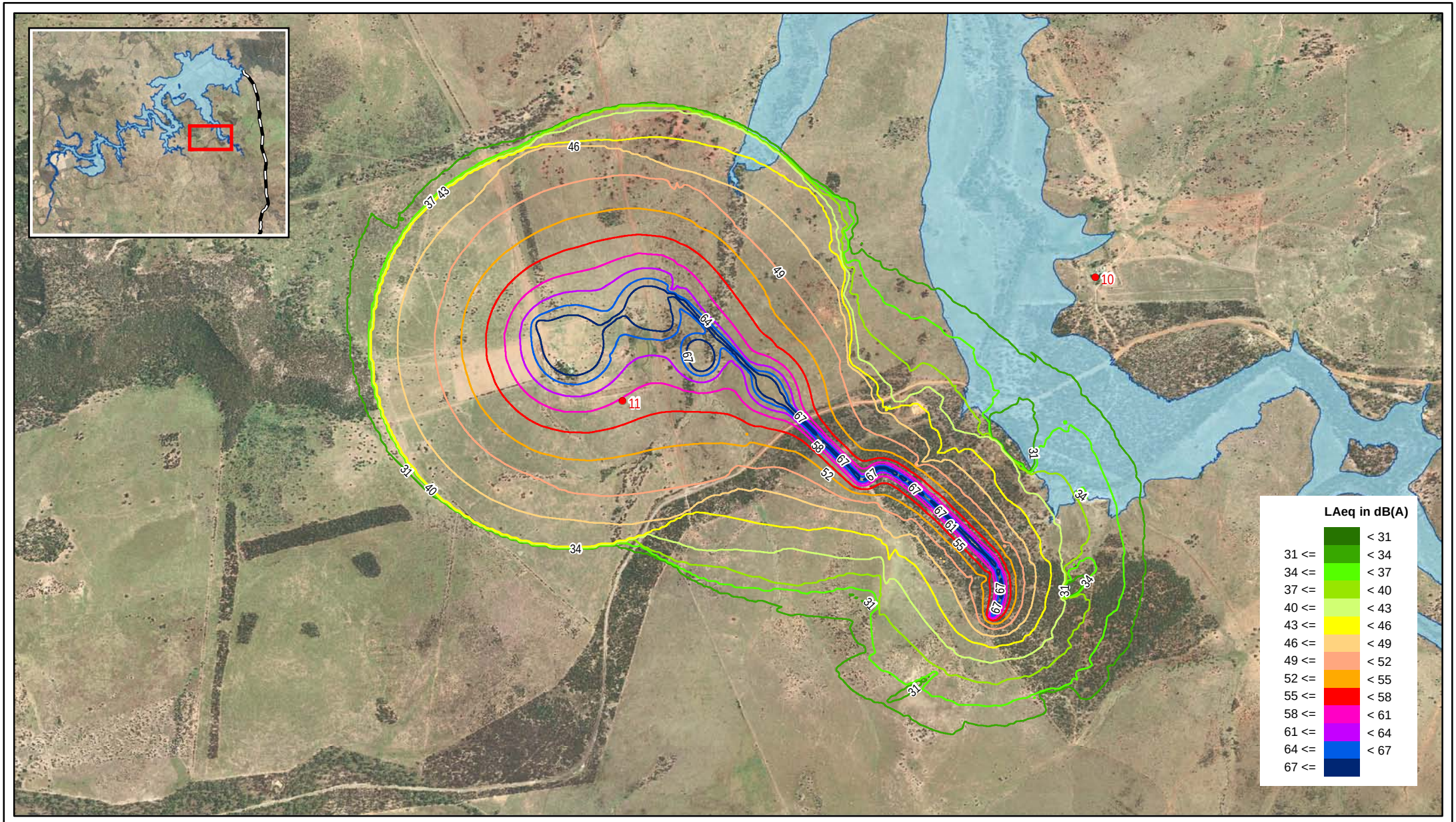
The noise impacts from resource extraction have been modelled based on the equipment assumptions shown in Table 19-16.

Table 19-16 Resource extraction equipment and sound powers used in noise modelling

Stage	Noise sources involved	SWL in dB(A)
Resource Extraction (Clay Borrow Areas)	3 x skidder	110
	8 x excavator	102 (movement), 100 (cutting)
	3 x dozers	111
	1 x Off Road Truck	111
	1 x Road Truck	107
	1 x Chipper	121 (Engine Noise), 115 (Chipping)
	1 x Mulcher	117
	FEL	120

The noise criterion is typically exceeded within a distance of 800 m from the main clay borrow areas and 180 m from the off road truck movements.

It is recommended that no significant resource extraction activity occur within 800 m of a noise sensitive receiver, and off road that trucks not travel within 180 m of a noise sensitive receiver, without mitigation. Potential mitigation strategies include using mobile noise barriers, limiting hours of operation of noise emitting activities, and selection of low noise equipment.



LEGEND

- Sensitive Receivers
- Proposed Pipeline
- Major Watercourse
- Full Supply Level (183.5m AHD)

Projection: GDA94 Zone 56

Figure 19-10

0 150 300 600
Metres

N

Scale 1:25,000 (at A4)

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NATHAN DAM AND PIPELINES EIS

Resource extraction (clay borrow areas) noise contour map

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19.2.7.2. Low frequency noise impacts

It is considered that low frequency noise from clay borrow areas will not be a problem at residences if the buffer distances discussed above are maintained.

19.2.8. Impacts on terrestrial and aquatic fauna

Wildlife, including terrestrial and marine animals, and birds (avifauna) may be affected to some degree by noise and vibration from construction activities. There is minimal applicable literature available on the impact of noise and vibration on wildlife, particularly for Australian wildlife.

In general, the available literature suggests that most animals will avoid the immediate vicinity of any industrial plant or construction area where noise or vibration presents an annoyance to them. Additionally, the literature supports the idea that most animals become desensitized to noise to some degree with exposure over time. Many animals react to new noise initially as a potential threat, but quickly 'learn' that the noise is not associated with a threat. Most wildlife is highly mobile and will act to avoid noise and vibration if it is perceived to be threatening.

In assessing the impact of the Project on wildlife the following can be said:

- There will be no significant sources of noise or vibration during the operational phases of the Project. Acoustic treatment to the pumping stations would result in low levels of noise to the surroundings;
- Construction noise is the most likely activity to have an effect on wildlife, due to the higher noise levels and higher vibration levels involved. It is noted that the dam construction area will largely be cleared and fenced to exclude wildlife from the immediate vicinity. Blasting could have a significant short term impact on some wildlife in proximity of the blasting area; and
- Generally most wildlife acts to avoid areas of noise or vibration that they sense as annoying or threatening. However in the case of wildlife mating or parenting young, the disruption through noise or vibration may be detrimental to the outcome.

19.2.9. Mitigation measures

19.2.9.1. Construction

Construction activities that will occur near NSRs (pipeline and roads) are of temporary nature and hence are not expected to produce a long-term noise impact. Residents should be notified in advance of the activities and have the construction process and timetable explained to minimize the risk of complaints.

Construction of the dam will be for an extended period (up to 3 years) but is well away from sensitive receivers and not expected to cause potential impacts.

Best practices should be considered to reduce the noise impacts. These may include:

- heavy machinery to be fitted with suitable noise controls (silencers, etc);
- machine use management to eliminate unnecessary noise generations (e.g. minimise the use of engine brakes and no extended periods of engine idling); and

- examine different types of machines that perform the same function and compare the noise level data to select the least noisy machine.

Blasting recommendations

Based on the formulae presented in AS2187.2 – 2006, the air blast overpressure noise criterion from blasting operations is generally more stringent than the ground vibration criterion.

The total explosive charge mass required to achieve 115 dBL at the nearest residence located approximately 6000 metres from the blast site is approximately 40,633 kg, depending on the site constants (It is important to note that formulae presented in AS2187.2 – 2006 are very sensitive to these site constants). These values are highly likely to exceed the maximum amounts of explosives that will be used in blasting.

Calculations have shown that noise and vibration impacts due to blasting at the dam site are unlikely given the long distances to the closest NSRs. It is recommended that trial blasts be conducted to determine the site constants and actual noise levels at the closest NSR. It is recommended that residents be notified prior to the blasting activities to reduce the risk of complaint.

19.2.9.2. Operation

At the operational stage, the pump stations will have to comply with the planning noise levels for the night time period as shown in Table 19-11 i.e. an $L_{Ar,T}$ equal to 28 dB(A) at the closest NSRs located in rural areas.

It is recommended that the pumps and their associated power sources be enclosed to reduce noise emissions. The enclosures should incorporate silencers at the air intakes and outlets. These elements should also be oriented away from the NSRs, where possible.

19.3. Impact assessment and residual risks

The methodology used for risk assessment and management is discussed in Section 1.8. This section assesses the risks relevant to noise and vibration and summarises the mitigation measures proposed to minimise those risks.

Table 19-17 and Table 19-18 set out the impact assessment and residual risks of the noise and vibration implications of the proposal, consequence and likelihood ratings for the identified hazards are shown with explanatory notes. The risk assessment is of the Project described in Chapter 2, in which SunWater has already incorporated a range of risk reduction and mitigation measures.

The highest noise contributions from the operation of the Project will be from the four pumping stations that will be installed at the dam and along the pipeline corridor.

At present it is expected that they will be installed in remote areas.

It is recommended that the location of the pumping stations be chosen carefully so they are positioned away from noise sensitive receivers and that the pumps and their associated power generators be properly treated to reduce their noise emissions. As the pumps at the dam will be in proximity to visitors they should be appropriately designed for noise attenuation.

Table 19-17 Impact assessment and residual risks - construction

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				Consequence	Likely	Current Risk			Consequence	Likely	Mitigated Risk
Nuisance impacts from noise and vibration from site establishment and dam construction.	Distances of at least 6 km from construction activities to closest sensitive receiver.	Disturbance would be limited to local sensitive receivers.		Minor	Unlikely	Low			Minor	Unlikely	Low
Nuisance impacts from noise and vibration from vegetation clearing.	Nuisance impacts will be minimised by maintaining a separation distance of >600 m from sensitive receivers.	Disturbance would be limited to local sensitive receivers.		Minor	Unlikely	Low			Minor	Unlikely	Low
Nuisance impacts from noise and vibration from construction equipment during pipeline construction.	Construction activities will be of short duration.	Disturbance would be limited to local sensitive receivers.	Nuisance impacts will be minimised by maintaining a separation distance of >900 m from sensitive receivers.	Minor	Unlikely	Low	Implement EMP provisions if closer		Minor	Unlikely	Low

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				Consequence	Likely	Current Risk			Consequence	Likely	Mitigated Risk
Nuisance impacts from noise and vibration from construction equipment on road construction.	Construction activities will be of short duration.	Disturbance would be limited to local sensitive receivers.	Nuisance impacts will be minimised by maintaining a separation distance of >900 m from sensitive receivers.	Minor	Unlikely	Low			Minor	Unlikely	Low
Nuisance impacts from noise and vibration from extraction activities at clay borrow areas.		Disturbance would be limited to local sensitive receivers.	Nuisance impacts will be minimised by maintaining a separation distance of >800 m between sensitive receivers and main operations, and >200 m from off-road truck movements.	Minor	Possible	Medium	Trial blasts be conducted to determine the site constants and actual noise/vibration levels at the closest NSR. Residents will be notified prior to blasting.	Moderately	Minor	Unlikely	Low
Property damage from blasting vibration and airblast overpressure during dam construction	Distances of at least 6 km from blasting activities to closest sensitive receiver.	Property damage would be limited to local sensitive receivers.		Minor	Rare	Low			Minor	Unlikely	Low

Table 19-18 Impact assessment and residual risks - operations

Hazards	Factors	Impacts	Project Description Controls & Standard Industry Practice	Risk with controls			Additional Mitigation Measures	Mitigation Effectiveness	Residual Risk		
				Consequence	Likely	Current Risk			Consequence	Likely	Mitigated Risk
Nuisance impacts from operational noise from pump stations along the pipeline.		The pumps and generator have the potential to cause adverse low frequency noise impacts.		Minor	Possible	Medium	Locate the pump stations >6 km from any sensitive receivers. Construct enclosures. Select low noise equipment.	Moderately	Minor	Unlikely	Low

19.4. Cumulative impacts

The different construction stages associated with the dam and pipeline that will occur near NSRs are relatively short term. No long-term cumulative noise impacts are expected.

The operational stages of the Project are not expected to result in noticeable noise or ground vibration levels at surrounding sensitive receivers due to the type of equipment and the large distance of separation. For the operational stages it is expected that both the human comfort vibration criteria and the cosmetic damage vibration criteria will be met at all surrounding residential receivers.

There are no other projects that may cause impacts near the dam site. Other projects, primarily pipeline projects, may occur at the same time or in the same locations as the pipeline construction. It is recommended that SunWater participate in regional coordination processes to ensure impacts from multiple projects are minimised. This should include ensuring that any pump stations associated with other pipelines are not in close proximity to those planned by SunWater.

19.5. Summary

This section has assessed potential noise and vibration impacts of the construction and operation of the Project. Sensitive receivers and acoustic quality environmental values to be protected have been identified in Sections 19.1.3 and 19.1.6 and potential noise and vibration levels have been predicted using modelling and fundamentals in Section 19.2.

Risk of noise and vibration nuisance impacts from the construction of the Project is low, given the distance between construction activities and sensitive receivers, temporary nature of impacts, and through the implementation of the mitigation measures identified in this section. When assessed against the Project noise and vibration goals, expected noise and vibration levels at sensitive receivers were found to comply, so long as the recommended buffer distances are followed.