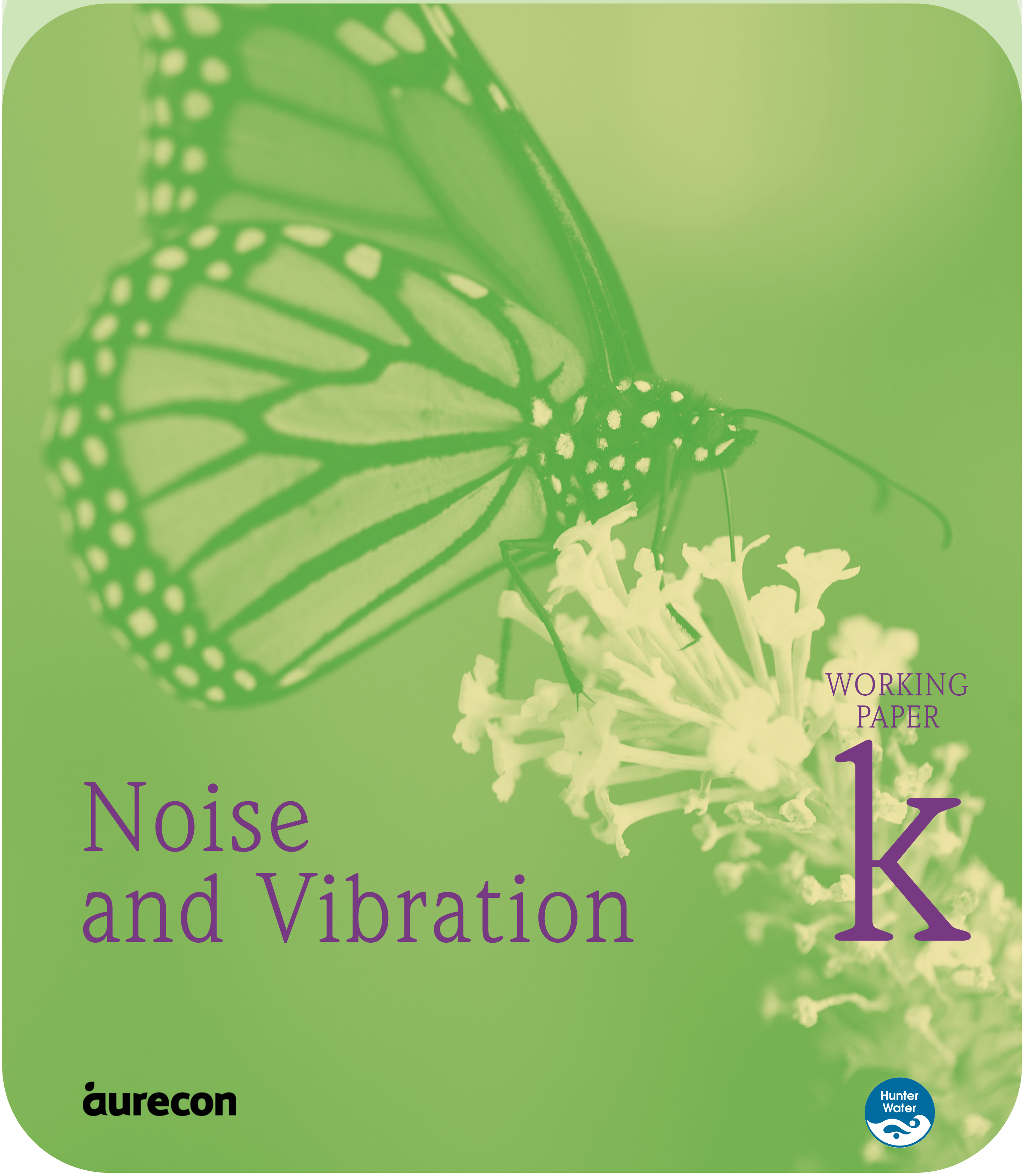
Tillegra Dam

Planning and Environmental Assessment



WORKING PAPER

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Noise and Vibration

aurecon

Hunter Water

Document Control

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Aurecon came into existence in March 2009 through the merger of Connell Wagner Pty Ltd and two South African companies, Africon (Pty) Ltd and Ninham Shand (Pty) Ltd. This post-dated Hunter Water Corporation's engagement of Connell Wagner in July 2007 for professional services for the Tillegra Dam Planning and Environmental Assessment. All references to Connell Wagner in this report should be taken to now refer to Aurecon.

Contents

1 Introduction

1.1 Background

Hunter Water Corporation (HWC) is proposing to construct a dam at Tillegra near the town of Dungog in the Hunter Valley. The dam would more than double the total existing water storage capacity of the Hunter and the Central Coast regions and is deemed an important component of the NSW Government's State Plan to secure the water future of the region for at least the next 60 years.

The Project would inundate an area of approximately 2,100 hectares and have the capacity to store 450,000 gigalitres of water. Subject to HWC securing all necessary environmental approvals, construction would commence in 2009 with the relocation of Salisbury Road. Construction of the dam would begin in late 2010 and it is anticipated that the dam would begin delivering water by 2013.

The Project would comprise the following components:

- a concrete face rockfill dam (CRFD) approximately 76 metres high and 800 metres wide, and spillway controlled by a 40 metre wide ogee crest which contracts to a 30 metre wide concrete lined chute, terminating in a flip bucket
- a multi-level offtake tower
- provision for a mini hydroelectric power (HEP) plant capable of generating up to 3,000 MW hours of electricity annually
- relocation and reconstruction of Salisbury Road (including construction of three waterway crossings) and provision of alternative access currently provided from Quart Pot Creek Road
- a transfer pipeline and pump station connecting Tillegra Dam to the Chichester Truck Gravity Main
- electrical and telecommunication installations (approx 20 kilometres route)
- relocation/upgrading of other public infrastructure (such as the Rural Fire Service station)
- heritage conservation works (including relocation of a cemetery and preservation of a historic house)
- carbon offsetting initiatives including tree planting
- ancillary works as required (potential recreational access areas, lookouts and related facilities).

The main noise and vibration sources of the Project would be associated with construction of the dam wall and operation of the mini HEP plant. Other sources would include operation of the downstream pump station and works associated with the realignment of Salisbury Road.

1.2 Object of Report

This report is intended to assess the noise and vibration aspects associated with the Tillegra Dam project and their impact on the surrounding environment. This involved carrying out an environmental noise survey to quantify the existing environment followed by predictions of the noise and vibration which would be emitted from construction and operation of the associated infrastructure which includes the dam wall and Salisbury Road realignment. Predicted noise levels are evaluated against applicable criteria to determine compliance. Recommendations to mitigate impacts are provided where appropriate.

1.3 Structure of Report

The structure of this report follows the sequence in which the environmental noise study was carried out. Applicable noise guidelines, policies and manuals have been identified and reviewed to determine criteria are of relevance to the Project. The assessment methodology employed for the noise survey is outlined and characterises the existing noise environment at and around the dam and road sites and their surroundings. This information is used to establish design noise criteria based on background noise levels. A discussion is provided outlining the selection of the noise prediction models together with the required inputs into those models. Modeling results are presented in tabular and graphical formats followed by their assessment against the design criteria. Recommendations for managing noise and vibration impacts are detailed in Section 7.

1.4 Director-General's environmental assessment requirements

The Director-General's environmental assessment requirements (DGRs) for the Project were issued on 8 January 2008. With respect to noise and vibration, the environmental assessment is required to:

- include an assessment of noise and vibration impacts associated with the construction (including the winning of extractive material) and operation (all end uses) of the Project
- consider the following guidelines, as relevant: *Noise Control Guideline Construction Site Noise (DECC), Environmental Criteria for Road Traffic Noise* (EPA, 1999), *Industrial Noise Policy* (EPA, 2000) and *Assessing Vibration: A Technical Guideline* (DECC, 2006).

This report is intended to address these matters.

1.5 Applicable noise guidelines, policies and manuals

1. *NSW Industrial Noise Policy*, NSW EPA , January 2000
2. *Assessing Vibration: A Technical Guideline*, Department of Environment and Conservation 2006
3. BS 6472-1992 *Evaluation of human exposure to vibration in buildings* (1–80 Hz)
4. *Environmental criteria for road traffic noise*, NSW EPA, May 1999
5. *Environmental Noise Control Manual*, NSW EPA, 1994
6. DECC | Construction noise, viewed 3 July 2008, <http://www.environment.nsw.gov.au /noise/constructnoise.htm>

7. *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration*, Australian & New Zealand Environment Council (ANZECC), September 1990

8. AS 2436-1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites*

9. AS 2187.2-2006 *Explosives – Storage and use Part 2: Use of explosives*

10. *Environmental Noise Management Manual*, Roads and Traffic Authority of New South Wales, December 2001

11. Manning CJ (May 1981) Report no. 4/81 *The propagation of noise from petroleum and petrochemical complexes to neighbouring communities*, CONCAWE

12. *Calculation of Road Traffic Noise* – Department of Transport Welsh Office, HMSO

13. *Road Traffic Noise Guidelines* – Department of Transport, Energy and Infrastructure, Government of South Australia, March 2007

14. *Interim Construction Noise Guideline, New South Wales Department of Environment and Climate Change, July 2009*

15. *Guidelines for Community Noise, World Health Organisation, 1999*

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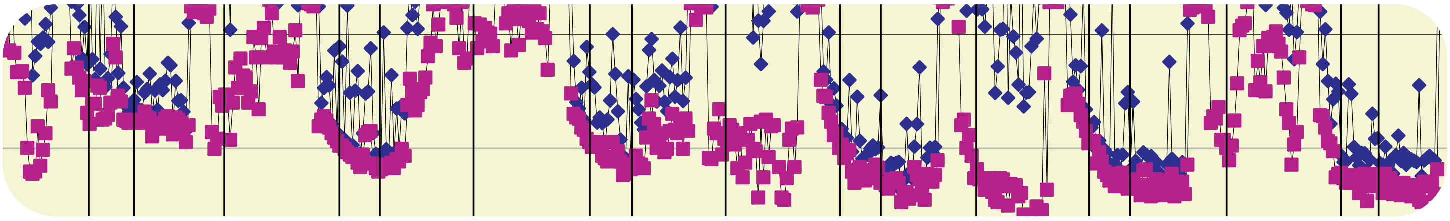

2 Noise Criteria

2.1 NSW Industrial Noise Policy

The recommended noise levels emitted from industrial sources are outlined in the *NSW Industrial Noise Policy* (INP) [Ref 1]. Intrusiveness and amenity criteria are determined based on type of receptor and existing ambient and background noise environment. The intrusiveness criterion is based on the existing background noise and is summarised by the following equation:

$$L_{Aeq,\ 15\ minute} < \textbf{rating background level + 5 dB}$$

Note: Rating Background Level (RBL) being defined as the median value of the Assessment Background Level (ABL) for that time period. ABL is a single figure for each time period; it is the tenth percentile of the measured LA90, 15 minute for the assessment period.

The amenity criterion is based on the ambient noise level of the receptor. Recommended noise levels from industrial noise sources for the type of receptors encountered during this assessment are shown in Table 2.1 .

TABLE 2.1 RECOMMENDED NOISE LEVELS FOR INDUSTRIAL SOURCES

TYPE OF RECEIVER	INDICATIVE NOISE AMENITY AREA	TIME OF DAY	RECOMMENDED L_{Aeq} NOISE LEVEL (dB(A))	
			ACCEPTABLE	RECOMMENDED MAXIMUM
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45

The Acceptable Noise Level (ANL) from Table 2.1 is compared to the ambient noise level from which the amenity criterion is determined based on a set of conditions outlined in the INP.

The design criterion is taken to be the lower of the intrusive criterion and amenity criterion.

Times of day are defined as:

- Day – 7:00 am to 6:00 pm
- Evening – 6:00 pm to 10:00 pm
- Night – 10:00 pm to 7:00 am
- On Sundays and public holidays: Day 8:00 am to 6:00 pm.

2.2 Environmental Criteria for Road Traffic Noise

The criteria outlined in *Environmental Criteria for Road Traffic Noise* (ECRTN) [Ref 4] are applicable to traffic noise emitted from public roads. The realignment of Salisbury Road would need to comply with these criteria as it would expose new receptors to noise from the road corridor. The applicable criteria are shown in Table 2.2. Salisbury Road is classified as a 'Local road – rural' as it is situated in a rural area, handling local traffic with characteristically intermittent traffic flows.

TABLE 2.2 APPLICABLE ROAD TRAFFIC NOISE CRITERIA

TYPE OF DEVELOPMENT	CRITERIA L_{eq}(1HR) (DBA)		
	DAY (7AM-10PM)	NIGHT (10PM-7AM)	WHERE CRITERIA ARE ALREADY EXCEEDED
12. Redevelopment of existing local roads	55	50	In all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2 dB.

2.3 Construction noise

The Director General's Requirements (DGRs) issued for this project required the inclusion of an assessment of noise and vibration impacts associated with the construction (including the winning of extractive material) and operation of the project. The DGRs specified that the assessment must take into account the following guidelines, as relevant:

- Noise control guideline Construction Site Noise (DECC)
- Environmental Criteria for Road Traffic Noise (EPA, 1999),
- Industrial Noise Policy (EPA, 2000)
- Assessing Vibration: A Technical Guideline (DECC, 2006).

Since the DGR's relating to this project were issued, DECC (now DECCW, Department of Environment, Climate Change and Water) released the Draft Construction Noise Guideline in late 2008 and subsequently, in July 2009), the Interim Construction Noise Guideline (ICNG). The ICNG represents the current best practice in construction noise management in NSW.

The ICNG covers the generation of noise from demolition, construction and maintenance activities, and aims to minimise impacts from these activities, as opposed to focusing solely on achieving numerical goals.

The ICNG presents two ways of assessing construction noise impacts:

- the quantitative method which is generally suited to longer-term construction, and
- the qualitative method which is generally suited to short-term works (shorter than three weeks) such as infrastructure maintenance.

The construction time for this development is expected to extend over three to four years therefore a quantitative assessment of construction noise is required.

The ICNG sets out standard construction hours, which are as follows:

- Monday to Friday 7.00 am to 6.00 pm
- Saturday 8.00 am to 1.00 pm
- No work on Sundays or public holidays.

The ICNG specifies that the noise level at a noise sensitive receiver (residential) should be less than the Noise Affected Level ($L_{Aeq15\ min}$). The Noise Affected Level is for the standard construction period is calculated based on the Rating Background Level (RBL) +10 dB(A). This level represents the point above which some adverse community reaction to the noise level may be recorded.

The Noise Affected Level for construction outside of the standard hours is calculated based on RBL+5dB(A). A strong justification would typically be required for exceedance of the Noise Affected Level outside of standard hours. If noise emissions from construction exceed the RBL +10 dB(A), community consultation is required.

The RBL is the median assessment background level (based on the daily 10th percentile background noise level) as described in the NSW *Industrial Noise Policy*.

Where the construction noise emissions exceed the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of the works to be carried out, the expected noise levels and duration as well as contact details.

Where noise levels during standard periods are above 75 dB(A), a strong community reaction against the noise can be expected. In this case, the relevant authority may impose respite periods, and restriction of construction activities taking into account:

- times identified by the community when they are less sensitive to noise
- whether the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

For non residential receivers, the noise affected levels are as follows:

- Industrial: 75 dB(A)
- Office/Retail 70 dB(A)

2.4 Sleep disturbance

The World Health Organisation (WHO) published the *Guidelines for Community Noise* in 1999 in which a process for assessing sleep disturbance is detailed. In order to minimise sleep disturbance, an equivalent internal noise level or LAeq 30 dB(A) should be achieved and a maximum individual noise event should not exceed 45 dB(A). It is generally accepted to assume a 10 dB(A) transmission loss of a building façade with a window open to allow for natural ventilation, therefore the external noise level should not exceed:

- Continuous noise level: 40 dB(A)
- Individual noise event: 55 dB(A)

2.5 Construction vibration criteria

The most relevant set of criteria are defined in a guideline published by the Department of Environment and Conservation [Ref 2] which is based on BS6472 [Ref 3]. This guideline sets criteria (shown in Table 2.3) for evaluating the effects of human exposure to continuous and impulsive vibration. It should be noted that these criteria do not apply to emissions from blasting activities.

TABLE 2.3 CONSTRUCTION VIBRATION GUIDELINES

PLACE	PEAK PARTICLE VELOCITY (mm/s)		
	TIME	PREFERRED	MAXIMUM
Continuous vibration			
Residences	Daytime	0.28	0.56
	Night-time	0.20	0.40
Workshops	Day or night-time	1.1	2.2
Impulsive Vibration			
Residences	Daytime	8.6	17.0
	Night-time	2.8	5.6
Workshops	Day or night-time	18.0	36.0

3 Noise and Vibration Survey

3.1 Survey outline

The noise and vibration survey was conducted from 3-9 August 2007. Three properties were identified at which to carry out noise and vibration surveys, representing different sensitive noise and vibration receptors. The locations of the data collecting properties relative to the dam area are shown in Figure 3.1. Figures showing the position of the noise loggers relative to homesteads and the road are shown in Appendix A.

TABLE 3.1 SUMMARY OF DATA COLLECTING PROPERTIES

PROPERTY	LOCATION	EXPECTED NOISE SOURCES FROM DEVELOPMENT
Site 1	Tillegra – below dam (near field)	Dam and road construction, operation, traffic from road realignment
Site 12	Bendolba – below dam (far field)	Pump station, dam construction
Site 17	Underbank – above dam	Construction traffic, road construction, traffic from road realignment

Meteorological conditions during the noise survey were generally rain free based on data collected from the BOM Paterson weather station located approximately 35 kilometres south of the noise survey locations. Data from this station was used as it was the closest station with data recorded at less than a 24 hour interval. A small amount of rain was recorded on 4 August 2007, however no heightened noise event was identified in the data from this occurrence at any of the three monitoring locations.

Noise sources in this area generally consist of rural noise such as livestock (along with other farm animals), wind noise from rustling leaves, insects and bird life as well as intermittent operation of farming equipment such as tractors or all terrain vehicles. Traffic noise emitted from intermittent vehicles along Salisbury Road and Chichester Dam Road dominates the noise environment. Throughout quiet evening and night time periods, the flow of water was audible from the Williams River.

The dwelling at Site 17 was located approximately 40 metres north of Salisbury Road near Underbank. A specific noise source expected during the measurement period was regular milk truck deliveries. These occurred once every few days during the morning hours of the day. The effect on the ambient noise only occurred during the single 15 minute sample that the truck was at the property. The homestead at Site 1 is set back approximately 700 metres north of Salisbury Road near Tillegra.

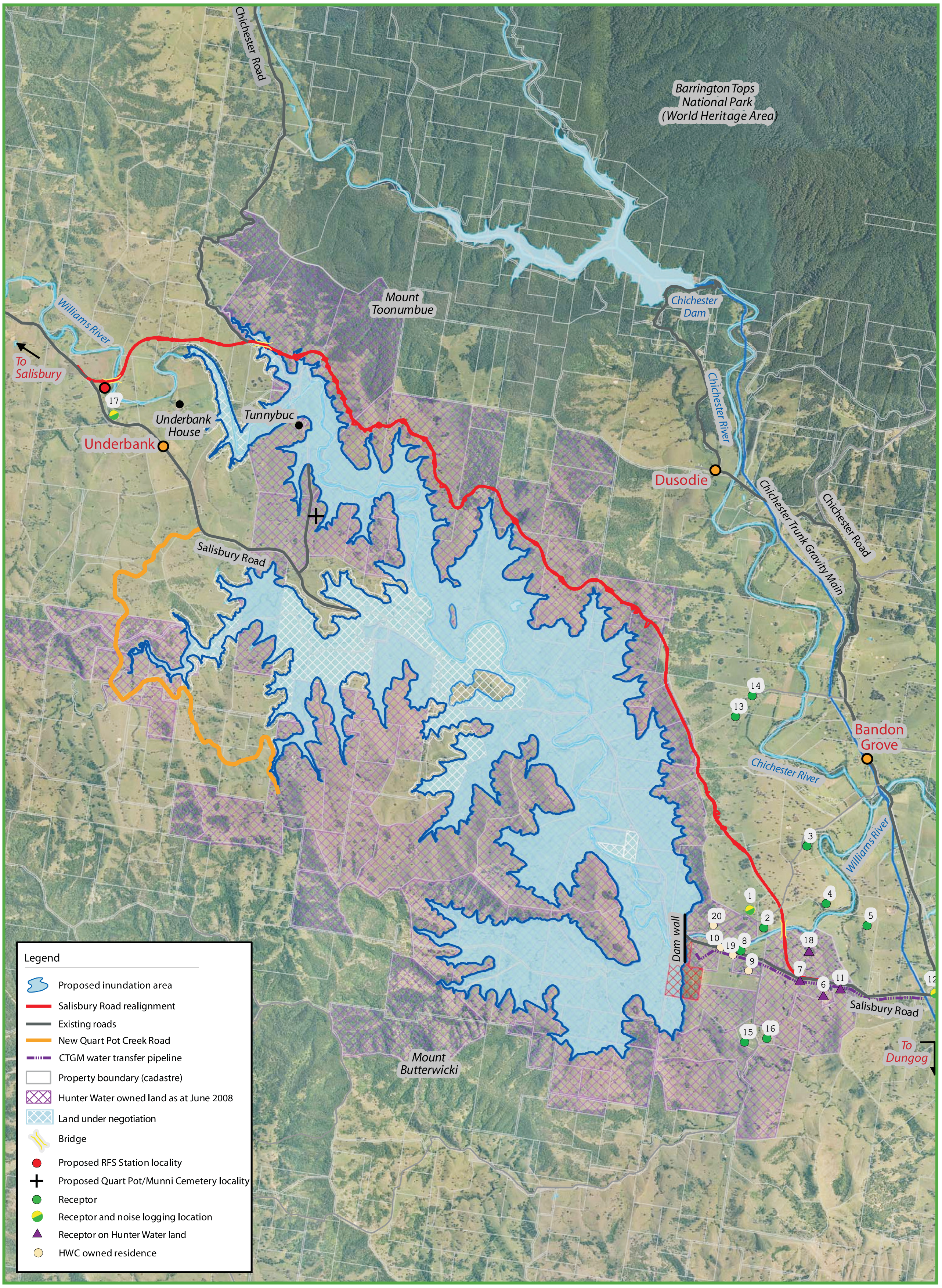

FIGURE 3.1 LOCATION OF SENSITIVE RECEPTORS AND NOISE LOGGING LOCATIONS

The major expected noise source was vehicular access along the driveway to the property. No dwellings were located at Site 12 at Bendolba, however the noise logger was positioned at an equivalent distance from Salisbury Road (30 metres) to the homesteads on the neighbouring properties. This site was also affected by traffic noise from Chichester Dam Road which was located approximately 200 metres east of the site.

3.2 Noise survey results

Table 3.2 summarises the noise logging results for each of the measurement sites. The table also shows the rating background level (RBL) which is defined as the median value of the background noise over the monitoring period, in each assessment period (ie day, evening or night). Where the RBL is less than 30 dB(A), it is then set to 30 dB(A) as outlined in the INP [Ref 1]. Full charts of logged noise descriptors are provided as Appendix B.

TABLE 3.2 SUMMARY OF NOISE LOGGING RESULTS

SPECIFIC LOCATION	TIME PERIOD	AVERAGE AMBIENT NOISE ($L_{eq,}$ dB(A))	CALCULATED RBL (dB(A))	ASSESSMENT RBL (dB(A))
Site 1	Day	47	31	31
	Evening	41	26	30
	Night	42	25	30
Site 12	Day	50	31	31
	Evening	49	37	37
	Night	45	36	36
Site 17	Day	48	30	30
	Evening	37	27	30
	Night	46	27	30

Some data was excluded from the analysis due to impulsive, non-regular single events that did not reflect the normal background and ambient noise environments. A constant, regular noise source was active in the vicinity of the noise logger for a continuous 13 hour period at the Tomlinson property on the evening of 6 August 2007 until the morning of 7 August 2007. As the source of this noise could not be determined, this measurement period has been excluded from the analysis due to the significantly heightened background noise level.

It was assumed that noise levels in the settlements of Dusodie and Bandon Grove would be similar to those measured at Site 1 based on a similar rural environment.

3.3 Vibration survey results

Based on spot measurements carried out at each site, all vibration levels recorded were below a peak particle velocity of 0.2 mm/s.

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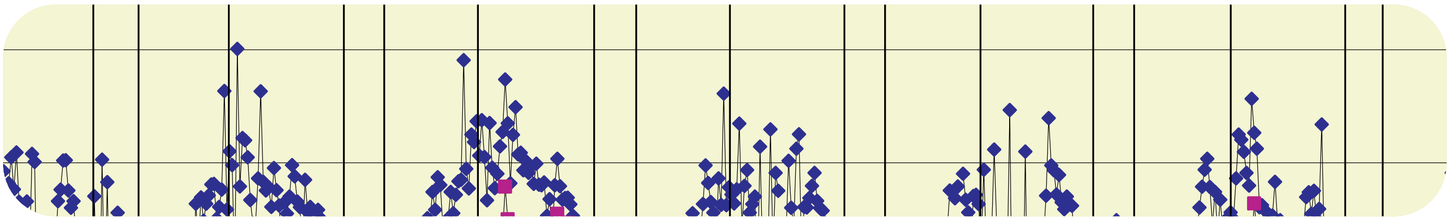


4 Design Noise Criteria

4.1 Construction noise

Construction would proceed in a number of broad stages. Construction of roads would be in two stages while the dam and related works would be done in three stages. The second stage of road construction would overlap with the first stage and the first half of the second stage of dam construction activities. In accordance with the ICNG, noise emissions from all stages of construction activities require a quantitative assessment as the construction period exceeds three weeks.

Construction activities would not be limited to one area. This requires a varied approach to control the noise and vibration impacts from these activities. The construction activities related to specific parts of the Project are split into separate sections (eg road realignment, dam wall construction).

Construction of the dam and associated works is expected to take approximately 180 weeks. Works would be concentrated in the same general area for the duration of construction. Consequently, quantitative assessment of all stages of construction is required.

Construction of the new section of Salisbury Road and the alternate access to the Quart Pot Creek area would take approximately 156 weeks. This approximates to an average of six weeks of construction works per kilometre.

The effective noise limits are shown in Table 4.1. The Noise Management Level L_{Aeq} is calculated based on the on the Assessment RBL measured at each site.

TABLE 4.1 CONSTRUCTION NOISE CRITERIA

	TIME OF DAY	EXISTING RATING BACKGROUND LEVEL (DB(A))	NOISE MANAGEMENT LEVEL $L_{eq,\,15min}$ (DB(A))	
			NOISE AFFECTED	HIGHLY NOISE AFFECTED
Underbank	Standard hours	30	40	75
	Non–Standard Hours	30	35	40*
Tillegra, Bandon Grove, Dusodie	Standard hours	31	41	75
	Non–Standard Hours	30	35	40*
Bendolba	Standard hours	31	41	75
	Non–Standard Hours	36	41	46*

* Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

Due to the large number of receivers in the vicinity of the proposed works, in order to maintain a constant assessment criterion for standard and non–standard hours, it is proposed that the strictest criteria be applied to all residences. The assessment criteria for the construction noise emissions on this basis are shown in Table 4.2:

TABLE 4.2 CONSTRUCTION NOISE CRITERIA

TIME OF DAY	NOISE MANAGEMENT LEVEL $L_{eq,\ 15min}$ (DB(A))	
	NOISE AFFECTED	HIGHLY NOISE AFFECTED
Standard hours	40	75
Non–Standard Hours	35	40

The ICNG stipulates that a strong justification is required for work outside of the standard construction hours. Construction activities which the ICNG determine as being generally acceptable outside of the standard hours include:

- the delivery of oversized plant or structures that require special arrangements to transport along public roads
- emergency work to avoid loss of life, damage to property or prevent environmental harm
- maintenance and repair of public infrastructure where disruption to essential services and/or consideration of worker safety do not allow work within standard hours
- public infrastructure works that shorten the length of the project and are supported by the affected community
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

It is expected that some construction will be required outside of the standard hours, and an assessment of construction noise for both standard and non–standard hours should be conducted.

To assess sleep disturbance during the night time periods, the following external noise criteria are applicable:

- Continuous noise level: 40 dB(A)
- Individual noise event: 55 dB(A)

4.2 Road traffic noise

The following criteria are applicable to traffic noise from the new section of Salisbury Road. The noise criteria at the applicable receptor areas are shown in Table 4.3.

TABLE 4.3 REALIGNED SECTION OF SALISBURY ROAD TRAFFIC NOISE CRITERIA

AREA	EXISTING AVERAGE MEASURED L_{eq} (dB(A))		CRITERIA $L_{eq(1HR)}$ (dB(A))	
	DAY (7AM-10PM)	NIGHT (10PM-7AM)	DAY (7AM-10PM)	NIGHT (10PM-7AM)
Tillegra, Bandon Grove, Dusodie,	46	46	55	50
Underbank	46	42	55	50

Note: The definition of day period in ECRTN encompasses the day and evening periods in NSW INP

4.3 Blasting noise and vibration

Blasting required for construction should follow the ANZECC guidelines [Ref 7] as recommended by the DECC. These have been developed to prevent damage from ground vibration and to minimise annoyance and discomfort of the local residents. These blasting criteria are summarised as follows.

Blasting noise criteria

- airblast overpressure must not be more than 115 dB (linear) peak for 95 per cent of total blasts initiated in a 12 month period (regardless of the interval between blasts)
- airblast overpressure must not exceed 120 dB (linear) peak at any time.

Blasting vibration criteria

- ground-borne vibration must not exceed peak particle velocity (PPV) of 5 mm/s for 95 per cent of total blasts initiated in a 12 month period (regardless of the interval between blasts)
- ground-borne vibration must not exceed PPV of 10 mm/s for any blast.

4.4 Vibration

The design vibration criteria are based on the *Assessing Vibration: a technical guideline* [Ref 2] and are outlined in Table 4.4.

TABLE 4.4 CONSTRUCTION VIBRATION CRITERIA

PLACE	PEAK PARTICLE VELOCITY (mm/s)		
	TIME	PREFERRED	MAXIMUM
Continuous vibration			
Residences	Daytime	0.28	0.56
	Night-time	0.20	0.40
Workshops	Day or night-time	1.1	2.2
Impulsive Vibration			
Residences	Daytime	8.6	17.0
	Night-time	2.8	5.6
Workshops	Day or night-time	18.0	36.0

4.5 Operation

The design criteria applicable to operation of the dam are shown in Table 4.5. These have been developed in accordance with the NSW INP as this provided the lowest allowable noise emitted associated with the development from the applicable policies and guidelines.

TABLE 4.5 OPERATION DESIGN CRITERIA

PROPERTY	TIME OF DAY	CRITERION $L_{eq,\ 15min}$ (dB(A))	DRIVING CRITERION
Site 1	Day	36	Intrusiveness
	Evening	35	Intrusiveness
	Night	35	Intrusiveness
Site 12	Day	36	Intrusiveness
	Evening	39	Amenity
	Night	35	Amenity
Site 17	Day	35	Intrusiveness
	Evening	35	Intrusiveness
	Night	35	Intrusiveness

The criteria from the three background noise monitoring sites can be applied for the assessment of neighbouring properties which are expected to contain similar background noise. These are outlined in Table 4.6.

TABLE 4.6 REPRESENTATIVE BACKGROUND NOISE SITES WITH SIMILAR DESIGN NOISE CRITERIA

BACKGROUND MONITORING SITES	AREA CONSIDERED TO HAVE SIMILAR BACKGROUND NOISE ENVIRONMENT
Site 1	Properties in the vicinity of Tillegra, Bandon Grove and Dusodie
Site 12	Properties in the vicinity of Bendolba, located near both Salisbury and Chichester Dam Roads
Site 17	Properties in the vicinity of Underbank

5 Noise Model

A virtual model of the Project area has been developed using SoundPLAN Environmental Noise Modelling software. This incorporates ground contours as well as meteorological effects to predict noise levels due to the various noise sources associated with the project. The CONCAWE Noise model [Ref 11] has been implemented in the environmental noise predictions as it contains a degree of conservativeness (when compared to ISO9613-2) while allowing direct input of atmospheric stability and wind speed data. Road traffic noise has been predicted using the CoRTN [Ref 12] model.

5.1 Meteorological conditions

The Air Pollution Model (TAPM) is a prognostic meteorological prediction software tool that has been used to predict hourly wind and atmospheric stability characteristics specific to the region in the vicinity of the Tillegra Dam project for an entire year. The results shown in the figures below are based on the use of 2002 synoptic meteorological data. A detailed description of TAPM, as well as associated meteorological parameters and effects, are discussed in the air quality assessment report for this Project (refer Working Paper J).

TABLE 5.1 FREQUENCY DISTRIBUTION OF STABILITY CLASS VERSUS TIME OF DAY

HOUR OF DAY	STABILITY CLASS					
	A	B	C	D	E	F
1	0	0	0	68	186	112
2	0	0	0	65	189	112
3	0	0	0	63	196	107
4	0	0	0	66	189	111
5	0	0	0	79	172	115
6	0	0	0	213	95	58
7	0	0	2	325	23	16
8	0	0	62	304	0	0
9	0	16	148	202	0	0
10	0	69	175	122	0	0
11	4	133	128	101	0	0
12	36	106	132	92	0	0
13	31	107	136	92	0	0
14	26	96	142	102	0	0
15	19	74	154	119	0	0

HOUR OF DAY	STABILITY CLASS					
	A	B	C	D	E	F
16	4	67	120	175	0	0
17	0	18	101	247	0	0
18	0	0	28	277	38	23
19	0	0	0	183	111	72
20	0	0	0	34	188	144
21	0	0	0	48	175	143
22	0	0	0	56	182	128
23	0	0	0	64	174	128
24	0	0	0	62	185	119

TABLE 5.2 FREQUENCY DISTRIBUTION OF STABILITY CLASS VERSUS WIND SPEED

WIND SPEED (m/s) AT 10 m ABOVE GROUND LEVEL	STABILITY CLASS						
	A	B	C	D	E	F	G
0-2.0	61	94	168	519	517	253	0
2.0-4.0	59	412	482	1145	827	1135	0
4.0-6.0	0	180	554	1074	759	0	0
6.0-8.0	0	0	124	339	0	0	0
8.0-10.0	0	0	0	78	0	0	0

Based on the data in Table 5.1 and Table 5.2, day time conditions are dominated by Stability Class D (occurring for 44 per cent of the time) whereas the night has regular periods of E (48 per cent) and F (30 per cent) stability. The INP requires consideration of temperature inversions if they are predicted for more than 30 per cent of the total night time during winter as they are considered significant and should be taken account of in the noise assessment.

The CONCAWE method incorporates meteorological effects on noise dispersion, through combining the Pasquill stability criterion with the magnitude of the wind vector to establish classifications for six meteorological categories (CAT) for which attenuation measures were experimentally derived. Each CAT has a set of attenuation curves which apply across various octave noise bands. Given that Table 5.2 shows that winds can reach up to 5 m/s on a regular basis during the day and night periods (except during stability class F when max speed won't exceed 3 m/s), this has been chosen as the modelling wind speed. Under all of these stability conditions (D,E and F) combined with a wind speed of 5 m/s, the worst case CAT 6 curve (from the CONCAWE model) applies to both day and night time noise predictions. This signifies there would be little difference between the predicted meteorological effects between day and night times. The most prevalent wind direction has been chosen in the model. A neutral no metrological effect case has also been modelled. Table 5.3 summarises the meteorological inputs utilised in the CONCAWE model.

TABLE 5.3 METEOROLOGICAL INPUTS USED IN THE CONCAWE MODEL

MODEL INPUT	INPUT VALUES		
	NEUTRAL	DAY	NIGHT
Temperature	20°C	20°C	10°C
Humidity	70%	70%	70%
Wind speed	–	5 m/s	5 m/s
Wind direction	–	112°	112°
Pasquill stability class	D	D	E

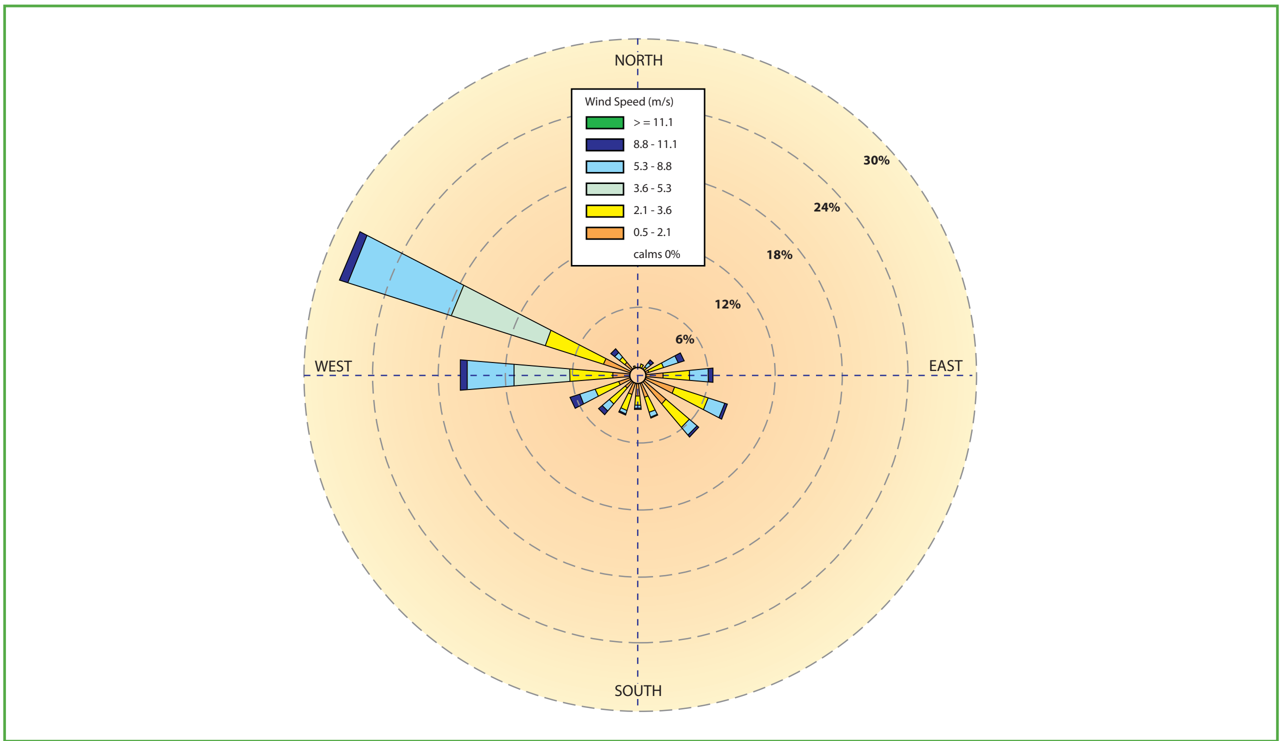


FIGURE 5.1 ANNUAL WIND ROSE FOR WIND SPEEDS AT 10 METRES ABOVE GROUND

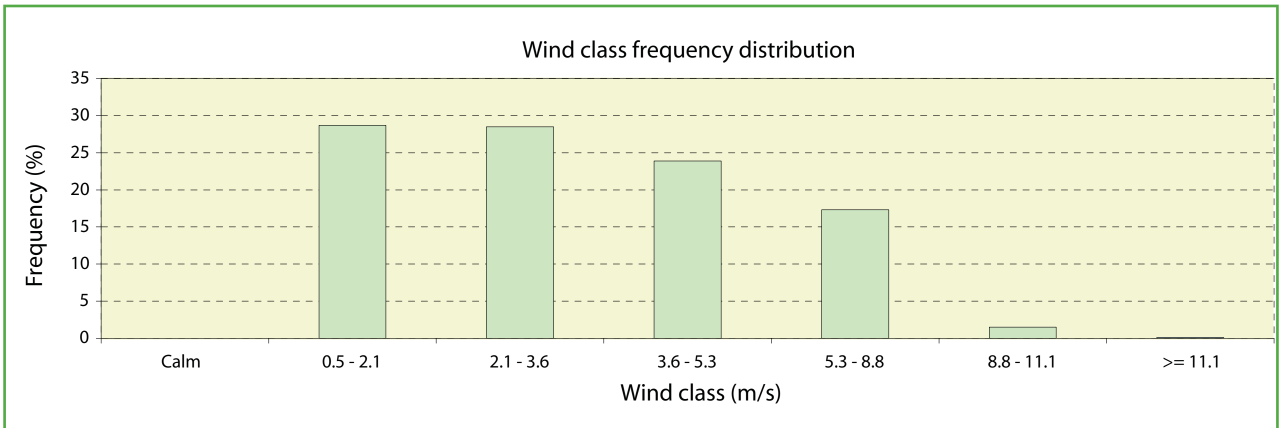


FIGURE 5.2 WIND CLASS FREQUENCY DISTRIBUTION

5.2 Construction noise

Noise from construction activities would be emitted from various sources which would depend on the stage of construction being carried out. The construction process would essentially be divided into two separate projects: the realignment of Salisbury Road (and construction of the alternate Quart Pot Creek area access) and construction of the dam wall and associated infrastructure. The principal phases of the Project are outlined below.

- **Roads Phase 1** – bridges and approaches (including temporary detour around dam construction site)
- **Roads Phase 2** – remaining works (including Quart Pot Creek area access)
- **Dam Phase 1** – planning and construction, preparatory works
- **Dam Phase 2** – dam construction to commencement of filling
- **Dam Phase 3** – dam completion and ancillary components.

While the second phase of road construction would overlap with dam construction activities, they would be assessed individually due to the substantial distance between the respective construction areas.

The noise modelling has taken into account the operation of quarries and the concrete batching plant during construction.

Table 5.4 provides a list of representative sound power levels of construction equipment expected to be used on the Project.

TABLE 5.4 CONSTRUCTION EQUIPMENT SOUND POWER LEVELS [REF 8]

EQUIPMENT	SOUND POWER LEVEL L_W (dB(A))
Excavator	118
Grader	117
Scraper	116
Jack hammer	105
Loader	115
Truck	105
Crane	106
Dump truck	114
Welder	104
Vibration roller	104
Roller	108
Rock breaker	120
Dozer tracked	114
Concrete mixer truck	110
Crane	108

5.2.1 Dam construction schedule

The program divides dam construction into three major phases which are relevant to coordination with the roads. The following is an indicative breakdown of each phase.

Phase 1	From award of contract to being ready to cut Salisbury Road (48 weeks)
1A	Management planning, location of major items of plant and equipment and establishment of a presence on site.
1B	Clearing the site and quarries above river level. Establish site access roads, quarry and associated crushing and concrete batching plants. Excavate inlet and outlet channels, the lower spillway clear of Salisbury Road, the embankment above river level, and the upstream coffer dam. Minimal or no blasting would be required during this stage.
1C	Excavate the diversion tunnel and upper spillway with blasting required throughout for the tunnel and in later months for the upper spillway. Prepare embankment foundations above river level by removing unsuitable material (no blasting required).
1D	Start construction of offtake tower, concrete lining of the upper spillway and concrete lining of the diversion tunnel.

Phase 2	From cutting Salisbury Road to starting to fill the dam (108 weeks)
2A	Excavate lower spillway through Salisbury Road (no blasting likely) and complete the intake tower and lining of the diversion tunnel.
2B	Construct coffer dams and divert river through tunnel.
2C	Excavate and prepare embankment foundations in the river bed (no blasting required). Install grout curtain along the upstream toe of embankment.
2D	Construct rockfill dam embankment and the concrete embankment facing (including around six months of regular blasting in the quarry for embankment rockfill followed by six months of less frequent blasting for concrete aggregates). Close the river diversion and start to fill the dam.
2E	CTGM pipeline.

Phase 3	Finishing off (24 weeks)
3A	Construct the valve block and install outlet pipework in the tunnel. Construct parapet wall and road on top of the embankment, amenities, landscaping, etc.

During Phase 2D it is likely that some construction activities (eg concrete pours) would need to be undertaken outside of the standard construction period.

Phase 1B and the beginning of Phases 2C and 2D have been modelled to represent the worst case scenarios of the dam construction given the amount of equipment and the location of the work area relative to the sensitive receptors. The beginning of Phases 2C and 2D represents the greatest concentration of machinery around the main embankment with no barrier effect due to the constructed height of the dam wall.

5.2.2 Salisbury Road construction schedule

The construction of Salisbury Road would broadly be undertaken in sections with each being progressively worked as follows:

- strip and stockpile topsoil
- excavate, haul and place OTR (other than rock) by self loading scraper and, if necessary, stockpile select material for the upper finishing layers

- rip weathered and weak rock by dozer, load, haul and place in fill areas and, if necessary, stockpile select material for the final courses
- blast strong rock, crush and grade rock if necessary, load, haul and place (note: broadly speaking, blasting is expected between chainages 3km to 4km, and 6km to 12km, with the rest expected to be rippable).
- install drainage culverts when the road level reaches an appropriate level at each culvert
- mix (if necessary) stockpiled material for finishing layers, load, haul and place
- bitumen spray seal the road in practical lengths as the work is finished

Three road construction noise cases have been investigated, these representing works in the Tillegra, Bandon Grove and Underbank localities. Each case involves equipment operating over approximately a two kilometre stretch of road in areas with most affected receptors.

5.3 Road traffic noise

Road traffic noise has been predicted using the CoRTN [Ref 12] model which predicts $LA_{10\ (1hr)}$ which can be converted to LAeq values for direct comparison with ECRTN criteria. It is generally accepted (based on previous road traffic noise study results) the following conversion applies $L_{Aeq} = L_{A10} - 3$ dB [Ref 13]. The CoRTN method predicts the traffic noise level based on the following inputs:

- number of vehicles
- vehicle speed
- percentage of heavy vehicles
- corrections for road gradient, road surface, barrier effects.

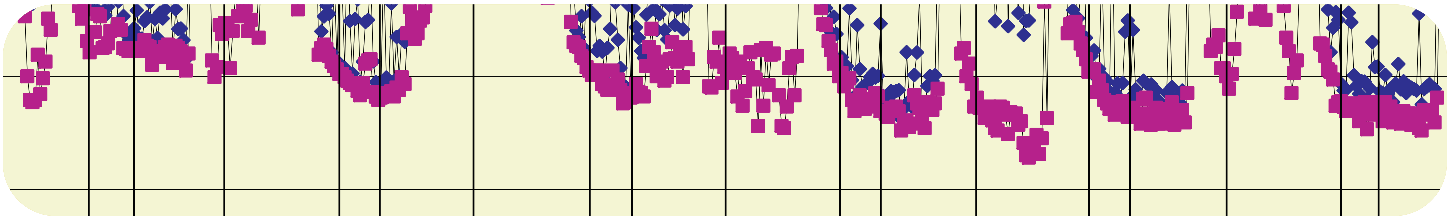
Existing traffic levels along Salisbury Road west of Chichester Dam Road have been measured at an average of 279 vehicles per day with less than one per cent comprising heavy vehicles. Peak traffic levels occur during at approximately 8.00 am and between 3.00 pm and 5.00 pm, which equates to volumes of 20 vehicles per hour during those times. Traffic volumes are not expected to increase significantly due to the new realignment. A doubling of the traffic volume would have to occur for a 3 dB increase in traffic noise.

5.4 Operational noise

Typical operational noise emissions would be associated with spillway flow, the transfer pump station, the mini HEP station, substation transformers, maintenance activities and visitors. Characterisation of the majority of these is subject to detailed design, hence sound power levels have been estimated from the likely operating duty where known.

- The mini HEP station infrastructure (ie turbine and associated generator) would be located within a purpose-built structure between the dam wall and outlet works. It has been assumed that the noise level within the turbine hall would be limited to 85 dB(A) for occupational health and safety purposes. It is noted, however, that the Project is only making provision for the mini HEP plant to be installed and that it does not actually form part of the Project. Noise emissions associated with installation and operation of the HEP plant would be specifically assessed if and when such plant is installed.

- Spillway noise would be associated with flow releases via the outlet works and flows over the spillway crest (typically during major rainfall events). For a given flow, the emitted noise would be approximately constant in nature and could be equated to noise from a waterfall, which can reach approximate levels of 75–85 dB(A) at three metres based on a five metre high waterfall.
- The frequency of noise emissions from the transfer pump station is expected to be very low. This would only operate in the event of significant water quality problems in Chichester Dam.
- However when required its operation would likely last an extended period (ie few months). Electric motors would be used to drive the pump sets with sound power levels likely to be about 110 dB(A) (or a sound pressure level of about 85 dB(A) within the enclosure).
- Maintenance noise would be generally related to regular inspections of the infrastructure, clean up activities and periodic testing of the emergency warning siren.
- Noise emitted from the substation would be dominated by operating transformer. The transformer sound power level is likely to be approximately 100 dB(A).



6 Predicted Noise and Vibration Levels

6.1 Construction noise

Given the variety of activities and various stages associated with the construction process, different worst case scenarios have been considered and modelled depending the stage of construction and the area of work in question. A 'snap shot' of each scenario has been taken to assess the noise level for that assumed moment in time.

Each noise source has been modelled to be operating at full power emitting its maximum sound power. This is a very conservative assumption, as most equipment would not be operating at full power constantly and simultaneously which leads to a significantly lower emitted noise level than the predicted levels for the absolute worst case. To take into account periods when machinery is idle, operating with reduced power, or not operating at all, Table 6.1 shows the expected noise reduction given the full power operating percentage of vehicles. It is a reasonable assumption that each machine would only be operating at full power for at most 30 per cent of the construction time leading to a 5 dB decrease in the noise levels predicted which has been incorporated in the sections below.

TABLE 6.1 ADJUSTMENTS TO PREDICTED NOISE LEVELS

OPERATING PERCENTAGE	NOISE REDUCTION (dB)
70	-1.5
50	-3
30	-5
10	-10

6.1.1 Construction of the dam wall

The construction noise associated with this activity assumes the following equipment operating simultaneously.

TABLE 6.2 ASSUMED CONSTRUCTION EQUIPMENT

EQUIPMENT QUANTITY	PHASE 1B	PHASE 2C/D
Dozers	5	5
Excavators	8	8
Trucks		8
Graders		1
Rollers		2
Batching plant		1
Rock crushing plant		1

The equipment listed in Table 6.2 have been chosen to represent the worst case noise emitting equipment that are most likely to be operating constantly during construction. Addition of other equipment (especially lower noise level equipment) would not significantly contribute to noise levels in the environment.

The predicted noise levels at the sensitive receptors for Phase 1B are shown in Table 6.3 with the day time and night time noise contours plotted in Figures 6.1 and 6.2 respectively. Noise levels for Phases 2C and 2D are displayed in Table 6.4, and Figures 6.3 and 6.4 for day and night times respectively.

For the non–standard period, construction activities were modelled assuming the same operating equipment as during the day. Detailed scopes and schedules of plant and equipment for the proposed night time works were not available for the assessment and so only general night time construction has been assessed. It is highly likely that a reduced workforce would be employed overnight, significantly reducing the construction noise emissions over the non–standard period. Different meteorological conditions have been taken into account between the day and night time periods.

Noise levels predicted for each scenario are considered worst case as once construction of the dam wall commences, 'natural' noise barriers would be created by topography as well as the dam wall itself. These would significantly decrease the noise level at the receptor.

The following key is used in Tables 6.3, 6.4, 6.6 and 6.7 for properties which are predicted to exceed the criteria:

- Noise Affected (blue)
- Community Consultation Required (orange)

It should be noted that the non–standard community consultation criteria is equivalent to the continuous external sleep disturbance criteria (40 dB(A))

TABLE 6.3 PHASE 1B DAM WALL CONSTRUCTION PREDICTED NOISE LEVELS

RECEPTOR	PHASE 1B $L_{eq, 15min}$ (dB(A)) – TYPICAL OPERATIONAL NOISE			CRITERIA – NOISE MANAGEMENT LEVEL ($L_{eq, 15min}$)			
				STANDARD		NON–STANDARD	
	Neutral	Standard	Non-Standard	Noise Affected	Highly Noise Affected	Noise Affected	Community Consultation
1	45	47 (blue)	49 (orange)	40	75	35	40
2	42	44 (blue)	46 (orange)	40	75	35	40
3	34	34	37 (blue)	40	75	35	40
4	36	37	39 (blue)	40	75	35	40
5	32	33	36 (blue)	40	75	35	40
6*	36	37	40 (orange)	40	75	35	40
7*	39	41 (blue)	43 (orange)	40	75	35	40
8	51	53 (blue)	54 (orange)	40	75	35	40
9*	48	50 (blue)	51 (orange)	40	75	35	40
10*	59	62 (blue)	62 (orange)	40	75	35	40
11*	34	35	38 (blue)	40	75	35	40
12	24	25	30	40	75	35	40

RECEPTOR	PHASE 1B $L_{eq, 15min}$ (dB(A))			CRITERIA			
	TYPICAL OPERATIONAL NOISE			NOISE MANAGEMENT LEVEL ($L_{eq, 15min}$)			
				STANDARD		NON–STANDARD	
	Neutral	Standard	Non-Standard	Noise Affected	Highly Noise Affected	Noise Affected	Community Consultation
15	25	29	31	40	75	35	40
16	27	32	34	40	75	35	40
18	38	40	42	40	75	35	40
19	55	59	60	40	75	35	40
20	59	55	55	40	75	35	40

* HWC-owned property, highlighted levels show exceedance of criteria

TABLE 6.4 PHASE 2C/D DAM WALL CONSTRUCTION PREDICTED NOISE LEVELS

RECEPTOR	PHASE 2C/D $L_{eq, 15min}$ (dB(A))			CRITERIA			
	TYPICAL OPERATIONAL NOISE			NOISE MANAGEMENT LEVEL ($L_{eq, 15min}$)			
				STANDARD		NON–STANDARD	
	Neutral	Standard	Non-Standard	Noise Affected	Highly Noise Affected	Noise Affected	Community Consultation
1	42	47	48	40	75	35	40
2	37	41	43	40	75	35	40
3	23	28	31	40	75	35	40
4	31	36	39	40	75	35	40
5	27	32	35	40	75	35	40
6*	30	35	38	40	75	35	40
7*	34	38	41	40	75	35	40
8	45	49	50	40	75	35	40
9*	41	45	47	40	75	35	40
10*	50	54	54	40	75	35	40
11*	29	34	37	40	75	35	40
12	19	24	29	40	75	35	40
15	18	22	25	40	75	35	40
16	20	25	27	40	75	35	40
18*	35	38	41	40	75	35	40
19*	49	53	53	40	75	35	40
20*	52	56	56	40	75	35	40

* HWC-owned property, highlighted levels show exceedance of criteria

Heavy vehicle movements for the haulage of materials and equipment to the site from external sources for construction works on the dam wall have been estimated at approximately 2,170 movements. Assuming a six day per week construction schedule and the need for trucks to arrive and depart along the haulage route, this equates to an average of four truck movements per day (including arrival and departure). This level of heavy vehicle movements would have a negligible effect on the overall noise environment.

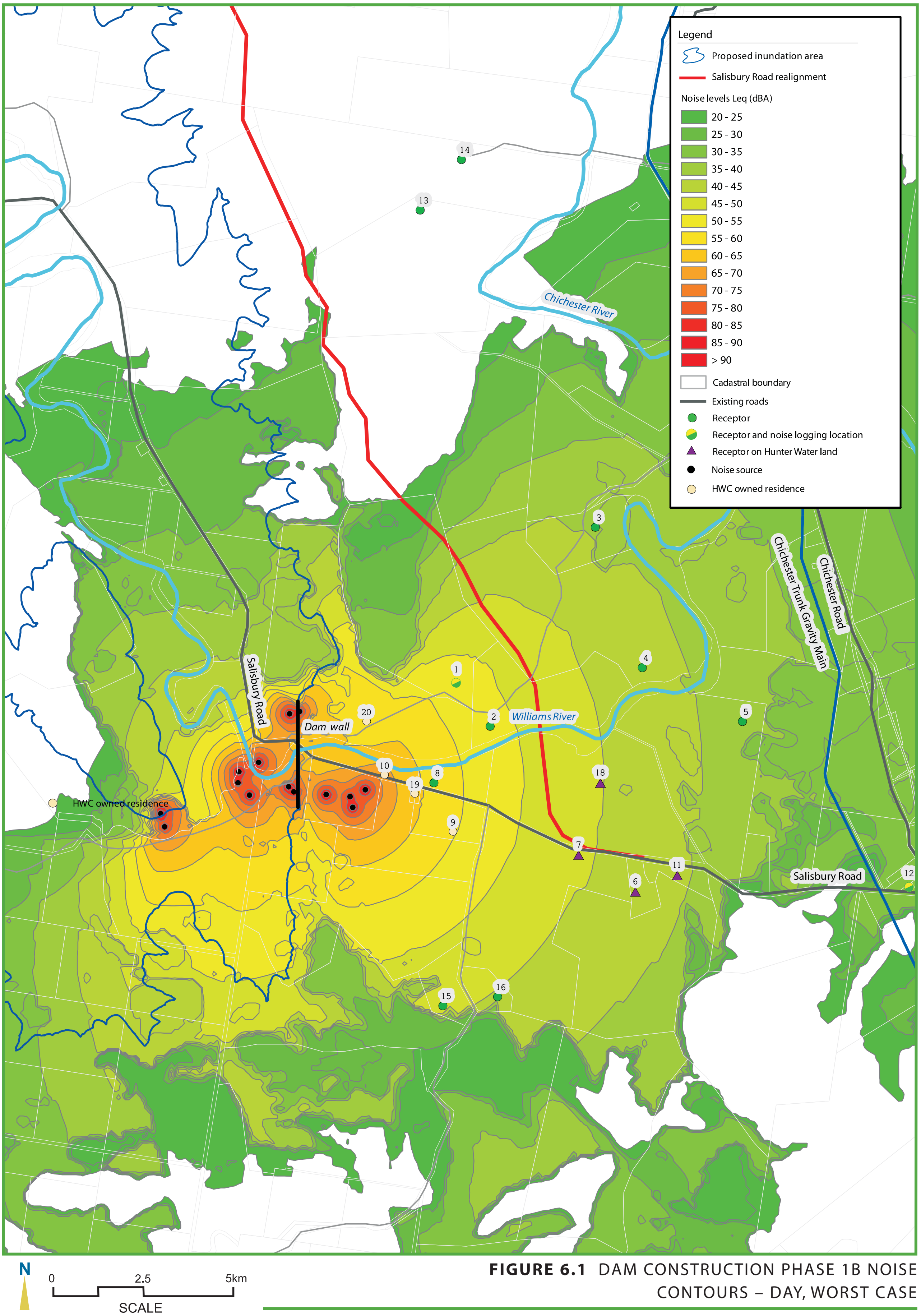


FIGURE 6.1 DAM CONSTRUCTION PHASE 1B NOISE CONTOURS – DAY, WORST CASE

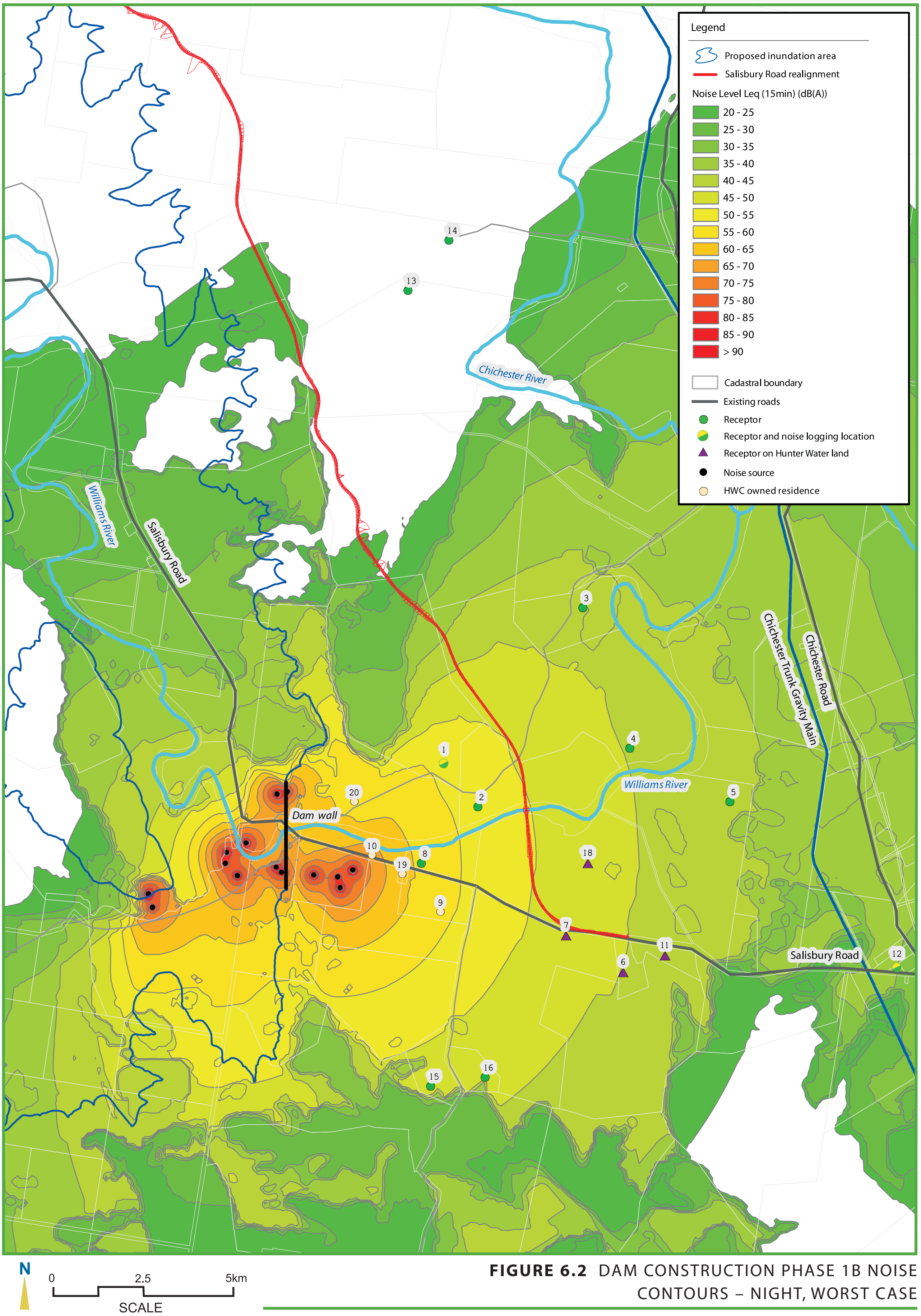
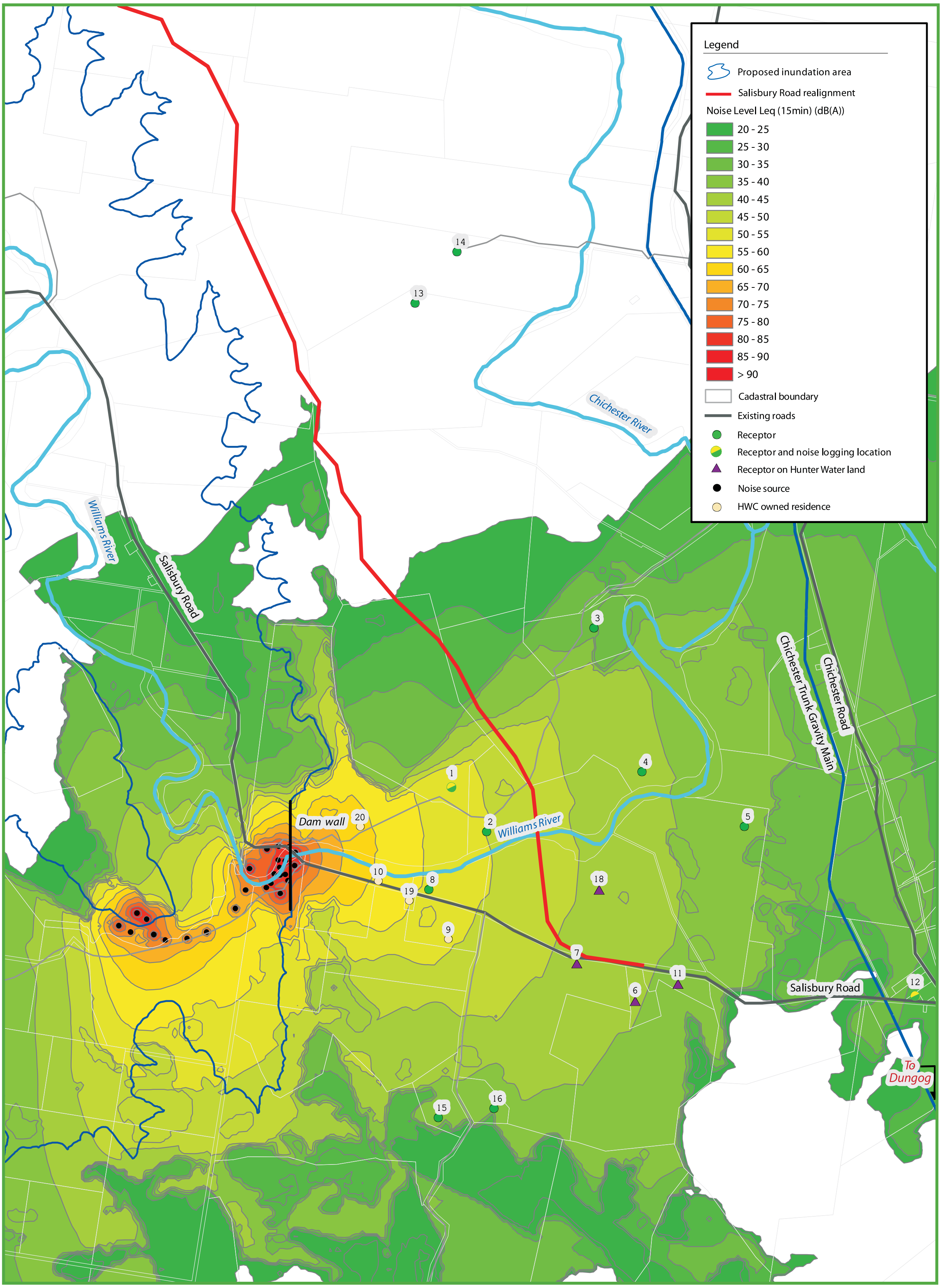


FIGURE 6.2 DAM CONSTRUCTION PHASE 1B NOISE CONTOURS – NIGHT, WORST CASE



N
0 2.5 5km
SCALE

FIGURE 6.3 DAM CONSTRUCTION PHASE 2C/D NOISE CONTOURS – DAY, WORST CASE

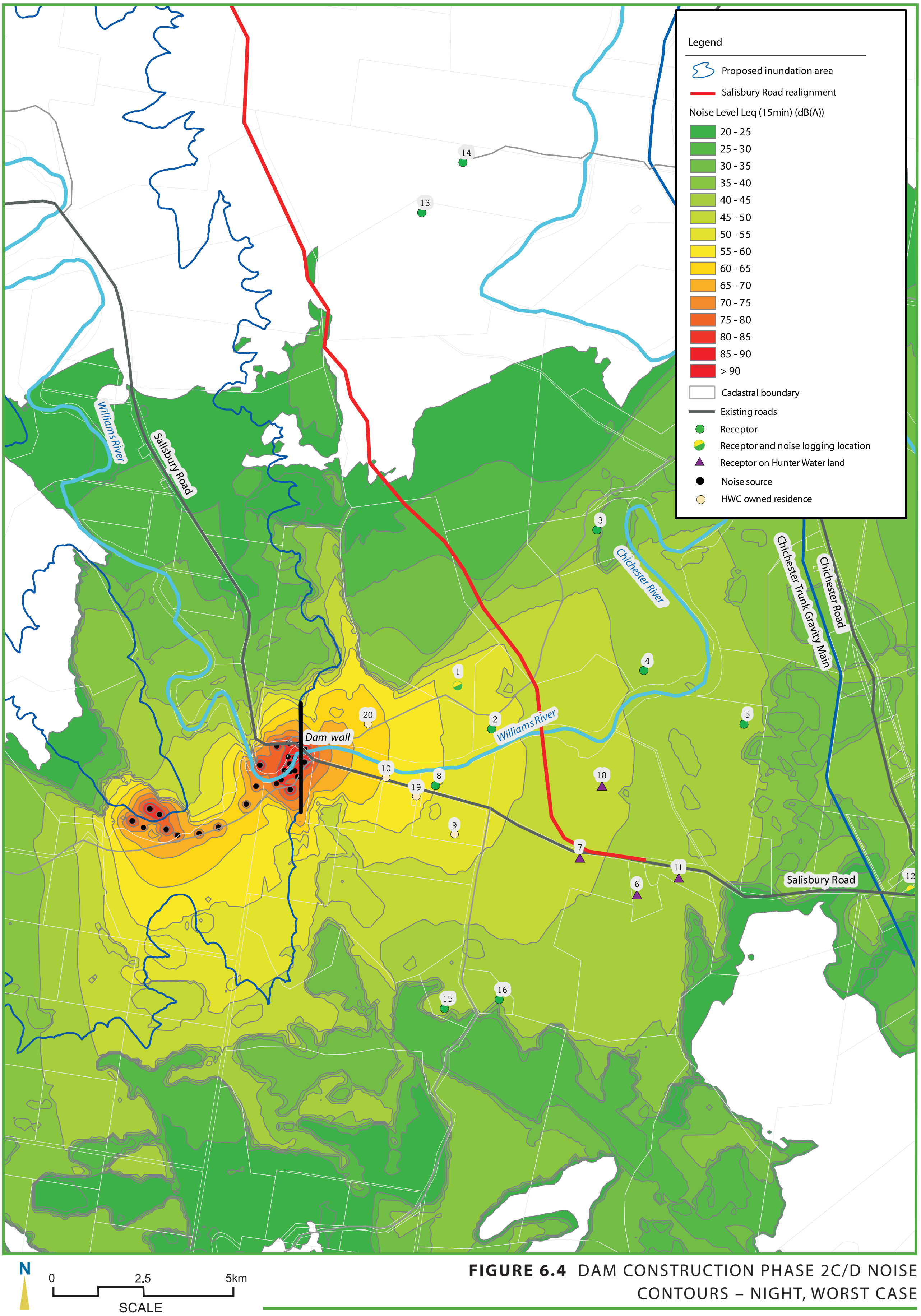


FIGURE 6.4 DAM CONSTRUCTION PHASE 2C/D NOISE CONTOURS – NIGHT, WORST CASE

6.1.2 Salisbury Road realignment

Construction noise emissions associated with this activity assumes the following equipment operating simultaneously.

TABLE 6.5 SALISBURY ROAD ASSUMED CONSTRUCTION EQUIPMENT

EQUIPMENT	QUANTITY
Dozers	4
Excavators	4
Trucks	6
Graders	4
Rollers	4
Asphalting plant	2
Rock crushing plant	1
Water carts	4
Scraper	2

Given that some equipment such as graders, rollers and other moving equipment would not be operating in the same position for a continuous period of time, an adjustment to their effective emitted noise level has been made based on the assumption that each vehicle would operate at the closest location to the sensitive receptor for approximately five minutes in each 15 minute period. This creates a more realistic prediction of the emitted noise by the construction equipment rather than the instantaneous worst case which does not represent accurately the average noise level at the receptor. This is consistent with the estimated 30 per cent operation adjustment discussed in the preceding section.

Construction noise at three worst case locations along the Salisbury Road new alignment has been calculated to assess noise at various receptors.

The predicted noise levels at the sensitive receptors are shown in Table 6.6, Table 6.7, and

Table 6.8 for the various construction areas with the respective noise contours plotted in Figures 6.5, 6.6 and 6.7.

TABLE 6.6 SALISBURY ROAD MODEL AREA 1 CONSTRUCTION PREDICTED NOISE LEVELS

RECEPTOR	SALISBURY 1 $L_{eq, 15min}$ (dB(A))		CRITERIA	
	TYPICAL OPERATIONAL NOISE		NOISE MANAGEMENT LEVEL ($L_{eq, 15min}$) STANDARD PERIOD	
	Neutral	Standard Period	Noise Affected	Highly Noise Affected
1	52	50	40	75
2	58	56	40	75
3	45	49	40	75
4	46	50	40	75
5	41	45	40	75
6*	48	52	40	75
7*	66	66	40	75
8	47	44	40	75

RECEPTOR	SALISBURY 1 $L_{eq, 15min}$ (dB(A))		CRITERIA	
	TYPICAL OPERATIONAL NOISE		NOISE MANAGEMENT LEVEL ($L_{eq, 15min}$	
			STANDARD PERIOD	
	Neutral	Standard Period	Noise Affected	Highly Noise Affected
9*	47	43	40	75
10*	44	40	40	75
11*	45	49	40	75
12	31	36	40	75
13	32	24	40	75
14	30	23	40	75
15	37	39	40	75
16	39	41	40	75
18*	54	60	40	75
19*	45	42	40	75
20*	36	30	40	75

* HWC-owned property, highlighted levels show exceedance of criteria

TABLE 6.7 SALISBURY ROAD MODEL AREA 2 CONSTRUCTION PREDICTED NOISE LEVELS

RECEPTOR	SALISBURY 2 $L_{eq, 15min}$ (dB(A))		CRITERIA	
	TYPICAL OPERATIONAL NOISE		NOISE MANAGEMENT LEVEL ($L_{eq, 15min}$	
			STANDARD PERIOD	
	Neutral	Standard Period	Noise Affected	Highly Noise Affected
1	34	38	40	75
2	33	38	40	75
3	37	42	40	75
4	30	35	40	75
5	25	30	40	75
6*	22	27	40	75
7*	25	30	40	75
8	25	30	40	75
9*	25	30	40	75
10*	22	27	40	75
11*	22	27	40	75
12	16	21	40	75
13	42	44	40	7
14	38	41	40	5
15	18	23	40	75
16	18	23	40	75
18*	27	32	40	75
19*	23	28	40	75
20*	22	27	40	75

* HWC-owned property

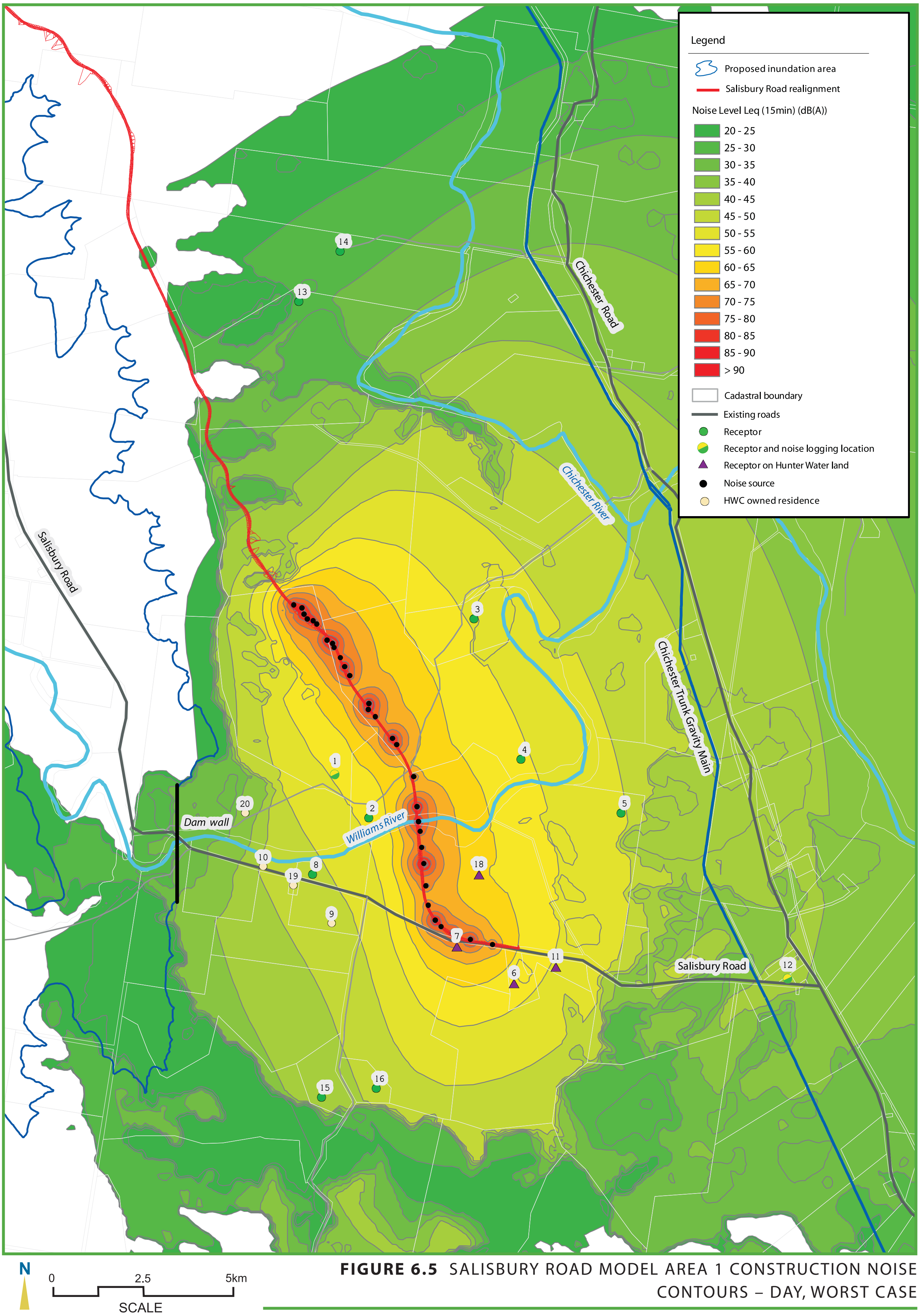


FIGURE 6.5 SALISBURY ROAD MODEL AREA 1 CONSTRUCTION NOISE CONTOURS – DAY, WORST CASE

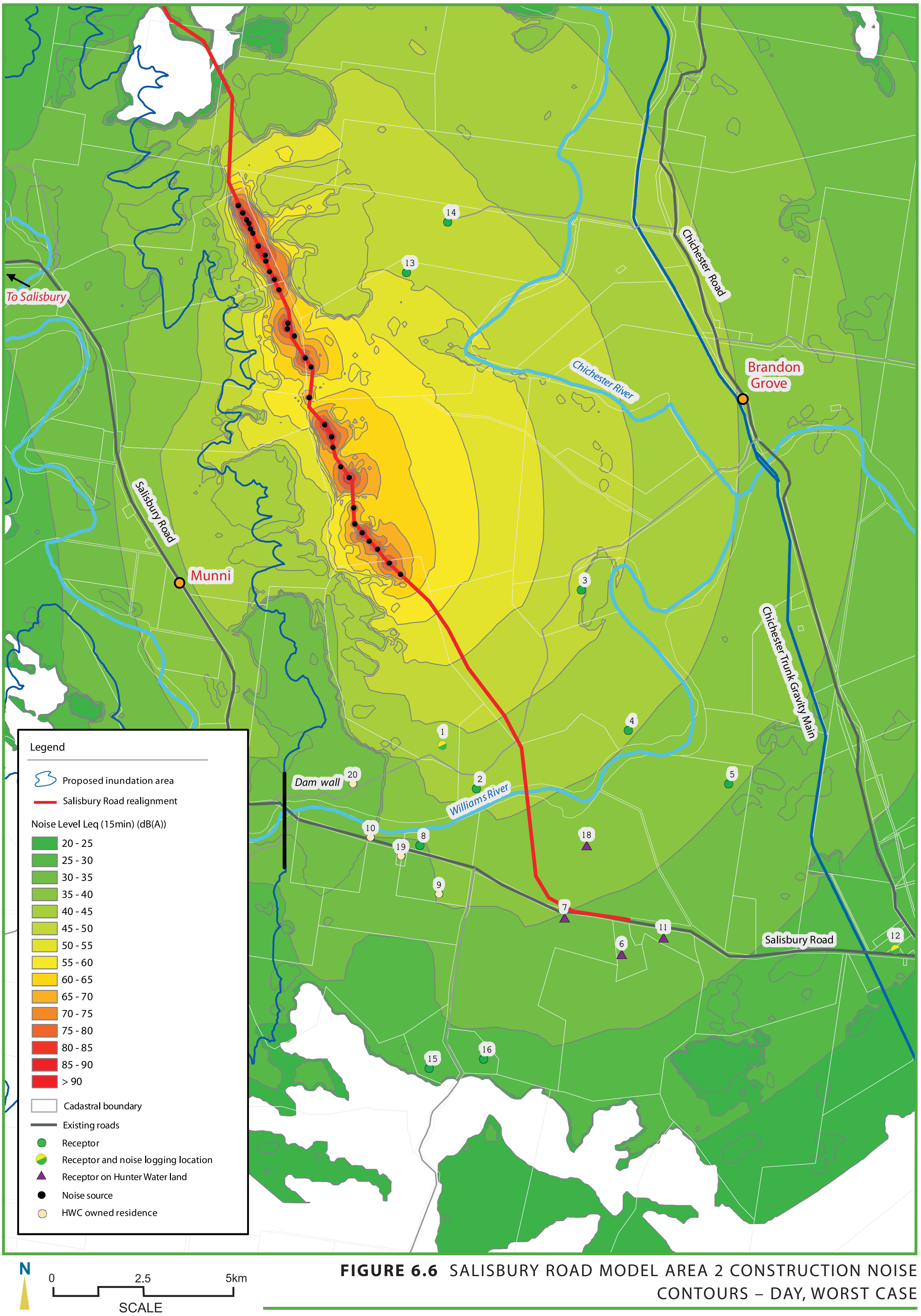


FIGURE 6.6 SALISBURY ROAD MODEL AREA 2 CONSTRUCTION NOISE CONTOURS – DAY, WORST CASE

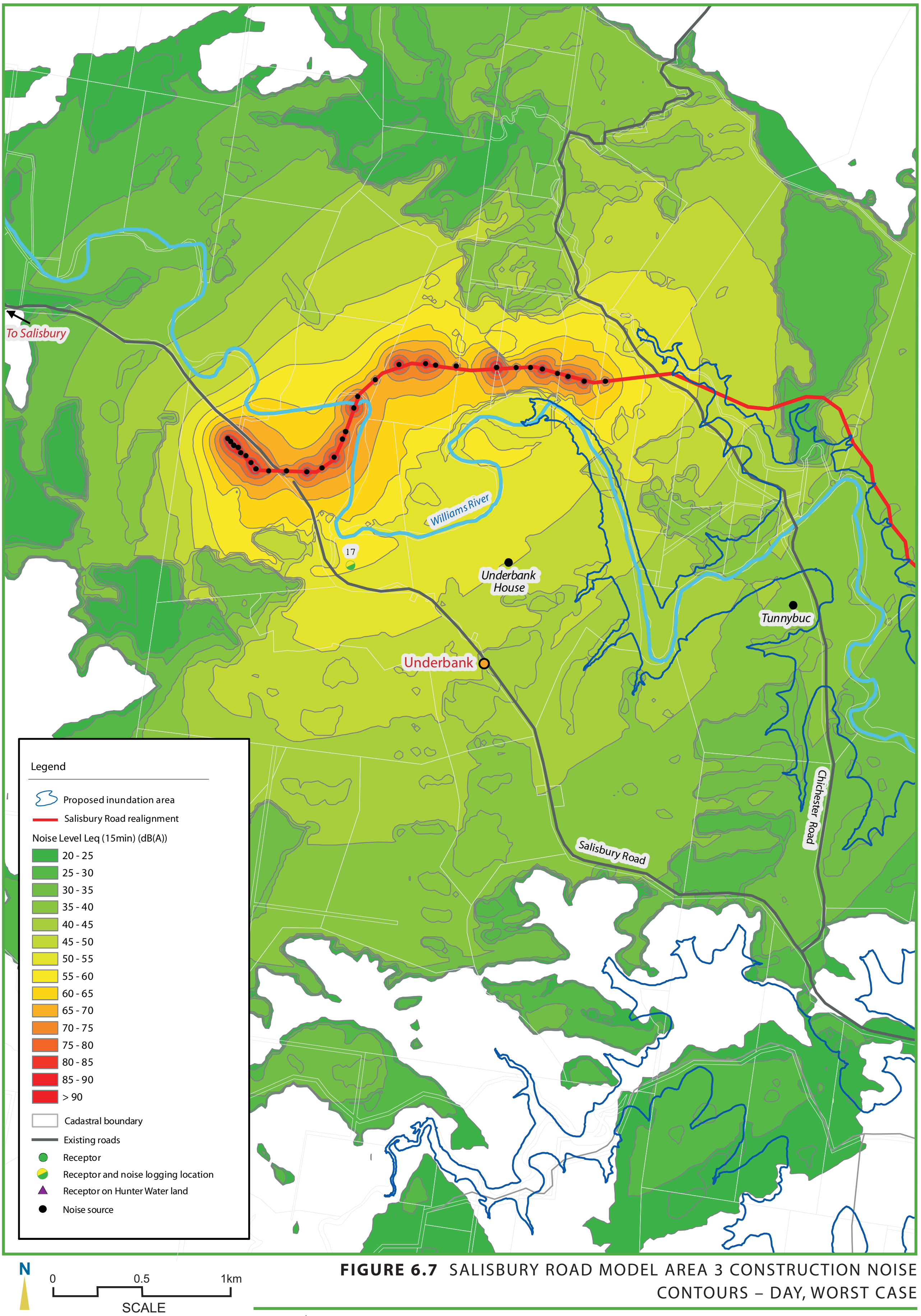


FIGURE 6.7 SALISBURY ROAD MODEL AREA 3 CONSTRUCTION NOISE CONTOURS – DAY, WORST CASE

TABLE 6.8 SALISBURY ROAD MODEL AREA 3 CONSTRUCTION PREDICTED NOISE LEVELS

RECEPTOR	SALISBURY 2 $L_{eq, 15min}$ (dB(A))		CRITERIA	
	TYPICAL OPERATIONAL NOISE		NOISE MANAGEMENT LEVEL ($L_{eq, 15min}$	
			STANDARD PERIOD	
	Neutral	Standard Period	Noise Affected	Highly Noise Affected
17	46	50	40	75

Given the close proximity of the road realignment to residences and the requirement to regularly use loud machinery, it is very unlikely that the proposed noise criteria would be satisfied for many of the residences especially at properties 1 and 2. A potential mitigation measure may be to erect a temporary noise barrier along the edge of the construction corridor in close proximity to the sensitive receptor. Otherwise an offer of short term temporary relocation during the worst case construction works for the worse affected residents should be considered.

Assuming a six day working week (Monday to Saturday), the average number of heavy vehicle movements (two way) would be nine per day for the peak construction period (refer Working Paper I). This level of heavy vehicle movements is not considered to represent a significant impact on noise environment at the sensitive receptors.

It is important to note that the Standard Period Highly Noise Affected criterion has not been exceeded, however should full construction activities be conducted at night, a high degree of community consultation would be required as it has been shown that the predicted noise level at several properties is expected to be above the Rating Background Level +10 dB(A) and the continuous sleep disturbance criteria.

6.2 Construction vibration levels

Vibration levels from construction activities (excluding blasting) should not exceed the allowable levels due to large propagation activities between the source and receptor (minimum of 200 metres). Typical vibration levels (peak particle velocities) from construction equipment are shown in Table 6.9 including a predicted vibration transmission.

TABLE 6.9 TYPICAL VIBRATION LEVELS OF CONSTRUCTION PLANT EQUIPMENT

EQUIPMENT	PPV (mm/s) AT 10 m [REF 10]	PREDICTED PPV (mm/s) AT 200 m	PREFERRED DAYTIME CRITERIA (mm/s)
Loader (breaking kerbs)	6 – 8	0.07 – 0.09	0.28*
15t roller	7 – 8	0.08 – 0.09	0.28
7t compactor	5 – 7	0.06 – 0.08	0.28
Roller	5 – 6	0.06 – 0.07	0.28
Pavement breaker	4.5 – 6	0.05 – 0.07	0.28
Dozer	2.5 – 4	0.03 – 0.04	0.28
Backhoe	1	0.01	0.28
Jackhammer	0.5	0.01	0.28

* Continuous vibration criteria

In addition to the vibration criteria being achieved, the ground borne noise at the nearest resident is expected to be negligible.

6.3 Blasting impacts

Impacts associated with blasting activities have been predicted according to Sections J7.2 and J7.3 from AS 2187.2-2006 [Ref 9] for airblast overpressure and ground vibration respectively. Table 6.10 shows the minimum recommended distance between the blasting site and nearest sensitive receptor to comply with the criteria outlined in Section 4.3. Average conditions have been input into the model however predictions using a 10 dB safety factor (overpressure less than 105 dB) have also been produced. In all cases the minimum airblast overpressure distance is the driving factor.

It should be noted that the prediction methods outlined in the Australian Standard do not take into account topographic shielding or meteorological effects for airblast overpressure and variations in ground conditions for ground vibration which could significantly alter the predicted levels. Blasting design should consider all relevant matters including location and ground conditions to satisfy ANZECC criteria.

TABLE 6.10 MINIMUM RECOMMENDED DISTANCES BETWEEN BLASTING AND SENSITIVE RECEPTORS

EFFECTIVE CHARGE MASS PER DELAY (kg)	DISTANCE (m) TO ACHIEVE AIRBLAST OVERPRESSURE		DISTANCE (m) TO ACHIEVE PPV <5mm/s (m)
	<115 dB (LIN)	<105 dB (LIN)	
5	185	409	67
25	316	699	149
50	398	881	210
100	502	1110	298
200	632	1398	421
500	858	1898	666

6.4 Road traffic noise

The road traffic noise predicted consisted of the worst case hourly exposure which occurs during the morning and afternoon peak volumes. Given the small traffic volumes along Salisbury Road, predicted noise levels at all the sensitive receptors satisfied the applicable ECRTN criteria. Single point predicted noise levels are shown in Table 6.11 with graphical contours displayed in Figure 6.8.

TABLE 6.11 NEW ALIGNMENT SALISBURY ROAD WORST CASE PREDICTED NOISE LEVELS

RECEPTOR	PREDICTED TRAFFIC		CRITERION
	$L_{10(1h)}$ (dB(A))	$L_{eq(1h)}$ (dB(A))	ECRTN ($L_{eq(1h)}$)
1	31	27	55
2	37	34	55
3	29	26	55
4	29	26	55
5	15	12	55
6*	31	28	55
7*	42	39	55
8	28	25	55
9*	29	26	55
10*	24	21	55
11*	29	26	55
12	15	12	55
13	23	20	55

RECEPTOR	PREDICTED TRAFFIC		CRITERION
	$L_{10(1h)}$ (dB(A))	$L_{eq(1h)}$ (dB(A))	ECRTN ($L_{eq(1h)}$)
14	22	19	55
15	25	22	55
16	26	23	55
17	28	25	55
18*	29	26	55
19*	26	23	55
20*	25	19	55

* HWC-owned property

6.5 Operation

As the plant associated with the dam would likely operate at any time over a 24 hour period, the operational noise emissions from the project should comply with the night time limit of 35 dB(A). Compliance with the night time noise goal automatically ensures compliance with the less stringent daytime noise goal.

A qualitative assessment of the operational noise impacts has been undertaken, as a more detailed analysis was not possible given the limited available information regarding equipment specification at this time and the position of such infrastructure relative to the dam. This was considered appropriate as the operational noise impacts related to the dam would be relatively minor and are unlikely to exceed allowable criteria.

As noted in Section 1.1, the Project does not include **installation** of a mini HEP plant, rather the design only makes **provision** for it. It is anticipated that consideration of noise emissions associated with operation of the mini HEP plant would be addressed when details on specifications are known. As a general comment, however, it is expected that noise emissions could be suitably controlled at source through appropriate acoustic shielding.

The current concept design as the transfer pump station located a short distance from the dam wall. Plant would be housed in a suitable enclosure with appropriate acoustic treatment. It is expected that compliance with operational noise criteria would be able to be achieved through inclusion of quantitative performance limits in the tender documents for equipment.

Spillway noise could become a dominating noise source depending on the volume of water associated with the flow. As noted previously, noise from a waterfall can reach approximate levels of 75 85 dB(A) at three metres based on a five metre high waterfall. This equates to about 35 45 dB(A) (ignoring shielding by topography) at the nearest residence. Given the design constraints, difficulty and large costs required to directly mitigate the noise generated by the spillway, it is proposed that any potential noise treatment would be better applied to the sensitive receptors (eg sound insulation of dwellings with increased thickness glazing, installation of solid fences acting as noise walls etc). It is recommended that regular monitoring at the sensitive receptors during the commissioning and operation of the spillway be undertaken to determine whether any additional insulation treatment would be required for the nearest affected dwelling.

Noise emitted from the substation (predominantly from the transformer) would comply with the operational noise criteria due to the relatively low emitted sound powers and the large propagation distance to the closest receptor. Noise emission restrictions would be included as part of the specification of the transformers and associated equipment to ensure compliance with the noise goals.

Significant maintenance noise would be predominantly associated with periodic testing of the emergency warning siren. This should be restricted to day time hours, and operation limited in duration to no longer than is necessary to demonstrate it is in working order. Testing should be carried out preferably with notification of local residents regarding the proposed testing times.

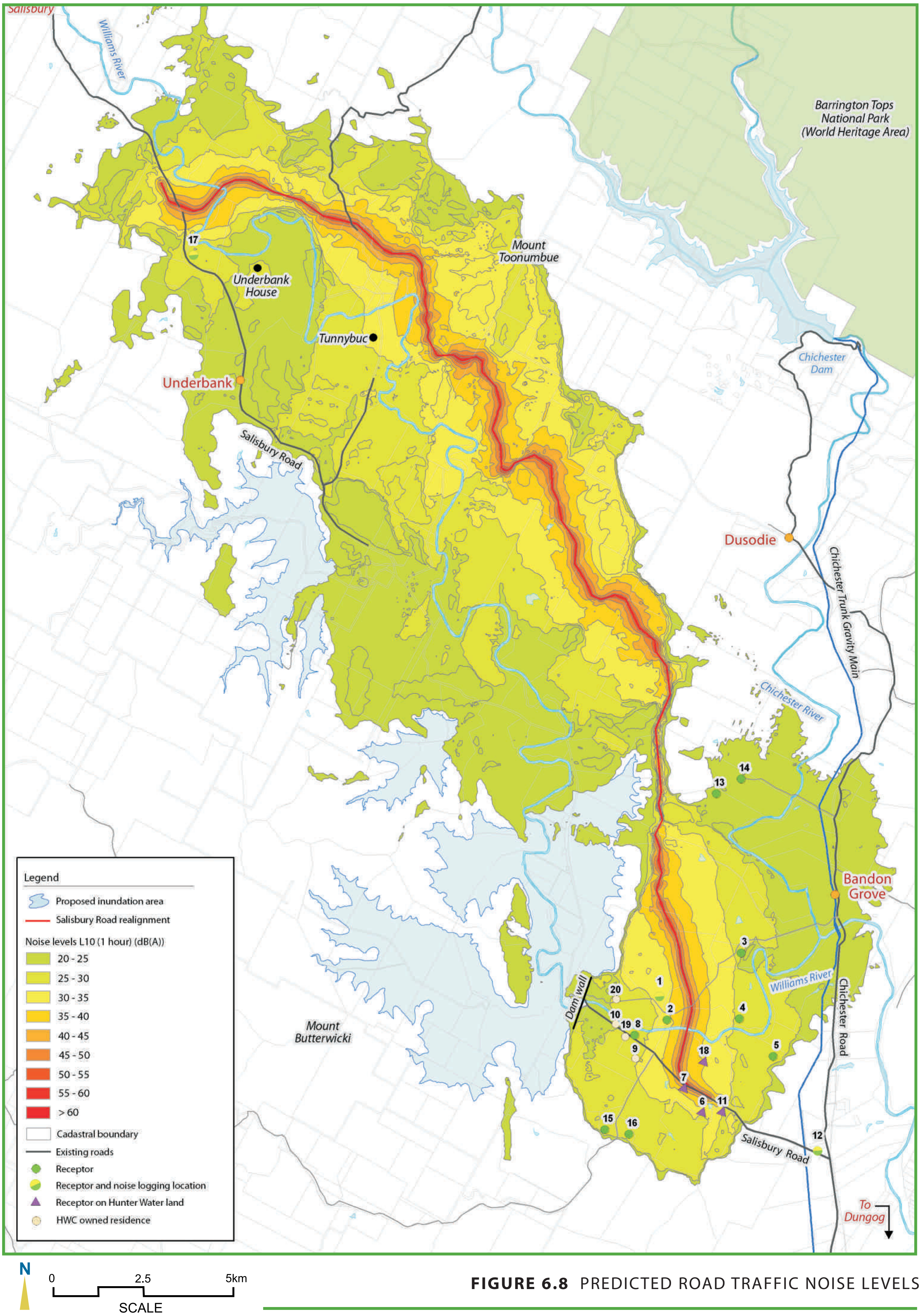


FIGURE 6.8 PREDICTED ROAD TRAFFIC NOISE LEVELS

7 Recommendations and Conclusions

7.1 Construction noise mitigation

Computational simulation of the construction activities has shown that a number of properties may be affected by the construction noise emissions. It should be noted that the noise levels predicted for the standards construction hours (daytime) do not exceed the Highly Noise Affected criterion, therefore the application of feasible and reasonable mitigation methods is required to satisfy the goals of the ICNG.

The ICNG recommends that where the noise affected criteria are exceeded, the proponent should apply all feasible and reasonable work practices to meet the noise affected level, and inform all potentially impacted resident of the nature of the works to be carried out and the expected noise levels and duration as well as contact details. Several properties exceed the Noise Affected criterion; therefore noise attenuation measures should be implemented.

Construction noise is dependant on the specific equipment used and the proximity of that equipment to noise sensitive areas. Due to the difficulty and impracticality of attenuating certain aspects of construction noise, impacts would need to be mitigated through the implementation of the following recommendations:

- Where possible limit construction activities to the following time restrictions for construction as set out in the ICNG:
  - Monday to Friday 7.00 am to 6.00 pm
  - Saturday 8.00 am to 1.00 pm
  - no work on Sundays or public holidays
- undertake appropriate community consultation with respect to works outside of standard hours
- restrict noisy activities (eg blasting) to between 9.00 am and 3.00 pm
- implementation of recommendations given in AS 2436:1981 [Ref 8]
- use low noise machinery where possible
- placement of stationary equipment such as crushing plants, air compressors and generators as far as possible from noise sensitive areas utilising created noise barriers that develop as part of the Project such as the dam wall and natural topography as well as potentially implementing temporary structures to shield most exposed equipment.
- minimise duration of idling of stationary equipment where possible

- provide advance notification to the community of any expected noise disruptions that can occur such as the blasting schedule
- develop a Noise Management Plan which would include logging and assessment of complaints, as well as routine monitoring of noise levels during construction
- work with the affected community to set up variations to noise criteria to allow for louder construction noise during certain times, as well provide regular updates informing them of upcoming work and whether they should expect any heightened disturbance
- temporary relocation of residents during worst case noise emitting construction.

7.2 Operational noise

Noise emissions associated with operation should be managed through the following measures:

- monitoring during, and immediately following commissioning at the closest sensitive receptors to determine whether design noise performance criteria have been exceeded. Identification of the dominating noise source would determine whether any additional attenuation measures are to be applied at the source or receptor. Such measures could include screens/barriers, retrofitting of increased insulation, glazing thickness etc for existing dwellings
- appropriate communication with the local community should be carried out to advise them of any unusual or irregular activities or noise sources which might cause a disturbance
- specification of acoustic enclosures for the pump station and turbine enclosure would be provided during the design stage once detailed specifications of the chosen equipment is available
- noise limits for major items of equipment (eg turbine, generator and transformer) should be specified for attention during detailed design.

7.3 Conclusion

Based on the analysis undertaken, noise levels associated with construction of the dam wall are predicted to exceed criteria at a number of residences for standard hours and for non-standard hours.

Predicted noise levels from construction of Salisbury Road for a number of properties, exceeds the proposed allowable noise criteria, when the work is in very close proximity to the residents. In these situations temporary relocation of those affected residences or the erection of provisional noise screens has been recommended along with time restrictions on the construction period. Regular noise monitoring should be carried out during the construction phase to assess compliance with the proposed criteria.

Traffic noise associated with the new alignment of Salisbury Road complies with the required ECRTN noise criteria.

Operational noise would not exceed the allowable criteria, however regular monitoring during the commissioning phase is recommended to ensure noise from the spillway is within allowable limits at the nearest receptors. Detailed design of acoustic enclosures for the pump station and turbine building are to be determined once final equipment selections have been made.

Appendix A

Photos of Noise Survey Locations

Connell Wagner

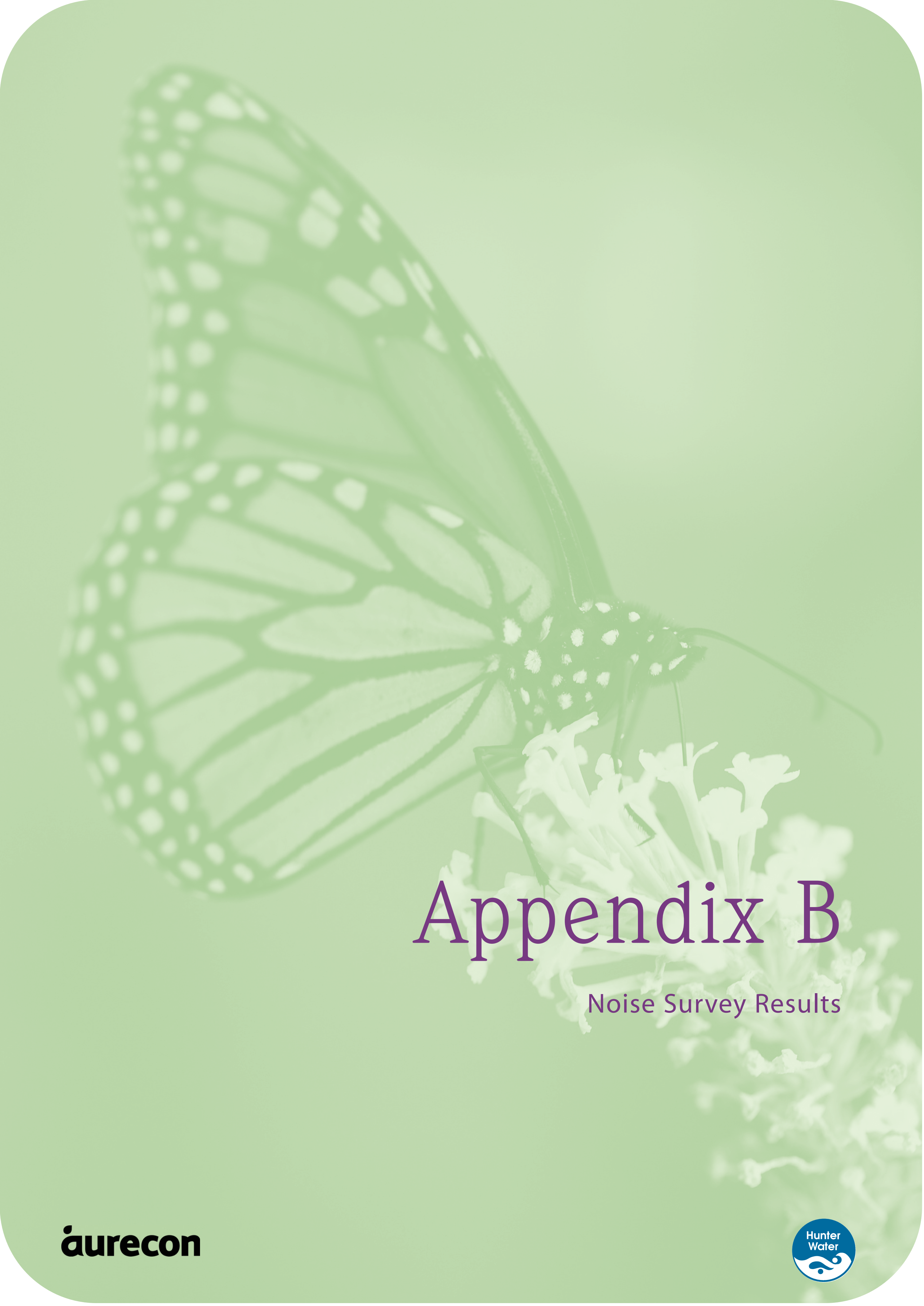
Hunter Water

Site 17 – Hopson property

Site 12 – Tomlinson property 1

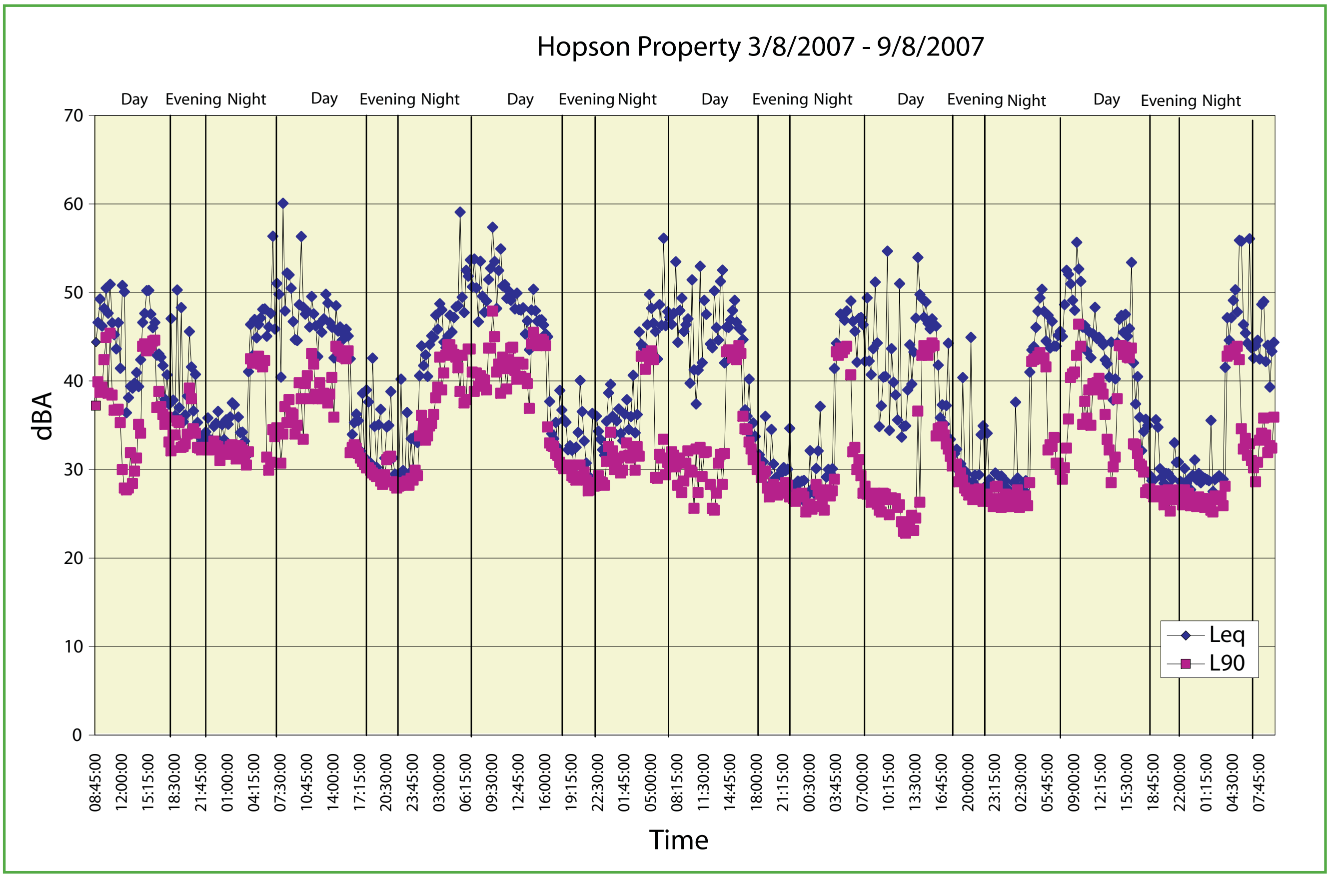
Site 12 – Tomlinson property 2

Site 1 – Lowrey property



Appendix B

Noise Survey Results


Hopson Property 3/8/2007 - 9/8/2007
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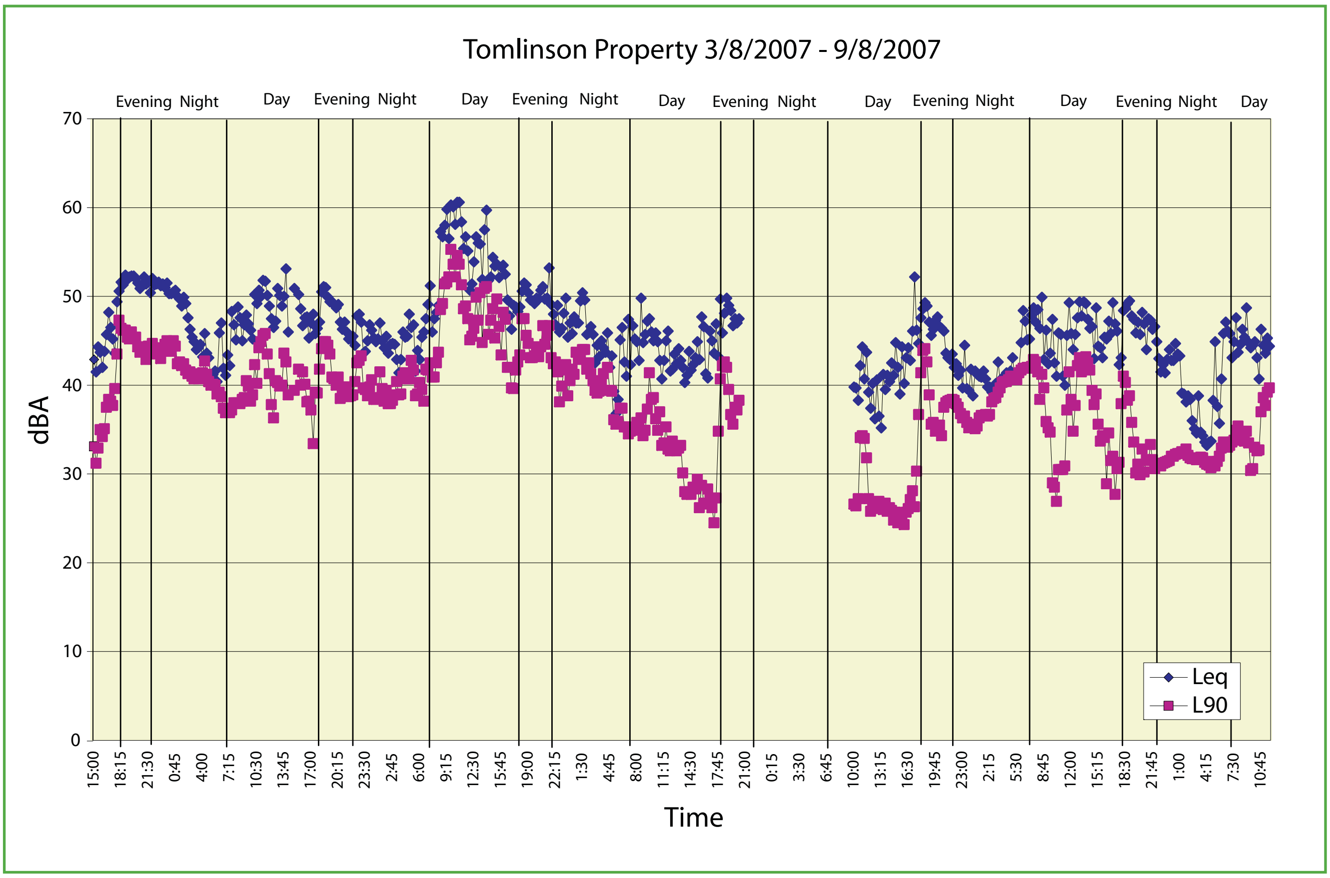
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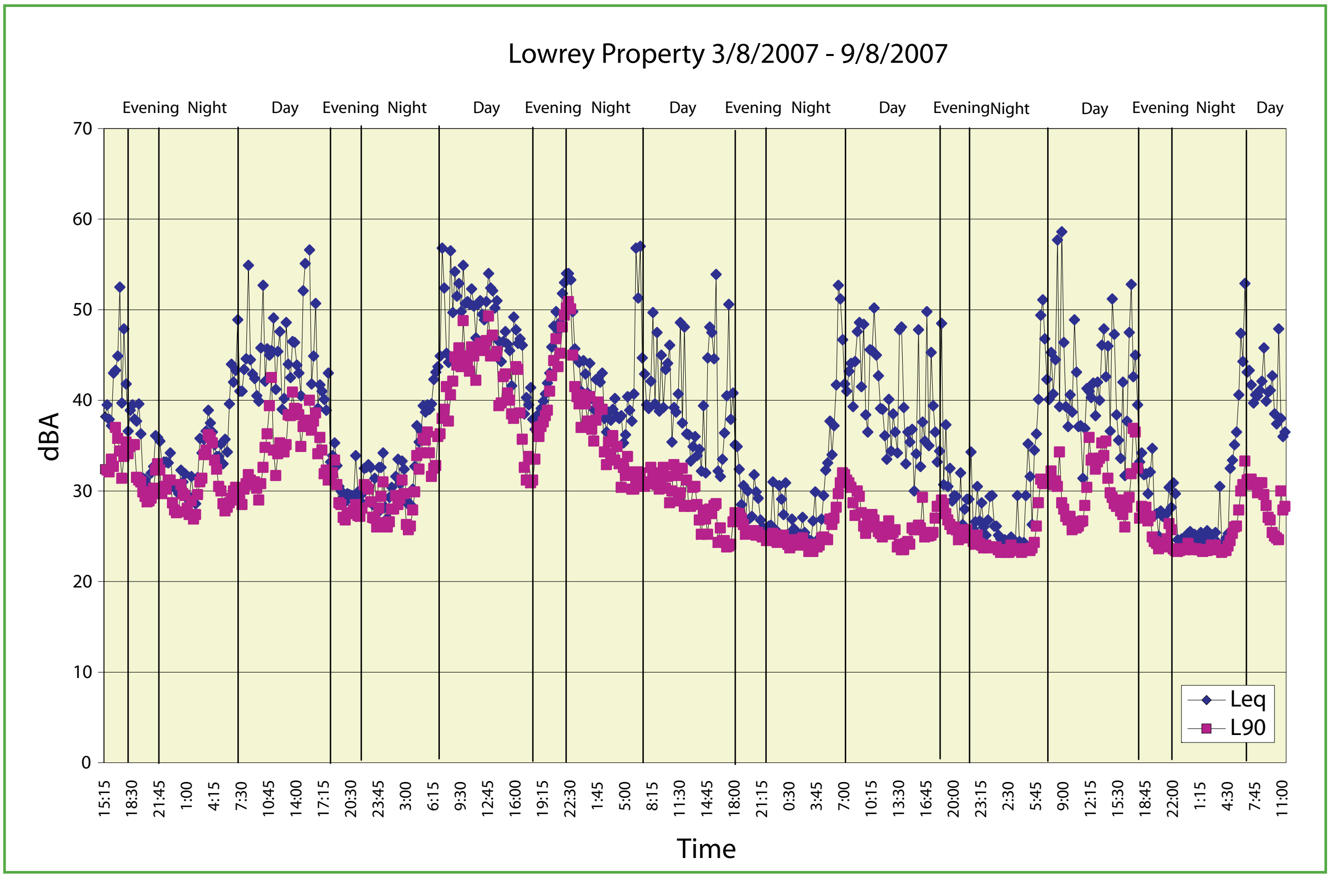
Lowrey Property 3/8/2007 - 9/8/2007
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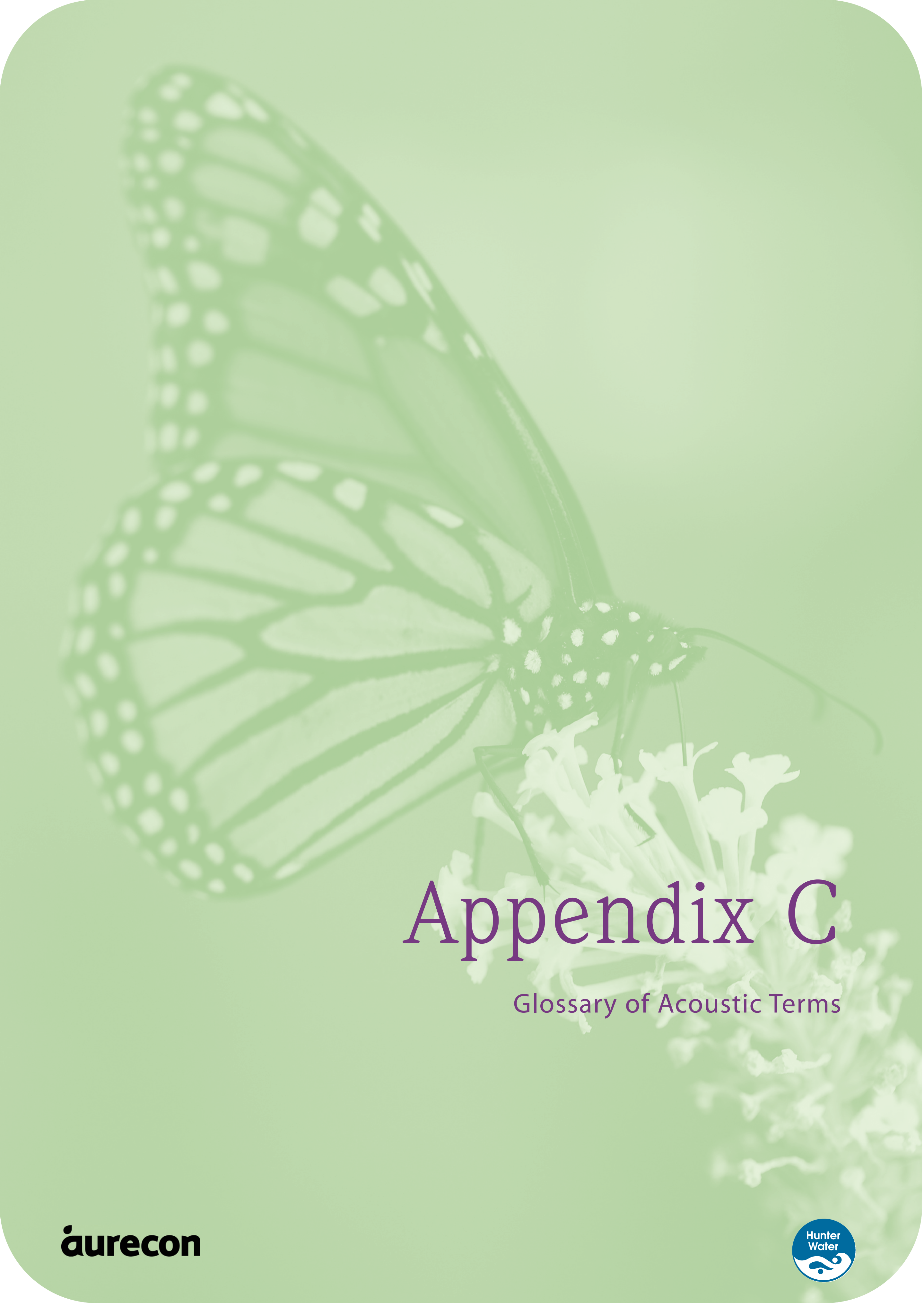


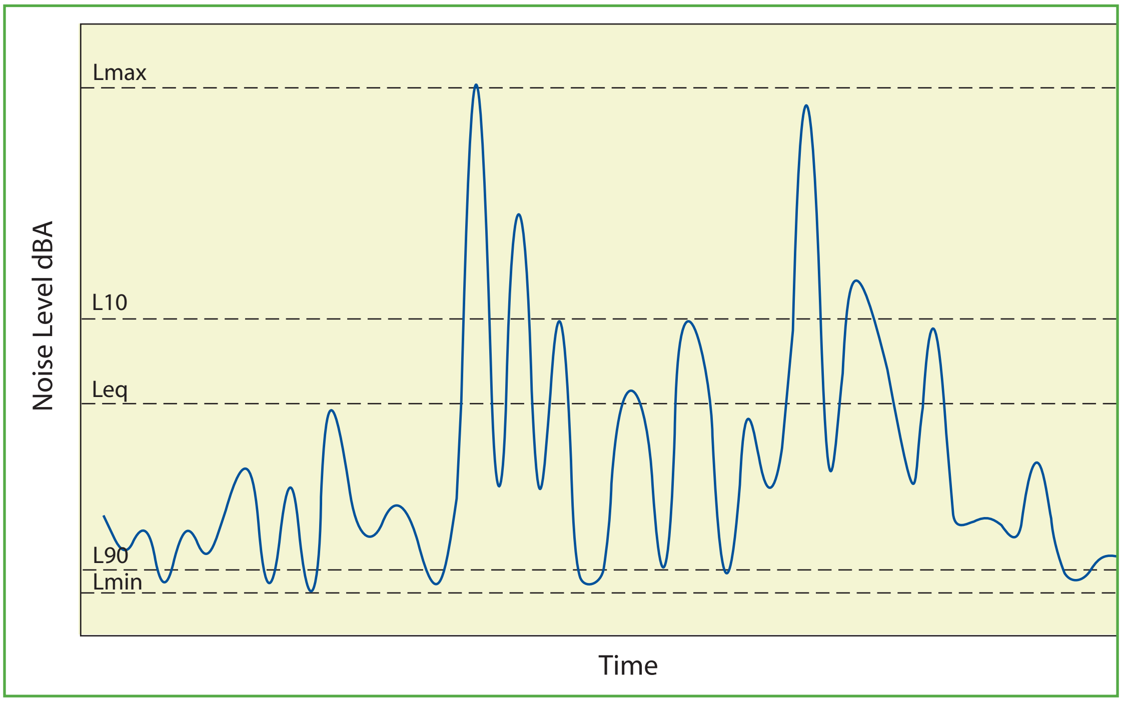
Appendix C

Glossary of Acoustic Terms

aurecon

Hunter Water

Sound Power Level	Property of the source of the sound and it gives the total acoustic power emitted by the source
Sound Pressure Level	Property of the sound at a given observer distance from the source and can be measured by a single microphone
dB(A)	A unit of measurement, decibels (A), of sound pressure level which has its frequency characteristics modified by a filter (A-weighted) which approximates the frequency response of the human ear.
L_{10}	The noise level which is equaled or exceeded for 10% of the measurement period. L_{10} is an indicator of the mean maximum noise level, and is the descriptor for intrusive noise. Nominal measurement period is usually 15 minutes.
L_{90}	The noise level which is equaled or exceeded for 90% of the measurement period. L_{90} is an indicator of the mean minimum noise level, and is the descriptor for background noise
L_{eq}	The equivalent continuous noise level for the measurement period, weighted for duration and intensity. L_{eq} is an indicator of the average noise level which is the descriptor for ambient noise.
L_{max}	The maximum noise level for the measurement period.
L_{min}	The minimum noise level for the measurement period.
L_{peak}	The maximum numerical noise level, usually unweighted, attained during the measurement period.



SEL	The single event Sound Exposure Level is the equivalent A-weighted sound level which, if it lasted for one second, would produce the same sound energy as the actual event.

Change in noise level	The subjective response or reaction to changes in noise levels can be described as follows:
+ 10dB	Perceived as a doubling in loudness
+ 5dB	Quite a noticeable change
+ 3dB	Just perceptible to the average human ear