Appendix M

Noise and vibration assessment

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Narrabri Gas Project - Environmental Impact Statement

Noise and vibration assessment

July 2015

Executive summary

The Proponent is proposing to develop natural gas from the Gunnedah Basin in New South Wales, southwest of Narrabri.

The specific elements of the Narrabri Gas Project for which planning approval is being sought are the gas field, a central water management facility, a gas processing facility, and supporting infrastructure.

The aim of this assessment is to identify potential noise and vibration issues associated with the construction and operation of the project. The assessment addresses the Secretary's environmental assessment requirements for the project.

Background noise and road traffic monitoring was undertaken in the project area. Background noise levels below 30 dB(A) were generally measured.

Analysis of meteorological conditions in the study area was undertaken to determine the occurrence of adverse meteorological conditions. Temperature inversions were found to occur for more than 30 per cent of the time and have been considered in the noise assessment.

Site specific noise predictions and impact assessment have been undertaken where the location of the infrastructure is known. Where the location of the infrastructure is unknown, a constraints based approach has been adopted and the buffer distances required to achieve the noise criteria have been estimated.

A predicted exceedance of the noise criteria does not necessarily mean the receiver will be adversely affected or impacted by the noise. Rather the criteria are proposed to ensure that potential noise impacts from the project are minimised through implementation of mitigation and measurement measures.

Assessment has been undertaken to the Secretary's environmental assessment requirements.

Operation noise assessment findings

There are a number of pieces of equipment proposed to be sited at the Leewood site, including gas processing and compression, water treatment and an optional power station. Without mitigation treatments, operational noise levels from Leewood are predicted to exceed the noise criteria at several surrounding sensitive receivers. However, with the implementation of mitigation treatments, operational noise levels from Leewood are predicted to comply with the noise criteria at all surrounding sensitive receivers during both calm and adverse meteorological conditions.

Operational noise levels from the Bibblewindi central gas processing facility are predicted to comply with the noise criteria at all identified sensitive receivers in all meteorological conditions.

In respect of operating wells, modelling predicts that a maximum distance of 218 meters and 138 meters (for adverse and calm meteorological conditions respectively) is required to meet the noise criteria for multiple production wells operating simultaneously under a worst case 750 metres well spacing configuration. The noise from the operation of a production well is steady in nature and would not produce significant maximum noise emissions events therefore, sleep disturbance impacts are not anticipated as a result of the operation of production wells.

The operation of a pilot well with an associated flare (where these pilot wells are not connected to the gas gathering system) is estimated to require a maximum distance of 3,412 metres and 2,423 metres (for adverse and calm meteorological conditions respectively) to meet the noise criteria for sensitive receivers.

Road traffic noise levels are not predicted to increase by more than 2 dB(A) as a result of the proposed operation. As 2 dB(A) is generally not a discernible increase in noise, and would comply with the road traffic noise criteria for sensitive receivers on the traffic routes.

The operation of the safety flares at Leewood and Bibblewindi has the potential to occasionally exceed the intrusive noise criteria at sensitive receivers, if they are required to be operated at maximum capacity in adverse meteorological conditions. However, the requirement for operation of the flare at this capacity would arise infrequently during maintenance or other situations where operational equipment is off-line and the highest noise levels would occur when all equipment is off-line (during maximum flow rate) which would be an extremely rare event. If maintenance activities required this to occur, activities would, as far as practical, be scheduled to occur during the recommended standard construction noise hours.

Construction noise assessment findings

Construction activities at Leewood are predicted to comply with the noise management levels during recommended standard hours at all sensitive receivers except for one receiver which is predicted to exceed the noise management levels by up to 3 dB(A). Five sensitive receivers are predicted to receive noise levels above the noise management levels if construction work is undertaken outside of recommended standard hours during calm meteorological conditions and up to eight sensitive receivers during adverse meteorological conditions. The predicted maximum construction noise levels do not exceed the sleep disturbance screening criteria at identified sensitive receiver.

Construction activities at Bibblewindi are predicted to comply with the noise management levels both during and outside of standard construction hours at all identified sensitive receivers. The predicted maximum construction noise levels are also below the sleep disturbance criteria at all identified sensitive receivers.

Drilling activities have an operational requirement to occur continuously 24 hours per day. A maximum distance of 1,875 metres is predicted to be required to meet noise management levels during the night time period (adverse meteorological conditions) during cementing, the highest noise source activity, with mitigation measures implemented. Maximum noise level events associated with drilling are likely to be associated with the movement of drill rod casings and air releases. There is the potential for sleep disturbance criteria to be exceeded where sensitive receivers are located within 1,300 metres of a drilling rig. The field development protocol would apply the noise constraints to guide the siting of wells and this dictates where management and mitigation measures would be required to be implemented, including in situations where multiple drill rigs are operating in vicinity of one another, or other project noise sources.

For the construction of access tracks and the installation of the gas and water gathering system, the maximum buffer distance to achieve the noise management levels during standard construction hours were estimated to be 2,021 metres during trenching activities for gathering line installation and 1,440 metres during vegetation clearing for access track and gathering line corridor establishment. By their nature, noise level exceedances of the construction noise management levels at sensitive receivers associated with the installation of access tracks or gathering lines are very short term as the installation work front proceeds along the corridor.

There are no anticipated exceedances of the noise management levels for sensitive receivers associated with construction activities along the Bibblewindi to Leewood infrastructure corridor during recommended standard hours and when work is undertaken outside of recommended standard hours during calm meteorological conditions. Five sensitive receivers are predicted to receive noise levels in excess of the noise management level if construction work was to be undertaken outside of recommended standard hours during adverse meteorological conditions. Management and mitigation measures are recommended to be implemented in such conditions.

Construction activities along the Wilga Park to Leewood transmission line construction corridor are predicted to exceed the construction noise management levels at up to 19 sensitive receivers during recommended standard hours and up to 57 sensitive receivers when work is undertaken outside of recommended standard hours during adverse meteorological conditions. The highly noise affected management level has the potential to be exceeded at one receiver for a short period of time likely to be less than one day. Management and mitigation measures are recommended to be implemented in such conditions.

Construction of the Westport worker’s accommodation is predicted to comply with the noise management levels during recommended standard hours and when work is undertaken outside of recommended standard hours during calm meteorological conditions. Noise levels are predicted to exceed the noise management level at one sensitive receiver if work was to be undertaken outside of recommended standard hours during adverse meteorological conditions.

Road resurfacing and intersection upgrade activities are predicted to comply with the construction noise management levels at all sensitive receivers both during and outside of recommended standard construction hours.

Construction of the water release pipeline from Leewood to the Bohena Creek is predicted to exceed the noise management levels during standard construction hours at three sensitive receivers. If work was to be undertaken outside of standard hours up to 14 sensitive receivers would exceed the noise management level during adverse meteorological conditions. Management and mitigation measures are recommended to be implemented as required to meet the noise criteria.

In relation to the potential for exceedances to the vibration criteria, buffer distances have been calculated for construction equipment. Based on the constraint of no infrastructure being located within 200 metres of a sensitive receiver unless otherwise agreed, the potential for exceedances to the vibration criteria as a result of the project is unlikely. Appropriate mitigation and management measures would be implemented if potential exceedances were predicted to occur. Although it is not expected that blasting will be required during construction activities, in the event that blasting is required, the potential for exceedances to the blasting criteria would be assessed in accordance with the relevant guidelines and required mitigation and monitoring measures implemented. The nearest sensitive receivers to the Bibblewindi to Leewood construction corridor are in excess of 2,000 metres away, and as such no exceedances to the blasting criteria from blasting activities that may be required are anticipated.

Road traffic noise levels are not predicted to increase by more than 2 dB(A) as a result of the proposed construction activities. As 2 dB(A) is generally not a discernible increase in noise, and would comply with the road traffic noise criteria for sensitive receivers on the traffic routes.

A suite of noise mitigation and management measures have been provided and these may be considered for implementation to ensure construction activities meet noise management levels where feasible and reasonable.

Where construction work is required to be undertaken outside of the recommended standard construction hours’ activities would be managed so that noise levels meet the out of hours’ noise management level of 35 dB(A) unless there is a private negotiated agreement in place with the sensitive receiver permitting a higher level of noise to occur.

Where noise is predicted to exceed the noise management levels at a sensitive receiver notification would be made of the nature and duration of the works, expected noise levels and a method of contact to raise noise complaints.

Conclusion

There are a number of noise sources during both construction and operation associated with the project. Given the localised and temporary nature of works in anyone location associated with the construction of a gas field, exceedances to the construction noise management levels as a result of construction noise are expected to be minor and temporary.

The operation of production wells is not expected to impact receivers if located appropriately.

Due to its significant distance from sensitive receivers the operation of the infrastructure at Bibblewindi is not predicted to exceed the noise criteria.

The operation of infrastructure at Leewood has the potential to cause exceedances to the noise criteria at surrounding sensitive receivers if noise mitigation and management measures are not implemented.

There are a suite of mitigation and management measures presented to assist in minimising potential impacts of noise from the construction and operation of the project. Final selection of measures will depend on the nature of the activities, noise emission produced and the proximity of the activities to sensitive receivers.

The proponent may enter into a private negotiated agreement with potentially affected sensitive receivers to minimise the impacts of noise from the project.

It is noted that the field development protocol will apply this assessment and the identified noise constraints into a protocol to be followed to locate the gas field infrastructure for the project, including production and pilot well pads, gas and water gathering lines and access tracks.

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Glossary

Term	Definition
Acoustic enclosure	A structure built around a noise source to reduce noise.
Adverse	Meteorological effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time.
Calm	Where noise enhancing meteorological conditions do not occur at a site for a significant period of time.
EPA	Environmental Protection Authority
dB	Decibel is the unit used for expressing the sound pressure level (SPL) or power level (SWL) in acoustics.
dB(A)	Decibel expressed with the frequency weighting filter used to measure 'A-weighted' sound pressure levels, which conforms approximately to the human ear response, as our hearing is less sensitive at low and high frequencies.
DECC	Department of Environment and Climate Change
DECCW	Department of Environment, Climate Change and Water
$L_{Aeq(period)}$	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
$L_{A90(period)}$	The sound pressure level that is exceeded for 90 per cent of the measurement period.
$L_{Aeq(15hr)}$	The L_{Aeq} noise level for the period 7:00 to 22:00 hours.
$L_{Aeq(9hr)}$	The L_{Aeq} noise level for the period 22:00 to 7:00 hours.
L_{Amax}	The maximum A-weighted sound pressure level occurring in a specified time period.
Noise sensitive receiver	A noise modelling term used to describe a map reference point where noise is predicted. They consist of areas or places potentially affected by noise or vibration including: • a residential dwelling • an educational institution, library, childcare centre or kindergarten • a hospital, surgery or other medical institution • an active (for example sports field, golf course) or passive (for example national park) recreational area • commercial or industrial premises • a place of worship.
Peak particle velocity	Peak particle velocity is the maximum vector sum of three orthogonal time-synchronized velocity components regardless of whether these component maxima occurred simultaneously.
Rating background level	The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period.
Study area	For the noise assessment the study are has been defined as a sensitive receiver within three kilometres of the project area.

Term	Definition
Tonality	Noise containing a prominent frequency or frequencies characterised by definite pitch.
VDV	Vibration dose value - As defined in BS6472 – 2008, VDV is given by the fourth root of the integral of the fourth power of the frequency weighted acceleration.
Vibration	The variation of the magnitude of a quantity which is descriptive of the motion or position of a mechanical system, when the magnitude is alternately greater and smaller than some average value or reference. Vibration can be measured in terms of its displacement, velocity or acceleration. The common units for velocity are millimetres per second (mm/s).

1. Introduction

1.1 Overview

The Proponent is proposing to develop natural gas in the Gunnedah Basin in New South Wales (NSW), southwest of Narrabri (refer to Figure 1).

The Narrabri Gas Project (the project) seeks to develop and operate a gas production field, requiring the installation of gas wells, gas and water gathering systems, and supporting infrastructure. The natural gas produced would be treated at a central gas processing facility on a local rural property (Leewood), approximately 25 kilometres south-west of Narrabri. The gas would then be piped via a high-pressure gas transmission pipeline to market. This pipeline would be part of a separate approvals process and is therefore not part of this development proposal.

The primary objective of the project is to commercialise natural gas to be made available to the NSW gas market and to support the energy security needs of NSW. Production of natural gas from coal seams under the project would deliver economic, environmental and social benefits to the Narrabri region and the broader NSW community. The key benefits of the project can be summarised as follows:

- Development of a new source of gas supply into NSW would lead to an improvement in energy security and independence to the State. This would give NSW gas markets greater choice when entering into gas purchase arrangements. Potential would also exist for improved competition on price. Improved competition on price would have flow on benefits for NSW's economic efficiency, productivity and prosperity.
- The provision of a reduced greenhouse gas emission fuel source for power generation in NSW as compared to traditional coal-fired power generation.
- Increased local production and regional economic development through employment and provision of services and infrastructure to the project.
- The establishment of a regional community benefit fund equivalent to five per cent of the royalty payment made to the NSW Government within the future production licence area. If matched by the NSW Government, the fund could reach $120 million over the next two decades.

1.2 Description of the project

The project would involve the construction and operation of a range of exploration and production activities and infrastructure including the continued use of some existing infrastructure. The key components of the project are presented in Table 1-1, and are shown on Figure 1.

Table 1-1 Key project components

Component	Infrastructure or activity
Major facilities	
Leewood	• a central gas processing facility for the compression, dehydration and treatment of gas • a central water management facility including storage and treatment of produced water and brine • optional power generation for the project • a safety flare • treated water management infrastructure to facilitate the transfer of treated water for irrigation, dust suppression, construction and drilling activities • other supporting infrastructure including storage and utility buildings, staff amenities, equipment shelters, car parking, and diesel and chemical storage • continued use of existing facilities such as the brine and produced water ponds • operation of the facility
Bibblewindi	• in-field compression facility • a safety flare • supporting infrastructure including storage and utility areas, treated water holding tank, and a communications tower • upgrades and expansion to the staff amenities and car parking • produced water, brine and construction water storage, including recommissioning of two existing ponds • continued use of existing facilities such as the 5ML water balance tank • operation of the expanded facility
Bibblewindi to Leewood infrastructure corridor	• widening of the existing corridor to allow for construction and operation of an additional buried medium pressure gas pipeline, a water pipeline, underground (up to 132 kV) power, and buried communications transmission lines
Leewood to Wilga Park underground power line	• installation and operation of an underground power line (up to 132 kV) within the existing gas pipeline corridor
Gas field	
Gas appraisal and production infrastructure	• seismic geophysical survey • installation of up to 850 new wells on a maximum of 425 well pads – new well types would include exploration, appraisal and production wells – includes well pad surface infrastructure • installation of water and gas gathering lines and supporting infrastructure • construction of new access tracks where required • water balance tanks • communications towers • conversion of existing exploration and appraisal wells to production

Component	Infrastructure or activity
Ancillary	• upgrades to intersections on the Newell Highway • expansion of worker accommodation at Westport • a treated water pipeline and diffuser from Leewood to Bohena Creek • treated water irrigation infrastructure including: – pipeline(s) from Leewood to the irrigation area(s) – treated water storage dam(s) offsite from Leewood • operation of the irrigation scheme

The project is expected to generate approximately 1,300 jobs during the construction phase and sustain around 200 jobs during the operational phase; the latter excluding an ongoing drilling workforce comprising approximately 100 jobs.

Subject to obtaining the required regulatory approvals, and a financial investment decision, construction of the project is expected to commence in early 2018, with first gas scheduled for 2019/2020. Progressive construction of the gas processing and water management facilities would take around three years and would be undertaken between approximately early/mid-2018 and early/mid-2021. The gas wells would be progressively drilled during the first 20 or so years of the project. For the purpose of impact assessment, a 25-year construction and operational period has been adopted.

1.3 Project location

The project would be located in north-western NSW, approximately 20 kilometres south-west of Narrabri, within the Narrabri local government area (LGA) (see Figure 1). The project area covers about 950 square kilometres (95,000 hectares), and the project footprint would directly impact about one per cent of that area.

The project area contains a portion of the region known as ‘the Pilliga’, which is an agglomeration of forested area covering more than 500,000 hectares in north-western NSW around Coonabarabran, Baradine and Narrabri. Nearly half of the Pilliga is allocated to conservation, managed under the NSW *National Parks and Wildlife Act 1974*. The Pilliga has spiritual meaning and cultural significance for the Aboriginal people of the region.

Other parts of the Pilliga were dedicated as State forest, and set aside for the purpose of ‘forestry, recreation and mineral extraction, with a strategic aim to “provide for exploration, mining, petroleum production and extractive industry” under the *Brigalow and Nandewar Community Conservation Area Act 2005*. The parts of the project area on state land are located within this section of the Pilliga.

The semi-arid climate of the region and general unsuitability of the soils for agriculture have combined to protect the Pilliga from widespread clearing. Commercial timber harvesting activities in the Pilliga were preceded by unsuccessful attempts in the mid-1800s to establish a wool production industry. Resource exploration has been occurring in the area since the 1960s; initially for oil, but more recently for coal and gas.

The ecology of the Pilliga has been fragmented and otherwise impacted by commercial timber harvesting and related activities over the last century through:

- the establishment of more than 5,000 kilometres of roads, tracks and trails
- the introduction of pest species
- the occurrence of drought and wildfire.

The project area avoids the Pilliga National Park, Pilliga State Conservation Area, Pilliga Nature Reserve and Brigalow Park Nature Reserve. Brigalow State Conservation Area is within the project area but would be protected by a 50 metre surface exclusion zone.

Agriculture is a major land use within the Narrabri LGA; about half of the LGA is used for agriculture, split between cropping and grazing. Although the majority of the project area would be within State forests, much of the remaining area is situated on agricultural land that supports dry-land cropping and livestock. No agricultural land in the project area is mapped by the NSW Government to be biophysical strategic agricultural land (BSAL) and detailed soil analysis has established the absence of BSAL. This has been confirmed by the issuance of a BSAL Certificate for the project area by the NSW Government.

1.4 Planning framework and structure of this report

1.4.1 Planning Framework

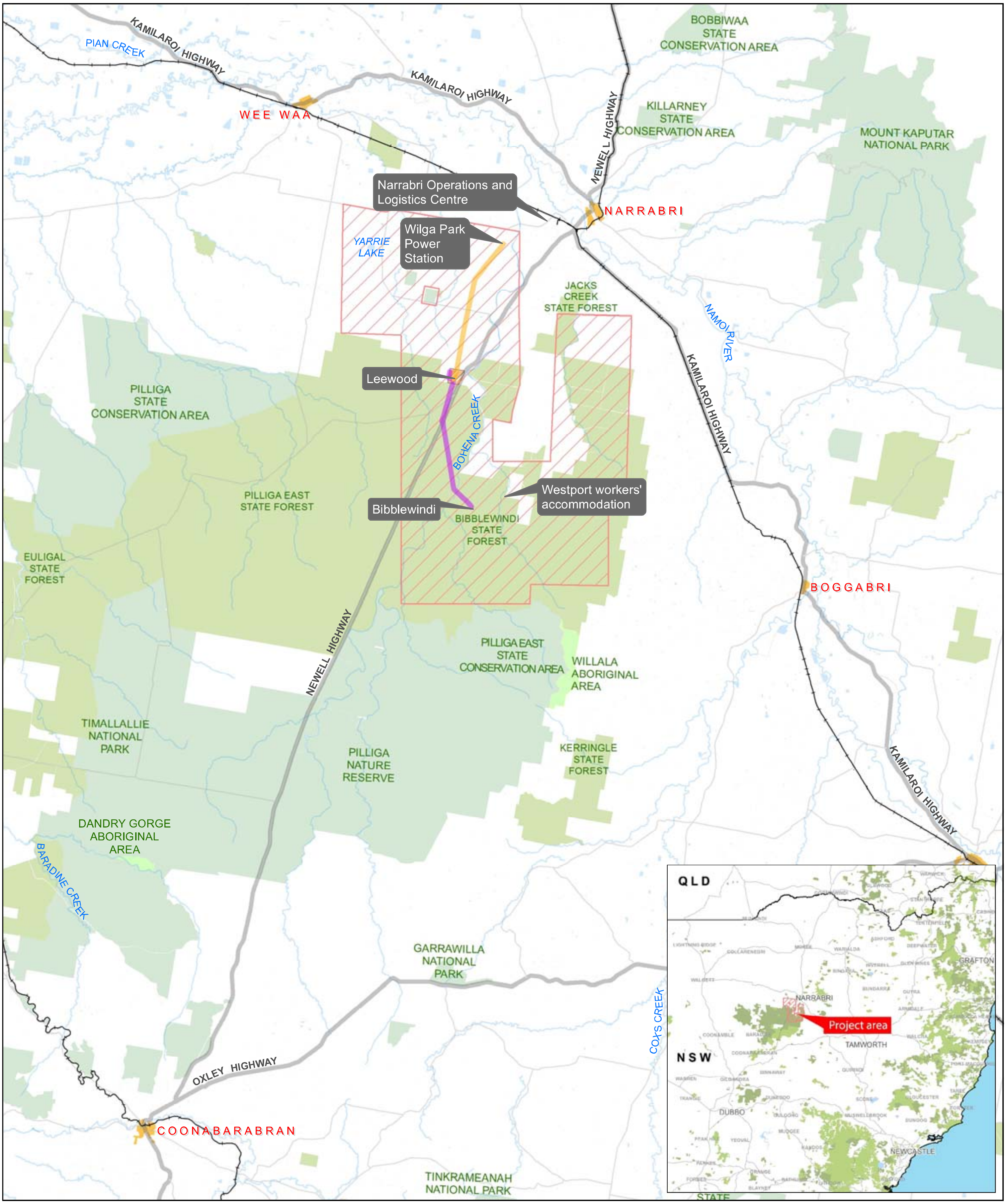
The project is permissible with development consent under the *State Environmental Planning Policy (Mining, Petroleum and Extractive Industries) 2007*, and is identified as 'State significant development' under section 89C(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *State Environmental Planning Policy (State and Regional Development) 2011*.

The project is subject to the assessment and approval provisions of Division 4.1 of Part 4 of the EP&A Act. The Minister for Planning is the consent authority, who is able to delegate the consent authority function to the Planning Assessment Commission, the Secretary of the Department of Planning and Environment or to any other public authority.

The project is also a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The project was declared to be a controlled action on 5 December 2014, to be assessed under the bilateral agreement between the Commonwealth and NSW Governments, and triggering the following controlling provisions:

- listed threatened species and ecological communities
- a water resource, in relation to coal seam gas development and large coal mining development
- Commonwealth land.

This noise and vibration assessment identifies the potential environmental issues associated with construction and operation of the project and addresses the Secretary's environmental assessment requirements for the project. The assessment will be used to support the EIS for the project.



LEGEND

- Project area
- Leewood
- Urban
- State forest
- Parks and reserves
- Aboriginal areas
- Lakes and dams
- Watercourses
- Highways
- Major Roads
- Train line
- Leewood to Wilga Park infrastructure corridor
- Bibblewindi to Leewood infrastructure corridor

0 5 10 20
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Narrabri Gas Project
EIS Technical Appendix Noise and Vibration

Job Number | 21-22463
Revision | A
Date | 12 Mar 2015

Regional context and location of key infrastructure

Figure 1

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Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

1.4.2 Structure of report

The report is structured as follows:

- **Chapter 1 – Introduction.** This chapter introduces the project and describes the project area.
- **Chapter 2 – Methodology.** This chapter defines the study area assessed in this report and describes the steps undertaken in the assessment.
- **Chapter 3 – Legislative context**. This chapter outlines the relevant Commonwealth and State legislation relating to the assessment. Guidelines and assessment criteria (where applicable) relevant to the gas field construction and operation are also identified.
- **Chapter 4 – Existing environment**. This chapter describes the existing environmental values of the study area relevant to the noise and vibration assessment; including results of field investigations and previous noise surveys.
- **Chapter 5 – Impact assessment.** This chapter examines the potential environmental impacts associated with the construction and operation of the project.
- **Chapter 6 – Mitigation measures.** This chapter outlines the proposed mitigation strategies during the construction and operational phases to manage the potential noise and vibration impacts.
- **Chapter 7 – Conclusion.** This chapter provides a conclusion to the report and presents the next steps in the advancement of the project.

2. Methodology

The following methodology was utilised to assess the potential noise and vibration impacts associated with construction and operation of the project in order to address the Secretary's environmental assessment requirements:

- identifying sensitive receivers within the defined study area
- describing the existing noise environment and local meteorology
- establishing noise and vibration assessment criteria at sensitive receiver locations
- assessing the potential construction and operational noise and vibration impacts from the project
- assessing potential traffic noise impacts from operation and construction
- assessing the potential vibration impacts from the project
- evaluating and assessing the extent of resulting impacts and the scope for the reduction of these impacts through reasonable and feasible mitigation strategies
- assessing cumulative noise impacts.

2.1 Study area

Since noise can travel outside the defined project area, a sensitive receiver within three kilometres of the project area has been considered as part of the study area for this assessment.

The project would involve a range of gas exploration and production activities, as well as the construction and operation of associated infrastructure. All exploration, construction and production activities would be located within the study area and can be broadly grouped into the following:

- Bibblewindi – located within the State Forest to the south of the project area; an infield compression facility and flare.
- Leewood – the central gas processing facility, centralised water management facilities, a communications tower, a flare and an optional power plant.
- the gas field – exploration, appraisal and production wells, and associated gas and water gathering lines located throughout the project area.
- New infrastructure to be constructed along an existing infrastructure corridor connecting the Bibblewindi and Leewood facilities, being an underground gas pipeline and underground electricity transmission and communication lines.
- Existing surrounding roads and access tracks on the traffic generation route with the potential to be exposed to increases in additional traffic from the project.

2.1.1 Leewood

Leewood is located centrally within the project area along the Newell Highway approximately 25 kilometres southwest of Narrabri. The property is approximately 246 hectares in size. There is existing infrastructure, as well as approved, but yet to be constructed, infrastructure at Leewood as part of previous planning approvals.

Existing infrastructure at Leewood includes:

- two produced water or brine storage ponds and a permeate tank
- a pipeline to transfer water from Bibblewindi
- staff amenities and car parking
- a storage and utilities area.

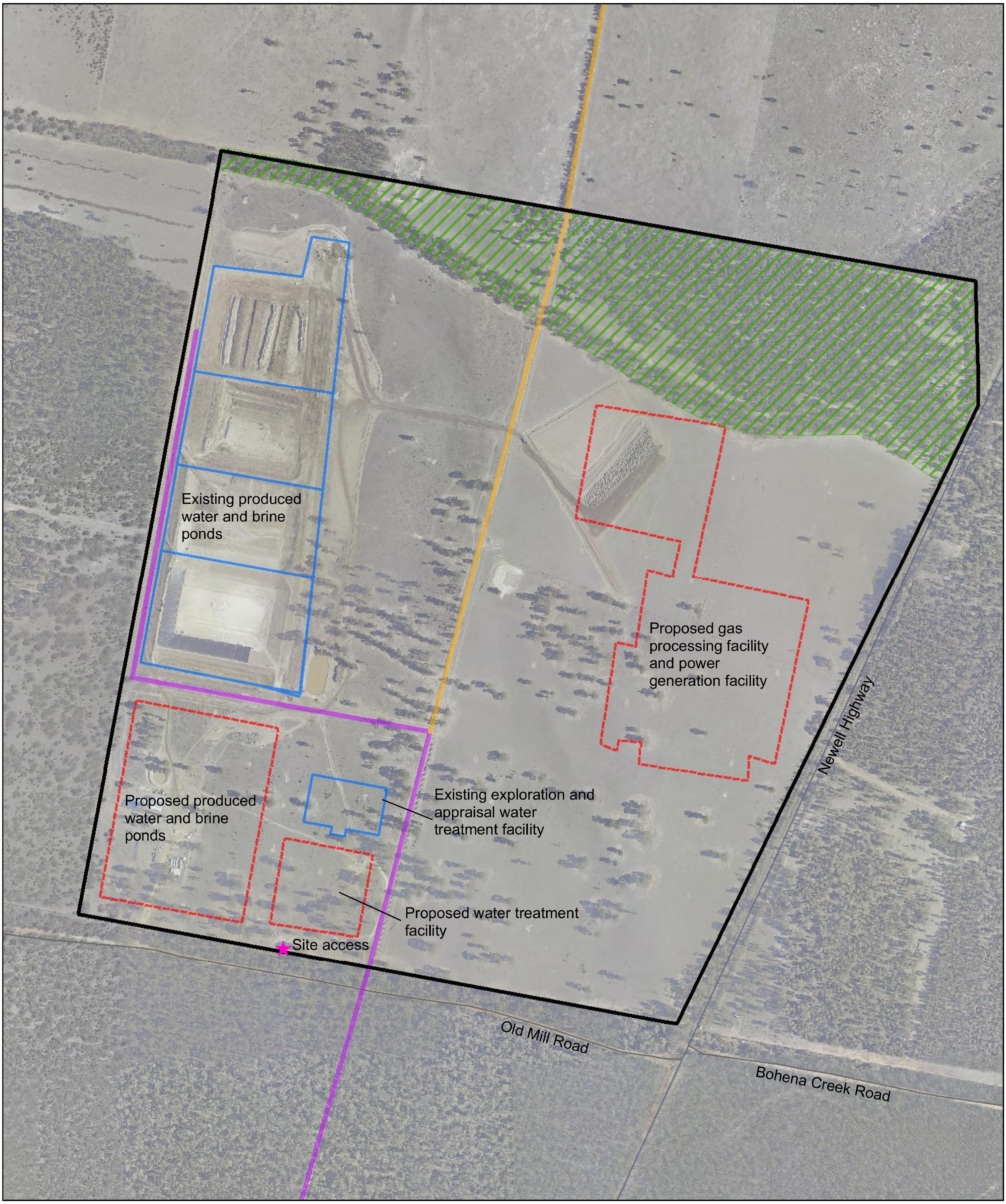
Approved (though yet to be constructed) infrastructure includes water management equipment for the approved exploration program, including:

- a water treatment plant using reverse osmosis technology
- a thermal brine concentrator and pilot-scale brine crystalliser
- a brine distribution manifold and associated water and brine piping
- a treated water storage tank of approximately five megalitres capacity
- a managed irrigation system.

Proposed additional infrastructure would include:

- the central gas processing facility
- an optional 100 megawatt power plant
- a safety flare
- dismantling of the existing water management facility and construction of a new facility to manage an increased volume of water, plus construction of two additional water or brine storage ponds
- infrastructure (including pipelines and managed irrigation systems) to transfer water for beneficial reuse
- a communications tower.

The location of the study area surrounding Leewood is shown in Figure 2. Residential sensitive receivers are located to the north, south and east of Leewood, with the closest sensitive receiver located approximately 1,400 metres east of the site.



LEGEND
- Leewood
- Roads
- Existing facilities
- Proposed infrastructure
- Vegetation to remain
- Leewood to Wilga Park infrastructure corridor
- Bibblewindi to Leewood infrastructure corridor

Aerial Imagery: Dec 2013

0 0.075 0.15 0.3
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Narrabri Gas Project
EIS Technical Appendix Noise and Vibration

Job Number	21-22463
Revision	A
Date	25 Jul 2015

Existing and proposed infrastructure at Leewood

Figure 2

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Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:jrichardson

2.1.2 Bibblewindi

The Bibblewindi facility is partially operational as part of previously approved exploration activities in the Pilliga. The Bibblewindi facility is located within the Bibblewindi State Forest to the south of the project area and seven kilometres east of the Newell Highway. The current facility has a footprint of about 12 hectares in size, and accessed via X-Line Road and Garlands Road.

The project would result in an additional footprint of approximately 16 hectares at Bibblewindi for the infield compression and flare infrastructure. An overview of the existing and proposed infrastructure at Bibblewindi is provided below.

Existing infrastructure:

- water storage ponds that would remain and be used as contingency
- appraisal wells that, if suitable for production, would be converted to production wells
- a safety flare that would remain and be upgraded under this project
- staff amenities and car parking that would remain
- a storage and utilities area that would remain
- a water balance tank that would remain
- a gas compression station that would be decommissioned.

Proposed additional infrastructure:

- up to 20 compressors (four standby) and associated after coolers for infield gas compression
- upgrade of the existing safety flare
- an electrical substation/motor control centre.

The location of Bibblewindi is shown in Figure 3 along with the location of the project infrastructure. Residential sensitive receivers are located to the north of Bibblewindi, with the closest sensitive receiver located approximately 4,000 metres north of the site.

LEGEND

- Indicative Bibblewindi site boundary
- Bibblewindi to Leewood infrastructure corridor
- Indicative infrastructure location
- Existing wells

Aerial Imagery: Dec 2013

0 0.05 0.1 0.2
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Narrabri Gas Project
EIS Technical Appendix Noise and Vibration

Job Number	21-22463
Revision	A
Date	25 Jul 2015

Existing and proposed infrastructure at Bibblewindi

Figure 3

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Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013.

2.1.3 Gas field

The gas field component of the project would be located entirely within the boundaries of the project area as shown in Figure 4.

Noise sensitive receivers within the project area have been identified. Residential sensitive receivers are located through the gas field study area and are identified in Appendix A.

2.1.4 Bibblewindi to Leewood infrastructure corridor

There is currently one existing water pipeline and one approved though yet to be constructed water pipeline in the infrastructure corridor between Bibblewindi and Leewood. There is also an existing gas pipeline that conveys gas from the Bibblewindi Site to the Wilga Park Power Station. The route of the gas pipeline takes it through the Leewood property and as such it is installed in the same infrastructure corridor. The existing corridor crosses both the Newell Highway and Bohena Creek.

The following additional infrastructure would be located along the existing corridor under the project:

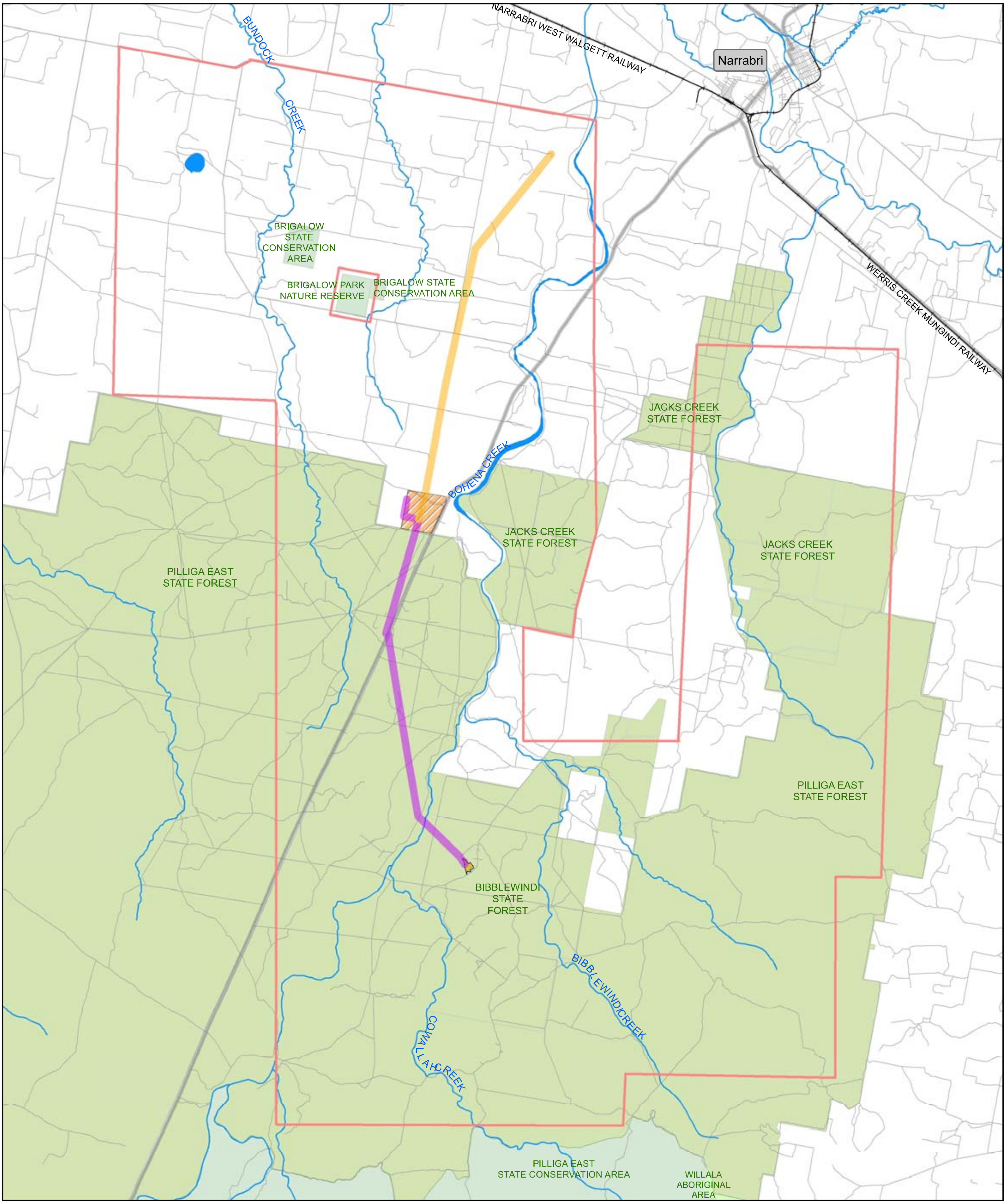
- a new intermediate gas pipeline to transfer gas from the in field compression station at Bibblewindi to the Leewood property for processing in the proposed central gas processing facility
- a new underground 66KV/132KV transmission line to reticulate power from the Leewood site to the Bibblewindi site
- communications cabling.

The construction and installation of this infrastructure would require an expansion of the existing corridor from approximately 12 metres to 30 metres. The location of the corridor is shown on Figure 4. The nearest sensitive receivers are located over two kilometres to the east and north east of the infrastructure corridor.

2.1.5 Surrounding road network

Surrounding roads on the traffic generation route which have the potential to be exposed to increases in additional traffic from the project are considered as part of the study area and include:

- Newell Highway
- Old Gunnedah Road
- Tibbereena Street
- Maitland Street
- X-Line Road
- Yarrie Lake Road
- Goobar Street
- Mooloobar Street
- Roads within the State Forest.



LEGEND

- Project area
- Leewood
- Bibblewindi
- Parks and reserves
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Train line
- Leewood to Wilga Park infrastructure corridor
- Bibblewindi to Leewood infrastructure corridor

0 1.75 3.5 7
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Narrabri Gas Project
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Gas field and infrastructure corridor

Figure 4

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Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: jrichardson

2.2 Existing environment

2.2.1 Existing noise environment

Background, ambient and road traffic noise monitoring was conducted as part of this assessment to establish the existing noise environment.

Background and ambient noise levels were measured using a combination of long-term noise monitoring and short-term attended noise monitoring. Long-term noise monitoring was conducted to establish typical noise levels considered representative of sensitive receivers within the study area. Short-term attended monitoring was also undertaken in order to gain an appreciation of the noise sources contributing to the ambient noise levels and the presence of existing noise from industry.

Existing road traffic noise levels were measured on the Newell Highway and Kiandool Lane which is a local road in the study area. This road traffic noise data was used in conjunction with traffic volumes, vehicle classification, road surface types and speeds to calculate the existing road traffic noise in the study area.

Details of the existing noise environment are provided in Section 4.2.

2.2.2 Local meteorological conditions

Analysis of meteorological conditions in the study area was undertaken to determine the adverse meteorological conditions for noise propagation in accordance with the *Industrial Noise Policy* (EPA 2000). Meteorological conditions which influence noise propagation include temperature, humidity, wind speed and direction and the presence of temperature inversions.

Noise impacts were then assessed using the established adverse meteorological conditions and also calm conditions.

2.3 Assessment criteria

2.3.1 Operational and construction noise criteria

The Secretary's environmental assessment requirements specify that operational noise impacts are assessed under the *Industrial Noise Policy* (EPA 2000) and that construction noise impacts should also be assessed under the *Industrial Noise Policy* (EPA 2000) unless a claim is made for specific construction noise criteria which would require justification and appropriate assessment under the *Interim Construction Noise Guideline* (DECC 2009).

Operational and construction criteria have been established and the justifications have been provided for certain activities to be assessed against the *Interim Construction Noise Guideline* (DECC 2009) where it is considered more appropriate.

2.3.2 Road traffic noise

Road traffic noise criteria were established based on the *Road Noise Policy* (EPA 2011) for assessment of potential road traffic noise impacts from the project during construction and operation.

2.3.3 Vibration criteria

Human comfort vibration criteria were established based on *Assessing Vibration: A Technical Guideline*, (DEC 2006) and structural damage criteria have been established based on German Standard *DIN 4150-3: 1999 Structural Vibration – Part 3: Effects of vibration on structures.*

2.4 Impact assessment

2.4.1 Noise impact assessment

Known infrastructure locations

Site specific noise predictions and impact assessment have been undertaken where the location of the infrastructure has been defined. Predictions for the following defined infrastructure consider noise attenuation potentially provided by shielding structures, topography and foliage:

- Leewood
  - Central gas processing facility and safety flare
  - Water management, treatment and beneficial reuse facilities
  - Power station
- Bibblewindi
  - In field compression and safety flare
  - Production wells
- Bibblewindi to Leewood infrastructure corridor construction
- Worker accommodation at Westport
- Road upgrades.

Gas field

The exact location of wells within the gas field cannot be defined at this stage of the project. The gas field would be developed in accordance with the desired well locations based on geology and therefore gas location, land private negotiated agreements, and the field development protocol.

A constraints approach has been adopted that identifies which gas field activities would be permitted in each specified area and the noise criteria that will apply. Buffer distance predictions to achieve the noise criteria have been undertaken. These buffer distance predictions ignore noise attenuation potentially provided by shielding structures, topography or foliage which would further reduce the noise levels.

As the project progresses the nature of the predicted noise impacts would be used to determine the suitability of site locations and the requirement for mitigation measures based on predefined noise management criteria.

This approach is required for the gas field infrastructure including:

- Production wells
- Gas and water gathering systems
- Access tracks
- Pilot wells.

Assessment parameters

Noise impacts have been predicted using SoundPlan version 7.3 noise modelling software. SoundPlan implements *The propagation of noise from petroleum and petrochemical complexes to neighbouring communities, Report Number 4/81*, (CONCAWE 1981) algorithm to predict the effects of construction and operational related noise under defined meteorological stability classes. The operational and construction noise impact assessment involved the following:

- Determining appropriate noise criteria

- Establishing appropriate site specific conditions. The following noise model assumptions were made with regard to the study area:
  - A general ground absorption coefficient of 0.5 was used throughout the noise model which represents a mix of hard and soft ground. As the surrounding area is generally soil on rural land or forested areas this assumption is considered conservative
  - Terrain topography of the study area at five metre resolution has been included in the noise predictions for infrastructure where the site locality has been defined
  - Foliage absorption has been included in the noise predictions where the site locality has been defined and modelled at a height of 10 metres with attenuation based on ISO 9613 -2, '*Acoustics attenuation of sound during propagation outdoors*.
- Determining appropriate calm and adverse meteorological conditions for the noise modelling process. Meteorological conditions were calculated using *The propagation of noise from petroleum and petrochemical complexes to neighbouring communities, Report Number 4/81* (CONCAWE 1981) algorithm based on stability classes. Further discussion on the meteorological conditions recommended by the *Industrial Noise Policy* (EPA 2000) are provided in Section 3.3.3. The following meteorological conditions have been applied to the noise modelling scenarios:
  - Calm meteorological conditions: Pasquill Stability Class D atmospheric conditions during the day, evening and night-time period and wind of less than 0.5 m/s
  - Adverse meteorological conditions during the night time period: Pasquill Stability Class F atmospheric conditions (to represent a moderate temperature inversion) with a 2 m/s wind from source to receiver. For non-arid areas the *Industrial Noise Policy* (EPA 2000) recommends that adverse meteorological conditions are assessed using a temperature inversion strength lapse rate of 3ºC/100 metres and a drainage flow of 2 m/s.
  - Air absorption based on typical worst case noise propagation conditions of 10 °C and 90 percent humidity was applied to calm and adverse prediction scenarios
- Identifying the noise generating equipment along with corresponding noise levels and characteristics at each site for the following stages of the project:
  - construction phase
  - operational phase
- Modelling the noise impacts at identified sensitive receivers for each stage of the project.

2.4.2 Assessing mitigation and management measures. Road traffic noise impact assessment

Noise impacts due to traffic generation on public roads have been assessed at identified sensitive receivers for the following stages of the project:

- construction
- operational phase.

The road traffic noise impact assessment considers existing and proposed traffic generation, percentage of heavy vehicles, time periods and road surface types in the calculations. Traffic noise modelling was conducted using the *Calculation of Road Traffic Noise* (Department of Transport Welsh Office 1988) algorithm for the Newell Highway. For roads with the State Forest and access tracks where existing traffic volumes are below 50 vehicles per hour the *Calculation of Road Traffic Noise* (Department of Transport Welsh Office 1988) algorithm is not valid.

Therefore, traffic noise on roads with the State Forest and access tracks have been modelled using a moving point source method with attenuation and propagation calculated with the ISO 9613 -2, *'Acoustics attenuation of sound during propagation outdoors'* algorithm. Relevant traffic generation data has been obtained from the *Narrabri Gas Project Traffic Impact Assessment Report* (GHD 2016).

2.4.3 Vibration and blasting impact assessment

An assessment of vibration generating equipment and blasting was undertaken to determine safe work buffer distances.

3. Legislative context

3.1 State legislation

3.1.1 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* is the key piece of environment protection legislation administered by the NSW Environment Protection Authority (EPA) and establishes a system of environment protection licensing for 'scheduled' activities which have the potential to significantly impact on the environment.

The commercial production of gas from coal seams requires a production lease under the *Petroleum (Onshore) Act 1991* and coal seam gas production is a scheduled item (Schedule 1 – Part 1: 9A) under the *Protection of the Environment Operations Act 1997.* Therefore, an environmental protection license will be required for the project and is likely to include noise limits and conditions for construction and operation noise.

3.1.2 Secretary's environmental assessment requirements

The Secretary's environmental assessment requirements with regards to noise include the following:

- an assessment of the likely operational noise impacts of the project (including construction noise) under the *Industrial Noise Policy* (EPA 2000), paying particular attention to the obligations in chapters 8 and 9 of the policy
- if a claim is made for specific construction noise criteria for certain activities, then this claim must be justified and accompanied by an assessment of the likely construction noise impacts of these activities under the *Interim Construction Noise Guideline* (DECC 2009).
- an assessment of the likely road noise impacts of the project under the *Road Noise Policy* (DECCW 2011).

3.2 Interim construction noise guideline

3.2.1 Construction hours

The *Interim Construction Noise Guideline* (DECC 2009) guideline recommends standard hours for construction activities as Monday to Friday: 7am to 6pm, Saturday: 8am to 1pm and no work on Sundays or public holidays. These hours are not mandatory and the *Interim Construction Noise Guideline* (DECC 2009) acknowledges that the following activities have justification to be undertaken outside the recommended standard construction hours assuming that all reasonable and feasible mitigation measures are implemented to minimise the impacts to the surrounding sensitive land uses:

- the delivery of oversized plant or structures that police or other authorities determine to require special arrangements to transport along public roads
- emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours

- works which maintain noise levels at sensitive receivers to below the noise management levels outside of the recommended standard construction hours.

3.2.2 Construction noise management levels

Construction noise management levels at sensitive residential receivers are provided in Table 3-1. The construction noise management levels during recommended standard hours represent a noise level that, if exceeded, would require management measures including the following:

- reasonable and feasible work practices
- contact with the residences to inform them of the nature or works to be carried out, the expected noise levels and durations and contact details.

The management measures are aimed at reducing noise impacts at the residential receivers. However, it may not be reasonable and feasible to reduce noise levels to below the noise affected management level. The noise affected construction noise management levels during recommended standard hours is not intended as a noise limit but rather a level where noise management is required and as such should not be included as a noise limit in the environmental protection license. The construction noise management levels outside of recommended standard hours should be considered as noise limits in the environmental protection license where a private negotiated agreement is not in place with the residence.

Other sensitive receivers relevant to this project included passive recreational areas (characterised by contemplative activities where benefits are compromised by external noise intrusion) such as Yarrie Lake. The *Interim Construction Noise Guideline* (DECC 2009) noise management level for passive recreational areas is $L_{Aeq(15min)}$ 60 dB(A) which applies when the passive recreational area is being used.

Table 3-1 Construction noise management levels

Time of day	Management level $L_{Aeq(15min)}$	How to apply
Recommended standard hours: • Monday to Friday 7am to 6pm • Saturday 8am to 1pm • No work on Sundays or public holidays	Noise affected Rating background level plus 10 dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15min)}$ is greater than 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 works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise Affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: • times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences • if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected Rating background level plus 5 dB(A)	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. 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.

3.2.3 Modifying factor adjustments for annoying activities

The *Interim Construction Noise Guideline* (DECC 2009) lists a number of activities which have proven to be particularly annoying to sensitive receivers including:

- use of 'beeper' style reversing or movement alarms, particularly at night-time
- use of power saws, such as used for cutting timber, rail lines, masonry, road pavement or steel work
- grinding metal, concrete or masonry
- rock drilling
- line drilling
- vibratory rolling
- rail tamping and regulating
- bitumen milling or profiling
- jackhammering, rock hammering or rock breaking
- impact piling.

If these activities are to be undertaken they should be factored into the assessment by adding 5 dB to the predicted noise levels.

3.2.4 Sleep disturbance criteria during construction

The *Interim Construction Noise Guideline* (DECC 2009) also refers to the *Environmental Criteria for Road Traffic Noise* (EPA 1999) for guidance on sleep disturbance from maximum noise level events. This guideline has since been superseded by the *Road Noise Policy* (DECCW 2011). Both guidelines provide a discussion on research into the effects of maximum noise events on sleep disturbance. The *Industrial Noise Policy* (EPA 2000) application notes also provide guidance on sleep disturbance impacts. The results of this research is aimed at limiting the level of sleep disturbance due to environmental noise and concludes that the L_{Amax} or $L_{A1(1min)}$ level of noise should not exceed the ambient $L_{A90(15min)}$ noise level by more than 15 dB(A) which is consistent with the *Industrial Noise Policy* (EPA 2000) screening test. The *Road Noise Policy* (DECCW 2011) provides further guidance, which indicates that:

- maximum internal noise levels below 50–55 dB(A) are unlikely to cause awakening reactions
- one or two noise events per night with maximum internal noise levels of 65–70 dB(A) are not likely to significantly affect health and wellbeing.

3.2.5 Justification for construction activities to be assessed under the *Interim Construction Noise Guideline* (DECC 2009)

The Secretary's environmental assessment requirements specify that construction noise impacts should also be assessed under the *Industrial Noise Policy* (EPA 2000). The exception to this is where a claim is made for specific construction noise criteria which would require justification and appropriate assessment under the *Interim Construction Noise Guideline* (DECC 2009).

The *Interim Construction Noise Guideline* (DECC 2009) is aimed at managing noise from construction works regulated by the NSW EPA under the *Protection of the Environment Operations Act 1997* which includes scheduled development work that would enable scheduled activities to be carried out. Coal seam gas exploration, assessment and production is a scheduled activity under the *Protection of the Environment Operations Act 1997,* therefore, the *Interim Construction Noise Guideline* (DECC 2009) is considered relevant for assessment of construction activities associated with the development of the project.

It should be noted that the *Interim Construction Noise Guideline* (DECC 2009) states in section 1.2 that, *'noise from industrial sources (for example, factories, quarrying mining, and including construction associated with quarry and mining) is assessed under the Industrial Noise Policy (EPA, 2000)'*. Under the *Protection of the Environment Operations Act 1997* coal seam gas production is not considered as an extractive or mining industry.

Construction activities that should be considered for assessment under the *Interim Construction Noise Guideline* (DECC 2009) are not expected to impact sensitive receivers for a significant duration of time. It is also important to note that the *Interim Construction Noise Guideline* (DECC 2009) construction noise management levels during standard recommended construction hours are 5 dB(A) higher than the *Industrial Noise Policy* (EPA 2000) intrusive criteria during all time periods. For this project the construction noise management level would be 40 dB(A) during recommended standard hours. It is submitted that this is reasonable as shorter term construction activities during this time period would not impact the surrounding sensitive receivers to the same extent. For periods outside of the standard recommended construction hours the *Interim Construction Noise Guideline* (DECC 2009) construction noise management levels are 35 dB(A) which is identical to the *Industrial Noise Policy* (EPA 2000) intrusive criteria.

It is considered justifiable that the following activities would be assessed under the *Interim Construction Noise Guideline* (DECC 2009) which would result in a 5 dB(A) allowance to the *Industrial Noise Policy* (EPA 2000) intrusive criteria during recommended standard construction hours:

- Leewood construction activities including:
  - Central gas processing facility construction
  - Water infrastructure construction
  - Power station construction
- Bibblewindi construction activities
- gas field construction activities
  - Drilling and construction of production and pilot wells
  - Construction of access tracks
  - Construction of water and gas gathering flow lines
- Bibblewindi to Leewood pipeline construction
- workers' accommodation construction at Westport camp
- road upgrades.

3.3 Industrial noise policy

The *Industrial Noise Policy* (EPA 2000) provides guidance on the assessment of operational noise impacts for scheduled items under the *Protection of the Environment Operations Act 1997*. The guidelines include both intrusive and amenity criteria that are designed to protect receivers from noise significantly louder than the background level and to limit the cumulative noise level from all sources near a receiver.

The *Industrial Noise Policy* (EPA 2000) noise criteria are planning levels and are not mandatory limits required by legislation however the noise criteria will assist the determining authority to assess operational noise impacts and establish noise limits in the conditions of consent. Where noise criteria are predicted to be exceeded, feasible and reasonable noise mitigation strategies are assessed.

3.3.1 Intrusive criteria

The intrusive noise criteria control the relative audibility of operational noise compared to the background level at residential receivers. The intrusive criteria are determined by a 5 dB(A) addition to the rating background level. The *Industrial Noise Policy* (EPA 2000) requires that, *'where the rating background level is found to be less than 30 dB(A), then it is set to 30 dB(A)'* which results in an intrusive noise criteria of 35 dB(A). The *Industrial Noise Policy* (EPA 2000) application notes recommend that the intrusive noise criteria for the evening period should not exceed the daytime period and the night-time period should not exceed the evening period. The intrusive noise criteria are applicable to residential receivers unless the residence is subject to a private negotiated agreement.

3.3.2 Amenity criteria

The amenity criteria limit the total level of extraneous noise and controls cumulative noise impacts from other industries and developments on all receiver types. The amenity criteria are determined based on the overall acoustic characteristics of the receiver area, the receiver type and the existing level of industrial noise.

Residential receiver areas are characterised into 'urban', 'suburban', 'rural' or other categories based on land uses, the existing level of noise from industry, commerce, and road traffic.

The amenity criteria aim to limit continual increases in noise levels from industrial noise sources and developments and apply to all industrial noise sources at the receiver location. To prevent cumulative noise level increases above the amenity criteria, the *Industrial Noise Policy* (EPA 2000) provides adjustments to the amenity criteria to set a target level for the project. The applicable adjustment is scaled as per *Industrial Noise Policy* (EPA 2000) Table 2.2 and is based on the existing level of industrial noise at the receiver location.

It is noted that in respect of the recent Maules Creek and Boggabri Coal projects approvals, the Planning Assessment Commission has determined that for the assessment of cumulative noise impacts the amenity criteria should be set to 40 dB(A) during the day, evening and night period which is more conservative than the *Industrial Noise Policy* (EPA 2000). For conservatism, this approach has been applied to this project. The applied *Industrial Noise Policy* (EPA 2000) amenity criteria for rural residences and other sensitive land uses relevant to the project are provided in Table 3-2.

Table 3-2 Amenity criteria

Type of receiver	Time of day[2]	Recommended $L_{Aeq(period)}$ noise level, dB(A)	
		Acceptable	Maximum
Rural Residence	Day	40[1]	55
	Evening	40[1]	50
	Night	40	45
Areas specifically reserved for passive recreation (e.g. national parks)	When in use	50	55

Note 1: Amenity criteria set to 40 dB(A) during the day evening and night period based on the Planning Assessment Commission determinations for the Maules Creek and Boggabri Coal projects

Note 2: Time of day:

- Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
- Evening: the period from 6 pm to 10 pm.
- Night: the remaining period.

3.3.3 Meteorological conditions

Adverse meteorological conditions

Temperature Inversions

Noise propagation can be enhanced by wind conditions and temperature inversions. The *Industrial Noise Policy* (EPA 2000) states:

"Where inversion conditions are predicted for at least 30% (or approximately 2 nights per week) of the total night time in winter, then inversion effects are considered to be significant and should be taken into account in the noise assessment.

Wind effects need to be assessed where wind is a feature of the area. Wind is considered to be a feature where source-to-receiver wind speeds (at 10 m height) of 3 m/s or below occur for 30 per cent of the time or more in any assessment period (day, evening, night) in any season."

Where temperature inversions occur for more than 30 per cent of the time (during any seasonal period assessed between 6 pm and 7 am) the *Industrial Noise Policy* (EPA 2000) recommends that in a non-arid area (rainfall > 500 mm/year) a 3 ºC/100 m with a 2 m/s wind speed from source to receiver should be used for determining noise impacts under adverse weather conditions. The Bureau of Meteorology's Narrabri Airport has a reported average annual rainfall of 569 mm/year.

The *Validation of Inversion Strength Estimation Method* (NSW EPA 2014) recommends that the *"Industrial Noise Policy* (EPA 2000) *default should be changed from 3 ºC/100 m to F Class stability"*.

Annual stability class frequency distribution has been determined from the meteorological data obtained from Bureau of Meteorology's Narrabri Airport weather station and are shown in Figure 5 for the winter night-time period. The data indicates the incidence of atmospheric stabilities as measured using the Pasquill Stability Class.

Analysis of the meteorological data indicates that night-time temperature inversions occur approximately 63 per cent of the time during winter (June – August) therefore the *Industrial Noise Policy* (EPA 2000) considers temperature inversions a feature of the study area. Therefore, an F Class temperature inversion with a 2 m/s wind speed from source to receiver has been applied to the CONCAWE algorithm to represent adverse meteorological conditions.

The occurrence of temperature inversions during other seasons and time periods (including shoulder periods) is provided in Table 3-3 to determine when adverse meteorological conditions should be considered in the assessment of noise impacts (Section 1). It is to be noted that the *Industrial Noise Policy* (EPA 2000) defines the night-time period for determining inversions as one hour before sunset and one hour after sunrise (which is nominally 6 pm to 7 am in winter). However, since these time frames vary for each season all time periods and shoulder periods have been provided.

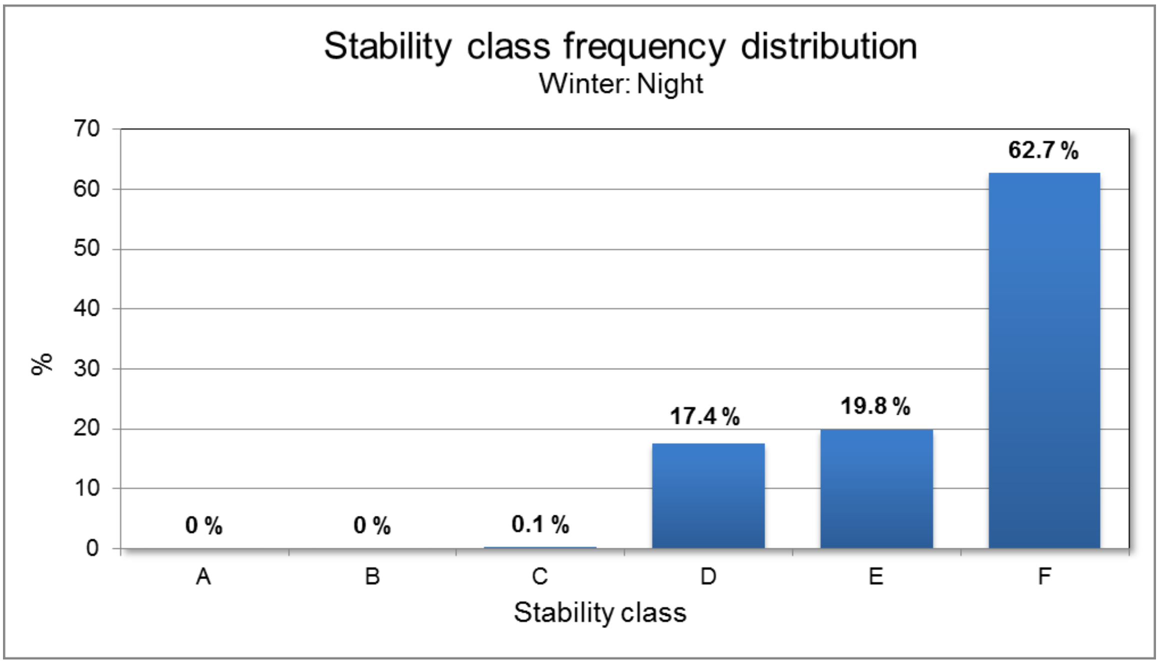


Figure 5 Narrabri Airport stability class frequency distribution (winter night period)

Table 3-3 Occurrence of F Class temperature inversions periods and season

Time period		Seasonal occurrence (per cent)			
		Summer	Autumn	Winter	Spring
Night	10pm to 7am[1]	35	49	63	41
Night (early morning shoulder period)	5am to 6am	20	57	63	22
	6am to 7am	0	26	61	0
	7am to 8am[1]	0	0	0	0
Day	7am to 6pm[2]	0	2	3	0
Evening (shoulder period)	6pm to 7pm	0	37	51	35
	7pm to 8pm	50	44	57	33
Evening	6pm to 10pm	32	41	55	39
(red shading)	Occurrence of 30 per cent or more				

Note 1: Night is also defined in the *Industrial Noise Policy* (EPA 2000) as 7am to 8am on Sundays and Public holidays
Note 2: Day is also defined in the *Industrial Noise Policy* (EPA 2000) as 8am to 6pm on Sundays and Public Holidays.

Noise enhancing wind

Temperature inversions generally occur during the night time period therefore to assess adverse weather conditions for other time periods, wind effects have been considered. The *Industrial Noise Policy* (EPA 2000) recommends an adverse weather condition of 3 m/s wind speed from source to receiver with Pasquill Stability Class D atmospheric conditions if those conditions occur for more than 30 per cent of the time in any season in any time period. Wind speed percentage occurrences below 3 m/s have been provided in each direction for each time period and season in Table 3-4.

Table 3-4 Narrabri Airport seasonal wind speed frequency distribution

Direction from source to receiver	Percentage occurrence of wind speeds less than 3 m/s											
	Summer			Autumn			Winter			Spring		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
N	3%	5%	3%	2%	0%	3%	3%	3%	4%	3%	3%	3%
NE	3%	11%	9%	2%	4%	5%	2%	4%	8%	3%	4%	5%
E	2%	7%	8%	2%	10%	11%	2%	11%	12%	3%	9%	9%
SE	5%	6%	7%	4%	5%	8%	5%	10%	11%	3%	6%	8%
S	4%	4%	7%	6%	6%	12%	5%	11%	17%	4%	7%	14%
SW	5%	2%	3%	6%	5%	3%	5%	7%	6%	3%	3%	2%
W	5%	1%	1%	4%	1%	2%	4%	2%	3%	2%	1%	1%
NW	5%	3%	1%	2%	0%	1%	3%	1%	2%	3%	1%	1%

Based on the wind speed frequency distribution data it can be seen that wind speeds below 3 m/s do not occur from source to receiver for more than 30 per cent of the time for any time periods in any seasons. Therefore, adverse wind effects have not been considered in the noise modelling during the day and evening period.

Calm meteorological conditions

Noise modelling also includes predicted noise levels during calm weather conditions as recommended by the *Industrial Noise Policy* (EPA 2000) application notes. Noise modelling has been undertaken with a 0.5 m/s or less wind speed from source to receiver with Pasquill Stability Class D atmospheric conditions to represent calm noise predictions.

3.3.4 Modifying factor adjustments

The *Industrial Noise Policy* (EPA 2000) requires that modifying factor adjustments are added to the measured or predicted noise levels if the noise sources contain tonal, low frequency, intermittent or impulsive characteristics, which have the potential to increase annoyance. The modifying factor adjustments are summarised in Table 3-5. Very low frequency (infrasound) noise has not been considered in this assessment as the proposed equipment on site is not expected to have significant infrasound characteristics.

Table 3-5 Modifying factor adjustments

Factor	Assessment/ measurement	When to apply	Correction[1,2]
Tonal noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: • 5 dB or more if the centre frequency of the band containing the tone is above 400 Hz • 8 dB or more if the centre frequency of the band containing the tone is 160 to 400 Hz inclusive • 15 dB or more if the centre frequency of the band containing the tone is below 160 Hz.	5 dB(A)[2]

Factor	Assessment/ measurement	When to apply	Correction[1,2]
Low frequency noise	Measurement of C-weighted and A-weighted level	Measure/assess C and A weighted levels over same time period. Correction to be applied if the difference between the two levels is 15 dB or more.	5 dB(A)[2]
Intermittent noise	Subjectively assessed	When the night-time noise level drops to that of the background noise level with a noticeable change in noise level of at least 5 dB(A).	5 dB(A)
Impulsive noise	A-weighted fast response and impulse response	If the difference in A-weighted maximum noise levels between fast response and impulse response is greater than 2 dB.	Apply the difference in measured noise levels as the correction up to a maximum of 5 dB(A)
Duration[3]	If the duration of the noise event in any 24 hour period is as follows: • 1.0 to 2.5 hours then increase the noise criteria by 2 dB(A) day and 0 dB(A) night • 15 minutes to 1 hour then increase the noise criteria by 5 dB(A) day and 0 dB(A) night • 6 minutes to 15 minutes then increase the noise criteria by 7 dB(A) day and 2 dB(A) night • 1.5 minutes to 6 minutes then increase the noise criteria by 15 dB(A) day and 5 dB(A) night • less than 1.5 minutes then increase the noise criteria by 20 dB(A) day and 10 dB(A) night.		

Note 1: Where two or more modifying factors are present the maximum correction is limited to 10 dB(A).

Note 2: Where a source emits a tonal and low-frequency noise, only one 5 dB correction should be applied if the tone is in the low frequency range.

Note 3: Duration correction is a negative correction which increases the noise criteria

3.3.5 Sleep disturbance

The *Industrial Noise Policy* (EPA 2000) application notes regarding sleep disturbance recommend that where the $L_{A1(1min)}$ or L_{Amax} exceeds the $L_{A90(15min)}$ by more than 15 dB(A) outside the bedroom window, a more detailed analysis is required.

Sleep disturbance are not anticipated for operation of the proposed development as operational noise sources are generally continuous in nature which do not produce maximum events during the night time period and as such the *Industrial Noise Policy* (EPA 2000) intrusive criteria would be the most stringent criteria.

3.3.6 Project specific operational noise criteria

The project specific operational noise criteria are shown in Table 3-6 which are applicable to the following activities:

- operation of the gas processing facility at Leewood
- operation of the power station at Leewood
- operation of the water management, treatment and beneficial reuse facilities at Leewood
- operation of the infield gas processing facility at Bibblewindi
- operation of the production and pilot wells in the gas field.

The operational noise criteria would be used to establish noise limits for the environmental protection license and would be applicable to residential receivers unless the residence is subject to a private negotiated agreement.

Table 3-6 Project specific operational noise criteria dB(A)

Receiver area	Time of day[3]	Amenity (cumulative) criteria[1],[2]	Intrusive criteria	Sleep disturbance screening criteria
All residential receivers	Day	40 $L_{Aeq(day)}$	35 $L_{Aeq(15min)}$	-
	Evening	40 $L_{Aeq(evening)}$	35 $L_{Aeq(15min)}$	-
	Night	40 $L_{Aeq(night)}$	35 $L_{Aeq(15min)}$	45 L_{Amax}
Yarrie Lake	When in use	50 $L_{Aeq(period)}$	-	-

Note 1: The amenity criteria are used for the assessment of cumulative noise impacts from other industry and projects.
Note 2: With consideration to the *Industrial Noise Policy* (EPA, 2000) 'noise amenity area' classification, the residential receivers surrounding the sites have been classified as 'rural.
Note 3: Time of day:

- Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
- Evening: the period from 6 pm to 10 pm.
- Night: the remaining period.

3.4 Road traffic noise

The *Road Noise Policy* (DECCW 2011) provides traffic noise criteria for residential receivers in the vicinity of existing roads (Table 3-7). The criteria are applied to operational and construction traffic on public roads to identify potential road traffic impacts and the requirement for reasonable and feasible mitigation measures.

The *Road Noise Policy* (DECCW 2011) application notes state that *"for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion."*

If road traffic noise increases during operation and construction work is within 2 dB(A) of current levels, then the objectives of the *Road Noise Policy* (DECCW 2011) are met and no specific mitigation measures are required.

Table 3-7 Road traffic noise criteria, $L_{Aeq(period)}$, dB(A)

Type of Development	Day 7am to 10pm	Night 10pm to 7am
Existing residence affected by additional traffic on arterial roads generated by land use developments	60 $L_{eq(15hr)}$	55 $L_{eq(9hr)}$
Existing residence affected by additional traffic on local roads generated by land use developments	55 $L_{eq(1hr)}$	50 $L_{eq(1hr)}$

3.5 Vibration

3.5.1 Human comfort

Vibration is assessed based on the criteria in *Assessing Vibration: a technical guideline* (DEC 2006). *British Standard (BS) 6472 – 2008, Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)* is recognised by the guideline as the preferred standard for assessing the 'human comfort criteria'.

Intermittent vibration is assessed using the vibration dose value. Acceptable values of vibration dose are presented in Table 3-8 for sensitive receivers.

Whilst the assessment of response to vibration in *BS 6472-1:1992* is based on vibration dose value and weighted acceleration, for construction related vibration, it is considered more appropriate to provide guidance in terms of a peak particle velocity, since this parameter is likely to be more routinely measured based on the more usual concern over potential building damage.

Humans are capable of detecting vibration at levels which are well below those causing risk of damage to a building. The degrees of perception for humans are suggested by the vibration level categories given in *BS 5228.2 – 2009, Code of Practice Part 2 Vibration for noise and vibration on construction and open sites – Part 2: Vibration,* as shown below in Table 3-9.

Table 3-8 Human comfort intermittent vibration dose values (BS 6472-1992)

Receiver type	Period[1]	Intermittent vibration dose value ($m/s^{1.75}$)	
		Preferred value	Maximum value
Residential	Day	0.2	0.4
	Night	0.13	0.26

Note 1: Day is between 7am and 10pm and night is between 10 pm and 7 am

Table 3-9 Guidance on effects of vibration levels for human comfort (BS 5228.2 – 2009)

Vibration level	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction.
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	It is likely that vibration at this level in residential environments will cause complaints, but can be tolerated if prior warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure.

3.5.2 Structural damage

Currently, there is no Australian Standard that sets criteria for the assessment of building damage caused by vibration. Guidance of limiting vibration values is attained from reference to German Standard *DIN 4150-3: 1999 Structural Vibration – Part 3: Effects of vibration on structures* (refer to Table 3-10).

Table 3-10 Guideline values for short term vibration on structures

Type of structure	Guideline values for velocity, (mm/s)		
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[1]
Buildings used for commercial purposes, industrial buildings, and buildings of similar design.	20	20 to 40	40 to 50
Dwellings and buildings of similar design and/or occupancy.	5	5 to 15	15 to 20
Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (for example heritage listed buildings).	3	3 to 8	8 to 10
Pipes - steel	100		
Pipes – clay, concrete, reinforced concrete, stressed concrete, metal	80		
Pipes – masonry, plastic	50		

Note 1: At frequencies above 100 Hz the values given in this column may be used as minimum values.

3.5.3 Summary of vibration criteria

A summary of vibration criteria is provided in Table 3-11. The criteria are provided as a guide for determining potential human comfort or structural damage impacted buffer distances to determine if further detailed investigation is required. During construction and operation of the project compliance with all criteria in Section 3.5 should be assessed.

Table 3-11 Recommended screening vibration criteria

Receiver area	Criteria type	Peak particle velocity screening criteria	
		Day	Night
Residential receivers	Human comfort	1 mm/s	0.3 mm/s
	Structural	5 mm/s[1]	

Note 1: Higher magnitude of vibration is acceptable at higher frequencies

3.6 Blasting

Although the use of blasting during construction activities is expected to be minimal, if at all, if the requirement arose, blasting impacts would be assessed in accordance with *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZEC 1990) which specifies recommended human comfort criteria for blasting activities.

The recommended maximum level for airblast overpressure is 115 dB(L) peak. This level may be exceeded on up to 5 per cent of the total number of blasts over a period of 12 months. However, the airblast overpressure must not exceed 120 dB(L) peak for a blast.

Ground-borne vibration levels should not exceed a peak particle velocity of 5 mm/s. The recommended peak particle velocity of level may be exceeded on up to 5 per cent of the total number of blasts over a period of 12 months. However, the level should not exceed 10 mm/s.

The guideline recommends that blasting should only be permitted during the following hours:

- Monday to Saturday, 9am to 5pm
- No blasting on Sundays or Public Holidays.

The frequency of blasting should not take place more than once per day. This requirement does not apply to minor blasts. The abovementioned restrictions on times and frequency of blasting do not apply to premises where the effects of the blasting are not perceived at noise sensitive sites.

When a temperature inversion is known to exist, blasting should be avoided if practicable. Note that temperature inversions do not generally occur during the recommended hours for blasting.

3.7 Voluntary land acquisition and mitigation

The *Voluntary Land Acquisition and Mitigation Policy* (NSW Government 2014) guides the attachment of voluntary acquisition or mitigation rights to approvals for State significant mining, petroleum and extractive industry developments. The policy states that these rights may be applied by consent authorities where operational noise does not comply with the assessment criteria after all reasonable and feasible measures have been incorporated into the design of the project and the proponent has not entered into a private negotiated agreement the relevant landholder.

As operations at Leewood and Bibblewindi are predicted to comply with the noise criteria at sensitive receivers and the operation of wells will be managed to ensure that noise complies with the assessment criteria unless a private negotiated agreement is in place, it is unlikely that the policy will need to be applied.

4. Existing environment

4.1 Sensitive receivers and land uses

4.1.1 Overview

Land use in the Narrabri LGA is dominated by agriculture (54.7 per cent). Other land uses comprise rural residential development (18.7 per cent), native vegetation (14.6 per cent), irrigated plants consisting predominantly of cotton (11.1 per cent), intensive animal husbandry (0.2 per cent) and extractive industries (0.1 per cent) (Edge Land Planning 2009).

The majority of the project would be located in an area designated as either RU1 (Primary Production) or RU3 (Forestry) under the Narrabri LEP 2012. Brigalow Park Nature Reserve, which is surrounded by the project area though excluded from the project footprint, is designated E1 (National Parks and Nature Reserves).

Noise and vibration sensitive receivers are defined based on the type of occupancy and the activities performed in the land use. Sensitive noise and vibration receivers could include both existing and proposed:

- residences
- educational institutes
- hospitals and medical facilities
- places of worship
- commercial or industrial premises
- passive recreational areas such as parks and Yarrie Lake flora and fauna reserve
- active recreational areas such as sporting fields, golf courses. Note that these recreational areas are only considered sensitive when they are in use or occupied.

4.1.2 Residential receivers

A total of 215 residential receivers have been identified within the study area and are shown in Appendix A. Residential receivers surrounding Leewood and Bibblewindi are also shown in Figure 6 and Figure 7 respectively.

4.1.3 Other sensitive land uses

An industry that is considered relevant to be assessed from a noise perspective is the tourism and recreational industry. Narrabri is the gateway to the Pilliga and it is understood that majority of the project area will be located in the Pilliga Forest. Key tourist sites and activities within the project area include:

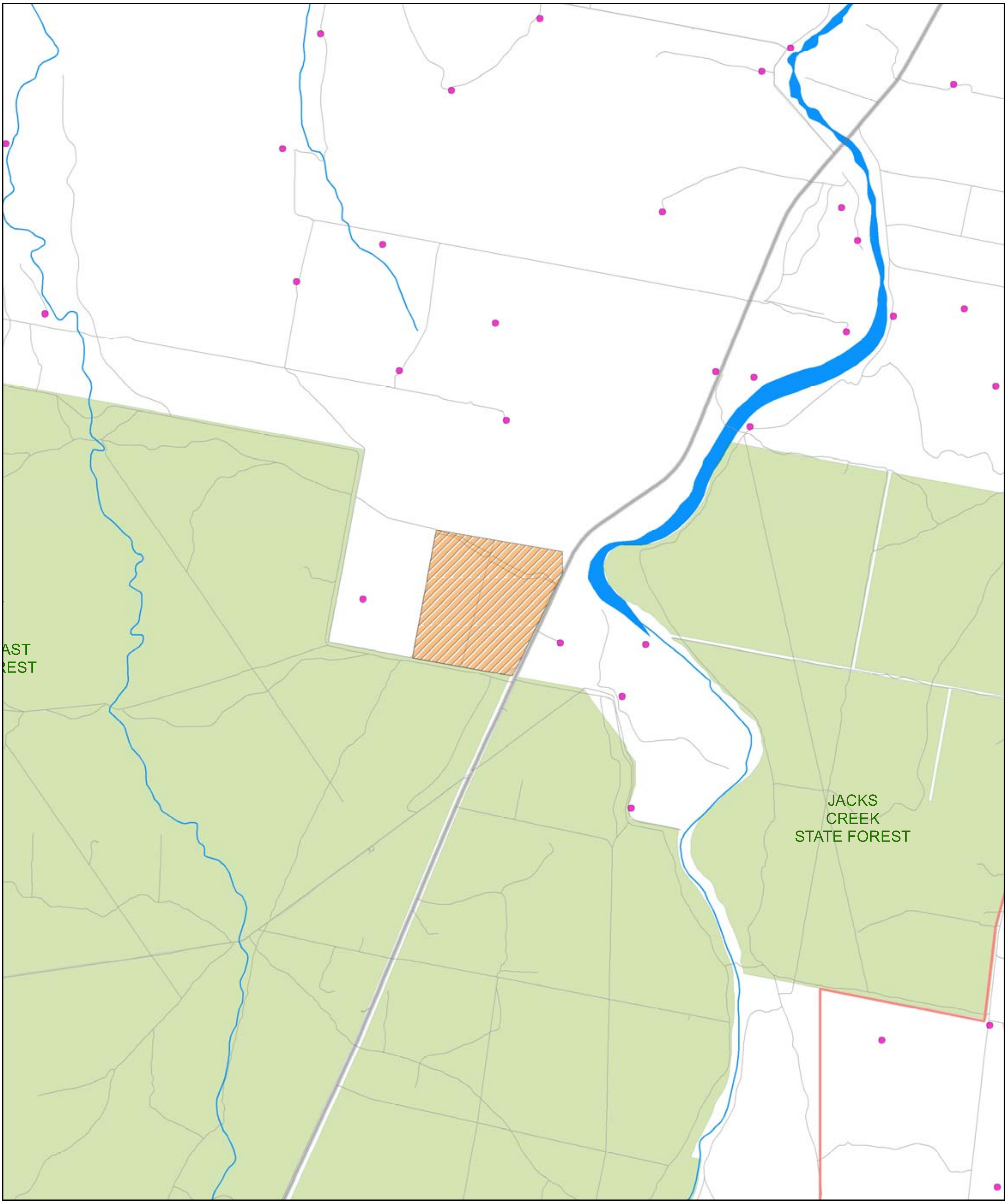
- Yarrie Lake flora and fauna reserve
- Wildflowers (September)
- Bird watching
- Bushwalking
- Boating
- Camping and
- Day picnics.

With the exception of Yarrie Lake, all other key visitor attractions fall outside the project area. The landscape elements of Yarrie Lake area are highly valued by the local community and as such has been considered a passive recreational area from a noise perspective for the project. There is a proposed ‘no go zone’ of 200 metres surrounding Yarrie Lake for construction and operational activities.

Other sensitive land uses could include passive recreational areas when they are in use however it is noted that state forests directly surrounding activities associated with the project would not be considered sensitive as users of the state forest would be restricted for safety reasons. It is anticipated that noise impacts within the state forests would be transient in nature, during which users of the state forest could perform the recreation activities such as bush walking, reading and meditation at other locations within the state forest. Note that no specific tourist landmarks or places of interest have been identified within the study areas.

4.1.4 Workers accommodation

The worker accommodation at Westport is not considered to be a sensitive receiver as the occupants would be working on the project and would accept higher external noise levels. The workers’ accommodation facilities would be designed to comply with the internal noise criteria presented in *AS2107:2000, Acoustics – Recommended design sound levels and reverberation time for building interiors* to ensure workers are provided with living spaces with acceptable internal noise levels so that their health and ability to sleep and relax is not compromised.



LEGEND

- Project area
- Leewood
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Sensitive receivers

0 0.5 1 2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Leewood surrounding sensitive receivers

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Figure 6

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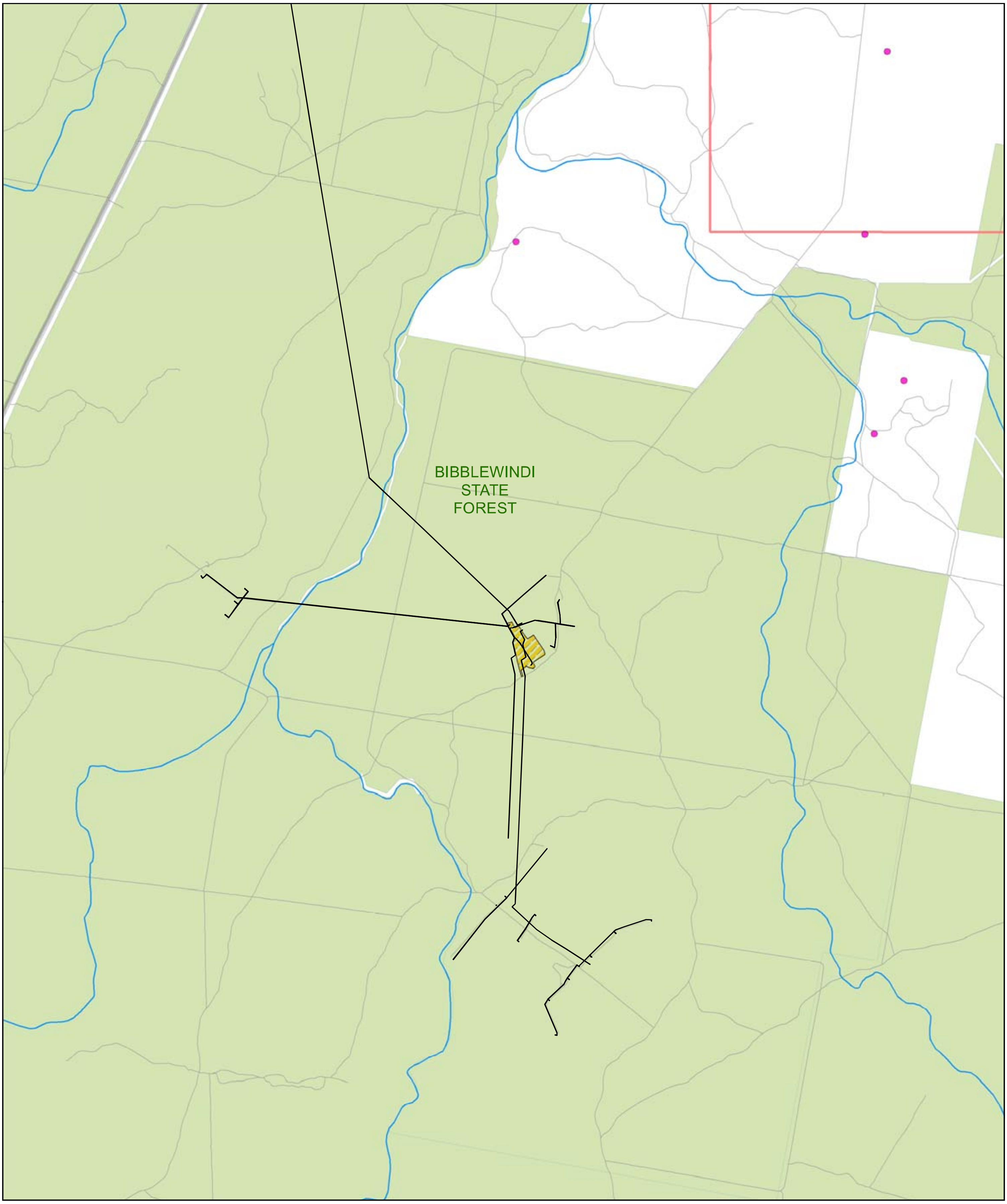
Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy



LEGEND

- Project area
- Sensitive receivers
- Bibblewindi
- State forest
- Aboriginal areas
- Watercourses
- Roads
- Existing pipelines

0 0.5 1 2
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Bibblewindi surrounding sensitive receivers

Figure 7

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Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

4.2 Existing noise environment

4.2.1 Noise monitoring methodology, locations and equipment

Background noise monitoring was undertaken at the locations identified below and recorded noise data was processed in accordance with the methodology outlined in the *Industrial Noise Policy* (EPA 2000). Noise monitoring included long-term unattended monitoring and short term attended measurements. Existing road traffic noise levels were measured in accordance with the *Road Noise Policy* (EPA 2011).

Noise monitoring was undertaken at five locations from 9 December to 20 December 2013 within the study area. The noise monitoring data was supplemented with previous noise monitoring undertaken in the project area for the *Dewhurst Pilot Expansion Noise Assessment Report*, (Noise Measurement Services 2013).

Noise monitoring site locations are provided in Table 4-1 and shown in Figure 8.

Table 4-1 Noise survey location details

Location	GPS coordinates	Justification for site selection	Photo
A – Wilga Park	757463 East 6637969 North	The site was selected as it was considered representative of the background noise environment at rural residential receivers within the study area. The Wilga Park Power Station was not operational at the time of noise monitoring therefore does not include operational noise from the facility as required by the *Industrial Noise Policy* (EPA 2000).	
B – Kirrby	753614 East 6632137 North	The site was selected as it was considered representative of the background noise environment at rural residential receivers within the study area. The location was also adjacent to the local road Kiandool Lane which was used to confirm low traffic volumes on the rural road network.	

Location	GPS coordinates	Justification for site selection	Photo
C - Leewood	752957 East 6623345 North	The site was selected to measure existing traffic noise from the Newell Highway. The location was approximately 15 metres away from the Newell Highway. It was also considered representative of the background noise environment at sensitive receivers in close proximity to the Newell Highway. Construction activities were occurring at Leewood approximately 1.5 kilometres from the monitoring location (during recommended standard hours) and were not observed to be significant during attended measurements.	
D- Killara	764627 East 6616511 North	The site was selected as it was considered representative of the background noise environment at sensitive receivers in the southern part of the study area surrounded by state forests or bushland.	

Location	GPS coordinates	Justification for site selection	Photo
E – Bibblewindi pilot well 12	753813 East 6604434 North	This site was selected as it was considered representative of the background noise environment at sensitive receivers within the Bibblewindi State Forest and the Pilliga East State Forrest. Bibblewindi pilot well 12 was not operational at the time of noise monitoring and does not include operational noise as required by the *Industrial Noise Policy* (EPA 2000).	

The long-term noise monitoring equipment measured the L_{Amax}, L_{A90}, L_{A10} and L_{Aeq} noise descriptors using a fast response time weighting. The instruments were Type 1 and programmed to accumulate environmental noise data continuously over sampling periods of 15 minutes for the entire monitoring period. Additional details of the noise monitoring equipment are summarised in Table 4-2.

Short-term attended measurements were taken at the long-term noise monitoring locations. Short-term attended noise measurements were conducted on 9 and 10 December 2013 during the day and night time period using a Bruel and Kjaer 2250L Sound Level Meter (Serial number: 2731849).

A calibration check was performed on the noise monitoring equipment using a sound level calibrator with a sound pressure level of 94 dB(A) at 1 kHz. At the completion of the measurements, the meter's calibration was re-checked and all noise monitoring equipment was found to be within the acceptable tolerance of ± 0.5 dB(A).

The data collected by the noise monitoring equipment was downloaded and analysed, and invalid data removed. Invalid data generally refers to periods of time where average wind speeds were greater than 5 m/s (at microphone height and calculated to be 7 m/s at weather station anemometer height considering vertical wind shear affects based on AS1170.2, *Structural Design Actions Part 2: Wind Actions*), or when rainfall occurred. Meteorological data was sourced from the Bureau of Meteorology's Narrabri Airport weather station. The Narrabri Airport weather station is located approximately 15 kilometres to the north east of the study area and considered representative of the study area due to the relatively flat terrain in the region. Parts of the study area are heavily vegetated and in those areas the wind speeds would generally be lower and hence the use of the Narrabri Airport weather station for filtering data is considered conservative for heavily vegetated areas.

Table 4-2 Long-term noise monitoring equipment details

Monitoring location	Make / model	Equipment serial No.	Measurement		Calibration check	
			Start time	Stop time	Pre	Post
A – Wilga Park	Rion NL52	131629	09/12/13 9:15	20/12/13 12:00	93.9	94.2
B – Kirrby	B&K 2250L	2122377	09/12/13 15:05	20/12/13 12:15	94.0	94.0
C - Leewood	Rion NL52	131632	09/12/13 11:00	20/12/13 12:45	93.9	93.8
D- Killara	Rion NL52	131630	09/12/13 13:30	20/12/13 14:45	93.9	93.9
E – Bibblewindi pilot well 12	Rion NL52	131631	09/12/13 12:30	20/12/13 13:15	94.0	93.8

Four monitoring locations described in the *Dewhurst Pilot Expansion Noise Assessment Report* (Noise Measurement Services 2013) are shown as noise monitoring location ML1, ML2, ML3 and ML4 in Figure 8.

4.2.2 Background and ambient noise monitoring results

A summary of calculated rating background levels and ambient L_{Aeq} (day, evening and night) noise levels for the monitoring periods are provided in Table 4-3. A summary from previous noise surveys in the study area is also provided in Table 4-4.

Daily noise level tables and charts of the monitoring results are also presented in Appendix B. The *Industrial Noise Policy* (EPA 2000) requires that, *'where the rating background level is found to be less than 30 dB(A), then it is set to 30 dB(A)'*. Where this is the case, the measured rating background levels in Appendix B are shown in brackets.

It is noted that the measured existing noise levels in the study area are consistent with previous noise surveys undertaken in the study area where low background noise levels below 30 dB(A) were generally measured.

Existing noise sources typical within the environment include those generated by commercial logging operations, agricultural activities, construction activities at Leewood, gas exploration activities and traffic along local roadways and the Newell Highway.

Table 4-3 Summary of the noise levels from monitoring

Location	Rating background level 90th percentile $L_{A90(15min)}$			Ambient noise levels, $L_{Aeq(period)}$		
	Day	Evening	Night	Day	Evening	Night
A – Wilga Park	30	30	30	40	35	34
B – Kirrby	30	30	30	42	43	39
C – Leewood	32	30	30	65	64	61
D – Killara	30	30	30	48	48	45
E – Bibblewindi	30	30	30	38	58[1]	52[1]

Note 1: Evening and night time ambient levels were measured at this location to be higher than the day time ambient level which is likely to be attributed to intermittent insect noise which is consistent with attended observations.

Table 4-4 Summary of the noise levels in the study area from previous noise surveys

Location	Rating background level 90th percentile $L_{A90(15min)}$			Ambient noise levels, $L_{Aeq(period)}$			Noise survey data source
	Day	Evening	Night	Day	Evening	Night	
ML1 - Rural residence in Bibblewindi State Forrest	32	33	35	47	56	54	*Dewhurst Pilot Expansion Noise Assessment Report (Rev 5), (Noise Measurement Services, 2013).*
ML2 – Bibblewindi State Forrest	30	33	30	42	44	36	
ML3 – Rural agriculture land in the gas field	30	30	30	48	37	39	
ML4 - Rural agriculture land in the gas field	30	30	30	43	31	33	

Short-term 15 minute attended measurements were conducted at the long-term monitoring locations to supplement the logger data and identify noise sources. Attended measurement noise levels and observations at each site are summarised in Table 4-5.

Table 4-5 Short-term attended noise survey summary, dB(A)

Location	Date	Time	$L_{A90(15min)}$	$L_{Aeq(15min)}$	$L_{A(min)}$	$L_{A(max)}$	Observations
A – Wilga Park	10/12/13	02:31	28	30	25.9	55.1	Occasional dog barking, insects, light breeze
		02:44	28	30	25.5	55.8	
	11/12/13	08:34	30	34	26.5	54.1	Birds, aircraft movement, distant road traffic noise to the east, light breeze
		08:49	30	41	26.3	61.4	
B – Kirrby	10/12/13	03:15	28	32	23.6	47.0	Insects, light breeze
		03:30	26	29	24.7	37.8	
	11/12/13	07:50	29	39	25.2	61.1	Birds, distant road traffic noise, occasional vehicle pass-by, aircraft movement, light breeze
		08:05	28	42	20.9	66.1	
C – Leewood	10/12/13	04:00	24	61	20.4	83.9	Road traffic noise from Newell Highway, mainly heavy vehicles and the occasional light vehicle, low insect noise, no wind.
		04:16	23	60	20.6	83.2	
	11/12/13	07:00	35	66	29.4	83.0	Road traffic noise from Newell Highway, mix of heavy vehicles and light vehicles, truck idling at truck stop, birds, light breeze, Leewood construction site was not audible
		07:15	34	65	30.2	83.6	
D – Killara	10/12/13	05:57	25	39	21.9	61.7	Birds, light breeze
		06:13	25	41	21.7	67.3	
	10/12/13	07:00	25	38	22.1	63.6	Birds, light breeze
		07:15	25	43	21.9	60.5	
E – Bibblewindi pilot well 12	10/12/13	04:55	21	60	19.8	55.7	Intermittent Insects and birds, light breeze
		05:09	24	28	21.7	40.8	
	10/12/13	08:05	24	28	23.6	58.2	Birds, heavy vehicle in distance, light breeze
		08:20	25	33	23.9	47.5	

4.2.3 Existing road traffic noise

There is a mix of State, Council and state forest roads within the project area. The Newell Highway passes through the project area and is a major transport route between NSW and Queensland. The road network in the vicinity of the project area also includes:

- The Kamilaroi Highway
- McFarlane's Road
- Rockdale Road
- Westport Road
- X-Line Road
- Beehive Road
- Old Mill Road.

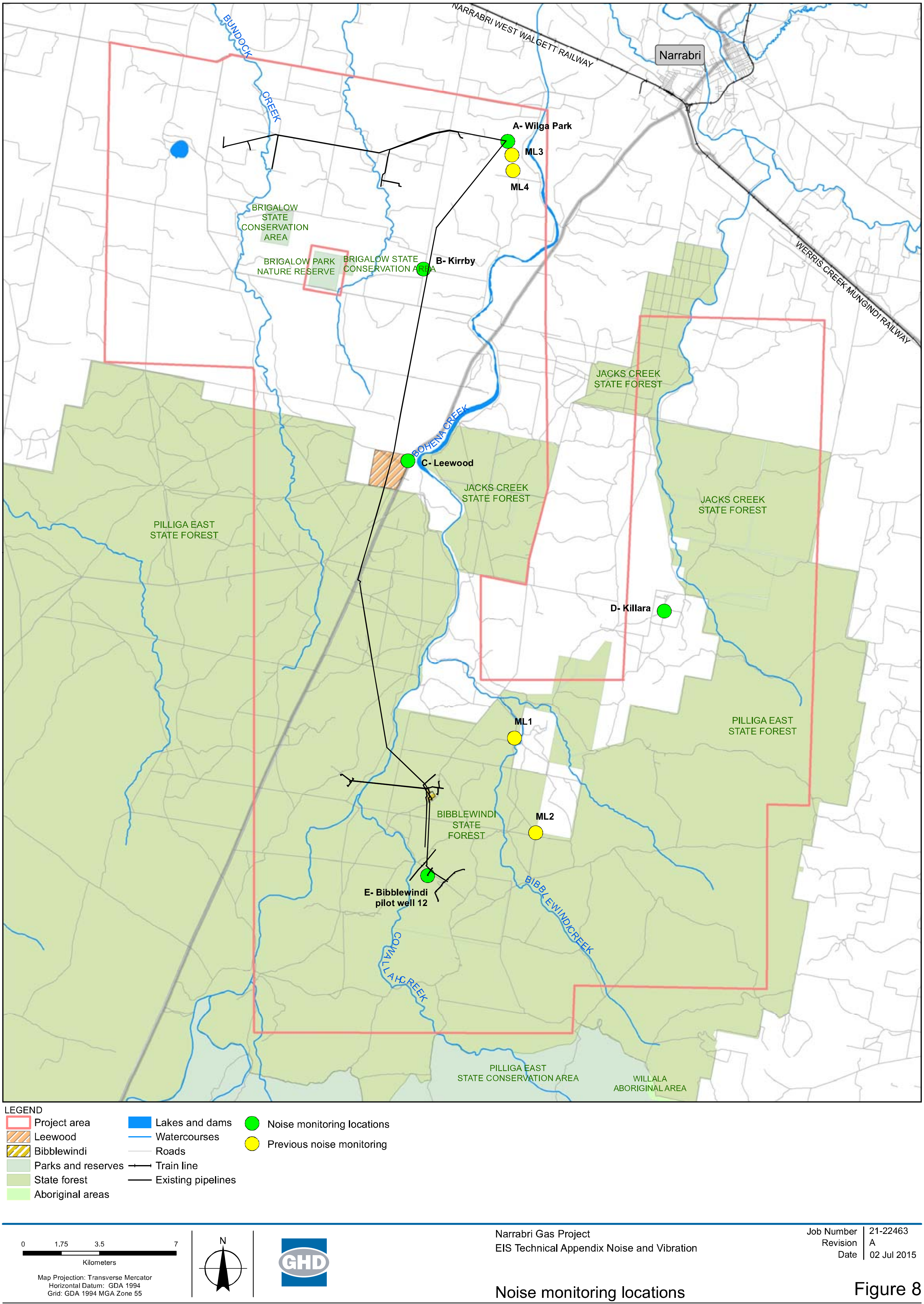
Existing road traffic noise descriptors are summarised in Table 4-6 for noise monitoring at location B and location C. The road traffic noise levels do not include facade corrections.

Noise monitoring location B was situated adjacent to a rural local road Kiandool Lane in the study area. The road traffic noise monitoring results demonstrate that there is no significant existing road traffic noise on Kiandool Lane and the measured noise levels are more than 10 dB(A) below the *Road Noise Policy* (DECCW 2011) road traffic noise criteria. Due to the low number of existing traffic movements at this site ambient environmental noise would also contribute to the measured existing traffic noise levels.

Measurement location C was located 15 metres from the Newell Highway in order to quantify existing road traffic noise on the Newell Highway. Attended observations noted that the measurements were dominated by existing road traffic noise and primarily heavy vehicle truck movements. The measured road traffic noise levels were significant at the measurement location and would reduce as the distance from the Newell Highway increases. Noise levels of this magnitude are typical of roads with significant heavy vehicle transportation movements.

Table 4-6 Existing road traffic noise descriptors

Noise monitoring location	Road traffic noise descriptors	
	$L_{Aeq(15hr)}$ dB(A)	$L_{Aeq(9hr)}$ dB(A)
	7 am to 10 pm weekdays	10 pm to 7 am weekdays
B – Kirrby (Kiandool Lane)	42	40
C – Leewood (Newell Highway)	65	62



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Noise monitoring locations

Figure 8

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Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

4.3 Local meteorology

Monthly mean temperatures at Narrabri Airport are displayed in Figure 9. These show a typical seasonal variation in the temperature range. Monthly mean minimums with their associated upper and lower percentiles (deciles 1 and 9) are shown in blue while monthly mean maximums with their associated deciles are shown in red. The highest temperature for each month is also shown.

Monthly mean diurnal humidity for Narrabri West Post Office and Dubbo Airport is displayed in Figure 10. Diurnal and seasonal patterns in relative humidity are seen where the afternoon and summer months experience a lower level of atmospheric moisture as compared to the afternoon and for winter. Relative humidity is highest in the mornings and during the wetter winter months and lowest in the summer afternoons.

The average annual rainfall measured at the Narrabri Airport is 569 mm/year. The average annual rainfall measured at Rosewood Farm which is located six kilometres north of Leewood (30.45º S, 149.67ºE) in Narrabri is 505 mm/year. A map of the average annual rainfall for NSW is shown in Figure 11 which shows the study area exceeds 500 mm/year.

Seasonal wind roses for Narrabri Airport weather station are presented in Figure 12. The prevailing winds are generally from the north in the warmer months and from the south east in the cooler months.

Temperature inversions are also a feature of the local meteorology and are discussed in Section 3.3.3.

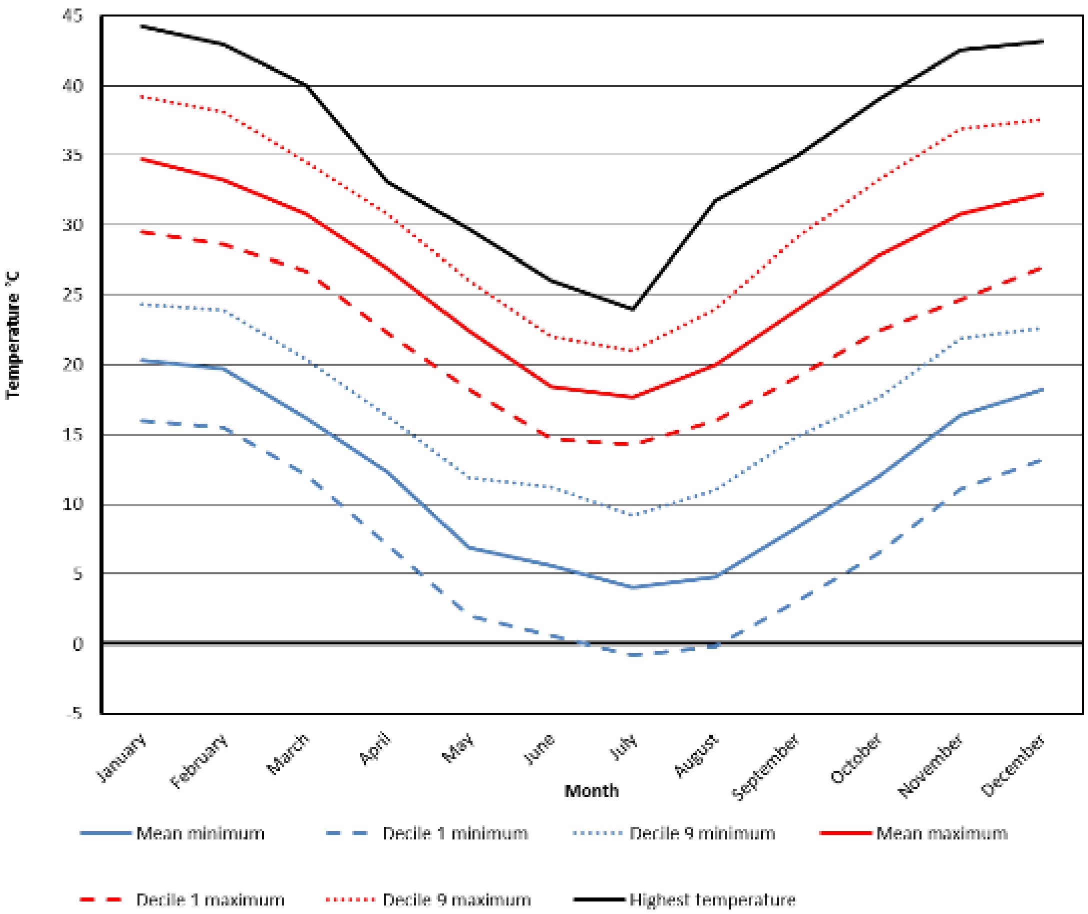


Figure 9 Narrabri Airport seasonal variation in temperature

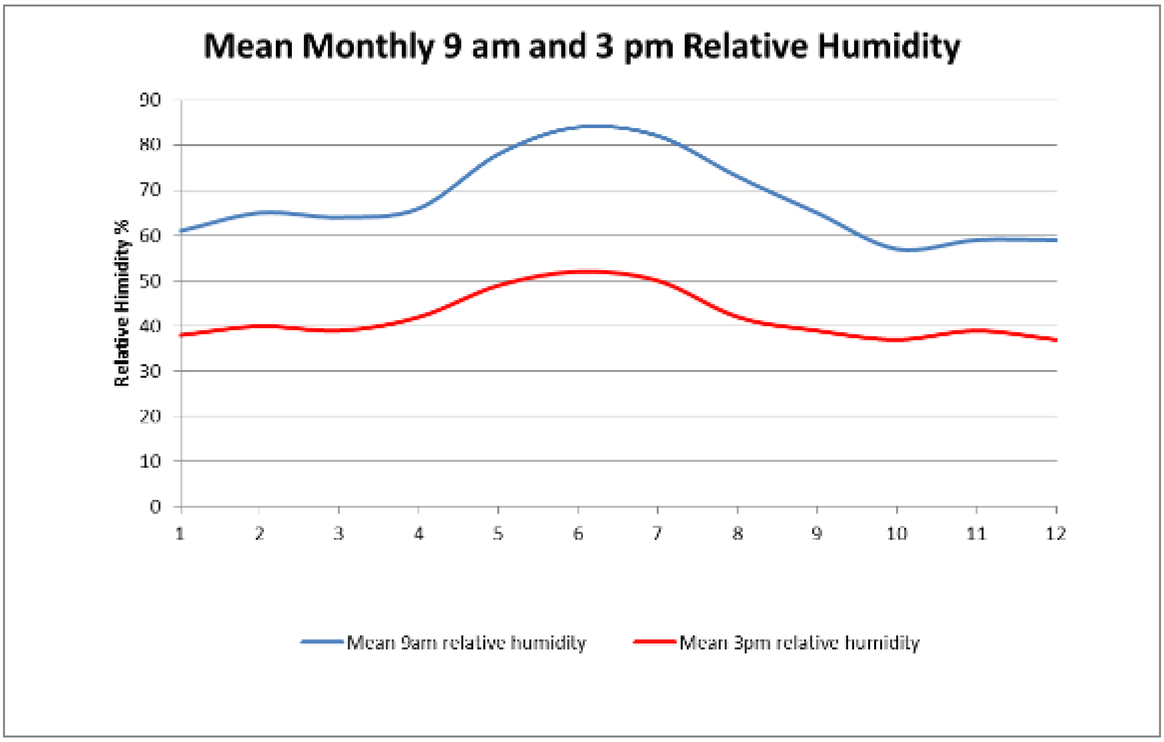


Figure 10 Narrabri West Post Office monthly mean relative humidity

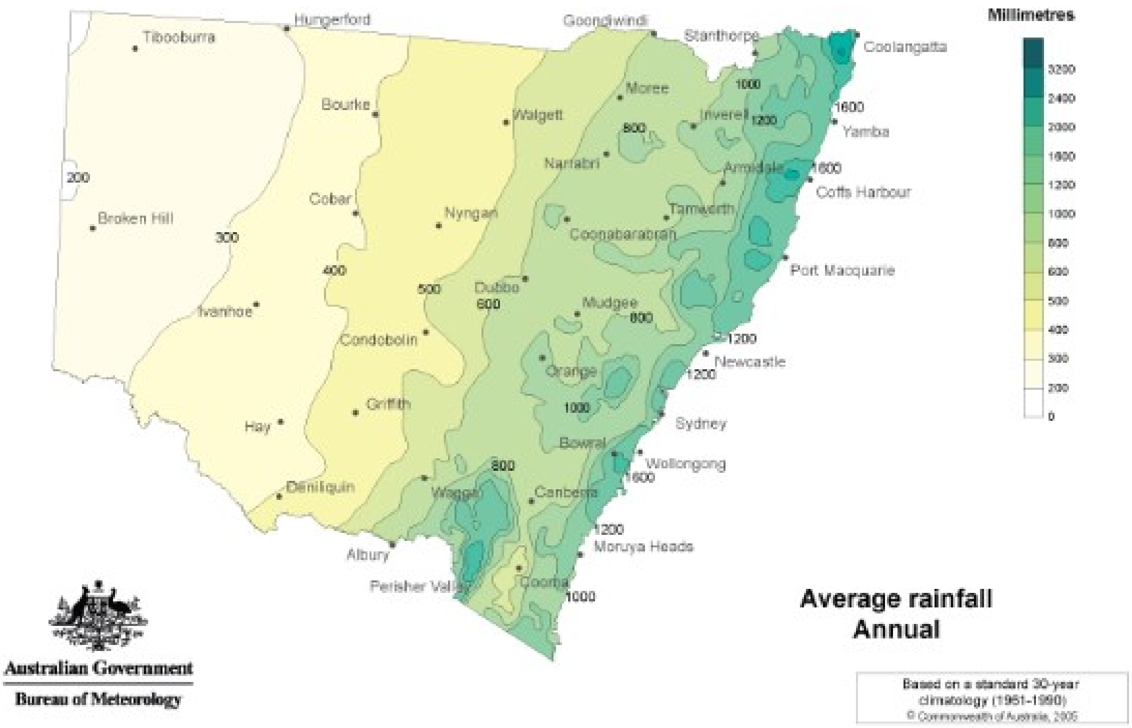
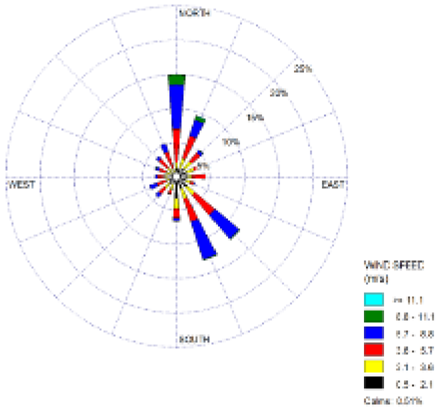
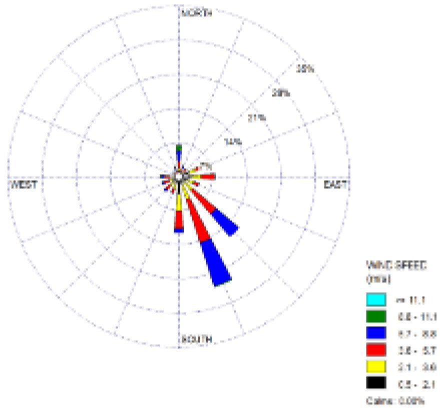


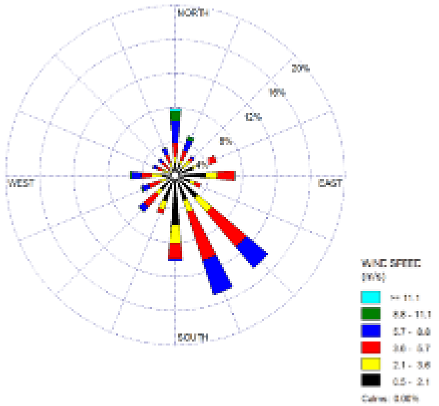
Figure 11 NSW average annual rainfall (mm) from 1961 to 1990



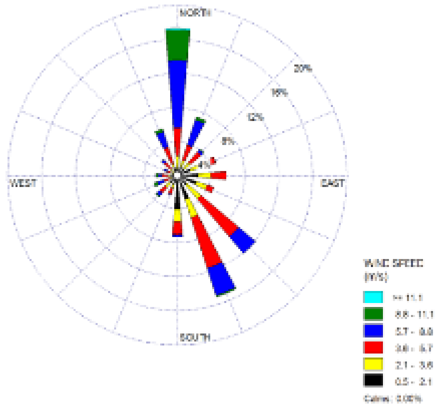
Summer – Ave Wind speed 4.2 m/s



Autumn - Ave Wind speed 4.0 m/s



Winter - Ave Wind speed 3.6 m/s



Spring - Ave Wind speed 4.3 m/s

Figure 12 Wind distribution and frequency of occurrence, Narrabri Airport weather station

5. Assessment of impacts

5.1 Leewood

5.1.1 Overview

Existing noise generating infrastructure and approved (though yet to be constructed) infrastructure at Leewood includes:

- a water treatment facility that comprises:
  - a water treatment plant using reverse osmosis technology
  - a brine treatment plant
  - a salt crystalliser
- staff amenities and car parking
- storage and utilities area.

Proposed additional infrastructure includes:

- the central gas processing facility
- an optional 100 megawatt power plant
- a safety flare
- replacement of the existing water management facility to manage an increased volume of water. This would include replacing the water and brine treatment facilities used to manage exploration produced water, and the construction of two additional water or brine storage ponds
- infrastructure to transfer water for beneficial reuse including pipelines and a managed irrigation system
- a communications tower.

The indicative location of each of these components is shown on Figure 2 and the surrounding sensitive receivers are shown in Figure 6.

Noise would be generated during the construction and operational stages of the project at Leewood and an assessment has been undertaken to predict the noise levels at the surrounding sensitive receivers.

5.1.2 Leewood construction noise

Construction noise sources

Construction at the Leewood facility is expected to generally occur seven days a week during daylight hours (nominally between 5 am and 7 pm however seasonally dependent). However, construction noise undertaken outside of the recommended standard construction hours of 7 am to 6 pm Monday to Friday and 8 am to 1 pm Saturday would be managed so that it complies with the out of hours' construction noise management level of 35 dB(A) unless the residence is subject to a private negotiated agreement.

Construction activities at the Leewood facility would include:

- clearing, levelling of the site and excavation as required
- construction of concrete pads and building foundations
- assembly of prefabricated units on site
- coating and painting activities
- testing and commissioning of the equipment.

The facilities at Leewood would be designed so as to minimise onsite construction through the use of the following methods:

- the power station equipment would be prefabricated and transported to the site
- structural steel platforms and supports not associated with operational equipment would be designed to be shop fabricated and transported to the site
- gas and water processing facility equipment would be pre-fabricated and transported to the site using skid mounts
- demountable buildings would be pre-assembled and flat packed for shipment to the site
- auxiliary buildings would be built from shipping containers
- civil structures such as minor pedestals and concrete sumps (if required) would be pre-cast and transported to the site. However other structural foundations and concrete bunding would be poured in-situ on the site.

Significant construction at the site of the proposed power station is not anticipated and construction works would be limited to site clearing and grading, in-situ concrete casting and the installation of equipment. Significant construction at the central gas processing facility and the water management, treatment and beneficial reuse facilities is not anticipated and construction works would be limited to site clearing and grading, asphalt paving and the installation of equipment. Typical equipment required for the construction activities and relevant noise data is summarised in Table 5-1.

For equipment operating continuously (such as generators) the L_{Amax} noise level are generally within 3 dB(A) of the L_{Aeq} noise level. For heavy machinery L_{Amax} noise level events are typically 8 dB(A) greater than the L_{Aeq} noise level at maximum power. For reversing alarms, a sound power level of 112 dB(A) L_{Amax} has been assumed. The L_{Amax} noise levels have been used for the sleep disturbance assessment.

Table 5-1 Leewood typical construction equipment

Sub-facility	Construction sub-stage	Equipment	Number of plant	Sound power level, dB(A)[1] per plant item	
				L_{Aeq}	L_{Amax}
Power station, central gas processing facility and water treatment plant	Clearing and grading	Dozer	2	115	123
		Scraper	3	113	121
		Excavator	4	107	115
		Truck	8	107	115
		Compactor	4	113	121
	Concrete pad, asphalt paving	Concrete truck and pump	4	108	116
		Asphalt paver	2	108	116
		Roller[2]	2	108+5[2]	116
	Installation of equipment	Crane	4	104	112
		Generator	20	99	102
		Welding rig	10	105	113
		Hand tools	5	102	110

Note 1: Refer to Appendix C for octave spectra and references for the sound power levels.
Note 2: A 5 dB(A) correction has been applied to the noise source to allow for annoying characteristics associated with vibratory rollers.

Predicted construction noise levels

L_{Aeq} construction noise levels have been predicted for both calm and adverse meteorological conditions and are presented in Table 5-2. Construction noise levels have been predicted for the worst case scenario where the power station, central gas processing facility and the water management, treatment and beneficial reuse facilities are being constructed simultaneously. In practice the construction work is likely to be staged and not all construction equipment would be operating simultaneously.

L_{Amax} construction noise levels are presented in Table 5-3 for assessment against the sleep disturbance screening criteria which assumes the highest L_{Amax} noise source which is a dozer and also reversing alarms.

Partial L_{Aeq} noise levels from each construction noise source at each modelled sensitive receiver are provided in Appendix D.

Table 5-2 Leewood predicted construction noise levels, $L_{Aeq(15min)}$

Sensitive receiver	Noise levels, dB(A)					
	Calm			Adverse[1]		
	Clearing and grading	Concrete pad, asphalt paving	Installation of equipment	Clearing and grading	Concrete pad, asphalt paving	Installation of equipment
160	21	10	16	26	16	20
163	24	15	18	29	21	23
166	22	10	16	26	17	21
167	26	18	20	31	23	25
169	26	18	20	31	23	25
170	21	8	15	25	15	20
171	22	12	17	27	18	21
172	30	24	24	**36**	29	29
173	24	15	18	29	20	23
177	29	22	22	34	27	28
178	27	20	21	32	25	26
179	32	26	25	**37**	31	31
180	21	9	16	26	15	20
182	**36**	31	30	**42**	**36**	35
183	28	22	22	34	27	27
189	**39**	34	32	**44**	**39**	**38**
191	**39**	33	32	**44**	**38**	**37**
192	33	27	26	**38**	32	32
216	**40**	35	34	**45**	**40**	**39**
217	**43**	**38**	**37**	**48**	**43**	**42**
Bold text indicates an exceedance to the 35 dB(A) noise management level outside of standard construction hours.						

Note 1: Adverse meteorological conditions occur for more than 30 per cent of the time during the time periods and seasons identified in Table 3-3.

Table 5-3 Leewood predicted maximum construction noise levels, L_{Amax}

Sensitive receiver (refer to Figure 6)	Noise levels, dB(A)			
	Calm		Adverse[1]	
	Reversing alarm	Dozer	Reversing alarm	Dozer
160	4	18	11	24
163	10	22	15	28
166	5	19	11	24
167	12	23	17	29
169	11	23	17	28

Sensitive receiver (refer to Figure 6)	Noise levels, dB(A)			
	Calm		Adverse[1]	
	Reversing alarm	Dozer	Reversing alarm	Dozer
170	3	18	10	23
171	7	20	13	25
172	18	29	24	34
173	10	22	15	27
177	17	28	22	34
178	14	26	20	31
179	20	30	25	35
180	4	18	10	23
182	26	36	31	41
183	17	28	22	33
189	29	39	34	45
191	28	38	33	43
192	21	31	26	37
216	30	40	35	45
217	33	44	38	48

Note 1: Adverse meteorological conditions occur for more than 30 per cent of the time during the time periods and seasons identified in Table 3-3.

Assessment of construction noise

All identified sensitive receivers are predicted to comply with the noise management levels during recommended standard hours under calm meteorological conditions except for receiver 217 which is predicted to exceed the noise management levels by up to 3 dB(A) as shown in Table 5-3

Five sensitive receivers are predicted to exceed the construction noise management levels when work is undertaken outside of recommended standard hours during calm meteorological conditions and up to eight sensitive receivers are predicted to exceed the construction noise management levels during adverse meteorological conditions.

The modelling assumes that all equipment is operating simultaneously in each construction area and is therefore likely to be conservative.

The predicted L_{Amax} construction noise levels do not exceed the 45 dB(A) sleep disturbance screening criteria at all identified sensitive receivers except one receiver where an exceedance of 3 dB(A) is predicted during adverse weather conditions.

Work practices outlined in Section 6.1 would be considered where feasible and reasonable and residents surrounding the site potentially exceeding the construction noise management levels would be notified of the nature of the works, expected noise levels, duration of works and a method of contact to raise noise complaints. Some work would be undertaken outside of the recommended standard hours however this work would be managed so that it complies with the out of hours' noise management level of 35 dB(A) unless the residence is subject to a private negotiated agreement. This process and measures for managing construction noise that exceeds the construction noise management levels are discussed further in Section 6.1.

It is also noted that to date there have been no complaints received for construction activities undertaken at Leewood as part of the existing approvals.

5.1.3 Leewood operational noise

Operational noise sources

Details of the noise sources and modelling assumptions used for the Leewood operational noise assessment are summarised in the following sections. All sub-facility locations are shown on Figure 2.

All noise sources would operate 24 hours per day seven days per week except for the safety flare which could operate for short durations during maintenance or emergencies.

Central gas processing facility

The central gas processing facility would be used to treat the gas via additional compression, carbon dioxide removal and dehydration so that it is suitable for transport via a gas transmission pipeline. The facility would consist of four 50 terajoule gas trains mounted on separate concrete pads. Each train would be made up of the following significant noise generating equipment:

- one 2-stage low pressure reciprocating compressor (and after coolers)
- one 1-stage high-pressure reciprocating compressor (and after coolers).

Carbon dioxide removal and dehydration equipment does not produce significant noise emissions and would not contribute to the noise levels from Leewood.

There would also be an electrical substation at the central gas processing facility which would consist of several transformers.

A safety flare would be located at the central gas processing facility which would operate with minimal operating flow during standard operations and may be required to operate at higher flow rates during maintenance or other situations where operational equipment is off-line. The safety flare would have a stack height of up to 50 meters and has been designed to be able to operate at a maximum flow rate of 244 million standard cubic feet of gas per day Maintenance would generally occur during recommended standard construction hours.

Noise data for operational equipment at the central gas processing facility is provided in Table 5-4. The following noise modelling assumptions have been made:

- the flare has been modelled at a stack height of 50 metres
- reciprocating compressors have been modelled as point sources with a source height of two metres. It is likely that due to work health and safety requirements the compressors would be acoustically enclosed. Where required acoustic enclosures would be designed to reduce the sound pressure level to 80 dB(A) or lower at one metres. Both the enclosed and unclosed scenarios have been considered as part of this noise assessment.
- the compressor coolers have been modelled as point sources with a source height of 1.5 metres.
- transformers have been modelled as point sources at a source height of 2.5 metres. Noise levels and spectra for transformers were calculated based on transformer power capacity and the equations presented in *VDI 3739: Emission benchmarks for acoustic sources, transformers* (1999).

Water management, treatment and beneficial reuse facilities

Produced water captured from the well head would be transferred to Leewood where it would undergo the following processes:

- solids removal
- reverse osmosis to remove salts
- the addition of acid or alkalinity to adjust pH values as required.

The majority of process equipment would be enclosed within the water treatment plant and the brine treatment plant and is not expected to contribute to the noise environment. The following noise generating equipment is expected to be located outside the water treatment plant and brine treatment plant:

- dissolved air flotation component systems: the compressor is expected to be the dominant noise source and would be enclosed
- service water tank and booster pumps
- crystalliser unit and cooling towers: The brine crystalliser would be located within the brine treatment plant and the cooling towers would be located adjacent to the brine treatment plant area
- pumps would be located around the site to enable the transfer of water and brine between the storage and treatment infrastructure components.

Other equipment associated with the treatment plant should not contribute to the noise environment and have not been considered in the noise predictions. Noise data for operational equipment at the water management, treatment and beneficial reuse facility is provided in Table 5-4. The following noise modelling assumptions have been made:

- booster and water pumps have been modelled as point sources with a height of 0.5 metres. Five pumps have been modelled as operational at a given time around the water treatment plant.
- the compressor has been modelled as a point source with a height of two metres. The compressor enclosure would be designed to comply with a sound pressure level to 80 dB(A) or lower at one metres outside of the enclosure
- the cooling tower has been modelled as a point source with a height of two metres.

100 MW gas fired power station

A 100 MW gas fired power station may be located adjacent to the central gas processing facility at Leewood and would provide power to the infrastructure at Leewood and Bibblewindi. The alternative is that mains power is sourced for operations at Leewood.

The noise assessment has been based on a typical gas fired power station which can provide 100 MW of power. A power station with ten gas engine generators (and two standby generators) has been considered with a 28 metres high silenced exhaust stack and radiator cooling fans.

The gas engines would be contained within an acoustically treated engine hall with a structural height of 10 metres. For each gas engine there would be an acoustically treated intake ventilation unit on each side of the engine hall and a roof mounted ventilation outlet. There would also be transformers on the site.

Noise data for the gas fired power station is provided in Table 5-4. The following modelling assumptions have been made:

- the exhaust stack noise source has been modelled as a 28 metres high point source with vertical directivity based on *VDI 3733 Noise in pipes* (1996).
- the ventilation units to the engine hall and from the roof have been modelled as area sources on the facades of the engine hall. Two ventilation units (one on each side of the engine hall) and one ventilation unit on the roof (per engine) have been assumed.
- two engine halls have been modelled at a height of 10 metres, with four (and one stand-by) gas engines operational at a given time.
- three radiator cooling fans have been modelled per engine as point sources at a height of 1.5 metres.
- transformers have been modelled as point sources at a height of 2.5 metres. Noise levels and spectra for transformers were calculated based on transformer power capacity and the equations presented in *VDI 3739: Emission benchmarks for acoustic sources, transformers* (1999).

Predicted operational noise levels

Operational noise levels have been predicted during calm and adverse meteorological conditions for the following operational scenarios:

- **Base case scenario 1 (with power station) -** central gas processing facility with unenclosed compressors, transformers, power station (with a moderate level of noise attenuation treatments) and the water treatment plant
- **Base case scenario 2 (mains power and no power station) -** central gas processing facility with unenclosed compressors, transformers and the water treatment plant (no power station as mains power would be available).
- **Mitigation scenario 1 -** central gas processing facility with acoustically enclosed compressors, transformers, power station (with a high level of noise attenuation treatments) and water treatment plant. The additional mitigation scenario noise data is provided in Table 5-6
- **Mitigation scenario 2 -** central gas processing facility with acoustically enclosed compressors, transformers and water treatment plant (no power station as mains power would be available).

The *Industrial Noise Policy* (EPA, 2000) requires that modifying factor adjustments are applied to the predicted received noise level before comparing to the noise criteria if low frequency, tonal, impulsive or intermittent characteristics are associated with the received noise level. No tonal, impulsive or intermittent characteristics are generally associated with the noise sources at Leewood. However, a review of the predicted noise levels at the sensitive receivers indicates that there are low frequency characteristics that are predominantly associated with the power station exhaust stacks. Therefore, a +5 dB(A) low frequency correction has been applied to the predicted noise level for the base case and mitigation scenario 1. There is no low frequency characteristics associated with Leewood without a power station therefore no low frequency modification factor has been applied for the base case and mitigation scenario 2.

Table 5-4 Leewood operational noise sources

Operating area	Equipment	Noise Level, dB(A)									Overall
		Frequency (Hz)									
		31.5	63	125	250	500	1000	2000	4000	8000	A
Central gas processing facility	Reciprocating compressor (no enclosure)	69	90	100	118	113	112	110	107	101	121
		Noise data sourced for an Arial JGC-6 reciprocating compressor.									
	Cooling fans	74	74	81	90	95	96	94	91	88	101
		Overall noise level provided by manufacturer. Noise spectra calculated based on Wartsila low noise cooling radiator (Wartsila radiator noise data sheet W20V32/34DF/34SG, 2012).									
	Transformer	26	36	68	74	71	68	70	69	65	79
		Overall noise level and spectra have been derived from *VDI 3739, Emission Benchmarks for Acoustic Sources, Transformers* (1999).									
	Safety flare	111	111	117	120	122	124	126	125	122	131
		Overall noise level has been based on data provided by Zeeco which specified a SPL of 93 +/- 3 dB(A) at the base of a stack operating at an emergency flow rate of 252 million standard cubic feet of gas per day. Flare spectra have been derived from *VDI 3732 Characteristic noise emission values of technical noise sources – Flares* (1999)									
Water management, treatment and beneficial reuse facilities	Compressor	51	67	79	83	85	86	83	79	74	91
		Based on typical noise level data. Noise spectra calculated based on *VDI 3731 Sheet 1 Emission benchmarks for acoustics sources, pumps, compressors (1982)*.									
	Cooling tower	61	73	82	88	90	90	88	83	77	96
		Based on typical noise level data. Noise spectra calculated based on *VDI 3734 Sheet 2: Emission benchmarks for technical sound sources, recooling plants, cooling towers (1990)*.									
	Water transfer pump	39	53	63	72	80	81	79	76	71	86
		Based on typical noise level data. Noise spectra calculated based on *VDI 3743- 1 Emission benchmarks of technical sound sources, pumps, centrifugal pumps (2000)*.									
Power station	Engine hall average internal noise level	-	78	86	97	102	106	101	103	96	110
		Noise spectra calculated from Wartsila engine sound power level (Wartsila W20V32/34SG/34DF noise data sheet, 2011).									
	Noise level at each ventilation unit	-	71	79	90	95	99	94	96	89	103
		Noise spectra calculated from Wartsila engine sound power level (Wartsila W20V32/34SG/34DF noise data sheet, 2011). Louvre outlet spectra assumed to be a typical NAP Silentflo rectangular silencer (with an overall insertion loss of									

Operating area	Equipment	Noise Level, dB(A)									Overall
		Frequency (Hz)									
		31.5	63	125	250	500	1000	2000	4000	8000	A
		23 dB(A)) to achieve a sound pressure level of 92 dB(A) at one metres (Wartsila supplied sound pressure level at the ventilation unit outlets).									
	Exhaust gas outlet (with EN4YX – 1200 silencer)	69	91	81	84	95	95	91	82	-	100
		Noise spectra for the exhaust gas outlet provided by Wartsila (Wartsila W20V32/34SG/34DF noise data sheet, 2011). Noise spectra for the silencer sourced from Universal Acoustic & Emissions Technologies (Fabrication Drawing No. 21-908-XA, 2010).									
	Low noise 5-fan cooling radiator	74	74	81	90	95	96	94	91	88	101
		Noise spectra provided by Wartsila (Wartsila radiator noise data sheet W20V32/34DF/34SG, 2012).									
	Transformer	26	36	68	74	71	68	70	69	65	79
		Overall noise level and spectra calculated based on the equations provided in *VDI 3739, Emission Benchmarks for Acoustic Sources, Transformers* (1999).									

Note: '-' indicates data not available for certain octave frequency bands

Noise levels at each modelled sensitive receiver are presented in Table 5-5 for base case operations at Leewood.

Operational noise contours for base case scenario 1 are shown in Figure 13 and Figure 14 for calm and adverse meteorological conditions respectively. Operational noise contours for base case scenario 2 are shown in Figure 15 and Figure 16 for calm and adverse meteorological conditions respectively. Where applicable, the noise contour maps include the +5 dB(A) low frequency modification factor. Partial noise levels from each operational noise source at each modelled sensitive receiver are provided in Appendix D.

Table 5-5 Leewood predicted noise levels for typical operation

Sensitive receiver (refer to Figure 6)	Base case scenario 1 noise levels, $L_{Aeq(15min)}$ dB(A)				Base case scenario 2 noise levels, $L_{Aeq(15min)}$ dB(A)	
	No low frequency correction		With low frequency correction of + 5dB(A)		No low frequency correction as there is no power station	
	Calm	Adverse	Calm	Adverse	Calm	Adverse
160	27	33	32	**38**	27	33
163	30	**36**	35	**41**	30	**36**
166	28	33	33	**38**	27	33
167	32	**38**	**37**	**43**	31	**37**
169	31	**37**	**36**	**42**	31	**37**
170	27	32	32	**37**	26	32
171	29	34	34	**39**	28	34
172	**36**	**42**	**41**	**47**	**36**	**42**
173	30	**36**	35	**41**	30	**36**
177	35	**41**	**40**	**46**	35	**41**
178	33	**40**	**38**	**45**	33	**39**
179	**37**	**44**	**42**	**49**	**37**	**43**
180	27	33	32	**38**	26	32
182	**42**	**48**	**47**	**53**	**42**	**48**
183	35	**41**	**40**	**46**	35	**41**
189	**45**	**51**	**50**	**56**	**45**	**51**
191	**44**	**50**	**49**	**55**	**44**	**50**
192	**38**	**44**	**43**	**49**	**38**	**44**
216	**43**	**49**	**48**	**54**	**42**	**48**
217	**50**	**55**	**55**	**60**	**49**	**54**

Bold text indicates an exceedance of the 35 dB(A) noise criteria.

Assessment of operational noise

Operational noise levels from the Leewood base case are predicted to exceed the noise criteria at several surrounding sensitive receivers (refer to Table 5-5). An analysis of the contributing noise sources (refer to Appendix D) indicates that the dominant noise sources at the sensitive receivers are the compressors, power station ventilation units, cooling fans and exhaust stacks. Two mitigation scenarios have been investigated as part of this assessment.

Mitigation scenario 1

The following noise mitigation measures could be implemented to reduce noise levels at sensitive receivers:

- enclosing the reciprocating compressors in individual enclosures or an acoustically treated building. This would include mitigation of significant noise associated with valves or pipework
- upgrading the power station exhaust silencers to achieve an additional 15 dB(A) noise reduction or reducing the height of the exhaust stack (note that the stack height has not been changed for the mitigation scenario calculations)
- upgrading the power station radiators to ultra-low noise 12-fan cooling radiators or utilising variable speed drives on radiator cooling fans and acoustic enclosure ventilation fans. This would allow the fan speeds to be reduced (and associated noise levels) when ambient temperature drop which typically occurs during the nigh-time periods and winter months when receivers are more sensitive and temperature inversions are more prominent
- upgrading the power station engine hall ventilation louvres
- the power station silencer is selected to ensure that there are no low frequency noise emissions characteristics, hence the Industrial Noise Policy (EPA 2000) 5 dB(A) modifying factor adjustment would not be applied to the noise predictions.

Noise source data for this mitigation option is provided in Table 5-6. Noise levels with these attenuation options implemented are provided in Table 5-7 and noise contours are shown in Figure 17 and Figure 18 for calm and adverse meteorological conditions respectively.

With the mitigation treatment implemented operational noise levels from Leewood are predicted to comply with the noise criteria at all surrounding sensitive receivers during calm and adverse meteorological conditions.

Mitigation scenario 2

Noise levels from Leewood without the power station (including the acoustically enclosed compressors) have been predicted and are provided in Table 5-7. Noise contours are shown in Figure 19 and Figure 20 for calm and adverse meteorological conditions respectively.

Without the power station (including the acoustically enclosed compressors), operational noise levels from Leewood are predicted to comply with the noise criteria at all surrounding sensitive receivers during calm and adverse meteorological conditions.

There is also the potential that five of the compressors at Bibblewindi would be relocated to Leewood. These compressors would be housed in acoustic enclosures and designed so that they would not significantly increase noise levels at Leewood.

Table 5-6 Leewood central gas processing facility noise data for recommended mitigation treatments

<table>
<tr><th rowspan="3">Equipment</th><th colspan="9">Noise Level, dB(A)</th><th rowspan="2">Overall</th></tr>
<tr><th colspan="9">Frequency (Hz)</th></tr>
<tr><th>31.5</th><th>63</th><th>125</th><th>250</th><th>500</th><th>1000</th><th>2000</th><th>4000</th><th>8000</th><th>A</th></tr>
<tr><td rowspan="2">Ultra low noise cooling radiator</td><td>-</td><td>67</td><td>75</td><td>78</td><td>86</td><td>87</td><td>87</td><td>84</td><td>75</td><td>93</td></tr>
<tr><td colspan="10">Noise spectra calculated from Wartsila engine sound power level (Wartsila W20V32/34SG/34DF noise data sheet, 2011).</td></tr>
<tr><td rowspan="2">Noise level at each ventilation unit</td><td>-</td><td>54</td><td>76</td><td>66</td><td>69</td><td>80</td><td>80</td><td>76</td><td>67</td><td>85</td></tr>
<tr><td colspan="10">Noise spectra calculated from Wartsila engine sound power level (Wartsila W20V32/34SG/34DF noise data sheet, 2011). Sound power level attenuated using louvre: NAP SilentFlo D50/240 Module 400 (or similar).
<table>
<tr><th colspan="9">NAP SilentFlo D43/240 Module 350 Noise attenuation data</th></tr>
<tr><td>63 Hz</td><td>125 Hz</td><td>250 Hz</td><td>500 Hz</td><td>1000 Hz</td><td>2000 Hz</td><td>4000 Hz</td><td>8000 Hz</td><td>Insertion loss</td></tr>
<tr><td>7</td><td>18</td><td>41</td><td>49</td><td>55</td><td>37</td><td>24</td><td>20</td><td>39</td></tr>
</table></td></tr>
<tr><td>Exhaust gas outlet (with recommended silencer)</td><td>-</td><td>59</td><td>75</td><td>71</td><td>75</td><td>85</td><td>85</td><td>81</td><td>72</td><td>90</td></tr>
<tr><td rowspan="2">Reciprocating compressor (acoustic enclosure)</td><td>39</td><td>60</td><td>70</td><td>88</td><td>83</td><td>82</td><td>80</td><td>77</td><td>71</td><td>91</td></tr>
<tr><td colspan="10">Acoustically enclosed noise levels designed to 80 dB(A) at 1 metres. Noise spectra calculated based on Arial JGC-6 reciprocating compressor.</td></tr>
</table>

Note: '-'indicates data not available for certain octave frequency bands

Table 5-7 Leewood predicted noise levels with mitigation

Sensitive receiver	Mitigation scenario 1 noise levels, $L_{Aeq(15min)}$ dB(A)				Mitigation scenario 2 noise levels, dB(A)	
	No low frequency correction as silencer would be selected to minimise low frequency noise from the power station				No low frequency correction as there is no power station	
	Calm	Adverse			Calm	Adverse
160	9	13			0	5
163	12	16			3	9
166	9	14			0	6
167	13	18			4	10
169	12	17			4	10
170	8	13			-	5
171	10	15			1	7
172	17	22			9	15
173	11	16			3	8
177	16	21			7	13
178	15	20			6	12
179	18	23			10	16
180	8	13			-	5
182	23	28			14	21
183	16	21			7	13
189	25	29			17	23
191	23	27			17	23
192	17	21			11	18
216	24	28			18	24
217	31	34			22	27

Note: '-' indicates noise levels of less than 0 dB(A)

LEGEND

- Leewood
- Roads
- Sensitive receivers

Noise level contours, db(A)

30, 35, 40, 45, 50, 55, 60, 65, 70, 75

Note - Noise contours include a low frequency modification factor of 5dB(A)

0 0.5 1 2
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Narrabri Gas Project
EIS Technical Appendix Noise and Vibration

Job Number	21-22463
Revision	A
Date	02 Jul 2015

Leewood predicted noise levels base case scenario 1, calm conditions

Figure 13

N:\AU\Sydney\Projects\21\22463\GIS\Maps\21_22463_KBM29_.mxd [KBM: 32]

Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

LEGEND

- Leewood
- Roads
- Sensitive receivers

Noise level contours, db(A)

30, 35, 40, 45, 50, 55, 60, 65, 70, 75

Note - Noise contours include a low frequency modification factor of 5dB(A)

0 0.5 1 2
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Narrabri Gas Project
EIS Technical Appendix Noise and Vibration

Job Number 21-22463
Revision A
Date 02 Jul 2015

Leewood predicted noise levels base case scenario 1, adverse conditions

Figure 14

N:\AU\Sydney\Projects\21\22463\GIS\Maps\21_22463_KBM29_.mxd [KBM: 33]

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

LEGEND

- Leewood
- Roads
- Sensitive receivers

Noise level contours, db(A)

30, 35, 40, 45, 50, 55, 60, 65, 70, 75

0 0.5 1 2
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Narrabri Gas Project
EIS Technical Appendix Noise and Vibration

Leewood predicted noise levels base case scenario 2, calm conditions

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Figure 15

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Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

LEGEND
- Leewood
- Roads
- Sensitive receivers

Noise level contours, db(A)

30, 35, 40, 45, 50, 55, 60, 65, 70, 75

0 0.5 1 2
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Narrabri Gas Project
EIS Technical Appendix Noise and Vibration

Leewood predicted noise levels base case scenario 2, adverse conditions

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Figure 16

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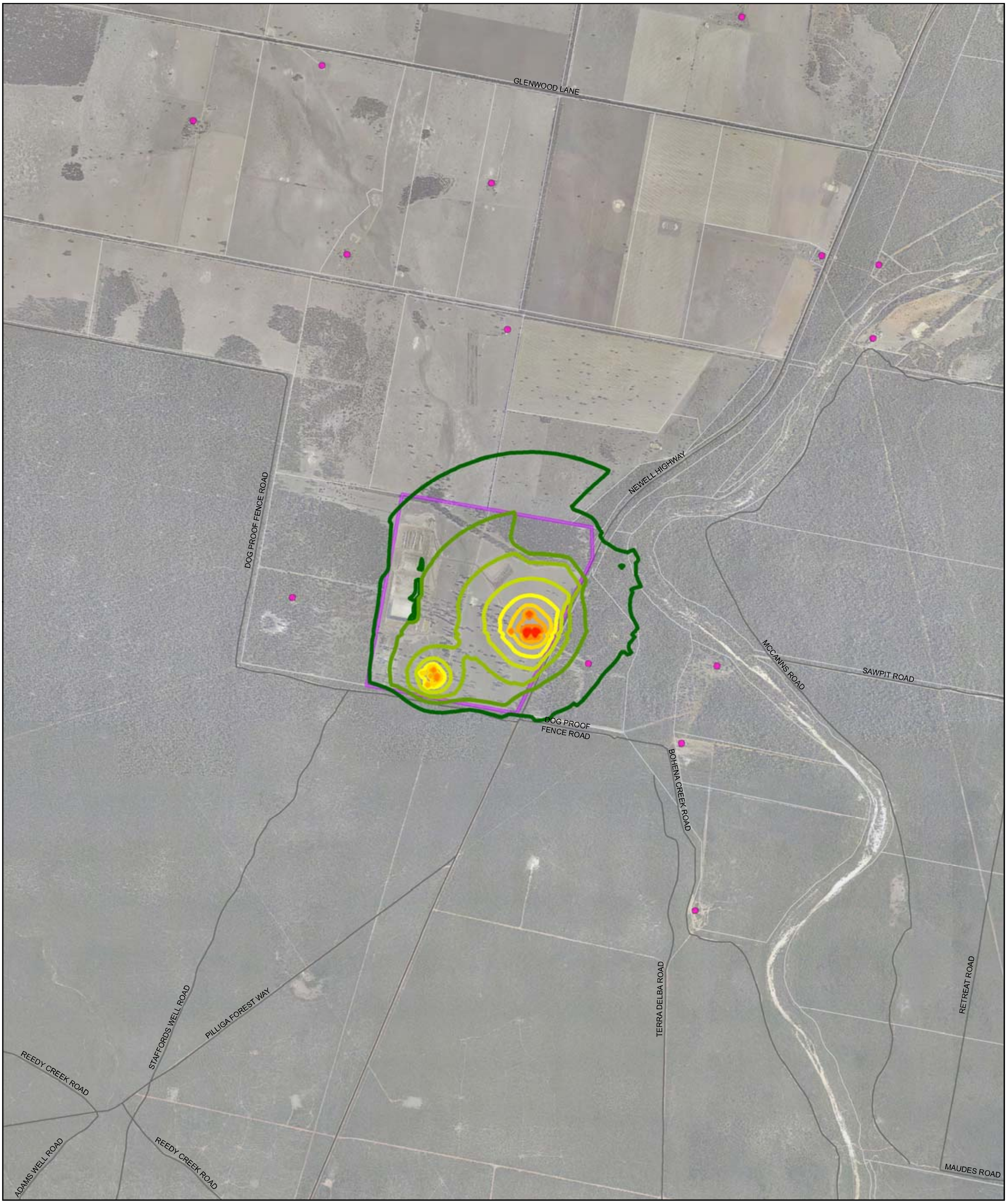
Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy



LEGEND
- Leewood
- Roads
- Sensitive receivers

Noise level contours, db(A)
30 45 60
35 50 65
40 55 70
75

0 0.35 0.7 1.4
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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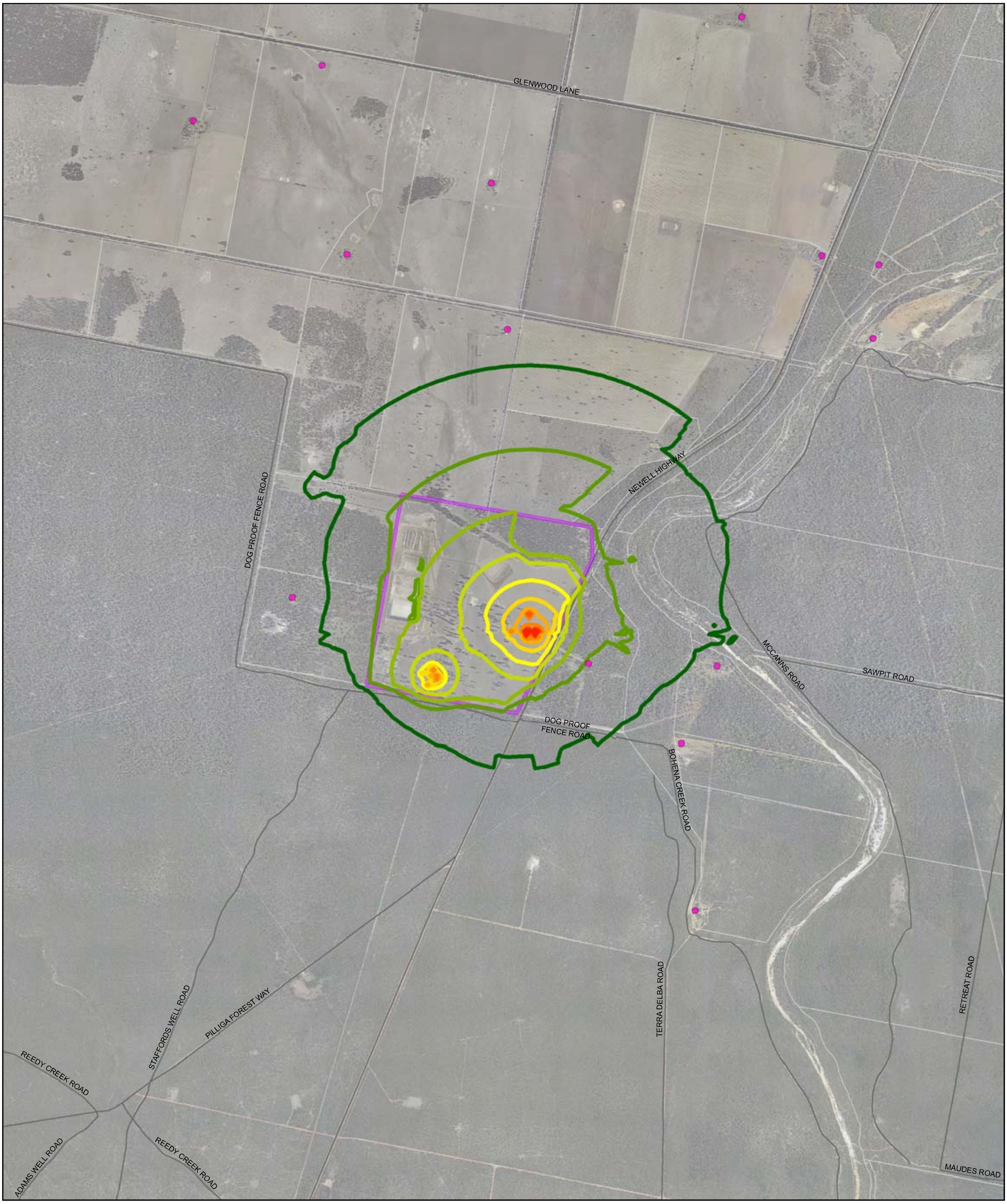
Leewood predicted noise levels mitigation scenario 1, calm conditions

Figure 17

N:\AU\Sydney\Projects\21\22463\GIS\Maps\21_22463_KBM29_.mxd [KBM: 36]

Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy



LEGEND

- Leewood
- Roads
- Sensitive receivers

Noise level contours, db(A)

30, 35, 40, 45, 50, 55, 60, 65, 70, 75

0 0.35 0.7 1.4
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Narrabri Gas Project
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Leewood predicted noise levels mitigation scenario 1, adverse conditions

Figure 18

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Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

LEGEND

Leewood

Roads

Sensitive receivers

Noise level contours, db(A)

30, 35, 40, 45, 50, 55, 60, 65, 70, 75

0 0.35 0.7 1.4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Narrabri Gas Project
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Leewood predicted noise levels mitigation scenario 2, calm conditions

Figure 19

N:\AU\Sydney\Projects\21\22463\GIS\Maps\21_22463_KBM29_.mxd [KBM: 38]

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Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

Narrabri Gas Project
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Revision A
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Leewood predicted noise levels mitigation scenario 2, adverse conditions

Figure 20

N:\AU\Sydney\Projects\21\22463\GIS\Maps\21_22463_KBM29_.mxd [KBM: 39]

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

Assessment of safety flare operation at Leewood

Predicted noise levels from operation of the safety flare operating at maximum flow are provided in Table 5-8. The graphical results are also shown in Figure 21 and Figure 22 for calm and adverse meteorological conditions respectively.

Operation of the safety flare is predicted to exceed the *Industrial Noise Policy* (EPA 2000) intrusive noise criteria of 35 dB(A) when operating at maximum. However, it is highly unlikely for this situation to occur as all compressors would need to go off line in an emergency. The safety flare would generally not operate at maximum flow during standard maintenance.

Section 7.6 of the *Industrial Noise Policy* (EPA 2000) acknowledges that *'from time to time, managing noise at the source may require a short-term increase in noise beyond the level approved.'* The *Industrial Noise Policy* (EPA 2000) considers *'abnormal operations due to unforseen breakdown or maintenance requirements'* as a potential situation justifying a short-term increase in noise. The operation of the safety flare would fall into this category. The *Industrial Noise Policy* (EPA 2000) states that mitigation strategies are often impractical for such short-term events and suggests the following management measures:

- maintenance operations should be scheduled during the less sensitive part of the day
- surrounding sensitive receivers should be informed of maintenance operations and their likely duration prior to commencement of maintenance work.

Operation of the flare beyond its standard safety flow is expected to be irregular. However, its operation at higher flow rates has the potential to occur at night during adverse meteorological conditions and therefor there is potential for minor noise levels to exceed the noise criteria at ten surrounding sensitive receivers identified in Table 5-8. To manage these exceedances associated with the safety flare operations at Leewood, maintenance activities would as far as practical be scheduled during the recommended standard construction noise hours. In addition, surrounding receivers with the potential to exceed the noise criteria by the safety flare operations would be informed of the potential noise levels during the scheduled maintenance period.

Table 5-8 Leewood safety flare noise levels during maximum flow

Sensitive receiver	Noise level, $L_{Aeq(15min)}$ dB(A)	
	Calm	Adverse
160	30	33
163	33	**37**
166	30	34
167	35	**38**
169	34	**38**
170	29	33
171	31	34
172	**40**	**43**
173	32	**36**
177	**37**	**41**
178	35	**39**
179	**41**	**45**
180	29	33
182	**47**	**50**
183	**37**	**41**
189	**47**	**49**
191	**45**	**48**
192	**39**	**42**
216	**47**	**49**
217	**54**	**55**

Bold text indicates an exceedance of the 35 dB(A) noise criteria.

LEGEND

Leewood

Roads

Sensitive receivers

Noise level contours, db(A)

30 45 60

35 50 65

40 55 70

75

0 0.5 1 2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Narrabri Gas Project

EIS Technical Appendix Noise and Vibration

Leewood safety flare operations calm conditions

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Revision	A
Date	02 Jul 2015

Figure 21

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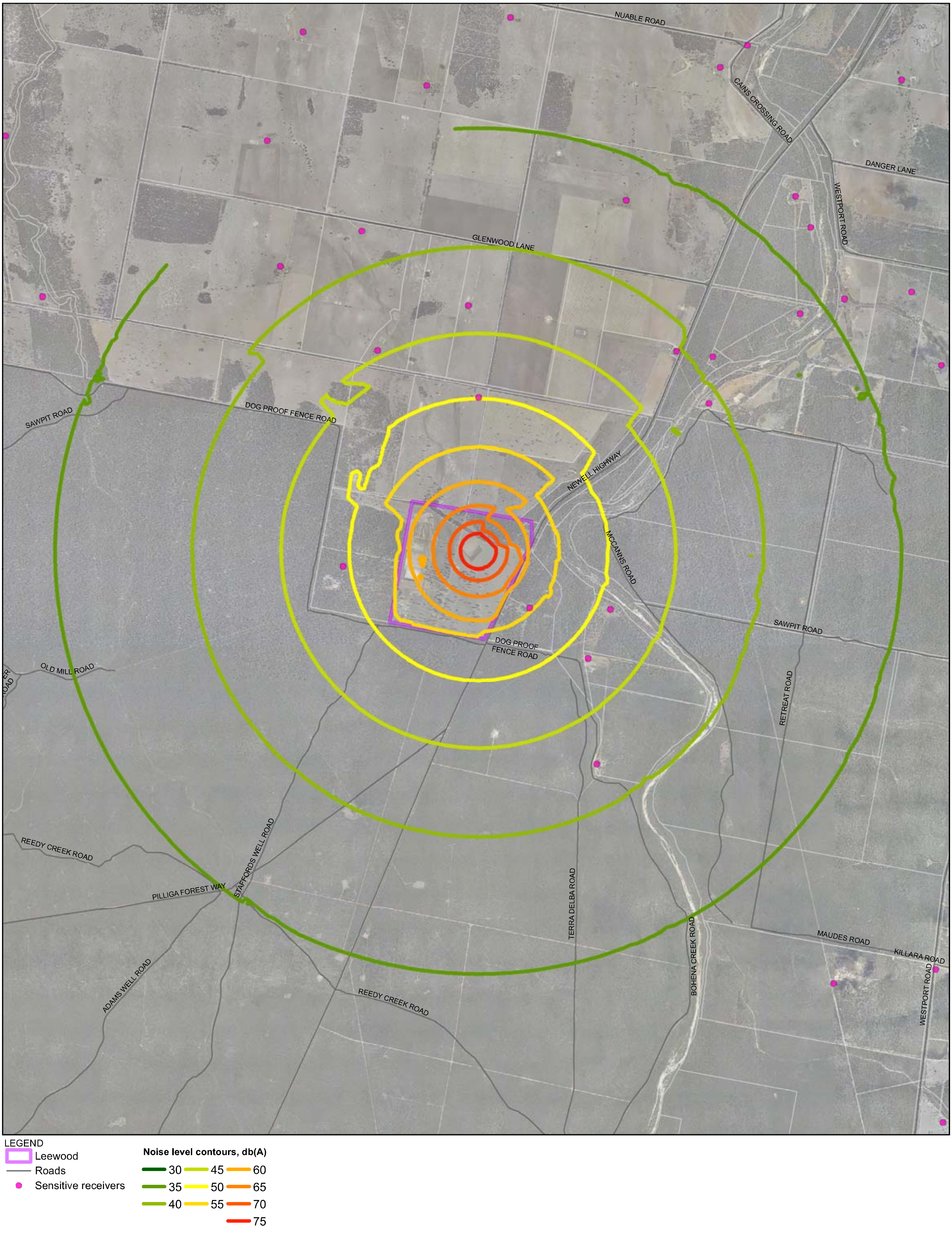
Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy



Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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EIS Technical Appendix Noise and Vibration

Leewood safety flare operations adverse conditions

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Figure 22

N:\AU\Sydney\Projects\21\22463\GIS\Maps\21_22463_KBM29_.mxd [KBM: 41]

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

5.2 Bibblewindi

5.2.1 Overview

There is no significant existing noise generating infrastructure at Bibblewindi currently in operation. Proposed noise generating infrastructure includes:

- a new compression station with up to 20 compressors and associated gas compression aftercoolers (16 operational and four standby) for infield gas compression
- upgrade of the existing safety flare
- an electrical substation
- decommissioning and construction works.

Existing appraisal wells are also located near the Bibblewindi site which have the potential to be converted to production wells, if suitable for production. These have been included in the operational noise assessment.

The location of each of these components is shown in Figure 3.

Noise would be generated during the construction and operation stages of the project at Bibblewindi and an assessment has been undertaken to predict the noise impacts at the surrounding sensitive receivers.

5.2.2 Bibblewindi construction noise

Construction noise sources

Construction at Bibblewindi is expected to generally occur seven days a week during daylight hours (nominally between 5 am and 7 pm however seasonally dependent). However, construction noise undertaken outside of the recommended standard construction hours of 7 am to 6 pm Monday to Friday and 8 am to 1 pm Saturday would be managed so that it complies with the out of hours' construction noise management level of 35 dB(A) unless the residence is subject to a private negotiated agreement.

Bibblewindi construction is expected to start mid 2016 with a duration of nine months.

Construction activities at the Bibblewindi facility would include:

- clearing and levelling of the site
- construction of concrete pads
- assembly of prefabricated units on site
- testing and commissioning of equipment
- work overs of up to seven existing non-operational appraisal wells.

The gas compression station would be designed so as to minimise onsite construction. Most of the equipment would be pre-fabricated and transported to the site using skid mounts. Significant construction at the gas compression station is not anticipated and construction works would be limited to site clearing and grading, asphalt paving and the installation of equipment. Typical equipment required for these activities is detailed in Table 5-9, along with their sound power levels. The existing non-operational appraisal wells would be redrilled and investigated. Suitable appraisal wells would be converted to production wells. Noise generated from appraisal wells has been assessed in Section 5.3.2

Night time (10pm to 7am) sleep disturbance at sensitive receivers have been assessed against the sleep disturbance screening test of 45 dB(A) L_{Amax}.

For equipment operating continuously (such as generators) the L_{Amax} noise level are generally within 3 dB(A) of the L_{Aeq} noise level. For heavy machinery L_{Amax} noise level events are typically 8 dB(A) greater than the L_{Aeq} noise level at maximum power. For reversing alarms, a sound power level of 112 dB(A) L_{Amax} has been assumed. The L_{Amax} noise levels have been used for the sleep disturbance assessment.

Table 5-9 Bibblewindi typical construction equipment

Construction stage	Construction sub-stage	Equipment	Number	Sound power level, dB(A)[1]	
				L_{Aeq}	L_{Amax}
Gas compression station	Clearing and grading	Dozer	2	115	123
		Scraper	3	113	121
		Excavator	4	107	115
		Truck	8	107	115
		Compactor	4	113	121
	Concrete pad, asphalt paving	Concrete truck and pump	4	108	116
		Asphalt paver	2	108	116
		Roller	2	108+5[2]	116
	Installation of equipment	Crane	4	104	112
		Generator	20	99	102
		Welding rig	10	105	113
		Hand tools	5	102	110
Drill rig	Refer to Table 5-15.				

Note 1: Refer to Appendix D for octave spectra and references for the sound power levels.
Note 2: A 5 dB(A) correction has been applied to the noise source to allow for annoying characteristics associated with vibratory rollers.

Predicted construction noise levels

L_{Aeq} construction noise levels have been predicted for calm and adverse meteorological conditions and are presented in Table 5-10.

L_{Amax} construction noise levels are presented in Table 5-11 which assumes the highest L_{Amax} noise source which is a dozer and also reversing alarms.

Partial L_{Aeq} noise levels from each construction noise source at each modelled sensitive receiver are provided in Appendix D.

Table 5-10 Bibblewindi predicted construction noise levels

Sensitive receiver (refer to Figure 7)	Noise level, $L_{Aeq(15min)}$ dB(A)					
	Calm			Adverse[1]		
	Clearing and grading	Concrete pad, asphalt paving	Installation of equipment	Clearing and grading	Concrete pad, asphalt paving	Installation of equipment
208	18	13	13	22	17	17
211	22	16	16	27	21	21
212	25	19	19	30	24	24
213	24	18	18	29	23	23
214	25	19	19	30	24	24

Note 1: Adverse meteorological conditions occur for more than 30 per cent of the time during the time periods and seasons identified in Table 3-3.

Table 5-11 Bibblewindi predicted construction noise levels, L_{Amax}

Sensitive receiver (refer to Figure 7)	Noise levels, dB(A)			
	Calm		Adverse[1]	
	Reversing alarm	Dozer	Reversing alarm	Dozer
208	-	13	2	18
211	4	18	10	23
212	9	22	15	27
213	8	21	14	26
214	11	22	17	27

Note 1: Adverse meteorological conditions occur for more than 30 per cent of the time during the time periods and seasons identified in Table 3-3.

Note: '-' indicates noise levels of less than 0 dB(A)

Assessment of construction noise

The predicted noise levels from construction at Bibblewindi are lower than the noise management level of 40 dB(A) during standard hours and 35 dB(A) outside of standard hours for calm and adverse weather conditions. The predicted L_{Amax} construction noise levels are below the 45 dB(A) sleep disturbance criteria at all identified sensitive receivers.

Therefore, noise generated from construction at Bibblewindi is not expected to adversely affect surrounding sensitive receivers. The general construction noise management measures provided in Section 6.2.3 would still be considered where feasible and reasonable.

It is also noted that to date there have been no complaints received for construction activities undertaken at Bibblewindi for construction work undertaken as part of the existing approvals.

5.2.3 Bibblewindi operational noise

Operational noise sources

The in-field compression station would be located at Bibblewindi and would be used to boost the gas pressure to enable it to be transported via the midfield pipeline to the central gas processing facility at Leewood.

The facility would consist of a compressor building containing 16 operational and four standby screw compressors. Noise sources associated with the compressors include noise from the compressors, pipework and cooling fans.

There would be an electrical substation at the field compression facility which would consist of several transformers.

A safety flare would be located at the field compression facility which would operate with minimal operating flow during standard operations and may be required to operate at higher flow rates during maintenance or other situations where operational equipment is off-line. The safety flare would have a stack height of up to 50 meters and has been designed to be able to operate at a maximum flow rate of 244 million standard cubic feet of gas per day Maintenance would generally occur during recommended standard construction hours.

Seven existing non-operational appraisal wells are located at Bibblewindi that, if it is determined that they are suitable for production, would be converted to production wells.

Noise data for all operational equipment is provided in Table 5-12.

Table 5-12 Bibblewindi operational noise sources

Operating area	Equipment	Noise Level, dB(A)									Overall
		Frequency (Hz)									
		31.5	63	125	250	500	1000	2000	4000	8000	A
Gas compression station	Compressor (unattenuated)	59	72	90	101	101	109	111	110	101	115
		Overall noise level sourced from *Prescribing noise conditions for environmental authorities for petroleum activities* (QLD Department of Environment and Heritage Protection). Noise spectra based on Howden WRV610 screw compressor (provided by Enerflex AustralAsia).									
	Compressor (attenuated)	35	48	66	77	77	85	87	86	77	91
		Typical achievable attenuation provided by Enerflex AustralAsia									
	Cooling fans	74	74	81	90	95	96	94	91	88	101
		Overall noise level provided by manufacturer. Noise spectra calculated based on Wartsila low noise cooling radiator (Wartsila radiator noise data sheet W20V32/34DF/34SG, 2012).									
	Transformer	26	36	68	74	71	68	70	69	65	79
		Overall noise level and spectra calculated based on the equations provided in *VDI 3739, Emission Benchmarks for Acoustic Sources, Transformers* (1999).									
	Safety flare	111	111	117	120	122	124	126	125	122	131
		Zeeco based on a SPL of 93 +/- 3 dB(A) at the base of a stack operating at an emergency flow rate of 252 million standard cubic feet of gas per day. Flare spectra have been derived from the equations presented in VDI 3732 Characteristic noise emission values of technical noise sources – Flares (1999).									
Upgraded pilot well	76 kVA power unit with acoustic enclosure	86	32	46	58	67	72	75	79	82	80
		Acoustic enclosure based on 76 kVA, 81 kW, 1500 rpm diesel generator manufacturer data sheet which specifies a sound pressure level of 75 dB(A) at 1 metres. Spectrum calculated based on VDI 3753 Sheet 1: Emission benchmarks for technical sound sources, stationary combustors (1997)									
	75 kW PCP well head drive	82	32	44	60	70	75	77	76	71	65
		Calculated based on a 75 kW 750 rpm 3-phase electric motor using VDI 3736, Emission benchmarks of technical sound sources, rotating electrical machines, asynchronous machines, April 1984. Spectrum calculated based on H. Schmidt, Technical sound pocket book, VDI publications Düsseldorf (1996)									

Predicted operational noise levels

Operational noise levels have been predicted during calm and adverse meteorological conditions for the following operational scenarios:

- **Base scenario -** Compression station with unenclosed compressors, new production wells and transformers
- **Mitigation scenario -** Central compression station with acoustically enclosed compressors, new production wells and transformers.

Noise levels at each modelled sensitive receiver are presented in Table 5-13 for the above operational scenarios at Bibblewindi.

The *Industrial Noise Policy* (EPA 2000) requires that modifying factor adjustments are applied to the predicted received noise level before comparing to the noise criteria if low frequency, tonal, impulsive or intermittent characteristics are associated with the received noise level. No tonal, impulsive or intermittent characteristics are generally associated with the noise sources at Bibblewindi therefore no modifying factor adjustments have been applied.

Operational noise contours are provided in Figure 23, Figure 24, Figure 25 and Figure 26 for the base case and mitigation scenario during calm and adverse meteorological conditions. Partial noise levels from each operational noise source at each modelled sensitive receiver are provided in Appendix D.

Table 5-13 Bibblewindi predicted operational noise levels for typical operation

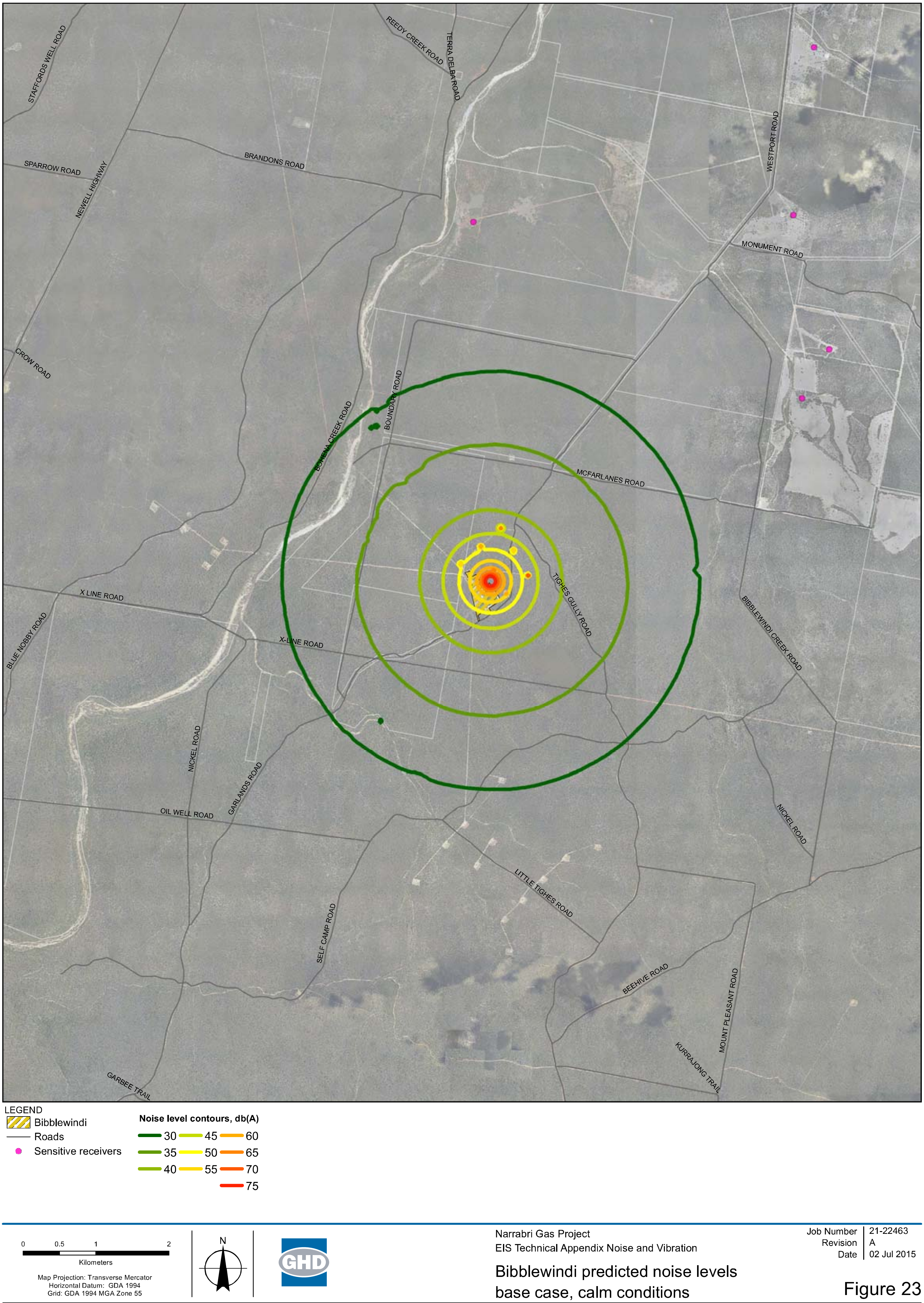
Sensitive receiver (refer to Figure 7)	Noise level, $L_{Aeq(15min)}$ dB(A)			
	Base scenario		Mitigation scenario	
	Calm	Adverse	Calm	Adverse
208	12	17	-	-
211	17	23	-	1
212	21	27	-	5
213	20	26	-	4
214	21	27	-	5

Note: '-' indicates noise levels of less than 0 dB(A)

Assessment of operational noise

Operational noise levels from the central gas processing facility are predicted to comply with the noise criteria of 35 dB(A) (base case and mitigation scenario) at all identified sensitive receivers.

It is likely that the mitigation scenario, with the gas compressors enclosed, would be constructed to meet work health and safety requirements. However, from an environmental noise perspective, the noise model results indicate operational mitigation measures are not required at Bibblewindi.



Narrabri Gas Project
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Bibblewindi predicted noise levels base case, calm conditions

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Revision A
Date 02 Jul 2015

Figure 23

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Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

0 0.5 1 2
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Narrabri Gas Project
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Date 02 Jul 2015

Bibblewindi predicted noise levels base case, adverse conditions

Figure 24

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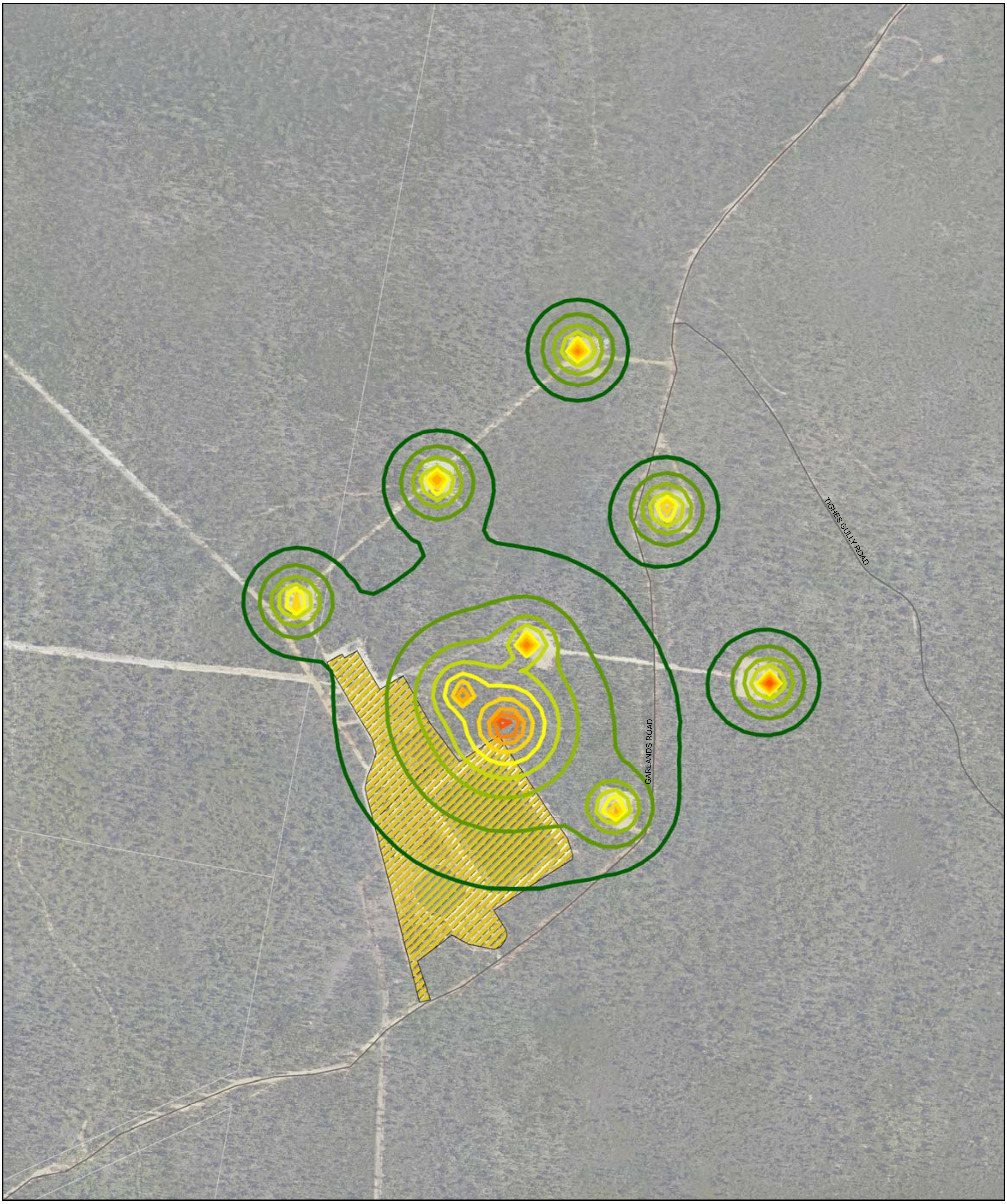
Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy



LEGEND

Bibblewindi	Noise level contours, db(A)
Roads	30, 35, 40, 45, 50, 55, 60, 65, 70, 75
Sensitive receivers	

0 0.075 0.15 0.3

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Bibblewindi predicted noise levels mitigation scenario, calm conditions

Figure 25

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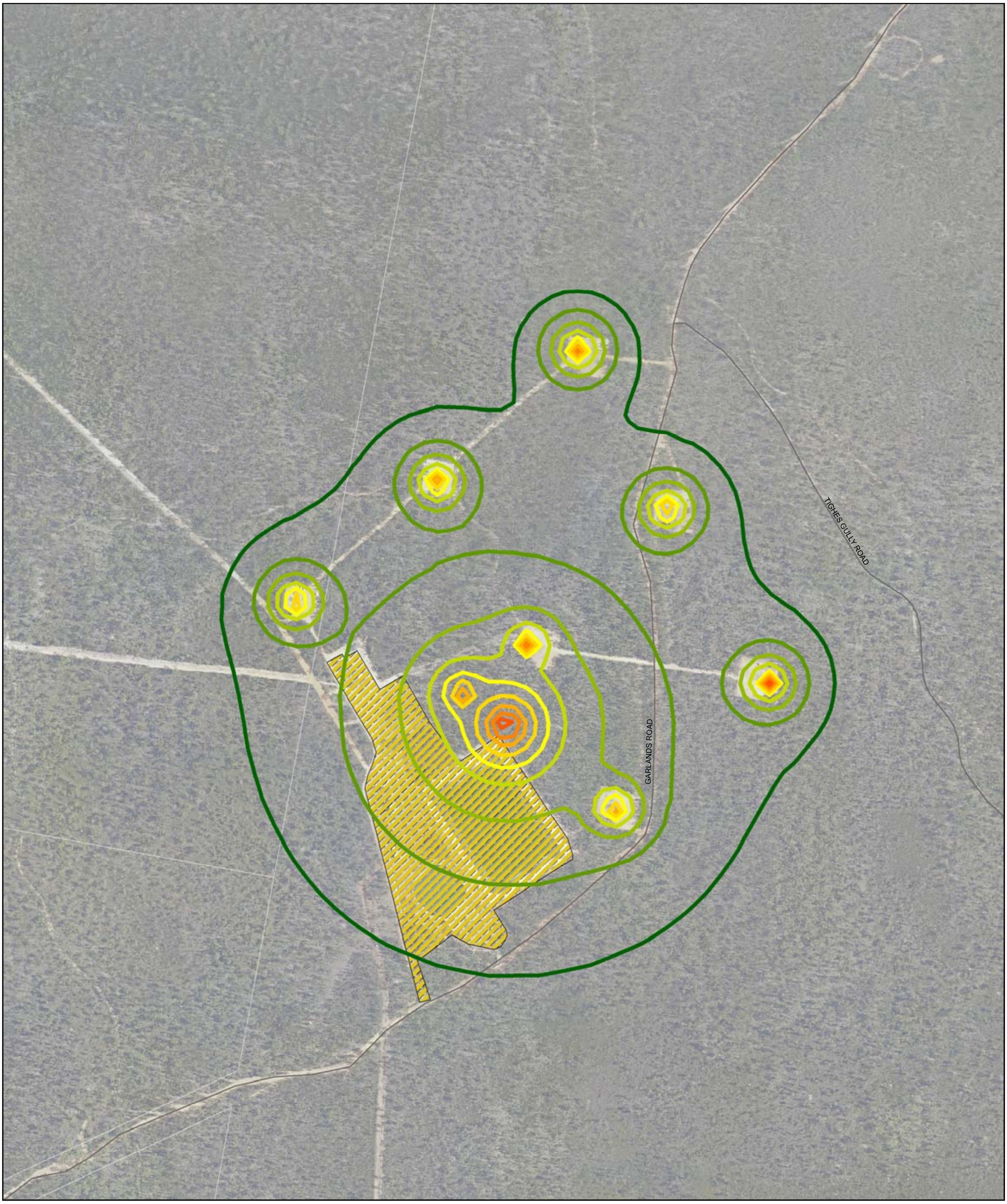
Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy



LEGEND

Bibblewindi

Roads

Sensitive receivers

Noise level contours, db(A)

30 45 60
35 50 65
40 55 70
75

0 0.075 0.15 0.3
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Narrabri Gas Project
EIS Technical Appendix Noise and Vibration

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Date	02 Jul 2015

Bibblewindi predicted noise levels
mitigation scenario, adverse conditions

Figure 26

N:\AU\Sydney\Projects\21\22463\GIS\Maps\21_22463_KBM29_.mxd [KBM: 45]

Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

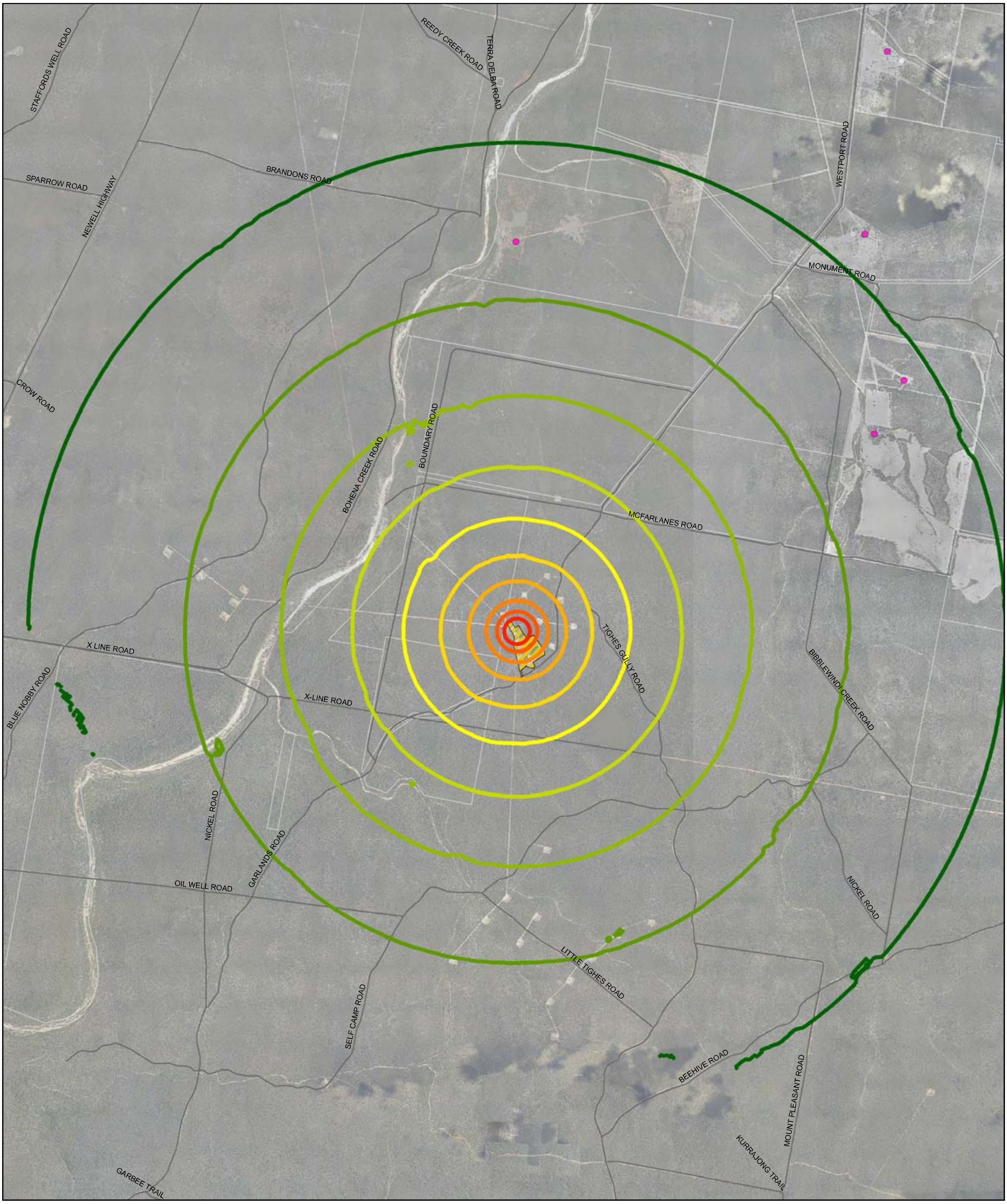
Assessment of safety flare operation at Bibblewindi

Predicted noise levels from operation of the safety flare at Bibblewindi are provided in Table 5-14, Figure 27 and Figure 28 for calm and adverse meteorological conditions respectively. Operation of the safety flare at maximum flow is predicted to exceed the *Industrial Noise Policy* (EPA 2000) intrusive noise criteria of 35 dB(A) during adverse meteorological conditions. The safety flare is unlikely to operate at maximum flow as all compressors would need to go off line in an emergency, and it is also unlikely that if this event did occur that it would happen at the same time as a temperature inversion.

Emergency operations of the safety flare are expected to be infrequent and therefore noise impacts are considered unlikely. However, there is potential for minor exceedances to the noise criteria to occur at night during adverse meteorological conditions at two surrounding sensitive receivers identified in Table 5-14. To manage these exceedances associated with the safety flare operations at Bibblewindi, maintenance activities would as far as practical be scheduled during the recommended standard construction noise hours. In addition, surrounding receivers with the potential to exceed the noise criteria by the safety flare operations would be informed of the potential noise levels during the scheduled maintenance period.

Table 5-14 Bibblewindi safety flare noise levels during maximum flow

Sensitive receiver (refer to Figure 7)	Noise level, $L_{Aeq(15min)}$ dB(A)	
	Calm	Adverse
208	25	29
211	29	33
212	33	**36**
213	31	35
214	33	**36**
Bold text indicates an exceedance of the 35 dB(A) noise criteria.		



LEGEND

- Bibblewindi
- Roads
- Sensitive receivers

Noise level contours, db(A)

30, 35, 40, 45, 50, 55, 60, 65, 70, 75

0 0.5 1 2
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Narrabri Gas Project
EIS Technical Appendix Noise and Vibration

Bibblewindi safety flare operations
calm conditions

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Date	02 Jul 2015

Figure 27

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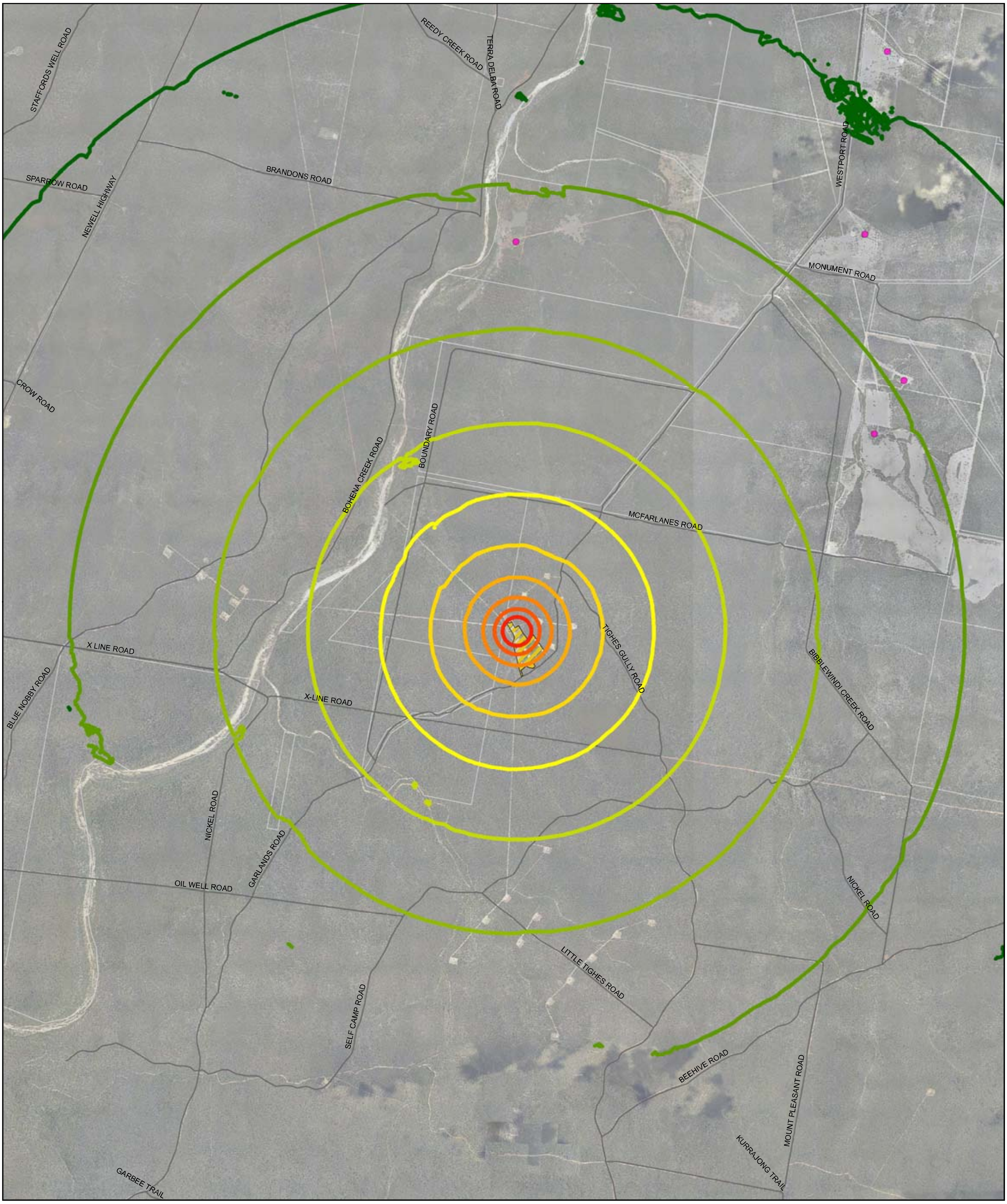
Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy



LEGEND

Bibblewindi

Roads

Sensitive receivers

Noise level contours, db(A)

30 35 40 45 50 55 60 65 70 75

0 0.5 1 2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Narrabri Gas Project
EIS Technical Appendix Noise and Vibration

Bibblewindi safety flare operations adverse conditions

Job Number	21-22463
Revision	A
Date	02 Jul 2015

Figure 28

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Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

5.3 Gas field

5.3.1 Overview

The gas field component of the project would be located entirely within the boundaries of the project area (refer to Figure 1).

The gas field would be developed in accordance with the designated well locations based on geology and therefore gas location, private negotiated agreements, and the field development protocol. The field development protocol provides a set of rules to guide the placement of gas field infrastructure. A constraints approach would be adopted that identifies which gas field activities would be prohibited in each specified area and where specific noise mitigation and management measures would be required.

Over time, as information from exploration and appraisal activities becomes available, field development planning would occur and the noise impacts of the final placement of wells, access tracks and gathering lines would be determined and managed.

Since the specific locations of these activities are not known at this stage, an impact buffer distance assessment has been conducted. Activities in the gas field with the potential to generate noise levels above the noise criteria at sensitive receivers include:

- exploration and appraisal activities including the drilling of pilot wells core and chip holes
- the undertaking of seismic surveys
- construction and operation of the production and pilot wells
- construction of access tracks
- construction of the gas and water gathering lines.

The project would comprise of up to 850 new wells and the use of up to 40 of the existing wells on up to a total of 465 well pads.

Construction at the gas field is expected to generally occur seven days a week during daylight hours (nominally between 5 am and 7 pm however seasonally dependent). However, construction noise undertaken outside of the recommended standard construction hours of 7 am to 6 pm Monday to Friday and 8 am to 1 pm Saturday would be managed so that it complies with the out of hours' construction noise management level of 35 dB(A) unless the residence is subject to a private negotiated agreement.

There would be a requirement to operate the drill rigs 24 hours per day seven days a week.

Gas field construction is expected to start in 2016 with a duration of approximately 20 years for the majority of construction activities and would be spread out over the project area.

Once construction is complete, operational noise sources including well pad generators, electric motors and pilot well flares could operate 24 hours per day 7 days per week.

5.3.2 Wells construction noise

Construction noise sources

Noise levels have been predicted for well construction during calm and adverse meteorological conditions for the following construction scenarios:

- **Construction activities undertaken in standard hours** - well lease pad construction and clearing preparation
- **Base case for 24 hour activities -** well drilling, pipe removal, casing completions and cementing with no mitigation
- **Mitigation scenario for 24 hour activities -** well drilling, pipe removal, casing, completions and cementing with all feasible and reasonable mitigation measures.

Typical construction equipment L_{Aeq} noise source data for construction activities undertaken in standard hours is provided in Table 5-15.

Table 5-15 Well lease pad construction, clearing and completions drill rig equipment and noise source data

Stage	Stage and description	Equipment	Sound power level, L_{Aeq}[1]
Well lease pad	Logging/Vegetation removal	Chainsaws (2-5)	114
		Ultra logger	116
	Easement preparation	Dozer	115
		Grader	110
		Excavator	107
		Bobcat skid steer loader	113
	Well lease construction	Front end loader	113
		Truck	107
		Generator	99
Production well	Clear and grade: Clearing vegetation and topsoil, levelling ground	Dozer	115
		Excavator	107
		Scraper	113

Note 1: Noise source octave spectra and references are provided in Appendix D

Note 2: Some work would be undertaken outside of recommended standard construction hours where the noise levels comply with the noise management level of 35 dB(A) or private negotiated agreements are in place

Note 3: Derived from Noise Assessment Report Halliburton Management System (FO-AUST-HAL-HSE-051, 25 Sep 2013 Rev B)

Setup, drilling, pipe removal, casing, completions and cementing L_{Aeq} noise source data for activities undertaken 24 hours per day are provided in Table 5-16 for base case with no mitigation and a mitigation scenario with all feasible and reasonable mitigation measures implemented. L_{Amax} noise levels have also been provided for non-continuous noise sources which have the potential to exceed the sleep disturbance criteria.

Table 5-16 Well drilling noise source data

Stage and description	Equipment	Sound power level, L_{Aeq} (unless specified)	
		Base case	**Mitigation scenario**
Drill rig setup: Transport and installation of temporary facilities and drill rig	Truck	107	107
	Mobile crane	104	104
	Hand tools	102	102
Drilling: Removal of material to produce the well	Winch	96	96
	Mud pump engine (high load)	115	110
	Mud shaker	102	102
	Generator	109	104
	Hydraulic power unit (high load)	120	105
	Total sum	**121**	**112**
Pipe removal: Removal of drill pipe and bit from the well Casing: Insertion of metal casing into the well	Winch	96	96
	Mud pump engine (low load)	106	101
	Generator	109	104
	Hydraulic power unit (high load)	120	105
	Total sum	**120**	**109**
Cementing: Injecting of high pressure cement between the well walls and the metal casing.	Mud pump engine (low load)	106	101
	Generator	109	104
	Hydraulic power unit (low load)	116	102
	High pressure cement unit	**122**	**122 (no treatment)** **113 (option 1)** **102 (option 2)**
	Total sum	**123**	**122 (no treatment)** **114 (option 1)** **108 (option 2)**
Completion drill rig: installation of well head valves, generators and pumps: Installation of equipment prior to operation of the production well	Hand tools	102	102
	Mobile crane	104	104
	Welding rig	105	105
	Truck	107	107
Potential maximum noise level events	Banging of drill rod casings	**105 to 110 L_{Amax}**	
	Air release	115 to 120 L_{Amax}	

Note: Noise source octave spectra and references are provided in Appendix D

L_{Amax} noise levels sourced from *Prescribing noise conditions for environmental authorities for petroleum activities* (QLD Department of Environment and Heritage Protection)

There is potential for impulsive noise characteristics during pipe removal and casing operations of the drill rig where banging can occur from the placement of drill pipe onto the pipe bins. This banging noise can be minimised by careful operation. As such no impulsive modifying factor adjustments have been applied to drill rig pipe removal operations.

Assessment of the noise source data indicates that there are no tonal or low frequency characteristics associated with the drill rig noise source therefore no modifying factor adjustments have been applied to the assessment.

As can be seen from the noise source data the unmitigated high pressure cement truck has the potential to be the loudest noise source therefore two mitigation scenarios were considered to treat the cement truck noise source:

- Option 1: Select a high pressure cement truck which produces lower noise emissions. Data for different cement trucks with different noise emissions have been used for this assessment and are detailed in Appendix C.
- Option 2: Provide a temporary demountable shed enclosure around the high pressure concrete truck. The shed or barrier would be designed to provide a minimum of 15 to 20 dB(A) attenuation.

The mud pump, generator and hydraulic power unit engines can also be designed to reduce noise emissions. A mitigation scenario was considered which includes a treated engine compartment of the mud pump, generator and hydraulic power unit. Data has been obtained from site measurements on two different types of drill rig from different projects. Both rig types were treated; however, the engine compartments were closed in on one of the rig types which has been used to assess the untreated base case scenario where the enclosures provided limited mitigation.

Buffer distances and noise levels at a specified distance for well construction are provided in Table 5-17, Table 5-18, Table 5-19 and Table 5-20.

It is important to note that drilling operations are temporary in nature and move around the project area. Cementing activities are the loudest noise source during drilling operations and occur only for a matter of hours. As such, exceedances of the construction noise management levels are temporary and not considered significant in nature.

Table 5-17 Predicted buffer distances for well lease pad construction, clearing preparation and completions (metres)

Noise level	Logging and Vegetation removal		Easement preparation		Well lease construction		Clear and grade		Completion drill rig		Drill rig setup	
	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]
25 dB(A)	3924	>5000	3473	4808	2763	3913	3456	4815	2213	3165	2053	2944
30 dB(A)	2859	4039	2523	3582	1939	2802	2494	3586	1525	2217	1401	2031
35 dB(A)	2052	2963	1786	2599	1330	1955	1751	2596	1028	1515	939	1371
40 dB(A)	1438	2118	1228	1822	892	1320	1193	1808	679	1007	619	903
45 dB(A)	985	1468	824	1230	589	865	792	1206	442	651	404	579
50 dB(A)	662	993	543	803	385	551	517	774	286	408	262	360
55 dB(A)	440	660	355	508	250	341	336	479	183	245	169	213
60 dB(A)	290	430	230	311	162	200	217	287	117	136	107	118
65 dB(A)	189	270	149	179	102	110	140	162	70	76	64	67
70 dB(A)	122	156	94	99	61	64	88	91	41	43	36	38
75 dB(A)	74	84	56	58	35	36	52	54	23	24	20	21

Note 1: Adverse meteorological conditions occur for more than 30 per cent of the time during the time periods and seasons identified in Table 3-3.

Table 5-18 Predicted noise levels at distance for well lease pad construction, clearing preparation and completions, dB(A)

Distance	Logging and Vegetation removal		Easement preparation		Well lease construction		Clear and grade		Completion drill rig		Setup of temporary facilities	
	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]
100 m	72	73	69	70	65	66	69	69	62	62	61	61
250 m	62	66	59	62	55	58	58	61	52	55	51	54
500 m	54	58	51	55	47	51	50	55	44	48	43	47
750 m	49	54	46	51	42	47	46	50	39	44	38	42
1000 m	45	50	43	48	39	43	42	47	35	40	34	39
1250 m	42	47	40	45	36	41	40	45	33	37	32	36
1500 m	40	45	37	43	34	39	37	42	30	35	29	34
1750 m	37	43	35	41	31	37	35	41	28	33	27	32
2000 m	35	41	34	39	30	35	33	39	26	31	25	30
2250 m	34	39	32	37	28	33	32	37	25	30	24	29
2500 m	32	38	30	36	27	32	30	36	23	28	22	27
2750 m	31	36	29	34	25	30	29	34	22	27	21	26
3000 m	29	35	27	33	24	29	27	33	21	26	20	25

Note 1: Adverse meteorological conditions occur for more than 30 per cent of the time during the time periods and seasons identified in Table 3-3.

Table 5-19 Predicted buffer distances for drilling, pipe removal, casing and cementing (m)

Noise level	Base case (without mitigation measures)						Mitigation scenario									
	Drilling		Pipe removal /Casing		Cementing		Drilling		Pipe removal /Casing		Cementing (no cement unit treatment[2])		Cementing (Option 1)		Cementing (Option 2)	
	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]
25 dB(A)	4122	>5000	3951	>5000	4332	>5000	2401	3298	1881	2634	4033	>5000	2544	3600	1843	2607
30 dB(A)	3102	4166	2946	3982	3260	4508	1706	2415	1289	1867	3018	4243	1818	2640	1264	1844
35 dB(A)	2272	3121	2136	2959	2394	3398	1165	1711	851	1281	2201	3180	1259	1875	838	1263
40 dB(A)	1602	2275	1490	2138	1705	2487	766	1169	546	847	1557	2308	844	1287	540	836
45 dB(A)	1082	1602	996	1491	1173	1758	489	769	343	539	1068	1618	551	855	341	533
50 dB(A)	704	1086	642	1000	782	1201	308	486	215	327	710	1096	352	550	214	325
55 dB(A)	446	707	404	644	507	793	193	291	135	184	461	720	223	340	135	184
60 dB(A)	279	440	253	396	323	506	121	160	83	93	294	458	141	198	83	94
65 dB(A)	174	258	158	228	204	309	73	82	48	53	186	278	88	101	48	54
70 dB(A)	111	136	101	116	129	176	42	47	27	30	118	157	51	59	27	31
75 dB(A)	66	72	58	64	79	91	27	27	18	19	71	83	29	34	18	19

Note 1: Adverse meteorological conditions occur for more than 30 per cent of the time during the time periods and seasons identified in Table 3-3.

Note 2: No treatment to the cement truck however treatment to the mud pump, generator and hydraulic power unit engines

Table 5-20 Predicted noise levels at distances for drilling, pipe removal, casing and cementing, dB(A)

Noise level	Base case (without mitigation measures)						Mitigation scenario											
	Drilling		Pipe removal /Casing		Cementing		Drilling		Pipe removal /Casing		Cementing (no cement unit treatment)[2]		Cementing (Option 1)		Cementing (Option 2)	
	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]
100 m	71	72	70	71	73	74	62	63	58	59	72	73	64	65	58	59
250 m	61	65	60	64	63	67	52	56	48	53	62	66	54	58	48	52
500 m	54	59	53	58	55	60	45	50	41	46	54	59	46	51	41	46
750 m	49	54	48	53	51	56	40	45	37	41	49	55	42	47	36	41
1000 m	46	51	45	50	47	52	37	42	33	38	46	51	38	43	33	38
1250 m	43	48	42	47	44	50	34	39	30	35	43	48	35	40	30	35
1500 m	41	46	40	45	42	47	32	37	28	33	41	46	33	38	28	33
1750 m	39	44	38	43	40	45	30	35	26	31	38	44	31	36	26	31
2000 m	37	42	36	41	38	43	28	33	24	29	37	42	29	34	24	29
2250 m	35	40	34	39	36	42	26	31	23	27	35	40	27	32	22	27
2500 m	34	39	33	38	34	40	24	30	21	26	33	39	25	31	21	26
2750 m	32	37	31	36	33	39	23	28	20	24	32	37	24	29	19	24
3000 m	31	36	30	35	31	37	22	27	18	23	30	36	22	28	18	23

Note 1: Adverse meteorological conditions occur for more than 30 per cent of the time during the time periods and seasons identified in Table 3-3.

Note 2: No treatment to the cement truck however treatment to the mud pump, generator and hydraulic power unit engines

Assessment of well construction

Well lease pad construction, clearing preparation and completions

During recommended standard construction hours the following buffer distances were predicted to comply with the noise management level of 40 dB(A):

- logging and Vegetation removal – 1,438 metres
- easement preparation – 1,228 metres
- well lease construction - 8,92 metres
- clear and grade – 1,193 metres
- completion drill rig – 679 metres.

Where receivers are located within the above buffer distances the noise mitigation measures detailed in Section 6.1 would be considered where feasible and reasonable. Potentially impacted residents surrounding the site would be notified of the nature of the works, expected noise levels, duration of works and a method of contact to raise noise complaints. Some work would be undertaken outside of the recommended standard hours however this work would be managed so that it complies with the out of hours' noise management level of 35 dB(A) unless the residence is subject to a private negotiated agreement. This process and measures for managing construction noise impacts are discussed further in Section 6.1.

There is the potential for noise to exceed the noise management level when construction activities are undertaken within 290 metres of Yarrie Lake during calm meteorological condition and 430 metres during adverse meteorological conditions.

Setup, drilling, pipe removal, casing and cementing

The impacted buffer distances for each configuration to comply with the 35 dB(A) criteria under adverse meteorological conditions are as follows:

- 1,371 metres for drill rig setup
- 3,121 metres for the drilling stage
- 2,959 metres for the pipe removal and casing stage
- 3,398 metres for the cementing stage.

With the proposed mitigation measures, the impacted buffer distances for each configuration to comply with the 35 dB(A) criteria under adverse meteorological conditions are reduced to the following:

- 3,180 metres for the mitigation scenario with no treatment to the high pressure cement unit (Cementing stage is the dominant noise impacted buffer)
- 1,875 metres for option 1 with the quiet high pressure cement unit (Cementing stage is the dominant noise impacted buffer)
- 1,711 metres for option 2 with the high pressure cement unit enclosed (Drilling stage is the dominant noise impacted buffer).

Option 2 does not significantly reduce the impacted buffer distance and may be challenging due to the nature of the activities.

Maximum noise level events associated with drilling would include banging associated with the movement of drill rod casings (105 to 110 L_{Amax}) and air releases (115 to 120 L_{Amax}). The sleep disturbance noise criteria of 45 dB(A) is 10 dB(A) greater than the noise management level of 35 dB(A). There is the potential for sleep disturbance impacts where sensitive receivers are located within 1,300 metres of the drilling rig.

Up to six drill rigs may be operational for the first 2-3 years, likely to be reducing to two drill rigs thereafter. The drill rigs would operate 24 hours per day during drilling, pipe removal, casing and cementing. Vertical drill rigs would be required for approximately nine to 10 days per well while horizontal drill rigs would be required for up to 28 days per well.

When considering cumulative effects from multiple drill rigs operating logarithmic addition of the noise sources is required. The following formula can be used to assess the cumulative effect of multiple wells:

$$L_R = 10 \times \left[Log_{10}\left(10^{Lx/10} + 10^{Ly/10} + 10^{Lz/10} .... \right) \right]$$

Where:

- L_R = The noise level at the receiver
- Lx,y,z are the contribution noise levels for each drill rig.

The cumulative impacts of multiple rigs operating in the gas field is shown in Table 5-21 which assumes that each drill rig is equal distance to the receiver and at the same stage of construction. The impacted buffer distances increase with multiple drill rigs operating within the vicinity of receivers and scheduling location would be considered in the field development protocol.

An assessment of multiple drill rigs has been undertaken to assess the impacted buffer distances required to comply with the 35 dB(A) criteria under adverse meteorological conditions for the base case and mitigation option scenarios. The field development protocol would apply the noise constraints to guide the siting of wells and this dictates where management and mitigation measures would be required to be implemented, including in situations where multiple drill rigs are operating in vicinity of one another, or other project noise sources.

Where noise levels from drilling activities are predicted to exceed the out of hours management level of 35 dB(A) (and the residence is not subject to a private negotiated agreement) the mitigation measures detailed in Section 6.2.3 would be considered along with the mitigation strategy and work practices shown in Section 6.1.

Table 5-21 Cumulative impact of multiple drill rigs operating - Distance to comply with 35 dB(A) under adverse meteorological conditions

Scenario	Stage	Distance (m)					
		1 rig	2 rigs	3 rigs	4 rigs	5 rigs	6 rigs
Base case	Setup	1371	1713	1929	2108	2239	2361
	Drilling	3121	3742	4119	4427	4652	4861
	Pipe removal /Casing	2959	3565	3935	4239	4460	4667
	Cementing	3398	4060	4459	4782	4999	4999
Mitigation scenario	Drilling	1711	2127	2383	2592	2745	2885
	Pipe removal /Casing	1281	1623	1839	2018	2149	2271
	Cementing (no cement unit treatment)	3180	3815	4195	4502	4723	4926
	Cementing (option 1)	1875	2327	2605	2833	2999	3151
	Cementing (option 2)	1263	1602	1816	1994	2124	2246

Note: All drill rigs assumed equal distance at the same stage of construction to assess cumulative impacts. The field development protocol would determine accurate buffer distances.

5.3.3 Gas and water gathering system construction noise impacts

Construction noise sources

Gas and water gathering systems would be installed between the pilot production wells. The gathering systems would require the following component construction activities:

- vegetation clearance - Vegetation would be cleared from the corridor and stockpiled at agreed locations determined during the negotiation of the access agreement
- topsoil stripping and stockpiling - If a conventional trenching method is used to install the pipe, the topsoil within approximately three metres of the flow line trench would be stripped to a depth of at least 100 millimetres and stockpiled next to retained vegetation
- trenching - The trench would be formed by wheel or chain trencher or excavator. Subsoils would be stockpiled in a windrow adjacent to the topsoil stockpile. In the event that hard rock or hardpan layer is encountered during trenching, a rock saw or other suitable machinery would be employed to achieve and maintain the correct trench depth
- pipe joining and laying - The lengths of poly pipe would be strung out along the work area and joined together before being lowered into the trench
- ploughing - Plough technique may be used as an alternative for trenching for the installation of the flow lines. The flow lines would be ploughed into a common channel using a pipe installation plough technology with a minimum cover of 750 mm. Cable and flow line ploughing is a trenchless technology. The technique is particularly suitable for sparsely populated rural areas where long flow lines with few connections are required. Some short hard rock sections of the flow line may need to be trenched however this would only be carried out where necessary. The ploughing technique proposed for the installation of the flow lines would minimise land disturbance

- horizontal direction drilling would be utilised where it is not possible to use plough in or trenching pipe installation techniques. This is likely to occur under the Newell Highway. This would involve drilling a pilot bore and then enlarging to the size required for intended use
- backfilling and restoration - The backfilling of the trench would commence at the completion of the pressure testing procedures. A magnetic identification/warning tape would be installed approximately 300 millimetres above the gas flow line itself. The compaction of the backfilled subsoil would be monitored to minimise the chances of subsequent settling within the trench. Additional fill may be imported from suitable local supplies (subject to landholder approval).

The equipment utilised in the gas and water gathering system construction process would vary depending on the contractor employed, however typical equipment required for the proposed activity is listed in Table 5-22.

Construction of the gas and water gathering systems is expected to generally occur seven days a week during daylight hours (nominally between 5 am and 7 pm however seasonally dependent). However, construction noise undertaken outside of the recommended standard construction hours of 7 am to 6 pm Monday to Friday and 8 am to 1 pm Saturday would be managed so that it complies with the out of hours' construction noise management level of 35 dB(A) unless the residence is subject to a private negotiated agreement.

Buffer distances for construction of the gas and water gathering system have been calculated for various noise levels and are provided in Table 5-23.

Table 5-22 Gas and water gathering system- Construction equipment per gathering line

Stage and description	Equipment	Number	SWL dB(A)[1] L_{eq}
Logging/Vegetation removal	Chainsaw	2-5	114
	Ultra logger	1	116
Easement preparation	Dozer	1	115
	Grader	1	110
	Excavator	2	107
	Bobcat skid steer loader	2	113
Pipe/ Gas flow line trenching	Chain trencher/ Plough in	2[2]	126
Transport/ Support	Prime mover and low loader	3	107
	Water cart	1	107
	Front end loader	1	113
	Flat-bed truck	2	107

Note 1: Refer to Appendix D for octave spectra and references for the sound power levels

Note 2: One trencher/plough has been assumed to be operational at a given time. Noise levels associated with horizontal directional drilling would be less and hence, predicted noise levels are considered conservative.

Table 5-23 Predicted buffer distances for gas and water gathering system (metres)

Noise level	Logging and vegetation removal		Easement preparation		Trenching		Transport/Support	
	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]
25 dB(A)	3924	4999	3833	4999	4620	4999	3408	4748
30 dB(A)	2859	4039	2785	3936	3622	4801	2418	3414
35 dB(A)	2052	2963	1979	2868	2753	3741	1686	2422
40 dB(A)	1438	2118	1368	2025	2021	2818	1148	1673
45 dB(A)	985	1468	922	1378	1431	2045	765	1121
50 dB(A)	662	993	610	905	980	1428	503	729
55 dB(A)	440	660	399	577	653	961	328	461
60 dB(A)	290	430	260	357	427	625	212	280
65 dB(A)	189	270	168	210	277	391	136	160
70 dB(A)	122	156	107	117	179	232	84	89
75 dB(A)	74	84	65	67	114	128	50	51

Note 1: Adverse meteorological conditions occur for more than 30 per cent of the time during the time periods and seasons identified in Table 3-3.

Table 5-24 Gas and water gathering system, $L_{Aeq(15min)}$ dB(A)

Distance	Logging and vegetation removal		Easement preparation		Trenching		Transport/Support	
	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]	Calm	Adverse[1]
100 m	72	73	71	71	76	77	68	69
250 m	62	66	61	64	66	69	58	61
500 m	54	58	52	57	58	63	50	54
750 m	49	54	48	52	53	58	45	50
1000 m	45	50	44	49	50	55	42	46
1250 m	42	47	41	46	47	52	39	44
1500 m	40	45	39	44	44	49	37	41
1750 m	37	43	37	42	42	47	35	40
2000 m	35	41	35	40	40	45	33	38
2250 m	34	39	33	39	38	44	31	36
2500 m	32	38	32	37	37	42	30	35
2750 m	31	36	30	36	35	40	28	33
3000 m	29	35	29	34	34	39	27	32

Note 1: Adverse meteorological conditions occur for more than 30 per cent of the time during the time periods and seasons identified in Table 3-3.

Assessment of construction noise impacts

During recommended standard construction hours the following buffer distances were predicted to comply with the noise management level of 40 dB(A):

- logging and clearing – 1,438 metres
- easement preparation – 1,368 metres
- trenching – 2,021 metres.

To comply with the noise management level of 35 dB(A) outside of recommended standard construction hours (assuming adverse meteorological conditions) the following buffer distances were predicted:

- logging and clearing – 2,963 metres
- easement preparation – 2,868 metres
- trenching – 3,741 metres.

Where receivers are located within the above buffer distances the noise mitigation measures detailed in Section 6.1 would be considered where feasible and reasonable. Sensitive receivers surrounding the site potentially exceeding the construction noise management levels would be notified of the nature of the works, expected noise levels, duration of works and a method of contact to raise noise complaints. Some work would be undertaken outside of the recommended standard hours however this work would be managed so that it complies with the out of hours' noise management level of 35 dB(A) unless the residence is subject to a private negotiated agreement. This process and measures for managing construction noise that exceeds the construction noise management levels are discussed further in Section 6.1.

There is the potential for noise when construction activities are undertaken within 427 metres of Yarrie Lake during calm meteorological condition and 625 metres during adverse meteorological conditions.

Generally, linear construction activities of this type proceed in a sequential fashion from one section of trench to the next, at an average rate of 400 to 600 metres per day. Therefore, construction noise will be taking place at different locations at a given time, and exceedances to the construction noise management levels at any one point are short-term, typically lasting less than five days during trenching.

5.3.4 Access track construction noise

Access to well pads would be via existing roads and access tracks wherever possible. Where it would not be possible to utilise existing roads and access tracks, new tracks would be constructed. A right of way approximately 12 metres wide would be required for the construction of new access tracks.

To minimise disturbance and limit the isolation of productive land, new tracks would be located in consultation with landowners.

Construction noise sources

Construction noise sources expected to be used for access track construction are summarised in Table 5-25. Detailed construction methodologies and equipment lists would be established by the construction contractor. Logging and clearing and easement preparation are the same as the gas and water gathering lines are is detailed in Section 5.3.3.

Table 5-25 Access track construction noise sources

Construction stage	Equipment	SWL dB(A) L_{eq}
Access track construction	Grader	110
	Water cart	107

Predicted construction noise levels

Buffer distances for operating equipment have been calculated for various noise levels and are provided in Table 5-26. Noise levels at various distances are also provided in Table 5-28.

Table 5-26 Predicted buffer distances from access track construction (metres)

Noise level	Grader and water cart	
	Calm[1]	Adverse
25 dB(A)	2245	3192
30 dB(A)	1575	2282
35 dB(A)	1078	1581
40 dB(A)	722	1061
45 dB(A)	477	693
50 dB(A)	312	440
55 dB(A)	203	268
60 dB(A)	130	153
65 dB(A)	80	85
70 dB(A)	47	49
75 dB(A)	27	28

Note 1: The time periods and seasons for which calm meteorological conditions are applicable are detailed in Table 3-3.

Table 5-27 Predicted noise levels at various distances, $L_{Aeq(15min)}$ dB(A)

Noise level	Grader and water cart	
	Calm[1]	Adverse
100 m	63	64
250 m	53	56
500 m	45	49
750 m	40	44
1000 m	36	41
1250 m	33	38
1500 m	31	36
1750 m	29	34
2000 m	27	32
2250 m	25	30
2500 m	24	29

Note 1: The time periods and seasons for which calm meteorological conditions are applicable are detailed in Table 3-3.

Assessment of access track construction noise

The following buffer distances are predicted to be required to comply with the noise management levels:

- 722 metres to comply with the 40 dB(A) construction noise management level during standard hours and calm meteorological conditions
- 1078 metres to comply with the 35 dB(A) construction noise management level outside of standard hours and calm meteorological conditions
- 1581 metres to comply with the 35 dB(A) construction noise management level outside of standard hours and adverse meteorological conditions.

Sensitive receivers along the access track routes within these buffer distances would be potentially subject to construction noise levels that exceed the criteria. Average construction rates are typically 400 to 600 metres per day. With these rates of construction sensitive receivers would exceed the construction noise management levels for less than five days.

Where receivers are located within the above buffer distances the noise mitigation measures detailed in Section 6.1 would be considered where feasible and reasonable. Sensitive receivers surrounding the site potentially exceeding the construction noise management levels would be notified of the nature of the works, expected noise levels, duration of works and a method of contact to raise noise complaints. Some work would be undertaken outside of the recommended standard hours however this work would be managed so that it complies with the out of hours' noise management level of 35 dB(A) unless the residence is subject to a private negotiated agreement. This process and measures for managing construction noise that exceeds the construction noise management levels are discussed further in Section 6.1.

There is the potential for noise when construction activities are undertaken within 153 metres of Yarrie Lake during calm meteorological conditions and 130 metres during adverse meteorological conditions. As there is a proposed 'no go zone' of 200 metres surrounding Yarrie Lake no exceedances to the construction noise management levels at Yarrie Lake would be anticipated from access rack construction.

Generally, linear construction activities of this type proceed in a sequential fashion from one section of access track to the next. Therefore, construction noise will be taking place at different locations at a given time, and exceedances to the construction noise management levels at any one point are short-term, typically lasting less than five days.

5.3.5 Production well operational noise

Operational noise sources

The majority of production well pads would consist of one generator supplying power for two electric motors to drive two well progressive cavity pumps. In the early stages of the project there is also the potential for three electric motors to drive three well progressive cavity pumps however the same generator would be used. The progressive cavity pumps would be submerged down the well and expected to produce no significant noise emissions at surface level.

The noise source data used for this assessment is provided in Table 5-28.

Table 5-28 Noise source sound power levels dB(A)

Equipment	Overall	Octave band frequency (Hz)								
		31.5	63	125	250	500	1000	2000	4000	8000
Gas generator power unit with acoustic enclosure	86	50	73	70	74	77	81	82	74	72
Acoustic enclosure based on 101 kW at 1500 rpm gas generator manufacturer data sheet which specifies a sound pressure level of 75 dB(A) at 1 metres.										
75 kW electric motor[1]	82	32	44	60	70	75	77	76	71	65

Note 1: Calculated based on a 75 kW 750 rpm 3-phase electric motor using VDI 3736, Emission benchmarks of technical sound sources, rotating electrical machines, asynchronous machines, April 1984. Spectrum calculated based on H. Schmidt, Technical sound pocket book, VDI publications Düsseldorf (1996)

Predicted operational noise levels

As the location of the production and pilot wells is yet to be determined, a buffer distance assessment has been undertaken. Buffer distances have been calculated for various noise levels and are provided in Table 5-29. Noise levels at various distances from the wells are provided in Table 5-29.

Table 5-29 Buffer distances for a production well (metres)

Noise level	Generator and two progressive cavity pump electric motors		Generator and three progressive cavity pump electric motors	
	Calm	Adverse	Calm	Adverse
25 dB(A)	338 m	523 m	363 m	568 m
30 dB(A)	213 m	322 m	229 m	348 m
35 dB(A)	134 m	185 m	144 m	203 m
40 dB(A)	83 m	96 m	89 m	105 m
45 dB(A)	48 m	55 m	52 m	60 m
50 dB(A)	27 m	32 m	30 m	34 m

Table 5-30 Predicted noise levels from a production well at various distances, dB(A)

Distance (m)	Generator and two progressive cavity pump electric motors		Generator and three progressive cavity pump electric motors	
	Calm	Adverse	Calm	Adverse
50 m	45	46	45	47
150 m	34	37	35	37
250 m	28	32	29	33
350 m	25	29	25	30
450 m	22	27	23	27
550 m	20	25	20	25
650 m	18	23	18	24
750 m	16	21	17	22

Assessment of production well operational noise

The buffer distances for each configuration to comply with the 35 dB(A) noise criteria under adverse meteorological conditions are 185 metres for one small generator and two progressive cavity pumps electric motors.

The production well operational noise sources are steady in nature and would not produce significant L_{Amax} noise emissions therefore the sleep disturbance criteria are not anticipated to be exceeded for operation of the production wells.

When considering cumulative effects from multiple wells logarithmic addition of the noise sources is required. The following formula can be used to assess the cumulative effect of multiple wells:

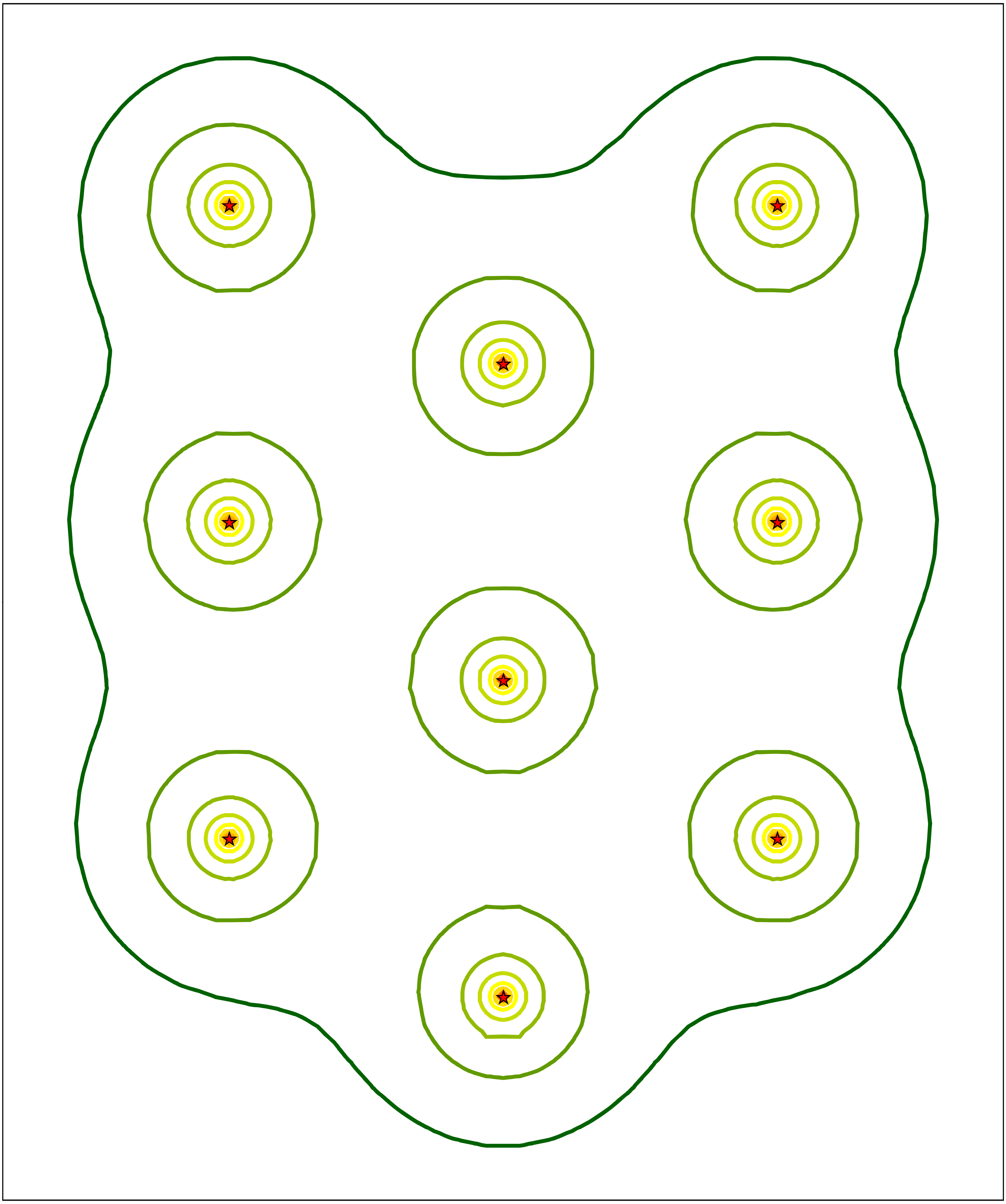
$$L_R = 10 \times \left[Log_{10}\left(10^{Lx/10} + 10^{Ly/10} + 10^{Lz/10} .... \right) \right]$$

Where:

- L_R = The noise level at the receiver
- Lx,y,z are the contribution noise levels corresponding to each noise source

For the production wells an assessment of multiple well pads (two progressive cavity pump configuration) has been undertaken by setting up a worst case triangular grid of well pads spaced at 750 metre intervals. This is conservative as the spacing of the well pads will be at a minimum of 750 metres. Figure 29 shows the multiple well pad worst case triangular grid layout and the noise contours for a generator and two progressive cavity pumps operating at each well pad under adverse meteorological conditions. It shows that even when production wells are spaced at the minimum distance of 750 meters apart the buffer distances increase by up to 35 meters which is not significant. The worst case buffer distance for multiple well pads (two progressive cavity pump configuration) with operating to comply with the 35 dB(A) criteria is as follows:

- 138 metres for calm meteorological conditions
- 218 metres for adverse meteorological conditions.



LEGEND

Well pad

Cumulative Noise Contours for Production Well, Noise level contours, db(A)

30, 35, 40, 45, 50, 55, 60, 65, 70, 75

0 0.1 0.2 0.4
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

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Multiple well pad conceptual scenario and noise contours (adverse), dB(A) showing noise levels if wells are placed at minimum separation distance of 750 meters

Figure 29

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Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:afoddy

This may increase by 20 metres when there are three progressive cavity pump electric motors per production well pad.

The worst case buffer distances surrounding residential receivers in the gas field for operation of multiple production wells is shown in Figure 30 to meet the 35 dB(A) noise criteria under calm and adverse meteorological conditions. The production well pads would be located at a distance from the residential receivers (or configured and designed) to comply with the 35 dB(A) criteria unless the residence is subject to a private negotiated agreement.

There is the potential for noise levels to exceed the 50 dB(A) passive recreation when production wells are within 32 metres of Yarrie Lake. However, as there is a proposed ‘no go zone’ of 200 metres surrounding Yarrie Lake at the noise criteria should not be exceeded at Yarrie Lake.

5.3.6 Pilot well operational noise

Operational noise sources

The pilot wells would be grouped in sets of up to six well pads and would be similar to the production wells, spaced approximately 250 to 700 metres apart. However, a pilot flare would be located on one of the well pads with a stack height of six metres which would operate with an average flow rate of between 3 and 5 million standard cubic feet of gas per day. One generator would be located at each pilot well and would produce similar noise emissions to the production wells.

The noise source data used for the pilot flare is provided in Table 5-31.

Table 5-31 Noise source Sound Power Levels dB(A)

Equipment	Overall	Octave band frequency (Hz)								
		31.5	63	125	250	500	1000	2000	4000	8000
Pilot flare[1]	124	99	104	110	113	115	117	119	118	115

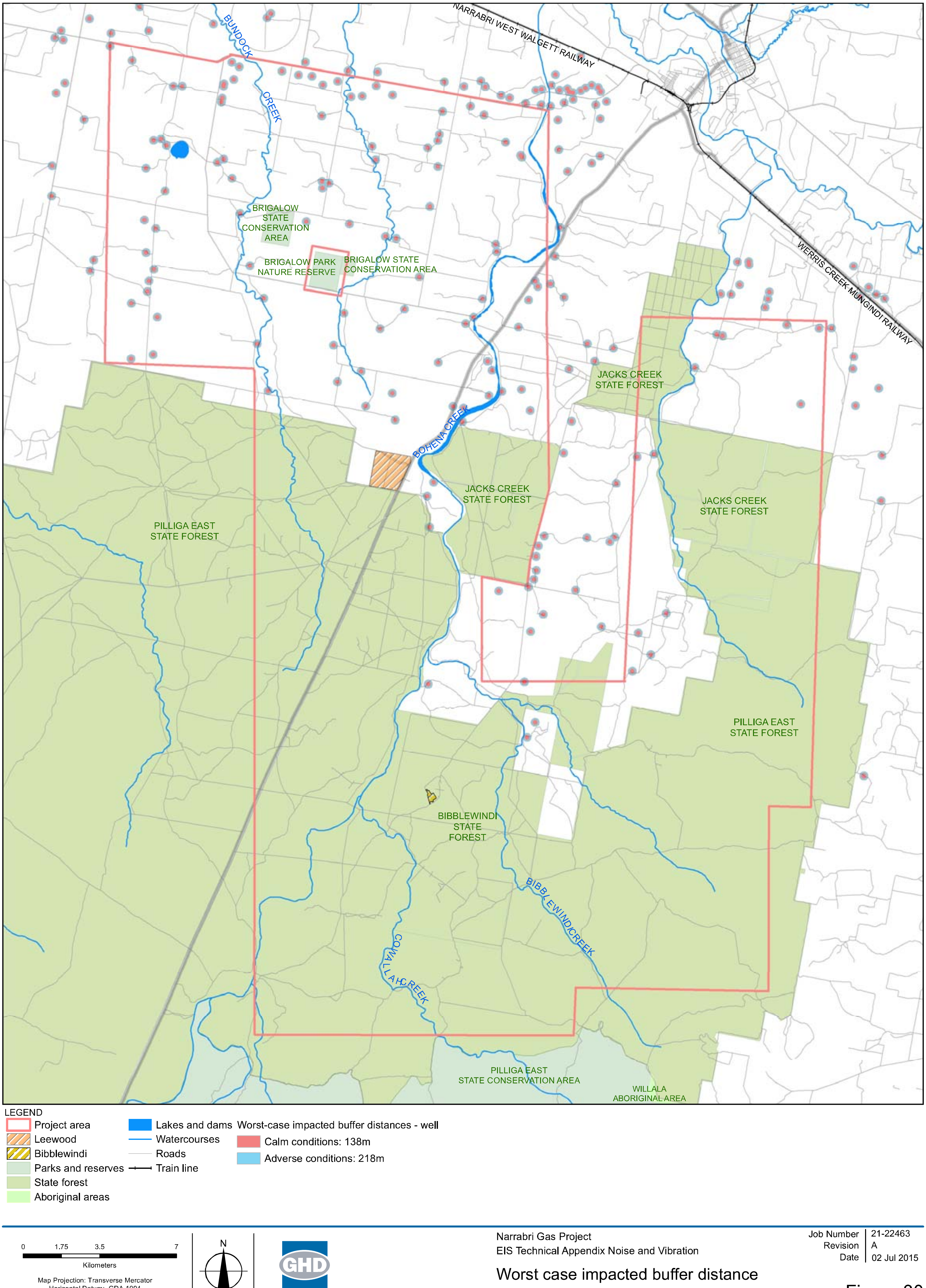
Note 1: Noise level and spectra calculated based on the equations provided in *VDI 3732 Characteristic noise emission values of technical noise sources – Flares* (1999) using a flow rate of 5 million standard cubic feet of gas per day.

Predicted operational noise levels

Buffer distances for the pilot well with a pilot flare have been calculated for various noise levels and are provided in Table 5-32. Buffer distances for the generator and the progressive cavity pump electric motors would remain the same as calculated for the production wells (refer to Table 5-29).

Under adverse meteorological conditions, if the pilot wells with flares are located within 3412 metres of a residential receiver then there is the potential for noise levels to exceed the 35 dB(A) criteria. If the pilot wells with flares are located within 1150 metres of Yarrie Lake, then there is the potential for noise levels to exceed the 50 dB(A) passive recreational area criteria.

Once the location of the pilot wells is known, the field development protocol process would be applied to determine the buffer distances to residential receivers (considering other project noise sources). The pilot wells would be located at a distance from the sensitive receivers (or configured and designed) to comply with the 35 dB(A) criteria unless the residence is subject to a private negotiated agreement.



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Revision A
Date 02 Jul 2015

Worst case impacted buffer distance for operation of multiple production wells

Figure 30

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Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

Table 5-32 Pilot wells with pilot flare predicted buffer distances for various noise levels, metres

Noise level	Distance of pilot well to comply with 35 dB(A) noise criteria	
	Calm	Adverse
25 dB(A)	4744 m	4999 m
30 dB(A)	3387 m	4714 m
35 dB(A)	2423 m	3412 m
40 dB(A)	1712 m	2434 m
45 dB(A)	1189 m	1694 m
50 dB(A)	813 m	1150 m

Table 5-33 Pilot wells with pilot flare predicted noise levels at various distances, dB(A)

Distance (m)	Predicted noise level at distance	
	Calm	Adverse
50 m	81	82
150 m	71	72
250 m	65	68
350 m	61	64
450 m	58	61
550 m	55	59
650 m	53	57
750 m	51	55
850 m	50	54
950 m	48	52
1050 m	47	51

5.4 Bibblewindi to Leewood infrastructure corridor

5.4.1 Overview

An existing water pipeline between Bibblewindi and Leewood has been constructed as part of a previous approval, and a gas pipeline between Bibblewindi and Wilga Park Power Station currently connect the facilities at Bibblewindi to the Leewood property. Additionally, there is an approved water flow line that has not yet been constructed, although it may be constructed in the future as required.

The following additional infrastructure would be located along the existing corridor under this project:

- a new intermediate gas pipeline to transfer gas from the in-field compression station at the Bibblewindi site to the Leewood site
- a new underground transmission line to reticulate power from the Leewood site to the Bibblewindi site
- communications cabling.

The construction and installation of this infrastructure would require an expansion of the existing corridor from approximately 12 metres to 30 metres. The location of the corridor is shown on Figure 4.

Construction of the infrastructure corridor is expected to generally occur seven days a week during daylight hours (nominally between 5 am and 7 pm however seasonally dependent). However, construction noise undertaken outside of the recommended standard construction hours of 7 am to 6 pm Monday to Friday and 8 am to 1 pm Saturday would be managed so that it complies with the out of hours' construction noise management level of 35 dB(A) unless the residence is subject to a private negotiated agreement.

The infrastructure corridor construction is expected to start mid 2017 with a duration of approximately 18 months.

5.4.2 Infrastructure corridor construction noise

Construction noise sources

Construction of the corridor would involve the following:

- locating/marking and protecting existing underground and overhead services along the corridor
- felling and removal of trees and vegetation with the material being mulched and stockpiled in the right of way
- top soil stripping and grading: tracked dozers, hydraulic excavators and motor graders would be used for the stripping and grading of the right of way
- temporary bridging
- right of way crossings
- pipe stringing: Pipes loaded into stringing trailers using tracked excavators and vacuum pad attachments
- pipe bending using dedicated machinery
- welding once pipe is strung and bent
- trench excavation

- pipe lowering and laying
- padding and backfilling using padder and excavators
- horizontal directional drilling will be undertaken where major crossings are required and is likely to be limited to the Newell Highway
- high voltage cable would be installed alongside the pipeline.

A detailed list of construction equipment for each construction stage would be determined by the construction contractor. A list of expected noise generating equipment and sound power levels is provided in Table 5-34.

The following construction scenarios have been assessed:

- all equipment shown in Table 5-34 operating across the length of the infrastructure corridor. Noise from listed equipment has been averaged over the infrastructure corridor route, as at a given time, only some of the listed plant would be operating simultaneously
- horizontal directional drilling operating at Newell Highway crossings.

Although the requirement for blasting during construction is expected to be minimal, if at all, a blasting assessment has been undertaken and is detailed in section 5.11.

Table 5-34 Infrastructure corridor construction: Significant noise sources, dB(A)

Equipment	Number	SWL L_{Aeq}, dB(A)
Dozer	5	115
Grader	12	110
Front end loader	3	113
Excavator	21[1]	107
Backhoe	2	104
Rocksaw	2	117
Pipelayer	19	109
Capping tractor	10	107
Tack rig	2	105
Hydraulic drill rig	2	113
Padding machine	1	110
Crane	4	104
Trailer	1	107
Pipeline Bender	1	94
Truck	35	107

Note 1: Excavator numbers include bucket excavators and excavators required for vacuum lifting pumps.
Note 2: Refer to Appendix D for octave spectra and references for the sound power levels

Predicted construction noise levels

Construction noise levels have been predicted for general construction activities and horizontal directional drilling operations and are shown in Table 5-35. The predictions have been undertaken for calm and adverse meteorological conditions at sensitive receivers within the vicinity of the infrastructure corridor.

Table 5-35 Bibblewindi to Leewood infrastructure corridor predicted construction noise levels

Sensitive receiver	Noise level, $L_{Aeq(15min)}$ dB(A)			
	Calm		Adverse[1]	
	Standard equipment	Horizontal directional drilling at Newell Highway	Standard equipment	Horizontal directional drilling at Newell Highway
182	26	13	31	17
189	30	16	35	20
191	32	17	**37**	22
192	32	18	**37**	23
203	25	15	30	19
211	25	16	29	20
212	34	21	**39**	25
213	25	16	29	20
214	25	16	30	20
216	32	17	**37**	22
217	33	17	**38**	21
Bold text indicates an exceedance to the 35 dB(A) noise management level outside of standard construction hours				

Note 1: Adverse meteorological conditions occur for more than 30 per cent of the time during the time periods and seasons identified in Table 3-3.

Assessment of Bibblewindi to Leewood infrastructure corridor construction noise

All receivers are predicted to receive noise less than the noise management levels during recommended standard hours and when work is undertaken outside of recommended standard hours during calm meteorological conditions.

Horizontal directional drilling rigs are predicted to comply with the noise management level during recommended standard hours and outside of recommended standard hours at the assessed Newell Highway crossing.

There are five receivers predicted to exceed the construction noise management levels when work is undertaken outside of recommended standard hours during adverse weather conditions.

The modelling assumption assumes that equipment is spread out over the corridor. However, if work was more intense in certain areas then there may be some minor exceedances to the construction noise management level that could be managed.

Work practices outlined in Section 6.1 would be considered where feasible and reasonable and residents surrounding the site potentially exceeding the construction noise management levels would be notified of the nature of the works, expected noise levels, duration of works and a method of contact to raise noise complaints. Some work would be undertaken outside of the recommended standard hours however this work would be managed so that it complies with the out of hours' noise management level of 35 dB(A) unless the residence is subject to a private negotiated agreement. This process and measures for managing construction noise that exceeds the construction noise management levels are discussed further in Section 6.1.

It is also noted that to date there have been no complaints received for construction activities undertaken along the Bibblewindi to Leewood infrastructure corridor for construction work undertaken as part of the existing approvals.

5.5 Wilga Park to Leewood transmission line

An existing gas pipeline between Wilga Park Power Station and the Leewood property has been constructed as part of a previous approval. A new underground transmission line to reticulate power from Wilga Park Power Station to the Leewood site will be constructed along the existing gas pipeline route.

The construction technique would involve plough in of the power lines to a depth of 900 mm and would be very similar to the construction of the gas and water gathering system construction. The construction equipment would be as detailed in Table 5-22.

Noise levels have been predicted at sensitive receivers within 5 km of the transmission line corridor and are shown in Table 5-37. The predictions have been undertaken for calm and adverse meteorological conditions.

Construction activities along the Wilga Park to Leewood transmission line construction corridor are predicted to exceed the construction noise management levels at up to 38 sensitive receivers during recommended standard hours and up to 57 sensitive receivers when work is undertaken outside of recommended standard hours during adverse meteorological conditions. The highly noise affected management level has the potential to be exceeded at one receiver (Receiver 75). Generally, linear construction activities of this type proceed in a sequential fashion from one section of trench to the next, at an average rate of 400 to 600 metres per day. Therefore, the highly noise affected level is likely to only be exceeded for a short period of time likely to be less than one day.

Work practices outlined in Section 6.1 would be considered where feasible and reasonable and residents potentially exceeding the construction noise management levels would be notified of the nature of the works, expected noise levels, duration of works and a method of contact to raise noise complaints. Some work would be undertaken outside of the recommended standard hours however this work would be managed so that it complies with the out of hours' noise management level of 35 dB(A) unless the residence is subject to a private negotiated agreement. This process and measures for managing construction noise that exceeds the construction noise management levels are discussed further in Section 6.1.

Table 5-36 Wilga Park to Leewood transmission line predicted construction noise levels

Sensitive receiver (refer to Figure 6 and Figure 7)	Noise level, $L_{Aeq(15min)}$ dB(A)					
	Calm			Adverse[1]		
	Logging and clearing	Easement preparation	Trenching	Logging and clearing	Easement preparation	Trenching
20	26	31	25	31	29	35
26	29	35	29	34	33	**39**
27	23	28	22	27	25	31
28	25	30	25	30	28	34
29	28	34	28	33	32	**38**
31	22	27	21	27	24	30
33	24	29	23	29	27	32

Sensitive receiver (refer to Figure 6 and Figure 7)	Noise level, $L_{Aeq(15min)}$ dB(A)					
	Calm			Adverse[1]		
	Logging and clearing	Easement preparation	Trenching	Logging and clearing	Easement preparation	Trenching
34	26	32	26	31	30	**36**
35	31	**37**	31	**36**	**36**	***41***
36	28	34	28	33	32	**38**
37	30	**36**	30	**35**	35	**40**
39	28	33	27	33	32	**37**
40	25	30	24	30	28	34
42	22	27	21	27	24	30
43	31	**37**	31	**36**	**36**	***41***
45	26	32	26	32	30	**36**
46	26	32	26	31	30	35
51	35	**40**	34	**39**	**39**	***45***
53	**36**	***41***	35	**40**	**40**	***45***
54	27	32	26	32	31	**36**
55	22	27	21	27	24	30
58	29	34	28	34	33	**38**
59	23	29	23	28	26	32
60	**36**	***42***	**36**	***41***	***41***	***46***
62	34	**39**	33	**39**	**38**	***44***
64	32	**38**	32	**37**	**37**	***42***
65	33	**39**	33	**38**	**38**	***43***
67	28	34	28	34	33	**38**
68	**38**	***44***	**38**	***43***	***43***	***48***
69	23	29	23	28	26	32
70	32	**38**	32	**37**	**37**	***42***
73	31	**37**	31	**36**	**36**	***41***
74	32	**38**	32	**37**	**37**	***42***
75	***79***	***81***	***78***	***79***	***84***	***84***
78	33	**38**	33	**38**	**38**	***43***
79	22	28	22	27	25	31
80	31	**37**	31	**36**	**36**	***41***
82	24	29	23	29	27	33
83	***47***	***52***	***46***	***51***	***52***	***56***
84	***46***	***51***	***45***	***50***	***50***	***55***
85	25	30	25	30	28	34
86	24	30	24	29	27	33
88	**37**	***43***	**37**	***42***	***42***	***47***

Sensitive receiver (refer to Figure 6 and Figure 7)	Noise level, $L_{Aeq(15min)}$ dB(A)					
	Calm			Adverse[1]		
	Logging and clearing	Easement preparation	Trenching	Logging and clearing	Easement preparation	Trenching
90	29	35	29	34	33	**39**
99	***46***	***51***	***45***	***50***	***51***	***56***
102	24	29	23	29	26	32
103	25	30	25	30	28	34
106	34	**39**	33	**39**	**38**	***44***
107	**37**	***43***	**37**	***42***	***42***	***47***
108	32	**38**	32	**37**	**37**	***42***
109	31	**36**	30	**36**	35	**40**
110	21	27	21	26	24	29
120	***58***	***63***	***57***	***61***	***63***	***67***
123	22	27	21	27	24	30
135	31	**37**	31	**36**	**36**	***41***
136	22	27	22	27	24	30
140	***50***	***55***	***49***	***53***	***55***	***59***
142	28	33	27	33	32	**37**
143	32	**38**	32	**37**	**37**	***42***
147	34	**40**	34	**39**	**39**	***44***
149	23	28	22	28	25	31
152	**39**	***44***	**38**	***43***	***44***	***49***
156	27	32	27	32	31	**36**
160	27	32	26	32	31	**36**
163	***41***	***46***	**40**	***46***	***46***	***51***
166	26	31	25	31	29	35
167	35	***41***	35	**40**	**40**	***45***
169	29	35	29	34	33	**39**
171	23	29	23	28	26	32
172	***54***	***59***	***53***	***57***	***59***	***63***
173	25	31	25	30	29	34
177	33	**39**	33	**38**	**38**	***43***
178	30	**36**	30	35	35	**40**
179	**39**	***44***	**38**	***44***	***44***	***49***
182	***70***	***72***	***69***	***70***	***74***	***75***
183	30	35	29	35	34	**40**
189	34	**40**	34	**39**	**39**	***44***
191	35	**40**	34	**40**	**40**	***45***
192	29	35	29	34	33	**39**

Sensitive receiver (refer to Figure 6 and Figure 7)	Noise level, $L_{Aeq(15min)}$ dB(A)					
	Calm			Adverse[1]		
	Logging and clearing	Easement preparation	Trenching	Logging and clearing	Easement preparation	Trenching
216	**40**	***46***	**40**	***45***	***45***	***50***
217	***43***	***48***	***43***	***47***	***48***	***53***
Italic text indicates an exceedance to the 40 dB(A) noise management level during standard construction hours						
Bold text indicates an exceedance to the 35 dB(A) noise management level outside of standard construction hours						

Note 1: Adverse meteorological conditions occur for more than 30 per cent of the time during the time periods and seasons identified in Table 3-3.

5.6 Westport worker's accommodation

5.6.1 Overview

Temporary accommodation is currently available for up to 64 workers at the Westport drillers' camp. As part of the project, the capacity at Westport would be tripled to provide accommodation for up to 200 people. The location of the workers accommodation is shown in Figure 4.

Construction of the workers' accommodation is expected to generally occur seven days a week during daylight hours (nominally between 5 am and 7 pm however seasonally dependent). However, construction undertaken outside of the recommended standard construction hours of 7 am to 6 pm Monday to Friday and 8 am to 1 pm Saturday would be managed so that it meets the out of hours' construction noise management level of 35 dB(A) unless the residence is subject to a private negotiated agreement.

5.6.2 Westport workers' accommodation construction noise

Expansion of the Westport workers' accommodation would involve the following construction sub-stages:

- clearing and grading of additional land
- installation of buildings: It is anticipated that the buildings would be pre-fabricated and transported to the site.

An assessment of construction noise during calm and adverse meteorological conditions has been undertaken. Typical construction noise generating equipment is summarised in Table 5-37.

Table 5-37 Workers accommodations construction activities

Stage and description	Equipment	SWL L_{Aeq}, dB(A)
Clear and grade	Dozer	115
	Scraper	113
	Excavator	107
	Truck	107
	Compactor	113
Installation of buildings	Crane	104
	Hand tools	102
	Truck	107

Predicted construction noise levels

L_{Aeq} construction noise levels have been predicted for calm and adverse meteorological conditions and are presented in Table 5-38. Partial L_{Aeq} noise levels from each construction noise source at each modelled sensitive receiver are provided in Appendix D.

Table 5-38 Westport workers accommodation predicted construction noise levels

Sensitive receiver	Noise level, $L_{Aeq(15min)}$ dB(A)			
	Calm[1]		Adverse	
	Clearing and grading	Installation of buildings	Clearing and grading	Installation of buildings
199	12	7	16	11
200	12	7	17	11
201	13	8	17	12
202	12	8	17	12
203	13	8	18	12
205	15	9	19	13
206	14	9	19	13
207	13	8	17	12
208	17	11	22	15
209	13	8	18	12
210	15	10	20	14
211	22	14	28	19
212	19	12	24	16
213	29	20	34	25
214	33	24	**38**	28
Bold text indicates an exceedance to the 35 dB(A) noise management level outside of standard construction hours				

Note 1: The time periods and seasons for which calm meteorological conditions are applicable are detailed in Table 3-3.

Assessment of Westport workers' accommodation construction noise

All receivers are predicted to comply with the noise management levels during recommended standard hours and when work is undertaken outside of recommended standard hours during calm meteorological conditions.

There is one receiver (receiver 214) predicted to receive noise levels greater than the construction management levels when work is undertaken outside of recommended standard hours during adverse weather conditions. Noise generated from construction Westport workers' accommodation should not adversely affect surrounding sensitive receivers during recommended standard hours.

5.7 Irrigation lands and other discharges

Discharge pipeline construction will be undertaken from the Leewood water treatment plant to Bohena Creek. Construction equipment associated with pipeline construction is expected to remain the same as discussed in Section 6.1. L_{Aeq} construction noise levels have been predicted for calm and adverse meteorological conditions and are presented in Table 5-39.

Construction of the irrigation and discharge infrastructure is expected to generally occur seven days a week during daylight hours (nominally between 5 am and 7 pm however seasonally dependent). However, construction noise undertaken outside of the recommended standard construction hours of 7 am to 6 pm Monday to Friday and 8 am to 1 pm Saturday would be managed so that it complies with the out of hours' construction noise management level of 35 dB(A), unless the residence is subject to a private negotiated agreement.

Table 5-39 Bohena Creek discharge pipeline construction: Predicted noise levels, $L_{Aeq(15min)}$ dB(A)

Sensitive receiver	Noise level, dB(A)	
	Calm	Adverse[1]
160	28	33
163	31	**36**
166	29	33
167	31	**36**
169	31	**36**
170	27	32
171	29	34
172	**37**	***42***
173	30	35
177	**36**	***41***
178	34	**39**
179	**37**	***43***
180	28	32
182	***43***	***48***
183	35	**41**
189	***43***	***48***
191	**40**	***45***
192	35	**40**
216	**40**	***45***
217	***45***	***49***
Italic text indicates an exceedance to the 40 dB(A) noise management level during standard construction hours		
Bold text indicates an exceedance to the 35 dB(A) noise management level outside of standard construction hours		

Note 1: Adverse meteorological conditions occur for more than 30 per cent of the time during the time periods and seasons identified in Table 3-3.

Noise levels are predicted to exceed the noise management levels during standard construction hours (40 dB(A)) at sensitive receivers 182,189 and 217 by up to 5 dB(A).

Noise levels are predicted to exceed the noise management levels outside of standard construction hours at eight sensitive receivers during calm meteorological conditions and at 14 sensitive receivers during adverse meteorological conditions outside of standard construction hours.

Work practices outlined in Section 6.1 would be considered where feasible and reasonable and residents surrounding the site potentially exceeding the construction noise management levels would be notified of the nature of the works, expected noise levels, duration of works and a method of contact to raise noise complaints. Some work would be undertaken outside of the recommended standard hours however this work would be managed so that it complies with the out of hours' noise management level of 35 dB(A) unless the residence is subject to a private negotiated agreement. This process and measures for managing construction noise that exceeds the construction noise management levels are discussed further in Section 6.1.

5.8 Road and intersection upgrades

Road and intersection upgrades are proposed at the following locations:

- Newell Highway and Access Road to Leewood intersection
- Newell Highway and X-Line Road intersection
- Re-surfacing and upgrading X-line Road between Newell Highway and Bibblewindi.

The road and intersection upgrade locations are shown in Figure 31.

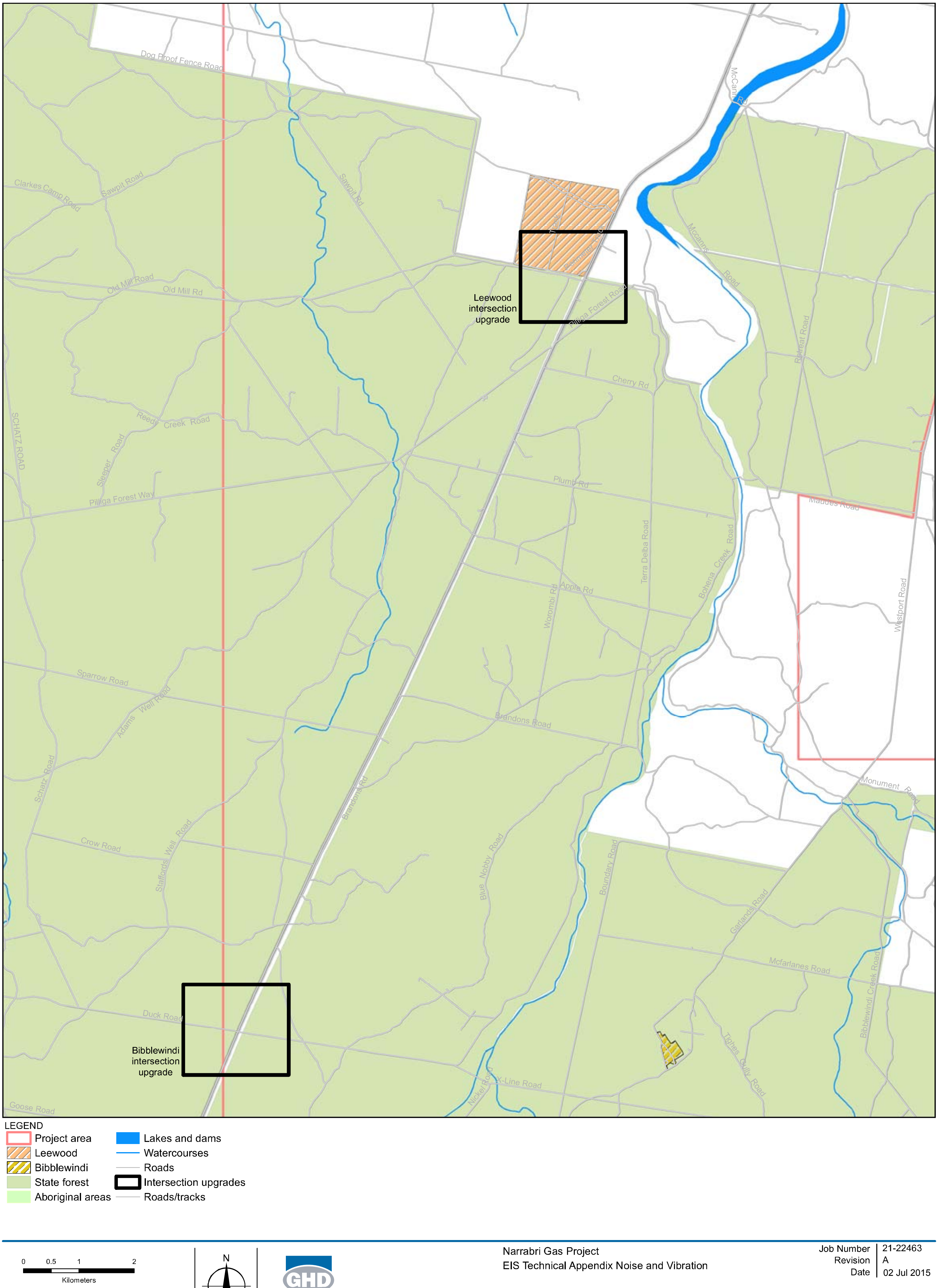
Construction noise levels have been predicted at surrounding sensitive receivers from road and intersection upgrades. Construction noise sources expected to be used for the upgrades are summarised in Table 5-39. Detailed construction methodologies and equipment lists would be established by the construction contractor.

Road and intersection upgrade construction is expected to generally occur seven days a week during daylight hours (nominally between 5 am and 7 pm however seasonally dependent). However, construction noise undertaken outside of the recommended standard construction hours of 7 am to 6 pm Monday to Friday and 8 am to 1 pm Saturday would be managed so that it complies with the out of hours' construction noise management level of 35 dB(A) unless the residence is subject to a private negotiated agreement.

Table 5-40 Road and intersection upgrade construction activities

Construction stage	Equipment	SWL L_{Aeq}, dB(A)
Milling	Milling machine	111
	Haul truck	107
	Bobcat	104
Paving	Asphalt paver	108
	Shuttle buggy	110
	Haul truck	107
Rolling	Vibratory roller	108
Rehabilitation	Bobcat (Broom)	98
	Line marking truck	107

Noise levels have been predicted from the noisiest construction stage (paving) during calm and adverse meteorological conditions and are provided in Table 5-40 and Table 5-41 from the intersection upgrade and the road resurfacing.



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Road and intersection upgrade location

Figure 31

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

Table 5-41 X-Line road intersection upgrade and re-surfacing

Receiver ID	Noise levels, $L_{Aeq(15min)}$ dB(A)			
	Calm		Adverse[1]	
	Intersection upgrade	Re-surfacing	Intersection upgrade	Re-surfacing
199	0	8	0	12
200	0	8	0	12
201	0	8	0	12
202	0	8	0	12
203	0	10	0	14
205	0	10	0	14
206	0	8	0	12
207	0	7	0	11
208	0	11	0	16
209	0	7	0	11
210	0	8	0	12
211	0	14	0	19
212	0	18	0	23
213	0	16	0	21
214	0	18	0	23

Note 1: Adverse meteorological conditions occur for more than 30 per cent of the time during the time periods and seasons identified in Table 3-3.

Table 5-42 Newell Highway and Leewood access road intersection upgrade

Receiver ID	Noise level, dB(A)	
	Calm	Adverse
160	11	15
163	12	17
166	11	15
167	13	18
169	13	18
170	10	15
171	12	16
172	16	21
173	13	17
177	16	20
178	14	19
179	17	22
180	11	15
182	20	25
183	16	21
189	26	31
191	28	32
192	24	29
216	24	29
217	31	35

Note 1: Adverse meteorological conditions occur for more than 30 per cent of the time during the time periods and seasons identified in Table 3-3.

Construction noise levels are predicted to comply with the construction noise management levels at all sensitive receivers during road resurfacing and intersection upgrade noise generating activities.

5.9 Road traffic noise

An assessment of road traffic noise generated during construction and operation of the proposal has been undertaken. The road traffic noise assessment has been undertaken for the following roads which are on the traffic generation route for the project:

- Newell Highway
- Kamilaroi Highway
- Tibbereena Street
- Old Gunnedah Road
- X-Line Road
- Yarrie Lake Road
- Mooloobar Street.

Roads within the State Forests and access tracks. Relevant traffic data has been obtained from the *Narrabri Gas Project Traffic Impact Assessment Report* (GHD, 2014).

5.9.1 Existing traffic volumes

Existing traffic data has been obtained from the *Narrabri Gas Project Traffic Impact Assessment Report* (GHD, 2014). Daily traffic volumes along arterial roads as well as peak traffic volumes along local roads have been provided in Table 5-43.

Additionally, the following assumptions regarding traffic volumes have been made:

- Day/Night traffic volume splits and heavy vehicle percentages along Newell Highway, North of Francis Street and Newell Highway, North of Killarney Street are the same as measured along Newell Highway, south of Narrabri.
- Day/Night traffic volume splits along Kamilaroi Highway, east of Narrabri are the same as measured along Newell Highway, south of Narrabri.
- Day/Night traffic volume percentage splits along X-Line Road and roads within the State Forests are 90/10 and the heavy vehicle percentages are the same as measured along Newell Highway, south of Narrabri.

Table 5-43 Existing traffic volumes along arterial and local roads

Road	Location	Road surface	Posted speed	Traffic volumes (AADT)			
				Existing traffic			
				Day	Night	Peak hour	Heavy vehicles (per cent)
Newell Highway	North of Francis St	Spray seal	50 km/h	2507	600	-	40
	North of Killarney St	Spray seal	50 km/h	8295	1984	-	40
	South of Mooloobar St	Spray seal	80 km/h, 110 km/h	6069	1451	-	40
	20 km south of Narrabri	Spray seal	110 km/h	1258	301	-	40
Kamilaroi Highway	East of Narrabri	Spray seal	80 km/h	1501	359	-	40
Tibbereena Street	Narrabri town centre	Spray seal	50 km/h	4488	241	411	7.5
Old Gunnedah Road	South of Regent St	Spray seal	50 km/h, 80 km/h	2588	231	282	27
Mooloobar Street	West of Newell Hwy	Spray seal	50 km/h	1069	114	169	24.3
Yarrie Lake Road	East of Bohena Creek	Spray seal	80 km/h	447	48	50	19.4
X-Line Road	State forest Road	Unsealed	60 km/h	270	30	30	40
Other state forest roads	Internal road	Unsealed	60 km/h	61	7	-	40

5.9.2 Traffic generation

The road traffic noise assessment considers the following scenarios:

- Scenario 1 – absolute peak traffic generation during construction which could occur occasionally. This would include:
  - mobilisation of Leewood and Bibblewindi construction sites
  - mobilisation of two rigs
  - work at six other well locations
  - shift changeover for staff
  - 75 operations staff
- Scenario 2 – typical peak daily traffic generation during construction which would typically occur three days every month. This would include:
  - delivery of oversize loads at Leewood/Bibblewindi
  - delivery of general materials at Leewood/Bibblewindi
  - mobilisation of two rigs
  - work at six other well locations
  - shift changeover for staff
  - 75 operations staff at NOC, Leewood and Bibblewindi
- Scenario 3 – typical daily movements during operation. This would include:
  - materials deliveries and general deliveries to Leewood and Bibblewindi
  - materials deliveries and general deliveries to the well locations
  - work at six other well locations
  - shift changeover for staff
  - 150 operations staff

5.9.3 Traffic noise prediction methodology

The road traffic noise assessment considers existing and proposed traffic generation, percentage heavy vehicles, time periods and road surface types in the calculations. Traffic noise modelling was conducted using the *Calculation of Road Traffic Noise* (Department of Transport Welsh Office, 1988) algorithm for the Newell Highway, Old Gunnedah Road, Tibbereena Street, Goobar Street and Mooloobar Street.

For local roads where existing traffic volumes are below 50 vehicles per hour the *Calculation of Road Traffic Noise* (Department of Transport Welsh Office, 1988) algorithm is not valid. The following roads have been identified with existing traffic volumes below 50 vehicles per hour:

- X-Line Road (existing case only)
- Roads within the State Forests

Hence, the following modelling methods have been used:

- Traffic volumes along X-Line Road have been modelled using a peak of 50 vehicles per hour. The conservative assumption complies with the CoRTN algorithm, and does not impact noise levels at other sensitive receivers as the nearest sensitive receivers are over three kilometres away from X-Line Road.
- Roads within the State Forests have been assessed using a moving point source method with attenuation and propagation calculated with the ISO 9613 -2, *'Acoustics attenuation of sound during propagation outdoors'* algorithm. This method considers the number of pass-by movements, the speed and the L_{Aeq} noise source level.

The noise model inputs and assumptions are summarised in Table 5-44.

Table 5-44 Road traffic noise model inputs and assumptions

Inputs / assumption	Data incorporated into noise model
Traffic speeds	Refer to Table 5-43.
Road surface	Refer to Table 5-43. +2 dB(A) correction applied for sealed roads.
Façade correction	+2.5 dB(A) to account for sound reflected from the façade.
Source heights	Cars - 0.5 metres. Truck engines - 1.5 metres. Truck exhausts - 3.6 metres.
Low traffic volumes	CoRTN low traffic speed correction disabled for L_{Aeq} prediction
Receiver heights	1.5 metres
Ground topography,	5 metres contours
CoRTN conversion factors	CoRTN predicts $L_{A10(1hr)}$ noise levels which are converted to the $L_{Aeq(1hr)}$ descriptor with a -3 dB(A) correction factor. The moving point source method is based on L_{Aeq} values therefore no corrections have been applied.
Moving point source method noise source	A heavy vehicle source noise level of 110 dB(A) and a light vehicle source noise level of 99 dB(A) has been calculated from vehicle passby measurements undertaken 21 metres from the Newell Highway. The noise levels were undertaken for a vehicle speed of 110 km/h and hence, have been adjusted by 10 dB(A) for a vehicle speed of 60 km/h based on the data provided in *Transportation Noise Reference Book* (Nelson 1987).

5.9.4 Noise modelling verification

The CoRTN algorithm and noise modelling process was verified against the road traffic noise monitoring data and simultaneous traffic counts undertaken for the proposal.

The model is deemed to be verified if the average difference between the measured and calculated values of the descriptors is within +/-2 dB(A).

A comparison of the modelling and monitoring results for daytime $L_{Aeq(15hr)}$ and night time $L_{Aeq(9hr)}$ noise levels is shown in Table 5-45. The predicted results and measured results have an average acceptable variance of within 2 dB(A). Therefore, the results are considered to provide a reasonable level of confidence in the accuracy of the noise model used for predicting traffic noise levels for the proposal.

Table 5-45 Noise model verification, dB(A)

Location	Day $L_{Aeq(15hr)}$			Night $L_{Aeq(9hr)}$		
	Measured	Modelled	Variation	Measured	Modelled	Variation
Leewood (Next to Newell Hwy)	65.4	64.8	-0.6	61.7	61.5	-0.2
Note 1: Facade effects not included in predictions or measurements. A +2 dB(A) spray seal correction has been applied to the predicted values.						

5.9.5 Construction traffic generation

The traffic generation from the construction of the project is shown in Table 5-46 for arterial and internal roads and in

Table 5-47 for local roads.

Table 5-46 Additional daily traffic volumes generated along arterial roads, and State forest roads and access tracks during construction

Road	Additional daily construction traffic (2-way)		
	Scenario 1	Scenario 2	Scenario 3
Newell Highway, North of Francis Street	24	0	0
Newell Highway, North of Francis Street	24	0	0
Newell Highway, South of Mooloobar Street	424	310	117
Newell Highway, 20 km south of Narrabri	424	310	117
Kamilaroi Highway, East of Newell Highway	84	84	84
State forest roads / access tracks	126	126	126

Table 5-47 Additional peak hour traffic volumes generated along local roads and X-line road during construction

Road	Additional peak construction traffic (2-way)		
	Scenario 1	Scenario 2	Scenario 3
Tibbereena Street (east of Newell Highway)	108	109	0
Old Gunnedah Road (South of Regent Street)	108	109	0
Mooloobar Street (west of Newell Highway)	81	71	83
Yarrie Lake Road (east of Bohena Creek)	81	71	83
X-Line Road	103	103	60

5.9.6 Construction traffic noise assessment

All roads except roads within the State Forests

Road traffic noise levels at the receivers most affected from construction traffic noise generation are provided in Appendix E.

The predicted noise levels show that construction road traffic during the absolute peak traffic generation period is not predicted to increase existing road traffic noise levels by more than 2 dB(A) at sensitive receiver for noise from both arterial and local roads. Where road traffic noise levels are predicted to exceed the noise criteria, this is due to existing traffic noise and noise levels are not predicted to significantly increase as a result of the proposal.

Roads within the State Forests and access tracks

Existing and predicted noise levels at various distances for roads within the state forest and access tracks (based on the moving point source method) are provided in Table 5-48. Noise levels are predicted to increase by more than 2 dB(A) however noise levels are predicted to comply with the local road noise criteria within 10 metres of the road. Sensitive receivers in the vicinity of state forest roads and access tracks would be located greater than 10 metres from the road corridor and therefore are not predicted to exceed the road traffic noise criteria during the 'worst case' absolute peak traffic generation period.

Table 5-48 Predicted road traffic noise levels from construction traffic on state forest roads and access tracks, $L_{Aeq(period)}$, dB(A)

Distance from road (m)	Existing road traffic noise		Predicted road traffic noise		Increase in road traffic noise	
	Day	Night	Day	Night	Day	Night
5 m	56	46.6	60.5	51	4.5	4.4
10 m	52.1	42.7	56.6	47.1	4.5	4.4
15 m	49.8	40.4	54.4	44.9	4.6	4.5
20 m	48.1	38.7	52.7	43.2	4.6	4.5
25 m	46.7	37.3	51.3	41.8	4.6	4.5
30 m	45.6	36.2	50.1	40.6	4.5	4.4
35 m	44.6	35.2	49.1	39.6	4.5	4.4
40 m	43.7	34.3	48.3	38.8	4.6	4.5
45 m	42.9	33.5	47.5	37.9	4.6	4.4
50 m	42.2	32.8	46.7	37.2	4.5	4.4
55 m	41.5	32.1	46.1	36.6	4.6	4.5

5.9.7 Operational traffic generation

The traffic generation from the construction of the project is shown in Table 5-46.

Table 5-49 Additional daily traffic volumes generated during operations

Road	Additional daily operational traffic		
	Scenario 1	Scenario 2	Scenario 3
Newell Highway	20	20	56
Yarrie Lake Road	20	20	56
X-Line Road	-	-	23

5.9.8 Operational traffic noise assessment

When compared to existing daily traffic volumes along the Newell Highway and Yarrie Lake Road, the increase in traffic noise from operations is considered insignificant. The noise levels are predicted to increase by less than 0.1 dB(A).

The nearest sensitive receivers are over three kilometres away from X-Line Road. Hence, no operational road traffic noise impacts are predicted along X-Line Road.

Road traffic noise levels are not predicted to increase by more than 2 dB(A) as a result of the proposed operation and should not significantly impact sensitive receivers on the assessed traffic routes.

5.10 Vibration

Assessment of vibration has been conducted to determine potential impacts with consideration to structural damage and human comfort criteria. Ground vibration caused by blasting is assessed in section 5.11.

5.10.1 Vibration source levels

Typical vibration levels for vibration generating equipment associated with the project are detailed in Table 5-50.

Table 5-50 Vibration generating equipment

Equipment	Peak particle velocity source level (mm/s)	Data reference
Vibroseis unit (Seismic truck)	28.3 at 10 m	See note 1
Loader	6 to 8 at 10 m	*Environmental Noise Management Manual* (RTA 2001)
Roller	5 to 8 at 10 m	
Compactor	5 to 7 at 10 m	
Dozer	2.5 to 4 at 10 m	
Pavement breaker	4.5 to 6 at 10 m	
Backhoe	1 at 10 m	
Jack hammer	0.5 at 10 m	
Excavator	2.5 at 8 m	Tynan, A.E. *Ground Vibration Damaging effects to Buildings*, Australian Road Research Board 1973
Grader	2.5 at 8 m	
Scraper	2.5 at 8 m	

Note 1: Calculated from data provided in Vibroseis Sweeps, TX, Revey Associates (2011)

Energy from equipment is transmitted into the ground and transformed into vibration, which attenuates with distance. The magnitude and attenuation of ground vibration is dependent on the following:

- the efficiency of the energy transfer mechanism of the equipment (i.e. impulsive; reciprocating, rolling or rotating equipment)
- the frequency content
- the impact medium stiffness
- the type of wave (surface or body)
- the ground type and topography.

Due to the above factors, there is inherent variability in ground vibration predictions without site-specific measurement data. Typical rate of vibration attenuation can be calculated from the following regression analysis formula:

$V = kD^{-n}$, *where*

- *V = Peak Particle Velocity*
- *D = Distance*
- *k = site constant (if k is unknown, the site constant can be calculated from the other known parameters)*
- *n = site attenuation exponent.*

The value of the site attenuation exponent, n, depends on the soil and ground type, *Construction noise and vibration impact on sensitive premises, Proceedings of Acoustics* (Roberts, 2009) suggests the following values for *n*:

- 1.4 for weak or soft soils such as loose soils, mud, loose beach sand, dune sand and ploughed ground
- 1.3 for competent soils such as most sands, sandy clays, gravel, silts and weathered rock
- 1.1 for hard soils such as dense compacted sand, dry consolidated clay and some exposed rocks
- 1.0 for hard competent rock such as bedrock and freshly exposed hard rock.

Lower values of *n* imply a more efficient vibration transmission rate. Hence, a conservative site attenuation exponent value of 1 has been assumed for this assessment.

5.10.2 Assessment of vibration

Vibration levels at various distances from plant and equipment are provided in Table 5-51. Buffer distances to comply with the recommended vibration screening criteria (refer to Table 3-11) are presented in Table 5-52.

Table 5-51 Typical vibration levels at distances

Equipment	Peak particle velocity (mm/s) at distance						
	10 m	20 m	30 m	40 m	50 m	100 m	200 m
Vibroseis unit	28.3	14.2	9.4	7.1	5.7	2.8	1.4
Loader	8.0	4.0	2.7	2.0	1.6	0.8	0.4
Roller	8.0	4.0	2.7	2.0	1.6	0.8	0.4
Compactor	7.0	3.5	2.3	1.8	1.4	0.7	0.4
Dozer	4.0	2.0	1.3	1.0	0.8	0.4	0.2
Pavement breaker	6.0	3.0	2.0	1.5	1.2	0.6	0.3
Backhoe	1.0	0.5	0.3	0.3	0.2	0.1	0.1
Jack hammer	0.5	0.3	0.2	0.1	0.1	0.1	0.0
Excavator	2.0	1.0	0.7	0.5	0.4	0.2	0.1
Grader	2.0	1.0	0.7	0.5	0.4	0.2	0.1
Scraper	2.0	1.0	0.7	0.5	0.4	0.2	0.1

Table 5-52 Vibration buffer distances to comply with recommended peak particle velocity screening criteria

Equipment	Human comfort buffer distance (m)		Structural damage buffer distance (m) Criteria 5 mm/s
	Day Criteria 1 mm/s	Night Criteria 0.3 mm/s	
Vibroseis unit	285	945	60
Loader	80	270	20
Roller	80	270	20
Compactor	70	235	15
Dozer	40	135	10
Pavement breaker	60	200	15
Backhoe	10	35	2
Jack hammer	5	20	1
Excavator	20	70	5
Grader	20	70	5
Scraper	20	70	5

Where buildings are located within the structural damage vibration buffer distances, a property condition report would be prepared for the premises before and after undertaking the work. Compliance vibration monitoring would also be undertaken during high vibration generating activities where buildings are located within the structural damage buffer distances to confirm vibration criteria are not exceeded.

Alternative work methods would be investigated where vibration generating activities are required to occur within the human comfort buffer distances. If no alternative work methods are available the sensitive receivers potentially exceeding the vibration criteria would be informed of the nature of the works, expected vibration levels, duration of works, advice regarding the potential for structural damage and a method of contact to raise vibration complaints.

5.11 Blasting

Although it is not expected that blasting will be required during construction activities, in the event that blasting is required, the potential for impacts would be assessed in accordance with the relevant guidelines and any required mitigation and monitoring measures implemented. A general assessment of blasting has been undertaken to determine typical buffer distances to comply with the blasting criteria. Estimations for typical ground vibration and air blast overpressure during blasting have been made with consideration to Australian Standard AS2187.2 (2006) *Explosives – Storage and use – Use of Explosives*.

Predictions made in this blasting assessment have been based on generic blast parameters and should be refined based on site specific data, once available. It is recommended that should blasting be required, this assessment be refined once the nature of the blasts and site parameters are better known. Site parameters can be determined through vibration monitoring during initial blasts or test blasts.

Blasting is non-linear in nature and variability in ground type and meteorological conditions makes it difficult to accurately predict ground vibration and airblast overpressure without site specific measurement data therefore these blasting predictions should only be used as a guide.

5.11.1 Estimation of air blast overpressure during blasting

Air blast overpressure can be estimated using the following equation:

$$P = K_a \left(\frac{R}{Q^{1/3}} \right)^a$$

Where:

- P is the pressure (kPa)
- R is the distance from charge (metres)
- Q is the charge mass (kg)
- Ka is the site constant. AS2187.2 recommends for confined blast hole charges values are commonly in the range of 10 to 100. A value of 50 has been adopted for this assessment
- a site exponent. AS2187.2 recommends for confined blast hole charges a good estimate of a = -1.45.

Air blast overpressure propagation can be increased with unfavourable meteorological conditions and decreased with topographic shielding. Unconfined surface charges would considerably increase the air blast overpressure propagation.

5.11.2 Estimation of ground vibration during blasting

Ground vibration has been estimated using the following equation:

$$V = K_G \left(\frac{R}{Q^{1/2}} \right)^{-1.6}$$

Where:

- V is the peak vector sum ground vibration peak particle velocity (mm/s)
- R is the distance from charge (metres)
- Q is the maximum instantaneous charge (kg)
- K_G is the ground constant AS2187.2 gives a site constant for a free face in average field conditions of 1140 which has been used for the predictions. This value can vary from 1/5 times – 4 times depending on ground conditions and other factors.

5.11.3 Predicted blasting buffer distances

Air blast overpressure and ground vibration has been predicted for a range of charge masses and are shown in Figure 32 and Figure 33 for varying distances and assuming average blasting parameters. The distance to comply with the *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZEC, 1990) are also shown.

The design of the blast would be up to the blast contractor and the blasting information has been assumed for this assessment, in the absence of specific information regarding blasting requirements.

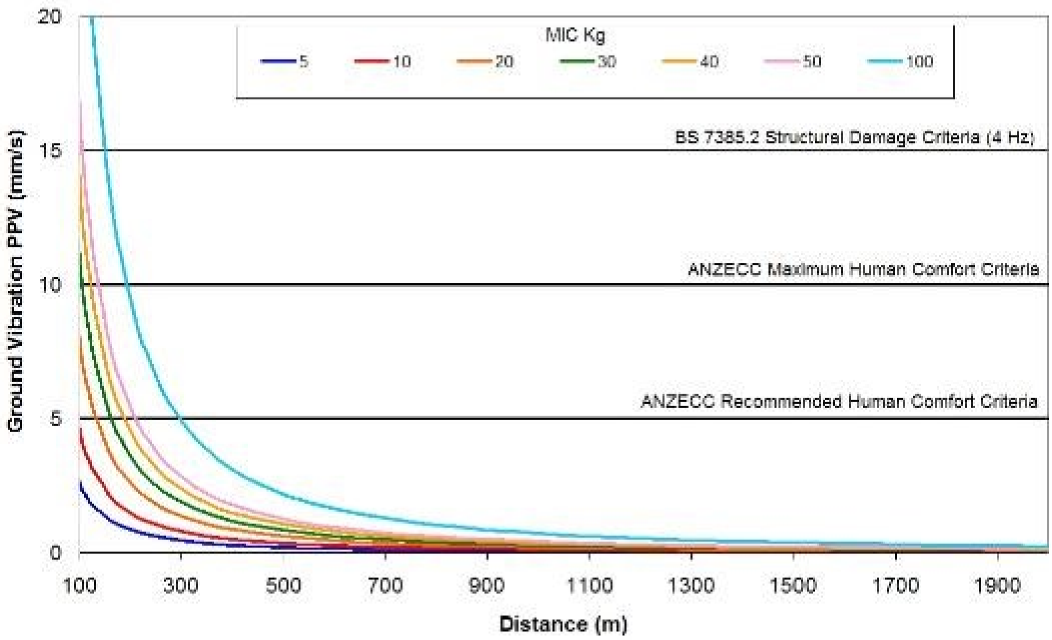

Figure 32 Ground vibration predictions for different charge masses and distances

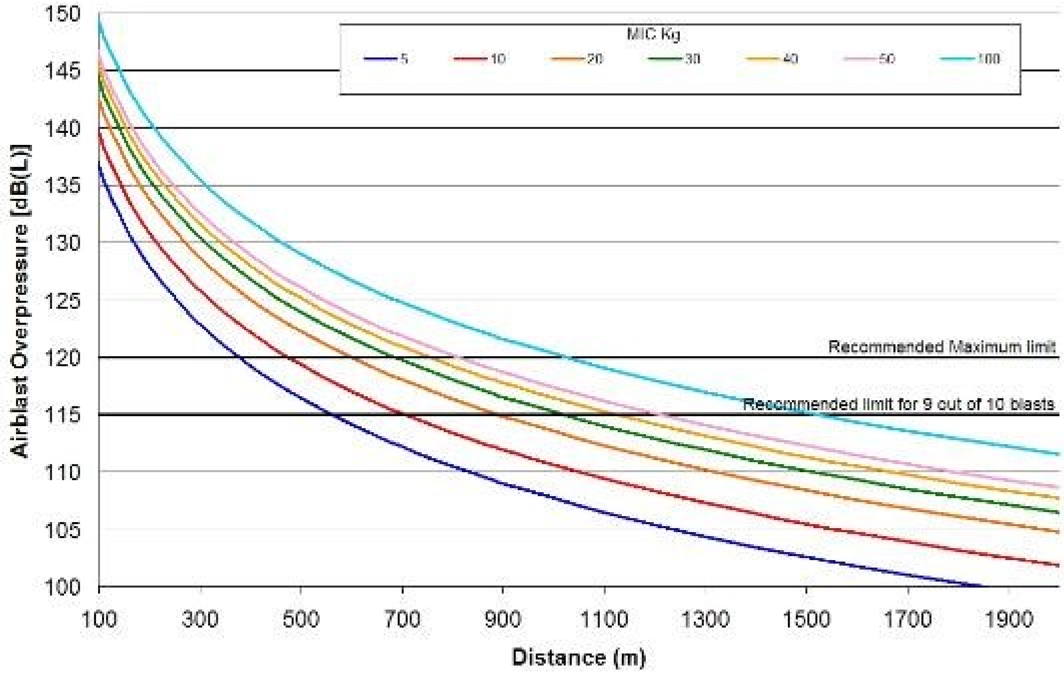

Figure 33 Air blast overpressure predictions for different charge masses and distances

5.11.4 Assessment of blasting

The predicted results shown in Figure 32 and Figure 33 indicate that blasting would be restricted by the air blast overpressure rather than the ground vibration levels.

Although the location of blasting is not known at this stage of the project, if it were to occur it would most likely be on the Bibblewindi to Leewood infrastructure corridor. Along this corridor the nearest sensitive receivers are over 2,000 metres away. Therefore, blasting ground vibration and airblast overpressure levels, based on the above parameters, are expected to comply with the blasting criteria.

If it were identified during detailed design or construction that blasting was required mitigation such as reduced maximum instantaneous charge may be employed to minimised potential airblast overpressure. Further methods to reduce airblast overpressure are provided in Section 6.2.3. It is noted that Along Bibblewindi to Leewood infrastructure corridor the nearest sensitive receivers are over 2,000 metres away. Blasting in this corridor is expected to comply with the blasting criteria, based on the above parameters.

It is recognised that the design of blast would be up to the blast contractor and that the above information has been assumed for this assessment only, in the absence of specific information regarding blasting at the proposed site.

Once the exact location and details of required blasting is known, the distance to the receiver should be used for the charge mass estimate. Blast monitoring should then be undertaken to assess compliance, determine the site specific blast parameters and confirm the predictions.

5.12 Cumulative noise

There is the potential for cumulative noise from other developments and industries within the study area.

Cumulative noise impacts of industrial noise sources are controlled by the *Industrial Noise Policy* (EPA 2000) amenity criteria. The amenity criteria aim to limit continual increases in noise levels from industrial noise sources and developments and apply to all industrial noise sources at the receiver location. The amenity criteria have been set to $L_{Aeq(period)}$ 40 dB(A) for sensitive receivers within the study area for this project which is 5 dB(A) greater than the *Industrial Noise Policy* (EPA 2000) intrusive criteria if the noise sources are continuous in nature.

Identified industrial project within or near the study area with the potential to generate noise and require further assessment include:

- Wilga Park Power Station
- Narrabri Gas Exploration
- Narrabri Landfill.
- Narrabri North Coal Mine

Wilga Park Power Station is located in the north of the study area and there are several sensitive receivers located over 900 metres from the facility. No long term cumulative impacts during operations would be expected as the production well would be located to comply with 35 dB(A) unless there is a private negotiated agreement with the residence. Since the noise limits for the Wilga Park Power Station is also 35 dB(A) the cumulative noise would be below the 40 dB(A) amenity criteria. Although there is the potential for short term cumulative exceedances to the construction noise management levels during construction of infrastructure in this area, these would be managed through consideration of the mitigation measures detailed in Section 6.1 or private negotiated agreements.

Narrabri North Coal Mine is located approximately four kilometres to the east of the project area. Due to the significant distance from the project related noise sources there is not anticipated there will be cumulative impacts from the operation or construction on sensitive receivers bordering the project area.

The Narrabri Landfill is located approximately three kilometres to the north east of the project area. Due to the significant distance from the project related noise sources there is not anticipated there will be cumulative impacts from the operation or construction on sensitive receivers bordering the project area.

There are ongoing exploration activities that are being undertaken as part of the Narrabri Gas Exploration project. The majority of the exploration activities are located within the State Forrest at Dewhurst. *Dewhurst Pilot Expansion Noise Assessment Report (Rev 5), (Noise Measurement Services, 2013)* assesses noise impacts to generally be below the 35 dB(A) noise criteria at residential receivers. If these previously approved activities are undertaken during construction of this project, there would be the potential for cumulative noise impacts. However, this would be managed through consideration of the mitigation measures detailed in Section 6.1 or via private negotiated agreements.

6. Mitigation measures

6.1 Noise and vibration commitments

The proponent commits to implementing the measures outlined in Table 6-1. The commitments listed in this table include the development of noise and vibration management plans. The noise and vibration mitigation measures detailed in Chapter 6 would be considered where feasible and reasonable to achieve these commitments.

Table 6-1 Noise and vibration commitments

Noise and vibration

9.1 Noise from the activity would meet the noise levels in the table below at occupied residences unless a written agreement is in place with the landholder.

Time period		***Construction noise (where written agreement is not in place)***	***Operational noise (where written agreement is not in place)***
Day	7 a.m. to 6 p.m. Monday to Friday and 8 a.m. to 1 p.m. Saturday	see Note 1	35 dB(A) LAeq(15min)
	7 a.m. to 8 a.m. and 1 p.m. to 6 p.m. Saturday, 8 a.m. to 6 p.m. Sunday and public holidays	35 dB(A) LAeq(15min)	35 dB(A) LAeq(15min)
Evening	6 p.m. to 10 p.m.	35 dB(A) LAeq(15min)	35 dB(A) LAeq(15min)
Night	10 p.m. to 7 a.m. Monday to Saturday and 10 p.m. to 8 a.m. Sunday and public holidays	35 dB(A) LAeq(15min) 45 dB(A) LAmax	35 dB(A) LAeq(15min) 45 dB(A) LAmax

Note 1: For construction between the hours of 7 a.m. and 6 p.m. Monday to Friday and 8 am to 1 pm Saturday, 40 dB(A) (or background plus 10 dB(A)) is the noise management level where feasible and reasonable work practices would be implemented. Potentially impacted occupied residences will be informed of the nature of the works, duration of works and a method of contact to raise complaints.

9.2 Noise levels would be measured in accordance with the *Industrial Noise Policy* (EPA 2000).

9.3 A Noise Management Plan would be implemented.

9.4 If vibration-generating activities are to be undertaken in the vicinity of sensitive receivers or buildings, a Vibration Management Plan would be developed and implemented containing measures such as:

- preparation of property condition reports
- investigation of alternative work methods
- provision of advice to potentially impacted receivers.

9.5 If blasting is required, Santos would comply with *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZEC 1990).

6.2 Construction

6.2.1 Summary of construction activities

A summary of the construction activities associated with the project and the time of operation are provided in Table 6-2.

Table 6-2 Summary of construction noise activities

Activity	Time period
Leewood construction activities	Standard construction hours. Some work would be undertaken out of recommended standard construction hours where the noise levels comply with the noise management level of 35 dB(A) or a private negotiated agreements is in place.
Bibblewindi construction activities	Standard construction hours. Some work would be undertaken out of recommended standard construction hours where the noise levels comply with the noise management level of 35 dB(A) or a private negotiated agreements is in place.
Bibblewindi to Leewood pipeline construction	Standard construction hours. Some work would be undertaken out of recommended standard construction hours where the noise levels comply with the noise management level of 35 dB(A) or a private negotiated agreements is in place.
Wilga Park to Leewood transmission line construction	Standard construction hours. Some work would be undertaken out of recommended standard construction hours where the noise levels comply with the noise management level of 35 dB(A) or a private negotiated agreements is in place.
Gas field: Construction of production and pilot wells	24 hrs per day for drill rig setup, drilling, pipe removal, completions and cementing (10 days for vertical wells and 28 days for horizontal wells).
Gas field: Construction of access tracks	Standard construction hours. Some work would be undertaken out of recommended standard construction hours where the noise levels comply with the noise management level of 35 dB(A) or a private negotiated agreements is in place.
Gas field: Construction of water and gas gathering flow lines	Standard construction hours. Some work would be undertaken out of recommended standard construction hours where the noise levels comply with the noise management level of 35 dB(A) or a private negotiated agreements is in place.
Westport workers accommodation construction	Standard construction hours. Some work would be undertaken out of recommended standard construction hours where the noise levels comply with the noise management level of 35 dB(A) or a private negotiated agreements is in place.
Road upgrades	Standard construction hours. Some work would be undertaken out of recommended standard construction hours where the noise levels comply with the noise management level of 35 dB(A) or a private negotiated agreements is in place.
Vibration	Standard construction hours. Some work would be undertaken out of recommended standard construction hours where the noise levels comply with the noise management level of 35 dB(A) or a private negotiated agreements is in place.
Blasting	No blasting has been identified however if required would be undertaken between the hours of: • Monday to Saturday, 9 am to 5 pm • No blasting on Sundays or Public Holidays.
Construction traffic	During the Road Noise Policy (DECCW, 2011) defined day time period of 7 am to 10 pm and night time period of 10 pm to 7 am

6.2.2 Construction Noise and Vibration Management Plan

A Construction Noise and Vibration Management Plan would be prepared prior to commencement of construction of the project. The Construction Noise and Vibration Management Plan would detail the methods used to minimise construction noise and vibration and would be reviewed and updated as necessary as additional information on construction becomes available.

6.2.3 Construction mitigation measures

For construction activities that are undertaken within the recommended standard construction hours (7am to 6pm Monday to Friday and 8am to 1pm Saturday) the work practices in

Table 6-3 would be considered where feasible and reasonable if noise levels were found to exceed the construction noise management levels.

Some construction work would be undertaken outside of the recommended standard hours. This work would be managed so that the out of hours' management level of 35 dB(A) at residential receivers is achieved, or a private negotiated agreement is put in place. Additional mitigation measures would be considered as necessary, including:

- scheduling noisier activities during recommended standard construction hours
- reducing the number of pieces of plant and equipment used during the out of hours' periods to reduce noise levels to below the construction noise management level
- compliance noise monitoring to confirm compliance with the out of hours' management level of 35 dB(A)

Table 6-3 Feasible and reasonable work practices

Construction noise and vibration mitigation measure	
Use broadband reversing alarms Construction site mitigation measures	**Site inductions** Inductions for the work crew would include the specific noise issues and mitigation measures required for the site. The induction would include: • all relevant project specific and standard noise mitigation measures • relevant licence and approval conditions • permissible hours of work • location of sensitive receivers that may exceed the construction noise management level • construction employee parking areas • designated loading/ unloading areas and procedures • site opening/closing times (including deliveries) • behavioural practices that minimise noise: • avoiding dropping materials from height and avoiding metal to metal contact on material.
	Maximise the distance between plant and equipment and sensitive receivers where practicable. For example, vehicle movements and generator storage would be located as far as practical from sensitive receivers.
	The use broadband reversing alarms
	Use quieter and lower vibration emitting construction methods where available.
	Vehicles, plant and equipment would be regularly maintained and kept in good operating condition

Construction noise and vibration mitigation measure	
	Where feasible and reasonable reducing the number of plant and equipment used during the out of hours periods to reduce noise emission levels.
	Scheduling noisier activities during recommended standard construction hours and minimise the use of heavy machinery during the out of hours periods.
Vibration	Where buildings are located within the structural damage vibration buffer distances identified in Section 5.10.2, a property condition report would be prepared for the premises before and after undertaking the work. Compliance vibration monitoring would also be undertaken during high vibration generating activities where buildings are located within the structural damage buffer distances to confirm vibration criteria are not exceeded.
	Where vibration generating activities are required to occur within the human comfort buffer distances identified in Section 5.10.2, alternative work methods would be investigated as part of the Construction Method Statement. If no alternative work methods are available sensitive receivers potentially exceeding the vibration criteria would be informed of the nature of the works, expected vibration levels, duration of works, advice regarding the potential for structural damage and a method of contact to raise vibration complaints.
Blasting	Where sensitive receivers are located within the blasting buffer distances identified in Figure 33 the maximum instantaneous charge should be reduced to meet air blast overpressure criteria. Further methods to reduce air blast overpressure would be considered by the blast contractor who would determine their effectiveness and practicability. These include the following: • optimising blast design by altering drilling patterns and adjusting the effective charge mass per delay • using a combination of appropriate delays • keeping face heights to a practicable minimum • ensuring stemming type and length is adequate • making extra efforts to eliminate the need for two shots • considering delaying or cancelling the blast by not loading if the weather is unfavourable (i.e. winds in the direction of source to receiver) • allowing for the effects of temperature inversion and wind speed and the direction on the propagation of air blast to surrounding areas. Note that temperature inversions are most common during night and early morning periods, therefore should not affect blasting during the recommended standard operating hours • orientating faces where possible so that they do not face directly towards sensitive receivers. Compliance blast monitoring would also be undertaken at sensitive receivers located within the blasting buffer distances. The monitoring will measure the blast ground vibration and air blast overpressure, assess if the blast criteria are exceeded and determine if the blast design should be refined for future blast events.

6.2.4 Additional mitigation measures for production well and pilot well drilling

Drilling and well completion activities would need to be undertaken 24 hours a day and in some locations this could result in noise exceeding. The out of hours' management level of 35 dB(A). Exceedances to the construction noise management levels at sensitive receivers would be temporary, typically lasting days to several weeks.

In order to reduce noise levels associated with 24 hour drilling and completions, the mitigation and management measures shown in Table 6-4 would be considered where feasible and reasonable in respect of activities that were predicted to result in noise levels greater than the management level.

Table 6-4 Additional mitigation measures for managing 24 hour drill and completion rig operations

Treatment type	Component	Treatment (where feasible and reasonable)
At source treatments	Engine compartment treatment	Acoustic treatment to the generator, power pack and mud pump engines compartments.
	High pressure cement truck	Select a high pressure cement truck which produces lower noise emissions.
	Pipe removal and casing operational procedure	Develop a procedure to minimise banging from the placement of drill pipe onto the pipe racks/bins during pipe removal and casing operations of the rig. This would minimise impulsive noise or sleep disturbance.
Scheduling	Scheduling the number of drill rigs operating in a potentially impacted area	Where feasible, schedule the drilling sites to minimise the number of drill rigs operating in the vicinity of sensitive receivers within the impacted buffer distances.
Private negotiated agreements	Alternative accommodation or financial compensation	Private negotiated agreements could be entered into with the potentially affected residential receiver. Private negotiated agreements may include alternative accommodation or financial compensation where required.

6.3 Operation

6.3.1 Summary of operational activities

A summary of the operational activities associated with the project and the time of operation are provided in Table 6-5.

Table 6-5 Summary of operational noise activities

Activity	Time period of operation
Leewood operation including: • central gas processing facility operation • water infrastructure operation • power station operation	24 hours per day
Leewood safety flare operation, above standard minimum flow	Infrequent
Bibblewindi in-field compression	24 hours per day
Bibblewindi safety flare operation, above standard minimum flow	Infrequent
Production well operation	24 hours per day
Pilot well operation	24 hours per day

6.3.2 Operational mitigation measures

Operations will be managed to ensure that operational noise does not exceed the operational noise level of 35 dB(A) at sensitive receivers, unless a private negotiated agreement is in place. To ensure compliance the measures provided in the following section would be considered where feasible and reasonable:

Operational phase noise monitoring to assess compliance against operational noise limits would be conducted. Remedial measures to achieve compliance would be undertaken if exceedances of the noise limits at a sensitive receiver are identified and a private negotiated agreement is not in place. Leewood operational phase infrastructure

The following noise mitigation measures would be considered during the design phase of the project to ensure noise levels at sensitive receivers surrounding Leewood are met:

- enclose the reciprocating compressors in individual enclosures or an acoustically treated building. This would include mitigation of significant noise associated with valves of pipework
- power station exhaust silencers and stack height
- low noise power station radiators and consideration of variable speed drives
- power station engine hall ventilation louvres
- design the facilities to minimise low frequency noise emissions
- consider location and orientation of the facilities in the design process.

Leewood and Bibblewindi safety flare

To manage noise associated with the operation of the safety flares above standard operating flows, maintenance activities would, where practical, be scheduled to ensure compliance with the operational noise levels. In addition, all surrounding receivers with the potential to exceed the noise criteria during operation of the safety flare would be informed of the potential for noise levels in excess of the noise criteria during the scheduled maintenance period.

Gas field

The pilot and production well placement, configuration and equipment would be designed to comply with the 35 dB(A) operational noise criteria.

7. Conclusion

Operation noise assessment findings

There are a number of pieces of equipment proposed to be sited at the Leewood site, including gas processing and compression, water treatment and an optional power station. Without mitigation treatments, operational noise levels from Leewood are predicted to exceed the noise criteria at several surrounding sensitive receivers. However, with the implementation of mitigation treatments, operational noise levels from Leewood are predicted to comply with the noise criteria at all surrounding sensitive receivers during both calm and adverse meteorological conditions.

Operational noise levels from the Bibblewindi central gas processing facility are predicted to comply with the noise criteria at all identified sensitive receivers in all meteorological conditions.

In respect of operating wells, modelling predicts that a maximum distance of 218 meters and 138 meters (for adverse and calm meteorological conditions respectively) is required to meet the noise criteria for multiple production wells operating simultaneously under a worst case 750 metres well spacing configuration. The noise from the operation of a production well is steady in nature and would not produce significant maximum noise emissions events therefore, exceedances of the sleep disturbance criteria are not anticipated as a result of the operation of production wells.

The operation of a pilot well with an associated flare (where these pilot wells are not connected to the gas gathering system) is estimated to require a maximum distance of 3412 metres and 2423 metres (for adverse and calm meteorological conditions respectively) to meet the noise criteria for sensitive receivers.

Road traffic noise levels are not predicted to increase by more than 2 dB(A) as a result of the proposed operation. As 2 dB(A) is generally not a discernible increase in noise, and would comply with the road traffic noise criteria for sensitive receivers on the traffic routes.

The operation of the safety flares at Leewood and Bibblewindi has the potential to occasionally exceed the intrusive noise criteria at sensitive receivers, if they are required to be operated at maximum capacity in adverse meteorological conditions. However, the requirement for operation of the flare at this capacity would arise infrequently during maintenance or other situations where operational equipment is off-line and the highest noise levels would occur when all equipment is off-line (during maximum flow rate) which would be an extremely rare event. If maintenance activities required this to occur, activities would, as far as practical, be scheduled to occur during the recommended standard construction noise hours.

Construction noise assessment findings

Construction activities at Leewood are predicted to comply with the noise management levels during recommended standard hours at all sensitive receivers except for one receiver which is predicted to exceed the noise management levels by up to 3 dB(A). Five sensitive receivers are predicted to receive noise levels above the noise management levels if construction work is undertaken outside of recommended standard hours during calm meteorological conditions and up to eight sensitive receivers during adverse meteorological conditions. The predicted maximum construction noise levels do not exceed the sleep disturbance screening criteria at identified sensitive receivers.

Construction activities at Bibblewindi are predicted to comply with the noise management levels both during and outside of standard construction hours at all identified sensitive receivers. The predicted maximum construction noise levels are also below the sleep disturbance criteria at all identified sensitive receivers.

Drilling activities have an operational requirement to occur continuously 24 hours per day. A maximum distance of 1,875 metres is predicted to be required to meet noise management levels during the night time period (adverse meteorological conditions) during cementing, the highest noise source activity, with mitigation measures implemented. Maximum noise level events associated with drilling are likely to be associated with the movement of drill rod casings and air releases. There is the potential for sleep disturbance criteria to be exceeded where sensitive receivers are located within 1,300 metres of a drilling rig. The field development protocol would apply the noise constraints to guide the siting of wells and this dictates where management and mitigation measures would be required to be implemented, including in situations where multiple drill rigs are operating in vicinity of one another, or other project noise sources.

For the construction of access tracks and the installation of the gas and water gathering system, the maximum buffer distance to achieve the noise management levels during standard construction hours were estimated to be 2,021 metres during trenching activities for gathering line installation and 1,440 metres during vegetation clearing for access track and gathering line corridor establishment. By their nature, exceedances to the construction noise management levels at sensitive receivers associated with the installation of access tracks or gathering lines are very short term as the installation work front proceeds along the corridor.

There are no anticipated exceedances of the noise management levels for sensitive receivers associated with construction activities along the Bibblewindi to Leewood infrastructure corridor during recommended standard hours and when work is undertaken outside of recommended standard hours during calm meteorological conditions. Five sensitive receivers are predicted to receive noise levels in excess of the noise management level if construction work was to be undertaken outside of recommended standard hours during adverse meteorological conditions. Management and mitigation measures are recommended to be implemented in such conditions.

Construction activities along the Wilga Park to Leewood transmission line construction corridor are predicted to exceed the construction noise management levels at up to 19 sensitive receivers during recommended standard hours and up to 57 sensitive receivers when work is undertaken outside of recommended standard hours during adverse meteorological conditions. The highly noise affected management level has the potential to be exceeded at one receiver for a short period of time likely to be less than one day. Management and mitigation measures are recommended to be implemented in such conditions.

Construction of the Westport workers’ accommodation is predicted to comply with the noise management levels during recommended standard hours and when work is undertaken outside of recommended standard hours during calm meteorological conditions. Noise levels are predicted to exceed the noise management level at one sensitive receiver if work was to be undertaken outside of recommended standard hours during adverse meteorological conditions.

Road resurfacing and intersection upgrade activities are predicted to comply with the construction noise management levels at all sensitive receivers both during and outside of recommended standard construction hours.

Construction of the water release pipeline from Leewood to the Bohena Creek is predicted to exceed the noise management levels during standard construction hours at three sensitive receivers. If work was to be undertaken outside of standard hours up to 14 sensitive receivers would exceed the noise management level during adverse meteorological conditions. Management and mitigation measures are recommended to be implemented as required to meet the noise criteria.

In relation to the potential for vibration impacts to occur, buffer distances have been calculated for construction equipment. Based on the constraint of no infrastructure being located within 200 metres of a sensitive receiver unless otherwise agreed, the potential for exceedances to the vibration criteria as a result of the project is unlikely. Appropriate mitigation and management measures would be implemented if potential exceedances were predicted to occur. Although it is not expected that blasting will be required during construction activities, in the event that blasting is required, the potential for impacts would be assessed in accordance with the relevant guidelines and required mitigation and monitoring measures implemented. The nearest sensitive receivers to the Bibblewindi to Leewood construction corridor are in excess of 2,000 metres away, and as such no impacts from blasting activities that may be required are anticipated.

Road traffic noise levels are not predicted to increase by more than 2 dB(A) as a result of the proposed construction activities. As 2 dB(A) is generally not a discernible increase in noise, and would comply with the road traffic noise criteria for sensitive receivers on the traffic routes.

A suite of noise mitigation and management measures have been provided and these may be considered for implementation to ensure construction activities meet noise management levels where feasible and reasonable.

Where construction work is required to be undertaken outside of the recommended standard construction hours, activities would be managed so that noise levels meet the out of hours' noise management level of 35 dB(A) unless there is a private negotiated agreement in place with the sensitive receiver permitting a higher level of noise to occur.

Where noise is predicted to exceed the noise management levels at a sensitive receiver notification would be made of the nature and duration of the works, expected noise levels and a method of contact to raise noise complaints.

Conclusion

There are a number of noise sources during both construction and operation associated with the project. Given the localised and temporary nature of works in anyone location associated with the construction of a gas field, exceedances to the construction noise management levels as a result of construction noise are expected to be minor and temporary.

The operation of production wells is not expected to impact receivers if located appropriately.

Due to its significant distance from sensitive receivers the operation of the infrastructure at Bibblewindi is not predicted to exceed the noise criteria.

The operation of infrastructure at Leewood has the potential to cause exceedances to the noise criteria at surrounding sensitive receivers if noise mitigation and management measures are not implemented.

There are a suite of mitigation and management measures presented to assist in minimising potential impacts of noise from the construction and operation of the project. Final selection of measures will depend on the nature of the activities, noise emission produced and the proximity of the activities to sensitive receivers.

The proponent may enter into a private negotiated agreement with potentially affected sensitive receivers to minimise the impacts of noise from the project.

The Field Development Protocol applies the findings in this assessment to ensure that the noise outcomes required during the construction and operation of this project are considerations that are included during the siting of infrastructure that is undertaken under the Protocol.

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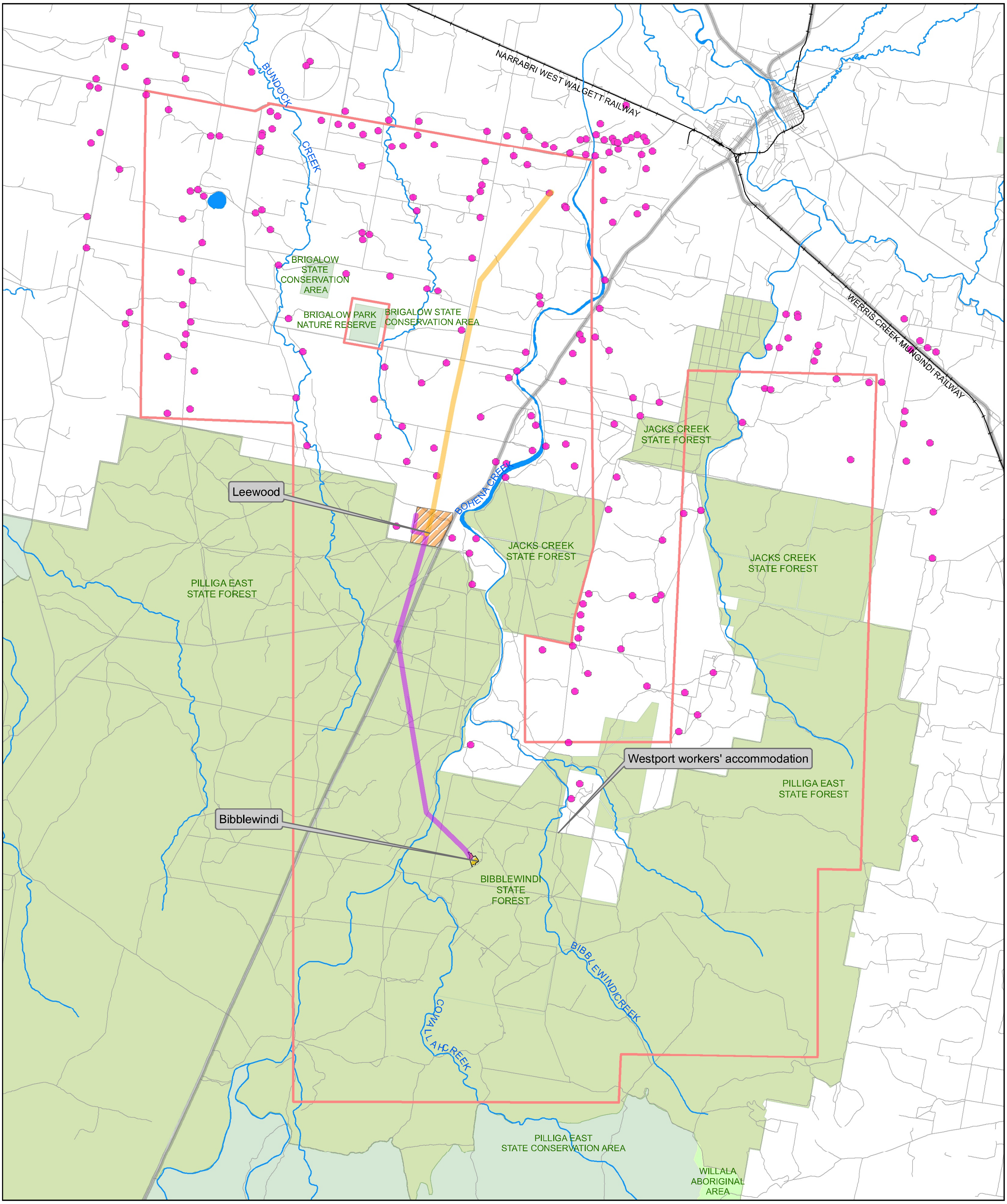
Appendices

Appendix A Noise sensitive receivers



LEGEND

- Project area
- Leewood
- Bibblewindi
- Parks and reserves
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Train line
- Sensitive receivers
- Leewood to Wilga Park infrastructure corridor
- Bibblewindi to Leewood infrastructure corridor

0 1.75 3.5 7
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Narrabri Gas Project
EIS Technical Appendix Noise and Vibration

Job Number 21-22463
Revision A
Date 02 Jul 2015

Sensitive receivers in the vicinity of the project area

Appendix A

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Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: jrichardson

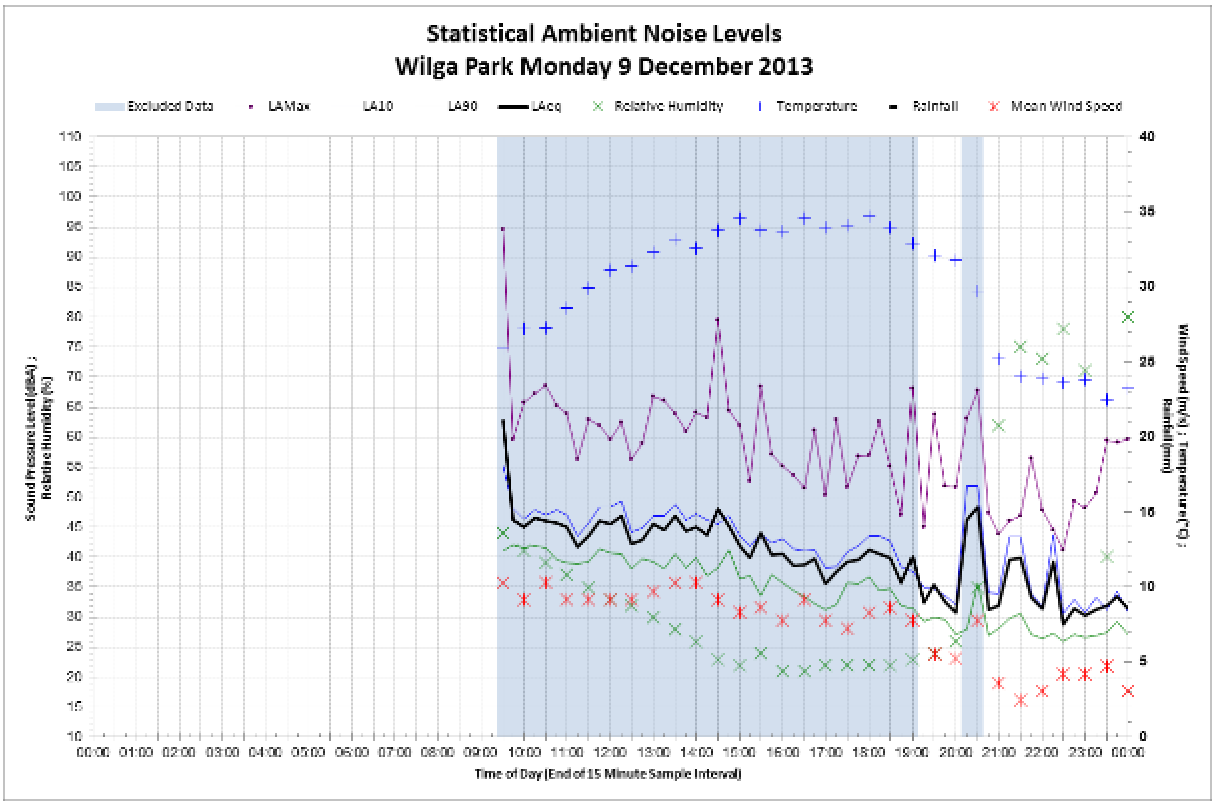
Appendix B Long-term noise monitoring results

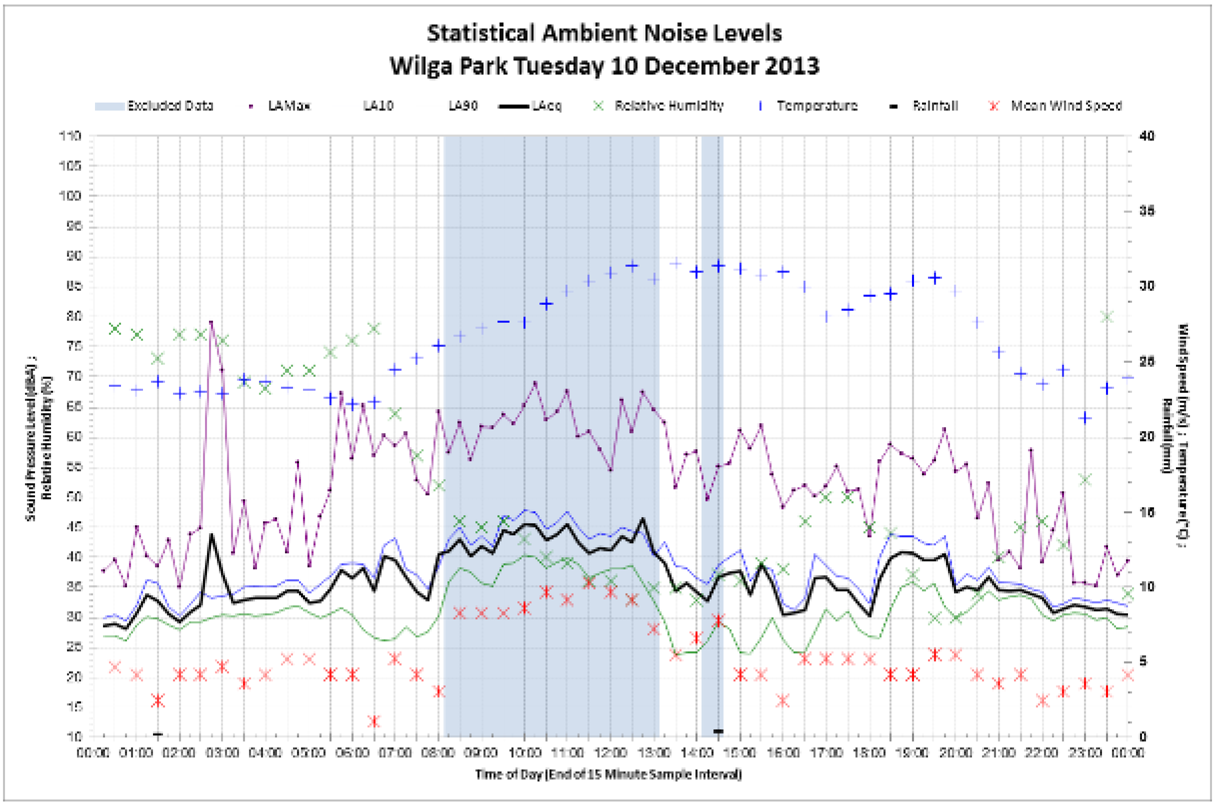
Table B-8-1 Noise monitoring Location A (Wilga Park) - noise levels, dB(A)

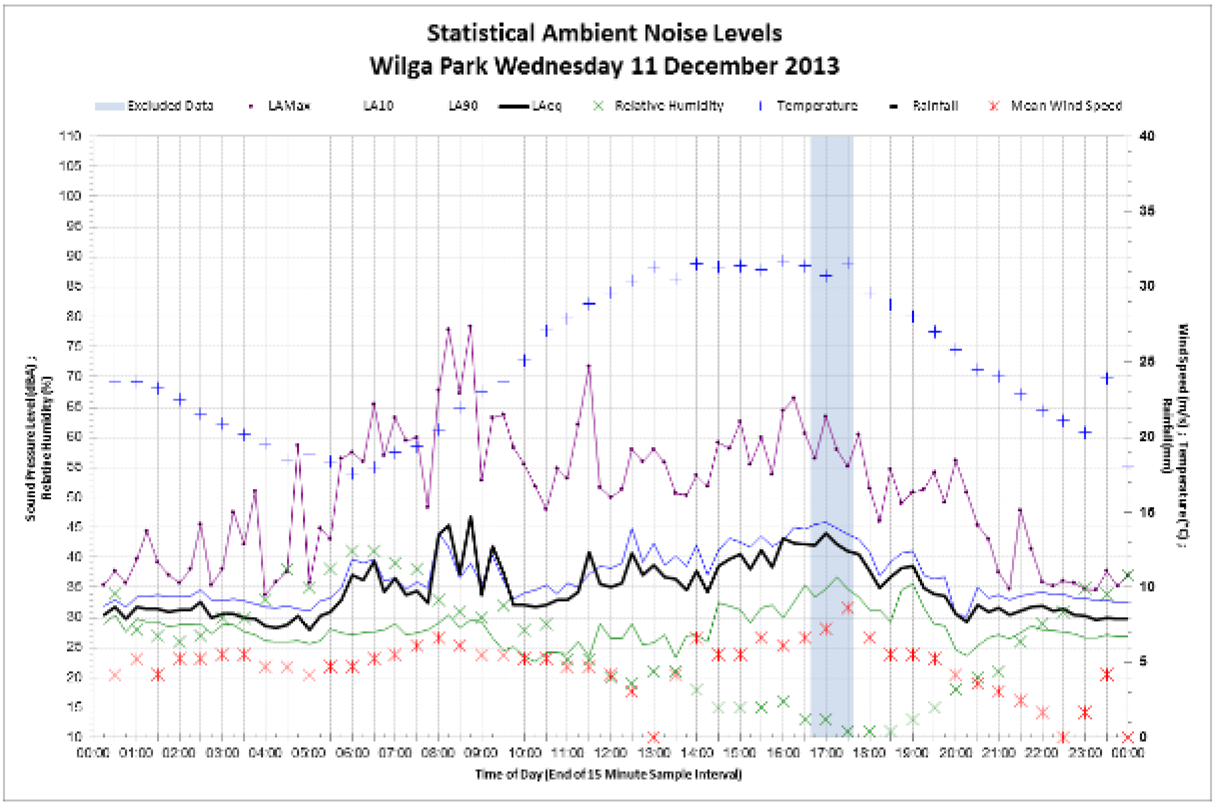
Date	Rating background level 90th percentile $L_{A90(15min)}$			Ambient noise levels, $L_{Aeq(period)}$		
	Day	Evening	Night	Day	Evening	Night
09/12/2013	-	*26*	27	-	*35*	35
10/12/2013	*24*	30	26	*36*	38	32
11/12/2013	*24*	25	23	*39*	34	32
12/12/2013	22	23	24	37	32	31
13/12/2013	24	24	*23*	43	31	*30*
14/12/2013	*24*	25	25	*38*	32	34
15/12/2013	26	26	25	39	32	37
16/12/2013	*26*	*26*	*23*	*38*	*38*	*40*
17/12/2013	24	27	23	40	35	33
18/12/2013	24	26	23	40	39	35
19/12/2013	25	24	*23*	41	36	*30*
20/12/2013	*28*	-	-	*36*	-	-
RBL / Log Average and LAeq	**30 (24)**	**30 (25)**	**30 (25)**	**40**	**35**	**34**

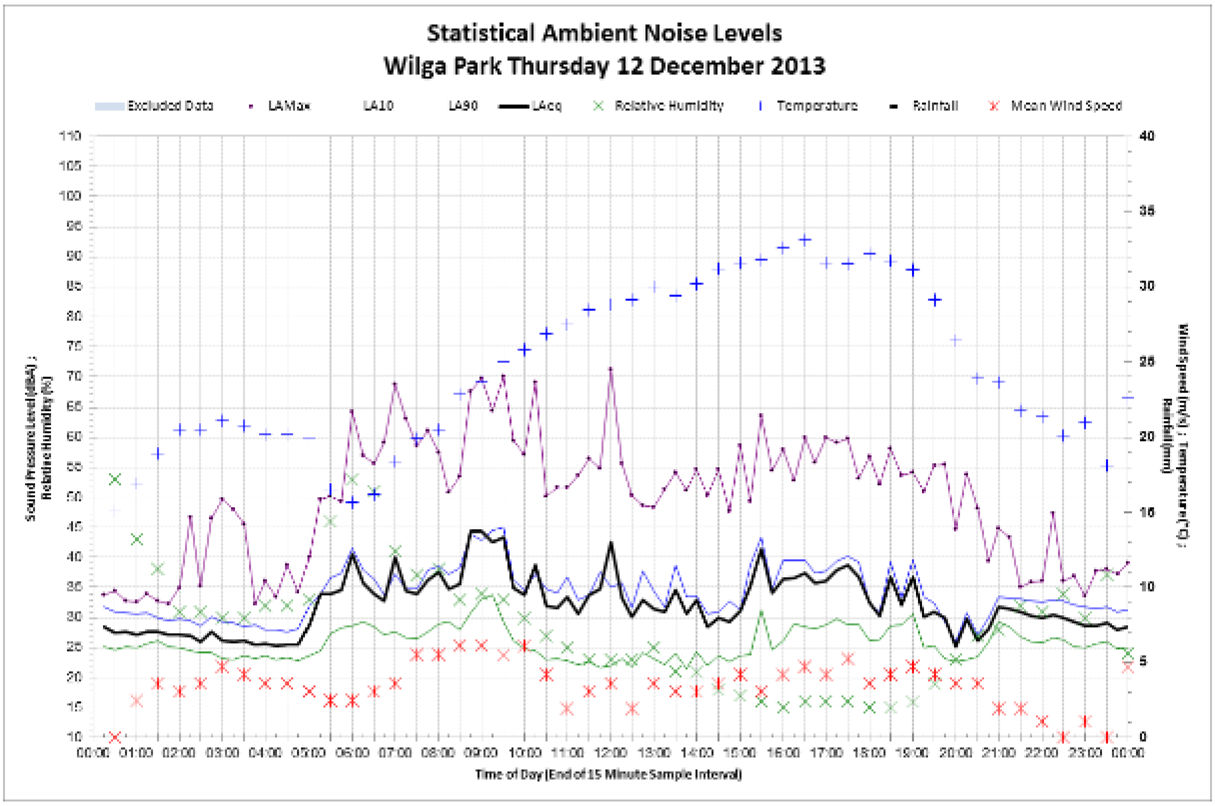
Note 1: Grey italic text indicates excluded data in accordance with the *Industrial Noise Policy* (EPA, 2000) analysis procedure (Section B1.3).

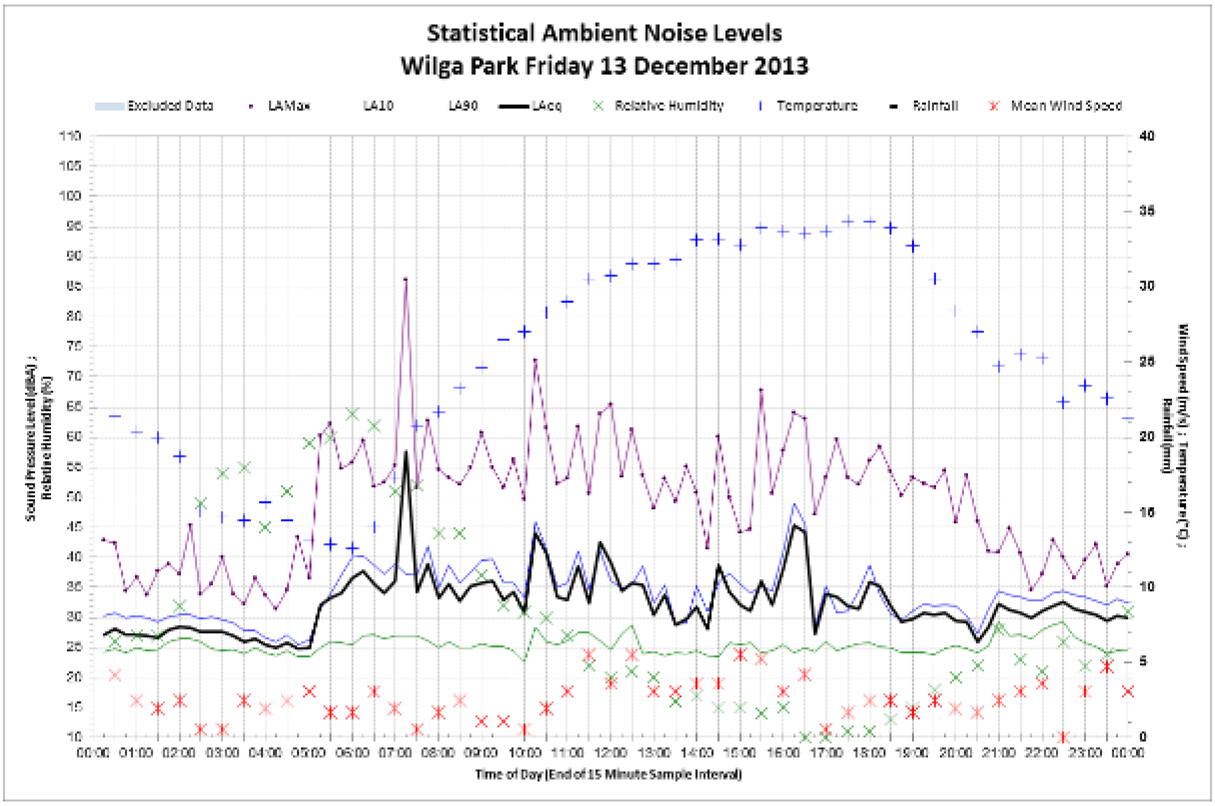
Note 2: The *Industrial Noise Policy* (EPA, 2000) requires that, *'where the rating background level is found to be less than 30 dB(A), then it is set to 30 dB(A)'*. Where this is the case, the measured rating background levels are shown in brackets.

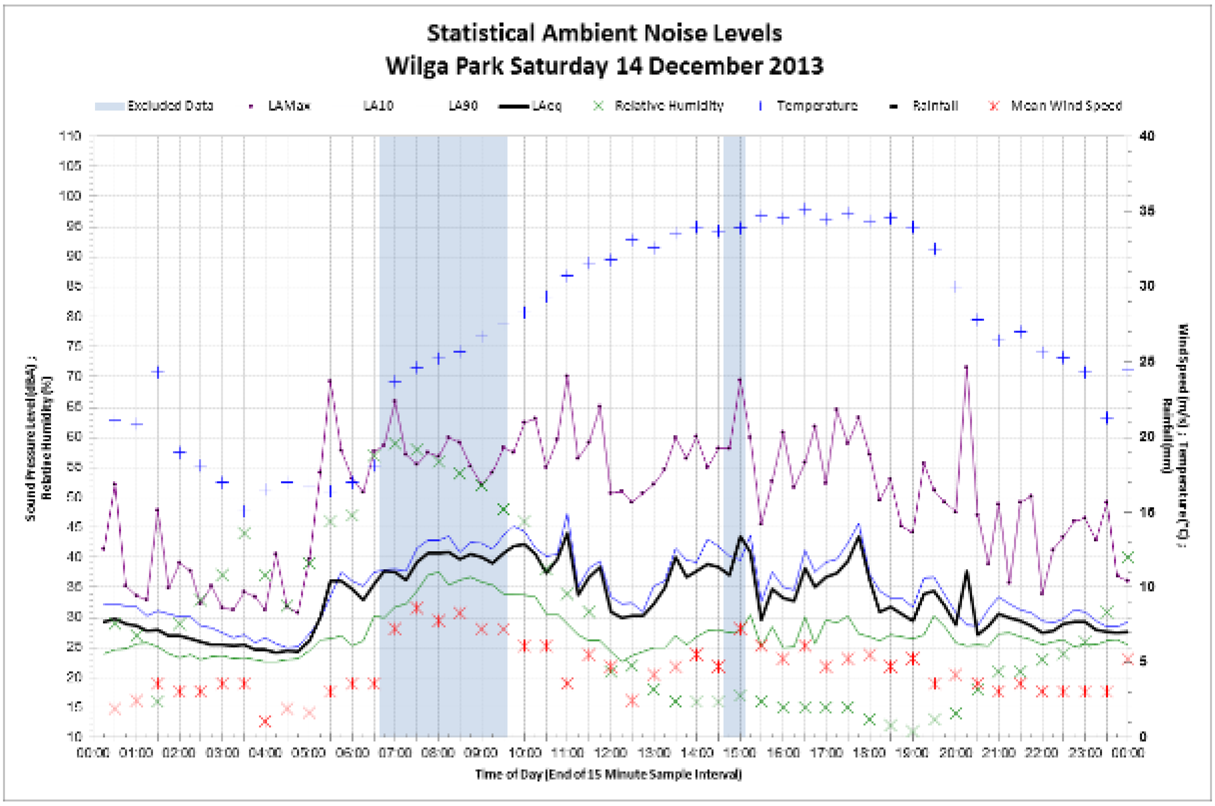

Statistical Ambient Noise Levels
Wilga Park Monday 9 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

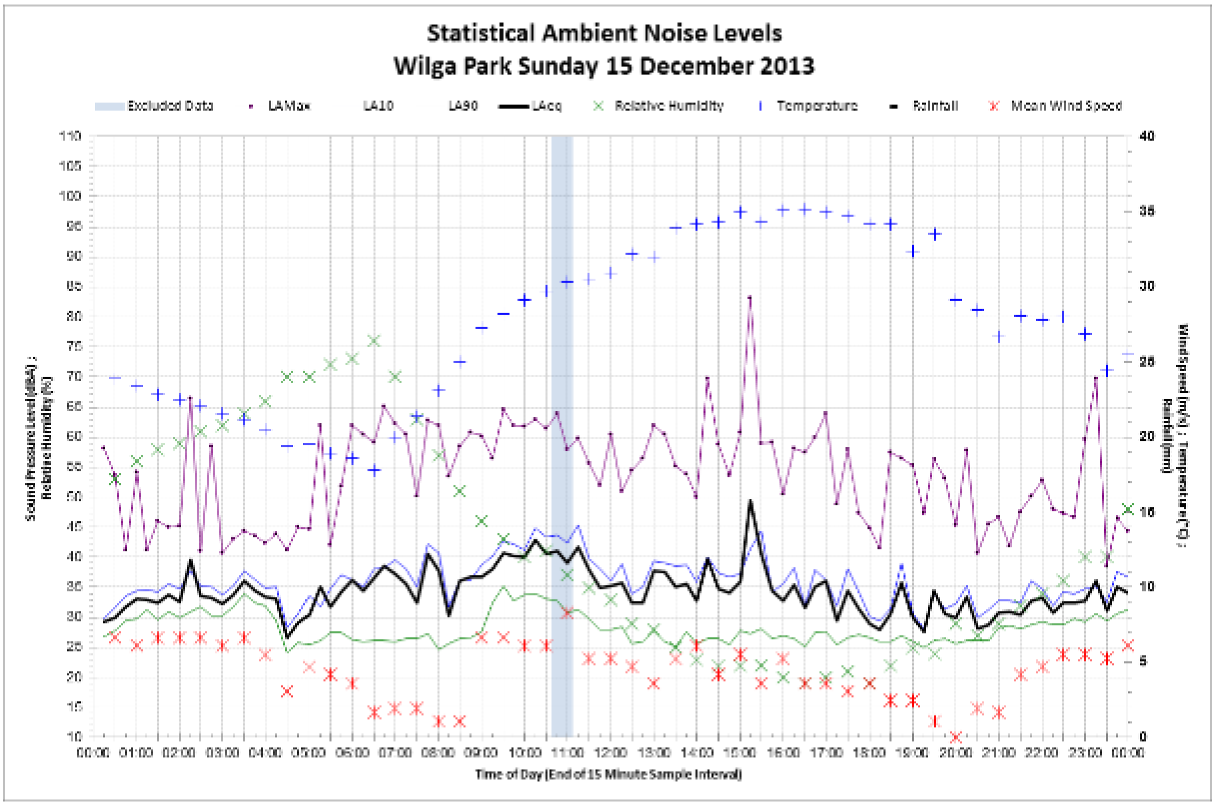

Statistical Ambient Noise Levels
Wilga Park Tuesday 10 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Wilga Park Wednesday 11 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

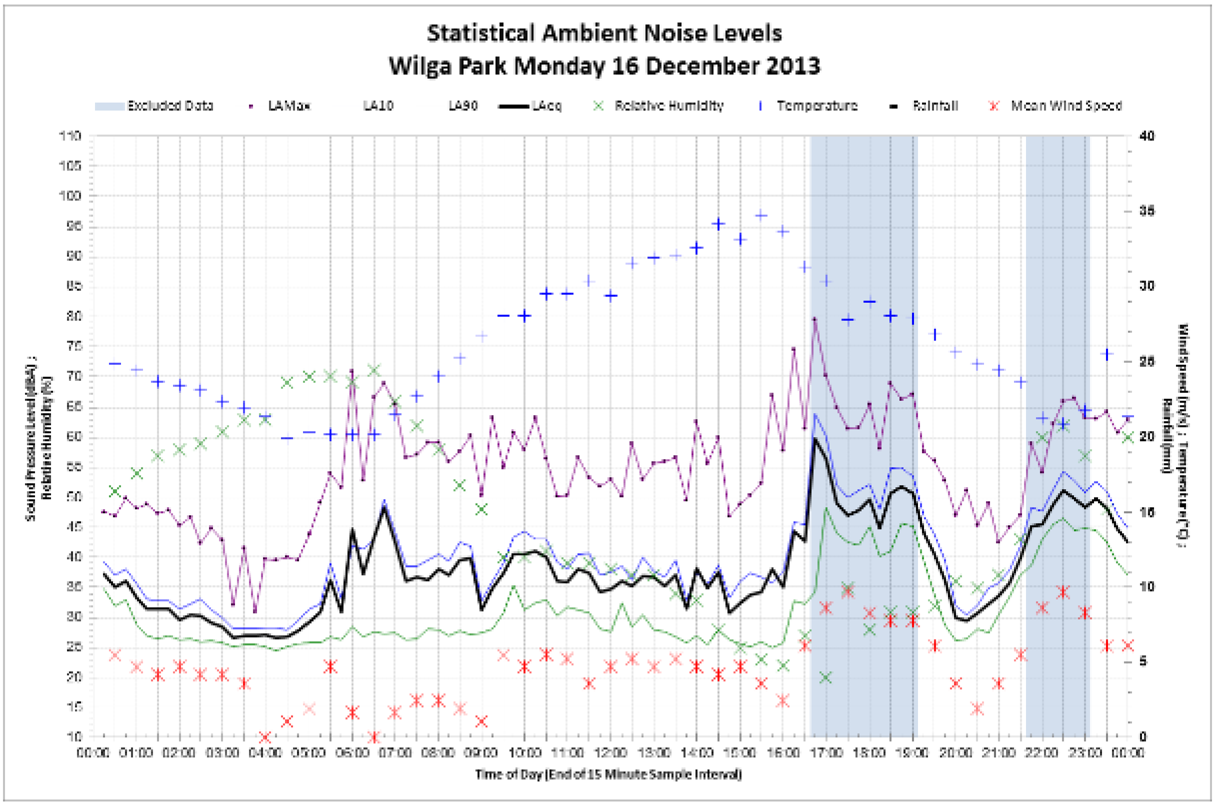

Statistical Ambient Noise Levels
Wilga Park Thursday 12 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Wilga Park Friday 13 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

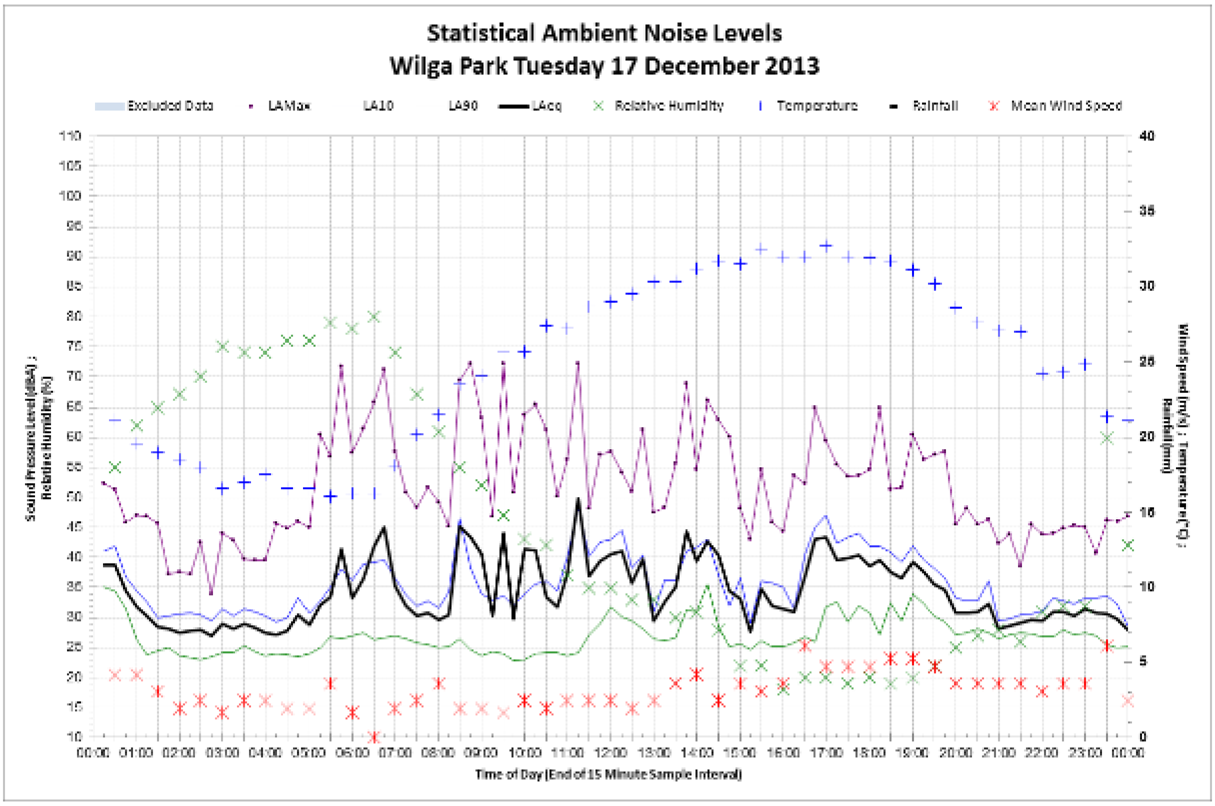

Statistical Ambient Noise Levels
Wilga Park Saturday 14 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

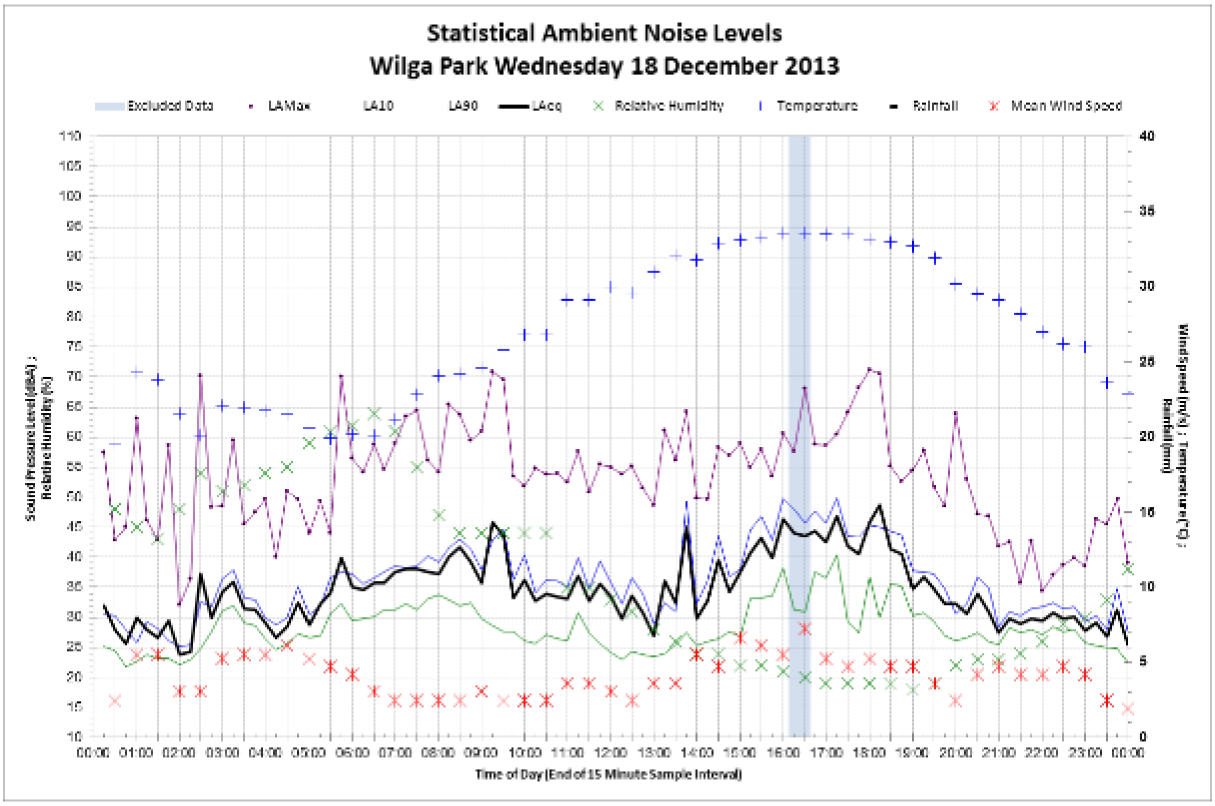


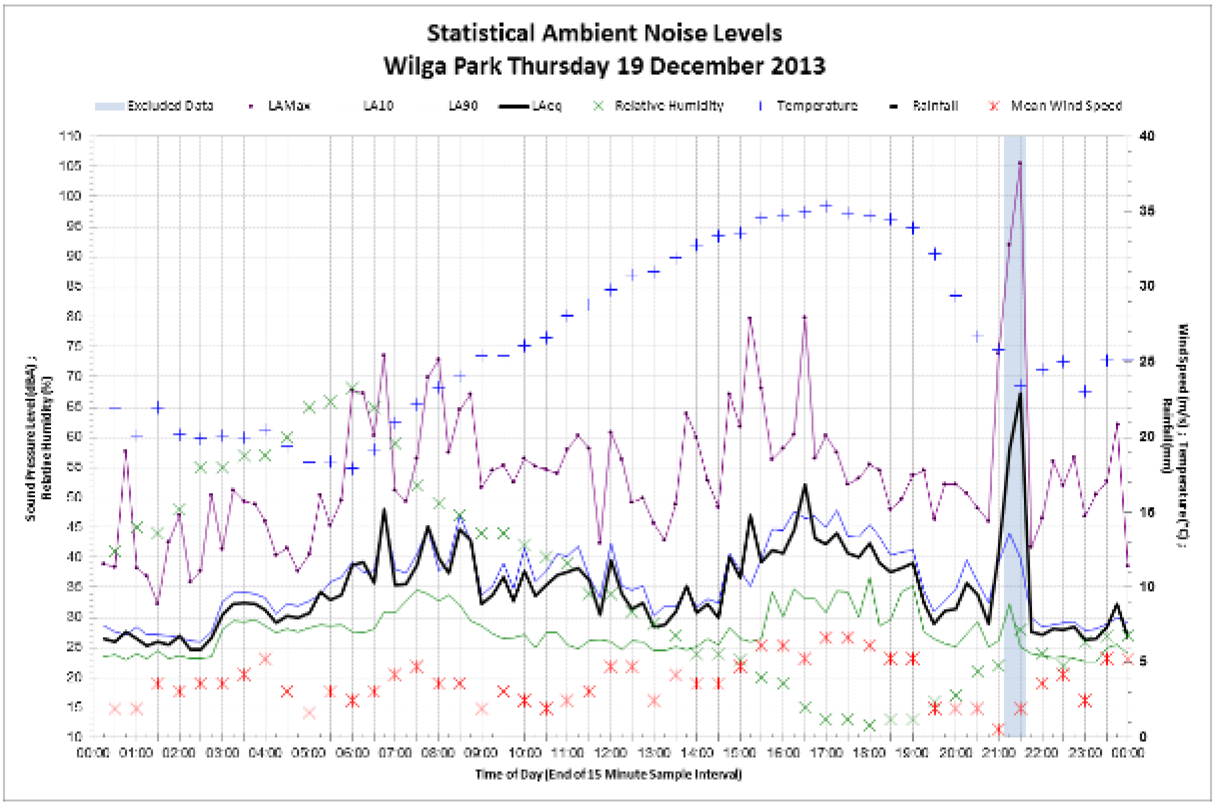
Statistical Ambient Noise Levels
Wilga Park Sunday 15 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



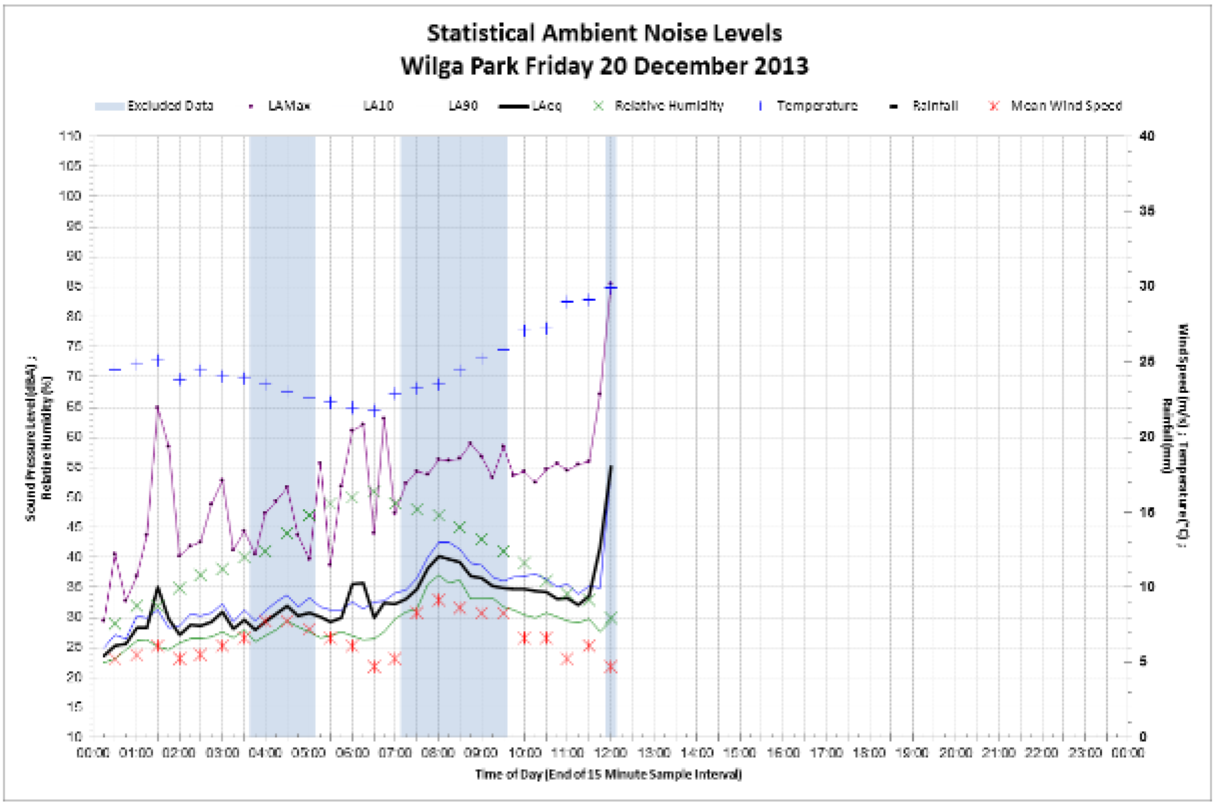
Statistical Ambient Noise Levels
Wilga Park Monday 16 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Wilga Park Tuesday 17 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Wilga Park Wednesday 18 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
Wilga Park Thursday 19 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



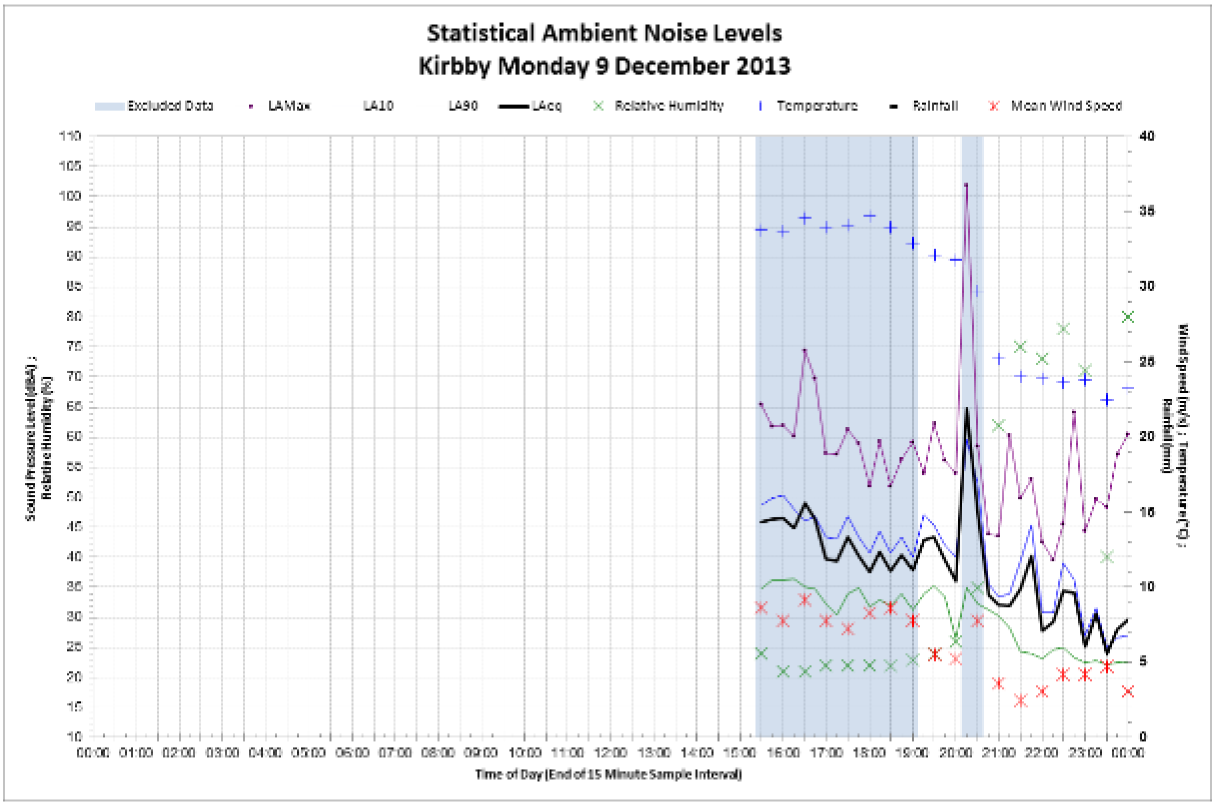
Statistical Ambient Noise Levels
Wilga Park Friday 20 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

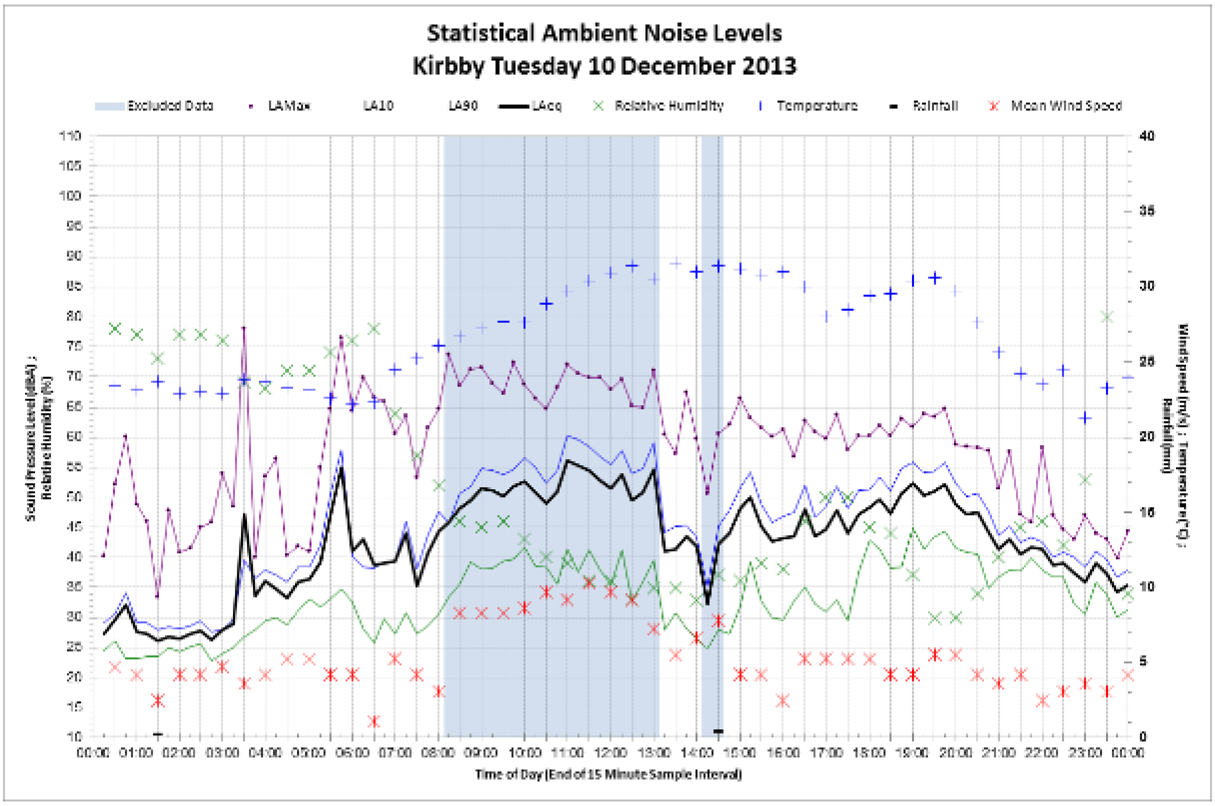
Table B-1-2 Noise monitoring Location B (Kirbby) - noise levels, dB(A)

Date	Rating background level 90th percentile $L_{A90(15min)}$			Ambient noise levels, $L_{Aeq(period)}$		
	Day	Evening	Night	Day	Evening	Night
09/12/2013	-	*23*	23	-	*39*	42
10/12/2013	*27*	37	28	*45*	48	39
11/12/2013	*24*	27	27	*45*	42	38
12/12/2013	22	27	25	40	39	39
13/12/2013	23	25	*24*	41	42	*39*
14/12/2013	*25*	28	23	*43*	41	37
15/12/2013	24	24	24	39	40	40
16/12/2013	*25*	*28*	*24*	*42*	*43*	*44*
17/12/2013	24	30	23	40	41	38
18/12/2013	25	31	23	41	42	41
19/12/2013	25	29	*25*	38	42	*37*
20/12/2013	*28*	-	-	*43*	-	-
Overall RBL and LAeq	**30 (24)**	**30 (28)**	**30 (24)**	**42**	**43[3]**	**39**

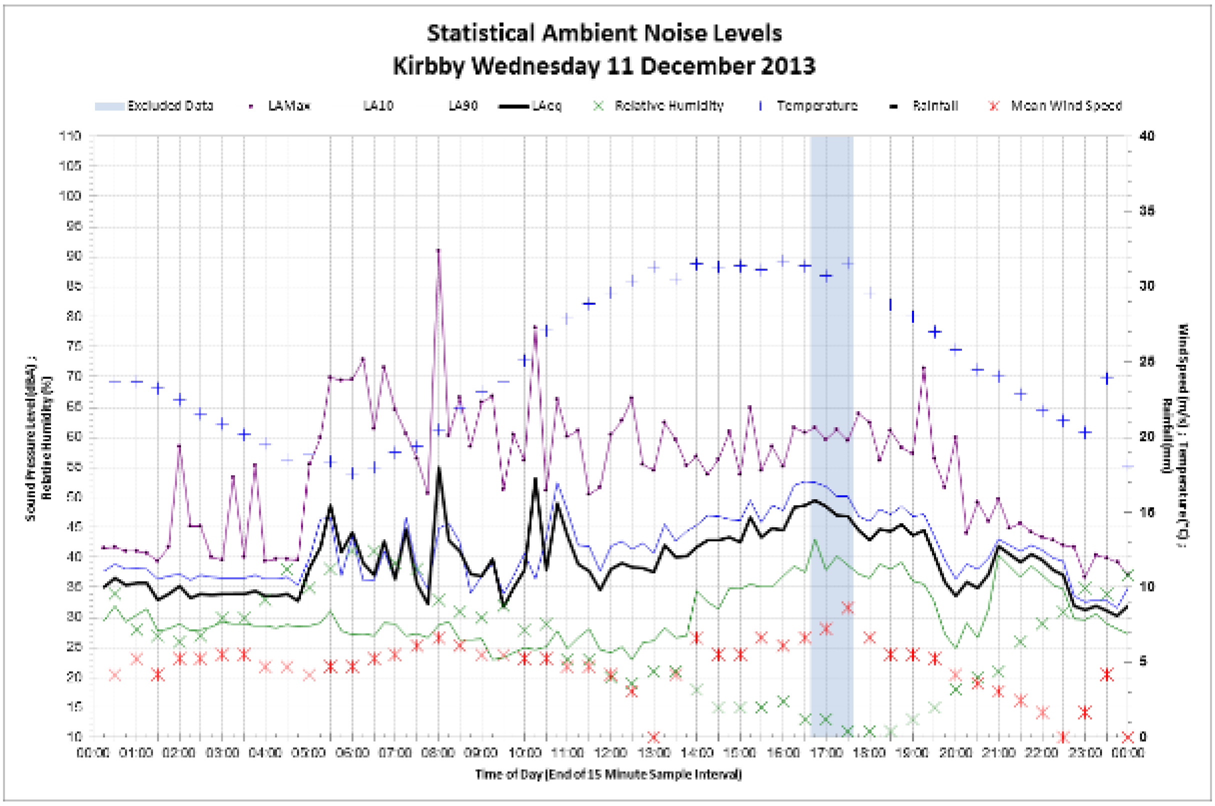
Note 1: Grey italic text indicates excluded data in accordance with the *Industrial Noise Policy* (EPA, 2000) analysis procedure (Section B1.3).

Note 2: The *Industrial Noise Policy* (EPA, 2000) requires that, *'where the rating background level is found to be less than 30 dB(A), then it is set to 30 dB(A)'*. Where this is the case, the measured rating background levels are shown in brackets.

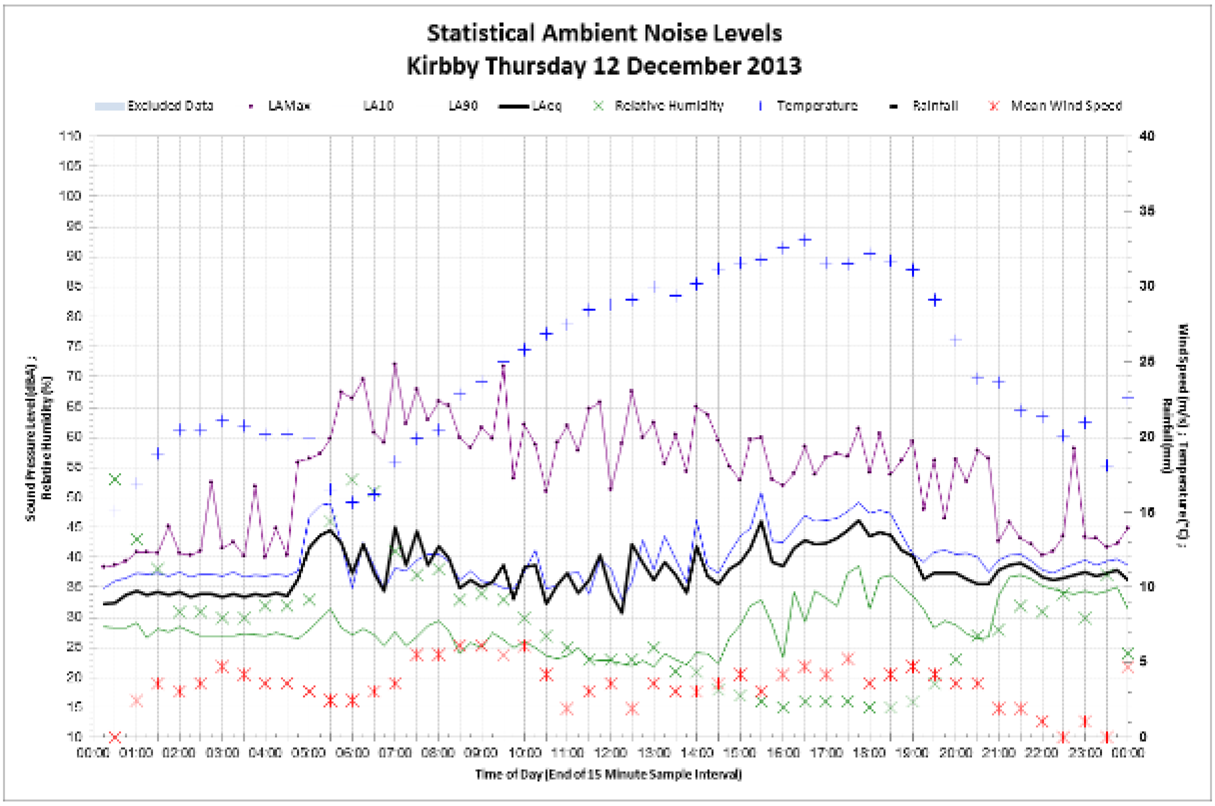




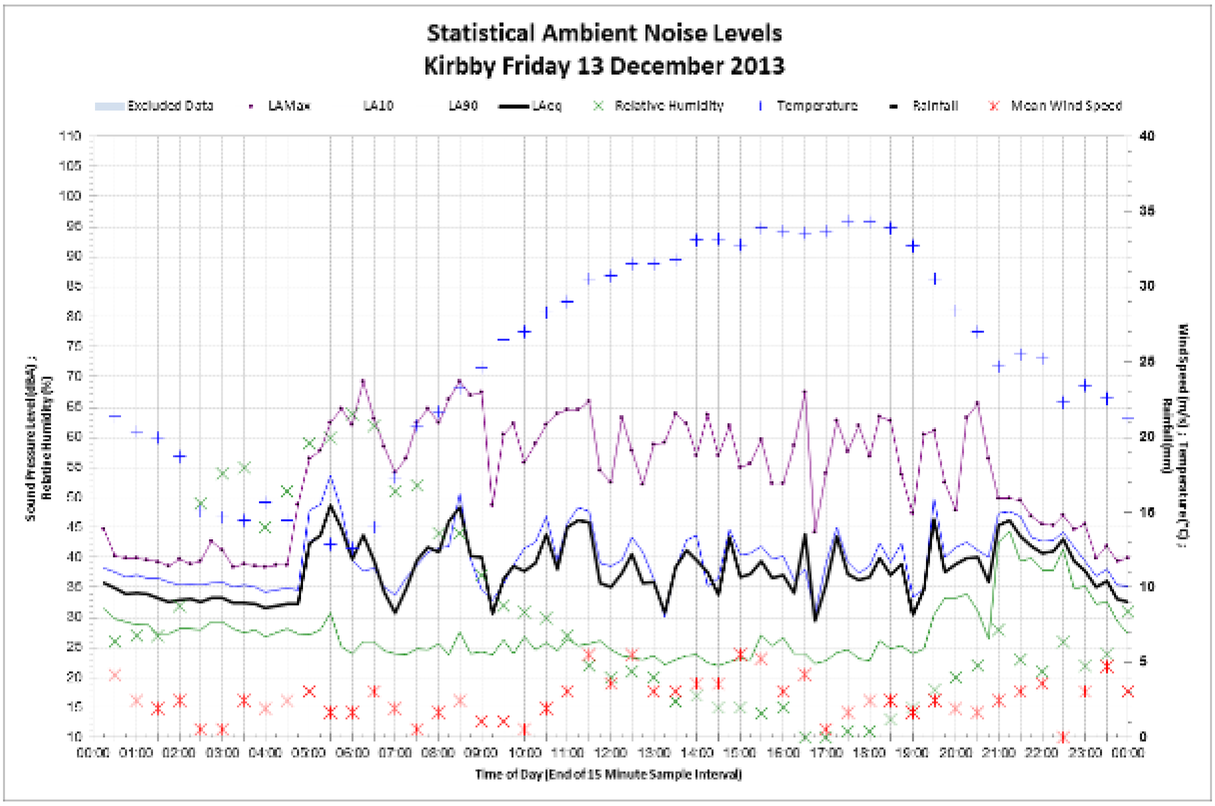
Statistical Ambient Noise Levels
Kirbby Tuesday 10 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



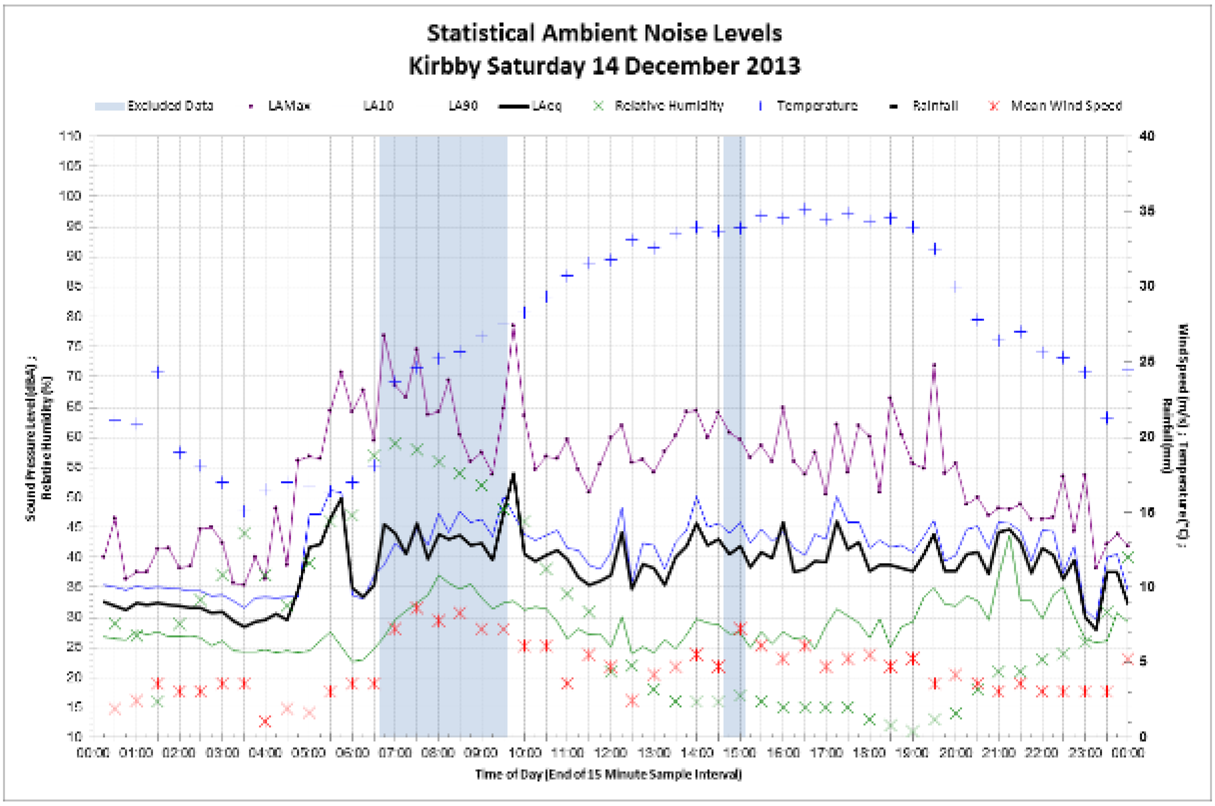
Statistical Ambient Noise Levels
Kirbby Wednesday 11 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



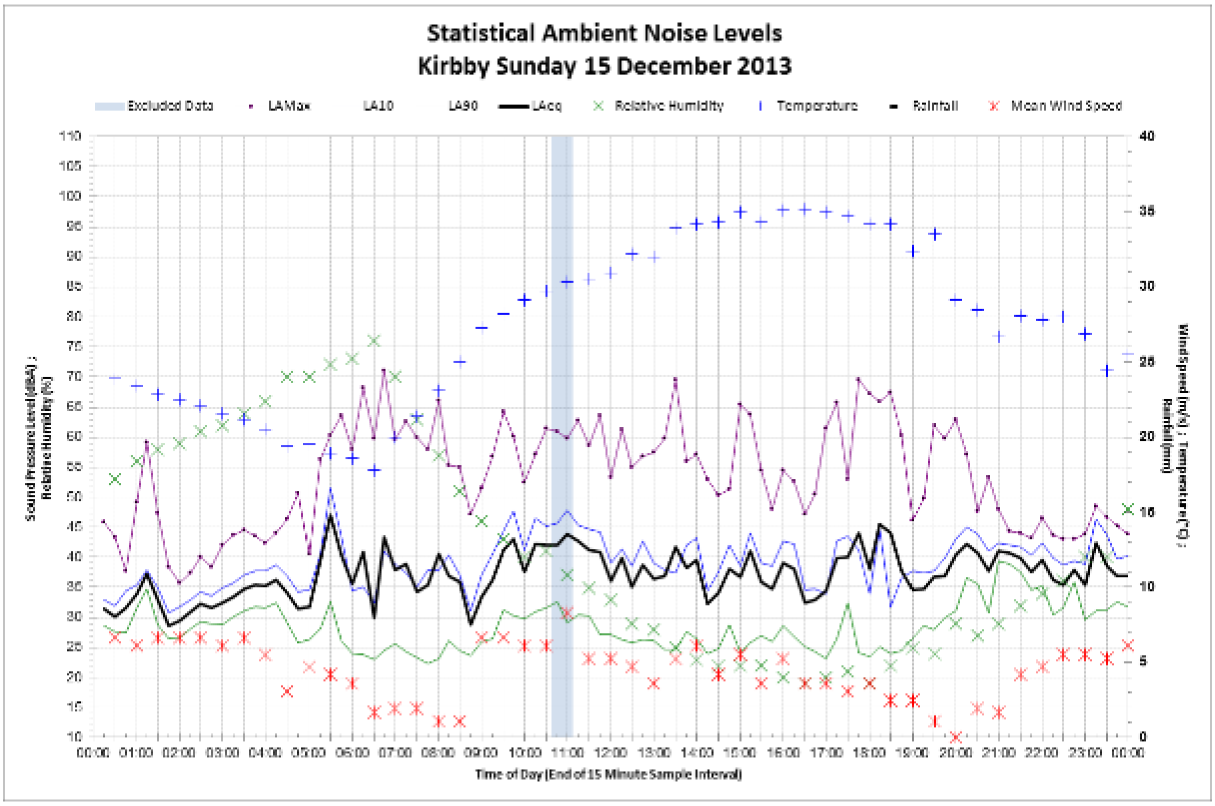
Statistical Ambient Noise Levels
Kirbby Thursday 12 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



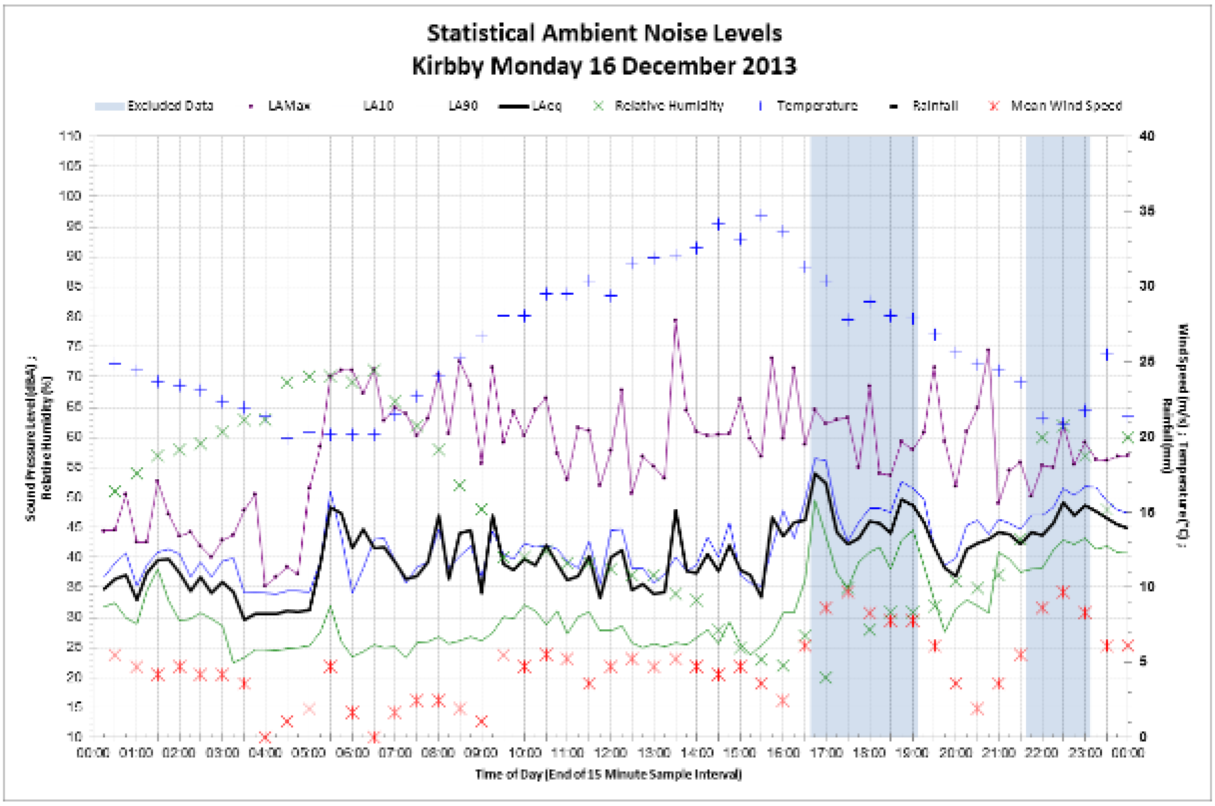
Statistical Ambient Noise Levels
Kirbby Friday 13 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

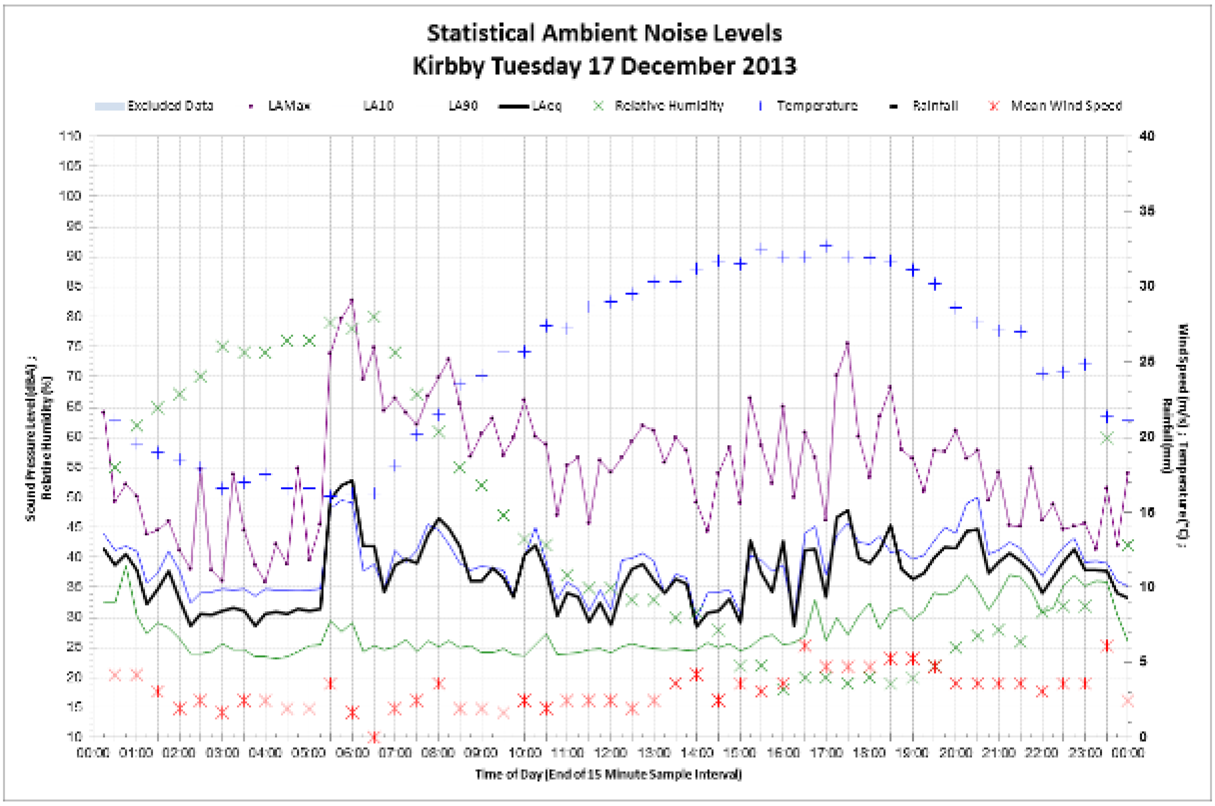


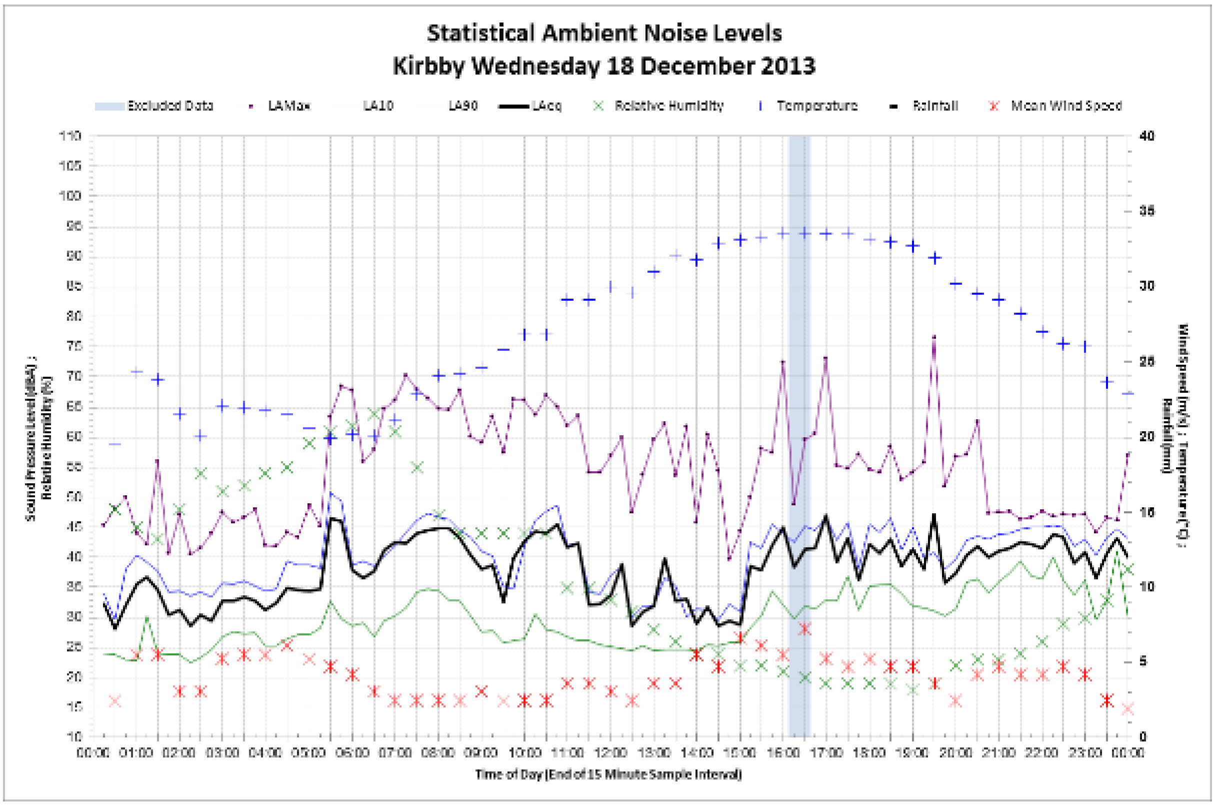
Statistical Ambient Noise Levels
Kirbby Saturday 14 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

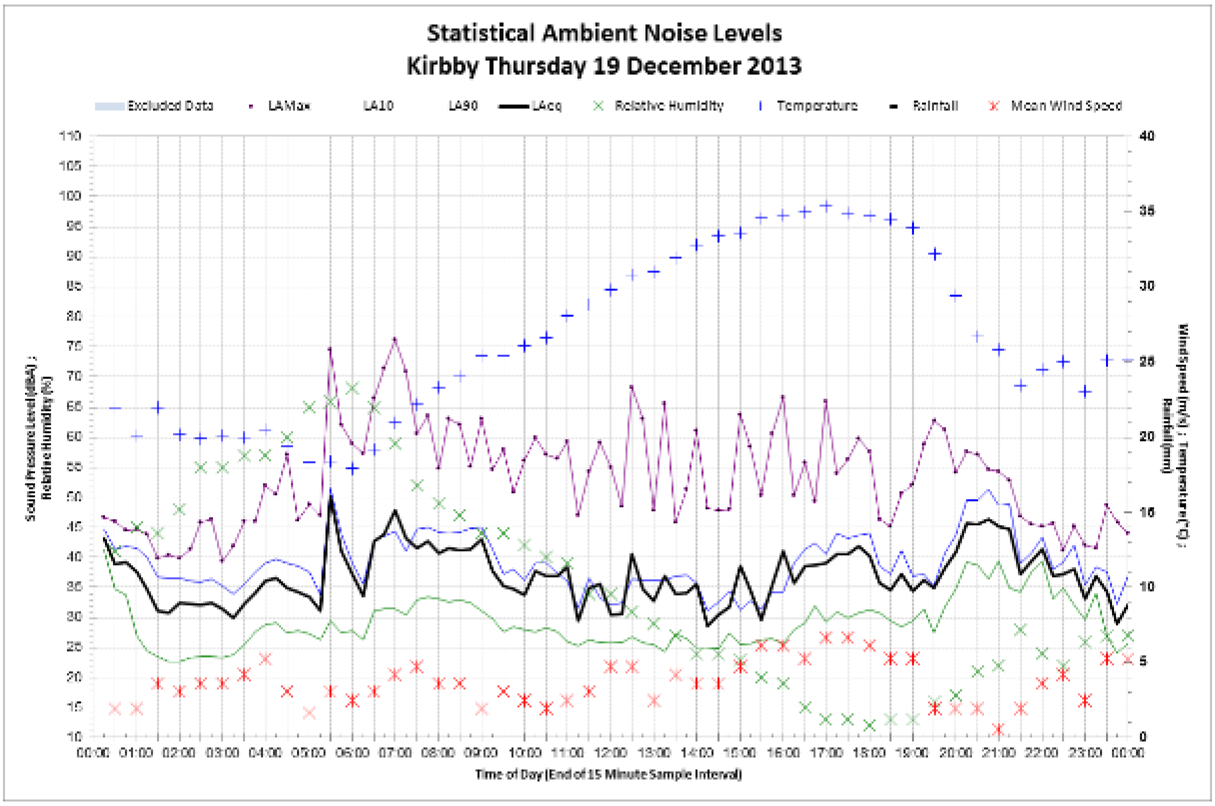


Statistical Ambient Noise Levels
Kirbby Sunday 15 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Kirbby Monday 16 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Kirbby Tuesday 17 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Kirbby Wednesday 18 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Kirbby Thursday 19 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

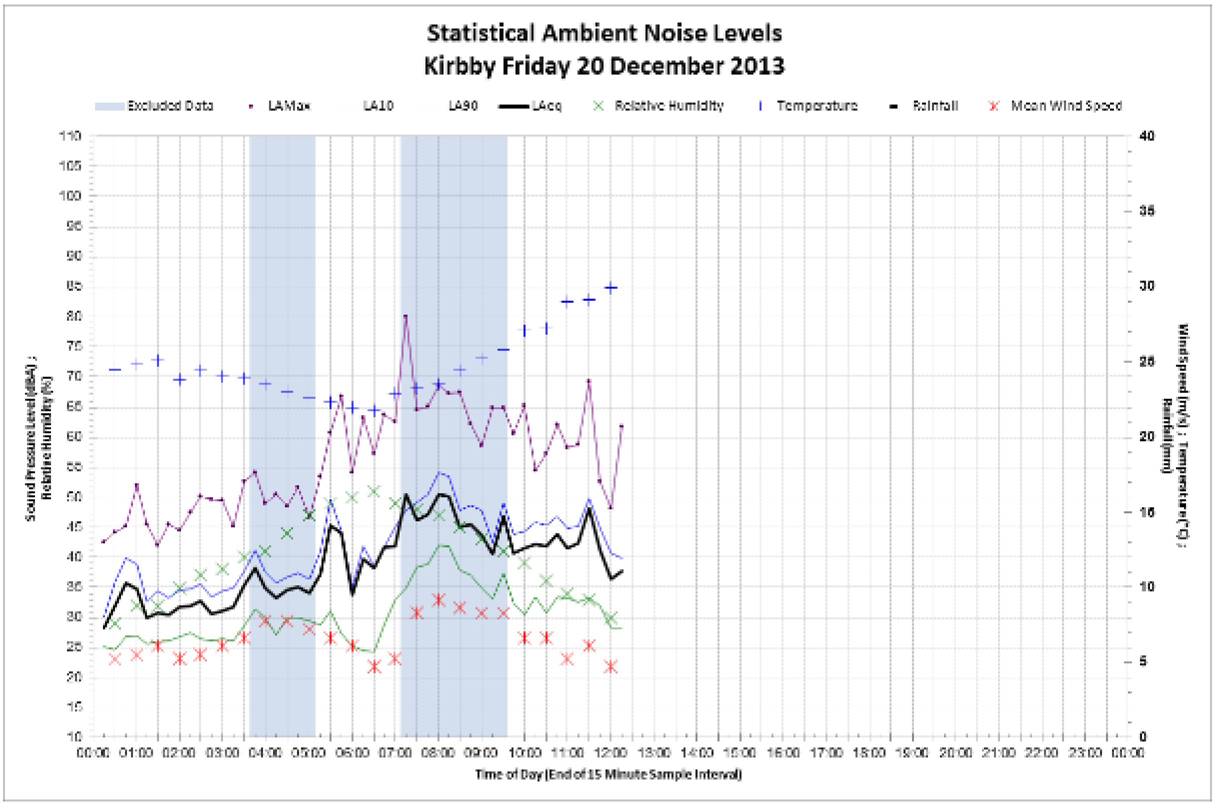
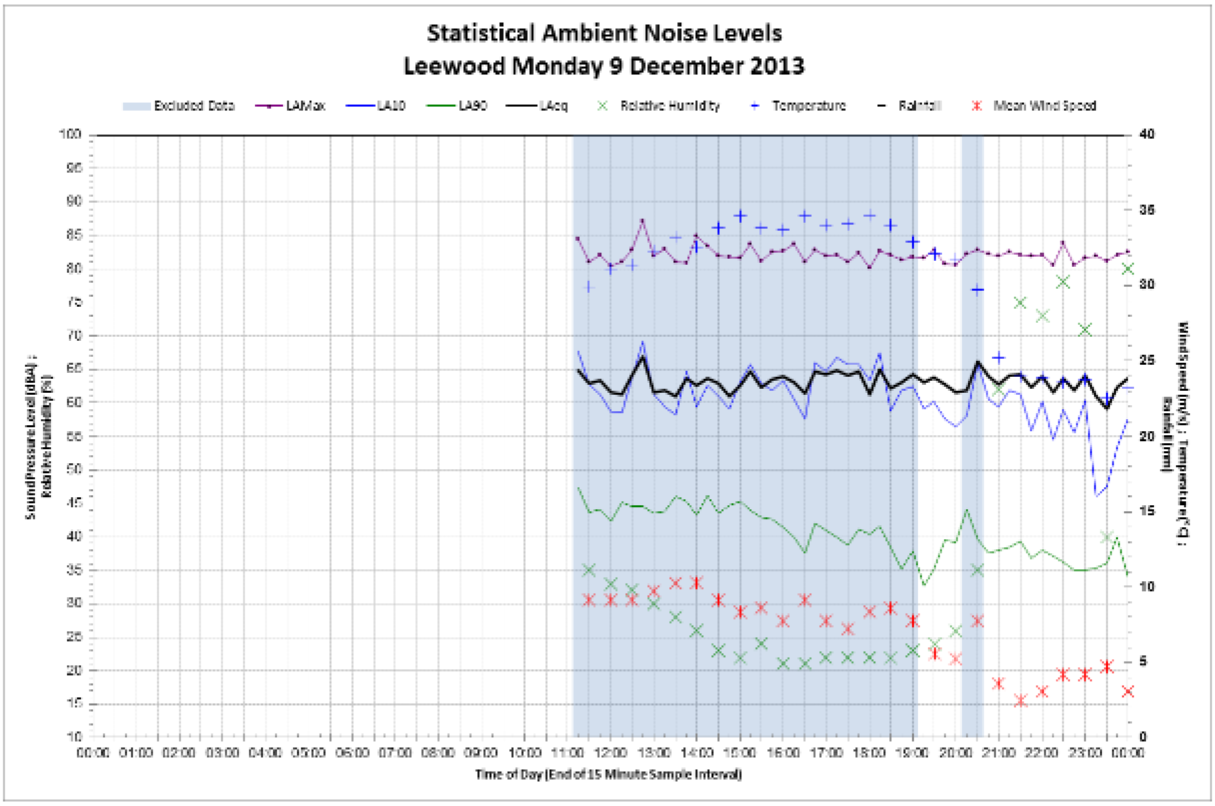

Statistical Ambient Noise Levels
Kirbby Friday 20 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

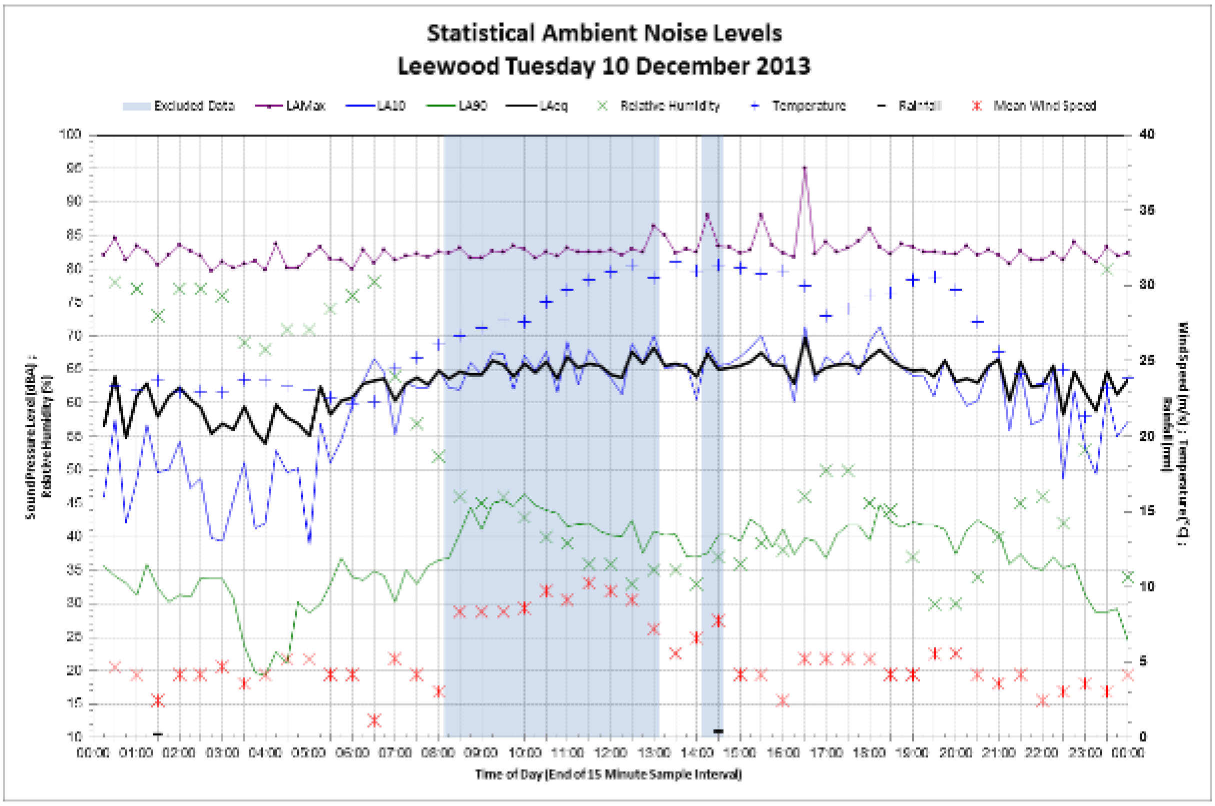
Table B-1-3 Noise monitoring Location C (Leewood) - noise levels, dB(A)

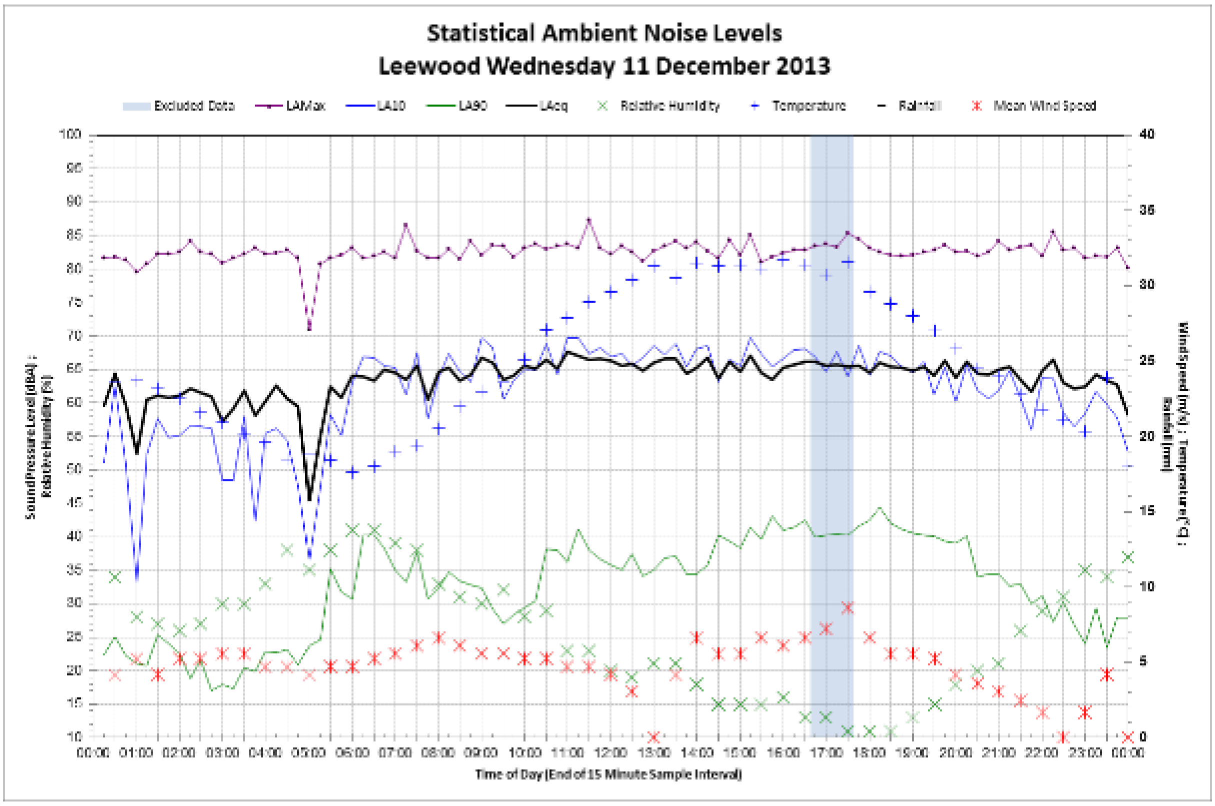
Date	Rating background level 90th percentile $L_{A90(15min)}$			Ambient noise levels, $L_{Aeq(period)}$		
	Day	Evening	Night	Day	Evening	Night
09/12/2013	-	*33*	23	-	*63*	61
10/12/2013	*36*	36	19	*66*	65	62
11/12/2013	*29*	31	19	*66*	65	62
12/12/2013	31	30	19	66	64	61
13/12/2013	32	22	*17*	64	62	*61*
14/12/2013	*32*	29	26	*64*	63	60
15/12/2013	27	25	21	65	50	53
16/12/2013	*29*	*31*	*34*	*63*	*63*	*61*
17/12/2013	31	30	17	66	65	61
18/12/2013	33	34	20	66	65	62
19/12/2013	33	30	*20*	66	64	*61*
20/12/2013	*37*	-	-	*65*	-	-
Overall RBL and LAeq	**32**	**30**	**30 (20)**	**65**	**64**	**61**

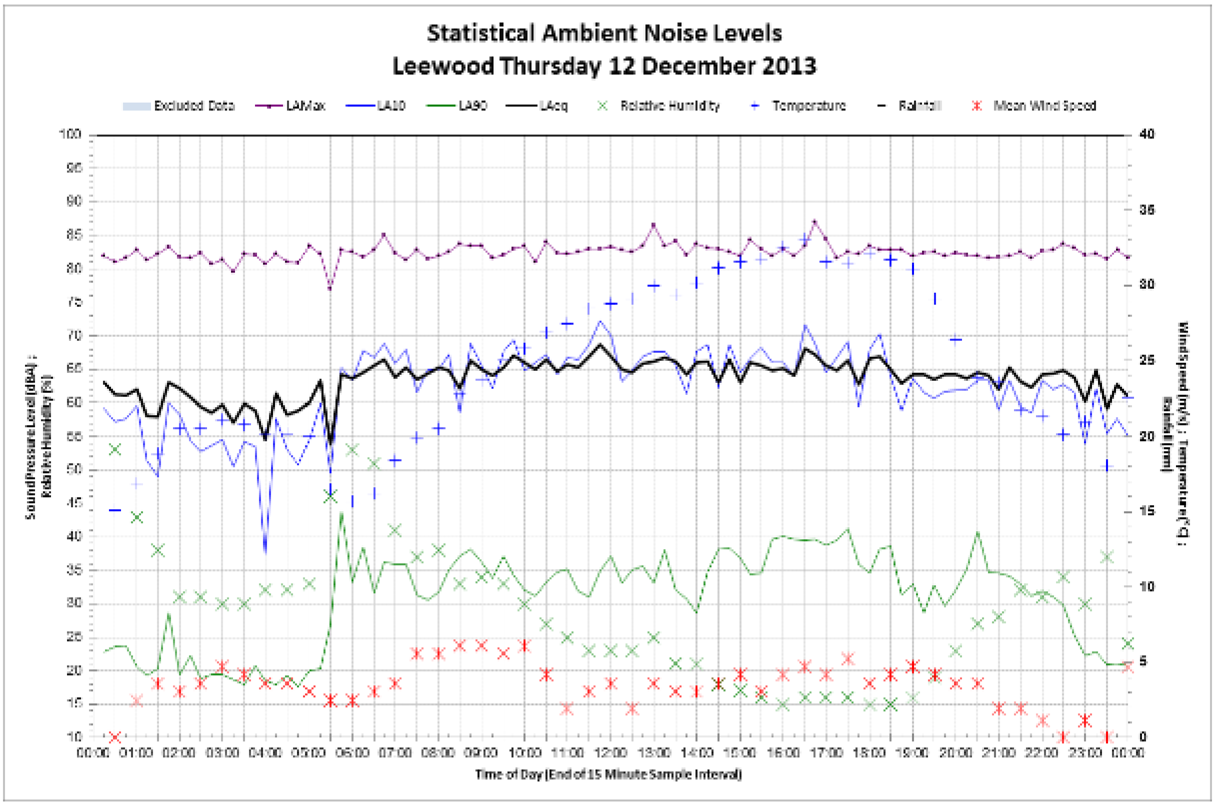
Note 1: Grey italic text indicates excluded data in accordance with the *Industrial Noise Policy* (EPA, 2000) analysis procedure (Section B1.3).

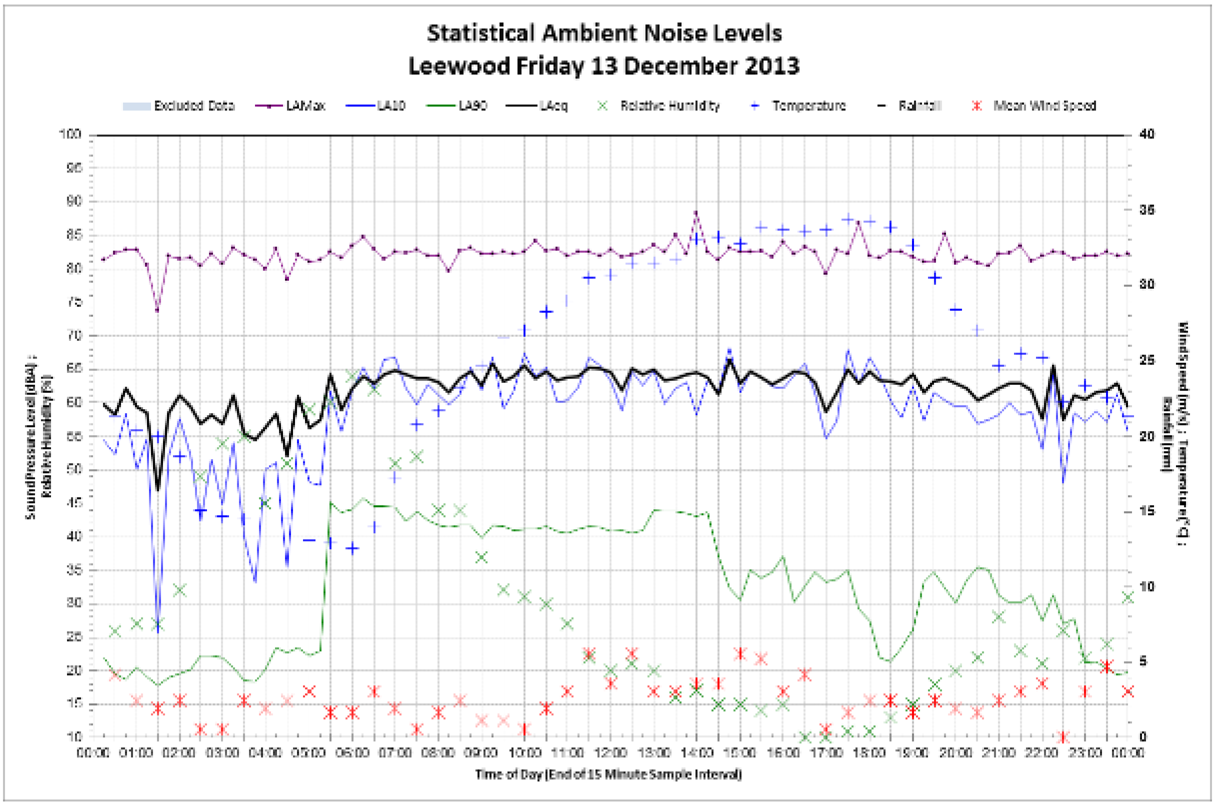
Note 2: The *Industrial Noise Policy* (EPA, 2000) requires that, *'where the rating background level is found to be less than 30 dB(A), then it is set to 30 dB(A)'*. Where this is the case, the measured rating background levels are shown in brackets.

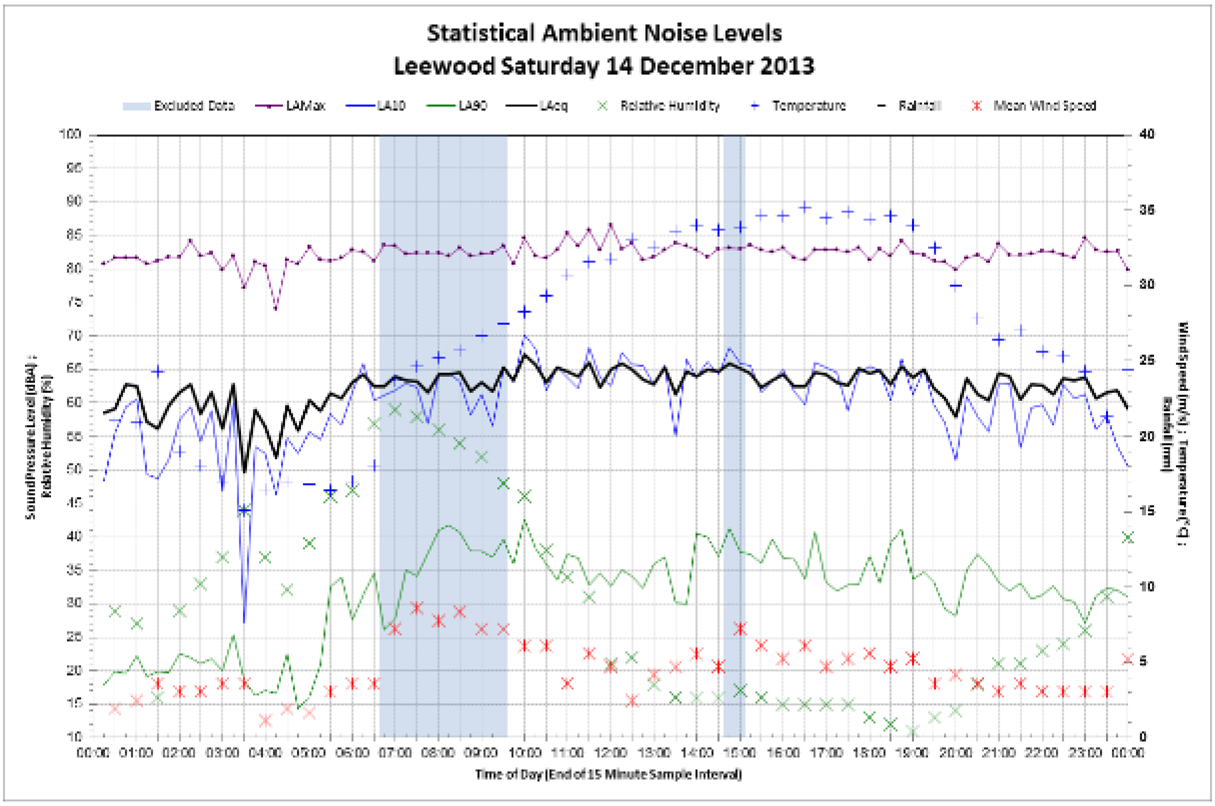


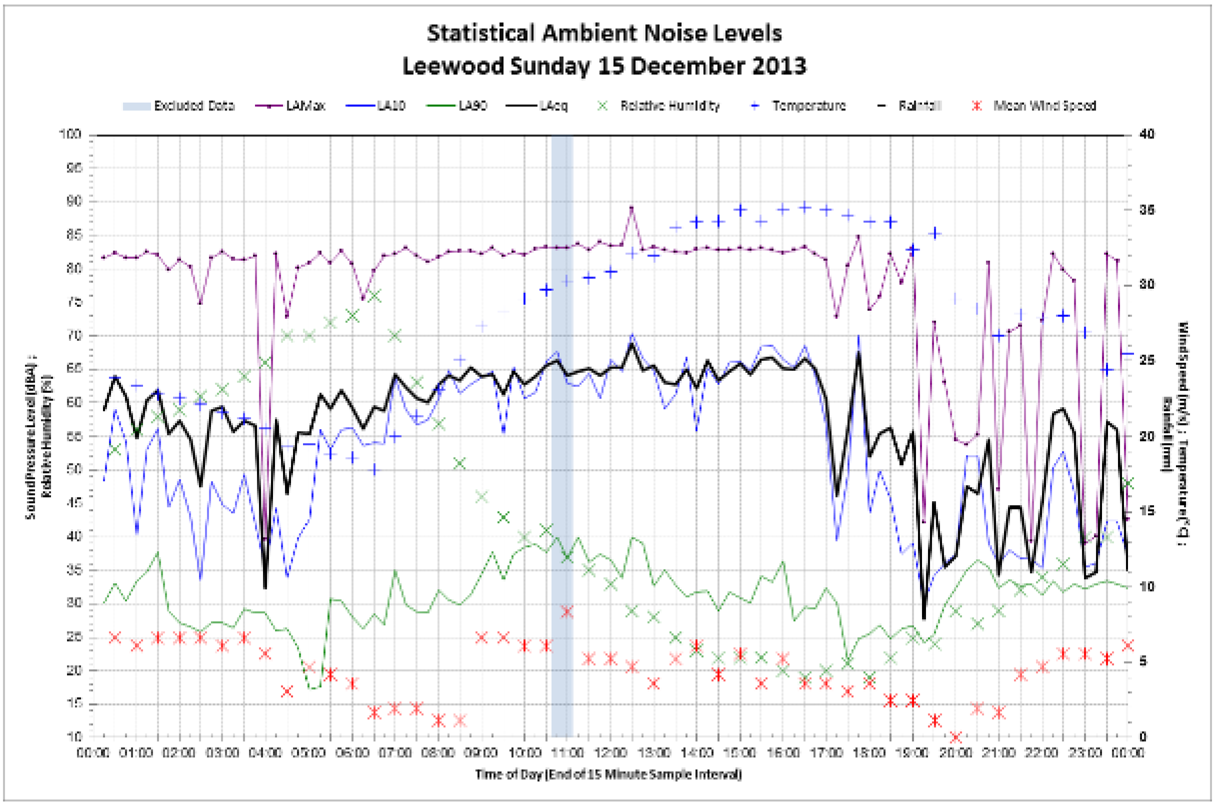

Statistical Ambient Noise Levels
Leewood Tuesday 10 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

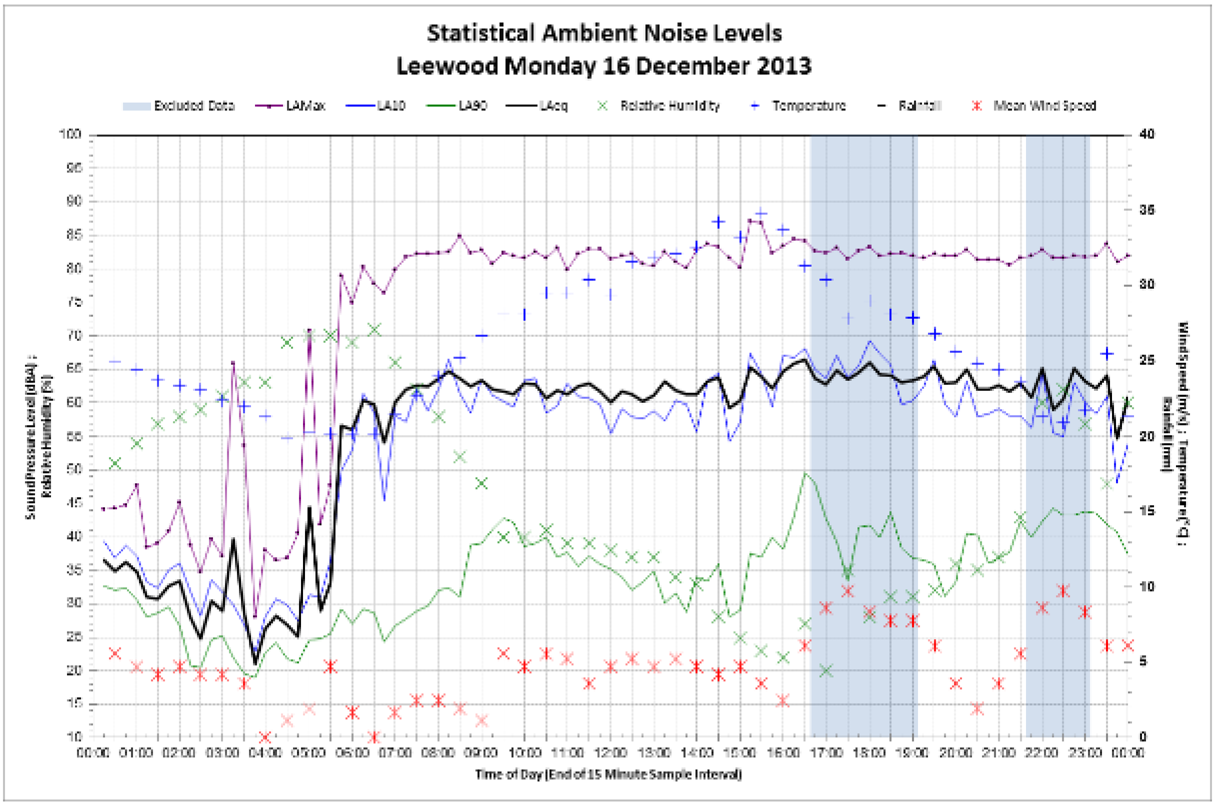

Statistical Ambient Noise Levels
Leewood Wednesday 11 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Leewood Thursday 12 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

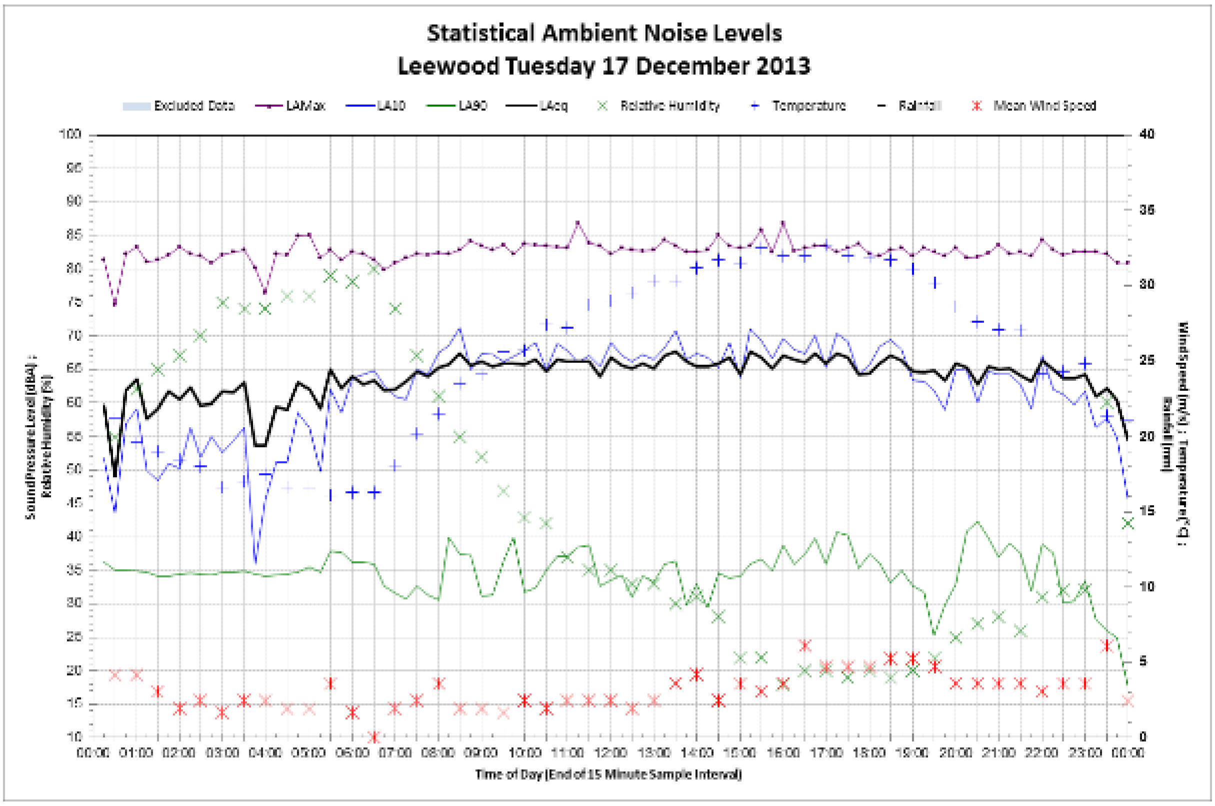

Statistical Ambient Noise Levels
Leewood Friday 13 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Leewood Saturday 14 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level [dBA] ; Relative Humidity [%]
Wind Speed [m/s] ; Temperature [°C] ; Rainfall [mm]
Time of Day [End of 15 Minute Sample Interval]

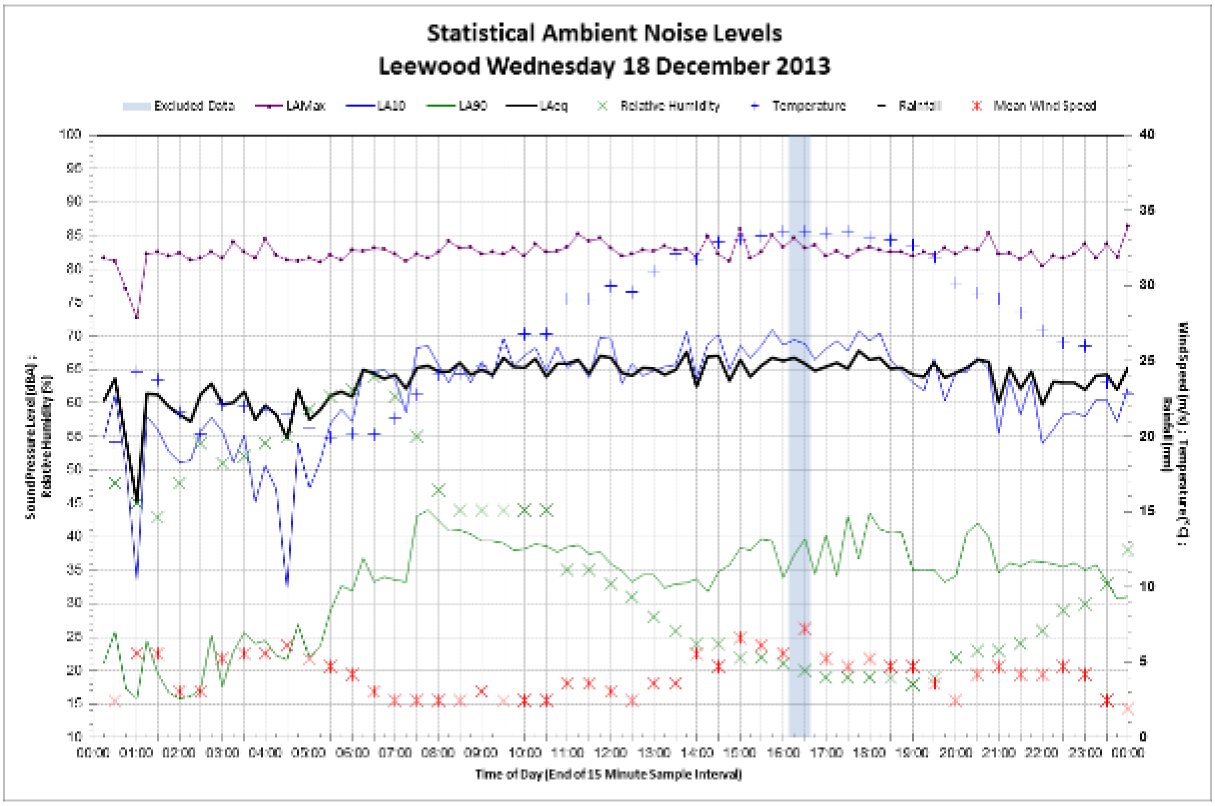

Statistical Ambient Noise Levels
Leewood Sunday 15 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level [dBA] ; Relative Humidity [%]
Wind Speed [m/s] ; Temperature [°C] ; Rainfall [mm]
Time of Day [End of 15 Minute Sample Interval]

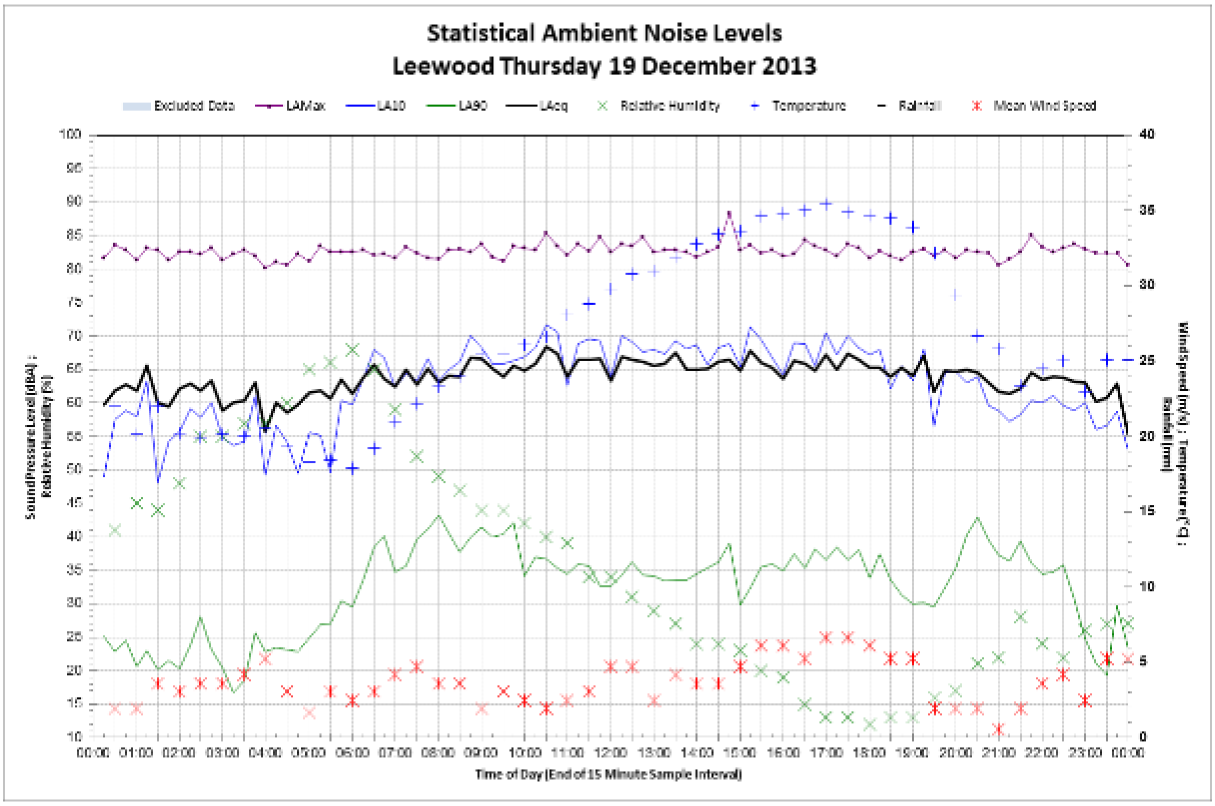


Statistical Ambient Noise Levels
Leewood Monday 16 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
Leewood Tuesday 17 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Leewood Wednesday 18 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)
00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 09:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 00:00


Statistical Ambient Noise Levels
Leewood Thursday 19 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)
00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 09:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 00:00

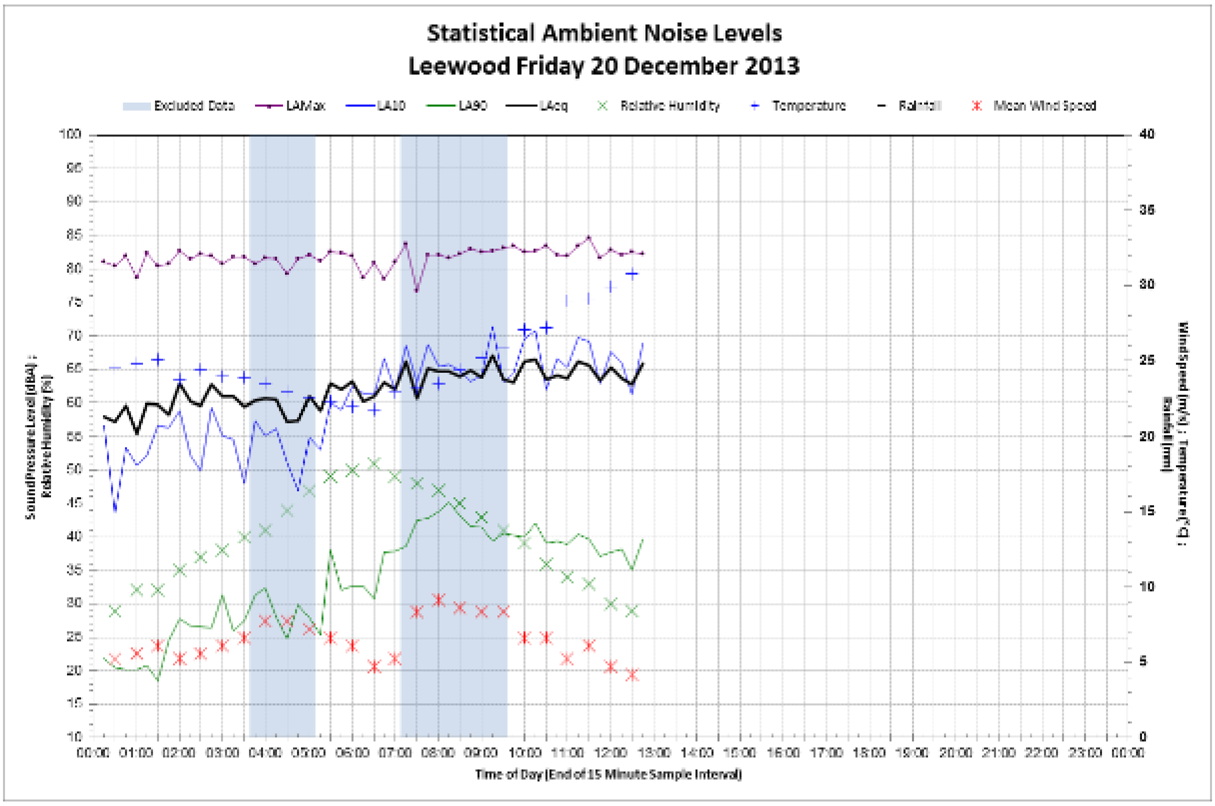
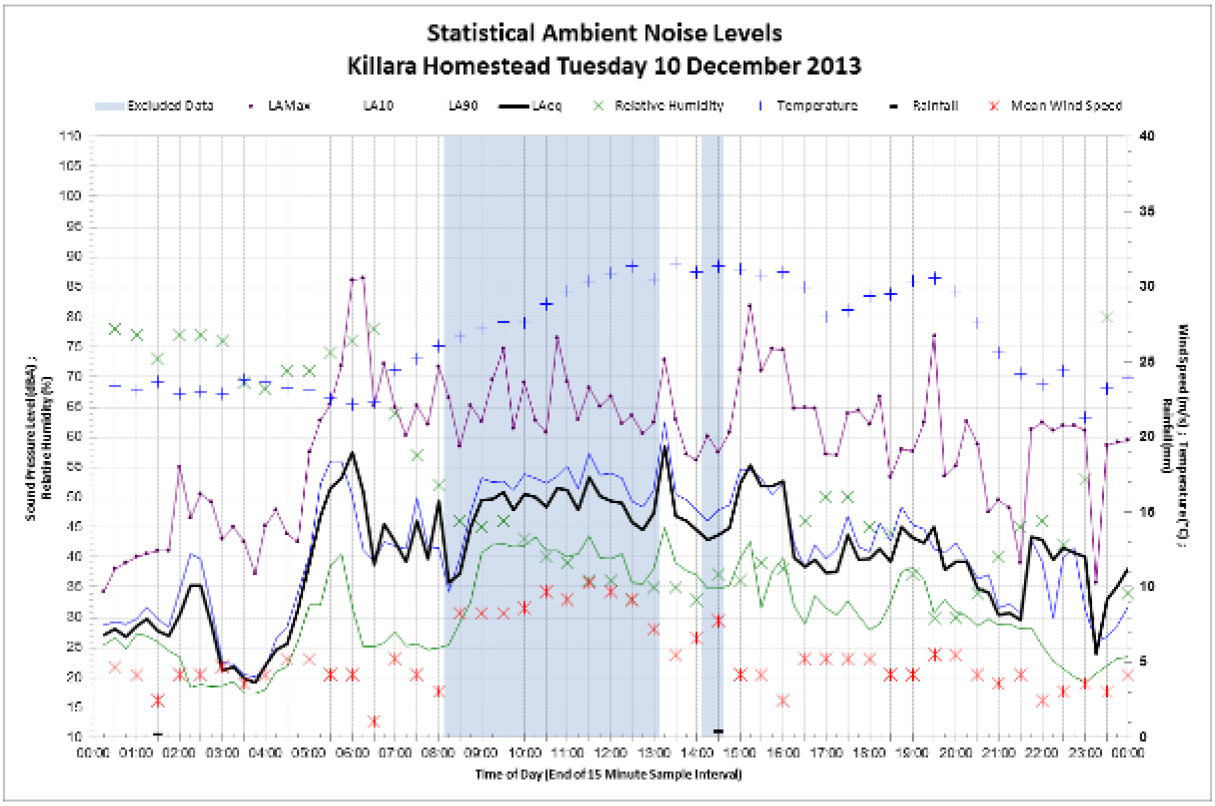

Statistical Ambient Noise Levels
Leewood Friday 20 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

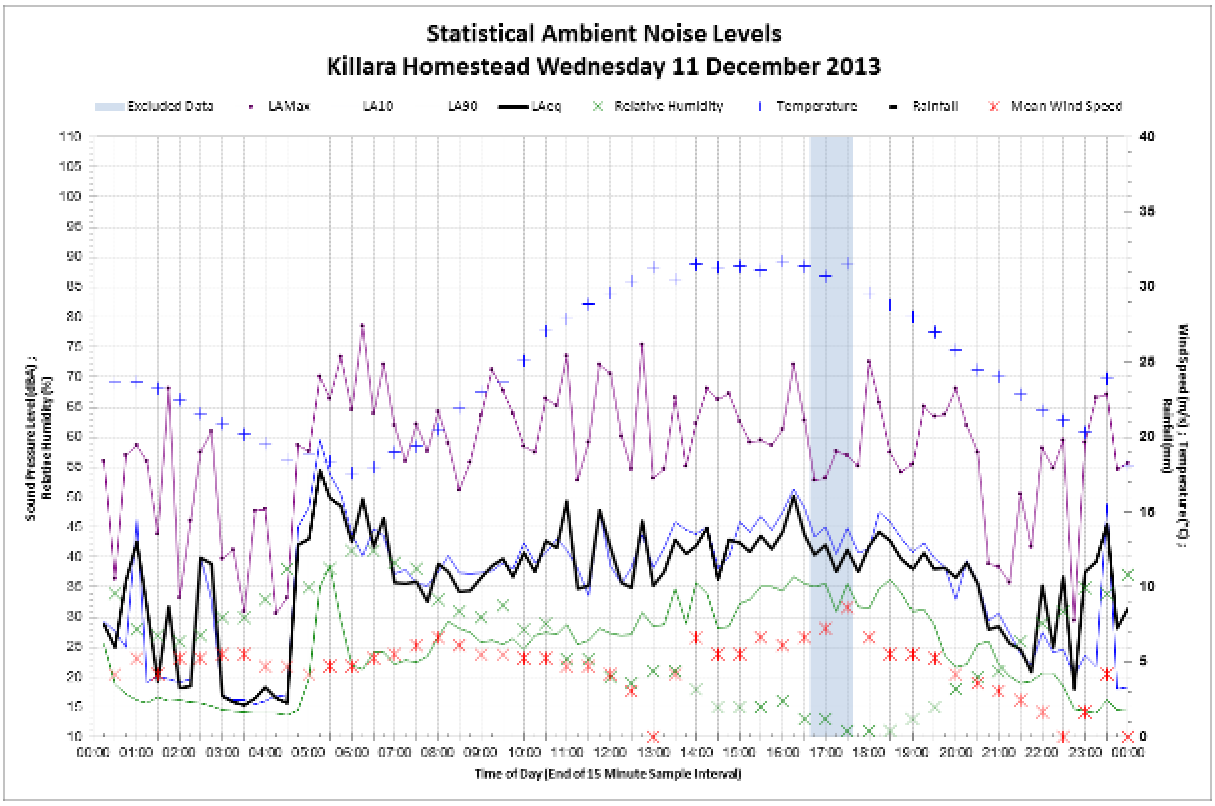
Table B-1-4 Noise monitoring Location D (Killara) - noise levels, dB(A)

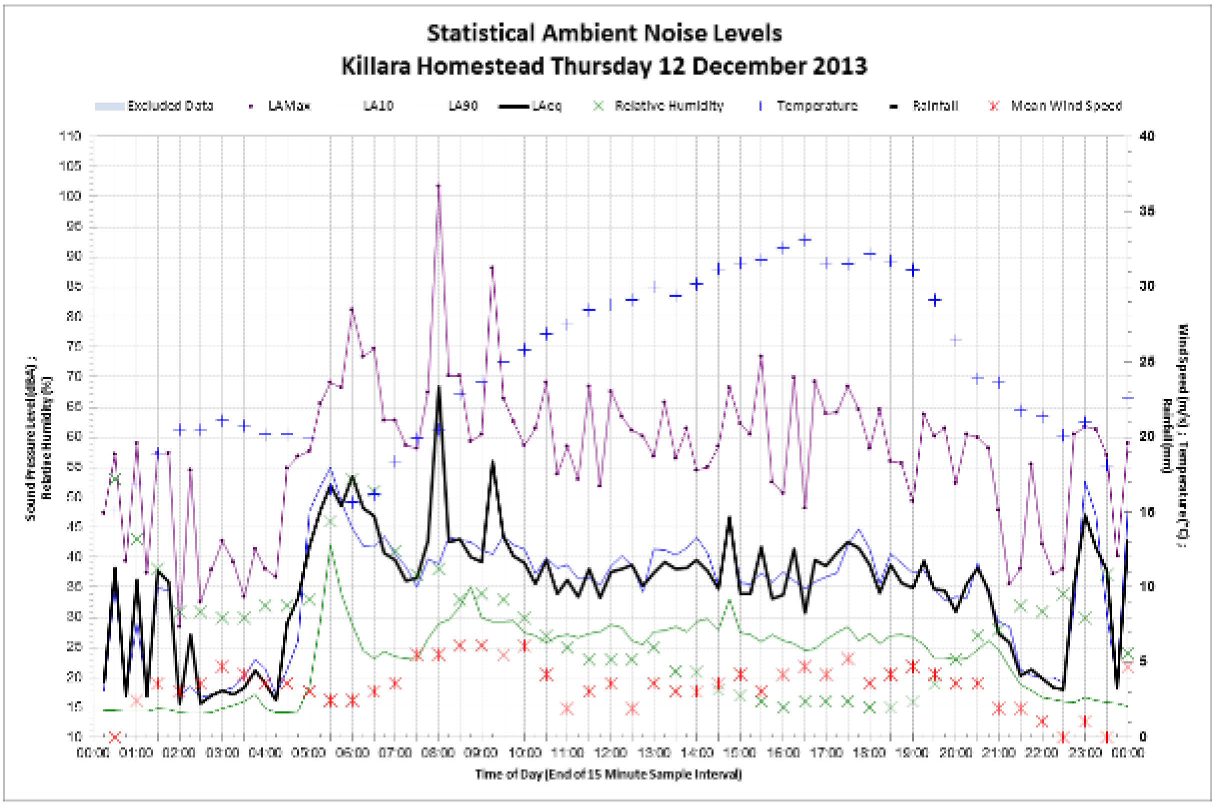
Date	Rating background level 90th percentile $L_{A90(15min)}$			Ambient noise levels, $L_{Aeq(period)}$		
	Day	Evening	Night	Day	Evening	Night
09/12/2013	-	*26*	18	-	*36*	45
10/12/2013	*25*	28	14	*50*	41	43
11/12/2013	*25*	19	14	*42*	38	43
12/12/2013	25	18	14	52	35	47
13/12/2013	24	22	*14*	50	40	*44*
14/12/2013	*26*	23	22	*45*	35	41
15/12/2013	24	24	23	42	41	46
16/12/2013	*24*	*29*	*15*	*44*	*45*	*45*
17/12/2013	24	25	14	47	43	48
18/12/2013	25	29	14	45	57	44
19/12/2013	24	23	*15*	41	37	*44*
20/12/2013	*25*	-	-	*42*	-	-
Overall RBL and LAeq	**30 (24)**	**30 (24)**	**30 (14)**	**48**	**48**	**45**

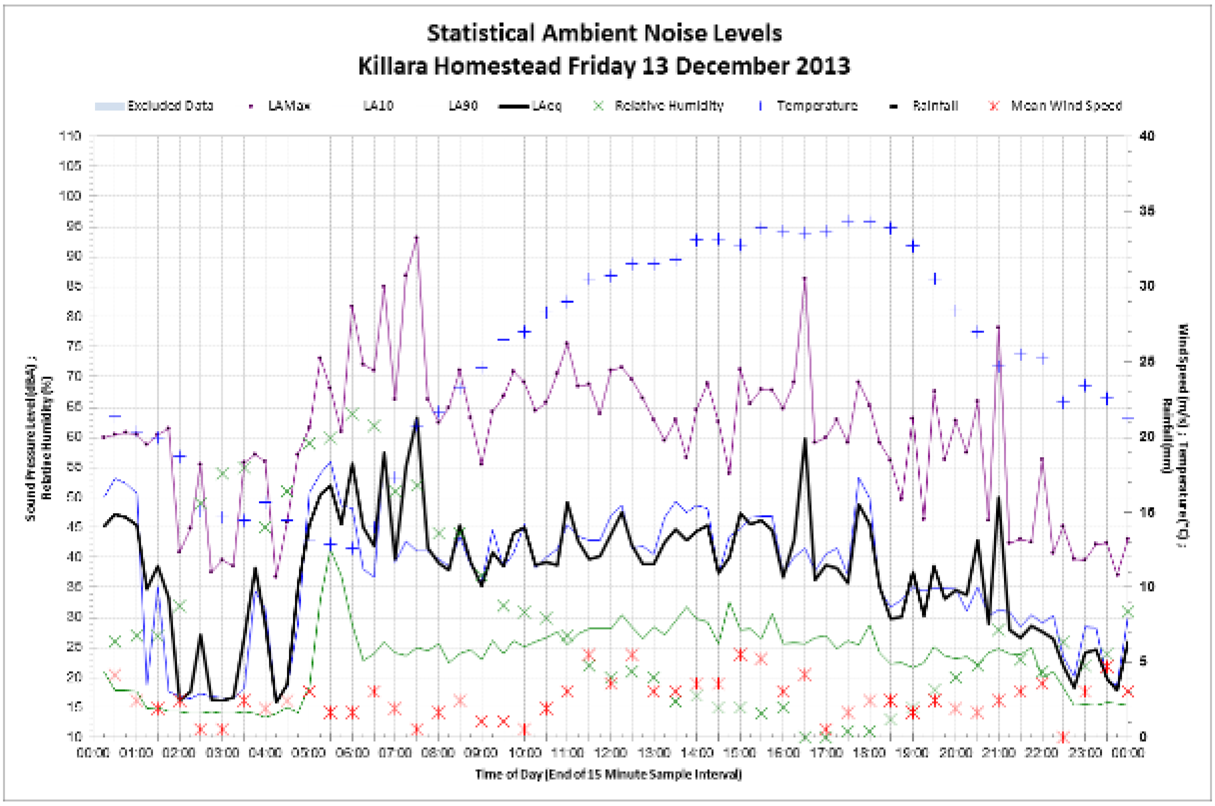
Note 1: Grey italic text indicates excluded data in accordance with the *Industrial Noise Policy* (EPA, 2000) analysis procedure (Section B1.3).

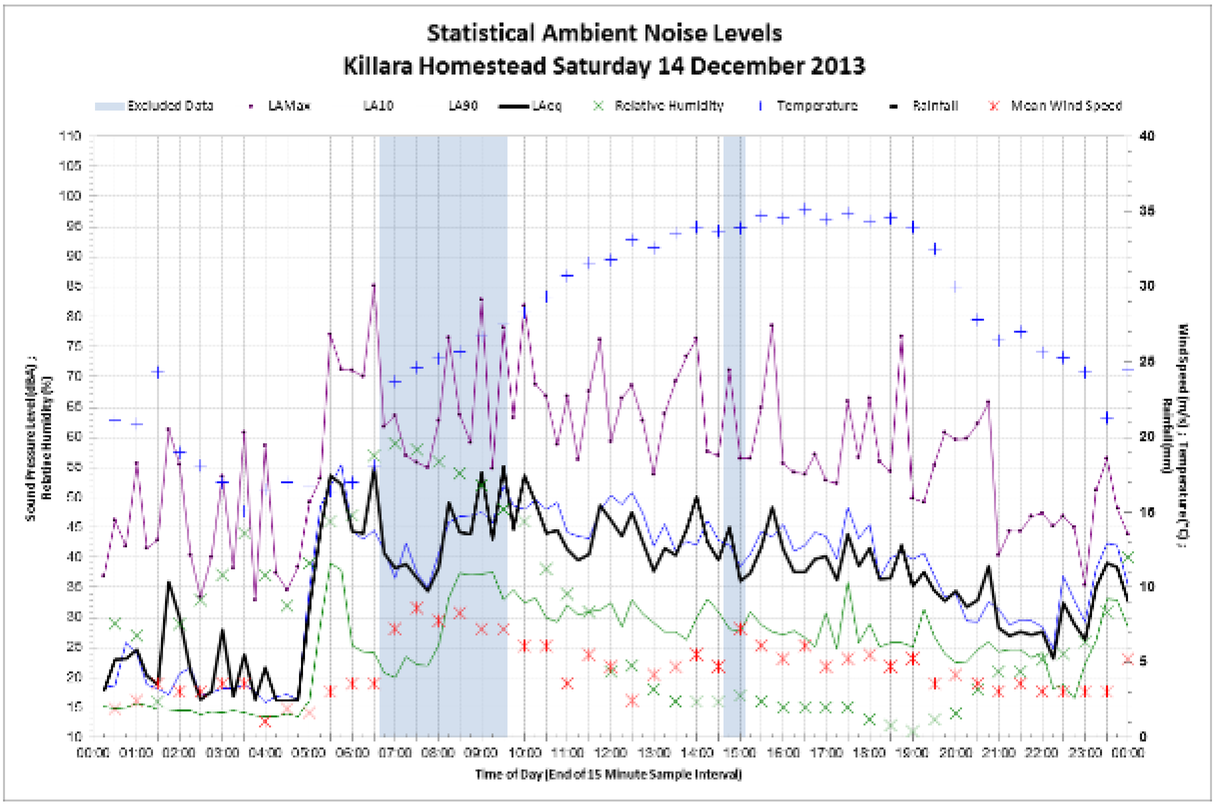
Note 2: The *Industrial Noise Policy* (EPA, 2000) requires that, *'where the rating background level is found to be less than 30 dB(A), then it is set to 30 dB(A)'*. Where this is the case, the measured rating background levels are shown in brackets.

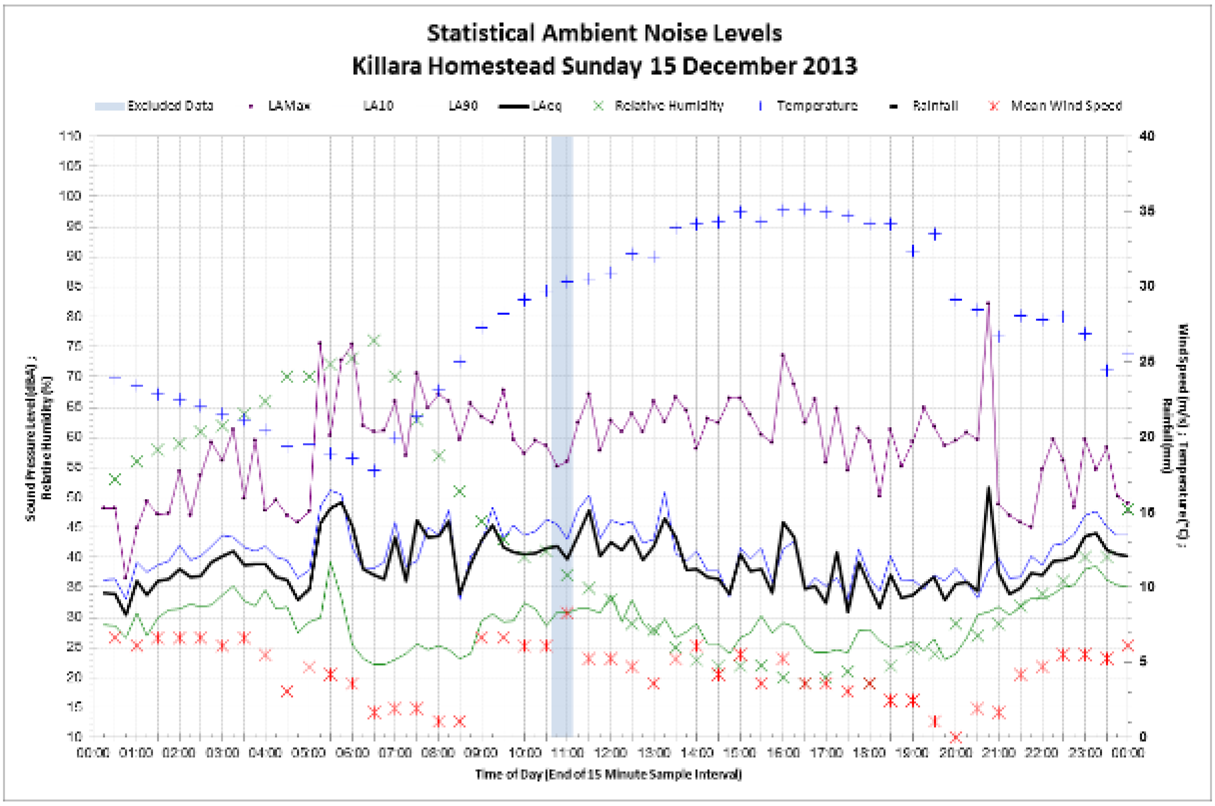


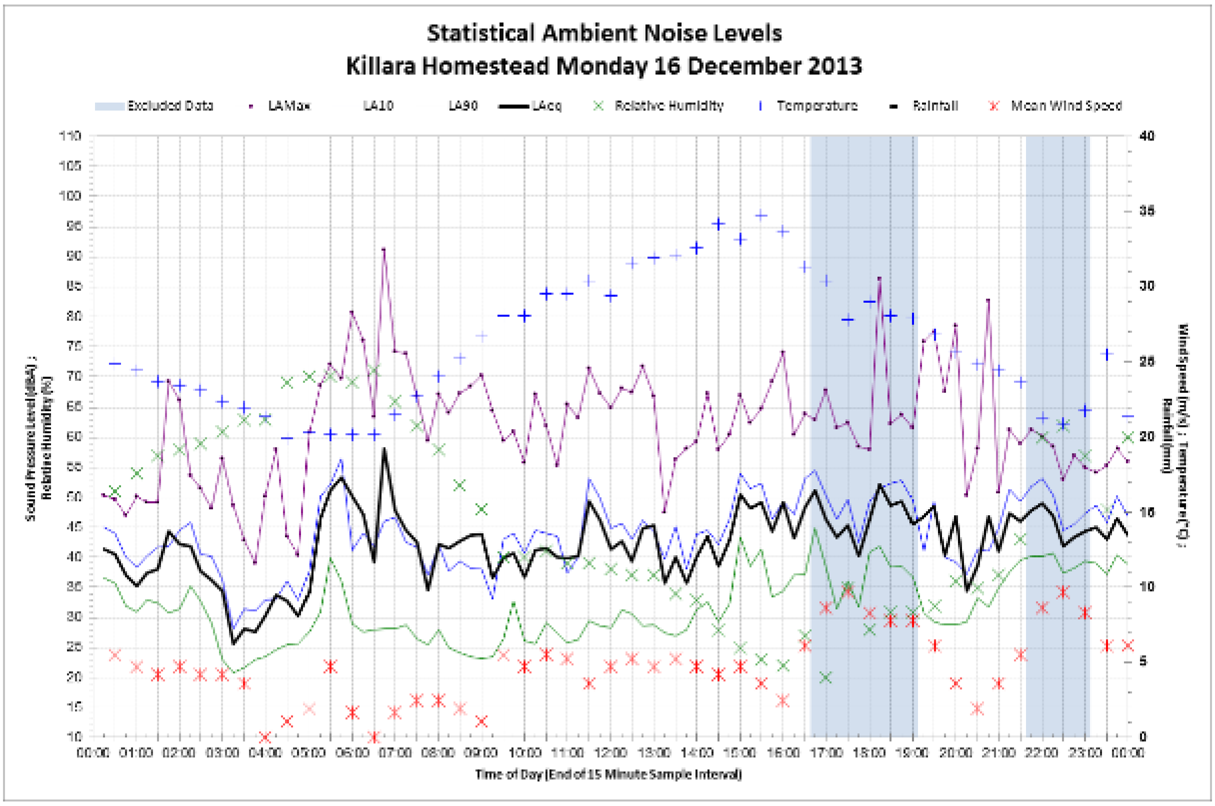

Statistical Ambient Noise Levels
Killara Homestead Wednesday 11 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

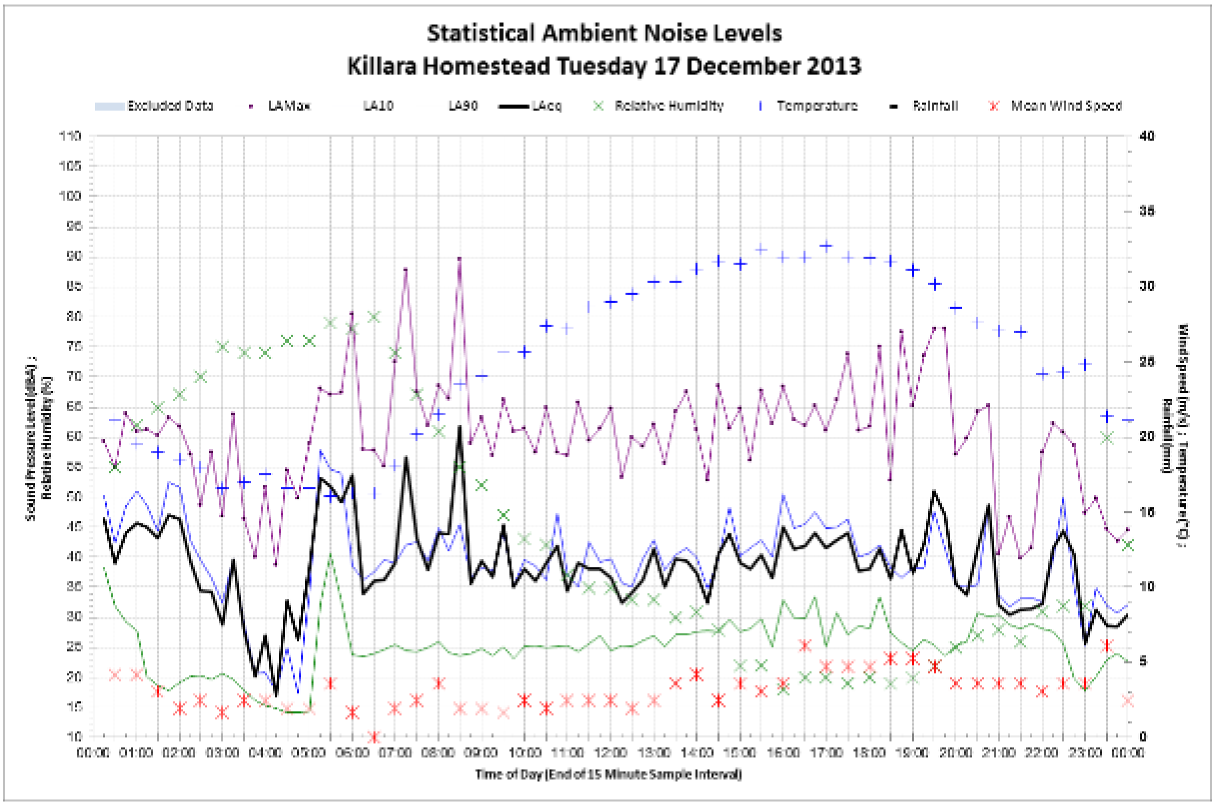

Statistical Ambient Noise Levels
Killara Homestead Thursday 12 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

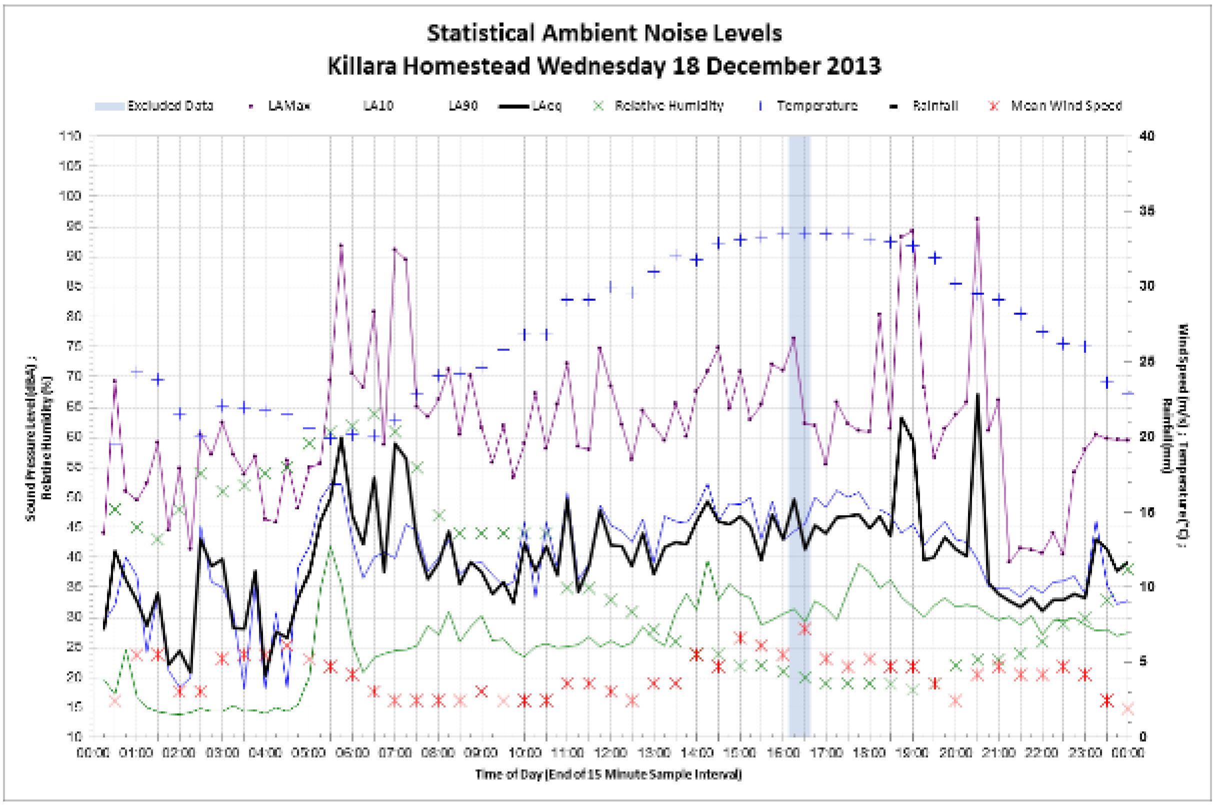

Statistical Ambient Noise Levels
Killara Homestead Friday 13 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

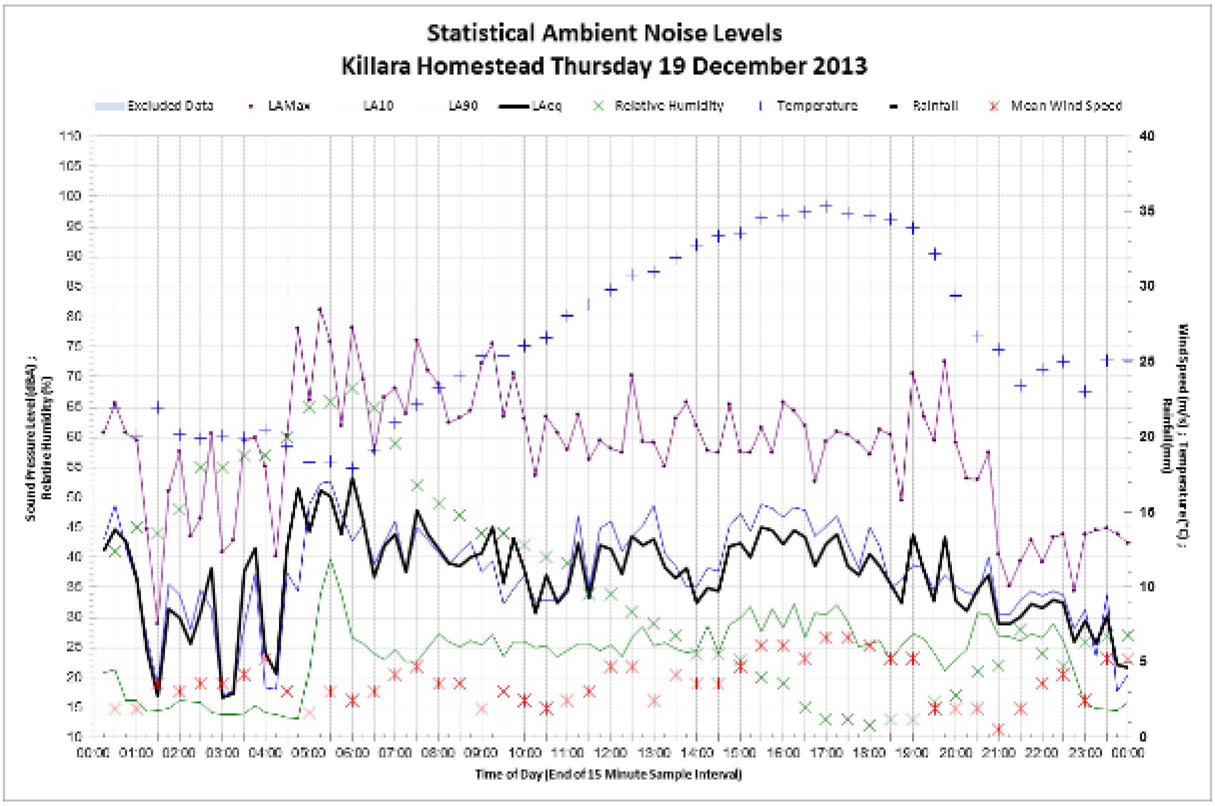

Statistical Ambient Noise Levels
Killara Homestead Saturday 14 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Killara Homestead Sunday 15 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

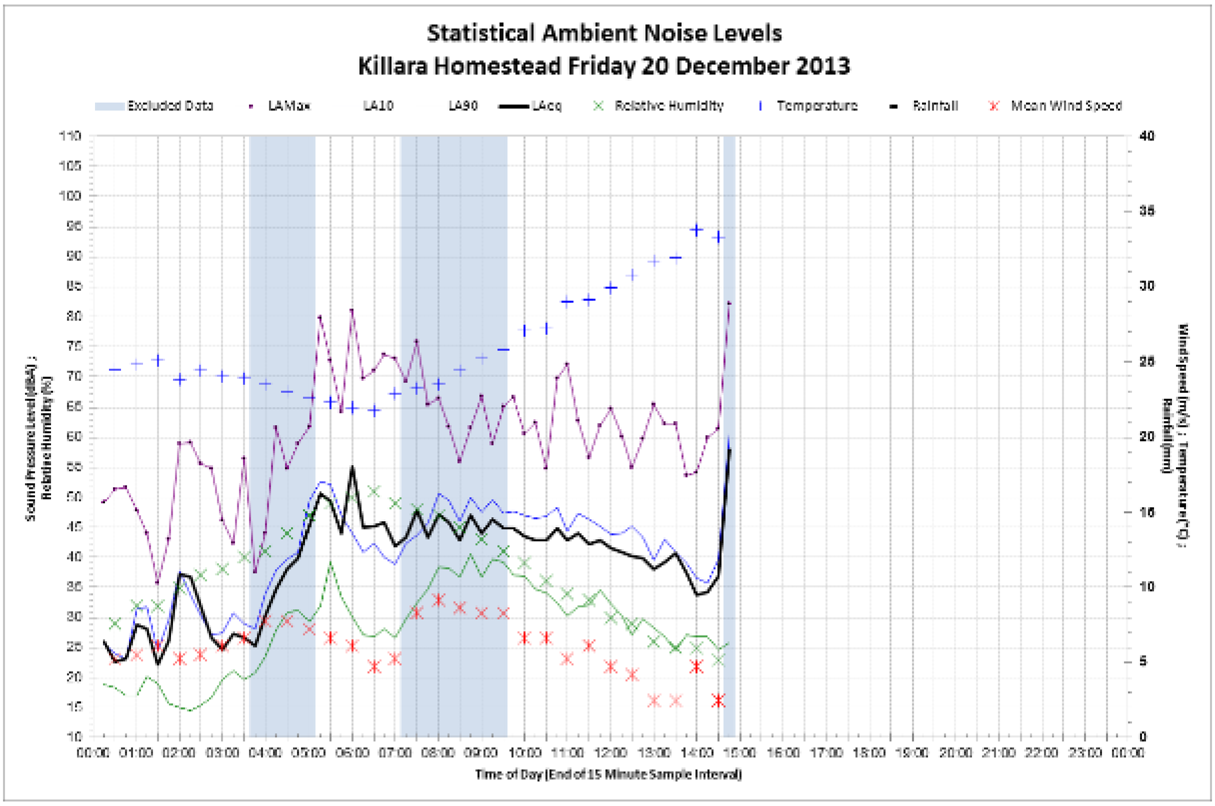

Statistical Ambient Noise Levels
Killara Homestead Monday 16 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Killara Homestead Tuesday 17 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Killara Homestead Wednesday 18 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
Killara Homestead Thursday 19 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



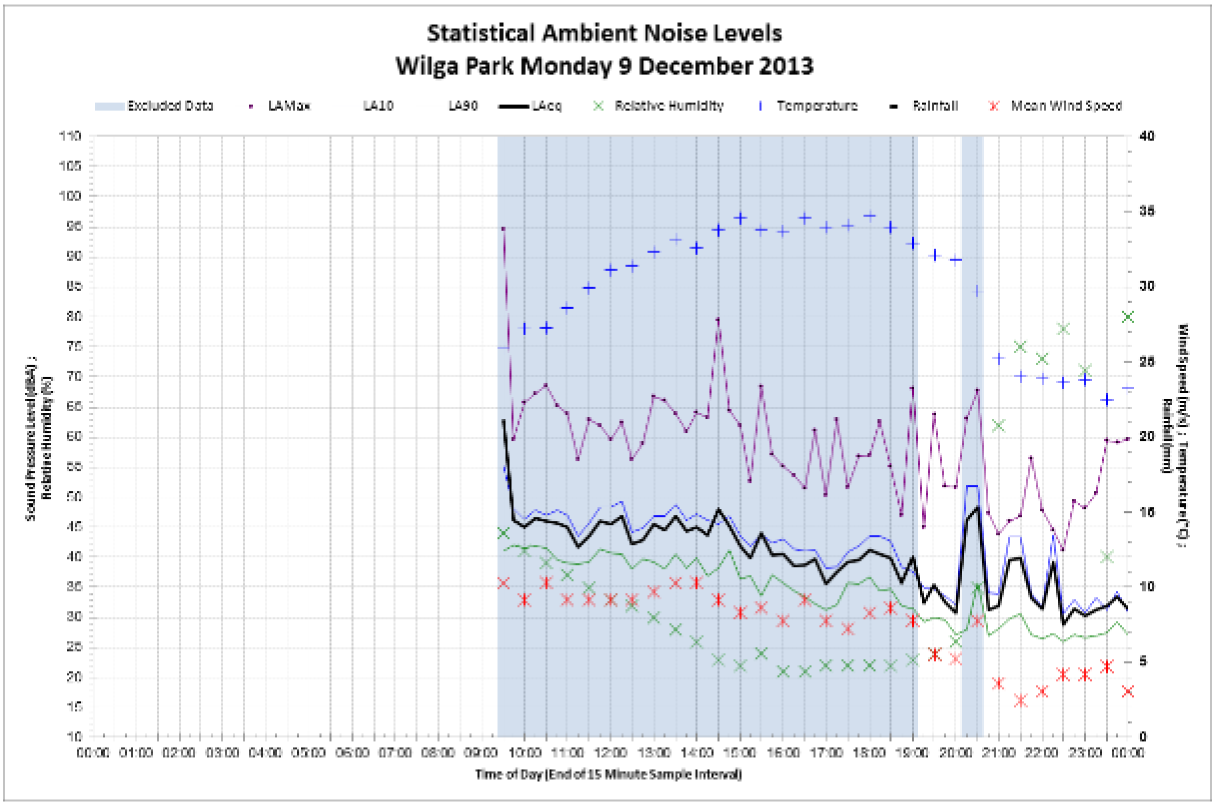
Statistical Ambient Noise Levels
Killara Homestead Friday 20 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

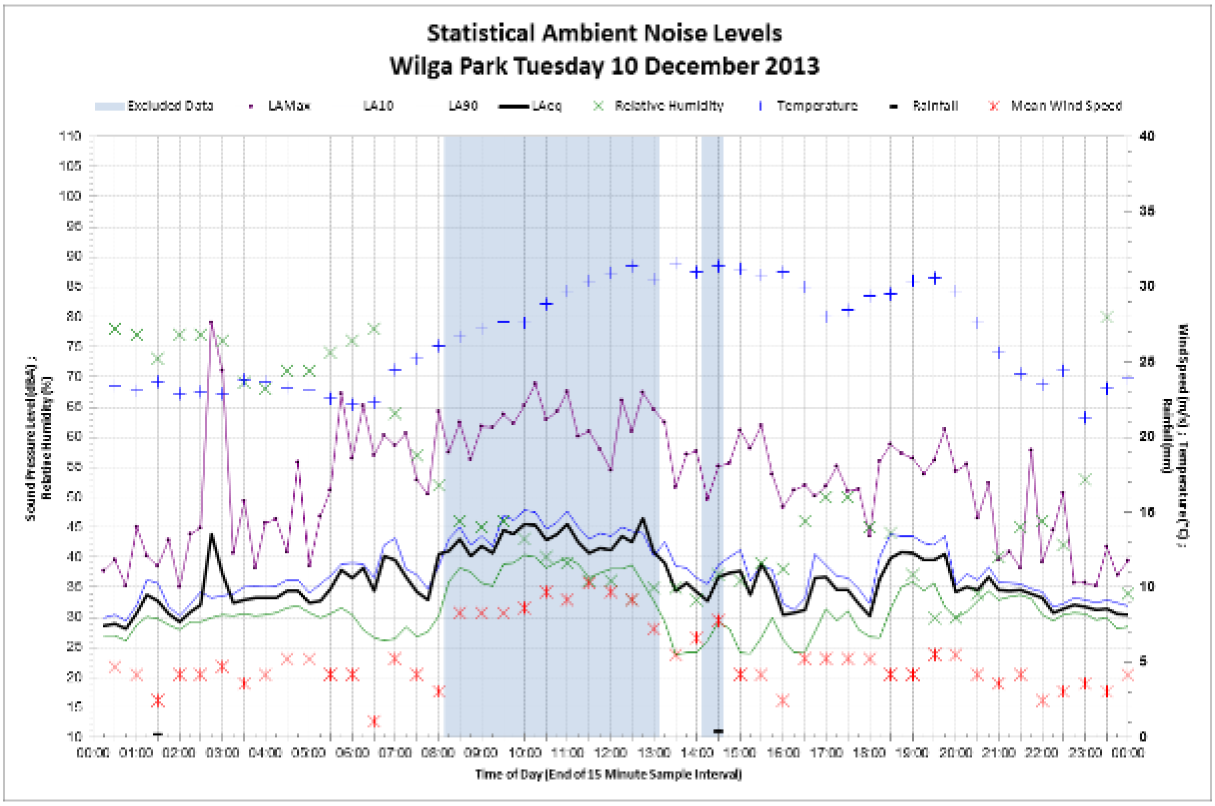
Table B-1-5 Noise monitoring Location E (Bibblewindi 12) - noise levels, dB(A)

Date	Rating background level 90th percentile $L_{A90(15min)}$			Ambient noise levels, $L_{Aeq(period)}$		
	Day	Evening	Night	Day	Evening	Night
09/12/2013	-	*32*	20	-	*62*	45
10/12/2013	*23*	34	13	*42*	49	46
11/12/2013	*22*	23	13	*36*	36	27
12/12/2013	22	22	13	40	35	30
13/12/2013	19	22	*13*	39	36	*27*
14/12/2013	*24*	26	19	*36*	38	34
15/12/2013	22	24	17	35	39	36
16/12/2013	*25*	*30*	*16*	*54*	*67*	*62*
17/12/2013	22	30	15	36	68	61
18/12/2013	22	33	15	40	40	34
19/12/2013	22	24	*15*	36	42	*33*
20/12/2013	*25*	-	-	*37*	-	-
Overall RBL and LAeq	**30 (22)**	**30 (24)**	**30 (15)**	**38**	**58**[3]	**52**

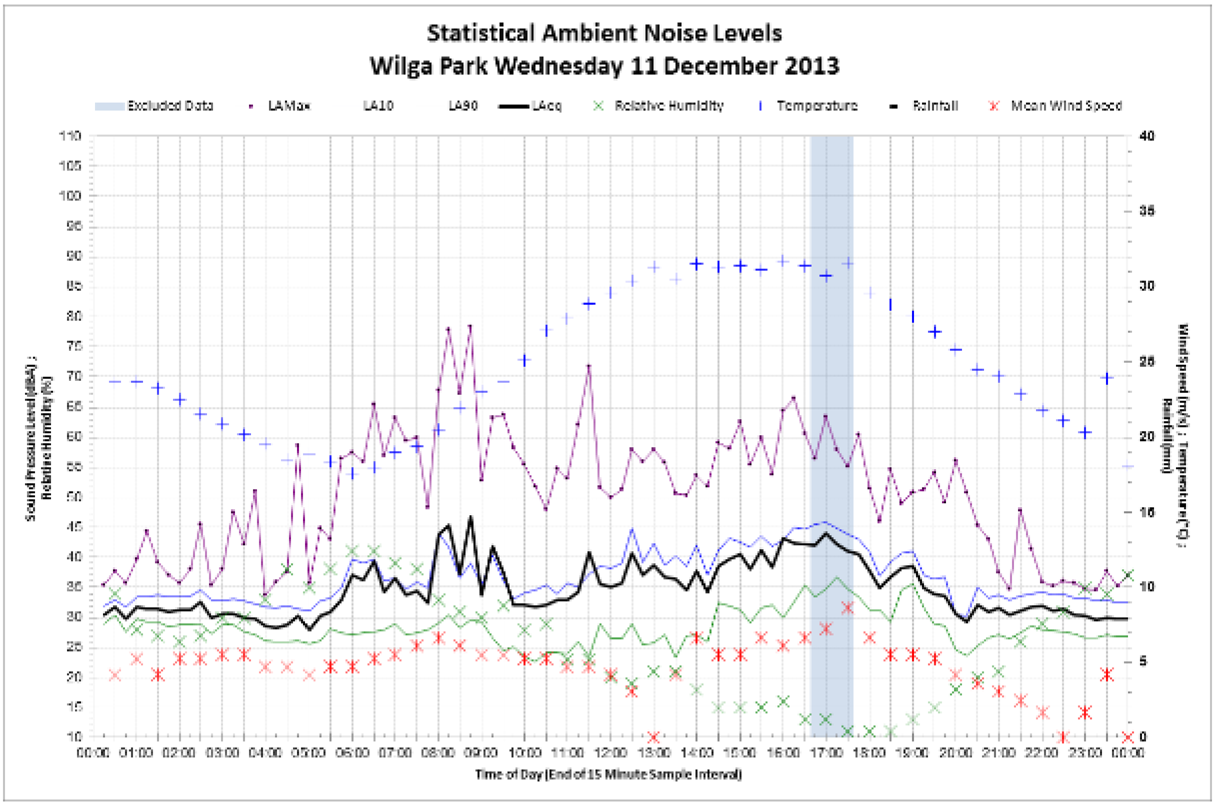
Note 1: Grey italic text indicates excluded data in accordance with the *Industrial Noise Policy* (EPA, 2000) analysis procedure (Section B1.3).

Note 2: The *Industrial Noise Policy* (EPA, 2000) requires that, *'where the rating background level is found to be less than 30 dB(A), then it is set to 30 dB(A)'*. Where this is the case, the measured rating background levels are shown in brackets.

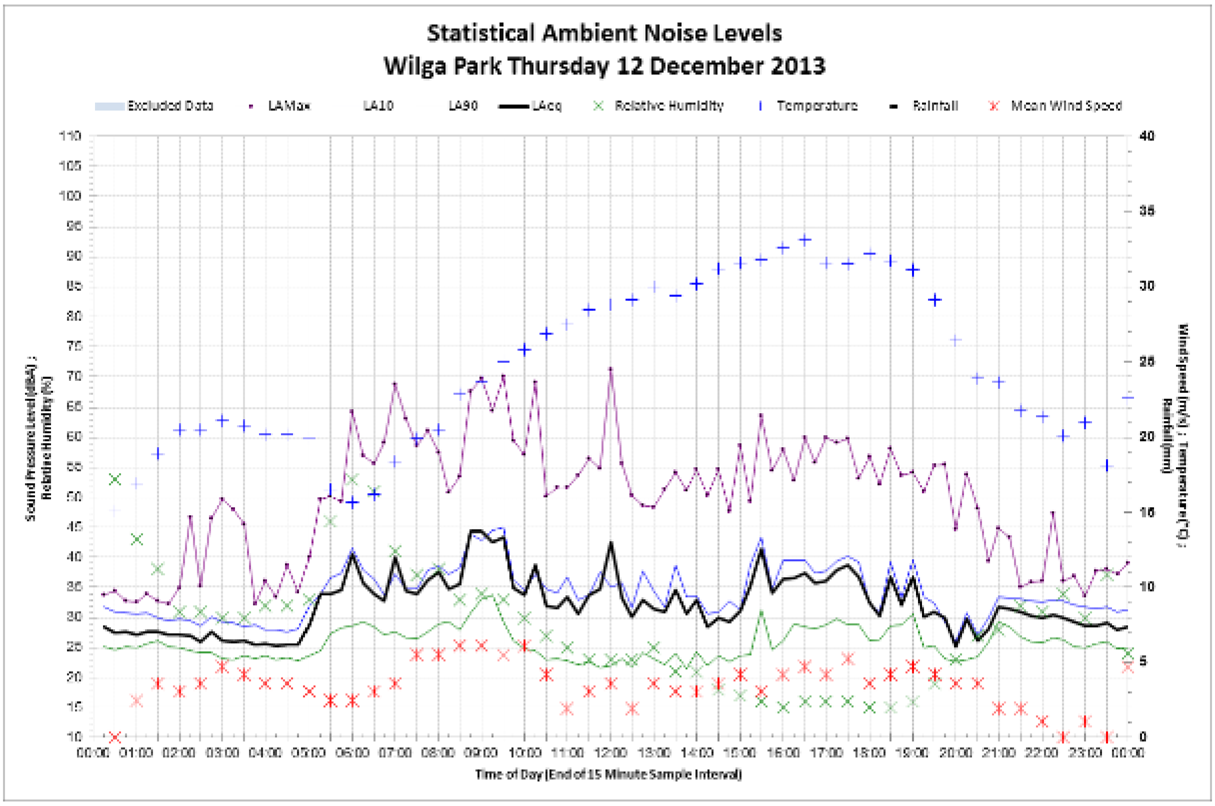


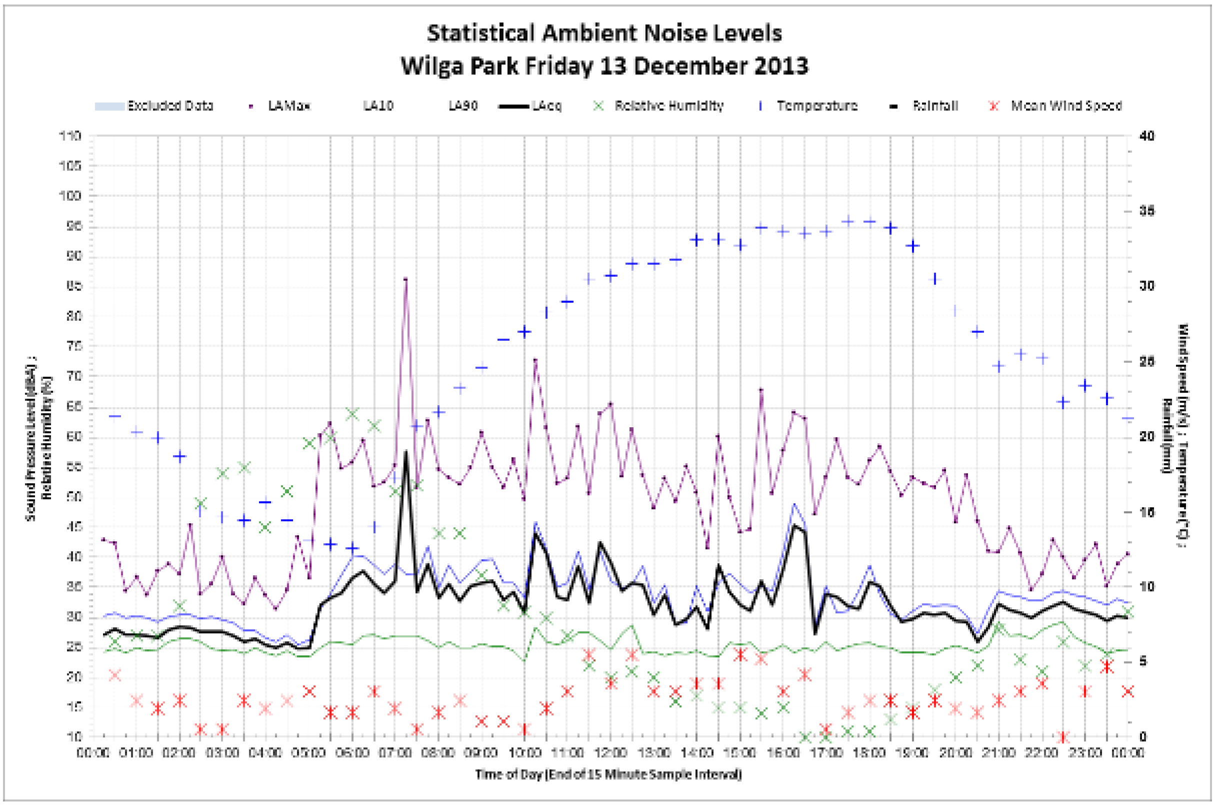


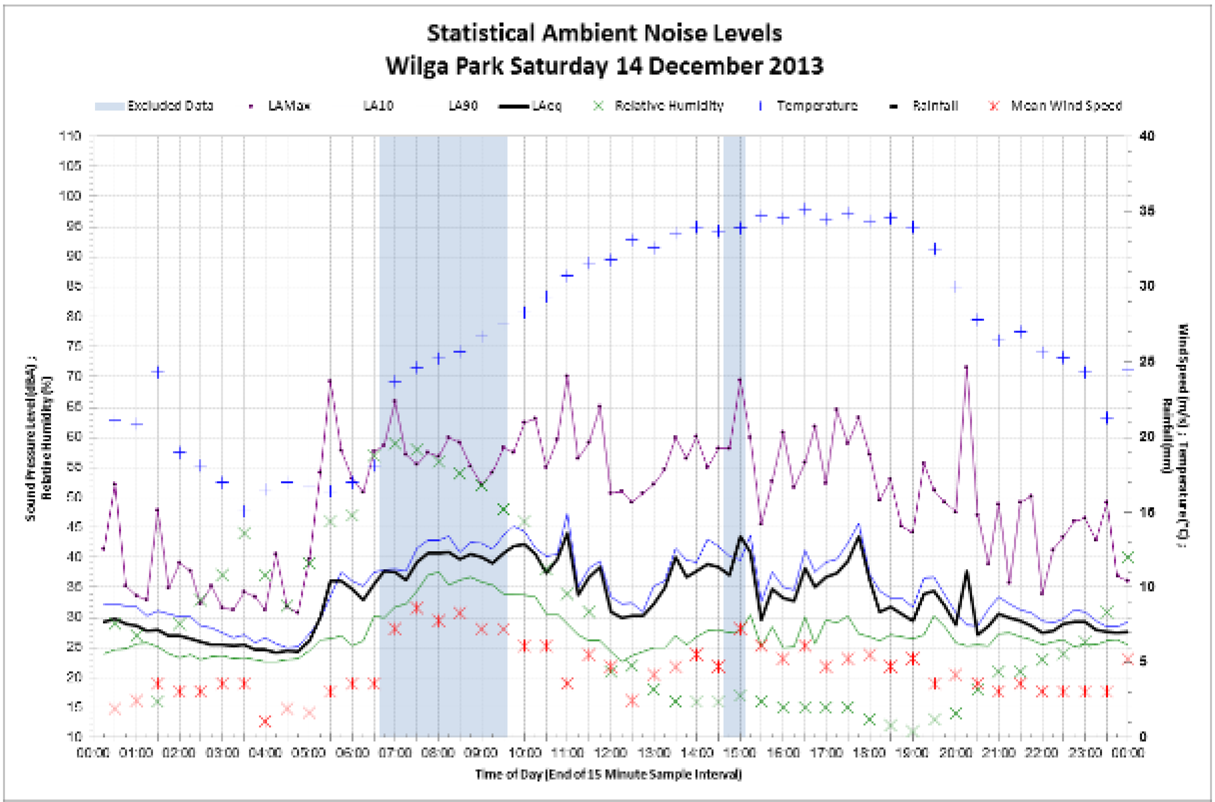
Statistical Ambient Noise Levels
Wilga Park Tuesday 10 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

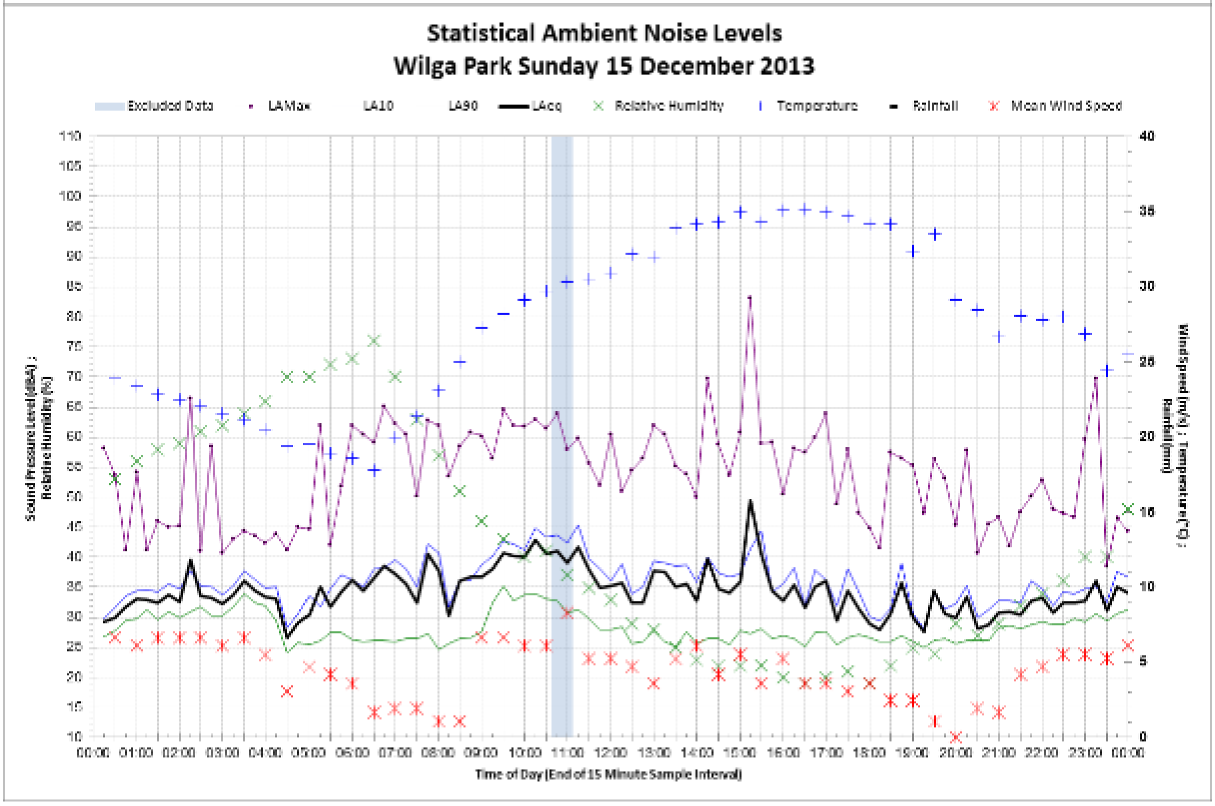


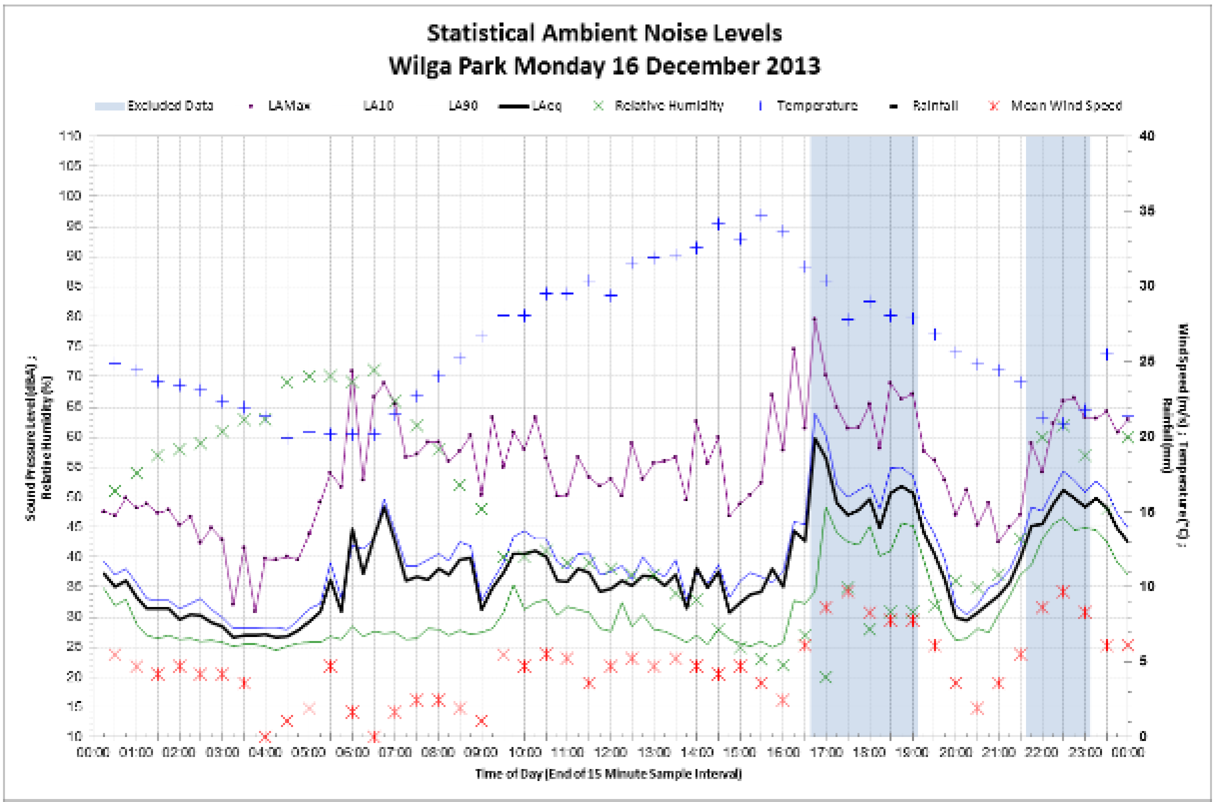
Statistical Ambient Noise Levels
Wilga Park Wednesday 11 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Wilga Park Thursday 12 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

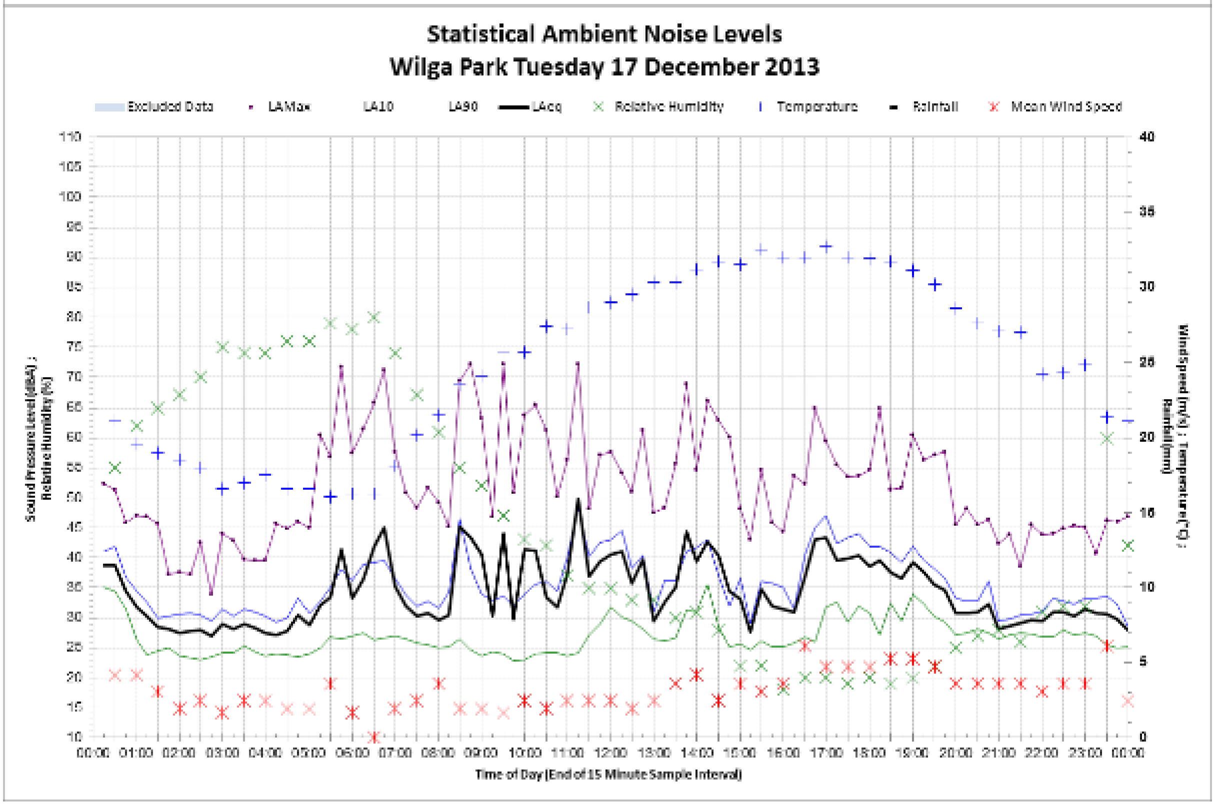

Statistical Ambient Noise Levels
Wilga Park Friday 13 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Wilga Park Saturday 14 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

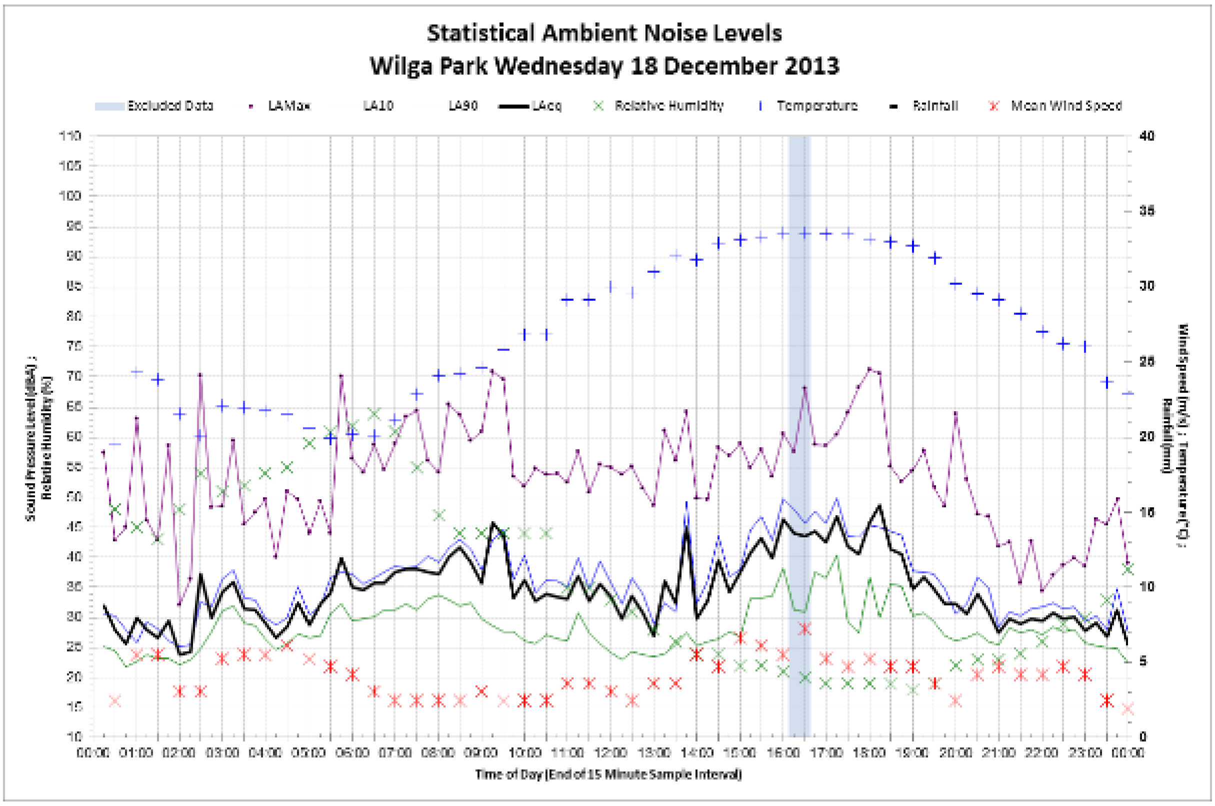

Statistical Ambient Noise Levels
Wilga Park Sunday 15 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

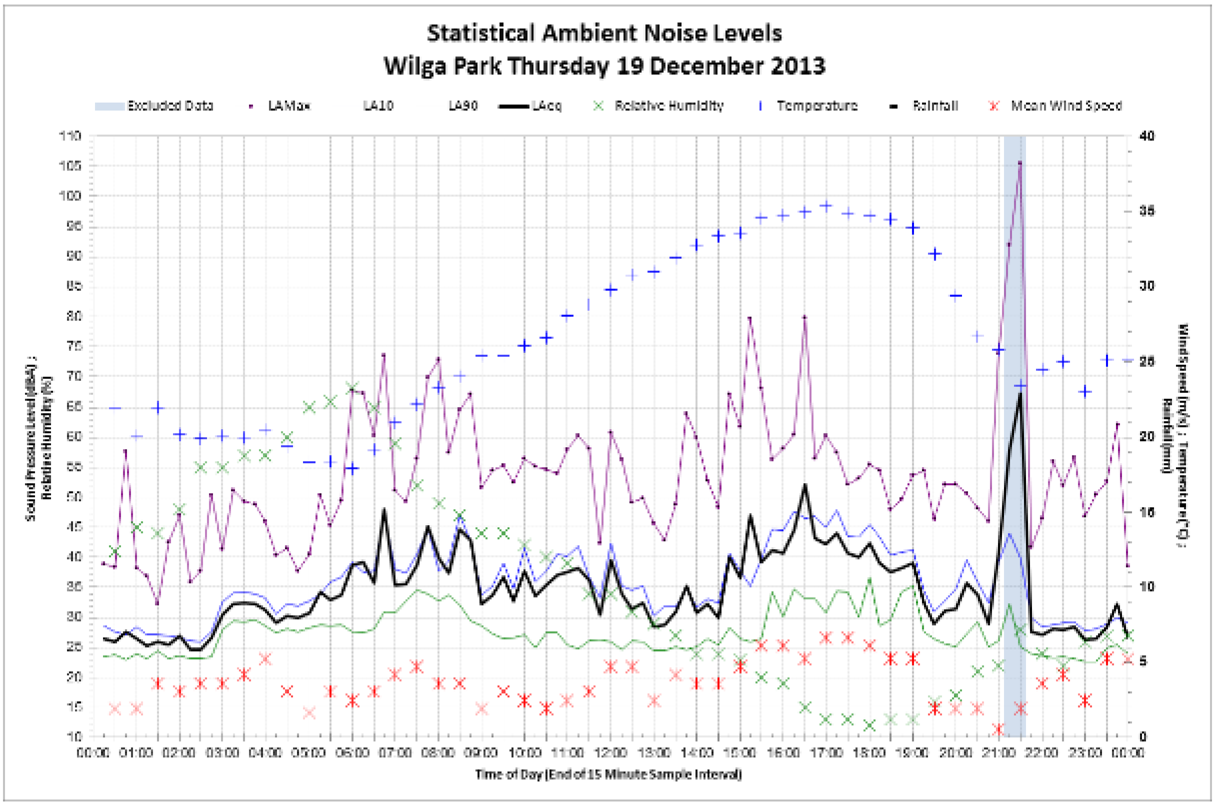


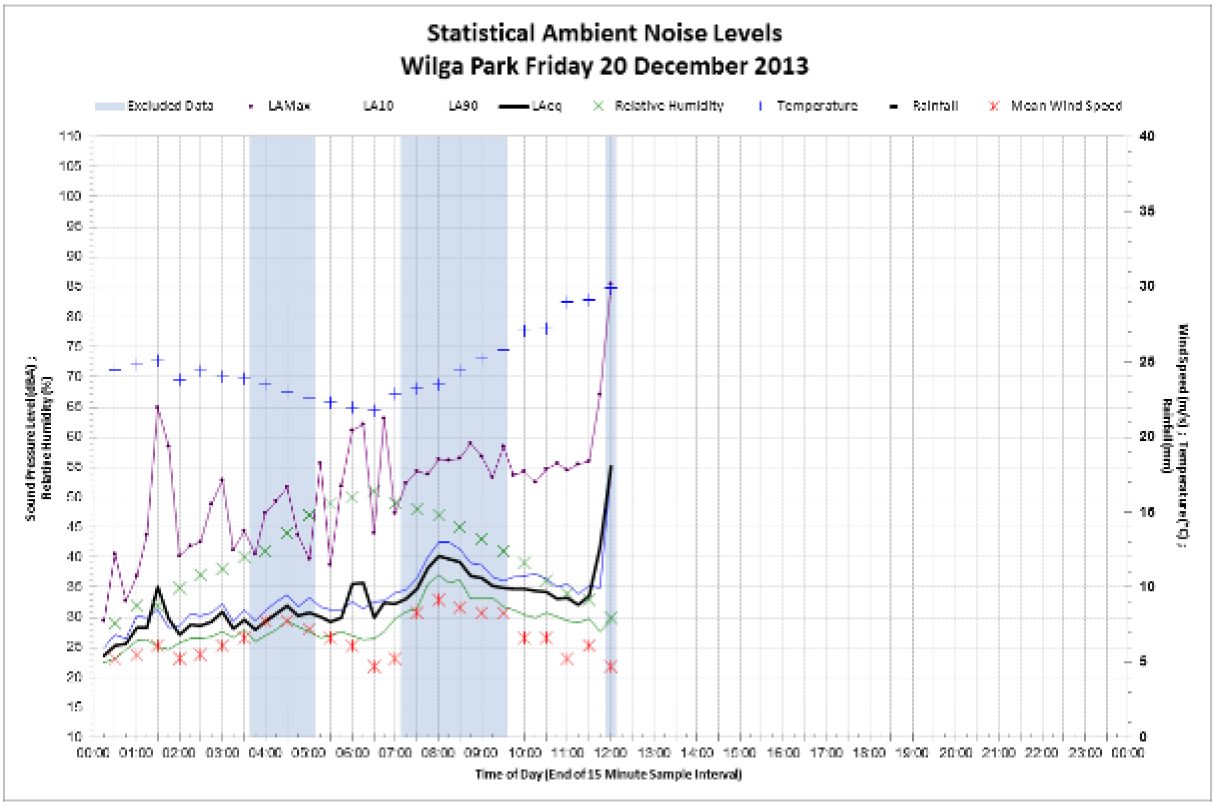
Statistical Ambient Noise Levels
Wilga Park Monday 16 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
Wilga Park Tuesday 17 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Wilga Park Wednesday 18 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Wilga Park Thursday 19 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
Wilga Park Friday 20 December 2013
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

Appendix C Construction equipment noise data

ID	Equipment	Noise Level, dB(A)									Overall, dB(A)
		Frequency (Hz)									
		31.5	63	125	250	500	1000	2000	4000	8000	
1	Asphalt paver	-	77	92	97	100	103	103	100	90	108
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C5:31.									
2	Backhoe	-	84	87	93	99	98	97	94	87	104
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C2:14.									
3	Bobcat skid steer loader	-	97	99	106	105	107	106	103	92	113
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C6:33.									
4	Capping tractor	-	90	96	94	98	103	101	97	87	107
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C6:26.									
5	Chainsaw	33	57	94	95	105	106	109	109	102	114
		Noise power level sourced from Husqvarna 375 manufacturer data sheet. Noise spectra derived from Potocnik, I. & Poje, A. (2010), *Noise Pollution in Forest Environment Due to Forest Operations,* Croatian Journal of forest engineering 31(2)									
6	Compactor	-	78	96	104	103	111	103	101	95	113
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C8:1.									
7	Concrete truck and pump	-	85	89	95	100	102	104	96	90	108
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C4:29.									
8	Crane	-	88	94	97	94	98	98	91	83	104
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C4:43.									
9	Dozer	-	91	96	102	108	111	109	104	96	115
		Noise data sourced from *Noise Assessment Report - Traffic Noise Assessment for Santos - Narrabri Flow lines Trenching* (Noise Measurement Services, 2014)									
10	Drilling generator (base case)	66	88	96	99	97	107	102	93	77	109
11	Drilling generator (with mitigation)	61	83	91	94	92	102	97	88	72	104
		Noise data for drilling generator sourced from *Ensign Rig 967 Narrabri Dewhurst 22 location - Noise Assessment* (Wilkinson Murray, 2013) and *EDA Rig 1 The Pilliga State Forest Noise Survey* (Wilkinson Murray, 2012).									
12	Excavator	-	87	90	96	102	101	100	97	90	107
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C2:14.									
13	Front end loader	-	97	99	106	105	107	106	103	92	113
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C6:33.									
14	Generator	-	74	81	84	90	96	93	89	85	99
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C3:32.									
15	Grader	-	79	94	99	102	105	105	102	92	110
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C5:31.									
16	Hand tools	-	85	97	94	92	93	94	93	91	102
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C3:35.									
17	High pressure cement unit	74	96	97	112	114	117	118	111	100	122

ID	Equipment	Noise Level, dB(A) Frequency (Hz)									Overall, dB(A)
		31.5	63	125	250	500	1000	2000	4000	8000	
18	High pressure cement unit (mitigation option 1)	65	87	88	103	105	108	109	102	91	113
19	High pressure cement unit (mitigation option 2)	54	76	77	92	94	97	98	91	80	102
		Noise data for equipment IDs 17 to 19 have been sourced from *Ensign Rig 967 Narrabri Dewhurst 22 location - Noise Assessment* (Wilkinson Murray, 2013) and *EDA Rig 1 The Pilliga State Forest Noise Survey* (Wilkinson Murray, 2012).									
20	Hydraulic drill rig	-	87	105	97	104	108	108	105	101	113
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C6:35.									
21	Hydraulic power unit (high load) (base case)	75	91	101	103	105	119	111	101	87	120
22	Hydraulic power unit (high load) with mitigation	60	76	86	88	90	104	96	86	72	105
23	Hydraulic power unit (low load)	71	87	97	99	101	115	107	97	83	116
24	Hydraulic power unit (low load) with mitigation	57	73	83	85	87	101	93	83	69	102
25	Mud pump engine (high load) base case	63	78	87	92	98	113	109	100	89	115
26	Mud pump engine (high load) with mitigation	58	73	82	87	93	108	104	95	84	110
27	Mud pump engine (low load) (base case)	54	69	78	83	89	104	100	91	80	106
28	Mud pump engine (low load) with mitigation	49	64	73	78	84	99	95	86	75	101
29	Mud shaker	70	73	84	95	98	96	94	86	76	102
		Noise data for equipment IDs 21 to 29 have been sourced from *Ensign Rig 967 Narrabri Dewhurst 22 location - Noise Assessment* (Wilkinson Murray, 2013) and *EDA Rig 1 The Pilliga State Forest Noise Survey* (Wilkinson Murray, 2012).									
30	Padding machine	-	75	93	101	100	108	100	98	92	110
		Noise power level sourced from *Red Hill Mining Lease Environmental Impact Statement Construction and Operational Noise and Vibration Assessment* (SLR 2013). Noise spectra derived from BS5228 - 1 Table C8:1.									
31	Pipelayer	-	98	100	103	103	102	100	97	88	109
		Noise data sourced from *Banda Field Development - Gas Project Environmental Impact Assessment* (ERM, 2013)									
32	Pipeline Bender	-	93	86	70	76	73	71	71	72	94
		Noise data sourced from *Banda Field Development - Gas Project Environmental Impact Assessment* (ERM, 2013)									
33	Plough	-	64	86	103	117	122	120	114	103	126
		Noise data sourced from *Noise Assessment Report - Traffic Noise Assessment for Santos - Narrabri Flowlines Trenching* (Noise Measurement Services, 2014)									
34	Rocksaw	-	72	99	99	103	106	110	113	110	117
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C4:70.									
35	Roller	-	87	95	99	101	102	103	96	90	108
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C5:28.									

ID	Equipment	Noise Level, dB(A)									Overall, dB(A)
		Frequency (Hz)									
		31.5	63	125	250	500	1000	2000	4000	8000	
36	Scraper	-	97	101	105	109	107	104	97	87	113
		Noise power level sourced from CAT 623H manufacturer data sheet. Noise spectra sourced from *Perth Waste - North Boddington Landfill* (Vipac, 2011)									
37	Tack rig	-	73	84	92	97	101	99	94	87	105
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C3:31.									
38	Truck	-	90	96	94	98	103	101	97	87	107
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C6:26.									
39	Ultra logger	-	88	106	102	108	111	110	103	90	116
		Noise data sourced from *Noise Assessment Report - Traffic Noise Assessment for Santos - Narrabri Flowlines Trenching* (Noise Measurement Services, 2014)									
40	Water cart	-	90	96	94	98	103	101	97	87	107
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C6:26.									
41	Welding rig	-	73	84	92	97	101	99	94	87	105
		Noise power level sourced from *AS2436*. Noise spectra derived from *BS5228 - 1* Table C3:31.									

Appendix D Partial noise levels at sensitive receivers

Leewood – Construction

Table D-1 Leewood partial noise levels: Construction scenario 1, calm meteorological conditions, dB(A)

Equipment	Sensitive receiver																			
	160	163	166	167	169	170	171	172	173	177	178	179	180	182	183	189	191	192	216	217
Dozer	12	16	13	18	18	11	13	23	15	21	19	24	12	29	21	32	32	26	33	37
Scraper	17	20	18	21	21	17	18	25	20	24	23	27	17	31	24	34	33	28	34	38
Excavator	9	12	9	14	14	8	10	18	12	17	15	20	8	24	17	28	27	22	28	32
Compactor	14	17	14	19	19	13	15	24	17	23	21	26	14	31	22	33	33	27	35	38
Truck	15	17	15	19	19	14	15	22	17	21	19	24	14	28	20	30	30	25	33	35
Total	**21**	**24**	**22**	**26**	**26**	**21**	**22**	**30**	**24**	**29**	**27**	**32**	**21**	**36**	**28**	**39**	**39**	**33**	**40**	**43**

Table D-2 Leewood partial noise levels: Construction scenario 1, adverse meteorological conditions, dB(A)

Equipment	Sensitive receiver																			
	160	163	166	167	169	170	171	172	173	177	178	179	180	182	183	189	191	192	216	217
Dozer	17	21	18	23	23	17	19	28	21	27	25	30	17	35	26	37	37	31	39	41
Scraper	22	25	22	26	26	21	23	31	24	30	28	32	21	36	29	39	39	34	40	43
Excavator	14	17	14	19	19	13	15	24	17	23	21	26	13	30	22	33	33	27	34	37
Compactor	19	23	20	25	25	18	20	30	22	28	26	32	19	36	28	38	38	33	40	42
Truck	19	21	19	23	23	18	20	27	21	26	24	29	19	33	25	35	34	29	37	40
Total	**26**	**29**	**26**	**31**	**31**	**25**	**27**	**36**	**29**	**34**	**32**	**37**	**26**	**42**	**34**	**44**	**44**	**38**	**45**	**48**

Table D-3 Leewood partial noise levels: Construction scenario 2, calm meteorological conditions, dB(A)

Equipment	Sensitive receiver																			
	160	163	166	167	169	170	171	172	173	177	178	179	180	182	183	189	191	192	216	217
Roller	7	12	7	15	15	5	9	21	12	19	17	23	6	28	19	31	30	24	32	35
Concrete truck and pump	5	10	6	13	13	4	7	19	10	17	15	21	4	26	17	29	29	22	30	34
Asphalt paver	2	7	2	10	10	0	4	16	6	14	12	18	1	23	14	26	26	19	27	31
Total	**10**	**15**	**10**	**18**	**18**	**8**	**12**	**24**	**15**	**22**	**20**	**26**	**9**	**31**	**22**	**34**	**33**	**27**	**35**	**38**

Table D-4 Leewood partial noise levels: Construction scenario 2, adverse meteorological conditions, dB(A)

Equipment	Sensitive receiver																			
	160	163	166	167	169	170	171	172	173	177	178	179	180	182	183	189	191	192	216	217
Roller	13	18	14	20	20	12	15	26	17	24	22	28	12	33	24	36	35	29	37	40
Concrete truck and pump	11	16	12	18	18	10	13	24	16	23	20	26	11	31	22	34	33	27	35	38
Asphalt paver	8	13	9	15	15	7	10	21	12	19	17	23	7	28	19	31	30	24	32	35
Total	**16**	**21**	**17**	**23**	**23**	**15**	**18**	**29**	**20**	**27**	**25**	**31**	**15**	**36**	**27**	**39**	**38**	**32**	**40**	**43**

Table D-5 Leewood partial noise levels: Construction scenario 3, calm meteorological conditions, dB(A)

Equipment	Sensitive receiver																			
	160	163	166	167	169	170	171	172	173	177	178	179	180	182	183	189	191	192	216	217
Welding rig	8	12	8	14	14	7	9	19	11	17	16	21	7	26	17	29	28	22	30	33
Crane	10	12	10	14	14	10	11	17	12	16	15	18	10	22	16	25	25	20	26	30
Generator	6	9	6	11	11	5	7	16	9	15	13	18	6	23	14	26	25	20	27	30
Hand tools	12	14	12	15	15	12	13	18	14	17	16	19	12	22	16	24	24	20	26	29
Total	**16**	**18**	**16**	**20**	**20**	**15**	**17**	**24**	**18**	**22**	**21**	**25**	**16**	**30**	**22**	**32**	**32**	**26**	**34**	**37**

Table D-6 Leewood partial noise levels: Construction scenario 3, adverse meteorological conditions, dB(A)

Equipment	Sensitive receiver																			
	160	163	166	167	169	170	171	172	173	177	178	179	180	182	183	189	191	192	216	217
Welding rig	13	18	14	20	20	13	15	25	17	23	21	27	13	32	23	34	33	28	35	38
Crane	14	17	15	18	18	14	15	22	17	21	19	23	14	27	21	30	30	25	31	34
Generator	11	15	12	17	17	10	13	22	14	20	18	23	11	28	20	31	31	25	32	36
Hand tools	16	18	17	20	20	16	17	22	18	21	20	24	16	27	21	29	29	24	31	33
Total	**20**	**23**	**21**	**25**	**25**	**20**	**21**	**29**	**23**	**28**	**26**	**31**	**20**	**35**	**27**	**38**	**37**	**32**	**39**	**42**

Leewood – Operational

Table D-7 Leewood partial noise levels: Operational (compressors not enclosed) calm meteorological conditions, dB(A)

Equipment	Sensitive receiver																			
	160	163	166	167	169	170	171	172	173	177	178	179	180	182	183	189	191	192	216	217
Central gas compression (compressors)	27	30	27	31	31	26	28	36	30	35	33	37	26	42	35	45	44	38	42	49
Central gas compression (cooling fans)	-15	-11	-14	-10	-10	-16	-13	-5	-12	-6	-8	-3	-15	2	-6	5	4	-2	3	9
Central gas compression (transformers)	-13	-10	-12	-9	-9	-13	-12	-5	-10	-6	-8	-4	-13	0	-7	-3	3	-3	2	9
Power plant (ventilation)	13	15	14	16	16	13	14	20	15	19	18	21	13	25	19	30	30	23	27	38
Power plant (cooling fans)	13	17	14	18	18	12	15	23	16	22	20	24	12	29	22	29	21	5	28	27
Power plant (exhaust stacks)	12	14	12	15	15	11	13	20	14	19	18	21	11	26	19	31	31	24	28	42
Power plant (transformers)	-31	-16	-31	-15	-18	-32	-31	-11	-30	-26	-28	-10	-33	-6	-27	-2	-2	-8	-21	3
Water treatment plant	-6	-3	-6	-1	0	-6	-5	3	-4	1	0	5	-6	8	0	10	11	7	15	15
Total	**27**	**30**	**28**	**32**	**31**	**27**	**29**	**36**	**30**	**35**	**33**	**37**	**27**	**42**	**35**	**45**	**44**	**38**	**43**	**50**

Note 1: Excludes 5 dB(A) low frequency correction

Table D-8 Leewood partial noise levels: Operational (compressors not enclosed), adverse meteorological conditions, dB(A)

Equipment	Sensitive receiver																			
	160	163	166	167	169	170	171	172	173	177	178	179	180	182	183	189	191	192	216	217
Central gas compression (compressors)	33	36	33	37	37	32	34	42	36	41	39	43	32	48	41	51	50	44	48	54
Central gas compression (cooling fans)	-9	-6	-9	-4	-4	-10	-8	2	-6	0	-2	3	-10	8	0	11	10	4	8	14
Central gas compression (transformers)	-8	-5	-8	-4	-4	-8	-7	0	-5	-1	-3	1	-8	6	-1	2	8	3	7	13
Power plant (ventilation)	18	20	18	21	21	17	19	25	20	24	23	26	18	30	24	35	34	28	32	42
Power plant (cooling fans)	18	22	19	24	23	18	20	29	22	28	26	30	18	35	28	35	27	11	34	32
Power plant (exhaust stacks)	15	18	16	19	19	15	16	24	18	23	21	25	15	29	23	34	34	28	31	43
Power plant (transformers)	-27	-11	-27	-10	-13	-28	-27	-6	-25	-21	-23	-5	-28	-1	-22	4	3	-3	-16	7
Water treatment plant	-1	2	-1	5	5	-2	0	8	1	6	5	11	-1	14	6	15	17	13	21	21
Total	**33**	**36**	**33**	**38**	**37**	**32**	**34**	**42**	**36**	**41**	**40**	**44**	**33**	**48**	**41**	**51**	**50**	**44**	**49**	**55**

Note 1: Excludes 5 dB(A) low frequency correction

Table D-9 Leewood partial noise levels: Operational (Mitigation Scenario 1) calm meteorological conditions, dB(A)

Equipment	Sensitive receiver																			
	160	163	166	167	169	170	171	172	173	177	178	179	180	182	183	189	191	192	216	217
Central gas compression (compressors)	-2	1	-2	2	2	-3	-1	7	1	6	4	8	-3	13	6	16	15	9	13	20
Central gas compression (cooling fans)	-15	-11	-14	-10	-10	-16	-13	-5	-12	-6	-8	-3	-15	2	-6	5	4	-2	3	9
Central gas compression (transformers)	-13	-10	-12	-9	-9	-13	-12	-5	-10	-6	-8	-4	-13	0	-7	-3	3	-3	2	9
Power plant (ventilation)	5	8	5	9	9	4	6	14	8	13	11	15	4	21	13	21	18	11	19	24
Power plant (cooling fans)	3	5	4	6	6	3	4	10	5	9	8	11	3	15	9	19	19	13	17	29
Power plant (exhaust stacks)	2	4	2	5	5	2	3	8	4	8	6	9	2	13	8	9	8	2	15	18
Power plant (transformers)	-21	-18	-20	-17	-18	-21	-20	-14	-18	-15	-16	-13	-21	-9	-14	12	12	6	0	18
Water treatment plant	-6	-3	-6	-1	0	-6	-5	3	-4	1	0	5	-6	8	0	10	11	7	15	15
Total	**9**	**12**	**9**	**13**	**12**	**8**	**10**	**17**	**11**	**16**	**15**	**18**	**8**	**23**	**16**	**25**	**23**	**17**	**24**	**31**

Note 1: Excludes 5 dB(A) low frequency correction

Table D-10 Leewood partial noise levels[1]: Operational (Mitigation Scenario 1) adverse meteorological conditions, dB(A)

Equipment	Sensitive receiver																			
	160	163	166	167	169	170	171	172	173	177	178	179	180	182	183	189	191	192	216	217
Central gas compression (compressors)	4	7	4	8	8	3	5	13	7	12	10	14	3	19	12	22	21	15	19	25
Central gas compression (cooling fans)	-9	-6	-9	-4	-4	-10	-8	2	-6	0	-2	3	-10	8	0	11	10	4	8	14
Central gas compression (transformers)	-8	-5	-8	-4	-4	-8	-7	0	-5	-1	-3	1	-8	6	-1	2	8	3	7	13
Power plant (ventilation)	10	13	10	15	15	9	11	20	13	19	17	21	9	26	19	26	21	14	25	28
Power plant (cooling fans)	7	9	7	10	10	6	8	13	9	13	11	14	7	18	13	22	22	16	20	31
Power plant (exhaust stacks)	6	7	6	8	8	5	6	11	7	11	10	12	6	16	11	11	11	5	17	21
Power plant (transformers)	-17	-15	-17	-14	-15	-17	-16	-11	-15	-12	-13	-10	-17	-7	-12	15	15	9	3	22
Water treatment plant	-1	2	-1	5	5	-2	0	8	1	6	5	11	-1	14	6	15	17	13	21	21
Total	**13**	**16**	**14**	**18**	**17**	**13**	**15**	**22**	**16**	**21**	**20**	**23**	**13**	**28**	**21**	**29**	**27**	**21**	**28**	**34**

Note 1: Excludes 5 dB(A) low frequency correction

Table D-11 Leewood partial noise levels: Operational (Mitigation Scenario 2) calm meteorological conditions, dB(A)

Equipment	Sensitive receiver																			
	160	163	166	167	169	170	171	172	173	177	178	179	180	182	183	189	191	192	216	217
Central gas compression (compressors)	-2	1	-2	2	2	-3	-1	7	1	6	4	8	-3	13	6	16	15	9	13	20
Central gas compression (cooling fans)	-15	-11	-14	-10	-10	-16	-13	-5	-12	-6	-8	-3	-15	2	-6	5	4	-2	3	9
Central gas compression (transformers)	-13	-10	-12	-9	-9	-13	-12	-5	-10	-6	-8	-4	-13	0	-7	3	3	-3	2	9
Water treatment plant	-6	-3	-6	-1	0	-6	-5	3	-4	1	0	5	-6	8	0	10	11	7	15	15
Total	**0**	**3**	**0**	**4**	**4**	**-1**	**1**	**9**	**3**	**7**	**6**	**10**	**-1**	**14**	**7**	**17**	**17**	**11**	**18**	**22**

Table D-12 Leewood partial noise levels: Operational (Mitigation Scenario 2) adverse meteorological conditions, dB(A)

Equipment	Sensitive receiver																			
	160	163	166	167	169	170	171	172	173	177	178	179	180	182	183	189	191	192	216	217
Central gas compression (compressors)	4	7	4	8	8	3	5	13	7	12	10	14	3	19	12	22	21	15	19	25
Central gas compression (cooling fans)	-9	-6	-9	-4	-4	-10	-8	2	-6	0	-2	3	-10	8	0	11	10	4	8	14
Central gas compression (transformers)	-8	-5	-8	-4	-4	-8	-7	0	-5	-1	-3	1	-8	6	-1	9	8	3	7	13
Water treatment plant	-1	2	-1	5	5	-2	0	8	1	6	5	11	-1	14	6	15	17	13	21	21
Total	**5**	**9**	**6**	**10**	**10**	**5**	**7**	**15**	**8**	**13**	**12**	**16**	**5**	**21**	**13**	**23**	**23**	**17**	**24**	**27**

Bibblewindi – Construction

Table D-13 Bibblewindi partial noise levels: Construction scenario 1, calm meteorological conditions, dB(A)

Equipment	Sensitive receiver (refer to Figure 7)														
	199	200	201	202	203	205	206	207	208	209	210	211	212	213	214
Dozer	5	6	5	5	7	7	6	5	8	5	6	13	17	16	17
Scraper	12	12	11	11	13	13	12	11	14	11	12	18	20	20	20
Excavator	2	3	2	2	4	4	3	2	5	2	3	10	13	12	13
Compactor	7	8	7	7	9	9	8	7	11	7	8	15	18	17	20
Truck	10	10	10	10	11	11	10	10	12	10	10	15	18	17	18
Total	**15**	**16**	**15**	**15**	**17**	**17**	**16**	**15**	**18**	**15**	**16**	**22**	**25**	**24**	**25**

Table D-14 Bibblewindi partial noise levels: Construction scenario 1, adverse meteorological conditions, dB(A)

Equipment	Sensitive receiver (refer to Figure 7)														
	199	200	201	202	203	205	206	207	208	209	210	211	212	213	214
Dozer	9	10	10	9	11	11	10	9	13	9	10	18	22	21	22
Scraper	16	16	15	15	17	17	16	15	18	15	16	22	25	25	25
Excavator	6	7	7	6	8	8	7	6	10	6	7	15	18	17	18
Compactor	12	12	12	11	13	14	12	11	15	11	12	20	24	23	25
Truck	14	14	14	14	15	15	14	13	16	14	14	19	22	21	23
Total	**19**	**20**	**19**	**19**	**21**	**21**	**20**	**19**	**22**	**19**	**20**	**27**	**30**	**29**	**30**

Table D-15 Bibblewindi partial noise levels: Construction scenario 2, calm meteorological conditions, dB(A)

Equipment	Sensitive receiver (refer to Figure 7)														
	199	200	201	202	203	205	206	207	208	209	210	211	212	213	214
Roller	9	9	9	9	10	10	9	8	11	9	9	15	17	16	17
Concrete truck and pump	1	2	1	1	3	3	2	1	4	1	2	9	12	11	12
Asphalt paver	1	1	1	1	2	2	1	0	3	0	1	7	10	9	10
Total	**10**	**11**	**10**	**10**	**11**	**12**	**10**	**10**	**13**	**10**	**11**	**16**	**19**	**18**	**19**

Table D-16 Bibblewindi partial noise levels: Construction scenario 2, adverse meteorological conditions, dB(A)

Equipment	Sensitive receiver (refer to Figure 7)														
	199	200	201	202	203	205	206	207	208	209	210	211	212	213	214
Roller	13	13	13	13	14	14	13	12	16	12	13	19	22	21	22
Concrete truck and pump	5	6	5	5	7	7	6	5	8	5	6	14	17	16	17
Asphalt paver	5	5	5	5	6	6	5	4	8	4	5	12	15	14	15
Total	**14**	**14**	**14**	**14**	**16**	**16**	**14**	**14**	**17**	**14**	**15**	**21**	**24**	**23**	**24**

Table D 17 Bibblewindi partial noise levels: Construction scenario 3, calm meteorological conditions, dB(A)

Equipment	Sensitive receiver (refer to Figure 7)														
	199	200	201	202	203	205	206	207	208	209	210	211	212	213	214
Welding rig	0	1	0	0	2	2	1	-1	4	0	1	9	13	12	13
Crane	6	6	5	5	7	7	6	5	7	5	6	11	13	12	13
Generator	0	0	0	0	1	2	0	-1	2	-1	0	7	10	9	10
Hand tools	9	9	8	9	10	10	9	8	10	8	9	13	14	14	15
Total	**11**	**11**	**11**	**11**	**12**	**12**	**11**	**11**	**13**	**11**	**11**	**16**	**19**	**18**	**19**

Table D-18 Bibblewindi partial noise levels: Construction scenario 3, adverse meteorological conditions, dB(A)

Equipment	Sensitive receiver (refer to Figure 7)														
	199	200	201	202	203	205	206	207	208	209	210	211	212	213	214
Welding rig	4	5	5	4	7	7	5	4	9	4	5	14	18	18	18
Crane	10	10	9	9	11	11	10	9	12	9	10	15	17	17	17
Generator	4	4	4	4	6	6	4	3	7	4	5	12	15	15	16
Hand tools	12	13	12	12	13	14	13	12	14	12	13	17	19	18	20
Total	**15**	**15**	**15**	**15**	**16**	**16**	**15**	**14**	**17**	**15**	**15**	**21**	**24**	**23**	**24**

Bibblewindi – Operational

Table D-19 Bibblewindi partial noise levels: Operational (compressors not enclosed) calm meteorological conditions, dB(A)

Equipment	Sensitive receiver (refer to Figure 7)														
	199	200	201	202	203	205	206	207	208	209	210	211	212	213	214
Screw compressors	8	8	8	8	10	10	8	7	12	7	8	17	21	20	21
Transformer	-15	-14	-15	-15	-13	-13	-14	-15	-12	-15	-14	-9	-7	-8	-7
Well head drive	-25	-24	-24	-25	-22	-22	-24	-26	-20	-25	-24	-15	-11	-12	-11
Well head generator	-27	-26	-26	-27	-25	-25	-26	-28	-23	-28	-26	-17	-13	-15	-14
Total	**8**	**8**	**8**	**8**	**10**	**10**	**8**	**7**	**12**	**7**	**8**	**17**	**21**	**20**	**21**

Table D-20 Bibblewindi partial noise levels: Operational (compressors not enclosed), adverse meteorological conditions, dB(A)

Equipment	Sensitive receiver (refer to Figure 7)														
	199	200	201	202	203	205	206	207	208	209	210	211	212	213	214
Screw compressors	12	13	13	12	15	15	13	11	17	11	13	23	27	26	27
Transformer	-11	-10	-11	-11	-9	-9	-10	-11	-8	-11	-10	-5	-2	-3	-2
Well head drive	-20	-20	-19	-20	-18	-17	-20	-21	-15	-21	-20	-9	-5	-6	-5
Well head generator	-23	-22	-22	-23	-20	-20	-22	-24	-18	-23	-22	-12	-7	-9	-8
Total	**12**	**13**	**13**	**12**	**15**	**15**	**13**	**11**	**17**	**12**	**13**	**23**	**27**	**26**	**27**

Table D-21 Bibblewindi partial noise levels: Operational (compressors inside enclosure) calm meteorological conditions, dB(A)

Equipment	Sensitive receiver (refer to Figure 7)														
	199	200	201	202	203	205	206	207	208	209	210	211	212	213	214
Screw compressors	-16	-16	-16	-16	-14	-14	-16	-17	-12	-17	-16	-7	-3	-4	-3
Transformer	-15	-14	-15	-15	-13	-13	-14	-15	-12	-15	-14	-9	-7	-8	-7
Well head drive	-25	-24	-24	-25	-22	-22	-24	-26	-20	-25	-24	-15	-11	-12	-11
Well head generator	-27	-26	-26	-27	-25	-25	-26	-28	-23	-28	-26	-17	-13	-15	-14
Total	**-12**	**-11**	**-12**	**-12**	**-10**	**-10**	**-12**	**-13**	**-9**	**-12**	**-11**	**-4**	**-1**	**-2**	**-1**

Table D-22 Bibblewindi partial noise levels: Operational (compressors inside enclosure), adverse meteorological conditions, dB(A)

Equipment	Sensitive receiver (refer to Figure 7)														
	199	200	201	202	203	205	206	207	208	209	210	211	212	213	214
Screw compressors	-12	-11	-11	-12	-9	-9	-11	-13	-7	-13	-11	-1	3	2	3
Transformer	-11	-10	-11	-11	-9	-9	-10	-11	-8	-11	-10	-5	-2	-3	-2
Well head drive	-20	-20	-19	-20	-18	-17	-20	-21	-15	-21	-20	-9	-5	-6	-5
Well head generator	-23	-22	-22	-23	-20	-20	-22	-24	-18	-23	-22	-12	-7	-9	-8
Total	**-8**	**-7**	**-7**	**-8**	**-6**	**-6**	**-7**	**-8**	**-4**	**-8**	**-7**	**1**	**5**	**4**	**5**

Appendix E Road traffic noise levels at sensitive receivers

Table E-1 Predicted construction traffic noise levels at sensitive receivers along arterial roads: Scenarios 1, 2 and 3, $L_{Aeq(period)}$ dB(A)

Receiver location	Existing road traffic noise level		Scenario 1		Scenario 2		Scenario 3		Increase in noise					
									Scenario 1		Scenario 2		Scenario 3	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
764673,6639961	54.5	50.8	54.7	50.9	54.6	50.8	54.6	50.8	0.2	0.1	0.1	0	0.1	0
768328,6641474	51.3	47.6	51.5	47.7	51.4	47.6	51.4	47.6	0.2	0.1	0.1	0	0.1	0
765025,6641153	51.2	47.5	51.4	47.6	51.3	47.5	51.3	47.5	0.2	0.1	0.1	0	0.1	0
764938,6641070	51.2	47.5	51.4	47.6	51.3	47.5	51.3	47.5	0.2	0.1	0.1	0	0.1	0
768815,6640835	47.9	44.2	48.1	44.3	47.9	44.2	47.9	44.2	0.2	0.1	0	0	0	0
768501,6639820	47.5	43.8	47.7	43.9	47.6	43.8	47.5	43.8	0.2	0.1	0.1	0	0	0
163DP,581092	47.4	43.6	47.6	43.9	47.5	43.8	47.4	43.7	0.2	0.3	0.1	0.2	0	0.1
765569,6635804	47.3	43.5	47.6	43.8	47.5	43.7	47.4	43.6	0.3	0.3	0.2	0.2	0.1	0.1
762499,6640703	47	43.3	47.6	43.8	47.4	43.7	47.1	43.4	0.6	0.5	0.4	0.4	0.1	0.1
1DP,623250	47	43.2	47.5	43.8	47.2	43.5	47.1	43.3	0.5	0.6	0.2	0.3	0.1	0.1
769382,6641756	46.9	43.2	47.2	43.5	47.1	43.4	46.9	43.2	0.3	0.3	0.2	0.2	0	0
768929,6640277	46.8	43	47	43.2	46.9	43.2	46.9	43.1	0.2	0.2	0.1	0.2	0.1	0.1

Receiver location	Existing road traffic noise level		Scenario 1		Scenario 2		Scenario 3		Increase in noise					
									Scenario 1		Scenario 2		Scenario 3	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
2DP,832612	46.5	42.8	46.8	43	46.7	42.9	46.6	42.8	0.3	0.2	0.2	0.1	0.1	0
3DP,843278	46.2	42.4	46.5	42.8	46.4	42.6	46.3	42.5	0.3	0.4	0.2	0.2	0.1	0.1
765496,6635387	46.1	42.3	46.3	42.5	46.2	42.5	46.2	42.4	0.2	0.2	0.1	0.2	0.1	0.1
153DP,588798	45.8	42.1	46.3	42.5	46	42.2	45.9	42.1	0.5	0.4	0.2	0.1	0.1	0
4DP,757097	45.6	41.8	46	42.3	45.9	42.2	45.7	41.9	0.4	0.5	0.3	0.4	0.1	0.1
16DP,757083	45	41.2	45.2	41.4	45.1	41.3	45	41.2	0.2	0.2	0.1	0.1	0	0
160DP,852877	44.9	41.2	45.1	41.4	45	41.3	44.9	41.2	0.2	0.2	0.1	0.1	0	0
3DP,1064422	44.8	41	45	41.3	44.9	41.2	44.8	41.1	0.2	0.3	0.1	0.2	0	0.1
14DP,609017	44.7	40.9	44.9	41.2	44.8	41.1	44.7	41	0.2	0.3	0.1	0.2	0	0.1
13DP,757083	44.5	40.7	44.8	41.1	44.6	40.9	44.5	40.8	0.3	0.4	0.1	0.2	0	0.1
757989,6637340	44.4	40.6	44.7	41	44.6	40.8	44.4	40.7	0.3	0.4	0.2	0.2	0	0.1
2DP,731881	44.3	40.6	44.7	41	44.5	40.8	44.4	40.6	0.4	0.4	0.2	0.2	0.1	0
1DP,248981	44.3	40.5	44.7	41	44.4	40.7	44.4	40.6	0.4	0.5	0.1	0.2	0.1	0.1
185DP,814965	44.3	40.5	44.6	40.9	44.4	40.7	44.3	40.6	0.3	0.4	0.1	0.2	0	0.1

Receiver location	Existing road traffic noise level		Scenario 1		Scenario 2		Scenario 3		Increase in noise					
									Scenario 1		Scenario 2		Scenario 3	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
2DP,248981	44.1	40.3	44.6	40.8	44.4	40.6	44.1	40.4	0.5	0.5	0.3	0.3	0	0.1
12DP,577385	43.9	40.1	44.5	40.8	44.4	40.6	44	40.3	0.6	0.7	0.5	0.5	0.1	0.2
753840,6620410	43.8	40.1	44.3	40.6	44.2	40.5	44	40.3	0.5	0.5	0.4	0.4	0.2	0.2
3DP,623250	43.8	40.1	44.1	40.4	44	40.3	43.9	40.2	0.3	0.3	0.2	0.2	0.1	0.1
3DP,248981	43.4	39.6	43.6	39.9	43.5	39.8	43.4	39.7	0.2	0.3	0.1	0.2	0	0.1
4DP,248981	43.1	39.4	43.4	39.6	43.3	39.5	43.2	39.4	0.3	0.2	0.2	0.1	0.1	0
1DP,834410	43	39.3	43.3	39.5	43.1	39.4	43.1	39.3	0.3	0.2	0.1	0.1	0.1	0
5DP,248981	43	39.2	43.2	39.4	43.1	39.3	43	39.2	0.2	0.2	0.1	0.1	0	0
157DP,632204	42.7	38.9	42.9	39.2	42.8	39.1	42.7	39	0.2	0.3	0.1	0.2	0	0.1
62DP,791840	42.6	38.9	42.9	39.1	42.7	39	42.7	38.9	0.3	0.2	0.1	0.1	0.1	0
22DP,757084	42.3	38.5	42.5	38.8	42.4	38.6	42.3	38.6	0.2	0.3	0.1	0.1	0	0.1
11DP,757084	42.2	38.5	42.5	38.7	42.4	38.6	42.3	38.5	0.3	0.2	0.2	0.1	0.1	0

Table E-2 Predicted construction traffic noise levels at sensitive receivers along local roads: Scenarios 1, 2 and 3($L_{Aeq,1hr}$, dB(A))

Receiver location	Existing road traffic noise level	Scenario 1 (S1)	Scenario 2 (S2)	Scenario 3 (S3)	Increase in road traffic noise		
					S1	S2	S3
767812,6641283	69.7	71	70.8	69.7	1.3	1.1	0
767907,6641141	69.6	70.9	70.7	69.6	1.3	1.1	0
767752,6641291	69.4	70.7	70.5	69.4	1.3	1.1	0
767740,6641448	68.7	70	69.8	68.7	1.3	1.1	0
767848,6641224	68.4	69.7	69.5	68.4	1.3	1.1	0
767760,6641415	67.9	69.2	69	67.9	1.3	1.1	0
768371,6640532	67.4	68.8	68.5	67.4	1.4	1.1	0
767898,6641158	67.3	68.6	68.4	67.3	1.3	1.1	0
768143,6640772	66.9	68.2	67.9	66.9	1.3	1	0
768331,6640630	66.8	68.1	67.9	66.8	1.3	1.1	0
768349,6640617	66.8	68.1	67.8	66.8	1.3	1	0
767800,6641347	66.8	68.1	67.8	66.8	1.3	1	0
768401,6640502	66.7	68	67.7	66.7	1.3	1	0
768035,6641002	66.6	68	67.6	66.6	1.4	1	0
768052,6640964	66.6	67.9	67.6	66.6	1.3	1	0
768273,6640602	66.6	67.9	67.6	66.6	1.3	1	0
768062,6640943	66.5	67.8	67.5	66.5	1.3	1	0
767871,6641205	66.5	67.8	67.5	66.5	1.3	1	0
768077,6640910	66.5	67.8	67.5	66.5	1.3	1	0
767882,6641187	66.4	67.7	67.5	66.4	1.3	1.1	0
767892,6641175	66.4	67.7	67.4	66.4	1.3	1	0
768367,6640608	66.3	67.6	67.3	66.3	1.3	1	0
768071,6640926	66.3	67.6	67.3	66.3	1.3	1	0
768353,6640539	66.3	67.6	67.3	66.3	1.3	1	0
768159,6640759	66.2	67.6	67.3	66.2	1.4	1.1	0
768249,6640692	66.2	67.5	67.2	66.2	1.3	1	0
768443,6640563	66.2	67.5	67.2	66.2	1.3	1	0
767691,6641591	66.1	67.4	67.2	66.1	1.3	1.1	0
768233,6640704	66.1	67.4	67.1	66.1	1.3	1	0
768097,6640873	66.1	67.4	67.1	66.1	1.3	1	0
768046,6640983	66.1	67.4	67.1	66.1	1.3	1	0
767879,6641198	66.1	67.4	67.1	66.1	1.3	1	0
768198,6640730	66	67.4	67	66.1	1.4	1	0.1
768177,6640746	66	67.3	67	66	1.3	1	0
768089,6640891	66	67.3	67	66	1.3	1	0
767925,6641051	65.9	67.2	67	66	1.3	1.1	0.1
768215,6640640	65.9	67.2	67	66	1.3	1.1	0.1
768335,6640551	65.9	67.2	66.9	65.9	1.3	1	0
767871,6641216	65.9	67.2	66.9	65.9	1.3	1	0
768288,6640586	65.9	67.2	66.9	65.9	1.3	1	0
768255,6640609	65.7	67.1	66.8	65.9	1.4	1.1	0.2
767635,6641488	65.7	67	66.7	65.9	1.3	1	0.2
768385,6640602	65.6	66.9	66.7	65.9	1.3	1.1	0.3
767713,6641558	65.6	66.9	66.6	65.8	1.3	1	0.2

Receiver location	Existing road traffic noise level	Scenario 1 (S1)	Scenario 2 (S2)	Scenario 3 (S3)	Increase in road traffic noise		
					S1	S2	S3
768239,6640620	65.5	66.9	66.6	65.8	1.4	1.1	0.3
767786,6641404	65.5	66.7	66.5	65.7	1.2	1	0.2
767841,6641287	65.4	66.7	66.5	65.7	1.3	1.1	0.3
767834,6641305	65.3	66.6	66.4	65.7	1.3	1.1	0.4
767853,6641265	65.3	66.6	66.4	65.6	1.3	1.1	0.3
764617,6640449	65.3	66.6	66.2	65.6	1.3	0.9	0.3
767962,6641164	65.2	66.5	66.2	65.6	1.3	1	0.4
764564,6640585	65.2	66.5	66.1	65.5	1.3	0.9	0.3
767805,6641371	65.1	66.4	66.1	65.5	1.3	1	0.4
764480,6640737	65	66.3	66.1	65.4	1.3	1.1	0.4
767774,6641441	65	66.3	66	65.4	1.3	1	0.4
767852,6641275	65	66.3	66	65.3	1.3	1	0.3
768300,6640570	65	66.3	66	65.3	1.3	1	0.3
764552,6640502	65	66.3	65.9	65.2	1.3	0.9	0.2
767765,6641461	65	66.3	65.8	65.2	1.3	0.8	0.2
764400,6640816	64.9	66.2	65.8	65.1	1.3	0.9	0.2
767668,6641664	64.9	66.2	65.8	65	1.3	0.9	0.1
764501,6640718	64.9	66.2	65.7	65	1.3	0.8	0.1
764791,6640345	64.9	66.2	65.7	65	1.3	0.8	0.1
767756,6641482	64.9	66.2	65.7	65	1.3	0.8	0.1
767738,6641525	64.7	66	65.7	65	1.3	1	0.3
768314,6640556	64.7	66	65.7	65	1.3	1	0.3
767679,6641648	64.7	66	65.7	64.9	1.3	1	0.2
764426,6640793	64.6	65.9	65.6	64.9	1.3	1	0.3
767687,6641633	64.6	65.9	65.6	64.9	1.3	1	0.3
767694,6641618	64.6	65.9	65.5	64.9	1.3	0.9	0.3
767683,6641641	64.6	65.9	65.5	64.8	1.3	0.9	0.2
768134,6640818	64.5	65.8	65.4	64.8	1.3	0.9	0.3
768416,6640596	64.4	65.7	65.3	64.7	1.3	0.9	0.3
765091,6640098	64.4	65.7	65.3	64.7	1.3	0.9	0.3
768013,6641104	64.3	65.6	65.1	64.7	1.3	0.8	0.4
764868,6640301	64.3	65.6	64.9	64.7	1.3	0.6	0.4
764706,6640401	64.2	65.5	64.9	64.7	1.3	0.7	0.5
764739,6640380	64.2	65.5	64.9	64.6	1.3	0.7	0.4
764445,6640778	64.1	65.4	64.8	64.6	1.3	0.7	0.5
764518,6640707	64.1	65.3	64.8	64.6	1.2	0.7	0.5
764810,6640338	64	65.3	64.8	64.5	1.3	0.8	0.5

Receiver location	Existing road traffic noise level	Scenario 1 (S1)	Scenario 2 (S2)	Scenario 3 (S3)	Increase in road traffic noise		
					S1	S2	S3
764566,6640653	64	65.2	64.7	64.5	1.2	0.7	0.5
764725,6640390	63.9	65.2	64.7	64.5	1.3	0.8	0.6
767954,6641183	63.8	65.1	64.6	64.4	1.3	0.8	0.6
767636,6641743	63.8	65.1	64.6	64.4	1.3	0.8	0.6
764760,6640370	63.7	65	64.4	64.4	1.3	0.7	0.7
765346,6639936	63.7	65	64.4	64.3	1.3	0.7	0.6
764774,6640363	63.6	64.9	64.3	64.3	1.3	0.7	0.7
764580,6640484	63.6	64.9	64.3	64.2	1.3	0.7	0.6
764386,6640840	63.5	64.8	64.2	64.2	1.3	0.7	0.7
764889,6640293	63.5	64.8	64.2	64.1	1.3	0.7	0.6
764561,6640522	63.5	64.7	64.1	64.1	1.2	0.6	0.6
765146,6640057	63.4	64.6	64.1	64	1.2	0.7	0.6
767606,6641785	63.3	64.6	64.1	63.8	1.3	0.8	0.5
764929,6640193	63.3	64.6	64	63.8	1.3	0.7	0.5
764831,6640331	63.2	64.5	64	63.8	1.3	0.8	0.6
764908,6640284	63.1	64.4	63.9	63.8	1.3	0.8	0.7
767945,6641199	63.1	64.3	63.9	63.8	1.2	0.8	0.7
764598,6640475	63	64.3	63.8	63.6	1.3	0.8	0.6
765362,6639922	63	64.3	63.8	63.6	1.3	0.8	0.6
768266,6640712	62.9	64.2	63.7	63.6	1.3	0.8	0.7
764683,6640423	62.9	64.2	63.7	63.4	1.3	0.8	0.5
768822,6640153	62.8	64.1	63.7	63.4	1.3	0.9	0.6
765499,6639913	62.8	64.1	63.7	63.4	1.3	0.9	0.6
765359,6640002	62.8	64.1	63.6	63.3	1.3	0.8	0.5
767624,6641775	62.7	64	63.5	63.3	1.3	0.8	0.6
769931,6639632	62.6	63.9	63.5	63.2	1.3	0.9	0.6
764577,6640577	62.6	63.9	63.5	63.2	1.3	0.9	0.6
765380,6639990	62.6	63.9	63.4	63.1	1.3	0.8	0.5
764587,6640399	62.6	63.9	63.3	63	1.3	0.7	0.4
767589,6641805	62.6	63.9	63.3	63	1.3	0.7	0.4
765449,6639947	62.6	63.8	63.2	63	1.2	0.6	0.4
764900,6640206	62.5	63.8	63.2	62.9	1.3	0.7	0.4
767939,6641216	62.4	63.7	63.2	62.9	1.3	0.8	0.5
765396,6639982	62.4	63.7	63.2	62.9	1.3	0.8	0.5
768929,6640277	62.3	63.6	63.1	62.8	1.3	0.8	0.5
764580,6640643	62.3	63.6	63.1	62.8	1.3	0.8	0.5

Receiver location	Existing road traffic noise level	Scenario 1 (S1)	Scenario 2 (S2)	Scenario 3 (S3)	Increase in road traffic noise		
					S1	S2	S3
765482,6639928	62.3	63.5	63	62.8	1.2	0.7	0.5
765467,6639938	62.2	63.5	63	62.7	1.3	0.8	0.5
764340,6640896	62.1	63.4	62.9	62.6	1.3	0.8	0.5
767928,6641235	62.1	63.4	62.9	62.6	1.3	0.8	0.5
764818,6640255	62.1	63.4	62.9	62.5	1.3	0.8	0.4
765516,6639906	62.1	63.3	62.8	62.4	1.2	0.7	0.3
764557,6640413	62.1	63.3	62.8	62.4	1.2	0.7	0.3
767586,6641812	62	63.3	62.7	62.3	1.3	0.7	0.3
767923,6641253	61.8	63.1	62.7	62.2	1.3	0.9	0.4
767915,6641267	61.7	63	62.7	62.1	1.3	1	0.4
764560,6640683	61.7	63	62.7	62	1.3	1	0.3
764534,6640424	61.6	62.9	62.6	62	1.3	1	0.4
767910,6641280	61.6	62.9	62.5	62	1.3	0.9	0.4
768287,6640720	61.5	62.8	62.3	62	1.3	0.8	0.5
767583,6641819	61.5	62.8	62.3	62	1.3	0.8	0.5
765419,6639975	61.5	62.7	62.2	62	1.2	0.7	0.5
764588,6640569	61.3	62.5	62.2	61.8	1.2	0.9	0.5
768230,6640768	61.3	62.5	62.2	61.7	1.2	0.9	0.4
765432,6639968	61.3	62.5	62.2	61.6	1.2	0.9	0.3
764618,6640368	61.3	62.5	62.1	61.6	1.2	0.8	0.3
765533,6639900	61.2	62.5	62.1	61.5	1.3	0.9	0.3
764590,6640634	61.2	62.5	62.1	61.5	1.3	0.9	0.3
767753,6641610	61.1	62.4	62.1	61.5	1.3	1	0.4
767900,6641320	61.1	62.4	62	61.3	1.3	0.9	0.2
767785,6641549	61.1	62.4	61.9	61.2	1.3	0.8	0.1
768013,6641188	61	62.3	61.9	61.1	1.3	0.9	0.1
767846,6641430	61	62.3	61.9	61.1	1.3	0.9	0.1
767738,6641644	60.9	62.2	61.9	61.1	1.3	1	0.2
767730,6641662	60.9	62.2	61.9	61.1	1.3	1	0.2
764430,6640823	60.9	62.2	61.8	61	1.3	0.9	0.1
764633,6640477	60.8	62.1	61.8	61	1.3	1	0.2
767579,6641829	60.8	62	61.7	61	1.2	0.9	0.2
768466,6640625	60.7	62	61.6	60.9	1.3	0.9	0.2
767765,6641603	60.7	62	61.6	60.8	1.3	0.9	0.1
768305,6640727	60.5	61.9	61.5	60.7	1.4	1	0.2
767832,6641480	60.5	61.8	61.5	60.7	1.3	1	0.2

Receiver location	Existing road traffic noise level	Scenario 1 (S1)	Scenario 2 (S2)	Scenario 3 (S3)	Increase in road traffic noise		
					S1	S2	S3
764445,6640813	60.5	61.8	61.5	60.7	1.3	1	0.2
768071,6641108	60.5	61.8	61.5	60.5	1.3	1	0
767787,6641571	60.5	61.8	61.5	60.5	1.3	1	0
768137,6640938	60.5	61.8	61.5	60.5	1.3	1	0
767780,6641590	60.4	61.7	61.4	60.5	1.3	1	0.1
767574,6641835	60.4	61.7	61.3	60.5	1.3	0.9	0.1
764598,6640562	60.3	61.6	61.2	60.4	1.3	0.9	0.1
768083,6641087	60.3	61.6	61.2	60.4	1.3	0.9	0.1
768094,6641063	60.2	61.5	61.1	60.4	1.3	0.9	0.2
768267,6640767	60.1	61.4	61.1	60.3	1.3	1	0.2
768113,6641019	60.1	61.4	61.1	60.3	1.3	1	0.2
768101,6641051	60.1	61.4	61.1	60.2	1.3	1	0.1
768108,6641037	60	61.3	61	60.1	1.3	1	0.1
768032,6641199	60	61.3	61	60.1	1.3	1	0.1
768484,6640633	59.9	61.2	61	60.1	1.3	1.1	0.2
767571,6641842	59.9	61.2	60.9	60	1.3	1	0.1
764469,6640800	59.9	61.2	60.9	60	1.3	1	0.1
768140,6640961	59.9	61.2	60.9	60	1.3	1	0.1
768167,6640903	59.9	61.2	60.9	60	1.3	1	0.1
768134,6640978	59.9	61.2	60.8	59.9	1.3	0.9	0
768128,6640999	59.8	61.1	60.8	59.9	1.3	1	0.1
768324,6640734	59.8	61.1	60.8	59.9	1.3	1	0.1
768161,6640923	59.7	61	60.7	59.9	1.3	1	0.2
768023,6641217	59.7	61	60.7	59.9	1.3	1	0.2
764607,6640558	59.7	61	60.6	59.9	1.3	0.9	0.2
767569,6641847	59.6	60.9	60.6	59.8	1.3	1	0.2
764605,6640634	59.6	60.8	60.6	59.8	1.2	1	0.2
767692,6641766	59.5	60.8	60.5	59.8	1.3	1	0.3
768015,6641232	59.5	60.8	60.4	59.7	1.3	0.9	0.2
767679,6641784	59.4	60.7	60.3	59.7	1.3	0.9	0.3
767999,6641256	59.4	60.7	60.3	59.7	1.3	0.9	0.3
768282,6640779	59.3	60.6	60.3	59.6	1.3	1	0.3
767670,6641796	59.2	60.5	60.2	59.6	1.3	1	0.4
764497,6640784	59.2	60.5	60.2	59.5	1.3	1	0.3
764616,6640552	59.2	60.5	60.1	59.5	1.3	0.9	0.3
768509,6640641	59.2	60.5	60.1	59.5	1.3	0.9	0.3

Receiver location	Existing road traffic noise level	Scenario 1 (S1)	Scenario 2 (S2)	Scenario 3 (S3)	Increase in road traffic noise		
					S1	S2	S3
764580,6640701	59.1	60.4	60.1	59.4	1.3	1	0.3
768339,6640746	59.1	60.4	60	59.4	1.3	0.9	0.3
767997,6641272	59	60.4	60	59.4	1.4	1	0.4
764513,6640772	59	60.3	59.9	59.3	1.3	0.9	0.3
767987,6641286	59	60.3	59.8	59.3	1.3	0.8	0.3
767978,6641304	58.9	60.2	59.8	59.2	1.3	0.9	0.3
764525,6640762	58.9	60.2	59.8	59.1	1.3	0.9	0.2
767833,6641568	58.9	60.2	59.7	59	1.3	0.8	0.1
764657,6640494	58.9	60.2	59.7	59	1.3	0.8	0.1
767799,6641634	58.8	60	59.7	58.9	1.2	0.9	0.1
767563,6641862	58.7	60	59.7	58.9	1.3	1	0.2
764629,6640545	58.7	60	59.7	58.9	1.3	1	0.2
764541,6640752	58.6	60	59.7	58.8	1.4	1.1	0.2
767953,6641360	58.6	59.9	59.6	58.7	1.3	1	0.1
767975,6641326	58.6	59.9	59.6	58.7	1.3	1	0.1
768525,6640650	58.6	59.9	59.5	58.6	1.3	0.9	0
767964,6641343	58.6	59.9	59.5	58.6	1.3	0.9	0
767921,6641421	58.6	59.9	59.5	58.6	1.3	0.9	0
768307,6640788	58.5	59.9	59.5	58.6	1.4	1	0.1
768357,6640756	58.4	59.7	59.4	58.5	1.3	1	0.1
767874,6641522	58.4	59.7	59.4	58.5	1.3	1	0.1
767794,6641663	58.4	59.7	59.4	58.5	1.3	1	0.1
767908,6641459	58.3	59.6	59.4	58.4	1.3	1.1	0.1
767916,6641444	58.3	59.6	59.4	58.4	1.3	1.1	0.1
767838,6641593	58.3	59.6	59.4	58.4	1.3	1.1	0.1
767900,6641481	58.3	59.6	59.3	58.4	1.3	1	0.1
767555,6641873	58.2	59.5	59.3	58.4	1.3	1.1	0.2
764649,6640531	58.2	59.5	59.2	58.4	1.3	1	0.2
768325,6640793	58.1	59.4	59.1	58.3	1.3	1	0.2
768109,6641174	58.1	59.4	59.1	58.3	1.3	1	0.2
767776,6641709	58	59.3	59.1	58.3	1.3	1.1	0.3
768549,6640658	58	59.3	59	58.3	1.3	1	0.3
768162,6641054	58	59.3	59	58.3	1.3	1	0.3
767857,6641579	58	59.3	59	58.2	1.3	1	0.2
768167,6641040	58	59.3	59	58.2	1.3	1	0.2
768144,6641105	58	59.3	59	58.1	1.3	1	0.1

Receiver location	Existing road traffic noise level	Scenario 1 (S1)	Scenario 2 (S2)	Scenario 3 (S3)	Increase in road traffic noise		
					S1	S2	S3
768377,6640762	57.9	59.2	59	58.1	1.3	1.1	0.2
768147,6641085	57.9	59.2	59	58.1	1.3	1.1	0.2
768177,6641021	57.9	59.2	59	58.1	1.3	1.1	0.2
768135,6641121	57.9	59.2	59	58	1.3	1.1	0.1
768207,6640959	57.9	59.2	58.9	58	1.3	1	0.1
768127,6641142	57.9	59.2	58.9	58	1.3	1	0.1
768116,6641157	57.9	59.2	58.9	58	1.3	1	0.1
767838,6641619	57.9	59.2	58.9	58	1.3	1	0.1
768199,6640973	57.8	59.2	58.9	58	1.4	1.1	0.2
768185,6641007	57.8	59.1	58.8	58	1.3	1	0.2
767552,6641882	57.8	59.1	58.8	58	1.3	1	0.2
768198,6640989	57.7	59	58.8	58	1.3	1.1	0.3
764636,6640604	57.7	59	58.7	58	1.3	1	0.3
764672,6640518	57.7	59	58.7	58	1.3	1	0.3
768220,6640945	57.7	59	58.6	57.9	1.3	0.9	0.2
764589,6640726	57.6	59	58.6	57.9	1.4	1	0.3
764709,6640488	57.6	58.9	58.5	57.9	1.3	0.9	0.3
768067,6641261	57.6	58.9	58.5	57.9	1.3	0.9	0.3
768394,6640770	57.5	58.8	58.4	57.9	1.3	0.9	0.4
764812,6640419	57.5	58.8	58.4	57.9	1.3	0.9	0.4
768094,6641230	57.5	58.8	58.4	57.9	1.3	0.9	0.4
764729,6640473	57.5	58.8	58.4	57.9	1.3	0.9	0.4
767813,6641683	57.5	58.8	58.3	57.9	1.3	0.8	0.4
768619,6640636	57.4	58.8	58.3	57.9	1.4	0.9	0.5
767550,6641890	57.4	58.7	58.3	57.8	1.3	0.9	0.4
764766,6640452	57.4	58.7	58.2	57.8	1.3	0.8	0.4
768061,6641280	57.4	58.7	58.2	57.8	1.3	0.8	0.4
764617,6640689	57.3	58.6	58.2	57.7	1.3	0.9	0.4
764831,6640410	57.3	58.6	58.2	57.7	1.3	0.9	0.4
764647,6640596	57.3	58.6	58.1	57.7	1.3	0.8	0.4
768056,6641294	57.3	58.6	58.1	57.7	1.3	0.8	0.4
764865,6640390	57.3	58.6	58.1	57.6	1.3	0.8	0.3
764754,6640465	57.2	58.5	58.1	57.6	1.3	0.9	0.4
764798,6640435	57.2	58.5	58.1	57.5	1.3	0.9	0.3
764847,6640403	57.2	58.5	58.1	57.5	1.3	0.9	0.3
768585,6640671	57.1	58.5	58.1	57.5	1.4	1	0.4

Receiver location	Existing road traffic noise level	Scenario 1 (S1)	Scenario 2 (S2)	Scenario 3 (S3)	Increase in road traffic noise		
					S1	S2	S3
764782,6640446	57.1	58.4	58	57.5	1.3	0.9	0.4
764605,6640716	57.1	58.4	58	57.4	1.3	0.9	0.3
768412,6640779	57.1	58.4	58	57.4	1.3	0.9	0.3
768028,6641346	57.1	58.4	58	57.4	1.3	0.9	0.3
768021,6641359	57.1	58.4	58	57.3	1.3	0.9	0.2
768567,6640686	57	58.4	58	57.3	1.4	1	0.3
768182,6641081	57	58.3	57.9	57.3	1.3	0.9	0.3
741347,6634015	57	58.3	57.9	57.3	1.3	0.9	0.3
27DP,757098	57	58.3	57.9	57.2	1.3	0.9	0.2
768037,6641336	57	58.3	57.9	57.2	1.3	0.9	0.2
768052,6641316	57	58.3	57.8	57.2	1.3	0.8	0.2
768552,6640701	57	58.3	57.8	57.1	1.3	0.8	0.1
768016,6641373	56.9	58.3	57.8	57.1	1.4	0.9	0.2
768367,6640818	56.9	58.3	57.8	57.1	1.4	0.9	0.2
764745,6640477	56.8	58.2	57.8	57.1	1.4	1	0.3
741038,6631619	56.8	58.2	57.8	57.1	1.4	1	0.3
32DP,828711	56.8	58.2	57.8	57	1.4	1	0.2
764457,6640876	56.8	58.2	57.8	57	1.4	1	0.2
768008,6641389	56.7	58.2	57.8	57	1.5	1.1	0.3
764471,6640865	56.7	58.1	57.7	57	1.4	1	0.3
768536,6640717	56.7	58.1	57.7	57	1.4	1	0.3
768517,6640731	56.7	58.1	57.7	57	1.4	1	0.3
767971,6641466	56.7	58.1	57.7	57	1.4	1	0.3
768496,6640744	56.7	58.1	57.7	57	1.4	1	0.3
768433,6640785	56.7	58	57.7	56.9	1.3	1	0.2
767556,6641905	56.6	58	57.6	56.8	1.4	1	0.2
768169,6641171	56.6	58	57.6	56.8	1.4	1	0.2
768188,6641132	56.6	58	57.6	56.8	1.4	1	0.2
768177,6641149	56.6	58	57.6	56.8	1.4	1	0.2
764663,6640596	56.6	57.9	57.6	56.8	1.3	1	0.2
767944,6641524	56.6	57.9	57.6	56.7	1.3	1	0.1
768161,6641192	56.5	57.9	57.6	56.7	1.4	1.1	0.2
768483,6640759	56.5	57.9	57.5	56.7	1.4	1	0.2
764490,6640855	56.5	57.9	57.5	56.7	1.4	1	0.2
767955,6641507	56.5	57.9	57.5	56.7	1.4	1	0.2
768265,6640969	56.4	57.9	57.5	56.7	1.5	1.1	0.3

Receiver location	Existing road traffic noise level	Scenario 1 (S1)	Scenario 2 (S2)	Scenario 3 (S3)	Increase in road traffic noise		
					S1	S2	S3
767987,6641454	56.4	57.9	57.4	56.6	1.5	1	0.2
767939,6641543	56.4	57.8	57.4	56.6	1.4	1	0.2
768003,6641435	56.4	57.8	57.4	56.6	1.4	1	0.2
768206,6641095	56.4	57.8	57.3	56.6	1.4	0.9	0.2
768235,6641042	56.4	57.8	57.3	56.6	1.4	0.9	0.2
768258,6640987	56.3	57.8	57.3	56.6	1.5	1	0.3
764505,6640844	56.3	57.7	57.3	56.6	1.4	1	0.3
768200,6641116	56.3	57.7	57.3	56.5	1.4	1	0.2
768254,6641007	56.3	57.7	57.3	56.5	1.4	1	0.2
768243,6641025	56.3	57.7	57.2	56.5	1.4	0.9	0.2
768451,6640795	56.2	57.6	57.2	56.5	1.4	1	0.3
768279,6640326	56.2	57.6	57.2	56.4	1.4	1	0.2
768399,6640835	56.1	57.6	57.2	56.4	1.5	1.1	0.3
764439,6640915	56.1	57.6	57.1	56.4	1.5	1	0.3
768229,6641060	56.1	57.6	57	56.4	1.5	0.9	0.3
764522,6640832	56.1	57.6	57	56.4	1.5	0.9	0.3
767894,6641636	56	57.5	57	56.3	1.5	1	0.3
768219,6641081	56	57.5	57	56.3	1.5	1	0.3
767875,6641674	56	57.4	57	56.3	1.4	1	0.3
767870,6641683	56	57.4	57	56.3	1.4	1	0.3
764643,6640690	55.9	57.4	57	56.3	1.5	1.1	0.4
764541,6640823	55.9	57.4	57	56.2	1.5	1.1	0.3
768673,6640676	55.9	57.3	57	56.1	1.4	1.1	0.2
767887,6641667	55.9	57.3	57	56.1	1.4	1.1	0.2
767897,6641654	55.9	57.3	56.9	56.1	1.4	1	0.2
768157,6641256	55.9	57.2	56.9	56.1	1.3	1	0.2
768659,6640690	55.9	57.2	56.9	56	1.3	1	0.1
767951,6641569	55.8	57.2	56.9	56	1.4	1.1	0.2
767918,6641630	55.8	57.2	56.9	56	1.4	1.1	0.2
767706,6641869	55.8	57.2	56.9	56	1.4	1.1	0.2
764571,6640801	55.8	57.2	56.9	56	1.4	1.1	0.2
768614,6640723	55.8	57.2	56.9	56	1.4	1.1	0.2
767869,6641701	55.8	57.2	56.9	55.9	1.4	1.1	0.1
768149,6641269	55.8	57.2	56.9	55.9	1.4	1.1	0.1
768630,6640712	55.8	57.2	56.8	55.9	1.4	1	0.1
767612,6641918	55.7	57.1	56.8	55.9	1.4	1.1	0.2

Receiver location	Existing road traffic noise level	Scenario 1 (S1)	Scenario 2 (S2)	Scenario 3 (S3)	Increase in road traffic noise		
					S1	S2	S3
768199,6641210	55.7	57.1	56.8	55.9	1.4	1.1	0.2
768131,6641306	55.7	57.1	56.8	55.9	1.4	1.1	0.2
768599,6640737	55.7	57.1	56.8	55.9	1.4	1.1	0.2
768142,6641289	55.7	57	56.7	55.9	1.3	1	0.2
768584,6640749	55.7	57	56.7	55.9	1.3	1	0.2
767532,6641939	55.6	57	56.7	55.9	1.4	1.1	0.3
764697,6640579	55.6	57	56.7	55.9	1.4	1.1	0.3
767867,6641720	55.6	57	56.7	55.8	1.4	1.1	0.2
768572,6640761	55.6	57	56.7	55.8	1.4	1.1	0.2
768109,6641342	55.6	57	56.7	55.8	1.4	1.1	0.2
768558,6640772	55.6	56.9	56.6	55.8	1.3	1	0.2
767854,6641737	55.5	56.9	56.6	55.8	1.4	1.1	0.3
768305,6641008	55.5	56.9	56.6	55.8	1.4	1.1	0.3
768314,6640989	55.5	56.9	56.6	55.8	1.4	1.1	0.3
768125,6641328	55.5	56.9	56.6	55.8	1.4	1.1	0.3
768543,6640785	55.5	56.8	56.5	55.8	1.3	1	0.3
768298,6641028	55.5	56.8	56.5	55.8	1.3	1	0.3
768531,6640800	55.5	56.8	56.5	55.7	1.3	1	0.2
768238,6641158	55.5	56.8	56.5	55.7	1.3	1	0.2
767528,6641947	55.5	56.8	56.5	55.7	1.3	1	0.2
768255,6641118	55.4	56.8	56.5	55.7	1.4	1.1	0.3
768260,6641100	55.4	56.8	56.5	55.7	1.4	1.1	0.3
768281,6641064	55.4	56.8	56.5	55.7	1.4	1.1	0.3
768217,6641218	55.4	56.8	56.5	55.7	1.4	1.1	0.3
768108,6641367	55.4	56.7	56.4	55.7	1.3	1	0.3
768245,6641138	55.4	56.7	56.4	55.6	1.3	1	0.2
768289,6641047	55.3	56.7	56.4	55.6	1.4	1.1	0.3
768517,6640813	55.3	56.7	56.4	55.6	1.4	1.1	0.3
768272,6641082	55.3	56.7	56.4	55.6	1.4	1.1	0.3
768502,6640826	55.3	56.7	56.4	55.6	1.4	1.1	0.3
764931,6640065	55.3	56.7	56.4	55.6	1.4	1.1	0.3
768229,6641173	55.3	56.7	56.4	55.6	1.4	1.1	0.3
764664,6640682	55.3	56.7	56.4	55.5	1.4	1.1	0.2
768080,6641415	55.3	56.6	56.3	55.5	1.3	1	0.2
768101,6641384	55.3	56.6	56.3	55.5	1.3	1	0.2
768444,6640871	55.3	56.6	56.3	55.5	1.3	1	0.2

Receiver location	Existing road traffic noise level	Scenario 1 (S1)	Scenario 2 (S2)	Scenario 3 (S3)	Increase in road traffic noise		
					S1	S2	S3
768473,6640849	55.2	56.6	56.3	55.5	1.4	1.1	0.3
768430,6640882	55.2	56.6	56.3	55.5	1.4	1.1	0.3
767983,6641575	55.2	56.6	56.3	55.5	1.4	1.1	0.3
768488,6640837	55.2	56.6	56.2	55.5	1.4	1	0.3
764763,6640524	55.2	56.6	56.2	55.5	1.4	1	0.3
764846,6640114	55.2	56.6	56.2	55.5	1.4	1	0.3
764675,6640671	55.2	56.6	56.2	55.5	1.4	1	0.3
8DP,757098	55.1	56.5	56.2	55.4	1.4	1.1	0.3
768463,6640864	55.1	56.5	56.1	55.4	1.4	1	0.3
767524,6641956	55.1	56.5	56.1	55.4	1.4	1	0.3
768693,6640715	55.1	56.5	56.1	55.4	1.4	1	0.3
764793,6640144	55.1	56.5	56	55.4	1.4	0.9	0.3
768061,6641464	55.1	56.4	56	55.4	1.3	0.9	0.3
768052,6641479	55.1	56.4	56	55.3	1.3	0.9	0.2

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