Appendix 7

Noise Impact Assessment

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NORTHPARKES

NOISE IMPACT ASSESSMENT

Northparkes Mines Step Change Project

July 2013

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Northparkes Mines Step Change Project

July 2013

Prepared by
Umwelt (Australia) Pty Limited

on behalf of
North Mining Limited

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Report No.	**2949/R12/FINAL**
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1.0 Introduction

Northparkes Mines (NPM) is an existing copper-gold mine located approximately 27 kilometres north-west of Parkes (refer to **Figure 1.1**) in the central west region of New South Wales (NSW). NPM has been operational since 1993 and has included the development of open cut and underground mining operations targeting a number of ore bodies, as well as associated ore processing and tailings storage infrastructure. The existing operations have been developed in accordance with a number of development consents and project approvals, the most recent of which being PA06_0026 (as modified), which provides for continued mining operations through to 2025.

NPM is seeking approval for the Step Change Project (the Project) which encompasses the continuation of underground block cave mining in two existing ore bodies, the development of underground block cave mining in the E22 resource, additional campaign open cut mining located in existing mining leases, augmentation of a tailings storage facility (TSF) and an extended mine life of seven years until 2032.

This Noise Impact Assessment (NIA) has been prepared by Umwelt (Australia) Pty Limited (Umwelt) to support an Environmental Assessment (EA) for the Project required under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

This NIA has been undertaken in accordance with the NSW Industrial Noise Policy (INP) (Environment Protection Authority (EPA) 2000) with the objective of addressing the key issues relating to noise as required by the Director-General's EA Requirements for the Project (refer to **Section 1.5**).

1.1 The Project

The Project Area is shown in **Figure 1.2** and shows the major components of the Project while **Figure 1.3** shows the existing and approved operations at NPM.

The major components of the Project include:

- continuation of approved underground block cave mining in the E48 and E26 ore bodies, and associated underground infrastructure;
- development of underground block cave mining in the E22 resource beneath the E22 open cut void;
- campaign open cut mining through development of five open cut resources including:
  - development of four small open cut pits E31, E31N, E28, E28N;
  - proposed E26 open cut which is located in an area of previous underground block cave subsidence (existing vertical extent of subsidence void is approximately 200 metres);
- amendments to the configuration of TSFs including:
  - continuation of tailings disposal to the existing and approved TSFs (TSF 1 and 2, infill between TSF 1 and 2, and Estcourt) to an approved height of 28 metres;
  - provision for additional raises on Estcourt TSF to provide for an increased height from the approved 25 metres to up to approximately 28 metres above ground surface;
  - development of a new TSF 3, which will extend to the south and from the southern embankment of TSF 2 to a height of approximately 28 metres above ground surface, which incorporates the approved Rosedale TSF (TSF 3)

Source: NPM (2013), Department of Lands (2006)

0 3.0 6.0 12km
1:250 000

Legend

Project Area

FIGURE 1.1

Locality Map

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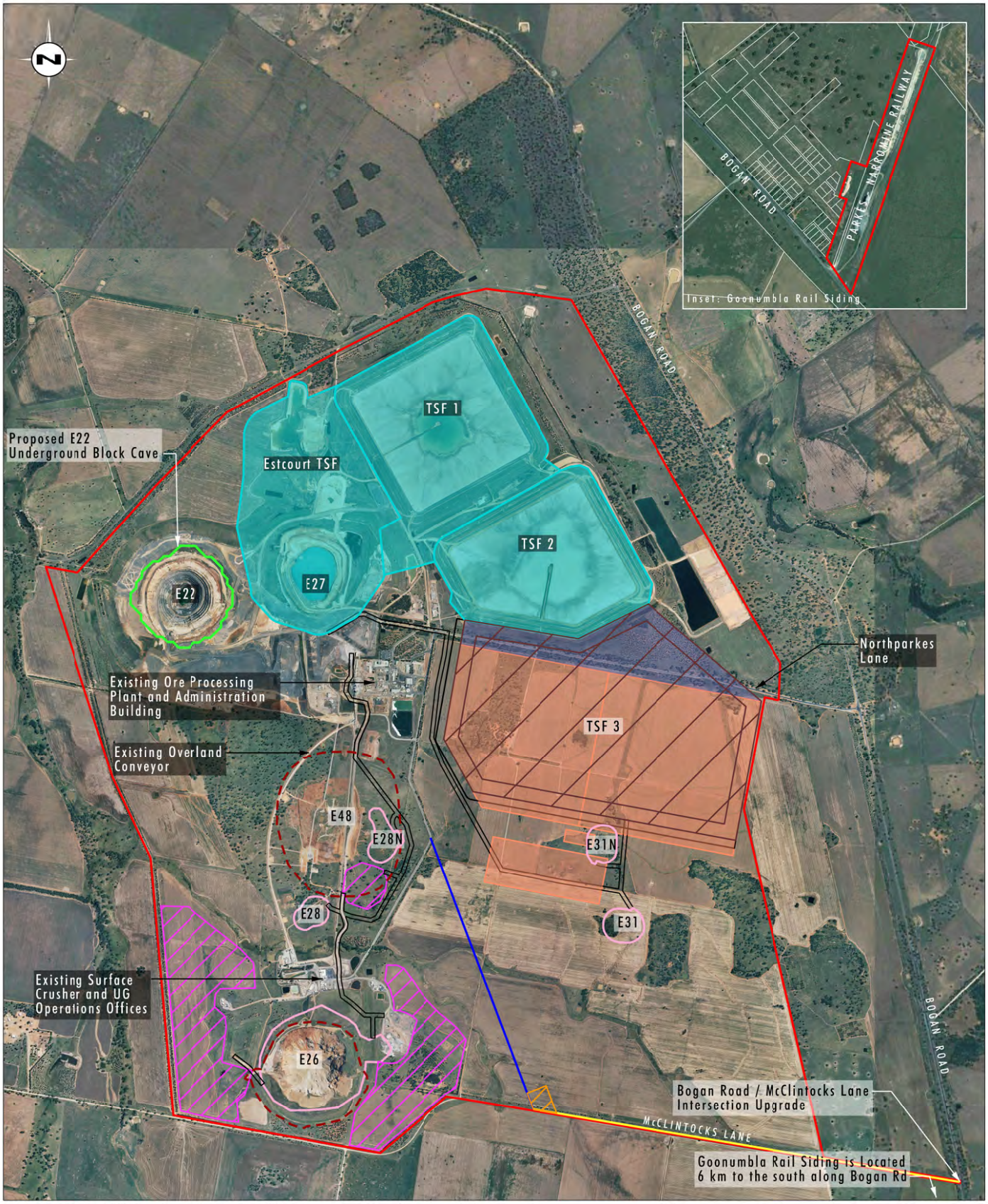
20130429 16.00



Source: NPM (2013), Google Earth (2010)

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Inset 1:16 000

0 0.5 1 2km
1:40 000

Legend

- Project Area
- Approved Tailings Storage Facility (Rosedale)
- Approved Subsidence Mancgement Areas
- Existirg Tailings Storage Facility
- Proposed Tailings Storage Facility Extension
- Proposed TSF3
- New Underground Block Cave Mining Area
- Proposed Open Cut Areas
- Proposed Upgrade to McClintocks Lane
- Proposed Access Control and Visitor Car Park
- Proposed Waste Dumps
- Proposed Site Access Road
- Proposed Haul Road

FIGURE 1.2

Northparkes Mines Step Change Project

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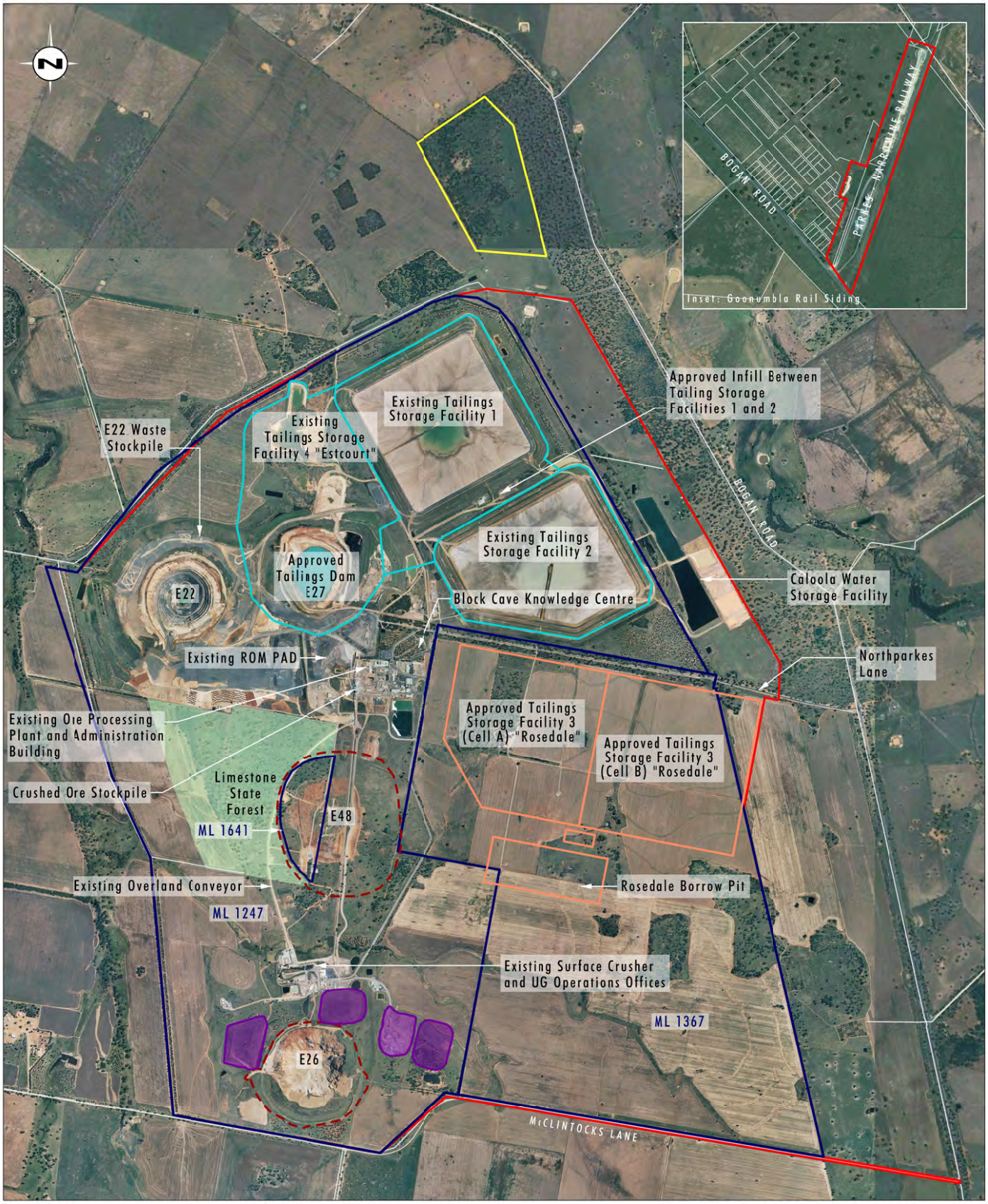
20130513 11.40



Source: NPM (2013) and Google Earth (2010)

0 200 400 800m
Inset 1:16 000

0 0.5 1 2km
1:40 000

Legend

- Project Area
- Approved Waste Rock Stockpile
- Approved Tailings Facility
- Approved Subsidence Management Areas
- Mining Lease Boundary
- Existing Biodiversity Offset Area
- Existing Tailings Storage Facility
- Limestone State Forest

FIGURE 1.3

Existing and Approved Operations

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20130513 11.43

- development of new waste dumps for the management of E28/E28N and E26 open cut waste rock. Waste rock from E31 and E31N open cut mining areas will be utilised in the development of TSF 3;

- continuation of approved ore processing infrastructure up to 8.5 million tonnes per annum (Mtpa) capacity, and road haulage of copper concentrate to the existing Goonumbla rail siding;

- continued use of existing site infrastructure including administration buildings, workshop, internal access roads and service infrastructure;

- continued use of surface mining infrastructure including ventilation shafts, hoisting shaft and ore conveyors;

- continuation of existing approved water supply and management processes;

- development of an amended access road to service all mine related traffic entering the site;

- establishment of new visitor car parking facilities and access control to support the amended mine site access;

- continuation of approved mining operations for an extended life of an additional seven years until end of 2032; and

- rehabilitation and closure of the mine site will be carried out after the end of the operational life of the Project in accordance with relevant approvals.

The Project provides the opportunity for the integration, update and consolidation of existing approvals for underground mining, open cut mining and infrastructure within the NPM Project Area. This process will include surrendering of the existing project approval PA06_0026 (as modified) and existing development consents following any granting of a Project Approval for this Project.

The conceptual design of the Project has been developed to maximise recovery efficiency and is based on detailed geological exploration, engineering design and detailed analysis of potential environmental and community constraints. A description of the key features that comprise the Project are summarised in **Table 1.1**.

Table 1.1 – Key Features of the Project

Major Project Components/ Aspects	Existing and Approved Operations	Proposed Operations
Mining Areas	• Underground block cave mining of E26 and E48 ore bodies; and • Open cut mining of E27 and E22 (ceased in 2010).	• Continued block cave mining of the E26 and E48 ore bodies (as per current approval). • Development of block cave mining in the E22 resource (previously subject to open cut mining). • Development of open cut mining area in existing mine subsidence zone for E26. • Development of four small open cuts to extract ore from E28, E28N, E31 and E31N. • All proposed open cut mining areas are located within the existing PA 06_0026 Project Area and existing Mining leases.
Ore Processing	• Up to 8.5 Mtpa of ore, sourced from underground and open cut mining areas.	• Continuation of processing up to 8.5 Mtpa of ore through the existing processing plant sourced from underground and open cut mining areas.
Mine Life	• Until 2025.	• Extension of mining by seven years until end of 2032.
Operating Hours	• 24 hours a day, seven days per week.	• No Change.
Number of Employees	• Approximately 700 full time equivalents.	• No Change.
Mining Methods	• Multiple Underground Block Cave; and • Campaign open cut mining yielding up to 2 Mtpa for stockpiling and processing as required.	• Multiple Underground Block Cave. • Campaign Open cut mining of up to 7 Mtpa for stockpiling and processing as required.

Table 1.1 – Key Features of the Project (cont.)

Major Project Components/ Aspects	Existing and Approved Operations	Proposed Operations
Infrastructure	Operation of: • TSF 1-4. • Ore processing plant including surface crusher, crushed ore stockpiles, active grinding mills, froth flotation area and concentrate storage. • Site offices, training rooms and workshop facilities. • Road haulage of concentrate to the Goonumbla rail siding for transport to Port Kembla. • An overland conveyor to transport ore from the hoisting shaft to the ore processing plant stockpiles. • Operation of four wastewater treatment plants.	Construction and operation of: • TSFs to be augmented to connect existing and approved tailings facilities, through the development of TSF 3 southward from the existing southern embankment of TSF 2. The proposed TSF 3 will substantially include the approved TSF 3 (known as Rosedale). • Establishment of new waste stockpiles to store waste material generated during open cut mining campaigns, including a vehicle wash down area. • Continued operation of existing processing plant, site offices, underground access, water supply infrastructure and logistics connections. • Continued road haulage of concentrate to Goonumbla rail siding for transport to Port Kembla. • Closure of the existing site access road through the development of TSF 3. • Provision of an upgraded site access road along a new alignment from McClintocks Lane. • Development of an access control and visitors car parking at the intersection of the proposed site access and McClintocks Lane. • Upgrade/sealing of McClintocks Lane between the NPM access road and Bogan Road. • Upgrades as required to the intersection of McClintocks Lane and Bogan Road.
Block Cave Knowledge Centre	• Onsite Rio Tinto Block Cave Knowledge Centre operates for the domestic and international training of underground block cave mining methodology.	• Continued operation of the Rio Tinto Block Cave Knowledge Centre.

2.0 Statutory Requirements

2.1 Director-General's Requirements

The Department of Planning and Infrastructure (DP&I) has issued Director–General's Requirement's (DGR's) for the Project that identifies noise impacts as a key issue for consideration in the EA for the Project. The DGR's specify that EA must include quantitative assessment of:

- noise from construction, operational and off-site transport noise impacts;
- reasonable and feasible mitigation measures, including evidence that there are no such measures available other than those proposed; and
- monitoring and management measures, in particular real-time, attended noise monitoring and predictive meteorological forecasting.

The DGR's specify that this assessment should be undertaken in accordance with the following policies and guidelines:

- INP (EPA 2000); and
- NSW Road Noise Policy (Department of Environment, Climate Change and Water (DECC) 2011).

2.2 Section 10 of the Industrial Noise Policy

Section 10 – 'Applying the policy to existing industrial premises of the INP' (EPA 2000) deals with application of the INP (EPA 2000) to existing industrial noise sources such as NPM. The approach established by the EPA was designed to allow established industries to adapt to changes in the noise expectations of the community while remaining economically viable.

The INP (EPA 2000) identifies four triggers for the application of Section 10. These are:

- the site becomes the subject of serious and persistent noise complaints;
- there is a proposal to upgrade and/or expand the site;
- the site has no formal consent or licence conditions and management wish to clarify their position; and
- management chooses to initiate a noise reduction program.

Using theses triggers as a guide, the methodology for the preparation of the NIA has taken into account:

1. NPM is not the subject of noise complaints from the community or Office of Environment and Heritage (OEH).

2. As discussed in **Section 1.0**, the preparation of the EA and supporting studies is to enable the expansion of the surface mining and TSFs at NPM. While the existing operations (underground and processing) will remain substantially the same, the Project will include some minor 'upgrade and/or expansion' to the existing site activities to account for changes in the open-cut component of the mining operation and the construction of additional tailings storage facilities. The Project does not specifically address improvements in operating practices, equipment selection and/or product quality/demand but this is likely to be an outcome of the continued operation of NPM.

3. The original development consent for NPM was granted in 1993. As a result, the management of the noise impacts was based around the expectation of the Environmental Noise Control Manual (EPA 1985). NPM currently operates under PA_0026 issued in 2007 by the NSW Department of Planning pursuant to Part 3A of the EP&A Act. NPM was granted a modification to PA06_0026 in October 2009. As a part of the 2006 Development Application, the Noise Management Plan (Heggies Australia Pty Ltd) established contemporary noise criteria for the site in accordance with the INP (EPA 2000).

4. The NPM Management Plan Site wide Environmental Noise and Vibration (NPM 2007) documents that the noise monitoring program for NPM comprises a combination of attended and unattended surveys to monitor performance. No exceedance of noise criteria has been reported since 2008 (Source: Northparkes Mines Independent Environmental Audit, ERM 2011).

As an established operation with a contemporary consent and Environmental Protection Licence (EPL), NPM is not seeking to reduce their noise emissions to achieve new target noise limits identified under Section 10 of the INP (EPA 2000). The NIA seeks to assess the performance of the Project against a noise criterion that has been established in accordance with the expectations of the INP (EPA 2000).

Section 10 of the INP (EPA 2000) outlines a methodology for the assessment of a project where a company proposes to upgrade or modify its existing operations. This methodology, outlined in **Section 2.3**, is also applicable to a proposal for the continuation of an existing operation where the proponent wishes to clarify its position with respect to the expectations of the INP (EPA 2000).

2.3 Methodology

To satisfy the requirements of the relevant policies and guidelines, the NIA has:

- identified noise sensitive locations likely to be affected by activities at the site and determined existing background and amenity noise levels at representative locations in accordance with the INP (EPA 2000) (refer to **Section 3.0**);

- determined the Project Specific Noise Levels (PSNL) for the Project based on the assessment of underlying background and amenity noise levels of the surrounding receiver areas (refer to **Section 3.0**);

- identified all noise sources from the Project and determined the expected noise levels and noise characteristics (e.g. tonality, impulsiveness, etc.) likely to be generated from the noise sources (refer to **Section 5.0**);

- identified the times of operation of the Project and all related noise producing activities (refer to **Section 1.0** and **Section 4.0**);

- determined the noise levels likely to be received at the most sensitive locations under neutral meteorological conditions and relevant gradient winds (refer to **Section 5.0**);

- considered the influence of existing meteorological conditions such as wind and temperature inversions in the prediction model so as to provide a true representation of actual noise levels (refer to **Section 4.0** and **Section 5.0**);

- assessed the effect of relevant noise mitigation measures incorporated into the predictive modelling (refer to **Section 4.2**);

- compared the predicted noise levels with the appropriate PSNL determined for the activity/operation being considered (refer to **Section 5.0**). The assessment of the predicted noise levels against PSNL was undertaken in accordance with Section 10 of the INP (EPA 2000) (refer to **Section 2.0**);

- discussed the findings from the predictive modelling and, where predicted noise levels exceeded the relevant PSNL, recommended additional mitigation measures (refer to **Section 5.0**);

- quantified the residual level of noise impact where relevant noise criteria cannot be met after application of all feasible and cost effective mitigation measures, where relevant (refer to **Section 5.0**);

- determined the achievable project noise levels that would form the basis of project specific noise criteria in accordance with the requirements of Section 10 of the INP (2000) (refer to **Sections 3.0**, **5.0** and **6.0**); and

- provided details of the recommended noise monitoring program to be undertaken at noise sensitive locations (subject to the agreement of the owners/occupiers) for the duration of the Project.

The computer-based modelling software package Environmental Noise Model (ENM) was used to predict the noise levels likely to be produced by the Project in the surrounding environment. The ENM noise models were based on machine and plant sound power level data obtained from NPM or collected by Umwelt, digital terrain maps of the region surrounding the Project prepared by Umwelt and the layout of the existing and proposed operations provided by NPM.

The NIA was based on the noise levels predicted by the ENM model of the existing and proposed operations. The predicted noise levels from the existing operation were compared with the results from routine noise monitoring program conducted by NPM. This information was used to validate the ENM model of the existing operation and assess the effects of meteorological conditions (primarily wind speed and wind direction).

The assessment of the predicted noise levels against PSNL was then undertaken in accordance with Section 10 the INP (EPA 2000). Where it was found that the predicted noise levels noise exceeded the respective target PSNL, appropriate mitigation measures were investigated. The results of this investigation are presented in **Section 5.0**.

A glossary of terms and abbreviations used in this report is provided in **Appendix A**.

The noise modelling and assessment process is described in **Sections 3.0** through **5.0**. A detailed summary of the INP (EPA 2000) assessment methodology used for this NIA is provided in **Appendix B**.

3.0 Existing Acoustic Environment and Assessment Criteria

3.1 Existing Noise Environment

The existing background level is routinely monitored as a part of the NPM noise monitoring program. The results of the noise monitoring program regularly report ambient background noise levels at, or below 30 dB(A). The existing background noise levels, measured by the L_{A90} descriptor, for Quarters 3 and 4 of the 2012 noise monitoring program are detailed in **Appendix C**.

Based on the monitoring results from the NPM noise monitoring program it can be reasonably assumed that, due to the rural nature of the area surrounding the Project, the existing background level is at or below 30 dB(A). In addition to this, there are no other industrial noise sources in area surrounding the Project. Therefore the existing industrial $L_{Aeq, period}$ (where period is day, evening or night) noise levels is more than 10 dB below the Acceptable Noise Level as defined by the INP (EPA 2000).

3.2 Intrusiveness and Amenity Criteria

3.2.1 Application of the Industrial Noise Policy

The INP (EPA 2000) has two components for the assessment of industrial noise sources, intrusive noise impacts and noise amenity levels. When assessing the noise impact of industrial sources both components are considered for residential receivers.

The PSNL reflects the most stringent noise levels derived from both the Intrusiveness and Amenity Criteria. Where the Intrusiveness Criteria is less than or equal to the Amenity Criteria, the Intrusiveness Criteria is applied as the limiting criterion and forms the PSNL for the industrial source as it is more stringent due to being determined over a much shorter period of time. Where the predicted amenity noise level is lower than the intrusive level, both the intrusive and amenity noise limits become the limiting criteria and form the PSNL for the industrial source.

PSNL set the benchmark against which noise impacts and the need for noise mitigation are assessed. For existing operations the PSNL are not mandatory but supply the initial target levels that are used to derive the achievable noise limits based on the implementation of feasible and reasonable control measures.

When setting the PSNL, the INP (EPA 2000) recommends the application of the most stringent requirement so that the applicable PSNL both limits intrusive noise and protects noise amenity. The PSNL derived for the Project are provided in **Section 3.3**.

3.2.2 Intrusiveness Criteria

Where the existing background level in the region surrounding the Project is at or below 30 dB(A) the corresponding Intrusiveness Criteria would be 35 dB(A). This is the minimum possible Intrusiveness Criterion under the INP (EPA 2000).

3.2.3 Amenity Criteria

To limit continuing increases in noise levels due to industrial development, the INP (EPA 2000) has identified maximum ambient noise levels for typical receiver areas and land uses. The recommended acceptable and maximum ambient noise levels for a rural environment are provided in **Table 3.1**. The Amenity Criteria is then determined by comparing the existing ambient noise levels resulting from industrial noise sources with the recommended acceptable ambient noise levels (refer to Table 2.1 and 2.2 in the INP (EPA 2000)).

Table 3.1 – Amenity Criteria – Recommended L_{Aeq} Noise Levels from Industrial Noise Sources, dB(A)

Type of Receiver	Indicative Noise Amenity Area	Time of Day [1] (Period)	Recommended L_{Aeq} Noise Level	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45

Note: 1.For Monday to Saturday, Day-time 7.00 am – 6.00 pm; Evening 6.00 pm – 10.00 pm; Night-time 10.00 pm – 7.00 am. On Sundays and Public Holidays, Day-time 8.00 am – 6.00 pm; Evening 6.00 pm – 10.00 pm; Night-time 10.00 pm – 8.00 am.

Where the existing industrial $L_{Aeq, period}$ (where period is day, evening or night) noise level is more than 10 dB below the Acceptable Noise Level referred to in **Table 3.1**, the Amenity Criteria is set at the Acceptable Noise Level nominated in **Table 3.1**.

3.3 Project-specific Noise Levels

The PSNL reflects the most stringent noise levels derived from both the Intrusiveness and Amenity Criteria and would be 35 dB(A) $L_{Aeq,15minute}$ for the day-time, evening and night-time periods.

3.4 Sleep Disturbance Criteria

The Sleep Disturbance Criteria are based on the criteria from the INP Application Notes which reference the review of research on sleep disturbance published in the NSW Road Noise Policy (DECC 2011). The INP Application Note suggests that to prevent sleep disturbance, the $L_{A1,1minute}$ or L_{Amax} level of a noise source should not exceed the L_{A90} background noise level by more than 15 dB when measured outside the bedroom window. The Sleep Disturbance Criteria for all identified noise sensitive locations is 45 dB(A).

3.5 Construction Noise Criteria

The EPA recognises that construction activities could potentially generate higher noise levels than those of an industrial operation. DECC's (now OEH's) Interim Construction Noise Guideline (DECC 2009) provides criteria for construction activities as presented in **Table 3.2**, for residential receivers surrounding the Project. The criteria are intended to guide the need for and the selection of feasible and reasonable work practices to minimise construction noise impacts.

Table 3.2 – DECC Construction Noise Management Levels at Residences, dB(A)

Construction Time	Management Level $L_{Aeq, 15\ minute}$
Recommended standard hours Monday to Friday 7.00 am to 6.00 pm Saturday 8.00 am to 1.00 pm No work on Sundays or public holidays	Noise Affected: Rating Background Noise Level + 10 dB
	Highly Noise Affected: 75 dB(A)
Outside recommended standard hours	Noise Affected: Rating Background Noise Level + 5 dB

Source: Interim Construction Noise Guideline (DECC 2009).

The construction phase of the Project is limited to the upgrade of McClintocks Lane and the intersection of McClintocks Lane with Bogan Road and the construction of a new access road from McClintocks Lane onto the site. The upgrade of McClintocks Lane is only anticipated to occur within recommended standard construction hours. Therefore the construction noise management level for all residential receivers surrounding the Project is 40 dB(A).

The Interim Construction Noise Guideline (DECC 2009) notes that construction activities that relate to or support the mining process are not covered by the guideline and should be assessed in accordance with the requirements of the INP (EPA 2000). Therefore, the construction of the TSF has been considered as a part of the normal operation activity of NPM.

3.6 Road Traffic Noise Criteria

The DECC's (now OEH's) NSW Road Noise Policy (DECC 2011) sets out criteria for road traffic noise through the provision of a framework that addresses traffic noise issues associated with new developments, new or upgraded road developments or planned building developments. While the proposed Project represents a continuation of existing operations, the Project includes a modification to the access route to the site from Bogan Road due to the construction of a new TSF (TSF 3). The new TSF is located over the existing NPM access road. NPM plan to upgrade McClintock Lane to replace the existing NPM access road. McClintocks Lane is an existing local road that intersects Bogan Road approximately 3.5 kilometres south of the existing NPM access Road.

Table 3.3 outlines the criteria relevant for the two way traffic volumes due to the Project on the new site access along McClintocks Lane.

Table 3.3 – Road Noise Criteria, dB(A)

Road Category	Type of Project/Land Use	Assessment Criteria	
		Day (7.00 am – 10.00 pm)	Night (10.00 pm –7.00 am)
Local roads	6. Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(1\ hour)}$ 55 (external)	$L_{Aeq(1\ hour)}$ 50 (external)

Source: Table 3 NSW Road Noise Policy (DECC 2011)

4.0 Noise Modelling Parameters

4.1 Prediction of Projected Noise Levels

Section 6 of the INP (EPA 2000) requires the prediction of noise levels taking into account all possible noise sources that may reasonably be expected when the plant or facility in question is fully operational. The schedule of major equipment items (or their equivalent) that NPM will typically use is described in **Section 4.2**. The ENM model has been prepared assuming that all the equipment available is operational for durations of time representative of typical operational scenarios. Sources were located in representative locations based on typical mining operations, mineral handling and processing, and product dispatch. This is likely to be representative of worst-case operational scenarios and give an indication of worst-case noise levels experienced at the receiver locations surrounding the Project.

A number of operational scenarios were modelled to determine the worst-case operational noise impacts associated with the Project. The components of the operational scenarios that were considered in the noise assessment are outlined in **Table 4.1.**

Table 4.1 – Model Scenarios

Operational Scenario	Scenario 1	Scenario 2	Scenario 3
The full operation of the process plant (crushing, screening, product floatation, water treatment and product filtration) up to 8.5 Mtpa processing.	X	X	X
The mining operations from the underground mines and associated mineral handling equipment and ventilation system.	X	X	X
Open-cut mining from E26 and the out-of-pit placement of waste product to the east and west of the E26 open-cut pit.	-	X	X
Open-cut mining from E31 combined with the construction of TSF 3.	-	X	-
Open-cut mining from E28 combined with the construction of Estcourt TSF.	-	-	X

Scenario 1 represents the existing seven days per week 24 hours per day operation of NPM, incorporating the process plant (including product loading and dispatch road haulage trucks), underground mining and the associated equipment supporting the underground mining activities.

Scenario 2 incorporates Scenario 1 as well as mining from open-cut E26 and the out-of-pit placement of waste material from the open-cut to the east and west of E26 open-cut. This scenario also includes the mining from open-cut E31 and construction of TSF 3. Scenario 2 also considers a sensitivity analysis of mining activities described above without the TSF 3 construction.

Scenario 3 incorporates Scenario 1 as well as mining open-cut E26 and the out-of-pit placement of waste material from the open-cut to the east and west of E26 open-cut. This scenario also includes mining from open-cut E28 and construction of the Estcourt TSF. Scenario 3 also considers a sensitivity analysis of mining activities described above without the Estcourt TSF construction.

4.2 Operational Noise Sources

Noise source models were prepared to represent the type of equipment currently in use at NPM. Throughout the life of the Project the equipment outlined in **Table 4.2**, or the equivalent, will typically be in use around the Project Area. **Table 4.2** provides a list of typical equipment and sound power levels (SWL) associated with each item of equipment.

Table 4.2 – Modelled Equipment SWL, dB(A)

Equipment [1]	SWL, dB(A)
300t excavator (Liebherr R9350)	116
120t Excavator (Hitachi EX1200)	113
Drill Rig (Tamrock Pantera 1500)	108
Mining Truck (Cat 785)	103 to 114
Water Cart (Cat 773)	111
Bulldozer (Cat D10) (Forward/Reverse)	112/122
Large Wheel Loader (Cat 998)	112
Medium Wheel Loader (Cat 950)	111
Grader (Cat 16G)	108
18t Roller	110
90t Excavator	95
22t Excavator	91
Medium Compactor (Cat 815)	110
Large Compactor (Cat 825)	111
Articulated Truck (Cat 740)	102
Articulated Water Cart (Cat 740)	102
Conveyor (dB(A)/m)	80
Transfer Tower	109
Rill Tower	93
Underground Ventilation Fan	108
Primary Jaw Crusher	114
Secondary Jaw Crusher	112
NPM Processing Plant (combined SWL)	118

Source: Umwelt SWL Library and field survey of NPM.

Note 1: Equipment make and model are listed for size comparison purposes only.

4.3 Construction Noise

A noise source model was prepared to assess the impacts of the construction noise impacts associated with the construction of the new site access road to NPM and the upgrade of McClintocks Lane.

A range of typical construction equipment likely to be utilised on the site were included in the model. The SWL of this equipment are described in **Table 4.3**. To account for variability in the construction noise levels and level of machine utilisation, an average sound power level of 116 dB(A) was used to represent the combination of machine related to construction activities during ‘standard hours’ as defined by the Interim Construction Noise Guideline (DECC 2009).

Table 4.3 – Construction Equipment SWL, dB(A)

Equipment [1]	SWL, dB(A)
Bulldozer (Forward/Reverse)	110/116
Grader	106
Dump Trucks	108
Water cart (small)	106
Compactor	109

Source: Umwelt SWL Library.

4.4 Road Traffic Noise

The road noise impacts associated with traffic movements generated by the Project were modelled using the US Federal Highway Administration (FHWA) Traffic Noise Model (TNM) Version 2.5 Look-Up Tables (U.S. Department of Transportation 2004). TNM is a highway traffic noise prediction and analysis model used to analyse highway geometries including vehicle speeds, vehicle type, setback distances and the effectiveness of barriers.

Traffic volumes associated with the Project are expected to remain unchanged from the existing operation. However, the upgrade and use of McClintocks Lane for access to NPM will result in increased traffic volumes along McClintocks Lane. Only one residence to the south of McClintocks Lane has the potential to be impacted by the changed traffic volumes along McClintocks Lane. The residence is setback approximately 3.5 kilometres from Bogan Road and 2.5 kilometres from McClintocks Lane.

Traffic volumes in a baseline traffic study undertaken for the existing NPM operation in 2012 (Transport and Urban Planning 2012) have been used as the basis for the road traffic noise assessment. The following bases and assumptions were used for the purpose of the road traffic noise impact assessment:

- AM and PM peak traffic volumes were used to estimate noise impacts.
- Peak traffic volumes along Bogan Road remain unchanged.
- Peak traffic volumes on the existing NPM access road are additive to the peak traffic volumes on McClintocks Lane.
- As no peak traffic data for McClintocks Lane was recorded in the baseline traffic study the peak traffic volumes on McClintocks Lane were estimated based on the peak traffic volume to average daily traffic volume ratio on Bogan Road.
- The predictions are based on an average speed on Bogan Road of 100 kilometres per hour with no noise barriers included in the traffic noise prediction model and 80 kilometres per hour on McClintocks Lane.

Traffic noise levels have been predicted using the FHWA Traffic Noise Model Version 2.5 Look-Up Tables (U.S. Department of Transportation 2004). The cumulative impact on the potentially affected residence of road traffic noise from Bogan Road and McClintocks Lane was estimated to give an indication of worst-case noise impacts due to traffic movements associated with the Project. The predicted road traffic noise impacts are based on the traffic volumes in **Table 4.4**.

Table 4.4 – Peak Two-way Traffic Volumes in 2012

Vehicle classification	Bogan Road		McClintocks Lane	
	AM	PM	AM	PM
Light	218	119	183	110
Heavy	24	13	22	13
Total	242	132	205	123

4.5 Receiver Locations

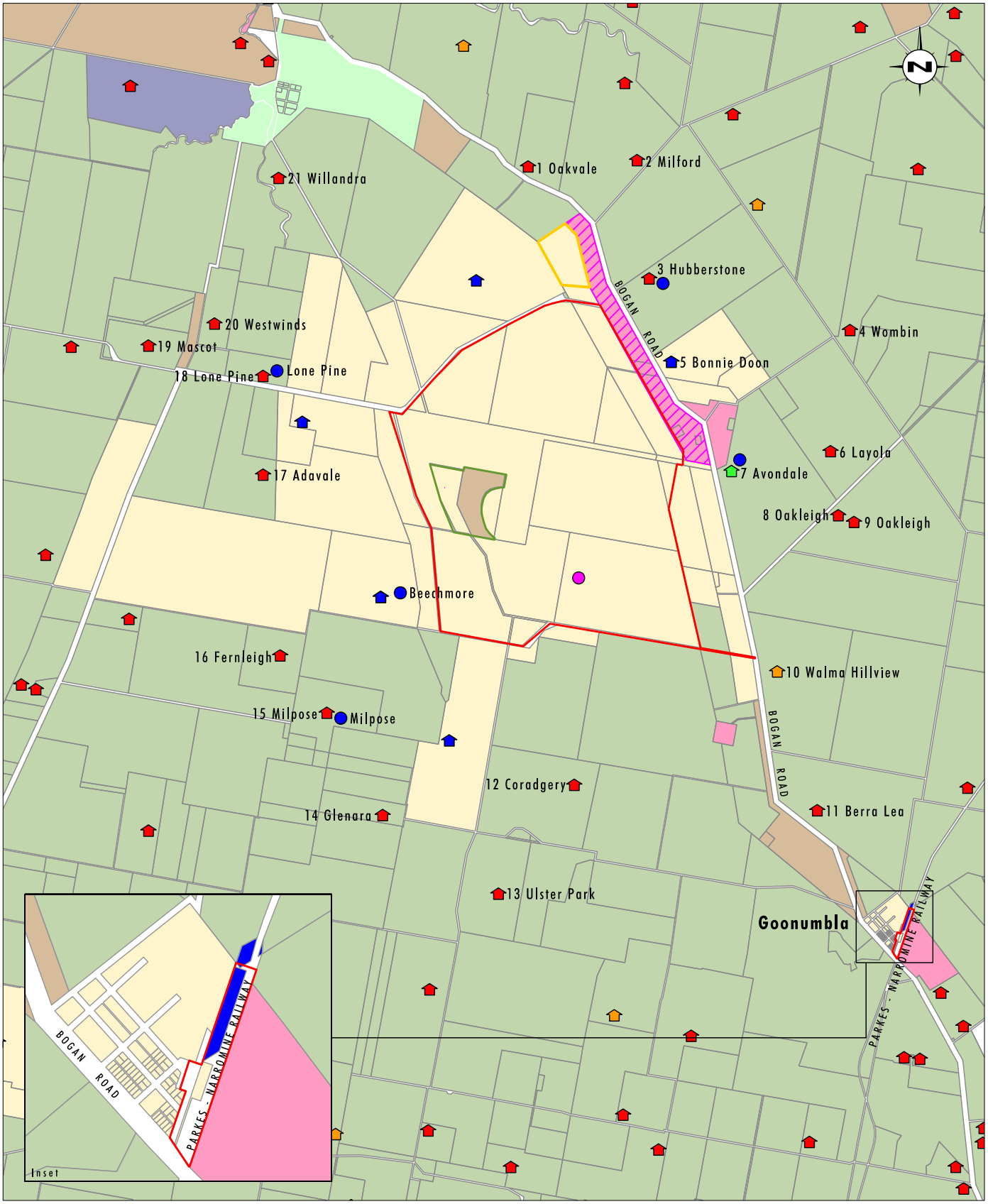
The Single Point Calculation module of ENM was used to predict the noise impacts of the Project at 20 receiver locations surrounding the Project Area, the location of which are shown on **Figure 4.1** and in **Table 4.5**.

NPM has a commercial agreement in place with one of the residential receiver locations shown on **Figure 4.1**, Receiver 7 (Avondale), which is in place over the life of the Project. A number of the residential properties shown on **Figure 4.1** are located on land owned by NPM and have not been included in this assessment.

Table 4.5 – Receiver Locations

Property Name	Easting	Northing
1 – Oakvale	598557	6362984
2 – Milford	600589	6363101
3 – Hubberstone	600814	6360898
4 – Wombin	604555	6359935
5 – Bonnie Doon	601226	6359345
6 – Layola	604193	6357678
7 – Avondale [1]	602348	6357307
8 – Oakleigh A	604337	6356484
9 – Oakleigh B	604631	6356359
10 – Walma Hillview	603199	6353574
11 – Berra_Lea	603945	6350990
12 – Coradgery	599419	6351462
13 – Ulster_Park	598005	6349433
14 – Glenara	595848	6350900
15 – Milpose	594806	6352805
16 – Fernleigh	593937	6353872
17 – Adavale	593619	6357241
18 – Lone Pine	593619	6359081
19 – Mascot	591483	6359646
20 – Westwinds	592714	6360056
21 – Willandra	593910	6362770

Note: 1. Commercial agreement in place with resident over life of Project.
2. Receiver 5 – Bonnie Doon owned by NPM and not included in the noise modelling results.



Source: NPM (2013), LPMA (2011)

0 250 625 1250m
Inset 1:25 000

0 1 2.5 5km
1:100 000

Legend

- Project Area
- Existing Biodiversity Offset Area
- Limestone State Forest Boundary
- State Forest of NSW
- Mine Owned
- Parkes Shire Council
- Private
- Department of Lands - Crown
- State of NSW
- State Rail Authority of NSW
- Travelling Stock Route
- Private Residence
- Agreement Residence
- Mine Owned Residence
- Derelict Residence
- Noise Monitoring Location
- Meteorological Station

FIGURE 4.1

Land Ownership and Existing Monitoring Locations

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4.6 Meteorological Conditions

The INP (EPA 2000) notes that there are two approaches for the assessment of meteorological effects, including gradient winds and temperature inversions, on propagating noise from the source to the receiver. The simple method is to use default conditions outlined in the INP (EPA 2000). Alternatively, the local meteorological data can be used to determine weather conditions that would be expected to occur at a particular site for a significant period of time.

Meteorological data for the period 1 January 2008 to 12 May 2011 was sourced from the NPM weather station. The location of the NPM weather station is shown on **Figure 4.1**. This data was analysed to determine the prevailing wind directions and frequency of temperature inversions. The detailed analysis of the meteorological data from the NPM weather station is presented in **Appendix D**.

4.6.1 Wind

Wind has the potential to increase the noise impacts upon a receiver when it is light and stable and blows from the direction of the noise source towards the receiver. As the strength of the wind increases the noise produced by the wind will begin to obscure the noise from most industrial and transport sources.

Wind effects need to be considered when wind is a feature of the potentially affected area. The INP (EPA 2000) states that where wind blows from the source to the receiver at speeds up to 3 m/s for more than 30 per cent of the time during any season, then wind is considered to be a feature of the area and noise level predictions must be made under these conditions.

The meteorological data from the NPM weather station for the 1 January 2008 to 12 May 2011 period was analysed to determine prevailing wind conditions within the study area. The results of this analysis for gradient winds is presented in **Appendix D** and summarised in **Table 4.6**.

Table 4.6 – Gradient Wind Analysis for NPM

Season	Direction	Period	Occurrence (%)
Summer	All directions	All Periods	< 30
Autumn	ESE	Night	30
	SE	Night	32
	SSE	Evening	31
		Night	32
	S	Evening	31
		Night	30
Winter	All directions	All Periods	< 30
Spring	All directions	All Periods	< 30

As outlined in **Table 4.6**, the results of the analysis of the NPM weather station data indicate that gradient winds of up to 3 m/s occur greater than 30 per cent of the time during autumn evening and night-time periods.

The meteorological scenarios that arise from the analysis of gradients winds that should be considered in the noise impact assessment are as follows:

- neutral (to very unstable) conditions with calm wind conditions; and
- neutral (to very unstable) conditions with a 3 m/s wind from the east-south-east to south-south-east associated with autumn evening and night-time periods.

4.6.2 Temperature Inversion

Temperature inversions, when they occur, have the ability to increase noise levels by focusing sound waves. Temperature inversions can also hinder the propagation of noise by acting as a barrier containing the noise above or below the inversion or even within a stratified layer of the inversion. Temperature inversions occur predominantly at night during the winter months but can also occur as a result of low cloud cover. According to the INP (EPA 2000), for a temperature inversion to be a significant characteristic of the area it needs to occur for approximately 30 per cent of the total night-time (i.e. the evening and night-time periods) during winter, or about two nights per week. Temperature inversions are generally determined based on the occurrence of atmospheric stability classes, as defined in the INP (EPA 2000), with moderate and strong inversions corresponding to atmospheric stability categories F and G respectively.

During the period from 1 January 2008 to 12 May 2011 the NPM weather station recorded F to G Class stability conditions associated with temperature inversions during winter evening and night-time periods approximately 64 per cent of the time. The detailed analysis of the meteorological data from the NPM weather station for determining inversion conditions is presented in **Appendix D**.

The default inversion condition for assessing winter night-time conditions in the area surrounding NPM is an F Class stability condition for all receivers, plus a 2 m/s source-to-receiver wind representative of the localised drainage flow. The INP (EPA 2000) notes that the use of default drainage flow conditions would probably result in an over-estimate of the noise propagation from source to receiver. The INP (EPA 2000) also notes that a gradient wind would only apply if the receiver is located at a lower elevation than the source.

The analysis of the meteorological data from the NPM weather station for drainage flow accompanying inversion conditions is presented in **Appendix D**. The meteorological scenario that arises from the analysis of inversion conditions that should be considered in the noise impact assessment is as follows:

- F class stability with a 2 m/s southerly drainage flow.

5.0 Noise Predictions

5.1 Operational Noise Levels

5.1.1 Acoustically Significant Plant and Equipment

Section 6 of the INP (EPA 2000) requires the prediction of noise levels to take into account all the acoustically significant plant and equipment that may reasonably be expected when the plant or facility in question is fully operational. NPM propose to operate the processing plant continuously seven days per week 24 hours per day. The construction of the TSFs and concurrent mining of E26, E28 and E31 is expected to occur over period of up to 12 months within the initial five to eight years of the Project. .

5.1.2 Predicted Noise Levels

ENM's Single Point calculation feature was used to determine noise levels from NPM at the nearest residential receiver locations identified in **Section 4.4**, under the meteorological conditions described in **Section 4.5**. **Tables 5.1** to **5.2** present the predicted operational noise levels for the three operational scenarios described in **Section 4.1**. The most stringent noise criteria that the mining operation will need to achieve at all residential receivers is a PSNL of 35 dB(A) during the day, evening and night-time periods.

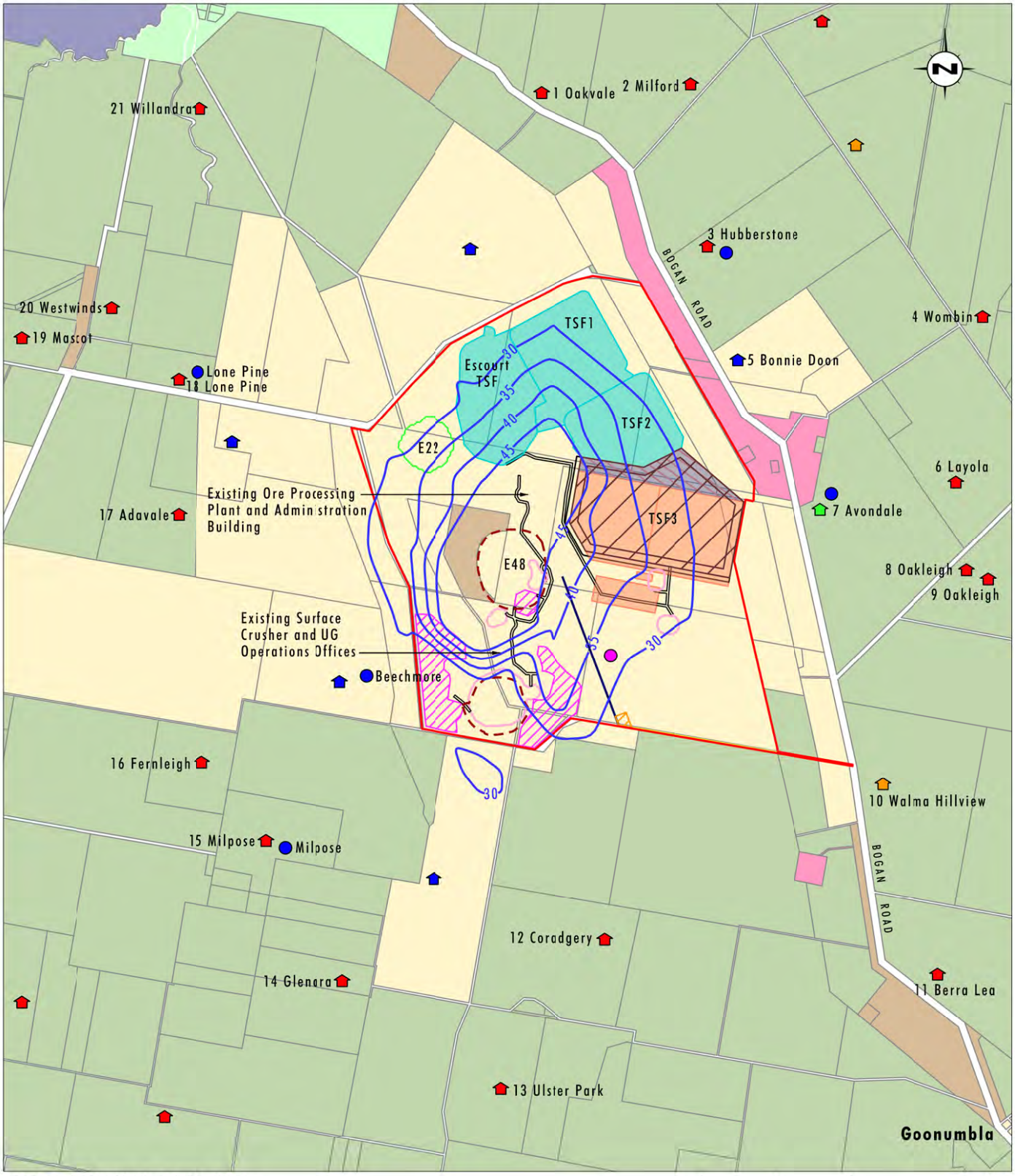
Table 5.1 presents the predicted noise impacts for operational Scenario 1, the existing seven days per week 24 hours per day operation of the NPM incorporating the process plant, underground mining and the associated equipment supporting the underground mining activities.

Table 5.2 presents the predicted noise impacts for operational Scenario 2, the operation of NPM as described for Scenario 1 above, plus mining from open-cut E26 and the out-of-pit placement of waste product to the east and west of the open-cut E26 as well as mining from open-cut E31 and construction of TSF 3 seven days per week 24 hours per day.

Table 5.3 presents the predicted noise impacts for operational Scenario 3, the operation NPM as described for Scenario 1 above, plus mining from open-cut E26 and the out-of-pit placement of waste product to the east and west of the open-cut pit as well as mining from open-cut E28 combined and the construction of Estcourt TSF seven days per week 24 hours per day.

Contour calculations are provided in **Figures 5.1** to **5.5** for:

- the predicted noise impacts for Scenario 1 under neutral, calm meteorological conditions, and worst meteorological conditions of 3 m/s south-south-east wind and F Class stability with 2 m/s southerly drainage flow (refer to **Figures 5.1** to **5.3**);
- the predicted noise impacts for the worst case operational/mining scenario of Scenario 2 under worst meteorological conditions of F Class stability with 2 m/s southerly drainage flow (refer to **Figure 5.4**); and
- the predicted noise impacts for the worst case operational/mining scenario of Scenario 3 under worst meteorological conditions of F Class stability with 2 m/s southerly drainage flow (refer to **Figure 5.5**).



Legend

- Project Area
- State Forest of NSW
- Mine Owned
- Parkes Shire Council
- Private
- Department of Lands - Crown
- State of NSW
- State Rail Authority of NSW
- Predicted Noise Impact Contour, dB(A)
- Private Residence
- Agreement Residence
- Mine Owned Residence
- Derelict Residence
- Noise Monitoring Location
- Meteorological Station
- Approved Tailings Storage Facility (Rosedale)
- Approved Subsidence Management Areas
- Existing Tailings Storage Facility
- Proposed Tailings Storage Facility Extension
- Proposed TSF3
- New Underground Block Cave Mining Area
- Proposed Open Cut Areas
- Proposed Upgrade to McClintocks Lane
- Proposed Access Control and Visitor Car Park
- Proposed Waste Dumps
- Proposed Site Access Road
- Proposed Haul Road

FIGURE 5.1

Predicted Noise Impacts for Continued Existing Operations (Scenario 1) Under Calm Neutral Conditions

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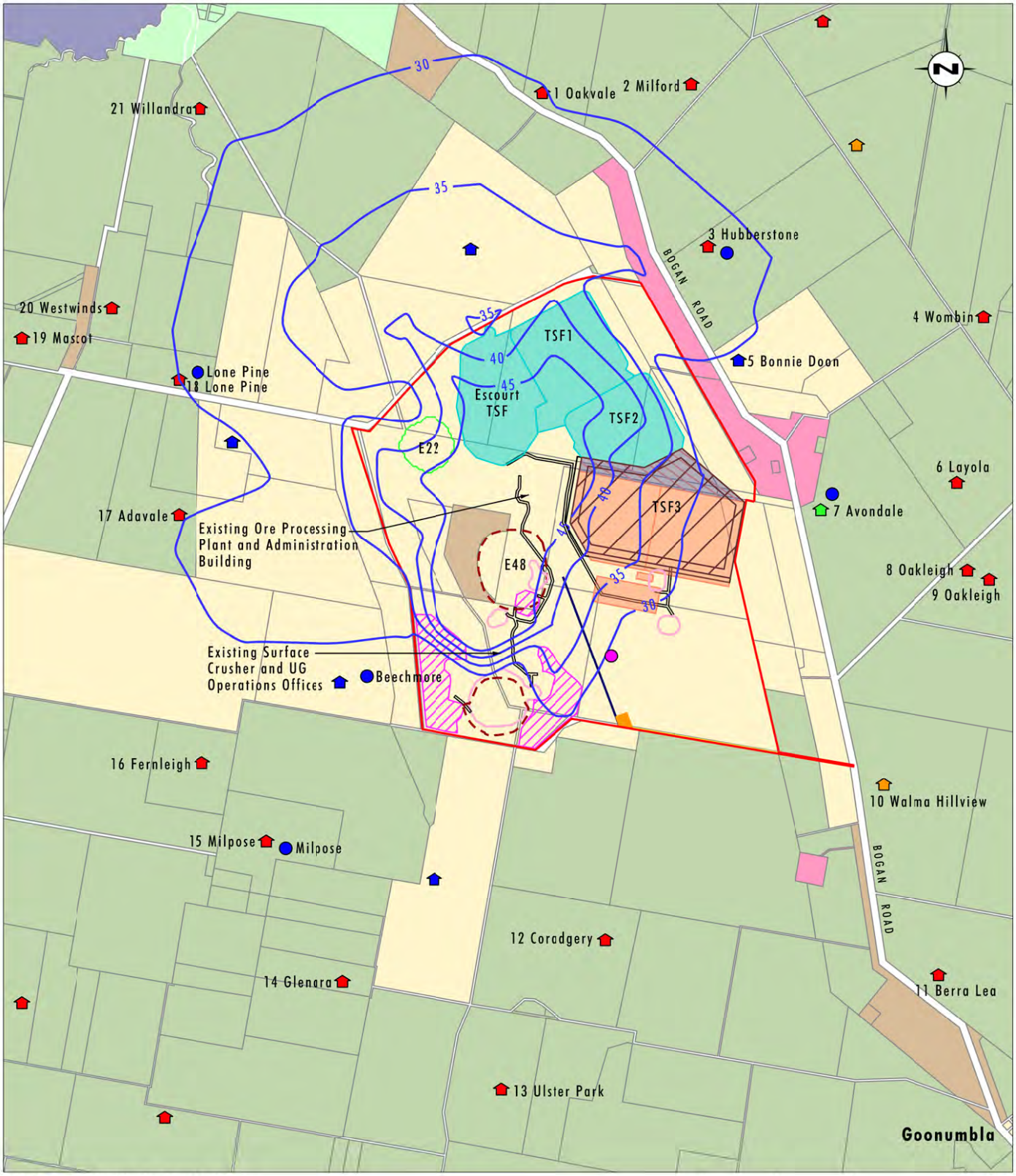

Legend

- Project Area
- State Forest of NSW
- Mine Owned
- Parkes Shire Council
- Private
- Department of Lands - Crown
- State of NSW
- State Rail Authority of NSW
- Predicted Noise Impact Contour, dB(A)
- Private Residence
- Agreement Residence
- Mine Owned Residence
- Derelict Residence
- Noise Monitoring Location
- Meteorological Station
- Approved Tailings Storage Facility (Rosedale)
- Approved Subsidence Management Areas
- Existing Tailings Storage Facility
- Proposed Tailings Storage Facility Extension
- Proposed TSF3
- New Underground Block Cave Mining Area
- Proposed Open Cut Areas
- Proposed Upgrade to McClintocks Lane
- Proposed Access Control and Visitor Car Park
- Proposed Waste Dumps
- Proposed Site Access Road
- Proposed Haul Road

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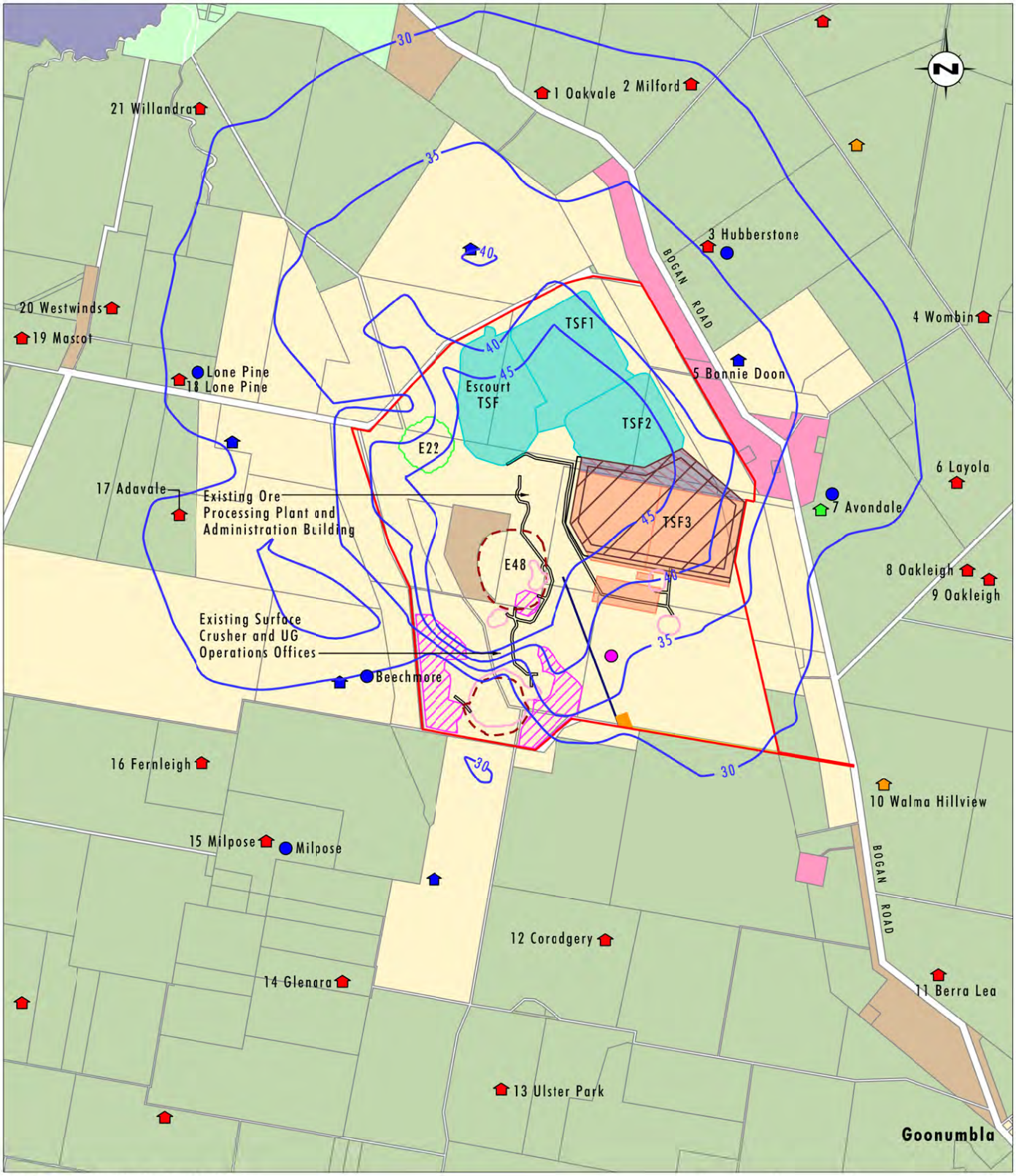
FIGURE 5.2

Predicted Noise Impacts for Continued Existing Operations (Scenario 1) Under South South Easterly 3m/s Winds



Source: NPM (2013), LPMA (2011)

0 1 2 4km
1:75 000

Legend

- Project Area
- State Forest of NSW
- Mine Owned
- Parkes Shire Council
- Private
- Department of Lands - Crown
- State of NSW
- State Rail Authority of NSW
- Predicted Noise Impact Contour, dB(A)
- Private Residence
- Agreement Residence
- Mine Owned Residence
- Derelict Residence
- Noise Monitoring Location
- Meteorological Station
- Approved Tailings Storage Facility (Rosedale)
- Approved Subsidence Management Areas
- Existing Tailings Storage Facility
- Proposed Tailings Storage Facility Extension
- Proposed TSF3
- New Underground Block Cave Mining Area
- Proposed Open Cut Areas
- Proposed Upgrade to McClintocks Lane
- Proposed Access Control and Visitor Car Park
- Proposed Waste Dumps
- Proposed Site Access Road
- Proposed Haul Road

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20130703 11.28

FIGURE 5.3

Predicted Noise Impacts for Continued Existing Operations (Scenario 1) Under Southerly Drainage Flow and F Class Stability Conditions

Source: NPM (2013), LPMA (2011)

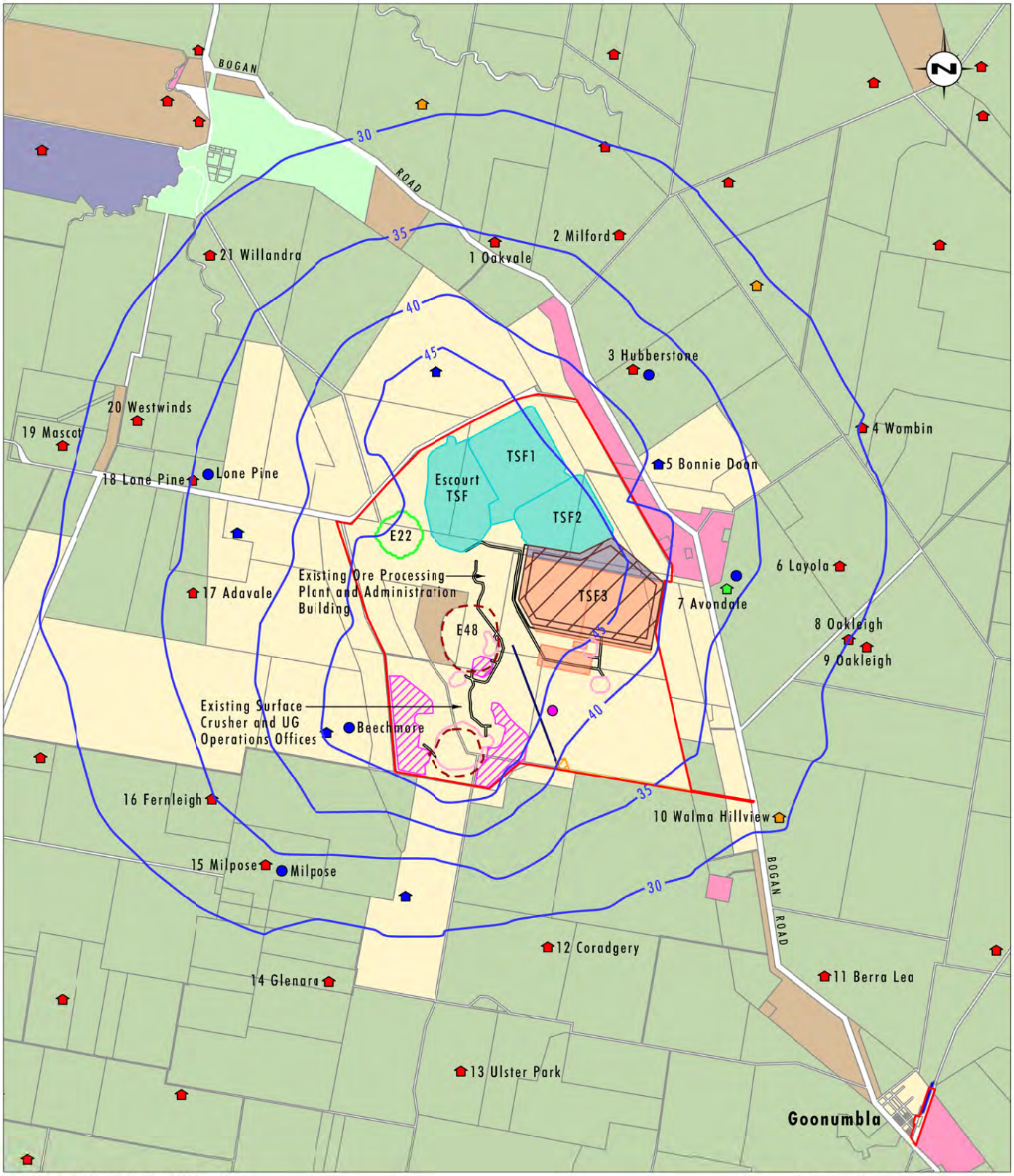
Legend

- Project Area
- State Forest of NSW
- Mine Owned
- Parkes Shire Council
- Private
- Department of Lands - Crown
- State of NSW
- State Rail Authority of NSW
- Predicted Noise Impact Contour, dB(A)
- Private Residence
- Agreement Residence
- Mine Owned Residence
- Derelict Residence
- Noise Monitoring Location
- Meteorological Station
- Approved Tailings Storage Facility (Rosedale)
- Approved Subsidence Management Areas
- Existing Tailings Storage Facility
- Proposed Tailings Storage Facility Extension
- Proposed TSF3
- New Underground Block Cave Mining Area
- Proposed Open Cut Areas
- Proposed Upgrade to McClintocks Lane
- Proposed Access Control and Visitor Car Park
- Proposed Waste Dumps
- Proposed Site Access Road
- Proposed Haul Road

File Name (A4): R12/2949_298.dgn
20130703 11.30

FIGURE 5.4

Predicted Noise Impacts for Proposed Operations (Scenario 2) Under Southerly Drainage Flow and F Class Stability Conditions



Source: NPM (2013), LPMA (2011)

0 1.0 2.0 4.0km
1:90 000

Legend

- Project Area
- State Forest of NSW
- Mine Owned
- Parkes Shire Council
- Private
- Department of Lands - Crown
- State of NSW
- State Rail Authority of NSW
- Predicted Noise Impact Contour, dB(A)
- Private Residence
- Agreement Residence
- Mine Owned Residence
- Derelict Residence
- Noise Monitoring Location
- Meteorological Station
- Approved Tailings Storage Facility (Rosedale)
- Approved Subsidence Management Areas
- Existing Tailings Storage Facility
- Proposed Tailings Storage Facility Extension
- Proposed TSF3
- New Underground Block Cave Mining Area
- Proposed Open Cut Areas
- Proposed Upgrade to McClintocks Lane
- Proposed Access Control and Visitor Car Park
- Proposed Waste Dumps
- Proposed Site Access Road
- Proposed Haul Road

FIGURE 5.5

Predicted Noise Impacts for Proposed Operations (Scenario 3) Under Southerly Drainage Flow and F Class Stability Conditions

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Table 5.1 – Predicted Operational Noise Levels, dB(A)
Scenario 1 - Existing NPM Operation

Receiver	PSNL	24 hour Operation	Evening and Night	
		Calm Neutral	3m/s South-south-east Wind	F Class Stability, 2m/s Southerly Drainage Flow
1 – Oakvale	35	16.5	30.2	32.0
2 – Milford	35	15.5	28.0	30.5
3 – Hubberstone	35	18.7	31.4	34.3
4 – Wombin	35	13.2	18.1	26.5
6 – Layola	35	15.1	13.0	28.3
7 – Avondale [1]	35	18.3	16.7	31.5
8 – Oakleigh A	35	13.7	10.8	26.1
9 – Oakleigh B	35	13.3	10.2	25.3
10 – Walma Hillview	35	18.1	14.0	26.7
11 – Berra Lea	35	10.0	5.4	17.7
12 - Coradgery	35	18.2	13.6	17.1
13 – Ulster Park	35	16.9	12.7	16.2
14 – Glenara	35	16.9	13.4	15.8
15 – Milpose	35	18.8	15.9	22.3
16 – Fernleigh	35	18.9	18.3	27.7
17 – Adavale	35	19.5	29.6	31.6
18 – Lone Pine	35	16.2	29.5	30.1
19 – Mascot	35	11.3	23.9	24.4
20 – Westwinds	35	13.0	26.9	27.3
21 – Willandra	35	15.0	28.2	28.8

Note: 1. Commercial agreement in place with resident over life of Project.

Table 5.2 – Predicted Operational Noise Levels, dB(A)
Scenario 2 - Existing NPM Operation plus Open-cut Mining in E26 and E31 and TSF 3 Construction

Receiver	PSNL	Daytime		Evening and Night			
		Mining in E26 and E31	Plus TSF 3 Construction	Mining in E26 and E31		Plus TSF 3 Construction	
		Calm Neutral	Calm Neutral	3m/s South-south-east Wind	F Class Stability, 2m/s Southerly Drainage Flow	3m/s South-south-east Wind	F Class Stability, 2m/s Southerly Drainage Flow
1 – Oakvale	35	20.3	21.6	32.9	34.7	33.4	35.0
2 – Milford	35	18.9	21.6	30.8	33.4	31.9	34.2
3 – Hubberstone	35	22.8	28.6	34.3	37.3	37.3	39.7
4 – Wombin	35	18.3	24.5	22.9	31.0	27.2	33.4
6 – Layola	35	21.4	28.6	18.4	31.9	27.9	34.9
7 – Avondale [1]	35	27.1	37.5	25.2	36.4	34.6	42.2
8 – Oakleigh A	35	20.0	26.7	16.1	29.5	24.8	32.2
9 – Oakleigh B	35	19.4	25.7	15.2	28.8	23.8	31.4
10 – Walma Hillview	35	24.0	26.3	19.4	30.9	23	31.6
11 – Berra Lea	35	16.9	17.5	9.9	23.7	13.2	23.8
12 – Coradgery	35	28.2	28.4	19.6	25.0	24.9	28.2
13 – Ulster Park	35	24.5	24.7	16.3	20.9	20.4	23.4
14 – Glenara	35	28.6	28.7	17.7	22.1	26.1	28.5
15 – Milpose	35	30.2	30.3	21.0	28.2	28.8	33.7
16 – Fernleigh	35	29.6	29.7	24.8	33.0	32.5	34.8
17 – Adavale	35	26.8	26.9	33.8	36.1	35.1	36.1
18 – Lone Pine	35	23.0	23.4	33.5	35.0	34.3	35.0
19 – Mascot	35	18.1	18.4	28.0	29.4	28.6	29.4
20 – Westwinds	35	20.1	20.4	30.8	32.1	31.4	32.1
21 – Willandra	35	19.2	19.4	30.4	31.4	30.7	31.4

Note: 1. Commercial agreement in place with resident over life of Project.

Table 5.3 – Predicted Operational Noise Levels, dB(A)
Scenario 3 - Existing NPM Operation plus Open-cut Mining in E26 and E28 and Estcourt TSF Construction

Receiver	PSNL	Daytime		Evening and Night			
		Mining in E26 and E28	Plus Estcourt Construction	Mining in E26 and E28		Plus Estcourt TSF Construction	
		Calm Neutral	Calm Neutral	3m/s South-south-east Wind	F Class Stability, 2m/s Southerly Drainage Flow	3m/s South-south-east Wind	F Class Stability, 2m/s Southerly Drainage Flow
1 – Oakvale	35	20.4	22.9	32.8	34.5	33.5	35.3
2 – Milford	35	19.3	19.8	30.6	33.2	30.9	33.5
3 – Hubberstone	35	22.9	23.5	34.2	37.0	34.3	38.1
4 – Wombin	35	18.0	18.2	22.9	29.6	22.9	29.8
6 – Layola	35	20.6	20.7	21.3	31.6	21.3	31.7
7 – Avondale [1]	35	22.9	23.0	25.4	35.5	25.4	35.6
8 – Oakleigh A	35	19.5	19.7	17.8	29.9	17.9	30.0
9 – Oakleigh B	35	19.0	19.1	17.1	29.3	17.2	29.3
10 – Walma Hillview	35	23.5	23.6	19.9	31.0	20.0	31.1
11 – Berra_Lea	35	16.7	16.8	12.3	23.8	12.3	23.8
12 – Coradgery	35	28.0	28.0	24.5	27.8	24.5	27.8
13 – Ulster Park	35	24.7	24.8	20.5	23.5	20.5	23.6
14 – Glenara	35	28.7	28.7	26	28.3	26.0	28.3
15 – Milpose	35	30.3	30.3	28.8	33.7	28.8	33.7
16 – Fernleigh	35	29.7	29.7	32.4	34.7	32.4	34.8
17 – Adavale	35	26.9	27.5	35.1	36.3	35.2	36.4
18 – Lone Pine	35	23.3	23.9	34.4	35.0	34.5	35.1
19 – Mascot	35	18.4	18.6	28.8	29.2	28.8	29.3
20 – Westwinds	35	20.3	20.8	31.5	31.9	31.6	32.1
21 – Willandra	35	19.4	20.2	30.6	31.2	30.9	31.5

Note: 1. Commercial agreement in place with resident over life of Project.

An analysis of the predicted noise level results for the inclusion of 'modifying factors' was conducted in accordance Section 4 of the INP (EPA 2000) (refer to **Appendix B**). Based on this no modifying correction factors are required to be applied to the predicted noise levels.

5.1.3 Control Measures

Control measures that have been considered as a standard part of the NPM operations and incorporated into the noise models include:

- maintenance of the existing equipment and associated sound attenuation features including mufflers and sound suppression lining of equipment;
- selection of new equipment with sound power levels equivalent to, or less than the sound power levels nominated in **Table 4.2**; and
- the management of mobile machines on top of the out-of-pit waste emplacement areas to the east and west of the E26 open-cut pit such that activity during the evening and night-time periods is eliminated during adverse weather conditions.

5.1.4 Summary of Findings

The number of potential exceedances of the project-specific noise criterion of 35 dB(A) for the existing operations (refer to **Table 5.1**) and for the proposed open-cut mining activities and TSF construction (refer to **Tables 5.2** and **5.3**) is summarised in **Table 5.4**. The potential exceedances identified in **Table 5.4** are inclusive of the control measures identified in **Section 5.1.3**.

Table 5.4 – Summary of Predicted Noise Impacts

Meteorological Conditions	**Scenario 1: [1] Existing Operations**	**Scenario 2: Existing [2] Operations plus**		**Scenario 3: Existing [3] Operations plus**	
		Mining in E26 and E31	**Plus TSF 3 Construction**	**Mining in E26 and E28**	**Plus Estcourt Construction**
Neutral Calm Conditions – Day, Evening and Night					
No. Properties	0	0	1	0	0
Maximum Exceedance	-	-	3 dB	-	-
Gradient Wind – Evening and Night					
No. Properties	0	0	1	0	0
Maximum Exceedance	-	-	2 dB	-	-
F Class Stability Conditions – Winter Evening and Night					
No. Properties	0	3	3	3	3
Maximum Exceedance	-	3 dB	7 dB[4], 5 dB[5]	2 dB	3 dB

Note: 1. Summary of results in **Table 5.1**.
Note: 2. Summary of results in **Table 5.2**.
Note: 3. Summary of results in **Table 5.3**.
Note: 4. Exceedance of up to 7dB predicted at Avondale residence which is subject to existing commercial agreement with NPM, in place over the life of the Project.
Note: 5. Exceedance of up to 5 dB predicted at Hubberstone private residence.

Neutral Calm Conditions

Noise levels are predicted to be less than the PSNL at all but one residential receiver under neutral, calm meteorological conditions. A 3 dB exceedance is predicted to occur at Receiver 7 (Avondale) when the existing operations are combined with mining from open-cut E26, the out-of-pit placement of waste product to the east and west the E26 open-cut pit, the mining from open-cut E31 and the construction of TSF 3.

The noise exceedance is associated with a worst case operating scenario in Scenario 3 for the construction of the TSF 3 during the evening and night-time period. In Scenario 3 the equipment used in the construction of TSF 3 has been located within the noise model at the eastern edge of the TSF. This is to provide for the assessment of a potential worse case operational scenario in the assessment.

Residential Receiver 7 (Avondale) currently has a commercial agreement in place with NPM over the life of the Project.

Gradient Wind Conditions

Under the 3 m/s south-south-easterly wind the PSNL is predicted to be exceeded at one residential receiver, Receiver 3 (Hubberstone) by 2 dB when the existing operations are combined with mining from open-cut E26, the out-of-pit placement of waste product to the east and west the E26 open-cut pit, the mining from open-cut E31 and the construction of TSF 3.

As with the neutral, calm meteorological conditions, the noise exceedance is associated with the use of equipment in Scenario 3 for the construction of TSF 3 during the evening and night-time period. Under a 3 m/s south-south-easterly wind the noise generated by the equipment used in Scenario 3 for the construction of TSF 3 is propagated towards the receivers located to the north of the TSF construction.

F Class Stability with 2 m/s Southerly Drainage Flow

In total, three residential receivers: Receiver 3 (Hubberstone), Receiver 7 (Avondale) and Receiver 17 (Adavale) could experience noise levels above the PSNL under F Class stability conditions (with supporting drainage flow) during winter evening and night-time periods.

At Receiver 3 (Hubberstone), a 5 dB exceedance is predicted to occur when the existing operations are combined with mining from open-cut E26, the out-of-pit placement of waste product to the east and west the E26 open-cut pit, the mining from open-cut E31 and the construction of TSF 3.

At Receiver 7 (Avondale), a 7 dB exceedance is predicted to occur when the existing operations are combined with mining from open-cut E26, the out-of-pit placement of waste product to the east and west the E26 open-cut pit, the mining from open-cut E31 and the construction of TSF 3.

As noted above, Receiver 7 (Avondale) currently has a commercial agreement in place with NPM over the life of the Project.

At Receiver 17 (Adavale), a 1 dB exceedance is predicted to occur when the existing operations are combined with mining from open-cut E26, the out-of-pit placement of waste product to the east and west the E26 open-cut pit, and mining in either of the other two open cut pits plus construction of the Rosedale or Estcourt TSF.

In all the above cases the noise levels predicted to exceed the PSNL during F Class stability conditions in the winter evening and night-time periods occurs as a result of the added sound power from the equipment used in the construction of TSFs.

5.2 Sleep Disturbance

Noise sources that could lead to sleep disturbance are typically transient noises and often have tonal characteristics. Activities occurring within the night-time that could lead to sleep disturbance include:

- heavy objects (rocks) being dropped into a truck tray;
- drill rod clatter when changing rods;
- air horns used to control truck movement;
- reversing beepers; and
- track clatter from bulldozers.

The Single Point Calculation feature of ENM was used to determine noise levels at the nearest residential receiver locations under worst-case meteorological conditions (F Class Stability with accompanying drainage flow from the south and/or gradient wind). The predicted received $L_{A1,1minute}$ noise levels associated with these activities that could result in sleep disturbance are presented in **Table 5.5**.

Table 5.5 – Predicted Sleep Disturbance Noise Levels, dB(A)

Receiver	Modelled Scenario		Sleep Disturbance Noise Goal $L_{A1,1minute}$
	Calm Neutral 0m/s Calm	Adverse Conditions F Class Stability or Gradient Wind	
1 – Oakvale	22	31	45
2 – Milford	18	27	45
3 – Hubberstone	28	37	45
4 – Wombin	24	30	45
6 – Layola	29	33	45
7 – Avondale [1]	38	41	45
8 – Oakleigh A	27	30	45
9 – Oakleigh B	26	28	45
10 – Walma Hillview	23	26	45
11 – Berra Lea	16	22	45
12 – Coradgery	30	30	45
13 – Ulster Park	26	25	45
14 – Glenara	32	32	45
15 – Milpose	31	35	45
16 – Fernleigh	31	36	45
17 – Adavale	26	33	45
18 – Lone Pine	22	32	45
19 – Mascot	17	26	45
20 – Westwinds	18	28	45
21 – Willandra	16	24	45

Note: 1. Commercial agreement in place with resident over life of Project.

The predicted noise levels in **Table 5.5** meet the recommended sleep disturbance noise goals outlined in **Section 3.4** at all residential receivers, for the modelled worst-case operational and meteorological scenarios. The predicted maximum $L_{A1,1minute}$ noise levels are associated with reversing beepers from equipment used in the construction of the TSFs and track clatter from bulldozers reversing in exposed location such as on the out-of-pit placement of waste product to the east and west the E26 open-cut pit under F Class stability conditions.

5.3 Construction Noise Assessment

A source to receiver noise model was used to determine construction noise impacts at the nearest residential receiver to the construction activities during standard hours. The construction noise levels at the nearest residential receiver 12 – Coradgery and 15 – Milpose is predicted to be at or below 37 dB(A) and less than 30 dB(A) respectively. The construction noise management level in **Table 3.2** for all residential receivers surrounding the Project is 40 dB(A).

5.4 Road Traffic Noise Assessment

5.4.1 Sub–Arterial Roads

The Project includes the continuation of the approved production capacity and road haulage of copper concentrate from the processing plant to the existing Goonumbla rail siding. The Project will not result in an increase in the light and heavy vehicle movements on Bogan Road and will not change the existing road traffic noise levels at the nearest potentially affected residential receivers along Bogan Road.

5.4.2 Local Roads

A new access route to the site from Bogan Road is required due to the proposed construction of the augmented TSF 3, which will require the closure of the existing Northparkes Lane. NPM plan to upgrade McClintocks Lane to replace the existing NPM access road. McClintocks Lane is an existing local road that intersects Bogan Road approximately 3.5 kilometres south of the existing Northparkes Lane.

An assessment of the road traffic noise impact has been conducted at the nearest residential receiver likely to be influenced by movement of light and heavy vehicles including product trucks, traveling to or from NPM via McClintocks Lane. The noise predictions were based on vehicle movements on both McClintocks Lane and Bogan Road. The road traffic noise impacts were modelled at set back distances to the nearest residential receiver of 3.5 kilometres from the centre line of Bogan Road and 2.5 kilometres from the centre line of McClintocks Lane.

The results of traffic noise modelling are presented in **Table 5.6.**

Table 5.6 – Predicted Day and Night Road Traffic Noise Levels, dB(A)

Source of Road Traffic Noise	Predicted $L_{Aeq,1hour}$		Assessment Criteria [1]
	Peak AM	Peak PM	Day/Night [2]
Bogan Road	40.0	36.3	55/50
McClintocks Lane	38.5	36.2	55/50
Cumulative Noise Level	42.4	39.3	55/50

Note: 1. Criteria for existing residences affected by noise from redevelopment of existing local roads.
Note: 2. Day (7.00 am – 10.00 pm) and Night (10.00 pm – 7.00 am).

The results presented in **Table 5.6** indicate the predicted road traffic noise levels from light and heavy vehicles traveling to or from NPM via McClintocks Lane do not exceed the day and night time road traffic noise criteria outlined in the NSW Road Noise Policy (DECC 2011) presented in **Table 3.2**.

5.5 Rail Noise Assessment

The Project includes the continuation of the approved for the dispatch of copper concentrate from the existing Goonumbla rail siding. The Project will not result in an increase rail traffic movements from the Goonumbla rail siding.

5.6 Cumulative Impact Assessment

To limit continuing increases in noise levels due to industrial development, the INP (EPA 2000) has identified maximum ambient noise levels for typical receiver areas and land uses. The recommended acceptable ambient noise levels are used as the cumulative noise impact assessment criteria. There are no other industrial noise sources in the region surrounding NPM. As outlined in **Sections 3.2.3** and **3.3** the limiting criterion for NPM will be the Intrusiveness Criteria, which has been adopted as the PSNL for the Project.

6.0 Conclusion and Recommendations

6.1 Conclusion

6.1.1 Operational Noise

Umwelt has undertaken a NIA of the Project in accordance with Section 10 of the INP (EPA 2000). Three main operational scenarios were modelled to represent the underground mining operation and existing process plant combined with open-cut mining in E26, E31 and E28, and construction of additional TSFs. These scenarios were modelled to provide an indication of the expected noise levels for operations over the life of the Project, including periods of potential worse case operational arrangements.

Process Plant and Underground Mining

The results in **Section 5.0** indicate that the noise levels from the seven days per week 24 hours per day operation of NPM incorporating the process plant, underground mining and the associated equipment supporting the underground mines activities (i.e. Scenario 1) are predicted to be less than the PSNL at all residential receivers.

Open-cut Mining and TSF Construction

Scenarios 2 and 3 incorporate mining from open-cut E26 and the out-of-pit placement of waste material from the open-cut to the east and west of the open-cut pit plus mining from either open-cut E31 or E28, and the construction of the Rosedale or Estcourt TSFs.

The results in **Section 5.0** indicate that with noise control measures discussed in **Section 5.1.3** in place at NPM the potential maximum exceedance of the PSNL from the NPM operations would be:

- 5 dB for Scenario 2 and 3 dB for Scenario 3 at Receiver 3 (Hubberstone);
- 7 dB for Scenario 2 and 1 dB for Scenario 3 at Receiver 7 (Avondale); and
- 1 dB for Scenario 2 and 1 dB for Scenario 3 at Receiver 17 (Adavale).

In all cases the potential maximum exceedance of the project-specific noise levels from the operational noise levels occur during F Class stability conditions in the winter evening and night-time periods and are associated with the equipment used in the construction of Rosedale (Scenario 2) or Estcourt (Scenario 3) TSFs.

The INP (EPA 2000) notes that when predicted noise levels exceed the project-specific noise levels a range of strategies should be considered to reduce the noise impact on offsite receivers. Specifically the DGR's require evidence that there are no additional reasonable and feasible mitigation measures that need to be included as a part of the Project. The three main strategies used to identify reasonable and feasible noise control/mitigation strategies are:

- **Controlling noise at the source** - There are three approaches to controlling noise generated by the source: source elimination; Best Management Practice (BMP) and Best Available Technology Economically Achievable (BATEA).
- **Controlling the transmission of noise** - There are two approaches: the use of barriers and land-use controls which attenuate noise by increasing the distance between source and receiver.
- **Controlling noise at the receiver** - There are two approaches: negotiating an agreement with the landholder or acoustic treatment of dwellings to control noise.

In the case of the maximum exceedances identified above, the elimination of the noise (controlling noise at the source) associated with the construction of TSF 3 would result in a:

- 3 dB reduction in the noise impact at Receiver 3 (Hubberstone) from 40 dB(A) to 37 dB(A) during the worst case meteorological condition of F Class stability conditions in the winter evening and night-time periods. This equates to a 2 dB exceedance of the PSNL.

- 6 dB reduction in the noise impact at Receiver 7 (Avondale) from 42 dB(A) to 36 dB(A) during the worst case meteorological condition of F Class stability conditions in the winter evening and night-time periods. This equates to a 1 dB exceedance of the PSNL.

No change would occur in the predicted noise levels of 36 dB(A) at Receiver 17 (Adavale).

In the case of the maximum exceedances identified above, the elimination of the noise (controlling noise at the source) associated with the construction of Estcourt TSF would result in a:

- 1 dB reduction in the noise impact at Receiver 3 (Hubberstone) from 38 dB(A) to 37 dB(A) during the worst case meteorological condition of F Class stability conditions in the winter evening and night-time periods. This equates to a 2 dB exceedance of the PSNL.

No change would occur in the predicted noise levels of 36 dB(A) at Receiver 7 (Avondale) and Receiver 17 (Adavale).

In the above cases, with no Rosedale or Estcourt TSFs construction occurring during the evening and night-time periods, the potential exceedances of the PSNLs are associated with the equipment used in the open-cut mining operations.

Should it be necessary to construct the TSF 3 or Estcourt TSFs during winter evening and night-time periods, when F Class stability conditions are present, controlling the transmission of the noise is not practical apart from relocating the machinery to less exposed locations. The other alternative is to negotiate an appropriate agreement with the affected landowners. In the case of Receiver 7 (Avondale), NPM already has a commercial agreement in already in place over the life of the Project.

Tailing Storage Facility Construction

Construction of the TSF 3 (Scenario 2) is proposed to occur on a 24 hour, seven days per week arrangement. Accordingly these activities would occur during neutral, calm meteorological conditions and adverse conditions, excluding F Class Stability conditions. The results in **Section 5.0** indicate that under these conditions the construction of TSF 3 the PSNL could be exceeded by:

- 2 dB (predicted noise level of 37 dB(A)) at Receiver 3 (Hubberstone) during the autumn evening and night time periods due to 3 m/s south-south-easterly wind conditions; and

- 3 dB (predicted noise level of 38 dB(A)) at Receiver 7 (Avondale) during neutral, calm meteorological conditions.

No exceedances are predicted to occur during neutral, calm meteorological conditions and adverse conditions, excluding F Class Stability conditions for Scenario 3, including construction of the Estcourt TSF (Scenario 3).

As noted above, at present NPM has a commercial agreement in place with Receiver 7 (Avondale) over the life of the Project. The management of the noise impacts at Receiver 3 (Hubberstone) could be managed through controlling noise at the source and or source control and/or controlling noise at the receiver. The success of the implementation of these measures can be assessed through a targeted monitoring program during the construction phases of the TSFs.

If unacceptable noise impacts from a development persist after noise mitigation action has been undertaken, Section 8 and Section 10 of the INP (EPA 2000) provide a process for negotiating an agreement between the proponent and the affected party(s).

6.1.2 Sleep Disturbance

Based on the modelling of the typically transient noises the calculated $L_{A1,1minute}$ noise levels from the operation are expected to comply with the recommended sleep disturbance noise goals at all residential.

6.1.3 Construction Noise

The results presented in **Section 5.3** indicate that the predicted construction noise levels at the nearest residential receiver to the construction activities at McClintocks Lane have the potential reach the construction noise management level of 40 dB(A). As a result NPM should apply all feasible and reasonable work practices to manage the construction noise levels. NPM 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 provided contact details as outlined in the Interim Construction Noise Guidelines (DECC 2009).

6.1.4 Road Traffic Noise

The results presented in **Table 5.6** indicate the predicted road traffic noise levels from light and heavy vehicles traveling to or from NPM via McClintocks Lane do not exceed the day and night time road traffic noise criteria outlined in the NSW Road Noise Policy (DECC 2011) presented in **Table 3.2**.

6.2 Management and Monitoring Recommendations

6.2.1 Noise Monitoring Program

It is recommended that NPM maintain an attended noise monitoring program in order to assess ongoing compliance with relevant noise impact assessment criteria over the life of the Project. The noise monitoring program should:

- specifically assesses operational performance against the Intrusiveness criteria using a $L_{Aeq, 15 minute}$ descriptor; and
- measure and assesses the transient noise levels due to industrial noise sources using the sleep disturbance criteria descriptor of $L_{A1, 1 minute}$.

The noise monitoring program should also measure and assess the environmental noise levels due to industrial noise sources using the amenity assessment descriptor of $L_{Aeq, Period}$. However, as NPM is the only industrial noise source in the region this metric would only be used to measure the ambient noise levels rather than cumulative industrial noise levels.

It is recommended that the monitoring program be based around a combination of routine attended noise monitoring sessions to assess the performance of NPM as a whole and a targeted attended noise monitoring program to assess the impacts of specific activities associated with the open-cut mining and construction of the TSFs. The requirements of the monitoring program could be achieved by supplementing existing monitoring programs already operating at NPM with strategically targeted monitoring designed to complement the coverage provided by existing monitoring program. To address the requirements of the targeted monitoring process it is recommended NPM prepare a TSF Construction Noise Management Plan.

It is recommended that the frequency of the attended monitoring program be six monthly for the routine attended noise monitoring program covering the day, evening and night-time periods. The targeted attended noise monitoring program would be conducted on an as required basis with justification for the monitoring program documented in EPL Annual Return.

NPM should maintain the meteorological monitoring program in order to assess the occurrence of noise enhancing conditions as part of the noise monitoring program. This will include the development of a procedure to determine relative Meteorological Stability Classes and the potential influence that F and G Class stability have on the measured noise levels. This information would then be used for predictive meteorological forecasting as a part of the TSF Construction Noise Management Plan.

The detailed procedures that will be employed by NPM for assessing noise compliance by the Project will be documented in a Noise Management Plan. The Noise Management Plan will also identify and prioritise the operational constraints that could be implemented in order to maintain compliance with the requirement of the Project consent and EPL.

In addition to predictive meteorological forecasting, the TSF Construction Noise Management Plan should also include the identification of feasible monitoring and management measures that included continuous real-time noise monitoring and associated alarming when the TSF construction activities are likely to have unacceptable noise impacts on sensitive receptors. The use of the continuous real-time noise monitoring is not necessary for the normal seven days per week 24 hours per day operation of NPM incorporating the process plant, underground mining and the associated equipment supporting the underground mines activities. However, continuous real-time noise monitoring could be used to augment the targeted monitoring associated with the TSF construction activities.

Process Plant and Underground Mining

The results in **Section 5.0** indicate that the noise levels from the seven days per week 24 hours per day operation of NPM incorporating the process plant, underground mining and the associated equipment supporting the underground mines activities (i.e. Scenario 1) are predicted to be less than the PSNL at all residential receivers.

6.2.2 Compliance Assessment

The methodology for assessing compliance with the requirement of the Project approval and EPL would be similar to the procedures currently in place at NPM for noise impact management in the region surrounding NPM and would utilise the following components:

- undertake attended noise monitoring surveys to measure ambient noise levels in the region surrounding NPM and determine the mine's contribution to measured noise levels; and

- compare the attended noise monitoring results with predicted noise impacts for the similar meteorological conditions and operating/mining conditions and with the relevant noise impact assessment criteria to assess compliance of the mine with the relevant development consent and EPL criteria.

6.2.3 Reporting

The monitoring results should be reviewed by the NPM environmental representative to assess compliance with the NIA predictions and with the relevant noise impact assessment criteria. The results will be reported in accordance with the requirements of the Project approval and EPL.

7.0 References

Department of Environment and Climate Change. Interim Construction Noise Guideline, 2009.

Department of Environment, Climate Change. NSW Road Noise Policy, 2011.

Environment Protection Authority. Environmental Noise Control Manual, 1985.

Environment Protection Authority. NSW Industrial Noise Policy, 2000.

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Northparkes Mines. Northparkes Mines Management Plan Site wide Environmental Noise and Vibration, 2007.

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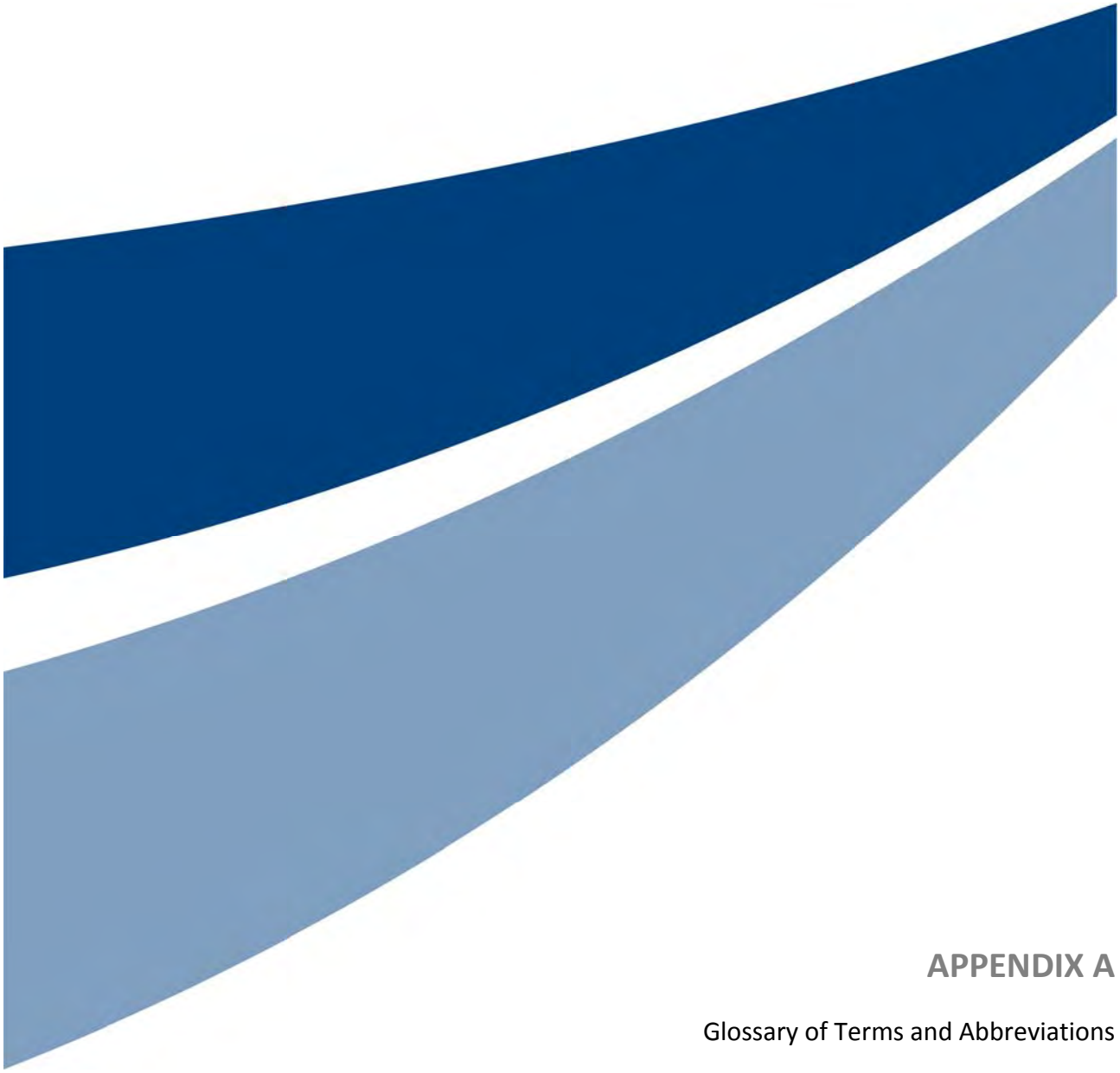


APPENDIX A

Glossary of Terms and Abbreviations

Appendix A – Glossary and Abbreviations

1/3 Octave	Single octave bands divided into three parts.
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment background level - A single-figure background noise level representing each assessment period – day, evening and night (that is, three assessment background levels are determined for each 24 hour period of the monitoring period). It is determined by taking the lowest 10th percentile of the L_{90} level for each assessment period.
Ambient Noise	The noise associated with a given environment. Typically a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dB(A), dBA	Decibels A-weighted.
dB(Z), dB(L)	Decibels Linear or decibels Z-weighted.
Decibel (dB)	The units of sound level and noise exposure measurement where a step of 10 dB is a ten-fold increase in intensity or sound energy and actually sounds a little more than twice as loud.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
L_{A10}	The percentile sound pressure level exceeded for 10 per cent of the measurement period with 'A' frequency weighting calculated by statistical analysis. Typically used to assess the impact of an existing operation on a receiver area and is referred to as the cumulative noise levels at the receiver attributable to the noise source.
L_{A90}	Background Noise Level. The percentile sound pressure level exceeded for 90 per cent of the measurement period with 'A' frequency weighting calculated by statistical analysis.
L_{Amax}	The maximum of the sound pressure levels recorded over an interval of 1 second.
$L_{A1,1minute}$	The measure of the short duration high-level noises that cause sleep arousal. The noise level is measured as the percentile sound pressure level that is exceeded 1 per cent of measurement period with 'A' frequency weighting calculated by statistical analysis during a measurement time interval of 1 minute.
$L_{Aeq,t}$	Equivalent continuous sound pressure level - The value of the sound pressure level of a continuous steady noise that, a measurement interval of time (t), has the same mean square sound pressure as the sound under consideration whose level varies with time. Usually measured in dB with 'A' weighting.

L_{An} Percentile level - A measure of the fluctuation of the sound pressure level which is exceeded ‘n’ per cent of the observation time.

RBL Rating background level - The overall single figure background level representing each assessment period over the whole monitoring period determined by taking the median of the ABLs found for each assessment period.

SPL (dBA) Noise: Sound pressure level - The basic measure of noise loudness. The level of the root-mean-square sound pressure in decibels given by:

$$SPL = 10.\log10\ (p/po)^2$$

where p is the rms sound pressure in pascals and po is the sound reference pressure at 20 μPa. decibels.

SWL Sound power level - a measure of the energy emitted from a source as sound and is given by:

$$SWL = 10.\log10\ (W/W_o)$$

where W is the sound power in watts and W_o is the sound reference power at 10^{-12} watts.

APPENDIX B

Industrial Noise Policy Assessment Methodology

Appendix B – Industrial Noise Policy Assessment Methodology

Industrial Noise Policy

Responsibility for the control of noise emissions in New South Wales (NSW) is vested in Local Government and the Office of Environment and Heritage (OEH). The NSW Environmental Protection Authority (EPA) Industrial Noise Policy (INP), 2000, provides a framework and methodology for deriving limit conditions for consent and licence conditions. Using this policy the OEH regulates premises that are scheduled under the *Protection of the Environment Operations Act 1997* (POEO Act).

The specific INP (EPA 2000) objectives are:

- to establish noise criteria that would protect the community from excessive intrusive noise and preserve the noise amenity for specific land uses;
- to use the criteria as the basis for deriving project specific noise levels;
- to promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects;
- to outline a range of mitigation measures that could be used to minimise noise impacts;
- to provide a formal process to guide the determination of feasible and reasonable noise limits for consent or licence conditions that reconcile noise impacts with the economic, social and environmental considerations of industrial development; and
- to carry out functions relating to the prevention, minimisation and control of noise from premises scheduled under the POEO Act.

The INP (EPA 2000) is designed for large and complex industrial sources and outlines processes designed to strike a feasible and reasonable balance between the operation of industrial activities and the protection of the community from noise levels that are intrusive or unpleasant.

The application of the INP (EPA 2000) involves the following processes:

- determining the project specific noise levels (PSNLs) from intrusiveness and amenity based measurement of the existing background and ambient noise levels. For existing industrial operations, the underlying level of noise present in the ambient noise, should be determined excluding the noise source under investigation;
- predicting or measuring the noise levels produced by the development; and
- comparing the predicted noise levels with the PSNLs and assessing the impacts.

Where the PSNLs are predicted to be exceeded the INP (EPA 2000) provides guidelines on the assessment of feasible and reasonable noise mitigation strategies, including:

- 'weighing up' the benefit of the development against the social and environmental costs resulting from the noise impacts;
- establishment of achievable and agreed noise limits for the development in consultation with the consent authority; and
- undertaking performance monitoring of environmental noise levels to determine compliance with the consent and licence conditions.

Industrial Noise Policy Assessment Methodology

There are two criteria to consider when establishing PSNLs for the assessment of industrial noise sources. These criteria are:

- **The intrusive noise criterion**, which is based on the background noise level plus 5 dB. The background noise level, or Rating Background Level (RBL), is determined in accordance with Section 3 of the INP (EPA 2000) and is based on the use of noise monitoring data or INP default RBLs (refer to INP (EPA 2000)), to establish the assessable background noise levels.
- **The noise amenity criterion**, which is based on the recommended noise levels in the INP (EPA 2000) for prescribed land use. The recommended acceptable and maximum ambient noise levels are outlined in Table 2.1 of the INP (EPA 2000). Table 2.2 of the INP (EPA 2000) outlines the requirements for developments where the existing noise level from industrial noise sources is close to the acceptable noise level.

The relevant Tables in Section 2 of the INP relating to the amenity criteria relevant to the Project are presented in **Table 1** and **Table 2**.

Table 1 – Amenity Criteria – Recommended L_{Aeq} Noise Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50 dB(A)	55 dB(A)
		Evening	45 dB(A)	50 dB(A)
		Night	40 dB(A)	45 dB(A)
	Suburban	Day	55 dB(A)	60 dB(A)
		Evening	45 dB(A)	50 dB(A)
		Night	40 dB(A)	45 dB(A)
	Urban	Day	60 dB(A)	65 dB(A)
		Evening	50 dB(A)	55 dB(A)
		Night	45 dB(A)	50 dB(A)
	Urban/Industrial Interface - for existing situations only	Day	65 dB(A)	70 dB(A)
		Evening	55 dB(A)	60 dB(A)
		Night	50 dB(A)	55 dB(A)

Table 1 – Amenity Criteria – Recommended L_{Aeq} Noise Levels from Industrial Noise Sources (cont.)

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level	
			Acceptable	Recommended Maximum
Area specifically reserved for passive recreation	All	When in use	50 dB(A)	55 dB(A)
Active recreation area (School playground, golf course)	All	When in use	55 dB(A)	60 dB(A)
Commercial premises	All	When in use	65 dB(A)	70 dB(A)
Industrial premises	All	When in use	70 dB(A)	75 dB(A)

Source: Table 2.1, INP (EPA 2000).
Note: 1. For Monday to Saturday, Daytime 7.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 7.00 am. On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time, 10.00 pm - 8.00 am.
Note: 2. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

Table 2 – Modification to Acceptable Noise Level (ANL) to Account for Existing Levels of Industrial Noise

Total Existing LAeq Noise Level from Industrial Noise Sources	Maximum L_{Aeq} Noise Level for Noise from New Sources Alone, dB
≥ Acceptable noise level plus 2 dB	If existing noise level is likely to decrease in future acceptable noise level minus 10 dB. If existing noise level is unlikely to decrease in future existing noise level minus 10 dB.
Acceptable noise level plus 1 dB	Acceptable noise level minus 8 dB
Acceptable noise level	Acceptable noise level minus 8 dB
Acceptable noise level minus 1 dB	Acceptable noise level minus 6 dB
Acceptable noise level minus 2 dB	Acceptable noise level minus 4 dB
Acceptable noise level minus 3 dB	Acceptable noise level minus 3 dB
Acceptable noise level minus 4 dB	Acceptable noise level minus 2 dB
Acceptable noise level minus 5 dB	Acceptable noise level minus 2 dB
Acceptable noise level minus 6 dB	Acceptable noise level minus 1 dB
< Acceptable noise level minus 6 dB	Acceptable noise level

Source: Table 2.2, INP (EPA 2000).
Note: 1. ANL - recommended acceptable L_{Aeq} noise level for the specific receiver.

In assessing the noise impacts from industrial sources at residential receivers both the intrusive and amenity criteria are considered. For each period (day, evening and night) the most stringent of either the intrusive or amenity criteria becomes the limiting criterion and forms the PSNL for the industrial source.

If the existing ambient noise level is close to the acceptable noise level, a new source must be controlled to preserve the amenity of the surrounding area. If the overall noise level from the industrial source already exceeds the acceptable noise level for the affected area, the L_{Aeq} noise level from a new source should meet the conditions set out in **Table 2** above.

Industrial Noise Policy Project Specific Criteria

The INP (EPA 2000) states that the criteria outlined in Tables 2.1 and 2.2 (refer to **Tables 1** and **2** above) have been selected to protect at least 90 per cent of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90 per cent of the time. Provided the criteria in the INP (EPA 2000) are achieved, it is unlikely that most people would consider the resultant noise levels excessive.

Table 3 presents the methodology for assessing noise levels which may exceed the INP (EPA 2000) project specific noise assessment criteria.

Table 3 – Noise Impact Assessment Methodology

Assessment Criterion	Project Specific Criteria	Noise Management Zone	Noise Affectation Zone
Intrusive	Rating background level plus 5 dB	≤ 5 dB above project specific criteria	≥ 5 dB above project specific criteria
Amenity	INP based on existing industrial level	≤ 5 dB above project specific criteria	≥ 5 dB above project specific criteria

For the purposes of assessing the potential noise impacts the project specific, management and affectation criteria are further defined in the following sections.

Project Specific Criteria

Most people in the broader community would generally consider exposure to noise levels that achieve the project specific criteria to be acceptable.

Noise Management Zone

Depending on the degree of exceedance of the project specific criteria (1 dB to 5 dB) noise impacts in this zone could range from negligible to moderate. It is recommended that management procedures be implemented including:

- prompt response to any issues of concern raised by community;
- noise monitoring on-site and within the community;
- refinement of on-site noise mitigation measures and plant operating procedures where practical;
- consideration of acoustical mitigation at receivers; and
- consideration of negotiated agreements with property holders.

Noise Affectation Zone

Exposure to noise levels corresponding to this zone (more than 5 dB above project specific criteria) may be considered unacceptable by some property holders and implementation of the following measures may be required:

- discussions with relevant property holders to assess concerns and provide solutions;
- implementation of acoustical mitigation at receivers; and
- negotiated agreements with property holders.

Assessing Intrusiveness Criteria

The OEH has provided an application note for the assessment of the intrusiveness criteria such that the level for night time is no greater than the evening and evening is no greater than the daytime level (OEH February 2013). The application note is reproduced below.

When the RBL for Evening or Night is Higher than the RBL for Daytime

http://www.environment.nsw.gov.au/noise/applicnotesindustnoise.htm

The results of long term unattended background noise monitoring can sometimes determine that the calculated Rating Background Level (RBL) for the evening or night period is higher than the RBL for the daytime period. These situations can often arise due to increased noise from for example insects or frogs during the evening and night in the warmer months or due to temperature inversion conditions during winter. The objective of carrying out long-term background noise monitoring is to determine existing background noise levels at a location that are indicative of the entire year.

In determining project-specific noise levels from the RBLs, the community's expectations also need to be considered. The community generally expects greater control of noise during the more sensitive evening and night-time periods than the less sensitive daytime period. Therefore, in determining project-specific noise levels for a particular development, it is generally recommended that the intrusive noise level for evening be set at no greater than the intrusive noise level for daytime. The intrusive noise level for night-time should be no greater than the intrusive noise level for day or evening. Alternative approaches to these recommendations may be adopted if appropriately justified.

Assessing Sleep Disturbance

The OEH have provided an application note for the assessment of sleep disturbance (OEH February 2013). The application note is reproduced below.

Sleep Disturbance

http://www.environment.nsw.gov.au/noise/applicnotesindustnoise.htm

Peak noise level events, such as reversing beepers, noise from heavy items being dropped or other high noise level events, have the potential to cause sleep disturbance. The potential for high noise level events at night and effects on sleep should be addressed in noise assessments for both the construction and operational phases of a development. The INP does not specifically address sleep disturbance from high noise level events.

Research on sleep disturbance is reviewed in the NSW Road Noise Policy. This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.

From the research, the EPA recognised that the current sleep disturbance criterion of an LA1, (1 minute) not exceeding the LA90, (15 minute) by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, the EPA will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.

The detailed analysis should cover the maximum noise level or LA1, (1 minute), that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy. Other factors that may be important in assessing the extent of impacts on sleep include:

- how often high noise events will occur;
- time of day (normally between 10.00 pm and 7.00 am); and
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

The LA1, (1 minute) descriptor is meant to represent a maximum noise level measured under 'fast' time response. The EPA will accept analysis based on either LA1, (1 minute) or LA, (Max).

Industrial Noise Policy Modifying Factor Adjustments

Section 4 of the INP (EPA 2000) provides guidance for the assessment of noise sources that contain characteristics such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequencies. Noise sources with these characteristics can cause greater annoyance than other noise at the same level.

Where the noise source contains annoying characteristics, the INP (EPA 2000) outlines correction factors that should be applied to the source noise level measured or predicted at the receiver before comparison with the PSNL.

The modifying factor corrections as defined by Section 4 of the INP (EPA 2000) that are potentially relevant to the NIA for the Project include:

- Low-frequency noise in the 20 Hz to 250 Hz range according to the following criteria:
  - 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.
- Tonal noises containing a prominent frequency determined where the level of the 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; and
  - 15 dB or more if the centre frequency of the band containing the tone is below 160 Hz.

Where two or more modifying factors are present, the maximum correction is limited to 10 dB. However, the INP (EPA 2000) also notes that where a source emits tonal and low frequency noise, only one 5 dB correction should be applied if the tone is in the low-frequency range.

The INP (EPA 2000) states that the modifying factors are to be applied to the noise from the source measured or predicted at the receiver and before comparison with the criteria. It is reasonable to conclude that if the predicted noise levels for each one-third octave band at the receiver is inaudible then it should not be included in the modifying factor assessments described above.

Audibility Test of Predicted Noise Levels

Each item of equipment used in the computer generated noise modelling for the Project is assessed for tonal noise and low frequency noise in accordance with the procedure outlined in Section 4 of the INP (EPA 2000). While an individual noise source may be observed to possess low frequency or tonal noise characteristics close to the source, the effects of attenuation between the source noise and the modelled receiver location can diminish the effects of low frequency and tonality annoyance predicted or observed at the receiver.

The threshold of audibility is defined in AS ISO 389.7-2003 Acoustics- Reference zero for the calibration of audiometric equipment Part 7: Reference threshold of hearing under free-field and diffuse field listening conditions.

For each predicted noise result an analysis of audibility, as defined by AS ISO 389.7-2003, is made against each one-third octave band. Where the predicted noise result for an octave band was found to be inaudible the octave band noise result is excluded from the assessment of tonality and low frequency noise.

Management of Tonal and Low Frequency Noise Sources

The noise models for the Project are prepared on the basis that equipment generating noise in the potentially audible range of 25 to 20,000 Hz range is well maintained. Failure to replace damaged mufflers, acoustic louvres and associated attenuation equipment could result in the generation of unacceptable tonal or low frequency noises.

APPENDIX C

Assessment of the Existing
Noise Environment

Appendix C – Assessment of the Existing Noise Environment

The following charts have been reproduced from Northparkes Mines - Environmental Noise Monitoring Quarter 3, 2012 (Environmental and Safety Professionals 2012) and Northparkes Mines - Environmental Noise Monitoring Quarter 4, 2012 (Environmental and Safety Professionals 2012).

For the night time period (10.00 pm to 7.00 am Monday to Saturday and 10.00 pm to 8.00 am on Saturday nights and the eve of public holidays), the monitoring data shows that background noise levels, as measured by the L_{A90} descriptor, at the monitoring locations Hubberstone, Lone Pine, Milpose and Beechmore are regularly at or below 30 dB(A).

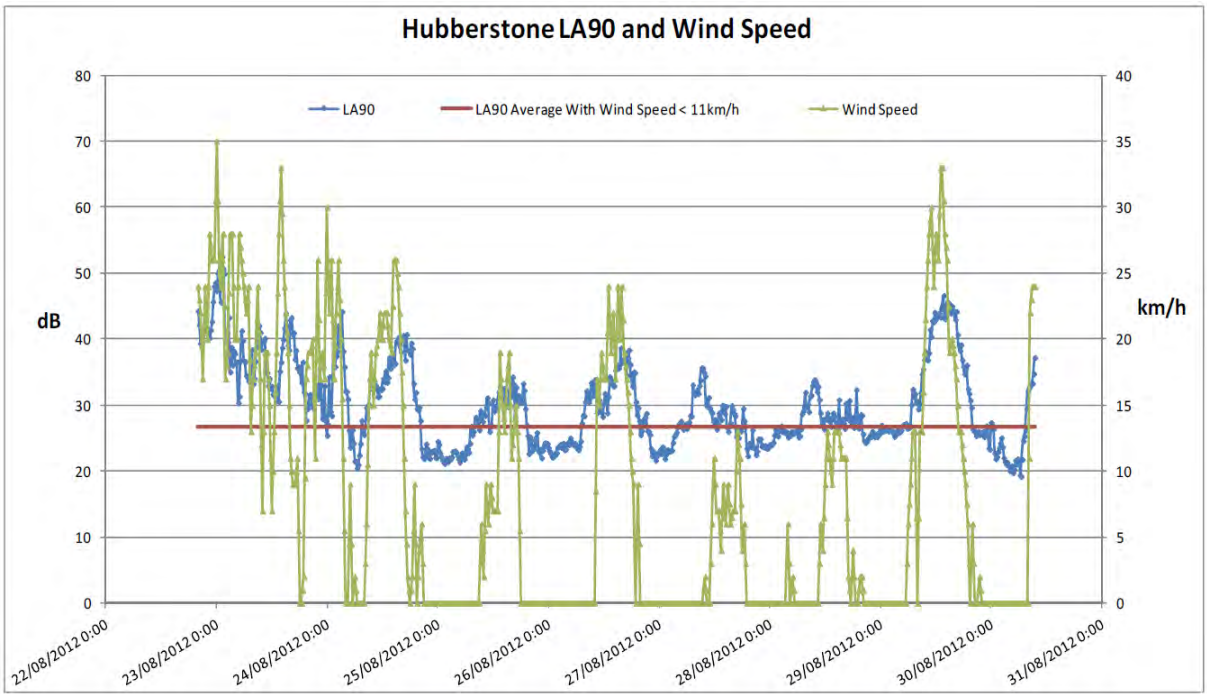
The monitoring information shows that background noise levels during the night-time period are generally less affected by wind-generated noise and have an absence of extraneous noise that typically occurs during the day-time and evening monitoring periods.

For the day time period (7:00 am to 6:00 pm Monday to Saturday and 8:00 am to 6:00 pm on Sundays and public holidays) and evening period (6:00 pm to 10:00 pm) the monitoring results show that there is a greater proportion of time when the measured background noise levels are either affected by wind generated noise or other non-industrial extraneous noise.

The monitoring reports note that extraneous non-industrial noise sources were present during the attended monitoring sessions. These noise sources consist of non-industrial related activities such as:

- intermittent road traffic noise;
- residential noise;
- birds;
- farming related activities;
- traffic noise;
- aircraft;
- wildlife (such as livestock and insects); and
- vegetation noise caused by the rustling of foliage.

In the absence of wind-generated noise and other non-industrial extraneous noise sources, the background noise levels for the day time and evening period, as measured by the L_{A90} descriptor, at the monitoring locations Hubberstone, Lone Pine, Milpose and Beechmore are likely to be regularly at or below 30 dB(A).


Hubberstone LA90 and Wind Speed
LA90
LA90 Average With Wind Speed < 11km/h
Wind Speed
dB
km/h
80
70
60
50
40
30
20
10
0
40
35
30
25
20
15
10
5
0
22/08/2012 0:00
23/08/2012 0:00
24/08/2012 0:00
25/08/2012 0:00
26/08/2012 0:00
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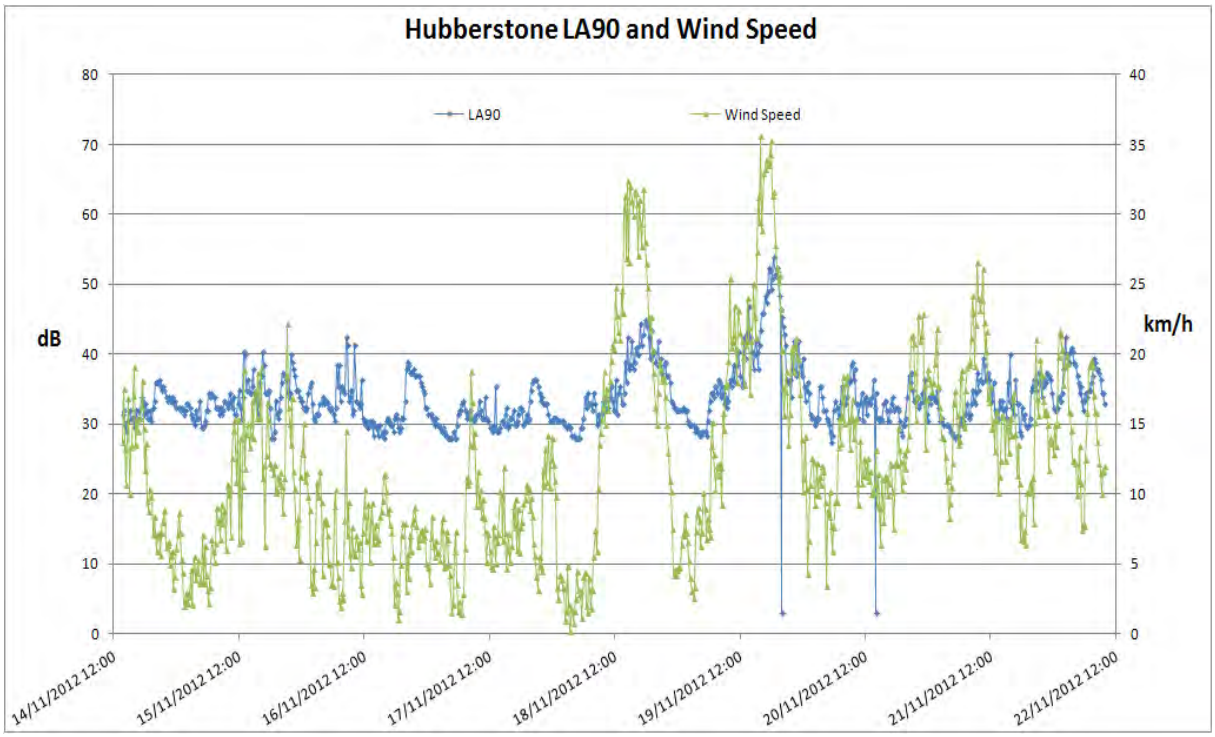
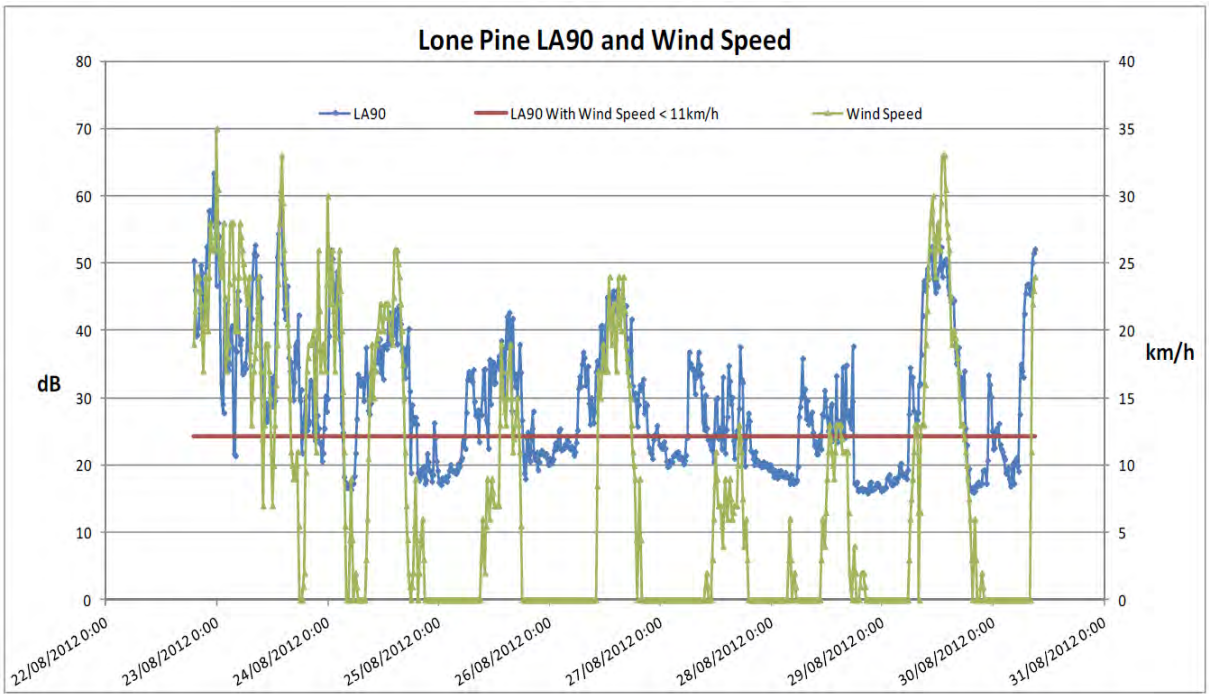
28/08/2012 0:00
29/08/2012 0:00
30/08/2012 0:00
31/08/2012 0:00


Hubberstone LA90 and Wind Speed
LA90
Wind Speed
dB
km/h
80
70
60
50
40
30
20
10
0
40
35
30
25
20
15
10
5
0
14/11/2012 12:00
15/11/2012 12:00
16/11/2012 12:00
17/11/2012 12:00
18/11/2012 12:00
19/11/2012 12:00
20/11/2012 12:00
21/11/2012 12:00
22/11/2012 12:00


Lone Pine LA90 and Wind Speed
LA90
LA90 With Wind Speed < 11km/h
Wind Speed
dB
km/h
80
70
60
50
40
30
20
10
0
40
35
30
25
20
15
10
5
0
22/08/2012 0:00
23/08/2012 0:00
24/08/2012 0:00
25/08/2012 0:00
26/08/2012 0:00
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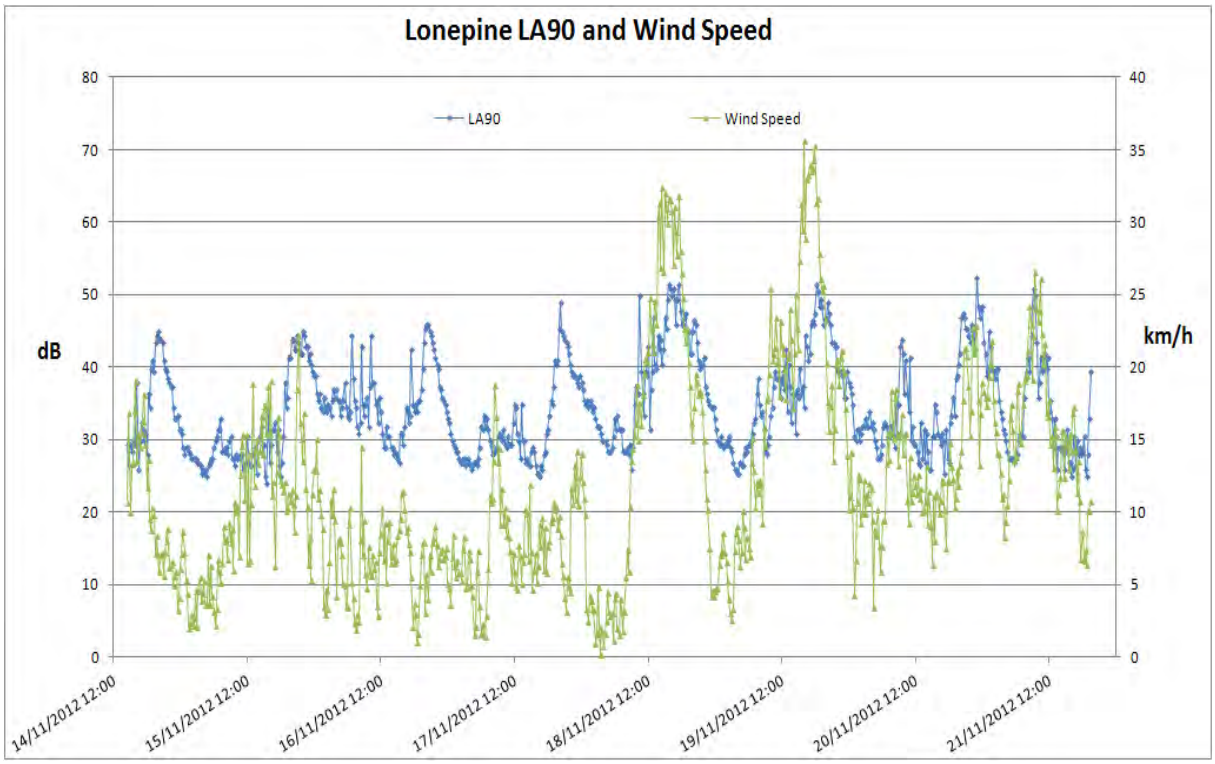
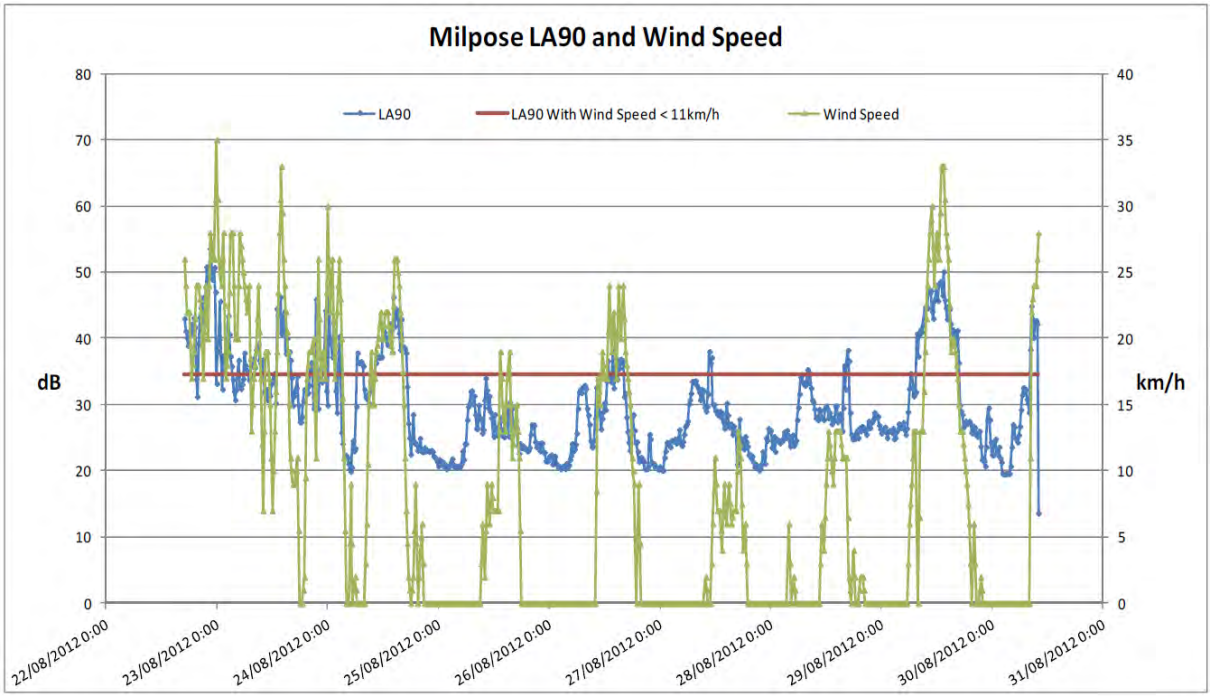
29/08/2012 0:00
30/08/2012 0:00
31/08/2012 0:00


Lonepine LA90 and Wind Speed
LA90
Wind Speed
dB
km/h
80
70
60
50
40
30
20
10
0
40
35
30
25
20
15
10
5
0
14/11/2012 12:00
15/11/2012 12:00
16/11/2012 12:00
17/11/2012 12:00
18/11/2012 12:00
19/11/2012 12:00
20/11/2012 12:00
21/11/2012 12:00


Milpose LA90 and Wind Speed
LA90
LA90 With Wind Speed < 11km/h
Wind Speed
dB
km/h
80
70
60
50
40
30
20
10
0
40
35
30
25
20
15
10
5
0
22/08/2012 0:00
23/08/2012 0:00
24/08/2012 0:00
25/08/2012 0:00
26/08/2012 0:00
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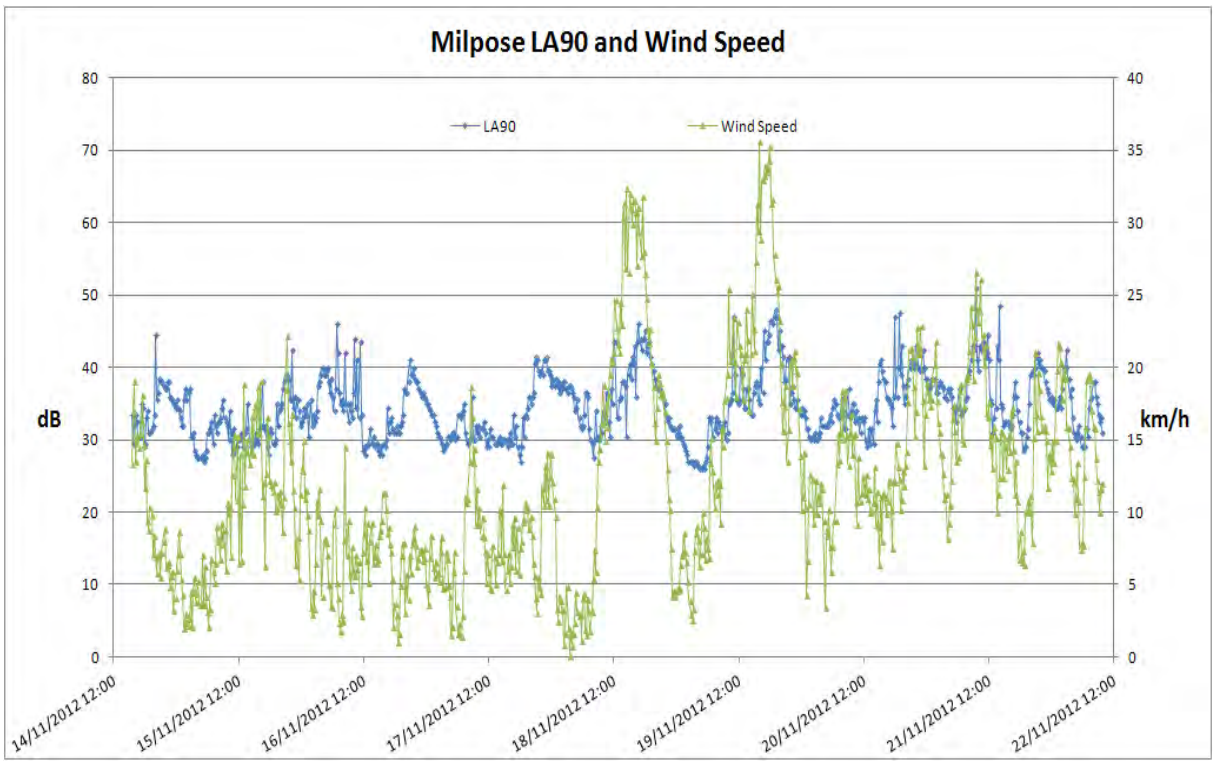
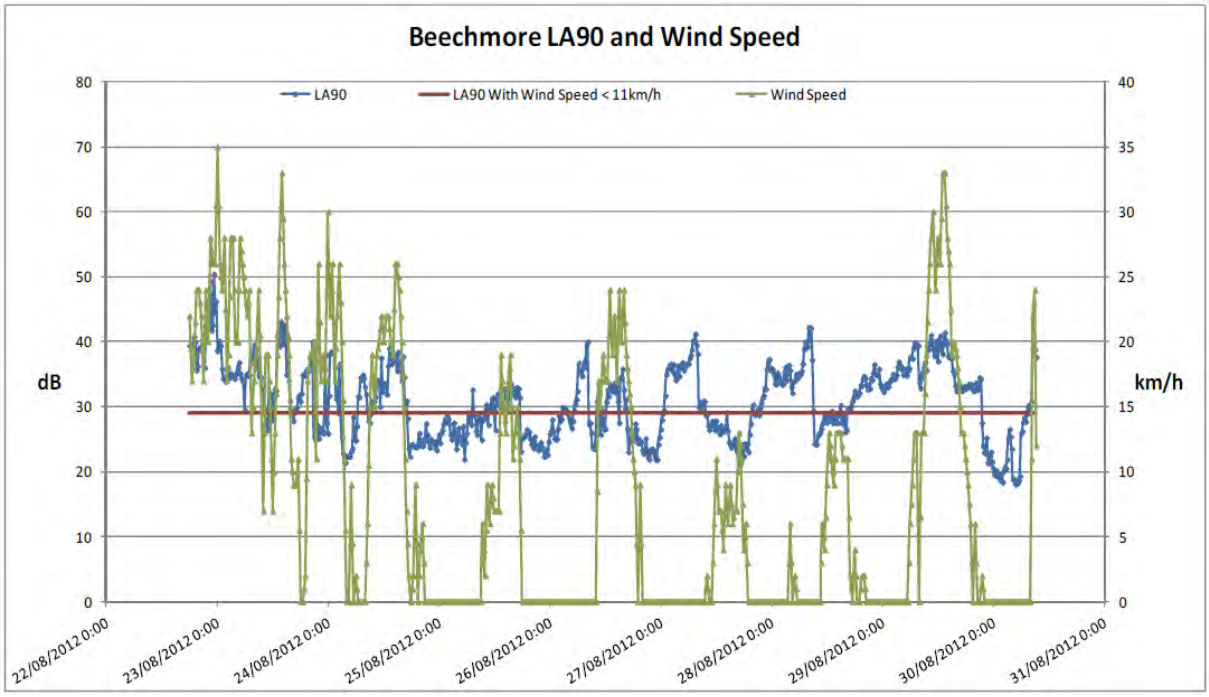
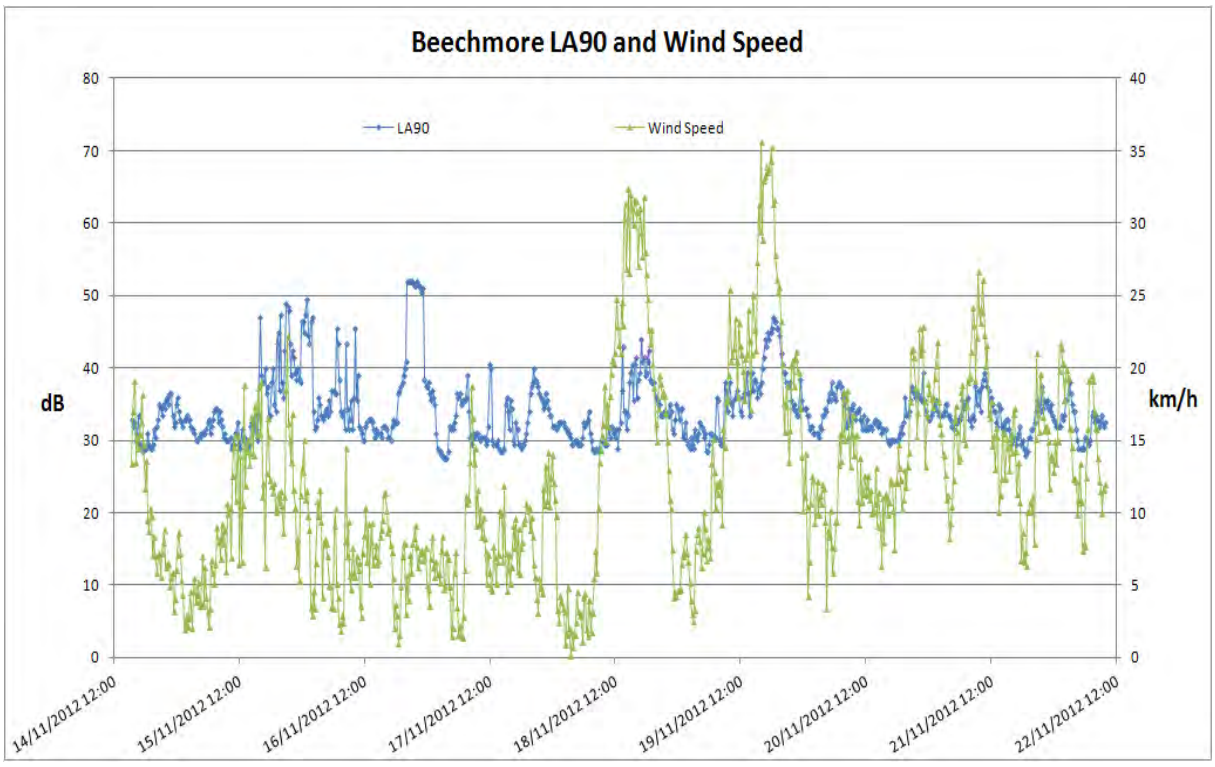
29/08/2012 0:00
30/08/2012 0:00
31/08/2012 0:00


Milpose LA90 and Wind Speed
LA90
Wind Speed
dB
km/h
80
70
60
50
40
30
20
10
0
40
35
30
25
20
15
10
5
0
14/11/2012 12:00
15/11/2012 12:00
16/11/2012 12:00
17/11/2012 12:00
18/11/2012 12:00
19/11/2012 12:00
20/11/2012 12:00
21/11/2012 12:00
22/11/2012 12:00


Beechmore LA90 and Wind Speed
LA90
LA90 With Wind Speed < 11km/h
Wind Speed
dB
km/h
80
70
60
50
40
30
20
10
0
40
35
30
25
20
15
10
5
0
22/08/2012 0:00
23/08/2012 0:00
24/08/2012 0:00
25/08/2012 0:00
26/08/2012 0:00
27/08/2012 0:00
28/08/2012 0:00
29/08/2012 0:00
30/08/2012 0:00
31/08/2012 0:00


Beechmore LA90 and Wind Speed
LA90
Wind Speed
dB
km/h
80
70
60
50
40
30
20
10
0
40
35
30
25
20
15
10
5
0
14/11/2012 12:00
15/11/2012 12:00
16/11/2012 12:00
17/11/2012 12:00
18/11/2012 12:00
19/11/2012 12:00
20/11/2012 12:00
21/11/2012 12:00
22/11/2012 12:00

APPENDIX D

Assessment of Meteorological Data

Appendix D – Meteorological Analysis

Section 5 of the Industrial Noise Policy (INP) (EPA 2000) requires that noise impacts be assessed under weather conditions that would be expected to occur at a particular site for a significant period of time.

The INP (EPA 2000) notes that there are two approaches for the assessment of meteorological effects, such as gradient winds and temperature inversions, on propagating the noise from the source to the receiver. The simple method is to use default conditions outlined in the INP. Alternatively, the local meteorological data can be used to determine weather conditions that would be expected to occur at a particular site for a significant period of time.

Meteorological data for the period January 2008 to May 2011 was sourced from Northparkes Mines. This data was analysed to determine the frequency of occurrence of prevailing winds and temperature inversions.

Wind

The INP (EPA 2000) requires that wind effects need to be assessed when wind is considered a feature of the area. Wind is considered a feature of the area where source-to-receiver winds of 3 m/s occur for 30 per cent of the time in any assessment period.

Section 5 of the INP requires that noise impacts be assessed under weather conditions that would be expected to occur at a particular site for a significant period of time.

The collated meteorological data for the January 2008 to May 2011 period was analysed to determine prevailing wind conditions likely to influence the propagation of noise at the project site and is summarised in **Tables 1** to **4**.

Table 1 – Gradient Wind Analysis, Summer

Direction	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
Day						
N	1.6%	0.4%	2.2%	3.3%	2.7%	5.0%
NNE		0.5%	2.1%	2.9%	1.9%	2.4%
NE		0.3%	1.7%	2.7%	2.8%	2.0%
ENE		0.3%	1.5%	2.5%	2.3%	1.4%
E		0.2%	1.3%	0.8%	0.8%	0.6%
ESE		0.3%	0.9%	0.6%	0.6%	0.4%
SE		0.2%	0.8%	0.7%	0.3%	0.1%
SSE		0.4%	1.1%	0.9%	0.4%	0.1%
S		0.3%	1.6%	2.0%	1.4%	0.6%
SSW		0.2%	1.3%	2.1%	2.0%	1.4%
SW		0.3%	1.3%	2.0%	2.3%	1.5%
WSW		0.1%	1.1%	1.5%	1.5%	1.2%
W		0.1%	0.9%	1.0%	0.6%	0.5%
WNW		0.2%	1.0%	1.1%	0.6%	0.4%
NW		0.1%	1.1%	1.6%	1.1%	1.2%
NNW		0.2%	1.4%	2.3%	2.0%	3.0%

Table 1 – Gradient Wind Analysis, Summer (cont.)

Direction	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
Evening						
N	2.5%	0.5%	2.6%	1.8%	1.1%	1.1%
NNE		0.3%	3.7%	2.4%	1.2%	0.8%
NE		0.5%	3.1%	3.5%	2.7%	1.3%
ENE		0.6%	2.6%	2.8%	2.2%	2.8%
E		0.2%	1.4%	0.9%	0.8%	1.0%
ESE		0.3%	1.2%	0.6%	0.4%	0.3%
SE		0.5%	1.2%	0.6%	0.1%	0.1%
SSE		0.7%	3.0%	1.7%	0.7%	0.2%
S		0.7%	2.6%	2.6%	1.7%	0.7%
SSW		0.6%	3.1%	4.2%	2.2%	1.4%
SW		0.2%	2.2%	3.5%	2.3%	1.9%
WSW		0.4%	0.9%	0.8%	1.1%	0.6%
W		0.3%	0.7%	0.3%	0.3%	0.3%
WNW		0.3%	0.8%	0.3%	0.2%	0.2%
NW		0.2%	0.7%	0.8%	0.3%	0.2%
NNW		0.5%	1.7%	1.3%	0.6%	0.5%
Night						
N	9.6%	0.7%	1.7%	1.7%	0.8%	0.3%
NNE		2.0%	4.1%	2.4%	0.8%	0.4%
NE		2.6%	6.6%	6.2%	4.1%	1.7%
ENE		1.3%	4.2%	3.5%	2.7%	2.1%
E		1.0%	2.2%	1.4%	0.6%	0.6%
ESE		1.0%	1.4%	0.8%	0.5%	0.2%
SE		1.1%	1.5%	0.6%	0.2%	0.1%
SSE		1.9%	3.7%	1.1%	0.1%	0.1%
S		1.4%	4.3%	1.6%	0.4%	0.4%
SSW		0.7%	2.1%	1.6%	0.5%	0.3%
SW		0.3%	1.1%	0.4%	0.3%	0.2%
WSW		0.3%	0.5%	0.2%	0.1%	0.2%
W		0.2%	0.2%	0.2%	0.1%	-
WNW		0.2%	0.3%	0.1%	-	-
NW		0.2%	0.2%	0.1%	-	-
NNW		0.3%	0.8%	0.3%	0.2%	-

Table 2 – Gradient Wind Analysis, Autumn

Direction	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
Day						
N	3.9%	0.5%	1.8%	1.5%	1.8%	2.2%
NNE		0.5%	2.1%	1.7%	1.9%	1.5%
NE		0.6%	2.3%	2.5%	1.9%	1.2%
ENE		0.5%	1.9%	2.0%	2.0%	1.4%
E		0.4%	1.4%	1.2%	0.7%	0.7%
ESE		0.3%	1.0%	0.9%	0.4%	0.6%
SE		0.5%	1.3%	1.2%	0.4%	0.1%
SSE		1.2%	3.0%	2.4%	0.8%	0.2%
S		1.4%	4.0%	3.8%	3.1%	1.0%
SSW		0.8%	2.1%	2.7%	2.0%	0.8%
SW		0.3%	1.7%	2.1%	1.6%	1.1%
WSW		0.4%	0.9%	1.0%	1.1%	1.1%
W		0.3%	0.7%	0.5%	0.5%	0.7%
WNW		0.3%	0.8%	0.5%	0.3%	0.2%
NW		0.3%	1.2%	1.0%	0.5%	0.3%
NNW		0.3%	1.3%	1.2%	1.1%	0.9%
Evening						
N	6.2%	0.3%	1.0%	0.8%	0.7%	0.4%
NNE		0.5%	2.2%	1.7%	0.6%	0.1%
NE		0.8%	3.7%	2.2%	0.6%	0.3%
ENE		0.8%	2.6%	2.9%	2.1%	1.4%
E		0.5%	2.4%	2.1%	0.9%	0.2%
ESE		0.6%	1.1%	1.4%	0.7%	0.1%
SE		1.2%	2.1%	0.9%	0.6%	0.4%
SSE		1.9%	7.1%	2.0%	0.5%	0.1%
S		1.8%	6.5%	2.9%	0.6%	0.2%
SSW		0.9%	5.1%	3.9%	1.1%	0.4%
SW		0.7%	2.8%	2.5%	0.8%	0.6%
WSW		0.5%	1.5%	1.1%	0.6%	0.1%
W		0.5%	0.6%	0.3%	0.1%	0.1%
WNW		0.3%	0.6%	-	-	0.1%
NW		0.3%	0.5%	0.2%	0.3%	-
NNW		0.3%	1.0%	0.6%	0.1%	0.1%
Night						
N	14.7%	0.6%	1.0%	0.5%	0.2%	-
NNE		1.5%	2.3%	1.0%	0.4%	0.2%
NE		1.9%	4.3%	5.1%	1.9%	0.6%
ENE		1.4%	3.6%	4.0%	1.9%	0.6%
E		1.1%	1.3%	1.0%	0.4%	-
ESE		1.0%	1.2%	0.7%	0.1%	0.1%
SE		2.0%	2.4%	0.8%	0.2%	-
SSE		3.7%	7.3%	2.0%	0.3%	-
S		3.2%	6.8%	2.1%	0.5%	0.1%

Table 2 – Gradient Wind Analysis, Autumn (cont.)

Direction	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
SSW		1.2%	2.4%	1.0%	0.2%	0.3%
SW		0.6%	1.1%	0.7%	0.3%	0.2%
WSW		0.3%	0.4%	0.2%	0.3%	0.1%
W		0.4%	0.5%	0.2%	0.2%	-
WNW		0.3%	0.4%	0.3%	0.1%	0.1%
NW		0.4%	0.6%	0.3%	0.1%	-
NNW		0.3%	0.3%	0.3%	0.1%	-

Table 3 – Gradient Wind Analysis, Winter

Direction	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
Day						
N	6.3%	0.8%	2.5%	2.8%	2.8%	2.6%
NNE		0.9%	2.0%	2.0%	1.4%	1.4%
NE		0.8%	1.7%	1.3%	0.8%	0.8%
ENE		0.4%	0.9%	1.5%	1.4%	0.8%
E		0.3%	0.8%	0.6%	0.1%	-
ESE		0.3%	0.4%	0.1%	0.1%	-
SE		0.3%	0.6%	0.3%	0.1%	-
SSE		0.9%	2.3%	1.0%	0.3%	0.1%
S		1.2%	4.5%	3.0%	2.0%	0.2%
SSW		0.7%	2.4%	3.8%	2.2%	0.7%
SW		0.4%	1.2%	2.9%	2.3%	0.8%
WSW		0.6%	1.0%	1.8%	1.8%	1.7%
W		0.4%	1.1%	1.2%	1.7%	1.3%
WNW		0.4%	1.3%	0.8%	0.7%	0.6%
NW		0.3%	1.3%	1.1%	0.5%	0.5%
NNW		0.4%	1.5%	2.0%	1.6%	1.3%
Evening						
N	9.9%	0.7%	1.8%	2.0%	0.7%	1.1%
NNE		1.0%	3.5%	1.8%	0.7%	0.3%
NE		1.2%	2.7%	2.0%	0.3%	0.1%
ENE		0.7%	2.8%	1.6%	0.6%	0.1%
E		0.9%	1.6%	0.6%	0.1%	-
ESE		0.8%	1.2%	0.5%	-	-
SE		1.0%	0.6%	0.2%	-	-
SSE		1.8%	4.2%	0.8%	0.1%	-
S		2.0%	5.7%	2.4%	0.1%	-
SSW		1.7%	6.4%	2.0%	0.3%	-
SW		0.7%	3.6%	3.3%	1.1%	0.3%

Table 3 – Gradient Wind Analysis, Winter (cont.)

Direction	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
WSW		0.7%	1.7%	1.8%	1.7%	0.7%
W		0.7%	1.3%	0.9%	0.6%	0.2%
WNW		0.8%	0.8%	0.8%	0.5%	0.2%
NW		0.4%	1.6%	0.9%	0.3%	0.4%
NNW		0.3%	1.3%	1.3%	0.4%	0.2%
Night						
N	18.1%	0.8%	1.4%	1.5%	0.9%	0.6%
NNE		2.1%	2.8%	1.6%	0.9%	0.5%
NE		2.7%	3.5%	2.0%	0.8%	0.6%
ENE		1.1%	1.6%	2.0%	0.8%	0.7%
E		0.9%	0.8%	0.4%	-	-
ESE		1.2%	0.8%	0.2%	-	-
SE		1.6%	1.0%	0.2%	-	-
SSE		2.6%	5.1%	1.0%	-	-
S		2.6%	6.1%	1.8%	0.1%	-
SSW		1.5%	3.0%	1.0%	0.2%	-
SW		0.7%	2.7%	1.5%	0.7%	0.5%
WSW		0.4%	1.5%	1.1%	0.9%	0.4%
W		0.7%	0.8%	0.7%	0.4%	0.5%
WNW		0.6%	0.9%	0.4%	0.1%	0.1%
NW		0.2%	0.9%	0.9%	0.1%	-
NNW		0.4%	1.0%	1.0%	0.3%	0.2%

Table 4 – Gradient Wind Analysis, Spring

Direction	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
Day						
N	2.5%	0.3%	2.2%	3.5%	3.1%	5.0%
NNE		0.5%	2.0%	2.8%	2.0%	2.2%
NE		0.6%	1.6%	2.0%	1.6%	0.7%
ENE		0.3%	1.4%	1.8%	1.8%	1.1%
E		0.3%	0.5%	0.5%	0.3%	0.5%
ESE		0.2%	0.6%	0.3%	0.1%	0.3%
SE		0.3%	0.6%	0.3%	0.1%	0.1%
SSE		0.6%	1.5%	0.8%	0.4%	0.3%
S		0.8%	2.7%	2.8%	1.5%	1.0%
SSW		0.4%	2.3%	3.4%	2.3%	1.2%
SW		0.3%	1.5%	2.9%	2.9%	1.5%
WSW		0.3%	1.0%	1.6%	1.7%	3.0%
W		0.2%	0.7%	0.8%	0.9%	1.8%
WNW		0.1%	1.0%	0.8%	0.5%	1.0%
NW		0.2%	0.9%	1.1%	0.4%	0.3%
NNW		0.2%	1.5%	1.7%	1.2%	2.0%

Table 4 – Gradient Wind Analysis, Spring (cont.)

Direction	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
Evening						
N	5.5%	0.2%	1.5%	2.0%	0.8%	0.9%
NNE		0.3%	2.6%	2.9%	1.6%	0.5%
NE		0.8%	4.3%	4.5%	1.1%	0.5%
ENE		0.8%	2.5%	3.0%	0.9%	0.4%
E		0.8%	1.3%	1.3%	0.7%	0.1%
ESE		0.9%	1.1%	0.2%	0.1%	0.4%
SE		1.3%	1.4%	0.4%	0.1%	0.1%
SSE		1.6%	4.4%	0.9%	0.3%	0.3%
S		1.3%	4.5%	1.9%	0.6%	0.4%
SSW		0.8%	5.7%	4.1%	0.9%	0.4%
SW		0.2%	3.6%	3.5%	1.9%	1.0%
WSW		0.5%	1.0%	1.2%	1.5%	1.6%
W		0.3%	1.2%	0.8%	0.5%	0.2%
WNW		0.5%	0.5%	0.3%	0.2%	0.2%
NW		0.3%	0.4%	0.2%	0.2%	0.2%
NNW		0.2%	0.9%	0.6%	0.2%	0.5%
Night						
N	14.1%	0.6%	1.4%	1.6%	0.7%	0.4%
NNE		1.6%	3.1%	3.0%	1.1%	0.6%
NE		2.6%	5.1%	3.8%	1.4%	0.3%
ENE		1.3%	3.7%	3.1%	1.2%	0.6%
E		1.1%	1.3%	0.6%	0.3%	-
ESE		1.0%	1.1%	0.3%	0.1%	-
SE		1.0%	1.2%	0.3%	0.1%	-
SSE		2.5%	4.5%	0.8%	-	-
S		2.5%	5.9%	1.5%	0.2%	0.4%
SSW		1.4%	3.4%	1.3%	0.2%	0.1%
SW		0.5%	2.3%	1.4%	0.6%	0.3%
WSW		0.4%	1.0%	0.8%	0.7%	0.5%
W		0.6%	1.2%	0.4%	0.2%	0.3%
WNW		0.3%	0.7%	0.2%	0.1%	0.2%
NW		0.3%	0.3%	0.2%	-	0.1%
NNW		0.3%	0.7%	0.5%	0.2%	0.4%

Wind speed analysis of the prevailing winds has also been conducted and is summarised in **Figures 1.1** to **1.4**.

The results of the source-to-receiver vectored wind analysis indicate that there are source-to-receiver wind conditions that occur greater than 30 per cent of the time during the autumn evening and night-time periods. The percentage occurrence of these source-to-receiver wind conditions are shown below in **Table 5**.

Table 5 – Percentage Occurrence of Prevailing Winds – Autumn

Direction	Period	Percentage Occurrence (%)
ESE	Night	30.1
SE	Night	31.5
SSE	Evening	31.0
	Night	31.6
S	Evening	30.8
	Night	30.3

Of these conditions, winds from the east-south-east to south-south-east at 3 m/s, associated with autumn evening and night-time periods should be considered in the assessment as prevailing meteorological conditions of the area.

The results presented in **Table 5** are consistent with the results of the Office of Environment and Heritage (OEH) Noise Enhancement Wind Analysis (NEWA) program (OEH 2009).

The results of the source-to-receiver vectored wind analysis also indicate that the majority of the source-to-receiver wind conditions occurred less than 25 per cent of the time. Inspection of the windroses, **Figures 1.1** to **1.4**, indicates source-to-receiver vectored wind can occur above 20 per cent of the time (but less than 30 per cent) due to:

- winds from the north-east (up to 27 per cent of the time) during summer nights;
- winds from the south (up to 28 per cent of the time) during winter evenings and nights; and
- winds from the south to south-west (up to 26 per cent of the time) and from the north-east (up to 22 per cent of the time) during spring evenings and nights.

Of these conditions, the winds from the south during winter evenings and nights need to be considered in the assessment of the noise impacts as the conditions are representative of drainage flow and occur as a part of the inversion conditions present at the time.

Temperature Inversions

Temperature inversions, when they occur, have the ability to increase noise levels by focusing sound waves. Temperature inversions occur predominantly at night during the winter months. For a temperature inversion to be a significant characteristic of the area it needs to occur for approximately 30 per cent of the total night-time (i.e. the evening and night-time periods) during winter, or about two nights per week.

Meteorological data was assessed in accordance with INP (EPA 2000) methodology to determine the likelihood of temperature inversions during the winter evening and night-time periods. These results of the analysis of the meteorological data for the January 2008 to May 2011 period are presented in **Table 6**.

Table 6 – Inversion Analysis Summary - Frequency of Stability Classes During Winter Evening and Night-time Periods

Pasquill-Gifford Stability Class	Frequency of Stability Class (%)
D	10.5
E	25.7
F & G	63.9

From the analysis of the meteorological data F and G class stability conditions are present more than 30 per cent of the time.

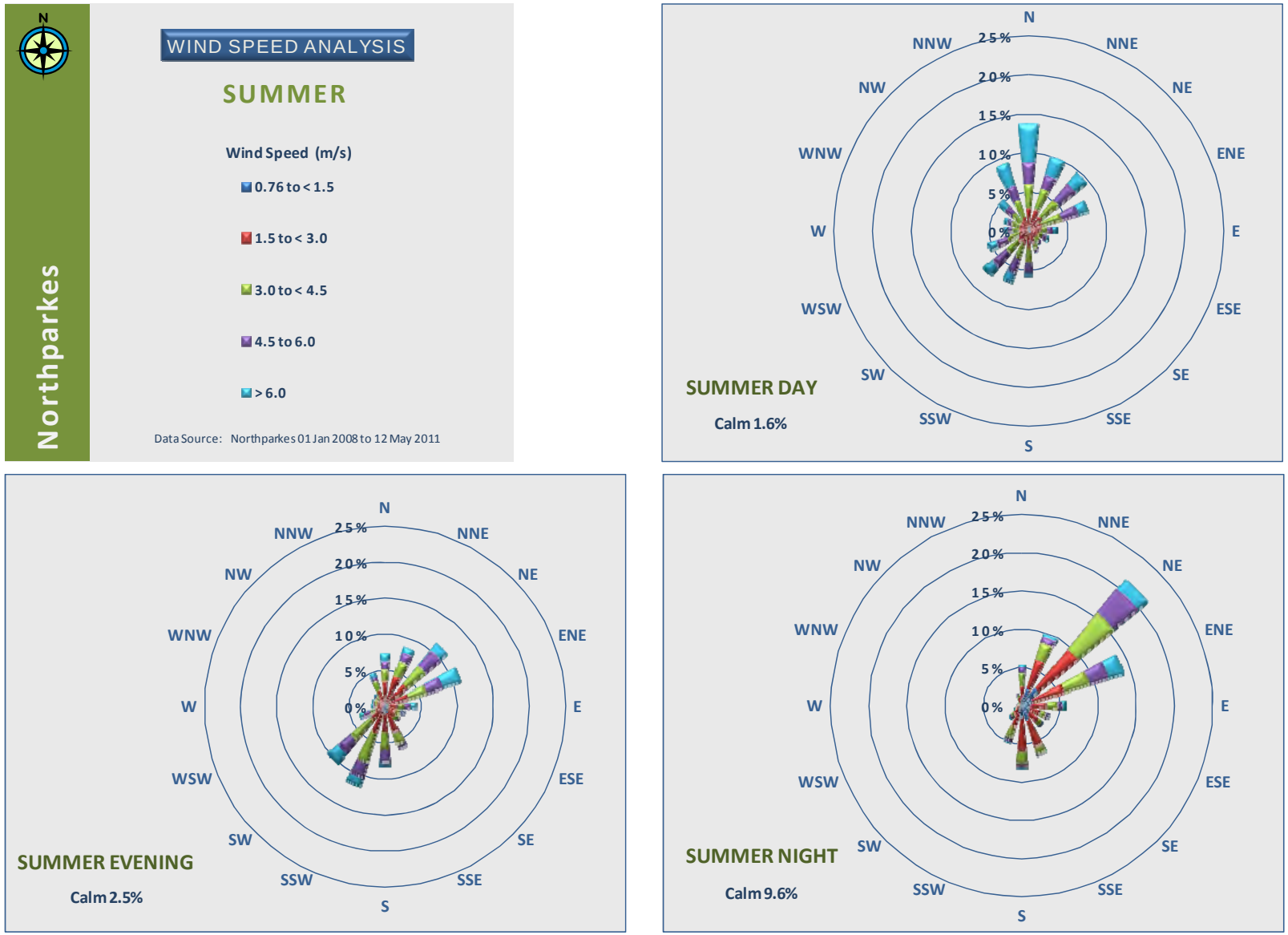


Figure 1.1 – Wind Speed Analysis, Summer

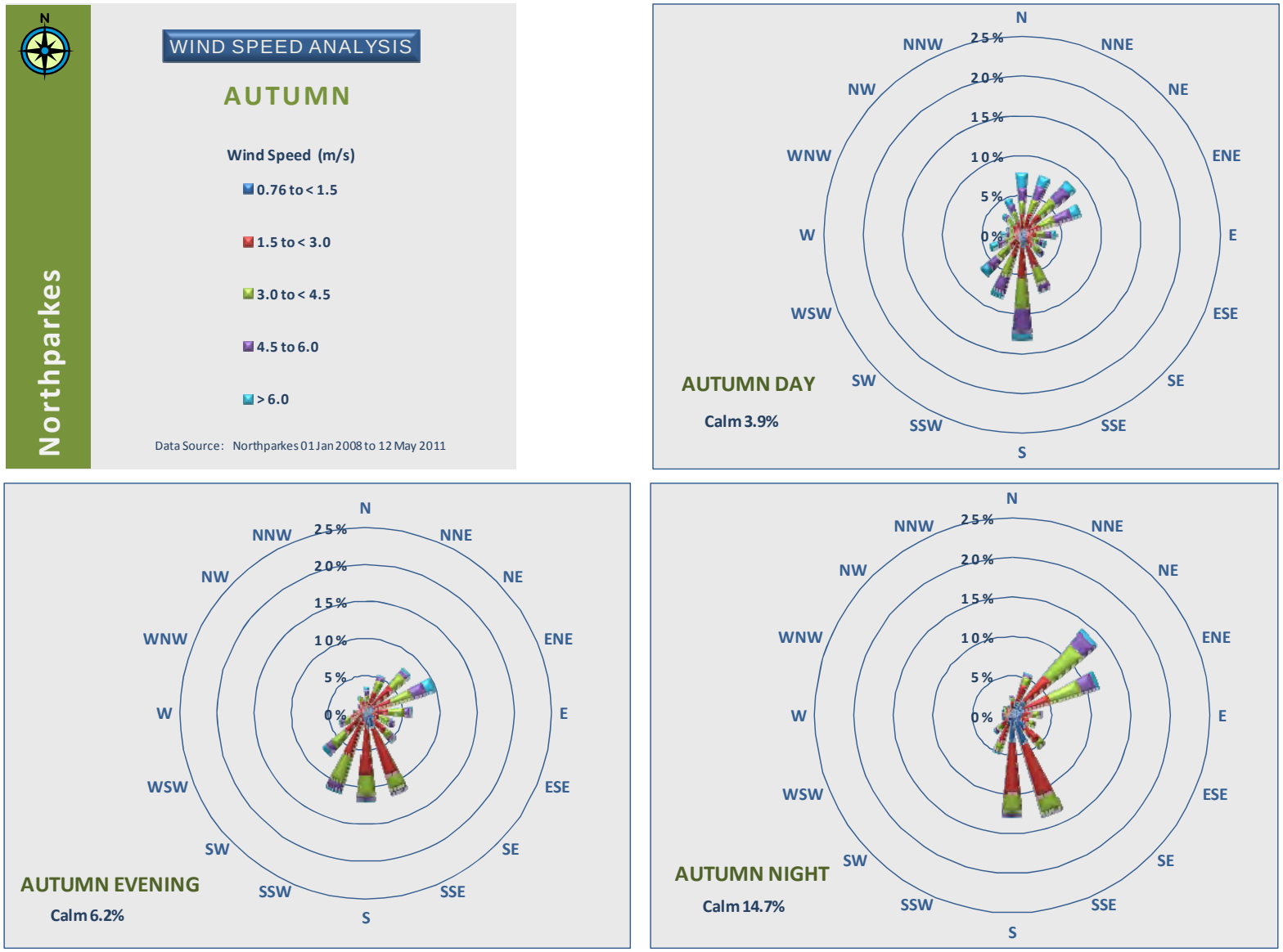


Figure 1.2 – Wind Speed Analysis, Autumn

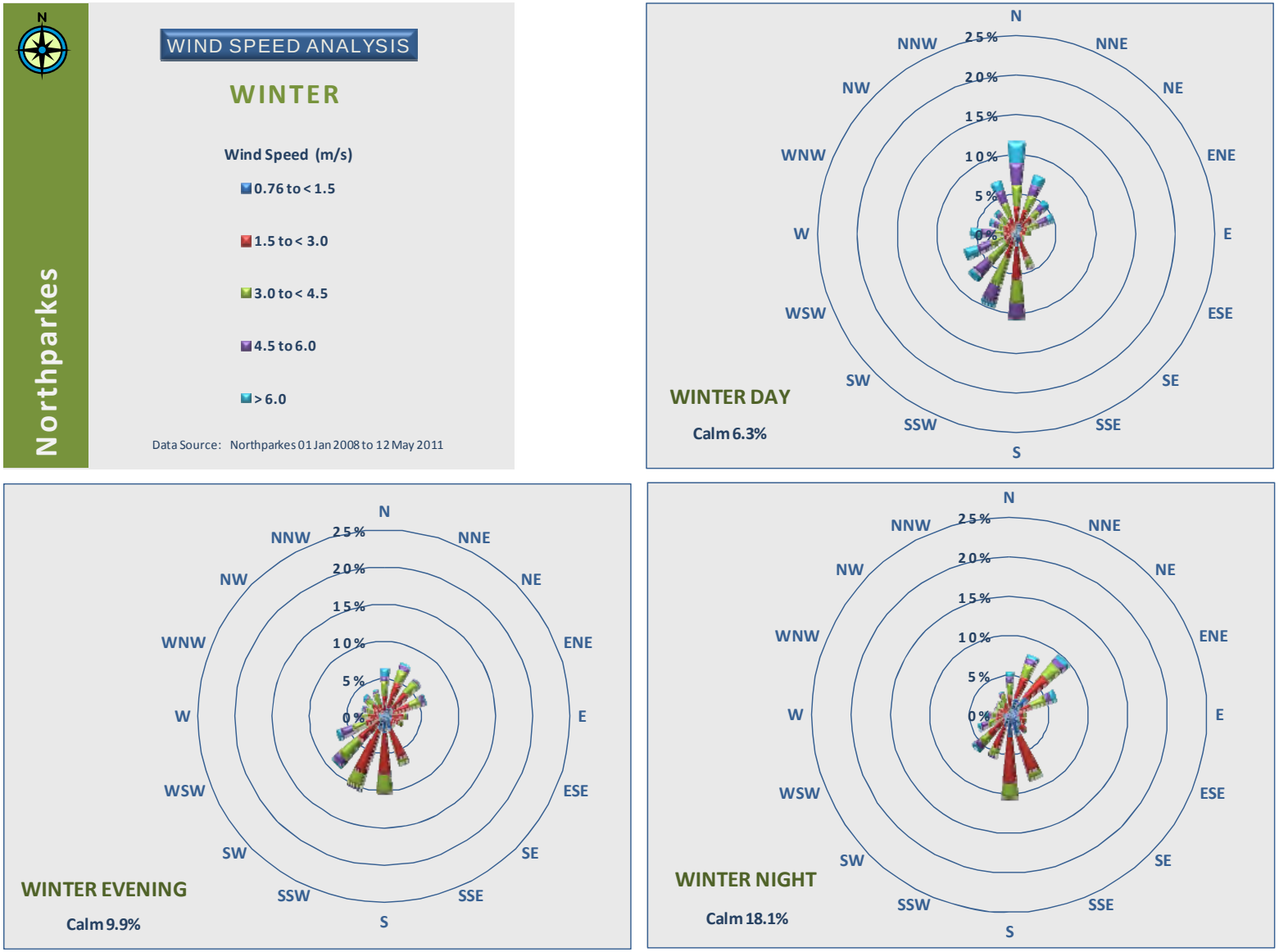


Figure 1.3 – Wind Speed Analysis, Winter

Figure 1.4 – Wind Speed Analysis, Spring

Temperature Inversion and Drainage Flow

Drainage flow is the low level wind associated with the flow of cold air from higher ground to lower during the presence of a temperature inversion.

The INP states that the:

> 'drainage-flow wind default value should generally be applied where a development is at a higher altitude than the residential receiver, with no intervening higher ground.'

The area surrounding the Project is typically flat and residential receivers have a similar altitude.

Inspection of the windroses in **Figure 1.5** indicates source-to-receiver vectored wind can occur from the south during winter evenings and nights. The results of the source-to-receiver vectored wind analysis indicates that the majority of the source-to-receiver wind conditions occurred up to than 27 per cent of the time from the south-south-east to south-south-west, due to the drainage from the south.

The meteorological data for the January 2008 to May 2011 period was analysed to determine the prevalence and speed of the prevailing winds from the south during winter evening and night. The results of this analysis are summarised in **Table 7**.

Based on the data presented in **Table 7** drainage-flow winds of 2.0 m/s from the south should be considered as part of the meteorological conditions for modelling the noise impacts of the Project.

Table 7 – Gradient Wind Analysis, Winter Night (6.00 pm to 7.00 am)

Direction	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
Inversion Conditions						
N	11.5%	0.6%	1.5%	-	-	-
NNE		1.4%	3.0%	-	-	-
NE		1.9%	4.5%	-	-	-
ENE		1.1%	3.1%	-	-	-
E		0.9%	1.5%	-	-	-
ESE		0.9%	1.1%	-	-	-
SE		1.3%	1.5%	-	-	-
SSE		2.3%	5.1%	-	-	-
S		2.1%	5.5%	-	-	-
SSW		1.1%	3.4%	-	-	-
SW		0.5%	2.1%	-	-	-
WSW		0.4%	0.9%	-	-	-
W		0.5%	0.7%	-	-	-
WNW		0.4%	0.6%	-	-	-
NW		0.3%	0.6%	-	-	-
NNW		0.3%	0.9%	-	-	-

Table 7 – Gradient Wind Analysis, Winter Night (6.00 pm to 7.00 am) (cont.)

Direction	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
Non-Inversion Conditions						
N	-	-	-	1.4%	0.7%	0.5%
NNE		-	-	2.0%	0.9%	0.4%
NE		-	-	4.0%	1.8%	0.7%
ENE		-	-	3.0%	1.6%	1.1%
E		-	-	1.0%	0.4%	0.2%
ESE		-	-	0.6%	0.2%	0.1%
SE		-	-	0.5%	0.2%	0.1%
SSE		-	-	1.3%	0.2%	0.1%
S		-	-	1.9%	0.5%	0.3%
SSW		-	-	1.9%	0.5%	0.3%
SW		-	-	1.6%	0.8%	0.5%
WSW		-	-	0.7%	0.7%	0.4%
W		-	-	0.4%	0.3%	0.2%
WNW		-	-	0.3%	0.1%	0.1%
NW		-	-	0.4%	0.1%	0.1%
NNW		-	-	0.6%	0.2%	0.2%

Modelling Parameters

The meteorological conditions that should be considered as a part of the noise impact assessment presented in **Table 8**.

Table 8 – Meteorological Conditions for Noise Modelling

Scenario	Temperature (^{o}C)	Humidity (%)	Wind Speed (m/s)	Wind Direction (deg from North)	Temperature Gradient (^{o}C/100 m)
Calm	20	65	-	-	-
Autumn - Evening and Nights	12	80	3	South-south-east (157.5^{o})	-
Winter – Night-time F Class Stability with Drainage Flow	4	80	2	South (180^{o})	4

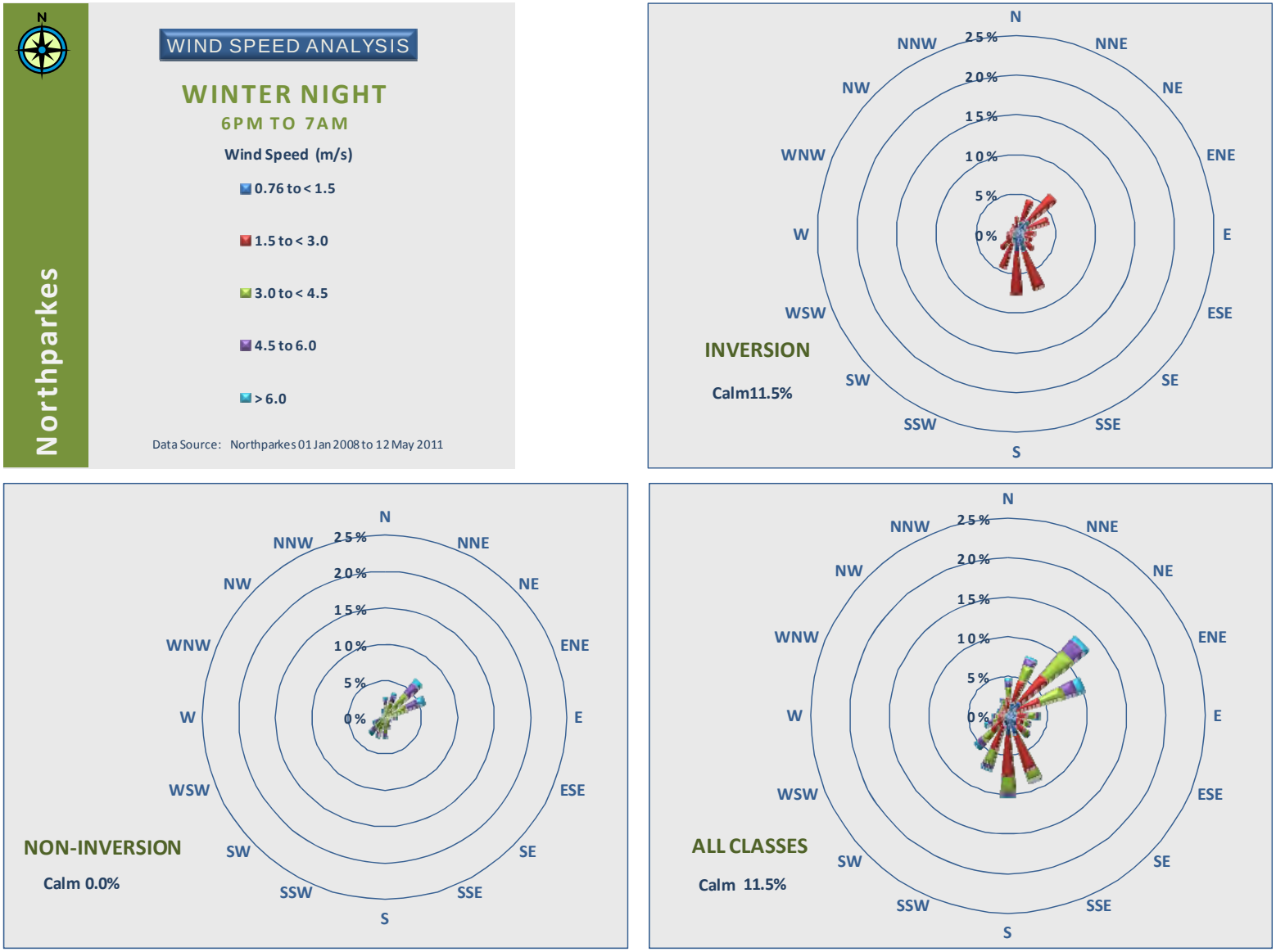


Figure 1.5 – Wind Speed Analysis, Winter Night (6.00 pm to 7.00 am)

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