APPENDIX 3

Noise Impact Assessment

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OBERON QUARRIES

Noise Impact Assessment

October 2014

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Noise Impact Assessment

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Prepared by
Umwelt (Australia) Pty Limited

on behalf of
Oberon Quarries Pty Limited

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Executive Summary

Oberon Quarries Pty Limited has operated a hard rock quarry at 'Langley Heights' (Oberon Quarry) since 1995. The development consent, granted by the Minister for Planning is due to lapse on 13 May 2016. In order to improve efficiency and environmental performance of the quarry operations and further the life of the quarry for extraction of proven reserves, Oberon Quarries is seeking consent to extend the life of the quarry DA 92/164 under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for an additional 30 years.

The Project represents the continuation of the existing quarry operations, which will remain substantially the same. As a part of the Project, Oberon Quarries proposes to replace some of the existing crushing and screening plant with modern plant, which is more energy efficient, produces less fines (a by-product of the crushing process) and results in an overall reduction in the environmental impacts of the operation. All other aspects of the approved quarry processing operations will remain unchanged. There are a number of other environmental improvements proposed however none of these will cause any significant change to noise levels or noise impacts from quarry operations.

Section 10 – Applying the policy to existing industrial premises of the Industrial Noise Policy (INP) (Environment Protection Agency (EPA) 2000) deals with application of the INP (EPA, 2000) to existing industrial noise sources such as Oberon Quarry. The approach established by the EPA in 2000 was designed to allow established industries to adapt to changes in the noise expectations of the community while remaining economically viable.

The methodology for the assessment of the noise impacts from Oberon Quarry is based on the requirements of Section 10 of the INP (EPA, 2000). Specifically the INP (EPA, 2000) notes that the project-specific noise levels (PSNL) identified for the Project should not be applied as mandatory noise limits but provide initial target levels that drive the process of assessing all feasible and reasonable control measures for the Project.

To satisfy the requirements of the relevant policies and guidelines, the Noise Impact Assessment (NIA) has:

- identified noise sensitive locations likely to be affected by activities at the site and estimated the existing background and amenity noise levels at representative locations;
- determined the target PSNLs for the Project based on the estimation of the underlying background and amenity noise levels of the surrounding receiver areas;
- identified all noise sources from the Project and determined the expected noise levels and noise characteristics likely to be generated from the noise sources;
- identified the times of operation of the Project and all related noise producing activities;
- determined the noise levels likely to be received at the most sensitive locations using an approved predictive noise model:
  - under neutral calm conditions;
  - gradient winds identified as being significant in accordance with the INP (EPA, 2000); and

    under temperature inversions;
- compared the predicted noise levels with the target PSNLs determined for the Project in accordance with Section 10 of the INP (EPA, 2000);

- discussed the findings from the predictive noise model and 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 (EPA 2000); and

- provided details of the recommended noise monitoring program to be undertaken at noise sensitive locations for the duration of the Project.

The computer-based modelling software package Environmental Noise Model (ENM) was used to predict the noise levels produced by the Project in the surrounding environment.

Without control measures in place ongoing operation of Oberon Quarries could result in noise levels exceeding the target PSNLs of 35 dB(A) in the region surrounding the Project. Control measures that have been considered as a part of the ongoing operation of Oberon Quarries include:

- maintenance of the existing equipment and associated sound attenuation features;

- increasing the height of the earth-berm situated adjacent to the process plant area;

- attenuation of the crushing and screening plant;

- locating processing equipment or part thereof within the quarry area; and

- restricting operational speeds of the road haulage trucks as they enter and leave the site.

As a part of the development, Oberon Quarries is proposing to replace some of the existing crushing and screening plant and include an additional cone crusher. The replacement/new crushing and screening plant will be more energy efficient, produce fewer fines and result in an overall reduction in the environmental impacts of the operation. Oberon Quarries is also proposing to utilise a Finlay 150E Hydrasander or equivalent on the quarry floor to produce manufactured sand from 5 mm minus material. The screen/dewaterer will be located in an acoustically shielded position. While all other aspects of the existing quarry remain unchanged the purchase of replacement/new crushing and screening plant provides an opportunity to install equipment with lower overall sound power.

The quarry has been operating without noise complaints for many years however has been generating noise levels under certain non-significant meteorological conditions in excess of the target PSNL of 35 dB(A). Inclusion of new crushing and screening plant is estimated to reduce the existing noise at the nearby residential receivers by 3 dB to 6 dB when compared to the current operations.

Modelling indicates that during the day, evening and night time period noise levels will not exceed the target PSNL of 35 dB(A) under calm conditions or under conditions associated with significant wind conditions as defined by the INP (EPA, 2000) at all surrounding residences except for the following:

- Under non-significant 3 m/s westerly winds noise levels of up to 41 dB(A) may be experienced at Location 1 (Hackfath) during quarry operations and 42 dB(A) during quarry operations and product dispatch. This is a 1 dB reduction in noise levels from existing operations under the same non-significant wind conditions. Mr Hackfath has stated that he does not find existing noise levels intrusive.

- Under temperature inversion conditions with a 2 m/s southerly drainage flow product dispatch on the private quarry haul road during evening and night time periods could result in noise levels of 38 dB(A) at Location 5 (Langley Heights). It is noted there is a commercial agreement between Oberon Quarries and the owner of Location 5.

The INP (EPA, 2000) notes that when predicted noise levels exceed the target PSNL a range of strategies should be considered to reduce the noise impact on offsite receivers. The three main strategies for noise control are:

- controlling noise at the source;
- controlling the transmission of noise; and
- controlling noise at the receiver.

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). One of the outcomes from this process is to set project-specific noise criterion for the Project that allows Oberon Quarries to adapt to changes in the noise expectations of the community while remaining economically viable. The project-specific noise criterion would be based on the noise levels achievable following the implementation of the identified reasonable and feasible controls measures. Normally the project-specific noise criterion relates to the noise impacts associated with worst case meteorological conditions identified as significant, as defined by the INP (EPA, 2000). For property Location 1 – Hackfath the achievable project-specific noise criterion needs to also consider non-significant meteorological conditions.

The predicted received $L_{A1,1minute}$ noise levels associated with the ongoing night time activities meet the recommended sleep disturbance noise goals at all residential receivers. The predicted noise levels that approach the recommended sleep disturbance noise goal are specifically associated with the product trucks entering and leaving the site.

The assessment of the road traffic noise impact indicates the predicted road traffic noise levels associated with product trucks travelling to or from Oberon Quarries' operation do not exceed the day and night time road traffic noise criteria outlined in the NSW *Road Noise Policy* (DECCW, 2011).

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1.0 Introduction

Oberon Quarries Pty Limited (Oberon Quarries) has been producing crushed aggregates from a hard rock quarry at 'Langley Heights' (Oberon Quarry), approximately 4 km south of Oberon since 1995 (refer to **Figure 1.1**). Development consent for the quarry was granted subject to a range of conditions, on 1 October 1993 by the Minister for Planning, following a Commission of Inquiry.

Development consent (DA 92/164) for the quarry was originally granted (subject to a range of conditions) on 1 October 1993 by the Minister for Planning, following a Commission of Inquiry. The consent has been modified five times with the most recent modification extending the consent timeframe to 13 May 2016 (MOD 5).

In order to improve efficiency and environmental performance of the quarry operations and further the life of the quarry for extraction of proven reserves, Oberon Quarries is seeking consent to extend the life of the quarry DA 92/164 under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for an additional 30 years. The Project is declared to be a State Significant Development under the provisions of the State Environmental Planning Policy (State and Regional Development) 2011, and the Minister for Planning will be the consent authority for the development.

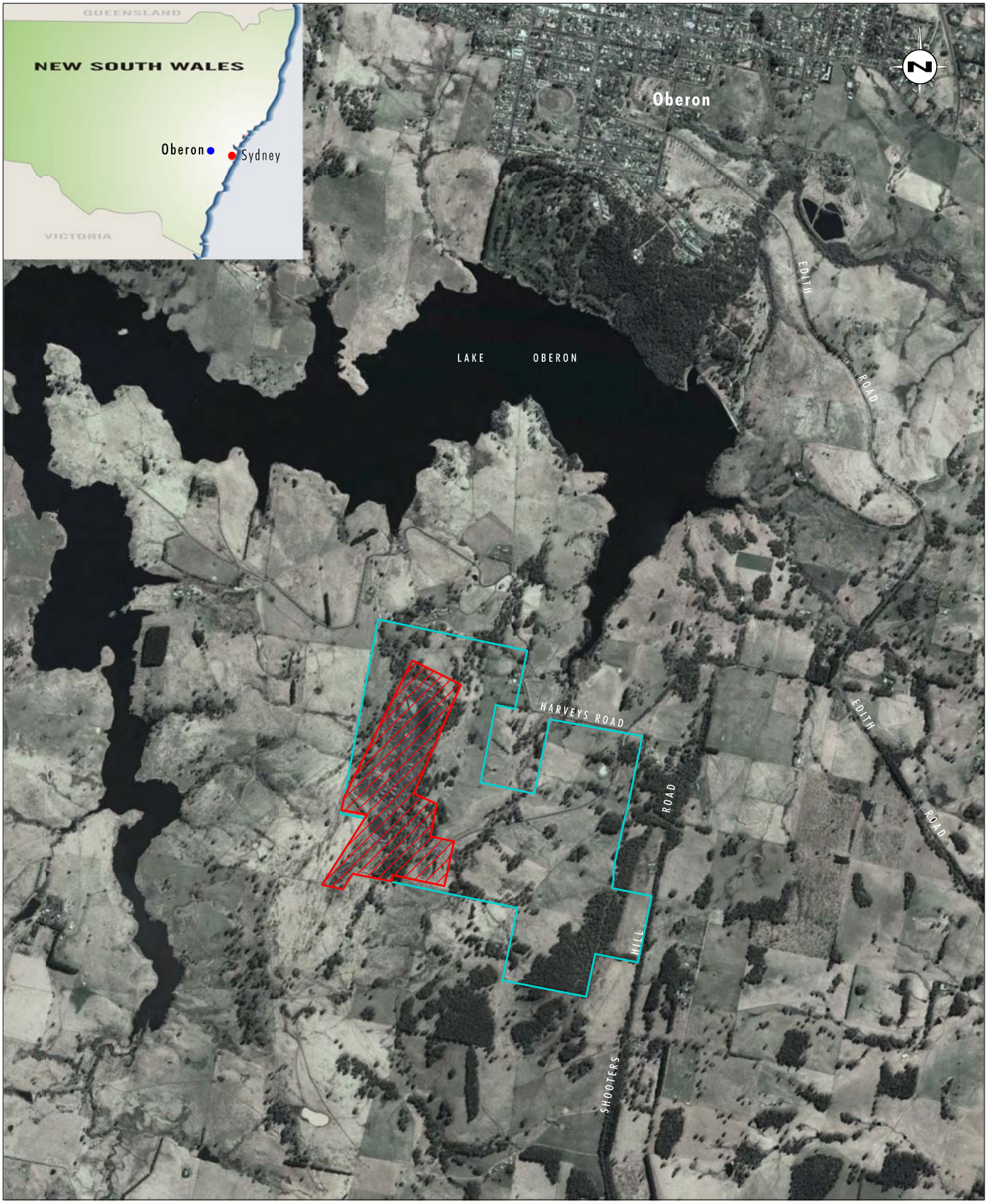
The Project represents the continuation of the existing quarry operations, which will remain substantially the same. As a part of the Project, Oberon Quarries proposes to replace some of the existing crushing and screening plant with modern plant, which is more energy efficient, produces less fines (a by-product of the crushing process) and results in lesser environmental impacts. Oberon Quarries also proposes to use a Finlay 150E Hydrasander or equivalent within the rim of the extraction area to produce manufactured sand from the 5 mm minus material. All other aspects of the approved quarry processing operations will remain unchanged.

This Noise Impact Assessment (NIA) has been prepared by Umwelt (Australia) Pty Limited in support of the development Application and Environmental Impact Statement (EIS) for the Project.

1.1 Project Description

1.1.1 Hours of Operation

The approved hours of operation at Oberon Quarry are dependent on the activity being undertaken and are detailed in **Table1.1**.



Source: Google Earth (2012)

0 0.5 1.0 1.5km

1:30 000

Legend

Project Area

Langley Heights Property

FIGURE 1.1

Locality Map

Table 1.1 – Approved Hours of Operation

Activity	Approved Hours of Operation
Quarrying and Processing Areas	7.00 am to 6.00 pm, Mondays to Fridays 7.00 am to 5.00 pm, Saturdays No quarrying or processing shall be undertaken on Sundays or public holidays.
Loading Haul Trucks	6.00 am to 10.00 pm, Mondays to Fridays 6.00 am to 5.00 pm, Saturdays No loading of haul trucks shall be undertaken on Sundays or public holidays.
Product Delivery	6.00 am to 10.00 pm, Mondays to Fridays 6.00 am to 5.00 pm, Saturdays No product delivery trucks are to enter the quarry prior to 6.00 am on any day. During the periods 6.00 am to 7.00 am and 6.00 pm to 10.00 pm a maximum of 4 laden delivery trucks shall leave the site per hour (total 8 truck movements per hour).
Construction of Haul Road and Quarry Infrastructure	7.00 am to 6.00 pm Mondays to Fridays 7.00 am to 4.00 pm Saturdays No construction shall be undertaken on Sundays or public holidays.
Maintenance	7.00 am to 6.00 pm Mondays to Fridays 7.00 am to 4.00 pm Saturdays.

1.2 Land Use and Ownership

The quarry is located in cleared land that is used for sheep and cattle grazing. Pasture in the area is mainly improved.

The location of the private residences and residences owned by Oberon Quarries or associated with Oberon Quarries are shown on **Figure 1.2**.

Image Source: Google Earth (2012)

0 0.25 0.5 1.0km
1:20 000

Legend

- Noise Monitoring Location
- Residential Receiver Location
- Residence Owned by Oberon Quarries or Associated with Quarry

FIGURE 1.2

Noise Monitoring and Residential Receiver Locations

2.0 Statutory Noise Requirements

2.1 Section 10 of the Industrial Noise Policy

Section 10 – Applying the policy to existing industrial premises of the Industrial Noise Policy (INP) (Environment Protection Authority (EPA), 2000) deals with application of the INP (EPA, 2000) to existing industrial noise sources such as Oberon Quarry. The approach established by the EPA in 2000 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. Oberon Quarry 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 EIS and supporting studies is to enable assessment of the proposed continuation of the existing quarry operations. The operations at the quarry will remain substantially the same. However, the Project will include some minor 'upgrade and/or expansion' to the site to account for changes/improvements in operating practices, equipment selection and product quality/demand.

3. The existing development consent for Oberon Quarries was granted in 1993. As a result, the management of the noise impacts is based around the expectation of the *Environmental Noise Control Manual* (EPA, 1985). In support of the development application for the continued operation of the quarry, Oberon Quarries will need to establish contemporary noise criteria for the site in accordance with the INP (EPA, 2000).

4. Based on Point 3 above, Oberon Quarries recognises that the quarry may not achieve contemporary project-specific noise levels as defined by the INP (EPA, 2000). However, Section 10 of the INP (EPA, 2000) notes that:

    - the project-specific noise levels (PSNL) should not be applied as mandatory noise limits;
    - the PSNLs supply the initial target levels and drive the process of assessing all feasible and reasonable control measures;
    - achievable noise limits result from applying all feasible and reasonable noise control measures; and
    - for a number of sites the achievable noise limits may sometimes be above the PSNL.

As noted in the INP (EPA, 2000), should there be noise complaints, the site may need to reduce its noise emissions progressively to achieve target project specific noise limits. Such

measures are typically set out in a noise reduction program attached as a licence condition to the sites Environment Protection Licence (EPL).

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 2.2**, 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 expectation of the INP (EPA, 2000).

With respect to the methodology outlined in **Section 2.2**, the PSNLs determined from the assessment of the underlying background and amenity noise levels in the receiver areas surrounding the Project, are not mandatory noise limits. The PSNLs provide the initial target levels that drive the process for assessing feasible and reasonable control measures. The achievable noise limits result from applying all feasible and reasonable control measures to the operation.

2.2 Methodology

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

- identified noise sensitive locations likely to be affected by activities at the site and estimated the existing background and amenity noise levels at representative locations in accordance with the INP (EPA, 2000) (refer to **Section 3.0**);
- determined the target PSNLs for the Project based on the estimation of the 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 predictive noise model so as to provide a true representation of actual noise levels (refer to **Sections 4.0**, **5.0** and **6.0**);
- compared the predicted noise levels with the target PSNLs determined for the Project (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 noise modelling and, where predicted noise levels exceeded the relevant PSNL, recommended additional mitigation measures to be applied to the Project (refer to **Sections 5.0** and **6.0**);
- 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 (EPA, 2000) (refer to **Sections 3.0**, **5.0**, **6.0** and **7.0**); 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 produced by the Project in the surrounding environment. The ENM noise models were based on machine and plant sound power level data obtained from Oberon Quarries 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 Oberon Quarries.

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 noise monitoring results obtained for the existing operation. 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 PSNLs 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 PSNLs, 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

Due to the rural nature of the area surrounding the Project it can be reasonably assumed that the existing background level is at or below 30 dB(A). In addition to this, there are no other industrial noise sources in the 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 intrusive and amenity criteria. Where the intrusive criteria is less than or equal to the amenity criteria, the intrusive 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** and the achievable noise limits are discussed in **Section 7.0**.

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 amenity 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 (Tables 2.1 and 2.2 in the INP (EPA, 2000) are reproduced in **Appendix B**).

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 levels 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. That is, the amenity criterion would be:

- 40 dB(A) for product truck loading and haulage on the private access road prior to 7.00 am (8.00 am Sunday);
- 50 dB(A) for the operation of the quarry and product truck loading during the day time (7.00 am – 6.00 pm Monday to Saturday, 8.00 am – 6.00 pm Sunday); and
- 45 dB(A) for product truck loading during the evening period (6.00 pm – 10.00 pm).

3.3 Project-specific Noise Levels

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

3.4 Sleep Disturbance Criteria

The EPA notes that the INP (EPA, 2000) does not specifically address sleep disturbance from high noise level events and has provided an Application Notes (EPA June 2013), which references the review of research on sleep disturbance published in the NSW Road Noise Policy (DECCW, 2011). The INP Application Notes suggests that to prevent sleep disturbance, the $L_{A1,1\ minute}$ or $L_{A\ max}$ 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 INP Application Notes further explains that other factors are also important in assessing the extent of impact on sleep and, 'that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required'.

The sleep disturbance criteria for all identified noise sensitive locations is 45 dB(A).

The INP Application Notes state that the sleep disturbance criteria are normally assessable for the night time period only (10:00 pm to 7:00 am).

3.5 Construction Noise Criteria

There is no proposed construction activities associated with the Project.

3.6 Road Traffic Noise Criteria

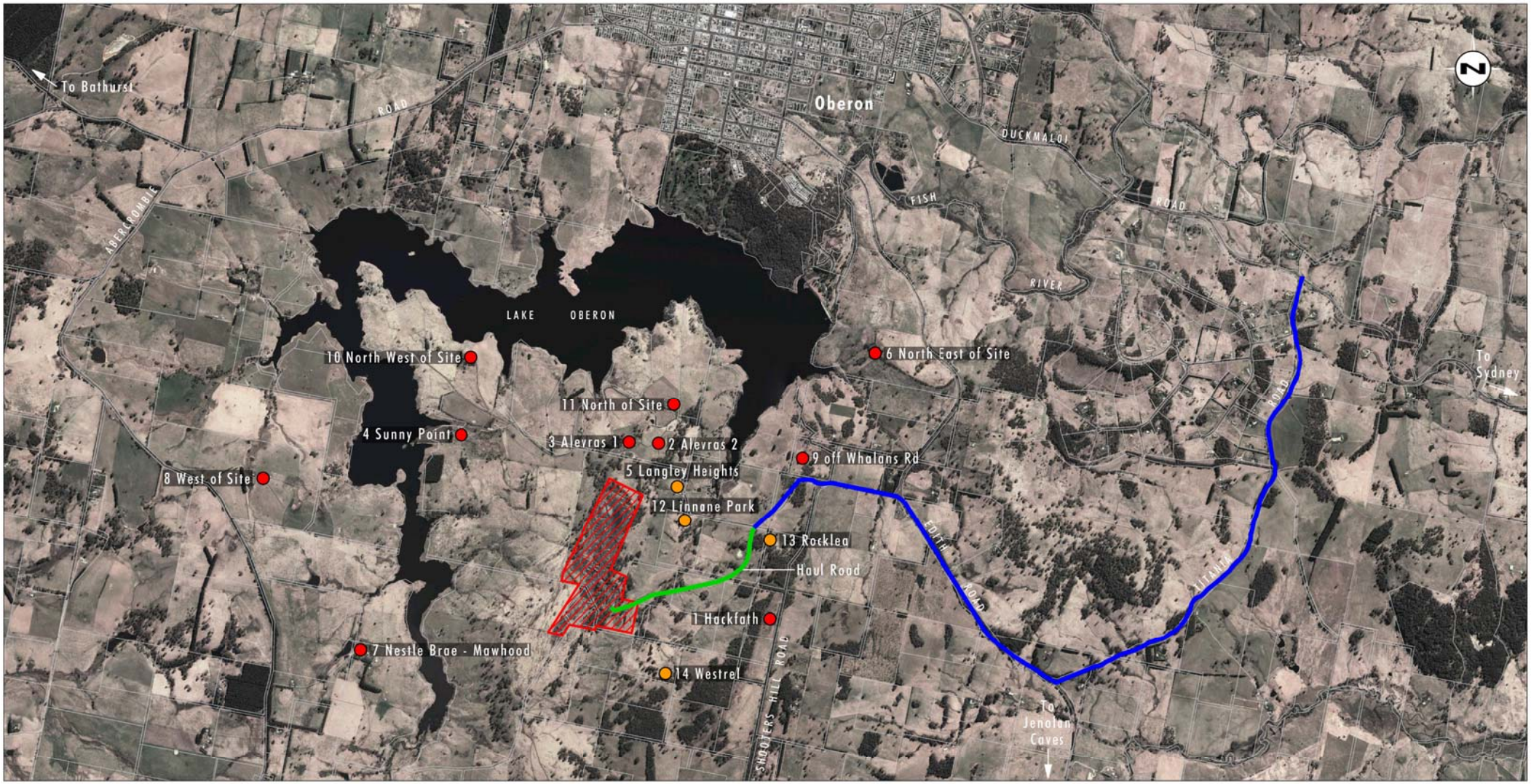
The DECCW's (now OEH's) *NSW Road Noise Policy* (DECCW, 2011) sets out criteria for road traffic noise through the provision of a framework that addresses traffic noise issues associated with new developments, new or upgraded road developments or planned building developments. While the proposed Project represents a continuation of existing operations, in keeping with the expectations of Section 10 on the INP (EPA, 2000), the road traffic noise from the existing operations have been assessed against the expectation of the *NSW Road Noise Policy* (DECCW, 2011).

Table 3.2 outlines the criteria relevant for the two way traffic volumes due to the Project along Oberon Quarry Road, Shooters Hill Road, Edith Road and Titania Road, the primary access route to Oberon Quarries (refer **Figure 3.1**). Product trucks on the quarry access road are assessed as industrial noise sources associated with the quarry.

Table 3.2 – Road Noise Criteria, dB(A)

Road Category	Type of Project/ Land use	Assessment criteria – dB(A)	
		Day (7 am – 10 pm)	Night (10 pm – 7 am)
Freeway/arterial/sub-arterial roads (i.e. Edith Road and Titania Road)	Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	$L_{Aeq, (15\ hour)}$ 55 (external)	$L_{Aeq, (9\ hour)}$ 50 (external)
	Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	$L_{Aeq, (15\ hour)}$ 60 (external)	$L_{Aeq, (9\ hour)}$ 55 (external)
	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments		
Local roads (i.e. Shooters Hill Road)	Existing residences affected by noise from **new** local road corridors	$L_{Aeq, (15\ hour)}$ 55 (external)	$L_{Aeq, (9\ hour)}$ 50 (external)
	Existing residences affected by noise from **redevelopment** of existing local roads		
	Existing residences affected by **additional traffic** on existing local roads generated by land use developments		

Source: *NSW Road Noise Policy* (DECCW, 2011)



Source: Resource Planning (1992)

Legend

- Project Area
- Private Haul Road
- Haulage Route on Public Roads
- Residential Receiver Location
- Residence Owned by Oberon Quarries or Associated with Quarry

FIGURE 3.1

Product Delivery Road Transport Route

4.0 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 equipment (or their equivalent) that the quarry will normally 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 quarry operations and product dispatch.

A number of operational scenarios were modelled to determine the worst-case operational noise impacts from the ongoing operation of the quarry. The components of the operational scenarios that were included in the noise assessment were:

1. Full operation of the process plant (crush and screening, and stockpiling product); and
2. Quarrying activities occurring in the northern extension of the pit; or
3. Quarrying activities occurring in the southern extension of the pit; and
4. Loading of product trucks; and
5. Product trucks on the quarry access road.

It is understood that the loading and dispatch of product trucks as a stand-alone activity represents the worst-case scenario for evening and night-time activities as quarrying activities and operation of the process plant would only occur during the daytime.

4.2 Operational Noise Sources

Noise source models were prepared to represent the type of equipment currently in use at Oberon Quarries. Throughout the life of the Project equipment with the sound power levels (SWL) outlined in **Table 4.1**, or the equivalent, will be in use around the project area.

Table 4.1 – Modelled Equipment SWL, dB(A)

Equipment	SWL, dB(A)
Product dispatch truck	110
Haul truck – CAT 769C	114
Excavator – CAT 330L	105
Excavator – CAT 345B	108
Dozer – CAT D8N	110
Finlay 150E Hydrasander	115
Front End Loader – CAT 980H	111
Quarry Processing Plant	116

4.3 Road Traffic Noise

The road noise impacts associated with traffic movements generated by the Project were modelled using the *U.S. 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.

Trucks travelling from Oberon Quarries to Western Sydney and Oberon utilise the private haul road, which connects to Oberon Quarry Road and then Shooters Hill Road, Edith Road and Titania Road, which form part of the public main road system. Sydney and Oberon bound trucks then travel via Titania Road, which is a designated heavy vehicle road, and then via Duckmaloi Road in the direction of either Sydney or Oberon township.

The road traffic noise impacts were modelled at set back distances of 60 m, 110 m and 250 m from the centre line of Oberon Quarry Road, Shooters Hill Road, Edith Road and Titania Road which represent the minimum, tenth percentile and average set back distance along the road transport route used to distribute product from the quarry.

4.4 Receivers

The Single Point Calculation module of ENM was used to predict the noise impacts of the Project at 11 receiver locations surrounding the project area indentified in **Table 4.2** and shown on **Figure 1.2**.

Table 4.2 – Receiver Locations

ID	Owner Name/Location	Easting	Northing	Comment
1	Hackfath	765158	6262213	Noise monitoring location NM1
2	Alevras 2	764244	6263646	Noise monitoring undertaken at NM4 (i.e. gate and back calculated to NM2)
3	Alevras 1	764005	6263656	Noise monitoring undertaken at NM4 (i.e. gate and back calculated to NM3)
4	Sunny Point	762633	6263714	-
5	Langley Heights [1]	764396	6263293	Commercial agreement in place
6	North East of Site	766021	6264384	-
7	Nestle Brae	761805	6261925	-
8	West of Site	761015	6263361	-
9	off Oberon Quarry Road	765425	6263525	-
10	North West of Site	762712	6264351	-
11	North of Site	764367	6263964	-

Note: 1 Commercial agreement in place with Oberon Quarries

Oberon Quarries has a commercial agreement in place with Property 5. There are also three other properties (i.e. Property 12 – 'Linnane Park', Property 13 – 'Rocklea' and Property 14 – 'Westrel') which are owned by Oberon Quarries or related parties and have not been included in the NIA.

4.5 Meteorological Conditions

Section 5 of the INP (EPA, 2000) notes that there are two approaches for the assessment of meteorological (including gradient winds and temperature inversions) effects on the propagation of noise 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 the presence of weather conditions that would be expected to occur at a particular site for a significant period of time.

Default INP wind conditions were initially used in the modelling of the predicted noise levels. This approach assumes that source-to-receiver gradient winds are present for a significant amount of time. As noted in the INP (EPA, 2000), this conservative approach predicted potential noise impacts that would be above the project-specific noise criteria.

To enable a more detailed assessment of meteorological effects, the availability of local meteorological data was investigated. It was found that there were no representative weather stations in proximity to the quarry. To address this, pDs Consultancy was engaged to compile a representative meteorological data set using TAPM V4. This data was analysed to determine the likely frequency of occurrence of prevailing winds and temperature inversions. The detailed analysis of the meteorological data and windroses prepared by pDs Consultancy are provided in **Appendix C**. The windroses indicate the presence of prevailing seasonal wind conditions that create vectored source-to-receiver winds for a significant period of time (i.e. greater than 30% of the time). The frequency of occurrence of the dominant prevailing seasonal wind conditions, as indicated by the windroses, is presented in **Table 4.3**.

Table 4.3 – Frequency of Occurrence of Prevailing Seasonal Winds

Season	Wind Direction	Frequency of Occurrence (%)			
		Calm	0.76 m/s to 1.5 m/s	1.5 m/s to 3 m/s	> 3 m/s
Day-time					
Summer	ENE to ESE	1.6	2.1	23.9	19.5
Autumn	E to SE	1.8	4.7	23.8	10.1
Spring	W to NW	0.3	0.3	14.1	27.6
Evening					
Summer	E to ESE	0.8	2.2	29.9	21.2
Autumn	E to ESE	1.6	5.7	35.6	7.6
Winter	SSW to WSW	0.0	1.1	16.8	23.1
Spring	SW to W	0.3	2.5	17.3	13.8
Night					
Summer	ENE to ESE	0.1	2.3	37.9	16.1
Autumn	ENE to ESE	0.7	6.8	26.3	10.4
Spring	W to NW	0.5	0.4	15.4	9.5

The results of the wind analysis indicate the presence of vectored source-to-receiver winds occurring up to or greater than 30% of the time during summer and autumn day-time period; during the evening period for all seasons; and during the summer, autumn and spring night-time period. The vectored winds are components of the prevailing winds identified in **Table 4.3**. Therefore, as part of the noise assessment the following prevailing wind scenarios, identified as significant in accordance with the INP (EPA, 2000), have been considered:

- 3 m/s east-north-easterly to east-south-easterly winds during the summer day-time, evening and night-time periods;
- 3 m/s easterly to south-easterly wind during the autumn day-time, evening and night-time periods;
- 3 m/s south-west to westerly wind during the winter evening period; and
- 3 m/s south-west to westerly wind during the spring evening and night-time periods.

The analysis of the available meteorological data/windroses indicates the presence of vectored winds from the west to north-west occurring in the day-time during winter and spring. As defined by the INP (EPA, 2000), the occurrence of these conditions is not considered significant. However, observations during site visits indicate the presence of west to north-westerly winds during the day-time at the wind speeds typically around 2 m/s. The available meteorological data/windroses indicate wind speeds up to 3.0 m/s are likely however they occur less than 15% of the time. A west to north-west wind (vectored or direct) represents a worst case source to receiver wind to the closest receiver (Location 1 – Hackfath). The predicted noise impacts at 2 to 3 m/s are likely to represent a worst case and potentially overstate the impact on the Location 1 – Hackfath. Notwithstanding this, the noise assessment (refer to **Section 6.0**) also considers the following non-significant meteorological conditions for the 7.00 am to 6.00 pm day-time period:

- 2.0 and 3.0 m/s westerly wind during the winter and spring day-time period.

The ongoing quarrying and processing operations would not be undertaken during the evening or night-time periods. During the night time period between 6.00 am to 7.00 am and the evening period from 6.00 pm to 10.00 pm operations at the quarry would be limited to product delivery (i.e. a maximum of four laden delivery trucks could be dispatched from the site per hour (a total eight truck movements per hour)). These operational restrictions are consistent with the 1993 development consent and current operational practices undertaken at the quarry.

Depending on the time of year, inversion conditions could be present during the night time period from 6.00 am to 7.00 am and the later part of the evening period. The analysis of the meteorological data prepared by pDs Consultancy indicates F to G class stability conditions could occur over the winter evening and night-time periods approximately 40% of the time. From Shooters Hill Road the access road to the quarry runs through a valley where drainage flow from the south to the north would naturally occur. Therefore as part of the noise assessment the following winter meteorological condition will also be considered for the 6.00 am to 7.00 am period of the night time and the evening period:

- F class stability with a 2 m/s southerly drainage flow (i.e. towards Lake Oberon) winter night-time (6.00 am to 7.00 am) and evening periods.

5.0 Predicted Impacts

5.1 Operational Noise Levels

5.1.1 Predicted Noise Levels

ENM's Single Point calculation feature was used to determine noise levels from the ongoing operation of the quarry at the nearest residential receiver locations identified in **Section 4.4**, under the meteorological conditions described in **Section 4.5**.

Table 5.1 presents the predicted operational noise levels for the ongoing operation of the quarry with quarrying activities occurring in either the northern extension or the southern extension of the pit respectively. The operational scenarios discussed in **Section 4.1** associated with full operation of the process plant and the loading and dispatch of product trucks has been considered in combination with the two quarrying scenarios (i.e. quarrying occurring in the Northern extraction area and quarrying occurring in the Southern extraction area).

In **Tables 5.1** the predicted operational noise levels for the Oberon Quarry have been compared with a target Project-specific Noise Levels for each receiver location of 35 dB(A).

5.1.2 Control Measures

The EIS is seeking approval for the continued operation of Oberon Quarries to allow for the continued extraction of the remaining 10 million tonnes of basalt reserves. The predicted noise levels in **Table 5.1** are based on the sound power levels, presented in **Section 4.2**, which represent the equipment currently in use at Oberon Quarries. For the continued operation of the quarry it has been assumed that the equipment will be well maintained and operated in accordance with the manufacture's recommendations. Notwithstanding this, the results in **Table 5.1** indicate the ongoing operation of Oberon Quarries could result in noise levels exceeding a target PSNL of 35 dB(A).

Table 5.1 – Predicted Operational Noise Levels – Existing Quarry Operations and Equipment under Significant Meteorological Conditions, dB(A)

Modelled Scenario		**Calm Neutral**		**Summer Day**		**Autumn Day**	
Met Condition		**0 m/s Calm**		**3 m/s ENE – ESE [1]**		**3 m/s E – ESE [1]**	
ID	Owner Name	Quarry	Quarry + Product Delivery	Quarry	Quarry + Product Delivery	Quarry	Quarry + Product Delivery
Quarrying in Northern Extraction Area							
1	Hackfath	33	34	31	32	30	31
2	Alevras 2	26	27	25	30	25	30
3	Alevras 1	27	28	29	30	29	30
4	Sunny Point	-	-	30	30	30	30
5	Langley Heights [2]	28	32	27	35	27	35
6	North East of Site	-	-	-	-	-	-
7	Nestle Brae	-	-	35	35	35	35
8	West of Site	-	-	32	32	32	32
9	off Oberon Quarry Road	-	25	-	-	-	-
10	North West of Site	-	-	26	26	26	26
11	North of Site	-	-	-	27	-	27

Table 5.1 – Predicted Operational Noise Levels – Existing Quarry Operations and Equipment under Significant Meteorological Conditions, dB(A) (cont)

Modelled Scenario		Calm Neutral		Summer Day		Autumn Day	
Met Condition		0 m/s Calm		3 m/s ENE – ESE [1]		3 m/s E – ESE [1]	
ID	Owner Name	Quarry	Quarry + Product Delivery	Quarry	Quarry + Product Delivery	Quarry	Quarry + Product Delivery
Quarrying in Southern Extraction Area (when equipment is operating on top of Racecourse Hill)							
1	Hackfath	35	36	32	33	32	33
2	Alevras 2	-	25	-	29	-	29
3	Alevras 1	-	-	-	27	-	27
4	Sunny Point	-	-	39	39	39	39
5	Langley Heights [2]	25	31	26	34	26	34
6	North East of Site	-	-	-	-	-	-
7	Nestle Brae	-	-	36	36	35	36
8	West of Site	-	-	34	34	34	34
9	off Oberon Quarry Road	26	26	24	25	24	25
10	North West of Site	-	-	33	33	33	33
11	North of Site	-	-	-	26	-	26

Notes: 1 Results for directions quoted as a range are the maximum noise level experienced by a receiver within that range of wind directions.
2 Commercial agreement in place with resident.
- Predicted noise level less than 25 dB(A).

Control measures that have been considered as a part of the ongoing operation of Oberon Quarries include:

- maintenance of the existing equipment and associated sound attenuation features including mufflers, sound suppression lining of equipment and equipment locations/orientation;
- increasing the height of the earth-berm situated along the eastern extent of the process plant area;
- attenuation of the crushing and screening plant through the construction of a partial building on the eastern side of the plant;
- location of processing equipment or part thereof within the quarry area;
- minimising equipment located on the top of the quarry extraction area during adverse meteorological conditions; and
- operational speeds of the road haulage trucks as they enter and leave the site.

Of the above noise control measures, the maintenance of the existing sound suppression features on existing equipment and the management of road haulage trucks have been considered as a part of the ongoing operation of the existing quarry. As a part of the proposed development, Oberon Quarries is proposing to replace some of the existing crushing and screening plant and include an additional cone crusher.

The replacement/new crushing and screening plant will be more energy efficient, produce fewer fines and result in an overall reduction in the environmental impacts of the operation. While all other aspects of the existing quarry operation remain unchanged, the purchase of replacement/ new crushing and screening plant provides an opportunity to install equipment with lower overall sound power.

Table 5.2 presents the predicted operational noise levels for the quarry with new crushing plant that has a SWL 6 dB less than the existing equipment and screening plant that has a SWL 3 dB less than the existing equipment.

Table 5.2 – Predicted Operational Noise Levels – New Attenuated Crushing and Screening Plant under Significant Meteorological Conditions, dB(A)

Modelled Scenario		**Calm Neutral**		**Summer Day**		**Autumn Day**	
Met Condition		**0 m/s Calm**		**3 m/s ENE – ESE [1]**		**3 m/s E – ESE [1]**	
ID	Owner Name	Quarry	Quarry + Product Delivery	Quarry	Quarry + Product Delivery	Quarry	Quarry + Product Delivery
Quarrying in Northern Extraction Area							
1	Hackfath	31	33	29	31	28	30
2	Alevras 2	-	26	-	30	-	30
3	Alevras 1	25	25	26	28	26	28
4	Sunny Point	-	-	27	27	27	27
5	Langley Heights [2]	26	31	-	34	-	34
6	North East of Site	-	-	-	-	-	-
7	Nestle Brae	-	-	32	32	31	31
8	West of Site	-	-	29	29	29	29
9	off Oberon Quarry Road	-	-	-	-	-	-
10	North West of Site	-	-	-	25	-	25
11	North of Site	-	-	-	26	-	26
Quarrying in Southern Extraction Area (when equipment is operating on top of Racecourse Hill)							
1	Hackfath	33	34	30	32	29	31
2	Alevras 2	-	-	-	29	-	29
3	Alevras 1	-	-	-	26	-	26
4	Sunny Point	-	-	35	35	35	35
5	Langley Heights [2]	-	30	-	34	-	34
6	North East of Site	-	-	-	-	-	-
7	Nestle Brae	-	-	34	34	34	34
8	West of Site	-	-	31	31	31	31
9	off Oberon Quarry Road	-	-	-	-	-	-
10	North West of Site	-	-	30	30	30	30
11	North of Site	-	-	-	26	-	26

Notes: 1 Results for directions quoted as a range are the maximum noise level experienced by a receiver within that range of wind directions.
2 Commercial agreement in place with resident.
- Predicted noise level less than 25 dB(A).

The results in **Table 5.2** show a reduction in the noise impacts from the quarry operations when compared to the predicted noise impacts in **Table 5.1**. As can be seen by comparing results in **Tables 5.1** and **5.2**, under worst case significant meteorological conditions the replacement of existing crusher and screens as proposed is predicted to reduce noise levels by approximately up to 4 dB.

Modelling of operations in the Southern Extraction Area as set out in **Table 5.2**, include extraction equipment operating on top of Racecourse Hill. This will only occur for short periods while the top extraction bench is opened up. During the majority of quarry operations, the time the extraction equipment will be operating below the top of the hill and will be acoustically shielded from surrounding receivers. Once the extraction bench is opened up and equipment is operating at a level below the surface, noise levels at Nestle Brae and Sunny Point will be approximately 2 dB(A) lower and consistent with noise levels for the northern extraction area as shown in **Table 5.1**.

5.1.3 Product Dispatch

While the quarry and processing area would only continue to operate during the day-time, road haulage trucks will continue to access the site from 6.00 am to 7.00 am during the night-time period and from 6.00 pm to 10.00 pm during the evening. It is proposed that up to a maximum of four laden delivery trucks could be dispatched from the site per hour (a total eight truck movements per hour).

Table 5.3 presents the predicted noise levels from the road haulage trucks as they enter the site, are loaded with product and then leave the site. ENM's Single Point calculation feature was used to determine noise levels from the road haulage trucks at the nearest residential receiver locations identified in **Section 4.4**, under the meteorological conditions described in **Section 4.5**.

Table 5.3 – Predicted Noise Levels for Delivery Trucks, dB(A)

Modelled Scenario		Calm Neutral	Summer Evening	Autumn Evening	Winter Evening	Winter Evening/Night	Spring Evening
Met Condition		0m/s Calm	3m/s E – SE [1]	3m/s E – ESE [1]	3m/s SW – W [1]	F Class Stability 2m/s Southerly Drainage Flow	3m/s WSW
ID	Owner Name	Product Dispatch	Product Dispatch	Product Dispatch	Product Dispatch	Product Dispatch	Product Dispatch
1	Hackfath	29	-	25	33	34	33
2	Alevras 2	-	-	-	-	33	-
3	Alevras 1	-	29	27	-	25	-
4	Sunny Point	-	-	-	-	-	-
5	Langley Heights [2]	30	34	33	30	38	30
6	North East of Site	-	-	-	-	27	-
7	Nestle Brae	-	-	-	-	-	-
8	West of Site	-	-	-	-	-	-
9	off Oberon Quarry Road	-	-	-	29	33	29
10	North West of Site	-	-	-	-	-	-
11	North of Site	-	25	-	-	30	-

Notes: 1 Results for directions quoted as a range are the maximum noise level experienced by a receiver within that range of wind directions.
2 Commercial agreement in place with resident.
- Predicted noise level less than 25 dB(A).

5.1.4 Summary of Findings

With the control measures discussed in **Section 5.1.2** above in place, the number of potential exceedances of the target PSNL of 35 dB(A) for the day-time activity in **Table 5.2** and for the night-time/evening activities in **Table 5.3** are summarised in **Table 5.4**.

Table 5.4 – Summary of Predicted Day-time Activity Noise Impacts

Maximum Level of Exceedance	Private Residences (Receiver No.) with Predicted Exceedance of PSNL		
	Day [1]		Evening and Night [2]
	Northern Extraction Area	Southern Extraction Area	
> 36 to 38 dB(A)	-	-	5 [3]
> 38 to 40 dB(A)	-	-	-

Notes: 1 Summary of results in **Table 5.2**.
2 Summary of results in **Table 5.3**.
3 Commercial agreement in place with resident.

Section 10 of the INP (EPA, 2000) notes that when the predicted noise impacts exceed the target Project-specific Noise Levels, noise mitigation strategies should be assessed. The control measures outlined above in **Section 5.1.2** address noise control at the source. The INP (EPA, 2000) also outlines a range of strategies for the control of the transmission of the noise and control of the noise at the receiver. The strategies that have been considered for the Project include:

- Controlling noise at the source through the elimination of noisy equipment and relocating equipment or re-orienting equipment to reduce the noise impacts. Where practical, this has been included in the control measures outlined above in **Section 5.1.2** and includes the use of new attenuation crushing plant and screening plant, and the maintenance of equipment. Other potential changes to the key noise sources include changing the location of the primary crushing plant to a location within the quarry and the installation of fixed noise control barriers around the existing crushing and screening plant were found to be not feasible.

- Controlling the transmission of noise through the construction of additional noise barriers along the eastern side of the processing area to further manage noise impacts from this area. While investigated and considered as a possible alternative, it was determined the construction of a noise barrier was not feasible as it would have to be in excess of 4 m high to be effective. Further raising of the existing bund for construction of a 4 m high wall on the existing bund is not considered feasible.

- Controlling noise at the receiver has not been investigated as a part of this assessment apart from recognising that Oberon Quarries has a commercial agreement in place with land identified as residential receiver Location 5 – Langley Heights.

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 6.00 am to 7.00 am period of the night-time that could lead to sleep disturbance include:

- public road haul trucks entering and leaving the site;
- CAT 980H Loader - working around stockpile area loading trucks; and
- reversing beepers.

The predicted $L_{A1,1minute}$ noise levels associated with these ongoing activities within the night period (6.00 am–7.00 am) are unlikely to lead to sleep disturbance in the nearby residential locations.

The predicted received $L_{A1,1minute}$ noise levels associated with the ongoing night-time activities are presented in **Table 5.5**.

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

Modelled Scenario		Calm Neutral 0 m/s Calm	Adverse Conditions F Class Stability or Gradient Wind	Sleep Disturbance Noise Goal $L_{A1,1minute}$
ID	Owner Name			
1	Hackfath	37	42	45
2	Alevras 2	29	37	45
3	Alevras 1	33	39	45
4	Sunny Point	< 25	27	45
5	Langley Heights [2]	39	44	45
6	North East of Site	< 25	33	45
7	Nestle Brae	< 25	24	45
8	West of Site	< 25	21	45
9	off Oberon Quarry Road	27	37	45
10	North West of Site	< 25	25	45
11	North of Site	26	38	45

Note: 1 Commercial agreement in place with resident.

The predicted noise levels in **Table 5.5** meet the recommended sleep disturbance noise goals outlined in **Section 3.4** at all residential receiver. The predicted noise levels that approach the recommended sleep disturbance noise goal are specifically associated with the product trucks entering and leaving the site.

5.3 Road Traffic Noise Impacts

Assessment of the road traffic noise impact of the Project has been conducted at three setback distances representative of the residential receivers likely to be influenced by movement of product trucks travelling to or from Oberon Quarry along Oberon Quarry Road, Shooters Hill Road, Edith Road and Titania Road. The road traffic noise impacts were modelled at setback distances of 60 m, 110 m and 250 m from the centre line of Oberon Quarry Road, Shooters Hill Road, Edith Road and Titania Road. Predictions were based on

a maximum of eight truck movements per hour, an average speed on Shooters Hill Road, Edith Road and Titania Road of 100 km/h with no noise barriers included in the traffic noise prediction model. The results of traffic noise modelling are presented below in **Table 5.6.**

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

Receiver	Setback Distance, m	Period	Assessment Criteria, $L_{Aeq,1\ hour}$	Traffic Noise Levels, $L_{Aeq,1\ hour}$
Oberon Quarry Road, Shooters Hill Road, Edith Road, Titania Road	60	Day	55	47
		Night	50	
	110	Day	55	43
		Night	50	
	250	Day	55	36
		Night	50	

The results presented in **Table 5.6** indicate the predicted road traffic noise levels associated with product trucks travelling to or from Oberon Quarries' operations do not exceed the day and night time road traffic noise criteria outlined in the NSW *Road Noise Policy* (DECCW, 2011) presented in **Table 3.2**.

6.0 Non-Significant Meteorological Conditions

When assessing noise impacts, the INP (EPA, 2000) notes that the project-specific noise levels are expected to apply under weather conditions characteristic of an area. The INP (EPA, 2000) notes that these conditions may include calm, winds and temperature inversions.

Wind is considered to be a significant feature where source-to-receiver vectored wind speeds (at 10 m height) of 3 m/s or below occur for 30% of the time or more in any assessment period (day, evening, night) in any season. The INP (EPA, 2000) states in Section 5.2:

> Where there is 30 per cent or more occurrence of wind speeds below 3 m/s (source-to-receiver component), then use the highest wind speed (below 3 m/s) instead of the default.
>
> Where there is less than a 30 per cent occurrence of wind of up to 3 m/s (source-to-receiver component), wind is not included in the noise-prediction calculation.

When assessing a development, the noise levels predicted under significant meteorological conditions for each receiver are compared with the project-specific noise levels, to establish whether the meteorological effect will cause an impact.

However, when assessing noise compliance, an Environment Protection License (EPL) typically notes that the project noise limits/criteria are expected to apply under weather conditions characteristic of an area (i.e. not just significant conditions). A typical EPL noise condition would state:

L3.2 The noise emission limits identified in condition L3.1 apply under meteorological conditions of:

- Wind speed up to 3 m/s at 10m above ground level; or
- Temperature inversion conditions of up to 3^0 C/100 m and wind speed up to 2 m/s at 10 m above ground level.

That is, the noise criteria applies to all wind conditions up to and including 3 m/s that were potentially not assessed as a part of the development application.

The Oberon Quarry EPL 4442 makes no reference to the applicability of the meteorological conditions with the clauses regarding noise limited to the following:

L3.1 Noise from the premises must not exceed:

a) 36 dB(A) LAeq(15 minute) during the day (7 am to 6 pm) Monday to Friday and 7.00 am to 5.00 pm Saturday ; and

b) 35 dB(A) LAeq(15 minute) during the evening (6 pm to 10 pm) Monday to Friday; and

c) at all other times 35 dB(A) LAeq (15 minute), except as expressly provided by this licence.

Where LAeq means the equivalent continuous noise level – the level of noise equivalent to the energy-average of noise levels occurring over a measurement period.

L3.2 To determine compliance with condition(s) L6.1 noise must be measured at, or computed for, any affected noise sensitive location(s) (such as a residence, school or hospital). A modifying factor correction must be applied for tonal, impulsive or intermittent noise in accordance with the "Environmental Noise Management - NSW Industrial Noise Policy (January 2000)".

Without appropriate qualification, it is could be assumed that the noise criteria applies to all wind conditions. The cut off wind speed in the INP (EPA, 2000) for the assessment of meteorological conditions is 5 m/s for gradient (actual) wind and 3 m/s for the vectored source to receiver component of a gradient wind. The cut off wind speed for the assessment of compliance is typically an actual wind speed of 3 m/s.

It is unusual to have an exclusion when assessing compliance for non-significant wind conditions where the occurrence of vectored source-to-receiver component of wind is less than 30% of the total period in any season. Therefore, it is reasonable to assume that the noise criteria applies to all wind conditions up to and including wind speeds of 3 m/s.

The analysis of the meteorological data/windroses indicates the highest occurrence of day-time westerly source-to-receiver (quarry to Hackforth) winds occurs during spring. This analysis indicates the presence of:

- a westerly vectored wind up to a maximum of 28% of the day-time during spring. The main source of the vectored wind in spring is from the west-south-westerly to north-westerly winds between 3 to 5 m/s; and

- a gradient wind up to 3 m/s from the west occurring only 6% of the time during spring. Winds from the west-south-westerly through to the west-north-westerly up to 3 m/s occur approximately 14% of the time during spring.

That is, all the wind conditions less than 5 m/s that can create 3 m/s source-to-receivers winds during the day-time are non-significant (i.e. occur less than 30% of the time). Under the INP (EPA, 2000) these conditions do not need to be assessed. However, under a contemporary EPL the licence noise limits apply for all wind conditions up to and including 3 m/s (actual, not vectored).

It is important to note that the analysis of vectored winds is for assessment purposes only. Vectored winds are made up of actual winds from a number of different directions. Therefore, in reality, the frequency of an actual source to receiver wind may be significantly less than the assessed vectored source to receiver wind frequency. In the case of the Hackfath property, the frequency of actual source-to-receiver wind (a westerly up to 3 m/s) during the day-time is less than 6% of the time. However, the summation of winds up to 3 m/s in the westerly quadrant is approximately 14% of the time and could result in predicted higher noise levels at the Hackfath property.

In **Table 6.1** the noise impacts associate with the propagation of noise from the quarry to the Hackfath property has been considered for two non-significant wind conditions; 2.0 m/s westerly and 3.0 m/s westerly.

Table 6.1 – Predicted Operational Noise Levels – NM1 Hackfath Property

Met Condition		0 m/s Calm		2.0 m/s westerly		3.0 m/s westerly	
ID	Quarry Operations	Quarry	Quarry + Product Delivery	Quarry	Quarry + Product Delivery	Quarry	Quarry + Product Delivery
Existing Quarrying Operations							
1	Northern Extraction Area	34	35	40	40	42	42
1	Southern Extraction Area	36	36	41	41	42	43
Proposed Quarrying Operations							
1	Northern Extraction Area	32	34	38	38	41	41
1	Southern Extraction Area	34	35	39	40	41	42

Noise limits are set based on the higher of the predicted noise levels for calm or applicable significant wind conditions. Monitoring against noise limits can occur during any condition including calm, significant or non-significant wind conditions (i.e. where the 3 m/s source-to-receivers vectored wind occur less than 30% of the time).

If a development complied during calm or significant wind conditions, it does not necessarily mean it would comply during non-significant wind conditions. At the Location 1 – Hackfath the predicted noise level under calm conditions is 32 to 34 dB(A), 1 to 3 dB below the 35 dB(A) project-specific noise level. Under a non-significant 3.0 m/s westerly wind, that could occur as an actual source-to-receiver wind during the day-time less than 6% of the time, the predicted noise level is 41 to 42 dB(A). While not significant in terms of likelihood of occurrence the actual noise impact is up to 7 dB above the project-specific noise level for the Project of 35 dB(A). When considering the westerly quadrant for reporting purposes, this impact could occur up to 14% of the time.

The exclusion of non-significant winds from the noise impact assessment could understate the noise impacts and be a risk to the operation of the development. However, the INP (EPA, 2000) excludes non-significant winds from the noise impact assessment as inclusion of the predicted noise levels could overstate the noise impact and result in the implementation of noise control measures that are unwarranted or an impost on the operation of the facility.

The objective of the INP (EPA, 2000) is to help strike a feasible and reasonable balance between the establishment and operation of industrial activities and the protection of the community from noise levels that are intrusive or unpleasant.

As set out in **Appendix D** the owner of Location 1 – Mr Hackfath has stated that he fully supports the quarry and considers noise from the quarry to be acceptable and not intrusive. To formalise this and address potential breaches of Environment Protection Licence in regard to noise exceedances at this location during non-significant winds, Oberon Quarries could enter into a commercial agreement with the landholder of residential receiver Location 1 – Mr Hackfath.

7.0 Conclusion and Recommendations

7.1.1 Conclusion

Umwelt has undertaken a NIA of the Project in accordance with Section 10 of the INP (EPA, 2000). Two main operational scenarios were modelled to represent quarry operations with full operation of the process plant and extraction occurring either in the northern extent of the pit or in the southern extent of the pit. These two operational scenarios were then combined with the loading and dispatch of product trucks. As the loading and dispatch of product trucks could occur during the evening period and during the 6.00 am to 7.00 am period of the night-time when other aspects of the quarry operations are not undertaken this activity was modelled as a separate stand-alone activity.

The results in **Section 5.0** indicate that with appropriate control measures in place the operational noise levels from the quarry would not exceed the target Project-specific Noise Levels of 35 dB(A) under calm conditions or under conditions associated with significant wind conditions as defined by the INP (EPA, 2000).

The noise modelling of the day-time activities identified that one property not associated with the quarry (Location 1 – Hackfath) could experience noise levels above the target PSNL of 35 dB(A) under conditions associated with non-significant winds from the west. The maximum level of exceedance from the quarry would be 6 dB under weather conditions associated with a 3 m/s westerly wind. When combined with the operational noise from product trucks on the quarry access road, the maximum level of exceedance would be 7 dB. As noted in **Section 4**, a vectored wind of 3 m/s from the west occurs less than 30% of the time and is likely to overstate the noise impacts. However, it has been considered as the vectored source to receiver wind could occur during winter and spring and represents a worst case source to receiver wind for the closest receiver (Location 1 – Hackfath). As noted in **Section 4**, the more likely source to receiver wind condition is 2 m/s and occurs less than 6% of the time, whereas the vectored source to receiver component of the wind is associated with prevailing winds typically greater than 3 m/s in strength. To address the infrequent occurrence of these non-significant wind conditions it is recommended that Oberon Quarries enters into a commercial agreement with land identified as residential receiver Location 1 – Hackfath.

The results in **Section 5.0** indicate the proposed operation will not result in noise levels that exceed the sleep disturbance criterion.

The INP (EPA, 2000) notes that when predicted noise levels exceed the target PSNL a range of strategies should be considered to reduce the noise impact on offsite receivers. The three main strategies for noise control 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; and
- **controlling noise at the receiver –**- There are two approaches: negotiating an agreement with the landholder or acoustic treatment of dwellings to control noise.

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). One of the outcomes from this process is to set project-specific noise criterion for the Project that allows Oberon Quarries to adapt to changes in the noise expectations of the community while remaining economically viable. The project-specific noise criterion would be based on the noise levels achievable following the implementation of reasonable and feasible controls suggested in **Section 5.0**. In accordance with Section 10 of the INP (EPA, 2000) the achievable noise levels are those presented in **Table 5.2**.

It is anticipated that the inclusion of new crushing and screening plant would reduce the existing noise at the nearby residential receivers by up to 3 dB, when compared to the current operations. However, when combined with the truck movements along the access road to the quarry the full benefit of the improvements to the processing plant may not be realised at all the surrounding receiver locations.

The results presented in **Table 5.3** indicated that truck movements along the access road to the quarry can result in noise levels of up to 38 dB(A) without the quarry operating. Approximately 120 metres of the access road adjacent to the processing plant area will be duplicated to improve safety for trucks entering and leaving the process area. There will be no other changes to the access road as a part of the Project. Predicted noise impacts are consistent with the existing noise impacts from haulage trucks as they enter and leave the site. Historically Oberon Quarries has managed the noise impacts from the haulage trucks as they enter and leave the site through the control of operational speeds of the road and maintenance of the road.

Oberon Quarries is committed to implementing the controls discussed in **Section 5.0**. As discussed above, with these controls in place the results in **Section 5.0** indicate that only one property that is not associated with or has agreement with Oberon Quarries will experience operational noise levels above the day-time target Project-specific Noise Levels. One property (Location 5) will experience noise levels above the evening/night-time target Project-specific Noise Levels from product trucks on the quarry access road. This property has a commercial agreement with Oberon Quarries.

7.1.2 Recommended Management and Monitoring Program

Oberon Quarries will implement the noise attenuation measures discussed in **Section 5.0** within 12 months of the date of consent for the proposed development. In addition to this Oberon Quarries will also prepare and implement a Noise Management Plan for the Project. The Noise Management Plan will be integrated into the Oberon Quarry Environmental Management Plan. The Plan will include:

- A compliance noise monitoring program to confirm the operational noise levels of the Project that specifically addresses:
  - compliance with the target project-specific noise criteria for the Project; and
  - measurement and assessment of any transient noise levels using the sleep disturbance criteria descriptor of $L_{A1,\ 1\ minute}$.
- The noise monitoring should be based around an attended monitoring program that:
  - measures $L_{A90,15\ minute}$ and $L_{Aeq,15\ minute}$ ambient noise levels;
  - measures and/or calculates the contributed noise level from the operation;
  - measures other statistical noise levels representative of the noise environment including the maximum and minimum noise levels measured during the interval; and
  - records weather conditions at the monitoring site.

The results of the monitoring program should be reviewed by the Oberon Quarries management to assess compliance with the goals outlined in **Section 5.0** and reported in accordance with any requirements of the development consent or EPL.

Should compliance not be achieved, the noise monitoring contractor should identify any feasible and reasonable noise mitigation measures and provide a recommendation on what measures are to be implemented.

As part of the compliance noise monitoring program, the contractor will confirm that the attenuation measures discussed in **Section 5.0** have been implemented and that other mitigation measures are being investigated and implemented when reasonable and feasible to do so.

8.0 References

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

NSW Environmental Protection Authority 1985. *Environmental Noise Control Manual*.

NSW Environment Protection Authority 2000. *New South Wales Industrial Noise Policy.*

NSW Environmental Protection Authority 2012. *Application Notes – NSW Industrial Noise Policy*.

U.S. Department of Transportation 2004. *US Federal Highway Administration Traffic Noise Model Version 2.5 Look-Up Tables*.

APPENDIX A

Glossary of Terms

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-hr period of the monitoring period). It is determined by taking the lowest 10thpercentile 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% 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% 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

INP Assessment Methodology

Appendix B – INP Assessment Methodology

Industrial Noise Policy

Responsibility for the control of noise emissions in NSW is vested in Local Government and the Office of Environment and Heritage (OEH). The *NSW 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 (PSNL) 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 project-specific noise levels and assessing the impacts.

Where the project-specific noise levels 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.

INP Assessment Methodology

There are two criteria to consider when establishing project-specific noise levels 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; and
- **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 **Tables 1** and **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 LAeq 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)
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 LAeq 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 LAeq 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 LAeq 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 project-specific noise level 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.

INP 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% of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90% 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 (DECC, July 2006). 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 Department of Environment and Climate Change (DECC) have provided an application note for the assessment of sleep disturbance (DECC, July 2006). 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.

DEC reviewed research on sleep disturbance in the NSW Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999). 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, DEC recognised that current sleep disturbance criterion of an $L_{A1, (1\ minute)}$ not exceeding the $L_{A90, (15\ minute)}$ by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, DEC 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 $L_{A1, (1\ minute)}$, 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 appendices to the ECRTN. 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 $L_{A1, (1\ minute)}$ descriptor is meant to represent a maximum noise level measured under 'fast' time response. DEC will accept analysis based on either $L_{A1, (1\ minute)}$ or $L_{A, (Max)}$.

APPENDIX C

Meteorological Analysis

Appendix C – Meteorological Analysis

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% 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.

Meteorological data for the period January 2008 to December 2008 was sourced from pDs Consultancy. This data was analysed to determine prevailing wind conditions likely to influence the propagation of noise at the project site and is summarised as wind roses in **Table 3.1** and **Figures 3.1** to **3.4**.

Table 3.1 – Occurrence of Prevailing Winds per Wind Speed Category
(Each Season All Periods)

Season	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
Summer	E	0.9%	1.1%	16.2%	10.5%	1.6%	-
	ENE		0.7%	9.0%	1.3%	-	-
	ESE		0.4%	5.8%	4.6%	0.5%	-
	SE		0.1%	1.7%	0.3%	-	-
	SSE		0.2%	0.7%	-	-	-
	S		0.3%	1.0%	-	-	-
	SSW		0.5%	1.1%	-	-	-
	WSW		0.6%	3.9%	4.4%	0.9%	0.2%
	SW		0.4%	3.5%	1.3%	0.2%	-
	NE		1.1%	1.2%	0.3%	-	-
	NNE		0.8%	0.8%	0.3%	-	-
	N		0.5%	1.0%	0.2%	-	-
	NNW		0.4%	1.7%	0.3%	-	-
	NW		0.5%	3.0%	1.3%	-	-
	W		0.5%	2.2%	4.2%	1.6%	-
	WNW		0.3%	2.7%	1.1%	-	-
Autumn	E	1.4%	2.2%	13.0%	3.4%	-	-
	ENE		1.9%	3.5%	0.4%	-	-
	ESE		2.2%	9.7%	5.8%	-	-
	SE		1.4%	3.5%	1.3%	-	-
	SSE		1.3%	1.3%	-	-	-
	S		0.4%	1.6%	-	-	-
	SSW		0.7%	2.8%	0.7%	-	-
	WSW		0.3%	2.5%	4.3%	1.4%	-
	SW		0.7%	4.1%	3.2%	0.1%	-
	NE		1.4%	1.0%	-	-	-
	NNE		1.3%	0.8%	-	-	-
	N		0.7%	1.0%	-	-	-
	NNW		0.5%	1.2%	0.1%	-	-
	NW		0.7%	3.8%	1.3%	0.4%	-
	W		0.6%	2.8%	2.3%	0.9%	-
	WNW		0.4%	3.2%	0.6%	-	-

Table 3.1 – Occurrence of Prevailing Winds per Wind Speed Category (cont)
(Each Season All Periods)

Season	Direction	< 0.76 m/s	0.76 m/s to < 1.5 m/s	1.5 m/s to < 3.0 m/s	3.0 m/s to < 4.5 m/s	4.5 m/s to 6.0 m/s	> 6.0 m/s
Winter	E	0.3%	0.3%	3.2%	4.3%	0.6%	-
	ENE		0.1%	1.6%	0.1%	-	-
	ESE		0.6%	2.8%	1.6%	0.7%	-
	SE		0.6%	2.5%	2.0%	-	-
	SSE		0.2%	1.3%	1.2%	-	-
	S		0.2%	2.8%	1.5%	-	-
	SSW		0.6%	3.6%	2.2%	-	-
	WSW		0.2%	3.6%	8.8%	7.2%	0.9%
	SW		0.3%	4.1%	3.7%	1.4%	-
	NE		0.4%	1.3%	0.2%	-	-
	NNE		0.1%	0.7%	-	-	-
	N		-	1.1%	0.4%	-	-
	NNW		0.3%	4.1%	0.4%	-	-
	NW		0.2%	2.7%	1.4%	0.1%	-
	W		-	2.5%	7.3%	4.3%	0.5%
	WNW		-	2.2%	4.5%	-	-
Spring	E	0.4%	1.1%	4.9%	4.9%	1.8%	-
	ENE		0.4%	3.6%	1.5%	-	-
	ESE		0.4%	2.6%	1.5%	0.1%	-
	SE		0.1%	1.5%	0.2%	-	-
	SSE		0.2%	1.4%	1.2%	0.2%	-
	S		0.6%	2.0%	0.6%	-	-
	SSW		0.4%	2.5%	0.2%	-	-
	WSW		0.3%	2.9%	7.2%	1.5%	0.6%
	SW		0.5%	3.7%	3.3%	-	-
	NE		0.9%	1.5%	0.5%	-	-
	NNE		1.1%	0.8%	-	-	-
	N		0.7%	1.8%	0.2%	-	-
	NNW		0.6%	2.6%	1.7%	0.2%	-
	NW		0.1%	4.9%	4.1%	1.4%	-
	W		0.1%	4.6%	4.2%	1.9%	0.3%
	WNW		0.1%	5.4%	4.0%	1.9%	0.2%

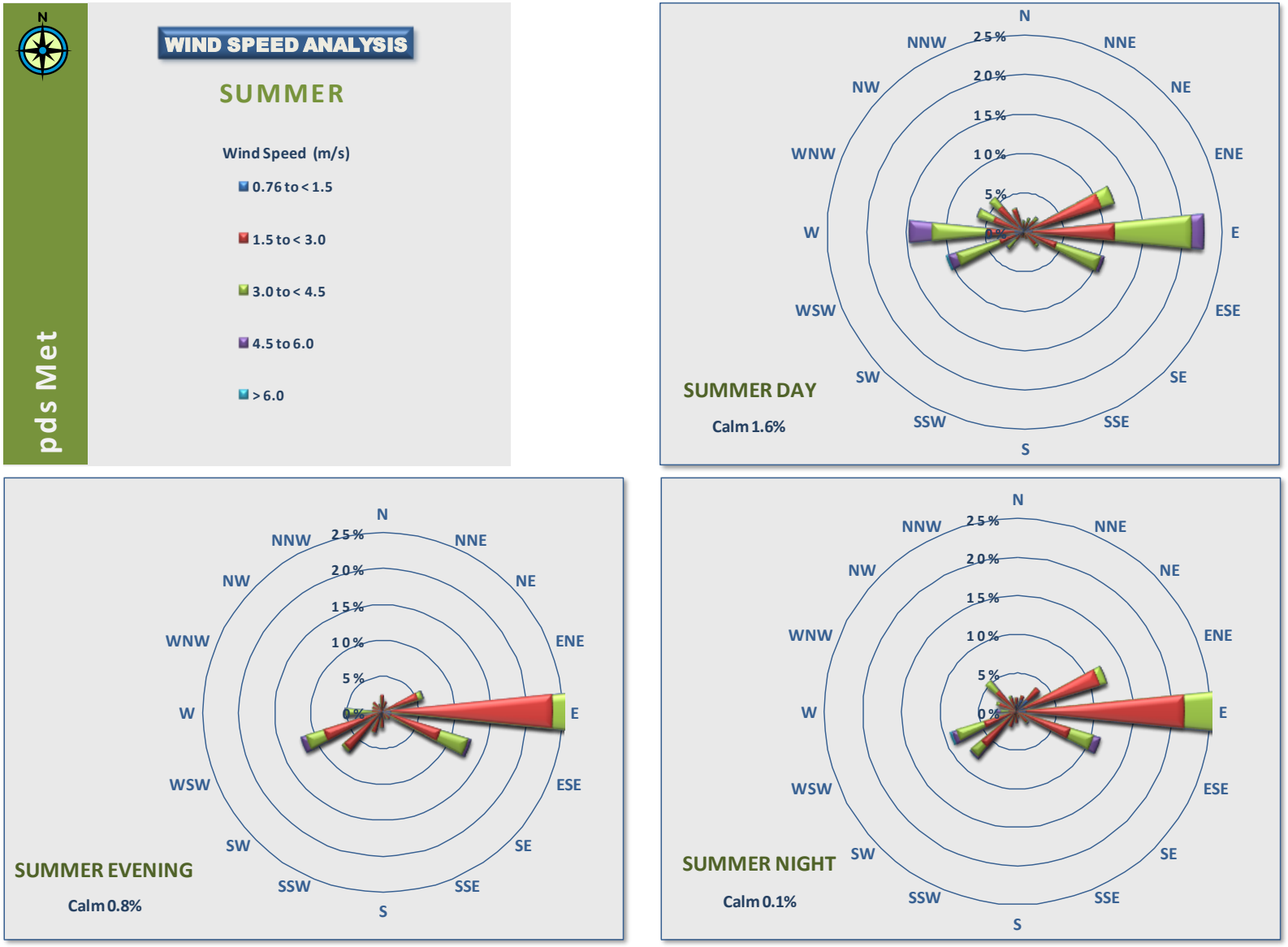


Figure 3.1 – Wind speed analysis, summer

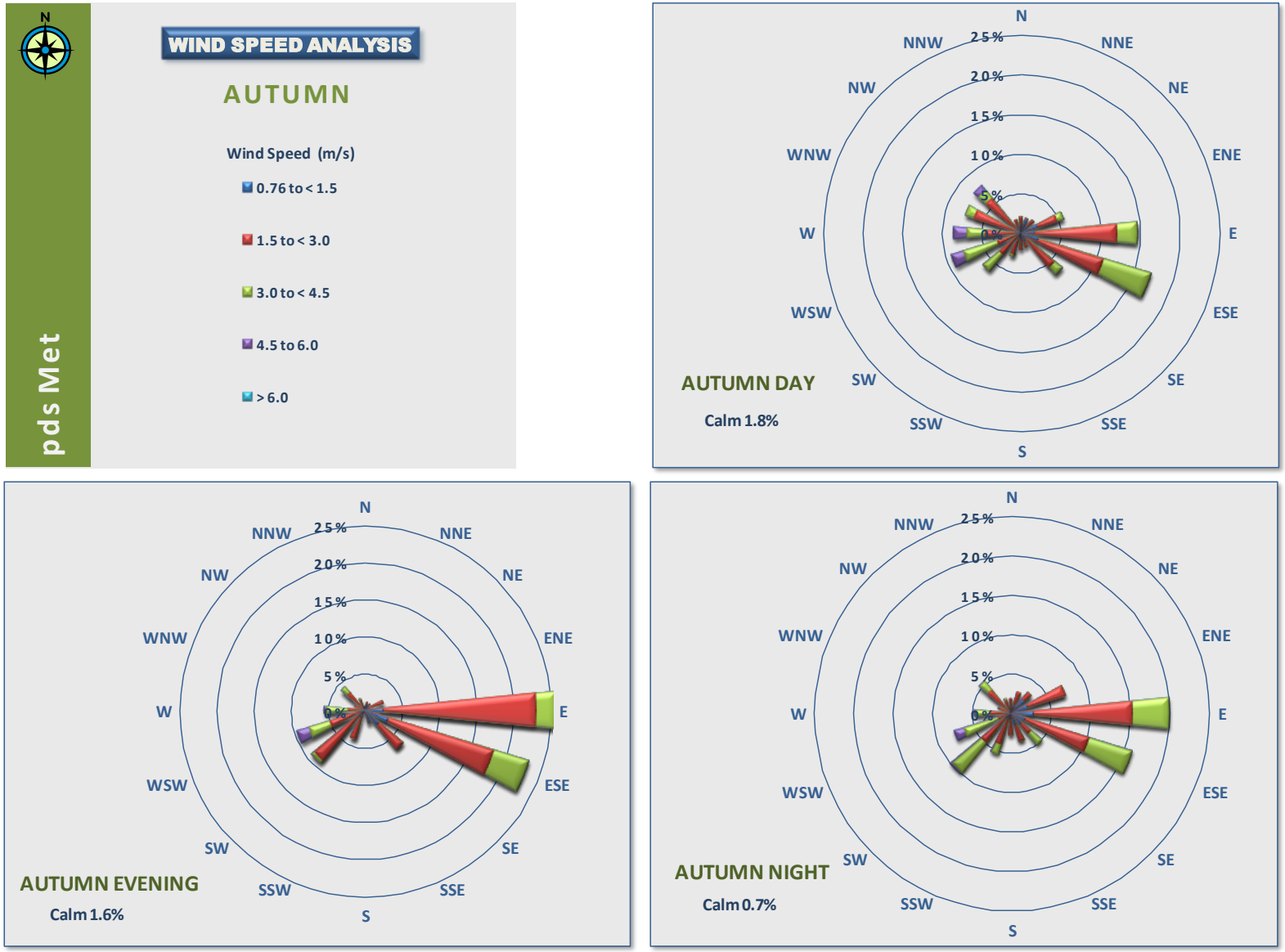


Figure 3.2 – Wind speed analysis, autumn

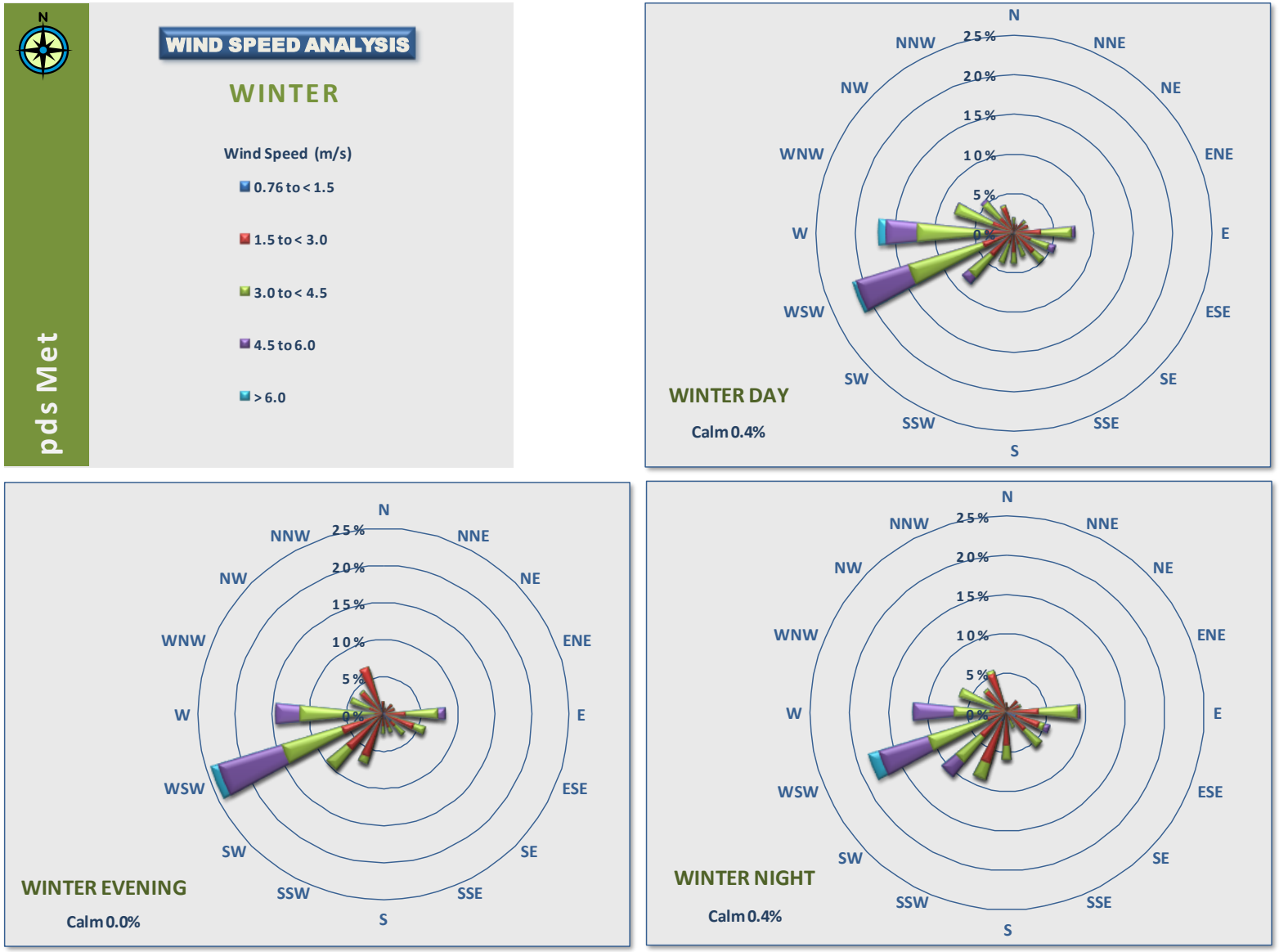


Figure 3.3 – Wind speed analysis, winter

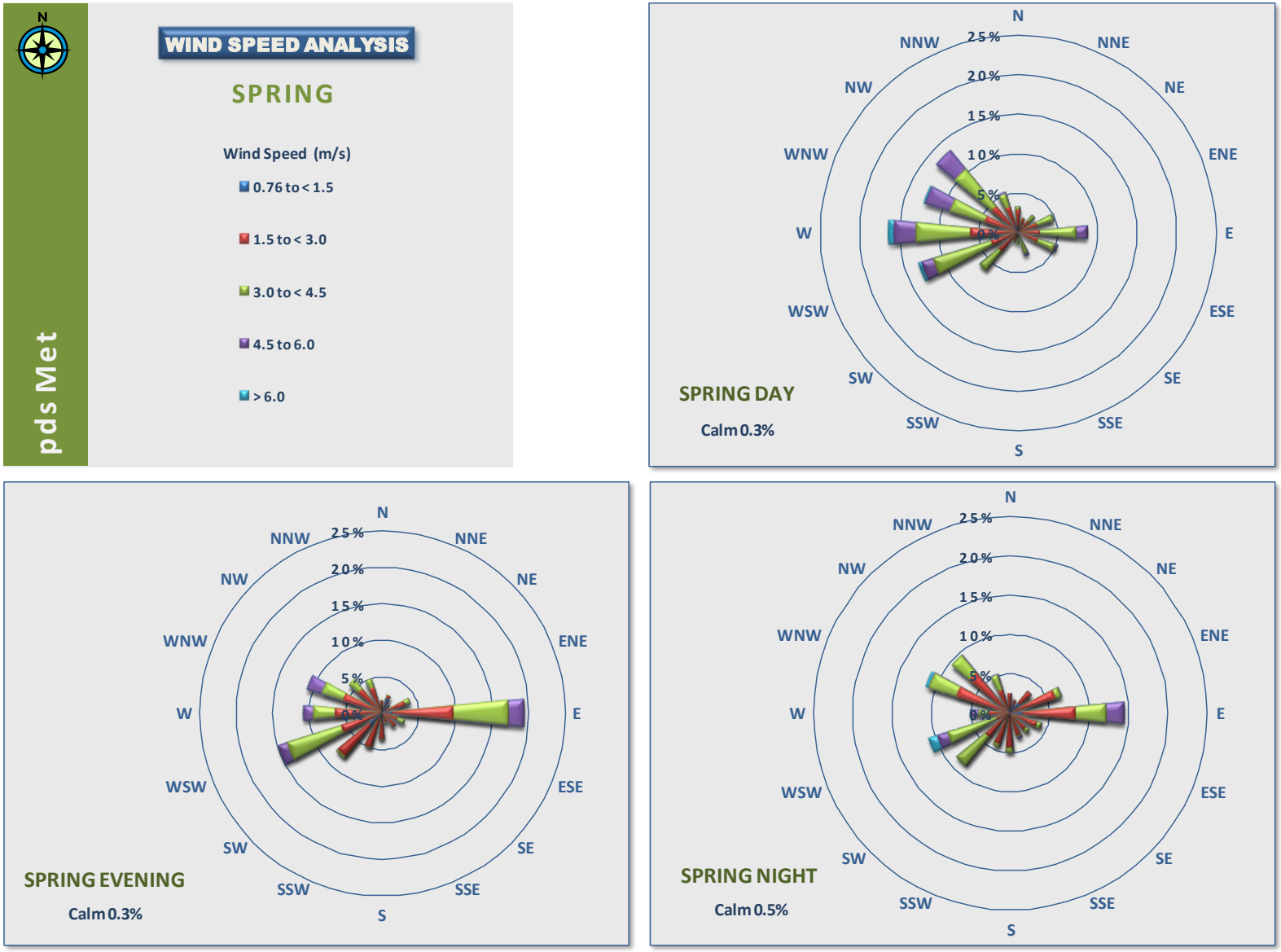


Figure 3.4 – Wind speed analysis, spring

APPENDIX D

Email from John Hackfath (Location 1)

Frances Davies

From: john.hackfath@bigpond.com
Sent: Wednesday, 21 August 2013 6:32 PM
To: Peter Jamieson
Subject: RE: 1296-Modification to Oberon Quarries Consent

Peter,

I fully support the operations of the quarry.
The current noise levels of 42dBa are not intrusive and acceptable.
If anyone would like to discuss the matter further I'm available on 0417 684 492.

Regards

John Hackfath