MARSHALL DAY Acoustics

MT FYANS WIND FARM

EES INITIAL SUBMISSION

ACOUSTIC CONSIDERATIONS AND PRELIMINARY PREDICTIONS

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1.0 INTRODUCTION

Woolnorth Wind Farms is proposing to develop the Mt Fyans Wind Farm north of Mortlake in Victoria.

This report has been prepared as part of the EES initial submission package and provides an overview of construction and operational noise considerations associated with the development of the wind farm, which may need to be addressed in the Environmental Effects Statement (EES) for the proposal and the preliminary predicted noise levels associated with operation of the wind farm.

Acoustic terminology used throughout this report is defined in Appendix A.

2.0 PROJECT DESCRIPTION

The Mt Fyans Wind Farm is proposed to be located approximately 4.5 km north of Mortlake and comprise up to 81 wind turbines with a maximum planned tip height of 165 m above ground level (AGL). A plan of the proposed turbine layout is presented in Appendix B. The coordinates for the wind turbines are provided in Appendix C.

The wind farm site covers an area of approximately 136 square kilometres and comprises 12 host landholders.

A total of 238 receiver locations surrounding the Mt Fyans Wind Farm have been considered in this report. The coordinates of the 238 receiver locations are tabulated in Appendix D.

The project is to include both an on-site and an off-site substation. The on-site substation will comprise 2 transformers of approximately 125 MVA each. The off-site substation located near the Mortlake Gas Power Station will comprise 1 transformer of approximately 250 MVA.

A plan detailing the indicative substation location is provided in Appendix E.

3.0 OPERATIONAL NOISE CRITERIA

The relevant operational noise assessment methodology for wind farms is provided in the Victorian Government's *Policy and planning guidelines for development of wind energy facilities in Victoria* dated January 2016 (the Victorian Guidelines).

Outside of the Melbourne metropolitan area, noise from commercial and industrial premises, such as the substation associated with the proposed wind farm, is assessed in accordance with the Victorian EPA publication 1411 titled *Noise from Industry in Regional Victoria – Recommended maximum noise levels from commerce, industry and trade premises in regional Victoria* (NIRV).

3.1 Victorian Guidelines

Section 4.3.3b of the Victorian Guidelines requires the following:

> [...] *an assessment of the noise impact of the proposal prepared in accordance with the New Zealand Standard NZS 6808:2010, Acoustics – Wind Farm Noise (the Standard), including an assessment of whether a high amenity noise limit is applicable, as assessed under Section 5.3 of the Standard.*

Furthermore, the Victorian Guidelines also states the following:

> [...] *no plans will be endorsed by the responsible authority, and no variation to the endorsed plans will be approved by the responsible authority, which allow a turbine to be located within 1 kilometre of an existing dwelling (measured from closest point of the turbine to closest point of the dwelling) unless evidence has been provided to the satisfaction of the responsible authority that the owner of the dwelling has consented in writing to the location of the turbine.*

3.2 New Zealand Standard 6808:2010

New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010) is used to assess wind farm noise as required by the Victorian Guidelines.

3.2.1 Objectives

Section C1.1 of NZS 6808:2010 discusses the intent of the standard, which is:

> [...] *to avoid adverse noise effects on people caused by the operation of wind farms while enabling sustainable management of natural wind resources.*

The *Outcome Statement* of NZS 6808:2010 expresses this intention in a planning context as follows:

> *This Standard provides suitable methods for the prediction, measurement, and assessment of sound from wind turbines. In the context of the* [New Zealand] *Resource Management Act, application of this Standard will provide reasonable protection of health and amenity at noise sensitive locations.*

The standard seeks to address health and amenity at noise sensitive locations by specifying noise criteria which are used to assess wind farm noise, as outlined below.

3.2.2 Protected premises

The provisions of NZS 6808:2010 are intended to protect noise sensitive locations that existed before the development of a wind farm. Noise sensitive locations are defined by the Standard as:

> *The location of a noise sensitive activity, associated with a habitable space or education space in a building not on the wind farm site. Noise sensitive locations include:*
>
> *(a) Any part of land zoned predominantly for residential use in a district plan;*
>
> *(b) Any point within the notional boundary of buildings containing spaces defined in (c) to (f);*

(c) Any habitable space in a residential building including rest homes or groups of buildings for the elderly or people with disabilities …

(d) Teaching areas and sleeping rooms in educational institutions …

(e) Teaching areas and sleeping rooms in buildings for licensed kindergartens, childcare, and day-care centres; and

(f) Temporary accommodation including in hotels, motels, hostels, halls of residence, boarding houses, and guest houses.

In some instances holiday cabins and camping grounds might be considered as noise sensitive locations. Matters to be considered include whether it is an established activity with existing rights.

For the purposes of an assessment according to the standard, the notional boundary is defined as:

A line 20 metres from any side of a dwelling or other building used for a noise sensitive activity or the legal boundary where this is closer to such a building.

NZS 6808:2010 was prepared to provide methods of assessment in the statutory context of New Zealand. Specifically, the Standard notes that in the context of the New Zealand Resource Management Act, application of the standard will provide reasonable protection of health and amenity at noise sensitive locations. This is an important point of context, as the New Zealand Resource Act states:

(3)(a)(ii): A consent authority must not, when considering an application, have regard to any effect on a person who has given written approval to the application.

Based on the above, the noise criteria outlined in the standard are not applied to participating land owner receiver locations or participating neighbours who have entered into an agreement with the project developers. For these locations, assessment is carried out on the basis of alternative guidance that is commonly used for the assessment of participating receiver locations. This approach is consistent with the statutory context of the New Zealand standard referenced in Victoria, and the approach adopted in other Australian states.

3.2.3 Noise limit

Section 5.2 *Noise limit* of NZS 6808:2010 defines acceptable noise limits as follows:

As a guide to the limits of acceptability at a noise sensitive location, at any wind speed wind farm sound levels ($L_{A90\,(10\,min)}$) should not exceed the background sound level by more than 5dB, or a level of 40dB $L_{A90\,(10\,min)}$, whichever is the greater.

This arrangement of noise limits requires the noise associated with wind farms to be restricted to a permissible level above background noise, except in instances when both the background and source noise levels are low. In this respect, the criteria indicate that it is not necessary to continue to adhere to a margin above background when the background noise levels are below the range of 30-35 dB.

It should be noted that compliance with the NZS 6808:2010 criteria may result in wind turbine noise being audible at some locations for some of the time.

The preliminary wind farm noise assessment provided in this document does not consider the background noise conditions at receivers as, at this stage, the noise monitoring has not been completed. The background noise monitoring will be required to derive the wind speed dependant noise limits for the detailed noise study.

3.2.4 High amenity areas

Section 5.3.1 of NZS 6808:2010 states that the base noise limit of 40 dB L_{A90} detailed in Section 3.2.2 above is "*appropriate for protection of sleep, health, and amenity of residents at most noise sensitive locations*." It goes on to note that high amenity areas may require additional consideration:

> […] *In special circumstances at some noise sensitive locations a more stringent noise limit may be justified to afford a greater degree of protection of amenity during evening and night-time. A high amenity noise limit should be considered where a plan promotes a higher degree of protection of amenity related to the sound environment of a particular area, for example where evening and night-time noise limits in the plan for general sound sources are more stringent than 40 dB $L_{Aeq(15\ min)}$ or 40 dBA L_{10}. A high amenity noise limit should not be applied in any location where background sound levels, assessed in accordance with section 7, are already affected by other specific sources, such as road traffic sound.*

The definition of a high amenity area provided in NZS 6808:2010 is specific to New Zealand planning legislation and guidelines. A degree of interpretation is therefore required when determining how to apply the concept of high amenity in Victoria.

Section 5.3 of NZS 6808:2010 provides details of high amenity noise limits. In particular, Sections 5.3.1 and 5.3.2 of NZS 6808:2010 provide guidance for determining whether a residential receiver should be considered as a high amenity location, based on New Zealand planning policy. If a receiver is deemed to be located within a high amenity area, the standard recommends that wind farm noise levels (L_{A90}) during the evening and night-time periods should not exceed the background noise level (L_{A90}) by more than 5 dB or 35 dB L_{A90}, whichever is the greater. The standard states that the reduced noise limits typically only apply for wind speeds below 6m/s at hub height. The standard does not define high amenity noise limits for the the daytime period.

3.2.5 Special audible characteristics

Section 5.4.2 of NZS 6808:2010 requires the following:

> *Wind turbine sound levels with special audible characteristics (such as tonality, impulsiveness and amplitude modulation) shall be adjusted by arithmetically adding up to +6dB to the measured level at the noise sensitive location.*

Notwithstanding this, the standard requires that wind farms be designed with no special audible characteristics at nearby residential properties while concurrently noting in Section 5.4.1 that:

> […] *as special audible characteristics cannot always be predicted, consideration shall be given to whether there are any special audible characteristics of the wind farm sound when comparing measured levels with noise limits.*

The assessment of potential special audible characteristics is undertaken during the post-construction commissioning noise monitoring to determine whether a penalty is deemed to be applicable.

3.2.6 Cumulative assessment

The criteria specified in NZS 6808 apply to the combined noise level of all wind farms influencing the noise environmental at a receiver location. Specifically, section 5.6.1 states:

> *The noise limits should apply to the cumulative sound level of all wind farms affecting any noise sensitive location.*

3.3 EPA Publication 1411 – NIRV

Guidance relevant to the assessment of noise from ancillary infrastructure is contained in the Victorian EPA publication 1411 titled *Noise from Industry in Regional Victoria – Recommended maximum noise levels from commerce, industry and trade premises in regional Victoria* (NIRV), applicable in rural Victoria.

NIRV defines separate procedures for determining noise limits for major urban and rural areas. A review of the maps of the urban centres available on the EPA website indicate that the proposed wind and surrounding receivers are not located in major urban areas. Accordingly, the rural area procedures are applicable in this instance

The NIRV criteria for this site have been calculated by determining the zone levels as per NIRV. The zone levels are dependent on the zone the noise source is in and the zone the residence is in. Based on the zoning map of the area surrounding the proposed substations (provided in Appendix F), the proposed substation locations and surrounding residential properties are located in a Farming Zone (FZ).

When substations, defined as utilities in the Victorian Planning Provisions, are located within a Farming Zone, the recommended maximum noise levels (RMNLs) detailed in Table 1 apply for each applicable time period.

Table 1: NIRV time periods and recommended levels for substations associated with the windfarm, dB L_{eff}[1]

Period	Day of week	Start time	End time	RMNLs
Day	Monday-Friday	0700 hours	1800 hours	45
	Saturday	0700 hours	1300 hours	
Evening	Monday-Friday	1800 hours	2200 hours	39
	Saturday	1300 hours	2200 hours	
	Sunday, Public holidays	0700 hours	2200 hours	
Night	Monday-Sunday	2200 hours	0700 hours	34

The RMNLs detailed in Table 1 are not dependent on background noise levels. NIRV allows for a background noise level adjustment in the event that affected residential properties are located in an area where background noise levels may be higher than usual for a rural area.

As the substation could operate 24 hours a day and 7 days a week, compliance with the NIRV night RMNL of 34 dB L_{eff} would allow compliance during all other time periods.

[1] L_{eff} is the effective noise level of commercial or industrial noise determined in accordance with SEPP N-1. This is an L_{Aeq} noise level over a half-hour period, adjusted for the character of the noise. Adjustments are made for tonality, intermittency and impulsiveness.

4.0 CONSTRUCTION NOISE CRITERIA

4.1 EPA Publication 1254

EPA Publication 1254 *Noise Control Guidelines* provides guidelines for the control of noise levels for a range of activities throughout Victoria. Guidance relevant to construction noise is provided in Section 2 which includes details of recommended working practices and recommended requirements concerning working hours and noise levels.

The noise requirements of EPA publication 1254 are summarised in Table 2.

Table 2: Construction noise requirements

Period	Day of the week	Time Period	Noise requirements depending on construction duration, L_{Aeq}	
			Up to 18 months	After 18 months
Day	Monday-Friday Saturday	0700-1800 hours 0700-1300 hours	No specific noise limit. Construction noise must be controlled to avoid unreasonable impact.	
Evening	Monday-Friday Saturday Sunday, Public Holidays	1800-2200 hours 1300-2200 hours 0700-2200 hours	10 dB above background (L_{A90}), outside residential dwelling	5 dB above background (L_{A90}), outside residential dwelling
Night	Monday-Sunday	2200-0700 hours	Noise from construction activities must be inaudible inside a habitable room with windows open	

While there is no specific noise limit for daytime activities, the EPA states that the following:

> *This guideline does not limit the general ability of a local government or police official to assess the unreasonableness of noise at any time.*

Therefore, construction noise levels must still be controlled to avoid unreasonable impact.

During the night period, noise is required to be inaudible within a habitable room of any residential premises. Publication 1254 allows for flexibility where it is not possible to avoid construction activities during the night stating the following:

> *Noise from the site needs to comply with the requirements of the schedule, except for:*
>
> - *unavoidable works*
> - *night period low-noise or managed-impact works approved by the local authority.*

Unavoidable works are defined as "*works that cannot practicably meet the schedule requirements because the work involves continuous work — such as a concrete pour — or would otherwise pose an unacceptable risk to life or property, or risk a major traffic hazard*."

Unavoidable works may include, but are not limited, to the following construction activities:

- Delivery of large size items such as wind turbine blades due to the risk of traffic hazard
- Turbine erection and assembly is dependent on appropriate wind conditions to minimise safety risks.

For such works, the guidelines require that "*affected premises should be notified of the intended work, its duration and times of occurrence*."

EPA publication 1254 defines low-noise or managed works as below:

...works approved by the local authority:

- *that are inherently quiet or unobtrusive (for example, manual painting, internal fit-outs, cabling)*

or

- *where the noise impacts are mitigated (for example, no impulsive noise and average noise levels over any half hour do not exceed the background) through actions specified in a noise management plan supported by expert acoustic assessment.*

Low-noise or managed-impact works do not feature intrusive characteristics such as impulsive noise or tonal movement alarms.

4.2 Construction vibration guidelines

There is no standard or regulation that specifies criteria for the control of construction vibration levels in Victoria. However, in New South Wales, the EPA document *Assessing Vibration: A Technical Guideline* dated February 2006 (the NSW Vibration Guideline) presents preferred and maximum vibration criteria for use in assessing human response to vibration.

The vibration criteria are separately specified for the following types of vibration characteristics:

- Continuous – vibration that continues uninterrupted for a defined period such as the duration of a day
- Impulsive – vibration that comprises a rapid build up to a peak followed by several cycles of progressively reducing vibration
- Intermittent – vibration that comprises interrupted periods of continuous (e.g. a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly.

The types of activities associated with the construction of a wind farm may include both continuous and impulsive vibration sources operating over interrupted periods of a working day. It is therefore expected that vibration would be typically classified as intermittent according to the NSW Vibration Guideline, but may be continuous or impulsive on occasion.

Table 3 summarises the preferred and maximum values for acceptable human exposure to continuous and impulsive vibration. It is noted that the NSW Vibration Guideline provides criteria for the assessment of continuous and impulsive vibration in the form of the weighted acceleration values. Given that empirical vibration data is more readily available in the form peak particle velocity (PPV) data, the criteria are reproduced here in the form of equivalent PPV values sourced from Appendix C of the NSW Vibration Guideline.

Table 3: Preferred and maximum values for vibration during daytime (mm/s) 1-80 Hz (PPV)

Location	Preferred Values	Maximum Values
Continuous		
Residences	0.28	0.56
Impulsive		
Residences	8.6	17

Table 4 summarises the preferred and maximum values for acceptable human exposure to intermittent vibration. The NSW Vibration Guideline recommends the assessment of intermittent vibration on the basis of a more complex parameter referred to as the vibration dose value (VDV) which relates vibration magnitude to the duration of exposure.

Table 4: Vibration dose values for intermittent vibration during daytime ($m/s^{1.75}$) 1-80 Hz

Location	Preferred Values	Maximum Values
Residences	0.2	0.4

The NSW Vibration Guideline does not address vibration induced damage to buildings or structures. However, the thresholds for human exposure to vibration are generally well below accepted thresholds for minor cosmetic damage to lightweight structures. Accordingly, vibration which complies with the criteria for human exposure does not pose a risk in terms of structure damage.

4.3 Construction traffic noise guidelines

There is no Victorian guidance document in relation to the assessment of construction traffic noise levels on public roads. We therefore propose to assess the significance of changes in traffic volumes associated with construction having regard to the guidance contained in the *NSW Road Noise Policy* dated 2011 (RNP).

The RNP does not specifically preclude direct application to temporary changes in noise levels associated with construction traffic; however the document is predominantly focussed on longer term or permanent impacts associated with completed road projects. Table 5 presents the proposed traffic noise thresholds for this development, however given these could be equally applied to permanent changes associated with a completed development, they can be considered as very conservative when assessing the effects of temporary and intermittent traffic noise level changes associated with construction. The noise thresholds apply outside sensitive receiver locations such as residential dwellings or schools.

Table 5: Road traffic noise threshold - Existing residences affected by additional traffic

Type of road	Assessment criteria	
	Day 0700-2200 hours	Night 2200-0700 hours
Existing freeways, arterial and sub arterial roads	60 dB $L_{Aeq, 15hr}$	55 dB $L_{Aeq, 15hr}$
Existing local roads	55 dB $L_{Aeq, 1hr}$	50 dB $L_{Aeq, 1hr}$

The RNP also recommends that traffic arising from the development should not increase existing noise levels by more than 12 dB L_{Aeq} averaged over the relevant time period (day or night). This does not apply to local roads.

5.0 OPERATIONAL NOISE CONSIDERATIONS

The noise produced by a wind farm is predominantly controlled by noise emissions from wind turbines. However, other sources of operational noise include substations, transformers and potentially power transmission lines. The following sections discuss these operational noise considerations for the Mt Fyans Wind Farm.

5.1 Turbine noise

A wind turbine's noise sources can be classified into two broad categories:

- mechanical noise from components in the turbine nacelle, and
- aerodynamic noise from the interaction between wind and turbine blades.

Sources of mechanical noise within a turbine's nacelle primarily comprise the gearbox (for turbine models which include gearboxes), generator and cooling systems. These types of noise sources can be attenuated by conventional noise control methods including acoustic insulation of the nacelle walls and vibration isolated mountings.

Aerodynamic noise is caused by a number of effects as the air passes across the surface of a turbines blade, and is comparatively more difficult to reduce without affecting the power generating capacity of the turbines. Modern wind turbine designs are characterised by significantly reduced aerodynamic noise as a result of improved blade design and control systems which regulate both the pitch of the blades and the rotational speed of the turbines. Aerodynamic noise from turbine blades is generally the dominant noise source from wind turbines[2].

5.1.1 Special audible characteristics

Any sound with special audible characteristics is likely to cause annoyance at lower levels than a sound without these characteristics. Examples are tonality (e.g. a hum or a whine) and impulsiveness. Special audible characteristics that are considered in relation to environmental noise assessments can include amplitude modulation, impulsiveness, infrasound, low frequency noise and tonality.

The following provides further detail on each of these characteristics in relation to wind farm noise.

Amplitude modulation

If a sound has a noticeable change in sound level, often which is regular and repeating, this can in some cases be described as amplitude modulation. Examples include a ringing telephone and the sound of waves crashing on the shore.

Amplitude modulation is a normal feature of a correctly functioning wind turbine, described as the rise and fall in broadband noise level corresponding to the rotation of the blades. This characteristic is typically most evident in close proximity to the turbine.

[2] (Oerlemans, Detection of aeroacoustic sound sources on aircraft and wind turbines, 2009)
(Oerlemans, Sijtsma, & Mendez-Lopez, Location and quantification of noise sources on a wind turbine, 2007)
(Doolan, 2011)

Other reported characteristics of modern wind farm noise relate to an effect sometimes referred to as 'atypical' or 'other' amplitude modulation which relates to the rhythmic rise and fall in the level of noise, over and above the normal variation in noise associated with a wind farm. If present, atypical levels of amplitude modulation can attract a special audible characteristics' penalty to compliance testing results. In this respect, Section 5.4.2 of NZS 6808:2010 states the following:

> *Wind turbine sound levels with special audible characteristics (such as tonality, impulsiveness and amplitude modulation) shall be adjusted by arithmetically adding up to +6dB to the measured level at the noise sensitive location.*

A study[3] released by Renewable UK in December 2013 presents the findings of a detailed research programme by an international consortium into atypical amplitude modulation of wind farm noise. The UK study found that situations can arise where the modulation of wind farm noise is sufficient to lead to increased annoyance from wind farm noise. However, based on the evidence available at sites where it was identified, its occurrence is relatively infrequent.

Importantly, the study found that the factors which give rise to the effect are multiple and complicated, rather than a single phenomenon such as wake effects.

As a result, the study determined that it is not feasible to reliably predict the likelihood of atypical amplitude modulation occurring at a particular site. While NZS 6808:2010 requires that wind farms be designed with no special audible characteristics at nearby residential properties, the standard concurrently recognises that these types of effects cannot always be predicted. Specifically, Section 5.4.1 of the standard notes:

> *[…] as special audible characteristics cannot always be predicted, consideration shall be given to whether there are any special audible characteristics of the wind farm sound when comparing measured levels with noise limits.*

An important finding of the UK study is that if atypical modulation were to arise in practice, turbine management systems can be used to control the individual turbines responsible so that the effects are mitigated under the particular conditions in which they occur, on a case by case basis.

In recognition of the limited apparent extent of this reported matter, the subject of enhanced amplitude modulation has not altered the current approach to assessing wind farm noise in Australia. Specifically, current noise policies continue to represent a suitable basis for designing and assessing new wind farm developments. However, consistent the requirements of NZS 6808:2010, amplitude modulation is a potential characteristic that is considered and assessed during compliance monitoring after the wind farm has commenced operating.

<u>*Impulsiveness*</u>

NZS 6808:2010 defines impulsive sound as "*transient sound having a peak level of short duration, typically less than 100 milliseconds.*" Examples of impulsive noise include gunfire sounds, car door slamming and pile driving[4].

The rise and fall in sound pressure level associated with the noise of a modern wind farm is generally not sufficiently rapid to be considered an impulsive characteristic. Any atypical periodic or rhythmic variations in noise are more appropriately assessed in terms of amplitude modulation, as described in the preceding section.

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[3] Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effects (http://tinyurl.com/RUK-OAM-Report - 12.6MB)

[4] (International Standards Organisation, 1996), ISO 1996-1:2003

Accordingly, impulsivity is generally not considered to be a significant feature of the noise of a modern wind farm. It is therefore not necessary to consider in detail during the planning stage of a project. Notwithstanding this, for completeness, impulsivity is included in the special audible characteristics that are assessed during the compliance monitoring stage of a project.

Tonality

NZS 6808:2010 emphasises assessment of special audible characteristics during the post-construction measurement phase of a project. However, an indication of the potential for tonality to be a characteristic of the noise emission from the assessed turbine model can be determined based on the results of tonality audibility assessment commonly provided by manufacturers with their IEC 61400-11[5] sound power level specifications.

It should be noted that the tonality assessment in accordance with IEC 61400-11 is undertaken in close proximity of a single tested turbine (generally within 150 m) whereas the assessment of potential characteristics is performed during post-construction noise monitoring at receiver locations and accounts for the combined noise of all operational turbines.

5.1.2 Low frequency noise and infrasound

Section 5.5 of NZS 6808:2010 provides the following comments regarding low frequency noise and infrasound.

> *5.5.1 Although wind turbines may produce some sound at (ultrasound and infrasound) frequencies considered to be outside the normal range of human hearing these components will be well below the threshold of human perception.*
>
> *5.5.2 Claims have been made that low frequency sound and vibration from wind turbines have caused illness and other adverse physiological effects among a very few people worldwide living near wind farms. The paucity of evidence does not justify at this stage, any attempt to set a precautionary limit more stringent than those recommended in 5.2 and 5.3.*

These clauses within NZS 6808:2010 are supported by contemporary studies by peak health bodies internationally and in Australia, including those of the Australian National Health and Medical Research Council. As a result, current noise policies continue to represent a suitable basis for designing and assessing new wind farm developments. While low frequency noise is not formally assessed, further contextual information and relevant research findings would be documented in the Planning Application for the project.

5.1.3 Cumulative noise levels

Noise from Mt Fyans Wind Farm, Dundonnell Wind Farm and Salt Creek Wind Farm should be considered in a noise assessment for the Mt Fyans Wind Farm noise assessment.

It is understood that one property is located within 3 km of more than one wind farm (house u25). At this property the predicted noise level from Mt Fyans Wind Farm is more than 10 dB below the base noise limit of 40 dB suggesting the risk of non-compliance when considering the cumulative noise level from Dundonnell and Salt Creek Wind Farms is minimal.

[5] *Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques* (IEC 61400-11)

5.1.4 Atmospheric effects

Atmospheric conditions which enhance the propagation of sound from a wind farm are primarily related to varying sound speed profiles associated with wind direction and wind speed. Regions of reduced air movement in sheltered locations may experience thermal inversions while the turbines are operating, however this type of localised inversion is not representative of the overall noise propagation path, and will not refract sound that propagates upwards of the turbines. These types of conditions are also likely to only occur during low wind speed conditions when the turbines rotate slowly.

Other atmospheric conditions relevant to the assessment of noise from wind farms are stable air conditions in which there is an increased difference between wind speeds near the ground and at the proposed height of the turbine rotors. The key consideration for stable air is not the way it influences sound propagation, but is the potential for lower background noise levels as a result of there being less wind near the ground to disturb vegetation in the vicinity of surrounding houses. Current practice for addressing this consideration is to correlate measured background noise levels with wind speeds referenced to the hub-height of the proposed turbines, as required by NZS 6808:2010.

5.1.5 Background sound level variations

To establish a representation of typical background noise conditions around the proposed wind farm, background noise monitoring is required. The background noise data could be used to:

- Determine operational noise limits
- Assist the identification of background noise dominated periods during any future compliance surveys for the wind farm.

However, background sound levels vary widely from moment to moment, at different times of day, during different weather conditions and at different times of year.

To account for uncertainty related to sound field variations the background noise levels should be measured utilising the following procedures:

- The selection of each receiver location where noise monitoring is to be carried out based on identifying the receiver, among a group of receivers, expected to experience the lowest background noise levels (accounting for elevation and local foliage)
- At each receiver location, the noise monitor should be placed at a point where the background noise levels were expected to be lowest around the dwelling. For example, placing the monitors as far as practically possible from tall local vegetation at each property
- Measuring rainfall throughout the survey in order to identify and remove any periods in which rain occurred
- Sound frequency measurements carried out throughout the survey to enable suspected periods of high insect noise to be identified and removed.

6.0 CONSTRUCTION NOISE CONSIDERATIONS

Construction tasks associated with the project may include the following:

- Access road and turbine hardstand construction
- Associated infrastructure construction, such as the substation & site facilities
- Turbine tower foundation construction
- Trench digging to accommodate underground cabling
- Assembly of turbine towers, nacelles and rotor blades.

6.1 Construction equipment noise data

It is anticipated that a variety of construction equipment would be used for this project.

Table 6 provides indicative plant and equipment schedule for the construction of a project of this scale.

Table 6: Construction phase schedule

Construction phase	Plant/Equipment
Access roads	Excavator, Tracked loaders, Dump truck, Grader and Bulldozer
Substation	Excavator, Crane, Delivery Trucks, Concrete trucks, Concrete pump, Generator and Bulldozer
Site Compound	Excavator, Crane, Delivery Trucks, Concrete trucks, Concrete pump, Generator and Bulldozer
Turbine foundations	Excavator fitted with pneumatic breaker, Excavator, Crane, Delivery Trucks, Concrete trucks, Concrete pump, Generator and Bulldozer
Cable trench digging	Excavator, Dump truck, Generator and Bulldozer
Turbine assembly	Cranes and a Generator

Sound power levels for the proposed construction equipment should be determined based on guidance and data sources including Australian Standard AS 2436:2010 *Guide to noise and vibration control on construction, demolition and maintenance sites* (AS 2436:2010), and noise level data from previous projects of a similar nature.

6.2 Predicted construction noise levels

Noise levels associated with key construction stages should be predicted at the nearest noise sensitive locations to provide an indication of potential noise associated with regular working areas.

The predictions should be undertaken using the method outlined in Appendix B of AS 2436:2010 (the reference standard for the source emission data noted in the preceding section). The predictions should account for a mix of soft and hard ground conditions which is considered to be consistent with the type of ground cover typically encountered in rural regions of eastern Australia.

6.3 Construction vibration

Ground vibration from construction activity is inherently variable, and is influenced by a range of factors related to the construction plant, ground conditions and the separating distance between the plant and the receiver location. Due to the complexity of the factors influencing ground vibration propagation, the prediction of ground vibration is subject to considerable uncertainty.

There is generally low risk of vibration impact from construction activities associated with wind farms. If sensitive situations are identified where residents may be in close proximity to vibration generating construction equipment, a detailed vibration prediction should be undertaken.

The NSW Vibration Guideline referenced earlier in Section 4.2 provides guideline criteria for assessing vibration levels, but does not provide specific information about vibration emission values or prediction methodologies.

In the absence of ratified empirical vibration data or prediction methodologies in Victoria or Australian guidelines, the prediction methodology detailed in the UK Transport Research Laboratory's (TRL) *Groundborne vibration caused by mechanised construction works* (Hiller & Crabb, 2000) should be used together with indicative empirical vibration data for common types of construction plant provided in the superseded NSW Roads and Traffic Authority's *Environmental Noise Control Manual* (ENCM) dated 2001.

6.4 Construction traffic noise

There is generally low risk of noise impact from construction traffic associated with wind farms. If sensitive situations are identified where residents may be in close proximity to construction vehicle routes, traffic noise predictions should be undertaken.

An assessment of noise associated with construction traffic would be prepared on the basis of the existing and forecast traffic information. The assessment would also need to consider the mix of heavy goods and passenger vehicles during the construction phase.

7.0 PRELIMINARY WIND FARM NOISE PREDICTIONS

The following sections present a preliminary assessment of wind turbine noise from the proposed Mt Fyans Wind Farm.

7.1 Wind turbine type

7.1.1 Turbine type

The actual turbine selection will not be determined until the project planning application process has been completed and would be the subject of a commercial tendering process for the supply of turbines from a range of manufacturers. It is therefore necessary to consider a turbine type which can be considered representative of the size, power rating and noise emissions of turbines which may be considered for this site.

A number of turbine types from multiple manufacturers were considered and, based on preliminary noise predictions, the GE 3.4-137 turbine was identified as a suitable candidate turbine for the purposes of this preliminary noise assessment.

The preliminary noise assessment detailed within this report has been based on this turbine with a hub-height of 100 m.

The GE 3.7-137 turbine model is characterised by sound power levels that are typical of the class of machine being considered. An important point of context is that the purpose of this preliminary assessment was to obtain an early indication of whether the proposed Mt Fyans Wind Farm can viably operate in accordance with relevant environmental noise criteria, based on a range of commercial options. An assessment based on the proposed turbine model satisfied this requirement.

Details of the candidate turbine model for the preliminary assessment are summarised in Table 7 below.

Table 7: WTG manufacturer specifications

	Details
Make	GE
Model	3.4 – 137
Rated electrical power (MW)	3.43
Rotor Diameter (m)	137
Hub Height (m)	100
Rotor orientation	Upwind
Wind class	IEC 3b + WZ S (II)
Cut-in Wind Speed (hub height, m/s)	3
Rated Wind Speed (hub height, m/s)	9
Cut-out Wind Speed (hub height, m/s)	14
Sound Power L_{WA} at 9m/s (hub height, dB)	106.5
Tonality audibility ($\Delta L_{a,k} > 0$)	4 dB

7.1.2 Sound power level data

Sound power data for the assessed turbine model has been sourced from the GE document *Noise_Emissions-NO_3.4-DFIG-137-xxHz_3MW_IEC_Eng-a1_EN_r02.docx* titled "Technical Documentation Wind Turbine Generator Systems 3.4-137 – 50/60 Hz Product Acoustic Specifications".

Summarised below is the sound power level for the proposed turbine at hub height wind speeds.

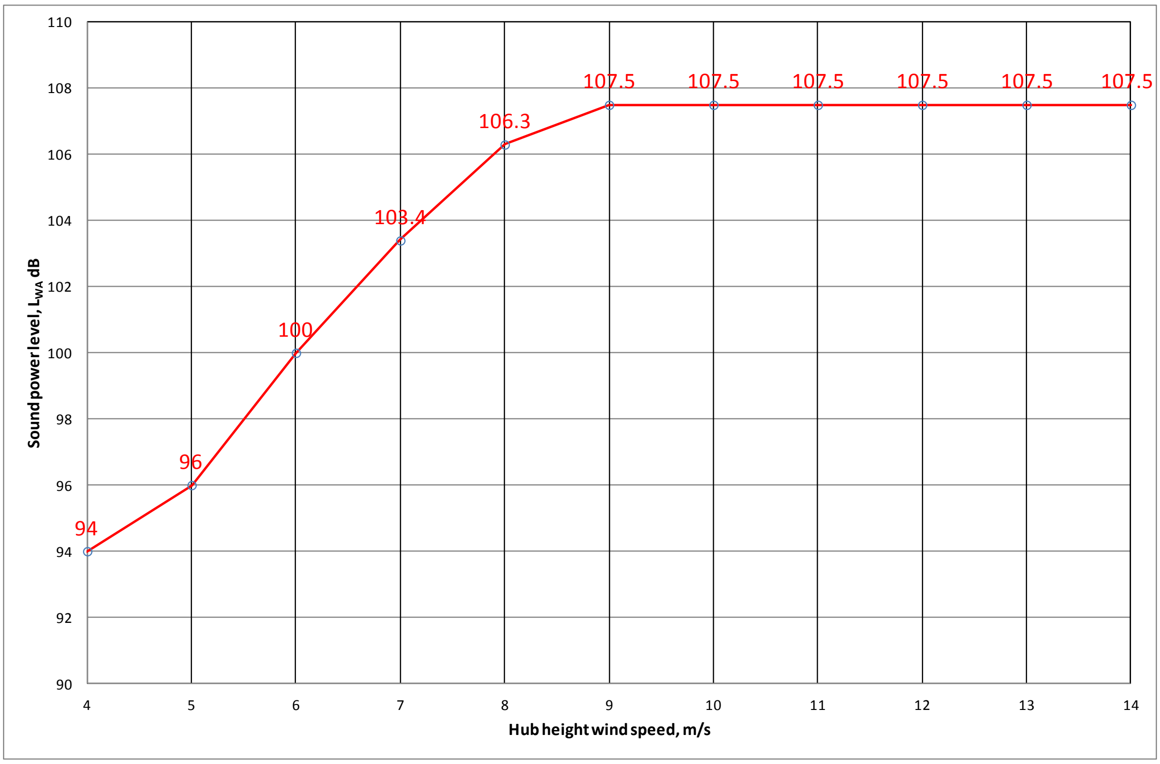
Table 8: Sound Power Levels at Hub Height, dB L_{WA}

	Hub Height wind speed (m/s)										
GE 3.4 – 137	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Sound power level, dB L_{WA}	93	95	99	102.4	105.3	106.5*	106.5	106.5	106.5	106.5	106.5

*Sound Power Level at rated wind speed

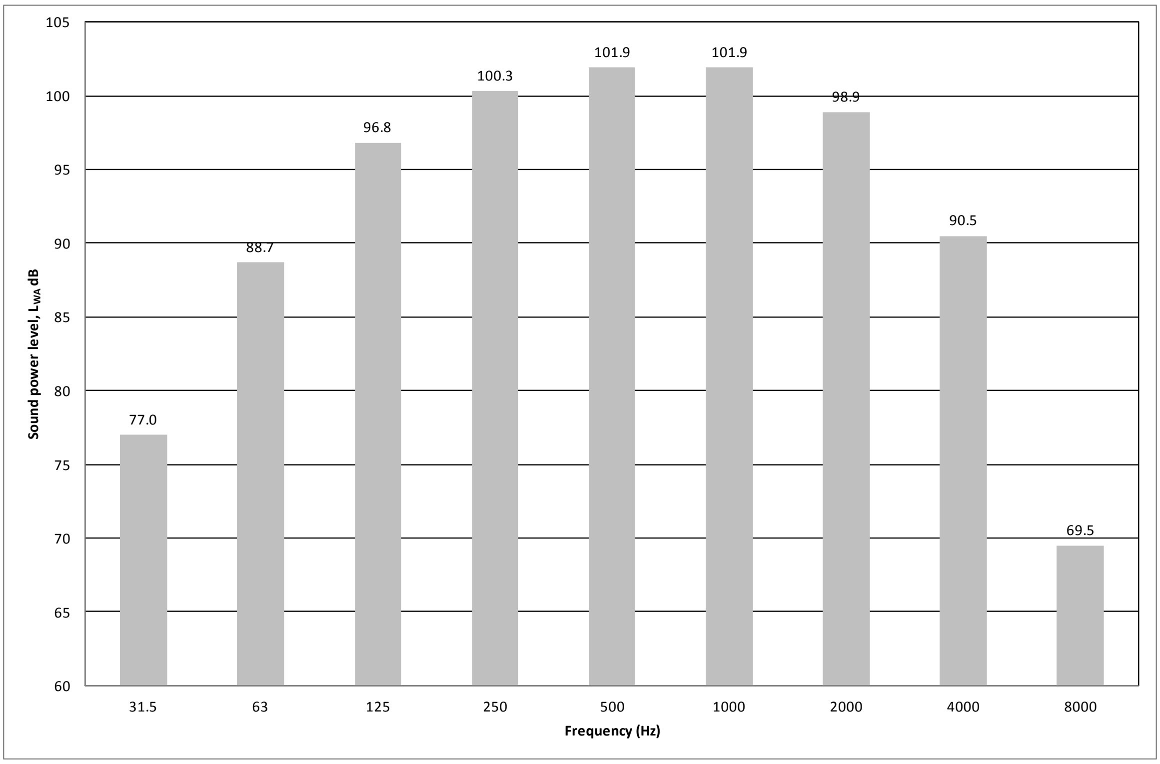
The sound power level is also presented graphically in Figure 1.

Figure 1: Sound power level vs. hub height wind speed



The A-weighted octave band sound power level spectrum from the assessed turbine at 9 m/s hub height wind speed is presented in Figure 2.

Figure 2: A-weighted octave band sound power level spectrum at 9m/s hub height wind speed



Sound power levels presented in Figure 2 are tabulated below.

Table 9: Octave band sound power level for GE 3.4-137, 9 m/s

	Octave Band Centre Frequency (Hz)									
	Overall	**31.5**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Maximum L_{WA} (dB)	107.5	77.0	88.7	96.8	100.3	101.9	101.9	98.9	90.5	69.5

Guaranteed sound power levels for the project would be supplied as part of a formal contract for the supply of turbines. As the project is still in its preliminary stages, the noise modelling presented herein has been based on the sound power levels presented in the GE specification adjusted by the addition of +1.0 dB to account for typical sound power level test uncertainties.

7.2 Prediction methodology

Preliminary predictions of operational noise from the proposed Mt Fyans Wind Farm have been undertaken on the basis of:

- The sound emissions of the candidate turbine as outlined in Section 7.1
- A 3D digital model of the site and surrounding environment
- International standards used for the calculation of environmental noise propagation, with input settings and adjustments specifically suited to wind farm noise assessment.

Details of the prediction methodology are summarised in Table 10 below. The prediction method is consistent with the procedures used to calculate operational noise levels during the planning stages of the project.

Table 10: Wind farm prediction methodology

Detail	Description
Software	Proprietary noise modelling software SoundPLAN version 7.4
Method	International Standard ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO 9613-2) Adjustments to the ISO 9613-2 method are applied on the basis of the guidance contained in the UK Institute of Acoustics publication *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise* (UK good practice guide). The adjustments are applied within the SoundPLAN modelling software and relate to the influence of terrain screening and ground effects on sound propagation. Specific details of adjustments are noted below.
Source characterisation	Each wind turbine is modelled as an incoherent point source of sound. The total sound of the wind farm is then calculated on the basis of simultaneous operation of all wind turbines and summing the contribution of each. Calculations of turbine to receiver distances and average sound propagation heights are made on the basis of the point source being located at the position of the hub of the turbine (100 m AGL). Calculations of terrain related screening are made on the basis of the point source being located at the maximum tip height of each turbine.
Terrain data	A digital model of the terrain for the site and surrounding areas on the basis of: Site and immediate environs: 1 m interval contour data supplied by HydroTas Surrounding environs: 10 m interval contour data provided by Spatial Datamart Victoria (Department of Environment, Land, Water and Planning)

Detail	Description
Terrain effects	Adjustments for the effect of terrain are determined and applied on the basis of the UK good practice guide. Valley effects: +3 dB is applied to the calculated noise level of a wind turbine when a significant valley exists between the wind turbine and calculation point. A significant valley is deemed to exist when the actual mean sound propagation height between the turbine and calculation point is 50 % greater than would occur if the ground was Terrain screening effects: only calculated if the terrain blocks line of sight between the maximum tip height of the turbine and the calculation point. The value of the screening effect is limited to a maximum value of 2 dB.
Ground conditions	Ground factor of G = 0.5
Atmospheric conditions	Temperature 10°C and relative humidity 70% This represents conditions which result in relative low levels of atmospheric sound absorption and is chosen on the basis of the UK good practice guide. The calculations are based on sound speed profiles[1] which increase the propagation of sound from each turbine to each receiver location, whether as a result of thermal inversions or wind directed toward each calculation point. The primary consideration for wind farm noise assessment is wind speed and direction. The noise level at each calculation point is assessed on the basis of being simultaneously downwind of every wind turbine at the site. Other wind directions in which part or the entire wind farm is upwind of the receiver will result in lower noise levels. In some cases, it is not physically possible for a receiver to be simultaneously downwind of each turbine and the approach is therefore conservative in these instances.
Receiver heights	1.5 m AGL

7.3 Preliminary predicted wind farm noise levels

Wind farm noise levels predictions have been carried out for a hub height wind speed of 9 m/s where the candidate turbine has reached its rated power and maximum noise emission. Results are presented below for receivers where the predicted wind farm noise levels are 35 dB or greater.

Table 11: Predicted A-weighted noise levels at hub height wind speed of 9 m/s, dB

House*	Predicted noise level, L_{Aeq}	House	Predicted noise level, L_{Aeq}
i15	40.5	i14	37.4
i1	39.8	u163	37.3
i11	39.4	i17	37.2
i8	38.9	u51	37.2
i12	38.7	u164	37
i19	38.7	u160	36.9
i6	38.3	u22	36.8
u58	38.3	u20	36.7
i7	38.2	u16	36.5
u17	38.2	i18	36.3
i13	38.1	u31	35.8
u47	38	u38	35.6
i5	37.8	u18	35.3
i16	37.8	u19	35.2

*The prefix 'i' refers to involved receivers which are dwellings on land that is part of the wind farm site and the prefix 'u' refers to uninvolved receivers which are dwellings that are outside of the site.

Preliminary noise contours are provided in Appendix G.

7.4 Preliminary wind farm noise assessment

Background noise monitoring for the purpose of establishing noise limits in accordance with NZS 6808:2010 is yet to be undertaken. In advance of conducting these surveys, a preliminary assessment can be made by comparing the predicted noise levels with the relevant base criteria (i.e. the minimum noise limit) provided by NZS 6808:2010.

To determine the applicable base limit(s) for the site, consideration has been given to whether or not a high amenity limit would be applicable to the receiver locations around the proposed wind farm.

In Section 5.1.2.a, the Victorian Guidelines states the following:

> *Under section 5.3 of the Standard, a 'high amenity noise limit' of 35 decibels applies in special circumstances. All wind farm applications must be assessed using section 5.3 of the Standard to determine whether a high amenity noise limit is justified for specific locations, following procedures outlined in clause C5.3.1 of the Standard. Guidance can be found on this issue in the VCAT determination for the Cherry Tree Wind Farm.*

The definition of a high amenity area provided in NZS 6808:2010 is specific to New Zealand planning legislation and guidelines. A degree of interpretation is therefore required when determining how to apply the concept of high amenity in Victoria. As recommended in the Victorian Guidelines, it is therefore appropriate to follow the guidance detailed in the Cherry Tree Wind Farm Pty Ltd v Mitchell Shire Council decisions.

Paragraph 53 of the Cherry Tree Wind Farm Decision states the following:

> *53. The Tribunal does not accept that the permit conditions need to refer to the High Amenity Area provisions of the New Zealand standard because it has not been established that any such area could reasonably be identified within the environs of this wind energy facility. […]*

Further justification for the above statement was provided in Paragraphs 107 to 109 of the Cherry Tree Wind Farm Interim Decision:

> *107. We were invited by the respondents to treat the subject land and the locality as a high amenity area. This invitation meets with the immediate conundrum that the language of the standard is not translatable to the Victorian planning framework. The "plan" referred to in section 5.3 is a plan as defined by the Resources Management Act of New Zealand. Section 43AA of that Act defines "plan" to mean "a regional plan or a district plan". No such animals exist under the Victorian legislation.*
>
> *108. Applying the standard mutatis mutandis to the Victorian experience we treat the plan referred to in the standard as a planning scheme approved under the Planning and Environment Act 1987. The Mitchell Planning Scheme does not anywhere expressly or by implication "promote a higher degree of protection of amenity related to the sound environment of a particular area". Approaching the matter by a process of elimination it can be seen with certainty that the controls contained within the Farming zone, which includes most of the locality, do not answer this description. The purpose of the Farming zone is to encourage agricultural use, which is not an inherently quiet land use. In fact reference to the zone purposes confirms that agricultural use is to be preferred to residential use if there is potential conflict between the two.*
>
> *109. Accordingly the Tribunal concludes that the subject land and its locality is not capable of designation as a high amenity area because it does not possess the necessary characteristics of such an area as specified in the NZ standard.*

As detailed in Paragraph 108, for the land surrounding the wind farm to be considered a high amenity area, the zoning of the land must be identified in the relevant planning scheme as promoting a higher degree of protection of amenity related to the sound environment.

The area surrounding the proposed wind farm is zoned Farming Zone. The Moyne Shire Council Planning Scheme dated 15 December 2016 does not specify the Farming Zone as promoting a higher degree of protection of amenity related to the sound environment.

Based on the above, following guidance from the VCAT determination for the Cherry Tree Wind Farm, as required by the Victorian Guidelines, the high amenity noise limit detailed in NZS 6808:2010 is not considered applicable for residential receivers in the vicinity of the proposed Mt Fyans Wind Farm. Accordingly, a minimum noise limit of 40 dB is applicable to the project and subsequently considered in this preliminary assessment.

Comparing the predictions to the applicable base limit, the results in Table 11 indicate that the predicted noise levels are below the minimum noise limit of 40 dB L_{Aeq} at all locations and wind speeds except for a single location, receiver i15, where the predicted noise level is marginally higher (0.5 dB) than 40 dB. The predictions therefore comply with the NZS 6808 criteria at the majority of locations. A definitive assessment of compliance at receiver location i15 will be dependent on the results of background noise monitoring carried out to determine the applicable wind-speed dependent noise limits. However, it is also noted that receiver i15 is an involved receiver and therefore the 40 dB limit may not apply at this receiver. It has only been compared to the 40 dB base limit for information purpose.

The results presented in Table 11 demonstrate that the proposed wind farm can be viably designed and operated to comply with the noise criteria defined in accordance with the Victorian guidelines and NZS 6808:2010. Revised noise predictions and compliance assessments will however need to be carried out as part of ongoing refinement of the wind farm layout during the environmental effects assessment. Layout modifications and alternative turbine selections would be considered as part of this process, where necessary, to assist with the development a proposed project which complies with the applicable noise criteria at all locations and wind speeds.

8.0 PRELIMINARY SUBSTATION NOISE PREDICTIONS

The proposed substations associated with the Mt Fyans Wind Farm are located within the site boundary and at the Mortlake Gas Power Station/Mortlake Substation.

Australian Standard AS 60076-10:2009 *Power transformers – Part 10: Determination of sound levels* (AS 60076-10:2009) provides a method for estimating transformer sound power levels. With reference to Figure ZA1 from AS 60076-10:2009, the estimated standard maximum sound power level is 95 dB L_{WA} for each 125 MVA transformer and 100 dB L_{WA} for the 250 MVA transformer. It is noted that transformers typically display tonality at 100 Hz, therefore a correction of +2 dB has been applied to the preliminary predicted L_{Aeq} noise levels to obtain the effective noise levels (L_{eff}).

Using the ISO 9613-2:1996 prediction methodology, the operational noise levels from the on-site substation is predicted to be 19 dB L_{eff} at House u47 which is the nearest affected residential property.

The operational noise level from the off-site substation is predicted to be 21 dB L_{eff} at the nearest affected residential property located approximately 1.5 km to the east of the substation.

The preliminary predictions therefore indicate that noise from both proposed substations associated with the Mt Fyans Wind Farm will be compliant with the night-time NIRV noise limit of 34 dB L_{eff} at the nearest residential properties.

9.0 SUMMARY OF CONSIDERATIONS TO BE INCLUDED IN THE DETAILED WIND FARM NOISE ASSESSMENT

The following provides a summary of the studies that should be carried out as part of a detailed noise assessment of the Mt Fyans Wind Farm.

- Background monitoring conducted at nearby residential properties to account for the factors outlined in section 5.1.4
- Noise limits derived from the background monitoring above
- A detailed noise assessment of the candidate turbine selection and wind farm layout developed as part of the preparation of the Planning Application (including any penalty for tonality if determined applicable based on test data) for a range of operational wind speeds
- A cumulative noise assessment of the proposed wind farm and nearby wind farms
- A detailed substation noise accounting for any revisions to the proposed substation transformer selection and location
- Consideration of corona and aeolian noise from high voltage overhead powerlines
- A detailed construction noise and vibration assessment including traffic noise associated with construction.

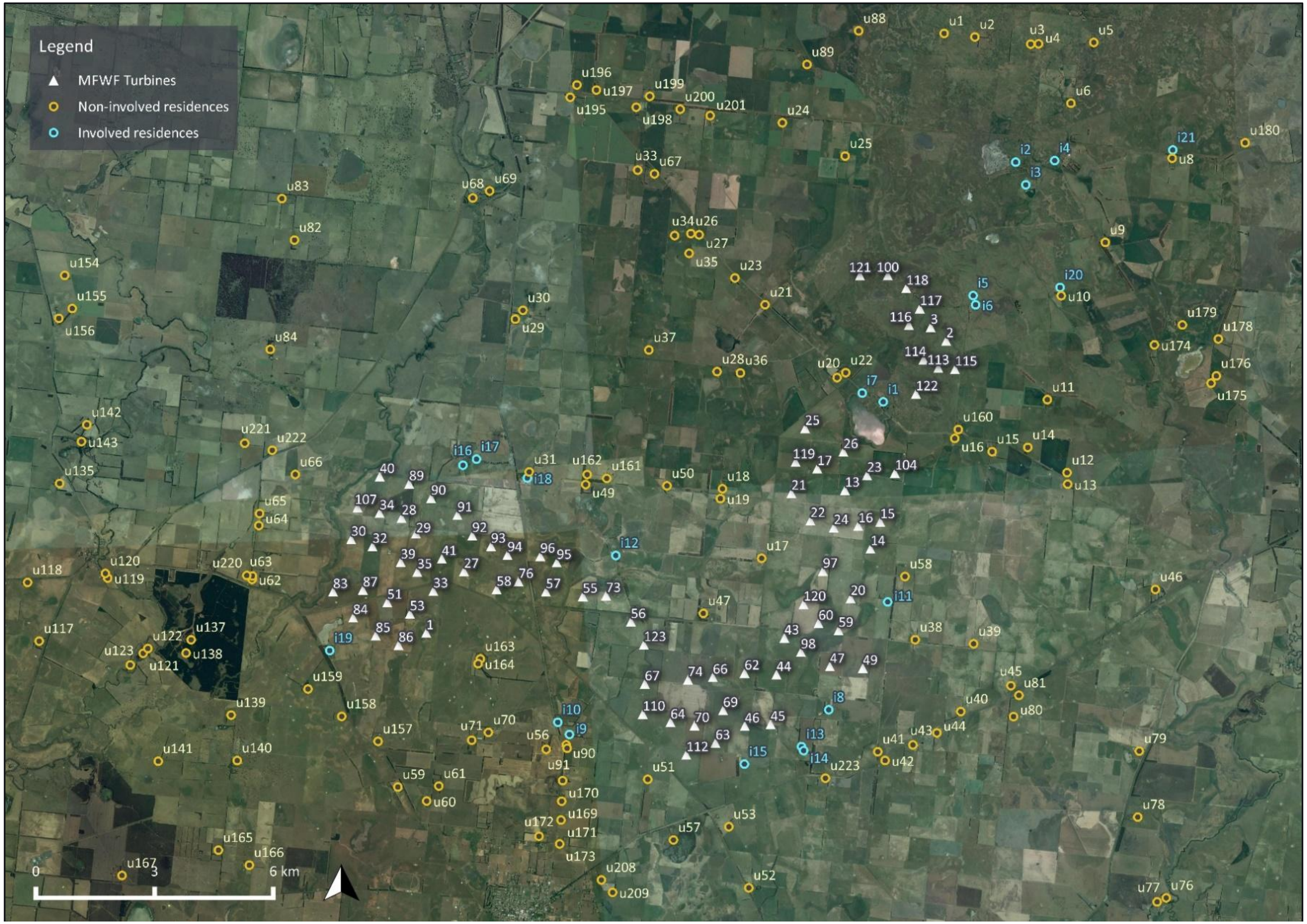
APPENDIX A ACOUSTIC TERMINOLOGY

dB	Decibel. The unit of sound level.
Frequency	Sound can occur over a range of frequencies extending from the very low, such as the rumble of thunder, up to the very high such as the crash of cymbals. Sound is generally described over the frequency range from 63Hz to 4000Hz (4kHz). This is roughly equal to the range of frequencies on a piano.
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
Infrasound	Sound at frequencies less than 20 Hz.
Octave Band	A range of frequencies where the highest frequency included is twice the lowest frequency. Octave bands are referred to by their logarithmic centre frequencies, these being 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz and 8 kHz for the audible range of sound.

Noise is often not steady. Traffic noise, music noise and the barking of dogs are all examples of noises that vary over time. When such noises are measured, the noise level can be expressed as an average level, or as a statistical measure, such as the level exceeded for 90% of the time.

L_{A90}	The A weighted noise level exceeded for 90% of the measurement period, measured in dB. This is commonly referred to as the background noise level.
L_{Aeq}	The A-weighted equivalent continuous sound level. This is commonly referred to as the average noise level and is measured in dB.
L_{WA}	The A-weighted sound power level is a logarithmic ratio of the acoustic power output of a source relative to 10^{-12} watts and expressed in dB.
	Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.

APPENDIX B SITE LAYOUT



The above site layout does not include the full extent of the receivers considered in the preliminary noise predictions. Refer to Appendix D for further details.

APPENDIX C TURBINE COORDINATES – MGA 94 ZONE 54

The following table sets out the coordinates of the proposed eighty-one (81) turbine layout (data supplied by HydroTas on 8 November 2016).

Table 12: Proposed turbine coordinates – MGA 94 Zone 54

WTG	Easting [m]	Northing [m]
1	656460	5790935
2	670053	5797447
3	669683	5797814
13	667255	5793844
14	667804	5792329
15	668094	5792993
16	667532	5792924
17	666591	5794437
20	667222	5791110
21	665899	5793857
22	666334	5793136
23	667837	5794186
24	666912	5792919
25	666350	5795470
26	667278	5794817
27	657513	5792423
28	656026	5793868
29	656364	5793450
30	654718	5793413
32	655246	5793201
33	656707	5791976
34	655480	5794031
35	656333	5792486
39	655933	5792758
40	655543	5794949
41	656974	5792776
43	665487	5790222
44	665229	5789313
45	664998	5788072
46	664344	5788067
47	666588	5789430
49	667417	5789331
51	655528	5791766
53	656079	5791439
55	660470	5791599
56	661643	5790882
57	659547	5791776
58	658306	5791917
59	666865	5790326
60	666371	5790536
62	664424	5789401
63	663577	5787690
64	662476	5788287

WTG	Easting [m]	Northing [m]
66	663619	5789349
67	661891	5789292
69	663823	5788499
70	663078	5788162
73	661057	5791580
74	662987	5789325
76	658874	5792076
83	654177	5792123
84	654641	5791437
85	655181	5790946
86	655743	5790670
87	654932	5792119
89	656272	5794717
90	656802	5794319
91	657438	5793852
92	657780	5793310
93	658237	5793010
94	658637	5792766
95	659867	5792496
96	659463	5792681
97	666567	5791843
98	665882	5789841
100	668686	5799190
104	668542	5794195
107	654930	5794201
110	661791	5788534
113	669809	5796775
114	669450	5797010
115	670227	5796715
116	669137	5797905
117	669438	5798302
118	669129	5798836
119	666057	5794638
120	666026	5791040
121	667984	5799234
122	669202	5796158
123	661931	5790280
112	662821	5787437

APPENDIX D RECEIVER LOCATIONS – MGA 94 ZONE 54

The following table sets out the involved and non-involved receiver locations considered in our preliminary assessment (coordinates supplied by HydroTas on 23 June 2016 and on 8 November 2016).

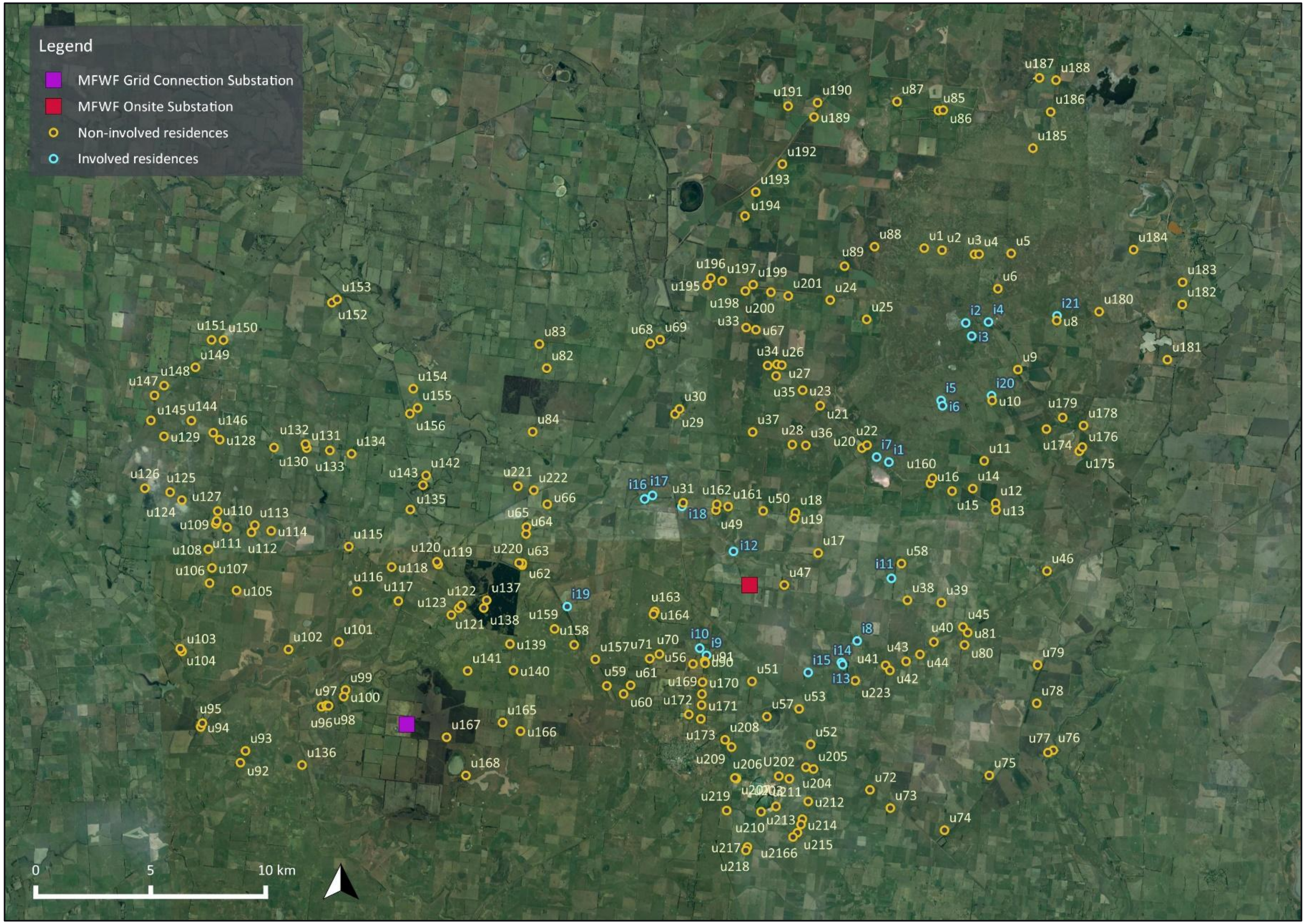
Table 13: Receiver locations – MGA 94 Zone 54

Receiver	Easting	Northing	Receiver	Easting	Northing
i1	668366	5796007	u108	638579	5794137
i2	672096	5801832	u109	638968	5795213
i3	672315	5801244	u110	639020	5795336
i4	673083	5801807	u111	639452	5795038
i5	670806	5798538	u112	640497	5794750
i6	670853	5798302	u113	640666	5795047
i7	667848	5796262	u114	641359	5794756
i8	666489	5788335	u115	644683	5793856
i9	659907	5788137	u116	644921	5791893
i10	659634	5788463	u117	646683	5791354
i11	668152	5790956	u118	646487	5792851
i12	661369	5792570	u119	648514	5792830
i13	665743	5787451	u120	648464	5792950
i14	665790	5787346	u121	649286	5790877
i15	664272	5787104	u122	649413	5790989
i16	657659	5795094	u123	648942	5790602
i17	658010	5795224	u124	637568	5796340
i18	659261	5794668	u125	637078	5796716
i19	653996	5790642	u126	635996	5796961
i20	673012	5798602	u127	639094	5795765
i21	676079	5801883	u128	639379	5798859
u1	670501	5805193	u129	636970	5799158
u2	671271	5805054	u130	641716	5798366
u3	672667	5804783	u131	643131	5798250
u4	672865	5804777	u132	643091	5798422
u5	674261	5804722	u133	644130	5798081
u6	673586	5803227	u134	645063	5797876
u8	676051	5801677	u135	647457	5795293
u9	674227	5799664	u136	642042	5784513
u10	673028	5798392	u137	650518	5791140
u11	672510	5795794	u138	650369	5790813
u12	672886	5793923	u139	651406	5789178
u13	672883	5793631	u140	651485	5788020
u14	671937	5794623	u141	649491	5788132
u15	671031	5794574	u142	648238	5796726
u16	670110	5794968	u143	648075	5796312
u18	664168	5794078	u144	638203	5799760
u19	664100	5793833	u145	636447	5799885

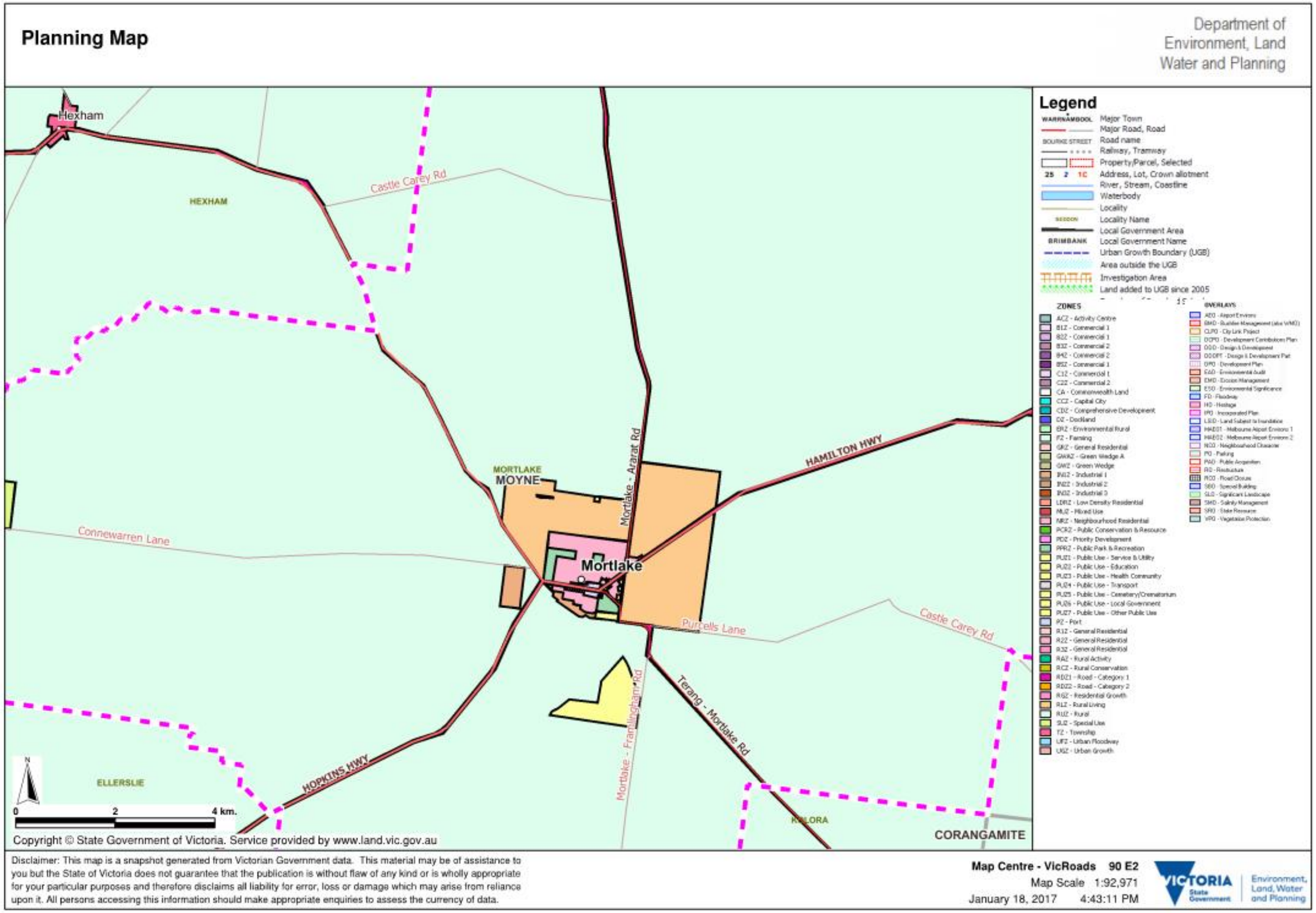
Receiver	Easting	Northing	Receiver	Easting	Northing
u20	667239	5796693	u146	639120	5799174
u21	665542	5798647	u147	636673	5800961
u22	667466	5796803	u148	637118	5801358
u23	664826	5799371	u149	638526	5802064
u24	666274	5803204	u150	639820	5803168
u25	667803	5802264	u151	639304	5803207
u26	663785	5800561	u152	644634	5804485
u27	663993	5800516	u153	644869	5804612
u28	664223	5797038	u154	647924	5800525
u29	659216	5798689	u155	648059	5799679
u30	659424	5798901	u156	647706	5799453
u31	659320	5794817	u157	655068	5788274
u33	662546	5802245	u158	654191	5788963
u34	663373	5800537	u159	653385	5789708
u35	663709	5800065	u160	670219	5795187
u36	664808	5796967	u161	661264	5794527
u37	662537	5797694	u162	660778	5794657
u38	668783	5789961	u163	657783	5790185
u39	670252	5789762	u164	657720	5790068
u40	669817	5788076	u17	665042	5792261
u41	667657	5787198	u59	655494	5787092
u42	667827	5786965	u60	656198	5786692
u43	668554	5787312	u61	656528	5787050
u44	669179	5787577	u165	650865	5785793
u45	671124	5788645	u166	651619	5785367
u46	674925	5790836	u167	648393	5785313
u47	663483	5790969	u168	649125	5783601
u49	660723	5794408	u169	659602	5786467
u50	662772	5794242	u170	659659	5786983
u51	661808	5786877	u171	659554	5785992
u52	664181	5783979	u172	658973	5785621
u53	663779	5785550	u173	659481	5785393
u56	659296	5787799	u174	675300	5797001
u57	662358	5785309	u175	676666	5795943
u58	668629	5791571	u176	676810	5796117
u62	652155	5792563	u178	676921	5797047
u63	652169	5792646	u179	676038	5797457
u64	652413	5793907	u180	677917	5801946
u65	652450	5794208	u181	680747	5799673
u66	653416	5795135	u182	681552	5802022
u67	662964	5802125	u183	681626	5802992
u68	658341	5801811	u184	679588	5804540

Receiver	Easting	Northing	Receiver	Easting	Northing
u69	658779	5801961	u185	675500	5809226
u70	657866	5788320	u186	676371	5810753
u71	657432	5788151	u187	675979	5812259
u72	666626	5781838	u188	676692	5812114
u73	667459	5780992	u189	666085	5811193
u74	669750	5779879	u190	666277	5811802
u75	671848	5782130	u191	664986	5811737
u76	674696	5783044	u192	664580	5809237
u77	674460	5782957	u193	663343	5808102
u78	674110	5785126	u194	662808	5807091
u79	674256	5786787	u195	660963	5804193
u80	671139	5787862	u196	661152	5804491
u81	671310	5788388	u197	661635	5804332
u82	653775	5801043	u198	662613	5803834
u83	653526	5802107	u199	662971	5804087
u84	652986	5798326	u200	663719	5803713
u85	671502	5811127	u201	664463	5803502
u86	671709	5811127	U202	662708	5782691
u87	669729	5811625	u203	663156	5782549
u88	668348	5805396	u204	663908	5783002
u89	666990	5804632	u205	664233	5782904
u90	659809	5787879	u206	660861	5782704
u91	659827	5787791	u207	660796	5782739
u92	639372	5784787	u208	660475	5784418
u93	639626	5785285	u209	660738	5784086
u94	637748	5786447	u210	661838	5781198
u95	637831	5786608	u211	662498	5781385
u96	643052	5786985	u212	663912	5781508
u97	643253	5787028	u213	663607	5780756
u98	643359	5787007	u214	663533	5780529
u99	644137	5787642	u215	663356	5780185
u100	644042	5787366	u2166	663153	5780010
u101	643983	5789748	u217	661145	5779706
u102	641777	5789563	u218	661069	5779562
u103	637150	5789776	u219	660345	5781346
u104	637082	5789903	u220	652028	5792668
u105	639685	5792268	u221	652191	5796005
u106	638538	5792664	u222	652872	5795783
u107	638683	5793313	u223	666293	5786618

APPENDIX E SUBSTATION LOCATION



APPENDIX F PLANNING MAP



APPENDIX G NOISE CONTOUR MAP