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Abbot Point Growth Gateway Project  
Terrestrial Noise Impact Assessment

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## Executive Summary

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Advisian to conduct a noise impact assessment of the Queensland Government's proposed Abbot Point Growth Gateway Project.

The objective of this study is to identify whether the impacts from the Project noise emissions and the existing T1 terminal operations might affect the:

- Habitat value of the Caley Valley Wetland (Wetland) and adjoining terrestrial areas.
- Acoustic amenity of existing noise sensitive residential receptors.

The methodology for the study can be simplified into the following two (2) basic elements:

1. For the terrestrial fauna component, develop appropriate assessment criteria for noise emissions from Project activities.
2. Predict noise emissions from Project activities and assess them against the criteria for human and terrestrial fauna receptors.

To accurately assess the impact of noise sources it is necessary to categorise these sources based on the nature of the noise emission. For the purposes of this study noise sources were divided into:

- Noise of a steady or continuous nature such as that from compressors, generators, pumps.
- Single event, fluctuating or short-term noise events such as mobile plant.

The noise criteria detailed in **Table 1** identifies the likely effects of predicted noise levels from operations on terrestrial fauna found in the study area. The thresholds identified in this table are based on a review of the scientific and published literature, experience of senior terrestrial ecologists with experience of noise impacts on wildlife and extrapolation from other relevant projects. Although the scientific and published literature is inconclusive regarding the precise noise thresholds for noise impacts on terrestrial fauna the thresholds identified are considered adequate for the assessment presented in this report.

**Table 1 Likely Effects on Terrestrial Fauna as a Result of the Project**

<b>Disturbance effect</b>	<b>Steady or continuous noise sources LAeq(15minute) (dBA)</b>	<b>Episodic (single event or short-term) noise sources LAmx (dBA)</b>	<b>Typical bird activities potentially impacted</b>
Occasional (Alert) – minor impacts on habitat use for most species	50 to 65	45 to 60	Nesting
Frequent (Alarm or Flight) – moderate impacts on habitat use	65 to 85	60 to 80	Nesting Roosting
Avoidance of area – by most of the population of some species	≥85	≥80	Nesting Roosting Foraging

Note: Masking impacts, particularly on smaller songbirds, may occur at noise levels of approximately the alert threshold right up until the point of avoidance.

Note: LAmx limits have been specifically set below the LAeq limits in recognition of considerations related to startle responses.

## Executive Summary

Only minor impacts on terrestrial fauna are anticipated at noise levels below 65 dBA LAeq(15minute) and 60 dBA LAmax, resulting in increasing levels of alert response from at least some terrestrial fauna. Thus, the most relevant noise criteria for this study are 65 dBA LAeq(15minute) and 60 dBA LAmax.

Using these thresholds, steady or variable noise emission models were developed in SoundPLAN to predict noise emissions from the Project under neutral and two worst-case weather conditions (i.e. temperature inversion and temperature inversion with wind). **Table 2** presents a summary of the approximate percentage of area of the Wetland predicted to exceed the likely disturbance thresholds for terrestrial fauna present in the Wetland. Predicted Project noise levels also include existing worst case operational noise from T1 as it is assumed this terminal will be operating concurrently with the Project.

**Table 2 Percentage of the Wetland Area Predicted to Exceed Disturbance Thresholds**

Scenario	Threshold level (dBA)	Percentage (%) of the Wetland above threshold level <sup>1</sup>		
		Neutral weather	Temperature inversion and no wind	Temperature inversion and 3 m/s wind
Existing T1 Operational Noise	Alert – 45 dBA LAmax	32	32	32
	Alarm/flight – 60 dBA LAmax	3	3	3
Existing T1 Operational Noise	Alert – 50 dBA LAeq(15min)	3	6	4
	Alarm/flight – 65 dBA LAeq(15min)	<0.5	<0.5	<0.5
<b>Scenario 1 -</b> Topsoil stripping & stockpiling	Alert – 45 dBA LAmax	34	35	36
	Alarm/flight – 60 dBA LAmax	3	4	3
<b>Scenario 2 -</b> Embankment preparation	Alert – 45 dBA LAmax	34	36	36
	Alarm/flight – 60 dBA LAmax	3	4	3
<b>Scenario 3 -</b> Embankment construction	Alert – 45 dBA LAmax	34	35	36
	Alarm/flight – 60 dBA LAmax	3	3	3
<b>Scenario 4 -</b> Pond liner installation	Alert – 50 dBA LAeq(15min)	3	6	4
	Alarm/flight – 65 dBA LAeq(15min)	<0.5	<0.5	<0.5
<b>Scenario 5 -</b> Dredging	Alert – 50 dBA LAeq(15min)	3	8	5
	Alarm/flight – 65 dBA LAeq(15min)	<0.5	<0.5	<0.5
<b>Scenario 6 -</b> Management of dredged material	Alert – 45 dBA LAmax	33	35	35
	Alarm/flight – 60 dBA LAmax	3	3	3
<b>Scenario 7 -</b> Post-dredging management	Alert – 45 dBA LAmax	34	35	36
	Alarm/flight – 60 dBA LAmax	3	3	3

Note 1: Percentage area calculations based on the Department of Environment and Heritage Protection mapping of Caley Valley Wetland.

## Executive Summary

The findings of the terrestrial fauna assessment identified the following:

- Noise from the Project will have either no overall effect or only marginally increase the extent of Wetland predicted to exceed the disturbance thresholds due to the Project being largely confined within the area previously allocated for T2. The noise contour maps show that the largest area of the Wetland calculated to exceed the disturbance thresholds is attributable to existing rail operations.
- In terms of cumulative noise, under both neutral and worst case weather conditions, large areas of the Wetland will likely experience minor alert responses as a result of steady noise emissions and variable noise emissions during the Project, at least prior to habituation.
- Variable noise emission levels equal to or above 60 dBA L<sub>Amax</sub>, having potential to result in alarm or flight responses from terrestrial fauna, are predicted to occur over a maximum percentage area of 4% of the Wetland under inversion conditions during Scenario 1 and Scenario 2. This is largely attributable to existing rail operations (included as part of the cumulative assessment) and therefore is not regarded as new source of noise associated with the Project.
- Steady noise emission levels associated with relatively short-term pond liner installation works (i.e. Scenario 4) and longer-term dredging works (i.e. Scenario 5) equal to or above 65 dBA L<sub>Aeq(15minute)</sub>, which have potential to result in alarm or flight responses from many terrestrial fauna, are predicted to occur over a maximum percentage area of less than 0.5% of the Wetland.
- Potential alert responses are predicted over a percentage area of up to 36% for variable noise emissions (L<sub>Amax</sub>) and up to 8% for steady noise emissions (L<sub>Aeq</sub>).
- Although the findings of the study indicate that large areas of the Wetland are almost certain to experience some minor occasional alert impacts to terrestrial fauna, only very small areas are likely to be exposed to noise levels that would initiate more substantial response behaviours.

Predicted noise emission levels at the nearest noise sensitive residential receptor (located approximately 12 km south-west of T1), are presented in **Table 3** with respect to the most stringent of the EPP(Noise) acoustic quality objectives. The noise levels in brackets in **Table 3** denote cumulative noise emission levels from the Project and existing T1 terminal operational noise.

**Table 3 Predicted Project Noise Emission Levels at the Nearest Sensitive Receptor**

Modelled Scenario	EPP(Noise) Acoustic Quality Objective	Predicted Noise Emission Level (dBA)		
		Neutral Weather	Temperature Inversion	Wind (2 m/s) and Temperature Inversion
Scenario 1	45 dBA LA1,adj	< 5 (20)	11 (21)	9 (20)
Scenario 2	45 dBA LA1,adj	6 (20)	14 (21)	12 (21)
Scenario 3	45 dBA LA1,adj	6 (20)	14 (21)	12 (21)
Scenario 4	35 dBA LAeq,adj	< 5 (29)	< 5 (30)	< 5 (30)
Scenario 5	35 dBA LAeq,adj	< 5 (29)	7 (30)	7 (30)
Scenario 6	45 dBA LA1,adj	< 5 (20)	9 (20)	9 (20)
Scenario 7	45 dBA LA1,adj	< 5 (20)	9 (20)	8 (20)

The noise modelling results presented in **Table 3** indicate compliance with the most stringent of the EPP(Noise) acoustic quality objectives during all stages of the Project under neutral and worst case weather conditions. Further, cumulative noise emission levels also comply with the acoustic quality objectives during all stages of the Project.

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## 1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Advisian to conduct a noise impact assessment of the Queensland Government's proposed Abbot Point Growth Gateway Project (the Project). The Project is part of ongoing developments at Abbot Point, approximately 25 km north of Bowen.

This report summarises the methodology and relevant findings of the assessment study with particular reference to Queensland State legislation.

### 1.1 The Project

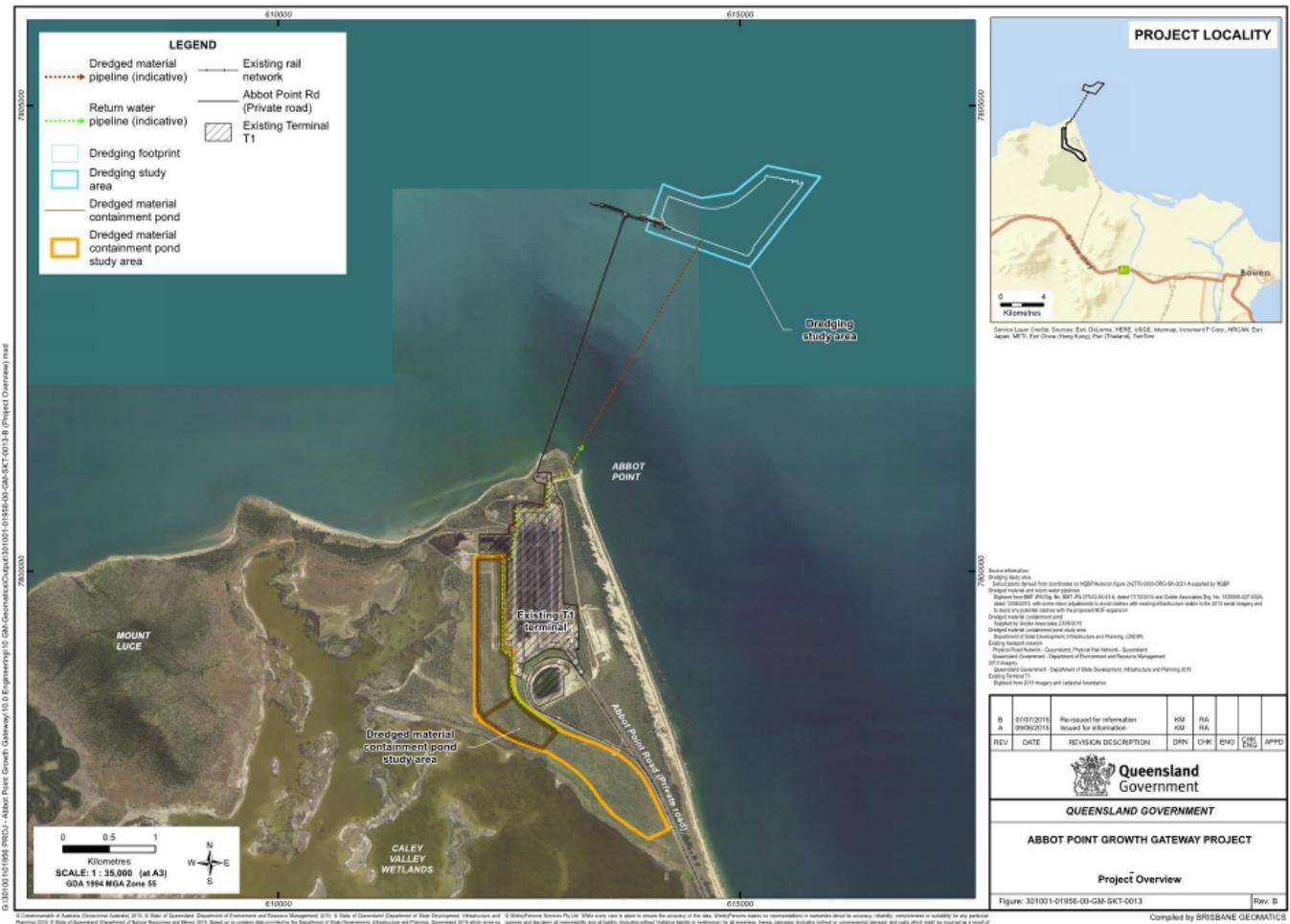
The Port of Abbot Point is located approximately 25 km North of Bowen on the North Queensland coast. The existing Terminal (T1) at the Port commenced operations in 1984, with infrastructure developed to support the export of coal from the Bowen Basin. Further expansion is required to meet the increasing demand for coal export through the Port.

The Abbot Point Growth Gateway Project will develop infrastructure to support development of planned Terminal 0 (T0). Dredging of berth pockets and arrival/departure apron is required to provide safe shipping access to the T0 offshore facility. The Project involves::

- 1 Construction of an onshore dredged material containment pond (DMCP) within the area previously allocated for the development of Terminal 2 (T2);
- 2 Dredging of approximately 1.1 million m<sup>3</sup> (Mm<sup>3</sup>) of previously undisturbed seabed within the Port of Abbot Point using a medium to large Cutter Suction Dredger (CSD) to dredge all materials;
- 3 Relocation of the dredge material via pipeline to the DMCP and offshore discharge of return water; and
- 4 Ongoing management of the dredged material including its removal, treatment and beneficial reuse within the port area and the State Development Area.

The relevant areas of the proposed actions are detailed in **Figure 1**.

Figure 1 Proposed Dredging and Onshore Placement Area



## **2 KEY TERMS**

Explanation of the key technical terminology contained within this Report is provided below.

### **2.1 Sound Level (or Noise Level)**

The terms sound and noise are almost interchangeable, except that in common usage noise is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear (and those of other species) responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (dB or dBL) scale reduces this ratio to a more manageable size by the use of logarithms.

### **2.2 A-weighted Sound Pressure Level**

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to human hearing.

There are numerous alternative frequency weightings available but none specifically designed for the assessment of noise affecting fauna. For the purposes of this Report, A-weighting has been used.

### **2.3 Sound Power Level**

The sound power of a source is the rate at which it emits acoustic energy. As with sound pressure, sound power levels (SWL) are expressed in dB units, but are identified by the symbols SWL.

The relationship between sound power and sound pressure may be likened to an electric radiator, which is characterised by a power rating but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

### **2.4 Change in Sound Pressure Levels**

For human perception, a change of 1 dBA or 2 dBA in the level of a sound is considered to be indiscernible, while a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness.

### **2.5 Typical Sound Pressure Levels**

**Table 4** lists examples of typical sound pressure levels.

**Table 4 Example of Typical Sound Pressure Levels**

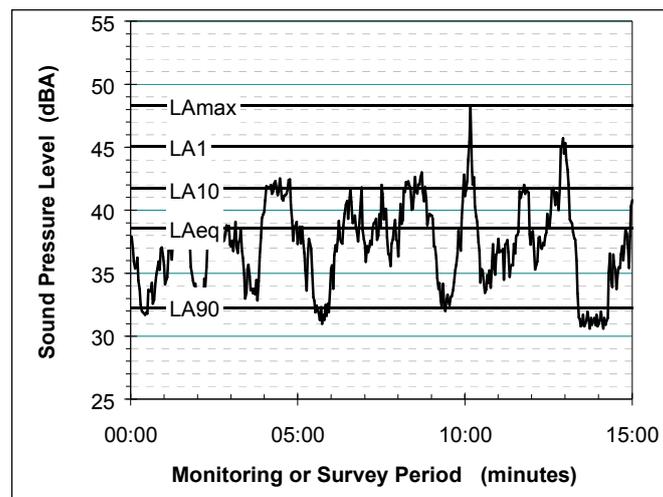
Sound Pressure Level (dBA)	Typical Example	Subjective (Human) Evaluation
130	Threshold of pain	Intolerable
120	Metal hammering	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 metres (m)	
90	Dog bark at 1 m	Very noisy
80	Cicadas at 1 m	
70	Noise level directly adjacent to a busy main road	Loud
60	Ambient noise level in urban area close to main roads	
50	Typical rural environment with high insect noise or close to a main road	Moderate to quiet
40	Ambient noise level in a rural environment with light breezes and some noise from insects, birds and distant traffic	
30	Ambient noise level in a typical rural noise environment in the absence of insect noise and wind	Quiet to very quiet
20	Ambient noise level in remote and quiet rural environment away from main roads with no wind and no insect noise	
		Almost silent

## 2.6 Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels (LAN), where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time and LA10 the noise exceeded for 10% of the time.

**Figure 2** presents a hypothetical 15 minute noise measurement, illustrating various common statistical indices of interest.

**Figure 2 Hypothetical 15 Minute Noise Measurement**



Of particular relevance to this study, are:

- LA<sub>max</sub> The maximum A-weighted noise level during any given measurement period.
- LA<sub>eq</sub> The A-weighted equivalent noise level (basically the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

## **2.7 Noise Propagation**

Provided the receiver is in the far-field of the noise source, noise levels will reduce as a receiver moves further away from the source. This is due to spreading of the noise source energy over distance. For a simple point source (for example, a motor) the theoretical reduction in noise levels is 6 dBA per doubling of distance. For a line source (for example, a busy road) the theoretical reduction is 3 dBA per doubling of distance. In reality however other factors affect noise propagation. These include ground absorption, air absorption, acoustic screening and meteorological effects.

## **2.8 Meteorological Effects**

At distances over 500 m, meteorological affects (for example, local weather and atmospheric conditions) can substantially enhance or impair noise propagation. The most influential meteorological conditions on noise propagation are wind speed and direction and the occurrence of temperature inversions. Ambient air temperature and humidity and atmospheric pressure also affect noise propagation although to a lesser extent than wind and temperature inversions.

## **2.9 Wind Conditions**

Wind conditions enhance noise propagation when the wind is blowing from a noise source towards a receiver and therefore noise levels at the receiver will be higher under these conditions. The wind can be thought to carry the noise in the direction it is heading. Where winds blow from the receiver towards the source, the propagation of noise is impaired and therefore lower noise levels will be experienced at the receiver.

It is important to consider the effect of prevailing wind conditions when assessing noise propagation over larger distances. Wind roses, which graph long term variations in wind speed and direction, are a useful tool for analysing prevailing wind conditions where available.

## **2.10 Temperature Inversions**

Temperature inversions are a meteorological phenomenon where a layer of cold air is trapped at the ground surface under a layer of warmer air. Temperature inversions enhance noise propagation because sound travelling away from the ground is reflected back down from where the colder air meets the warmer air due to the change in pressure between the two layers.

Conditions that favour the development of a strong surface inversion are nights with calm winds and clear skies. Calm winds prevent warmer air above the surface from mixing down to the ground, and clear skies increase the rate of cooling at the Earth's surface. It is therefore important to consider the effect of temperature inversions when assessing noise propagation over larger distances and during night-time periods.

### 3 SCOPE AND OBJECTIVES

The objective of this study is to identify whether the impacts from the Project noise emissions and the existing T1 terminal operations might affect the:

- Habitat value of the Caley Valley Wetland (Wetland) and adjoining terrestrial areas.
- Acoustic amenity of existing noise sensitive residential receptors.

Based on the degree of potential noise impact, improvement measures and management controls would then be determined.

The study scope involved:

- Development of an emissions model based on information provided by Advisian on anticipated Project activities, with appropriate assumptions where detailed information is not available (**Section 4**).
- Establishment of baseline noise characteristics based on existing information from the Abbot Point Coal Terminal X110 Expansion for Ports Corporation of Queensland in 2009 (GHD 2009) (**Section 6.1**).
- Modelling of noise emissions from the proposed construction and operation activities and predicting noise levels arising from the Project (**Section 7**).
- Drawing on existing ecological studies for Abbot Point, specialist advice and international precedents, to determine appropriate noise impact criteria for ecologically sensitive receptors (**Section 7.1.1**).
- Assessment of the extents of identified ecologically sensitive areas within which the criteria is predicted to be exceeded (**Section 7.1.2**).
- The development of measures to reduce noise levels which are reasonably implemented in the event that adverse effects on ecologically sensitive receptors are predicted (**Section 8**).

### 4 STUDY METHODOLOGY AND ASSUMPTIONS

#### 4.1 Study Methodology

The methodology for the study can be simplified into the following two (2) basic elements:

1. For the terrestrial fauna component, develop appropriate assessment criteria for noise emissions from Project activities.
2. Predict noise emissions from Project activities and assess them against the criteria for human and terrestrial fauna receptors.

For point 1 above, the criteria for the study were derived from a combination of existing guidelines and legislation, the findings of a detailed literature review and guidance from experts, which is discussed in detail in **Section 7.3**.

For point 2 above, noise emissions from Project activities were predicted using 3-D computer noise modelling techniques and detailed information for the study. This information included the following:

- Detailed site data including existing topography and aerial imagery.
- Detailed long-term meteorological data for the area including wind speeds and direction.
- Engineering drawings of the Project layout, for example, the pipeline and DMCP design.
- Detailed mechanical plant list of all acoustically significant noise sources.

- Sound power level data for all acoustically significant noise sources associated with the Project.

The model was used to predict average ( $L_{Aeq(15\text{minute})}$ ) and maximum ( $L_{Amax}$ ) noise emissions from the Project.

#### **4.1.1 SoundPLAN**

In order to predict noise emission levels from proposed Project activities, a SoundPLAN (Version 7.3) noise model was developed. SoundPLAN is a software package which enables compilation of a computer model comprising a digitised ground map (containing ground contours and buildings), the location and acoustic sound power levels of potentially critical noise sources on site and the location of receivers for assessment purposes.

The model can calculate noise levels taking into account such factors as the source of sound power levels and locations, distance attenuation, ground absorption, air absorption and shielding attenuation, as well as meteorological conditions, including wind effects.

For the purposes of the assessment it was conservatively assumed that the ground across the Wetland was acoustically reflective, as would be the case during water-logged conditions.

#### **4.1.2 Industrial Noise Modelling**

The Conservation of Clean Air and Water Europe (CONCAWE 1981) prediction methodology was utilised within SoundPLAN. The CONCAWE prediction method is specially designed for large industrial facilities and incorporates the influence of wind effects and the stability of the atmosphere.

The statistical accuracy of environmental noise predictions using CONCAWE was investigated by Marsh (Applied Acoustics 15 – 1982). Marsh concluded that CONCAWE was accurate to  $\pm 2$  dBA in any one octave band between 63 hertz (Hz) and 4 kHz and  $\pm 1$  dBA overall.

#### **4.1.3 Meteorological Conditions**

In accordance with the Ecoaccess Planning for Noise Control (PNC) Guideline, consideration has been given to the effects of prevailing and worst case meteorological conditions (wind, temperature, humidity and temperature inversions) on noise propagation from the Project.

##### **4.1.3.1 Wind Effects**

PNC describes two alternative methods for assessing the effects of wind on noise emissions:

- by using a wind rose to determine whether wind is a feature based on the frequency of occurrence and wind speed and assessing the source-to-receiver components of winds that are relevant; and
- by assuming that wind is a feature of the area (foregoing the need to do a detailed assessment of long-term site wind conditions) and applying a maximum impact scenario.

In the absence of meteorological data for the Abbot Point area, meteorological modelling using The Air Pollution Model (TAPM) meteorological model (Version 4) was undertaken to calculate all required meteorological parameters required for the Cumulative Noise Assessment. TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which may be used to predict 3-D meteorological data and air pollution concentrations with no local data inputs required.

TAPM predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows users to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses). They are subsequently used in the model input to generate site-specific hourly meteorological observations at user-defined levels within the atmosphere.

In accordance with the PNC, the TAPM generated meteorological data was analysed for the following wind parameters:

- $\geq 30\%$  occurrence in any assessment period (day, evening or night) in any season;
- $\leq 3$  metres per second (m/s) source to receiver component; and
- 10 m height for wind speed.

Analysis of the TAPM generated meteorological data for 2009 noted that there were no calculated periods of wind speeds of up to 3 m/s occurring at least 30% of the time in any one season and assessment period. The peak wind occurrence was autumn nights where wind from the east-southeast occurred 28% of the time. TAPM meteorological data supplied by Katestone Environmental Pty Ltd for 2007 indicated a 42% occurrence of wind speeds up to 3 m/s during the autumn night-time period.

Notwithstanding the findings of the above analysis, the generation of more recent TAPM meteorological data was not considered necessary as the study includes assessment of potential worst case weather including prevailing wind.

#### 4.1.3.2 Temperature Inversion

The other meteorological effect to be considered in accordance with PNC is that of temperature inversions. PNC recommends the effects of temperature inversions should be assessed when they occur for 30% or more of the total evening and night-time period (6.00pm to 7.00am) during winter (June, July and August).

PNC describes two options for deciding on temperature inversion parameters to be used:

- use default parameters for temperature inversions and drainage-flow wind speed where inversions are present for at least 30% of the total night time during winter as specified; or,
- use parameters determined by direct measurement. Wind data should be collected at 10 m height.

In accordance with PNC, TAPM generated meteorological data was analysed for the following temperature inversion parameters (non-arid):

- 30% or more occurrence for night time (6.00 pm–7.00 am) period during winter (June, July, August); and
- moderate inversions (defined as 'F-class' Pasqual stability category for the purposes of the noise modelling).

Analysis of 2009 temperature inversion data for the Abbot Point region determined that an F-class Pasqual stability category had an occurrence of 52%. As noted in **Section 4.1.3.1**, more recent TAPM meteorological data was not generated as the study includes assessment of potential worst case weather including temperature inversion.

#### 4.1.3.3 Modelled Meteorological Parameters

Based on the above analysis of the meteorological data, the weather conditions used to assess the effect of neutral and worst case meteorological conditions are detailed in **Table 5**. The assessment for worst case weather is applied to all sensitive receptors due to the effects of the temperature inversion.

**Table 5 Meteorological Conditions – Neutral and Worst Case**

Parameter	Neutral Weather	Worst Case Weather	
		No Wind	Wind Enhanced
Temperature	10°C	10°C	10°C
Humidity	70%	90%	90%
Temperature inversion conditions (Pasqual stability class)	D	F	F
Wind speed and Direction	0 m/s	0 m/s	3 m/s from the south-east

#### 4.1.4 Noise Modelling Scenarios

To accurately assess the cumulative impact of noise sources it is necessary to categorise these sources based on the nature of the noise emission. For the purposes of this study Project noise sources were divided into:

- Noise of a steady or continuous nature such as that from compressors, generators, pumps.
- Single event, fluctuating or short-term noise events such as mobile plant.

The two primary noise metrics used to describe these noise emissions are:

- LAeq(15minute) – ‘Equivalent Continuous Noise Level’, sometimes referred to as the energy-averaged noise level. The LAeq(15minute) may be likened to a noise dose, representing the cumulative effect of all operating noise sources occurring within a 15 minute period.
- Single event maximum level – For the single event, fluctuating or short duration noise sources (referred to herein as variable), the maximum sound pressure level (LAmax) would be applicable.

From information supplied by Advisian, regarding proposed Project activities, scenarios were identified with the aim of covering the range of potential noise impacts across the varying stages of the Project.

For all of the below scenarios, this study assumes the existing T1 is operational, ensuring the “cumulative” effect of the proposed Project and T1 noise emissions is captured. In addition, a baseline noise scenario consisting of just existing T1 terminal operational noise has been included to demonstrate the potential contribution from the Project to the predicted cumulative emissions.

The scenarios relating to noise emissions from the various phases of the Project are summarised as follows:

- **Scenario 1** - Topsoil stripping and stockpiling for re-use.
- **Scenario 2** - Embankment subgrade preparation involving removal of unsuitable material to form a competent subgrade for embankment construction.
- **Scenario 3** - Bulk earthworks for external and internal embankment construction (using material won from on-site borrow areas supplemented by local quarries) and construction of the return water pipeline.
- **Scenario 4** - Pond liner installation on internal pond batters.
- **Scenario 5** - Dredging of the seabed within the Port of Abbot Point using a medium to large cutter suction dredge (CSD), relocation of the dredged material via pipeline to the DMCP and pumping tailwater via a return water pipe from the DMCP to an offshore discharge location within the Port of Abbot Point.
- **Scenario 6** - Short-term management of placed dredged material within the DMCP (biased towards the southern end of the DMCP closer to the Wetlands).

- **Scenario 7** - Post-dredging management and conditioning of the DMCP.

#### 4.1.5 Acoustically Significant Plant and Equipment

Acoustically significant plant and equipment likely to be utilised during each scenario is detailed in **Table 6**.

**Table 6 Acoustically Significant Plant and Equipment**

Plant	Scenario						
	1	2	3	4	5	6	7
Dozers	✓	✓	✓			✓	✓
Water Trucks	✓	✓	✓				
Tractor Ploughs	✓	✓	✓				
Scrapers	✓	✓	✓				
Cat 825 Compactors		✓	✓				
18 Tonne Pad Food Drum Roller		✓	✓				
Cat 14H Grader	✓	✓	✓				
Cat 16 Grader	✓	✓	✓				
Tractor with Laser Bucket	✓	✓	✓				
45 Tonne Dump Trucks	✓	✓	✓			✓	✓
Cat 965 Front End Loaders	✓	✓	✓			✓	✓
32 Tonne Excavators	✓	✓	✓				
45 Tonne Excavators	✓	✓	✓				
Smooth Drum Vibratory Rollers		✓	✓				
B-Doubles		✓	✓				
Pumps							✓
Franna Crane		✓	✓				
Welding Truck		✓	✓				
4 Tonne Telehandlers				✓			
Specialised Liner Equipment				✓			
Dredge Material Pumps					✓		
Cutter Suction Dredge					✓		
Generators				✓	✓		

**Table 7** lists the modelled SWLs for the items of mobile plant contained in the modelled scenarios. SWLs were obtained through SLR's databases.

**Table 7 SWL of Acoustically Significant Plant used for Noise Modelling**

Plant Item	Plant Noise Level Used in the Model	
	LAeq(15minute) SWL (dBA)	LAmx SWL (dBA)
Dozers	-	123
Water Trucks	-	112
Tractor Ploughs	-	108
Scrapers	-	116
Cat 825 Compactors	-	114
18 Tonne Pad Food Drum Roller	-	112
Cat 14H Grader	-	112
Cat 16 Grader	-	115
Tractor with Laser Bucket	-	116
45 Tonne Dump Trucks	-	116
Cat 965 Front End Loaders	-	115
32 Tonne Excavators	-	121
45 Tonne Excavators	-	122
Smooth Drum Vibratory Rollers	-	110
B-Doubles	-	111
Pumps	105	-
Franna Crane	-	111
Welding Truck	-	107
4 Tonne Telehandlers	106	-
Specialised Liner Equipment	83 - 89	-
Dredge Material Pumps	115	-
Cutter Suction Dredge	115	-
Generators	114	-

#### 4.1.6 Assumptions and Technical Limitations

##### 4.1.6.1 General Assumptions

Predicted Project noise levels will depend on the number of plant items and equipment operating at any one time and their precise location relative to the receiver(s). Therefore a sensitive receptor will experience a range of values representing 'minimum' and 'maximum' Project noise emissions depending on:

- The location of the particular Project activity. That is whether plant items were as close as possible to or further away from the reception point.
- The likelihood of the various items of equipment operating simultaneously.

The noise modelling predictions assume all equipment in each scenario is operating simultaneously. This can be considered 'worst case'. In the case of LAeq(15minute) predicted noise levels, SoundPLAN logarithmically adds all noise emission levels at any chosen point in the study area whereas LAmx predicted noise levels are determined by the highest noise level generated by a single item of plant at any given location in the model. In practice, maximum noise level events resulting from typical activities (ie multiple plant) are unlikely to occur at the same time preventing maximum noise levels from accumulating.

As stated in **Section 4.1.4**, this study assesses variable ( $L_{Amax}$ ) and steady ( $L_{Aeq}$ ) noise sources separately. In practice, variable noise source events associated with Project works may potentially be masked in areas where steady noise sources, such as coal wagon noise or conveyor drive noise, occur at higher noise levels. An assessment of scenarios where this may occur has not been carried out for this study due to the complexity of masking noise. While areas of masking have not been considered, the assessment of  $L_{Amax}$  variable noise levels for this study is considered to be conservative.

Representative SWLs for fixed and mobile plant items in the SoundPLAN noise model were obtained from SLR's extensive noise source database based on details of the fixed and mobile plant items provided by Advisian. It should be noted that the plant items detailed in this study are at this stage indicative of the plant required to complete the Project. The accuracy of the SoundPLAN noise model may be affected should plant be modified, moved (substantially) or replaced. Any major changes to plant can be updated in the SoundPLAN noise model as and when required.

All  $L_{Aeq}(15\text{minute})$  and  $L_{Amax}$  predictions of noise levels associated with the Project include existing worst case operational noise from T1 as it assumed this terminal will be operational during all modelled scenarios. An existing T1 terminal noise modelling scenario (i.e. baseline scenario) has been included to inform the predicted change in noise emission level attributable to the Project.

It is anticipated that some of the works assessed by this study, for example the dredging phase, would be conducted 24 hours a day, seven days a week.

Measurement of ambient noise levels at all potentially affected areas has not been carried out as part of this study; rather results from previous measurements (GHD 2009) have been used where practicable. Where ambient levels have not been measured for an area of interest, ambient noise levels have been inferred from measurement locations where it is believed the relative proximity to the major source of ambient noise (i.e. T1) is similar. Where ambient levels have been inferred in this manner, the representative location has been specifically identified in the analysis for reference purposes.

Noise levels associated with personal vehicle movements have not been predicted as part of the study. It is understood the majority of the workforce would be bussed in from the proposed accommodation camps using existing roads (e.g. Bruce Highway and Abbot Point Road) where practicable. Noise from proposed bus movements would likely be perceived as part of the existing road network for which some level of habituation, by terrestrial fauna, would be expected.

## 5 POLICY CONTEXT AND LEGISLATIVE FRAMEWORK

Applicable statutory requirements for noise emissions associated with the Project are given in the:

- *Queensland Environmental Protection Act 1994* (EP Act) reprinted as in force on 2 July 2015; and
- *Queensland Environmental Protection (Noise) Policy* (EPP(Noise)) reprinted as in force on 1 January 2012.

The Environmental Protection Act 1994 (EP Act) enables the framework for environmental assessments to be developed in Queensland. The EP Act is applicable to all members and bodies in the community, including industry and governmental. It provides a method for governmental departments to incorporate environmental factors into their decision-making process.

A summary of the objective of the EP Act is as follows:

*The object of the Environmental Protection Act 1994 is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.*

The Act, Section 440R states the following for building works:

1. A person must not carry out building work in a way that makes an audible noise—

(a) on a business day or Saturday, before 6.30a.m. or after 6.30p.m.; or

(b) on any other day, at any time.

The reference in subsection (1) to a person carrying out building work—

(a) includes a person carrying out building work under an owner-builder permit; and

(b) otherwise does not include a person carrying out building work at premises used by the person only for residential purposes.

Thus, Project activity between the hours of 6.30 am to 6.30 pm Monday to Saturday, excluding public holidays is not normally subject to numerical noise limits, providing the machinery being used is in good working condition.

The EP Act allows the Environmental Minister to produce Environmental Protection Policies, designed to protect environmental aspects in Queensland. The EPP (Noise) was developed under this framework and the most recent revision was published in 2008 and was in force as of 1 January 2009.

The purpose of the EPP(Noise) is to achieve the objective of the Act in relation to protecting Queensland's acoustic environment while allowing for development that improves the total quality of life. The EPP(Noise) defines the values to be protected as the qualities of the acoustic environment that are conducive to protecting the health and biodiversity of ecosystems.

The EPP(Noise) includes long term acoustic quality objectives, where it is intended that the objectives be progressively achieved as part of achieving the purpose of the EPP(Noise) over the long term. The EPP(Noise) acoustic quality objectives documented in the Policy, which are relevant to the Project is detailed in **Table 8**.

**Table 8 EPP(Noise) Acoustic Quality Objectives**

Sensitive Receptor	Time of Day	Acoustic Quality Objectives (Measured at the Receptor) dBA		Environmental Value
		LAeq,adj,1hr	LA1,adj,1hr	
Dwelling (for outdoors)	Daytime and evening	50	65	Health and wellbeing
Dwelling (for indoors)	Daytime and evening	35	45	Health and wellbeing
	Night-time	30	40	Health and wellbeing, in relation to the ability to sleep
Protected area, or an area identified under a conservation plan under the <i>Nature Conservation Act 1992</i> as a critical habitat or an area of major interest	Any time	The level of noise that preserves the amenity of the existing conservation area		Health and biodiversity of ecosystems

As some stages of the construction and operation of the Project are expected to occur 24 hours a day, the night-time internal acoustic quality objectives will be most stringent. As the Abbot Point SoundPLAN noise model predicts external noise emission levels only, a conservative noise reduction of 5 dBA between indoor and outdoor noise (ie a facade noise reduction) has been assumed.

Accordingly, the limiting night-time acoustic quality objectives are:

- 35 dBA LAeq,adj (external)
- 45 dBA LA1,adj (external)

Assessment of compliance of the Project against the acoustic quality objectives has been conservatively carried out by assessing the modelled Project LAmax noise emission levels against the LA1,adj acoustic quality objective.

The impact of a project on community values relating to noise is normally evaluated using statutory regulations and policies, such as the EPP(Noise) which describe acceptable levels of noise from various sources for human receptors.

In situations where statutory regulations or policies do not nominate numerical limits for a particular ecosystem such as terrestrial fauna, it is common practice to refer to relevant Australian or internationally recognised standards or research literature that define acceptable levels of noise in similar contexts. Such literature can serve an advisory function to regulatory organisations and may be adopted by statutory authorities for the purpose of defining regulatory levels.

A detailed review of literature relating to potential noise impacts to terrestrial fauna is provided in **Section 7.1.1**.

## 6 EXISTING CONDITIONS

### 6.1 Acoustical Environment

Measurement of the existing acoustical environment in the Abbot Point area has not been carried out for the study because the findings of an earlier noise study (GHD 2009) were considered to be relevant for the present study.

As part of the earlier noise study, an extensive noise monitoring program was carried out on behalf of North Queensland Bulk Ports (NQBP) for the proposed T2 and T3 terminals. The details and findings of this study are summarised in the following sections.

#### 6.1.1 Noise Monitoring Locations

Drawing on the earlier study, those noise monitoring locations considered to be relevant are summarised in **Table 9** and shown in **Figure 3**.

**Table 9 GHD's X110 Terminal Proposed Development Noise Monitoring Locations**

Site	Location	Detail	Measurement Dates	
			Start	Finish
Location 03	Abbot Point Road	Residential dwelling located off Abbot Point Road. Monitoring undertaken across road and not at dwelling (note dwelling no longer exists).	9/10/08	16/10/08
Location 04	Wetland site	Access track adjacent to Wetland to the west of the existing port facility.	9/10/08	16/10/08
Location 05	Concrete slab (near hill)	Concrete slab to the north west of the site.	9/10/08	16/10/08



## 6.1.2 Noise Monitoring Results

**Table 10** presents a summary of the results from the noise monitoring carried out by GHD (2009). The GHD Report states data collected over the periods of time where the average wind speeds were greater than 5 m/s, or when rainfall has occurred was considered invalid and removed from the results.

**Table 10 GHD (2009) Noise Monitoring Results**

Site	Rating background noise level LA90 (dBA)			Ambient noise level LAeq (dBA)		
	Day	Evening	Night	Day	Evening	Night
Location 03	40	42	37	58	54	50
Location 04	49	49	46	54	53	51
Location 05	33	36	32	41	46	46

Note: The rating background noise level is essentially the typical lowest noise level and is determined from the measured background noise levels (LA90) for each period. Background noise levels (LA90) are the measured noise levels exceeded for 90% of the time.

From the noise monitoring results in **Table 10** it is considered that, of the three (3) monitoring locations relevant to this study, Location 4 was most impacted by noise emission from T1. Location 5 had the lowest background and ambient noise levels due to remoteness from the terminal and transport corridors. Ambient noise sources identified during the noise measurements included:

- Existing port facilities.
- Rail noise.
- Natural noise including wind, birds and insects.

## 6.2 Existing Terrestrial Fauna

Terrestrial fauna species diversity within the APSDA has been previously recorded from a number of desktop and field surveys. A summary of the relevant terrestrial fauna studies is presented in **Table 11**.

**Table 11 Summary of Terrestrial Fauna Survey Results**

Fauna Group	Database records (Wildlife Online)	Broader Wetland area surveys reported for X110 (GHD 2010)	Ecoserve surveys (Abbot Point and Caley Valley Wetland) (2007)
Amphibians	1	3 Dry 5 Wet Total 7	5 Dry 12 Wet Total 12
Reptiles	0	19 Dry 13 Wet Total 24	21 Dry 21 Wet Total 29
Birds	118	111 dry 139 wet Total 153	104 Dry 149 Wet Total 164
Mammals	0	27 Dry 10 Wet Total 30	19 Dry 21 Wet Total 26

### 6.3 Nearest Noise Sensitive Residential Receptor

The nearest noise sensitive residential receptor to the Port of Abbot Point is located approximately 12 km south-west of T1 and approximately 840 m north of the Bruce Highway. The locality of the nearest noise sensitive residential receptor is shown in **Figure 4**.

**Figure 4** Nearest Noise Sensitive Residential Receptor to the Port of Abbot Point



Image Source: Google Earth

## 7 NOISE IMPACT ASSESSMENT

### 7.1 Terrestrial Fauna Assessment

#### 7.1.1 Environmental Context

The potential effects of noise on terrestrial fauna include physical damage to hearing organs, increased energy expenditure or physical injury while responding to noise, interference with normal animal activities, and impaired communication. The ongoing impacts of these effects can include habitat loss through avoidance, reduced reproductive success and increased mortality.

There are no current government policies or other widely accepted guidelines as to noise levels or thresholds of relevance for terrestrial fauna, partly because the effects of noise on most fauna species are poorly understood (Larkin *et al* 1996, Brown 2001; OSB 2003).

This limited understanding of the effects of noise on fauna is understandable when the following points are considered:

- Responses to noise disturbance cannot be generalised across species or genera.
- Studies of one species cannot be extended to other species.
- Responses even of individuals within a single species may vary.
- Hearing characteristics are species-specific – for example, noise impacts on humans are determined using a frequency weighting filter (A-weighting) which corresponds to human hearing characteristics, determined through laboratory testing. The frequency-dependent hearing characteristics of fauna cannot be determined in this way.
- When studying the effects of noise on fauna, it can be difficult to separate noise effects from other sensory disturbing effects (for example, visual or olfactory cues).
- Experimental research in a laboratory is not always applicable in a natural setting.

As with humans, an animal's response to noise can depend on a variety of factors including noise level, frequency distribution, duration, number of events, variation over time, rate of onset, noise type, existence and level of ambient noise, time of year and time of day. The animal's location, age, sex, and past experience may also affect their response to noise.

Despite the difficulties associated with assessing noise impacts on animals, there are a few studies that can assist in drawing some general conclusions. The literature in the field has been collated in a number of reviews including AMEC (2005) (noise from mining operations), Dawe and Goosem (2008) (an Australian study on road traffic noise impacts), Mancini *et al* (1988) (effects of aircraft noise and sonic booms), and the United States Department of Transportation Federal Highways Administration (US FHWA 2004) (road traffic noise impacts). Some key findings of these reviews are summarised in the following sections of this Report.

#### **7.1.1.1 Impacts on Particular Fauna Groups**

##### **Invertebrates**

Mancini *et al* (1988) describes several studies on the effects of noise on insects. In some cases, noise has been studied with a view to controlling pest insects such as meal-moths and flour beetles, with some success in reducing hatching from the larval stage. Some studies have shown reduced lifespan in insects exposed to noise, and reduced number of eggs produced by females.

Some insects (including bees) stop moving when exposed to high noise levels. Honey bees ceased moving for up to 20 minutes in response to frequencies of approximately 200 Hz – 2,000 Hz with intensities varying from 107 – 119 dB, and did not appear to habituate to the sound (Mancini *et al* 1988).

##### **Amphibians**

Sound influences the activities of most amphibians and plays a substantial role in the reproductive behaviour of many, but not all, species (Mancini *et al* 1988). Dawe and Goosem (2008) consider that the degree to which traffic noise affects frog densities remains unclear, although some factor associated with roads and traffic has been shown to reduce frog populations.

In a report on nocturnal noise and amphibians in tropical rainforests of the Kuranda Range in Northern Queensland, (Goosem *et al* 2007), a decline in population densities of at least one frog species was attributed to road noise, with impacts up to 200 m from the road. Noise levels near the road were approximately 60 dB.

While specific noise levels, which may result in amphibians abandoning habitats or being injured, are not available in the literature, personal observations and experience indicate that amphibians are very sensitive to noise. Even the minor noises of researchers approaching habitats where amphibians are calling can cause a cessation of calling by individuals in close proximity. Conversely, it is common to find some frog species calling in ponds immediately adjacent to roads or railway lines.

### Reptiles

Sound perception appears to be subordinate in importance to vision and chemoreception in the activities of most reptiles. However, studies have shown that certain desert reptiles are sensitive to low-intensity sound (Manci *et al* 1988). Noise may be of more adaptive significance for nocturnal species because full use cannot be made of vision. Critical environmental sounds are often of relatively low intensity (for example, the movement of insect prey and predators such as snakes and owls).

Some studies reviewed by Manci *et al* (1988) indicate hearing damage to some lizard species after exposure to steady noise levels above 95 dB.

### Birds

Measures of absolute auditory sensitivity in a wide variety of bird species show a region of maximum sensitivity between 1 kHz – 5 kHz, with a rapid decrease in sensitivity at higher frequencies. The data suggest that in this frequency range birds show a level of hearing sensitivity that is similar in most respects to that found for the most sensitive mammals, with avian performance clearly inferior above and below this range of frequencies (Manci *et al* 1988).

The general conclusion of the US FHWA review (2004) is that some (although not all) bird species are sensitive to road traffic noise (at least during breeding), and that the distances over which this effect is observed can vary considerably (from a few metres to more than 3 km away). Observations also include reduced bird diversity and density of bird life near roads, and in some cases this is associated with average noise levels above 50 dBA.

Dawe and Goosem (2008) state that:

*'Anthropogenic noise can also trigger flight and alert responses in birds and altered behaviour after the noise disturbance, which can lead to reduced breeding success, at noise levels ranging from 65–85 dB(A). Complete habituation to such disturbance does not always occur, even in less noise-sensitive species'*

An investigation by the US Fish and Wildlife Service (US FWS) (2004) provides some relevant data for the effects of noise on the Marbled Murrelet and the Northern Spotted Owl (reproduced in **Table 12**). The former is an oceanic feeder and nests in old-growth forests, and the latter strictly occupies forests. As there is very little information specific to Australian birds, the noise thresholds from the US FWS have been used to inform this study.

**Table 12 Noise Thresholds for Responses by North American Birds**

Effect Threshold	Defined as	Noise level
Detectability	Where the noise is detectable but a Murrelet or Spotted Owl does not show any reaction.	4 dB above baseline noise level
Alert	Where the Murrelet or Spotted Owl shows apparent interest by turning its head or extending its neck.	'could not be documented with any precision' therefore 'subjectively placed between the detectability and harassment/injury threshold' Alert – 57 dBA L <sub>Max</sub>
Disturbance	Where the Murrelet or Spotted Owl shows avoidance of the noise by hiding, defending itself, moving the wings or body, or postponing a feeding.	'could not be documented with any precision' therefore 'subjectively placed between the detectability and harassment/injury threshold' Disturbance – 70 dBA L <sub>Max</sub>
Harassment/injury	Where the Murrelet or Spotted Owl is injured, defined as an adult flushed from the nest or the young missing a feeding.	92 dBA L <sub>Max</sub>

A further study (Awbrey *et al* 1995) determined that Californian Gnat-catchers (with a call of approximately 50 dB) had a masking distance of 15.2 m from the edge of the road, and did not occur where the road noise was greater than 69 dB. However, this species also successfully bred near an airport with noise levels in excess of 70 dB.

A study of road noise in Victoria (Parris and Schneider 2008) revealed reductions in populations of the Grey Shrike-thrush and Grey Fantail adjacent to busy roads, with those species becoming undetectable at sites with road noise levels of 67 and 72 dB respectively.

As mentioned previously, it has been reported that jet fighter over-flights had no substantial effect on egrets in Florida (Black *et al* 1984), and that aircraft noise levels of 85 dB(A) were required to elicit escape behaviour in the Crested Tern (Brown 1990).

## Mammals

Manci *et al* (1988) state that:

*'Sound levels above about 90 dB are likely to be adverse to mammals and are associated with a number of behaviours such as retreat from the sound source, freezing, or a strong startle response. Sound levels below about 90 dB usually cause much less adverse behaviour. Laboratory studies of domestic mammals have indicated that behavioural responses vary with noise types and levels, and that domestic animals appear to acclimate to some sound disturbances'*

The US FHWA review notes that some mammals avoid roads and that in some cases this avoidance behaviour has been attributed to noise.

### 7.1.1.2 Abbot Point Growth Gateway Project

The relevant issues with respect to terrestrial fauna with respect to the Project include:

- The location of activities themselves relative to the Wetland and the nature of the works.
- For the adjoining Wetland, which occupies a substantial area (in excess of 5,000 hectares), there is:
  - A seasonal cycle of drying out of the Wetland through the winter and early spring, gradual filling in the early part of the wet season, a period of maximum Wetland levels (during the main part of the wet season in late spring and summer), and subsequently the return to a gradual drying out period.

- A consequent focus of breeding activities by most terrestrial fauna (particularly waterbirds and Wetland birds) during the wet season.
- A variation in the use of habitats and resources present between the dry season and wet season, with Wetland and wading birds, as well as amphibians, dominating during the wet season, and species typical of more xeric grasslands present during the dry season.

As a result of those circumstances, the array of species likely to occur close to the APSDA will vary during the year, with Wetland species populations expanding towards the work areas during the wet season and moving away during the dry season. There are also a substantial number of nomadic or migratory bird species, the majority of which would be absent during the dry season.

For the purposes of this study, several groups of terrestrial fauna are considered of particular relevance, particularly the smaller Wetland bird species (such as the grebes, ducks, sandpipers, curlews, whimbrels), larger wading birds (such as the herons, Black-necked Stork and Magpie Goose) and the amphibians present in the Wetland. Species typical of the Wetland were identified during investigations of the Wetland and the project area over the last four to five years (Eco Logical Australia 2014).

### **Noise Disturbances**

With respect to the impacts of noise on terrestrial fauna, although there is a substantial body of research and observations, there are no clear or well-defined thresholds for species' tolerance, even on an individual species basis. While there are many observations with respect to the responses of breeding and non-breeding birds to aircraft over-flights, as well as a number of studies relating to bird densities in proximity to roads, these studies are inconclusive with respect specific thresholds at which different responses are elicited in different species. Furthermore, many of those observations and studies have been unable to differentiate between the impacts of noise itself and the other associated impacts of the movement of vehicles, aircraft or people.

There are a number of considerations with respect to noise disturbances which would result from the proposed Project including:

- The types of noise emitted –continuous noise (for example, pumps and generators) and episodic or short duration and/or intermittent noise (for example, mobile plant during excavation works).
- The types of response elicited – ranging from the masking of calls, to a scale of responses from alert to avoidance (or abandonment) of habitats.
- Variations in the responses of different species, and even of individuals within a single species, to different noise disturbances.
- The interactions between noise disturbances and bird activities.

### **Types of Noise**

The responses of terrestrial fauna to noise disturbances will vary depending upon the type of noise. Generally continuous noise, i.e. noise produced by generators while operating, is more readily tolerated by terrestrial fauna (particularly birds) than episodic noise disturbances – for instance, haul trucks moving about the site). For example, where a Wetland bird has become habituated to the continuous (background) noise of generators, the episodic noise of a haul truck passby may still elicit an adverse response. Obviously, the levels of noise are also relevant in identifying the likely responses of terrestrial fauna.

It is also relevant to consider the period of the noise impact when addressing the likely responses and thresholds for terrestrial fauna. With respect to steady state noise sources such as generators and pumps, the most notable impact is likely to occur at start-up, when the equipment transitions from a quiet phase into the continuous noise of on-going activities. In that instance, initiation of the equipment may trigger an alert reaction from terrestrial fauna nearby, while the continuous noise of the equipment may be more readily tolerated by the same terrestrial fauna at the same distance.

Another relevant consideration is that terrestrial fauna are not adapted solely to a quiet environment. Heavy rainfall and thunderstorms can generate noise levels in excess of those likely from the Project and Abbot Point terminal facilities, and the terrestrial fauna present in the locality is clearly adapted to those circumstances. Conversely, the Project will impose additional noise stimuli as well as noise stimuli over longer periods than those natural weather events.

A high density of birds congregate seasonally in the detention basin near the existing terminal facilities (GHD location 4 (GHD 2009)). This Wetland is subjected to existing noise events from the current terminal operations, and the continuing use of impacted areas demonstrates the adaptability of many Wetland bird species and/or their tolerance of noise events typical of the Project.

### Responses to Noise Events

There are two relevant elements to the responses of terrestrial fauna to noise events:

- Masking – where noise affects communication between individuals of a species.
- Individual reactions – ranging from a mild alert response through to avoidance (or abandonment) of habitat including the possibility of nests being abandoned due to novel noise impacts.

The effects of masking are likely to be extremely varied. In general it can reasonably be assumed that small forest or grassland songbirds and smaller Wetland bird species, as well as many amphibians, will be adversely affected by masking to a greater degree than larger and/or more solitary species. For many of these species vocal communications are vital, and the smaller species at least would have difficulty calling at sufficient volumes to overcome masking when the noise stimuli are at high levels and/or are of long duration.

Individual responses to noise events, as noted above, will vary from a mild alert response (to relatively low noise events) through to avoidance or the abandonment of otherwise suitable habitat. The individual responses, summarised in **Table 13**, will vary between species and groups, as well as between individuals within a single species.

**Table 13 Likely Responses of Terrestrial Fauna (Birds and Amphibians) to Noise Stimuli**

Response	Birds	Amphibians
Alert	Looks briefly at source Turns head.	Briefly ceases calling
Alarm	Looks intently at source Changes position Shows intent to flee.	Ceases calling for a long period
Flight	Moves a short distance from source. Ceases feeding of young and/or foraging.	Temporarily moves away from source
Avoidance	Permanently vacates area or abandons nests.	Permanently vacates area

### Bird Activities

It is also to be noted that the likely responses of individual birds to the noise events which will arise from the Project will depend in part on the timing of noise in relation to the bird activities.

For example, it is likely a feeding heron standing in the Wetland 100 m from a continuous noise source (for example, a generator) may respond to the initiation of the generator by alarm and/or flight. Such a bird could reasonably be expected to move away from the noise source either by walking or flying, whereas a foraging heron may well move towards the generator, even closer than 100 m, because the generator noise will be perceived as a continuous and on-going source of background noise.

As discussed widely in the literature, and as regularly observed, many species become habituated to noise disturbances, particularly continuous noise such as that created by the generators. There is, however, as discussed above, likely to be some initial alert or alarm response to the start-up of continuous noise sources.

For example, the high densities of Wetland birds (on a seasonal basis) at the Wetland at GHD location 4 (GHD 2009), near the existing terminal facilities, demonstrate this habituation response. Noise levels of 54 dB at that location have not prevented Wetland species from using the sediment pond.

#### **7.1.1.3 Proposed Noise Criteria**

Initially, Project activities are likely to result in alterations in the behaviour of some of the fauna which inhabit the Wetland, particularly those individuals in close proximity to the activities.

Following the initial stages of operation of the DMCP, an equilibrium is likely to be reached, involving:

- Likely changes in species composition near the work areas, with less noise-tolerant species moving further away.
- Selection for more noise-tolerant individuals within the populations of species close to the work areas.
- Habituation of some species and individuals to the noise impacts (as is the case with the use by Wetland species in high densities in the sediment pond near T1).

It is clear that noise can have adverse effects on terrestrial fauna, with different species being more or less sensitive to noise. Extremely high noise levels can result in hearing damage or other physiological effects, although fauna generally avoid exposure to such impacts wherever possible. At lower noise levels, terrestrial fauna will generally avoid anthropogenic noise sources and prefer to occupy areas further from noise sources.

Generally, terrestrial fauna will avoid areas where very high noise levels (sufficient to cause injury or damage) occur. It is anticipated that noise levels in excess of 100 dBA, over extensive periods, would be required to create physical damage or injury. It is unlikely that any terrestrial fauna would remain in any area affected by noise levels of this order.

With regard to amphibians, there do not appear to be any specific noise criteria or thresholds published. However, given their small size and high dependence on vocalisations for communication and, particularly, breeding, it is anticipated most amphibians would at least be as sensitive to noise impacts as the smaller Wetland birds. Thus, it is likely that habitat close to noise sources where levels are higher than approximately 55 to 60 dBA will be vacated by some amphibian species.

On the basis of information in the literature, and personal observations, the Project would not be regarded as likely to involve substantial masking of bird species such as the raptors or large wading birds, such as herons and the Black-necked Stork, as individuals of these species are naturally louder and/or rely less on regular vocalisations. Conversely, the activities can be expected to adversely affect communication between smaller songbirds (such as the Reed Warbler, Grebes and Painted Snipe), as well as amphibians, in close proximity to the works.

It is noted, however, that where communication does become adversely affected, individuals of such species would be likely to move away from the noise source to a point where the noise no longer masks the bird's calls. Thus, masking of small songbirds' calls would likely result in avoidance behaviours, including the abandonment of previously occupied habitat. There is also some potential for other less sensitive species to dominate habitats close to work areas, and thus for a new equilibrium to be established in terms of the sharing of habitat by various species.

Further, some individuals of a species will be less tolerant to noise impacts than other individuals of the same species. The long-term effect (beyond areas adversely affected by high levels of noise) is likely to be natural selection for noise-tolerant individuals of a species closer to work areas.

The noise criteria identified in **Table 14** indicate the likely effects on terrestrial fauna of noise levels experienced at the Wetland as a result of the Project. As discussed above, the scientific and published literature is inconclusive with respect to the thresholds or threshold criteria for terrestrial fauna with respect to noise impacts. The thresholds identified in **Table 14** involve a combination of published information (as discussed above), personal observations and extrapolation. Although derived predominantly from studies of birds, the nominated thresholds in **Table 14** are considered relevant to all terrestrial fauna present in the APSDA.

**Table 14 Likely Effects on Terrestrial Fauna as a Result of Project Activities**

<b>Disturbance Effect</b>	<b>Steady or continuous noise sources LAeq(15min) (dBA)</b>	<b>Episodic (single event or short-term) noise sources LAmx (dBA)</b>	<b>Typical bird activities potentially impacted</b>
Occasional (Alert) – minor impacts on habitat use for most species	50 to 65	45 to 60	Nesting
Frequent (Alarm or Flight) – moderate impacts on habitat use	65 to 85	60 to 80	Nesting Roosting
Avoidance of area – by most of the population of some species	≥85	≥80	Nesting Roosting Foraging

Note: Masking impacts, particularly on smaller songbirds, may occur at noise levels of approximately the alert threshold right up until the point of avoidance.  
 LAmx limits have been specifically set below the LAeq limits in recognition of considerations related to startle responses.

Variations will doubtless exist in individual responses (as noted above), and a combination of those variations in tolerance to noise between individuals of a species, as well as habituation to noise impacts, meaning that the thresholds identified in **Table 14** may be somewhat conservative. Therefore, some individuals from several of the species affected will become at least partially habituated to the noise over time, and potentially recolonise areas that had initially been abandoned. The continuing use of the sediment pond near the T1 facility by high densities of Wetland birds at times demonstrates the adaptability of many of these species.

Conversely, as discussed above and in several of the reports on wildlife and noise previously cited, the noise tolerances and thresholds of different species of birds (and of other animals) vary considerably. As a consequence, it is possible some species are more sensitive than suggested by the values in **Table 14**, and individuals of some species may vacate habitat close to the noisiest work sites.

In this regard, an initial effect when Project activities first commences in a new area is likely, causing individuals of a number of species in near proximity to move away or abandon the area altogether. However, over time, an equilibrium is likely to be ultimately reached between more noise-tolerant specimens of the same species and longer term work areas. It is anticipated individuals of a number of species which would probably move some distance away during initial Project activities will return to disturbance areas, up to a point.

Some species within each of the groups are more tolerant than others. For example, it is likely several amphibian species, which are tolerant of urban or industrial sites, would be less affected by noise than others. Consequently, there is likely to be some localised population shifts as a result of the imposition of noise effects from the Project, with more noise-tolerant species becoming more prevalent closer to the works and less noise-tolerant species being excluded from close proximity. Similar effects would be anticipated with both the small forest and Wetland birds and even among the larger wading birds.

The likely impacts on forest birds adjacent to the Project along the base of Mount Luce and small songbirds occupying dried reeds or grasslands during the dry season are anticipated to be similar to those of the smaller Wetland birds. While some of these species appear (personal observations) to be more sensitive to visual triggers, episodic and/or high level noise is also likely to trigger an avoidance response, at least for birds in proximity to and with line of sight to the works.

#### **7.1.2 Predicted Noise Emission Levels Relevant to Terrestrial Fauna**

Noise contour plots of predicted noise emission levels from the modelled scenarios have been generated for the APSDA extents. The noise contours, presented in **Appendix A**, have been calculated at 1.5 m above ground level.

**Table 15** presents a summary of the approximate percentage of area of the Wetland predicted to exceed likely disturbance thresholds for terrestrial fauna present in the Wetland for the modelled scenarios with T1 operating.

**Table 15 Percentage of the Wetland Area Predicted to Exceed Disturbance Thresholds**

Scenario	Threshold level (dBA)	Percentage (%) of the Wetland above threshold level <sup>1</sup>		
		Neutral weather	Temperature inversion and no wind	Temperature inversion and 3 m/s wind
Existing T1 Operational Noise	Alert – 45 dBA LA <sub>max</sub>	32	32	32
	Alarm/flight – 60 dBA LA <sub>max</sub>	3	3	3
Existing T1 Operational Noise	Alert – 50 dBA LA <sub>eq</sub> (15min)	3	6	4
	Alarm/flight – 65 dBA LA <sub>eq</sub> (15min)	<0.5	<0.5	<0.5
<b>Scenario 1</b> - Topsoil stripping & stockpiling	Alert – 45 dBA LA <sub>max</sub>	34	35	36
	Alarm/flight – 60 dBA LA <sub>max</sub>	3	4	3
<b>Scenario 2</b> - Embankment preparation	Alert – 45 dBA LA <sub>max</sub>	34	36	36
	Alarm/flight – 60 dBA LA <sub>max</sub>	3	4	3
<b>Scenario 3</b> - Embankment construction	Alert – 45 dBA LA <sub>max</sub>	34	35	36
	Alarm/flight – 60 dBA LA <sub>max</sub>	3	3	3
<b>Scenario 4</b> - Pond liner installation	Alert – 50 dBA LA <sub>eq</sub> (15min)	3	6	4
	Alarm/flight – 65 dBA LA <sub>eq</sub> (15min)	<0.5	<0.5	<0.5
<b>Scenario 5</b> - Dredging	Alert – 50 dBA LA <sub>eq</sub> (15min)	3	8	5
	Alarm/flight – 65 dBA LA <sub>eq</sub> (15min)	<0.5	<0.5	<0.5
<b>Scenario 6</b> - Management of dredged material	Alert – 45 dBA LA <sub>max</sub>	33	35	35
	Alarm/flight – 60 dBA LA <sub>max</sub>	3	3	3
<b>Scenario 7</b> - Post-dredging management	Alert – 45 dBA LA <sub>max</sub>	34	35	36
	Alarm/flight – 60 dBA LA <sub>max</sub>	3	3	3

Note 1: Percentage area calculations based on the Department of Environment and Heritage Protection mapping of Caley Valley Wetland.

Comparing the seven modelled Project scenarios against the existing T1 operational noise emissions in **Table 15** indicates that noise from the Project will have either no overall effect or only marginally increase the extent of Wetland predicted to exceed the disturbance thresholds. This is due to the Project being largely confined within the area previously allocated for T2. The noise contour maps (in **Appendix A**) show that the largest area of the Wetland calculated to exceed the disturbance thresholds is attributable to existing rail operations.

From a cumulative perspective, variable noise emission levels equal to or above 60 dBA LA<sub>max</sub>, having potential to result in alarm or flight responses from terrestrial fauna (refer to **Section 7.1**), are predicted to occur over a maximum percentage area of 4% of the Wetland under inversion conditions during Scenario 1 and Scenario 2.

Steady noise emission levels associated with relatively short-term pond liner installation works (i.e. Scenario 4) and longer-term dredging works (i.e. Scenario 5) equal to or above 65 dBA LA<sub>eq</sub>(15minute), which have potential to result in alarm or flight responses from many terrestrial fauna, are predicted to occur over a maximum percentage area of less than 0.5% of the Wetland.

With regards to potential alarm or flight responses, the results in **Table 15** and the noise contours presented in **Appendix B** show the largest area of potential impact of the Wetland under temperature inversion only conditions. The presence of a 3 m/s wind from the south-east enhances the propagation of noise offshore and conversely attenuates noise in the direction of the Wetland (i.e. to the south).

Potential alert responses are predicted over a percentage area of up to 36% for variable noise emissions (LA<sub>max</sub>) and up to 8% for steady noise emissions (LA<sub>eq</sub>).

It is important to note many terrestrial fauna species, and many individuals within a single species, will become habituated to noise events over time. In particular, steady or continuous noise will become less likely to trigger responses as terrestrial fauna become used to those noises as part of the background noise. Even single event or short-term noise events are likely to be tolerated more readily over time as well as a result of habituation.

## 7.2 Residential Receptor Noise Assessment

This section details the predicted noise emission levels for the Project under neutral and worst case weather conditions during the modelled scenarios detailed in **Section 4.1.4**. Predicted noise emission levels at the nearest noise sensitive residential receptor, detailed in **Section 6.3**, are presented in **Table 16** with respect to the most stringent of the EPP(Noise) noise criteria presented in **Section 5**.

The noise levels in brackets in **Table 16** denote cumulative noise emission levels from the Project and existing T1 terminal operational noise.

**Table 16 Predicted Project Noise Emission Levels at the Nearest Sensitive Receptor**

Modelled Scenario	EPP(Noise) Acoustic Quality Objective	Predicted Noise Emission Level (dBA)		
		Neutral Weather	Temperature Inversion	Wind (2 m/s) and Temperature Inversion
Scenario 1	45 dBA LA1,adj	< 5 (20)	11 (21)	9 (20)
Scenario 2	45 dBA LA1,adj	6 (20)	14 (21)	12 (21)
Scenario 3	45 dBA LA1,adj	6 (20)	14 (21)	12 (21)
Scenario 4	35 dBA LAeq,adj	< 5 (29)	< 5 (30)	< 5 (30)
Scenario 5	35 dBA LAeq,adj	< 5 (29)	7 (30)	7 (30)
Scenario 6	45 dBA LA1,adj	< 5 (20)	9 (20)	9 (20)
Scenario 7	45 dBA LA1,adj	< 5 (20)	9 (20)	8 (20)

The noise modelling results presented in **Table 16** indicate compliance with the most stringent of the EPP(Noise) acoustic quality objectives during all stages of the Project under neutral and worst case weather conditions. Further, cumulative noise emission levels also comply with the acoustic quality objectives during all stages of the Project.

Based on the above assessment outcomes, no specific noise mitigation measures (i.e. to address impacts to residential receptors) are required for the Project.

## 8 MITIGATION AND MANAGEMENT

This report indicates that large parts of the Wetland are likely to experience some minor impacts (for example, occasional alert) on terrestrial fauna, such as Wetland birds and amphibians, as a result of noise emissions from the existing Port operations and proposed Project activities. Conversely, the vast majority of the Wetland would not be exposed to noise levels that would result in more tangible impacts such as avoidance, flight or alarm responses.

Generic good practice measures applicable to the operation of projects of this nature should be considered in the detailed design phase of the Project. Such measures may include some or all of the following:

- Using mobile plant with efficient muffler design.
- Avoid the coincidence of noisy plant working simultaneously, close together and adjacent to observed fauna.
- Briefing of the work team in order to create awareness of and to emphasise the importance of minimising noise emissions.
- Use of less noise intensive equipment, where reasonable and feasible.
- Keep equipment well maintained.
- Using quieter engines, such as electric instead of internal combustion and newer quieter equipment, wherever possible.
- Adjusting reversing alarms on plant to make them smarter, by limiting the acoustic range to the immediate danger area.

## 9 CONCLUSIONS

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Advisian to conduct a noise impact assessment of the Queensland Government's proposed Abbot Point Growth Gateway Project.

The findings of this study identified the following:

- Noise from the Project will have either no overall effect or only marginally increase the extent of Wetland predicted to exceed the disturbance thresholds due to the Project being largely confined within the area previously allocated for T2. The noise contour maps show that the largest area of the Wetland calculated to exceed the disturbance thresholds is attributable to existing rail operations.
- In terms of cumulative noise, under both neutral and worst case weather conditions, large areas of the Wetland will likely experience minor alert responses as a result of steady noise emissions and variable noise emissions during the Project, at least prior to habituation.
- Variable noise emission levels equal to or above 60 dBA  $L_{Amax}$ , having potential to result in alarm or flight responses from terrestrial fauna, are predicted to occur over a maximum percentage area of 4% of the Wetland under inversion conditions during Scenario 1 and Scenario 2. This is largely attributable to existing rail operations (included as part of the cumulative assessment) and therefore is not regarded as new source of noise associated with the Project.
- Steady noise emission levels associated with relatively short-term pond liner installation works (i.e. Scenario 4) and longer-term dredging works (i.e. Scenario 5) equal to or above 65 dBA  $L_{Aeq(15minute)}$ , which have potential to result in alarm or flight responses from many terrestrial fauna, are predicted to occur over a maximum percentage area of less than 0.5% of the Wetland.
- Potential alert responses are predicted over a percentage area of up to 36% for variable noise emissions ( $L_{Amax}$ ) and up to 8% for steady noise emissions ( $L_{Aeq}$ ).
- Although the findings of the study indicate that large areas of the Wetland are almost certain to experience some minor occasional alert impacts to terrestrial fauna, only very small areas are likely to be exposed to noise levels that would initiate more substantial response behaviours.
- Predicted Project noise emission levels at the nearest noise sensitive residential receptor indicate compliance with the most stringent of the EPP(Noise) acoustic quality objectives during all stages of the Project under neutral and worst case weather conditions.

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## 6 ABBREVIATIONS

APSDA	Abbot Point State Development Area
CONCAWE	The Conservation of Clean Air and Water Europe
dB	decibels
dBA	decibels (A weighted)
EPP(Noise)	Environmental Protection (Noise) Policy 2008
Hz	hertz (unit of measurement for frequency)
Kilde 130	the Nordic Rail Traffic Noise Prediction Method
Khz	Kilohertz (unit of frequency equal to 1000 hertz)
Kw	Kilowatt
LA90 (dBA)	noise level (dBA exceeded for 90% of the measurement period)
LAeq(1hour)	equivalent continuous (or average) noise level (dBA weighted) over a one hour measurement period
LAeq(15minute)	equivalent continuous (or average) noise level (in db – A weighted) over a 15 minute measurement period
LAmx	maximum noise level
LAeq (dBA)	equivalent continuous (or average) noise level (in db – A weighted)
°	degree
m	metre
m/s	metres per second
m <sup>3</sup>	cubic metres
NQBP	North Queensland Bulk Ports
%	per cent
PNC	Planning for Noise Control
SLR	SLR Consulting Australia Pty Ltd

SWL	sound power levels
T	terminal
TAPM	The Air Pollution Model

## **Appendix A**

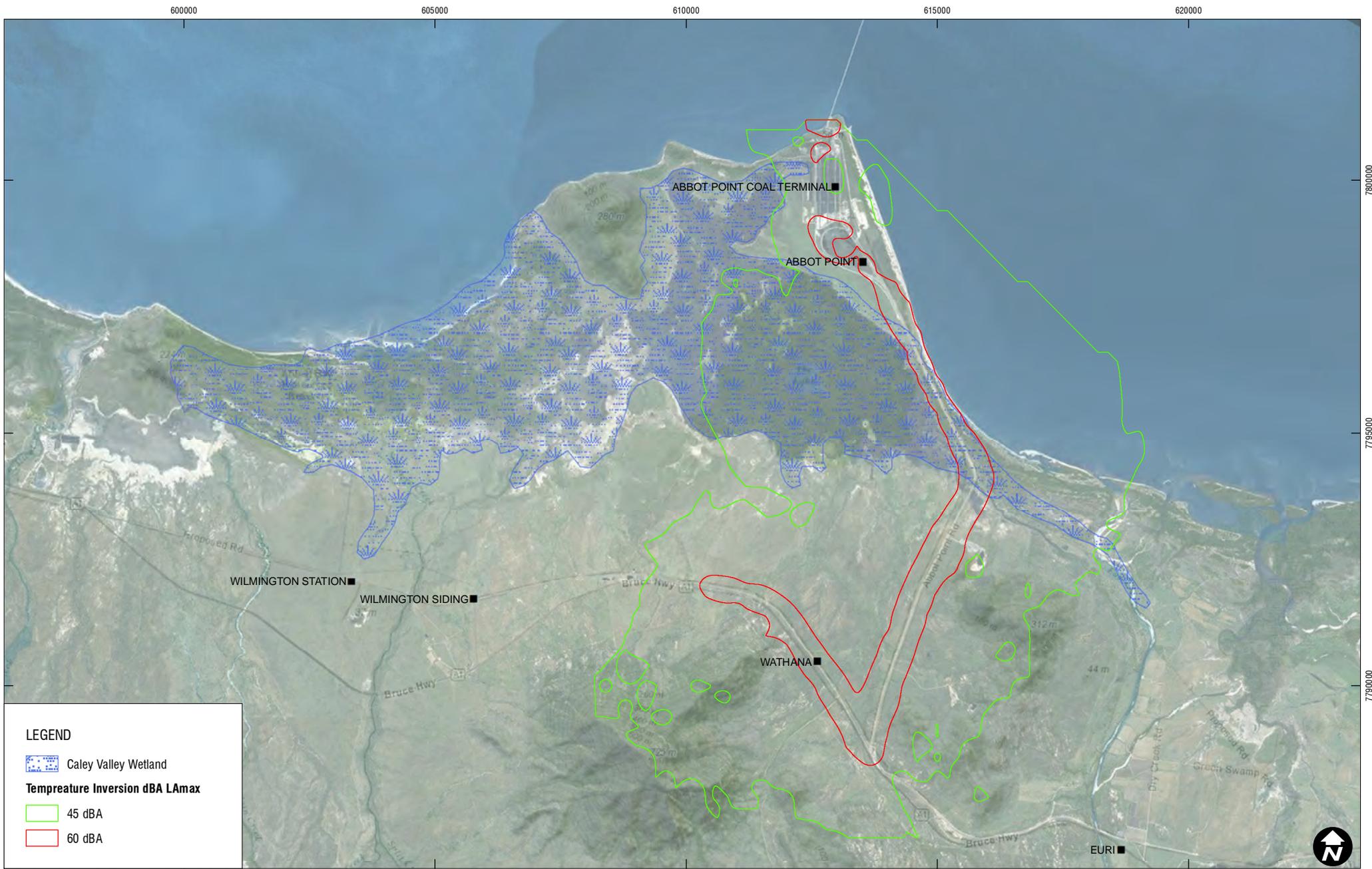
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Existing T1 Operational Noise Contour Maps



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**LEGEND**

Caley Valley Wetland

**Temperature Inversion dBA L<sub>max</sub>**

45 dBA

60 dBA

0 1 2 3 4 5  
Kilometers

Scale: 1:100,000  
GDA 1994 MGA Zone 55

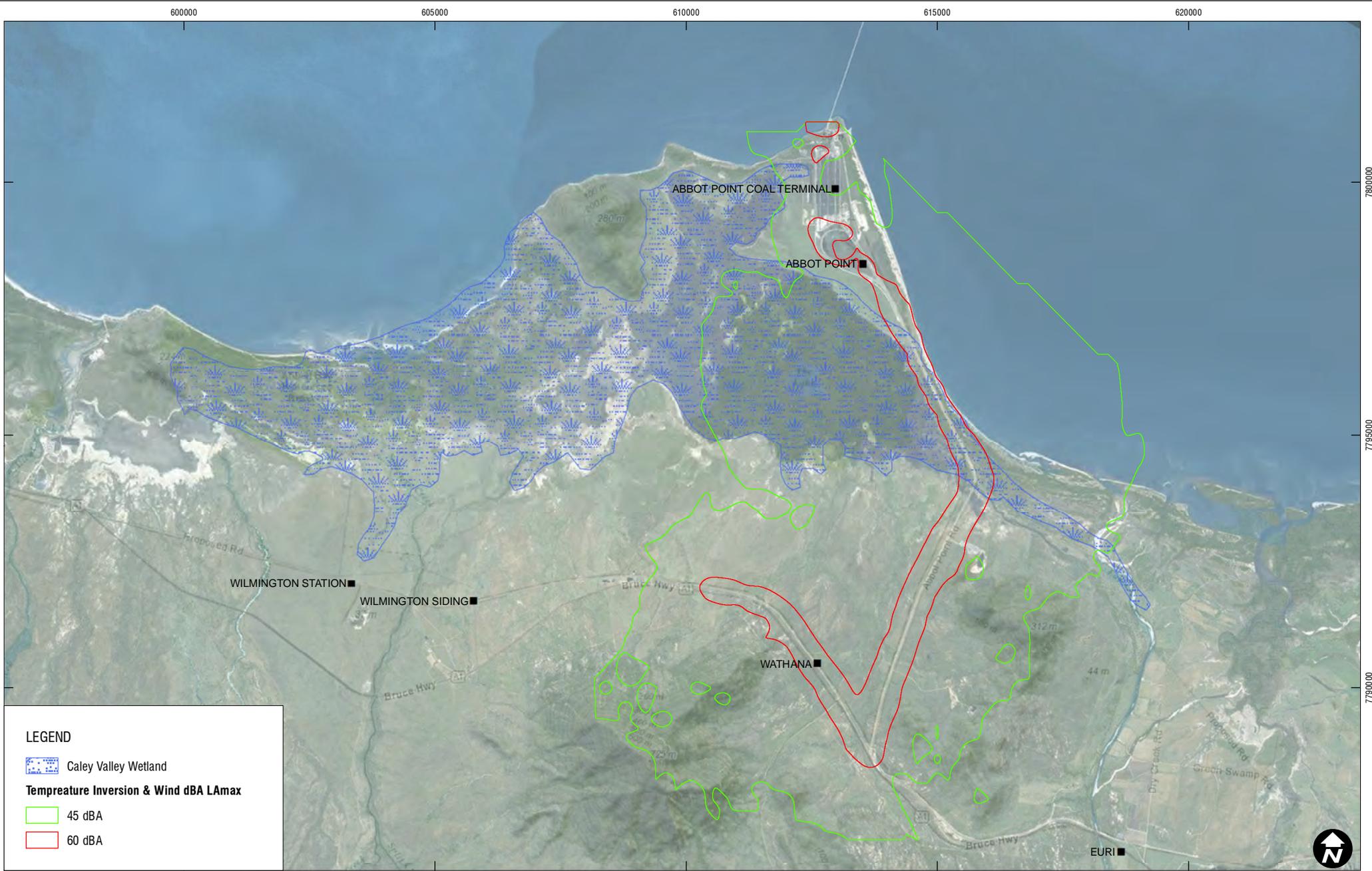


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**Existing T1 and Rail Noise  
L<sub>max</sub>  
Temperature Inversion**

**FIGURE 2**

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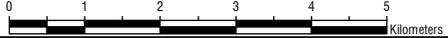
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Caley Valley Wetland

**Temperature Inversion & Wind dBA L<sub>Amax</sub>**

45 dBA

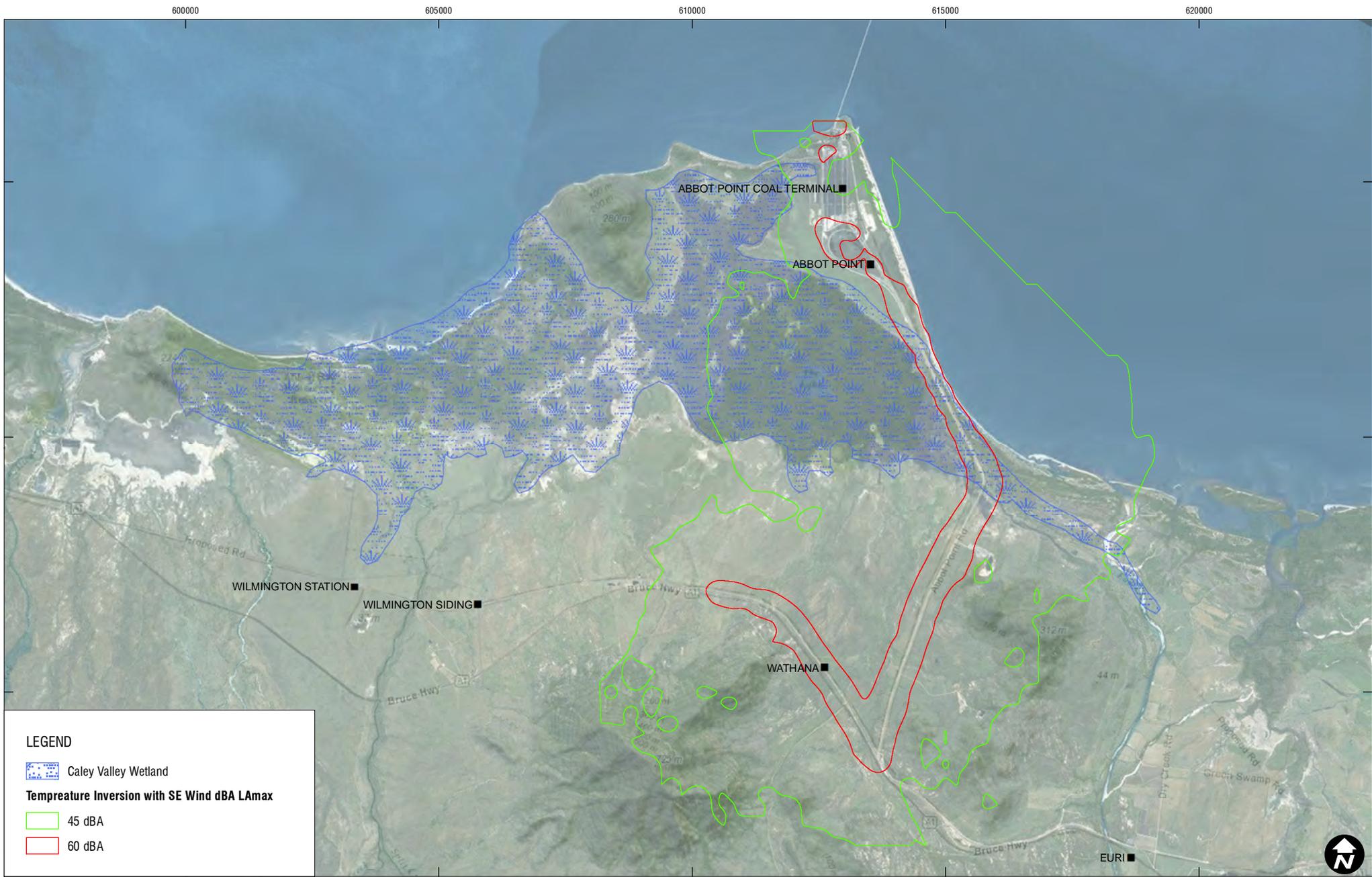
60 dBA



Scale: 1:100,000  
GDA 1994 MGA Zone 55

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**LEGEND**

Caley Valley Wetland

**Temperature Inversion with SE Wind dBA L<sub>max</sub>**

45 dBA

60 dBA

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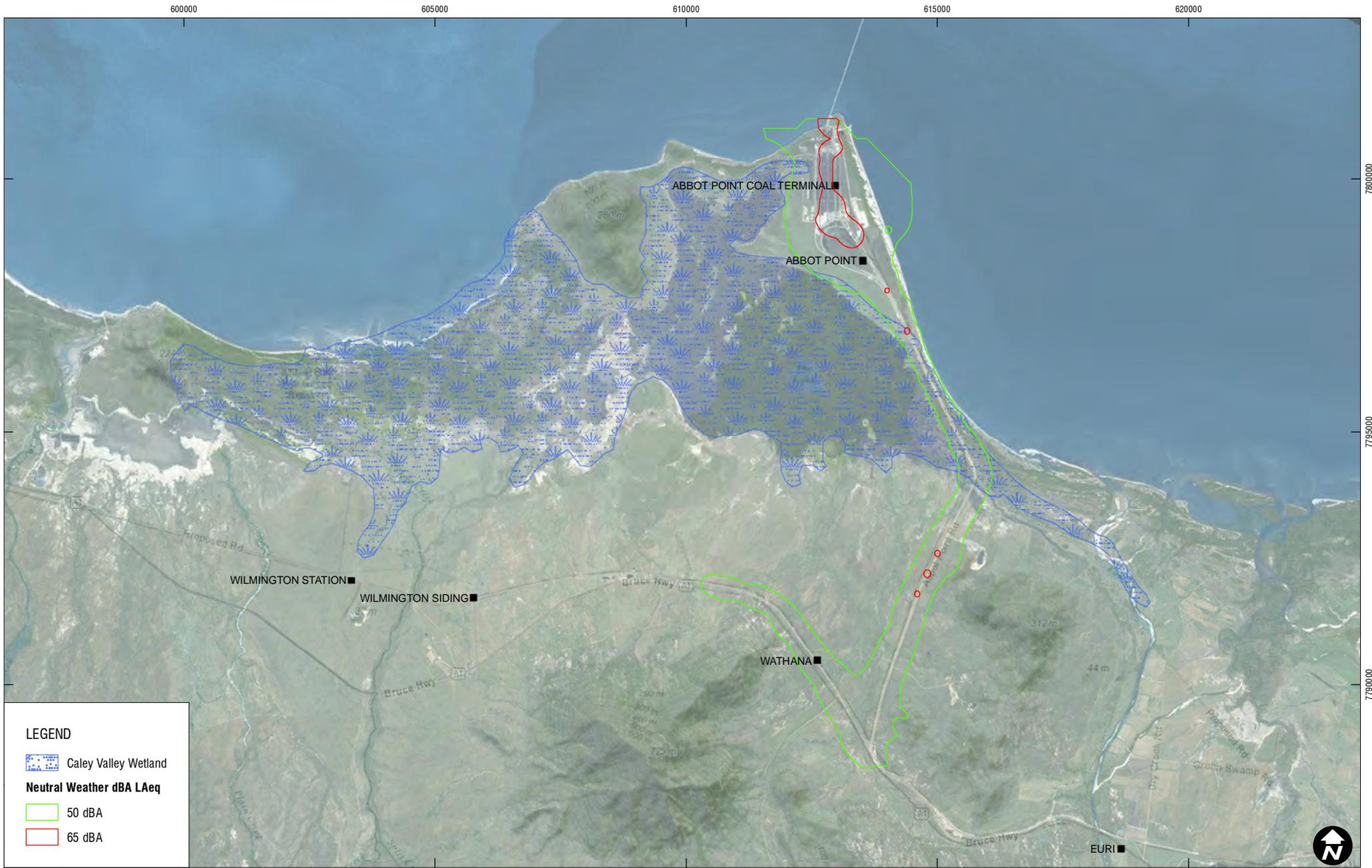
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**Existing T1 and Rail Noise  
L<sub>max</sub>  
Temperature Inversion with SE Wind**

**FIGURE 3**

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**LEGEND**

-  Caley Valley Wetland
- Neutral Weather dBA LAeq**
-  50 dBA
-  65 dBA

0 1 2 3 4 5 Kilometers

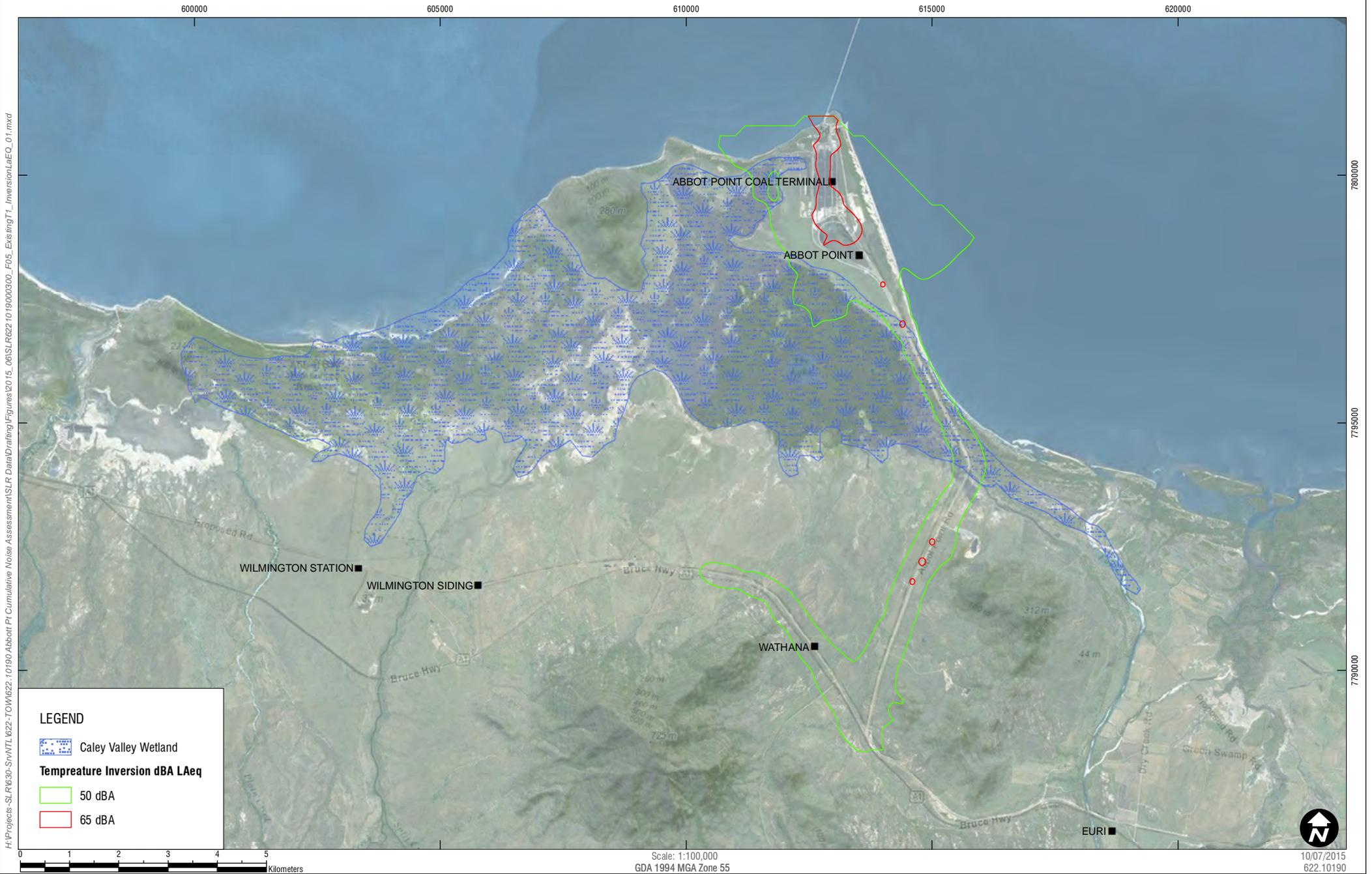
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**Existing T1 and Rail Noise  
Laeq  
Neutral Weather**

**FIGURE 4**



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**LEGEND**

-  Caley Valley Wetland
- Temperature Inversion dBA LAeq**
-  50 dBA
-  65 dBA

0 1 2 3 4 5  
Kilometers

Scale: 1:100,000  
GDA 1994 MGA Zone 55

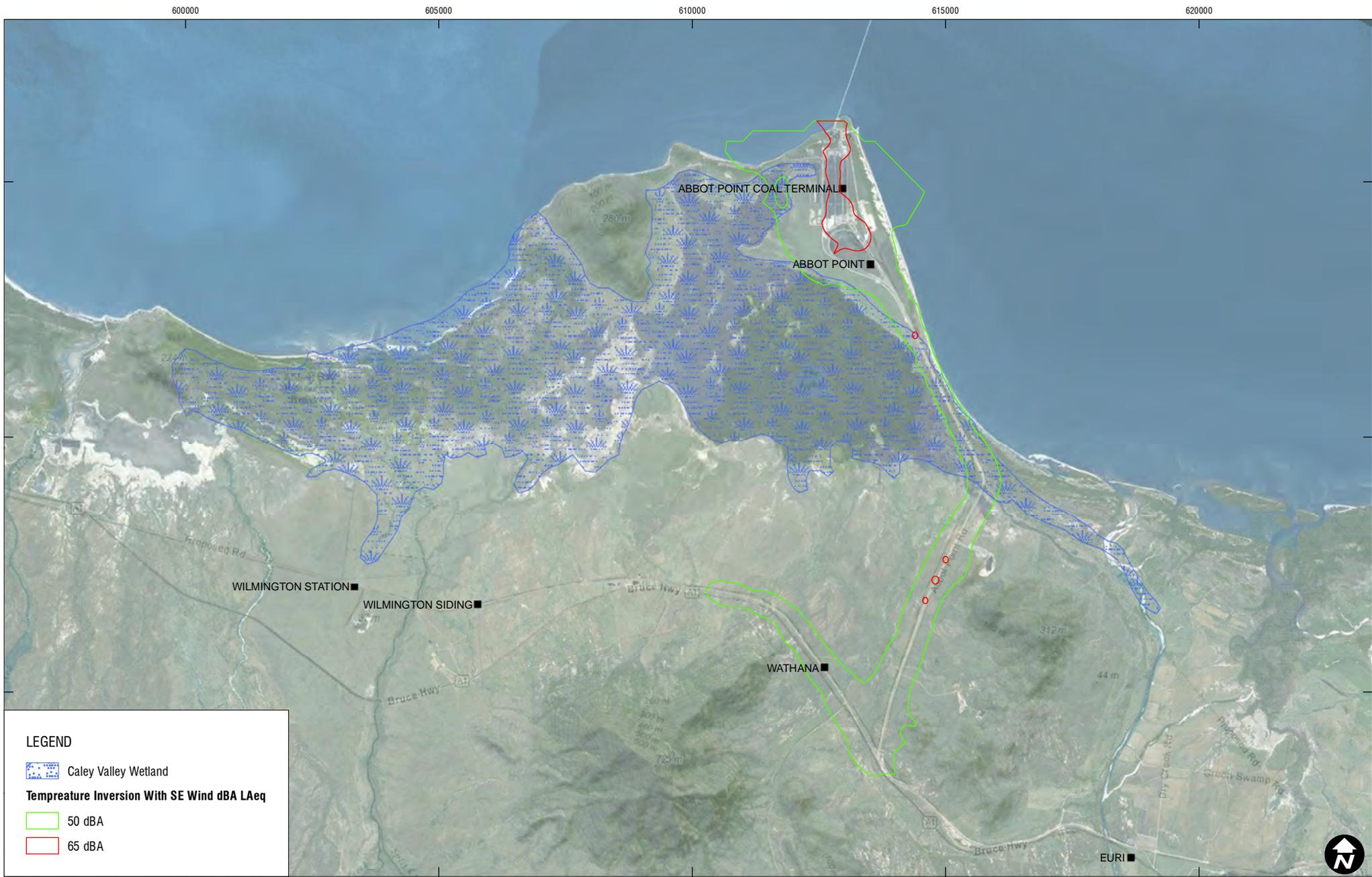


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**Existing T1 and Rail Noise  
LAeq  
Temperature Inversion**

**FIGURE 5**

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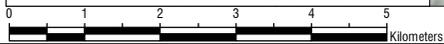
**LEGEND**

Caley Valley Wetland

**Temperature Inversion With SE Wind dBA LAeq**

50 dBA

65 dBA



Scale: 1:100,000  
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**Existing T1 and Rail Noise  
LAeq  
Temperature Inversion with SE Wind  
FIGURE 6**

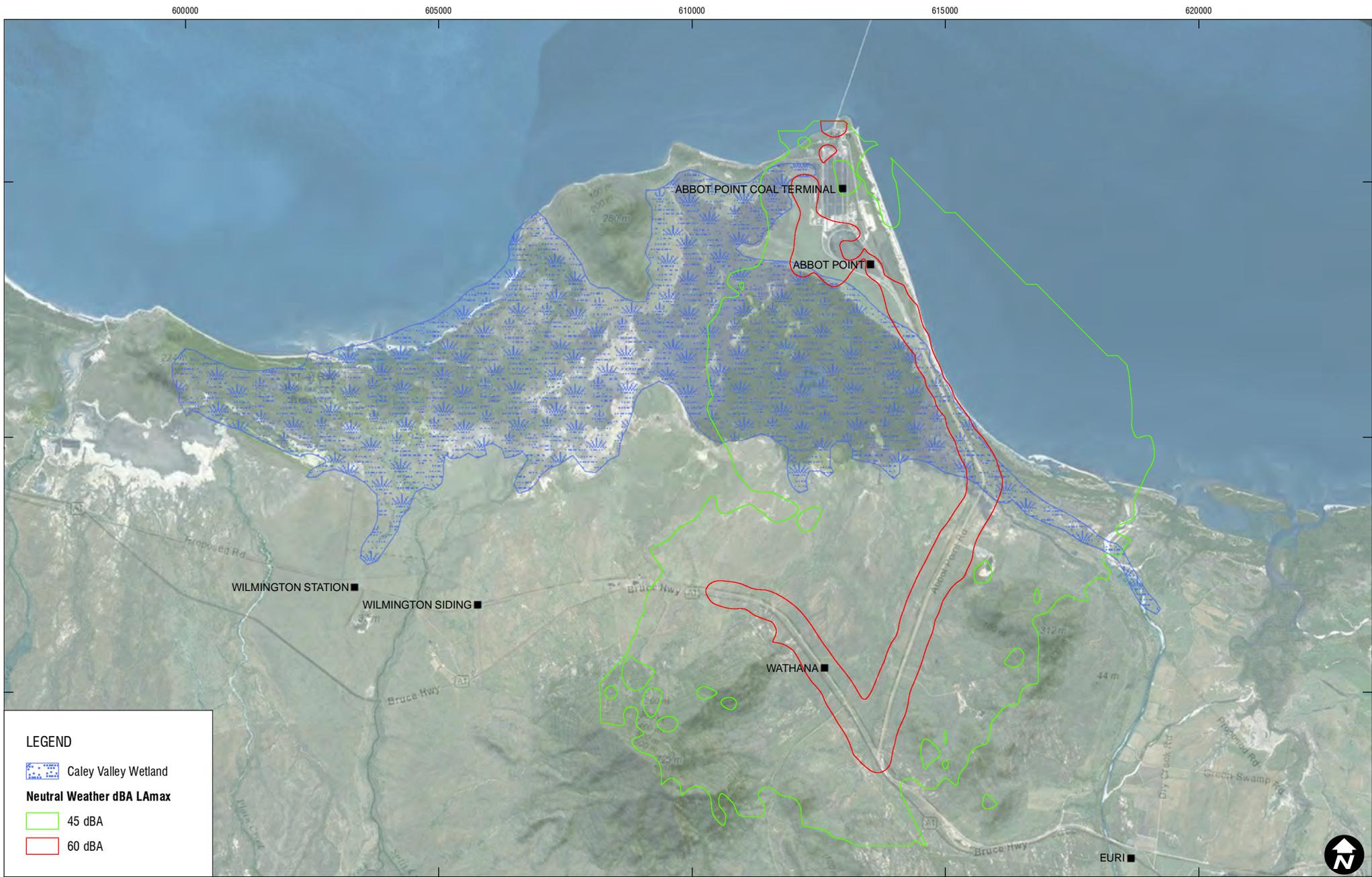
## **Appendix B**

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Cumulative Noise Contour Maps

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**LEGEND**

-  Caley Valley Wetland
- Neutral Weather dBA L<sub>max</sub>**
-  45 dBA
-  60 dBA

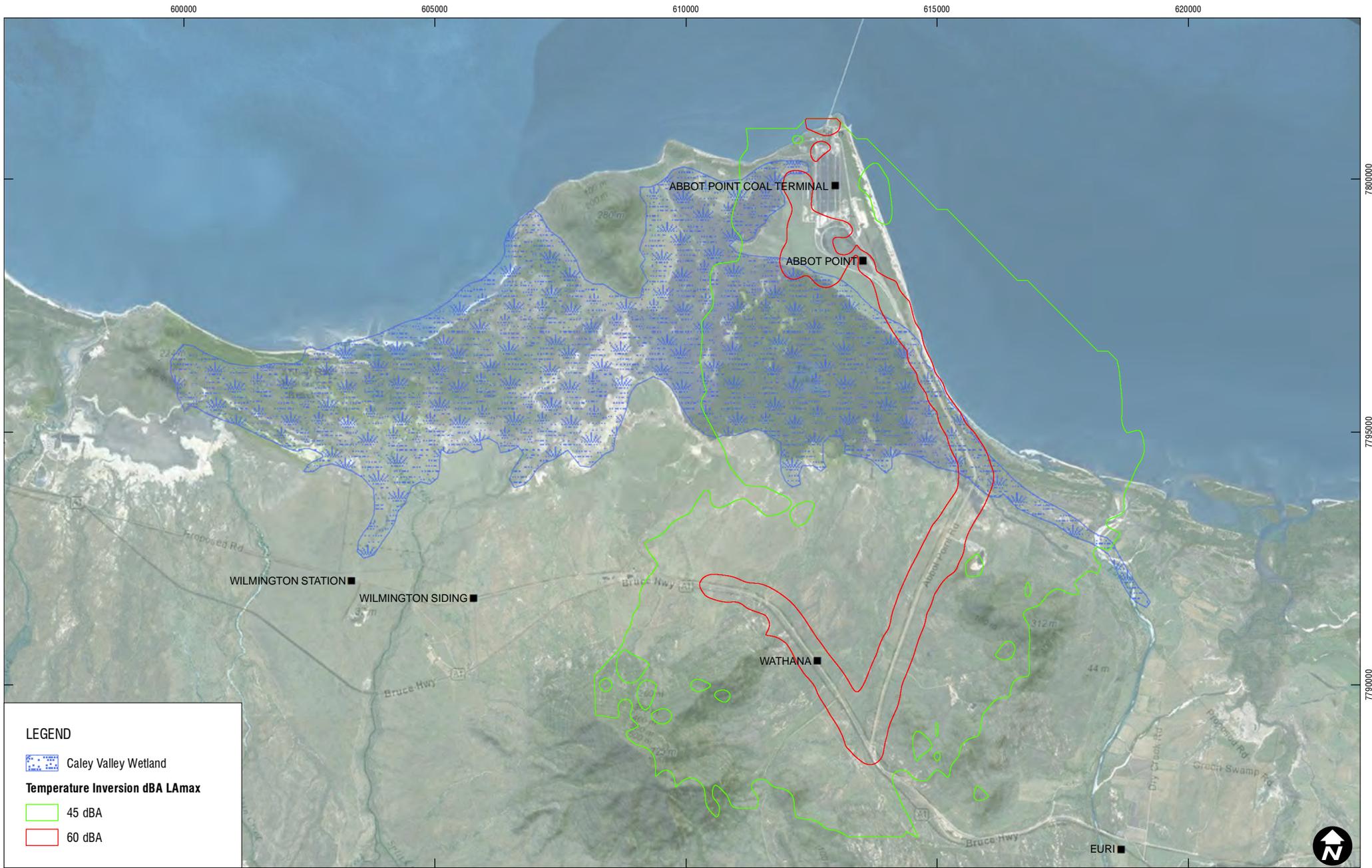


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**LEGEND**

Caley Valley Wetland

**Temperature Inversion dBA Lmax**

45 dBA

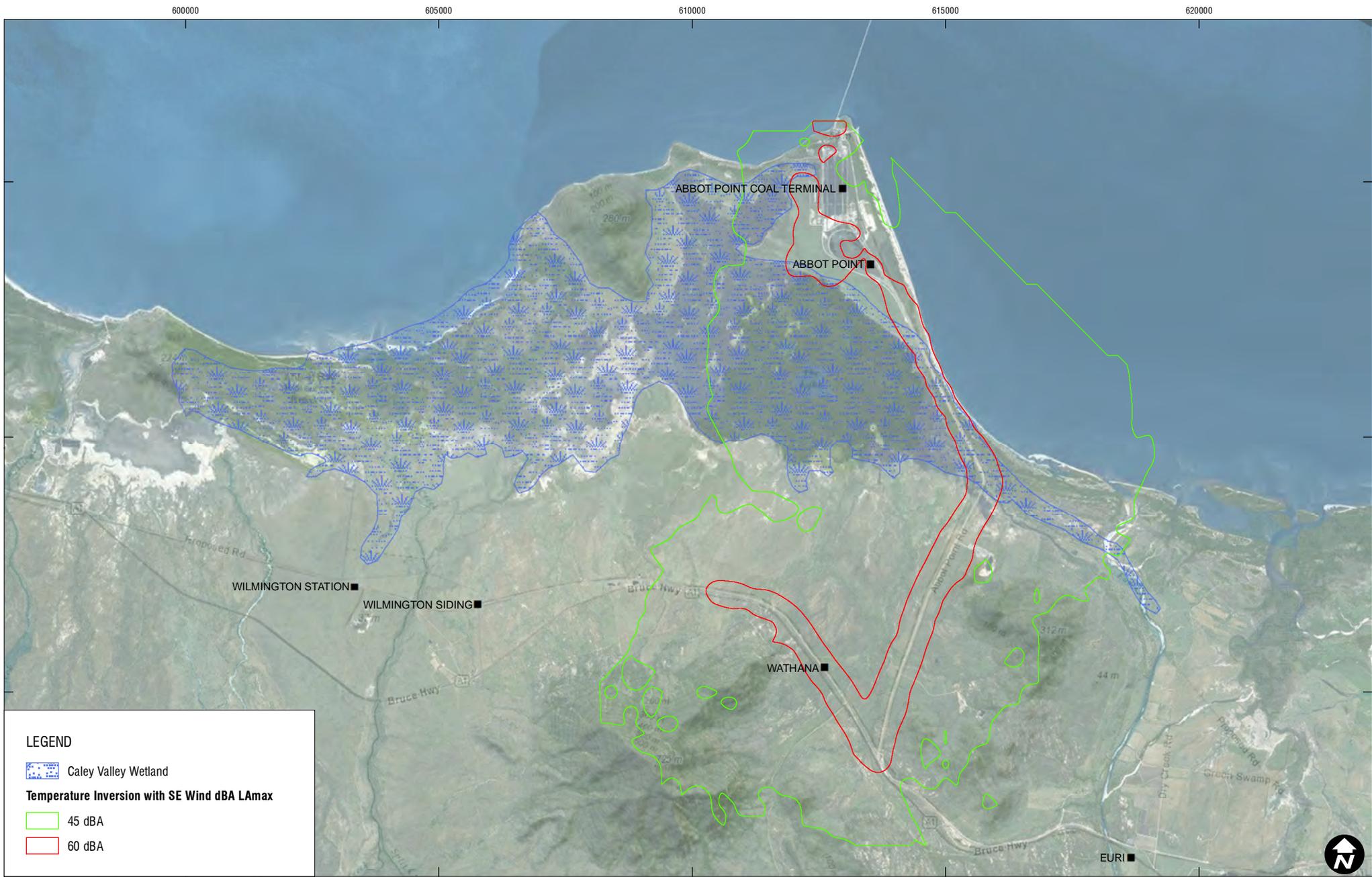
60 dBA



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GDA 1994 MGA Zone 55



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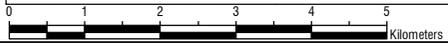
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Caley Valley Wetland

**Temperature Inversion with SE Wind dBA LMax**

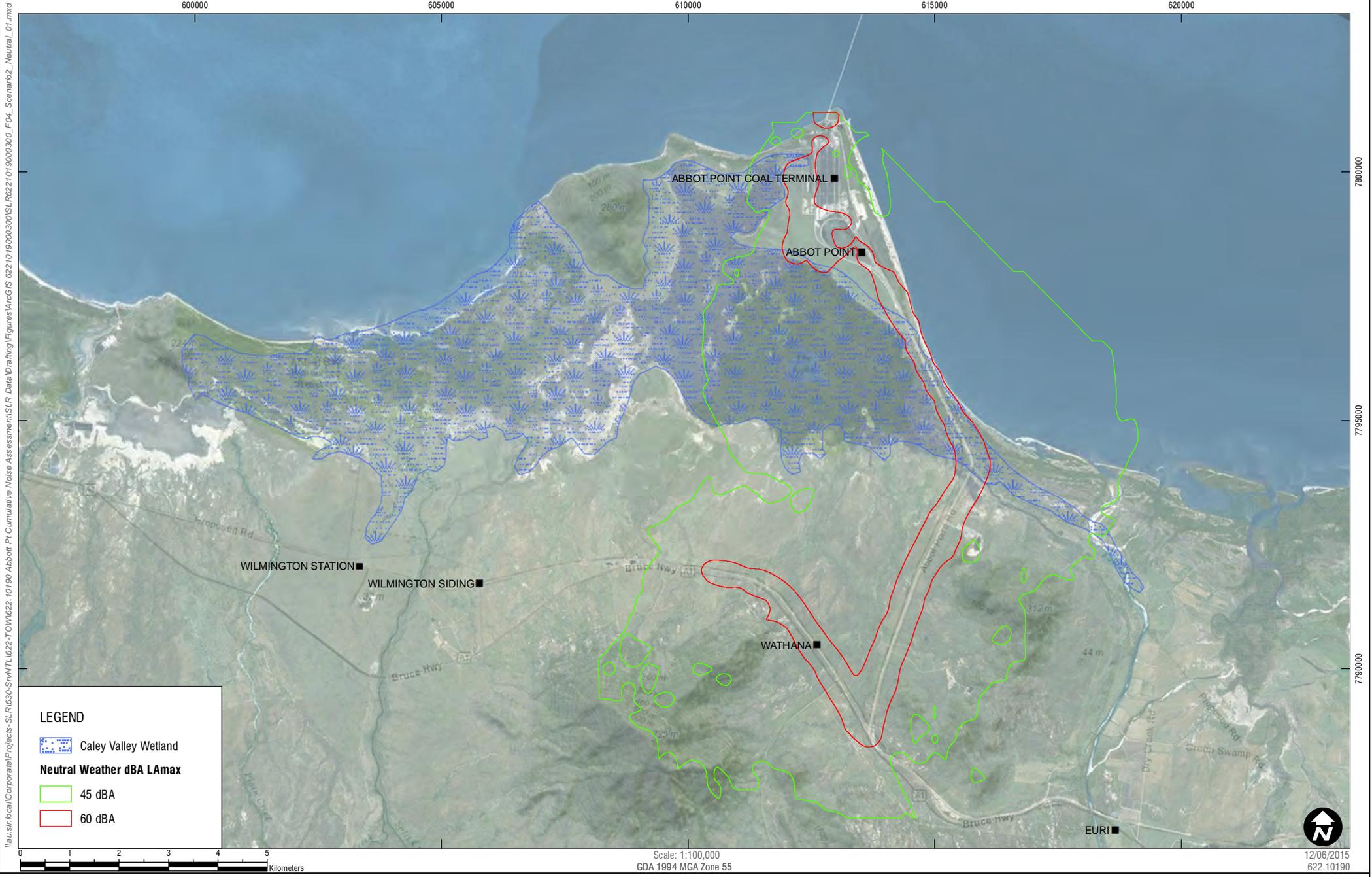
45 dBA

60 dBA



Scale: 1:100,000  
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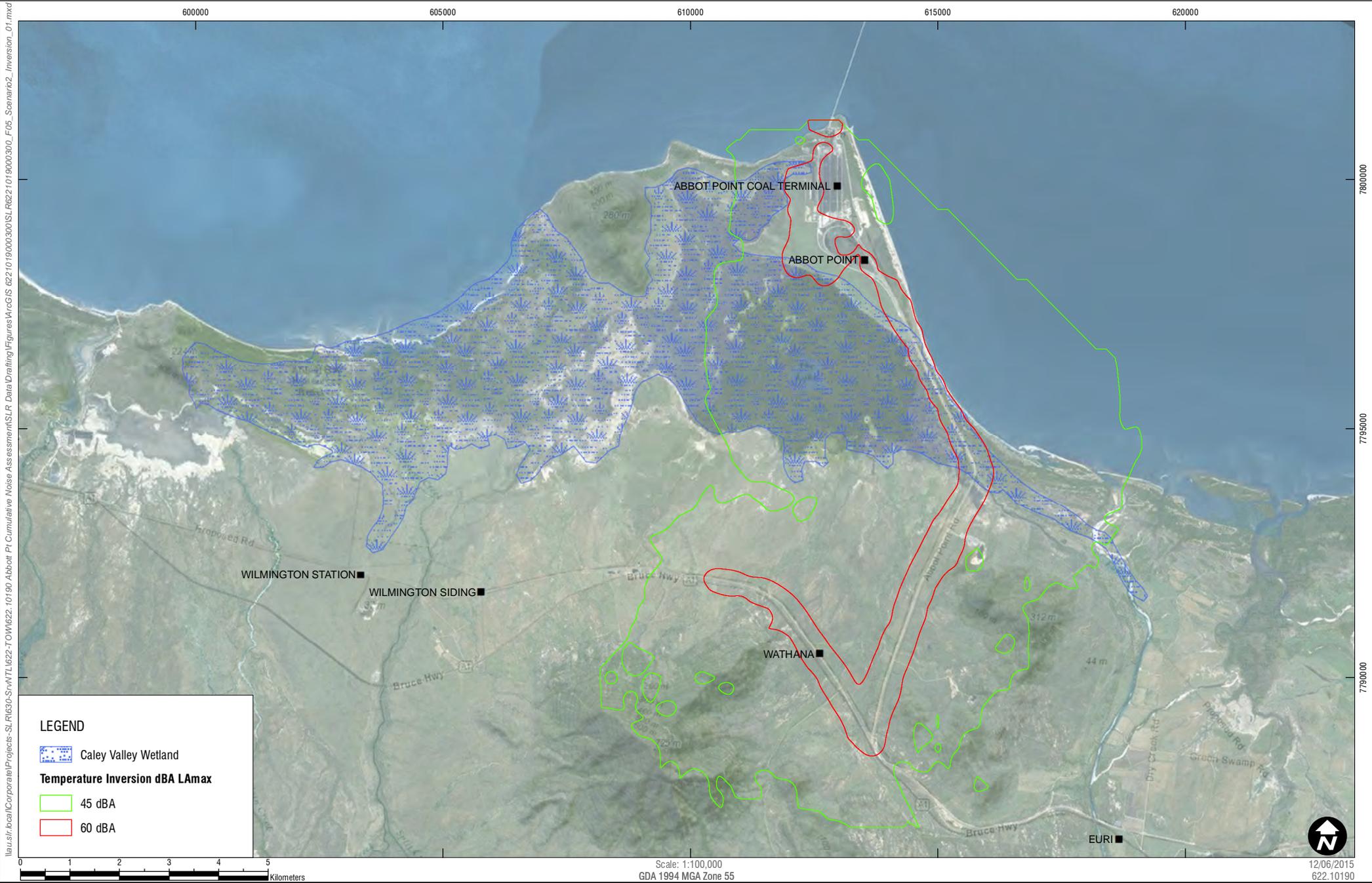


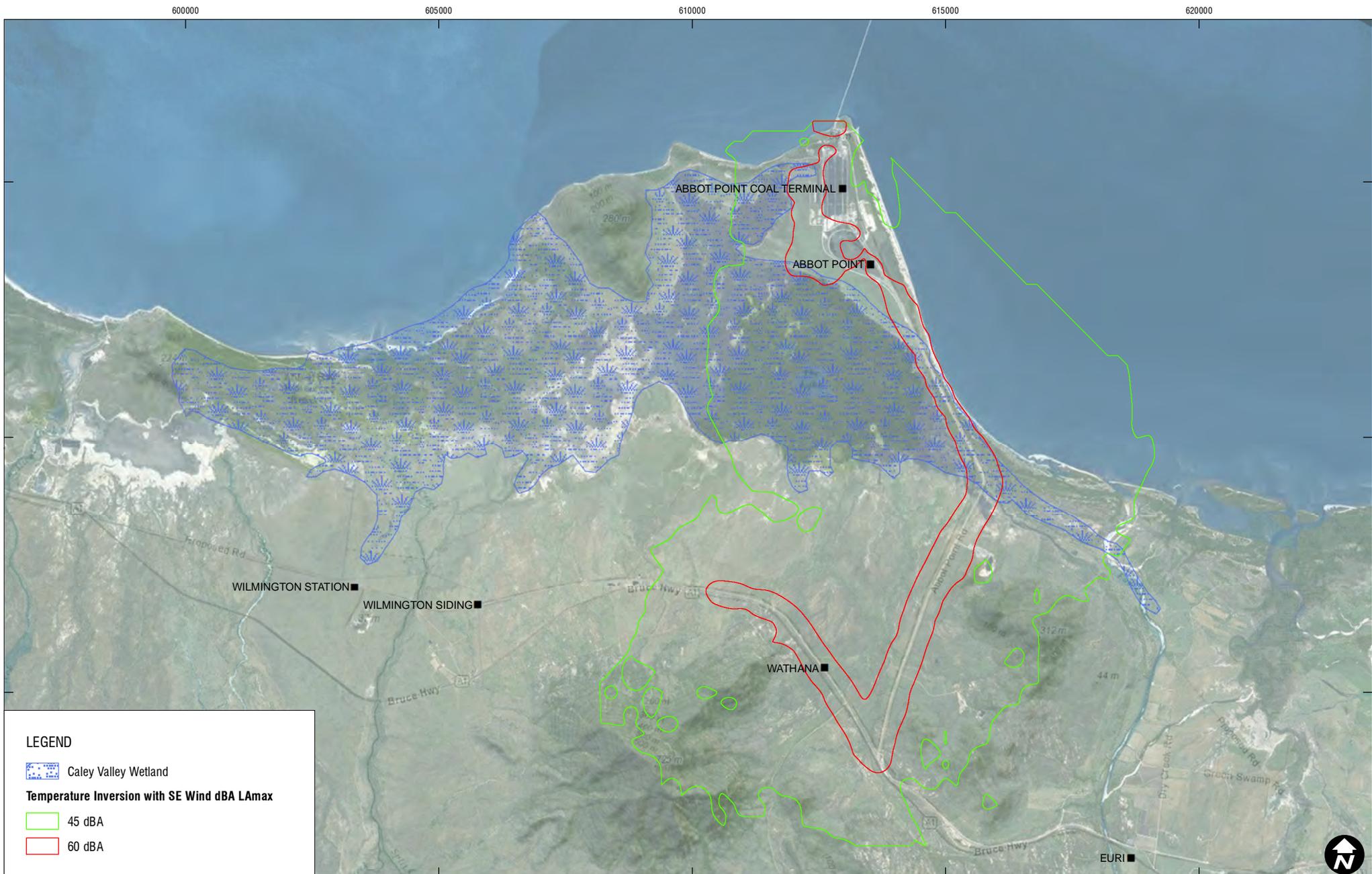
**LEGEND**

-  Caley Valley Wetland
- Neutral Weather dBA L<sub>max</sub>**
-  45 dBA
-  60 dBA

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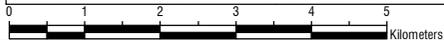
**LEGEND**

Caley Valley Wetland

**Temperature Inversion with SE Wind dBA L<sub>max</sub>**

45 dBA

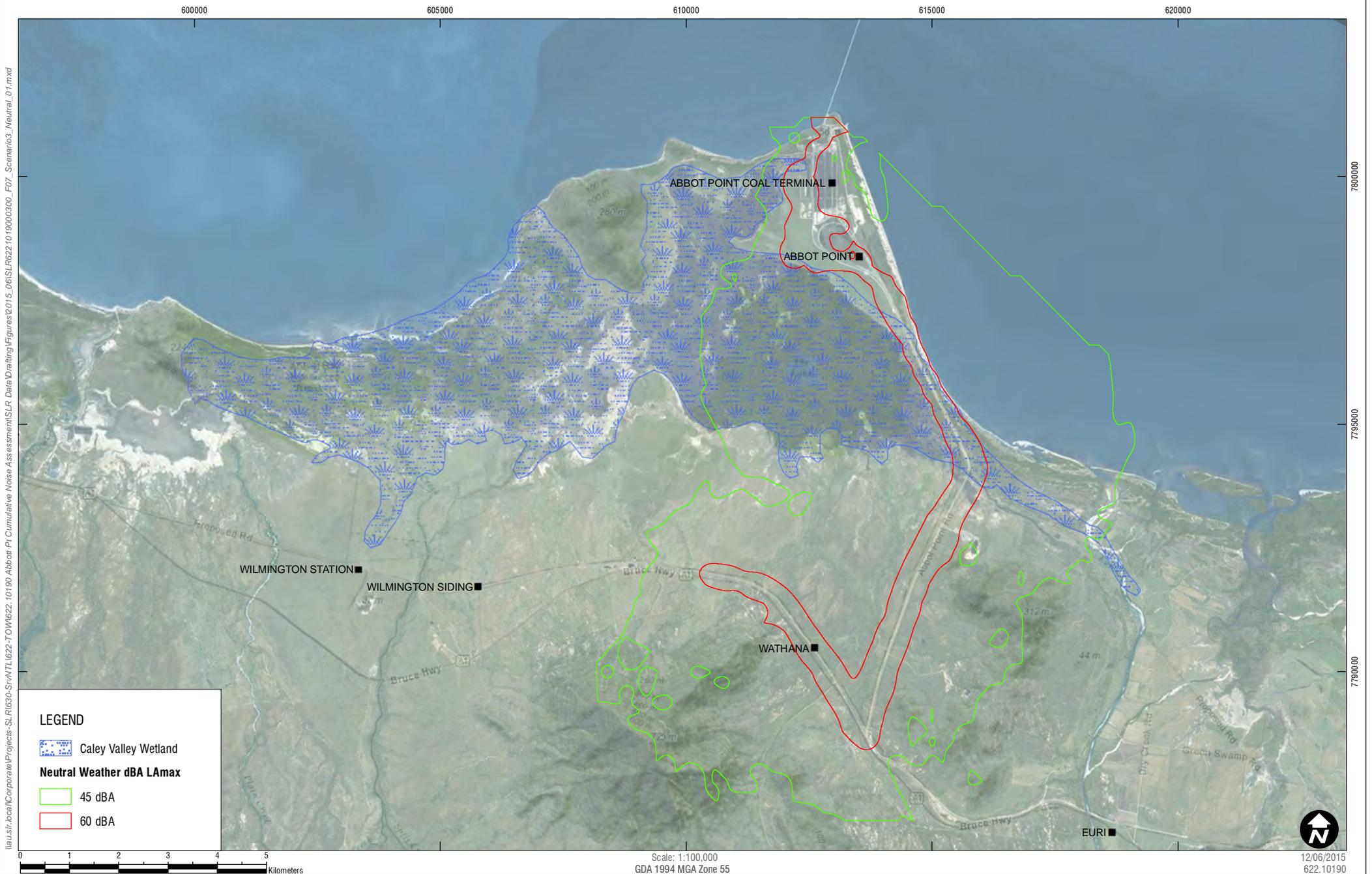
60 dBA



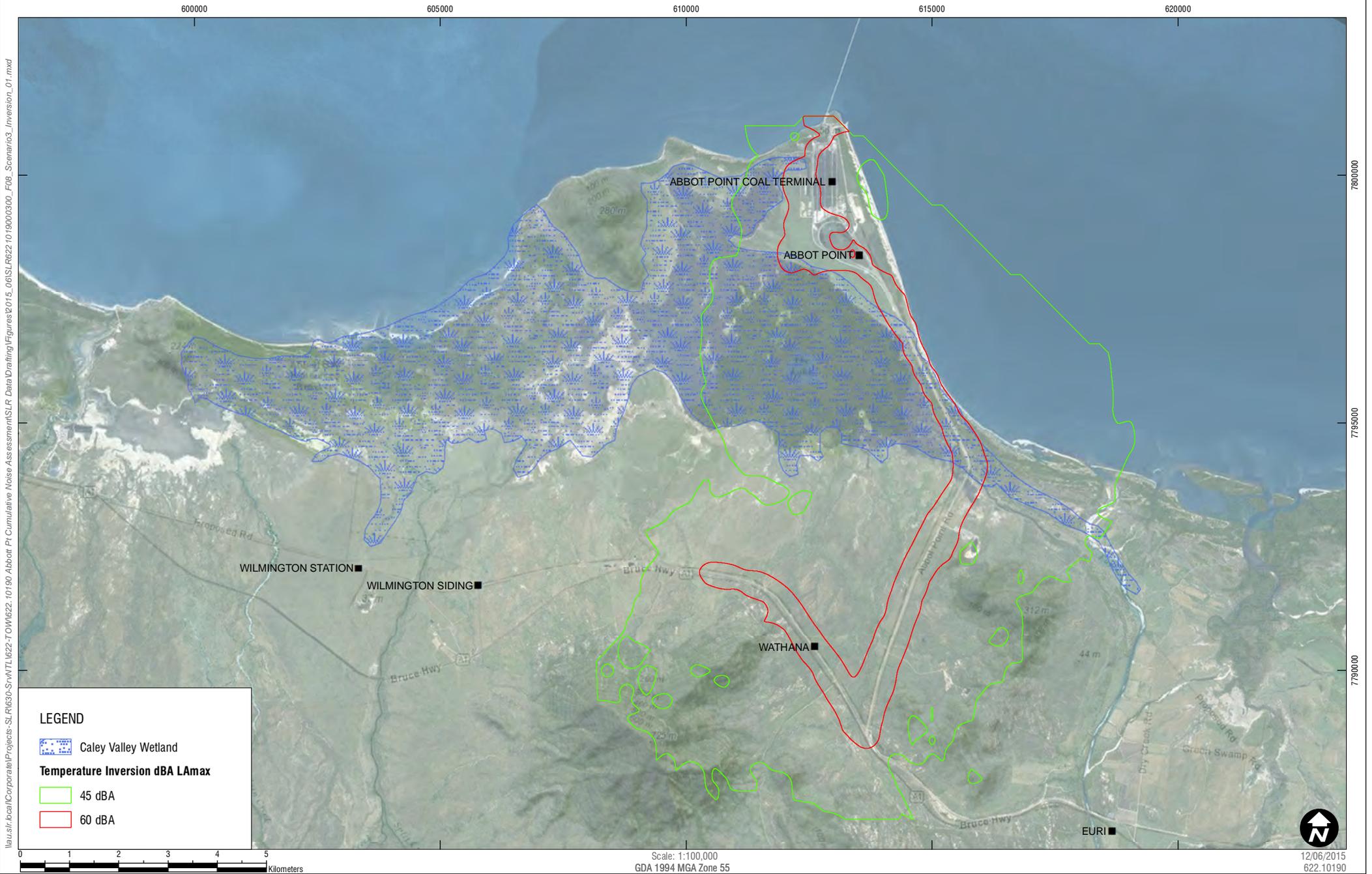
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GDA 1994 MGA Zone 55



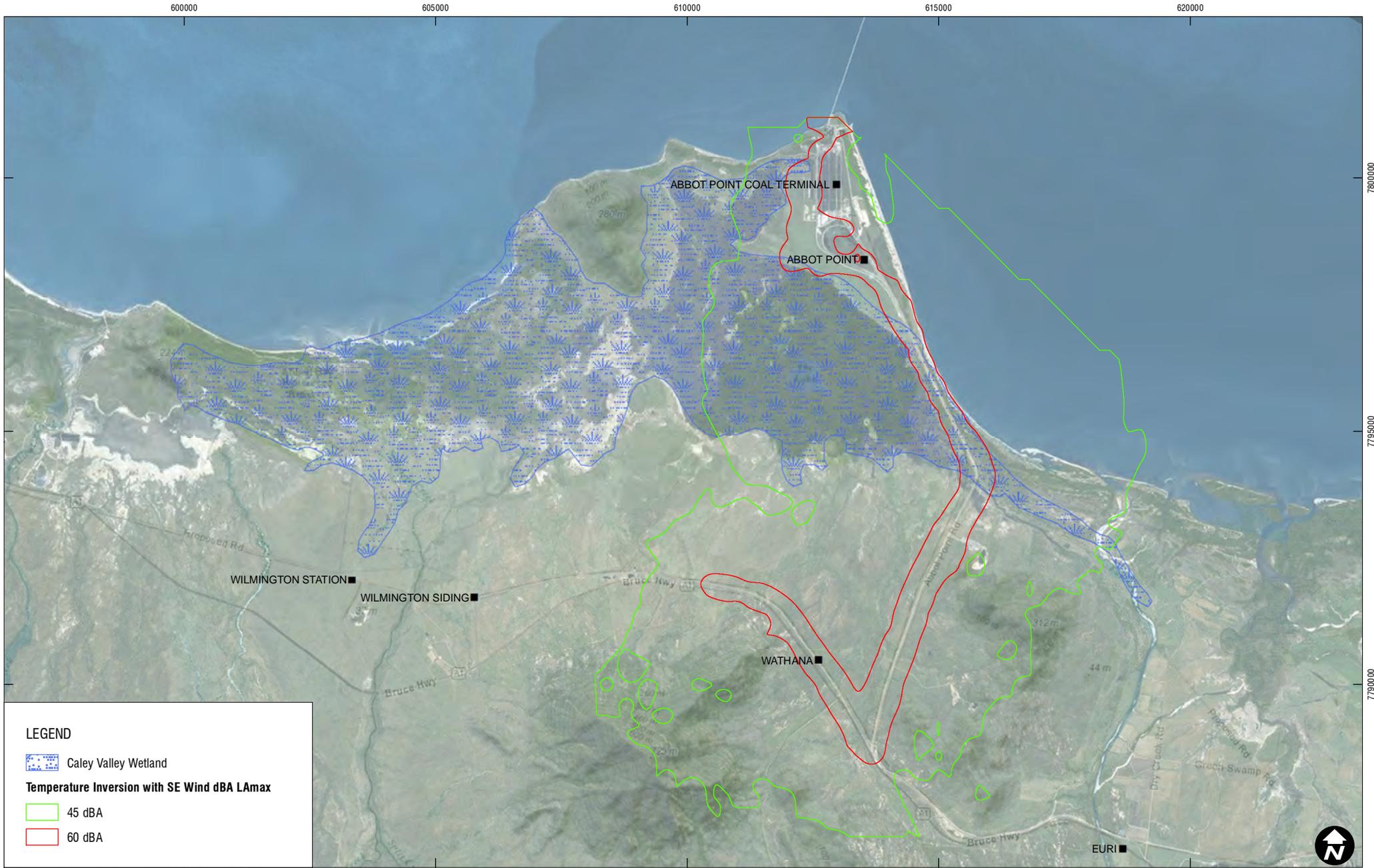
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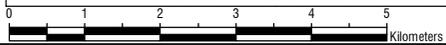
**LEGEND**

Caley Valley Wetland

**Temperature Inversion with SE Wind dBA L<sub>max</sub>**

45 dBA

60 dBA



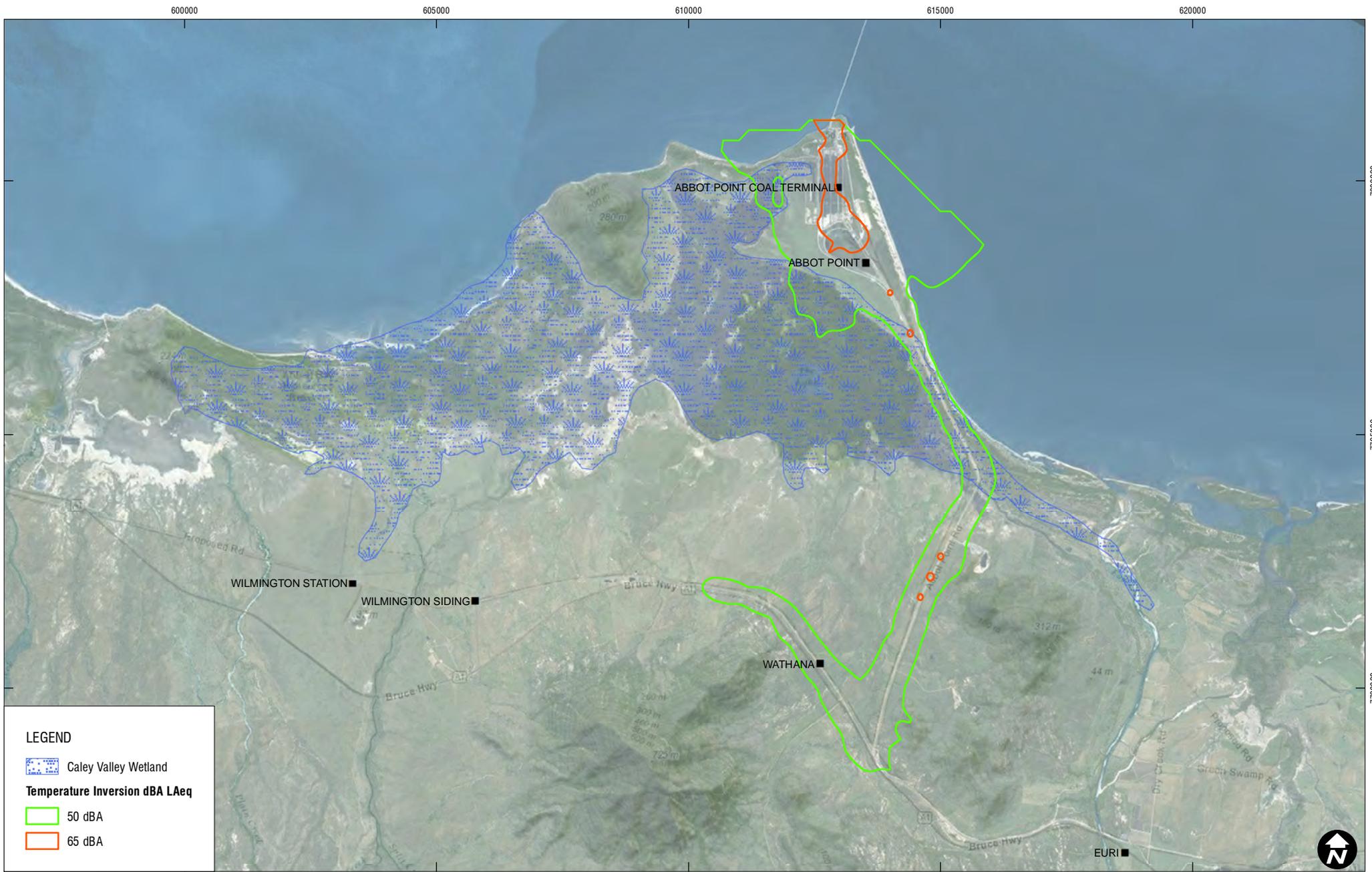
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GDA 1994 MGA Zone 55



12/06/2015  
622.10190



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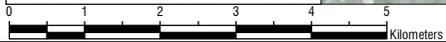
**LEGEND**

Caley Valley Wetland

**Temperature Inversion dBA LAeq**

50 dBA

65 dBA

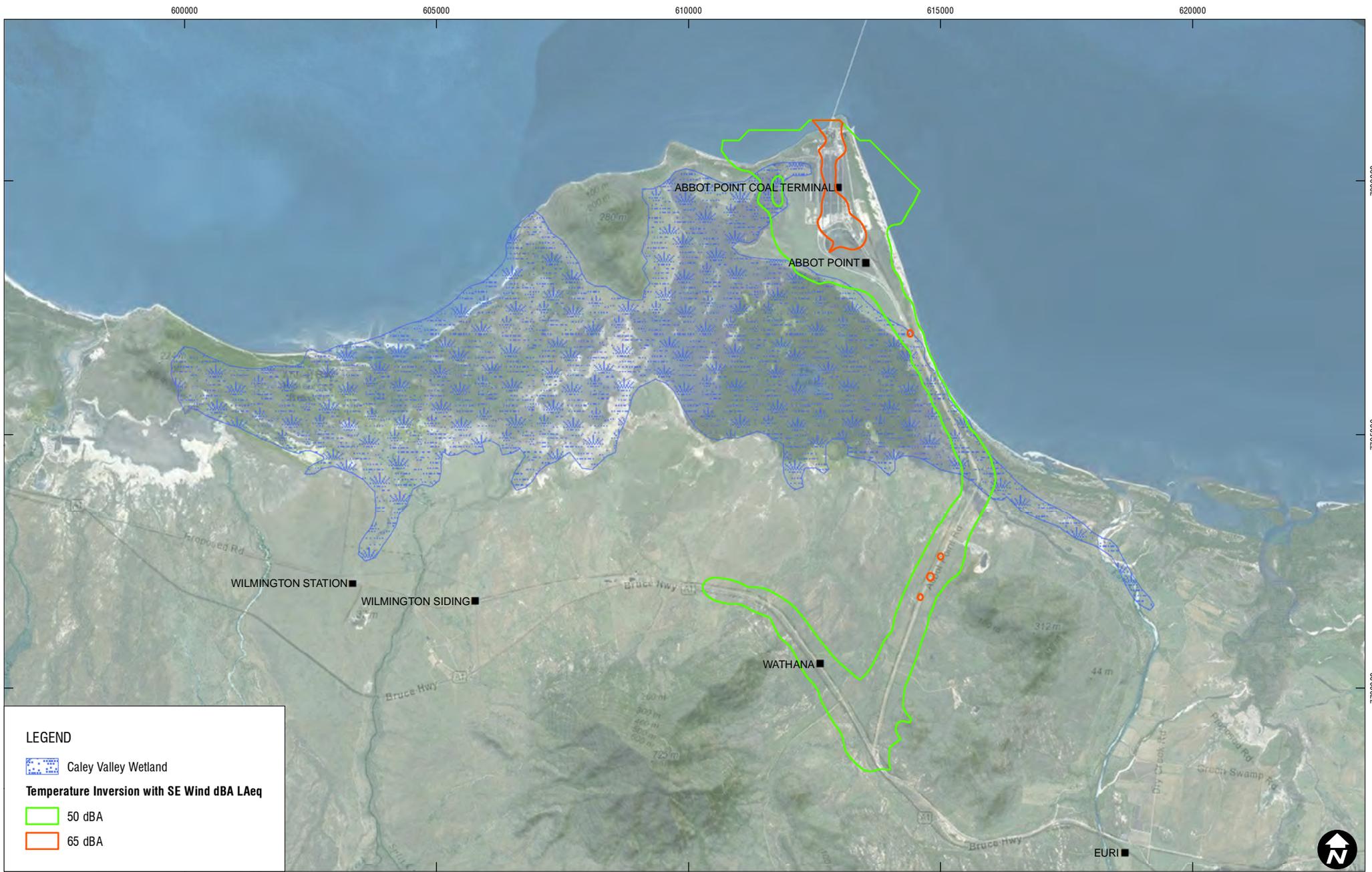


Scale: 1:100,000  
GDA 1994 MGA Zone 55



12/06/2015  
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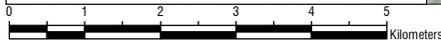
**LEGEND**

Caley Valley Wetland

**Temperature Inversion with SE Wind dBA LAeq**

50 dBA

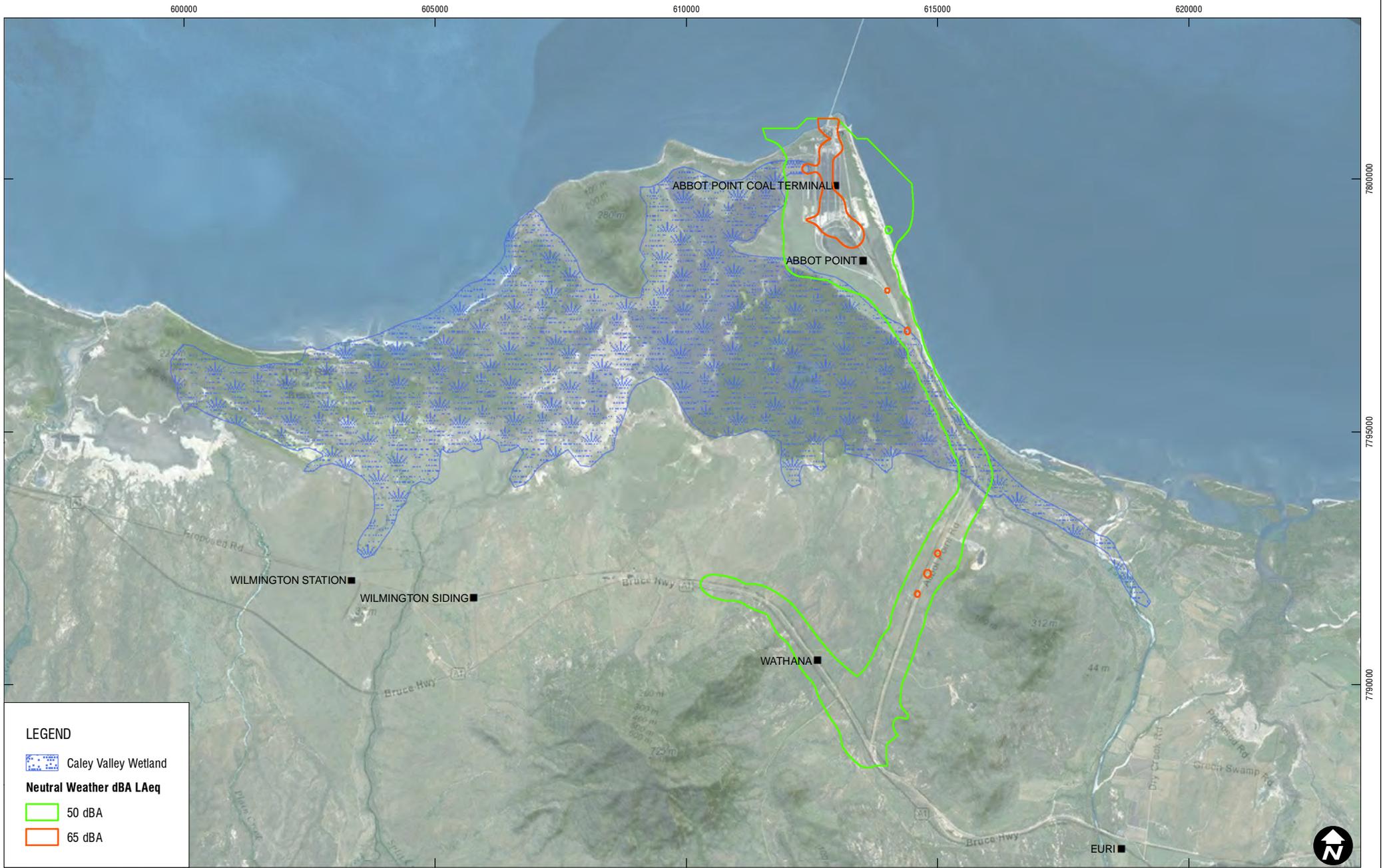
65 dBA



Scale: 1:100,000  
GDA 1994 MGA Zone 55

12/06/2015  
622.10190

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**LEGEND**

Caley Valley Wetland

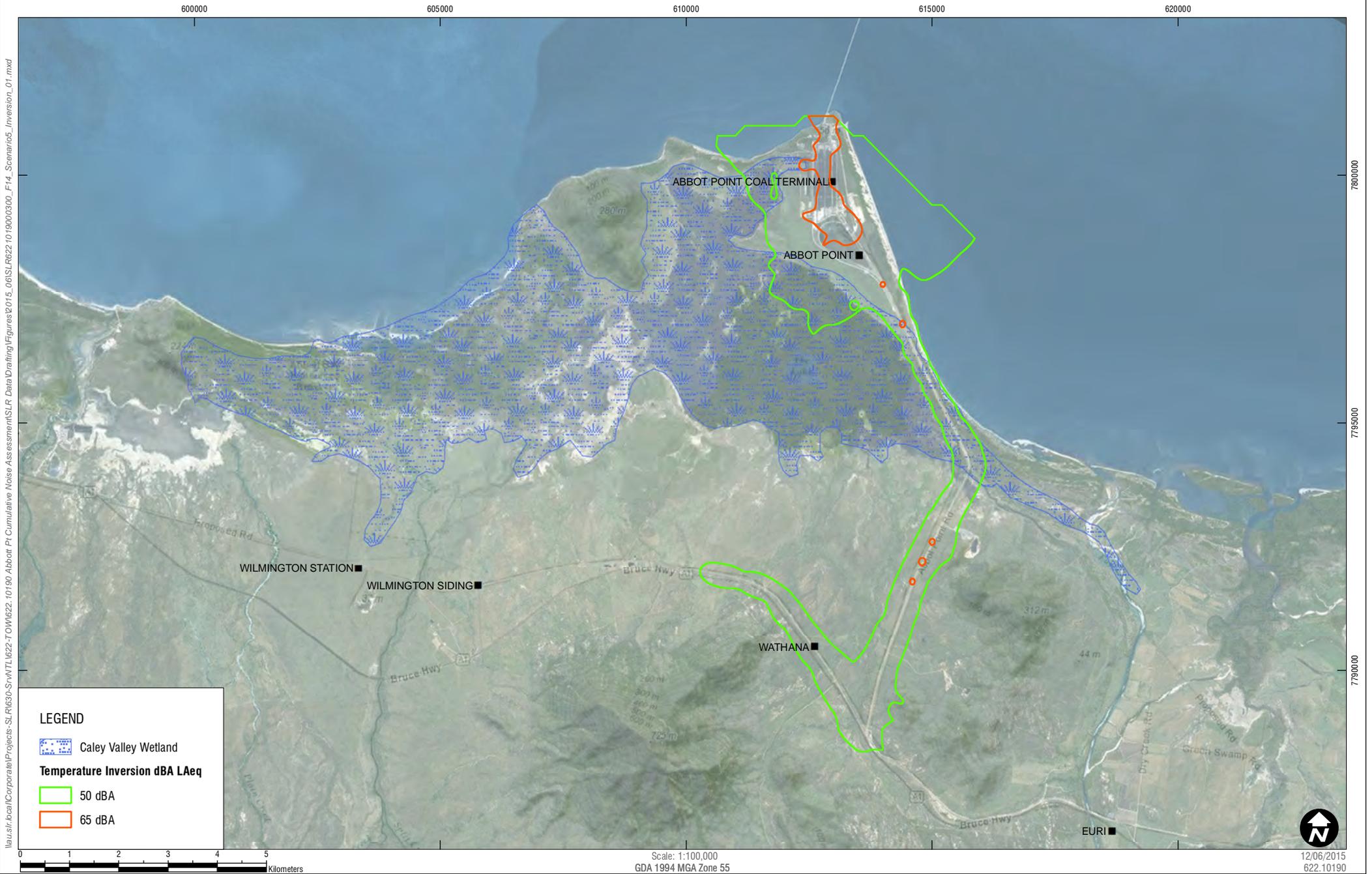
**Neutral Weather dBA LAeq**

50 dBA

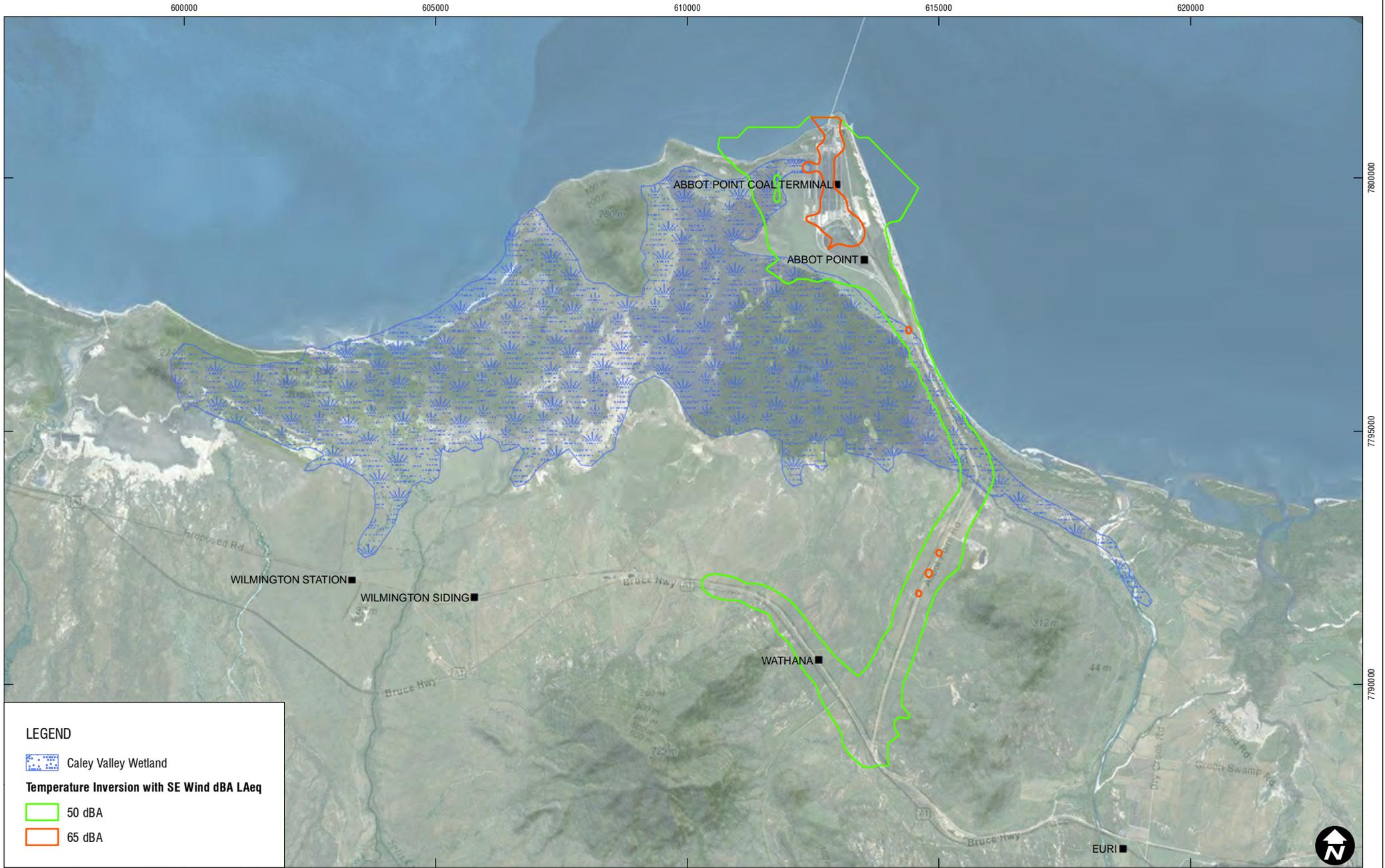
65 dBA

Scale: 1:100,000  
GDA 1994 MGA Zone 55

12/06/2015  
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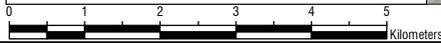
**LEGEND**

Caley Valley Wetland

**Temperature Inversion with SE Wind dBA LAeq**

50 dBA

65 dBA

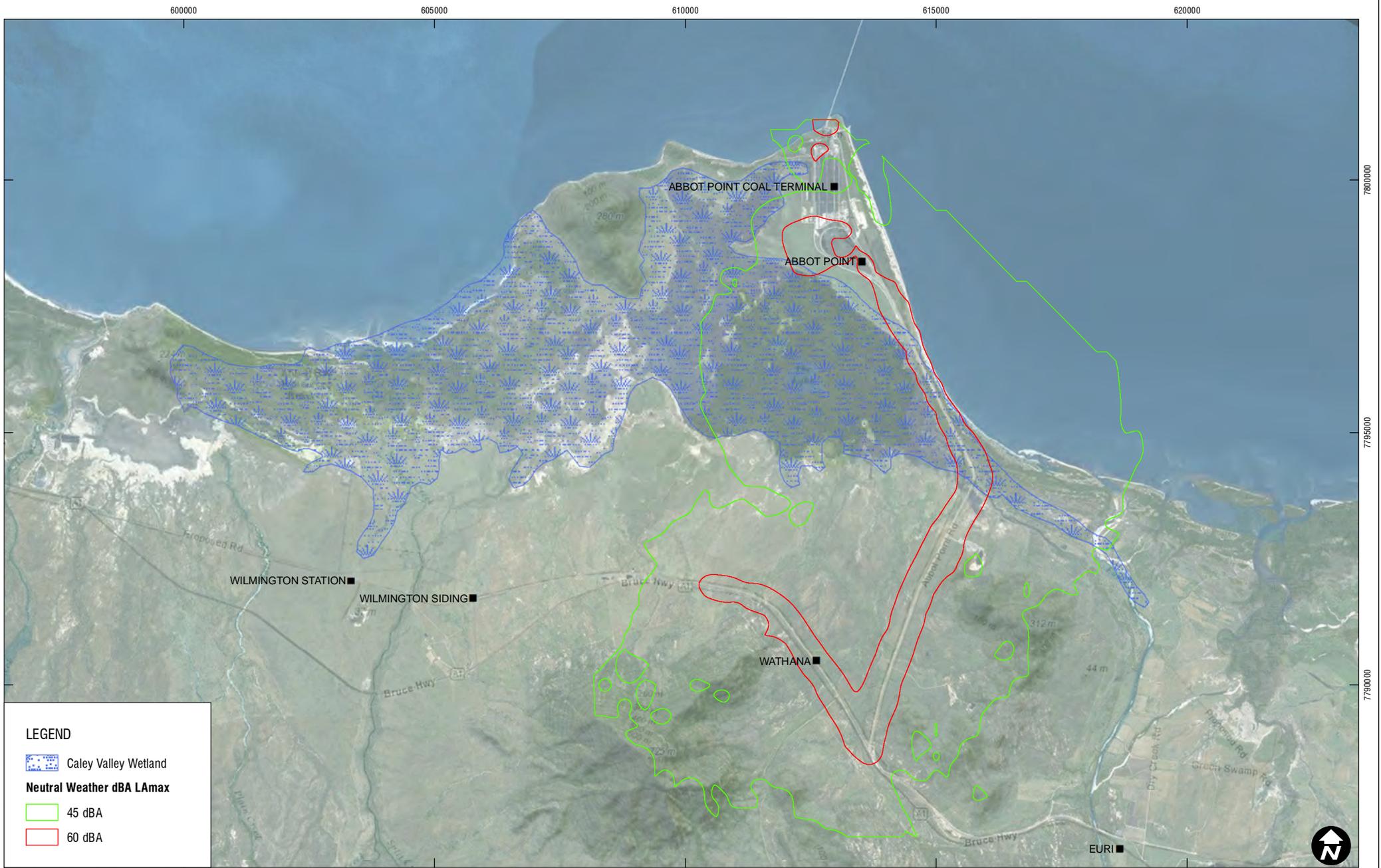


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GDA 1994 MGA Zone 55



12/06/2015  
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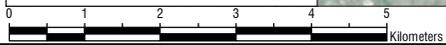
**LEGEND**

Caley Valley Wetland

**Neutral Weather dBA L<sub>max</sub>**

45 dBA

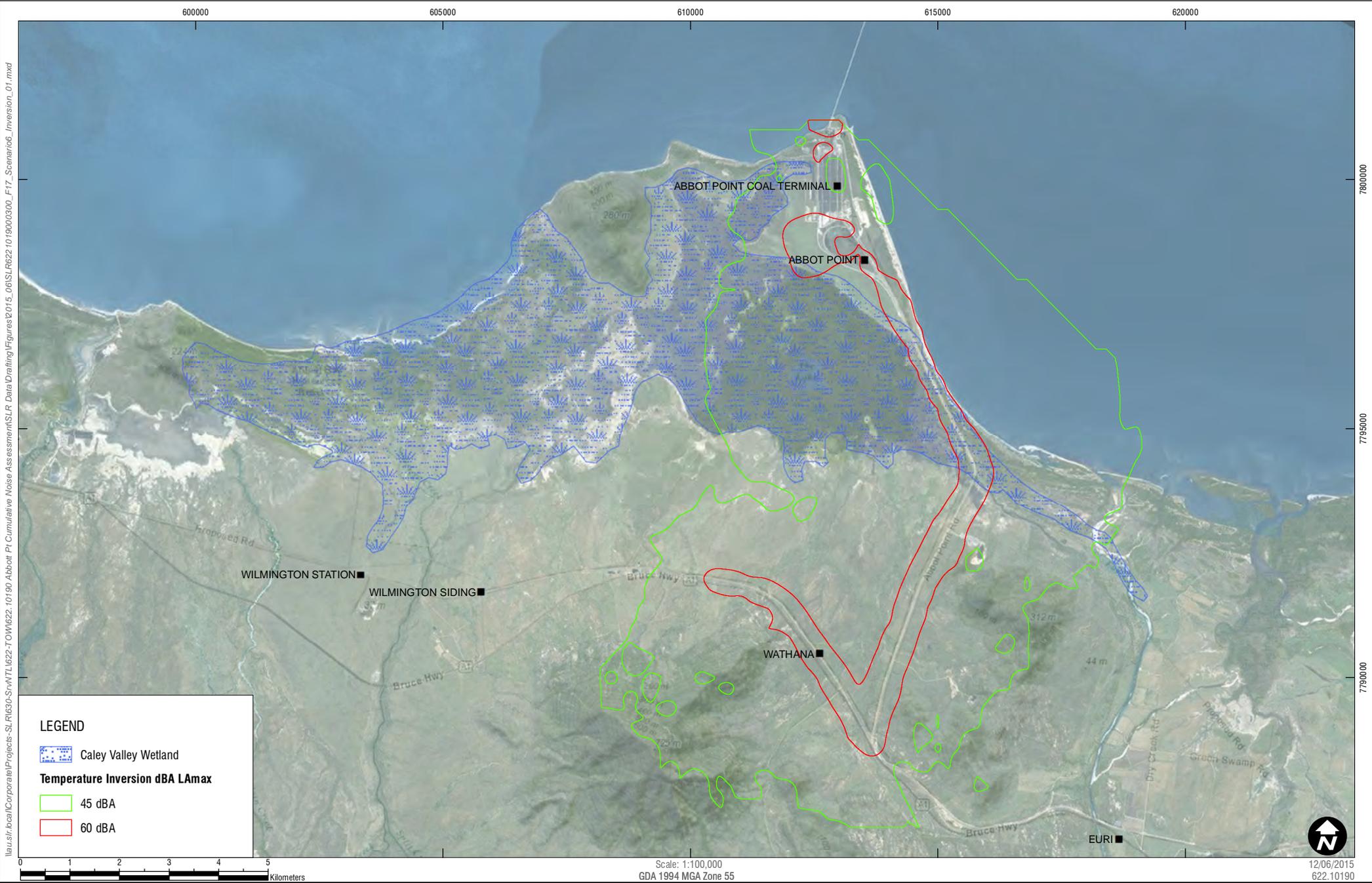
60 dBA



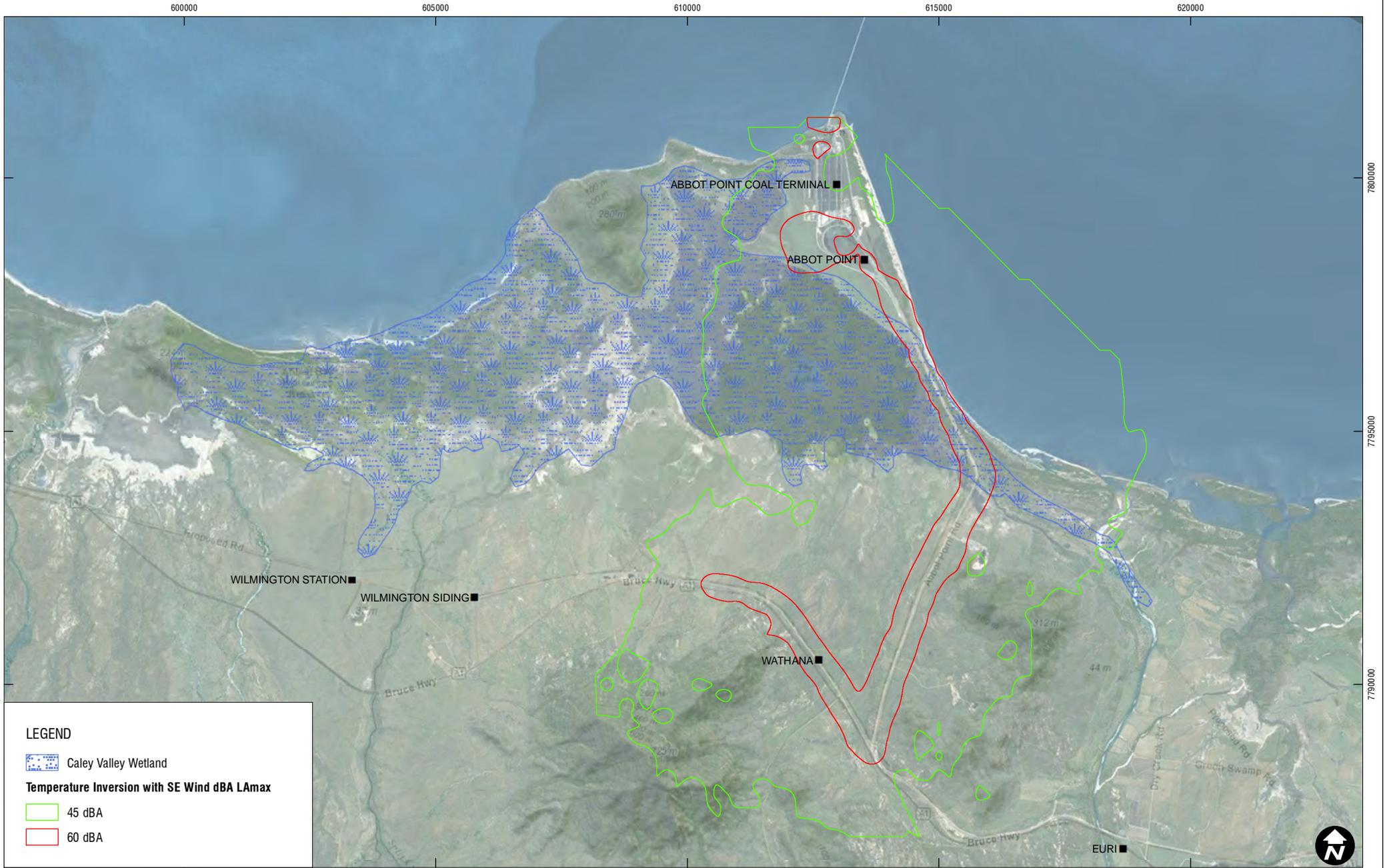
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GDA 1994 MGA Zone 55



12/06/2015  
622.10190



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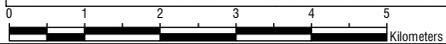
**LEGEND**

Caley Valley Wetland

**Temperature Inversion with SE Wind dBA L<sub>max</sub>**

45 dBA

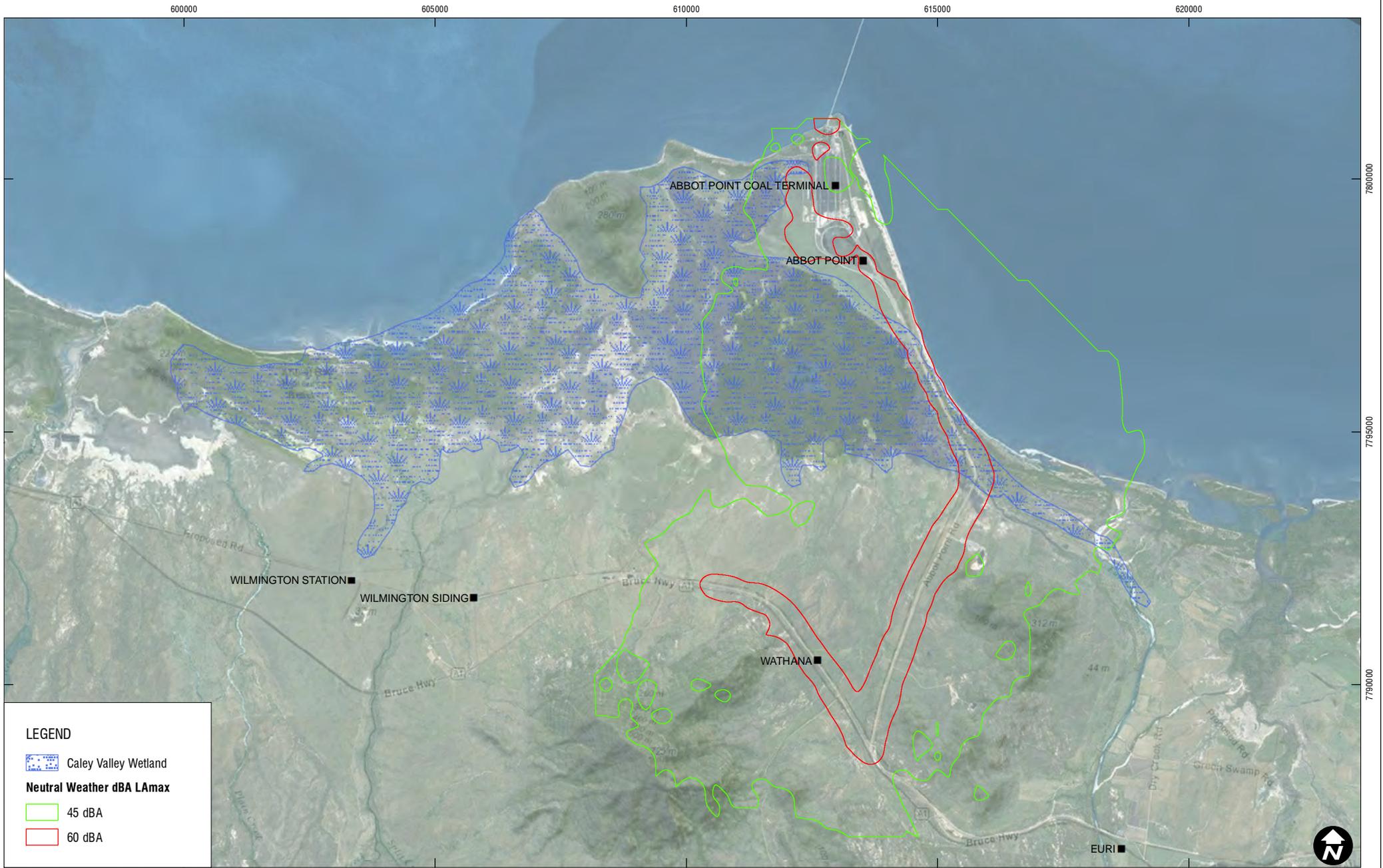
60 dBA



Scale: 1:100,000  
GDA 1994 MGA Zone 55

12/06/2015  
622.10190

\\slr\slr\local\Corporate\Projects-SLR\630-Sr\WTL\622-10190-Abbot Pt\Cumulative Noise Assessment\SLR Data Drafting\Figures\2015\_06\SLR622\_1019002000\_L\_F19\_Scenario7\_Neutral\_01.mxd



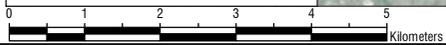
**LEGEND**

Caley Valley Wetland

**Neutral Weather dBA L<sub>Amax</sub>**

45 dBA

60 dBA



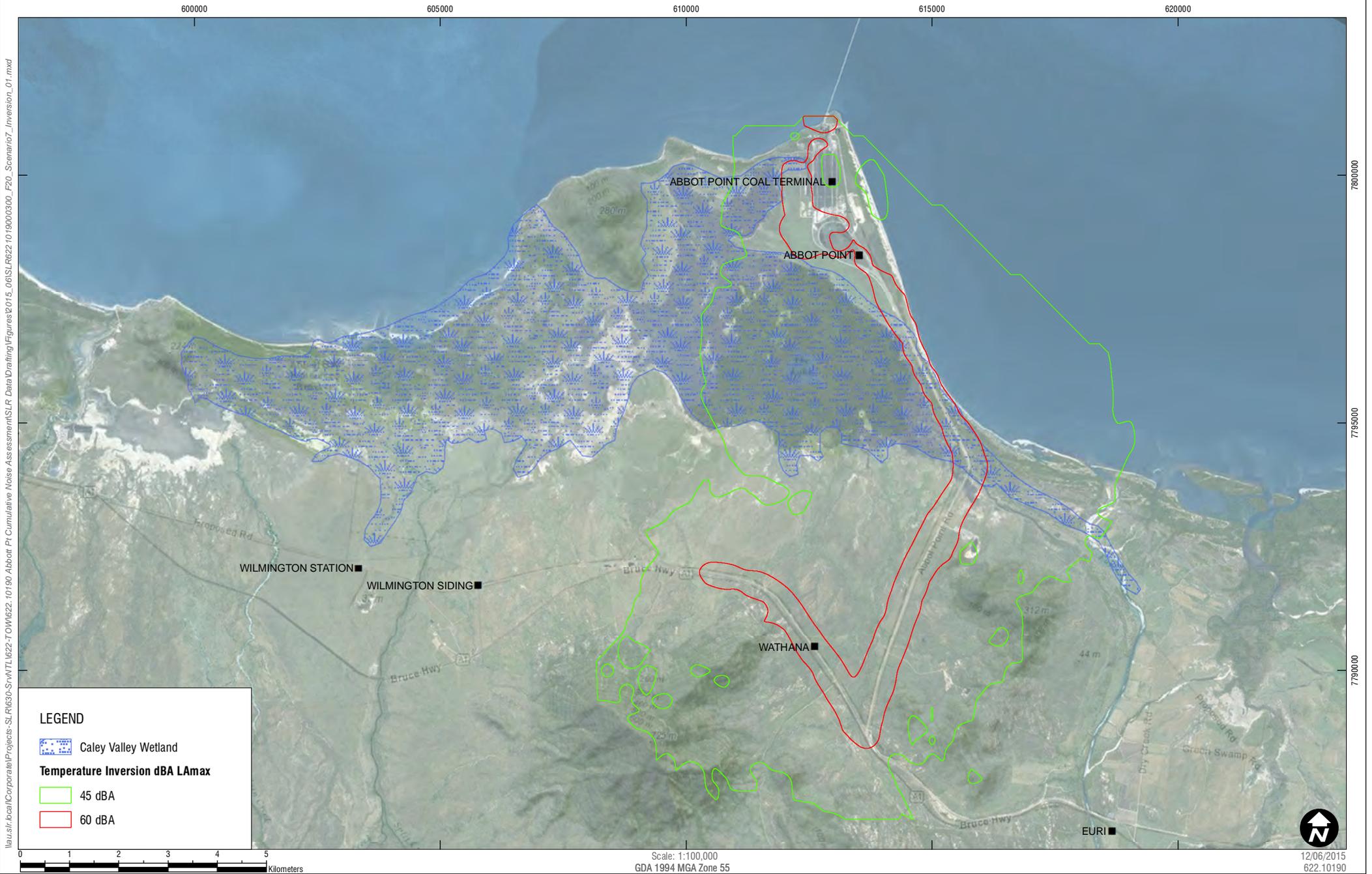
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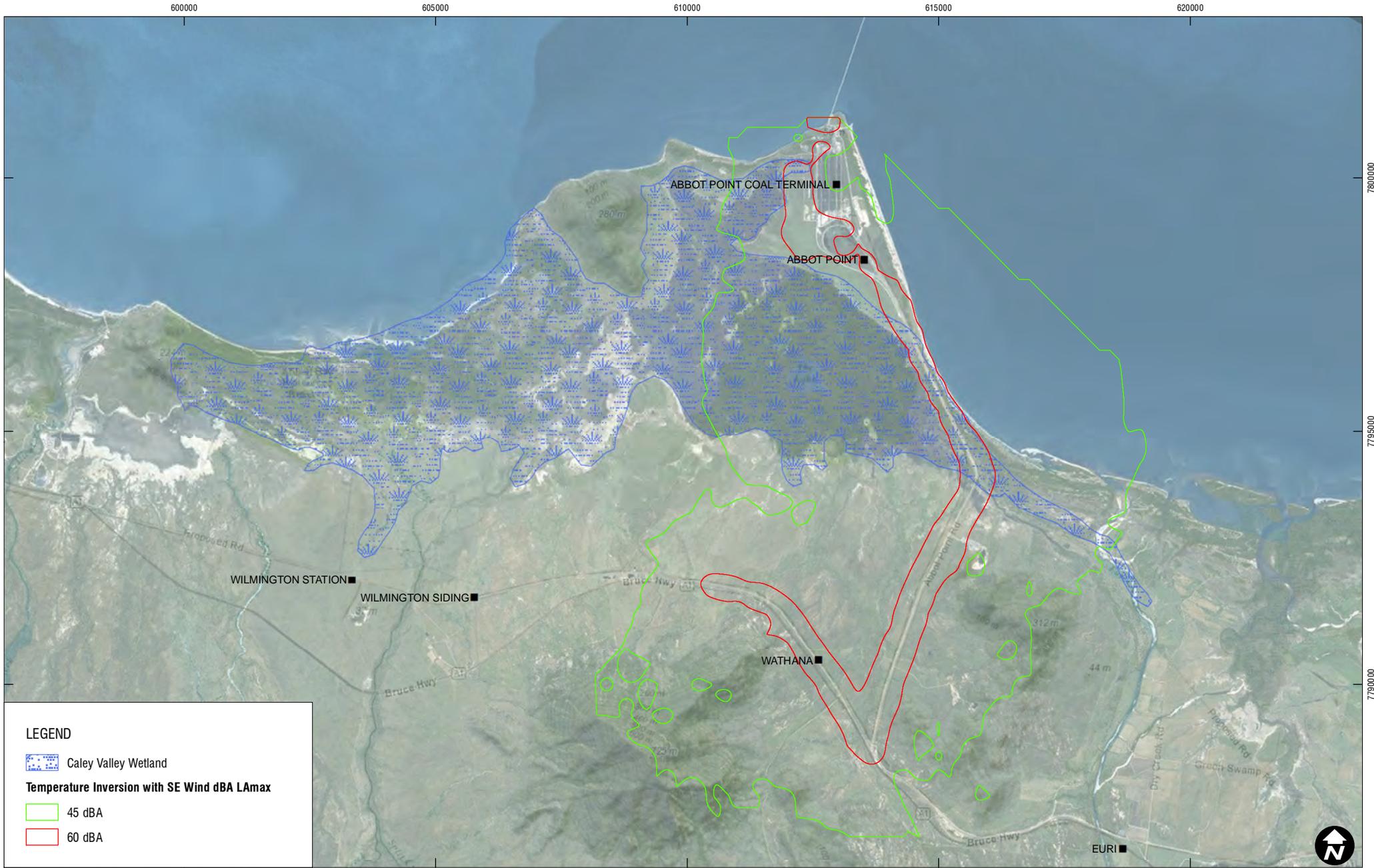
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**Scenario 7 L<sub>Amax</sub> - Post-dredging  
Management of the DMCP  
Neutral Weather**

**FIGURE 19**



\\slr.local\Corporate\Projects-SLR\630-Sr\WTL\622-TOW\622-10190-Abbot Pt\Cumulative Noise Assessment\SLR Data Drafting\Figures 2015\_06\SLR622 1019000000\_P21\_Scenario7\_InversionSEWind\_01.mxd



**LEGEND**

Caley Valley Wetland

**Temperature Inversion with SE Wind dBA L<sub>max</sub>**

45 dBA

60 dBA

0 1 2 3 4 5  
Kilometers

Scale: 1:100,000  
GDA 1994 MGA Zone 55

12/06/2015  
622.10190