APPENDIX M

ENVIRONMENTAL NOISE AND VIBRATION ASSESSMENT - INFRASTRUCTURE AND LONG TERM EMPLOYEE VILLAGE

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Central Eyre Iron Project

IRON ROAD LIMITED

Environmental Noise and Vibration Assessment – Infrastructure Corridor and Long Term Employee Village

Revision 0

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Executive summary

This environmental noise and vibration assessment report considers noise and vibration levels to be generated due to the construction and operation of the proposed railway line, borefield, transmission line and long term employee village as part of the Iron Road Limited (Iron Road) Central Eyre Iron Project (CEIP).

This assessment report considers noise and vibration levels to be generated due to the construction and operation of the proposed infrastructure corridor (including the railway line, water pipeline, borefield and transmission line) and the long term employee village.

Separate assessment reports address predicted noise and vibration levels at the proposed mine and port sites.

This assessment includes:

- A review of the proposed infrastructure corridor and long term employee village, identification of noise sources and processes and determination their corresponding sound power levels.
- Determination of applicable noise and vibration criteria based on review of national and state legislation and guidelines.
- Acoustic modelling using the SoundPlan computer model using the NORD 2000 algorithm to predict train noise levels. Noise level contours have been presented in steps of 5 dB(A) from a lower limit of 30 dB(A).
- Comparison of the predicted noise levels at the closest sensitive receiver due to the proposed railway line with the noise criteria derived in accordance with the Environment Protection Authority (EPA) *Guidelines for the assessment of noise from railway infrastructure* (EPA 2013) (Rail Noise Guidelines).
- Acoustic modelling using the SoundPlan computer model using the CONCAWE algorithm to predict industrial source noise levels due to the operation of the proposed borefield. Noise level contours have been presented in steps of 5 dB(A) from a lower limit of 30 dB(A).
- Comparison of the predicted noise level at the closest sensitive receivers due to the operation of pumps and transformers located at the proposed borefield with the relevant indicative noise levels derived in accordance with the *Environment Protection (Noise) Policy 2007* (Noise Policy).
- A review of construction noise levels in accordance with the noise level criteria presented the Noise Policy and other relevant guidelines.
- Consideration of typical vibration levels from construction and operation of the proposed infrastructure and comparison with the applicable vibration criteria.
- Calculation of potential airblast and ground vibration due to blasting during construction using the methodology presented in the *Imperial Chemical Industries (ICI) Blasting Guide* (ICI 1995).

The findings of the assessment are summarised below.

Railway operation

The noise and vibration levels associated with railway line operation were predicted to be significantly less than the noise and vibration limit criteria presented in the Rail Noise Guidelines, as summarised in Section 5.1.

Long term employee village operation

Modelling was not performed for the operation of the long term employee village as once established noise from the village would comprise of standard domestic type noises such as air conditioners and vehicles entering and leaving the premises, similar to existing noise sources and levels that currently exist in Wudinna.

Borefield operation

A review of the predicted noise levels at the nearest sensitive receivers for the borefield operational noise emissions show that the noise criteria, in accordance with the Noise Policy*,* will be met, as summarised in Section 5.3.

Transmission line operation

Corona noise levels generated by the power transmission line will be insignificant and will have minimal acoustic impact on the existing ambient noise levels at the nearest noise sensitive receivers, as discussed in Section 5.4.

Construction noise

As noted in Section 4.6 night time construction works would only be undertaken in exceptional circumstances and would be uncommon. Day time construction, 7 days a week (including on Sundays and public holidays), is planned.[1]

The construction noise prediction modelling for the proposed railway line, borefield and transmission line indicate that when construction works are performed on Sundays or public holidays, and at night time if required, then a separation distance of at least 1-1.5 km between the construction works and the sensitive receiver will be instituted or specific environmental management controls as detailed in a Construction Environmental Management Plan (EMP) will be implemented, to ensure the noise emissions meet the Noise Policy requirements.

The Construction EMP will aid in setting work procedures and processes to manage noise from construction operations at various distances from sensitive receiver locations during different periods of time, eg night time, Sundays and public holidays. All construction works would be managed with all reasonable and practical measures undertaken to minimise noise resulting from the activity to minimise its impact in accordance with the Noise Policy.

As construction works will be performed in sections the noise levels generated at individual sensitive receiver locations will be for a relatively short duration as the construction operations move along the infrastructure corridor.

It should also be noted that the prediction noise modelling for construction was performed assuming that all of the construction equipment is operating at full load, therefore presenting the worst case scenario. This is generally not the case in reality as some equipment will be idling or switched off when not in use while others will be working at full load. As the modelling was based on a worst case scenario it is considered there is considerable scope for managing the actual noise levels within the Noise Policy requirements.

Modelling was not undertaken for the construction of the long term employee village as the exact location was unknown and there are standard controls which are commonly applied for this type of construction.

Construction vibration

Based on a comparison of the typical ground vibration levels presented for various pieces of construction equipment (refer to Section 4.7) and the various types of construction equipment likely to be used during construction of the proposed railway line, borefield and transmission line (refer to Table 4-5, Table 4-6 and Table 4-7), it was deemed that the vibration levels at the closest sensitive receivers will be below the preferred day time human response levels for residential properties specified in Section 3.3.1.1, and hence well below the structural damage criteria presented in Section 3.3.1.2. This is because it is known that attenuation of vibration occurs over short distances and experience of railway construction related vibration demonstrates imperceptibility even at 20 m in some cases. There is a low probability of adverse comment or disturbance to building occupants at vibration levels below the human response preferred values (DEC 2006).

[1] Aaron Deans, Project Manager, Iron Road, *pers comm* 10/12/14 and confirmed by email 9/1/15

Construction blasting

As blasting sites and operating procedures have not been fully defined, generic calculations have been performed which predict the typical airblast over pressure and ground vibration levels associated with construction blasting for various distances and charge masses (refer to Section 5.6.3). These predications indicate that blasting should not cause adverse impact where minimum distances for respective charge masses are established.

Glossary

Term	Description
Acoustic spectrum	The sound pressure level (or sound power level) as a function of frequency (eg octave band, 1/3 octave or narrow band). Generally used to identify noise sources or items contributing disproportionately to an overall noise level.
Ambient noise level	The prevailing noise level at a location due to all noise sources but excluding the noise from the specific noise source under consideration. Generally measured as a dB(A) noise level.
Background noise level	The lower ambient noise level, usually defined as the value of the time varying ambient noise level exceeded for 90% of the measurement time. Usually defined in the dB(A) scale - L_{A90}.
Central Eyre Iron Project (CEIP)	Refers to the entire CEIP project (proposed mine, long term employee village, infrastructure corridor and port).
CEIP Infrastructure	Refers to the proposed port development, railway line, water pipeline, power transmission line, borefield and the long term employee village.
dB	Sound pressure levels are expressed in decibels as a ratio between the measured sound pressure level and the reference pressure. The reference pressure is $2x10^{-6}$ Pascal (Newtons per square meter).
dBL	Airblast sound pressure level
dB(A)	The A-weighted sound pressure level in decibels, denoted dB(A) is the unit generally used for the measurement of environmental, transportation or industrial noise. The A-weighting scale approximates the sensitivity of the human ear when it is exposed to normal levels and correlates well with subjective perception. An increase or decrease in sound level of approximately 10 dB corresponds to a subjective doubling or halving in loudness. A change in sound level of 3dB is considered to be just noticeable.
Frequency	The rate of repetition of a sound wave. The unit of frequency is the Hertz (Hz), defined as one cycle per second. Human hearing ranges approximately from 20 Hz to 20,000 Hz. For design purposes, the octave bands between 63 Hz to 8 kHz are generally used. The most commonly used frequency bands are octave bands. For more detailed analysis each octave band may be split into three one-third octave bands or in some cases, narrow frequency bands.
Imperceptible	So slight, gradual, or subtle as not to be perceived.
Infrastructure corridor	Refers to the railway line, railway access road, road crossings and realignments, water pipeline, borefield and power transmission line between the proposed mining lease boundary and the port site boundary.
L_{A90}	The ‘A’ weighted Sound Pressure Level that is exceeded for 90% of the measurement period. Usually used to represent the background noise level.
L_{Amax}	The maximum noise level at a sensitive land use due to individual pass – by events
L_{Aeq}	The ‘A’ weighted equivalent continuous sound level is denoted $L_{Aeq.}$
$L_{Aeq,1h}$	Equivalent noise level addressing the average noise exposure of a land sensitive use measured over a 1 hour time period.
$L_{Aeq,9h}$	Equivalent noise level addressing the average noise exposure of a land sensitive use for the day night time period. Night time period is defined as from 10 pm to7 am.
$L_{Aeq,15h}$	Equivalent noise level addressing the average noise exposure of a land sensitive use for the day time period. Day time period is defined as from 7 am to10 pm.
L_{eq}	The equivalent continuous sound level. The steady level which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level.

Term	Description
Mtpa	Million tonnes per annum
Noise Policy	The *Environment Protection (Noise) Policy 2007* (Noise Policy) provides a legal framework for the assessment of a wide range of often complex noise issues.
PPV	Ground vibration peak particle velocity
rms	Root Mean Square
Sound level meter	An instrument consisting of a microphone, amplifier and data analysis package for measuring and quantifying noise.
Sensitive receivers	Sensitive receivers* that may be impacted by noise or vibration include: • residential dwellings and associated private outdoor recreational areas at the ground level (if applicable) • nursing homes and caravan parks that accommodate existing long-term residential use • educational institutions • hospitals • places of worship • passive recreation areas, such as parks • active recreation areas, such as sporting fields. *As defined in the *Guidelines for the assessment of noise from rail infrastructure* (EPA 2013)
VDV	Vibration dose value

1. Introduction

Iron Road has engaged Jacobs to conduct an assessment of the predicted environmental noise and vibration levels due to the construction and operation of the CEIP infrastructure corridor.

Iron Road's CEIP incorporates development of an iron concentrate mining and processing operation at Warramboo, approximately 25 km south east of Wudinna on the Eyre Peninsula of South Australia and associated ancillary infrastructure. Significant infrastructure is required to provide the logistics chain to enable export of the iron concentrate from the proposed mine to market. The required ancillary infrastructure includes a deep water port site at Cape Hardy on the east coast of Eyre Peninsula linked to the mine by an infrastructure corridor incorporating a standard gauge railway line, a water pipeline for process water supplied from a borefield and a 275 kV transmission line. Long term accommodation for the mine workforce is also planned at Wudinna.

This assessment report considers noise and vibration levels to be generated due to the construction and operation of the proposed infrastructure corridor (including the railway line, water pipeline, borefield and transmission line) and the long term employee village.

Separate assessment reports address predicted noise and vibration levels at the proposed mine and port sites.

This assessment includes:

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2. Project description

Iron Road plans to export 21.5 million tonnes per annum (Mtpa) of iron concentrates for 25 years from the mine and transport the iron concentrate to the proposed port site from the mine by rail.

The proposed mine will be located approximately 130 kilometres[2] north west of the proposed Cape Hardy port site. Refer to Figure 2-1.

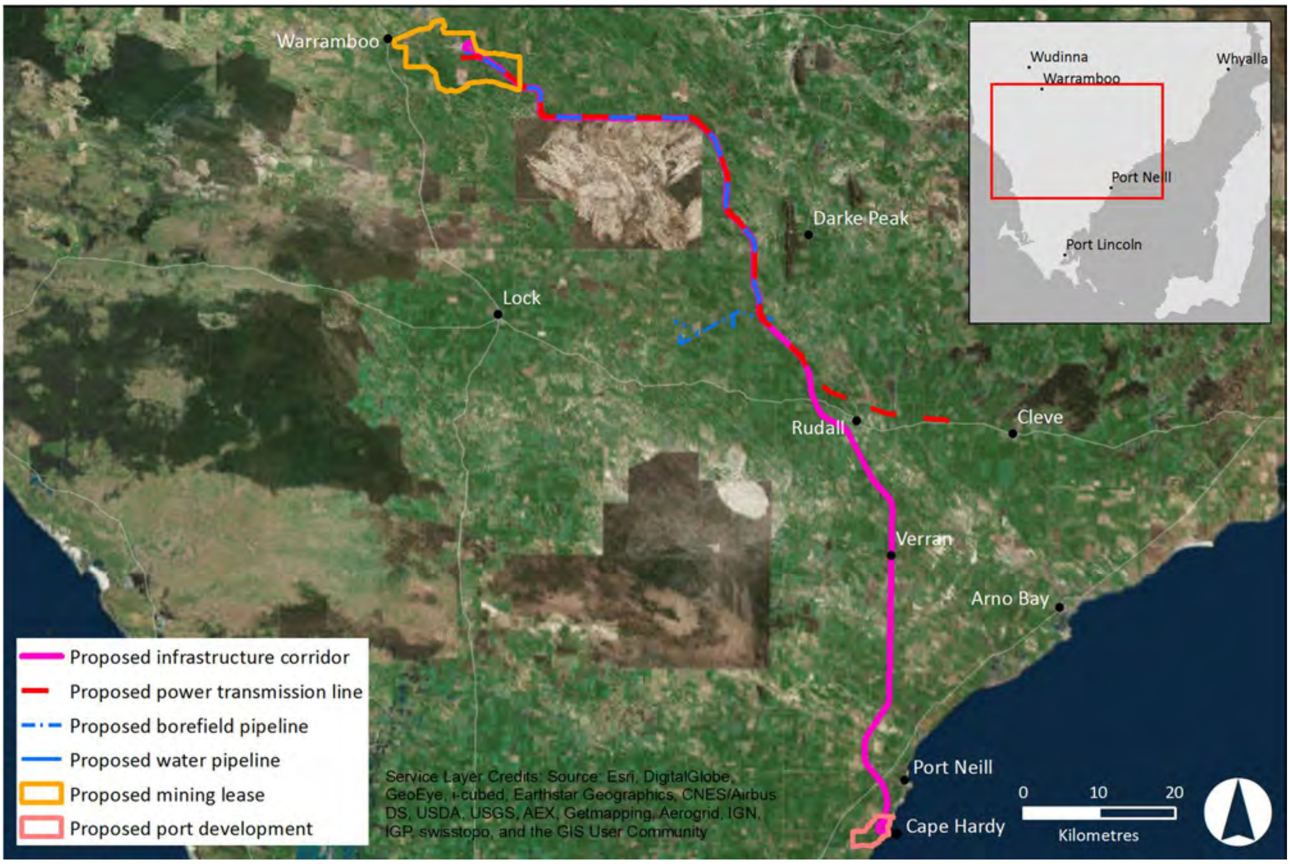

Figure 2-1: Relative location of the proposed mine and port site

2.1 Proposed railway operation

It is proposed that a train will consist of two 3,200 kW head end locomotives (nominally DownerEDi Rail GT46C ACe) pulling 138 'belly drop' covered iron concentrate wagons with a total train length of approximately 1.3 km. To transport 21.5 Mtpa of iron concentrate from the proposed mine, six loaded trains per day are required. To achieve this, three trains running two return trips each per day will be used. The two passing sidings will be long enough to allow a complete train to be clear of the main line so another train can pass-by. The planned cycle time for each train is 8.5 hours including travel to the proposed mine, loading, return to port and unloading.

Each wagon will carry 78 tonnes of iron concentrate and have a gross weight of 100 tonnes. The total load of iron concentrate for each train will be 10,764 tonnes.

A speed limit of 60 km/h will be enforced for loaded trains and 80 km/h for unloaded trains along the main line. A speed limit of 10 km/h will apply for the mine and port railway yards.

[2] Measured from the proposed mining lease boundary to the boundary of the port site

The nature of the proposed CEIP railway line operation, is one which will result in relatively short periods of high noise levels (when compared to the ambient background noise levels) intermittently during the day and night, separated by longer periods of quiet. In order to assess the potential railway noise effects, it is important to consider both the overall railway noise exposure across a 24 hour day and also the noise from individual railway pass-bys.

Diesel locomotives can be a considerable source of noise (from the engine) with significant engine exhaust noise emitted at a height of approximately 4 m above the railway.

As the rail tracks will include relatively large arced bends, it is deemed that rail squeal due to wheel / rail interaction noise will be minimal.

2.2 Proposed long term employee village

The proposed long term employee village is located on the north eastern edge of the Wudinna township, adjacent to the existing residences.

Once the employee village is established, noise from the village to the existing residences would comprise of standard domestic type noises such as air conditioners and vehicles entering and leaving the premises.

Figure 2-2 presents the proposed location of the employee village.

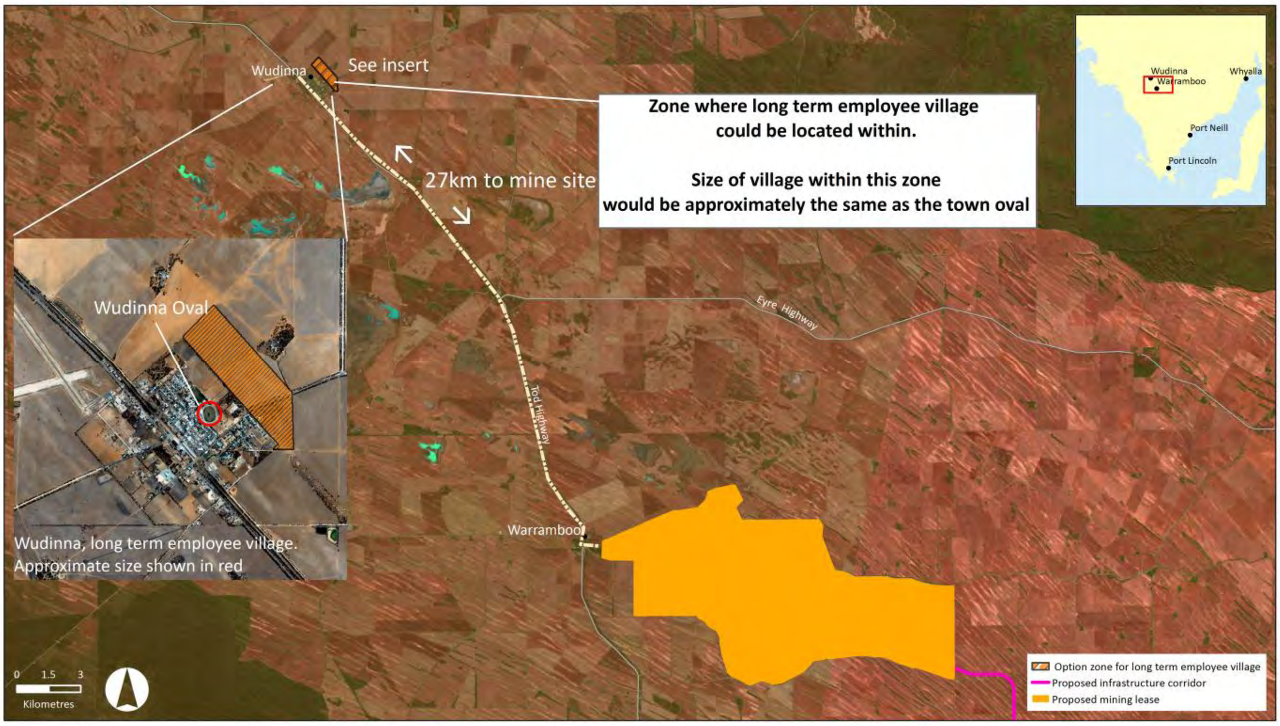

Figure 2-2: The proposed long term employee village site

2.3 Proposed borefield

The borefield will consist of 10 bore wells installed to approximately 300 m depth and spaced approximately 2,000 m apart, each having a 150 – 200 kW submersible pump. Nine of the bores will be located west of the proposed infrastructure corridor, with one located east of the corridor adjacent to Kilroo-Kiepla Road, all within existing road reserves. The water is to be pumped continuously through pipework to two storage tanks.

The water from the storage tanks is to be piped to the proposed mine using two 900 kW transfer pumps, via a pipeline that will be located within the proposed infrastructure corridor.

The electrical power supply to each bore pump will be via post mounted transformers (total 10 units), and to the two transfer pumps will be from a 'Kiosk' style transformer (i.e. prefabricated substation), all connected to the local electricity network. The transformers will be a noise source more than likely generating a tonal noise component.

Due to the noise associated with the pump and transformers the operation of the borefield has potential to impact on sensitive receivers in close proximity.

Figure 2-3 below presents a general overall view of the relative locations of the bore wells, storage tanks and pipeline route.

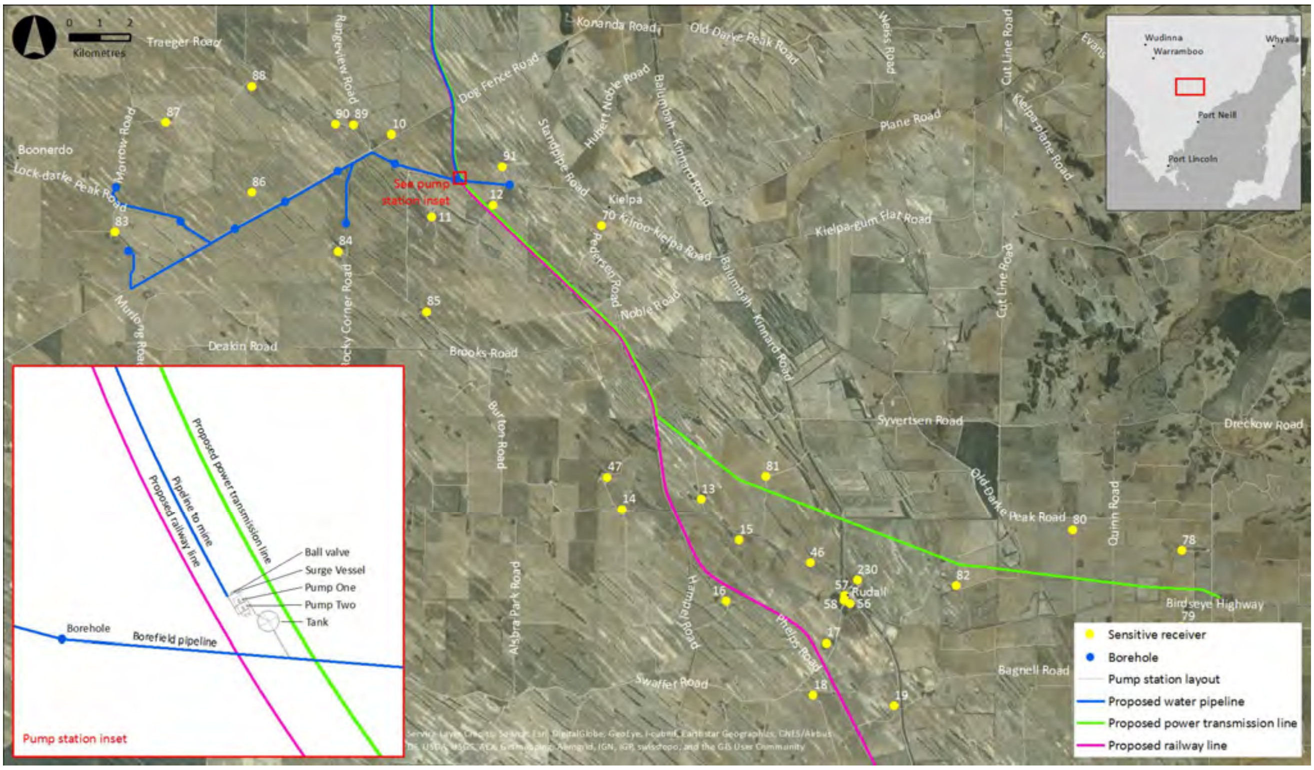

Figure 2-3: The proposed borefield and transmission line layout

2.4 Proposed transmission line

As illustrated in Figure 2-3, the proposed transmission line originates from the existing Yadnarie substation and will run west, parallel to the existing ElectraNet transmission line. The transmission line will continue parallel to the existing transmission line until its intersection with the proposed railway line. At this point, the transmission line will run parallel to the railway line, forming part of the infrastructure corridor and continuing to the mine site.

The transmission line is a 275 kV line which will predominately utilise steel mono poles/pylons. The transmission line consists of a series of poles between which conductors and earth wires are strung.

2.5 Existing environment and sensitive receivers

The proposed infrastructure corridor is used for agriculture, predominately cereal cropping, and has largely been cleared of native vegetation. The existing noise environment is expected to be dominated by natural noise sources such as wind, insects and birds. Local road traffic, existing train pass-bys and agricultural activity would have an influence on background noise in some locations.

The proposed long term employee village is located adjacent Wudinna where the existing noise conditions would be generated by residential, small businesses and services including local traffic, delivery trucks, air conditioners and people.

There are residential properties intermittently spread along the proposed infrastructure corridor. Figure 2-4 illustrates the location of the closest identified sensitive receivers along the infrastructure corridor and near the proposed borefield and transmission line.[3] These sparsely located sensitive receivers would enjoy a high level of amenity due to minimal human induced noise sources.

The nearest sensitive receiver to the proposed railway line was identified as the Driver River Uniting Church at Verran (number 27 on Figure 2-4) and is located approximately 140 metres (m) from the railway line. All other identified sensitive receivers are believed to be residential houses and there are approximately 13 houses between 170 m and 500 m and another eight houses between 500 and 1000 m from the proposed railway line.

The nearest sensitive receiver to the proposed borefield is a residential property located approximately 580 m from a bore to the north east of the proposed borefield (number 91 on Figure 2-4). The closest sensitive receiver to the proposed pump station (two 900 kW transfer pumps) is located approximately 1370 m away (number 12 on Figure 2-4)

The nearest sensitive receivers to the proposed transmission line are two residential properties that are understood to be derelict[4] and are located approximately 100 m and 170 m from the proposed transmission line (number 8 east of Hambidge Wilderness Protection Area and number 12 near Kielpa on Figure 2-4). The nearest habitable residential property to the proposed transmission line route is number 6 on Figure 2-4 which is located approximately 290 m away.

[3] The locations of sensitive receivers have been primarily determined by desktop assessment and are subject to field and community verification.
[4] Advise from Steve Green, Environmental Manager, Iron Road, April 2014, based on site visit

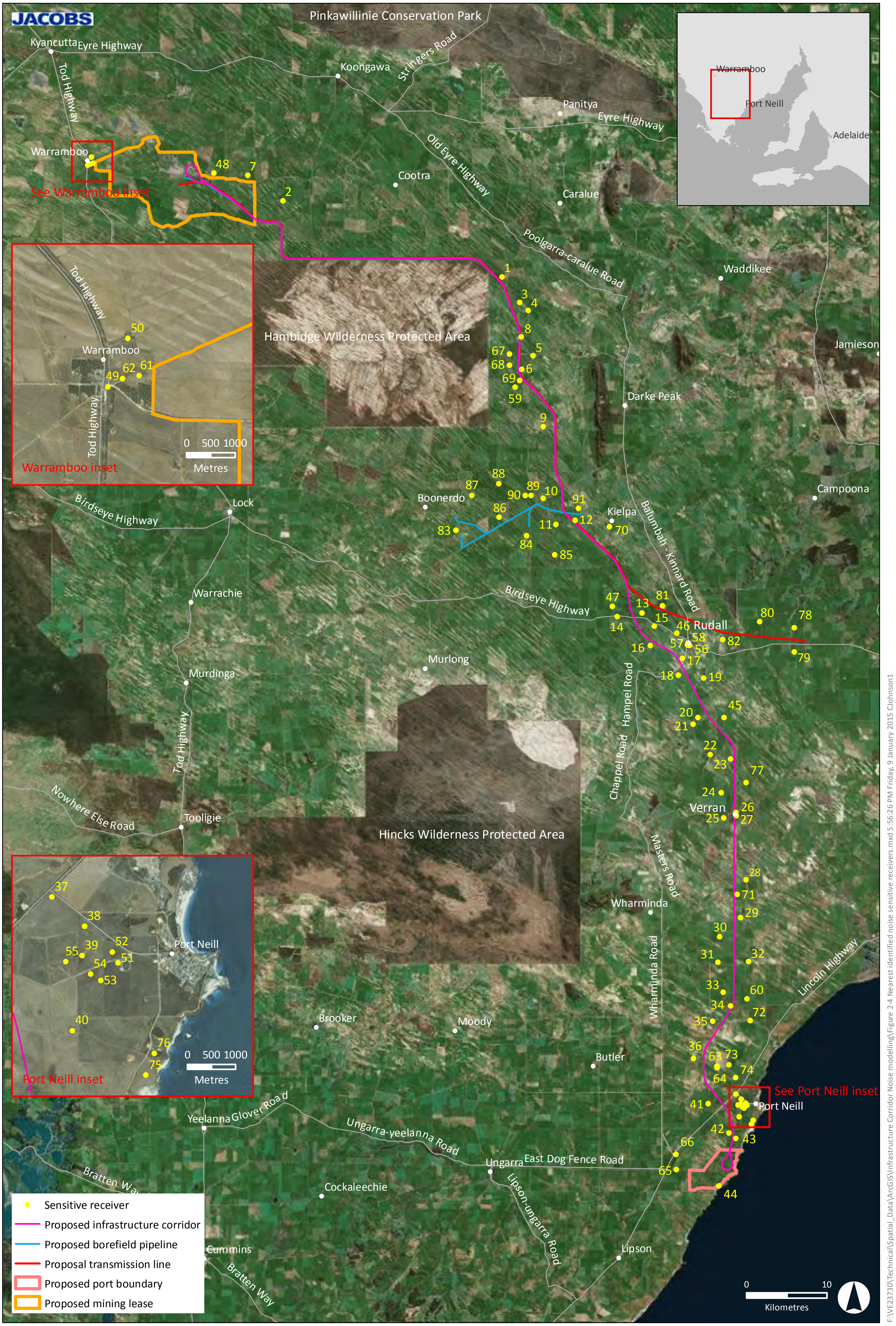

Figure 2-4 Nearest identified sensitive receivers

3. Noise and vibration criteria

The Rail Noise Guidelines present noise and vibration criteria that should be achieved at noise sensitive receivers along the railway corridor for the operation of the railway line.

The Noise Policy provides the relevant indicative noise levels that are to be achieved at the proposed borefield development and for limiting construction noise from the borefield and long term employee village.

3.1 Rail noise guidelines

Page 2 of the Rail Noise Guidelines state:

> "The Guidelines define the evaluation distance from rail infrastructure where potential adverse noise and vibration impacts may exist for noise (and vibration) sensitive receivers. These distances are indicative only, and aim to provide guidance for developers of rail infrastructure or new residential areas (or other sensitive uses) with respect to whether an investigation of potential impacts will be required. In practice, rail infrastructure and residential areas can be brought closer than the stated evaluation distance by effective mitigation of the noise source, between the source and the sensitive development, or at the sensitive development itself."

As specified in the Rail Noise Guidelines, the evaluation distance for a new train line is 180 m. There are only two sensitive receivers within 180 m of the proposed railway line. They are the church site (estimated at 140 m and a derelict residential property (number 8 on Figure 2-4) approximately 170 m away). When the distance from the proposed railway line is greater than 180 m, the Rail Noise Guidelines consider that the railway noise and vibration impacts will be minimal and therefore detailed consideration during the design of the project is not required.

The proposed railway as part of the CEIP is considered a 'new railway line' where nearby sensitive receivers are not already exposed to railway noise. The Rail Noise Guidelines for a 'new railway line' state that the criteria will apply at existing noise sensitive receivers as well as at proposed future sensitive receivers which have already gained development consent under the *Development Act 1993* prior to the announcement of the railway project. The exception is for cases where the development is situated in the previously identified Noise and Air Overlay in the relevant Development Plan.

As listed in the Rail Noise Guidelines, sensitive receivers that may be impacted by noise or vibration due to the railway operation include:

- Residential dwellings and associated private recreational areas at the ground level
- Nursing homes and caravan parks that accommodate long term residential use
- Educational institutions
- Hospitals
- Places of worship
- Passive recreation area, such as parks
- Active recreational areas, such as sporting fields

The relevant noise and vibration criteria are provided below.

3.1.1 Railway operation - air-borne noise criteria

To assess railway noise, the Rail Noise Guidelines provide the following criteria:

- $L_{Aeq,15h}$ and $L_{Aeq,9h}$ equivalent noise levels, addressing the average noise exposure of a sensitive land use across the day or night period respectively.

- L_{Amax} levels, addressing the maximum noise levels at a sensitive land use due to individual pass-by events.
- $L_{Aeq,\ 1h}$ equivalent noise levels, addressing the worst – case average noise exposure of non- residential sensitive receivers during their hours of operation.

Table 3-1 below presents the noise criteria at noise sensitive receivers (applicable for residential, nursing homes and caravan parks accommodating long term residential use) for a new railway line (as specified in the Guidelines):

Table 3-1: Noise criteria for residential receivers

Period	Noise criteria, dB(A) for new railway lines
Day, 7am to 10 pm	60 $L_{Aeq,\ 15h}$ 80 L_{Amax}
Night, 10 pm to 7 am	55 $L_{Aeq,\ 9h}$ 80 L_{Amax}

Table 3-2 presents the noise criteria for non- residential sensitive receivers near the proposed new railway line. The noise criteria represent external L_{Aeq} noise levels at the most exposed sensitive façade for the hours of operation of the land use unless otherwise stated.

Table 3-2: Noise criteria for non – residential sensitive receivers during hours of operation

Land use	Noise criteria, dB(A) for new railway lines
Educational Institutions	65 $L_{Aeq,\ 1h}$
Hospitals	60 $L_{Aeq,\ 1h}$
Places of Worship	60 $L_{Aeq,\ 1h}$
Passive recreation areas	60 $L_{Aeq,\ 1h}$
Active recreation areas such as sporting fields	65 $L_{Aeq,\ 1h}$

3.1.2 Railway operation - ground-borne noise criteria

Table 3-3 presents the ground-borne noise criteria for sensitive receivers as provided in the Rail Noise Guidelines. These criteria are only to be applied where the level of ground-borne noise from railway pass-bys is higher than the air borne noise from the pass-by and are not to be exceeded for 95% of rail pass-by events.

Table 3-3: Ground borne noise criteria for sensitive receivers

Land use	Time Period	Ground borne noise level dB(A)
Residential	Day, 7 am to 10 pm	40 L_{Amax} (slow)
	Night, 10 pm to 7 am	35 L_{Amax} (slow)
Educational Institutions & places of worship – quiet areas	When in use	40 L_{Amax} (slow)
Educational Institutions & places of worship – other areas	When in use	45 L_{Amax} (slow)
Hospital – sleeping areas	When in use	35 L_{Amax} (slow)
Hospital – other areas	When in use	35 - 40 L_{Amax} (slow)

The Rail Noise Guidelines also state that in the majority of situations, ground-borne noise is not normally noticeable as it is at a much lower level than the level of the air-borne noise from railway pass-bys. However ground-borne noise may be significant for sensitive receivers above or in close proximity to underground railways.

3.1.3 Rail operation - ground-borne vibration criteria

In accordance with the Rail Noise Guidelines, ground-borne vibration levels from 95% of train pass-bys at adjacent sensitive receivers should achieve compliance with the evaluation criteria for intermittent vibration sources provided in Annex A of Australian Standard *AS 2670.2-1990: Evaluation of human exposure to whole body vibration, Part 2 – Continuous and shock-induced vibration in buildings (1 to 80 Hz)* (AS 2670.2-1990).However, AS 2670.2-1990 was withdrawn in April 2014.

Alternatively for the purpose of this assessment the construction vibration criteria summarised in Section 3.3 has been considered to assess potential rail operation vibration.

3.2 Noise policy

The *Environment Protection (Noise) Policy 2007* (the Noise Policy) is applicable to operational noise associated with the non-rail components of the proposed development including the borefield, transmission line and long term employee village.

Part 5, Division 20 of the Noise Policy was used to determine the noise criteria to be achieved for non-rail components of the proposed development.

The Noise Policy also provides guidance for construction noise criteria.

3.2.1 Non-rail operational noise

3.2.1.1 Long term employee village – Wudinna

The Noise Policy Clause 25 titled 'Fixed domestic machine noise' states that fixed domestic machine noise level shall not exceed:

- 52 dBA between the hours of 7:00 am and 10:00 pm
- 45 dBA between the hours of 10:00 pm and 7:00 am

If the ambient noise levels are higher than the noise levels presented above, then the units can operate as long as the machine levels do not exceed the ambient noise levels.

3.2.1.2 Borefield and transmission line

Clause 4 of the Noise Policy presents the method for determining the relevant indicative noise limits for operations based on Development Plan zones and land uses associated with the land where the noise source and sensitive receivers are located. The proposed borefield and transmission line and the nearest defined sensitive receivers are located in an area zoned primary production in the *Cleve Council Development Plan* (Department of Planning, Transport and Infrastructure (DPTI) 2013). A primary production zone is considered a rural industry land use in the Noise Policy.

For development applications, such as the CEIP infrastructure development, a more stringent criterion of 5 dB(A) below the indicative noise level (continuous) must be applied (Clause 20(3)of the Noise Policy).

For quiet localities (defined as a locality precinct or area that would be assigned a rural living use category which also includes parks and reserves), the predicted noise level (continuous) must not exceed L_{Aeq} 52 dB(A) during the day period, L_{Aeq} 45 dB(A) during the night period and the maximum predicted noise level during the night period must not exceed L_{Aeq} 60 dB(A) (Noise Policy, Part 5, Clause 20, Section (4)(a) to (c) inclusive).

Table 3-4: Indicative noise factors for the proposed borefield and transmission line

Criteria	Indicative noise level, $L_{Aeq(15\ mins)}$	
	Day (7 am - 10 pm)	Night (10 pm - 7 am)
Rural Industry indicative noise factor	57	50
Development authorisation criterion	- 5	- 5
Noise criteria*	**52**	**45**

* The noise criteria is determined to be below the maximum for quiet localities.

Also the source noise level (continuous) must be adjusted for any specific acoustic characteristics (impulsive, low frequency, modulating, tonal). A correction (increase) to the source noise level is applied if one or more acoustic characteristics are present (+5 dB(A) for any one characteristic, +8 dB(A) for 2 characteristics and +10 dB(A) for 3 or more characteristics). Based on the land use and the likely operational noise levels generated by the borefield operational equipment, a noise character correction of 5 dB(A) could be warranted and is applied to predicted noise levels.

3.2.2 Construction noise

3.2.2.1 Railway construction

The Noise Policy Division 1 titled *'Construction noise, C*lause 22 titled *'Application'* does not apply to construction activity related to roads, railways or other public infrastructure.

It is proposed the guidelines presented in the DPTI *Management of Noise and Vibration: Construction and Maintenance activities*, Operational instruction 21.7 (DPTI 2014) are relevant as a means of demonstrating compliance with the general environmental duty. It states:

> "Although Section 22 of the *Environment Protection (Noise) Policy 2007* specifically excludes road, rail and public infrastructure construction work from Division 1 of the Policy (which deals with construction noise), the department and its contractors still have a responsibility under Section 25 of the *Environment Protection Act 1993* to have a "duty of care" to not pollute the environment through noisy activities:
>
> "a person must not undertake an activity that pollutes, or might pollute, the environment unless the person takes all reasonable and practicable measures to prevent or minimise any resulting environmental harm."
>
> This Operational Instruction provides the guidance on DPTI's "duty of care"."

The proposed railway line construction works will include not only the laydown of railway ballast, sleepers and track but will also incorporate the construction of bridges and railway cuttings.

Table 3-5 provides the noise level targets from DPTI 2014 for short, medium and long term works.

Table 3-5: Railway construction noise level targets (DPTI 2014)

(For infrastructure works adjacent to noise sensitive uses (based on NZS 6803:1999 "Acoustics – Construction Noise"))

Day of the week	Time period	Duration of impacts					
		Short term works (dBA) Up to 2 nights		Medium term works (dBA) 3 – 14 nights		Long term works (dBA) Exceeds 14 nights	
		Leq, 15min	Lmax	Leq, 15min	Lmax	Leq, 15min	Lmax
Weekdays	0600-0700	65	75	60	75	55	75
	0700-1900	See EPA Information Sheet "Construction Noise"*					

Day of the week	Time period	Duration of impacts					
		Short term works (dBA) Up to 2 nights		Medium term works (dBA) 3 – 14 nights		Long term works (dBA) Exceeds 14 nights	
		Leq, 15min	Lmax	Leq, 15min	Lmax	Leq, 15min	Lmax
	1900-2200	75	90	70	85	65	80
	2200-0600	45	75	45	75	45	75
Saturday	0000-0700	45	75	45	75	45	75
	0700-1900	See EPA Information Sheet “Construction Noise”*					
	1900-2400	45	75	45	75	45	75
Sunday & Public Holidays	0000-0700	45	75	45	75	45	75
	0900-1900	See EPA Information Sheet “Construction Noise”*					
	1900-2400	45	75	45	75	45	75

*As per EPA Information Sheet “Construction Noise” (EPA 2013a) all reasonable and practicable measures must be taken to minimise noise from construction activity and reduce its impact at all times including between 7am – 7pm, but no specific noise levels are applicable.

Based on the noise targets from DPTI 2014, as specified in Table 3-5, the adopted rail construction noise criteria for the purpose of this assessment is the long term work (exceeding 14 days) night time (7 pm to 7 am), Sunday and public holiday targets of $L_{eq,\ 15min}$ 45 dB(A) and L_{max} 75 dB(A).

3.2.2.2 Borefield, transmission line and accommodation village (non-rail construction)

Other construction in the infrastructure corridor will include road construction, water pipeline and transmission line construction. Construction activities at the accommodation village at Wudinna will include building construction.

These relatively short term construction activities may have an impact on sensitive receivers and therefore the construction works will need to comply with the construction noise provisions of the Noise Policy (Part 6, Clause 23). These provisions do not allow noisy construction works resulting in noise with an adverse impact on amenity on Sundays, public holidays and between 7 pm and 7am on any other day (except to avoid unreasonable interruption to traffic or if authorised by the EPA).

Clause 23 also stipulates that adverse impact on amenity will occur if the noise level exceeds L_{Aeq} 45 dB(A) or L_{Amax} 60 dB(A) unless the ambient noise level exceeds these levels in which case the noise source level should not exceed ambient.

At all times the person responsible for the construction activity must ensure that works are undertaken within allowable times in accordance with the Noise Policy and that all reasonable and practical measures are taken to minimise noise resulting from the activity and to minimise its impact. For example, noisy equipment (such as masonry saws or cement mixers) or processes must be located to minimise impact on sensitive receivers and noise reduction devices such as mufflers must be fitted and operating effectively.

The L_{Aeq} 45 dB(A) noise criteria has been adopted for this assessment as an indicator of potential adverse noise impact for night time, Sundays and public holidays if exceeded at a sensitive receiver location.

3.3 Construction vibration

Ground vibration impacts may cause annoyance or complaints by some residents, particularly during the construction phase when heavy equipment, such as pile drivers and compactors, are in operation.

The effects of ground vibration may be separated into two categories, these being:

- Human Response - Vibration that inconveniences or possibly disturbs the occupants or users of the building.
- Structural damage - Vibration may also impact on the structural integrity of a building such as cracks in plaster walls, cracks in masonry etc.

3.3.1.1 Human response vibration levels

The human response to vibration is significantly more sensitive than the vibration levels for structures.

The EPA does not have a vibration policy or guideline and the *Australian Standard AS 2670.2-1990: Evaluation of human exposure to whole-body vibration* was withdrawn in April 2014. In Appendix C of the guideline titled *Assessing Vibration: a technical guideline* (DEC 2006), acceptable root mean square (RMS) vibration values for continuous and impulsive vibration are provided and are considered applicable for the purpose of this assessment. These vibration levels in the guideline have been derived from *British Standard, BS 6472-1992, Evaluation of human exposure to vibration in buildings (1–80 Hz)*.The guideline presents the vibration criteria levels as preferred and maximum values as presented in Table 3-6 below.

Table 3-6: Preferred and maximum vibration levels at the nearest vibration sensitive receivers – human response

Location	Assessment Period Day time (7:00 am – 10:00 pm) Night Time (10:00 pm – 7:00 am)	Preferred and Maximum Weighted RMS Vibration Values (mm/s)	
		Preferred value	**Maximum value**
CONTINUOUS VIBRATION			
Critical Areas	Day or Night	0.10	0.20
Residences	Day time Night time	0.20 0.14	0.40 0.28
Office, schools, educational institutions and places of worship	Day or night time	0.40	0.80
Workshops	Day or night time	0.80	1.6
IMPULSIVE VIBRATION			
Critical Areas	Day or Night	0.10	0.20
Residences	Day time Night time	6.0 2.0	12.0 4.0
Office, schools, educational institutions and places of worship	Day or night time	13.0	26.0
Workshop	Day or night time	13.0	26.0

There is a low probability of adverse comment or disturbance to building occupants at vibration levels below the preferred values. Adverse comment or complaints may be expected if vibration approaches the maximum values (DEC 2006).

3.3.1.2 Structural vibration levels

The risk of cosmetic or structural damage to buildings is only found to be due to extreme vibration levels relative to what humans would find tolerable.

There is no Australian Standard that provides recommended vibration levels to prevent building structural damage. The German Deutsches Institut für Normung (DIN) Standard DIN 4150-3 (1999-02), *Structural vibration Part 3 – Effects of vibration on structures* (DIN 1999) is a commonly used reference (including in DPTI 2014, *Management of Noise and Vibration: Construction and Maintenance activities, Operational Instruction 21.7*).

DIN 4150-3 (1999-02) presents recommended vibration limits for a range of various building configurations. Table 3-7 below presents the maximum recommended ground vibration levels for various building configurations for short term evaluation.

Table 3-7: Recommended maximum vibration levels presented by DIN 4150-3 (1999-02) – structural

Line	Type of structure	Vibration peak particle velocity (mm/s)			
		Foundation Frequency			Plan of floor of uppermost storey
		Less Than 10 Hz	10 Hz to 50 Hz	50 Hz to 100* Hz	Frequency mixture
1	Buildings used for commercial purpose, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of design and/or use	5	20 to 40	40 to 50	15
3	Structures that, because of their sensitivity to vibration do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (eg buildings that are under a preservation order)	3	3 to 8	8 to 10	8

*For frequencies above 100 Hz, at least the values specified in this column shall be applied

3.4 Blasting – construction

Areas along the proposed railway corridor will require blasting to remove rock outcrops during the construction of the rail cuttings.

Australian Standard *AS 2187.2-2006: Explosives – Storage and use Part 2: Use of explosives* addresses (AS 2187.2-2006) two potential environmental effects of blasting:

- Ground vibration (peak particle velocity (PPV))
- Airblast (sound pressure levels (dBL))

AS 2187.2-2006 provides background information, guidelines for measurement and criteria for peak levels ground vibration and airblast.

Human discomfort levels set by the authorities are less than the levels that are likely to cause damage to structures, architectural elements and services. Ground vibration and airblast levels are influenced by a number of factors some of which are not under the control of the shot firer.

3.4.1.1 Ground vibration

Ground vibration generated by blasting results from the movement of energy within a rock mass or soil. It comprises of various vibration waves travelling at different velocities. These waves are reflected, refracted, attenuated and scattered within the rock mass or soil, so that the resulting ground vibration at any particular location will have a complex character with various peaks and frequency content. Typically, higher frequencies are attenuated rapidly so that at close distances to the source, such frequencies will be present in greater proportion than at far distances from the source.

Significant factors influencing the ground vibration levels during the blasting operation are the:

- Amount of explosive detonated per delay
- The distance from the blast to the sensitive receiver.
- Geological factors

Therefore, as blasting activities approach the neighbouring residences, a reduction in effective charge weights may be required.

Studies and experience show that well designed and controlled blasts are unlikely to create ground vibrations of a magnitude that causes damage to buildings or structures.Table 3-8 below presents the ground vibration levels specified in AS 2187.2-2006 for human comfort.

Table 3-8: Ground vibration limits presented in AS 2187.2 -2006 for human comfort

Category	Type of blasting operations	Peak component particle velocity (mm/s)
Sensitive site (includes houses)	Operations lasting longer than 12 months or more than 20 blasts	5 mm/s for 95% blasts per year. 10 mm/s unless agreement is reached with the occupier that a higher limit may apply.
Sensitive site (includes houses)	Operations lasting less than 12 months or less than 20 blasts	10 mm/s unless agreement is reached with the occupier that a higher limit may apply.
Occupied non – sensitive site, such as factories and commercial premises	All blasting	25 mm/s maximum unless agreement is reached with occupier that a limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specification or levels that can be shown to adversely affect the equipment operation.

3.4.1.2 Airblast

Airblast is the pressure wave produced by the blast and transmitted through the air. Unlike ground vibration, there is only one airblast phase but it is a complex wave train consisting of various peaks and with a range of frequencies.

The sources of the airblast include:

- The air pressure pulse generated by ground vibration
- The direct air pressure pulse generated by rock movement during the blast
- An air pressure pulse caused by direct venting of gases from the region of the blast

It must be also noted that airblast may be reflected by upper layers in the atmosphere and be refocused at distances remote from the blast.

Airblast may be audible by people if it contains energy in the frequency range, typically 20 Hz – 20 KHz. However, some of the energy lies in the frequency range between 2 Hz and 20 Hz and is "sub audible" at the levels normally generated. Such low frequency airblast is often experienced indoors as a secondary audible effect, such as rattling of windows and of sliding doors. A blast perceived as loud indoors due to rattling may be therefore barely audible outdoors.

Airblast is generally the cause of more complaints than ground vibration.Table 3-9 below presents the recommended airblast limits for human comfort from AS 2187.2 -2006.

Table 3-9: Airblast limits presented in AS 2187.2 -2006 for human comfort

Category	Type of blasting operations	Peak component particle velocity (mm/s)
Sensitive site (includes houses)	Operations lasting longer than 12 months or more than 20 blasts	115 dBL for 95% blasts per year. 120 dBL unless agreement is reached with the occupier that a higher limit may apply.
Sensitive site (includes houses)	Operations lasting less than 12 months or less than 20 blasts	120 dBL for 95% blasts per year. 125 dBL unless agreement is reached with the occupier that a higher limit may apply.
Occupied non – sensitive site, such as factories and commercial premises	All blasting	125 dBL maximum unless agreement is reached with occupier that a limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specification or levels that can be shown to adversely affect the equipment operation.

The human comfort criterion is the most stringent criterion and has therefore been used as the criterion that must be achieved.

3.4.1.3 Blasting - ground vibration and airblast criteria

As the blasting operations are expected to be of a short duration, that is less than 12 months, with less than 20 blasts, the following blast criteria are have been applied, refer to Table 3-10.

Table 3-10 : Blasting - ground vibration and airblast criteria limits

Category	Type of blasting operations	Peak level (mm/s – dBL)
Ground Vibration Sensitive site (includes houses)	Operations lasting less than 12 months or less than 20 blasts	10 mm/s unless agreement is reached with the occupier that a higher limit may apply
Airblast Sensitive site (includes houses)	Operations lasting less than 12 months or less than 20 blasts	120 dBL for 95% blasts per year. 125 dBL unless agreement is reached with the occupier that a higher limit may apply

4. Prediction modelling and input data

In order to estimate the likely noise levels at sensitive receivers resulting from the construction and operation works, a noise model was developed using SoundPlan V7.25, a modelling package that is accepted and endorsed by numerous agencies nationally and internationally.

The SoundPlan computer prediction modelling used the CONCAWE algorithm to predict the noise levels at sensitive receiver locations and to predict noise level contours around the proposed development.

The model inputs are described below as well as other information sourced to inform the noise and vibration assessment.

4.1 Weather conditions for the predictions

The CONCAWE prediction algorithm takes into account attenuation due to distance, atmospheric absorption, structural and topographical barriers, directivity of the noise sources and the effect of intervening ground types. The CONCAWE prediction algorithm divides the various meteorological weather conditions into six individual weather categories. Each weather category considers wind speed, direction, time of day, and level of cloud cover:

- Category 1 presents the 'best case weather' conditions, i.e. weather conditions conducive for the lowest propagation levels
- Category 4 presents 'neutral weather' conditions
- Category 5 presents 'worst case weather' conditions, i.e. weather conditions conducive for the highest propagation levels during the day time
- Category 6 presents the 'worst case weather' conditions, i.e. weather conditions conducive for the highest propagation levels during the night time.

The CONCAWE methodology is referenced in the Noise Policy 2007 and the *Guidelines for the Use of the Environmental Protection (Noise) Policy 2007* (EPA 2009), page 46, state:

> "Predictions of the source noise levels for distances over 100 metres should be made using default weather conditions that are equivalent to the CONCAWE meteorological category 6 at night, and CONCAWE meteorological category 5 for the day period. A different weather category to the default values can be used for comparison against the Noise Policy where it can be shown that the associated weather conditions occur for less than 10% of the year and 30% of any one season during the day or night period as relevant."

The Rail Noise Guideline also states that worst case weather conditions shall be used in the modelling process and requires the same CONCAWE weather conditions.

Table 4-1 below presents the meteorological parameters that were used in the prediction modelling.

Table 4-1: Meteorological parameters

Parameter	Meteorological conditions – 'default' weather	
	Day (category 5 – worst case)	Night (category 6 – worst case)
Temperature (^{o}C)	20^{o}C	15^{o}C
Humidity (%)	70%	70%
Wind Speed (m/sec)	4 m/s (in direction of noise source to the noise sensitive receiver)	3 m/s (in direction of noise source to the noise sensitive receiver)
Pasquil Stability Index	E	F

Note also that the uncertainty of the noise level prediction is +/- 3 dBA within a 90% confidence limit.

4.2 Spatial data inputs

The prediction modelling presented in this report has been based on 3D terrain data and infrastructure CAD layouts provided by Iron Road in February 2014.

4.3 Railway operational noise modelling inputs

In order to predict the likely noise levels at sensitive receivers due to the operation of the proposed railway line, a noise model was developed using SoundPlan V7.25, a modelling package that is accepted and endorsed by numerous agencies nationally and internationally.

The Nordic Railway Prediction Method (Nord 2000) algorithm as implemented in SoundPlan was used to predict the noise levels at designated noise sensitive receivers and also to present the predicted noise level contours.

The Nordic Railway Prediction Method (Nord2000) algorithm takes into account attenuation due to distance, atmospheric absorption, structural and topographical barriers, directivity of the noise source and the effect of intervening ground types.

The Nordic Railway Prediction Method was developed from data obtained from train configurations in Denmark.

4.3.1 Train pass-by noise levels

To provide a representative noise level for the iron concentrate train pass-bys which will use the proposed railway line, L_{Aeq} noise level measurements were performed on heavy haul coal trains running 2 x 81 series locomotives and coal wagons. For the locomotive noise level, data was obtained from a report detailing the L_{Amax} due to an iron ore train pass-by in the Pilbara.

Note that the coal trains were only in the order of 40 to 50 coal wagons as compared to the 138 iron concentrate wagons proposed for use by Iron Road.

To rationalize the impact on noise level due to the extended length of an iron concentrate train pass-by as compared to the measured coal train pass-by, the noise level data for the coal train pass-by was plotted as a sound pressure level vs time trace. The time trace clearly shows the locomotive pass-by with an increase to, and then decrease from, the maximum noise level and with a relatively long duration lower level as the coal wagons pass-by.

The coal wagon design is similar to the proposed iron concentrate wagon design. However, the axle loading will be slightly lower for the iron concentrate wagon (coal wagon gross weight is in the order of 100 - 120 tonnes compared to the proposed iron concentrate wagon having a laden gross weight of 100 tonnes). It is believed that the differential in axle loading is minimal and will have minimal impact on the overall noise emission generated by the wagons.

As expected, the highest sound pressure level during the pass-by was recorded when the locomotives were adjacent to the measurement position.

However, due to the increased overall loading of the iron concentrate train relative to the coal train (due to the increased number of iron concentrate wagons), the tractive force required by the locomotives to move the proposed iron concentrate train will be greater, therefore generating higher locomotive noise levels than that measured for the coal train locomotives.

A web search found a report by Lloyd Acoustics titled *West Pilbara Iron Ore Hardey Mine Project*. This report presented an overall L_{Amax} noise level measurement for an iron ore train pass-by in the Pilbara and it is therefore considered the data is an appropriate indication of the typical noise levels generated by an iron concentrate train pass-by.

The limited details about the iron train configuration as described in this report are presented below:

- Noise level measurement was performed 15 m away from the locomotives as they passed by
- Speed of the train was 77 km/h
- 5 locomotives – train length 2,000 m
- A maximum noise level of L_{Amax} 93 dBA was measured

It is also noted that the train speed for the proposed Iron Road train configuration with loaded iron concentrate wagons will be 60 km/h compared to 77 km/h for the Pilbara iron ore train pass-by. On the other hand, the proposed Iron Road iron concentrate train with empty wagons will have a speed limit for the return trip to the mine site of 80 km/h.

As a worst case scenario, a maximum noise level of L_{Amax} 93 dBA at a distance of 15 m was used for the **locomotive** noise level component in the noise level prediction modelling for both loaded and unloaded wagons. In real operational conditions, it is envisaged, that the locomotives will not be operating at full throttle for a high percentage of the trip, only during acceleration, on grades and braking.

Table 4-2 below presents the overall results of the noise level measurements performed on a number train pass-bys.

Table 4-2: Iron ore locomotive train pass-by noise levels

Measurement	Distance from train pass-by (m)	Measured maximum noise levels dB(A) L_{Amax}
5 Diesel Locomotives – iron ore wagons (Lloyd acoustics report)	15	93

To replicate the iron concentrate train configuration, the noise data for the coal wagons was “extended” to provide an indication of the noise level due to a train configuration of 138 wagons.

Table 4-3 below presents the octave band L_{Aeq} sound pressure level spectra for the 2 coal train pass-bys measured over the duration of the pass-by.

Table 4-3: Octave band L_{Aeq} sound pressure level spectra measured over the duration of the pass-by

Equipment	Pass-by duration (sec)	L_{eq} (duration of train pass-by) ‘A’ Weighted Sound Pressure Levels (L_{Aeq})									
		Octave band centre frequency (Hz)									Overall (dBA)
		31.5	63	125	250	500	1K	2K	4K	8K	
– 50 full coal wagons – travelling at 53.5 km/h (Loaded coal wagon noise levels) (Measurement performed at a distance of 30 m)	53	32	41	53	58	56	50	59	59	51	65
– 42 empty coal wagons – travelling at 77.5 km/h (Measurement performed at a distance of 23 m)	31	41	51	59	65	64	73	73	69	60	78

4.4 Vibration levels due to railway pass-bys

Vibration levels from laden and unladen coal trains have been widely studied in the Hunter Valley. A vibration level measurement survey was reported by Spectrum Acoustics Pty Ltd (March 2008) in a report titled *Sunnyside Coal Project.* They determined that most train pass-by vibration measurements measured at a distance of 20 m did not 'trigger' the data logger to start monitoring when it was set to a 0.5 mm/s trigger point. This data has been used for this assessment.

4.5 Borefield operational noise modelling inputs

Using the CONCAWE algorithm as implemented by SoundPlan, the noise contour levels due to the operation of equipment located at the borefield site were predicted. Table 4-4 below presents the octave band noise source spectra (based on Jacobs noise level data library) for the proposed equipment operating at the borefield site.

Table 4-4: Sound power level octave band spectra for the borefield noise sources

Equipment	'A' weighted sound power levels (dBA)									
	Octave band centre frequency (Hz)									Overall (dBA)
	31.5	63	125	250	500	1K	2K	4K	8K	
150 - 200 Kw Bore Pumps	25	36	52	57	62	64	63	53	47	68.5
900 Kw Transfer Pumps	52	64	76	84	90	96	95	87	80	99.5
Post Mounted Transformers	36	52	64	66	72	69	65	60	52	75.5
'Kiosk' Transformer	56	62	74	76	82	79	75	70	61	85.5

4.6 Construction noise modelling inputs

To model the noise levels likely to be generated during the railway line, borefield and transmission line pylon construction works, noise levels for a range of construction equipment that would be typically used during the construction works were used as detailed in Sections 4.6.1 to 4.6.3.

It should be noted that night time construction works would only be undertaken in exceptional circumstances and would be uncommon. Day time construction, 7 days a week (including on Sundays and public holidays) is planned.[5] As night time construction works would only be undertaken in exceptional circumstances and would be uncommon, predictions of day time instantaneous sound pressure level have been made using the SoundPlan CONCAWE algorithm.

As a worst case scenario, noise levels for construction activities have been modelled with the construction equipment all running simultaneously at normal operating condition. Using this scenario will present a conservative estimation of the noise levels at the nearest noise sensitive receiver locations.

As construction works will be performed in sections the noise levels generated at individual sensitive receiver locations will be for a relatively short duration as the construction operations move along the infrastructure corridor.

Noise source heights have been taken to be 2 m above ground level for plant (representing exhaust noise and casing radiation), with the exception of mobile cranes which have been modelled with the source at a height of 3 m.

4.6.1 Railway line construction equipment

Table 4-5 below presents a list of the typical equipment that has been assumed for this assessment of the potential noise and vibration associated with the proposed railway line construction.

[5] Aaron Deans, Project Manager, Iron Road, *pers comm* 10/12/14 and confirmed by email 9/1/15

Table 4-5: Plant associated with the various railway construction activities

Construction Activity	Equipment configuration	Number of equipment
Railway cutting	Tracked excavator	2
	Front end loader	2
	Vibratory compactor	1
	Trucks	6
	Grader + water cart	1
	Bulldozer	1
	Generator	1
Bridge construction	Cranes	2
	Concrete Trucks	1
	Articulated Truck	1
	Tracked excavator	1
	Front end loader	1
	Generator	1
Level ground and embankment preparation	Tracked excavator	1
	Front end loader	1
	Vibratory compactor	3
	Trucks	6
	Grader + Water cart	2
	Bulldozer	1
	Generator	1
Track laying	Sleeper/Track Layer Plant	1
	Continuous Ballast Tamper	1
	Rail Welding Unit	1
	Ballast Tamper	1
	Truck	1
	Water Cart	1
	Tractor & Backhoe	1
	Excavator	1

The sound power levels used in the prediction modelling for the railway construction works are shown in Table 4-8 below. As sound power levels for track laying equipment was not available the sound power levels generated by earth moving equipment were used for the purpose of the noise level prediction modelling; it has been assumed that the track laying equipment will have a similar noise level and character.

4.6.2 Borefield construction equipment

Table 4-6 below presents a list of the typical equipment that may be employed during the construction phase of the project. A worst case scenario was used, that is, the equipment was located at the transfer pump closest to the nearest noise sensitive receiver with all of the equipment operating.

Table 4-6: Plant associated with the various construction activities at the borefield

Construction activity	Equipment configuration	Number of equipment
Borefield well	Drill Rig	1
	Front end loader	1
	Vibratory compactor	1
	Trucks	2
	Grader	1
	Generator	1

The sound power levels used in the prediction modelling for the borefield construction works are shown in Table 4-8 below.

4.6.3 Transmission line construction equipment

As the exact location of each steel pylon is not known, a general contour plot with all of the equipment operating was performed to give an indication of the typical noise levels that will be experienced at various distances from the epicentre of the construction works.

Construction noise level prediction modelling for pylon construction was performed using the construction equipment presented below. A worst case scenario was used, that is the equipment was located at the closest point along the transmission line to the nearest noise sensitive receiver with all of the equipment operating.

Table 4-7: Plant associated with the various construction activities along the transmission line

Construction activity	Equipment configuration	Number of equipment
Transmission line pylon	Crane	1
	Front end loader	1
	Vibratory compactor	1
	Trucks	2
	Grader	1
	Generator	1

The sound power levels used in the prediction modelling for the transmission line construction works are shown in Table 4-8 below.

4.6.4 Construction equipment sound power levels used in prediction modelling

The sound power levels assigned to the various pieces of construction equipment have been obtained from the Jacobs noise level data library and from information presented by the Department for Environment, Food and Rural Affairs (DEFRA) in the UK and are deemed to be representative of the typical noise levels generated by the equipment to be used .

Table 4-8 below shows the sound power levels used in the prediction modelling for the various aspects of the construction works.

Table 4-8: Sound power levels for the proposed construction equipment

Construction Equipment	'A' weighted sound power levels (dBA)									
	Octave band centre frequency (Hz)									Overall (dBA)
	31.5	63	125	250	500	1K	2K	4K	8K	
Tracked excavator (Cat 245- 242 kW)	67	78	91	94	101	99	95	85	75	104
Front end loader	28	53	84	92	102	104	103	95	85	108
Vibratory compactor (Cat 825C)	63	78	93	103	104	105	103	97	89	110
Dump Trucks – (15T Ford Louisville)	70	89	86	100	101	102	100	101	91	108
Grader (Cat 12G – 101 kW)	67	83	95	105	108	107	102	97	82	112
Bulldozer (Cat D10N)	71	85	110	100	108	113	109	103	93	116
Pile Driver 4 tonne drop -0.5 m drop)	69	84	94	101	114	111	106	107	104	116
Crane	73	87	85	86	96	100	98	92	83	104
Concrete Trucks	38	58	75	93	101	106	106	98	86	110
Articulated Truck	65	77	84	103	104	106	106	99	88	111
Generators	60	77	84	95	95	97	94	85	74	102
Drill Rig	50	59	77	69	76	80	80	75	75	86

4.7 Typical vibration levels due to construction equipment

The vibration produced by construction works will be highly dependent on the particular construction processes and equipment that will be employed and also on the local geotechnical conditions.

Vibration impacts from construction works will have a limited distance before being imperceptible.

The EPA does not have any guidelines pertaining to ground vibration from construction, however the DPTI *Management of Noise and Vibration: Construction and Maintenance activities*, Operational instruction 21.7 (DPTI 2014) presents typical vibration levels generated by construction equipment which are listed in Table 4-9. Vibration levels are influenced by the actual operating condition of the plant and equipment being used and the local site and geographical conditions therefore the information in Table 4-9 should be used for indicative purposes only.

Table 4-9: Typical vibration levels and safe working distances for the various pieces of construction equipment.

Activity	Typical Levels of Ground Vibration
Vibratory Rollers	1.5 mm/s at 25m Higher levels could occur at closer distances depending on local conditions and the roller operation. For a heavy roller, it is expected that damage will not occur with a minimum 12 m buffer to the foundations of a standard residential building.
Hydraulic Rock Breakers (levels typical of a large rock breaker in hard sandstone)	4.5 mm/s at 5m 1.3 mm/s at 10m 0.4 mm/s at 20m 0.1 mm/s at 50m
Compactor	20 mm/s at 5m 2 mm/s at 15m 0.3 mm/s at 30m

Activity	Typical Levels of Ground Vibration
Excavators	0.2 mm/s at 40m
Ballast Tamping	6 mm/s at 3m 2 mm/s at 10m
Truck traffic (over maintained road surfaces)	0.2 mm/s at 10m
Truck traffic (over irregular surfaces)	2 mm/s at 10m
Impact pile driving / removal	≤ 15 mm/s at distances of 15 m ≤ 9 mm/s at distances greater than 25 m Typically below 3 mm/s at 50 m Significant changes to the vibration levels can occur based on the soil conditions and the driving energy of the hammer
Continuous Flight Auger (CFA) piling	Negligible vibration at distances greater than 20 m from the piling
Bored piling	Negligible vibration at distances greater than 20 m from the piling
Bulldozers	2 mm/s at 5 m 0.2 mm/s at 20 m
Air track drill	5 mm/s at 5 m 1.5mm/s at 10m 0.6mm/s at 25m 0.1mm/s at 50m
Jackhammer	1mm/s at 10m

4.8 Blasting - construction

Ground vibration and airblast levels have been predicted using the methodology outlined in the ICI Blasting Guide (ICI 1995) to provide an understanding of the potential of impacts from blasting.

4.8.1 Ground vibration prediction

The Peak Vector Sum (PVS) ground vibration site law is defined as:

$$PVS\ (mm/s) = 1140\ (SD)^{-1.6}$$

where scaled distance (SD) is calculated as:

$$SD = d\ /\sqrt{MIC}$$

- MIC is the maximum explosive charge mass (kilograms) detonated per delay at any 8 millisecond interval;
- d is the distance between charge and receptor

4.8.2 Airblast prediction

The 95th percentile airblast, which maybe exceeded up to 5% of the total annual blasts, is defined by the peak airblast level measured in dB (Z) and is defined as:

$$\text{Airblast Overpressure (95\%)} = 165.3 - 24 \log_{10}(SD)$$

where scaled distance (SD) is calculated as:

$$SD = d\ /(MIC^{0.33})$$

- MIC is the maximum explosive charge mass (kilograms) detonated per delay at any 8 millisecond interval.
- d is the distance between the charge (blast location) and receptor (metres).

5. Prediction modelling results and discussion

5.1 Railway operation

5.1.1 Noise

The Rail Noise Guidelines specifically considers the SoundPLAN software produced by Braunstein + Berndt GmbH as one of the packages acceptable for noise prediction modelling. The SoundPLAN computer model incorporates the NORD 2000 prediction algorithm to predict rail noise levels. The NORD 2000 prediction method provides both the average $L_{Aeq\ 15hr}$ (day time) and $L_{Aeq\ 9\ hr}$ (night time) levels and the maximum (L_{Amax}) noise levels.

Appendix A presents the predicted $L_{Aeq\ 9\ hour}$, $L_{Aeq\ 15\ hour}$ and L_{Amax} noise levels at each of the identified noise sensitive receivers based on the scenario incorporating a total of six train movements each way per 24 hour day. In accordance with the Rail Noise Guidelines, the predicted $L_{Aeq\ 1\ hour}$ noise level was calculated for the church site and is also listed in Appendix A.

Appendix B presents the predicted noise level contours along the proposed infrastructure corridor due to the operation of the iron concentrate trains.

The predicted sound pressure levels have been 'rounded' to the nearest integer number in accordance with Clause 16 of the Noise Policy.

From the noise level prediction modelling, it can be determined that the predicted noise levels due to the train operation will be below the noise limit criteria presented in the Rail Noise Guidelines for both the day time and night time periods.

The predicted $L_{Aeq\ 1\ hour}$ noise levels at the church site are 8 dB(A) below the day and night noise limit criteria.

The predicted L_{Amax} noise levels at the noise sensitive receiver locations were at least 8 dB(A) less than the 80 dB(A) L_{Amax} criterion as presented by the Rail Noise Guidelines.

The predicted $L_{Aeq15\ hr}$ (Day) and $L_{Aeq\ 9\ hr}$ (Night) noise levels at the noise sensitive receiver locations were at least 9 dB(A) less than respective criteria and the majority of predicted noise levels were significantly lower.

5.1.1.1 Train horns

There are a significant number of railway crossings along the proposed railway corridor, which would warrant sounding of the train horn on the approach to the crossing as part of the safety requirement for train operations.

Noise from the train horns may exceed L_{Amax} 60 dB(A) at the closest residential locations during iron concentrate train operation. The noise level due to the horns is highly dependent on the driver operation. The noise level from the horn can be up to 14 dB higher if the driver presses heavily on the horn activation rather than 'tapping' it lightly. Drivers will be made aware of this to assist to protect the amenity of the nearby residences.

5.1.2 Ground vibration

The nearest vibration sensitive receiver to the proposed railway line is approximately 140 m away. Due to low ground vibration levels measured at a distance of 20 metres for coal train pass-bys (refer to Section 4.4) and the extended separation distance between the proposed railway line and sensitive receivers (at least 140 metres), ground vibration modelling was not proposed.

The calculated maximum vibration level due to a train pass-by at a distance of 140 m (using the vibration level of 0.5 mm/s at 20 metres) is in the order of 0.07 mm/s. The calculated ground vibration level is below the recommended vibration criteria presented in Table 3-6 which presents the human response preferred values for vibration, the most stringent criteria being 0.1 mm/s (for continuous vibration in critical areas e.g. operating theatres).

It must also be noted that the train pass-bys will be intermittent 12 train pass-bys over a 24 hour period and the remainder of the time the vibration levels will be typical ambient levels.

5.2 Long term employee village operation - noise

Modelling was not performed for the operation of the long term employee village as once established noise from the village would comprise of standard domestic type noises such as air conditioners and vehicles entering and leaving the premises, similar to existing noise sources and levels that currently exist in Wudinna.

5.3 Borefield operation - noise

The nearest four noise sensitive receivers to the borefield were considered because the further away a receiver is located from the noise source, the lower the noise level. Table 5-1 below presents the predicted L_{Aeq} sound pressure levels at the nearest identified sensitive receivers (refer to Figure 2-4 to determine the locations of the sensitive receivers listed in the table).

Table 5-1: Predicted L_{Aeq} sound pressure levels due to the operation of pumps and transformers at the borefield and relevant noise criteria

Identified nearest sensitive receivers	Predicted 'A' weighted sound pressure level (L_{Aeq})*			
	Predicted		Noise criteria	
	Night	Day	Night	Day
10	12	14	45	52
11	25	22	45	52
12	25	22	45	52
91	24	21	45	52

*The predicted sound pressure levels have been 'rounded' to the nearest integer number in accordance Clause 16 of the Noise Policy.

Appendix C presents the predicted noise level contours due to the operation of the borefield pumps and transformers.

As noted in Section 3.2.1.2 due to the likely operational noise levels generated by the borefield equipment, a noise character correction of 5 dB(A) is considered warranted. Table 5-2 below presents the predicted L_{Aeq} sound pressure levels plus a 5 dB(A) penalty to take into account noise character at the nearest identified sensitive receivers.

Table 5-2: Predicted L_{Aeq} sound pressure levels plus a 5 dB(A) noise character penalty due to the operation of pumps and transformers at the borefield and relevant noise criteria

Identified nearest sensitive receivers	Predicted 'A' weighted sound pressure level (L_{Aeq}) + 5 dB(A) penalty*			
	Predicted		Noise criteria	
	Night	Day	Night	Day
10	17	19	45	52
11	30	27	45	52
12	30	27	45	52
91	29	26	45	52

*The predicted sound pressure levels have been 'rounded' to the nearest integer number in accordance Clause 16 of the Noise Policy.

From the noise level prediction modelling for the borefield, it can be determined that the predicted noise levels (maximum of 30 dB(A) during the night and 27 dB(A) during the day) are well below the noise criteria (of 45 dB(A) at night and 52 dB(A) during the day) presented in the Noise Policy for both the day time and night time periods.

5.4 Transmission line operation - noise

Modelling was not performed for the transmission line as it was assumed the only noise generated by the proposed transmission line would be due to the 'corona' effect. This phenomenon generally occurs only during fog or rain conditions and generates noise levels of the order of L_{Aeq} 45 - 50 dB(A) at a distance of 3 m from the power line (Egger *et al* 2009 and Wszolek 2008). During dry conditions this noise source rarely occurs.

The potential noise level will be significantly attenuated by distance. As summarised in Section 2.5, the closest sensitive receivers to the proposed transmission line are numbers 8 and 12 on Figure 2-4 (100 m and 170 m respectively from the proposed transmission line), however these houses have been identified as derelict. In any case based on the measured overall noise levels presented for the corona effect (45 - 50 dB(A) at a distance of 3 m) it is predicted the noise levels at these closest sensitive receiver locations would be in the order 25 – 35 dB(A), well within the noise criteria of 45 dB(A) for the night time.

Therefore at all the nearest sensitive receiver locations it is predicted the noise levels due to the corona effect will be below the day and night time noise criteria.

5.5 Construction works

As noted in Section 4.6 night time construction works would only be undertaken in exceptional circumstances and would be uncommon. Day time construction, 7 days a week (including on Sundays and public holidays) is planned.[6] As night time construction works would only be undertaken in exceptional circumstances and would be uncommon, predictions of day time instantaneous sound pressure level have been made using the SoundPlan CONCAWE algorithm.

5.5.1 Railway line

The CONCAWE prediction method provides the $L_{Aeq\ (15\ mins)}$ sound pressure level contours. The predicted noise levels have been developed using the noise data presented in Table 4-8.

Due to the length of the proposed railway corridor and the infinite number of iterations that would be required along the railway corridor, three construction configurations were modelled to obtain an indication of the likely acoustic impact due to construction works. The predicted contours can be overlaid anywhere along the proposed railway line to obtain an indication of the likely impact of that particular construction works phase at that location.

Appendix D presents the predicted noise level contours due to construction works at three representative construction activities along the proposed railway corridor.

The three construction works scenarios modelled were:

- Construction of railway 'cuttings' (including earthworks and track laying)
- Bridge construction (including earthworks and track laying)
- Normal ground base on flat terrain (including earthworks and track laying)

As sound power levels for track laying equipment were not available the sound power levels generated by earth moving equipment were used to represent track laying equipment for the purpose of the noise level prediction modelling.

[6] Aaron Deans, Project Manager, Iron Road, *pers comm* 10/12/14 and confirmed by email 9/1/15

It is evident from the prediction modelling that day time noise levels associated with the three railway construction scenarios would be sufficiently attenuated to meet Noise Policy requirements in relation to construction works on Sundays and public holidays, if the separation distance between the construction activity and sensitive receiver was in excess of approximately 1-1.5 km. Therefore railway construction within 1-1.5 km of sensitive receivers on Sundays and public holidays would need to be avoided or managed to below acceptable levels.

All day time railway construction works would be managed with all reasonable and practical measures undertaken to minimise noise resulting from the activity to minimise its impact in accordance with the Noise Policy.

Sunday and public holiday railway construction works, and night time works if required, would require implementation of specific environmental management controls, if undertaken within approximately 1-1.5 km of a sensitive receiver, to ensure the noise emissions meet the Noise Policy criterion.

Note that the construction works on the railway line will be relatively transient, that is, the work will be constructed in a relatively short period of time except for the bridge and cutting works. The track construction works will be continuously moving along the length of the infrastructure corridor as the track works are performed, thus any potential noise impacts at a noise sensitive receiver location will be of a short duration.

5.5.2 Long Term Employee village

It is proposed to locate the employee village adjacent to the residential properties located on the north – eastern edge of Wudinna. Construction works entailing the construction of buildings, access roads and services will be performed.

Modelling was not undertaken for the construction of the employee village as the exact location was unknown and there are standard controls which are commonly applied for this type of construction.

5.5.3 Borefield

Appendix E presents the predicted noise level contours due to borefield construction works at the closest sensitive receivers.

The construction noise modelling was performed based on the siting of a borefield well and the closest sensitive receivers. This would present a worst case scenario and if the nearest sensitive receivers meet the noise criteria, then it is implied that all sensitive receivers located around the borefield will meet the criteria.

Prediction modelling indicates that during construction of a well the day time noise level may reach 48 dB(A) at the closest sensitive receiver (number 91, approximately 580 m away) and 45 dB(A) at the next closest sensitive receiver (number 12, approximately 700 m away). These predicted noise levels (continuous) exceed the noise criteria of 45 dB(A) for Sundays and public holidays. It is evident from the prediction modelling that day time noise levels during construction of a bore would be sufficiently attenuated to meet Noise Policy requirements in relation to construction works on Sundays and public holidays, if the separation distance between the construction activity and sensitive receiver was in excess of approximately 1 km. There are six identified sensitive receivers within 1 km of proposed borefield infrastructure (numbers 91, 12, 10, 84, 86, 83 (from east to west) on Figure 2-4) therefore construction in the vicinity of these sensitive receivers on Sundays and public holidays would need to be avoided or managed to below acceptable levels.

All day time borefield construction works would be managed with all reasonable and practical measures undertaken to minimise noise resulting from the activity to minimise its impact in accordance with the Noise Policy.

Sunday and public holiday borefield construction works, and night time works if required, would require implementation of specific environmental management controls, if undertaken within approximately 1 km of a sensitive receiver, to ensure the noise emissions meet the Noise Policy criterion.

5.5.4 Transmission line

Appendix F presents the predicted noise level contours due to an indicative pylon construction works with noise contours for various distances from the pylon.

As with the borefield construction noise modelling, is evident from the transmission line construction prediction modelling that day time noise levels would be sufficiently attenuated to meet Noise Policy requirements in relation to construction works on Sundays and public holidays, if the separation distance between the construction activity and sensitive receiver was in excess of approximately 1 km. There are nine identified sensitive receivers within 1 km of the proposed transmission line route (numbers 1, 3, 8, 6, 69, 12, 81, 82, 68 (from north to south) on Figure 2-4) therefore construction in the vicinity of these sensitive receivers on Sundays and public holidays would need to be avoided or managed to below acceptable levels.

All day time transmission line construction works would be managed with all reasonable and practical measures undertaken to minimise noise resulting from the activity to minimise its impact in accordance with the Noise Policy.

Sunday and public holiday transmission line construction works, and night time works if required, would require implementation of specific environmental management controls, if undertaken within approximately 1 km of a sensitive receiver, to ensure the noise emissions meet the Noise Policy criterion.

5.5.5 Ground vibration due to construction

It can be seen from the typical ground vibration levels presented for various pieces of construction equipment (refer to Section 4.7), that vibration is generated by the various types of construction equipment likely to be used during construction of the proposed railway line, borefield and transmission line including ballast tampers, compactors and vibratory rollers (refer to Table 4-5, Table 4-6 and Table 4-7).

The human response vibration criteria detailed in Section 3.3.1.1 indicates that for residential properties the preferred day time vibration dose value is 0.20 mm/s. Although some of the typical ground vibration levels (eg pile driving, below 3 mm/s at 50 m) may exceed this value at 50 m it is known that vibration from construction equipment has a limited distance before being imperceptible.

The closest sensitive receiver is approximately 140 m away and although vibration sources (ie construction equipment) may infringe closer perhaps up to 100 m (within an indicative construction zone for the railway line), it is deemed that the vibration levels will be below the preferred day time human response levels, and hence well below the structural damage criteria presented in Section 3.3.1.2. This is because it is known that attenuation of vibration occurs over short distances and experience of railway construction related vibration demonstrates imperceptibility even at 20 m in some cases. There is a low probability of adverse comment or disturbance to building occupants at vibration levels below the human response preferred values (DEC 2006).

5.5.6 Summary

It can be determined from the railway, borefield and pylon construction noise prediction modelling (refer to Appendix D, Appendix E and Appendix F) that day time noise levels during construction would be sufficiently attenuated to meet Noise Policy requirements in relation to construction works on Sundays and public holidays, if the separation distance between the construction activity and sensitive receiver is in excess of approximately 1-1.5 km.

When construction works are performed on Sundays or public holidays, and at night time if required, then a separation distance of at least 1-1.5 km between the construction works and the sensitive receiver will be instituted or specific environmental management controls as detailed in a Construction EMP will be implemented to ensure the noise emissions meet the Noise Policy requirements.

The Construction EMP will aid in setting work procedures and processes to manage noise from construction operations at various distances from sensitive receiver locations during different periods of time, eg night time, Sundays and public holidays. All construction works would be managed with all reasonable and practical measures undertaken to minimise noise resulting from the activity to minimise its impact in accordance with the Noise Policy.

As construction works will be performed in sections the noise levels generated at individual sensitive receiver locations will be for a relatively short duration as the construction operations move along the infrastructure corridor.

It should also be noted that the prediction noise modelling for construction was performed assuming that all of the construction equipment is operating at full load, therefore presenting the worst case scenario. This is generally not the case in reality as some equipment will be idling or switched off when not in use while others will be working at full load. As the modelling was based on a worst case scenario it is considered there is considerable scope for managing the actual noise levels within the Noise Policy requirements.

Based on the separation distances between construction works and sensitive receivers and as it is known that attenuation of vibration from construction equipment occurs over short distances, it is deemed that construction vibration levels will be below the preferred day time human response levels, and hence well below the structural damage criteria.

5.6 Blasting - construction

The sites requiring blasting and the blasting procedures have not been fully defined. However, there is a strong possibility that blasting will occur at a number of locations between the proposed port facility and the mine site and is most likely to be required along the first 7.5 km of the railway line from the boundary of the port site.

It has been determined that blasting will occur at the railway line / Lincoln Highway intersection where a cutting will be constructed for the railway line. The distance from the site to the nearest identified residential property is approximately 1,500 m from this proposed crossing (number 41 on Figure 2-4).

This railway line / Lincoln Highway intersection has been used to indicate the variation in ground vibration and airblast (over pressure) levels for a range of charge masses that may be used. The charge mass can then be chosen to ensure compliance with the criteria presented in AS 2187.2-2006 and the results can be applied to other areas where blasting will occur as required.

Ground vibration and airblast levels have been predicted using the methodology outlined in the *ICI Blasting Guide* (ICI 1995) to provide an understanding of the potential of impacts from blasting.

5.6.1 Ground vibration – Lincoln Highway intersection

Table 5-3 below presents the calculated ground vibration level peak particle velocity (PPV) for various charge masses and a given distance of 1,500 m in comparison with the 10 mm/sec AS 2187.2-2006 human comfort criterion for blasting operations lasting less than 12 months.

Table 5-3: Predicted ground vibration levels for varying charge masses at set distance of 1,500 m

Charge mass (Kg)	Distance to the nearest noise & vibration receiver (m)	Predicted PPV (mm/sec)	AS 2187.2-2006 Human comfort PPV criterion (mm/sec)
250	1,500	0.8 mm/sec	10 mm/sec
500	1,500	1.4 mm/sec	10 mm/sec
750	1,500	1.9 mm/sec	10 mm/sec
1,000	1,500	2.2 mm/sec	10 mm/sec
2,000	1,500	4.2 mm/sec	10 mm/sec

5.6.2 Airblast overpressure – Lincoln Highway intersection

Table 5-4 below presents the calculated predicted airblast level for a given charge mass and a fixed distance 1,500 m in comparison with airblast over pressure (OP) of 120 dBL AS 2187.2-2006 human comfort criterion for blasting operations lasting less than 12 months.

Table 5-4: Predicted air blast over pressure levels with varying charge masses at set distance of 1,500 m

Charge mass (Kg)	Distance to the nearest noise & vibration receiver (m)	Predicted airblast OP level (dBL)	AS 2187.2-2006 Human comfort criterion (dBL)
250	1,500	108	120 dBL
500	1,500	111	120 dBL
750	1,500	112	120 dBL
1,000	1,500	113	120 dBL
2,000	1,500	116	120 dBL

5.6.3 Guidance on minimum distances for given charge mass

Table 5-5 presents the minimum charge mass and distance from the blast site to a sensitive receiver which would result in compliance with the airblast OP of 120 dBL and associated PPV for ground vibration level. Note that the airblast OP is the limiting criterion.

Table 5-5: Minimum charge mass / distance and resultant ground vibration level that would also comply with the airblast criterion

Charge mass (Kg)	Distance to the nearest noise & vibration receiver (m)	AS 2187 – 2006 Human comfort criterion ground vibration level (PPV = 10 mm/sec)	AS 2187 – 2006 Human comfort criterion predicted airblast OP level (120 dBL)
2	100	1.2	120*
20	200	2.6	120*
60	300	3.3	120*
160	400	4.5	120*
275	500	5	120*
400	600	5	120*
550	700	5	119*

*Limiting criterion

5.6.4 Summary

Ground vibration and airblast levels have been predicted using the methodology outlined in the *ICI Blasting Guide* (ICI 1995) to provide an understanding of the potential of impacts from blasting undertaken during construction of the railway line.

As blasting sites and operating procedures have not been fully defined, generic calculations have been performed which predict the typical airblast over pressure and ground vibration levels associated with construction blasting for various distances and charge masses. These predications indicate that blasting should not cause adverse impact where minimum distances for respective charge masses are established.

6. Conclusion

6.1 Railway line operation

The noise and vibration levels associated with railway line operation were predicted to be significantly less than the noise and vibration limit criteria presented in the Rail Noise Guidelines, as summarised in Section 5.1.

6.2 Long term employee village operation

Modelling was not performed for the operation of the long term employee village as once established noise from the village would comprise of standard domestic type noises such as air conditioners and vehicles entering and leaving the premises, similar to existing noise sources and levels that currently exist in Wudinna.

6.3 Borefield operation

A review of the predicted noise levels at the nearest sensitive receivers for the borefield operational noise emissions show that the noise criteria, in accordance with the Noise Policy*,* will be met, as summarised in Section 5.3.

6.4 Transmission line operation

Corona noise levels generated by the power transmission line will be insignificant and will have minimal acoustic impact on the existing ambient noise levels at the nearest noise sensitive receivers, as discussed in Section 5.4.

6.5 Construction noise

As noted in Section 4.6 night time construction works would only be undertaken in exceptional circumstances and would be uncommon. Day time construction, 7 days a week (including on Sundays and public holidays), is planned.[7]

The construction noise prediction modelling for the proposed railway line, borefield and transmission line indicate that when construction works are performed on Sundays or public holidays, and at night time if required, then a separation distance of at least 1-1.5 km between the construction works and the sensitive receiver will be instituted or specific environmental management controls as detailed in a Construction EMP will be implemented, to ensure the noise emissions meet the Noise Policy requirements.

The Construction EMP will aid in setting work procedures and processes to manage noise from construction operations at various distances from sensitive receiver locations during different periods of time, eg night time, Sundays and public holidays. All construction works would be managed with all reasonable and practical measures undertaken to minimise noise resulting from the activity to minimise its impact in accordance with the Noise Policy.

As construction works will be performed in sections the noise levels generated at individual sensitive receiver locations will be for a relatively short duration as the construction operations move along the infrastructure corridor.

It should also be noted that the prediction noise modelling for construction was performed assuming that all of the construction equipment is operating at full load, therefore presenting the worst case scenario. This is generally not the case in reality as some equipment will be idling or switched off when not in use while others will be working at full load. As the modelling was based on a worst case scenario it is considered there is considerable scope for managing the actual noise levels within the Noise Policy requirements.

[7] Aaron Deans, Project Manager, Iron Road, *pers comm* 10/12/14 and confirmed by email 9/1/15

Modelling was not undertaken for the construction of the long term employee village as the exact location was unknown and there are standard controls which are commonly applied for this type of construction.

6.6 Construction vibration

Based on a comparison of the typical ground vibration levels presented for various pieces of construction equipment (refer to Section 4.7) and the various types of construction equipment likely to be used during construction of the proposed railway line, borefield and transmission line (refer to Table 4 5, Table 4 6 and Table 4 7), it was deemed that the vibration levels at the closest sensitive receivers will be below the preferred day time human response levels for residential properties specified in Section 3.3.1.1, and hence well below the structural damage criteria presented in Section 3.3.1.2. This is because it is known that attenuation of vibration occurs over short distances and experience of railway construction related vibration demonstrates imperceptibility even at 20 m in some cases. There is a low probability of adverse comment or disturbance to building occupants at vibration levels below the human response preferred values (DEC 2006).

6.7 Construction blasting

As blasting sites and operating procedures have not been fully defined, generic calculations have been performed which predict the typical airblast over pressure and ground vibration levels associated with construction blasting for various distances and charge masses (refer to Section 5.6.3). These predications indicate that blasting should not cause adverse impact where minimum distances for respective charge masses are established.

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Appendix A. Predicted operational train noise levels at noise sensitive receivers located along the railway line

Sensitive Receiver number*	Easting	Northing	Predicted 'A' weighted sound pressure level (dBA)			
			$L_{eq15\ hr}$ (Day)	$L_{eq\ 9\ hr}$ (Night)	L_{max} (Day)	L_{max} (Night)
1	598801	6309683	38	38	62	61
2	576059	6317768	25	25	43	43
3	600634	6307036	33	33	53	53
4	601500	6306151	27	27	45	45
5	601976	6301469	30	30	49	49
6	600761	6300084	35	35	55	55
7	572420	6320418	24	24	38	38
8	600752	6303413	44	44	69	69
9	602931	6294130	31	31	51	51
10	602849	6286672	28	28	45	45
11	604150	6283968	27	27	44	44
12	606163	6284370	43	43	67	67
13	612986	6274710	35	35	55	55
14	610396	6274381	30	30	49	49
15	614227	6273369	31	31	49	49
16	613796	6271364	40	40	63	63
17	617095	6269996	39	39	65	64
18	616650	6268300	37	37	59	59
19	619300	6267962	32	31	50	50
20	618641	6263875	31	31	52	51
21	618119	6263181	27	26	44	44
22	619850	6260021	28	28	43	43
23	621953	6259554	39	39	64	64
24	620958	6256048	32	32	51	51
25	621180	6253507	34	34	54	54
26	622497	6253686	46	46	72	72
28	623409	6247087	32	32	52	52
29	622788	6243170	36	35	57	57
30	620615	6241212	30	30	49	49
31	620402	6238648	31	31	48	48
32	623568	6238614	31	30	49	49
33	620895	6235520	34	34	53	53
34	621663	6234136	45	44	70	69
35	619752	6232537	32	32	55	55
36	617727	6228764	33	33	54	54
37	622068	6225028	25	25	41	41
38	622624	6224514	26	26	42	42
39	622576	6224010	27	27	46	46
40	622387	6222727	35	35	56	56

Sensitive Receiver number*	Easting	Northing	Predicted 'A' weighted sound pressure level (dBA)			
			$L_{eq15\ hr}$ (Day)	$L_{eq\ 9\ hr}$ (Night)	L_{max} (Day)	L_{max} (Night)
41	619189	6224074	28	28	51	51
42	621326	6221057	41	41	64	64
43	622029	6220485	30	30	55	55
44	620253	6215701	25	25	46	46
45	621348	6263833	33	33	52	52
46	616565	6272623	26	26	43	43
47	609915	6275437	28	28	45	45
48	568923	6320701	34	34	54	54
49	555788	6321605	6	6	11	11
50	556140	6322438	6	6	9	10
51	623190	6223875	24	24	44	44
52	623093	6224070	24	24	43	43
53	622889	6223580	27	27	47	47
54	622719	6223693	27	27	47	47
55	622290	6223911	29	29	51	51
56	617864	6271283	27	27	47	47
57	617691	6271545	26	26	46	46
58	617654	6271384	27	27	47	46
59	600068	6298262	32	32	54	53
60	623351	6234826	27	27	48	48
61	556338	6321793	7	7	13	13
62	556044	6321744	6	6	12	12
63	620116	6227913	28	28	45	45
64	620161	6227776	28	28	46	46
65	615841	6217328	15	15	27	27
66	615830	6218932	16	16	26	26
67	599507	6301667	35	35	56	56
68	599478	6300546	35	35	58	57
69	600528	6298920	43	42	68	68
70	609715	6283693	26	26	44	43
71	622456	6245565	43	42	68	68
72	623657	6232584	24	24	46	46
73	621380	6228041	23	23	38	38
74	622058	6226729	23	23	41	41
75	623645	6221953	27	27	45	45
76	623793	6222321	25	25	42	42
77	623543	6257082	33	33	52	52

*Refer to Figure 2-4 or Appendix B to determine the location of the sensitive receivers.

Sensitive Receiver number*	Easting	Northing	Predicted 'A' weighted sound pressure level (dBA)*	
			$L_{eq1\ hr}$ (Day) (Criteria of 60 $L_{Aeq,\ 1h}$)	$L_{eq1\ hr}$ (Night) (Criteria of 60 $L_{Aeq,\ 1h}$)
27 - Church	622446	6254029	52	52

*Refer to Figure 2-4 or Appendix B to determine the location of the sensitive receivers.

Appendix B. Predicted noise level contours due to the proposed railway line operation

B.1 Predicted noise level contours due to the proposed railway line operation - Day time $L_{Aeq\ 15\ Hour}$

B.2 Predicted noise level contours due to the proposed railway line operation – Night time $L_{Aeq,\ 9\ Hour}$

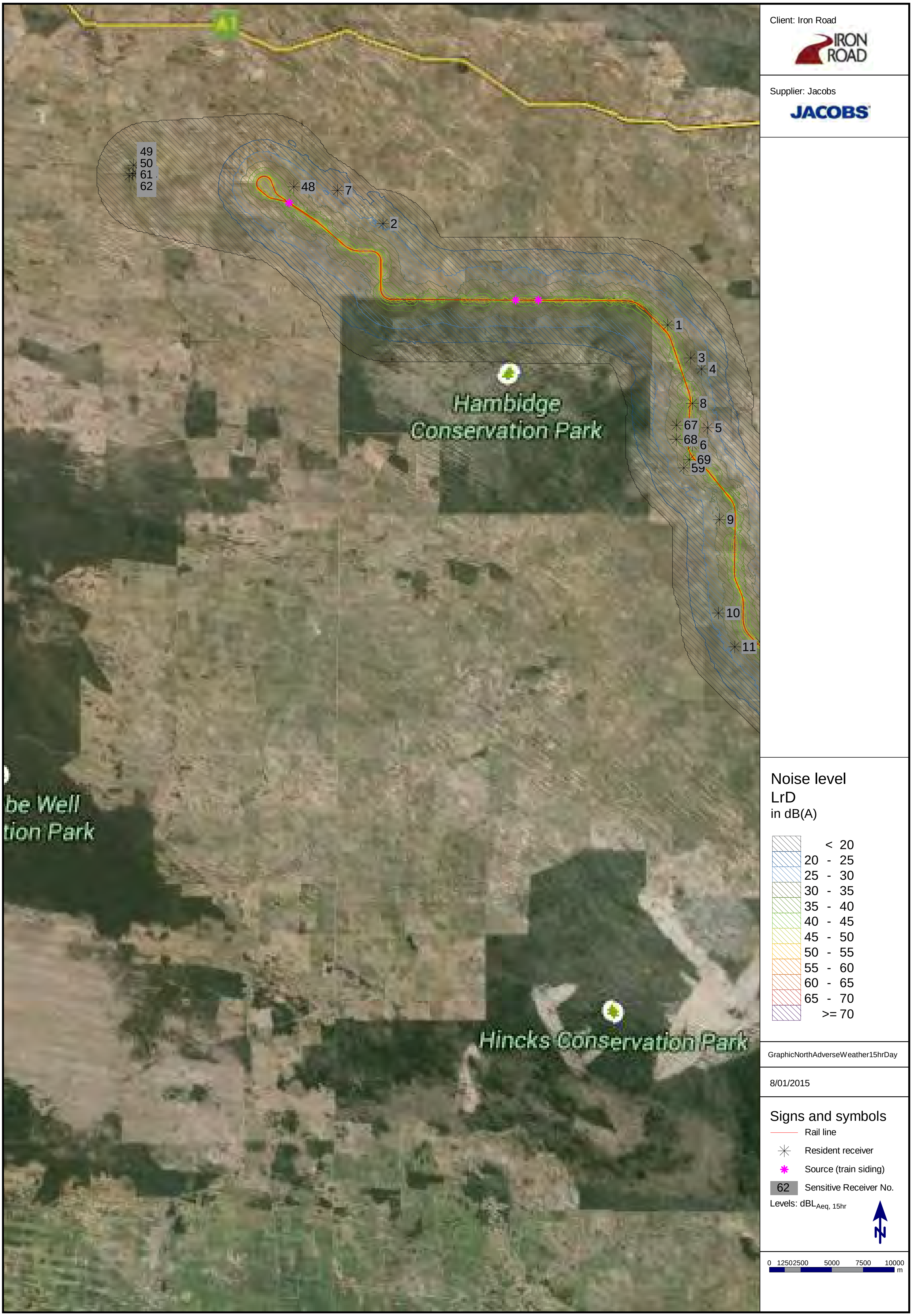
B.3 Predicted noise level contours due to the proposed railway line operation – Day time $L_{Aeq,\ 1\ Hour}$

B.4 Predicted noise level contours due to the proposed railway line operation – Night time $L_{Aeq,1\ Hour}$

B.5 Predicted noise level contours due to the proposed railway line operation – Day time L_{Amax}

B.6 Predicted noise level contours due to the proposed railway line operation – Night time L_{Amax}

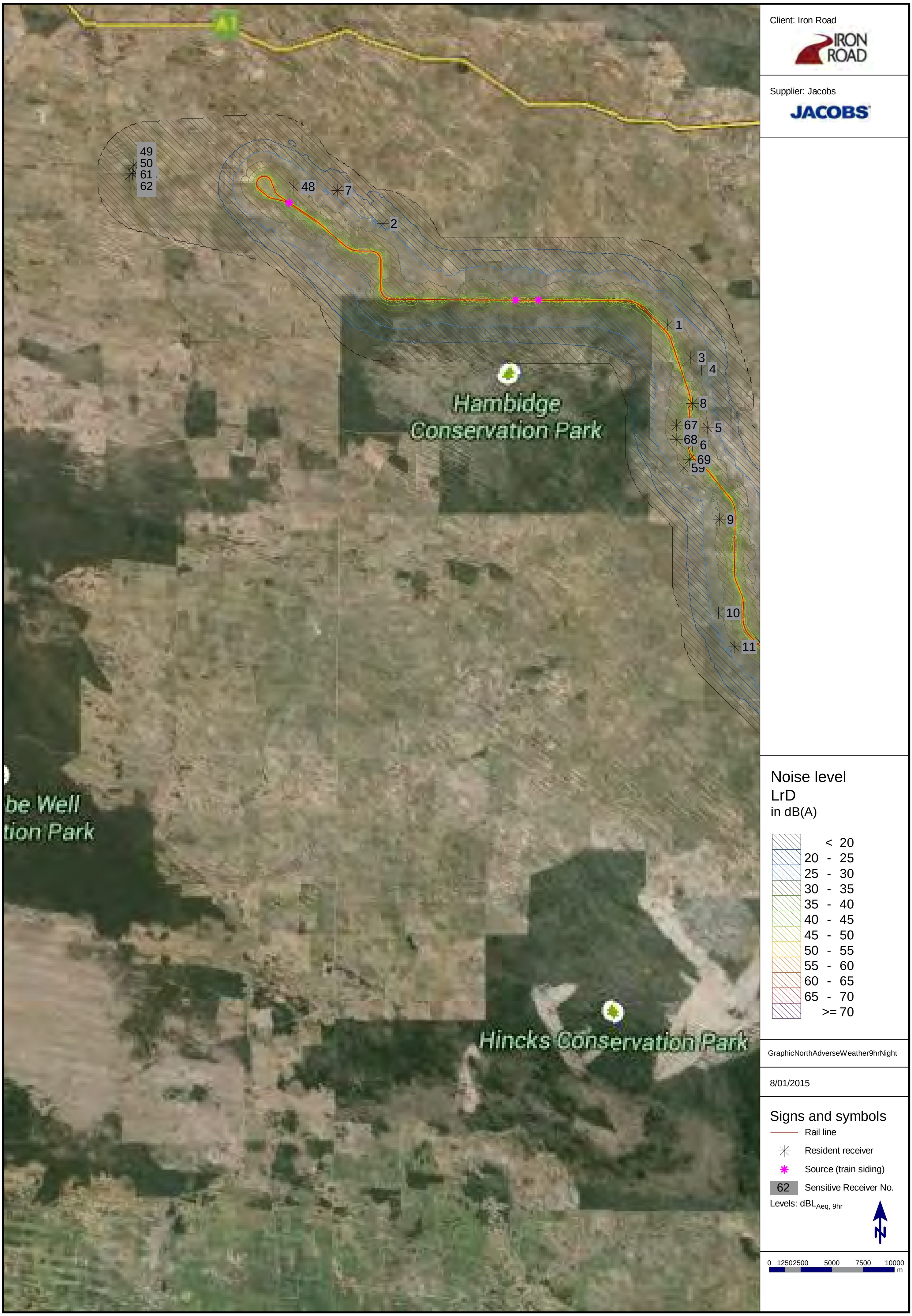
B.1 Predicted noise level contours due to the proposed railway line operation - Day time $L_{Aeq\ 15\ Hour}$



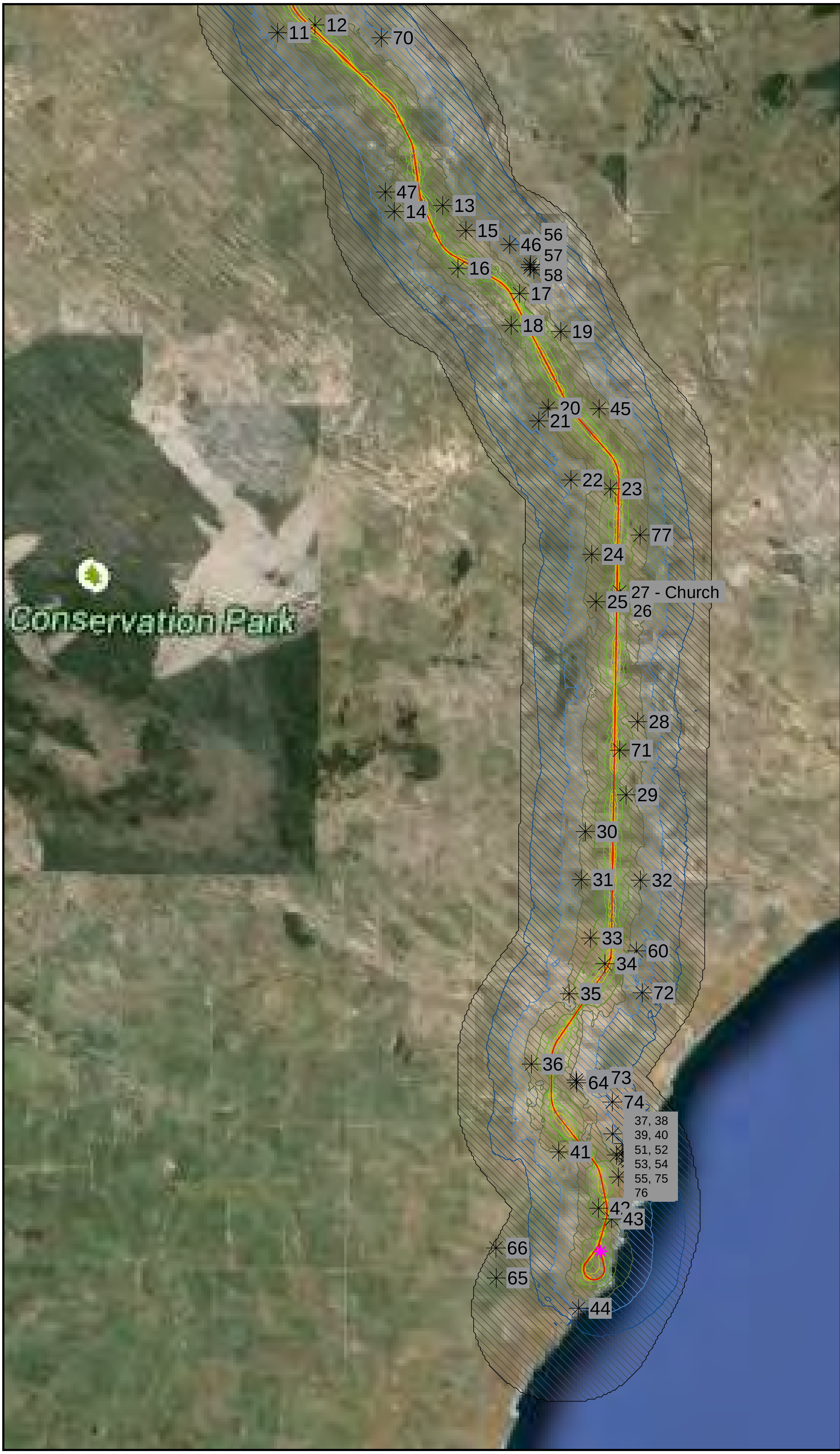
A1
49
50
61
62
48
7
2
1
3
4
8
67
5
68
6
69
59
9
10
11
Hambidge
Conservation Park
be Well
tion Park
Hincks Conservation Park
Client: Iron Road
IRON ROAD
Supplier: Jacobs
JACOBS
Noise level
LrD
in dB(A)
< 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
>= 70
GraphicNorthAdverseWeather15hrDay
8/01/2015
Signs and symbols
Rail line
Resident receiver
Source (train siding)
62 Sensitive Receiver No.
Levels: dBL$_{Aeq, 15hr}$
N
0 12502500 5000 7500 10000
m

Client: Iron Road
IRON ROAD
Supplier: Jacobs
JACOBS
Conservation Park
11
12
70
47
14
13
15
46
56
57
58
16
17
18
19
20
45
21
22
23
77
24
27 - Church
25
26
28
71
29
30
31
32
33
60
34
35
72
36
64
73
74
37, 38
39, 40
51, 52
53, 54
55, 75
76
41
42
43
66
65
44
Noise level
LrD
in dB(A)
< 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
>= 70
GraphicSouthAdverseWeather15hrDay
8/01/2015
Signs and symbols
Rail line
Resident receiver
Source (train siding)
62
Sensitive Receiver No.
Levels: dBL Aeq, 15hr
N
0 750 1500 3000 4500 6000 m

B.2 Predicted noise level contours due to the proposed railway line operation – Night time $L_{Aeq,\ 9\ Hour}$



Client: Iron Road
IRON ROAD
Supplier: Jacobs
JACOBS
A1
49
50
61
62
48
7
2
1
3
4
8
67
5
68
6
69
59
9
10
11
Hambidge Conservation Park
be Well
tion Park
Hincks Conservation Park
Noise level
LrD
in dB(A)
< 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
>= 70
GraphicNorthAdverseWeather9hrNight
8/01/2015
Signs and symbols
Rail line
Resident receiver
Source (train siding)
62 Sensitive Receiver No.
Levels: dBLAeq, 9hr
N
0 12502500 5000 7500 10000
m



Client: Iron Road

Supplier: Jacobs

Noise level LrD
in dB(A)

	< 20
20	- 25
25	- 30
30	- 35
35	- 40
40	- 45
45	- 50
50	- 55
55	- 60
60	- 65
65	- 70
	>= 70

GraphicSouthAdverseWeather9hrNight

8/01/2015

Signs and symbols

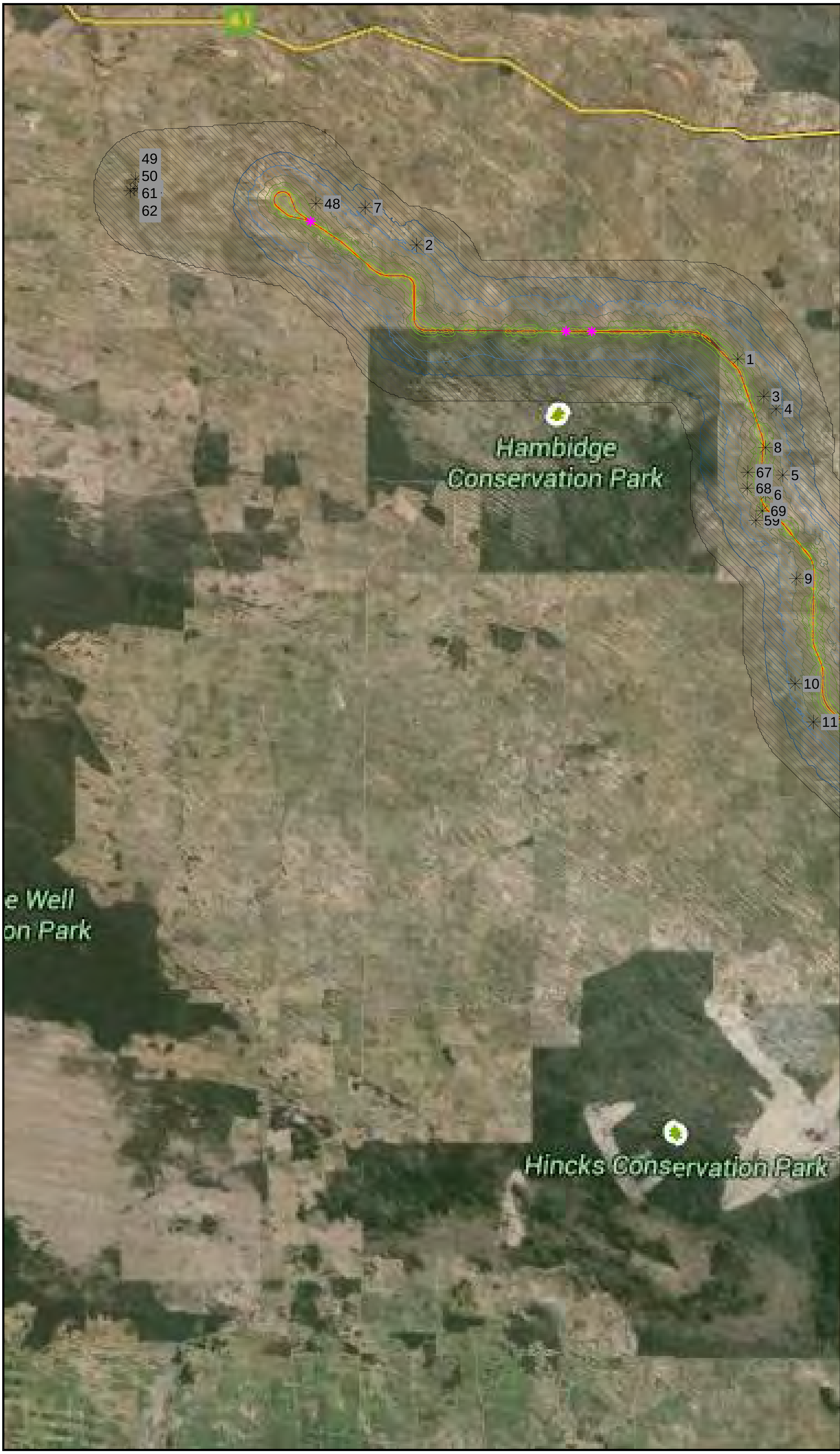
- Rail line
- Resident receiver
- Source (train siding)
- 62 Sensitive Receiver No.

Levels: $dBL_{Aeq,\ 9hr}$

N

0 750 1500 3000 4500 6000 m

B.3 Predicted noise level contours due to the proposed railway line operation – Day time $L_{Aeq,\ 1\ Hour}$



Client: Iron Road

IRON ROAD

Supplier: Jacobs

JACOBS

Noise level
LrD
in dB(A)

< 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
>= 70

GraphicNorthAdverseWeather1hrDay

8/01/2015

Signs and symbols

Rail line

Resident receiver

Source (train siding)

62 Sensitive Receiver No.

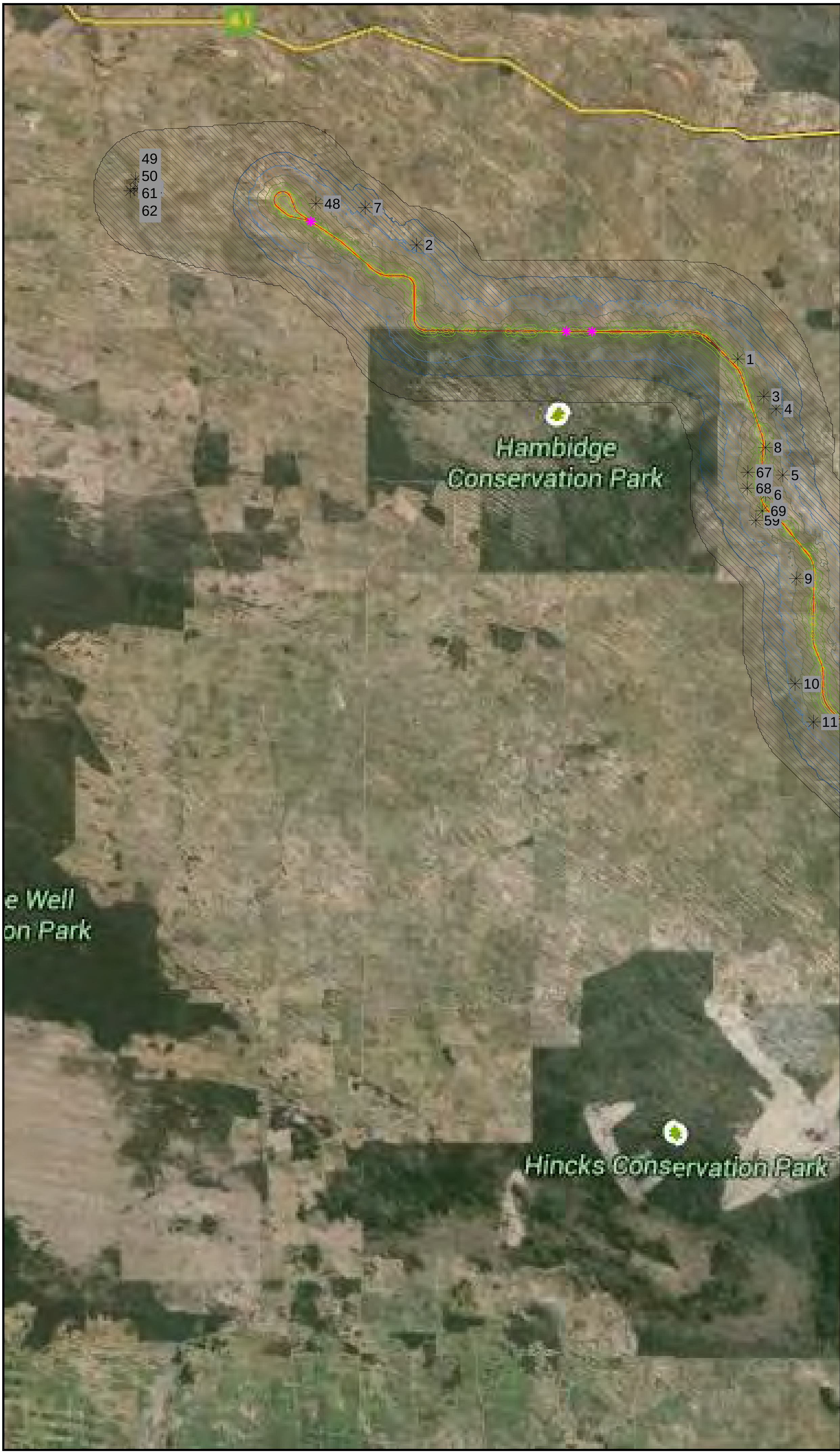
Levels: dBL_{A1hr}

N

0 1250 2500 5000 7500 10000 m

Client: Iron Road
IRON ROAD
Supplier: Jacobs
JACOBS
Conservation Park
11
12
70
47
14
13
15
46
56
57
58
16
17
18
19
20
45
21
22
23
77
24
25
27 - Church
26
28
71
29
30
31
32
33
60
34
35
72
36
64
73
74
37, 38
39, 40
51, 52
53, 54
55, 75
76
41
42
43
66
65
44
Noise level
LrD
in dB(A)
< 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
>= 70
GraphicSouthAdverseWeather1hrDay
8/01/2015
Signs and symbols
Rail line
Resident receiver
Source (train siding)
62
Sensitive Receiver No.
Levels: dBL_{A1hr}
N
0 750 1500 3000 4500 6000
m

B.4 Predicted noise level contours due to the proposed railway line operation – Night time $L_{Aeq,1\ Hour}$



Client: Iron Road

Supplier: Jacobs

Noise level
LrD
in dB(A)

	< 20
	20 - 25
	25 - 30
	30 - 35
	35 - 40
	40 - 45
	45 - 50
	50 - 55
	55 - 60
	60 - 65
	65 - 70
	>= 70

GraphicNorthAdverseWeather1hrNight

8/01/2015

Signs and symbols

Rail line

Resident receiver

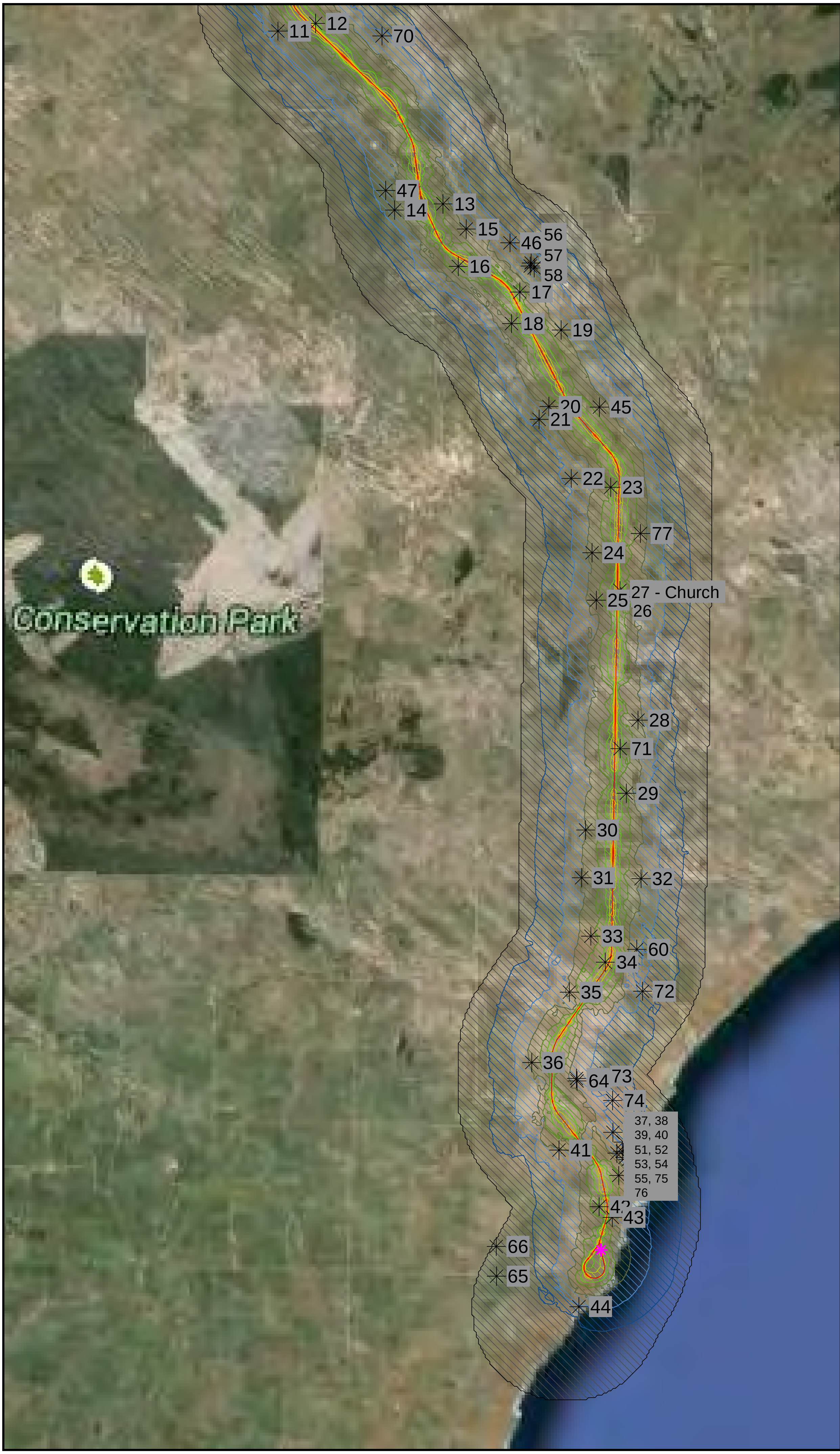
Source (train siding)

62 Sensitive Receiver No.

Levels: dBL_{A1hr}

N

0 1250 2500 5000 7500 10000 m



Client: Iron Road

Supplier: Jacobs

Noise level LrD in dB(A)

	< 20
	20 - 25
	25 - 30
	30 - 35
	35 - 40
	40 - 45
	45 - 50
	50 - 55
	55 - 60
	60 - 65
	65 - 70
	>= 70

GraphicSouthAdverseWeather1hrNight

8/01/2015

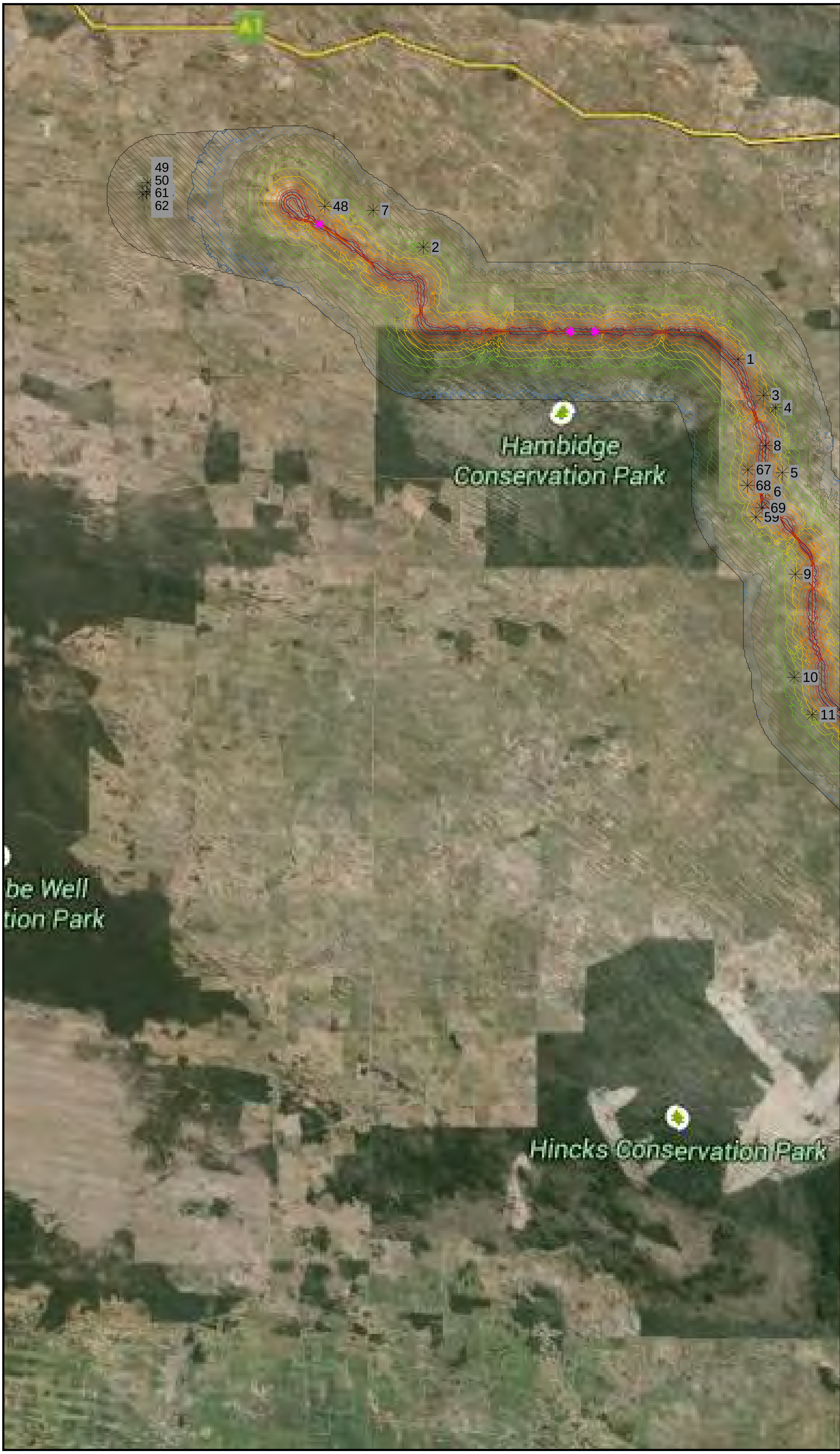
Signs and symbols

- Rail line
- Resident receiver
- Source (train siding)
- 62 Sensitive Receiver No.

Levels: dBL_{A1hr}

0 750 1500 3000 4500 6000 m

B.5 Predicted noise level contours due to the proposed railway line operation – Day time L_{Amax}



Client: Iron Road

Supplier: Jacobs

Noise level
Lr
in dB(A)

< 20	
20 - 25	
25 - 30	
30 - 35	
35 - 40	
40 - 45	
45 - 50	
50 - 55	
55 - 60	
60 - 65	
65 - 70	
>= 70	

GraphicNorthAdverseWeatherMAXDay

8/01/2015

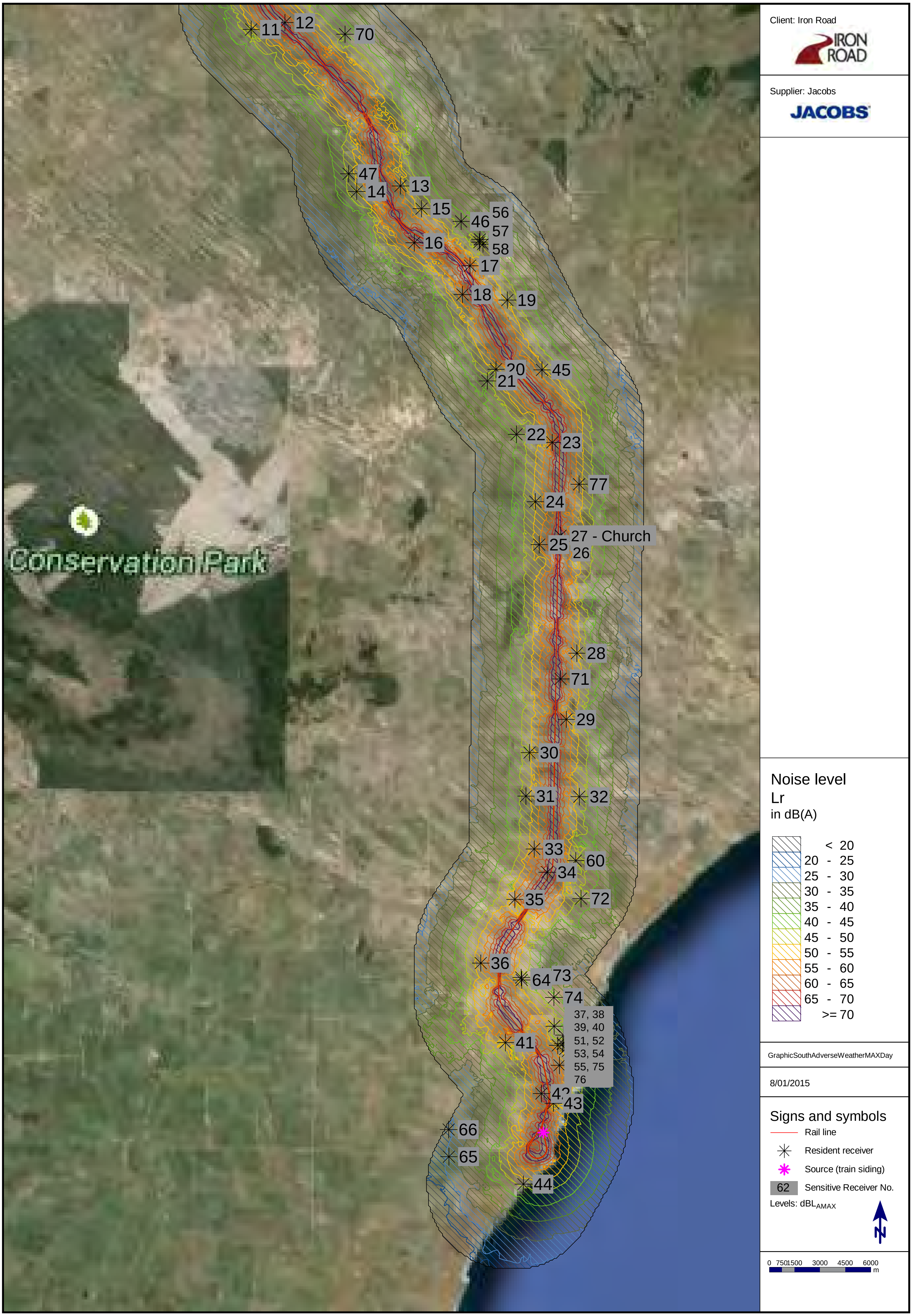
Signs and symbols

- Rail line
- Resident receiver
- Source (train siding)
- 62 Sensitive Receiver No.

Levels: dBL_{AMAX}

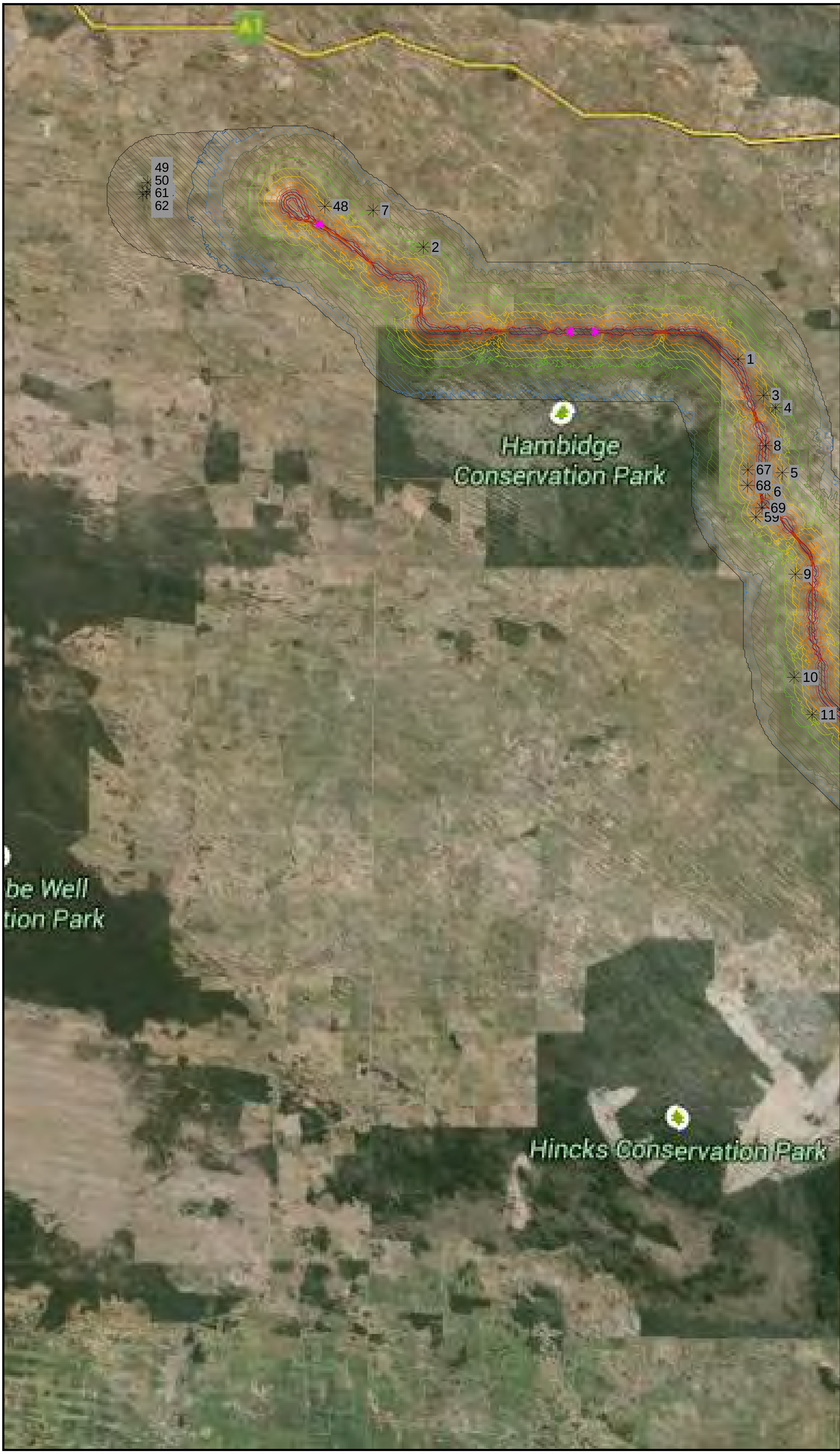
N

0 1250 2500 5000 7500 10000 m



Client: Iron Road
IRON ROAD
Supplier: Jacobs
JACOBS
Conservation Park
11
12
70
47
14
13
15
46
56
57
58
16
17
18
19
20
45
21
22
23
77
24
27 - Church
25
26
28
71
29
30
31
32
33
60
34
35
72
36
64
73
74
37, 38
39, 40
51, 52
53, 54
55, 75
76
41
42
43
66
65
44
Noise level
Lr
in dB(A)
< 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
>= 70
GraphicSouthAdverseWeatherMAXDay
8/01/2015
Signs and symbols
Rail line
Resident receiver
Source (train siding)
62 Sensitive Receiver No.
Levels: dBL$_{AMAX}$
N
0 750 1500 3000 4500 6000
m

B.6 Predicted noise level contours due to the proposed railway line operation – Night time L_{Amax}



Client: Iron Road

IRON ROAD

Supplier: Jacobs

JACOBS

Noise level
Lr
in dB(A)

<	20
20 -	25
25 -	30
30 -	35
35 -	40
40 -	45
45 -	50
50 -	55
55 -	60
60 -	65
65 -	70
>=	70

GraphicNorthAdverseWeatherMAXNight

8/01/2015

Signs and symbols

Rail line

Resident receiver

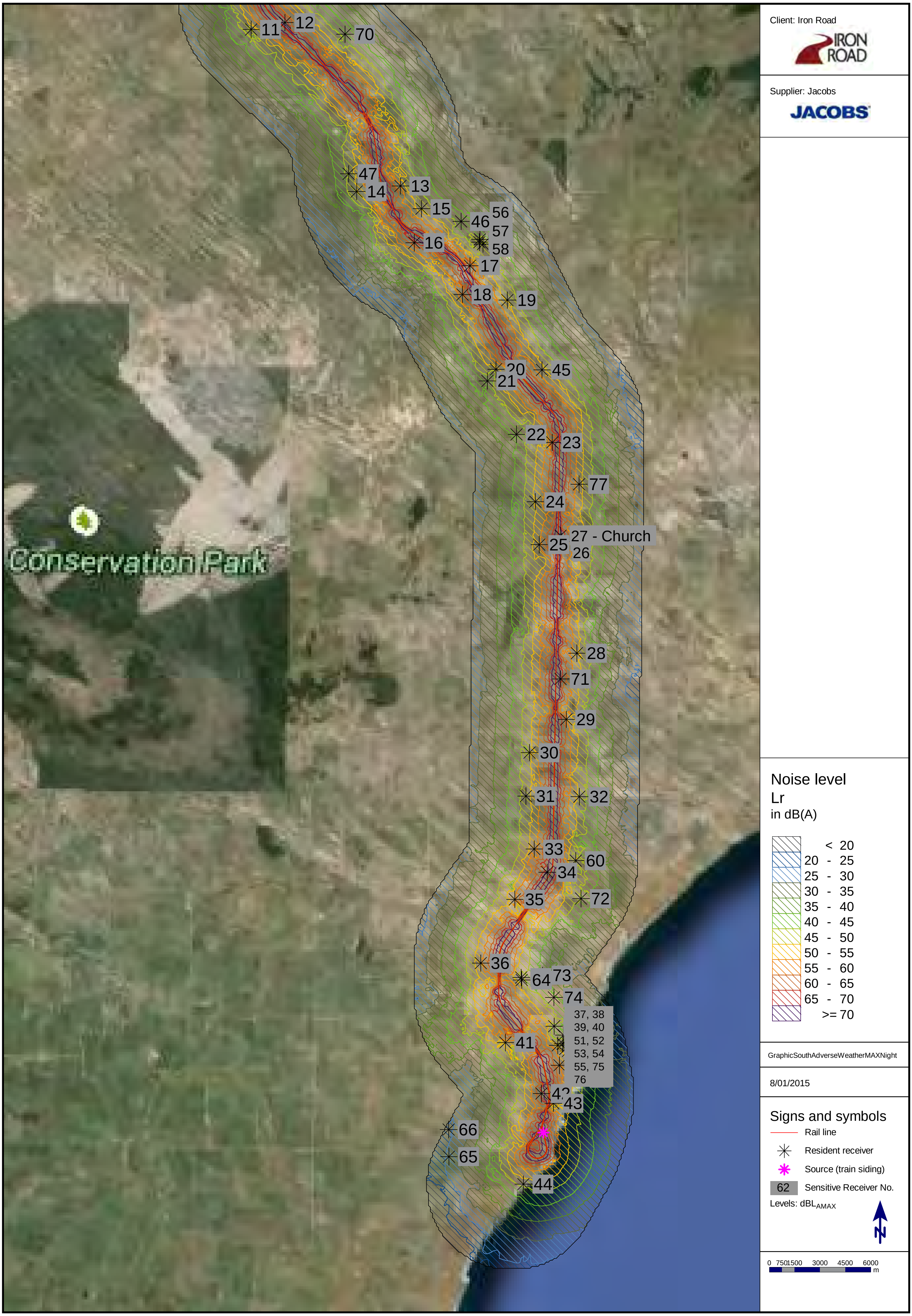
Source (train siding)

62 Sensitive Receiver No.

Levels: dBL_{AMAX}

N

0 12502500 5000 7500 10000 m

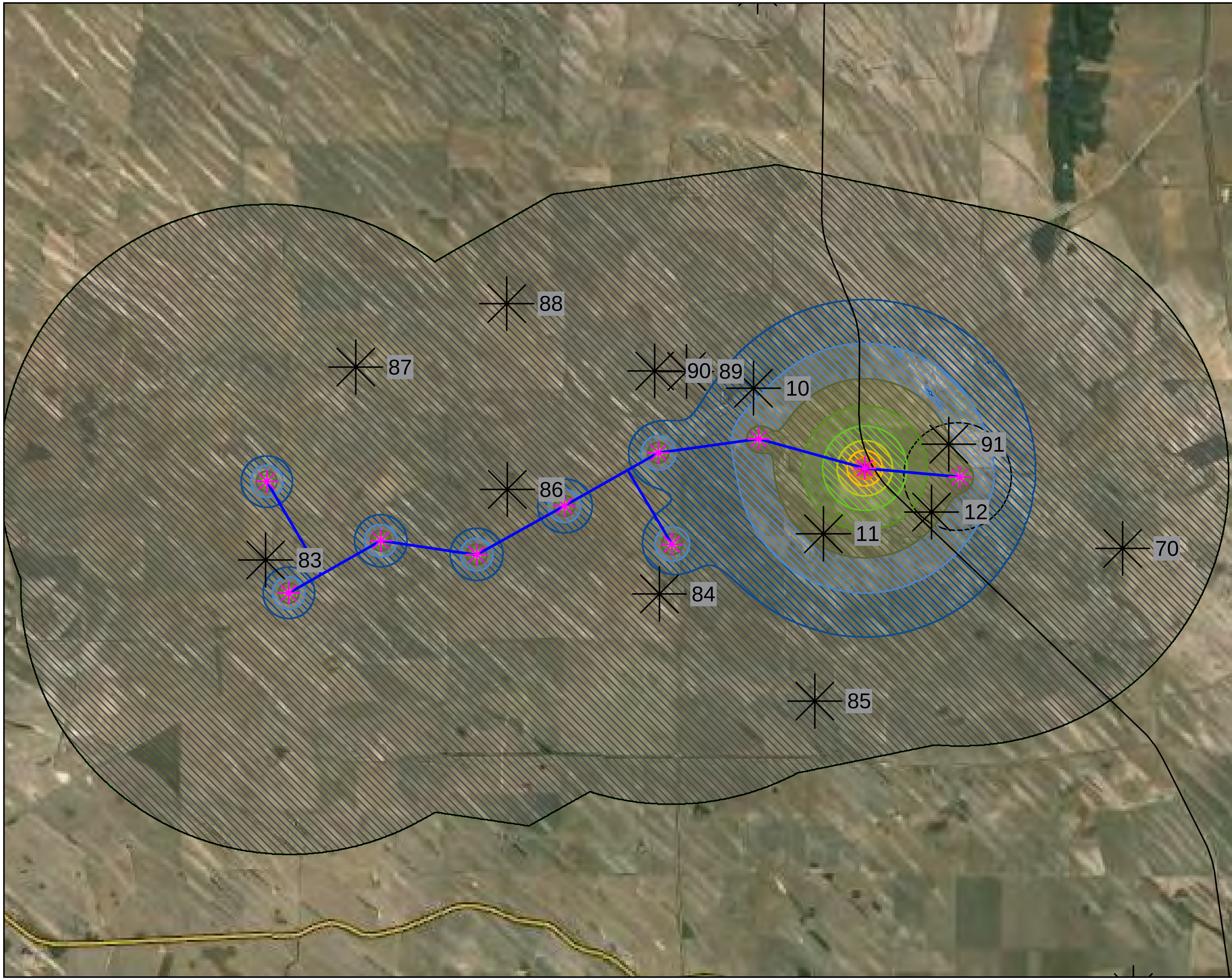

Client: Iron Road
IRON ROAD
Supplier: Jacobs
JACOBS
Conservation Park
11
12
70
47
14
13
15
46
56
57
58
16
17
18
19
20
21
45
22
23
77
24
27 - Church
25
26
28
71
29
30
31
32
33
60
34
35
72
36
64
73
74
37, 38
39, 40
51, 52
53, 54
55, 75
76
41
42
43
66
65
44
Noise level
Lr
in dB(A)
< 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
>= 70
GraphicSouthAdverseWeatherMAXNight
8/01/2015
Signs and symbols
Rail line
Resident receiver
Source (train siding)
62 Sensitive Receiver No.
Levels: dBL AMAX
N
0 750 1500 3000 4500 6000
m

Appendix C. Borefield - Predicted operational noise level contours

C.1 Borefield – Predicted operational noise level contours - Day time L_{Aeq}

C.2 Borefield – Predicted operational noise level contours - Night time L_{Aeq}

C.1 Borefield – Predicted operational noise level contours - Day time L_{Aeq}



Client: Iron Road

Supplier: Jacobs

Noise level
in dB(A)

	< 10
10	- 15
15	- 20
20	- 25
25	- 30
30	- 35
35	- 40
40	- 45
45	- 50
50	- 55
55	- 60
	>= 60

GraphicBoreDay

9/01/2015

Signs and symbols

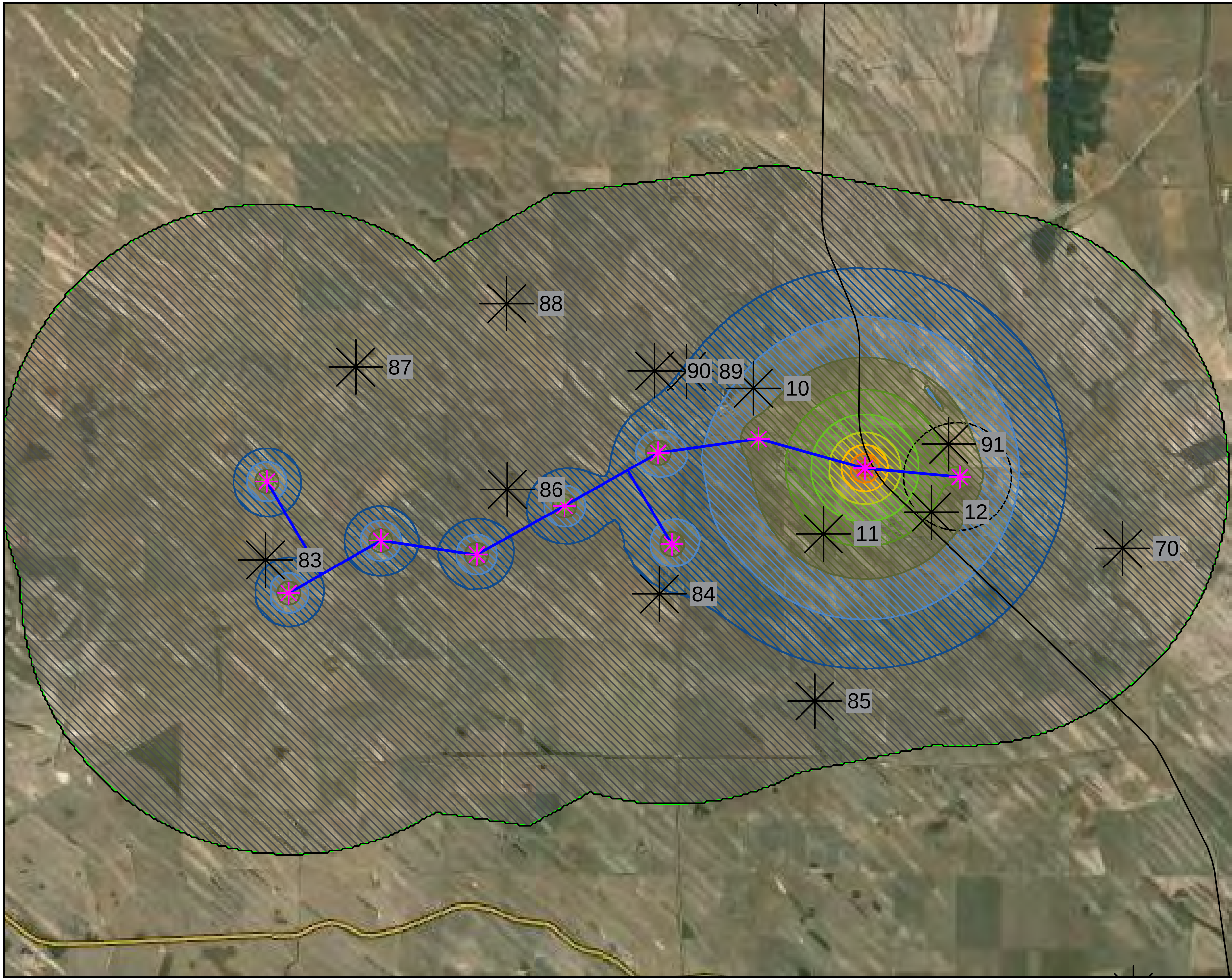
- Rail Centre Line
- WaterPipeline
- 91 Sensitive Receiver No.
- Resident receiver
- Noise Source

Levels: dBL_{Aeq}

N

0 500 1000 2000 m

C.2 Borefield – Predicted operational noise level contours - Night time L_{Aeq}



Client: Iron Road

Supplier: Jacobs

Noise level
in dB(A)

	< 10
	10 - 15
	15 - 20
	20 - 25
	25 - 30
	30 - 35
	35 - 40
	40 - 45
	45 - 50
	50 - 55
	55 - 60
	>= 60

GraphicBoreNight

9/01/2015

Signs and symbols

- Rail Centre Line
- WaterPipeline
- Sensitive Receiver No.
- Resident receiver
- Noise Source

Levels: dBL_{Aeq}

0 500 1000 2000 m

Appendix D. Predicted construction noise levels along the railway corridor at selected locations for three construction activities

D.1 The location of the cutting site used in the noise prediction modelling

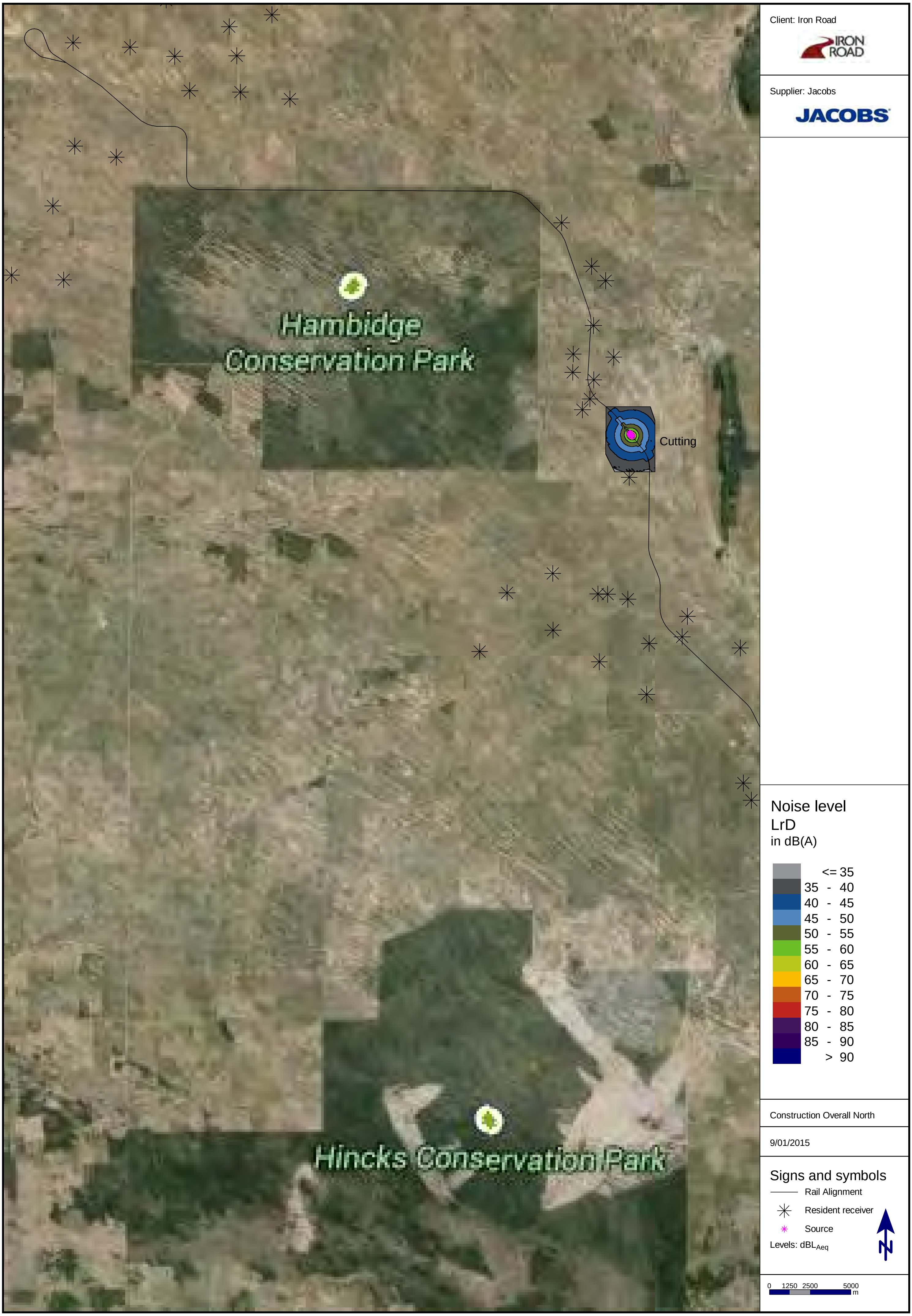
D.2 The location of the bridge and level ground preparation sites used in the noise prediction modelling

D.3 Predicted noise level contours generated for a typical railway cutting construction $L_{Aeq\ (15\ min)}$

D.4 Predicted noise level prediction contours generated for a typical bridge construction $L_{Aeq\ (15\ min)}$

D.5 Predicted noise level prediction contours generated for a typical railway construction on flat terrain $L_{Aeq\ (15\ min)}$

D.1 The location of the cutting site used in the noise prediction modelling



Hambidge Conservation Park
Cutting
Hincks Conservation Park
Client: Iron Road
Supplier: Jacobs
Noise level
LrD
in dB(A)
<= 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
> 90
Construction Overall North
9/01/2015
Signs and symbols
Rail Alignment
Resident receiver
Source
Levels: dBL_Aeq
N
0 1250 2500 5000 m

D.2 The location of the bridge and level ground preparation sites used in the noise prediction modelling

Client: Iron Road

IRON ROAD

Supplier: Jacobs

JACOBS

Noise level
LrD
in dB(A)

	<= 35
	35 - 40
	40 - 45
	45 - 50
	50 - 55
	55 - 60
	60 - 65
	65 - 70
	70 - 75
	75 - 80
	80 - 85
	85 - 90
	> 90

Construction Overall South

9/01/2015

Signs and symbols

Rail Alignment

Resident receiver

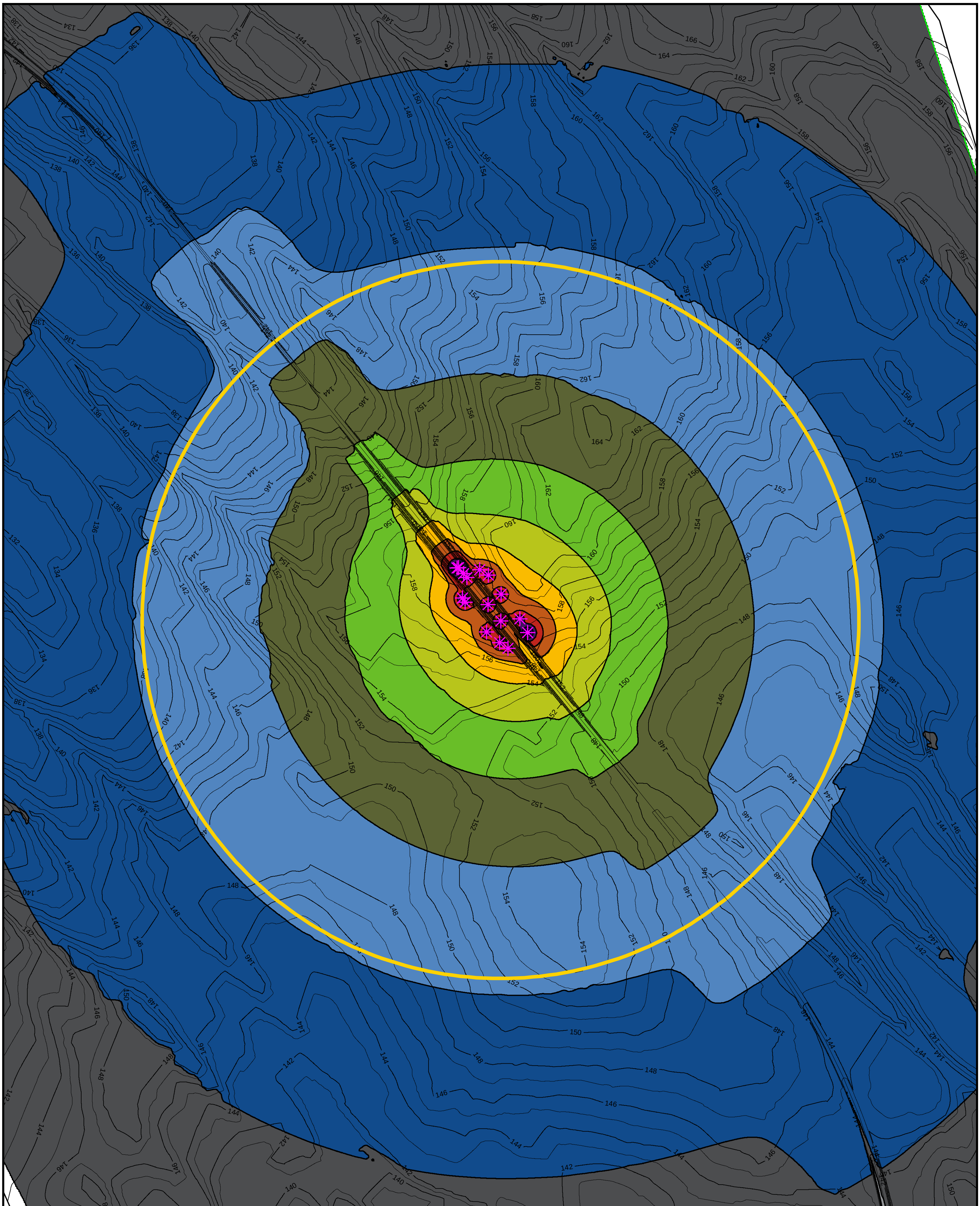
Source

Levels: dBL_{Aeq}

N

0 1750 3500 700

D.3 Predicted noise level contours generated for a typical railway cutting construction $L_{Aeq\ (15\ min)}$



Client: Iron Road

IRON ROAD

Supplier: Jacobs

JACOBS

Signs and symbols

- Rail Alignment
- Source
- Sensitive Receiver
- 1km radius

Levels: $dBL_{Aeq,\ 15min}$

Noise level in dB(A)

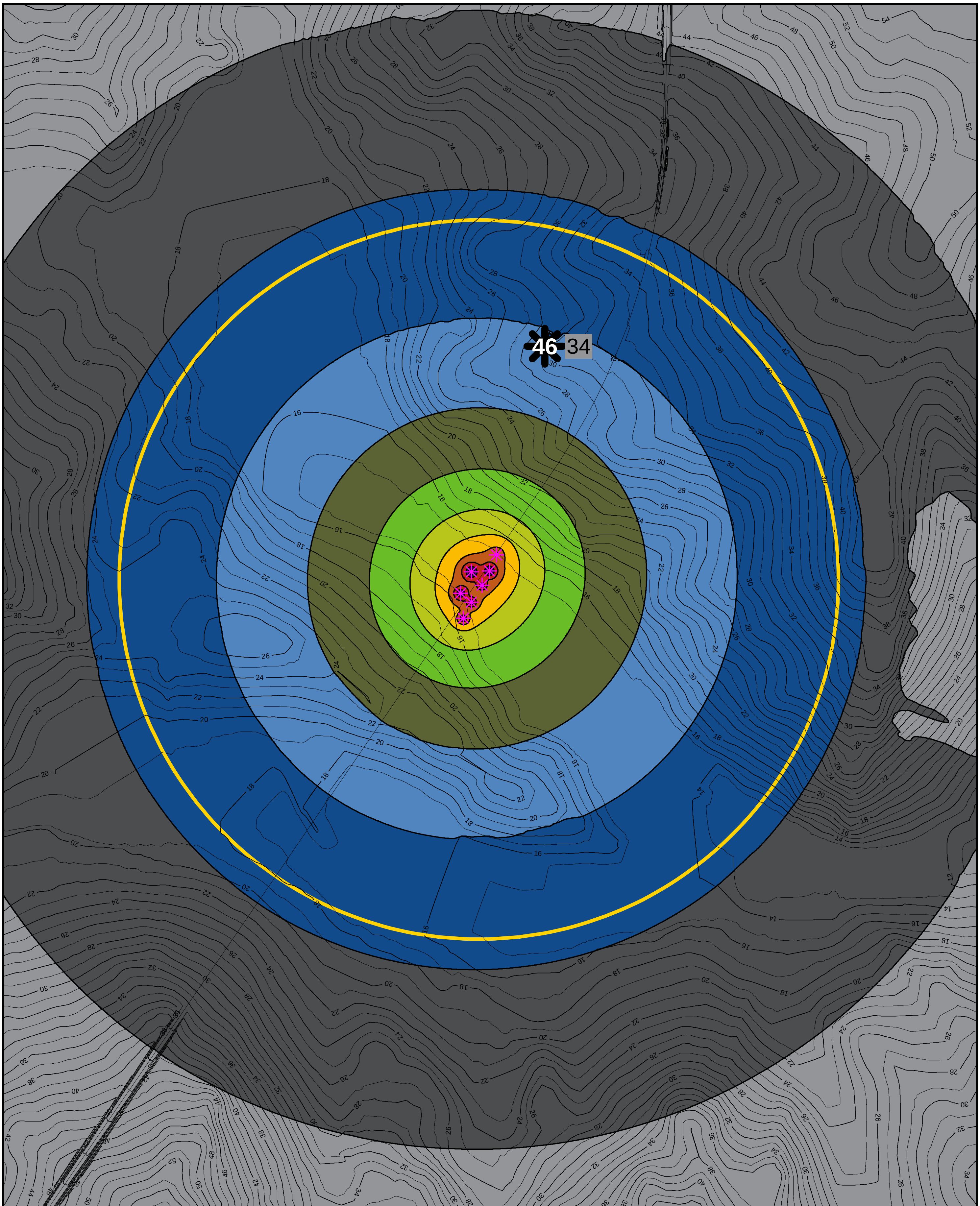
<=	35
35 -	40
40 -	45
45 -	50
50 -	55
55 -	60
60 -	65
65 -	70
70 -	75
75 -	80
80 -	85
85 -	90
>	90

Construction Cutting

9/01/2015

0 50 100 200 300 400 m

D.4 Predicted noise level prediction contours generated for a typical bridge construction $L_{Aeq\ (15\ min)}$



Client: Iron Road

IRON ROAD

Supplier: Jacobs

JACOBS

Signs and symbols

- Rail Alignment
- Source
- Sensitive Receiver
- 34 Sensitive Receiver No.
- 1km from sources

Levels: $dBL_{Aeq,\ 15min}$

Noise level in dB(A)

<=	35
35 -	40
40 -	45
45 -	50
50 -	55
55 -	60
60 -	65
65 -	70
70 -	75
75 -	80
80 -	85
85 -	90
>	90

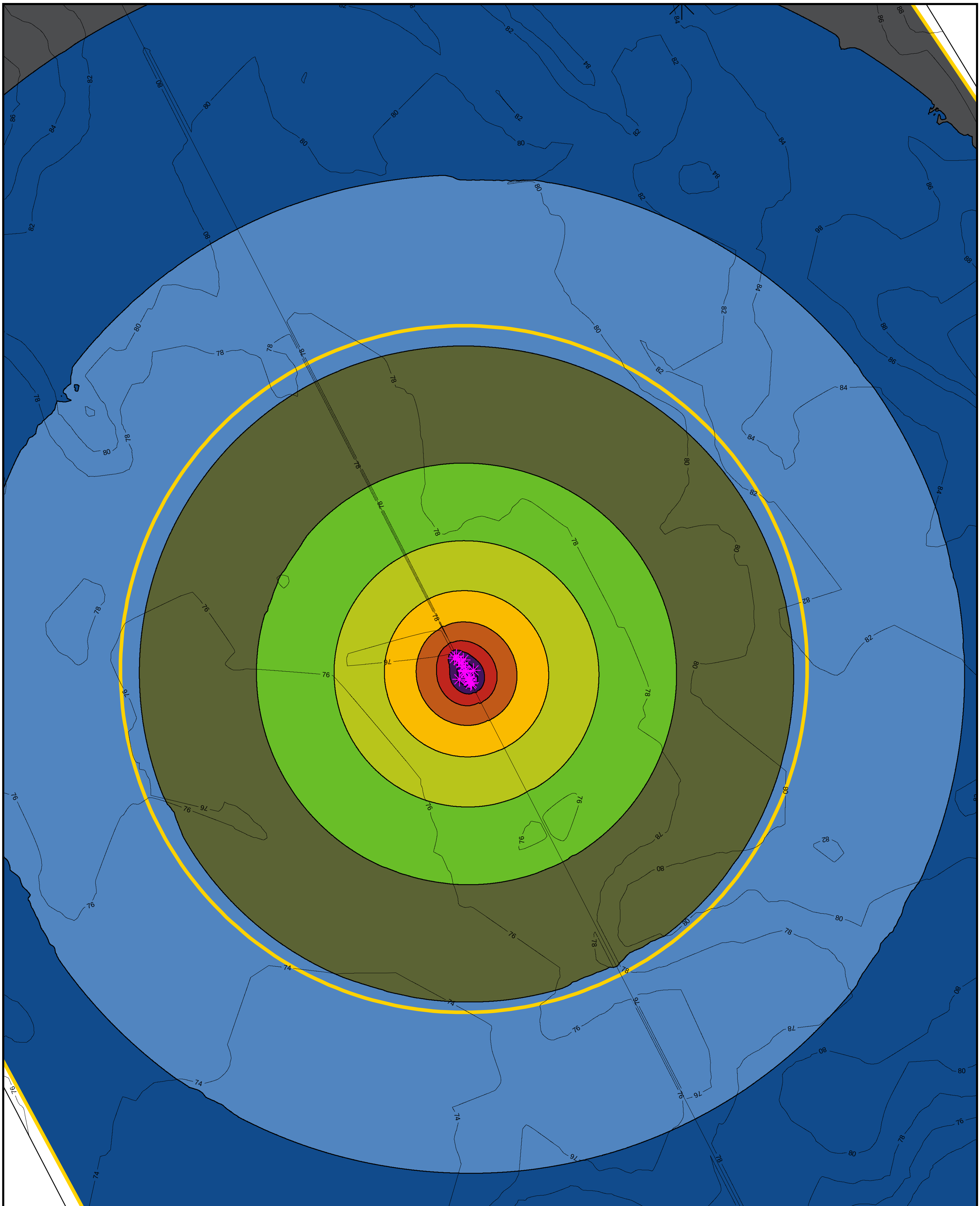
N

Construction Bridge

9/01/2015

0 50 100 200 300 400 m

D.5 Predicted noise level prediction contours generated for a typical railway construction on flat terrain $L_{Aeq\ (15\ min)}$



Client: Iron Road

IRON ROAD

Supplier: Jacobs

JACOBS

Signs and symbols

- Rail Alignment
- Source
- Sensitive Receiver
- 1km radius

Levels: $dBL_{Aeq, 15min}$

Noise level in dB(A)

<=	35
35 -	40
40 -	45
45 -	50
50 -	55
55 -	60
60 -	65
65 -	70
70 -	75
75 -	80
80 -	85
85 -	90
>	90

Jacobs® and Sinclair Knight Merz (SKM) have combined to form one of the world's largest and most diverse providers of technical professional and construction services across multiple markets and geographies

Construction Ground Base Preparation

9/01/2015

0 50 100 200 300 400 m

Appendix E. Predicted noise level contours generated for a bore well construction (L_{Aeq})

Client: Iron Road

IRON ROAD

Supplier: Jacobs

JACOBS

Signs and symbols

- Rail/Pipe Centreline
- Proposed Waterpipe
- 91 Sensitive Receiver No.
- ~1km radius
- Resident receiver
- Source

Levels: dBL_{Aeq}

Noise level in dB(A)

<=	35
35 -	40
40 -	45
45 -	50
50 -	55
55 -	60
60 -	65
65 -	70
70 -	75
75 -	80
80 -	85
85 -	90
>	90

N

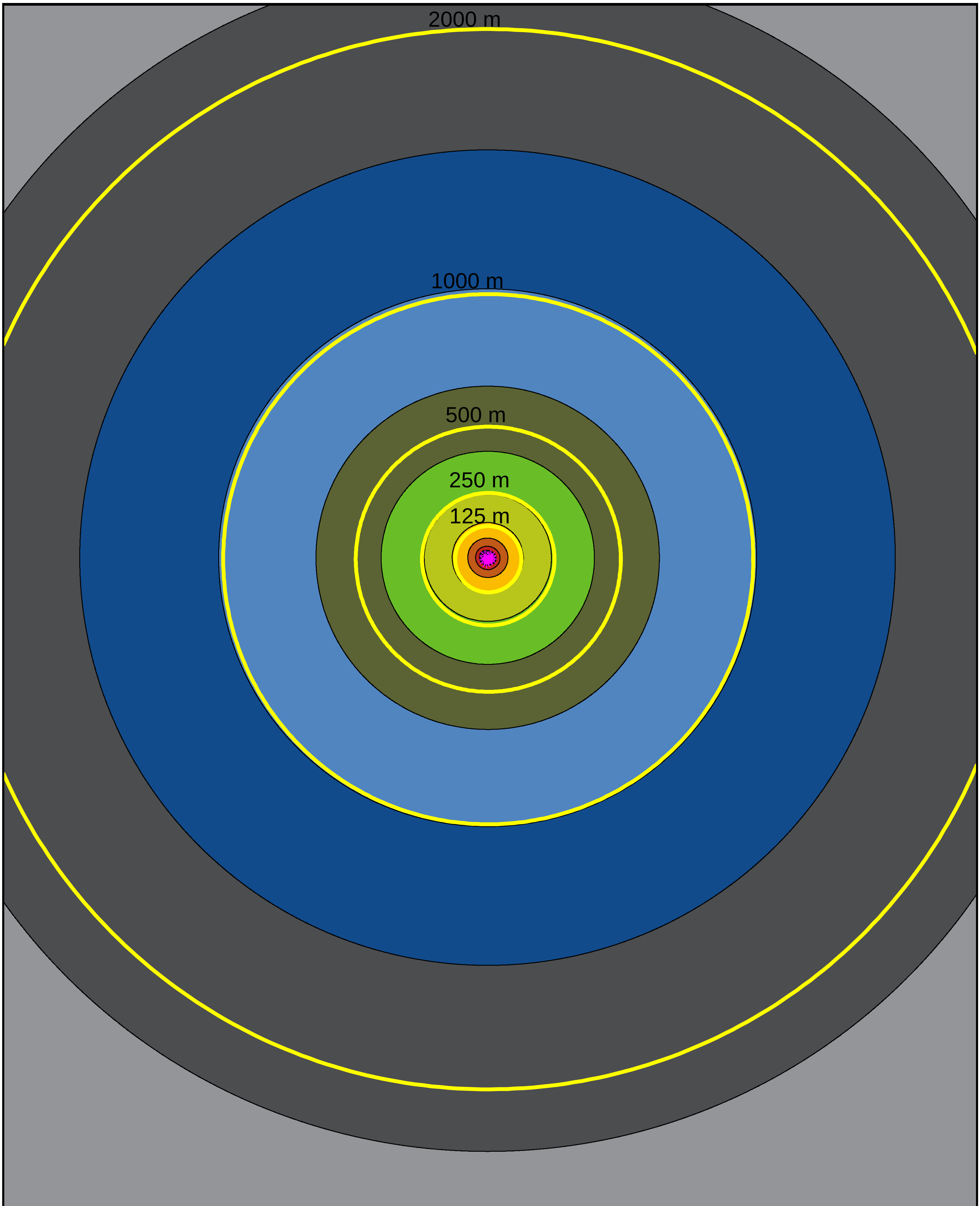
Jacobs® is one of the world's largest and most diverse providers of technical, professional and construction services across multiple markets and geographies

ConstructionBoreField

9/01/2015

0 50 100 200 300 400 m

Appendix F. Predicted noise level contours generated during a pylon construction (L_{Aeq})



Client: Iron Road

Supplier: Jacobs

Signs and symbols

Distance Line

Sources

Levels: $dBL_{Aeq,\ 15min}$

Noise level in dB(A)

<=	35
35 -	40
40 -	45
45 -	50
50 -	55
55 -	60
60 -	65
65 -	70
70 -	75
75 -	80
80 -	85
85 -	90
>	90

Construction Pylon

9/01/2015

0 50 100 200 300 400 m

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