Central Eyre Iron Project
Environmental Impact Statement

APPENDIX L

ENVIRONMENTAL NOISE AND VIBRATION ASSESSMENT - CAPE HARDY PORT FACILITY

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Central Eyre Iron Project

IRON ROAD LIMITED

Environmental Noise and Vibration Assessment

– Cape Hardy Port Facility

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 port facility at Cape Hardy on the east coast of the Eyre Peninsula, as part of the Iron Road Limited (Iron Road) Central Eyre Iron Project (CEIP).

Separate assessment reports address predicted noise and vibration levels due to the proposed infrastructure corridor and mine.

It is proposed that iron concentrate will be transported by rail to the port facility from the proposed mine located approximately 130 kilometres (km)[1] north west of Cape Hardy. Iron Road plans to export 21.5 million tonnes per annum (Mtpa) of iron concentrate for 25 years from the mine.

This assessment includes:

- An environmental noise level survey to define the existing acoustic environment at the proposed port facility (this is not mandatory in accordance with Part 5 of the *Environment Protection (Noise) Policy 2007* (the Noise Policy)).
- A review of the proposed port facility layout and identification of noise sources and processes and determining their corresponding Sound Power Levels.
- A review of the proposed port facility layout and identification of ground vibration sources and processes.
- Determination of applicable noise and vibration criteria based on review of national and state legislation and guidelines.
- Acoustic modelling using the SoundPlan computer model and using the CONCAWE algorithm to predict environmental noise levels for construction and operation. 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 receivers due to the iron concentrate exporting facility construction and operation with the applicable noise criteria.
- Consideration of typical vibration levels from construction and operation of the proposed port facility 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).

For this assessment, two construction scenarios were modelled with construction activity in two different areas, (1) construction of materials handling infrastructure landside of the proposed jetty and (2) construction of the rail unloading facility and associated infrastructure (refer to proposed port layout in Figure 2-2). The Noise Policy stipulates that construction noise which causes an adverse impact on amenity cannot occur at night time (between 7 pm and 7am), on a Sunday or on a public holiday and deems that an adverse impact will occur if the construction noise level exceeds L_{Aeq} 45 dB(A) or L_{Amax} 60 dB(A). The noise prediction modelling demonstrates that the location and type of construction activity can be managed to minimise noise at sensitive receiver locations and avoid adverse impact on amenity as required in accordance with the Noise Policy.

The operational noise level was predicted for a worst case scenario of all plant and conveyors operating with simultaneous train unloading and ship loading underway with ‘default’ weather conditions in accordance with the Noise Policy. A review of the predicted operational noise levels at the nearest sensitive receivers shows that the applicable noise criteria will be met under these conditions. Compliance with the requirements presented in the Noise Policy will therefore be achieved for the operational phase of the proposed Cape Hardy port facility.

Sources of ground vibration due to construction and operational of the proposed port facility were considered. No current Environment Protection Authority (EPA) or Australian Standard assessment criteria are available, therefore the preferred human response vibration levels specified in Appendix C of *Assessing Vibration: a*

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

technical guideline (NSW Department of Environment and Conservation (DEC) 2006) were considered applicable for this assessment. Based on review of the typical vibration levels of construction equipment, the slow and constant speed of operational equipment and the separation distance to sensitive receivers of at least 1000 m, it was deemed that vibration levels from construction and operation of the proposed port facility will be below the applicable vibration criteria.

Blasting at the proposed port site will occur over a period of approximately 5-6 months as part of construction of the port infrastructure including cuttings for the rail loop and the rail unloading facility. From initial airblast and ground vibrations calculations using the methodology presented in the *ICI Blasting Guide* (ICI 1995), it has been determined that a maximum instantaneous charge mass of 1000 kg at a distance of 1000 m is well within the applicable Australian Standard *AS 2187.2- 2006: Explosives – Storage and use Part 2: Use of explosives* (AS 2187.2-2006) human comfort criteria. The majority of the blasting is likely to be further than 1000 m from the closest sensitive receiver as it will be required at the rail loop and rail unloading facility which is over 1200 m from the sensitive receiver locations. The assessment indicates there is scope for a well-designed and executed blasting operation to be managed well within the blasting criteria.

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 contributing 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 reflects 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 pressure 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 generally from 20 Hz to 20,000 Hz for normally occurring sounds. 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.
Indicative noise level	Noise level limit for a noise source (ie port facility) at nearby sensitive receivers determined in accordance with Clauses 4, 5 and 20 of the Noise Policy.
Infrastructure corridor	Refers to the proposed 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 levels at a sensitive land use due to individual events
L_{Aeq}	The ‘A’ weighted equivalent continuous sound level is denoted $L_{Aeq.}$
$L_{Aeq,1h}$	Equivalent noise levels addressing the average noise exposure of a land sensitive use measured over a 1 hour time period.
$L_{Aeq,9h}$	Equivalent noise levels 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 levels 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	As defined in the Noise Policy “noise-affected premises” or sensitive receivers are defined as premises that: (a) are in separate occupation from the noise source and used for residential or business purposes; or (b) constitute a quiet ambient environment set aside as a park or reserve or for public recreation or enjoyment.

1. Introduction

Iron Road has engaged Jacobs to conduct an assessment of the predicted noise and vibration levels due to the construction and operation of a proposed port facility at Cape Hardy on the east coast of the Eyre Peninsula, South Australia.

It is proposed that iron concentrate will be transported by rail to the port facility from the proposed mine located approximately 130 km north west of Cape Hardy. Iron Road plans to produce 21.5 Mtpa of high quality iron concentrate for 25 years from the mine. The proposed port facility would have the capacity to export 70 Mtpa by Capesize vessels, of which 21.5 Mtpa would be used by Iron Road. Iron Road is seeking approvals for infrastructure to support a 21.5 Mtpa operation. Any additional infrastructure or activities proposed by any third party users of the port site would be subject to a separate approvals process.

Separate assessment reports address predicted noise and vibration levels due to the proposed infrastructure corridor and mine.

This assessment includes:

- An environmental noise level survey to define the existing acoustic environment at the proposed port facility (this is not mandatory in accordance with Part 5 of the Noise Policy).
- A review of the proposed port facility layout and identification of noise sources and processes and determining their corresponding sound power levels.
- A review of the proposed port facility layout and identification of ground vibration sources and processes.
- Determination of applicable noise and vibration criteria based on review of national and state legislation and guidelines.
- Acoustic modelling using the SoundPlan computer model and using the CONCAWE algorithm to predict environmental noise levels for construction and operation. 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 receivers due to the iron concentrate exporting facility construction and operation with the applicable noise criteria.
- Consideration of typical vibration levels from construction and operation of the proposed port facility 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 *ICI Blasting Guide* (ICI 1995).

2. Project description

Iron Road plans to produce 21.5 Mtpa of iron concentrate for at least 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 north west of the proposed Cape Hardy port facility site. Refer to Figure 2-1.

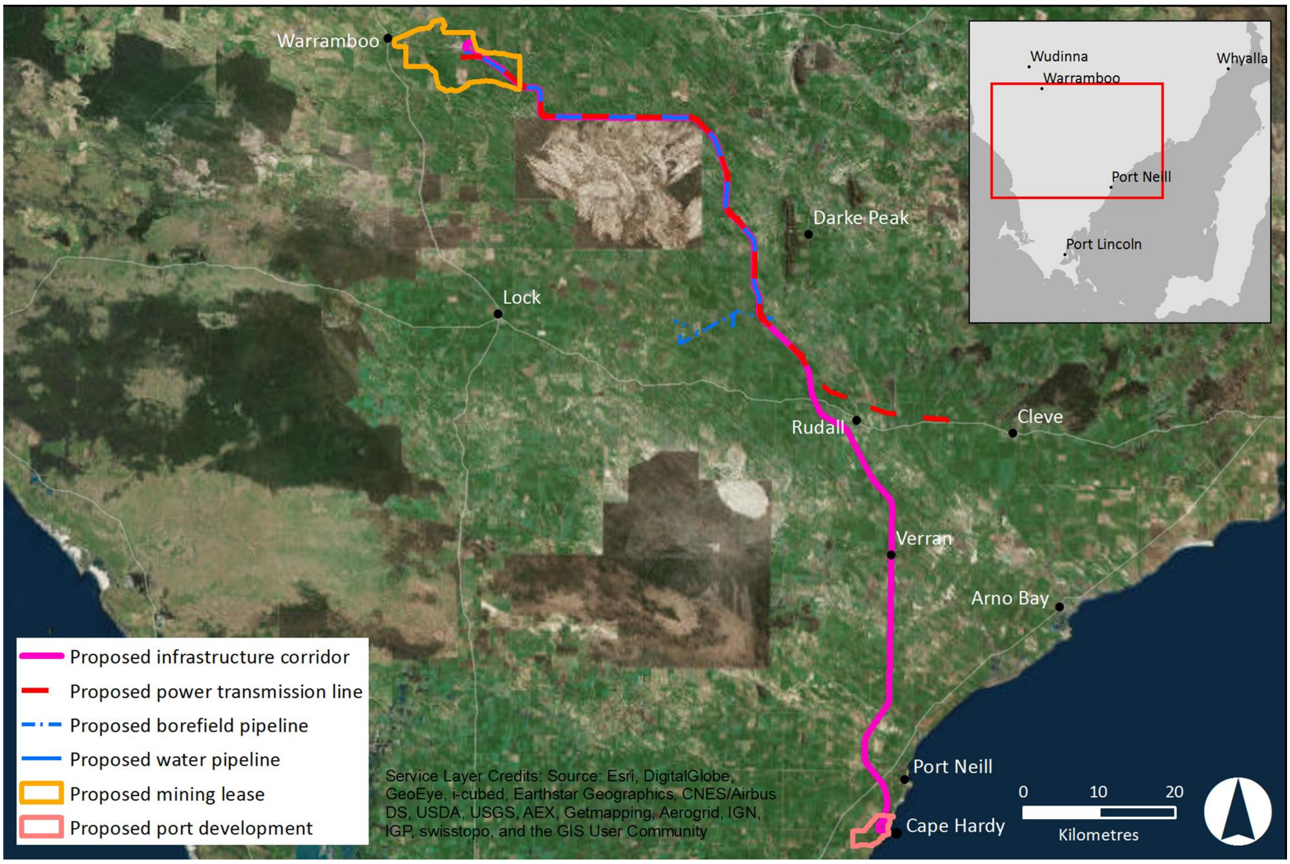

Figure 2-1: Relative location of the proposed mine and port sites

The proposed port facility is at Cape Hardy approximately 75 km north east of Port Lincoln and approximately 7 km south west of Port Neill[2].

The terrain around the port site is gently undulating leading to low foot hills inland.

There are residential dwellings sparsely spread surrounding the proposed port site. The closest sensitive receiver, a dwelling located on council owned land, is approximately 1000 m south west of where the security fence surrounding the port facility will be (refer to Figure 2-2). Further information about sensitive receivers is provided in Section 2.5.

Iron concentrate stockpiles within the port facility will be located between the rail unloading facility and the nearest noise sensitive receiver (refer to Figure 2-2).

[2] Measured from centre of the proposed port site to the centre of Port Neill

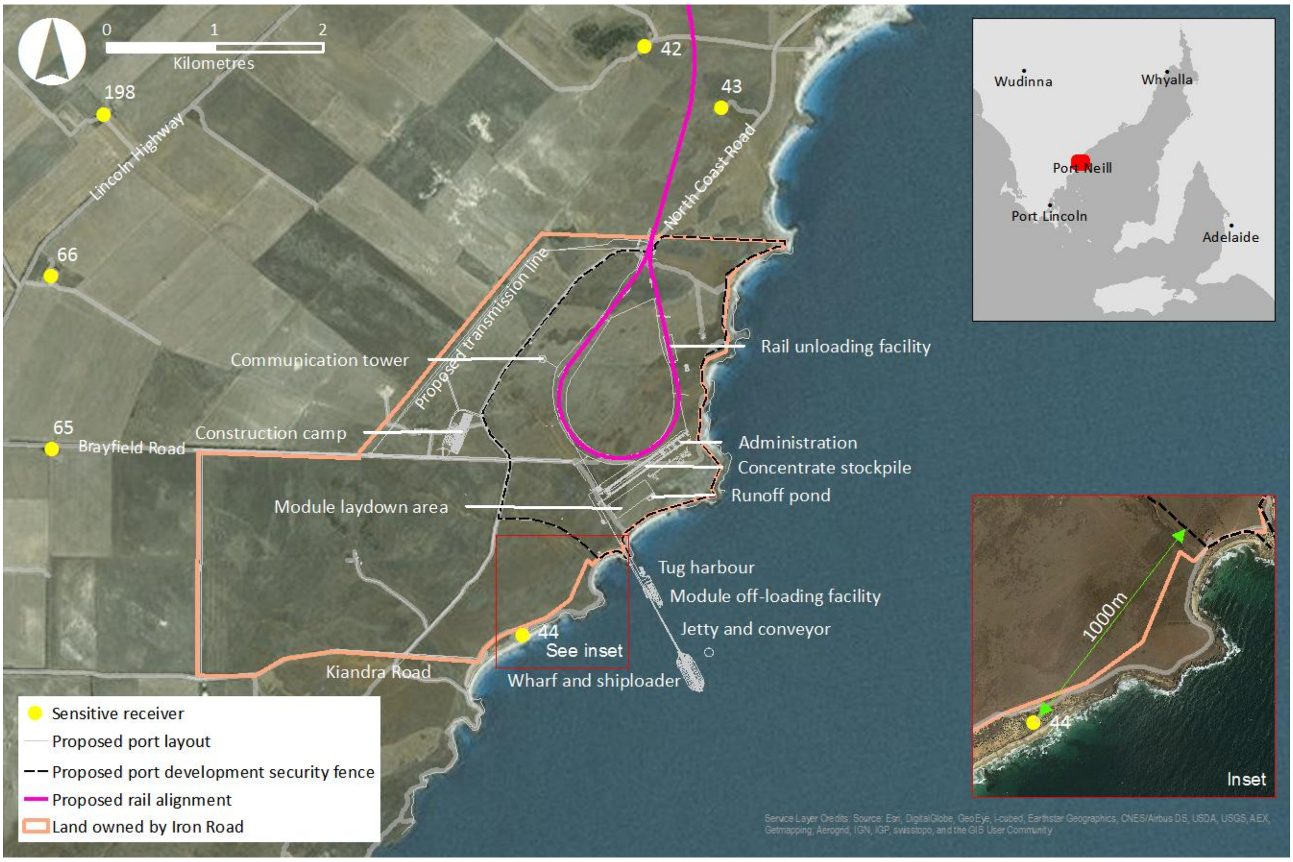

Figure 2-2: Cape Hardy port facility proposed layout and location of sensitive receivers

The proposed jetty and wharf at Cape Hardy has been designed to cater for Panamax and Capesize vessels. The port is proposed to have a bulk export capacity of 70 Mtpa. As Iron Road's export requirement is 21.5 Mtpa of iron concentrate, the proposed port will have capacity for an additional third-party export (subject to necessary approvals).

It is intended the port will operate 24 hours a day, seven days a week and will employ approximately 70 full time employees.

An overview of the port site is shown on Figure 2-2. The port will include:

- Rail unloading facility
- Bulk materials handling facilities – conveyors, stacker, reclaimer and ship loader
- Concentrate stockpile
- 1300 m long combined causeway, jetty and wharf
- Module offloading facility
- Tug and support vessel harbour
- Plant and equipment workshop and facilities
- Ancillary port administration and customs facilities
- Car parking and internal access roads
- Stormwater management
- Water supply and wastewater treatment facilities

- Substation
- Road upgrades and realignments, including secure access gates
- Emergency services facility

During construction of the CEIP Infrastructure, a temporary construction workforce camp to accommodate up to 650 construction personnel working on the port construction and the southern section of the rail corridor. The construction camp will be located approximately 2100 m north west of the proposed land/ jetty interface. The construction camp will be removed once construction has been completed.

2.1 Rail unloading facility

A rail unloading facility is proposed to be constructed to enable the unloading of the iron concentrate from the rail wagons. The rail unloading facility will be located on the port side rail loop approximately 400 m north of the concentrate stockpile.

The train will maintain continuous motion through the rail unloading facility at a very slow speed of approximately 0.8 km/h. The rail wagon bottom dumping doors will open once the wagon is inside the facility, emptying the iron concentrate into the hoppers below the railway level. An automatic wagon vibrator machine will detect if iron concentrate is hanging on to the wagon sides and use a mechanical arm to vibrate the affected wagon to ensure the contents are emptied completely.

Belt feeders located underneath the hopper chutes will collect the concentrate and transfer it to the conveyor system. The concentrate will then be transported to the concentrate stockpile for storage prior to loading.

The rail unloading facility will incorporate a dust control system that will draw air through filters to collect dust and minimise dust generation during the unloading process.

2.2 Conveyor systems

The proposed port site layout includes two conveyor systems to connect the materials handling facilities:

- The stockpile conveyor system connects the rail unloading facility to the concentrate stockpile.
- The ship loader conveyor system connects the concentrate stockpile to the ship loader.

The stockpile conveyor system conveyor belts will be 1.6 m wide and the ship loader conveyor system conveyor belts will be 1.8 m wide. Both conveyor systems will run at approximately 3 m/s and will be fully covered. Two transfer stations are included in the conveyor system design to enclose the transfer points where the iron are concentrate is transferred from one conveyor to another. The transfer stations will be clad with in colorbond steel and will be fitted with dust extraction units.

2.3 Concentrate stockpile and equipment

The concentrate stockpile will be located on a relatively flat part of the port site, to the north of the jetty (refer to Figure 2-3). The stockpile would be approximately 20 m high, 44 m wide and 660 m long and store approximately 660,000 tonnes of concentrate, which equates to three to four shiploads of material. The concentrate will be deposited in the form of a continuous prism using a boom stacker (refer to Figure 2-3).

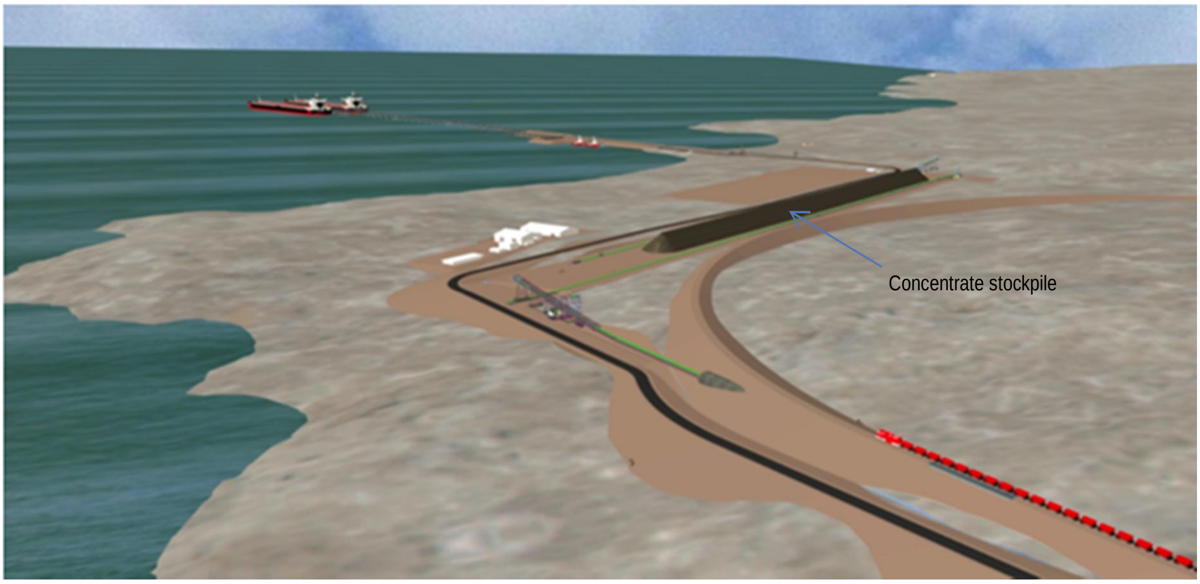

Figure 2-3: Port facility presenting the iron concentrate stockpile location

The stacker will operate when a train is unloading and the product is to be stacked on the stockpile. As the concentrate is discharged, the tripper and stacker will move to maintain the stockpile height.

Figure 2-4 presents a graphic of an iron concentrate stacker to be located at the port site.

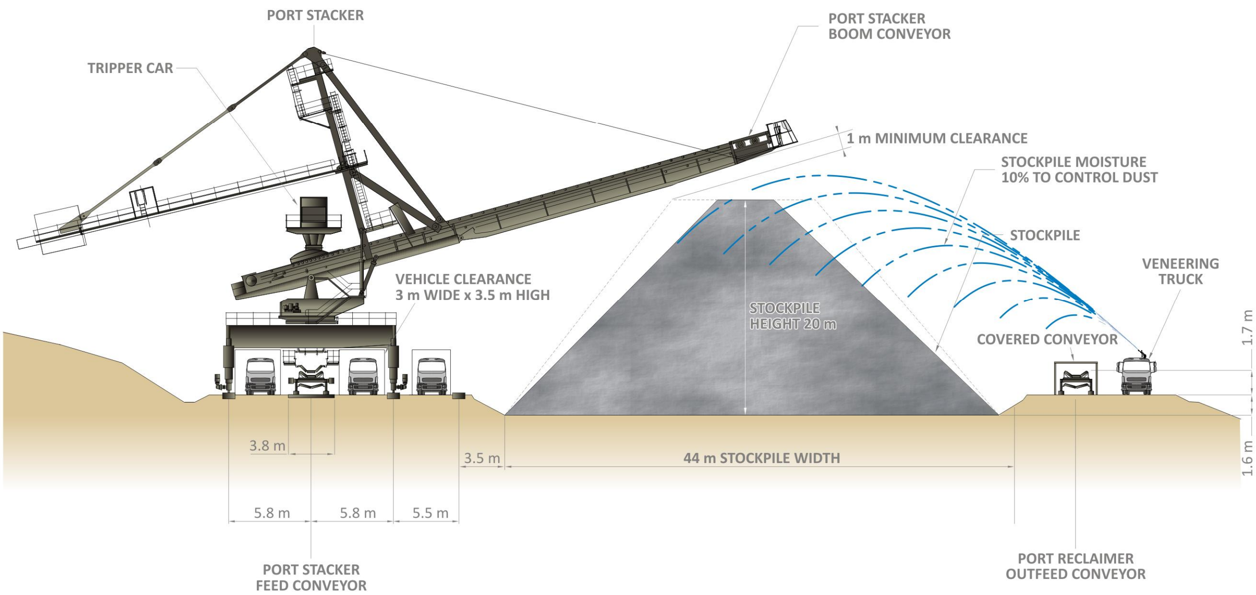

Figure 2-4: Iron concentrate stacker to be located at the port site.

A low height bucket-wheel reclaimer will be used to move the concentrate from the stockpile to the conveyor system feeding the ship loader. Refer to Figure 2-5.

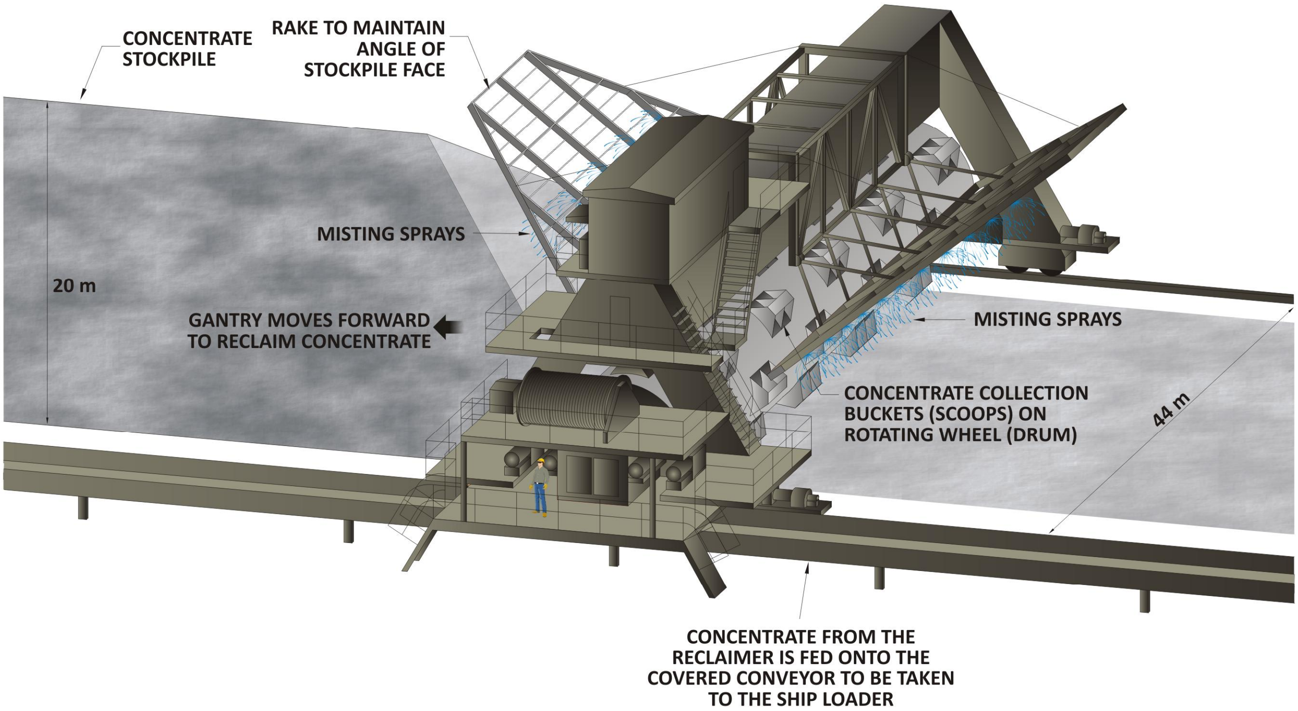

Figure 2-5: Example of a low height bucket-wheel reclaimer proposed at the port site

2.4 Ship loader

A ship loader will be located at the end of the jetty and will be able to load both Panamax and Capesize vessels on either side of the wharf. The ship loader's travel limits will be approximately 240 m, with a radial reach of approximately 50 m. During ship loading, the ship loader boom will be positioned over the loading hatch of the vessel. The ship loader design includes a flared telescopic chute that will be extended into the loading hatch to be a short distance above the bottom of the hold as the concentrate begins to load. As the hold fills, the chute will rise to maintain this short separation.

2.5 Sensitive receivers

In accordance with the Noise Policy, potential sensitive receivers include residential and business premises outside the port site and areas with quiet ambient environment that are set aside as parks or reserves used for public recreation.

The noise and vibration assessment is primarily based on the assumption that the closest sensitive receivers would be the most likely affected by the introduction of a new port facility. Figure 2-2 presents the location of the nearest sensitive receivers in relation to the proposed layout of the port facility.

As noted above the closest sensitive receiver is a dwelling (sensitive receiver number 44 on Figure 2-2) located on council owned land approximately 1000 m south west of where the security fence surrounding the port facility will be located. The next five closest residential sensitive receivers are located between 1.2 km and 3.7 km from the closest boundary of the port facility.

The closest identified business premise are the Port Neill silos on the Lincoln Highway located approximately 3.8 km to the north of the port site boundary but this site has not been considered as part of the assessment due to the extended separation distance.

The closest informal public recreational area is Cowley's Beach, approximately 1.5 km to the south west of where the port facility security fence will be located. The beach is accessible by public road, however, is not a designated park or reserve and does not provide any formal facilities therefore is not considered a sensitive receiver location for the purpose of the Noise Policy. In any case the beach is further away than the closest sensitive receiver to the south west of the port facility.

The sensitive receivers have been identified at different stages of the project development and assessment process so are not sequential, however the same sensitive receiver numbers are used for the same sites in each CEIP environmental impact assessment report to allow cross-referencing, e.g. noise and air quality.

3. Noise and vibration criteria

3.1 Noise policy

The Noise Policy provides guidance on noise limits for construction and operation of proposed development, including port development.

3.1.1 Construction noise criteria

Construction works at the port facility would include construction of the materials handling machinery, buildings and marine infrastructure. 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.

3.1.2 Operational noise criteria

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 indicative noise limits are determined for day time and night time periods as defined below:

- Day time – 7:00 am – 10:00 pm
- Night time - 10:00 pm – 7:00 am

The Development Plan relevant to the land based component of the proposed port facility and the locations of the sensitive receivers is the *Tumby Bay (DC) Development Plan* (Department of Planning, Transport and Infrastructure (DPTI) 2013a). The proposed port facility and most of the nearest identified noise sensitive receivers are located in an area zoned General Farming, whereas the closest sensitive receiver is located in an area zoned Coastal.

The Development Plan relevant to the marine based components of the proposed port facility is the *Land Not Within a Council Area (LNWCA) (Coastal Waters) Development Plan* (DPTI 2013b). The proposed jetty is within the Coastal Waters zone.

The indicative noise level assigned to the proposed port facility and sensitive receivers is dictated by the applicable indicative noise factors provided in the Noise Policy (Clause 4(9)). The relevant noise factors for the site of the proposed development and sensitive receiver locations are determined based on the existing and promoted uses within the relevant zones.

Table 3-1 below shows the indicative noise factors for various land use categories (Clause 4(9), Tables 1 and 2 of the Noise Policy).

Table 3-1: Indicative noise factors from the Noise Policy, for various land uses

Land use category	Indicative noise factor, $L_{Aeq,15mins}$ dB(A)	
	Day (7 am - 10 pm)	Night (10 pm - 7 am)
Special Industry	70	60 (70*)
General Industry	65	55 (65*)
Commercial	62	55
Light Industry	57	50
Rural Industry (Primary Production)	57	50
Residential	52	45
Rural Living	47	40

* Where the noise affected premises is in the same land use category as the noise source

Clause 4(5) of the Noise Policy requires that if the noise source and sensitive receivers do not fall within a single land use category, the indicative noise level is the average of the indicative noise factors for the land use categories within which those land uses fall. Using this clause and based on guidance in the *Guidelines for Use of the Environment Protection (Noise) Policy 2007* and from the Environment Protection Authority (EPA) the following sections provide a summary of how the indicative noise limits were determined.

3.1.2.1 Indicative noise factor for the port facility

As the proposed port facility straddles the Tumby Bay Coastal Zone and LNWCA (Coastal Waters) un-zoned area, the indicative noise level for the port facility is an average of the indicative noise factors for these two areas.

Land Not Within a Council Area (Coastal Waters) un-zoned area indicative noise factor

Based on discussion with DPTI, the EPA[3] advised that all land use categories (except Special Industry) are promoted in the un-zoned area of the *Land Not Within a Council Area (Coastal Waters) Development Plan,* as no land use is promoted over another, therefore the indicative noise factor is the average of the General Industry, Commercial, Light Industry, Rural Industry, Residential and Rural Living factors from Table 3-1. The average of these applicable indicative noise factors is the indicative noise factor for the Coastal Waters un-zoned area and is presented in Table 3-2 below.

Table 3-2: Un-zoned Coastal Waters indicative noise factor

Land use category	Indicative noise factor, $L_{Aeq,15mins}$ dB(A)	
	Day (7 am - 10 pm)	Night (10 pm - 7 am)
Un-zoned Coastal Waters	57	49

[3] Kym Pluck, Principal Adviser, Planning Policy and Projects, EPA, by email 22/10/14

Tumby Bay Coastal Zone indicative noise factor

The Coastal Zone is a mixed use zone and the EPA[4] advised that the land use categories relevant to the Coastal Zone include Rural Living, Rural Industry, Commercial (Tourist Accommodation) and General Industry (Aquaculture). The average of these applicable indicative noise factors is the indicative noise factor for the Coastal Zone and is presented in Table 3-4 below.

Table 3-3: Coastal Zone indicative noise factor

Land use category	Indicative noise factor, $L_{Aeq,15mins}$ dB(A)	
	Day (7 am - 10 pm)	Night (10 pm - 7 am)
Coastal Zone	58	48

Port facility indicative noise factor

The indicative noise factor for the port facility is provided in Table 3-4.

Table 3-4: Calculated indicative noise factor for the port facility

Indicative noise factors	Indicative noise factor, $L_{Aeq,15mins}$ dB(A)	
	Day (7 am - 10 pm)	Night (10 pm - 7 am)
LNWCA (Coastal Waters) un-zoned	57	49
Tumble Bay Coastal Zone	58	48
Port facility	**58**	**49**

3.1.2.2 Indicative noise levels (noise criteria) for the sensitive receiver sited on the coastal zoned land

The indicative noise level at the sensitive receiver within the Coastal Zone is calculated by taking the average of the indicative noise factor for the port facility and the indicative noise factor for the Coastal Zone (as defined in Section 3.1.2.1). Clause 20(3) of the Noise Policy requires that the predicted noise levels for a proposed development should not exceed the indicative noise levels minus 5 dB(A).Table 3-5 provides the final indicative noise levels (noise criteria) for the sensitive receiver sited on coastal zoned land.

Table 3-5: Indicative noise levels (noise criteria) for the sensitive receiver on coastal zoned land

Land use	Indicative noise levels, $L_{Aeq,15mins}$ dB(A)	
	Day (7 am - 10 pm)	Night (10 pm - 7 am)
Coastal Zone	58	48
Port facility	58	49
Averaged indicative noise factors	**58**	**49**
Development authorisation criterion	-5	-5
Final indicative noise levels	**53**	**44**

[4] Kym Pluck, Principal Adviser, Planning Policy and Projects, EPA, by email 7/5/14

In addition, Clause 14(3) of the Noise Policy requires a penalty be applied to the indicative noise level to account for specific acoustic characteristics (impulsive, low frequency, modulating, tonal). Based on the nature of the proposed development and the likely operational noise level generated by train movements on the rail loop, the predicted noise level will be increased by 5 dB(A) to account for the characteristic penalty.

3.1.2.3 Indicative noise levels (noise criteria) for the sensitive receivers sited on general farming zoned land

The indicative noise levels at the sensitive receivers within the General Farming Zone are calculated by taking the average of the indicative noise factor for the port facility site and the indicative noise factor for the General Farming Zone. As summarised in Section 3.1.2.2 the indicative noise level must also be adjusted by a development authorisation criterion and the noise characteristic penalty applied to the predicted noise levels.

Refer to Table 3-6 for the final indicative noise levels (noise criteria) for the sensitive receivers sited on general farming zoned land.

Table 3-6: Indicative noise levels (noise criteria) for the sensitive receivers on general farming zoned land

Land use	Indicative noise levels, $L_{Aeq,15mins}$ dB(A)	
	Day (7 am - 10 pm)	Night (10 pm - 7 am)
General farming (Rural Industry land use category)	57	50
Port facility	58	49
Averaged indicative noise factors	**58**	**50**
Development authorisation criterion	-5	-5
Final indicative noise levels	**53**	**45**

3.2 Vibration criteria

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.

The vibration criteria for human response are more stringent than the vibration criteria for structural damage for buildings therefore adoption of the human response criteria would ensure that compliance is also achieved for the structural damage category.

Where adverse human response is possible and/or the structural damage criteria may be exceeded, appropriate operational or construction vibration mitigation measures would be required to be implemented.

3.2.1 Human response to vibration

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 3-7 below.

Table 3-7: Preferred and maximum vibration levels at the nearest vibration sensitive receivers (mm/s)

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).

3.2.2 Structural vibration

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 3-8 below presents the maximum recommended ground vibration levels for various building configurations for short term evaluation.

Table 3-8: Recommended maximum ground vibration levels presented by DIN 4150-3 (1999-02)

Line	Type of Structure	Vibration Peak Particle Velocity (mm/s)			
		Foundation Frequency (Hz)			Plane 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

3.3 Construction blasting criteria

Blasting at the proposed port site will occur over a period of approximately 5-6 months as part of construction of the port infrastructure including cuttings for the rail loop and the rail unloading facility. The material excavated during blasting will be used for construction of the marine causeway and as fill in other areas of the port site (subject to assessment once excavated).

Australian Standard *AS 2187.2-2006: Explosives – Storage and use Part 2: Use of explosives* (AS 2187.2-2006) addresses 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 of ground vibration and airblast.

Human discomfort levels set by 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.

3.3.1 Ground Vibration

Ground vibration from blasting is due to the movement of mechanical 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 cause damage to buildings or structures.

Table 3-9 below presents the ground vibration levels specified in AS 2187.2-2006 for human comfort.

Table 3-9: 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 maximum 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 maximum 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 higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specification or below levels that can be shown to adversely affect the equipment operation.

3.3.2 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 also a complex wave train consisting of various peaks and with a range of frequencies.

The sources of the airblast include:

- Air pressure pulse generated by ground vibration
- 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 layers within the atmosphere and that the airblast may 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 3-10 below tabulates the recommended airblast limits for human comfort presented in the AS 2187.2-2006.

Table 3-10: Airblast limits presented in AS 2187.2 -2006 for human comfort

Category	Type of blasting operations	Peak sound pressure level (dBL)
Sensitive site (includes houses)	Operations lasting longer than 12 months or more than 20 blasts	115 dBL for 95% blasts per year. 120 dBL maximum unless agreement is reached with the occupier that a

Category	Type of blasting operations	Peak sound pressure level (dBL)
		higher limit may apply.
Sensitive site (includes houses)	Operations lasting less than 12 months or less than 20 blasts	120 dBL for 95% blasts. 125 dBL maximum 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 higher 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.

3.3.3 Blasting - ground vibration and airblast criteria

As the blasting operations are expected to be of a duration of approximately 5-6 months, the following blasting criteria have been applied, refer to Table 3-11.

Table 3-11: 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 maximum 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 maximum unless agreement is reached with the occupier that a higher limit may apply

4. Existing acoustic environmental measurement methodology and results

4.1 Methodology

Unattended noise level measurements were performed within the port site near where the south western extent of the security fence surrounding the port facility will be (refer to Figure 2-2), which is approximately 1000 m from the closest sensitive receiver (dwelling located on council owned land to the south west), to give an overview of the existing ambient noise environment.

Continuous noise level measurements were performed over 15 minute intervals over a seven day measurement period to determine the existing typical background noise levels (L_{A90}) at the proposed port facility site.

4.2 Instrumentation

The noise level data was recorded at the proposed port facility site using an ARL Ngara data logger.

The Ngara is a real time sound acquisition system, simultaneously recording the following acoustic measurements; Fa st SPL-A, Fast SPL-C, L_{eq}-A and L_{eq}-C and is ideally suited to monitor environmental noise continuously for up to three weeks. The logged data is saved as a formatted list of sound pressure level measurements in a CSV file. Samples can be taken every 100 ms.

The Ngara offers class 1 specifications allowing post-processing of statistical noise levels from the 1/10th of a second stored data files.

The Ngara can store calibrated continual 48 kHz raw audio data.

The ARL Ngara data logger used a 13 mm condenser microphone and was set as presented below:

- A Weighting scale
- Measurement Range: 20 – 120 dB
- Sampling interval : 100 ms
- Time Response125 ms
- WAV file Specifications: 48 kHz

The data logger has been certified by a NATA accredited laboratory and was checked for calibration prior to and after the noise level survey using a NATA certified Bruel & Kjaer Acoustic Calibrator type 4231 (Serial No.2583258).

The ‘noise floor’ of the data loggers is 20 dB(A). As the noise levels measured at each of the measurement locations were in excess of 10 dB(A) above the ‘noise floor’, the impact of the noise floor on the measured noise level is insignificant.

The serial number of the Ngara data logger used at the measurement position is S/N 8780E3.

4.3 Results

Although the Noise Policy does not include a provision to take into account existing background noise levels, a noise level survey was performed to determine the typical existing ambient noise level.

The existing 'A' weighted background octave band sound pressure level (L_{A90}), the L_{Aeq} and the L_{A10} sound pressure level measured over 15 minute periods at the proposed port facility over the noise survey are presented in Figure 4-1 below.

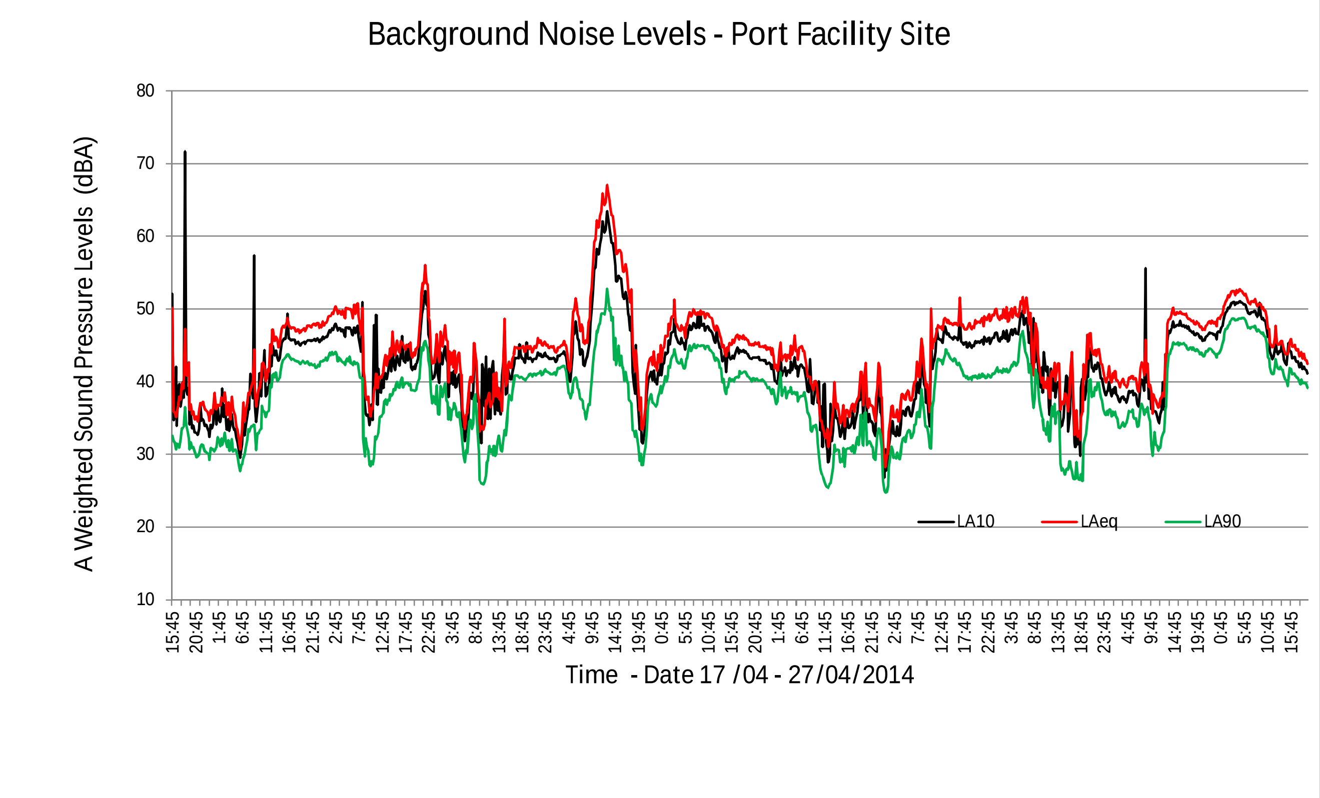

Figure 4-1: Existing ambient noise levels at the proposed port facility

It can be seen that the background noise levels (L_{A90}) varied significantly from levels as low as 25 dB(A) during the night time period up to approximately 50 dB(A) during the day time period.

The time trace shows the variability of the noise levels and it can be seen that the noise level is not fully dependant on the time of day.

The main contributors to the overall noise level were insect noise, wind noise and wave noise from the coast.

5. Meteorological conditions

In determining the likely acoustic impact due to the operation of the proposed port facility, the weather conditions in the area were investigated to determine if there was a prevailing weather condition. The following wind data was obtained from the CEIP Infrastructure Air Quality Assessment Report prepared by Jacobs.

5.1 Overview

With respect to determining local meteorology for the proposed port site, data was obtained from the Bureau of Meteorology (BoM) Port Lincoln weather stations, including:

- Port Lincoln station data 1866 - 2002
- North Shields, Port Lincoln Automatic Weather Station data

These two weather stations were considered to provide the highest quality meteorological data that was most representative of the proposed port facility site, due to similarities in coastal settings and land use. Although proposed port site is located approximately 73 km north of Port Lincoln and North Shields is approximately 14 km from Port Lincoln, all other weather stations were deemed to be too far inland to be representative of the Cape Hardy site.

5.2 Wind roses

Wind roses for the 3 pm wind direction and wind speeds observed by the BoM at North Shields near Port Lincoln over 1992 - 2010 are provided in Appendix A. The results for the middle month of each season are also provided.

Wind roses for the four seasons were also plotted using a TAPM-modelled wind dataset created specifically for the proposed port site and are provided in Appendix B. Note these modelled wind data include all hours so include more detail than the BoM wind roses. However the TAPM modelling was limited to the year 2009 only (‘typical meteorology’ for 2009 in SA was selected for assessment to be consistent with the CEIP Infrastructure Air Quality Assessment completed by Jacobs).

Comparing the BoM North Shield wind observations with the TAPM model results for Cape Hardy (2009), the wind roses show that the dominant winds expected for Cape Hardy are:

- South south east winds dominant in summer with most wind speeds for this direction, 5.5–8.3 m/s:
  - dominant wind direction based on modelled results for Cape Hardy
  - wind speeds from BoM observations
- South east winds dominant in autumn with most wind speeds for this direction, 2.8–5.5 m/s:
  - dominant wind direction based on modelled results for Cape Hardy
  - wind speeds from BoM observations
- West north west winds dominant in winter with most wind speeds for this direction, 5.5–8.3 m/s:
  - dominant wind direction based on modelled results for Cape Hardy
  - wind speeds from BoM observations
- Dominant winds expected to switch between west and east during spring. The model results indicate west winds will occur more often than east for Cape Hardy. Wind speeds also variable, the modelling indicates most west winds in range 4–6 m/s.

It can be seen that the prevailing wind direction is significantly dependent on the season, as the wind direction changes to different quadrants of the compass, depending on the season.

The dominant winds from the annual wind roses (also shown in the appendices), are:

- TAPM modelling for Cape Hardy port; south south east, followed by west north west
- BoM observations at North Shields; east followed by south east.

Table 5-1: Wind speed summary – Bureau of Meteorology, North Shields Monitoring Station

Month	Mean 9 am Wind Speed (m/s): 1992–2010	Mean 3 pm Wind Speed (m/s): 1992–2010
January	5.8	7.4
February	5.4	7.0
March	4.7	6.7
April	4.7	6.4
May	4.5	6.1
June	4.6	6.1
July	4.9	6.5
August	5.0	6.8
September	5.5	7.1
October	5.9	7.1
November	5.6	7.2
December	5.8	7.3
Annual	**5.2**	**6.8**

6. Prediction modelling and input data

In order to estimate the likely noise levels at sensitive receivers resulting from the construction and operational works at the proposed port site, 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 noise sensitive receiver locations and to predict noise level contours around the proposed development.

The model inputs are described below.

6.1 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 (used for day time conditions)
- Category 6 presents the ‘worst case weather’ conditions, i.e. weather conditions conducive for the highest propagation levels (used for night time conditions).

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

> “Predictions of the source noise levels for distances over 100 m 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.”

As discussed in Section 5.2 the prevailing winds are seasonal, therefore the ‘default’ weather conditions presented in the Noise Policy were used for this assessment. Table 6-1 below presents the ‘default’ meteorological parameters that were used in the prediction modelling.

Table 6-1: Meteorological parameters

Parameter	Meteorological conditions – ‘default’ weather conditions	
	Day (category 5)	Night (category 6)
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

The uncertainty of the noise level prediction is +/- 3 dB(A) within a 90% confidence limit.

6.2 Spatial data inputs

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

6.3 Construction equipment and sound power levels

The sound power levels assigned to the various pieces of construction equipment have been obtained from the Jacobs noise level 'data bank' and from information presented by the Department for Environment, Food and Rural Affairs (DEFRA). The assumed number of each type of construction equipment and associated sound power levels used in the modelling are shown in Table 6-2 below.

Table 6-2: Numbers and sound power levels for the construction equipment fleet

Construction Equipment	Number of units	'A' Weighted Sound Power Levels (dB(A))									
		Octave Band Centre Frequency (Hz)									Overall (dB(A))
		31.5	63	125	250	500	1K	2K	4K	8K	
Tracked excavator (Cat 245- 242 kW)	3	67	78	91	94	101	99	95	85	75	104
Front end loader	2	28	53	84	92	102	104	103	95	85	108
Vibratory compactor (Cat 825C)	1	63	78	93	103	104	105	103	97	89	110
Dump Trucks – (15T Ford Louisville)	4	70	89	86	100	101	102	100	101	91	108
Grader (Cat 12G – 101 kW)	2	67	83	95	105	108	107	102	97	82	112
Bulldozer (Cat D10N)	2	71	85	110	100	108	113	109	103	93	116
Pile Driver 4 tonne drop -0.5 m drop)	1	69	84	94	101	114	111	106	107	104	116
Crane	2	73	87	85	86	96	100	98	92	83	104
Concrete Trucks	2	38	58	75	93	101	106	106	98	86	110
Articulated Truck	2	65	77	84	103	104	106	106	99	88	111
Generators	4	60	77	84	95	95	97	94	85	74	102
Drill Rig	2	50	59	77	69	76	80	80	75	75	86

6.4 Typical vibration levels of construction equipment

The vibration produced by port facility construction works will be highly dependent on the particular construction processes and equipment that will be employed.

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

The EPA does not have any guidelines pertaining to ground vibration; however DPTI has issued a document titled *Management of Noise & Vibration Construction and Maintenance Activities, Operational Instruction 21.7* (DPTI 2014) which presents typical vibration levels and safe distances for various configurations of construction equipment which are listed in Table 6-3. 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 6-3 should be used for indicative purposes only.

Table 6-3: Typical Vibration levels and safe working distances for various configurations of construction equipment (DPTI 2014)

Activity	Typical Levels of Ground Vibration
Vibratory Rollers	1.5mm/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 12m buffer to the foundations of a standard residential building.
Hydraulic Rock Breakers (levels typical of a large rock breaker in hard sandstone)	4.5mm/s at 5m 1.3mm/s at 10m 0.4mm/s at 20m 0.1mm/s at 50m
Compactor	20mm/s at 5m 2mm/s at 15m 0.3mm/s at 30m
Excavators	0.2mm/s at 40m
Ballast Tamping	6mm/s at 3m 2mm/s at 10m
Truck traffic (over maintained road surfaces)	0.2mm/s at 10m
Truck traffic (over irregular surfaces)	2mm/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 3mm/s at 50m 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	2mm/s at 5m 0.2mm/s at 20m
Air track drill	5mm/s at 5m 1.5mm/s at 10m 0.6mm/s at 25m 0.1mm/s at 50m
Jackhammer	1mm/s at 10m

6.5 Operational equipment and sound power levels

The sound power level data used in the computer modelling was determined from noise level surveys performed at other iron concentrate loading facilities. Table 6-4 below presents the assumed numbers of units and sound power levels of the equipment modelled for the operation of the proposed port facility.

Table 6-4: Numbers and sound power levels assumed for the operational equipment fleet

Equipment	Number of units	Linear Sound Power Levels (dB)									
		Octave Band Centre Frequency (Hz)									Overall (dB)
		31.5	63	125	250	500	1K	2K	4K	8K	
Conveyors (closed) (dB/m)	Conveyor length is approx.4 Km	62	72	77	72	67	61	55	56	46	79.5
Rail unloading facility	(dB/m^2 of metal deck enclosure)	65.5	61.5	59	54	53	50.5	46	41	35.5	64.5
Iron concentrate stacker	1	89	93.5	94	92	93.5	93	89.5	81.5	76	100.5
Iron concentrate reclaimer	1	105	113	113	111	111	110	103	97	91	119
Ship loader	1	128	117	114	110	108	107	107	107	105	129
Transfer station	2	101	100	103	101	103	99	101	94	92	101
Locomotives (2 units Engine speed set to idling or notch 1)	2	-	76	85	88	93	93	89	89	76	98
Stretching with Brake car	1	80	74	71	73	71	70	67	67	60	79.5
Wheel squeal	4 wagons	36	47	54	66	59	58	60	58	54	69

The conveyors were modelled as line sources and all other sources were modelled as point sources, with the calculation of the sound power levels of each source being based on measured sound power levels and the noise source size.

Table 6-5 below presents the height of each noise source modelled.

Table 6-5: Assumed height of noise sources

Equipment Configuration	Height (m)
Conveyors (line source)	Ranges from ground level to 40 m at the end of the Jetty
Conveyor drives	Integrated into conveyor infrastructure
Ship loader	40
Rail unloading	Ground level
Rail noise	1
Locomotive exhaust noise	3.5

6.5.1 Rail noise due to shunting and train movements

Train noise has been taken into account in this assessment based on a single train unloading iron concentrate. The planned unloading operation involves approximately 1.5 hours to unload the iron concentrate and a maximum of 4 hours train turnaround time including fuelling and provisioning of locomotives. A total of six train unloading operations will occur every 24 hours.

6.6 Blasting

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.

6.6.1 Airblast prediction

The 95th percentile airblast site law, which may be 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 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 (m)

6.6.2 Blasting vibration prediction

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

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

Where scaled distance is calculated as:

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

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

7. Prediction modelling results and discussion

Computer prediction noise modelling has been performed for both the operational and the construction phases of the port facility. The predicted noise levels were compared with noise criteria summarised in Section 3.1. The construction noise modelling results and discussion is provided in Section 7.1. The operational noise modelling results and discussion is provided in Section 7.3.

Ground vibration modelling was not completed for the operational or construction phases of the port facility for reasons discussed in Section 7.2 and 0 with reference to criteria identified in Section 3.2.1 and 3.2.2.

Predicted airblast over pressure levels and the predicted ground vibration levels due to blasting were determined using the formula presented in the *ICI Blasting Guidelines* (ICI 1995) and the results are discussed in Section 7.5. The predicted airblast and ground vibration levels were compared to the recommended criteria presented in AS 2187.2 – 2006, as summarised in Section 3.3.3.

7.1 Construction noise

Computer prediction modelling was performed to assess the typical noise level due to construction works involving mechanical equipment and plant that would be used at the port facility. Noise prediction modelling is difficult as the plant and equipment are mobile and will be located at an infinite number of locations throughout the construction phase.

The noise prediction modelling is also based on the premise that all of the plant and equipment will be operating at maximum engine speed continuously throughout the working period, except with no pile driving for the night time period. In real life, some plant and machinery will not be operating at all times.

For this modelling exercise, two construction scenarios were modelled in which equipment was “placed” in two different locations to simulate two possible construction operations. The two scenarios were:

1. All of the construction plant and equipment working near the materials handling infrastructure landside of the proposed jetty
2. All of the construction plant and equipment working near the rail unloading facility and associated infrastructure

Appendix C presents the predicted noise level contours for the two construction scenarios.

Table 7-1 below presents the predicted sound pressure levels at the nearest sensitive receivers to the proposed port facility during the construction phase with all equipment operating for the day time period but without the pile driving operation during the night time period.

Table 7-1: Predicted $L_{Aeq\ 15\ mins}$ at the nearest noise sensitive receivers during port construction - day and night ‘default’ weather conditions

Identified sensitive receiver locations	Construction scenario 1 Predicted $L_{Aeq,15mins}$ Sound Pressure Level at Nearest Noise Sensitive Receiver (dB(A))*	Construction scenario 2 Predicted $L_{Aeq,15mins}$ Sound Pressure Level at Nearest Noise Sensitive Receiver (dB(A))*
Day time - worst case weather conditions (all equipment operating)		
Sensitive receiver 43	33	40
Sensitive receiver 42	31	37
Sensitive receiver 198	25	21
Sensitive receiver 66	27	21

Identified sensitive receiver locations	Construction scenario 1 Predicted $L_{Aeq,15mins}$ Sound Pressure Level at Nearest Noise Sensitive Receiver (dB(A))*	Construction scenario 2 Predicted $L_{Aeq,15mins}$ Sound Pressure Level at Nearest Noise Sensitive Receiver (dB(A))*
Sensitive receiver 65	28	21
Sensitive receiver 44	**51****	34
Night time - worst case weather conditions (all equipment operating except the pile driver)		
Sensitive receiver 43	32	39
Sensitive receiver 42	30	36
Sensitive receiver 198	25	21
Sensitive receiver 66	26	21
Sensitive receiver 65	27	21
Sensitive receiver 44	**50****	34

* Predicted sound pressure levels rounded to nearest integer number

** Predicted sound pressure levels exceed construction noise criteria of $L_{Aeq\ 15min}$ 45 dB(A) criterion for continuous noise for night time, Sundays and public holidays

The modelling results in Table 7-1 indicate that during the night time period and during the day time on a Sunday or public holiday, the construction noise level may exceed the $L_{Aeq\ 15min}$ 45 dB(A) criterion for continuous noise as presented in Clause 23(3) of the Noise Policy at the closest sensitive receiver (number 44) for construction scenario 1, therefore may cause adverse impact on amenity. However the construction noise criteria is not exceeded at any of the sensitive receiver locations for construction scenario 2.

A review of the background noise levels measured next to proposed port facility site (refer to Section 4.3 of this report), shows that the existing background noise levels are between $L_{A90\ 15\ min}$ 30 – 40 dB(A) during the night time periods.

To achieve the night time, Sunday and public holiday noise criteria of $L_{Aeq\ 15\ mins}$ 45 dB(A) (continuous) and of L_{AFmax} 60 dB(A) (maximum) as presented in the Noise Policy, construction will be managed to avoid adverse impact on amenity with particular focus on minimising noise at sensitive receiver location 44. As demonstrated by construction scenario 2 it will be possible to manage the location and type of construction activities to minimise noise at sensitive receiver locations as required in accordance with the Noise Policy.

7.2 Construction vibration

It can be seen from the typical ground vibration levels presented for various pieces of equipment (refer to Section 6.4), that vibration is generated by the various types of construction equipment to be used during construction of the port facility including pile drivers, compactors and vibratory rollers (refer to Table 6-2).

The human response vibration criteria detailed in Section 3.2.1 indicates that for residential properties the preferred night time vibration value is 0.14 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.

As the closest sensitive receiver is approximately 1000 m away from any vibration sources (ie proposed construction activity), it is deemed that the vibration levels will be below the preferred human response levels, and hence well below the structural damage criteria presented in Section 3.2.2. There is a low probability of adverse comment or disturbance to building occupants at vibration levels below the human response preferred values (DEC 2006).

7.3 Operational noise

The operational noise level was predicted for a worst case scenario of all plant and conveyors operating with simultaneous train unloading and ship loading underway ie:

- Train unloading operation including wheel squeal and wagon indexing
- Stacker operational
- Reclaimer operational
- Ship loader operational
- Conveyors and conveyor drives operational

It was deemed that the worst case wind direction should be modelled with the wind direction from the proposed port facility to the nearest sensitive receiver.

The resultant noise level contour plots are provided in Appendix D.

Table 7-2 below presents the predicted sound pressure levels at the nearest identified sensitive receivers.

Table 7-2: Predicted $L_{Aeq\ 15\ mins}$ at the nearest noise sensitive receivers during port operation - day and night 'default' weather conditions (no noise character penalty)

Identified noise sensitive receiver positions	Predicted $L_{Aeq\ 15\ mins}$ sound pressure level at nearest noise sensitive receiver (dB(A))*
Day time - worst case weather conditions	
Sensitive receiver 43	23
Sensitive receiver 42	20
Sensitive receiver 198	15
Sensitive receiver 66	16
Sensitive receiver 65	17
Sensitive receiver 44	37
Night time - worst case weather conditions	
Sensitive receiver 43	23
Sensitive receiver 42	21
Sensitive receiver 198	16
Sensitive receiver 66	17
Sensitive receiver 65	18
Sensitive receiver 44	37

* Predicted sound pressure levels rounded to nearest integer number

Clause 14(3) of the Noise Policy requires a penalty be applied to the predicted noise level to account for specific acoustic characteristics (impulsive, low frequency, modulating, tonal). Based on the nature of the proposed development and the likely operational noise level generated by train movements on the rail loop, the predicted sound pressure level has been increased by 5 dB(A) to account for the characteristic penalty.

Table 7-3 presents the predicted sound pressure levels at the nearest identified noise sensitive receivers imposing a 5 dBA noise character adjustment / penalty.

Table 7-3: Predicted $L_{Aeq\ 15\ mins}$ at the nearest noise sensitive receivers during port operation - Day and Night worst case weather conditions (with +5 dB(A) noise character penalty)

Identified noise sensitive receiver positions	Predicted $L_{Aeq\ 15\ mins}$ sound pressure level at nearest noise sensitive receiver (dB(A))*
Day time - worst case weather conditions	
Sensitive receiver 43	28
Sensitive receiver 42	25
Sensitive receiver 198	20
Sensitive receiver 66	21
Sensitive receiver 65	22
Sensitive receiver 44	42
Night time - worst case weather conditions	
Sensitive receiver 43	28
Sensitive receiver 42	26
Sensitive receiver 198	21
Sensitive receiver 66	22
Sensitive receiver 65	23
Sensitive receiver 44	42

It can be seen that the noise criteria of $L_{Aeq\ 15\ mins}$ 53 dB(A) day / 44 dB(A) night for sensitive receiver 44 in the Coastal Zone and noise criteria of 53 dB(A) day / 45 dB(A) at all other sensitive receivers in the General Farming Zone are not exceeded.

7.4 Operational vibration

Ground vibration predictions were not completed for the operational phase of the port facility. Potential vibration sources during operation of the proposed port facility will include train movements, unloading of iron concentrate at the rail unloading facility, stacking and reclaiming iron concentrate from the concentrate stockpile and the conveyor system. However as much of the equipment is relatively slow and constant speed (e.g. train speed of approximately 0.8 km/h during unloading and conveyor speed of approximately 3 m/s as summarised in Section 2), the vibration levels due to the operation of the equipment will be very low.

It is expected that vibration levels generated during operational phase will considerably lower in magnitude than the vibration levels generated during the construction phase.

7.5 Blasting

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 ground vibration and airblast impacts due to blasting.

Table 7-4 below presents the calculated charge mass and generated ground vibration PPV within AS 2187 – 2006 human comfort criterion for blasting operations lasting less than 12 months or less than 20 blasts.

Table 7-4: Predicted ground vibration levels with varying charge masses

Maximum Instantaneous Charge Mass (Kg)	Distance to the nearest sensitive receiver (m)	Predicted PPV (mm/s)	AS 2187 – 2006 Human Comfort Criterion (mm/s)
250	1000	1.34	10
500	1000	2.4	10
750	1000	3.3	10
1000	1000	4.1	10

Table 7-5 below presents the calculated charge mass required to generate an airblast overpressure less than 120 dBL (AS 2187 – 2006 human comfort criterion for operations lasting less than 12 months or less than 20 blasts).

Table 7-5: Predicted airblast overpressure levels with varying charge masses

Maximum Instantaneous Charge Mass (Kg)	Distance to the nearest sensitive receiver (m)	Predicted Airblast OP level (dBL)*	AS 2187 – 2006 Human Comfort Criterion (dBL)
250	1000	111	120
500	1000	113	120
750	1000	115	120
1000	1000	116	120

*Value to the nearest integer number

The predicted airblast and ground vibration generated by blasting with a maximum instantaneous charge mass of 1000 kg at a distance of 1000 m is well within the applicable AS 2187 – 2006 human comfort criteria. The majority of the blasting is likely to be further than 1000 m from the closest sensitive receiver as it will be required at the rail loop and rail unloading facility which is over 1200 m from the sensitive receiver locations. The assessment indicates there is scope for a well-designed and executed blasting operation to be managed well within the blasting criteria.

8. Conclusion

8.1 Construction

8.1.1 Construction noise

The Noise Policy stipulates that an adverse impact on amenity will occur if the construction noise level exceeds L_{Aeq} 45 dB(A) or L_{Amax} 60 dB(A) at night time, on a Sunday or on a public holiday. The noise prediction modelling demonstrates that the location and type of construction activity can be managed to minimise noise at sensitive receiver locations and avoid adverse impact on amenity as required in accordance with the Noise Policy.

8.1.2 Construction vibration

Ground vibration is generated by construction equipment however it has been determined that the levels of vibration typically generated will be well below the preferred human response vibration criteria at a distance of 1000 m, which is the distance between the proposed construction site and the closest sensitive receiver.

8.1.3 Blasting

From initial airblast and ground vibrations calculations using the methodology presented in the *ICI Blasting Guide* (ICI 1995), it has been determined that a maximum instantaneous charge mass of 1000 kg at a distance of 1000 m is well within the applicable AS 2187 – 2006 human comfort criteria. The majority of the blasting is likely to be further than 1000 m from the closest sensitive receiver as it will be required at the rail loop and rail unloading facility which is over 1200 m from the sensitive receiver locations. The assessment indicates there is scope for a well-designed and executed blasting operation to be managed well within the blasting criteria.

8.2 Operational

8.2.1 Operational noise

The results of the noise prediction modelling show that the noise criteria, determined in accordance with the Noise Policy, will be met at all of the sensitive receivers for the operational phase of the proposed port facility. This is for the ‘default’ weather conditions and assumes the simultaneous operation of train unloading and ship loading at the proposed port facility.

8.2.2 Operational vibration

Potential vibration sources during operation of the proposed port facility will include train movements, unloading of iron concentrate at the rail unloading facility, stacking and reclaiming iron concentrate from the concentrate stockpile and the conveyor system. As much of the equipment is relatively slow and constant speed the vibration levels due to the operation of the equipment will be very low and less than during construction, therefore well within the preferred human response vibration criteria.

9. References

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Appendix A. Bureau of Meteorology Wind Roses – North Shields Automatic Weather Station

Figure A-1: Wind rose – 3 am – January, 1992 - 2010

Figure A-2: Wind rose – 3 am – April, 1992 – 2010

Figure A-3: Wind rose – 3 am – July, 1992 - 2010

Figure A-4: Wind rose – 3 am – October, 1992 - 2010

Figure A-5: Wind rose – 3 am – Total Observations, 1992 - 2010

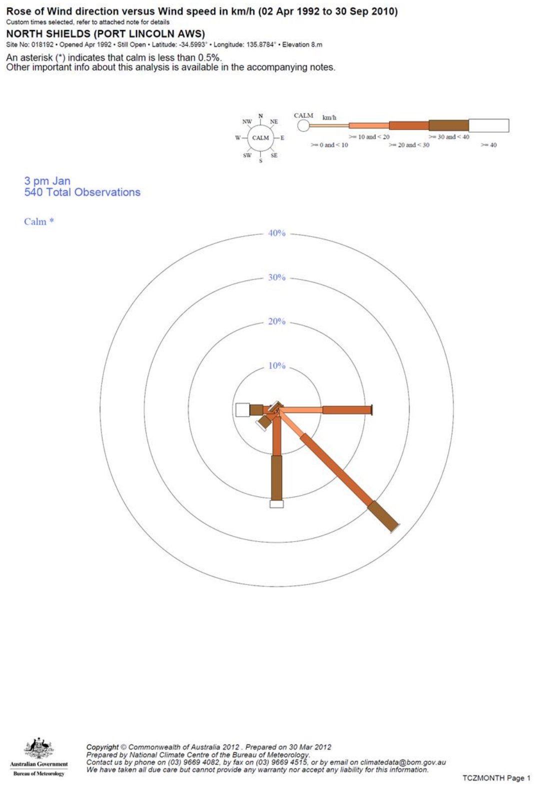


Figure A-1: Wind rose – 3 am – January, 1992 - 2010

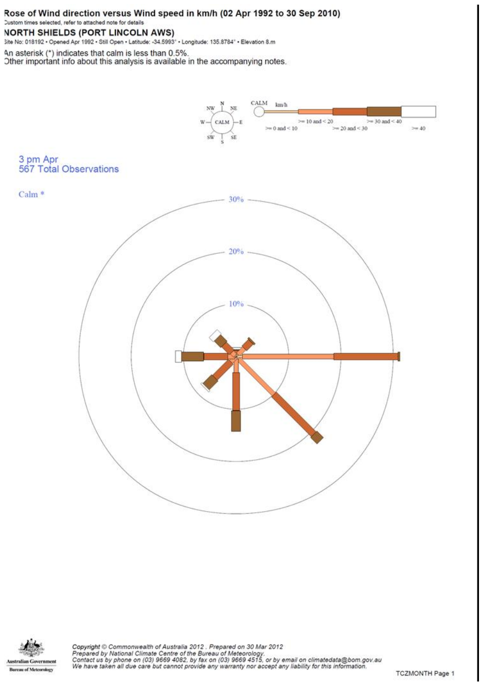


Figure A-2: Wind rose – 3 am – April, 1992 – 2010

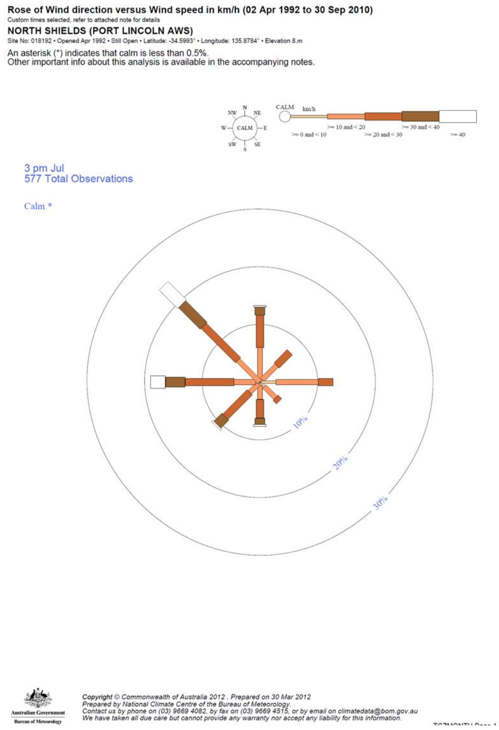


Figure A-3: Wind rose – 3 am – July, 1992 - 2010

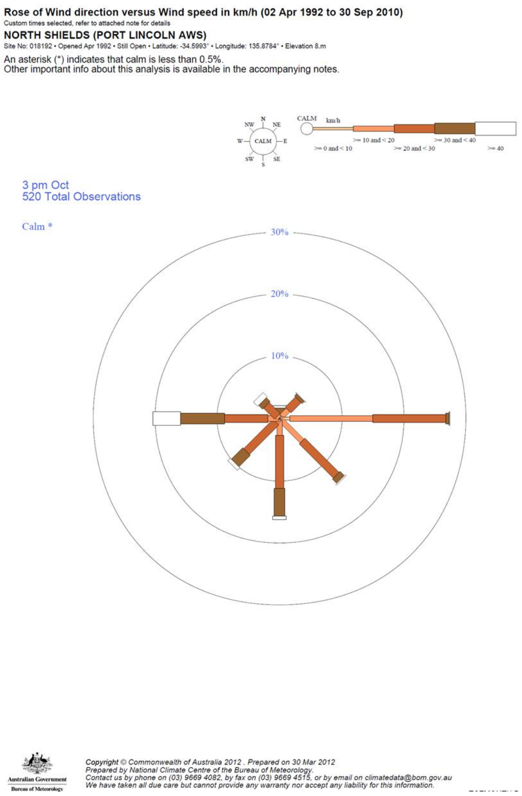


Figure A-4: Wind rose – 3 am – October, 1992 - 2010

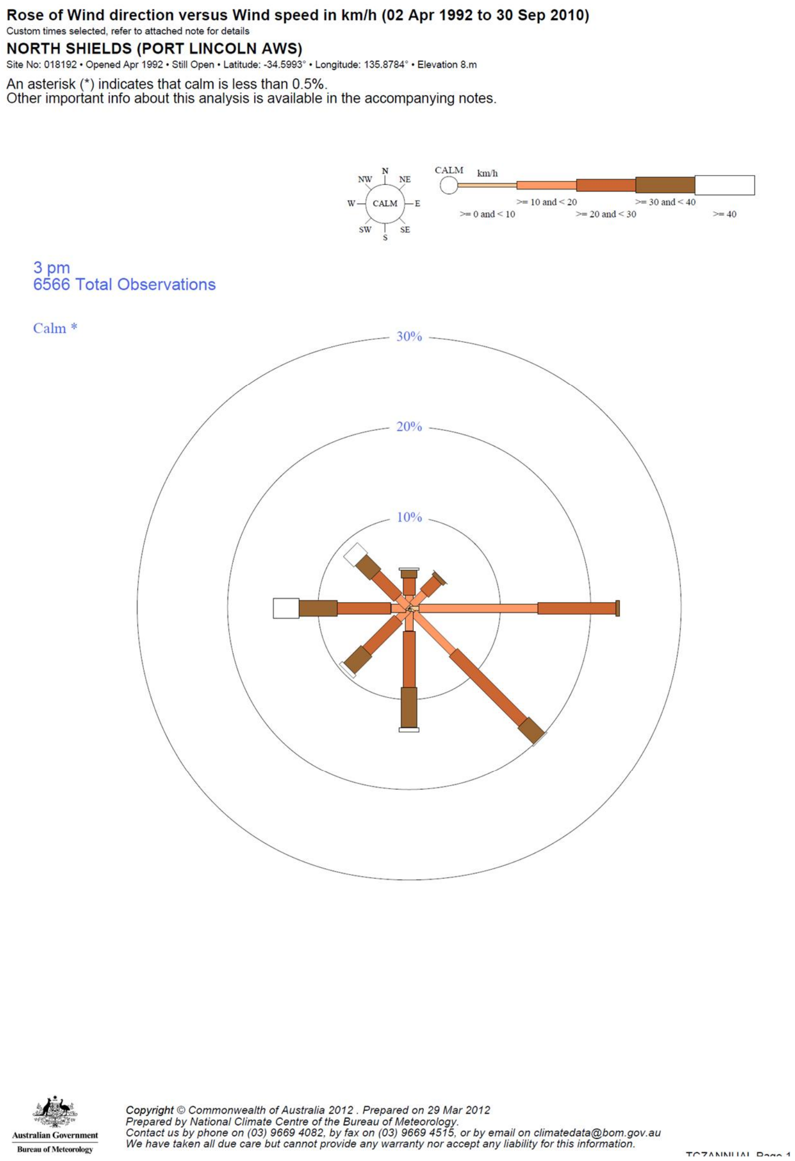


Figure A-5: Wind rose – 3 am – Total Observations, 1992 - 2010

Appendix B. Wind Roses Developed Using TAPM – Cape Hardy Site – 2009 data

Figure B-1: Wind rose – Summer – Total Hours

Figure B-2: Wind rose – Autumn – Total Hours

Figure B-3: Wind rose – Winter – Total Hours

Figure B-4: Wind rose – Spring – Total Hours

Figure B-5: Wind rose – Total Observations – Total Hours

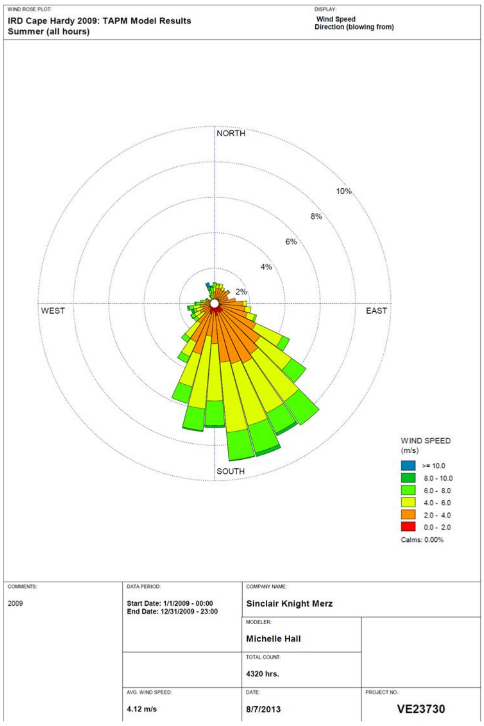


Figure B-1: Wind rose – Summer – Total Hours

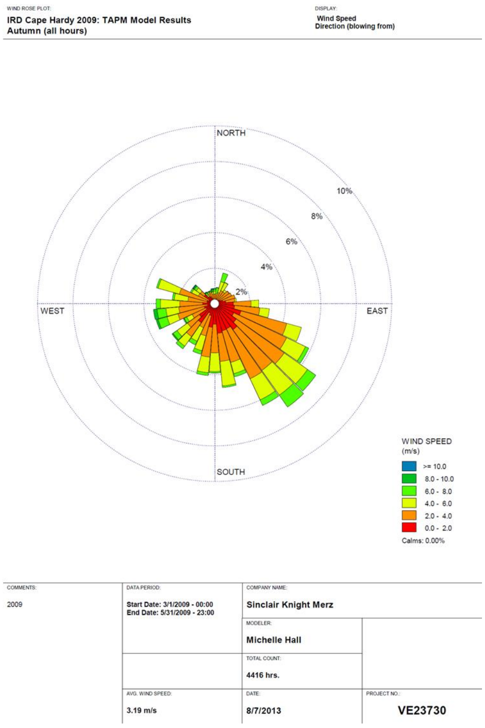


Figure B-2: Wind rose – Autumn – Total Hours

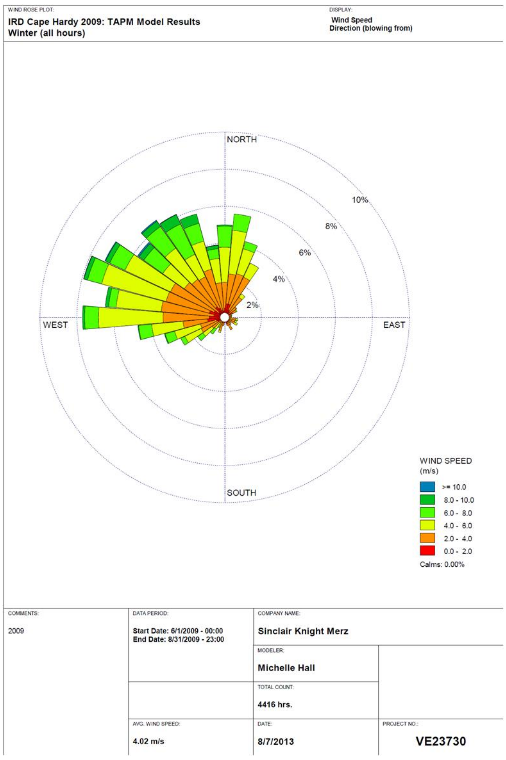


Figure B-3: Wind rose – Winter – Total Hours

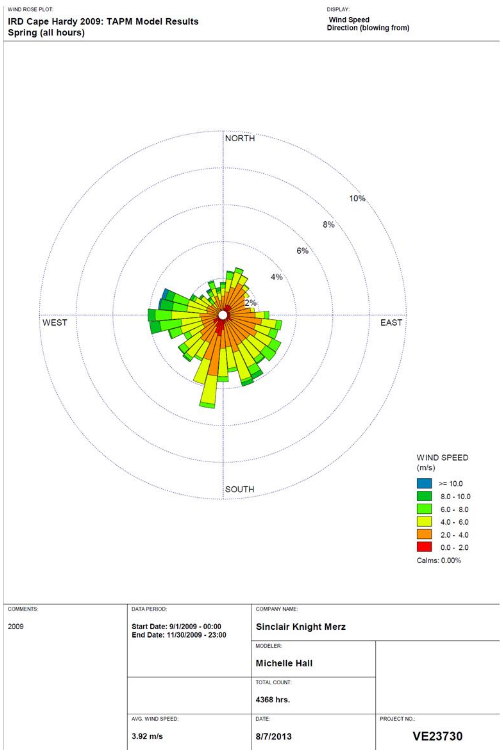


Figure B-4: Wind rose – Spring – Total Hours

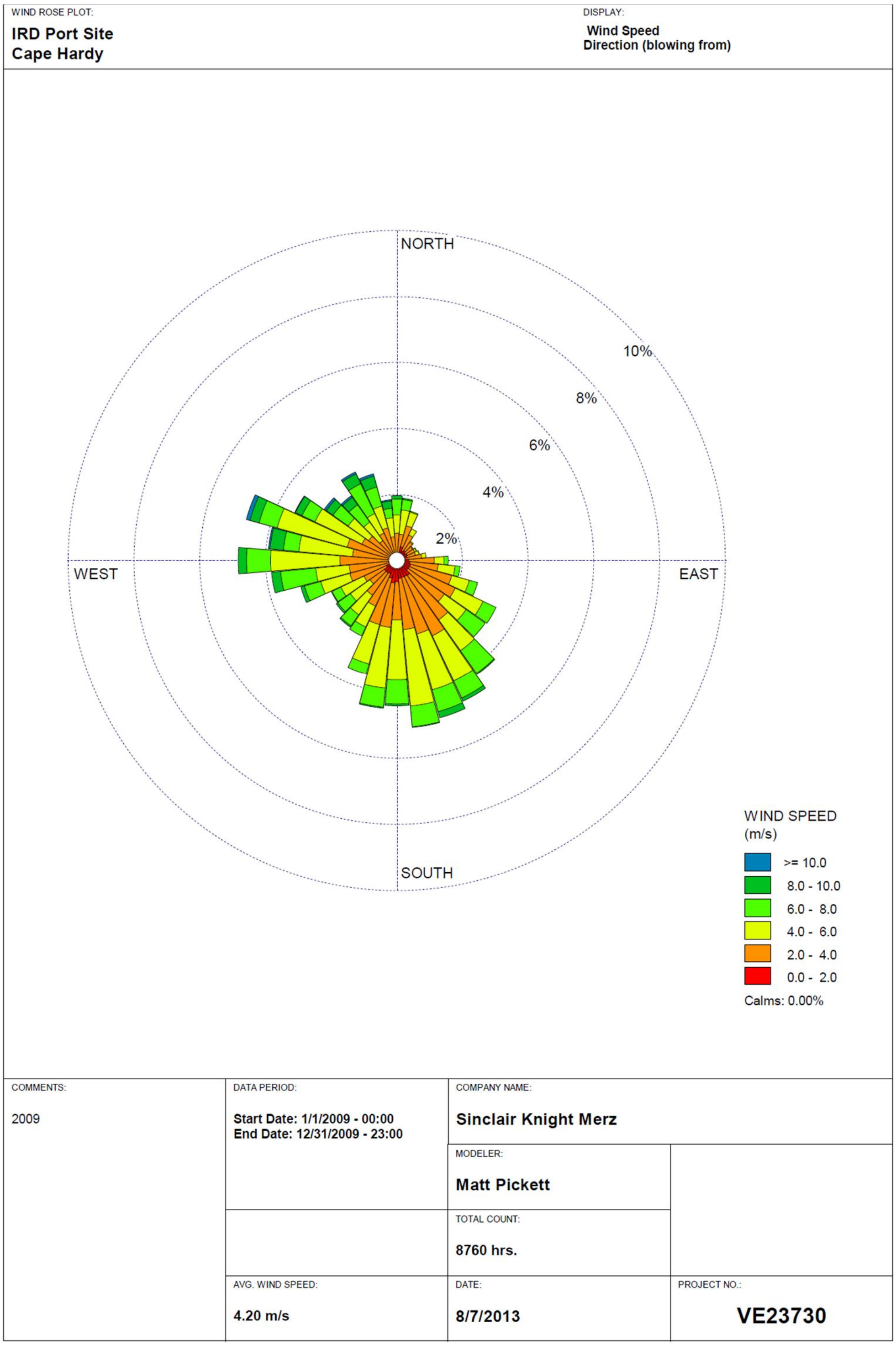


Figure B-5: Wind rose – Total Observations – Total Hours

Appendix C. Predicted $L_{Aeq,15mins}$ noise level contours for typical construction equipment operating at the port facility site (day and night) – 'default' weather conditions – for two scenarios

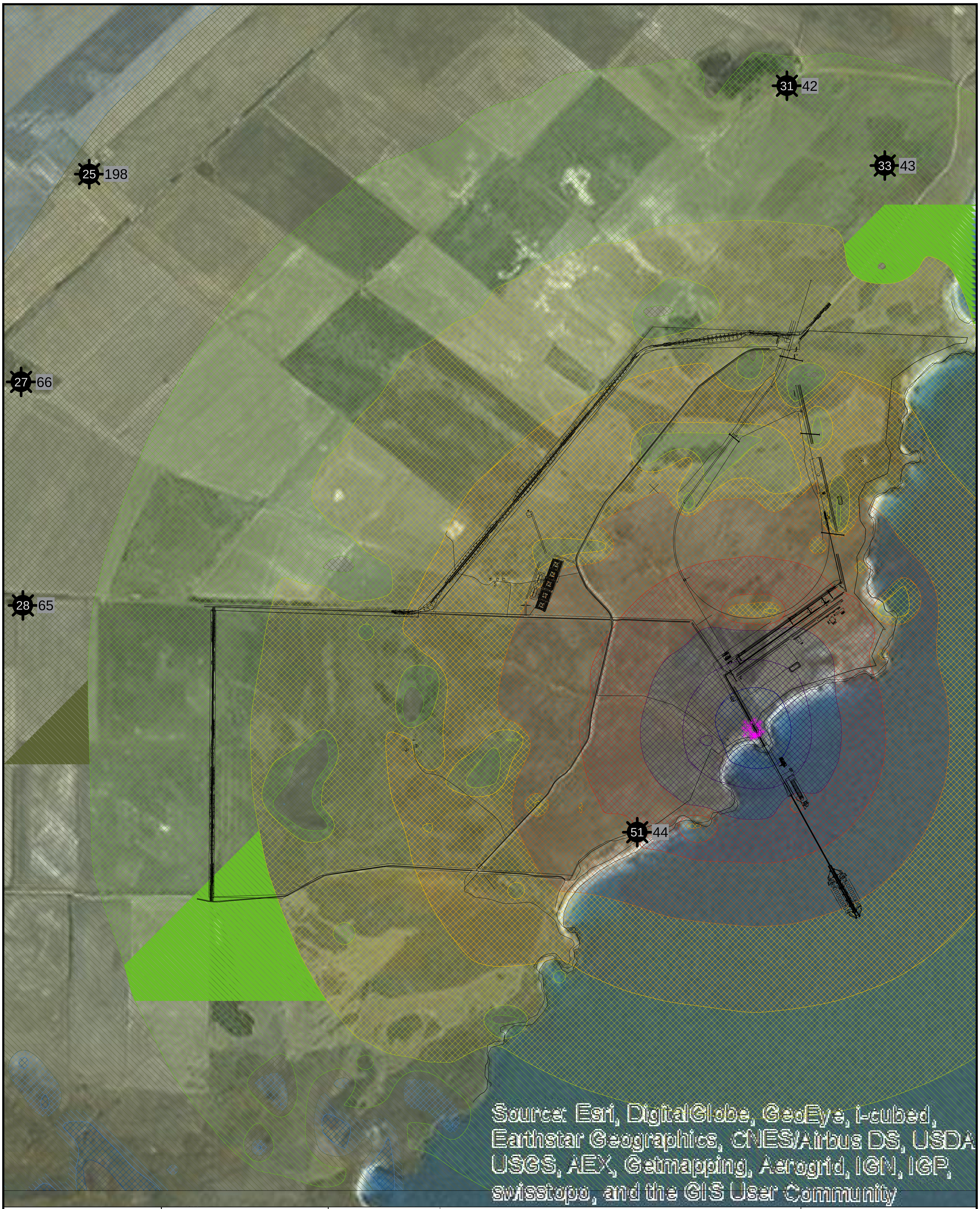
Figure C-1: Construction scenario 1 - Construction of materials handling infrastructure landside of the proposed jetty - predicted LAeq,15mins noise level contours for day time operation with all construction equipment operating – 'default' weather conditions.

Figure C-2: Construction scenario 1 - Construction of materials handling infrastructure landside of the proposed jetty - predicted LAeq,15mins noise level contours for night time operation with all construction equipment, except pile driver, operating – 'default' weather conditions.

Figure C-3: Construction scenario 2 - Construction of the rail unloading facility and associated infrastructure - predicted LAeq,15mins noise level contours for day time operation with all construction equipment operating – 'default' weather conditions.

Figure C-4: Construction scenario 2 - Construction of the rail unloading facility and associated infrastructure - predicted LAeq,15mins noise level contours for night time operation with all construction equipment, except pile driver, operating – 'default' weather conditions.

Figure C-1: Construction scenario 1 - Construction of materials handling infrastructure landside of the proposed jetty - predicted $L_{Aeq,15mins}$ noise level contours for day time operation with all construction equipment operating – 'default' weather conditions.



Client: Iron Road

Iron Road limited

Supplier: Jacobs

JACOBS

Signs and symbols

Resident receiver

Noise Sources

Levels: $dBL_{Aeq,15min}$

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 -	65
>	65

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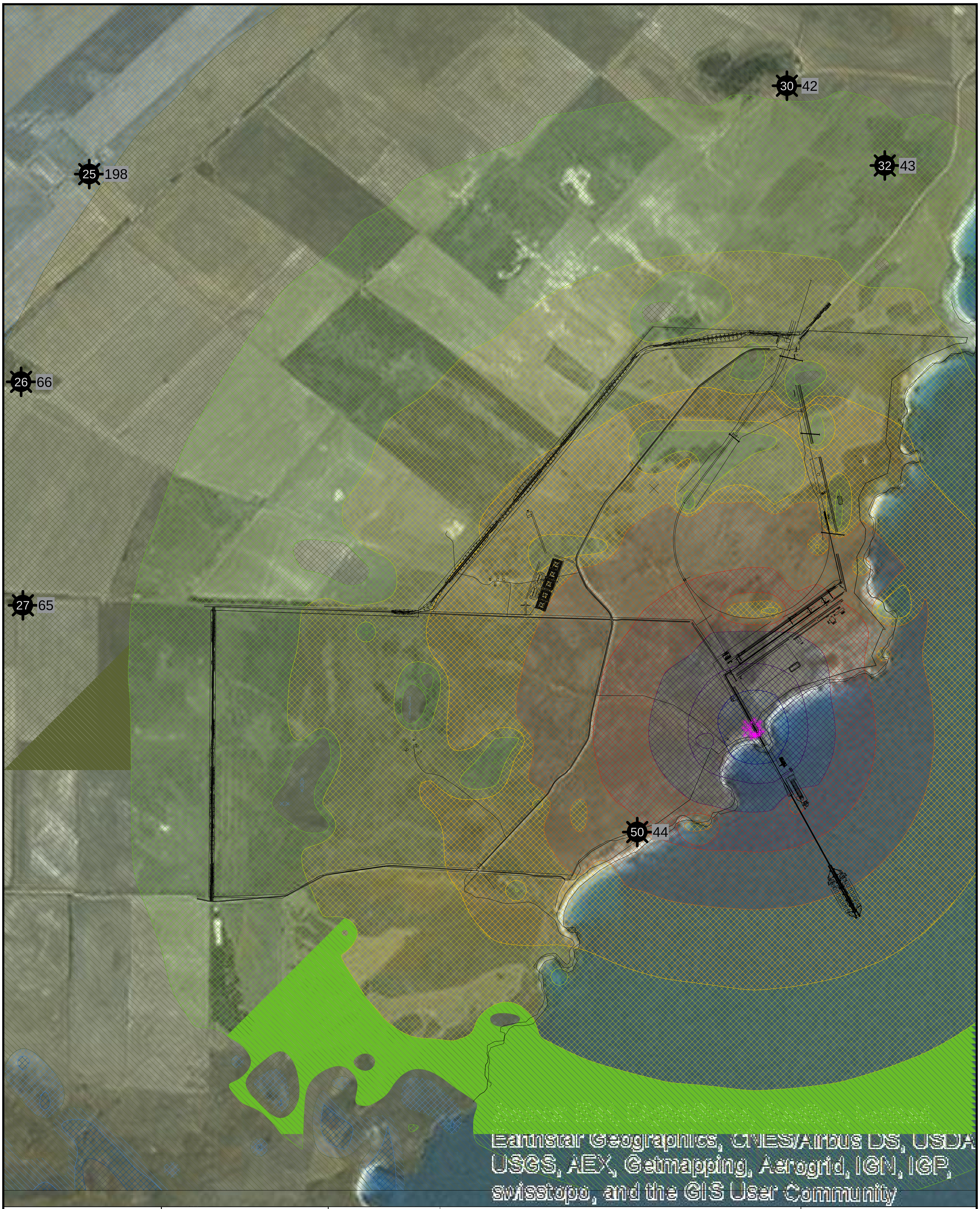
PortDayConstructionAerial

22/12/2014

Scale 1:25227

0 100 200 400 600 800 m

Figure C-2: Construction scenario 1 - Construction of materials handling infrastructure landside of the proposed jetty - predicted $L_{Aeq,15mins}$ noise level contours for night time operation with all construction equipment, except pile driver, operating – ‘default’ weather conditions.



Client: Iron Road

Iron Road limited

Supplier: Jacobs

JACOBS

Signs and symbols

- Rail line
- Resident receiver
- Noise Sources

Levels: $dBL_{Aeq,15min}$

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 -	65
>	65

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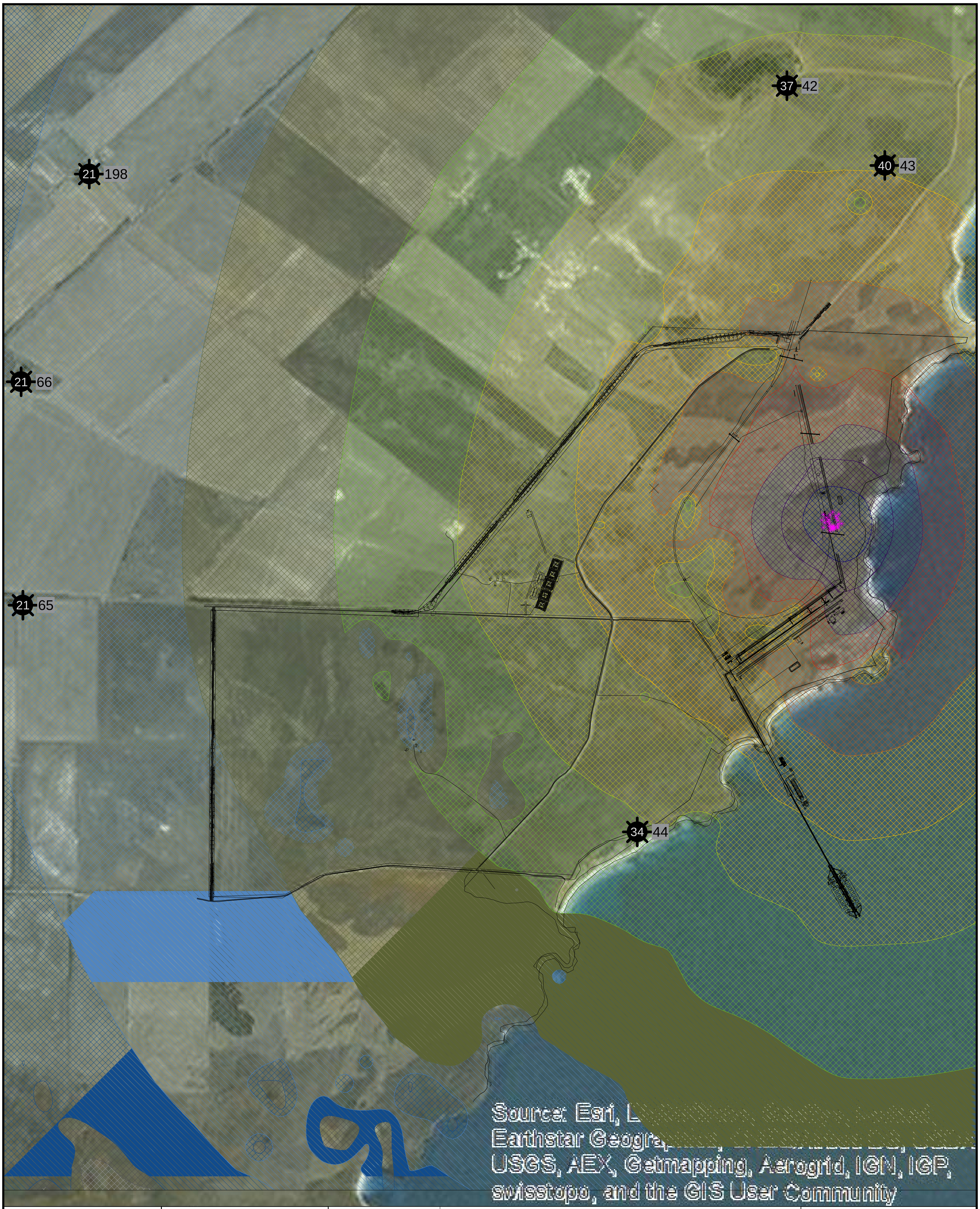
Figure C-3: Construction scenario 2 - Construction of the rail unloading facility and associated infrastructure - predicted $L_{Aeq,15mins}$ noise level contours for day time operation with all construction equipment operating – 'default' weather conditions.



Client: Iron Road

Supplier: Jacobs

Signs and symbols

- Resident receiver
- Noise Sources

Levels: $dBL_{Aeq,15min}$

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 -	65
>	65

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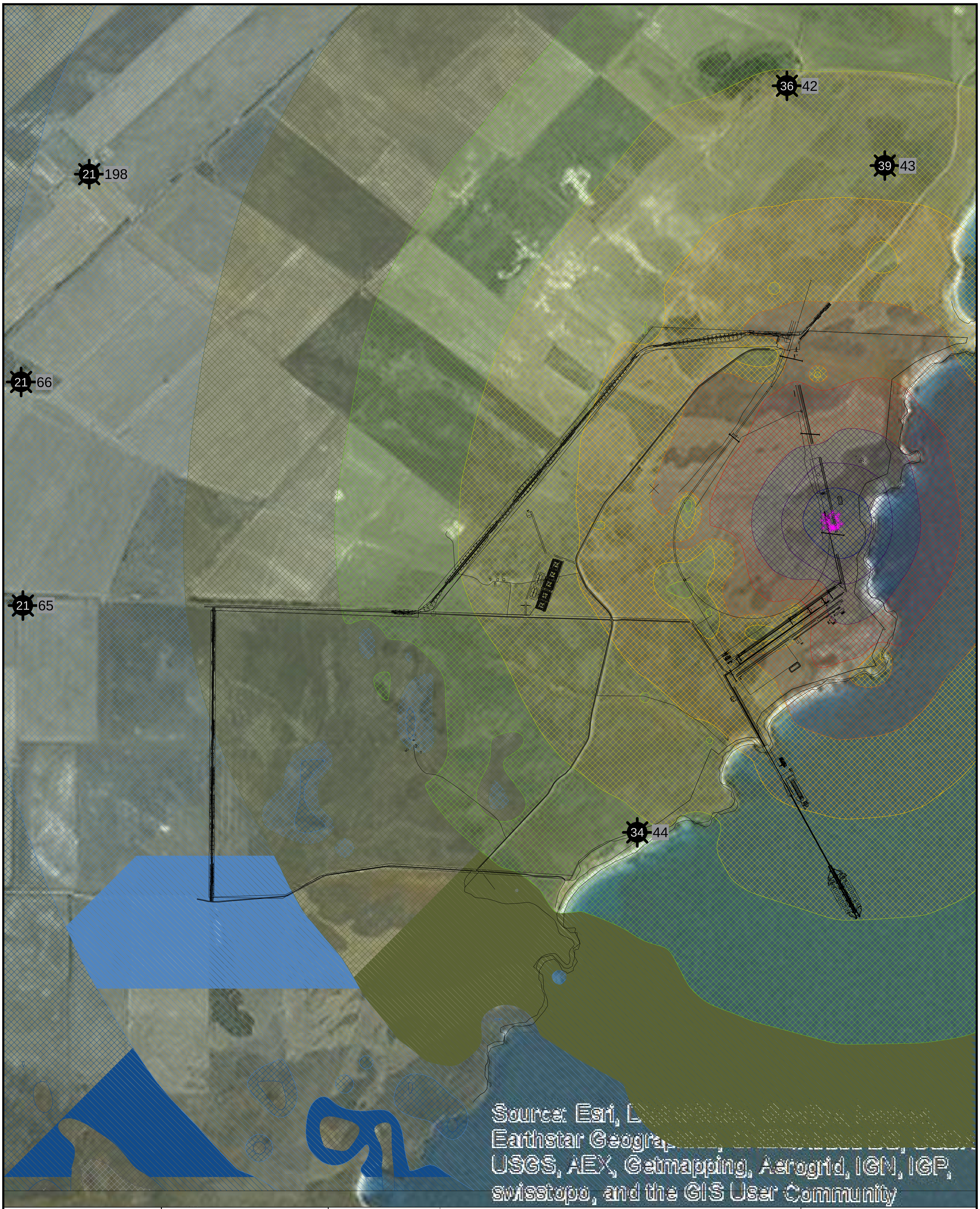
0 100 200 400 600 800 m

Figure C-4: Construction scenario 2 - Construction of the rail unloading facility and associated infrastructure - predicted $L_{Aeq,15mins}$ noise level contours for night time operation with all construction equipment, except pile driver, operating – 'default' weather conditions.



Client: Iron Road

Iron Road limited

Supplier: Jacobs

JACOBS

Signs and symbols

- Resident receiver
- Noise Sources

Levels: $dBL_{Aeq,15min}$

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 -	65
>	65

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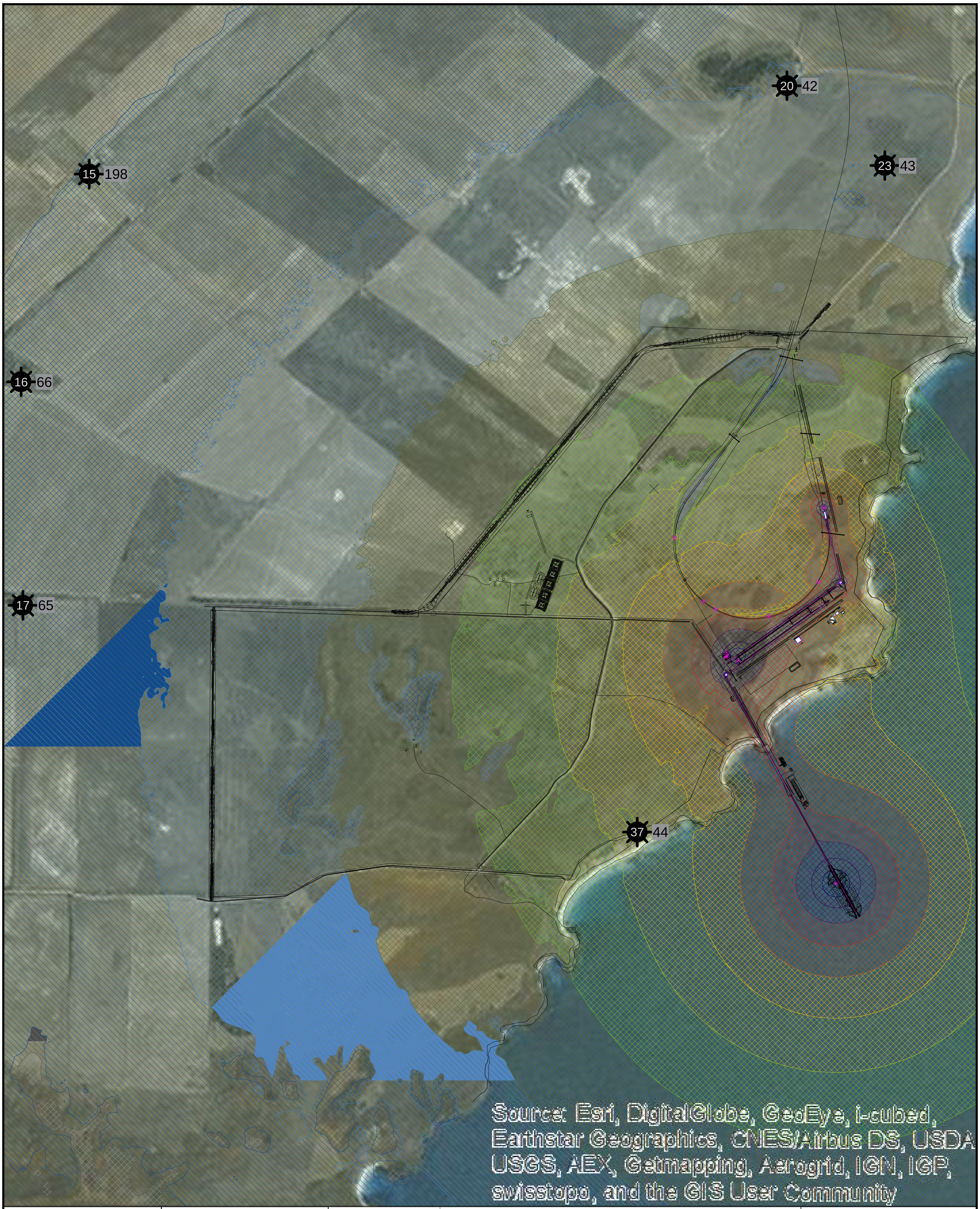
Appendix D. Predicted operational $L_{Aeq,15mins}$ noise level – ’default’ weather conditions (day and night)

Figure D-1: Predicted operational $L_{Aeq,15mins}$ noise level – ’default’ weather conditions – day time

Figure D-2: Predicted operational $L_{Aeq,15mins}$ noise level – ’default’ weather conditions – night time

Figure D-1: Predicted operational $L_{Aeq,15mins}$ noise level – ’default’ weather conditions – day time



Client: Iron Road

Iron Road limited

Supplier: Jacobs

JACOBS

Signs and symbols

- Resident receiver
- Noise Sources

Levels: $dBL_{Aeq,15min}$

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 - 65
> 65

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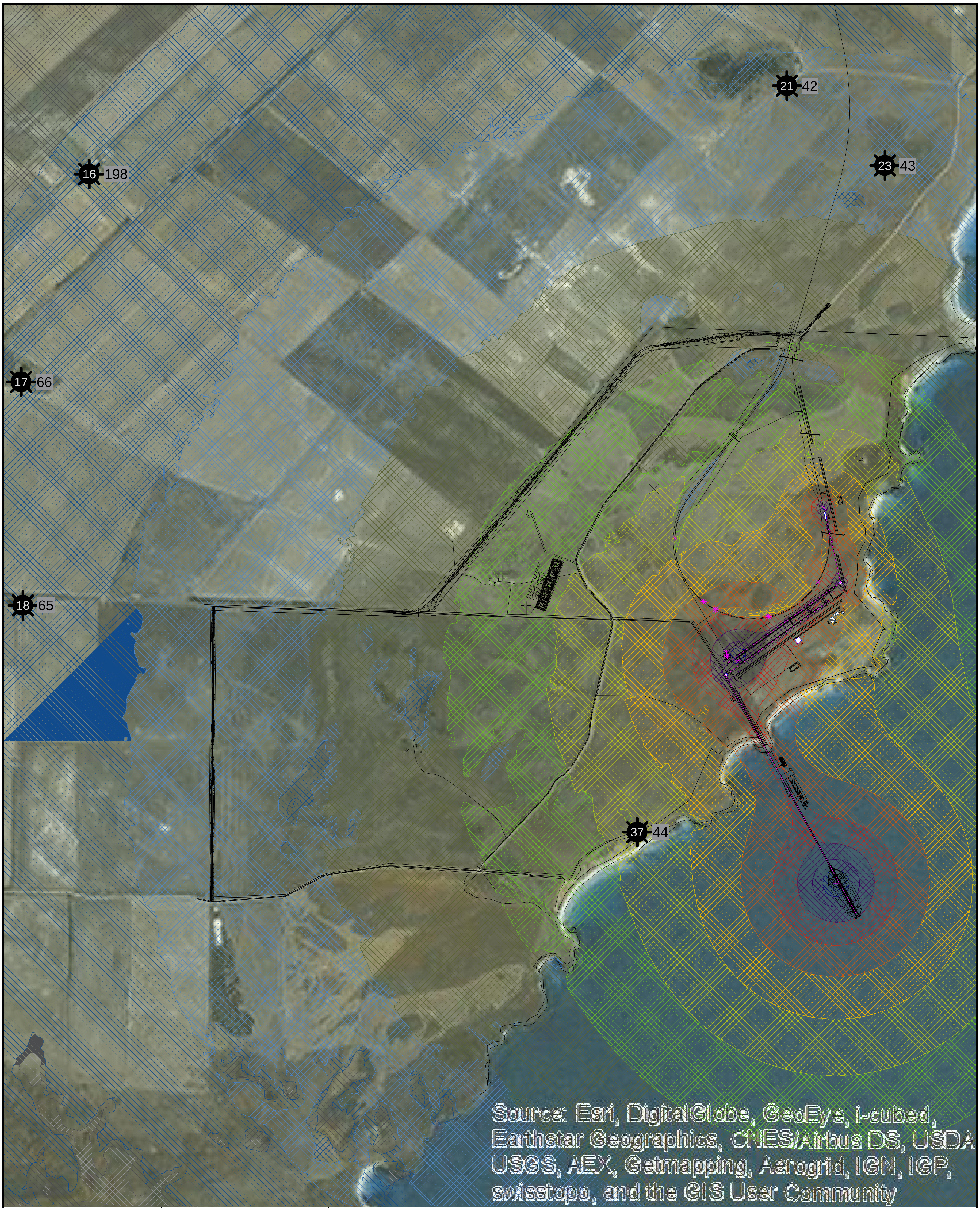
Scale 1:25227

0 100 200 400 600 800 m

Figure D-2: Predicted operational $L_{Aeq,15mins}$ noise level – 'default' weather conditions – night time



Client: Iron Road

Iron Road limited

Supplier: Jacobs

JACOBS

Signs and symbols

Resident receiver

Noise sources

Levels: $dBL_{Aeq,15min}$

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 - 65
> 65

N

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0 100 200 400 600 800 m

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