10. Noise and vibration

10. Noise and vibration

This chapter presents the results of a noise and vibration assessment of the JRYUP that has been undertaken by Heggies Pty Ltd. This chapter has been prepared to address the requirements for the JRYUP EIS that are specified in Section 3.6 of the Terms of Reference.

The following noise and vibration issues have been addressed:

- An assessment of predicted noise and vibration levels experienced by selected sensitive receivers during the construction phase of the Project.
- An assessment of predicted noise and vibration levels experienced by selected sensitive receivers during the ultimate operational phase of the Project.
- Noise predictions compared to the relevant goals under the *Environmental Protection Policy (Noise) 1997.*

10.1 Description of environmental values

This section presents the results of ambient noise monitoring conducted at (or near) four residential locations in the communities surrounding the proposed JRYUP and associated rail infrastructure corridors. Both attended and unattended noise measurements have been conducted in order to accurately document the existing background noise environment. The established background noise levels are used to determine allowable project noise criteria.

10.1.1 Methodology

In order to characterise the existing noise environment in the vicinity of the JRYUP, long-term unattended noise monitoring was undertaken at the following four locations in the surrounding communities between Thursday 10 May 2007 and Friday 18 May 2007:

- Location 1 – Smyths Road, Sarina – noise logger located on the patio next to house
- Location 2 – Arron Road, Sarina – noise logger located on veranda of house
- Location 3 – 149 Gurnett Road, Sarina– noise logger located on steps in front of house
- Location 4 – 231 Gurnett Road, Sarina– noise logger located in front of house next to driveway

The noise monitoring locations were selected in consultation with QR staff in accordance with and the Queensland Environmental Protection Agency's (EPA) noise measurement manual. These locations were chosen to provide spatial coverage of the communities surrounding the proposed JRYUP. Each location is considered to be representative of the area in which it is located in terms of the existing noise environment and any potential noise impacts associated with the Project. Figure 10.1 illustrates the noise monitoring locations.

Attended noise measurements were also conducted at each site to confirm background noise levels and to observe typical noise sources associated with the ambient noise environment during the evening and night-time periods. The attended noise measurements were conducted between 29 May and 30 May 2007.

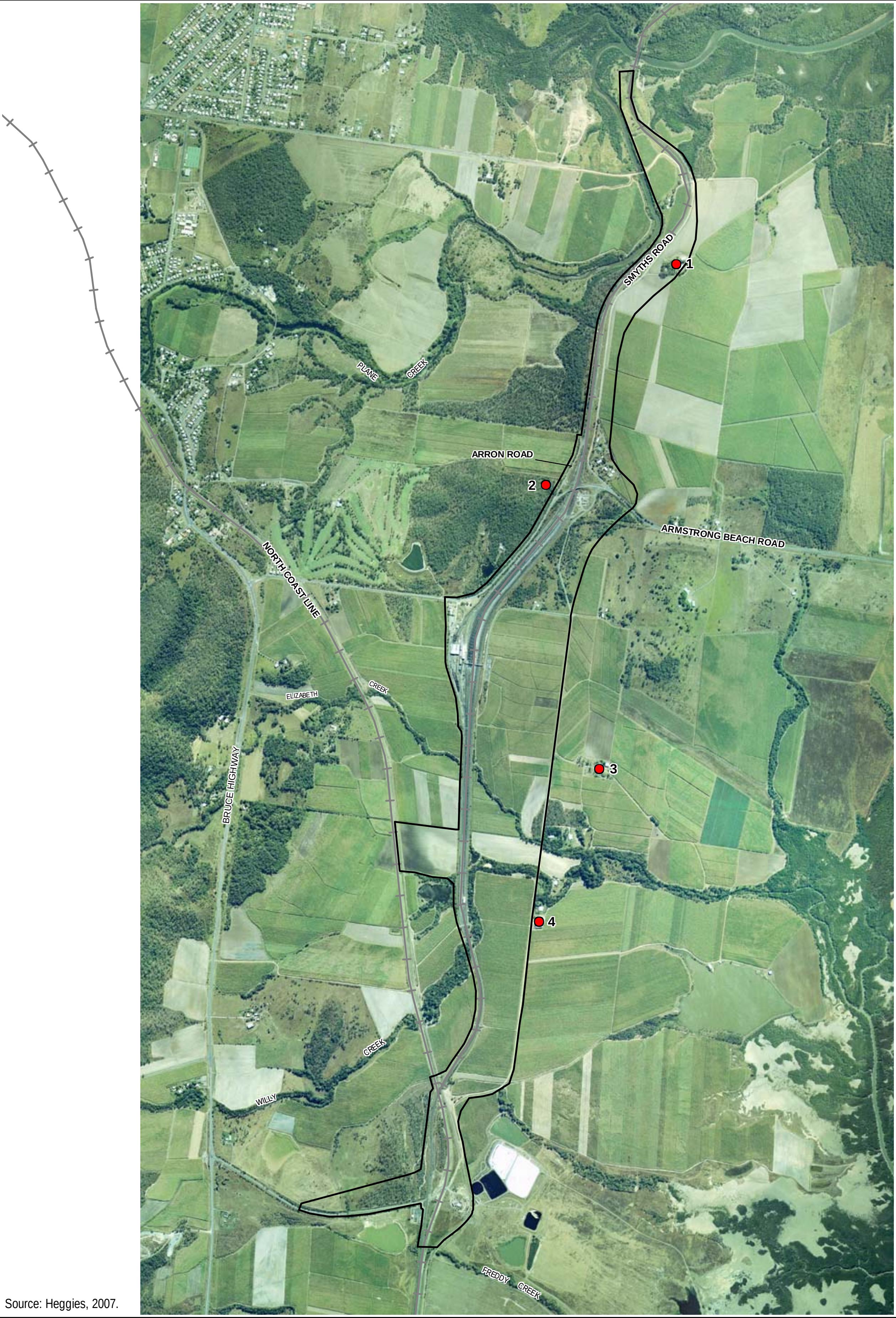
10.1.2 Instrumentation

The monitoring was undertaken using Acoustic Research Laboratories Type EL-316 Environmental Noise Loggers programmed to record various statistical noise levels over consecutive 15-minute intervals. Each logger was checked for calibration before and after the survey with a Rion NC-73 Sound Level Calibrator and no significant drift (greater than 1 dBA) in calibration was detected.

ARL EL-316 Noise Loggers are NATA certified Type 1 meters. It is common practice to use Type 1 or 2 noise loggers for measuring unattended background noise levels in accordance with the *Queensland Environmental Protection (Noise) Policy 1997* [EPP(Noise)] and relevant Australian Standard. The noise floor of EL-316 loggers is around 22 dBA.

Jilalan Rail Yard Upgrade Project

Connell HATCH



Source: Heggies, 2007.

N

0 1000 (m)

Scale 1:20 000 (m) (@ A3 size)

LEGEND

Project Area

Rail

Noise Monitoring Location

NOISE MONITORING LOCATIONS

FIGURE 10.1

V:\Projects\Qld_Rail\HR5001\GIS\Workspaces\Jilalan_32.wor By: SLG Date: 06/09/07 Version 2

Attended measurements were undertaken using a Rion NA-27 Precision Sound Level Meter. This unit is a Type 1 Sound Level Meter. The Rion NA-27 was checked for calibration before and after each set of noise measurements using a Rion NC-73 Sound Level Calibrator and no significant drift (greater than 1 dBA) in calibration signal level was observed.

All items of acoustic instrumentation employed during the noise monitoring were set to 'Fast' response in accordance with the relevant Australian Standards and the Queensland EPA's *Noise Measurement Manual*. Each noise monitoring meter was checked for calibration before and after each survey with a Rion NC-73 Sound Level Calibrator. There was no significant drift (greater than 1 dBA) in calibration signal on any of the measurement equipment. All items of acoustic instrumentation employed during the noise measurement surveys were designed to comply with AS 1259.2 *Sound Level Meters* and carry current calibration certificates.

10.1.3 Noise monitoring results

Unattended noise logging

The unattended ambient noise measurements were used to determine the "Rating Background Level" (RBL) for the daytime (7.00 am to 6.00 pm), evening (6.00 pm to 10.00 pm) and night-time (10.00 pm to 7.00 am) periods at each location.

The RBL is the median of the 90th percentile of the background (L_{A90}) noise levels in each assessment period (day, evening and night) over the duration of the monitoring. Table 10.1 contains the determined RBL for each measurement location (refer Appendix K for full monitoring results).

Table 10.1 Rating background levels

Monitoring location		Rating background level (dBA)		
		Day	Evening	Night
Location 1	Smyths Road, Sarina	43	45	44
Location 2	Arron Road, Sarina	39	38	35
Location 3	149 Gurnett Road, Sarina	34	37	36
Location 4	231 Gurnett Road, Sarina	37	39	38

The maximum $L_{Aeq(1hour)}$ for each daytime, evening and night-time period was also noted. The L_{Aeq} is the A-weighted equivalent noise level. It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

The median maximum $L_{Aeq(1hour)}$ noise levels measured at each location are shown in Table 10.2.

Table 10.2 Measured maximum $L_{Aeq(1hour)}$ noise levels

Monitoring location		Maximum $L_{Aeq(1hour)}$ (dBA)		
		Day	Evening	Night
Location 1	Smyths Road, Sarina	56	52	51
Location 2	Arron Road, Sarina	57	57	53
Location 3	149 Gurnett Road, Sarina	46	47	47
Location 4	231 Gurnett Road, Sarina	56	53	49

Graphs showing the statistical noise levels measured at the monitoring locations over the whole monitoring period are presented in Appendix K for each 24-hour period. The graphs show various statistical noise levels, including the background (L_{A90}) noise level at each site.

Hourly weather data over the noise monitoring period was sourced from the Bureau of Meteorology (Mackay Airport). The weather conditions during the monitoring period were generally fine, with temperatures generally ranging from 20°C to 25°C, with light to moderate breezes (below 5 m/s) blowing generally from the south to southeast.

Some rainfall was recorded during the monitoring period and the measurement results have been excluded from any calculations due to rainfall. The weather conditions during the remainder of the monitoring period are considered to be suitable for background noise measurements.

It should be noted that during the colder winter months (ie in the absence of insect related noise) the measured background levels may fall even lower that those reported in Table 10.1

Attended noise measurements

The results of attended measurements are summarised in Table 10.3 and Table 10.4.

Note that the L_{A90} is the noise level exceeded for 90% of the sample period (ie the noise level that is exceeded for 54 minutes over a 1 hour monitoring period). This noise level is described as the background level. The L_{A10} is the noise level exceeded for 10% of the sample period, and is commonly referred to as the average maximum noise level. The L_{Aeq} is the energy average, or the equivalent continuous level, over the sample period.

Table 10.3 Attended measurement results – Evening period (6.00 pm – 10.00 pm)

Monitoring location	Date	Time (end of 15 min period)	Measured noise level (dBA)			Comments
			L_{A90}	L_{Aeq}	L_{A10}	
Location 1	29/05/07	19:50	43.5	51.1	55.9	Frogs and insects (cricket, cicadas) dominated the ambient environment. Occasional train passbys were just audible at this location
Location 2	29/05/07	20:32	40.0	53.7	58.0	Frogs and insects (cricket, cicadas) dominated the ambient environment. Train passbys were not audible at this location
Location 3	29/05/07	21:19	46.6	48.5	49.8	Frogs and insects (cricket, cicadas) dominated the ambient environment. Occasional train passbys were just audible at this location
Location 4	29/05/07	21:57	50.0	52.4	53.7	Frogs and insects (cricket, cicadas) dominated the ambient environment. Train passbys were not audible at this location

Table 10.4 Attended measurement results – Night-time period (10.00 pm – 7.00 am)

Monitoring location	Date	Time (end of 15 min period)	Measured noise level (dBA)			Comments
			L_{A90}	L_{Aeq}	L_{A10}	
Location 1	29/05/07	23:38	43.2	45.3	46.7	Frogs and insects (cricket, cicadas) dominated the ambient environment. Occasional train passbys were just audible at this location
Location 2	30/05/07	00:20	43.7	47.8	49.2	Frogs and insects (cricket, cicadas) dominated the ambient environment. Train passbys were not audible at this location

Monitoring location	Date	Time (end of 15 min period)	Measured noise level (dBA)			Comments
			L_{A90}	L_{Aeq}	L_{A10}	
Location 3	30/05/07	01:09	44.8	49.5	52.4	Frogs and insects (cricket, cicadas) dominated the ambient environment. Train passbys were not audible at this location
Location 4	30/05/07	01:58	43.3	45.7	47.0	Frogs and insects (cricket, cicadas) dominated the ambient environment. Train passbys were not audible at this location

The attended measurements were not undertaken during any significant rain period. Light rain was observed, however the attended noise measurements were not undertaken during these periods.

10.2 Recommended limits and criteria

10.2.1 Construction noise

QR Rail Code

The EPP(Noise) does not include construction noise limits other than those which apply to blasting.

It should be noted that the Queensland Rail Code of Practice for Railway Noise Management endorsed by the Environment Minister in 1999 states that:

"Given the nature of railway operations however, particularly construction works within existing corridors, the only available time for some construction work may be outside the standard working hours including Sundays and public holidays. Work during these times will be minimised where practicable, however, the timing of work will be governed by railway operational requirements as well as safety constraints."

This provision of the Code will be implemented as part of construction rail works.

Environmental Protection Act – Environmentally Relevant Activities

This section presents the likely conditions that would be imposed on a QR Environmentally Relevant Activity as defined by the EP Act. These conditions have been provided as a guideline for compliance with the typical conditions under the EP Act.

"(1) In the event of a complaint, and when requested by the administering authority, the holder will:
- *in the first instance alter procedures with to reduce the noise nuisance; and*
- *Liaise with the administering authority and/or complainant over remedial action*

Where the above actions do not resolve the nuisance noise issue and where appropriate, noise monitoring will be undertaken to investigate any complaint of environmental nuisance noise. When requested by the administering authority, noise monitoring must be undertaken to investigate any complaint of noise nuisance, and the results, once received by the holder, notified within 7 days to the administering authority. Monitoring must include:
(a) $L_{Amax, adj\ T}$*;*
(b) $L_{AN,\ T}$ *(where N equals statistical levels of 1, 10, and 90);*
(c) the level and frequency of occurrence of impulsive or tonal noise;
(d) atmospheric conditions including temperature, relative humidity and wind speed and direction; and
(e) effects due to extraneous factors such as traffic noise;

(2) The method of measurement and reporting of noise levels must comply with the latest edition of the Environmental Protection Agency's Noise Measurement Manual."

10.2.2 Low frequency noise

The EPA Ecoaccess Draft Guideline *'Assessment of Low Frequency Noise'* contains methods and procedures that are applicable to low frequency noise emitted from industrial premises and mining operations for planning purposes. Items such as pumps, transformers, cooling fans, compressors, ventilation and air-conditioning equipment, are sources of high noise levels having frequency components less than 200 Hz.

These sources exhibit a spectrum that characteristically shows a general increase in sound pressure level with a decrease in frequency. Annoyance from low frequency noise can be high even though the dBA level is relatively low. Typically, annoyance is experienced in typically quiet areas adjacent to or near to low frequency noise sources. Generally the annoyance of low frequency noise becomes more apparent when the masking effect of higher frequencies is absent.

Where a noise emission occurs exhibiting an unbalanced frequency spectra, the overall sound pressure level inside residences should not exceed 50 dB(linear) to avoid complaints of low frequency noise annoyance.

10.2.3 Operational noise

The potential noise impacts associated with the proposed rail infrastructure will result from the proposed maintenance facility, and the additional rail traffic that will be travelling through the yards.

The applicable criteria for operational rail noise are:

- 87 dBA single event maximum level[1]
- 65 dBA $L_{Aeq\ (24hours)}$

These are in accordance with the EPA and QR agreement for operational rail noise.

10.2.4 Vibration limits

Human comfort

Humans are far more sensitive to vibration than is commonly realised. They can detect and possibly even be annoyed by vibration at levels which are well below those causing any risk of damage to a building or its contents.

The actual perception of motion or vibration may not, in itself, be disturbing or annoying. An individual's response to that perception, and whether the vibration is "normal" or "abnormal", depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as "normal" in a car, bus or train is considerably higher than what is perceived as "normal" in a shop, office or dwelling.

No Queensland EPA or Australian Standards are available for adopting to address vibration issues during construction. As a result German and British Standards are discussed below.

Human tactile perception of random motion, as distinct from human comfort considerations, was investigated by Diekmann and subsequently updated in German Standard DIN 4150 Part 2-1975. On this basis, the resulting degrees of perception for humans are suggested by the continuous vibration level categories given in Table 10.5.

[1] In the absence of any statutory or Australian Standard definition of "single event maximum level", a reasonable and practical interpretation has been collaboratively defined with the administering authority (EPA). This interpretation being the arithmetic average of the highest 15 maximum levels over a 24 hour period.

Table 10.5 Vibration levels and human perception of motion

Approximate vibration level	Degree of perception
0.10 mm/s	Not felt
0.15 mm/s	Threshold of perception
0.35 mm/s	Barely noticeable
1 mm/s	Noticeable
2.2 mm/s	Easily noticeable
6 mm/s	Strongly noticeable
14 mm/s	Very strongly noticeable

Table Note:
These approximate vibration levels (in floors of building) are for vibration having a frequency content in the range of 8 Hz to 80 Hz.

The information above suggests that people will just be able to feel continuous floor vibration at levels of about 0.15 mm/s and that the motion becomes "noticeable" at a level of approximately 1 mm/s.

Guidance in relation to assessing the potential human disturbance from ground-borne vibration inside buildings and structures is contained in British Standard 6472-1992 "Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)" (BS 6472).

Satisfactory magnitudes of peak vertical vibration velocity (ie below which the probability of "adverse comment" is low) are shown in Table 10.6 for generally sinusoidal vibration.

Table 10.6 Satisfactory levels of peak vertical vibration velocity (8 Hz to 80 Hz)

Type of Space Occupancy	Time of Day	Satisfactory Peak Vibration Levels in mm/s Over the Frequency Range 8 Hz to 100 Hz			
		Continuous Vibration		Impulsive Vibration with up to 3 Occurrences per Day	
		Vertical	Horizontal	Vertical	Horizontal
Critical working areas (eg hospital operating theatres, precision laboratories, etc)	Day Night	0.14 0.14	0.4 0.4	0.14 0.14	0.4 0.4
Residential	Day Night	0.3 to 0.6 0.2	0.8 to 1.6 0.6	8.4 to 12.6 2.8	24 to 36 8
Offices	Day Night	0.6 0.6	1.6 1.6	18 18	51 51
Workshops	Day Night	1.2 1.2	3.2 3.2	18 18	51 51

Source: After BS 6472-1992

The information above indicates that continuous floor vibration levels above which "adverse comment" in residences and offices may arise during daytime hours ranges from approximately 0.3 mm/s to 0.6 mm/s.

Cosmetic damage

For the applicable vibration limits associated with the Project British Standard 7385: Part 2-1993 *"Evaluation and measurement for vibration in buildings Part 2"* provides criteria against which the likelihood of building damage from ground vibration can be assessed. The standard sets guide values for building vibration, based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration that are considered in the standard include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended maximum peak particle velocities for transient vibration (eg vehicle passby) to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented in Table 10.7. Should the indicative values in Table 10.7 be exceeded, then further detailed analysis will be required in accordance with the values expressed in Table 10.8.

The standard states that the guide values relate predominantly to transient vibration that does not give rise to resonant responses in structures and low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then typically the guide values for transient vibration in Table 10.7 may need to be reduced by up to 50%. These values are also expressed in Table 10.8.

Table 10.7 Recommended transient maximum peak particle velocity for cosmetic damage

Type of building	Peak particle velocity (mm/s)
Houses and low-rise residential buildings; commercial buildings not included below	10
Commercial and industrial buildings or structures of reinforced concrete or steel construction	25

Table 10.8 Transient vibration guide levels for cosmetic damage

<table>
<tr><th rowspan="2">Type of building</th><th rowspan="2">Type of vibration</th><th colspan="3">Peak component particle velocity in frequency range of predominant pulse</th></tr>
<tr><th>1 Hz to 4 Hz</th><th>4 Hz to 15 Hz</th><th>15 Hz and above</th></tr>
<tr><td>Reinforced or framed structures; industrial and heavy commercial buildings</td><td>Transient Vibration (eg single impact piling)</td><td>4 mm/s at 1 Hz increasing to 15 mm/s at 15 Hz</td><td colspan="2">50 mm/s at 4 Hz and above</td></tr>
<tr><td>Unreinforced or light framed structures; residential or light commercial type buildings</td><td>Transient Vibration (eg single impact piling)</td><td>4 mm/s at 1 Hz increasing to 15 mm/s at 15 Hz</td><td>15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz</td><td>20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above</td></tr>
<tr><td>Reinforced or framed structures; industrial and heavy commercial buildings</td><td>Continuous Vibration (eg vibratory piling)</td><td>2 mm/s at 1 Hz increasing to 7.5 mm/s at 15 Hz</td><td colspan="2">25 mm/s at 40 Hz and above</td></tr>
<tr><td>Unreinforced or light framed structures; residential or light commercial type buildings</td><td>Continuous Vibration (eg vibratory piling)</td><td>2 mm/s at 1 Hz increasing to 7.5 mm/s at 15 Hz</td><td>7.5 mm/s at 4 Hz increasing to 10 mm/s at 15 Hz</td><td>10 mm/s at 15 Hz increasing to 25 mm/s at 40 Hz and above</td></tr>
</table>

The British Standard goes on to state that "some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity".

10.3 Noise impact assessment approach

The aims of the noise assessment for the proposed JRYUP and associated rail infrastructure were as follows:

- Identification of all sensitive receivers in the vicinity of the proposed development and associated transport corridors.
- Setting suitable criteria and limits for activities associated with the construction and operation of the proposed development.
- Determination of potential impact on the sensitive receivers.
- Evaluation and assessment against criteria and limits.
- Determination of mitigation measures, if required.

10.3.1 SoundPLAN Modelling

A SoundPLAN (Version 6.4) computer noise model has been used for the prediction of future project noise levels at sensitive receivers. The noise model comprises a digitised ground map containing topography, buildings, all significant plant and relevant noise sources, including emission characteristics and the location of noise sensitive receivers. The computer model calculates the received noise levels, taking into account:

- All noise source sound power levels and frequency spectra.
- Noise propagation variables such as distance attenuation, ground absorption, air absorption and shielding attenuation.
- Meteorological conditions, including wind effects.

The model was based on the concept design as shown in Chapter 2 of the EIS.

Various computation algorithms were utilised within the SoundPLAN model. These are outlined below.

The CONCAWE Standard for industrial noise modelling

CONCAWE is commonly implemented in industry and resource sector projects for environmental noise prediction. It allows for investigation of effects of wind and atmospheric stability on noise propagation. The CONCAWE standard is based on a research paper published in 1981 under the title "*The propagation of noise from petroleum and petrochemical complexes to neighbouring communities*".

The statistical accuracy of environmental noise predictions using CONCAWE was investigated by Marsh (Applied Acoustics 15 - 1982), with the conclusion that CONCAWE was accurate to ±2 dBA in any one octave band between 63 Hz and 4 kHz and ± 1 dBA overall.

Nordic rail traffic noise prediction method

The Nordic Rail Traffic Noise Prediction Method (Kilde 130) dates from 1984 and is commonly utilised for QR rail noise assessments. It calculates emission noise level based on the number of trains, speed, and length and predicts $L_{Aeq(24hour)}$ and single event maximum level as recommended by QR and EPA.

10.3.2 General SoundPLAN modelling parameters

Assessment receiver locations

JRYUP assessment noise levels have been evaluated at eight representative receivers throughout the residential areas of Jilalan which surrounds the proposed Project. The original noise monitoring sites identified through the initial site visit have been included in the assessment.

The assessment receivers have been selected on the basis of providing good spatial coverage of the surrounding areas, including those receivers closest to and potentially most impacted by the Project.

All receivers have been positioned 1.5 m above ground and a minimum of 4 m from the nearest building façade (ie free field). Rail noise has been assessed at a distance of 1 m from the most affected façade in accordance with EPP(Noise).

The receivers are grouped by proximity to the nearest representative noise monitoring location and numbered accordingly, and have been presented in Figure 10.2.

CONCAWE setup

CONCAWE has been implemented for modelling of construction activities associated with the JRYUP and for typical rail yard maintenance and train movement activities within the yards.

The requirement in Ecoaccess is for neutral and "worst case" meteorological enhancement conditions to be considered for operational noise assessment. For construction and maintenance scenarios only the neutral case is considered. Neutral weather conditions are modelled as:

- 10°C
- 70% Humidity
- Pasquill Stability Category D
- 0 m/s wind speed

Nordic rail prediction setup

Noise emission levels were corrected to reflect the local coal rail fleet, based on in-house measurement results.

Wheel and rail noise has been modelled for all trains. Radius corrections were applied where rail curve radii are less than 500 m, and the rail was considered to be jointed. Bridges were modelled as concrete with a ballasted deck. Electric locomotive engines and exhaust noise were modelled separately at an elevation of 4 m above rail level.

Rail operations were modelled for the JRYUP running at ultimate capacity. The rail traffic information shown in Table 10.9 was assumed to be operating.

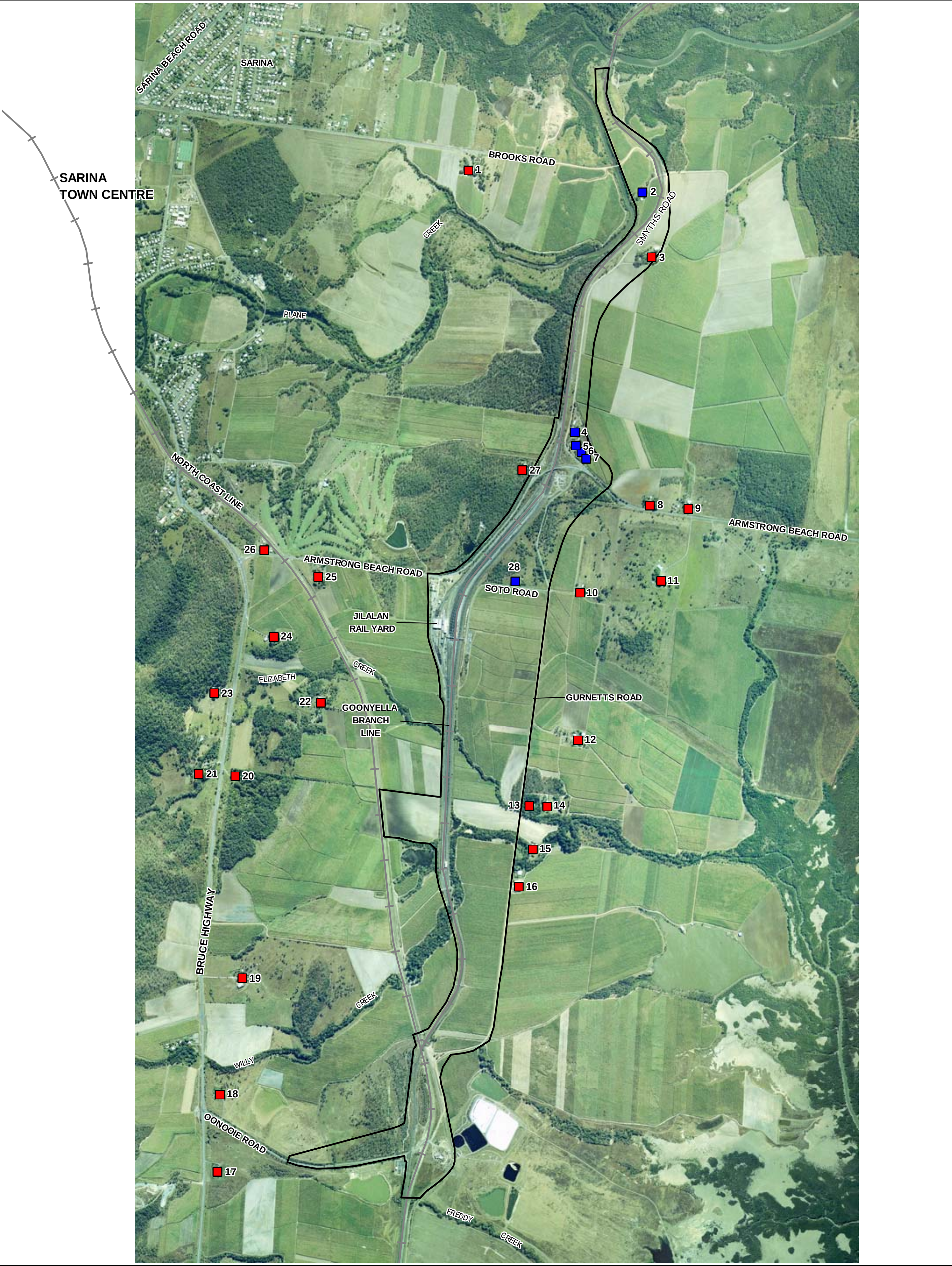
Table 10.9 Operational rail traffic for JRYUP

Scenario	Daily train numbers	Locomotive	Consist	Speeds
Existing	60 (30 each direction)	5 x electric locos	120 x 104 T wagons	40 km/hr approaching yards 30 km/hr through yards
Future	80 (40 each direction)	5 x electric locos	120 x 104 T wagons	70 km/hr

Rail traffic on the through tracks was assumed to be travelling at a maximum speed of 70 km/hr based on information provided by QR. This information would need to be revised and/or confirmed in the detailed design phase of the Project.

Jilalan Rail Yard Upgrade Project

Connell HATCH



N

0 1000 (m)

Scale 1:20 000 (m) (@ A3 size)

LEGEND

Rail

Project Area

Residential Dwelling

Residential Dwelling to be removed by QR

LOCATION OF RESIDENTIAL DWELLINGS

FIGURE 10.2

V:\Projects\Qld_Rail\HR50011GIS\Workspaces\Jilalan_59.wor By: SLG Date: 10/09/07 Version 3

10.4 Construction noise and vibration assessment

10.4.1 Construction scenarios

Significant construction noise sources typically include mobile equipment (eg earthmoving equipment, air compressors, cranes and trucks).

Full details of the exact equipment to be used for the construction activities are yet to be finalised, however a list of the currently proposed construction equipment with their associated maximum sound power levels is presented in Table 10.10.

Table 10.10 Summary of typical maximum sound power levels for construction equipment

Equipment	Typical L_{Amax} Sound Power Level (dB (Lin))
Dozer D10	115
Dozer D9	115
Excavator 66t	111
Truck - Haulage	111
Truck and dog	103
Roller - Flat Drum	115
Roller - Sheep Foot	115
Water Cart	115
621Scraper	125
Cat 12G Grader	114
Cat 625 Compactor	110

Construction noise levels will generally depend upon the number of plant items and equipment operating at any one time and on their precise location relative to the receiver(s). A receiver will therefore experience a range of values representing “minimum” and “maximum” construction noise emissions depending upon:

- The location of the particular construction activity (ie if the plant of interest were as close as possible or further away from the receiver of interest).
- The likelihood of the various items of equipment of interest operating simultaneously.

Four representative construction scenarios have been generated that depict “snapshots” of the proposed construction activities. The locations where equipment is proposed to be operating have been divided into four general construction categories, including:

1. Clearing
2. Ground improvement
3. Bulk earthworks
4. Laying of tracks and rail infrastructure

Each scenario has been modelled to represent likely maximum construction noise levels at nearby residential dwellings. Each noise source will act within a defined area. For the purposes of noise modelling, noise sources have been located within these areas as close as possible to the nearest residential receivers.

10.4.2 Construction noise assessment

Noise levels for both construction scenarios have been predicted at eight representative receivers for neutral weather conditions. The predicted noise levels are summarised in Table 10.11. The predicted noise levels assume that no special mitigation measures have been employed to limit noise emissions (eg enclosures around compressors).

Table 10.11 Predicted noise levels – construction

Receiver (residential dwelling number)	Clearing	Ground improvement	Bulk earthworks	Laying of tracks and rail infrastructure
	L_{Amax} in (dB(Lin))			
3	64	66	81	74
8	48	50	63	60
10	56	58	67	65
12	46	49	63	59
13	54	56	64	62
14	51	53	63	60
15	52	54	64	61
16	51	54	65	61

Noise contour plots for the construction noise scenarios for single event maximum level are shown in Figures 10.3A to 10.3D.

Based upon these predictions, rail construction being undertaken in close proximity to residential receivers will implement appropriate mitigation measures to reduce the potential construction noise impacts (refer Section 10.8).

10.4.3 Construction vibration assessment

The major potential sources of vibration on this Project include vibratory rollers, dozers, excavators and tamping machines. Of these sources, vibration emissions from a vibratory roller are likely to result in the highest vibration levels at nearby residential buildings.

Safe working distances for typical items of vibration intensive plant are listed in Table 10.12. Safe working distances are quoted for both “cosmetic” damage and human comfort. These safe working distances are indicative and will vary depending on the particular item of plant and local geotechnical conditions, water table, etc. Furthermore, it is noted that the safe working distances for “cosmetic” damage apply to damage of typical buildings and do not address heritage structures (for which the safe working distances should be doubled).

Vibration monitoring is recommended for site-specific activities and in any situations where there is doubt regarding the suitability of the plant or where there may be a risk of exceeding the applicable vibration criteria.

Jilalan Rail Yard Upgrade Project

Source: Heggies, 2007.

Disclaimer:
Noise Contours have been calculated based on a grid spacing of 25 metres and are therefore only approximate.

V:\Projects\Qld_Rail\HR5001\GIS\Workspaces\Jilalan_73.wor By: SLG Date: 13/09/07 Version 3

N

0 1000 (m)

Scale 1:20 000 (m) (@ A3 size)

LEGEND

Project Area

Rail

Residential Dwelling

Residential Dwelling to be removed by QR

<50 55 60 65 70 75 80 85 90 95 100 105 >110

NOISE LEVEL
in db(A)

CONSTRUCTION -
CLEARING OPERATIONS
SINGLE EVENT MAXIMUM
LEVEL NOISE CONTOURS

FIGURE 10.3A

Jilalan Rail Yard Upgrade Project

Source: Heggies, 2007.

V:\Projects\Qld_Rail\HR50001\GIS\Workspaces\Jilalan_74.wor By: SLG Date: 13/09/07 Version 3

Scale 1:20 000 (m) (@ A3 size)

LEGEND

- Project Area
- Rail
- Residential Dwelling
- Residential Dwelling to be removed by QR

NOISE LEVEL in db(A): <50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 105, >110

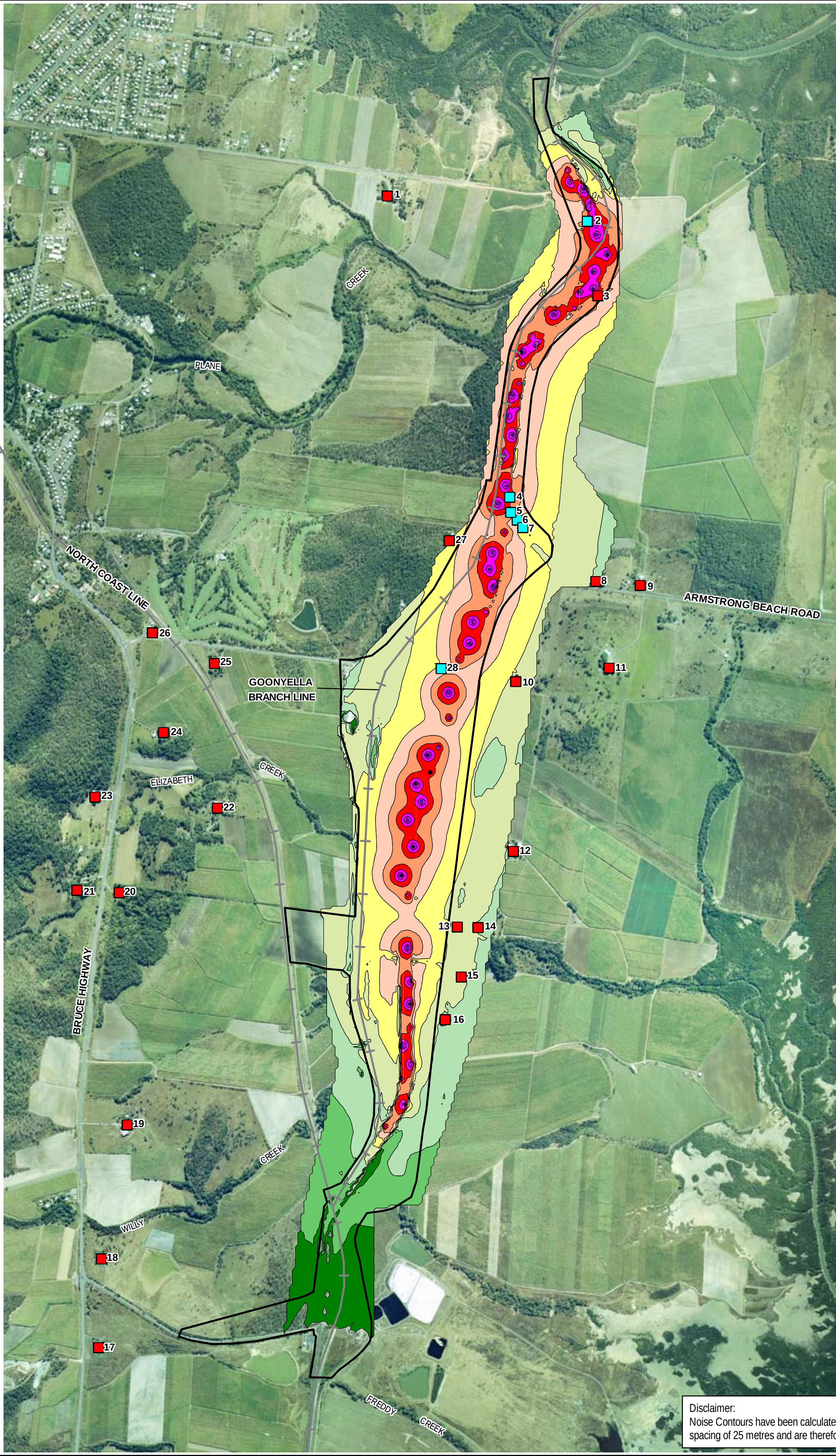
CONSTRUCTION - GROUND IMPROVEMENT SINGLE EVENT MAXIMUM LEVEL NOISE CONTOURS

FIGURE 10.3B

Jilalan Rail Yard Upgrade Project

QR

Connell HATCH



Disclaimer:
Noise Contours have been calculated based on a grid spacing of 25 metres and are therefore only approximate.

Source: Heggies, 2007.

V:\Projects\Qld_Rail\HR5001\GIS\Workspaces\Jilalan_75.wor By: SLG Date: 13/09/07 Version 3

N

0 1000 (m)

Scale 1:20 000 (m) (@ A3 size)

LEGEND

Project Area

Rail

Residential Dwelling

Residential Dwelling to be removed by QR

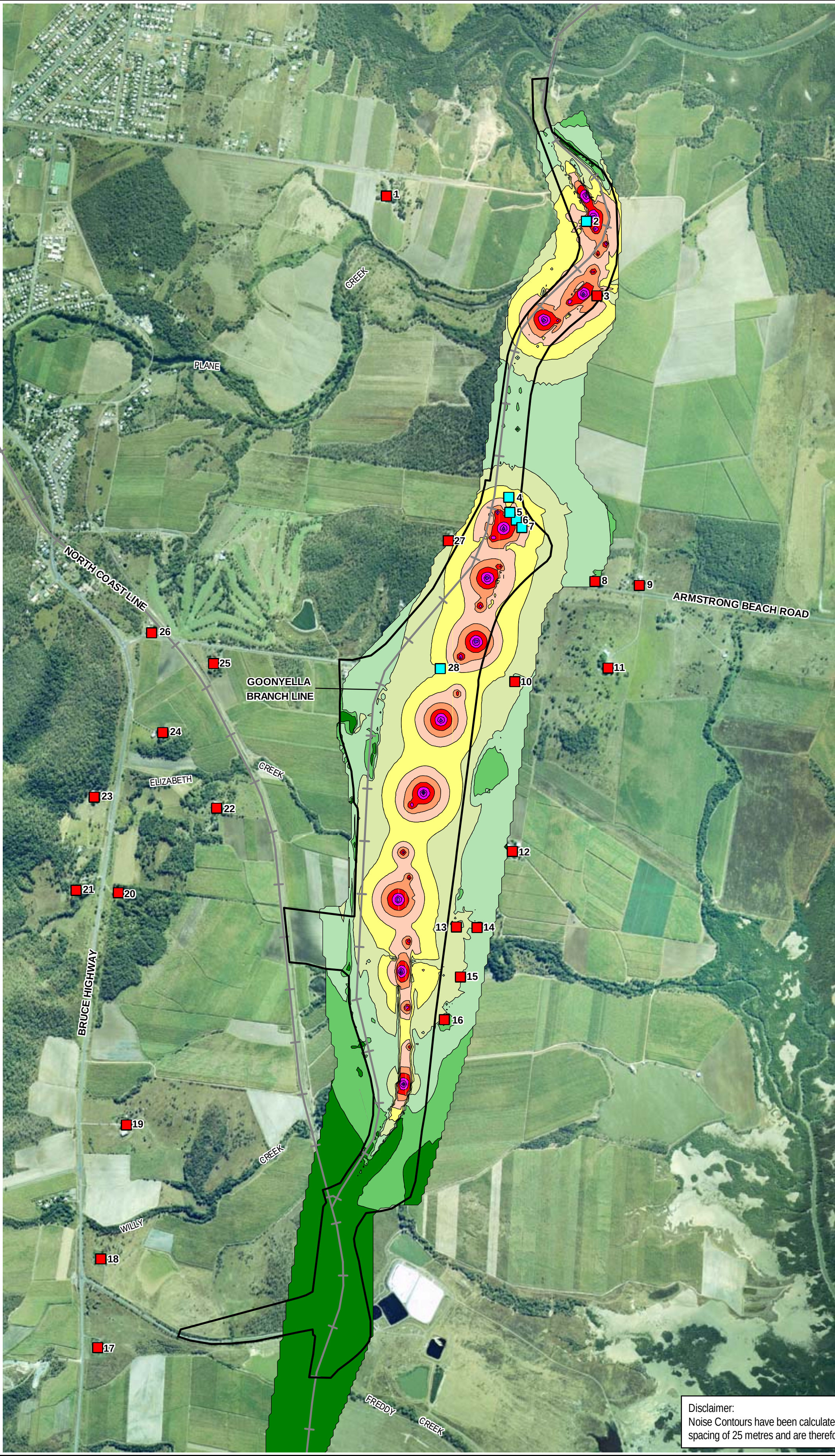
<50 55 60 65 70 75 80 85 90 95 100 105 >110

NOISE LEVEL
in db(A)

CONSTRUCTION -
BULK EARTHWORKS
SINGLE EVENT MAXIMUM
LEVEL NOISE CONTOURS

FIGURE 10.3C

Jilalan Rail Yard Upgrade Project



Disclaimer:
Noise Contours have been calculated based on a grid spacing of 25 metres and are therefore only approximate.

Source: Heggies, 2007.

V:\Projects\Qld_Rail\HR5001\GIS\Workspaces\Jilalan_76.wor By: SLG Date: 13/09/07 Version 3

N

0 1000 (m)

Scale 1:20 000 (m) (@ A3 size)

LEGEND

Project Area

Rail

Residential Dwelling

Residential Dwelling to be removed by QR

<50 55 60 65 70 75 80 85 90 95 100 105 >110

NOISE LEVEL
in db(A)

CONSTRUCTION -
LAYING OF RAILWAY TRACKS
SINGLE EVENT MAXIMUM
LEVEL NOISE CONTOURS

FIGURE 10.3D

Table 10.12 Safe working distances for vibration intensive plant items

Item	Rating	"Safe" Working Distance to avoid …	
		Cosmetic Damage (refer BS 7385)	Human Response (refer BS 6472)
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-11 tonnes)	25 m	100 m
	> 300 kN (> 12 tonnes)	25 m	100 m
Pile Boring	(< 800 mm)	2 m (nominal)	na
Impact Pile Driver[1]		20 m to 40 m	80 m to 120 m
Vibratory Pile Driver[1]		5 m to 15 m	20 m to 50 m
Jack hammer		1 m (nominal)	Avoid contact with structure

Table Note:

1 Not expected to be used for the rail upgrade works.

Since the nearest buildings are located greater than 10 m from the proposed construction works, vibration levels from light vibratory rollers would not be expected to cause cosmetic damage to adjacent residential buildings. In locations with offset distances greater than 12 m, consideration may be given to the use of medium vibratory rollers. It is expected that vibration levels would be clearly perceptible within nearby buildings during the operation of vibratory rollers.

Typical peak particle velocity (PPV) vibration levels from a large dozer are approximately 2 mm/s at a distance of 7 m. Vibration emissions may therefore be perceptible at the nearest residential receiver locations (during dozer operations), but would be significantly lower than the vibration criteria for cosmetic damage.

Rail traffic

Trains passing over jointed rail track generate relatively low vibration levels, typically ranging from 0.01 mm/s to 0.2 mm/s at the footings of buildings located 10 m to 20 m from a railway. Very large surface irregularities can cause levels up to 5 to 10 times higher.

Based on this data, vibration levels from rail traffic utilising the rails on site will be well below both "cosmetic damage" and "human comfort" criteria. In fact, as most homes are greater than 25 m away from the rail corridor, it is expected that any vibration from train movements would be imperceptible (ie less than 0.15 mm/s).

10.5 Low frequency noise assessment

Assessment of low frequency noise is a two step process. The first step is to compare the overall unweighted (or linear weighted) noise level with the 50 dB(Lin) criterion outlined in Section 10.2.2. If the noise level exceeds 50 dB(Lin), then its spectrum is required to be assessed to check for excessive low frequency components. For calculation purposes, a 5 dB reduction has been allowed for when considering noise intrusion through the façade (ie to calculate internal noise levels from the external noise predictions presented in Table 10.11 and Table 10.14.

From Table 10.11, it can be seen that the predicted noise levels exceed the 50 dB(Lin) (internal) criterion in several instances.

A check of frequency balance is to compare the overall unweighted noise level with the overall a-weighted noise level. If there is a difference of more than 15 dB then further analysis is required. A check of the linear-weighted and A-weighted levels of the noise sources used in the calculations determined that in all instances the difference was less than 15 dB, and therefore low frequency noise is considered acceptable.

10.6 Operational noise assessment - rail maintenance and yard train movements

10.6.1 Modelling scenarios

Significant noise sources associated with the maintenance and rail yard activities typically include gantry cranes, forklifts, idling locomotives, wagon coupling and refrigeration units (wagons).

Full details of the exact equipment to be used for the maintenance and rail yard activities are yet to be finalised, however a list of the currently proposed equipment with their associated maximum sound power levels is presented in Table 10.13.

Table 10.13 Summary of typical maximum sound power levels for rail yard and maintenance activities

Equipment	Typical L_{max} Sound Power Level (dB (Lin))
Gantry Crane	102
Forklift	104
Loco Idling	102
Refrigeration Unit	92
Wagon Coupling	106

Rail yard noise levels will generally depend upon the number of plant items and equipment operating at any one time and on their precise location relative to the receiver(s). A receiver will therefore experience a range of values representing “minimum” and “maximum” noise emissions depending upon:

- The location of the particular activity (ie if the plant of interest were as close as possible or further away from the receiver of interest).
- The likelihood of the various items of equipment of interest operating simultaneously.

Maintenance and rail yard activities have been modelled to represent likely maximum operational noise levels at nearby residential dwellings. Each noise source will act within a defined area. For the purposes of noise modelling, noise sources have been located within these areas as close as possible to the nearest residential receivers.

10.6.2 Maintenance and rail yard noise assessment

Maintenance and rail yard activities have been predicted at eight representative receivers for neutral weather conditions. The predicted noise levels are summarised in Table 10.14. The predicted noise levels assume that no special mitigation measures have been employed to limit noise emissions (eg enclosures around compressors).

Table 10.14 Predicted noise levels – maintenance and rail yard activities

Receiver (residential dwelling number)	Single event maximum level in dB(A)
3	<20
8	33
10	38
12	47
13	45
14	45
15	44
16	40

Noise contour plots for the rail yard operations for single event maximum level are shown in Figure 10.4.

The modelling results indicate that the QR noise criteria contained in Section 10.2.3 are likely to be achieved.

10.7 Operational noise assessment – rail operations

10.7.1 Modelling results

The $L_{Aeq(24hour)}$ and single event maximum level results from JRYUP (existing and future) rail operations at the eight receiver positions are shown in Table 10.15.

Table 10.15 Receiver noise levels

Receiver (residential dwelling number)	Existing rail operations		Future rail operations	
	L_{Aeq} (dBA)	Single event maximum level (dBA)	L_{Aeq} (dBA)	Single event maximum level (dBA)
3	65	73	61	78
8	56	66	50	66
10	53	67	53	70
12	52	65	54	65
13	55	69	58	71
14	54	67	57	68
15	56	69	58	71
16	58	70	59	74

Noise contour plots for $L_{Aeq(24hour)}$ and single event maximum level rail operations are shown in Figures 10.5A and 10.5B (existing) and Figures 10.6A and 10.6B (future), respectively.

No exceedances of the QR criteria were reported for either the $L_{Aeq(24\ hour)}$ or the single event maximum level criteria.

Jilalan Rail Yard Upgrade Project

V:\Projects\Qld_Rail\HR5001\GIS\Workspaces\Jilalan_77.wor By: SLG Date: 13/09/07 Version 3

N

0 250 (m)

Scale 1:5 000 (m) (@ A3 size)

LEGEND

Project Area

Rail

Residential Dwelling

Residential Dwelling to be removed by QR

<50 55 60 65 70 75 80 85 90 95 100 105 >110

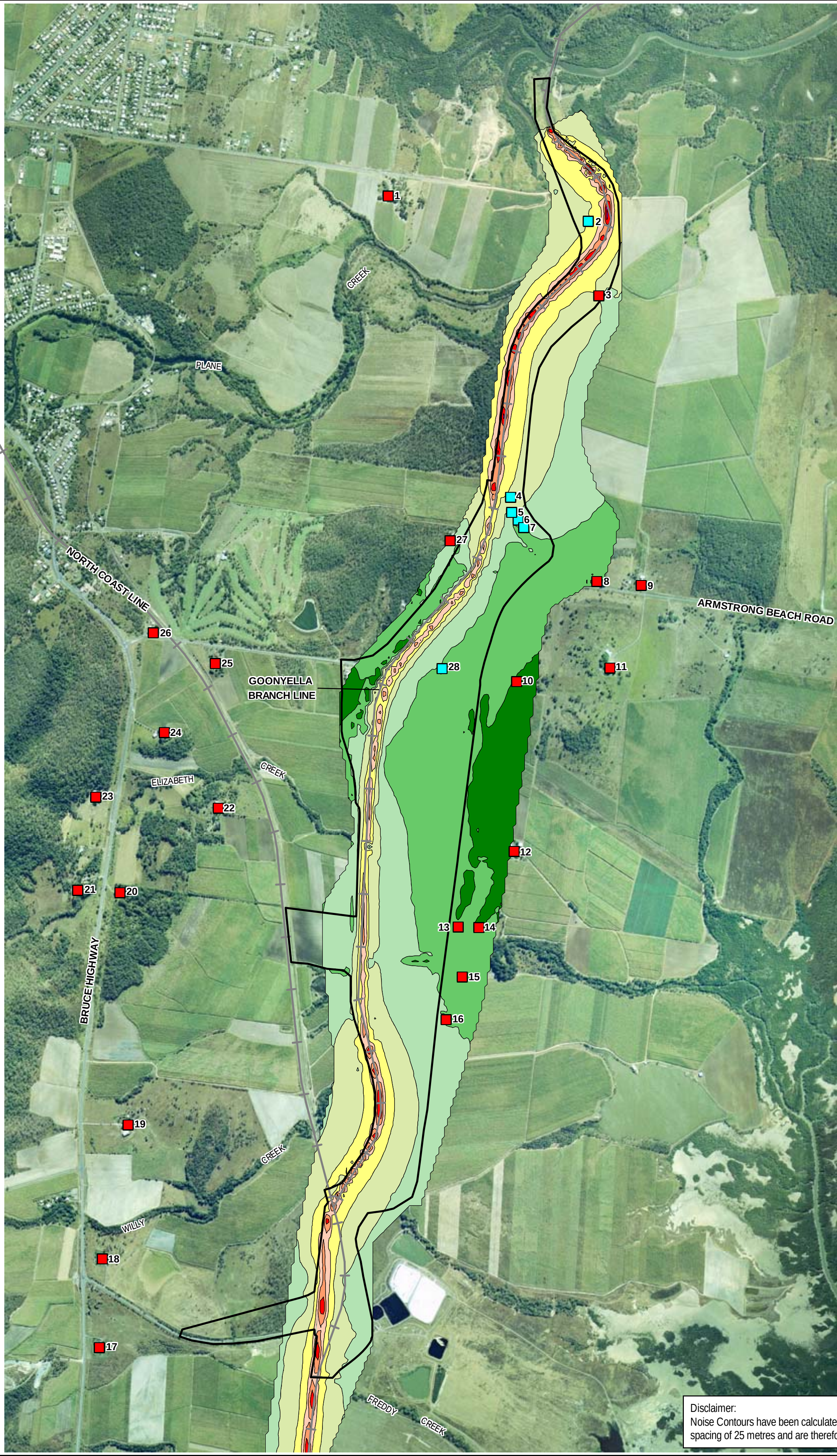
NOISE LEVEL
in db(A)

RAIL YARD OPERATIONS
SINGLE EVENT MAXIMUM
LEVEL NOISE CONTOURS

FIGURE 10.4

Jilalan Rail Yard Upgrade Project

Connell HATCH



Disclaimer:
Noise Contours have been calculated based on a grid spacing of 25 metres and are therefore only approximate.

Source: Heggies, 2007.

V:\Projects\Qld_Rail\HR50001\GIS\Workspaces\Jilalan_78.wor By: SLG Date: 13/09/07 Version 3

N

0 1000 (m)

Scale 1:20 000 (m) (@ A3 size)

LEGEND

Project Area

Rail

Residential Dwelling

Residential Dwelling to be removed by QR

<50 55 60 65 70 75 80 85 90 95 100 105 >110

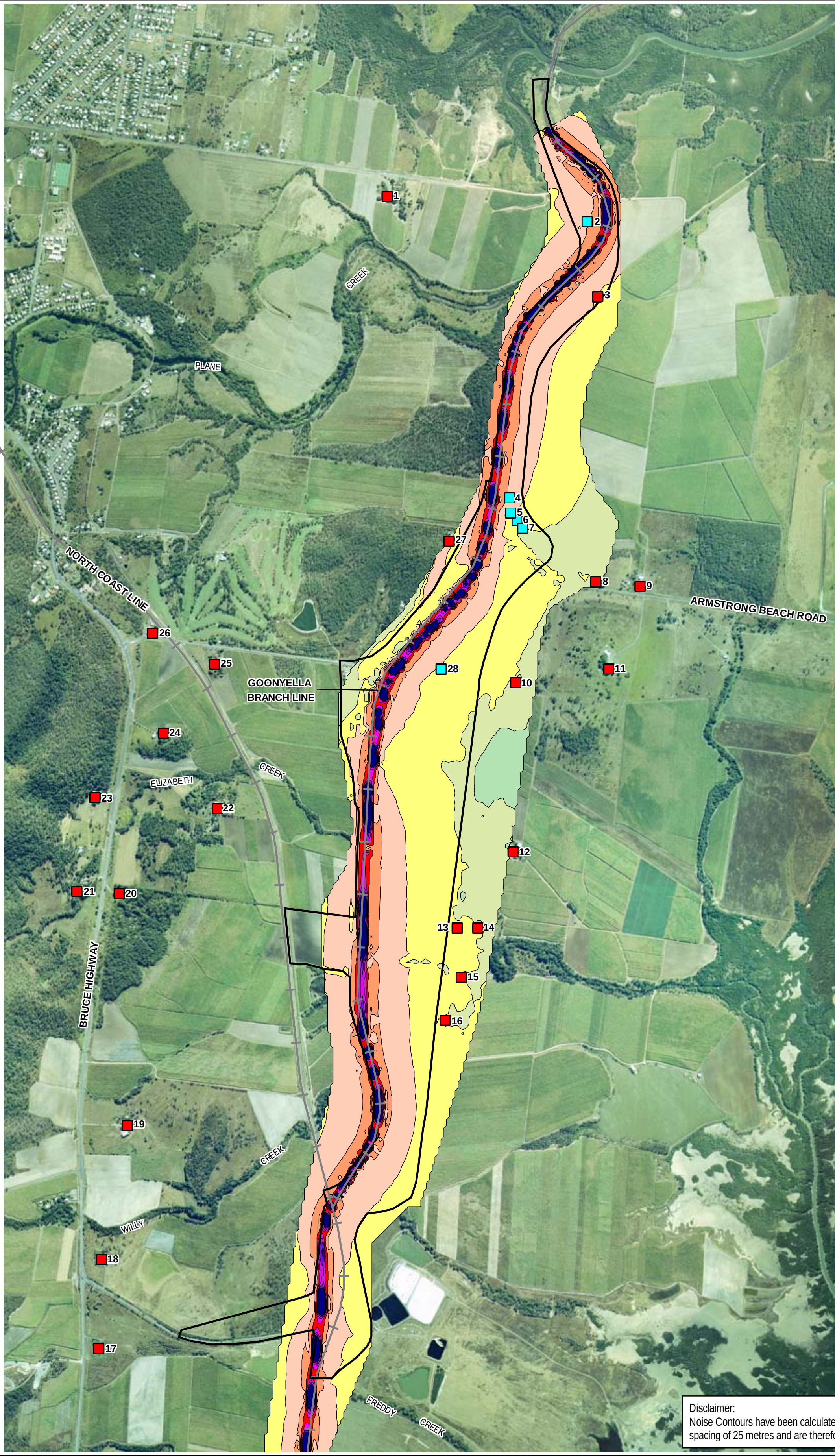
NOISE LEVEL
in db(A)

EXISTING SITUATION YEAR 2008
LAeq(24hr) NOISE CONTOURS

FIGURE 10.5A

Jilalan Rail Yard Upgrade Project

Connell HATCH



Disclaimer:
Noise Contours have been calculated based on a grid spacing of 25 metres and are therefore only approximate.

Source: Heggies, 2007.

V:\Projects\Qld_Rail\HR50001\GIS\Workspaces\Jilalan_79.wor By: SLG Date: 13/09/07 Version 3

N

0 1000 (m)

Scale 1:20 000 (m) (@ A3 size)

LEGEND

- Project Area
- Rail
- Residential Dwelling
- Residential Dwelling to be removed by QR

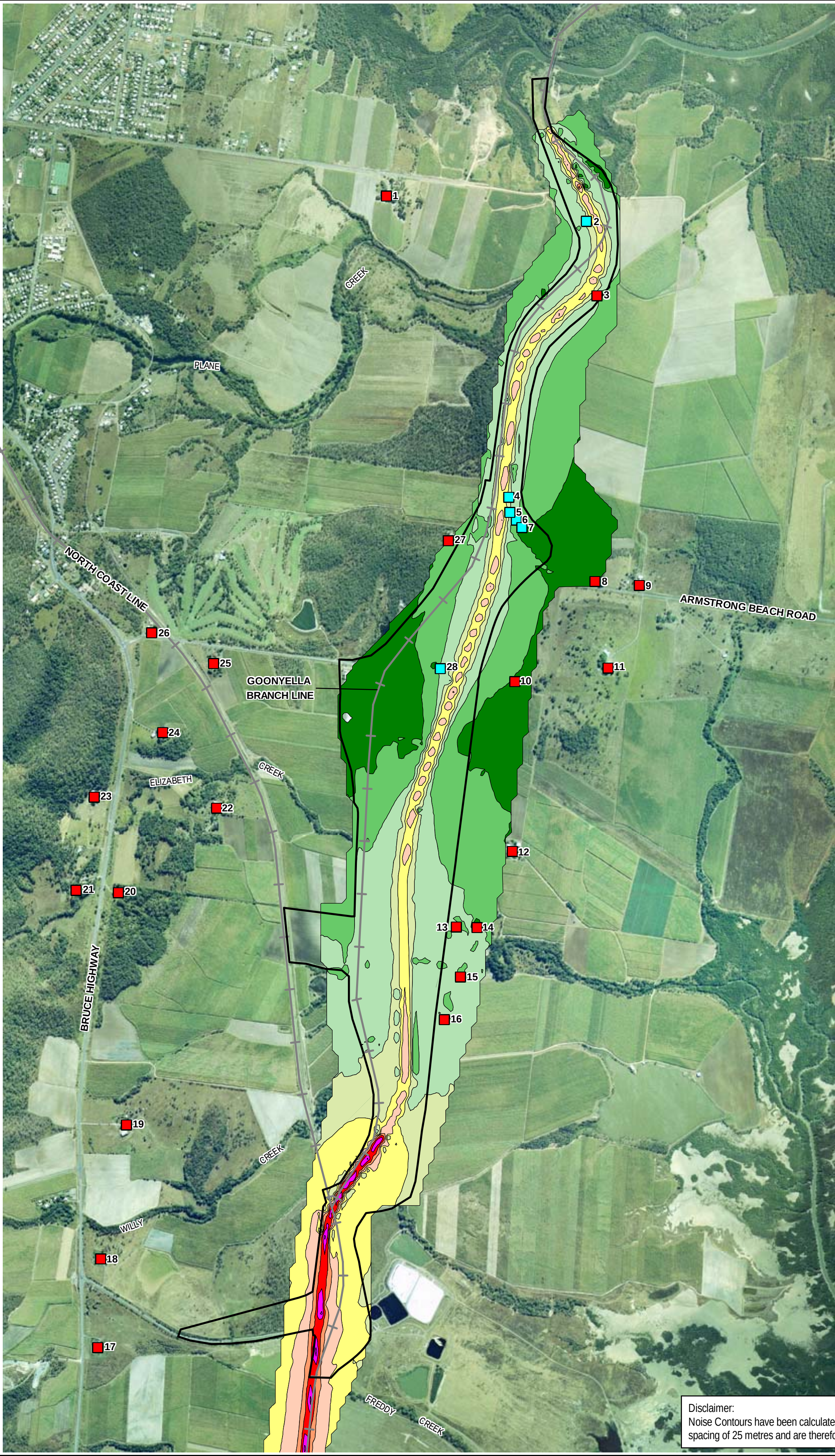
<50 55 60 65 70 75 80 85 90 95 100 105 >110

NOISE LEVEL
in db(A)

EXISTING SITUATION YEAR 2008
SINGLE EVENT MAXIMUM
LEVEL NOISE CONTOURS

FIGURE 10.5B

Jilalan Rail Yard Upgrade Project



Source: Heggies, 2007.

Disclaimer:
Noise Contours have been calculated based on a grid spacing of 25 metres and are therefore only approximate.

V:\Projects\Qld_Rail\HR5001\GIS\Workspaces\Jilalan_80.wor By: SLG Date: 13/09/07 Version 3

N

0 1000 (m)

Scale 1:20 000 (m) (@ A3 size)

LEGEND

Project Area

Rail

Residential Dwelling

Residential Dwelling to be removed by QR

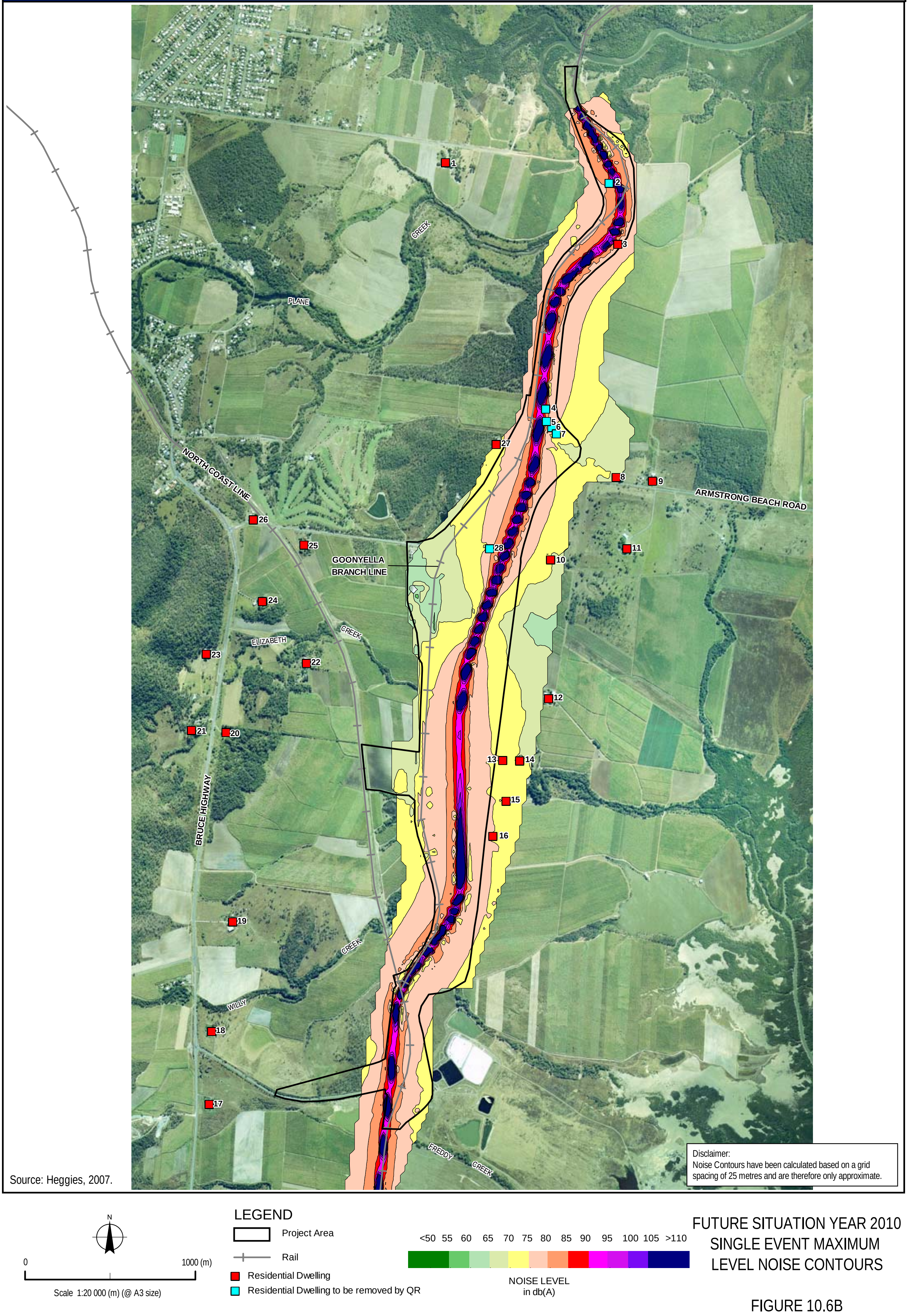
<50 55 60 65 70 75 80 85 90 95 100 105 >110

NOISE LEVEL
in db(A)

FUTURE SITUATION YEAR 2010
LAeq(24hr) NOISE CONTOURS

FIGURE 10.6A

Jilalan Rail Yard Upgrade Project



Source: Heggies, 2007.

FUTURE SITUATION YEAR 2010
SINGLE EVENT MAXIMUM
LEVEL NOISE CONTOURS

FIGURE 10.6B

V:\Projects\Qld_Rail\HR50001\GIS\Workspaces\Jilalan_81.wor By: SLG Date: 13/09/07 Version 3

The addition of JRYUP rail traffic is unlikely to affect single event maximum level noise levels significantly at locations that are currently exposed to rail movements. It is noteworthy that the number of train related noise events will increase on average from approximately 60 per day to 80 per day with the average train speed being increased from 30 km/hr to 70 km/hr. The effect of this increase will be confirmed during the operational phase as stated in Section 10.8.3.

10.8 Mitigation measures

10.8.1 Design phase

During the detailed design phase of the Project investigate the possibility of moving the rail infrastructure to the west, further away from residential dwellings to the east of the project area.

10.8.2 Construction phase

Noise

In general, the quietest suitable plant and equipment will be utilised in combination with management measures in order to minimise the noise impacts on the local community.

The levels of diesel engine noise emissions associated with construction machinery are largely dependent on the extent of exhaust silencing and whether the engine is housed within an acoustic enclosure. Noise emission levels also depend upon the condition of the equipment and the type of operation.

The management of noise impacts is best achieved by the efficient scheduling of these activities and restricting their hours of operation to those times of the day during which the noise from such sources is least likely to be disruptive.

Noise mitigation strategies would need to be considered and implemented during any evening and night-time work periods.

AS2436-1981 "*Guide to Noise Control on Construction, Maintenance and Demolition Sites*" sets out numerous practical recommendations to assist in mitigating construction noise emissions. Noise control strategies that will be implemented during the construction phase are listed below.

Source noise control strategies

- Quietest plant and equipment that can economically undertake the work should be selected, wherever possible.
- Regular maintenance of equipment to keep it in good working order.

Source noise controls

- Noise measurements of plant and equipment to maintain/check noise emissions against manufacturers specification.
- Mobile plant and other diesel powered equipment to be fitted with residential class mufflers.
- Minimise the usage of truck exhaust brakes onsite.
- Where practicable, use silenced air compressors onsite.

Work practice control strategies

- Construction work to occur within the daytime period, wherever possible.
- Where practicable, avoid the coincidence of plant and equipment working simultaneously close together.

- Operators of construction equipment are to be made aware of the potential noise issues and of techniques to minimise noise emissions through a continuous process of operator education.

Work practice controls

- Reversing alarms within construction areas cannot be avoided for safety reasons. Consideration should therefore be given to sourcing so-called "quiet" white-noise alarms whose annoying character diminishes quickly with distance and self-adjusting alarms which adjust emission levels relative to the local background noise level.
- Large rocks are to be placed in dump trucks not dropped.
- Horn signals should be kept at a low volume, where feasible without compromising public and employee safety.

Community liaison strategies

Anecdotal evidence exists that resident sensitivity thresholds are strongly influenced by "fear of the unknown", the unexpected and by concerns surrounding the possibility of damage to their dwellings. While these typical reactions are clearly understandable, the underlying concerns are often technically unjustified.

It is therefore proposed to implement, as part of the broader community involvement plan, a well-planned, focussed community awareness programme in order to improve the understanding of the noise and vibration issues and to assist in allaying potential fears and concerns. This programme may include, for example:

- Active community consultation and the maintenance of positive relations with residents. Representative groups of the community could be invited to attend a short, concentrated Noise and Vibration Briefing prior to the works approaching their community.
- Ensure measures are undertaken to reduce the noise and vibration impact at neighbouring properties.
- Where construction noise levels exceed the recommended criteria or in the event of complaints, an investigation of construction noise will be required.
- Provision of a complaints phone number.

Community liaison controls

- Construction site personnel are to be made aware of all community attitudes and complaints
- Residents are to be made aware of the times and duration that they will likely be affected. Making residents aware of likely future occurrence of noise significantly reduces annoyance and allows people to make arrangements accordingly.
- Implement mitigation measures contained in Chapter 15.

Vibration

Based on predicted vibration levels and safe working distances outlined in Table 10.12, no mitigation measures are required to reduce vibration levels at residential dwellings surrounding the Project.

Where possible, the safe working distances described in Table 10.12 should be adhered to onsite.

The use of compactors should be examined as a substitute for vibratory rollers. Likewise, bored piles should be used for bridge supports where feasible as opposed to driven piles.

During the detailed design phase of the Project consideration will be given to the completion of building condition surveys for any buildings that fall within the safe working distances for the prevention of cosmetic damage.

Further investigations are also recommended for any structures within and around the safe working distances in order to determine if the “light weight” cosmetic damage criterion (as used for this assessment), is applicable or whether a higher value may be more appropriate.

10.8.3 Operational phase

No potential exceedances of the QR criteria were reported for either the $L_{Aeq(24\ hour)}$ or the singe event maximum level criteria.

Given the modelling information provided, the accuracy of the modelling predictions and the number of variables and assumptions made, it is recommended that rail noise levels at these locations be investigated in more detail during the detailed design phase of the Project and during confirmed post-commissioning of the line. Monitoring will be undertaken for a single 48 hour period at representative noise sensitive receptors.

If exceedances of QR’s noise criteria are identified during the detailed design phase, mitigation measures will need to be investigated, as required.

10.9 Conclusions

10.9.1 Construction works

Construction noise was assessed for four representative construction scenarios. The predicted results for early phase construction indicate that the construction noise criteria will have an impact on nearby noise sensitive receivers.

Noise mitigation strategies will be implemented during any evening and night-time work periods to mitigate potential construction noise impacts.

AS2436-1981 “*Guide to Noise Control on Construction, Maintenance and Demolition Sites*” sets out numerous practical recommendations to assist in mitigating construction noise emissions. In general, the quietest suitable plant and equipment will be utilised in combination with management measures in order to minimise the potential noise impacts on the local community.

10.9.2 Construction vibration

The major potential sources of vibration on this Project include vibratory rollers, dozers, excavators and tamping machines. Of these sources, vibration emissions from a vibratory roller are likely to result in the highest vibration levels at nearby residential buildings.

Vibration levels from truck traffic utilising the roads onsite will be well below both “cosmetic damage” and “human comfort” criteria. In fact, as most homes are greater than 25 m away from the roads, it is expected that any vibration from truck movements would be imperceptible (ie less than 0.15 mm/s PPV).

Based on predicted vibration levels and safe working distances, no mitigation measures are required to reduce vibration levels at residences surrounding the Project.

Vibration monitoring will be implemented for site-specific activities and in any situations where there is doubt regarding the suitability of the plant or where there may be a risk of exceeding the applicable vibration criteria.

10.9.3 Rail operational noise – maintenance and rail yard activities

Significant noise sources associated with the maintenance and rail yard activities typically include gantry cranes, forklifts, idling locomotives and wagon coupling.

The modelling results presented in Table 10.14 indicate that the QR noise criteria contained in Section 10.2.3 are likely to be achieved.

10.9.4 Rail operational noise

All receiver locations are predicted to comply with QR operational criteria for both the $L_{Aeq(24\ hour)}$ and single event maximum level criteria given the accuracy of the modelling predictions, the number of variables and assumptions made. The additional rail traffic associated with the JRYUP is unlikely to affect single event maximum level noise levels significantly at locations that are currently exposed to rail movements.

It is noteworthy that the number of train related noise events will increase on average from approximately 60 per day to 80 per day with the average train speed being increased from 30 km/hr to 70 km/hr. This information would need to be revised and/or confirmed in the detailed design phase of the Project.

If exceedances of QR's noise criteria are identified during the detailed design phase, mitigation measures will need to be investigated, as required.