CHAPTER 11

Noise and Vibration

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11.1 Introduction

SLR Consulting Australia Pty Ltd (SLR) have prepared a Noise and Vibration Impact Assessment (NVIA) for the Project. The NVIA has been prepared to provide an assessment of potential noise and vibration impacts associated with the construction phase of the Project. The NVIA is provided in Appendix K and summarised in this chapter.

11.2 Legislative Framework

11.2.1 Construction Noise

Environmental noise control in Queensland is governed under the *Environmental Protection Act 1994* (EP Act) which aims to strike a balance between protecting the amenity of sensitive receptors and allowing industrial, commercial and development activities to occur in an ecologically sustainable manner. In accordance with the principles of ecological sustainable development established in the EP Act, the *Environmental Protection (Noise) Policy 2008* (EPP (Noise)) sets out a management hierarchy for all activities involving noise. The relevant acoustic quality objectives for residential dwellings, as specified by the EPP (Noise), are shown in Table 11-1.

Table 11-1: EPP (Noise) Acoustic Quality Objectives

SENSITIVE RECEPTORS	TIME OF DAY	ACOUSTIC QUALITY OBJECTIVES (MEASURED AT THE RECEPTOR, dBA)			ENVIRONMENTAL VALUE
		$L_{Aeq, adj, 1 hr}$	$L_{A10, adj, 1 hr}$	$L_{A1, adj, 1 hr}$	
Dwelling (for outdoors)	Daytime and evening	50	55	65	Health and wellbeing
Dwelling (for indoors)	Night time	30	35	40	Health and wellbeing, in relation to the ability to sleep

The *Planning for Noise Control Guideline 2004* (EPA 2004) provides assessment criteria for sleep disturbance. This guideline recommends that maximum instantaneous internal noise levels in sleeping areas should not exceed approximately 45 dBA more than 10 to 15 times per night. The corresponding external noise level, assuming partially closed windows, is 52 dBA maxLpA, measured in the free field.

11.2.2 Construction Vibration

Construction generated vibration was assessed against criteria for cosmetic damage only. In the absence of a relevant Australian Standard, the British Standard (BS) *7385-2:1993 Evaluation and measurement for vibration in buildings. Part 2 Guide to damage levels from ground borne vibration* is a reference standard against which the likelihood of building damage from ground vibration can be assessed. The standard sets levels 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. The BS7385 standard for vibration levels for cosmetic damage are presented in Table 11-2.

A vibration value of 7.5 mm/s has been adopted for the Project due to nearby residential sensitive receptors.

Table 11-2: BS7385 vibration guide values for cosmetic damage

TYPE OF BUILDING	PEAK COMPONENT PARTICLE VELOCITY IN FREQUENCY RANGE OF PREDOMINANT PULSE	
	4 Hz TO 15 Hz	15 Hz and above
Reinforced or framed structures (Industrial and heavy commercial buildings)	50 mm/s at 4 Hz and above	
Non-reinforced or light framed structures (Residential or light commercial type buildings)	7.5 mm/s at 4 Hz increasing to 10 mm/s at 15 Hz	10 mm/s at 15 Hz increasing to 50 mm/s at 20 Hz and above

11.3 Methodology

The NVIA included the following broad methodology:

- A site visit to the Project area and surrounding areas to identify the existing noise environment
- Environmental noise logging within the sensitive receptor catchment area to obtain baseline information required to establish noise criteria in accordance with the relevant guidelines
- Development of a computer noise model for the site to predict noise emission levels from the Project at the nearest noise sensitive receptor locations
- Spreadsheet calculations to determine the safe working offset distances for each of the planned vibration intensive activities
- Assessment of the potential vibration impacts based on the construction activities being undertaken at the locations closest to the relevant receptors
- Noise and vibration control measures, where required.

11.3.1 Baseline Noise

Unattended monitoring was carried out using a SVAN 957 Noise Logger and a Ngara Noise Logger. Attended noise monitoring was undertaken with a Brüel and Kjær Type 2250 Sound Level Meter (SLM). The noise loggers were configured to record a range of A-weighted fast-response statistical noise levels, including the LA1, LA10, LA90, and LAeq noise levels over consecutive 15 minute periods.

The loggers were checked for calibration before and after the monitoring, using a Bruel and Kjaer Sound Level Calibrator (Serial number 2594716) and no significant drift in calibration was detected. The noise loggers were both located in the free-field with a microphone height of 1.5 m above the existing ground level.

11.3.2 Construction Noise

A set of assessment construction scenarios were developed for each construction stage using typical plant items and defined areas of operation across the Project area. A three-dimensional SoundPLAN (v7.4) noise model accounting for the ground terrain and built environment over the entire Project area has been assembled for each construction scenario, for both standard and non-standard working hours where relevant, as well as the respective default weather conditions. Given the scale of the Project area, airborne noise from construction activities were then predicted using industry standard numerical codes for a representative set of residential locations. These predicted noise levels were then compared to targets in accordance with the measured ambient noise levels.

Noise Targets

The NVIA nominated acoustic targets derived from the EPP(Noise) acoustic quality objectives, as outlined in Section 11.2.1. To establish an external limit for night time activity, a conservative 5 dBA reduction between outside and inside is applied (assuming open windows). Sleep disturbance targets are set as per *Planning for Noise Control Guideline 2004* (EPA 2004). The noise targets for the Project are outlined in Table 11-3 below.

Table 11-3: Project construction noise targets

TIME OF DAY	NOISE TARGET
Daytime and evening (7am-10pm)	50 dBA L_{Aeq}, 1 hr
Night (10pm-7am)	35 dBA L_{Aeq}, 1 hr
Sleep disturbance (10pm-7am)	52 dBA L_{Amax}

11.3.3 Construction Vibration

The vibration impact assessment included spreadsheet calculations to determine the safe working offset distances for each of the planned vibration intensive activities. Potential vibration emissions to sensitive receptors were assessed by considering the construction methodology, distance between identified construction zones and existing receptors and equipment vibration data.

11.3.4 Operational Noise and Vibration

Operational noise and vibration emissions were not assessed as the operational noise and vibration emission characteristics from the facility because of the upgrade are expected not to differ from existing noise and vibration levels.

11.4 Existing Environment

The Project area is bordered to the north by Tewantin National Park and otherwise surrounded by a semi-rural residential area (Lake Macdonald suburb) as shown in Figure 11-1. The sensitive receptor catchment in the area surrounding the Project consists of residential dwellings and public spaces.

The closest dwellings to the Project construction area are located:

- Approximately 30 m to the west of the left embankment;
- Approximately 210 m to the west of the area in which the Concrete Batching Plant (CBP) may be located
- Approximately 215 m to the west of the closest proposed stockpile area; and
- Approximately 300 m to the east of the clay borrow area.

Unattended and attended noise monitoring was undertaken for the Project in May and June 2018 and the results are discussed below.

FIGURE 11-1: SENSITIVE RECEPTORS

Six Mile Creek Dam Safety Upgrade Project

PROJECT NO: 30041832

CREATED BY / DATE: BM14706, 30/11/2018

VERSION: DRAFT A

PAGE SIZE: A4

0 100 200
Metres

N

SOURCES:
1. Localities, Roads, LGA, Waterways, Waterbody, Protected Areas © QLD Spatial Catalogue, State of Queensland (Department of Natural Resources, Mines and Energy) 2018
2. Basemap © Nearmap, 2018

seqwater
WATER FOR LIFE

LEGEND

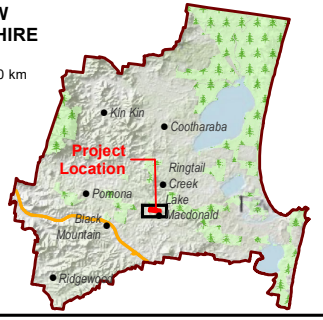
- Sensitive Receptors
- Six Mile Creek and Upper Tributary
- Watercourse
- Local Governmental Area
- Project Area
- Lake Macdonald

Protected Areas

- National Parks

OVERVIEW
NOOSA SHIRE

0 5 10 km



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11.4.1 Unattended Noise Monitoring

Unattended noise monitoring was undertaken at two locations from 29 May to 7 June 2018 as shown on Figure 11-1. The aim of the monitoring was to quantify the existing baseline noise levels in the area and assist in determining appropriate noise targets for construction and operation of the Project. A summary of baseline ambient noise levels is presented in Table 11-4 below.

Table 11-4: Unattended measured noise levels (baseline)

PARAMETER	PERIOD	AVERAGE NOISE LEVELS (dBA)	
		LOCATION 1 43 Highland Drive	LOCATION 2 407 Lake Macdonald Drive
L_{A1}	Daytime (7am-6pm)	63	52
	Evening (6pm-10pm)	59	47
	Night (10pm-7am)	54	43
L_{A10}	Daytime (7am-6pm)	56	46
	Evening (6pm-10pm)	46	42
	Night (10pm-7am)	45	36
Rating background level (RBL)[1]	Daytime (7am-6pm)	40	34
	Evening (6pm-10pm)	40	30
	Night (10pm-7am)	40	28
L_{Aeq}	Daytime (7am-6pm)	55	47
	Evening (6pm-10pm)	47	47
	Night (10pm-7am)	49	40

[1]The RBL is the median of the 90th percentile of the daily background (LA90) noise levels in each assessment period (day, evening and night) over the duration of the monitoring.

The measured RBL at 43 Highland Drive was the same for all time periods due to water flowing over the spillway, approximately 100 m from the noise monitoring location (refer to section 0). As such, the RBLs from 407 Lake Macdonald Drive were considered more typical, with the daytime and evening noise levels being higher than that for the night-time period.

11.4.2 Attended Noise Monitoring

Operator attended noise measurements were undertaken at the same locations as unattended noise monitoring on 29 May 2018 during the daytime period. All significant noise sources were identified during the operator attended measurements. The attended noise measurements allowed for the characterisation of the existing noise environment. The results of the attended noise monitoring are shown in Table 11-5 below.

As shown in Table 11-5, the ambient noise environment at 43 Highland Drive was dominated by noise generated by water rushing over the dam spillway. Insect noise and road traffic noise were features of the ambient noise environment at both monitoring locations.

Table 11-5 Attended measured noise levels

LOCATION	MEASURED NOISE LEVEL (dBA)				DESCRIPTION OF LOCATION
	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	
43 Highland Drive	62	54	46	51	• Dominant noise generated by water rushing over the dam spillway • Road traffic noise audible during vehicle passing by on Lake Macdonald Drive • Insect noise clearly audible • Intermittent bird noise audible at times • No mechanical plant noise was audible from water treatment plant
407 Lake Macdonald Drive	51	45	35	42	• Insect noise was dominant • Road traffic noise audible during vehicle passing by on Lake Macdonald Drive • Intermittent bird noise, dog bark and wind generated noise in trees audible at times • No mechanical plant noise was audible from water treatment plant

11.5 Impact Assessment

11.5.1 Construction Noise Impacts

The Project is expected to be constructed in accordance with the program outlined in Chapter 2. The Project schedule indicates that the major earthworks and other construction activities with the potential for noise emissions are expected to occur over a period of approximately 18 to 24 months.

Standard hours of operation for the duration of the Project would be six-days per week, 6:30 am to 6:30 pm Monday to Friday and 6:30 am to 4:00 pm on Saturdays, with no work to be carried out on Sunday or public holidays. There is likely to be the need for extended work hours from time to time for critical construction activities. Construction scenarios with non-standard hours include:

- Lake drawdown
- Spillway excavation (reduced activity)
- Spillway construction (reduced activity)

Construction Noise Modelling Results

An assessment of the construction scenarios against the noise targets is identified in Table 11-6.

The table outlines the maximum predicted noise level for each activity and the amount of any exceedances compared with the noise targets for daytime/evening and night (refer to section 11.3.2.1). Where an activity is not proposed to occur at night, the exceedance is marked not applicable (n/a).

With regards to lake drawdown location 'A' and 'B', this refers to two possible locations for the siting of a pump/generator to be used for dewatering the lake. Location A refers to a site within the western embankment along Lake Macdonald Drive, adjacent to the lake's edge, while B, refers to a location on the eastern end of the eastern embankment, adjacent to the Noosa Water Treatment Plant. All other construction, modelling scenarios and locations are outlined in more detail in Appendix K.

Table 11-6: Construction noise modelling results

CONSTRUCTION SCENARIO	MAXIMUM PREDICTED NOISE LEVEL (Leq dBA)	EXCEEDANCE COMPARED WITH DAYTIME/EVENING NOISE TARGET (Leq dBA)	EXCEEDANCE COMPARED WITH NIGHT NOISE TARGET (Leq dBA)
Lake drawdown location A	62	12	27
Lake drawdown location B	50	-	15
Sheet piling	60	10	n/a
Spillway excavation	60	10	22
Spillway construction	57	7	21
Clay borrow area	49	-	n/a
East embankment construction	60	10	n/a
West embankment construction	64	14	n/a
Saddle dam	45	-	n/a
Demobilisation	62	12	n/a

Construction Noise Modelling Discussion

Whilst no mandatory numeric criteria are required for construction noise between 6.30am and 6.30pm, exceedances of predicted maximum noise levels compared with targets has been highlighted and recommendations made with respect to noise management principles.

A summary of construction noise modelling results is provided below:

- Lake drawdown locations A and B
  - The lake drawdown may require pumps to operate for 24 hours per day
  - The maximum predicted noise level at location A can be reduced by installing a noise barrier, reducing the maximum predicted noise level from 62 dBA to 50 dBA
  - The maximum predicted noise level at location B can be reduced by installing a noise barrier, reducing the maximum predicted noise level from 50 dBA to 36 dBA
  - Noise emissions from both locations are expected to exceed the nominated 35 dBA night time target
- Sheet piling
  - Sheet piling is not expected to occur outside of standard hours

  - Noise management principles apply as the maximum predicted noise level exceeds the daytime/evening noise target by 10 dB (refer to section 11.6)
- Spillway excavation
  - Spillway excavation (demolition) is likely to occur in non-standard construction hours
  - Noise management principles apply as the maximum predicted noise level exceeds the daytime/evening noise target by 10 dB (refer to section 11.6)
  - Noise levels of up to 57 dBA have been predicted for the reduced activity non-standard construction hours scenario which exceeds the evening external noise target by 7 dB and night time noise target by 22 dB
  - Short term Lmax events of up to 68 dBA have been predicted and exceed the 52 dBA sleep disturbance target
- Spillway construction
  - Noise management principles apply as the maximum predicted noise level exceeds the daytime/evening noise target by 7 dB (refer to section 11.6)
  - Noise levels of up to 56 dBA have been predicted for the reduced activity non-standard construction hours scenario which exceeds the evening external noise target by 6 dB and night time noise target by 21 dB
  - Short term Lmax events of up to 62 dBA have been predicted and exceed the 52 dBA sleep disturbance target
- Clay borrow area
  - Borrow area activities are not expected to occur outside of standard hours
  - No noise level exceedance associated with this construction scenario
- East and west embankment construction
  - Embankment construction activities are not expected to occur outside of standard hours
  - Noise management principles apply as the maximum predicted noise level exceeds the daytime/evening noise target by 10 dB and 14 dB, respectively (refer to section 11.6)
- Saddle dam
  - Saddle dam construction area activities are not expected to occur outside of standard hours
  - No noise level exceedance associated with this construction scenario
- Demobilisation
  - Noise management principles apply as the maximum predicted noise level exceeds the daytime/evening noise target by 12 dB (refer to section 11.6)

Construction Traffic

Staff movements (mostly light vehicles) and haulage of material to/from the site (heavy vehicle movements) would add to the traffic on the existing road network. These movements are assumed to occur during daytime working hours only, except where over-size regulations require transit at other times and for delivery of plant. It is understood that most heavy vehicles required for the Project would utilise Lake Macdonald Drive.

As discussed in Chapter 2 there is likely to be a maximum peak of 110 people at the site during the construction period. For the purposes of a worst-case assessment, it is assumed that all 110 staff will be driving into the site in the peak hour and 25% of the vehicles will be heavy vehicles. It is also assumed that during the peak construction months an additional 10 heavy vehicles (e.g. concrete trucks) will be generated during the peak hour. This equates to approximately 120 vehicle movements per peak period during the peak construction period.

Based on existing traffic volumes on these roads, the introduction of construction or operational traffic to and from the work site is not expected to result in an increase to existing road traffic noise of no more than 2.6 dBA. This falls below the 3 dBA threshold normally adopted for assessment of construction traffic.

11.5.2 Construction Vibration Impacts

The NVIA provided in Appendix K identified the minimum distance required to achieve the building damage criterion is approximately 15 m from construction work.

The nearest vibration sensitive receptors are located approximately 50 m away from the construction area. As such, vibration levels are expected to be below the nominated cosmetic damage thresholds. At 50 m, vibration levels from

the high energy events may be in the order of 1 mm/s Peak Particle Velocity (PPV) which may be perceptible by building occupants.

General vibration management and control recommendations are provided in section 11.6.

11.6 Impact Mitigation and Management

Given the proximity of sensitive receptors to the Project and the intensive nature of the construction works, potential exceedances of the noise targets have been identified for the unmitigated scenario. In accordance with the relevant regulations and standards, all reasonable and practicable mitigation and management measures have been considered.

Recommended mitigation measures to minimise impacts associated with noise and vibration impacts from the Project are provided below in Table 11-7 and discussed further in Appendix K.

Table 11-7: Noise and vibration mitigation measures for the Project

IMPACT AREA	MITIGATION MEASURE	CONSTRUCTION STAGE
Noise management	Noise generating construction works to be carried out within daytime hours (6.30 am to 6.30 pm Monday to Friday, and 6.30 am to 4.00 pm Saturday) No noise generating construction works to be undertaken on Sundays or Public Holidays.	Construction
	Deliveries to be carried out within standard daytime hours where possible. Loading and unloading carried out as far as possible away from sensitive receptors.	Construction
	Trucks are not to queue on public roads near residential dwellings prior to 6.30am.	Construction
	Where possible, plant should be located / orientated to direct noise away from sensitive receptors.	Construction
	Where practical, install acoustic barriers on site at the source, to reduce the impacts of noise at receptors. This may include temporary buildings, site sheds, material stockpiles as noise barriers, installing purpose built noise barriers and maintaining any existing barriers for as long as possible.	Construction
	Site access roads to be located as far as practicable away from noise sensitive areas.	Pre-construction and construction
Construction plant and equipment	All mobile plant and tools to be regularly serviced to reduce excessive noise emissions.	Construction
	All engine and enclosure panels on plant to be kept closed.	Construction
	Plant and equipment should be selected to minimise noise emission, in-so-far-as possible whilst maintaining efficiency of function.	Pre-construction and construction
	Machines found to produce excessive noise should be removed from site or stood down until repairs, modification or replacement can be made.	Construction
	Residential grade mufflers to be fitted and all noise control equipment should be maintained in good order.	Construction

IMPACT AREA	MITIGATION MEASURE	CONSTRUCTION STAGE
	The use of hand tools such as grinders, impact wrenches and hammers are to be used in specifically designated areas as far as possible from residential receptors, and preferably separated by barriers. Metal on metal contact should be avoided where possible.	Construction
	Stationary plant should be located as far from sensitive receptors as possible	Construction
	Mobile plant and trucks operating on site for a significant portion of the Project shall have broadband squawker alarms where practicable (as opposed to tonal type), recognising the need to maintain occupational safety. Reversing alarm alternatives should also be considered as appropriate (e.g. variable-level alarms, non-audible warning systems)	Construction
	Trucks are not to use engine brakes on site.	Construction
	No externally mounted public address systems to be used.	Construction
Work scheduling	Schedule noisy work such that it is undertaken during hours that would least adversely affect sensitive receptors (e.g. daytime for dwellings)	Pre-construction and construction
	Schedule noisy work such that it would coincide with high levels of ambient noise, for example during daytime traffic periods, so that construction noise is partially masked by road traffic	Pre-construction and construction
	Plan truck movements with consideration to the nearest receptors, and also minimising drive and idle time on site	Pre-construction and construction
	Designate, design and maintain access routes to the site to minimise noise and vibration impacts	Pre-construction and construction
	Loading and unloading should be scheduled during hours that would least affect sensitive receptors, and at locations away from sensitive receptors;	Construction
	Scheduling should avoid the coincidence of noisy plant work simultaneously close together, and should aim to minimise consecutive works in the same locality	Construction
Construction vibration control	Where vibration levels from construction activities are projected to exceed 1 mm/s, a dilapidation survey of all potentially affected structures be undertaken prior to construction. Each dilapidation survey report must include at least the following: • A visual inspection of all buildings and structures (more specifically all internal and external walls, ground level floors and pavements, any exposed foundations, connections to other structures above ground level and their connection at ground level) • Photographs of all cracks and/or defects observed A record of the location of all cracks and/or defects observed, and measurements of the crack width/defect size.	Pre-construction and construction

IMPACT AREA	MITIGATION MEASURE	CONSTRUCTION STAGE
Community consultation	A programme of community liaison and complaint response should be implemented.	Pre-construction and construction
	The community is to be kept informed as to the nature, timing and duration of impending works, the nearest sensitive receptors likely to be affected and the monitoring program associated with the impending works.	Pre-construction and construction
Training	Inductions of all employees and subcontractors would be need to be provided as per the Project-specific Environmental Management Plan for which the contractor would provide, this plan would: • Highlight the importance of reducing noise and vibration emissions from construction activity to as low as reasonably practicable in the wider environmental context • Educate staff as to the Project environmental noise and vibration controls in place. A record of all training is to be maintained.	Pre-construction and construction
Complaints handling	Provide a publicly visible and accessible point of contact for complaint handling and community consultation. The contact person would have an adequate level of responsibility to respond to the complaint, and there would be a publicly accessible reception area outside the controlled site area for administration.	Pre-construction and construction
	All noise complaints received would be recorded as per the Contractor's Community Engagement Plan and include the following: • Unique identification number for future reference • Time and date of complaint as received by proponent • Approximate time and date of event associated with the complaint • Complainant(s) location Short description of the noise/vibration (if possible), such as location, activity, duration.	Construction
	Investigation of complaints to be undertaken as follows: • Justifiable complaints, substantiated complaints or widespread complaints to be investigated to determine level of extent and review any mitigation options • An appropriate number of short-term attended noise measurements would be undertaken to accurately determine the cause of substantiated complaint/incidents and to determine how to rectify the situation • Review any unattended noise measurement data obtained relevant to the complaint or incident • Apply noise and/or vibration mitigation • Assess the effectiveness of the mitigation • File incident report • Supply a response in writing within 10 working days of the complaint.	Construction

IMPACT AREA	MITIGATION MEASURE	CONSTRUCTION STAGE
Monitoring	If vibration complaints are received during the construction period, attended vibration monitoring is recommended to be undertaken. All vibration measurements should be conducted using laboratory calibrated equipment. Performance characteristics for the measurement instrumentation should meet the requirements set out in BS 7485 Part 2.	Construction
	On-site noise levels to be monitored regularly by a suitably qualified person in accordance with AS 2436.	Construction
	Noise monitoring is to be undertaken at a sensitive receptor to the east and west of the Project site at a minimum of two locations throughout the construction period. Noise logging should be conducted in accordance with procedures outlined in AS1055-1997 – Acoustics – Description and measurement of environmental noise.	Construction

11.7 Summary

SLR prepared a NVIA for the Project, which is provided in Appendix K. The potential noise impacts associated with construction activities for the Project have been assessed against the EP Act, the EPP (Noise) and BS 7385. Noise monitoring was undertaken at two sites adjacent to the Project from 29 May to 7 June 2018 to quantify the existing acoustic environment and to provide context to the predicted construction emissions.

Construction scenarios with the potential to generate noise impacts were assessed using typical plant items and areas of operation defined across the entire Project area. A three dimensional noise model accounting for the ground terrain has been developed for each construction scenario, for both standard and non-standard working hours where relevant, as well as the respective default weather conditions. Given the scale of the Project area, airborne noise from construction activities was then predicted at identified noise sensitive receptors. The predicted noise levels were then compared to the Project construction noise targets.

Given the close proximity of sensitive receptors to the Project and the intensive nature of the construction works, potential exceedances of the noise targets have been identified. In accordance with the relevant regulations and standards, all reasonable and practicable mitigation and management measures have been considered in these cases. As described in section 11.5, certain construction activities have the potential to exceed the Project construction noise targets (even with mitigation) and therefore community consultation is recommended.

Ground vibration at the distances identified is expected to be compliant with the nominated cosmetic damage criteria. Notwithstanding, any complaints received from receptors throughout the construction period should be investigated.

The mitigation measures proposed in section 11.6 would minimise adverse impacts resulting from noise and vibration.