



Western Ring Route – Waterview Connection



Construction Noise and Vibration Management Plan



This report has been prepared for the benefit of the NZ Transport Agency (NZTA). No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other person.

This disclaimer shall apply notwithstanding that the report may be made available to other persons for an application for permission or approval or to fulfil a legal requirement.

Quality Assurance Statement

Prepared by: Siiri Wilkening, Associate, and James Whitlock,
Consultant (Marshall Day Acoustics)

Reviewed by: Stephen Chiles, Principal (URS)

Approved for Issue by: Siiri Wilkening, Associate (Marshall Day
Acoustics)

Contents

- 1. Introduction 1
- 2. Noise Performance Standards 2
 - 2.1 Construction Noise excluding Blasting 2
 - 2.2 Noise from Blasting 4
- 3. Vibration Performance Standards 5
 - 3.1 Building Damage Risk: DIN 4150-3:1999 5
 - 3.2 Human Response: BS 5228:2009 Appendix B 5
- 4. Key Construction Noise and Vibration Effects 7
- 5. Timeframe..... 9
- 6. Hours of Operation..... 10
- 7. Roles and Responsibilities..... 11
- 8. Training 12
- 9. Monitoring 13
 - 9.1 Noise..... 13
 - 9.2 Vibration 14
 - 9.3 Contingency Measures 15
 - 9.4 Reporting 15
- 10. Procedures for Handling Noise and Vibration Complaints 16
- 11. General Management Procedures and Mitigation Measures 17
 - 11.1 Consultation..... 17
 - 11.2 Training of Personnel..... 18
 - 11.3 Selection of Low Noise and Vibration Plant 18
 - 11.4 Night-Time Operation 18
 - 11.5 Blasting 18

11.6	Noise Barriers and Enclosures	19
11.7	Reversing Alarms.....	19
11.8	Concrete Batching and Crushing Plant Management	19
11.9	Building Condition Surveys.....	20
11.10	Vibration Barriers.....	20
11.11	Mechanical Ventilation of Dwellings	20
11.12	Temporary Resident Relocation	21
11.13	Effects on Housing NZ Properties	21
11.14	Noise Mitigation Option Determination – Hierarchy of Mitigation Options	21
11.15	Site Specific construction noise management plans	22
12.	Sector-specific Noise and Vibration Management and Mitigation Measures.....	24
12.1	Noise Mitigation	24
12.2	Vibration Risk.....	24
12.3	Sector 1 – Te Atatu Interchange	25
12.4	Sector 2 – Whau River	26
12.5	Sector 3 – Rosebank Terrestrial	26
12.6	Sector 4 – Reclamation.....	26
12.7	Sector 5 – Great North Road Interchange.....	27
12.8	Sector 6 – SH16 to St Lukes.....	29
12.9	Sector 7 – Great North Road Underpass	30
12.10	Sector 8 – Avondale Heights Tunnel	31
12.11	Sector 9 – Alan Wood Reserve	33
13.	Construction Noise and Vibration Management Schedule.....	36
14.	CNVMP Review.....	37

Appendices

Appendix A – Glossary of Technical Terminology

Appendix B – Sector Diagram

Appendix C – Response Plans for Construction Vibration Issues

Appendix D – Response Plan for Construction Noise Complaints

Appendix E – Dwellings potentially requiring Mechanical Ventilation due to Batching Plant (Sector 9)

Appendix F – Schedules of at-risk buildings and high-vibration generating equipment

1. Introduction

This Construction Noise and Vibration Management Plan (CNVMP) (the Plan) forms part of a comprehensive suite of environmental controls within the Construction Environmental Management Plan (CEMP) for the construction phase of:

- State Highway: 16 and 20
- Project: The Western Ring Route - Waterview Connection project (“the Project”)
- Construction location: Sectors 1 – 9 (SH20 connection to Te Atatu Interchange & St Lukes Interchange)
- Construction start date: **[Contractor to complete]**
- Construction finish date: **[Contractor to complete]**
- Designation number: **[Contractor to complete]**
- NZTA CSVue permit #: **[Contractor to complete]**

This CNVMP identifies the minimum standards that must be complied with as well as best practicable options for noise and vibration management for the Project. It is intended as a framework for the development of particular noise control practices and procedures to minimise affects on health and safety and to reduce the impact on the environment.

The CNVMP will be updated, with the necessary approval, throughout the course of the Project to reflect material changes associated with any changes to the construction methodologies or techniques or the natural environment. Approval from the [Auckland City] will be required for any relevant revisions of a material nature for the TSMP. The document shall be reviewed yearly to reflect any changes.

The Project is divided into 9 Sectors. A diagram showing the location and the extent of each Sector is attached in Appendix B.

This CNVMP will be implemented in alignment with information, management tools and standards as specified on the NZTA website for the management of transport noise located at <http://acoustics.nzta.govt.nz/construction-noise-management>.

2. Noise Performance Standards

2.1 Construction Noise excluding Blasting

Table 2.1: Project Construction Noise Criteria: Residential Receivers

Time of week	Time period	Project Construction Noise Criteria (Long Term Construction) dB		
		Sectors 1 to 7	Sectors 8 and 9	All Sectors
		$L_{Aeq(10-60 \text{ min})}$	$L_{Aeq(10 - 60 \text{ min})}$	L_{AFmax}
Monday - Saturday	0630-0730	60	45	75
	0730-1800	70	70	85
	1800-2000	65	65	80
	2000-0630	60	45	75
Sundays and Public Holidays	0630-0730	45	45	75
	0730-1800	60	45	85
	1800-2000	45	45	75
	2000-0630	45	45	75

Table 2.2: Project Construction Noise Criteria: Commercial and Industrial Receivers

Time period	Project Construction Noise Criteria (Long Term Construction) dB
	$L_{Aeq(10-60 \text{ min})}$
0730 - 1800	70
1800 - 0730	75

Table 2.3: Project Construction Noise Criteria: Internal for Residential Receivers

Time period	Project Construction Noise Criteria (Inside)	Habitable Rooms
0730 - 1800	35 dB $L_{Aeq(16h)}$	All habitable rooms
1800 - 0730	30 dB $L_{Aeq(8 \text{ h})}$	Bedrooms

The following activities require specific mitigation in order to achieve compliance with the Project construction noise criteria above.

Daytime

- Retaining wall construction, road milling, road construction and surfacing, cycle underpass construction (Sector 1)

- Bridge pad footing construction, precast segment delivery/craning, span finishing, bridge surfacing (Sector 3 – industrial receivers only)
- Most activities associated with the Great North Road interchange (Sector 5)
- Retaining wall construction, construction of additional lanes (Sector 6)
- Most activities associated with the construction of the northern portal (Sector 7)
- Emergency smoke stack installation by helicopter (Sector 8)
- Preliminary portal works with equipment at ground level, grout curtain, road construction and finishing, basalt crushing (Sector 9)

Night Time

- Road construction and surfacing (Sector 1)
- Bridge pad footing construction (Sector 3)
- Most activities associated with the Great North Road interchange (Sector 5)
- Construction of additional motorway lanes (Sector 6)
- Most activities associated with the construction of the northern portal (Sector 7)
- Richardson Road overbridge segment launching and finishing (Sector 9)
- Contractor Yard operation (Sector 9)

2.2 Noise from Blasting

Noise from blasting shall be predicted, measured and managed in accordance with *AS 2187.2:2006 Explosives - Storage, transport and Use. Part 2: Use of Explosives*.

Table 2.4: Project Construction Noise Criteria: Airblast

Category	Type of Blasting Operations	Peak Sound Pressure Level (L_{Zpeak} dB)
Human Comfort Limits		
Sensitive Site	Operations lasting longer than 12 months or more than 20 Blasts	115 dB for 95% blasts per year. 120 dB maximum unless agreement is reached with occupier that a higher limit may apply
Sensitive Site	Operations lasting less than 12 months or less than 20 Blasts	120 dB for 95% blasts per year. 125 dB maximum unless agreement is reached with occupier that a higher limit may apply
Occupied non-sensitive sites such as factories and commercial premises	All blasting	125 dB maximum unless agreement is reached with the occupier that a higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specifications of levels that can be shown to adversely affect the equipment operation
Damage Control Limits		
Structures that include masonry, plaster and plasterboard in their construction and also unoccupied structures of reinforced concrete or steel construction	All Blasting	133 dB unless agreement is reached with owner that a higher limit may apply.
Service structures such as pipelines, powerlines and cables located above ground	All Blasting	Limit to be determined by structural design methodology

3. Vibration Performance Standards

Two construction vibration standards have been adopted for use in this Project:

- DIN 4150-3:1999 for building damage risk and
- BS 5228:2009 for human response

3.1 Building Damage Risk: DIN 4150-3:1999

Table 3.1: Summary of Building Damage criteria

Type of structure	Short-term vibration			Long-term vibration	
	PPV at the foundation at a frequency of			PPV at horizontal plane of highest floor	PPV at horizontal plane of highest floor
	1 - 10Hz	1 - 50 Hz	50 - 100 Hz		
Commercial/Industrial	20	20 - 40	40 - 50	40	10
Residential/School	5	5 - 15	15 - 20	15	5
Historic or sensitive structures	3	3 - 8	8 - 10	8	2.5

A statistical method may be applied to the assessment of blasting activities (which are categorised as short term activities in Table 3.1 above). This methodology requires that vibration from each and every blast is measured. Survey results are used to ensure that activities are conducted so that 95 % of the 20 most recent events, measured on the foundation of any building, produce peak particle velocities not exceeding the criteria specified for short-term activities in Table 3.1 above, and 100 % of the measured events do not exceed twice these criteria.

3.2 Human Response: BS 5228:2009 Appendix B

The criteria in British Standard BS 5228:2009 (Appendix B.2) shall be used for the management of complaints relating to construction vibration. Compliance with the criteria set out in Table 3.2 below are not mandatory, but provide contextual information on people's expected response to vibration.

Table 3.2: Human Response to Vibration

Vibration level (PPV)	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 mm/s	Vibration might be just perceptible in residential environments
1.0 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

4. Key Construction Noise and Vibration Effects

The Project construction involves significant numbers of machinery operating in close proximity to noise and/or vibration sensitive receivers. Night-time construction is required in certain areas.

The primary effects of construction noise relate to annoyance and disturbance of people.

The primary effects of construction vibration relate to building damage. Secondary vibration effects relate to annoyance and disturbance of people. Responding to and mitigating the primary (building damage) effects often alleviates the secondary (annoyance) effects.

A list of the predominant noise and vibration generating activities in each Sector are outlined in Table 4.1 below:

Table 4.1: Key Construction Noise and Vibration Activities

Sector	Noise generating activities	Vibration generating activities
1	Base course and sealing of SH16 and Te Atatu Interchange Noise barrier construction	Vibratory rollers for base course and sealing of SH16 and Te Atatu Interchange
2	Piling for bridge construction Road milling and sealing	Piling for bridge construction
3	Bridge construction and surfacing Road widening and sealing	Vibratory rollers for base course and sealing of SH16
4	Causeway fill delivery for construction/ reclamation Piling Road sealing	Vibratory rollers for base course and sealing of SH16, and piling for bridge abutments
5	Interchange ramp footing and segment construction Piling Concrete batching	Vibratory rollers for base course and sealing of on-grade ramps
6	Piling, blasting and rockbreaking for widening works and retaining walls	Piling, blasting and rockbreaking for widening works and retaining walls Vibratory rollers for base course and sealing of on-grade ramps
7	Piling for diaphragm wall Excavation Road realignment and resurfacing	Piling for diaphragm wall Excavation plant Vibratory rollers for road realignment and resurfacing

Sector	Noise generating activities	Vibration generating activities
8	Tunnelling (road header or excavators) Construction of emergency smoke extract vent and services building Helicopter delivery of materials	Tunnelling (road header or excavators)
9	Blasting for portal construction Drilling for portal construction and grout curtain Rock breaking for portal construction Piling for portal construction Road basecourse and sealing Crushing of basalt Batch plant operation House demolition Noise barrier construction	Blasting for portal construction Drilling for portal construction and grout curtain Rock breaking for portal construction Piling for portal construction Vibratory rollers for road construction

Other construction machinery and activities, not specified in the above table, will produce noise and ground vibration also, but generally to a lesser degree.

5. Timeframe

The overall construction timeframe for the entire Project is expected to be five and a half years. This will comprise of the following activities:

- Tunnel construction: 4 years
- Te Atatu Interchange: 4 years
- Causeway and the Whau River bridge construction: 5 years
- Great North Road interchange: 2 years
- Widening works on SH16: 1 year
- SH20 from tunnel to Maioro Interchange: 1 year

6. Hours of Operation

Hours of operation are generally:

- Sectors 1, 2, 3, 5, 6, 7 and 9: Generally daytime operation, 6 days per week. Some night-time operation for specific areas.
- Sector 4: Causeway construction will occur at varying times throughout any 24 hour period at low tide.
- Sector 8: Tunnelling: 24 hours per day, 7 day per week

Blasting activities shall occur between 9 am and 5 pm, Monday to Saturday, only.

7. Roles and Responsibilities

Section 3.1 of the CEMP details roles and responsibilities associated with managing environmental effects from construction on the Project. The contractor will appoint a Contractor Environmental Manager who has the overall responsibility for the implementation of this CNVMP, including all required noise and vibration monitoring, and leading the review of results with appropriate communication to Local Authorities and the NZTA.

The following is a schedule of contact details for key personnel connected to the Construction Phase of the Project: **[The following schedule of contact details shall be completed by the contractor prior to commencement of the Project]**

Table 7.1 Schedule of Contact Details

Role	Name	Organisation	Phone	Email
Contractor Environmental Manager				
Client		NZTA		
Engineer				
Project Acoustic and Vibration Consultants				
Contractor				
Contractor's acoustics advisor				
Council - Noise/ Environmental Health				
Public complaint contact number				

[Contractor to insert name and company of appropriate person] will be responsible for ensuring that this CNVMP is correctly implemented. He/she will review all documentation relating to construction noise and vibration before it is issued.

All site personnel will be required to read this CNVMP and sign appropriate induction forms and any relevant schedules. All personnel working on the Project, including Contractor employees and subcontractors, are responsible for following the requirements of this CNVMP.

8. Training

Environmental training for all staff will be undertaken as part of the site induction programme as described in section 3.2 of the CEMP. Training for all site personnel shall be undertaken as part of the site induction programme. This requires all new staff to participate in an induction training session when they commence work, and regular (annual as a minimum) refresher courses.

Environmental Induction will include information on the following aspects of this CNVMP:

- Roles and responsibilities for management of Project noise and vibration issues
- Designation requirements/conditions
- Information about noise and vibration sources on site, and locations of critical receiver positions
- Noise and vibration management procedures
- Complaints management procedures

If required, training of site personnel in matters relating to construction noise and vibration will be provided by a suitably qualified person.

9. Monitoring

9.1 Noise

Construction noise levels shall be monitored and assessed:

- generally in accordance with the requirements of NZS 6801:2008 “Acoustics - Measurement of Environmental Sound”, NZS 6802:2008 “Acoustics - Assessment of Noise” and NZS 6803:1999 “Acoustics - Construction Noise”
- at monthly intervals throughout construction, but not at pre-arranged times
- as and when required, during critical phases of construction, i.e. when possible exceedance of the Project noise criteria is anticipated
- in response to reasonable noise complaints being received
- at locations representative of sensitive receivers in the vicinity
- at 1 metre from the most affected façade, or, if this position is not accessible, at an equivalent position where practicable. If this is not possible, measured noise levels shall be adjusted for distance and façade reflections if necessary.
- to reflect representative construction activities, and shall be no less than 10 minutes and longer than 60 minutes duration. The measured noise level shall be stated with the measurement duration: $L_{Aeq(T)}$
- by a suitably qualified acoustic specialist
- for any and all blasting activities (this would typically be undertaken by the blasting contractor)

General monitoring locations may include, but are not limited to:

- Sector 1: Residential areas near Te Atatu Interchange
- Sector 2: Residential areas overlooking bridge widening
- Sector 5: Residential areas located near retaining structures
- Sector 6: Adjacent to Ramp 2 and Ramp 4
- Sector 7: Adjacent to the tunnel portal

- Sector 8: Dwellings located above the tunnelling operation
- Sector 9: Adjacent to the tunnel portal, Richardson Road underpass and Contractor's Yard 10

9.2 Vibration

Prior to construction, trial measurements of high-vibration activities (including blasting) shall be undertaken to establish Project specific ground attenuation characteristics and safe distances to inform the risk categories for the vibration schedules (refer Section 12 below).

During construction, vibration levels shall be monitored and assessed:

- generally in accordance with the requirements of DIN 4150-3:1999
- at monthly intervals throughout construction at high risk receivers as set out in the vibration schedules
- as and when required, during critical phases of construction, i.e. when possible exceedance of the Project vibration criteria is anticipated
- in response to reasonable vibration complaints being received
- to reflect representative construction activities, and shall comprise measurements of peak particle velocity (PPV) at one second intervals
- by a suitably qualified and experienced specialist

The monitoring and complaints management procedure for vibration sources other than blasting is outlined in the second flowchart (for continuous vibration sources) attached in Appendix C.

For blasting activities:

- each and every blast shall be monitored by the blasting contractor at the high-risk receiver(s) in the vicinity (or equivalent location if access to the building structure is not granted)
- the criteria in DIN 4150-3:1999 apply, however the statistical method outlined in Section 3.1 above shall be applied such that 95% of all measurements must comply with the DIN criteria, and 100% of all measurements must comply with twice these criteria.

The monitoring and complaints management procedure for blasting is outlined in the first flowchart (for impulsive vibration sources) attached in Appendix C.

9.3 Contingency Measures

In the event that a measurement shows non-compliance with the Project criteria, the following procedures shall be implemented:

- For vibration, a building condition survey shall be undertaken and a report prepared by a suitably qualified person, including photographs, detailing the state of repair of the existing structure, and an opinion as to whether any damage may be due to construction activity.
- For noise, further measurements shall be undertaken where necessary, to determine the extent of non-compliance.
- A report shall be prepared, outlining the non-compliance and, if required, potential mitigation and management measures.
- Upon implementation of any additional mitigation measures, further measurements shall be undertaken to confirm the effectiveness of those mitigation measures.
- The Contractor Environmental Manager shall liaise with affected receivers throughout this process.

9.4 Reporting

Any noise, vibration or building condition surveys shall be summarised in a report, to be submitted to the Contractor Environmental Manager within one week of the assessment. Monitoring records shall be kept at the site office and made available upon request.

10. Procedures for Handling Noise and Vibration Complaints

Complaints procedures are detailed in section 3.6.1 of the CEMP. As part of the liaison process, affected parties shall be informed to direct noise and/or vibration complaints to the Contractor Environmental Manager. A flowchart outlining the process for noise complaints is contained in Appendix D.

The following complaint procedures shall be followed:

- The Contractor shall maintain a 24 hour hotline and this number shall be displayed in all consultation material and other publications
- Upon receiving a complaint, the complainant's name, contact details and the nature of their complaint will be noted and immediately forwarded to a designated Contractor staff member
- The Contractor staff member shall contact the complainant within one hour during the day and 15 minutes at night (10:00 pm to 7:00 am), or as soon as practicable thereafter, to address their concerns
- If practicable and appropriate, construction workers shall be instructed to modify the activity of concern and the complainant shall be informed
- If the complaint is in regards to building damage from construction vibration, the activity of concern shall cease and a building condition survey shall be undertaken. Flowcharts outlining the processes for blasting and other vibration sources are contained in Appendix C.

For on-going complaints, the Project Manager shall request additional measurements by a suitably qualified and experienced acoustic specialist targeting the specific noise or vibration source. The investigation of an ongoing noise or vibration complaint may include the following:

- Identification of noise or vibration inducing activities at the time of complaint, and measurement and assessment of noise or vibration levels from these activities
- Determination of the best practicable mitigation options in conjunction with the Contractor Environmental Manager
- Measurement of noise or vibration levels following implementation of mitigation action(s)
- Communication with complainant
- Reporting of findings and actions to the Contractor Environmental Manager

In addition, a complaints file will be maintained at the Project office, and available for inspection during normal office hours by affected parties and the relevant local authority.

11. General Management Procedures and Mitigation Measures

The following sections outline noise and vibration management and mitigation measures that shall be implemented throughout construction of the Project.

Sector specific mitigation measures are provided in Section 12 of this CNVMP and shall be implemented in addition to the general measures outlined below.

11.1 Consultation

Consultation with affected parties shall be carried out prior to commencement of construction activities as follows:

- Receivers within **100 metres** of the construction area: Written notification and a Project description shall be provided to raise awareness of the Project, its expected activities and duration in the vicinity.

For blasting activities, written notification shall be provided for all receivers within **200 metres**.

Where noisy activities are to be conducted during the night-period, it should be suggested to residents that they keep their windows shut when sleeping.

- Receivers within **50 metres** of the construction area: Individual notification shall be provided and opportunity made available for discussions on a case-by-case basis, if required by the occupants/owners.
- Receivers within **20 metres** of the construction area: Individual discussions shall be held and, if required, suitable alternatives and/or mitigation options explored that are acceptable to both parties. Ongoing consultation shall be carried out throughout the duration of construction.

For vibration, the distances specified above represent a suitable basis for standard consultation practice.

Further detail on identifying at-risk receivers in each Sector in relation to construction noise and vibration effects are contained in Schedules [xx] in Appendix F. **[Schedules xx of at-risk buildings and high-vibration equipment shall be completed by the contractor prior to commencement of the Project]**

11.2 Training of Personnel

All personnel on site shall be made aware of the importance of operating in the least disruptive manner. All personnel working on the Project, including Contractor employees and subcontractors, shall be familiar with, and be responsible for, implementing this CNVMP.

11.3 Selection of Low Noise and Vibration Plant

Low noise and vibration plant shall be selected and used wherever practicable. Where plant is identified as being particularly noisy and/or vibration inducing, action shall be taken to reduce emissions. This may involve the fitting of mitigation measures, such as silencers, enclosures or isolation pads. Plant shall be maintained to ensure that noise and vibration emissions remain as low as practicable.

11.4 Night-Time Operation

In close proximity to residences, high-noise and/or vibration activities shall be scheduled for the daytime where practicable, and avoided during the night-time.

In close proximity to schools and commercial buildings, high-noise and/or vibration activities shall be scheduled during the evening and night-time period where this is practicable.

For contractors yards located adjacent to noise sensitive receivers, noisy vehicles shall enter and leave the site during daytime hours, where practicable. Where this is not practicable, truck routes shall be chosen so as to minimise disruption to sensitive receiver positions.

11.5 Blasting

If blasting is required, this shall be notified at least 24 hours in advance to all receivers within 200 metres of the blast site. Blasts shall be performed at set times during the daytime between 9:00am and 5:00pm Monday to Saturday only.

Blasting activities will generate the highest noise and vibration levels of all construction activities. Prior to blasting works commencing, the blasting contractor shall undertake trial blasts to assess the potential for noise and vibration effects on critical receivers, and design the blasting programme.

In areas close to sensitive receivers alternative rock excavation methods shall be implemented, such as hand-drilling for small MICs, or PCF (gas).

Noise and vibration monitoring shall be undertaken for every blast to assess compliance and effects on critical buildings and building occupants. Blasting records shall be kept at the site office with weekly reports submitted to the Contractor Environmental Manager.

11.6 Noise Barriers and Enclosures

In areas where the Project noise criteria may be exceeded, noise barriers shall be used where they provide effective mitigation (i.e. break acoustic line-of-sight and are close to either the source (preferable) or the receiver).

Where practicable, permanent (traffic) noise barriers required for operational noise mitigation following completion of the Project shall be erected early during construction. This is relevant for Sectors 1, 6 and 9 specifically where substantial traffic noise barriers are required. Permanent noise barriers can be constructed in their final form and utilising the proposed final materials. Alternatively, permanent framing of barriers can be used in conjunction with temporary barrier materials such as plywood which, after completion of construction, can then be replaced with permanent materials. This may be practicable where permanent materials may be damaged by construction activities.

Temporary noise barriers shall be utilised for those areas where no permanent noise barriers are required or where these cannot be practicably implemented early during construction. Temporary barriers are typically constructed from plywood, shall contain no gaps and be of sufficient height to screen line-of-sight between the receiver and the source. Alternative barrier constructions may include fibre cement, shipping containers or mass-loaded vinyl etc

Where a noise barrier is not sufficient to achieve compliance with the Project noise criteria, an enclosure may be used where practicable, i.e. stationary plant such as conveyors or crushers. The enclosure shall be designed by a suitably qualified and experienced acoustic specialist.

11.7 Reversing Alarms

All equipment operating on any of the Project construction sites during night-time shall be fitted with alternatives to tonal reversing alarms. Such alternatives may include, but not be limited to, broadband auditory devices, visual signals, etc.

11.8 Concrete Batching and Crushing Plant Management

The concrete batching plants required in Sectors 5 and 9 will operate 24 hours per day, 7 days per week. The basalt crushing plant will operate in Sector 9 during daytime only.

The contractor must therefore ensure that all practicable noise mitigation measures are implemented at all plants.

Specific management and mitigation measures for the concrete batching plants and crushing plant are set out in the Concrete Batching and Crushing Plant Management Plan (CBCPMP).

11.9 Building Condition Surveys

Prior to the commencement of Project construction operations, a detailed pre-construction building condition survey of identified at-risk buildings, services and structures shall be conducted by a suitably qualified engineer. The survey shall include, but not be limited to, the following:

- Existing condition of buildings, services or structures, including existing levels of any aesthetic damage or structural damage
- Record (including photographs) of the major features of the buildings, services and structures including location, type, construction, age and present condition, including defects
- Foundation type of the building, service or structure
- Preparation of a report recording the findings of the survey. A copy of each report shall be forwarded to the Contractor Environmental Manager and kept at the site office
- Resurvey of buildings, services and structure, which are the subject of complaints or if the vibration criteria have been exceeded and there is potential for damage to have occurred
- Within six months of completion of the Project, a detailed post-construction condition survey of the same buildings, services and structures shall be conducted and a report prepared

11.10 Vibration Barriers

Vibration barriers can provide limited attenuation for ground-borne vibration. Accordingly, the practicability of implementing vibration barriers shall be assessed on a case-by-case basis by a suitably qualified and experienced specialist.

Vibration barrier options include, but are not limited to; open trenches, backfilled trenches, concrete-filled trenches, sheet pile walls, concrete pile walls, grout curtains etc.

The required depth of the barrier is based on the frequency characteristics of the vibration source.

11.11 Mechanical Ventilation of Dwellings

Where external windows of a residence must be closed in order to achieve compliance with the internal night-time Project noise criteria, the installation of mechanical ventilation shall be considered for that residence. This shall be investigated only after all other general noise management and mitigation have been deemed impracticable.

11.12 Temporary Resident Relocation

Where all practicable noise and vibration management and mitigation measures have been implemented, but compliance with the Project criteria is still not achievable, relocation of affected receivers may need to be considered.

Relocation shall be considered in exceptional cases only, and expert advice from a suitably qualified and experienced acoustics specialist shall be sought.

11.13 Effects on Housing NZ Properties

Where any HNZN properties and/or tenants are affected by the management of noise and vibration effects under *11. General Management Procedures and Mitigation Measures*, which include but are not limited to,

- proposed temporary relocation or
- other mitigation measures e.g. glazing of windows, alternative ventilation, insulation in cavities etc

HNZN shall be notified immediately in writing by the Project Manager.

In notifying HNZN, the Project Manager ensures all management of construction noise and vibration effects shall be undertaken at the applicants' cost, guided by both the Corporations Relocation Policy for relocation of its tenants, as well as being in accordance with agreed protocols of the MOU between the NZTA and HNZN.

11.14 Noise Mitigation Option Determination – Hierarchy of Mitigation Options

In the event that potential non-compliance with the construction noise criteria of Section 2 of this Plan have been determined, appropriate mitigation options will be determined following the hierarchy set out below. Each question shall be considered in sequence before moving onto the next option.

1. Is it imperative that night-time works are undertaken, or can works be rescheduled to daytime?
2. Have equipment and methodologies been chosen that reduce the overall noise from the activity? Can quieter alternative equipment or methodologies be practicably implemented?
3. Can temporary construction noise barriers or screens be erected within the designation that provide effective acoustic shielding of the equipment/activity?
4. Can the works be sequenced to avoid sensitive times for neighbouring residents/businesses, e.g. can works be scheduled for school holidays?

5. Have affected persons be contacted and implications be discussed/feedback been taken into consideration in the planning of this activity?
6. When appropriate, have residents been offered temporary relocation to suitable alternative accommodation, and have they accepted the offer?
7. Is the activity of long duration and likely to impact on the same group of residents for an extended time? Can affected houses be upgraded to provide a suitable internal noise environment during this activity, e.g. by installing alternative ventilation/improved glazing? (Advice from a suitably qualified acoustic engineer required)

11.15 Site Specific construction noise management plans

For any construction activities that have the potential to breach the noise criteria, as set out in Section 2, a noise assessment will be undertaken and a Site Specific Noise Management Plan (SSNMP) will be prepared and held with the CNVMP (CEMP).

Where the modelled/predicted noise levels are greater than the noise criteria in Section 2 by less than 5 dBA, all practicable measures will be implemented as per the CNVMP with an aim to achieve compliance with the construction noise criteria (this is provided for on the assumption that the noise levels of Section 2 will generally be able to be met with implementation of mitigation). Monitoring of these works will be undertaken to confirm that the actual noise levels are less than or equal to the predicted levels. The SSNMP will be available for Auckland Council certification if requested.

If the measured noise levels are higher than the predicted noise levels and exceed the noise criteria in Section 2, those works shall cease and a Site Specific Construction Noise Management Plan (SSNMP) will be submitted to Auckland Council for certification.

Where the modelled/predicted noise levels are 5 dBA or more above the noise criteria in Section 2, a SSNMP will be submitted to Auckland Council for certification prior to works commencing.

Notwithstanding the requirement to submit a SSNMP, noise mitigation measures will continue to be implemented as per the CNVMP and reviewed/monitored to confirm compliance and effectiveness of the plan. This includes the overall aim to achieve compliance with the relevant project noise criteria.

The likelihood of exceedance shall be determined by utilising appropriate prediction tools, e.g. the calculation tools of NZTA, specifically the NZTA NZS 6803 Tool:

[http://acoustics.nzta.govt.nz/monitoring-prediction-assessment/ construction-maintenance-noise](http://acoustics.nzta.govt.nz/monitoring-prediction-assessment/construction-maintenance-noise)

The SSNMP shall contain, to an appropriate detail:

- The activity and location proposed;

- Timing/duration;
- Equipment utilised;
- Predicted noise levels;
- Identified dwellings at which compliance cannot be achieved with conventional mitigation measures;
- Alternative management and mitigation measures proposed.

The SSNMP shall be submitted to the Council Noise Officer and Council Compliance Officer for review and certification at least 7 working days prior to the proposed works commencing. Certification or otherwise will be provided by the Council within 5 working days of receipt of the SSNMP. Works will not commence until certification is received from Auckland Council.

The above is not required for emergency works or similar circumstances where the potential non-compliance could not be foreseen.

12. Sector-specific Noise and Vibration Management and Mitigation Measures

12.1 Noise Mitigation

Sections 12.3 to 12.11 below outline site specific noise mitigation measures that are required in each of the Project Sectors in addition to the general measures noted in Section 11 above.

Noise mitigation and management shall be implemented throughout the Project.

12.2 Vibration Risk

The primary management measure for vibration is to identify and develop awareness of vibration risk, i.e. which construction sources impose a risk of exceeding the Project criteria. The tables in the following sections specify key vibration sources and their 'design safe distances'.

The design safe distances are based on theoretical models, and should be updated to become 'safe distances' (i.e. no longer for design purposes only) as site-specific measurement data becomes available.

The 'safe distances' shall be used to identify at-risk receivers.

Risk is categorised as Low, Medium or High and each risk category requires specific actions to be undertaken when working in those areas, as follows:

High Risk: Receivers that are located within the 'design safe distance'

- Individual discussion with building owners and ongoing consultation
- Building condition survey prior to construction
- Site-specific vibration measurements to assess damage risk

Med Risk: Receivers that are close to the 'design safe distance' (safe distance + 20%)

- Notification of building owners and opportunity for discussion if requested
- Site-specific vibration measurements to assess damage risk if requested

Low Risk: Receivers that are further than the 'design safe distance' + 20%

- Notification of building owners

12.3 Sector 1 – Te Atatu Interchange

Table 12.1: Sector 1 Specific Noise Mitigation

Activity	Mitigation Measures	Detail
<ul style="list-style-type: none"> Road Milling Road Construction and Surfacing 	Night-time restriction of noisy activities	<ul style="list-style-type: none"> noisy activities to be programmed for daytime restrict night-time works to quieter activities for construction activities during both daytime and night-time, works should be scheduled to ensure that operation nearest to dwellings occurs during the day period with night-time operation occurring as far from dwellings as possible.
<ul style="list-style-type: none"> Road Construction and Surfacing 	Noise barriers	<ul style="list-style-type: none"> installation of traffic noise barriers shall be programmed for construction early in the construction period, if practicable. if not practicable, localised screening around noisy equipment or screening at property boundaries
<ul style="list-style-type: none"> Pedestrian cycle underpass 	Cover cut early on	<ul style="list-style-type: none"> construction should be performed underneath the cover as early on in the construction period as possible excavation should be performed from underneath the capping, if practicable.

Retaining wall construction, road milling, road construction and surfacing and cycle underpass construction are all likely to exceed the Project noise criteria.

Estimated design safe distances for vibration including activities in Sector 1 are shown in Table 12.2 below.

Table 12.2: Estimated design safe distances for vibration from construction activities in Sector 1

Source	Design safe distance
Vibratory rollers for road construction	15 m
Excavators	3 m

12.4 Sector 2 – Whau River

No specific noise mitigation measures are required for Sector 2.

Estimated design safe distances for vibration inducing activities in Sector 2 are shown in Table 12.3 below.

Table 12.3: Estimated design safe distances for vibration from construction activities in Sector 2

Source	Design safe distance
Vibratory rollers for road construction	15 m
Piling for bridge abutments	18m

12.5 Sector 3 – Rosebank Terrestrial

Bridge pad footing construction, precast segment delivery/craning, span finishing and bridge surfacing are all activities that are likely to exceed the Project noise criteria. For these activities, the general noise mitigation measures outlined in Section 11 shall be implemented and are considered the best practicable mitigation options.

Estimated design safe distances for vibration inducing activities in Sector 3 are shown in table 12.4 below.

Table 12.4: Estimated design safe distances for vibration from construction activities in Sector 3

Source	Design safe distance
Vibratory rollers for road construction	8 m

12.6 Sector 4 – Reclamation

Compliance with the Project noise and vibration criteria is anticipated for Sector 4.

12.7 Sector 5 – Great North Road Interchange

Table 12.5: Sector 5 Specific Noise Mitigation Measures

Activity	Mitigation Measures	Detail
<ul style="list-style-type: none"> • Contiguous bored piling • Pad footing construction or pier construction • Precast segment delivery, etc. • Span finishing • Sealing works 	<p>Noise Barriers</p>	<ul style="list-style-type: none"> • temporary noise barriers to be erected around noisy activities such as drilling, jack hammering, noisy hand tools, concrete slumping areas, cranes, concrete pumping plant, etc • temporary noise barriers not required for certain activities if the activities are restricted to daytime hours or to distances greater than set out below
	<p>Night-time restriction of noisy activities</p>	<ul style="list-style-type: none"> • where practicable, noisy operations on the ramps shall be scheduled for daytime where operational areas are close to receivers or noise sensitive activities • night-time construction shall be scheduled for ramp structures that are located further from residential areas (Ramp 1, 3 and some parts of 4) • recommended minimum distances between dwellings and activities for night-time construction operation are: <ul style="list-style-type: none"> ▪ Contiguous bored piling – 200m ▪ Pad footing construction or pier construction – 300m ▪ Precast segment delivery, etc. – 120m ▪ Span finishing – 120m ▪ Sealing works – 100m
	<p>Resident relocation</p>	<ul style="list-style-type: none"> • where night construction must occur in close proximity to dwellings and no other mitigation measure is found to be practicable, affected residents may need to be temporarily relocated where noise levels would exceed the Project criteria • relocation should be considered on a case-by-case basis. Before the implementation of this measure, advice shall be sought from an acoustic specialist

Activity	Mitigation Measures	Detail
Batch plant operation	Enclosure/operation	<p>night-time operation of the batch plant in Construction Yard 6 will require the following noise mitigation measures:</p> <ul style="list-style-type: none"> • Batch plant located as far as possible from sensitive receivers • Enclosure of mixing vessels or dry mixing hoppers • Enclosure of conveyors • Enclosure or screening of truck load-out area • Truck slumping below ground level where practicable • Daytime operation of equipment such as loaders. Conveying of material to be used in preference to driven loaders • Noise barriers located around concrete batch plant • Batch plant designed and located such that reversing of trucks is not required • Enclosure and treatment of other noisy equipment where identified • Driver and operator education regarding noise mitigation

Estimated design safe distances for vibration inducing activities in Sector 5 are shown in Table 12.6 below.

Table 12.6: Estimated design safe distances for vibration from construction activities in Sector 5

Source	Design safe distance
Vibratory rollers for road construction	30m
Piling	25m

12.8 Sector 6 – SH16 to St Lukes

Table 12.7: Sector 6 Specific Noise Mitigation Measures

Activity	Mitigation Measures	Detail
<ul style="list-style-type: none"> Retaining Wall Construction Construction of additional lanes 	Noise barriers	<ul style="list-style-type: none"> installation of permanent traffic noise barriers shall be programmed early in the construction programme if practicable otherwise, localised screening around noisy equipment or screening at property boundaries will be required
	Night-time restriction of noisy activities	<ul style="list-style-type: none"> noisy activities shall be programmed to occur during the daytime, with night-time activities restricted to quieter activities
	Resident relocation	<ul style="list-style-type: none"> where night construction must occur in close proximity to dwellings and no other mitigation measure is found to be practicable, affected residents may need to be temporarily relocated where noise levels would exceed the Project criteria relocation should be considered on a case-by-case basis. Before the implementation of this measure, advice shall be sought from an acoustic specialist
<ul style="list-style-type: none"> Construction Yard 	Noise barriers	<ul style="list-style-type: none"> temporary noise barriers on the western and northern sides of the yard limit operation of material handling and lime drying on site during the night time period

Estimated design safe distances for vibration inducing activities in Sector 6 are shown in Table 12.8 below.

Table 12.8: Estimated design safe distances for vibration from construction activities in Sector 6

Source	Design safe distance
Vibratory rollers for road construction	30m
Piling for Carrington Road Bridge	25m

12.9 Sector 7 – Great North Road Underpass

Table 12.9: Sector 7 Specific Mitigation Measures

Activity	Mitigation Measures	Detail
<ul style="list-style-type: none"> Cut and cover tunnelling 	Top down construction	<ul style="list-style-type: none"> top down construction is the preferred methodology from a noise perspective
<ul style="list-style-type: none"> Great North Road realignment Retaining wall construction Vent building construction Construction Yard 7 	Night-time restriction of noisy activities Noise Barriers	<ul style="list-style-type: none"> all noisy surface activity (i.e. pre-tunnel capping) shall be performed during the day-period where practicable noise barriers may be required if surface night-time operation is undertaken
<ul style="list-style-type: none"> Great North Road realignment Retaining Wall Structure 	Resident relocation	<ul style="list-style-type: none"> where night construction must occur in close proximity to dwellings and no other mitigation measure is found to be practicable, affected residents may need to be temporarily relocated where noise levels would exceed the Project criteria relocation should be considered on a case-by-case basis. Before the implementation of this measure, advice shall be sought from an acoustic specialist

Estimated design safe distances for vibration inducing activities in Sector 7 are shown in table 12.10 below.

Table 12.10: Estimated design safe distances for vibration from construction activities in Sector 7

Source	Design safe distance
Vibratory rollers for road construction	30m
Piling for secant pile and diaphragm walls	25m

12.10 Sector 8 – Avondale Heights Tunnel

Table 12.11: Sector 8 Specific Mitigation Measures

Activity	Mitigation Measures	Detail
Tunnelling (Continued overleaf)	Choice of methodology	<ul style="list-style-type: none"> conventional excavator/trucks should be considered in the selection of an appropriate methodology as they result in lower re-radiated noise
	Daytime operation	<ul style="list-style-type: none"> at commencement of construction, noise levels from tunnelling are expected to be above the Project night-time noise criteria where the tunnelling has not yet progressed deep inside the tunnel, a restriction to daytime operation may be required until sufficient depth is obtained to mitigate noise
	Tunnel breakout noise control	<ul style="list-style-type: none"> at commencement of construction, noise levels from tunnelling are expected to be above the Project night-time noise criteria if night-time operation is required, noise emissions may be reduced through the provision of baffles or acoustic screens at the outlet of the tunnel.

Activity	Mitigation Measures	Detail
Tunnelling (Continued)	Resident relocation	<ul style="list-style-type: none"> if internal noise levels are unreasonable due to re-radiated noise, temporary relocation of residents may be required relocation may be required for around 7 days at the worst affected locations
	Monitoring	<ul style="list-style-type: none"> noise levels should be monitored at receivers from the beginning of the tunnel construction, and as needed throughout data obtained should be used to update the noise mitigation measures required
Above ground activity	Conveyors	<ul style="list-style-type: none"> conveyors between the construction face and the construction yards should be selected to be as quiet as possible conveyors may require enclosure
Helicopter delivery	Scheduling	<ul style="list-style-type: none"> helicopter delivery of materials shall occur for no more than 10 times in any month residents within 200 metres shall be notified in advance of the helicopter delivery schedule a tight timeframe shall be maintained

Estimated Design safe distances for vibration inducing activities in Sector 8 are shown in table 12.12 below.

Table 12.12: Estimated design safe distances for construction activities in Sector 8

Source	Design safe distance
Tunnelling: Road header	6m
Tunnelling: Excavator – Bucket only	2m
Tunnelling: Excavator mounted rockbreaker	4m

12.11 Sector 9 – Alan Wood Reserve

Table 12.13: Sector 9 Specific Mitigation Measures

Activity	Mitigation Measures	Detail
Operation occurring at ground level for: <ul style="list-style-type: none"> • Southern portal construction • Roading construction • Richardson Road overbridge • Contractor Yards 9 and 10 	Noise Barriers	<ul style="list-style-type: none"> • for noisy operation occurring at ground level, provide noise barriers between noisy sources and nearby receivers • permanent traffic noise barriers should be constructed early in the programme to provide acoustic screening of dwellings • for dwellings that are not protected by noise barriers, provide temporary noise barriers for the duration of above-ground construction. • contractor yards should be surrounded with solid hoarding where this provides line-of-sight screening between noise sources and dwellings
Richardson Road Overbridge construction	Daytime Operation	<ul style="list-style-type: none"> • Richardson Road overbridge construction has the potential to exceed the Project night-time criterion • noisy activities should be programmed to occur during the daytime, with night-time activities restricted to quieter activities • where night-time operation is critical, temporary noise barriers should be implemented around noisy sources
Batch plant (Continued overleaf)	Location, enclosures and alternatives	<ul style="list-style-type: none"> • batch plants required for 24 hour use will require noise control measures to be applied. • the batch plant should be located on the edge of the cut and designed such that the batch plant can load out to trucks below • design of the batch plant in this manner will ensure that trucks do not need to be loaded out and slump at ground level.

Activity	Mitigation Measures	Detail
Batch Plant (Continued)	Location, enclosures and alternatives	<p>Noisy areas of the batch plant will need to be enclosed or screened from surrounding receivers.</p> <p>Mitigation may include but shall not be limited to:</p> <ul style="list-style-type: none"> • Batch plant located as far from receivers as possible; • Enclosure of mixing vessels or dry mixing hoppers; • Enclosure of conveyors; • Enclosure of truck loadout area. Alternatively the batch plant may be able to be constructed such that trucks remain inside the tunnel cutting and are loaded out from above; • Truck slumping to occur in the tunnel cutting and not at ground level where practicable; • Daytime operation of equipment such as loaders. Conveying of material to be used in preference to driven loaders; • Noise barriers located around concrete batch plant yard; • Batch plant designed and located such that reversing of trucks is not required; • Enclosure and treatment of other noisy equipment where identified; and • Good driver and operator education regarding noise mitigation. <p>Dwellings within 150 metres of the batch plant may still experience noise levels of above 45 dB $L_{Aeq(t)}$ during night-time. If noise levels from the batch plant exceed the Project criteria, mechanical ventilation/air conditioning may need to be provided where external windows need to remain shut. The affected area is shown in Appendix E.</p> <p>The following alternative locations should also be considered for the batch plant:</p> <ul style="list-style-type: none"> • at the bottom of the cut near the southern portal (this will result in noise sources being further from residents and very well screened by the edges of the cut) • in the industrial area to the east of the operation (Stoddard Road Area), or in an industrial area further afield, together with a combination of noise enclosure and screening (truck movements to and from the tunnel would be well screened by cuttings, however temporary noise barriers may be required at some locations)

Activity	Mitigation Measures	Detail
Crushing	Management and location	<ul style="list-style-type: none"> • crushing plant shall be enclosed, where practicable, with a well sealed enclosure with lined feed and output conveyor chutes • a large sheet steel enclosure lined internally with a heavier panel such as fibre cement may be the best solution • crushing shall occur during the daytime only • choose quiet plant for operation in and around the crusher, such as quiet loaders.
Blasting	Notification	<ul style="list-style-type: none"> • blasting shall occur between the hours of 9am and 5pm, Monday to Saturday only • predictions of blast overpressure shall be performed prior to any blasting and charge sizes selected to ensure that the Project noise criteria are complied with • residents within 200 metres of the blast shall be notified prior to blasting
All operation	Resident relocation / façade improvements	<ul style="list-style-type: none"> • where noisy construction techniques are critical and must occur regardless of the exceedance of the Project noise criteria, temporary relocating of affected residents shall be considered on a case-by-case basis • where residents are unwilling to relocate or the construction period is sufficiently long as to make relocation not practicable, the improvement of the sound insulation of dwelling façades should be considered as an alternative, on a case-by-case basis and only after all other practicable noise control options have been considered.

Preliminary portal works with equipment at ground level, grout curtain, road construction and finishing, basalt crushing, Richardson Road overbridge segment launching and finishing and contractor yard operation may all exceed the Project noise criteria. Within this sector, careful implementation of the general and specific noise mitigation measures is necessary and all practicable steps should be taken to reduce noise emissions.

Estimated design safe distances for vibration including activities in Sector 9 are shown in Table 12.14 below.

Table 12-14: Estimated design safe distances for construction activities in Sector 9

Source	Design safe distance
Vibratory rollers for road construction	30m
Drilling for grout curtain and secant piles	15m
Piling	25m
Rockbreakers	15m
Blasting	Depends on Charge Weight

13. Construction Noise and Vibration Management Schedule

Once the contractor has defined the construction methodology and all proposed plant and equipment, management schedules for construction noise and vibration shall be prepared for each Sector.

The vibration schedules (Schedules [xx] in Appendix F) shall detail high-vibration equipment, their safe distances and all sensitive receivers within the high and medium risk categories (refer Section 12.2).

The noise schedules (Schedules [xx] in Appendix F) shall detail high-noise equipment and all sensitive receivers as follows:

- for daytime work: within the 20 metre and 50 metre categories and
- for night-time work: within the 20 metre, 50 metre and 100 metre categories (refer Section 11.1)

The schedules shall be completed prior to commencement of construction works in each Sector. An example schedule can be found at <http://acoustics.nzta.govt.nz/file/construction-noise-management-schedule-template>.

14. CNVMP Review

This CNVMP, including environmental controls and procedures, shall be reviewed to ensure that it remains applicable to the activities being carried out.

The CNVMP will be reviewed by the contractor after confirmation of the resource consent and designation conditions and will be revised in accordance with these conditions. The CNVMP will be updated, with the necessary approval, throughout the course of the Project to reflect material changes associated with changes to construction techniques or the natural environment. Approval from the [Auckland Council] will be required for any relevant revisions of a material nature for the CNVMP

A management review of the CNVMP will be undertaken at least annually by the Project Management team and the NZTA Environmental Representative. The management review will be organised by the Environmental Manager, and the Project team will be informed of any changes to this plan through the regular project communications processes.

The review will take into consideration:

- Significant changes that affect the noise and/or vibration generation
- Key changes to roles and responsibilities within the Project
- Changes in industry best practice standards
- Changes in methodology or management in response to noise and/or vibration monitoring showing non-compliance
- Changes in legal or other requirements (social and environmental legal requirements, consent conditions, NZTA objectives and relevant policies, plans, standards, specifications and guidelines)
- Public complaints

Reasons for making changes to the CNVMP will be documented. A copy of the original CNVMP document and subsequent versions will be kept for the Project records, and marked as obsolete. Each new/updated version of the CNVMP documentation will be issued with a version number and date to eliminate obsolete CNVMP documentation being used.

APPENDIX A

Glossary of Terminology

Parameter	Description
dB	A measurement of sound level which has its frequency characteristics modified by a filter (A-weighted) so as to more closely approximate the frequency bias of the human ear.
$L_{Aeq(60 \text{ min})}$	The A-weighted, time averaged sound level (on a logarithmic/energy basis) over the measurement period.
L_{A95}	The sound level which is equalled or exceeded for 95% of the measurement period.
L_{A90}	The sound level which is equalled or exceeded for 90% of the measurement period. L_{A90} is an indicator of the mean minimum noise level and is used in New Zealand as the descriptor for background noise (normally A-weighted).
L_{A10}	The sound level which is equalled or exceeded for 10% of the measurement period.
L_{AFmax}	The maximum sound level recorded during the measurement period (normally A-weighted).
L_{Zpeak}	The peak instantaneous pressure level recorded during the measurement period (flat weighted (Z)).
Noise	A sound that is unwanted by, or distracting to, the receiver.
NZS 6801:2008	New Zealand Standard NZS 6801:2008 " <i>Acoustics - Measurement of Sound</i> "
NZS 6802:2008	New Zealand Standard NZS 6802:2008 " <i>Acoustics - Environmental Noise</i> ".
NZS 6803:1999	New Zealand Standard NZS 6803:1999 " <i>Acoustics - Construction Noise</i> ".
Ambient Noise	Ambient Noise is the all-encompassing noise associated with any given environment and is usually a composite of sounds from many sources near and far.

Vibration

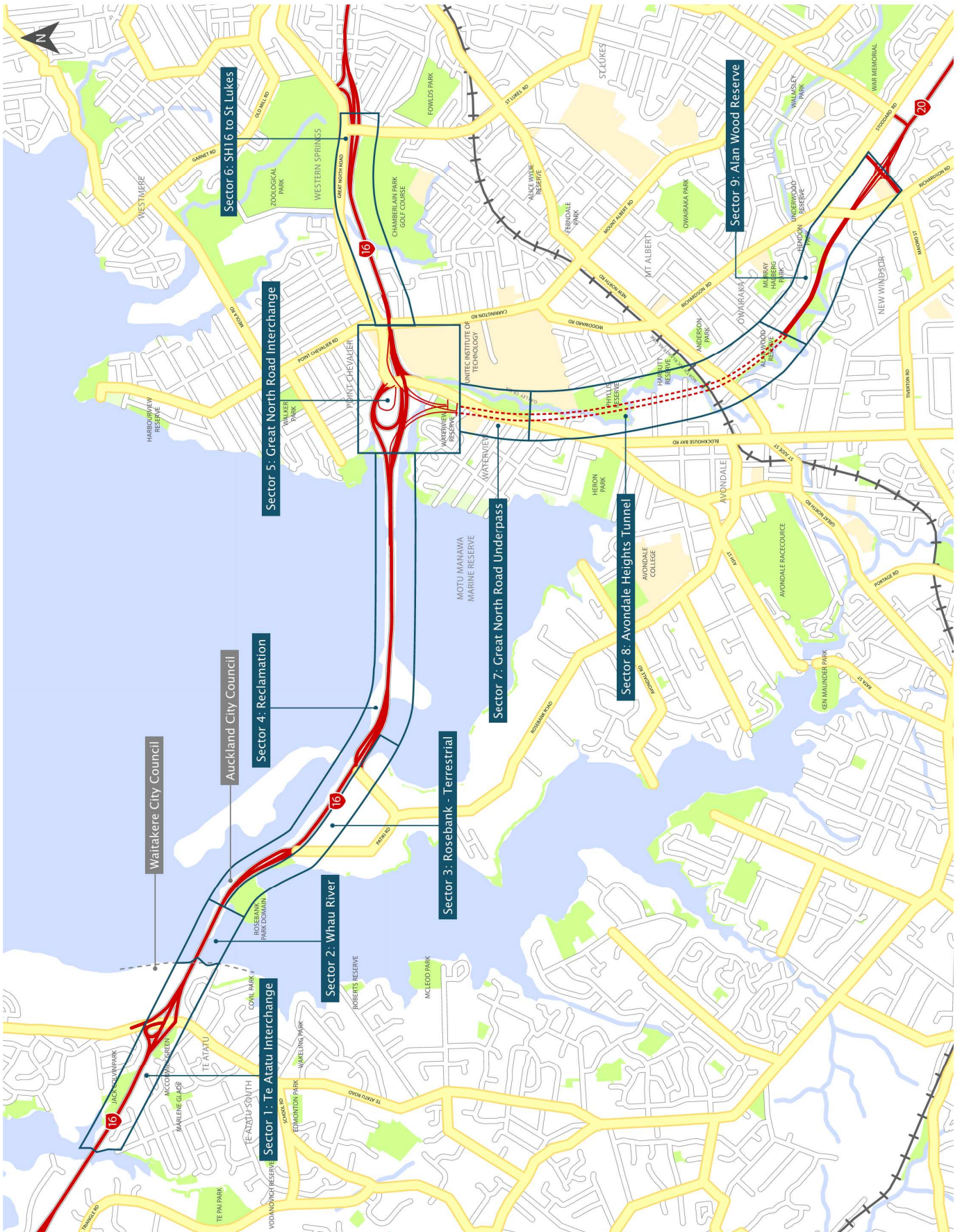
PPV	Peak Particle Velocity, measured in mm/s. This is the standard metric for assessing construction vibration levels.
DIN 4150-3:1999	German Standard DIN 4150-3:1999 “Structural Vibration – Part 3: Effects of vibration on structures”. This standard generally adopted in NZ to assess building damage.
BS 5228-2:2009	British Standard BS 5228-2:2009 “Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration”. This is the standard adopted for this Project to assess human response to construction.
MIC	Maximum Instantaneous Charge Weight. In blasting, this is the weight of explosive (in kg) used.

General

CNVMP	Construction Noise and Vibration Management Plan. This document
AEE	Assessment of Environmental Effects. A document relating to, and assessing the effects of a specific element of the Project e.g. Noise, Air Quality, Traffic, Vibration

APPENDIX B

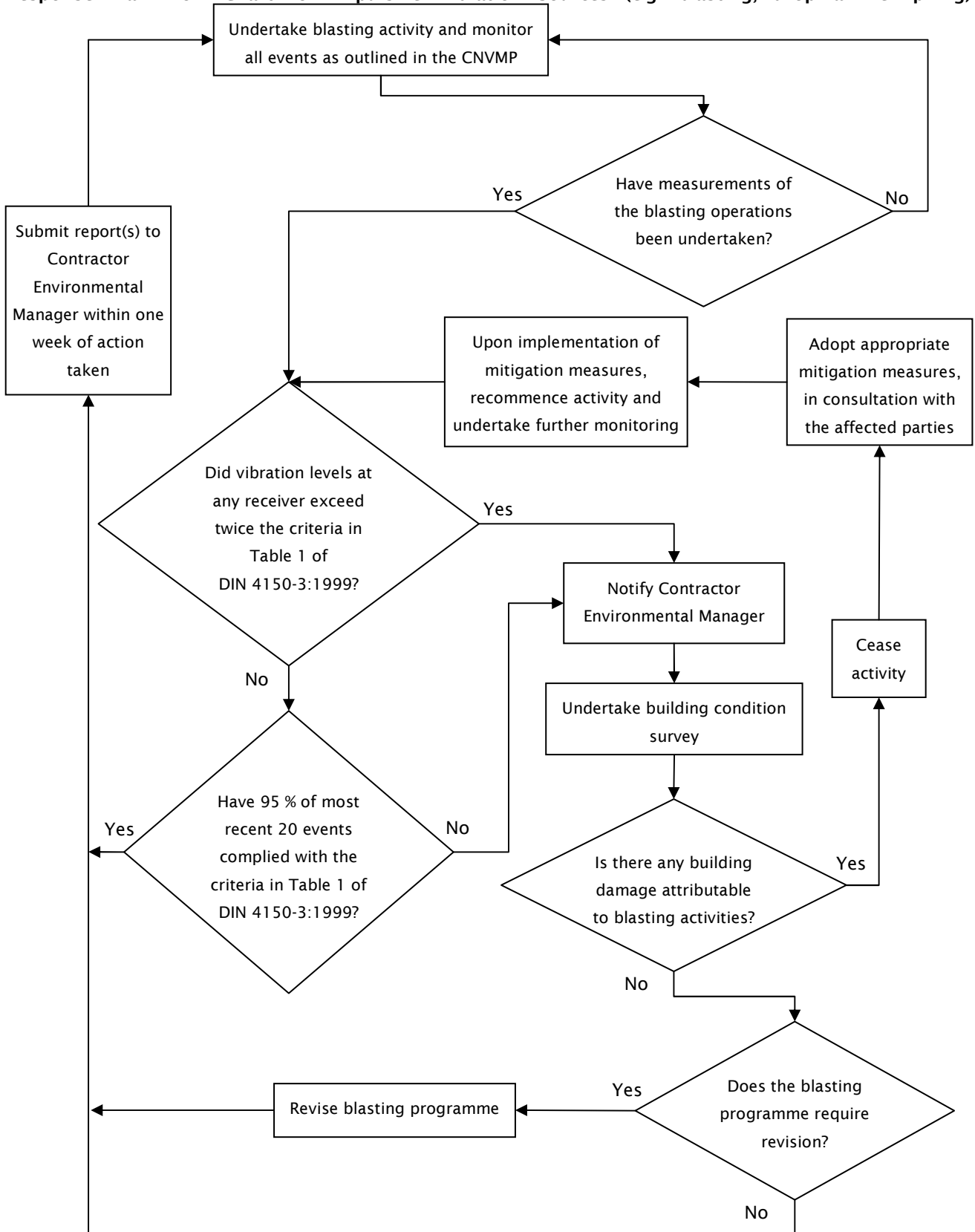
Project Sector Diagram



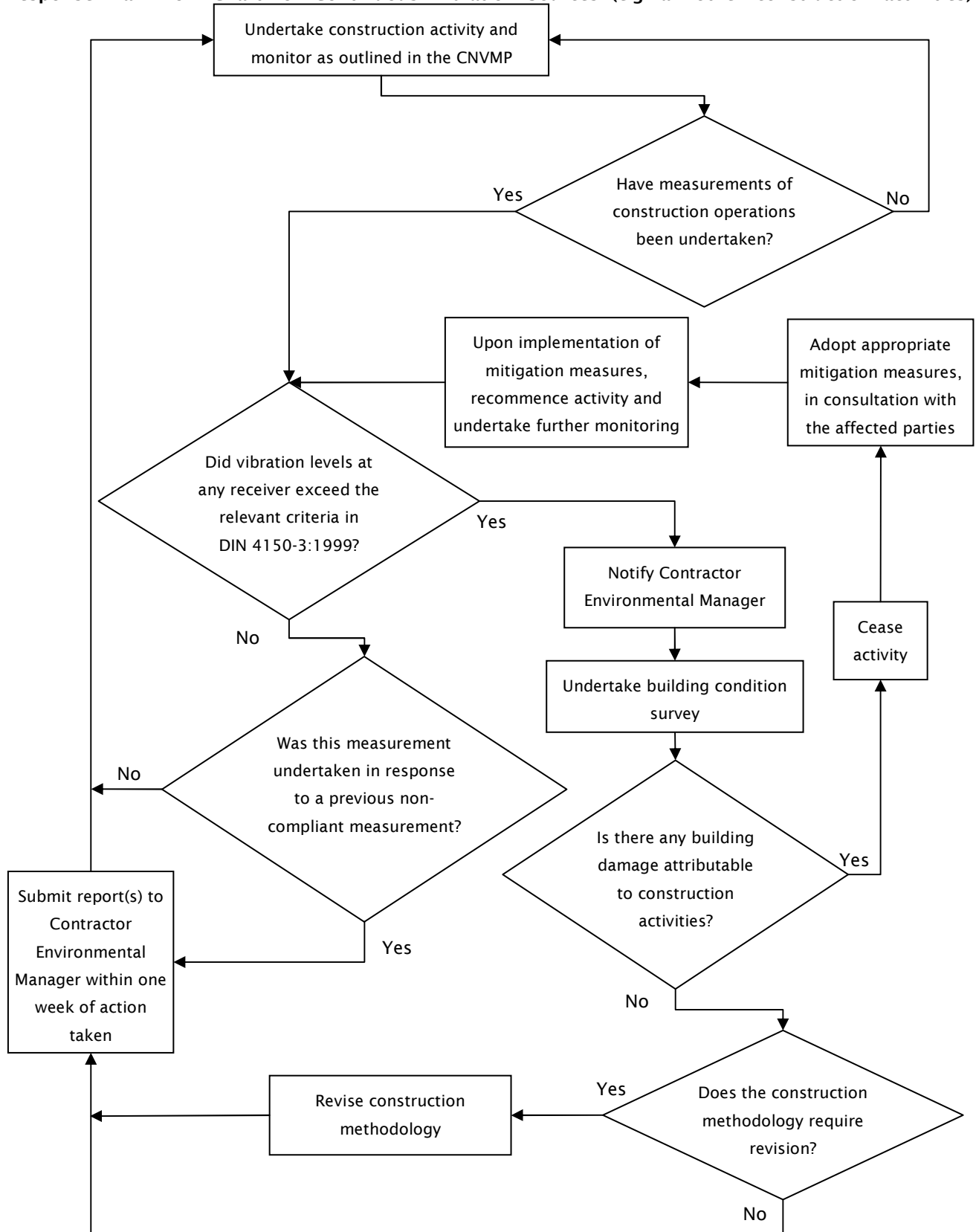
APPENDIX C

Response Plans for Construction Vibration Issues

Response Plan Flow Chart for Impulsive Vibration Sources (e.g. blasting, drop-hammer piling)



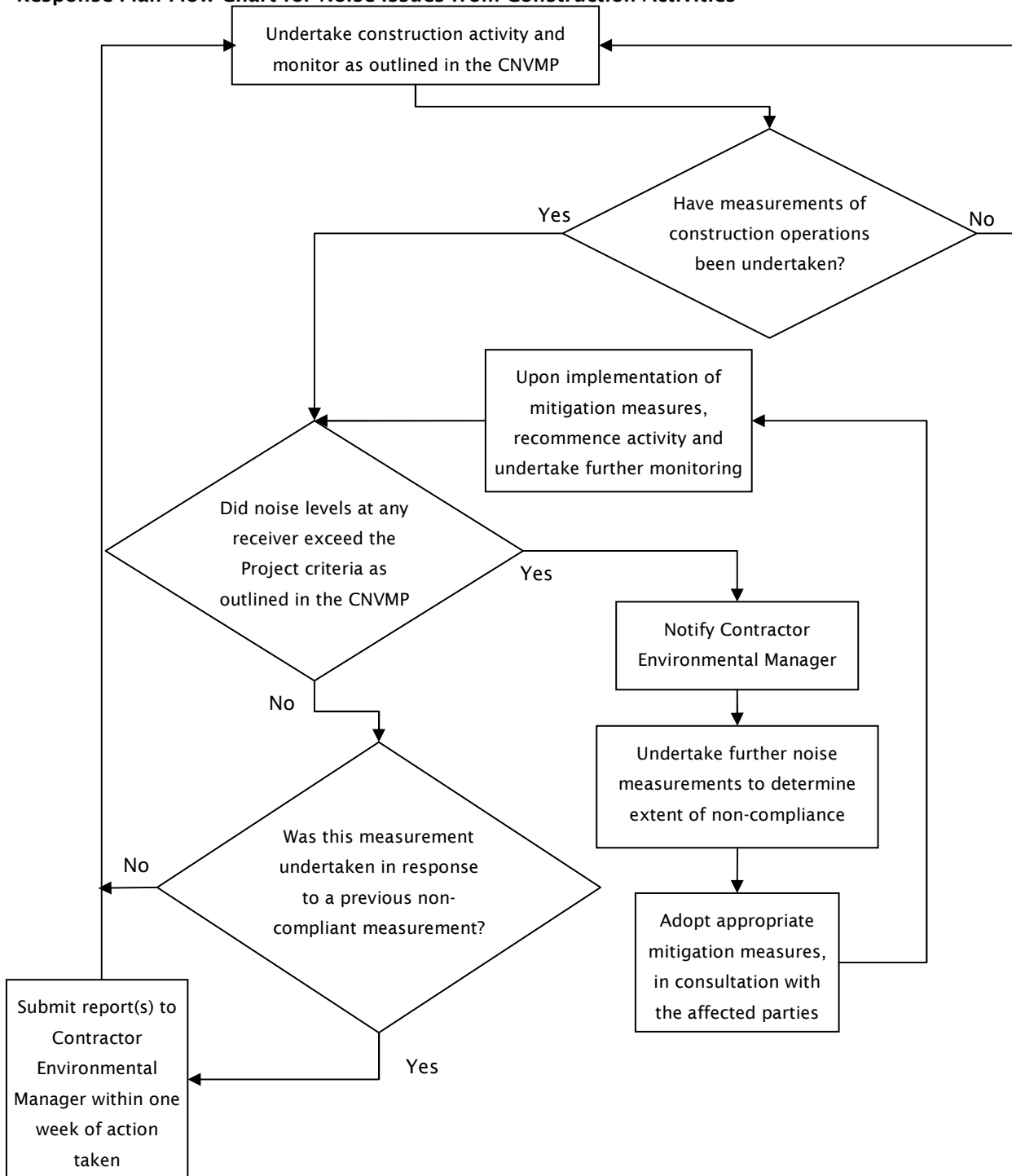
Response Plan Flow Chart for Continuous Vibration Sources (e.g. all other construction activities)



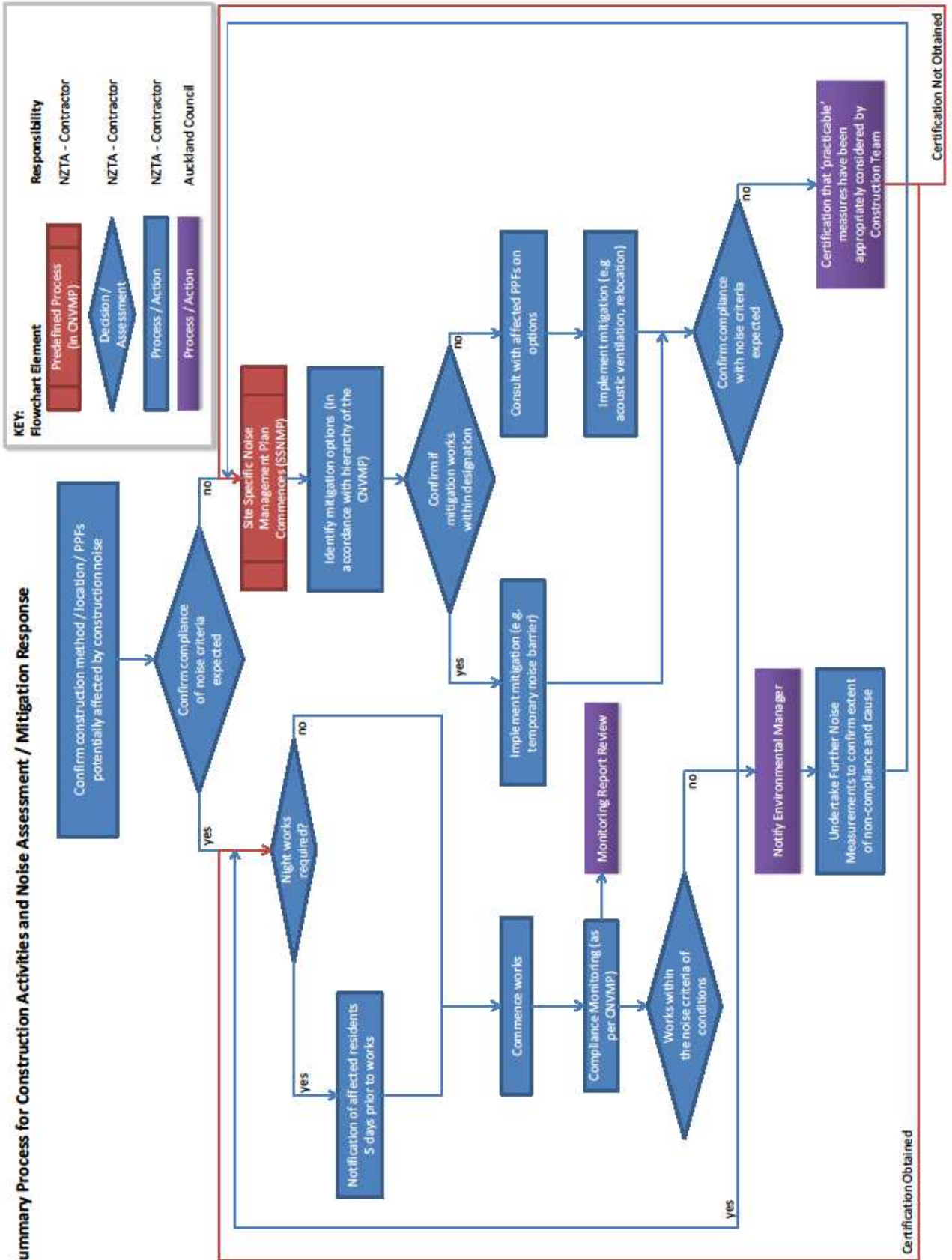
APPENDIX D

Response Plan for Construction Noise Issues

Response Plan Flow Chart for Noise Issues from Construction Activities

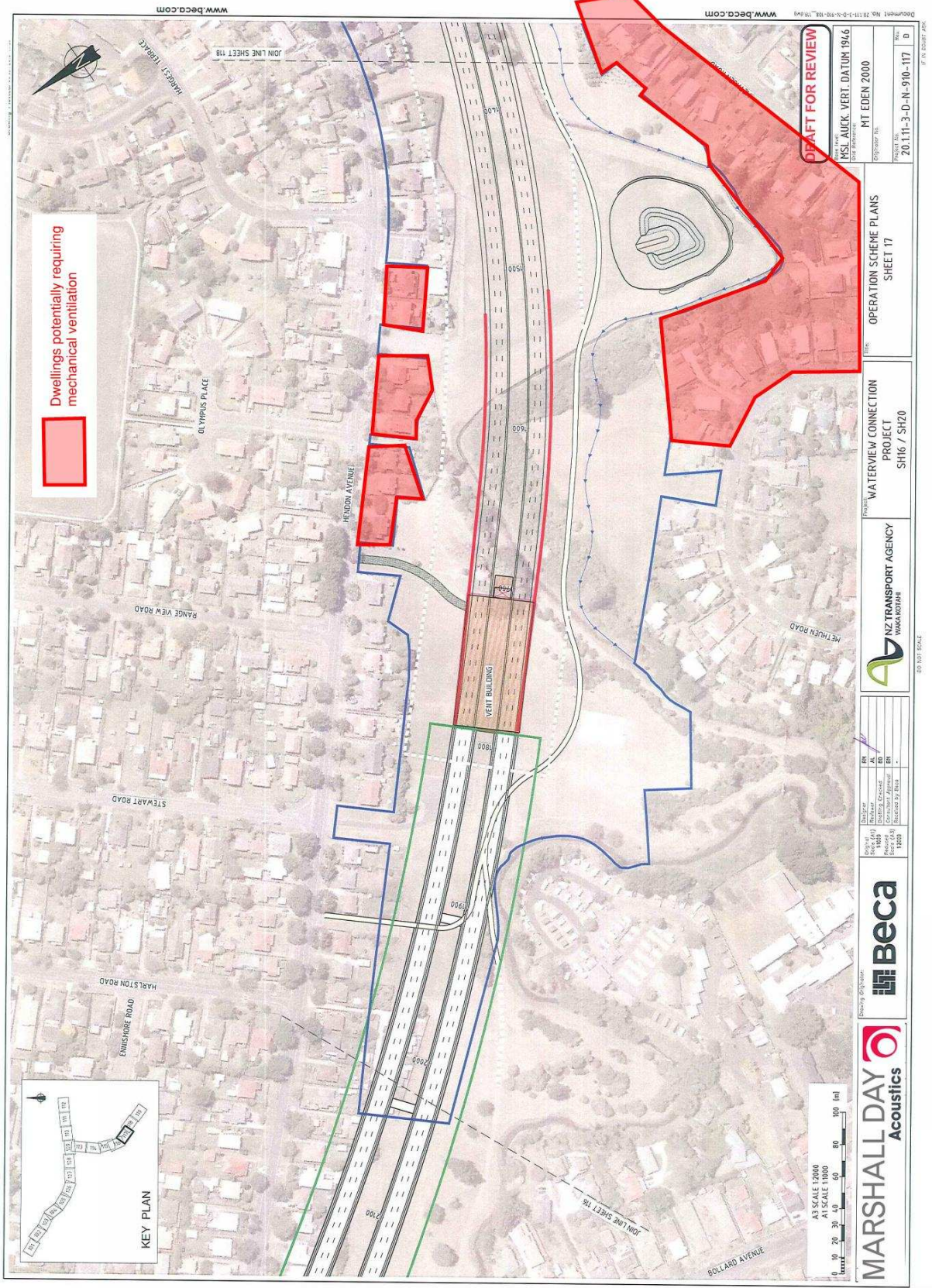


Summary Process for Construction Activities and Noise Assessment / Mitigation Response



APPENDIX E

Dwellings potentially requiring mechanical Ventilation due to Batching Plan (Sector 9)



Dwellings potentially requiring mechanical ventilation

DRAFT FOR REVIEW

MSL AUCK. VERT. DATUM 1946
 Date of Revision: MT EDEN 2000
 Project No: 20.1.11-3-D-N-910-117
 Rev: D

OPERATION SCHEME PLANS
 SHEET 17

WATERVIEW CONNECTION
 PROJECT
 SH16 / SH20

ANZ TRANSPORT AGENCY
 WAKA MOTARA

Drawn	AL
Checked	AL
Reviewed	AL
Approved	AL
Received	AL
Received by	AL

Beca

MARSHALL DAY Acoustics

APPENDIX F

Schedules of at-risk buildings and high-vibration generating equipment

[Schedules of at-risk buildings and high-vibration equipment shall be completed by the contractor prior to commencement of the Project]