REPORT

Tonkin+Taylor

NZ Cherry Corp

PC14 Noise Assessment

Prepared for
NZ Cherry Corp (Leyser) LP Limited
Prepared by
Tonkin & Taylor Ltd
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Appendix A : Glossary of terms

1 Introduction

NZ Cherry Corp (Leyser) LP Limited (NZ Cherry Corp) has engaged Tonkin & Taylor Ltd (T+T) to provide an acoustic assessment in relation to a Private Plan Change Request (PC14) to Sections 4 and 19 of the Operative Central Otago District Plan (CODP). This report assesses the noise effects associated with PC14 from existing sources of noise generation in the local area and from future PC14 land uses (including reverse sensitivity).

1.1 Background

NZ Cherry Corp owns the property located at 144 Ripponvale Road, Cromwell (herein referred to as "the site"). The site (see Figure 1.1) comprises 244 ha in western Cromwell, along the base of the Pisa Range.

Nearby properties (within ~1 km of the site boundary) include Rural (Ru)/Rural Residential (RR) zonings and are developed for pastoral/agricultural/horticultural use with associated dwellings and outbuildings (e.g. garages, sheds). Exceptions include the Cromwell Racecourse and the Cromwell Aerodrome, located southwest of the nearest site boundary at distances of approximately 0.3 km and 0.6 km, respectively. Further afield, the suburban extents of Cromwell are located approximately 1 km to the east and the Highlands Motorsport Park is located approximately 2 km to the south. Pastoral farming occupies the land adjoining the western and northern boundaries of the site. Cherry growing is the main horticultural land use surrounding the site and is located on parts of the southern and eastern boundaries of the site. Vines are also located in the surrounding area.

The site can be broadly separated into three topographical zones: the eastern zone of the site is generally flat or gently sloping, the central zone has low, undulating hills, and the western zone rises steeply into the Pisa Range, where a portion has been classified as an Outstanding Natural Landscape (ONL).

Figure 1.1: Aerial view of the site (reproduced from WSP Opus (July 2018) Preliminary Site Investigation: 144 Ripponvale Road, Cromwell)

The site is currently located within a Rural Resource Area. In its application for a private plan change, NZ Cherry Corp proposes the following (see Figure 1.2):

- Developing a 29 ha section for horticultural activity as an extension to the existing NZ Cherry Corp orchard;
- Providing for 142 ha to enable up to 160 rural lifestyle allotments;
- Expanding the adjacent ONL; and
- Providing for communal outdoor spaces/easements to encompass the balance of the site.

In submissions to the Central Otago District Council (CODC), concerns have been raised regarding the potential for adverse noise effects. These concerns relate to noise effects on future residential occupants due to existing offsite sources, specifically horticulture activities in the local area, and the orchard extension. Submissions which identify potential noise effects are summarised in Section 4.

This assessment has been undertaken to:

- Identify and characterise noise sources received at the site, and evaluate their significance to current and future residents;
- Provide comment on the potential for reverse sensitivity effects;
- Inform the design and layout of the PC14 site to mitigate potential future noise issues; and
- Establish noise performance standards for the site taking into account the Central Otago District Plan, NZ Standards and WHO guidance.
- Recommend measures to manage potential noise and reverse sensitivity effects.

This report has been undertaken in accordance with our engagement dated 14 February 2020.

A glossary of terms is included at the end of this report.

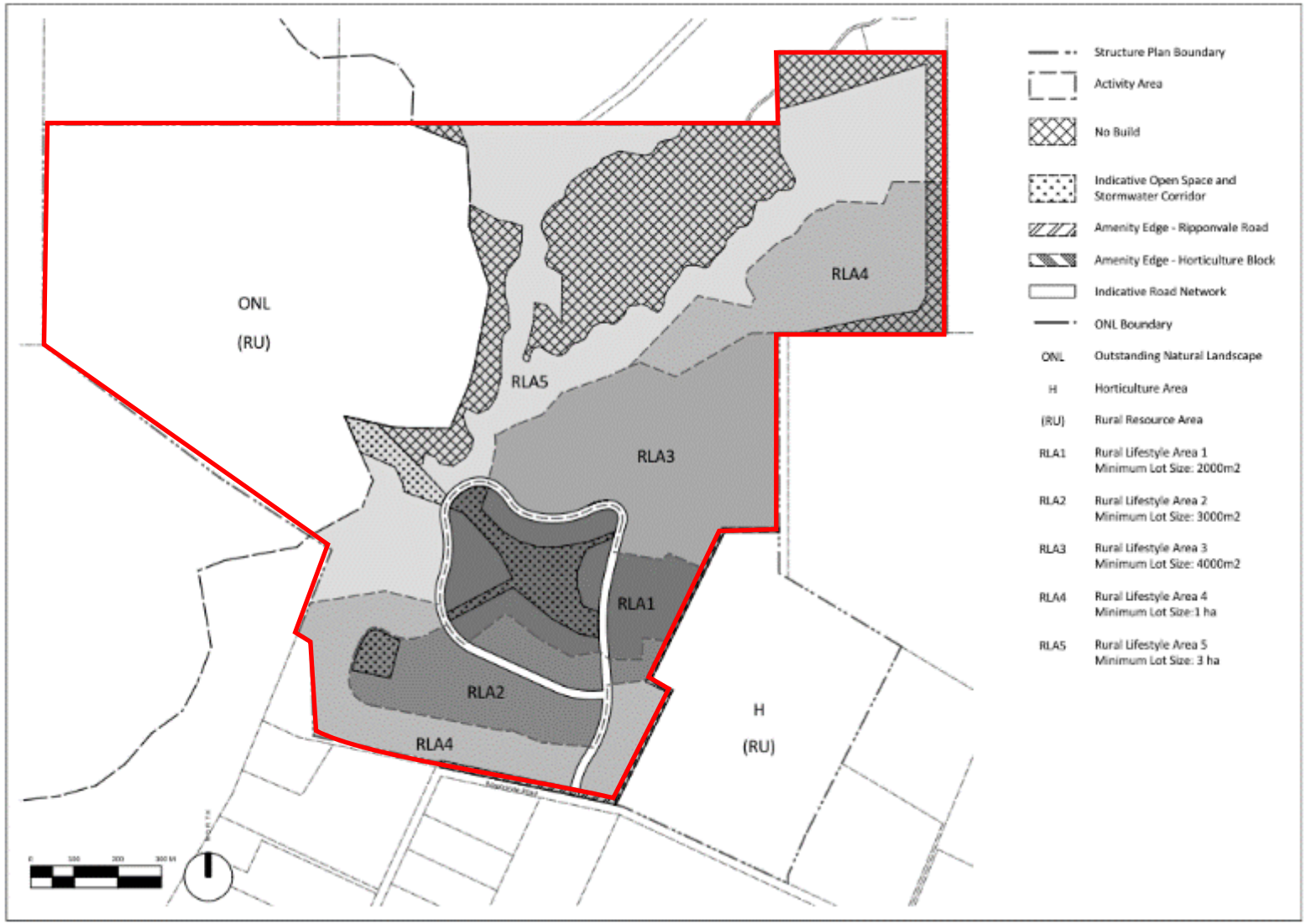


Figure 1.2: Proposed site structure plan, approximate site boundaries in red (base figure reprinted from Town Planning Group (28 May 2019) Request for a Change to the Operative Central Otago District Plan)

2 Performance standards

The following documents were reviewed to inform this assessment:

- Resource Management Act 1991;
- Central Otago District Plan;
- NZS 6801:2008 – Acoustics – Measurement of environmental noise;
- NZS 6802:2008 – Acoustics – Environmental noise;
- AS NZ 2107:2016 – Acoustics – Recommended design sound level and reverberation times for building interiors; and
- World Health Organization (WHO) guidance on noise.

The following sections detail the requirements/recommendations of these documents.

2.1 Resource Management Act 1991

District plan noise limits (see below) identify noise levels which are generally acceptable within a zone, and provide a consenting regime for noise in excess of the limits. In addition, there is a duty to avoid unreasonable noise. Section 16(1) of the RMA requires:

"*Every occupier of land (including any premises and any coastal marine area), and every person carrying out an activity in, on, or under a water body or the coastal marine area, shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level."*

Council officers may issue notices in relation to excessive noise, defined in Section 326 as:

"*any noise that is under human control and unreasonably interferes with the peace, comfort and convenience of any person*."

Section 17 of the RMA imposes duties to avoid, remedy, or mitigate any adverse effects whether or not the activity is in accordance with a rule in a plan.

Potential measures that NZ Cherry Corp will implement to control adverse noise effects are provided within Section 7 of this report.

2.2 Central Otago District Plan

The site is located within a Rural Resource Area (see Figure 2.1). The CODP includes the following policy (4.4.9):

"*To recognise that some rural activities, particularly those of a short duration or seasonal nature, often generate noise and other effects that can disturb neighbours by ensuring that new developments locating near such activities recognise and accept the prevailing environmental characteristics associated with production and other activities found in the Rural Resource Area.*"

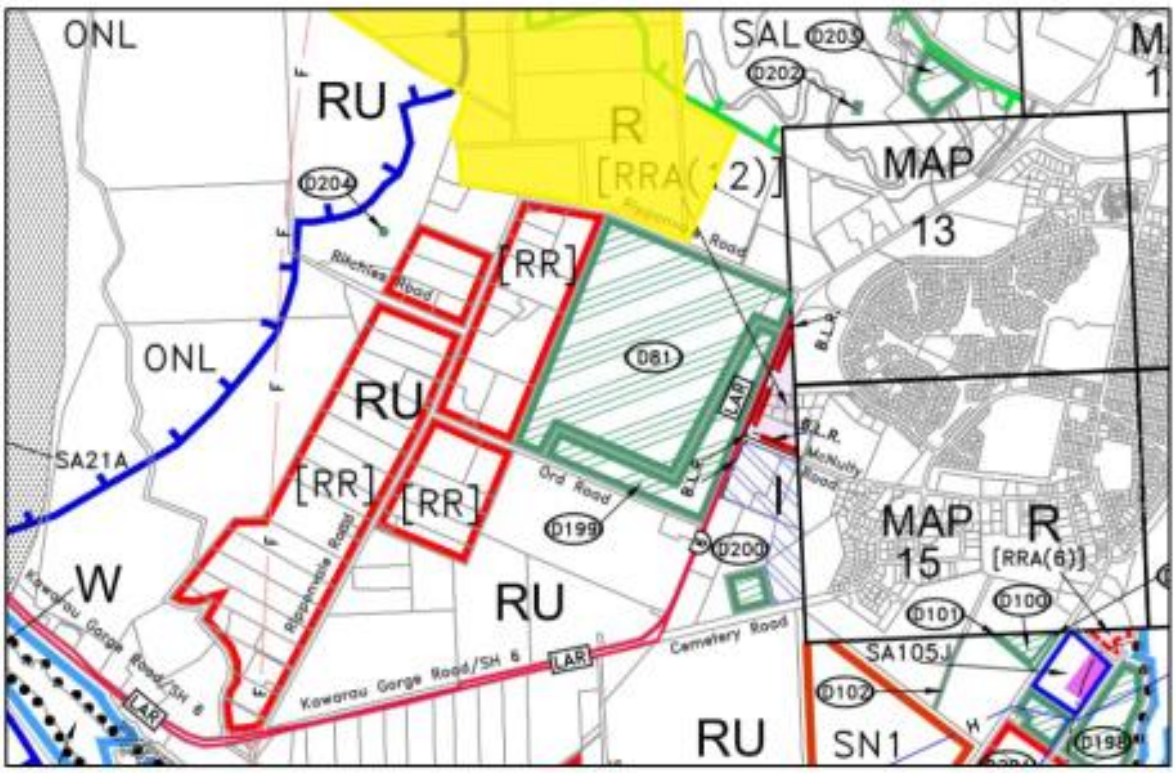


Figure 2.1: Local resource areas with the PC14 site location in yellow (reprinted from Town Planning Group (28 May 2019) Request for a Change to the Operative Central Otago District Plan, base map excerpted from CODP Map 44)

The following zone standards apply within the Rural Resource Areas (Rule 4.7.6E, abridged below):

"All activities shall be conducted so as to ensure the following noise limits are not exceeded at any point within the notional boundary of any dwelling, rest home or hospital, or at any point within any Residential Resource Area or any Rural Settlement Resource Area:

On any day 7:00am to 10:00pm	*55 dBA L_{10}*
10:00pm to 7:00am the following day	*40 dBA L_{10}*
	70 dBA L_{MAX}

Provided that the above noise limits shall not apply to:

2. devices used to protect crops from birds or frost (see (b)-(c) below)

(b) <u>Audible Bird Deterrent Devices</u>

Percussive devices	*65 dB ASEL provided that the noise limit is 70 dB ASEL where the device is sited 500 meters or more from any Residential Resource Area or Rural Settlements Resource Area*
Nonpercussive devices	*55 dBA L_{10}*

<u>PROVIDED THAT</u>

No audible bird deterrent devices shall be operated:

(ii) Between half an hour after sunset and half an hour before sunrise

(c) <u>Wind machines for Frost Control</u>

Any wind machine used for frost control shall be so constructed and operated that any noise emission measured at a distance of 300 meters shall not exceed 65 dBA L_{10} provided that:

1. *The wind machine will be allowed to operate during the frost danger period until the leaves of the plant are dry and the air temperature has reached 1°C.*
2. *The speed of the wind machine must be governed such that the top speed of the rotor does not exceed the speed of sound.*
3. *The wind machine is located no closer than 300 meters to any Residential or Rural Settlement Resource Area, or within 100 meters of a dwelling house not located on the property*

(d) *Where any new activity locates within any part of the Rural Resource Area and that activity includes any noise sensitive activity, the activity or any building associated with the noise sensitive activity shall be sited, oriented and constructed so as to ensure that habitable spaces within the building shall be adequately isolated from any noise source on another site within the class of sources described in sub-clauses (b)-(c) of this rule. Adequate sound isolation shall be achieved by siting and constructing the building to achieve an indoor design sound level of 45 dBA L_{max} within any habitable room where the exterior noise source is within the class of sources described in sub-clauses (b)-(c) of this rule. The indoor design level shall be achieved with windows and doors open unless adequate alternative ventilation means is provided, used, and maintained in operating order."*

Unlike some other district plans, such as the proposed district plan of neighbouring Queenstown Lakes District Council, Rule 4.7.6.E(b) does not specify the number of 'allowable' percussive bird scaring events. It simply states a sound level and not the number of events that may occur at certain times of the day. As discussed in Section 5, the number of 'events' is a consideration when determining the significance of a noise generating activity.

2.3 New Zealand Standards

New Zealand Standard NZS 6802:2008 sets out a procedure for the assessment of environmental noise for compliance with noise limits and provides guidance for the setting of noise limits for consent conditions, rules or national environmental standards.

The Foreword goes on to state that '*this Standard should be used in conjunction with NZS 6801:1999 [current version 2008], which contains detailed requirements for the measurement of environmental sound. The standard is intended for the guidance of those involved in managing noise in the construction industry and the local authorities with responsibility for control of noise within their districts and regions under the Resource Management Act 1991*'.

NZS 6802:2008 provides guidance on how sound should be rated.

Australian/New Zealand Standards 2107:2016 provides recommended design sound levels for a range of building uses. The standard provides design criteria for conditions affecting the acoustic environment within occupied spaces, and these guidelines values are intended to ensure that building interiors remain healthy, comfortable and productive for the occupants and users. The following table reproduces the relevant design standards for new residential dwellings.

Table 2.1: Internal noise performance standards (source Table 1- Item 7 of AS NZS 2107-2016)

Type of occupancy	Design sound level ($L_{Aeq,t}$) range / dB
Living areas	30 to 40
Sleeping areas (night time)	25 to 30* 30 to 35**

* for areas with negligible transportation noise

** for suburban areas or near minor roads

2.4 World Health Organisation

The noise limits recommended in NZS 6802:2008 are based on the community noise guidelines[1] of the World Health Organisation (WHO). Clause C8.6.2 of NZS 6802 states:

"The recommended daytime limit of 55 dB $L_{Aeq(15\ min)}$ is consistent with the guideline values for community noise in specific environments published by the World Health Organisation. The World Health Organisation identifies that during the daytime, few people are seriously annoyed by activities with levels below 55 dB LAeq. The night-time limit recommended should not exceed 45 dB $L_{Aeq(15\ min)}$ outside dwellings so that people can sleep with windows open for ventilation and achieve the desirable indoor 30 to 35 dB $L_{Aeq(15\ min)}$ level as a design level to protect against disturbance."

The WHO daytime guidance value is based upon studies that have showed that few people are highly annoyed by external L_{Aeq} levels of 55 dB during the day. The night-time external level is derived from the sound insulation afforded by a partially open window (15 dB) and the desirable internal sound level to avoid negative effects on sleep.

2.5 Summary of performance standards

Based upon the above guidance, Table 2.2 summarises the performance standards that will be used for the purposes of this assessment to determine the significance of noise experienced both outdoors and indoors at existing and PC14 proposed noise sensitive locations.

In line with current guidance, the L_{10} noise metrics used in the operative CODP have been updated for the purposes of this report to the L_{eq} metric which is consistent with the guidance of NZS 6802:2008 and those of the Ministry for Environment's draft national planning standards (noise metrics[2]). For a typical noise source, the L_{Aeq} metric is generally around 3 dB lower than the L_{A10}. A difference of 3 dB is just perceptible with normal hearing. When updating the noise metrics used in district plans, councils will typically use the same numerical value, which was the situation when NZS 6802 was updated in 1999 from the previous 1991 version. Commentary on the implications of the operative CODP (L_{A10} standard) and the performance standards recommended in this assessment (L_{Aeq} standard) are discussed in Section 7.

It should be noted that there is an exemption in Rule 12.7.4 (iii) which states that:

"Noise limits in any part of the plan shall not apply… In area to activities of a limited duration necessary for the production (but not processing) of primary products"

Therefore whilst performance standards have been developed, the noise limits outlined in Table 2.2 do not apply to the majority of noise generating horticulture activities such as orchard spraying and

[1] Berglund, B. Lindvall, T. and Schwela, D. (Eds). 2000. Guidelines for community noise. World Health Organisation.
[2] https://www.mfe.govt.nz/publications/rma/guidance-noise-and-vibration-metrics-standard

pruning and when helicopters are used for a limited duration for drying fruit and frost fighting (excluding the noise from frost fans and bird scaring devices).

Table 2.2: Performance standards

Location	Environment	Design sound level ($L_{Aeq,t}$) range / dB	Source
External to buildings – all locations (e.g. within the PC14 site and surrounding sites outside of PC14)	Outdoor amenity area – daytime (0700-2200)	55	WHO / CODP**
External to buildings – all locations (e.g. within the PC14 site and surrounding sites outside of PC14)	At notional boundary - night time (2200 – 0700)	40	WHO / CODP**
Internal to buildings (PC14 proposed rural residential units only)	Internal living areas daytime (0700-2200)	40	AS NZS 2107
	Internal sleeping areas (night-time 2200-0700)	25-30	AS NZS 2107
		45 dB L_{AFmax}*	WHO / CODP**

* - for protection against noise from frost fans in any habitable space - as required by Rule 4.7.6 E (d).

** - in part as the noise level has been used but not the noise metric

3 Existing environment

3.1 NZ Cherry operations

Horticultural noise generated on the current NZ Cherry Corp site can be broken down into those noise sources which are stationary (static) and those that move (moving). Static sources include the four existing frost fans and the two diesel engines which power the irrigation pumps which are also used for frost protection. There are other static sources on-site, for example electric pumps, but the sound level emissions from these sources would not be audible off-site.

Moving sources include tractors and / or sprayers, vehicles, pruning including tractor mulching, and helicopters used for drying fruit. Apart from the use of helicopters, all of these sources produce relative low sound levels when experienced off-site even when operating at the boundary of the NZ Cherry Corp site and other horticulture sites.

The NZ Cherry Corp extension within PC14 will operate in a similar manner to the existing orchard. The cherry orchard will likely require frost protection and NZ Cherry Corp has confirmed that it is their intention to install four additional frost fans. The finalised locations being subject to design advice from a frost fan specialist/supplier. NZ Cherry Corp has advised that Frost Boss C59 five blade fans would be installed. There will also be workers' accommodation on site with full welfare facilities and sleeping accommodation, accessed from Ripponvale Road.

Most of the Ripponvale orchards will operate in a similar manner to the NZ Cherry Corp site with minor variations depending the type of frost protection and the method of protecting the orchards from birds. Similarly, it is realistic to expect that viticulture activities will use similar equipment and plant, albeit that there will be minor seasonal changes when these activities occur.

The following sections describe orchard activities in more detail and provides relevant sound levels where appropriate.

3.1.1 Frost protection

Frost fans are used to mitigate against the adverse effects of frost damage to agricultural crops (fruit). A frost fan is used to draw down the warmer air from an inversion layer 10-50 m above the ground and to blow this air into an orchard or vineyard. Frost fans are turned on automatically before a critical frost occurs. The normal hours of operation are between 4 am and 6 am and it is a seasonal occurrence.

A typical frost fan has its blades located approximately 10 m above ground and the number of blades vary depending upon the manufacturer and/or model type. Most of the noise is aerodynamic, i.e. generated by the rotation of the fans. There is also the noise contribution from the diesel engine and gearbox system which are located at the base of the fan tower. Frost fans rotate 360° around the hub to provide coverage across the orchard or vineyard, therefore the sound level fluctuates depending upon the orientation of the blades to the receiving location. A typical frost fan will perform one revolution around the tower every 6-7 minutes. An assessment period of 15 minutes is typically used to capture at least 2 revolutions/precessions of the frost fan. This assessment period is consistent with that recommended in NZS 6802:2008.

Certain fans have distinctive tonal qualities which correspond to the blade passing frequency of the frost fan (function of the number of revolutions of the fan blades per second and the number of blades). This tonal character can warrant the application of a Special Audible Characteristic (SAC) in accordance with the tests of Appendix B4 of NZS 6802:2008. Frost fan noise assessments will typically perform the simplified test method for tonality, which requires the sound level within adjacent frequency bands to be compared.

NZ Cherry Corp orchard has four existing frost fans. Three of the units are Defender four blade units and the fourth is a Frost Boss C49 four bladed fan, which is located in the middle of areas 1 and 2 (most northern existing fan). The NZ Cherry Corp frost fans are operated to provide protection against frost. The fans operate when the ambient temperature at ground level drops below 1°C. Use of frost fans will occur from early to mid September to mid to late November. Fruit trees require protection at any time after petal drop. In 2019 for example, the NZ Cherry Corp frost fans were operated 18 times from September to November, on average the fans operated for five hours each. In 2018, there were 22 occasions with an average operating time of 7.5 hours.

Frost fans are also used on nearby sites and are expected to operate in a similar manner to the NZ Cherry Corp Site, with four blade fans being the most common (there are a limited number of two blade models).

The sound levels of the fans are detailed in the following table. The table includes the sound level data for the Frost Boss C59 fan which is proposed to be installed on the orchard extension site.

Table 3.1: Frost fans sound levels

Situation	Model	Tower height	Levels / $L_{Aeq(15min)}$	Sound Power Level / dB(A)	Data source
Existing fans	Frost Boss C49 (4 blades)	10.5 m	63 dB at 100 m	111	T+T 2020*
	Defender 4 blade	10.5 m	61 dB at 100 m	110	University of Canterbury May 2009
	2 blade	10.5 m	64 dB at 100 m	116	T+T 2020*
Future fans	Frost Boss C59 (5 blades)	10.4 m	50 dB at 300 m (~62 dB at 100 m)	112	Hegley 2015

* Measurements were recorded by T+T of a Frost Boss C49 and 2 blade fan in January 2020 for a site in Gibbston Valley.

The data in the above table has been used to undertake predictions of the sound levels from the various frost fans in the Ripponvale valley, both existing and proposed. Full third octave frequency data has been used in the predictions, see Section **Error! Reference source not found.**.

As the fan assembly rotates around the tower, there will be a fluctuation in the sound level. The level difference between the L_{A10} and L_{Aeq} is shown in Table 3.2 for the Frost Boss C49 and a 2 blade model, which were both measured by T+T.

Table 3.2: Frost fan sound levels – L_{10} and L_{Aeq}

Model	Measurement distance / m	$L_{Aeq(15\ min)}$ / dB	$L_{A10(15min)}$ / dB
C49	50	69	71
	100	63	65
2 blade	50	74	76
	100	64	66

On average level, there is a level difference of 2 dB between the L_{A10} and L_{Aeq} when frost fans operate. This 2 dB variation between the two noise metrics has been applied to the sound levels from the other fan models.

During severe frosts, NZ Cherry Corp can use the orchard irrigation system to protect the trees. Two diesel engines are located within the central maintenance area and are enclosed within one of the

two buildings. The engines power two high capacity pumps which distribute water to the entire site and have sufficient capacity to service the orchard extension too. The engines and pumps can often operate for many hours during severe frosts.

Sound levels measured on site indicated that at 10 m from the outside of the building when the two engines were operating under load conditions the L_{Aeq} was 87 dB. At the boundary of the existing orchard the sound level from operation of the engines has been estimated to be 55 dB. The nearest existing dwellings will experience sound levels less than 40 dB $L_{Aeq,t}$. The sound from the engines is relatively constant and there is no significant level difference between the L_{Aeq} and L_{A10}.

Orchards and vineyards may use helicopters for frost fighting if they do not have frost fans. The downdraught the helicopter produces brings down warmer air from the inversion layer, albeit that the benefit is only short term and very localised and often there is tree damage due to the highly turbulent airflow. NZ Cherry Corp does not use helicopters for frost fighting, although some orchards in the wider Ripponvale area, which do not have frost fans, may use helicopters for frost protection.

3.1.2 Helicopters

Helicopters are used for drying fruit most often when there has been overnight rain and the air temperature is rising (typically around sunrise). To prevent the fruit swelling, helicopters overfly the orchard and the down draught "blow dries" the fruit. A helicopter will fly along each row at a height of approximately 15 m (50 feet) and will travel at approximately 15 knots (~28 km/h). Helicopters are only used during the fruit harvest season (mid-December to end of January). Frost fans are not used for drying fruit.

During a typical harvest period, a helicopter may be used on 8 to 12 occasions any anywhere between 30 minutes to two hours. NZ Cherry Corp uses Squirrel helicopters operated by Alpine Helicopters and only one helicopter is operated at a time. Other orchards in the wider Ripponvale area use helicopters for fruit drying.

T+T has previously monitored sound levels of a Squirrel helicopter performing various operations including hovering, hover taxiing and low speed forward flight. Helicopters used for fruit drying do not land on the site and therefore only the moving sound level data has been reported in the following table.

Table 3.3: Helicopter sound level data

Manoeuvre	L_{Ae} / dB *
Forward flight at 50' above ground level	102

* – as measured at 25 m from side of flight track and for a fly-by along a straight flight path

3.1.3 Bird scaring

NZ Cherry Corp relies on bird netting as the primary protection against birds. They do not use any audible deterrents such as gas guns, shot guns or other audible devices. The orchard extension will be fully netted.

We understand that the most proximate orchards to the PC14 site also rely on bird netting and do not utilise bird scarers. However some other orchards in the Ripponvale area do not fully rely on netting for protection against birds. For example, 45 South (~1.2 km to the south east of PC14) has approximately one third of their orchard protected by netting. For these orchards, audible deterrents are used which may affect both existing dwellings and the proposed PC14 residential allotments. Portable gas guns and use of airguns and shot guns fired from quadbikes are the common forms of these audible devices.

The operative CODP requires devices which create discrete audible events to not exceed 65 dB L_{Ae} (ASEL) and 70 dB L_{Ae} where the device is sited 500 m or more from any Residential Resource Area or Rural Settlements Resource Area. As noted previously, the CODP has no restriction on the number of bird scaring events that may occur.

The sound level from a gas powered Vinetech bird scarer will exceed 100 dB L_{Ae} and 110 dB L_{AFmax} at a distance of 20 m from the device. For shotgun noise, sound levels will be of a similar magnitude.

3.1.4 Spraying

Orchard spraying at the NZ Cherry Corp orchard is carried out with two tractors (90 hp and 100 hp) and Silvan 2000l fan dispersed crop sprayers. Spraying is intermittently carried out most of the year but more intensely during November, December and January. Most spraying is carried out early morning to ensure no wind. Spraying can occur as early as sunrise and last for a couple of hours. We understand that similar activity is undertaken on other proximate orchards.

Spraying involves the tractor driving along each row and spraying both lines of trees either side. The main source of noise is the fan unit and typically sound levels from similar measurements undertaken by T+T are in the range of 78-90 dB(A) when measured at a distance of 10 m from a moving tractor and sprayer unit. The upper level being when the fan unit is operating at maximum speed. Sound levels will vary as the tractor drives along each row and turns at the end to start spraying on the next row. From site observations the sound level from a tractor spraying will last approximately 20 seconds and will diminish as the tractor passes along other rows further away from the receiver location. Depending upon the length of the row, separate noise events will be audible every few minutes.

3.1.5 Crop picking

Fruit picking is labour intensive. However, the noise generated by the picking (workers and vehicles) is negligible when experienced at the site boundaries. Once the NZ Cherry Corp fruit is picked it is the packed at the packhouse which in 5 km away in the Cromwell Industrial Area. Fruit leaves the orchard site via the main entrance on the state highway and not along Ripponvale Road. It is assumed that similar activity will occur on other property in the vicinity, noting that a packhouse is located on the Jakimm Orchard site.

3.1.6 Orchard maintenance

Pruning takes place at the end of the harvest season, and comprises teams pruning trees to promote new growth in the growing season. Within the NZ Cherry Corp orchard, the teams use electric pruners which create minimal noise. A tractor unit will then drive between the rows and mulch the prunings. It is assumed that similar activity will occur on other orchards in the vicinity.

3.2 Additional noise

Road traffic noise from State Highway 6 is a source of local noise which is audible across the local area.

Diagonally opposite the application site is the Cromwell Racecourse and the Cromwell Aerodrome (identified as D81 and D199 respectively under Schedule 19.2 of the District Plan). The racecourse hosts horse racing events throughout the year.

Adjacent to the racecourse is the aerodrome which is a private airfield operated by CODC. The aerodrome operates two grass runways as shown in Figure 3.1. To the south of the airfield along the boundary with Ord Road are a number of small aircraft hangars. The Aeronautical Information Publication (AIP) states the circuits pattern for light aircraft using the two runways. Aircraft do not

overfly the PC14 site but turn away and perform circuits to the east towards the township or to the south (due to the rising land topography to the north and west).

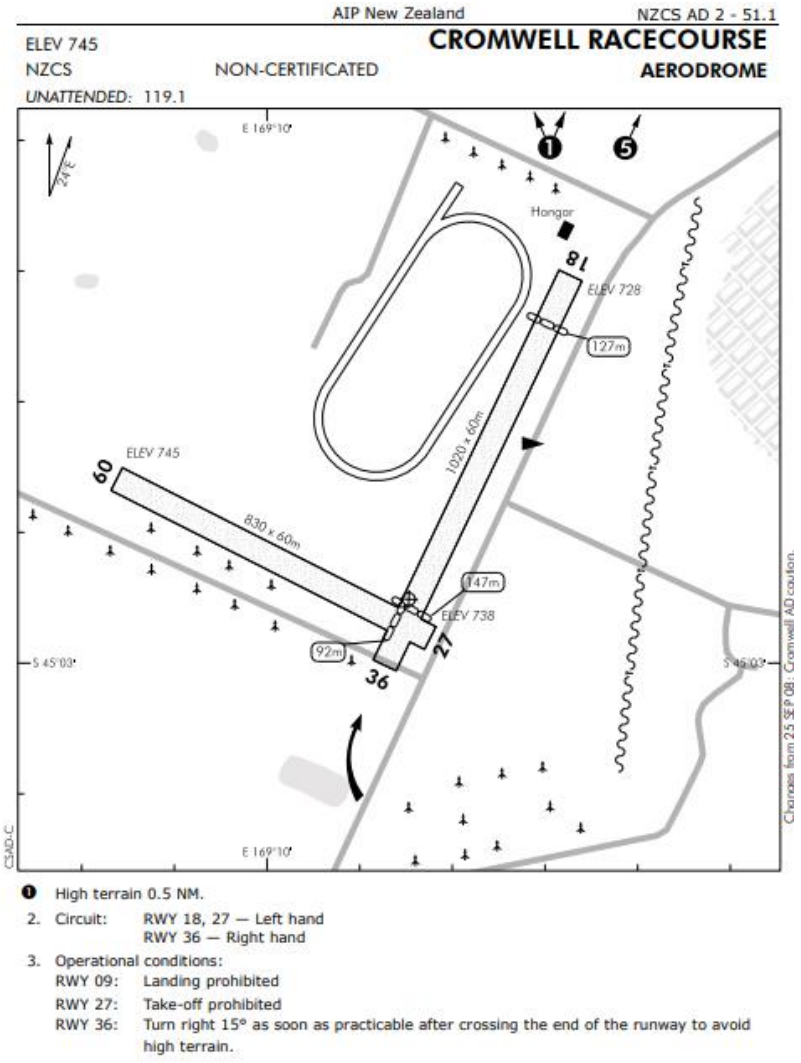


Figure 3.1: Cromwell Racecourse Aerodrome (source AIP New Zealand)

The aerodrome is used by general aviation aircraft i.e. light single engine aircraft. The airfield does not have a training role and therefore repetitive circuits and touch-and-go movements are infrequent. Helicopters also operate from the aerodrome. Aircraft will climb quickly when departing to the north and will perform a right hand turn to avoid the rising terrain. Aircraft using the aerodrome will therefore not overfly the PC14 site and therefore noise from aircraft movements has not been considered in this assessment.

Approximately 2 km to the south of the site is the Highlands Motorsport Park (HMP). At this distance sound from motorsport activities would be audible when the prevailing wind conditions are from the HMP to the Ripponvale area. However, the level of noise generated by HMP will be very low in comparison with the prevailing ambient noise levels in the Ripponvale area.

3.3 Main noise sources

The main sources of noise considered in this assessment are the sound levels generated by frost fans, helicopter movements, bird scaring devices and to a lesser degree the noise from spraying. All other sources of noise are either localised within the orchards or at such a low level (e.g. manual

pruning) that noise experienced offsite would be negligible. In the case of the two diesel engines in the NZ Cherry Corp orchard, their location is such that their spatial separation from the boundaries of neighbouring sites affords a high level of sound reduction.

3.4 Receiving environment

Much of the surrounding Ripponvale area is zoned Rural Resource Area or Rural Residential (see Figure 4.1), meaning that the environment includes a number of receivers (rural-residential living) that are sensitive to noise. Lifestyle residential lots are located along Ripponvale Road as well as pastoral farmland, vineyards, and orchards. Rockburn Winery is also located adjacent to the PC14 site. Apart from the residential lots there are no other noise sensitive locations, such as schools or health care facilities.

There is minimal acoustic shielding in the local area. The local topography is such that the area around the racecourse and aerodrome is predominantly flat, gently sloping to the north. There are shelter belts, but the planting (trees and vegetation) are not sufficiently dense or deep to provide any acoustic benefit (sound reduction).

The majority of the residential dwellings are single storey and from on-site observations are constructed using thermal double-glazed windows. A number of orchards have workers accommodation units which also qualify as noise sensitive buildings.

Figure 4.1: Site (dashed red line) and surrounding features (reprinted from Town Planning Group (28 May 2019) Request for a Change to the Operative Central Otago District Plan)

3.5 Site visit

A site visit was undertaken between 5 and 6 March 2020 at NZ Cherry Corp and the local area. Observations were made of orchard activities on site and a meeting was held with orchard staff which informed the description of the horticultural activities that take place. In addition, observations were made of the various frost fans present at neighbouring orchards and the type of fans installed. The number of blades and their shape helps to identify the model of frost fan installed.

An ambient noise survey was undertaken during the morning of Friday 6 March 2020 along Ripponvale Road. The survey was taken at the boundary of the orchard extension and comprised three 15-minute measurements. The summary of the measured data is listed below in Table 3.4. The measured daytime data is representative of a rural area with passing road traffic. The sound levels from the light aircraft were not considered significant.

Based on observations taken, sound levels will be around 35 – 45 dB further into the PC14 site, i.e. at least 150 m from the road, and likely to be below 30 dB during the evening period and night time i.e. between 2200 and 0600h.

Table 3.4: Summary of sound level data

Time period	$L_{Aeq(15\ min)}$ dB	L_{A90} dB	L_{AFmax} dB	Comments
1115-1145	56	42	84	Low ambient levels with two car passbys
1155-1210	52	40	78	Including light aircraft take off to north
1215-1230	54	41	82	Tractor passby with trailer unit + ute

4 Concerns of submitters

The CODC *Proposed Plan Change 14, Summary of Decisions Requested in Submissions* was reviewed to identify the submitter concerns with regards to noise effects in the Ripponvale area. The main themes are summarised in Table 4.1.

Table 4.1: Summary of submissions with respect to noise

Noise source	Commentary
Frost fans	Several frost fans are located on nearby horticultural properties. The fans may be in operation overnight and for an extended duration. There is therefore the concern that future occupiers will complain.
Bird scaring	Similarly there is the concern that future occupiers will complain when bird scaring devices operate.
General horticultural activities	Nearby horticultural properties operate all day/night during key times of the year (e.g. harvesting). Noise sources can include truck and heavy machinery movement, harvesting equipment, personnel.
Motorsports	The Highlands Motorsports Park is located over 2 km from the nearest proposed dwelling area.
Aerodrome	Noise from aircraft activity and the effects on future occupiers.

The key issues identified in the submissions also align with the main noise sources identified in Section 3.3. Issues raised identify that there are potential reverse sensitivity effects due to future residents complaining about existing noise generating activities and the additional noise created by the orchard extension and how that may increase noise in the area and alter the local character / soundscape of the area.

For completeness it is noted that HMP is not considered to generate significant noise effects as there are existing residential dwellings less than half the distance of the PC14 site from the park. The effects on HMP are not considered further in this report. Similarly, as the PC14 site is not overflown by aircraft operating from the aerodrome, the effects of aircraft (excluding helicopters) are not considered.

5 Noise and amenity

Excessive noise can interfere with speech communication; it can interrupt a wide range of different types of work, particularly activities requiring sustained concentration; it can disturb rest and relaxation; and depending on the hours of operations it can disrupt normal patterns of sleep. Continuous high noise levels for extended periods of time can contribute to noise induced hearing loss, whilst at the generally lower sound levels typically found outside houses, residents often report varying degrees of annoyance. The WHO defines noise annoyance as '*a feeling of displeasure evoked by a noise*'.

The degree of the noise effects will depend upon the magnitude, frequency of occurrence and duration of the noise exposure. Reported annoyance is known to be affected by:

- noise level and nature of noise - including whether the sound is constant, fluctuating, impulsive (startle), has low frequency components (e.g. rumble/boom) or is high pitched (e.g. whine/whoosh); and
- occurrence of exposure - reported annoyance varies depending on the frequency of events and whether they are anticipated or randomly occur;

The effects of noise are also dependent upon the time of day at which it occurs. This is due to acoustic factors, such as the relative level of background noise, and non-acoustic factors, such as the activities being disturbed and people's expectations of noise levels at different times of the day.

While the “loudness” of a noise is a purely subjective parameter it is commonly accepted that change in noise level of 3 dB is just perceptible, and an increase/decrease of 10 dB corresponds to a doubling/halving in perceived loudness.

Section 16 of the RMA creates a duty, which applies to all occupiers of land, to keep noise emissions to a reasonable level by adopting the best practicable option to manage noise. Even if noise emissions comply with noise limits set by rules in a District Plan or a condition of resource consent, or where there are no noise standards in the District Plan, the s16 duty still applies.

The perception of unreasonable noise in the context of horticultural activities and the effects on residents living in the area is likely to vary based on their expectation of the noise levels in the area. For example, residents who have connections to horticulture or viticulture may be less sensitive to noise in a rural environment compared to ‘new’ residents who may be sensitive to certain activities, such as the use of frost fans. Recently in resource consent RC180121 approved by the CODC to Schooner Developments Ltd (112-114 Ripponvale Road), the issue of reverse sensitivity was evaluated. The CODC noted that rural uses are already well established in the Ripponvale area, such that any prospective purchaser of the new lots to be subdivided will be well aware of the existing environment and “should manage expectations accordingly”.

When considering unreasonable noise, a judgement has to be made whether the noise in question is of a level and character which is to be expected in the local area and whether at an overall level of activity/occurrence likely to result in annoyance to the ‘average’ person. For example, frost fans will normally operate in the early morning when frost conditions prevail. Hence there is an expectation that in a rural environment surrounded by horticulture activities frost fans may be audible. However, it would be unreasonable to operate a frost fan at any other time when frost protection is not required or to locate the frost fan in such a close proximity to a neighbouring site that noise disturbance will occur. Similarly, the use of a helicopter for drying fruit would be considerable unreasonable if it were present for longer periods than necessary and directly overflying or in close proximity to residential dwellings.

The test whether a noise is considered unreasonable, therefore takes into account the context of the receiving environment and the level, character and frequency of noise that may be experienced.

As residents will experience noise inside and outside their dwellings, if they are at home, an indication of the potential effects is provided in Table 5.1 for a range of sound levels. This table of effects has been adapted from a table commonly used to rate the effect of construction noise and high levels of infrastructure noise (road, rail, airports). This table principally relates to noise experienced during non-sleeping hours for a typical New Zealand construction with single glazed windows.

Table 5.1: Subjective response to environmental noise levels

External noise level / LAeq	Potential daytime effects outdoors	Corresponding internal noise level / L_{Aeq}	Potential effects indoors
Up to 55 dB	Unlikely to result in significant noise disturbance (WHO guidance)	Up to 35 dB	Quiet internal conditions – acceptable conditions for sleep
55 to 60 dB	Outdoor enjoyment of areas becomes difficult – noise becomes intrusive	35 to 40 dB	Noise levels would be noticeable but unlikely to interfere with residential activities, including sleep.
60 to 65 dB	Conversation becomes strained, particularly over longer distances.	40 to 45 dB	Noise levels would be noticeable but unlikely to interfere with residential activities.
65+ dB	People would not want to spend any length of time outside	45 to 50 dB	Concentration would start to be affected. TV and telephone conversations would begin to be affected, i.e. increased volume.

Note : The adjustment factor between the external noise level and the internal noise level is based on a 20-decibel reduction as allowed for in NZS 6803 for a typical New Zealand residential building.

If noise occurs during the night, external sound levels greater than 45-50 dB L_{Aeq} will have the potential to result in sleep disturbance if residents sleep with windows open[3]. For a modern insulated dwelling with closed windows, external sound levels can be up to 55-65 dB L_{Aeq} before adverse effects occur[4]. Higher external sounds levels can be mitigated by having enhanced acoustic insulation. The primary weak point of the building envelop is the glazing unit and the use of heavy glazed panels or acoustic laminates can provide increased sound insulation compared to standard insulating glass units (IGUs), i.e. thermal double-glazed windows.

The WHO guidance does not provide any guidance on the duration of noise that is acceptable but it is generally accepted that people are more likely to be less affected by high levels of noise if exposed for a short period of time. A typical example is the noise experienced from overflying aircraft. People are also more likely to be accept this type of activity if they only occasionally experience this type of noise. Therefore in the context of this assessment, the duration or frequency of noise exposure is also a consideration.

5.1 Reverse sensitivity

Noise sensitive activities such as new residential units near to existing sources of noise can potentially be affected by these noise sources. This could cause annoyance and sleep disturbance potentially resulting in adverse health effects. In turn, this can cause reverse sensitivity effects on

[3] Based on an internal design level of 30-35 dB L_{Aeq} for bedrooms and a typical sound reduction of 15 dB for a partially open window.

[4] Based on an internal design level of 30-35 dB L_{Aeq} for bedrooms and a typical sound reduction of 25-30 dB for a closed façade.

the noise generating activity. Reverse sensitivity is the legal vulnerability of an established activity to complaint from a new land use[5]. The most effective means of avoiding reverse sensitivity effects is to ensure that there is adequate separation between the source of the noise and the receiving location such that the resulting noise does not give rise to adverse effects such as annoyance and sleep disturbance.

For new noise sensitive residential units, the best means of protecting outdoor amenity areas is to use a combination of spatial separation and the layout and design of the buildings to provide 'quiet areas' around the dwelling by using the building structure to provide acoustic shielding, or to install acoustic barriers along boundaries.

As stated above, the sound insulation of the building can provide a suitable internal living and sleeping environment in habitable spaces. For buildings subject to high levels of environmental noise (typically above 65 dB L_{Aeq}), enhanced sound insulation can be installed. If windows are opened, the performance benefit is lost. To enable windows to remain closed, supplementary ventilation is often required to provide good indoor air quality and to ensure that there is an element of comfort cooling, which is especially the case during the summer when solar gain can occur. Noise from this ventilation should not contribute to the internal sound level.

In the context of this assessment the management of reverse sensitivity effects includes good design, i.e. layout of the site and individual buildings, and that the residential buildings are designed to control noise 'break-in' from external sources.

[5] NZ Journal of Environmental Law (1999) Volume 3, Pardy, B. and Kerr, J. Reverse sensitivity – the common law giveth, and the RMA taketh away.

6 Noise modelling

Sound pressure levels from frost fans have been predicted using sound propagation modelling software, SoundPLAN version 8.1. The software enables noise contours to be produced and location specific noise levels to be calculated based upon a three-dimensional model of the project and local area. For helicopters, bird scaring devices and orchard spraying, estimated sound levels have been provided based on distance reduction alone.

The project's SoundPLAN model incorporates 1 m resolution LiDAR terrain data and the surrounding buildings and the shielding properties of these buildings have been included within the model. The ground has been assumed to be mixed (ground factor = 0.5). Calculations have been undertaken in accordance with ISO:9613-2[6]. The Standard predicts the long-term average equivalent continuous A-weighted sound level (L_{Aeq}) under meteorological conditions favourable to propagation, i.e. downwind propagation or propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night. The model assumes that there is no localised sound reduction from any walls, fence or other types of barriers or the effects of shelter belts, etc.

The model takes into account:

- Geometric divergence;
- Atmospheric adsorption;
- Ground effect;
- Reflection from surfaces; and
- Screening by obstacles (buildings and topography).

The locations of the frost fans were entered into the noise model together with the sound level data (see Table 3.1). Two scenarios have been modelled:

1 Existing situation to establish the existing noise environment (all current frost fans north of Ord Road operating simultaneously);

2 Existing (1) plus orchard extension frost fans.

Other existing noise sources outside the site (see section 3.2) have not been modelled.

The sound levels from helicopters and bird scaring devices have been estimated based on distance attenuation alone and are therefore likely to over estimate the level of sound compared to computer noise modelling.

[6] ISO 9613-2 Attenuation of sound propagation outdoors. Part 2: General method of calculation

7 Assessment of effects

This section presents the results of the noise modelling and the likely sound levels from the NZ Cherry Corp extension at existing noise sensitive locations. Reverse sensitivity effects are then discussed for future residential occupiers of PC14 from horticultural activities in the surrounding area.

7.1 Noise modelling results

7.1.1 Existing and proposed frost fans

A noise contour map has been provided for each of the frost fan scenarios, see Figure 7.1 and Figure 7.2 and sound levels have been calculated at existing residential dwellings, which have been identified as locations 1 to 7, see Figure 7.3.

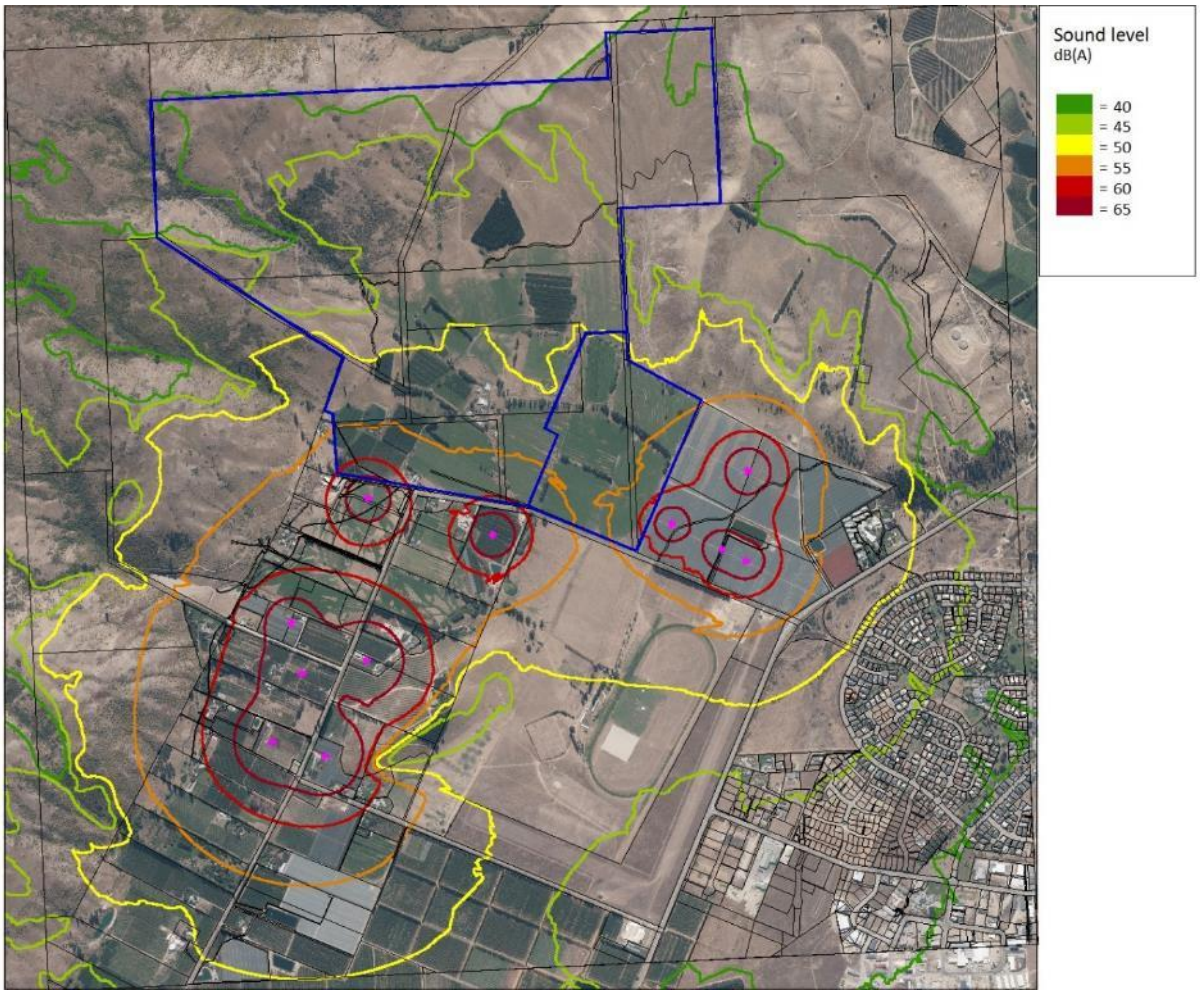


Figure 7.1: Existing frost fan noise contour

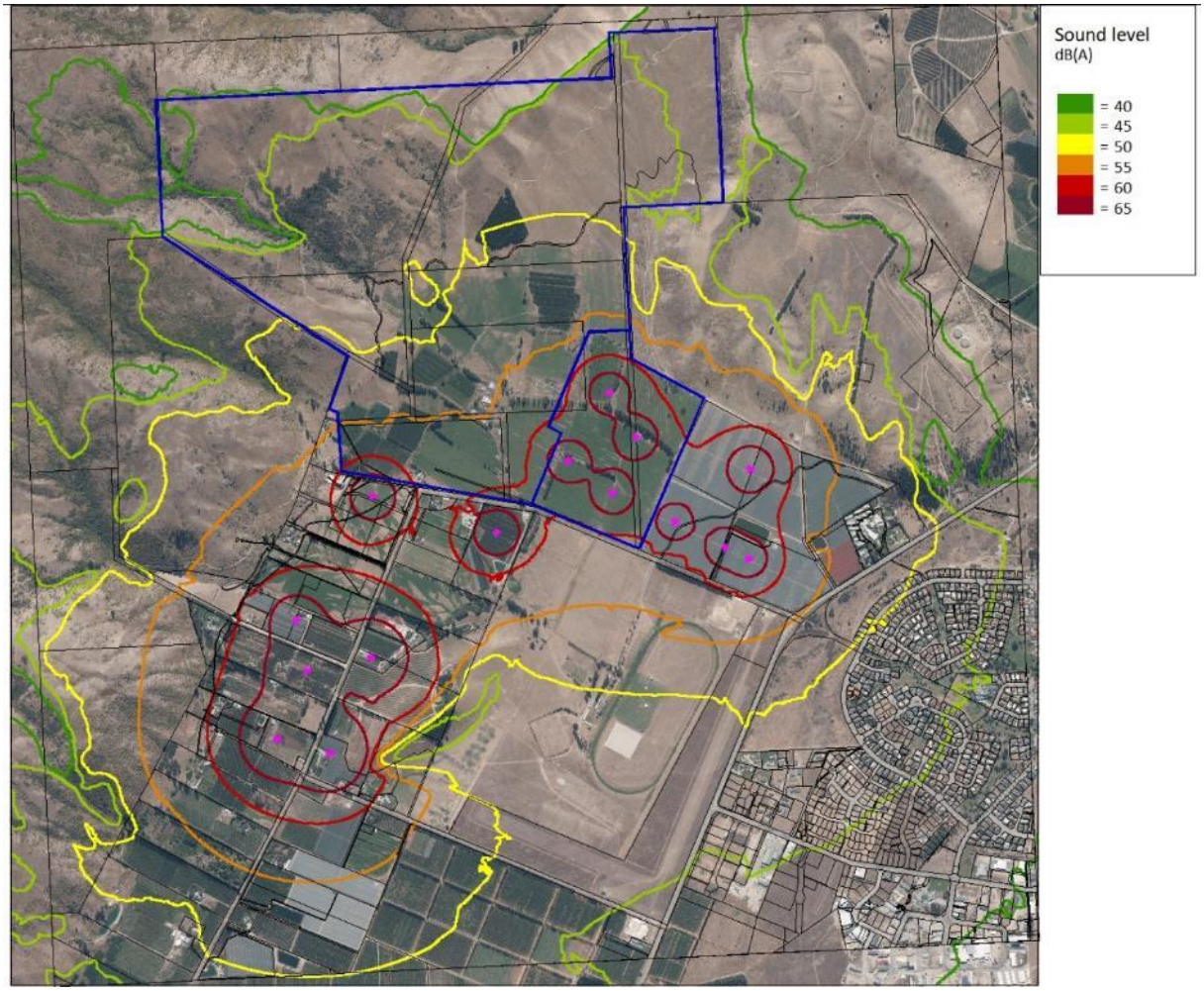


Figure 7.2: Existing plus NZ Cherry Corp orchard extension frost fan noise contour

Figure 7.3: Existing noise sensitive locations outside of the PC14 site (1 to 7)

The relative size of each contour line shows the noise contribution from each fan. For the new C59 fans on the orchard extension the extent of the 65 dB contour line around each fan is smaller compared to other frost fans on either the existing NZ Cherry Corp orchard site or other nearby orchards. This reflects the fact that the sound levels from the Frost Boss C59 are the lowest (Table 3.1). Figure 7.2 shows that the two closest non-NZ Cherry Corp fans to the south influence, to a greater degree, frost fan noise within the future PC14 residential areas.

The shape of each contour line below 55 dB is influenced by the local topography. This is shown by the 'irregularity' in the contours, especially to the north west of the PC14 site towards the ONL area.

Sound levels predicted at the closest existing dwellings when frost fans operate are shown in Table 7.1. The table shows the predicted sound level at each offsite receiver and the sound level difference between the two scenarios. With the introduction of four C59 frost fans on the NZ Cherry Corp extension, the overall level of frost fan noise increases (as would be expected).

The sound level increase is at most 0.8 dB, which occurs to the east of the NZ Cherry Corp site at 78 Waenga Drive. Within the Ripponvale Road area, the maximum increase is 0.6 dB at 123 Ripponvale Road. When all frost fans operate there will not be a perceptible change in the local noise environment when experienced at existing residential dwellings as the change in sound level is significantly less than 3 dB.

Table 7.1: Frost fans sound levels at existing residential dwellings

House Identifier	Scenario 1: Existing frost fans $L_{Aeq(15\ min)}$ dB	Scenario 2: Existing plus orchard extensions $L_{Aeq(15\ min)}$ dB	Sound level increase / dB
1 – 146 Ripponvale Road	51.9	52.1	0.3
2 – 176 Ripponvale Road	57.8	57.8	0
3 – 165 Ripponvale Road	57.9	58.2	0.3
4 – 143 Ripponvale Road	58.5	59.0	0.5
5 – 123 Ripponvale Road	60.0	60.6	0.6
6 – 109 Ripponvale Road	60.3	60.7	0.4
7 – 78 Waenga Drive	50.8	51.6	0.8

Note – sound levels calculated at notional boundaries

The sound level contribution from the C59 fans alone has been calculated, see Table 7.2. Sound levels from the C59 fans are no greater than 52 dB $L_{Aeq(15\ min)}$ / 54 dB $L_{A10(15\ min)}$ at all residential dwellings. The CODP requires that noise from new frost fans does not exceed 65 dB L_{A10} at a distance of 300 m. The C59 fans achieve this requirement as the sound level at 300 m is approximately 52 dB L_{A10}.

Table 7.2: New frost fans sound levels (C59) at existing residential dwellings

House Identifier	C59 frost fans $L_{Aeq(15\ min)}$ dB	C59 frost fans $L_{A10(15\ min)}$ dB
1 – 146 Ripponvale Road	42.5	44.5
2 – 176 Ripponvale Road	39.7	42
3 – 165 Ripponvale Road	46.2	48
4 – 143 Ripponvale Road	46.3	48
5 – 123 Ripponvale Road	51.8	54
6 – 109 Ripponvale Road	50.9	53
7 – 78 Waenga Drive	43.9	46

7.1.2 Helicopters

Helicopter sound levels have been calculated (using the data in Table 3.3) for a single helicopter performing one flight along a row of trees on the boundary of the existing NZ Cherry Corp orchard and along the most western row of trees on the orchard extension

NZ Cherry Corp does not use helicopters for frost fighting and therefore the noise effects along the western boundary of the PC14 site are restricted to the summer months, typically around sunrise (6 am) for 30 minutes to 2 hours, during which there is the likelihood that residents may have windows open. Other orchards may use helicopters for frost protection and/or fruit drying.

Therefore, potential effects from helicopters are limited to the period when residents will be inside.

A single helicopter performing movements along each row of trees or when frost fighting will typically generate sound levels in the order of 75 to 80 dB L_{Aeq} at a distance of 100 m from the helicopter. Similarly, L_{Amax} levels will be 75 to 80 dB at a distance of 250 m from the helicopter.

Sound levels predicted at the closest existing properties when NZ Cherry Corp helicopters operate are shown in Table 7.3 for a single helicopter flyby.

Table 7.3: Helicopter sound levels at existing residential dwellings – single flyby of NZ Cherry Corp helicopter

House Identifier	Existing helicopter flight path dB		Future helicopter flight path	
	L_{Aeq} / dB	L_{Amax} /dB	L_{Aeq} / dB	L_{Amax} /dB
1 – 146 Ripponvale Road	40	53	42	55
2 – 176 Ripponvale Road	43	56	46	59
3 – 165 Ripponvale Road	48	61	53	66
4 – 143 Ripponvale Road	48	61	53	66
5 – 123 Ripponvale Road	50	63	57	70
6 – 109 Ripponvale Road	52	65	58	71
7 – 78 Waenga Drive	47	60	44	57

Sound levels from the operation of NZ Cherry helicopters will increase at existing residential dwellings as a result of the orchard extension. The maximum increase is 7 dB at 123 Ripponvale Road which while clearly audible, is not considered significant having regard to the limited duration of the activity. There will be not be a sound level increase within Cromwell township and wider area as helicopters will be still be required to operate on the existing orchard, which is closer to the township than the orchard extension.

7.2 Reverse sensitivity effects

Future occupiers of the residential area will experience noise from a variety of sources; with frost fans, helicopters and audible bird scaring devices being the most dominant of these sources. Each of these sources will operate at different times and it is unlikely that they will occur cumulatively. Sound levels will be experienced both internally within the dwellings and externally within outdoor amenity spaces depending upon when the noise occurs.

As discussed in Section 5.1, the use of spatial separation (buffer areas), building orientation (shielding) and the sound insulation of dwellings are all effective measures to reduce the potential effects of reverse sensitivity. The use of buffer areas and building orientation are the primary controls to preserve the quality of outdoor noise amenity. Whereas, appropriate sound insulation is typically used to protect living areas and bedrooms from adverse noise intrusion. Sound insulation is only required for habitable spaces.

It is understood that the following buffer distances are proposed:

- Adjacent to the cherry orchard extension, in the RL3 area - 21 m.
- Adjacent to the cherry orchard extension, in the RL1, 2 and 4 areas - 25 m.
- Adjacent to Ripponvale Road – 30 m from road boundary.
- Adjacent to 146 Ripponvale Road in the RL4 area - 25m from property boundary.

These buffer distances are the minimum distance from the boundary where a building could be located. The distances do not necessarily mean that a house will be constructed at these distances.

The orientation of buildings can be designed such that the main amenity areas are screened from the main noise sources which will occur to the east and south of the PC14 site. Main amenity areas, including outdoor dining spaces, are generally within 20 m of the building (as per the definition of a

notional boundary). A screened courtyard area for example can provide at least 10 dB of sound reduction compared to a location on an exposed part of the building. This level reduction would apply to all noise sources, including helicopters as they operate at 15 m above ground level and therefore screening effects will occur.

The following section discuss the noise generated from each of the dominant noise sources and the effects on future occupiers of PC14 along with the recommended controls to address reverse sensitivity effects. Noise from NZ Cherry Corp operations and other orchards is also considered.

7.2.1 Frost fans

Figure 7.2 shows the predicted levels of frost fan noise across PC14. Sound levels at the boundary of the residential area (see Figure 1.2) are lower than 60 dB L_{Aeq} (62 dB L_{A10}) reducing to 45 dB in the north eastern area of the site. These predicted levels assume that frost fans on all surrounding orchards operate concurrently.

The nearest existing frost fan to the PC14 site boundary is the Frost Boss C49 fan unit on the Jakimm Orchard, which is approximately 80 m from the PC14 site boundary. Along Ripponvale Road there will be a 25 m zone boundary setback (RLA4). Therefore the closest a dwelling house could be to the nearest fan is 105 m. From the data in Table 3.2, the sound levels generated by a C49 fan is 65 dB L_{A10} at 100 m. Therefore, the noise generated by the nearest existing frost fan to the PC14 site would be 'compliant' with the CODP noise standard. Figure 7.4 shows the CODP 100 m buffer distance applied to all frost fans to demonstrate that along the PC14 boundary there is only one frost fan which overlaps the PC14 site boundary.

Figure 7.4: 100 m buffers around existing and future frost fans

Frost fans operate when a critical frost is expected and only during the colder months and only at night (typically between 4 am and 6 am). The performance standards of Table 2.2 require the internal sound level within living areas to be no greater than 40 dB $L_{Aeq,t}$ and within bedrooms, no greater than 30 dB $L_{Aeq,t}$ for areas with negligible transportation noise (AS NZS 2107:2016). It is highly

unlikely that residents will sleep with windows open at night during these periods and therefore provided that internal noise levels within bedrooms are no greater than 30 dB $L_{Aeq,t}$ then there should be no adverse noise effects.

Modern constructed dwellings that achieve the minimum thermal performance requirements of the New Zealand Building Code will achieve a sound reduction from outside to inside of approximately 25-30 dB with windows and doors closed. Provided that the external sound level is no greater than 55 dB(A) a standard building construction will achieve a sound level in bedrooms of no greater than 30 dB $L_{Aeq,t}$ as demonstrated in Figure 7.5. For residential units exposed to sound levels of approximately 60 dB, enhanced building treatment is required to provide the necessary sound insulation. Enhanced treatment would be to install insulated glazing units (IGUs) with thicker glass (e.g. 4mm glass, 12 mm airgap and 6.4 mm laminated glass rather than 4-12-4 standard IGUs).

The CODP requires noise from frost fans to achieve 45 dB L_{AFmax} inside any habitable space. Based upon the same sound insulation requirements, an internal L_{AFmax} no greater than 45 dB will be achieved, as typically the L_{AFmax} from an operating frost fan is no greater than 6 dB above the measured $L_{Aeq,t}$ value.

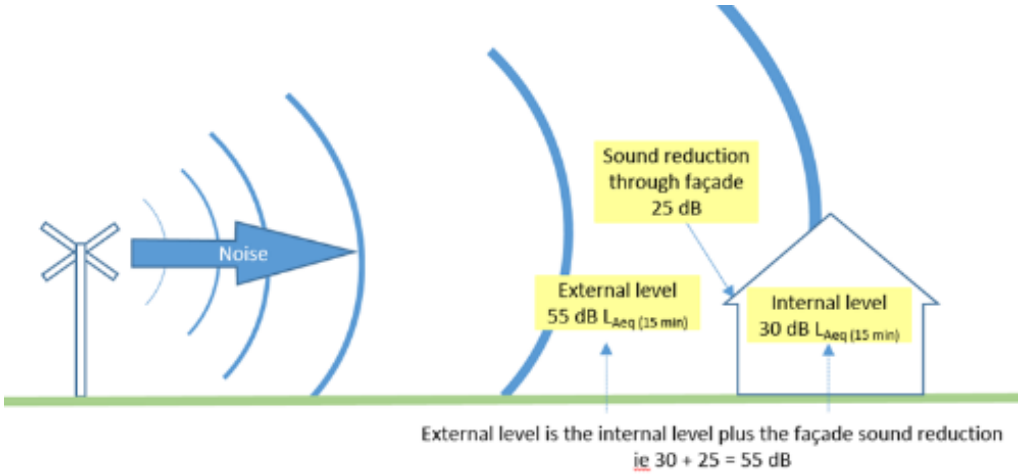
To protect future residents from the noise effects of frost fans, and to protect orchardists from potential reverse sensitivity effects, the following measures are recommended for bedrooms:

- For dwellings exposed to less than 55 dB L_{Aeq}, windows and glazed door systems should meet the minimum thermal performance requirements of the Building Code (4-12-4 IGU or similar acoustic performance).
- For dwelling exposed to sound levels in the range 55-60 dB L_{Aeq}, window and door systems should be installed which offer a higher level of sound insulation (4-14-6.4 IGU or similar).

No future residential dwelling will experience sound levels greater than 60 dB L_{Aeq} (62 dB L_{A10}).

Sound levels are typically greater than 55 dB L_{Aeq} at a distance of less than 250 m from the PC14 boundary. Even if additional frost fans were to be installed on other orchards this 250 m distance would be sufficient to achieve district plan compliance and address reverse sensitivity effects. Therefore, dwellings less than 250 m from the PC14 site boundary should be installed with 4-14-6.4 IGU or similar windows/door systems to bedrooms. This enhanced glazing specification is comparable to a performance standard of 35 dB Rw+Ctr.

Figure 7.5: External to internal sound levels



7.2.2 Helicopters

Helicopters may operate for both frost protection (in the early hours of the morning – 4 am to 6 am) and the drying of fruit in the summer (6 am for 30 minutes to 2 hours).

NZ Cherry Corp do not use helicopters for frost fighting and therefore the noise effects along the western boundary of the PC14 site are restricted to around sunrise during the summer months (mid-December to end of January) when it is expected that residents will be indoors, but may have windows open.

Helicopters are used infrequently and as noted by NZ Cherry Corp, helicopters are needed for approximately 8-12 days per year (for drying fruit). It is recognised that residents may be outdoors during the summer months in the morning period if fruit drying lasts longer than a couple of hours. These occurrences are very infrequent, and therefore the primary aim of this assessment is to provide protection from helicopter noise when experienced indoors.

To address activity on other orchards which may use helicopters for frost fighting, similar control measures as outlined below should be adopted, noting that it is expected that residents will have windows closed when helicopters are used for frost fighting.

Table 7.3 provides calculated sound levels from a single helicopter performing a flyby when drying fruit. Similar sound levels will occur when fighting frost.

As helicopters generate higher sound levels than frost fans, enhanced sound insulation of the complete building envelope (walls, windows, doors and ceiling/roof) is required which exceeds the frost fan requirements stated above in Section 7.2.1 along the boundary with the orchard extension.

A sound insulation performance standard should apply to all new residential dwellings such that:

- At distances less than 200 m from the PC14 orchard extension site boundary the sound insulation of habitable spaces should achieve 40 dB Rw+Ctr with the addition of mechanical ventilation to bedroom spaces.
- At distances between 200 m and 350 m from the PC14 orchard extension site boundary the sound insulation of habitable spaces should achieve 35 dB Rw+Ctr with the addition of mechanical ventilation to bedroom spaces.
- At distances greater than 350 m from the PC14 orchard extension site boundary the sound insulation of habitable spaces should achieve 30 dB Rw+Ctr which is typical for a dwelling built to the current requirements of the Building Code.

With these measures in place, sounds levels of less than 40 dB will be achieved indoors and given the infrequent nature of helicopter operations, the noise effects will be less than minor.

7.2.3 Audible bird scaring devices

Audible bird scaring devices are used by orchards in the Ripponvale area although it is understood from NZ Cherry Corp that the three adjacent orchards to the PC14 site do not use audible bird scaring devices. The nearest potential orchard that may use these audible devices is approximately 500-600 m from the PC14 boundary along Ripponvale Road, with 45 South being the primary user of bird scaring devices at over 1 km to the south of the site.

Audible devices can operate at any time and external sound levels will be in the order of 60-65 dB L_{Ae} at approximately 500-600 m from a gas powered Vinetech bird scarer. Given this spatial separation and likely level of noise (<65 dB L_{Ae}), operation of audible bird scaring devices would be 'compliant' with the CODP noise rule. Furthermore the design measures outlined above for frost fans and helicopters would ensure that the noise generated by audible bird scaring devices will not result in adverse noise effects.

7.2.4 Spraying

For the situations when spraying occurs, the proposed spatial separation, building orientation and treatment of the building will control any adverse noise effects as the sound levels from spraying are less than those experienced from helicopters.

7.3 Cumulative noise

Horticultural activities do not tend to result in cumulative noise from more than one orchard / vineyard activity taking place at the same time. Cumulative effects are therefore considered negligible.

7.4 Noise barriers

Mitigation measures could include the use of boundary treatment to provide additional noise reduction, for example bunding or noise walls (barriers). A bund or barrier would have to be located either close to the source of the noise (impracticable in this situation) or near the receiving location, i.e. around each dwelling. To provide adequate protection at the receiving location the dimensions of the bund / barrier would have to be significant (i.e. greater than 3 m in height).

7.5 Noise rules

To protect future occupiers of the residential dwellings, the following sound insulation standards should be incorporated into the future district plan noise rules for the PC 14 site:

- At distances less than 200 m from the PC14 orchard extension site boundary the sound insulation of habitable spaces should achieve 40 dB Rw+Ctr with the addition of mechanical ventilation to bedroom spaces. This is denoted as the orange highlighted area in Figure 7.6.
- At distances between 200 m and 350 m from the PC14 orchard extension site boundary and at distances less than 250 m from the Ripponvale Road site boundary the sound insulation of habitable spaces should achieve 35 dB Rw+Ctr with the addition of mechanical ventilation to bedroom spaces. This is denoted as the green highlighted area in Figure 7.6.
- At distances greater than 350 m from the PC14 orchard extension site boundary and at distances greater than 250 m from the Ripponvale Road site boundary the sound insulation of habitable spaces should achieve 30 dB Rw+Ctr. This is denoted as the un-highlighted areas in Figure 7.6.

Note there is no distinction between living areas and bedrooms due to the design complexities of specifying enhanced sound insulation to individual rooms.

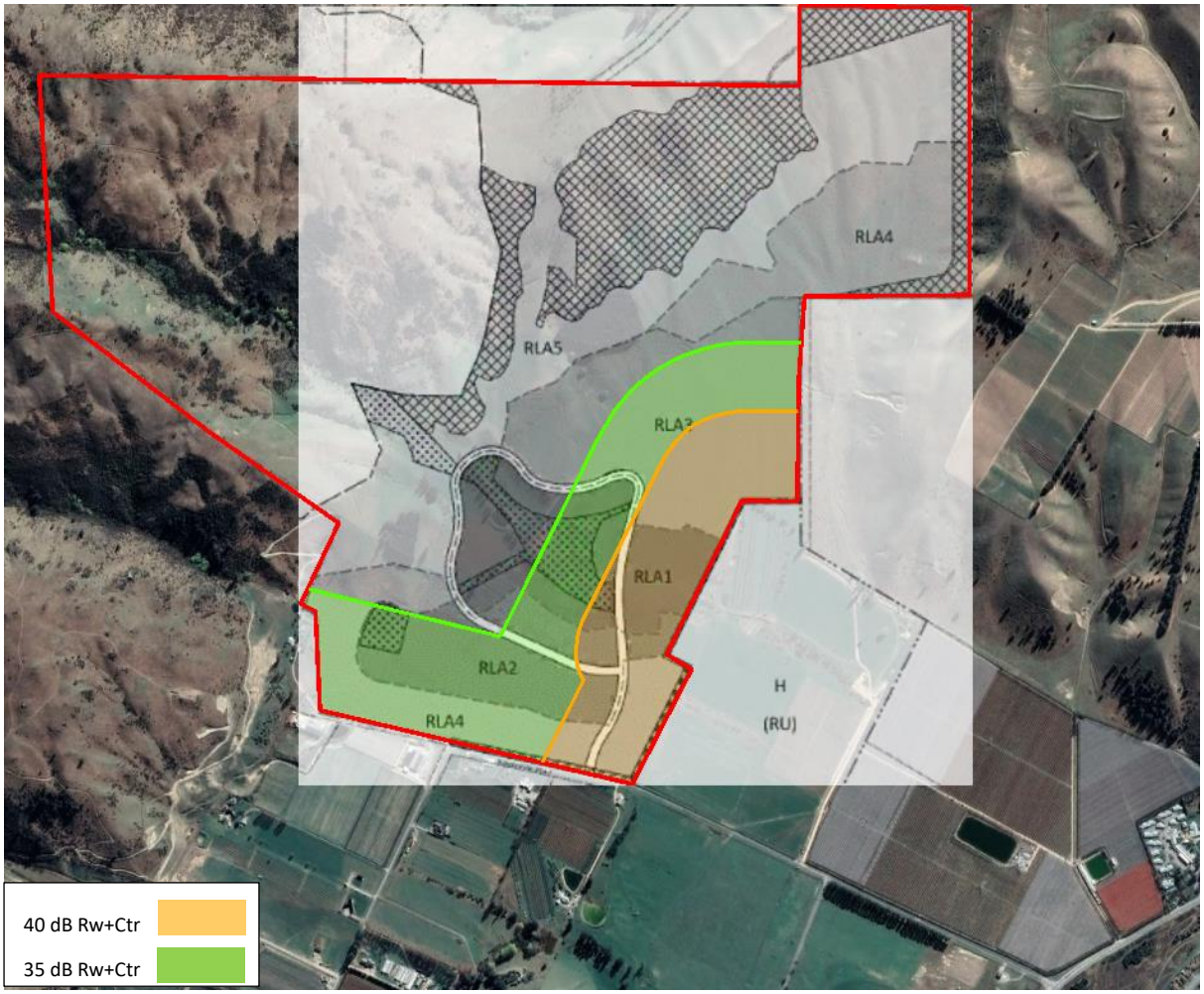


Figure 7.6: PC14 Structure Plan with sound insulation zones highlighted

8 Conclusions

An assessment of noise effects has been prepared for a private Plan Change 14, which includes addressing noise matters raised in submissions. The PC14 site is surrounded by Rural and Rural Residential zoned land, where cherry growing and pastoral farming are the primary land use activities.

Accordingly, horticulture activities in the Ripponvale area, including the expanded NZ Cherry Corp orchard, have the potential to generate noise effects on future occupiers of the residential lifestyle allotments within PC14. This also raises the potential for reverse sensitivity effects on horticultural activities.

Sources of noise include the sound levels generated by frost fans, helicopter movements, bird scaring devices and general orchard activities including spraying. NZ Cherry Corp will install Frost Boss C59 frost fans on the cherry extension and these fans are some of the quietest units currently available.

To address the noise when frost fans and helicopters operate, the sound insulation of the future residential dwellings will be designed to achieve minimum specified acoustic requirements (with mechanical ventilation and comfort cooling required in some instances) depending upon the distance from each boundary. Furthermore, it is suggested that the dwellings should be orientated to shield outdoor amenity spaces by positioning these spaces in a northerly orientation.

By including these control measures, residential amenity of both future occupiers and existing properties will be protected such that adverse noise effects will be appropriately managed. These recommendations also address the concerns of several submitters who have raised concerns regarding reverse sensitivity effects from existing horticultural activities on future residential users of PC14.

9 Applicability

This report has been prepared for the exclusive use of our client NZ Cherry Corp (Leyser) LP Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that our client will submit this report as part of an application for a plan change (PC14) and that Central Otago District Council as the consenting authority will use this report for the purpose of assessing that application.

Tonkin & Taylor Ltd

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Appendix A: Glossary of terms

Term	Definition
dB	A unit of measurement on a logarithmic scale which describes the magnitude of sound pressure with respect to a reference value (20 μPa).
$L_{Aeq(t)}$	The A-weighted time-average sound level over a period of time (t), measured in units of decibels (dB).
L_{Amax}	The maximum A-weighted sound pressure level over a period of time or of a particular noise event, measured in units of decibels (dB).
L_{Ae}	Sound exposure level. The A-weighted time-average sound level compressed into a unit period of time (one second), measured in units of decibels (dB).
L_w / SWL	Sound power level of a source, measured in decibels (dB).
Noise	Unwanted sound.
Rw+Ctr	Weighted sound insulation rating with a low frequency spectral correction
SAC	Special audible characteristics – a sound that has a noticeable quality.

Every 10 dB increase in sound level doubles the perceived noise level. A sound of 70 dB is twice as loud as a sound level of 60 dB and a sound level of 80 dB is four times louder than a sound level of 60 dB. An increase or decrease in sound level of 3 dB or more is perceptible. A change in sound level of less than 3 dB is not usually discernible.

As sound levels are measured on a logarithmic scale, the following chart provides examples of typical sources of noise.

Decibel (dB)	Example
0	Hearing threshold
20	Still night-time
30	Library
40	Typical office room with no talking
50	Heat pump running in living room
60	Conversational speech
70	10 m from edge of busy urban road
80	10 m from large diesel truck
90	Lawn mower - petrol
100	Riding a motorcycle at 80 kph
110	Rock band at a concert
120	Emergency vehicle siren
140	Threshold of permanent hearing damage

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