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File Ref: AC20335 – 02 – R1

23 December 2020

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Dear Nick

Re: Hanmer Springs Fly-Ride Project – Assessment of Environmental Noise Effects

As requested, we have undertaken a review of the expected noise levels from a proposed new adventure ride on Conical Hill in Hanmer Springs. The Applicant requires an assessment of environmental noise effects with regard to section 104 (1) of the Resource Management Act (RMA), which requires the actual and potential effects of the activity on the environment to be considered.

Our analysis is primarily based on the following information:

- Briefing email dated 16 of November 2020, including the attached *RFP Hanmer Fly-Ride Project Request for Proposal* produced by Cequent Limited and dated 29 September 2020,
- Proposal document titled *Cequent Projects Conical Hill Switchback System* produced by Holmes Solutions and dated 16 October 2020.
- Concept document titled *Switchback, Conical Hill, Hanmer Springs, Landscape Concept Documentation* produced by Rough and Milne Landscape Architects and dated the 15th of December 2020.

1.0 SITE AND PROPOSAL

1.1 Site and surrounding area

The proposed adventure ride is located in the Conical Hill Reserve in Hanmer Springs settlement. The site is zoned as Open Space under the Hurunui District Plan, while the neighbouring sites to the west, north, and east are classified as Rural zone, outside the area of Hanmer Springs settlement. Sites to the south are zoned Residential 1H, some of which contain residential dwellings and others are undeveloped. The site and surrounding area are shown below in figure 1.1.

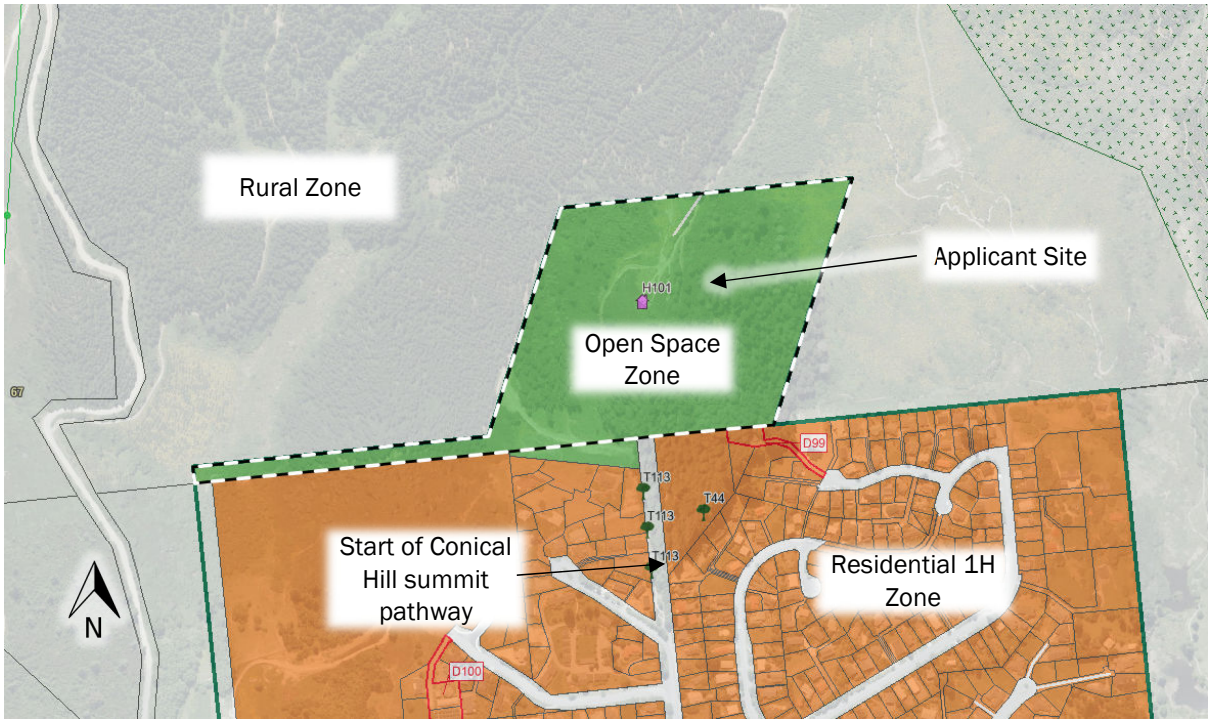

Figure 1.1 – Site locality (Canterbury Maps)

1.2 Proposal

The proposal is to build a new adventure attraction at the Conical Hill site, which involves a ride down the hill beneath the tree canopy, suspended from an overhead wire (similar to zip-line systems) and portions of rigid track. A ride length of approximately 550 metres will be provided, taking approximately 106 seconds. The ride starts at a station near the summit of Conical Hill, and terminates at a station down the hill, closer to nearby residences. A map view of the ride is shown in figure 1.2. Also shown is the location of the closest residential properties.

Users of the FlyRide attraction are expected to walk up the existing Conical Hill summit pathway to reach the top of the ride, and to walk between the two stations of the ride. The path starts from the top of Conical Hill Road and climbs up the eastern face of Conical Hill. Users of the FlyRide attraction who arrive in vehicles are expected to use on street parking on Conical Hill Road.

We have assumed that operations will be limited to within the Hurunui Operative District Plan day-time hours (0700 hours to 1900 hours).

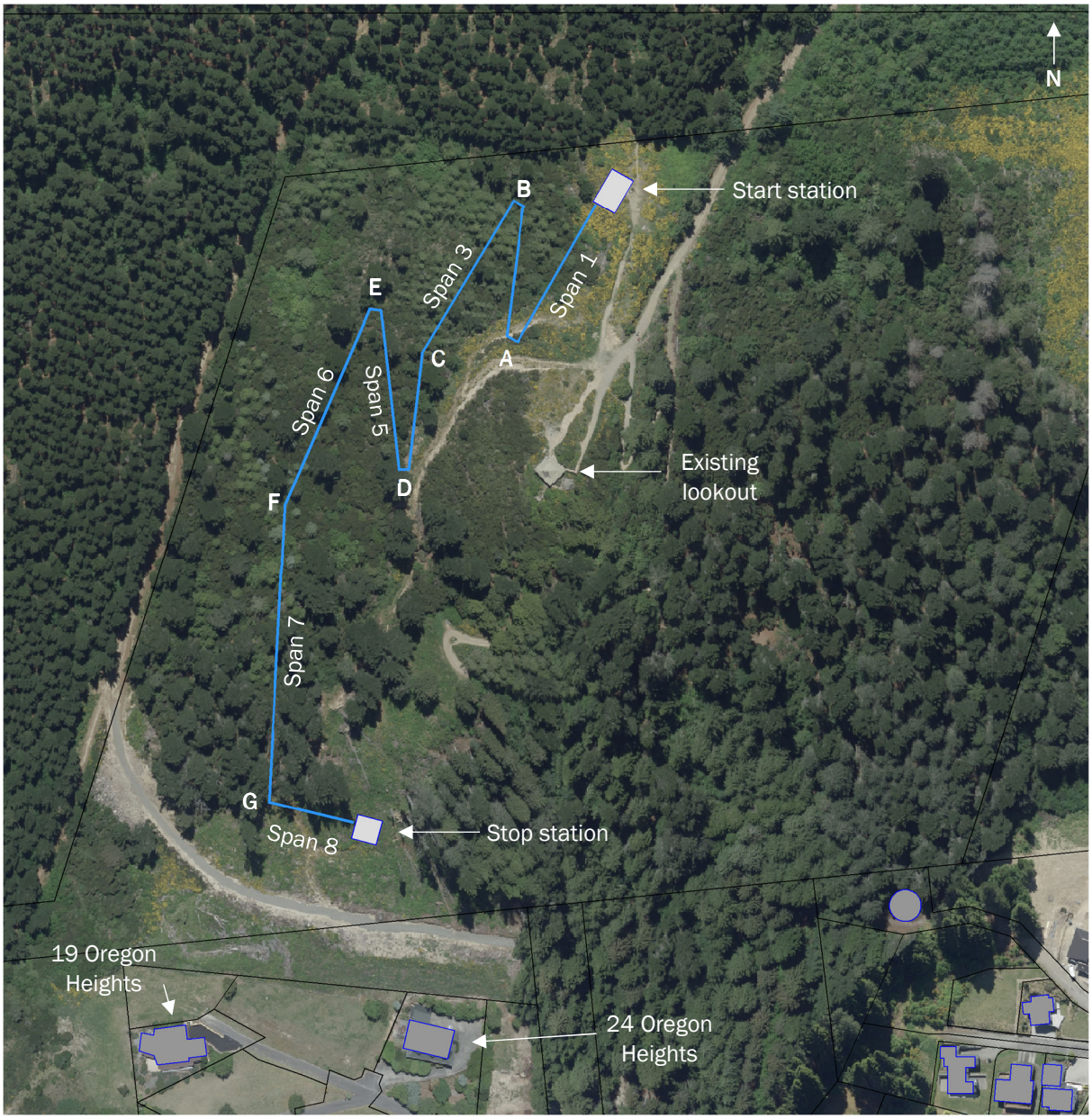

Figure 1.2 – Plan view of the proposed FlyRide system

The proposed Switchback system differs from traditional zip-line systems in that the trolley can switch between cable and rigid track elements, and the trolley contains an onboard motor for speed control, which enables the ride experience to be tailored to the preferences of individual riders for a more, or less, exhilarating ride. Additionally, the master control system allows trolleys to be speed controlled on portions of the track, as necessary for operational and safety reasons.

We understand that the ride is designed with future expansion in mind. This report is however limited to analysis of the ride extent as proposed in the concept documentation produced by Rough and Milne Landscape Architects.

We anticipate that the main noise source from this activity will be the noise from participants' vocal reactions to the ride, screaming and/or shrieking during the ride experience. We have therefore sought to quantify and assess the impact on nearby residences of noise from the vocal effort of users of the ride. Throughout this

report, the phrase 'noise generated by ride users' is used to refer to human screaming, shrieking, squealing, etc.

Other noise sources from the activity are expected to be:

- People accessing the attraction by walking up and down the existing Conical Hill summit pathway
- Noise from trolleys moving on the Switchback system track
- Noise produced by the electric motor and gearing of the trolley return system
- Private vehicles manoeuvring and parking on Conical Hill Road

Noise from people on the walking tracks and vehicles on Conical Hill Road are already part of the existing environment. Based on our discussions with the Switchback system supplier we understand that only low levels of noise are produced by that system. We therefore expect the noise from these additional sources will have a less than minor effect, and no change will be noticeable in the wider area. We have therefore not assessed these sources further in this report.

2.0 ACOUSTIC CRITERIA

The Resource Management Act requires consideration of the significance of any adverse effects associated with the proposal. Guidance as to the significance of any adverse effects may be obtained from several sources.

2.1 Hurunui District Plan noise standards

The Conical Hill Reserve site is located within an Open Space zone, and therefore, to be a permitted activity, noise from the operation would need to comply with the noise limits outlined in the Hurunui District Plan Chapter 4 – *Settlements; Open space Rules 4.21 Standards for permitted activities*, as follows:

4) Noise

a) All activities shall be designed and conducted so as to ensure that the following noise limits are not exceeded, at or outside the boundary of the site:

55 dB $L_{Aeq(1\text{-}hr)}$ 7am – 7pm daily

45 dB $L_{Aeq(1\text{-}hr)}$ 7pm – 7am daily

75 dB L_{AFmax} all days between 10pm and 7am

As outlined in section (c) of the above rule, noise measurements are to be undertaken in accordance with New Zealand Standard NZS 6801:2008 Acoustics – Measurement of Environmental Sound.

As these noise limits apply at the boundary of the site generating noise, no account is taken of the nature and noise sensitivity of adjoining sites. The noise limits for activities in the Residential Zone (Rule 4.6.7) are the same as those for the Open Space Zone. Noise limits for activities conducted in the Rural Zone apply at the notional boundary of any dwelling and the levels and times are given in Rule 3.4.3.9 and are the same as those given above.

2.2 New Zealand Standard 6802

NZS 6802:2008 *Acoustics – Environmental Noise* outlines a guideline daytime limit of 55 dB $L_{Aeq\ (15\ minutes)}$ for "the reasonable protection of health and amenity associated with the use of land for residential purposes".

NZS 6802:2008 *Acoustics – Environmental Noise*, which the District Plan references, has some guidance for highly impulsive sounds, and / or sounds of a unique spectral character. It states:

> *6.3.1 The intrusiveness of a sound is not just a function of its sound pressure level. It is also affected by its character. Sound that has special audible characteristics, such as tonality or impulsiveness, is likely to cause adverse community response at lower sound levels, than sound without such characteristics.*

The standard provides for the special audible characteristics of various types of sounds by adding a 5 dB penalty to account for the higher likelihood of annoyance or otherwise. While it does not explicitly list sounds such as those that may be generated by ride users in this case as sounds that would incur a penalty, it does list other sources with similar tonal characteristics such as saws, grinding, and scraping.

Therefore, for the purposes of compliance with the Hurunui Operative District Plan rule, we consider that a 5 dB penalty to the predicted level $L_{Aeq(1h)}$ is appropriate.

2.3 World Health Organisation

The World Health Organisation (WHO) document, *Guidelines for Community Noise*[1], recommends a guideline limit of 55 dB $L_{Aeq\ (16\ hours)}$ to ensure few people are seriously annoyed in residential situations, based on extensive international research. A guideline limit of 50 dB $L_{Aeq\ (16\ hours)}$ is recommended to prevent moderate annoyance.

The WHO document does not directly address sounds such as those that may be generated by ride users in this case, but does acknowledge that short, impulsive, repeated noises can lead to annoyance and other negative social and behavioural effects. It acknowledges that time-averaged approximations of noise such as L_{Aeq} are not suited to assessing these types of noises, and recommends that attention is paid to other parameters such as L_{max}.

2.4 Existing noise levels

Ambient noise measurements have been undertaken on the site and in the surrounding area on a typical weekday morning.

Ollie Hutchison of AES visited the site at 1530 hours on the Monday the 14th of December 2020 to observe and measure the existing ambient noise in the daytime in general accordance with NZS 6801:2008 *Acoustics – Measurement of Environmental Sound*. Measurements were taken at two locations:

- In close proximity to the location of the proposed end station of the ride,
- On the road outside 1 Oregon Heights.

It was not possible to take measurements closer to the dwellings at 19 and 24 Oregon Heights, as the road is private.

Noise sources audible in the area included:

- Birds and the natural environment,
- A distant lawn mower and residential building activity.

During our visit, the ambient noise level in the area was observed to be:

[1] Edited by Berglund, B *et al. Guidelines for community noise.* World Health Organization 1999.

- 53 dB L_{AFmax}, 41 dB L_{Aeq}, and 37 dB L_{A90} in close proximity to the location of the proposed end station of the ride

- 56 dB L_{AFmax}, 44 dB L_{Aeq}, and 39 dB L_{A90} outside 1 Oregon Heights.

At this time, noise from the natural environment (birds, trees rustling, etc.) dominated the measurements.

2.5 Discussion about sensitivity to noise generated by rider users

As mentioned above, sound created by riders on the proposed adventure ride may not be meaningfully quantified by time-averaged noise limits discussed in the above documentation. The impulsive nature of noise from the sounds, and their spectral content are substantially different from the types of noise that are usually associated with the assessment of intrusive noise in residential situations (traffic noise, industrial noise, machinery, etc.). It is likely that noise from ride users will not exceed the time-averaged limits specified in the above documentation, at the nearest residential properties – because it is highly transient. However, it should not be assumed that compliance with the rules means that the noise is not problematic.

Firstly, due to the different spectral energy distribution of noise from ride users from that of typical residential area ambient noise, noise from ride users may 'penetrate' through ambient noise (even when distant and at low level). The spectral shape of this type of sound differs substantially from that of typical ambient noise. Typical ambient noise has energy in the low- and mid-band frequencies (1 kHz and below), whereas screaming has predominate energy in the 2 kHz octave band. This sound will not be masked by ambient noise in the way that lower frequency noise would be.

Secondly, neuroscientific research has suggested that this type of sound, in its role as an audible signal to alert others to a situation of calamity, can trigger a subconscious 'fight or flight' reaction in the brain, and can lead to highly emotional impulses.[2] This type of sound, even at low levels of audibility, could be problematic in this sense.

Subjectively, the type of vocalisations produced by users of the ride may be subtly different in character to the vocalisation of people in genuine existential stress. During our observations of people using the water slides at the nearby Hanmer Springs Alpine Spa Village, it was observed that the peak effort vocalisation of users of the water slides varied from being seemingly provoked by genuine fear, to less alarming 'whoops' of joy.

2.6 Discussion regarding appropriate noise levels

In terms of assessing compliance with the Hurunui District Council Operative District Plan, and in line with the guidance of the relevant standard (NZS 6802:2008), we consider that modelling of $L_{Aeq(1h)}$ from of users on the ride should include a 5 dB penalty for Special Audible Characteristics.

In terms of assessing effects of the activity, we consider that the District Plan limits are not suitable for determining potential effects of users of the ride due to the impulsive, and high-pitched nature of this noise. In line with the WHO guidance, and that of other literature consulted, we consider that assessment of the L_{AFmax} level for this noise is more appropriate when seeking to understand the potential effects of this noise.

When considering the measured existing ambient noise levels, and the guidance above (which studied the level of 'emergence' of these types of sounds above the ambient noise level), we consider that where sounds from ride users typical do not exceed a level of 45 dB L_{AFmax} at the boundary of any dwelling, the noise effects will be minimal.

[2] Arnal, L. H., Flinker, A., Kleinschmidt, A., Giraud, A., and Poeppel, D. (2015). Human Screams Occupy a Privileged Niche in the Communication Soundscape. *Current Biology*, 25, 2051–2056.

Noise effects experienced by users of the Conical Hill summit pathway may also be of interest. We consider that higher noise levels will be acceptable in this location, as it is only occupied intermittently, by people who are in the area for a brief period, and who are also engaged in an active outdoor pursuit.

3.0 NOISE GENERATED BY THE ACTIVITY

As discussed above, the dominant noise source from the proposed adventure activity is expected to be noise from users on the ride. We have considered the expected noise levels below.

3.1 Modelling

SoundPlan computational modelling based on *ISO 9613 Acoustics – Attenuation of sound outdoors – Part 2: General method of calculation* has been used to calculate the propagation of noise from the site. Modelling has considered the topography of the area, worst-case downwind conditions, and sound power levels of the noise source.

The source level in our analysis has been based on a measured noise levels of users on an existing adventure ride, the hydroslide at the Hanmer Springs Alpine Spa Village. The vocalisations of a variety of different users over a period of half an hour were measured. The sound pressure level of the measured peak effort vocalisations was converted to sound power level assuming spherical propagation. Observed sound power levels ranged from 117 to 121 dB L_{wAFmax}. These levels are consistent with levels reported in the literature.[3] Therefore, our analysis has used a sound power level of 118 dB L_{wAFmax}, which was the average sound power level of the peak effort vocalisations observed in our measurements, and so is a reasonable approximation of what may be 'typical'.

The spectral content of peak effort vocalisation was also measured at the Hanmer Springs Alpine Spa Village site. The spectrum of a measured female peak effort vocalisation was used in our analysis. The spectrum of the vocalisation used showed a sharp peak of energy in the 2 kHz octave band, which is consistent with the spectral distribution of energy from peak effort vocalisation reported in the literature.[4]

3.2 Predicted L_{AFmax} noise levels

Due to the topography of the site, the closest residential properties, and the Conical Hill summit pathway are well shielded from most of the ride's route. Only the final corner (corner G on figure 1.2) and the final span (span 8) of the route, have a line-of-sight view to neighbouring dwellings. If users of the ride exert high levels of vocal effort at the final corner, or along the final span of the route, our analysis confirms that this would exceed the 45 dB L_{AFmax} criterion by some margin.

The closest distance where a peak effort vocalisation would comply with the 45 L_{AFmax} criterion is approximately 100 metres prior to corner G. This is shown in figure 3.2 below. If users of the ride exert high levels of vocal effort at earlier points in the ride, this would readily comply with the criterion at the boundaries of neighbouring dwellings, due to the shielding provided by the terrain.

[3] Begault, D. R. (2008). Forensic Analysis of The Audibility of Female Screams. *Proceeds of the AES 33rd International Conference*, Denver, CO, USA, June 5 – 7 2008.

[4] Begault, D. R. (2008). Forensic Analysis of The Audibility of Female Screams. *Proceeds of the AES 33rd International Conference*, Denver, CO, USA, June 5 – 7 2008.

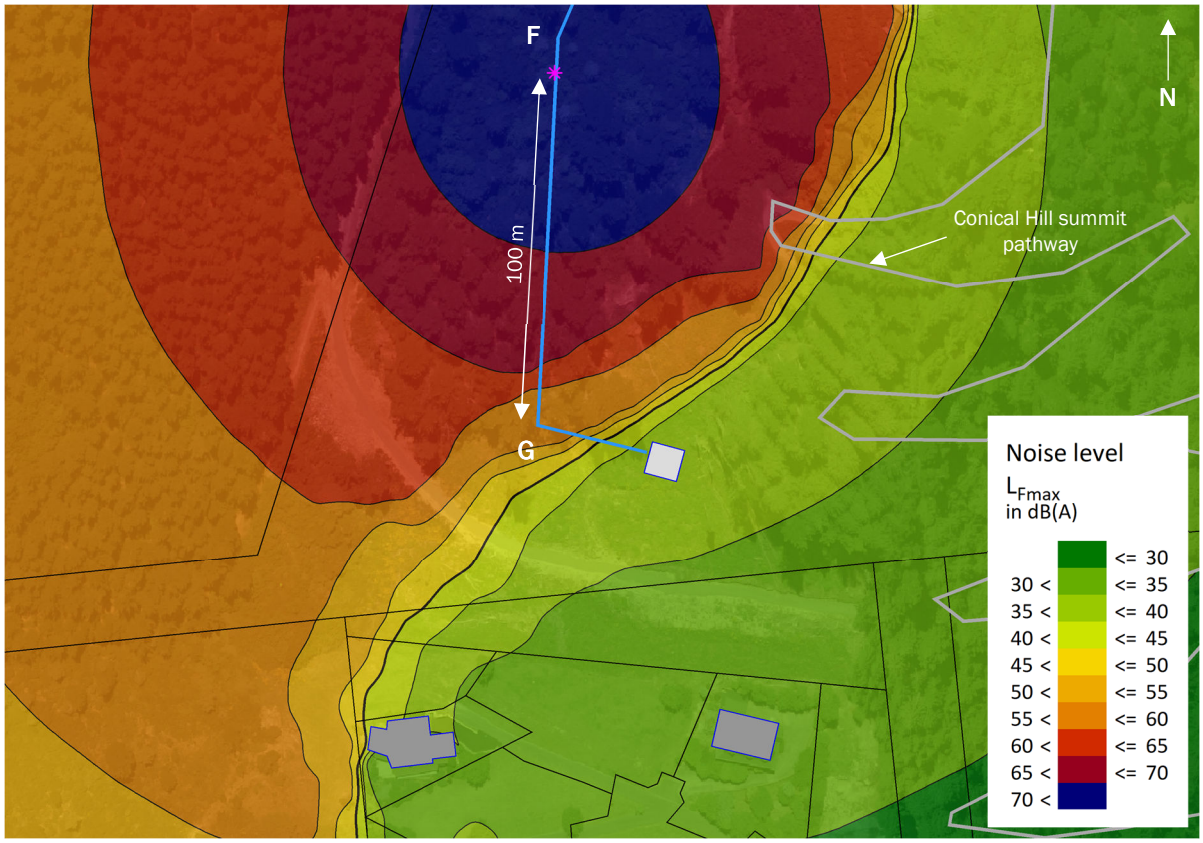

Figure 3.2 – L_{AFmax} of a scream at 100 metres from the final corner (corner G) of the route (contour shown at 1.5 m height).

We therefore recommend that the design and operation of the Conical Hill Switchback ride is managed so as to limit, as far as practicable, the likelihood of users exerting peak effort vocalisation as they traverse the final two spans (7 and 8) of the ride. This may involve control of the speed of the trolleys, or other aspects of ride design. We understand that this level of control is practicable.

For this scenario noise levels of up to 65 L_{AFmax} are expected over a small portion of the Conical Hill summit pathway. Because this pathway it is only occupied intermittently, and by people who are in the area for a brief period and are also engaged in an active outdoor pursuit, we do not expect this aspect of the noise to have any adverse effect.

3.3 District Plan compliance

We have also analysed a scenario with multiple users on the ride exerting peak effort vocalisation over the course of one hour of operation. In our correspondence with the client, we understand that, depending on the project budget, the system may be capable of a rider throughput of up to 60 riders per hour. This scenario would be considered the peak capacity throughput of the system and such patronage levels are not expected to occur for all hours of the day, or on all days of operation.

Our analysis assumes that not all riders will exert peak effort vocalisation, as some may choose to ride at slower speed, and some riders may be more comfortable during the experience than others. Therefore, our analysis has conservatively assumed that 60 % of riders will exert peak effort vocalisation at 8 points throughout the ride. We have estimated that the duration of a peak effort vocalisation is 2.5 seconds.

Using the above assumptions, the resultant 1-hour averaged sound pressure levels are shown in figure 3.2 below, including a 5 dB penalty for special audible characteristics.

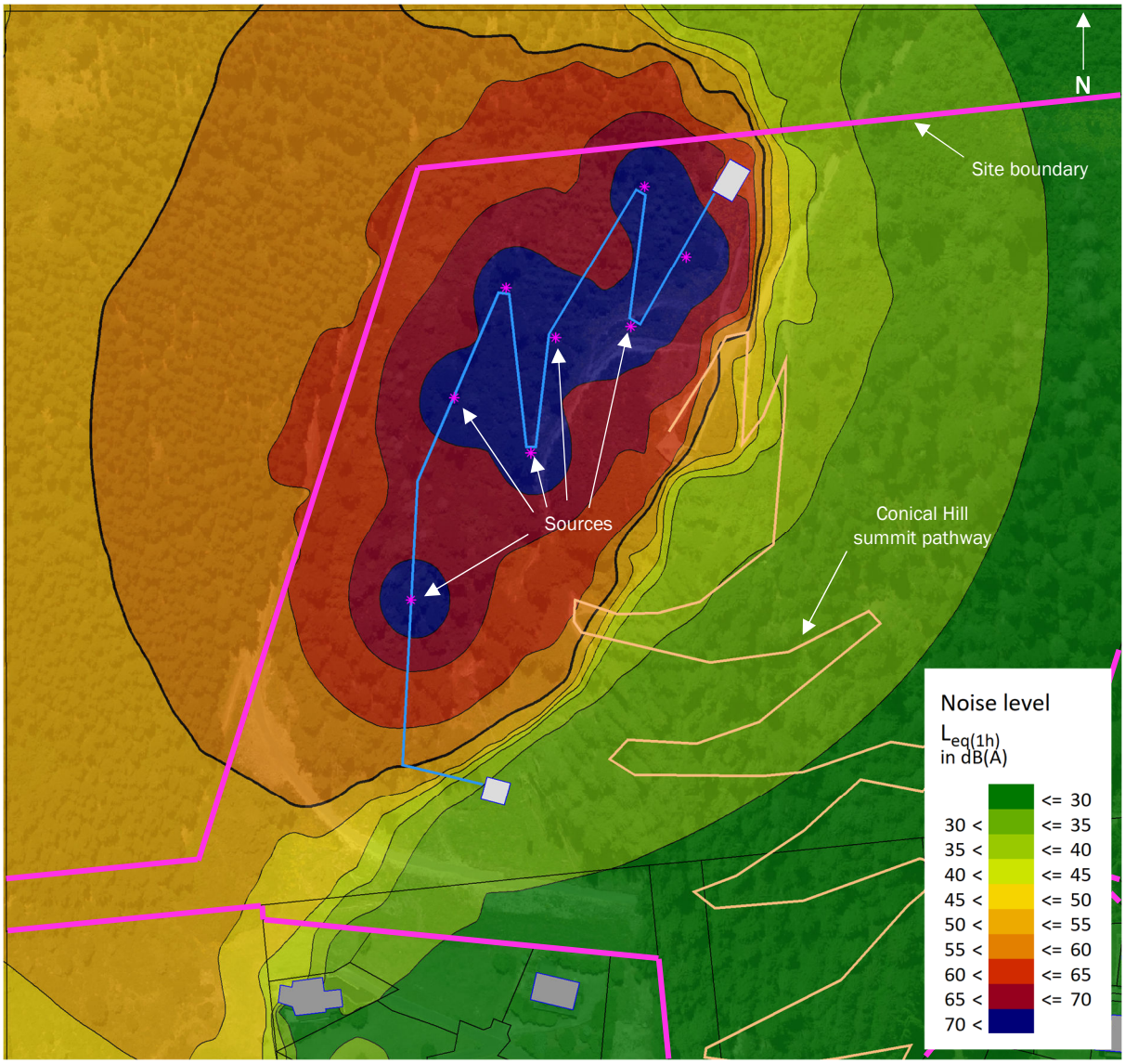

Figure 3.2 – $L_{Aeq(1h)}$ of screams from riders throughout the route over a 1 hour duration (contour shown at 1.5 m height)

This analysis demonstrates that the expected noise levels at the southern site boundary readily comply with the District Plan daytime noise limit.

Non-compliances may be experienced at the northern and western site boundaries, as these pass within relatively close proximity to the ride route, with no shielding. However, these areas are infrequently occupied, and we do not expect this noise to have any adverse effect. We also note that our analysis is conservative, and any areas of non-compliance at the site boundary would likely be smaller than our model suggests.

3.4 Noise from external plant associated with the Stations

External plant associated with the start and stop stations may include extraction systems from the toilets, and external air-conditioning condenser units. It is reasonable to expect that these systems can be designed, installed, and operate in compliance with the District Plan noise limits at the site boundaries using standard good practice.

4.0 CONSTRUCTION NOISE

Noise generated by construction activities associated with the development of the Fly-ride structure and associated buildings has the potential to adversely affect adjoining properties, especially if carried out during the early morning or evening hours.

The Hurunui District Plan provides specific guidance for noise from construction in all zones, specifically *Rule 4.21.4 (e) Settlements – Open Space Zone Rules – Standards for permitted activities* states that *construction noise shall not exceed the recommended limits in, and shall be measured and assessed in accordance with, the provisions of NZS 6803:1999 "Acoustics - Construction Noise".*

We therefore recommend that the Applicant adopts best practice procedures to reduce the likelihood of annoyance, nuisance and adverse health effects to people in the vicinity of construction work, and that these activities are planned and managed in accordance with *NZ 6803:1999 Acoustics – Construction Noise*, and that construction is undertaken to ensure noise does not exceed the sound levels specified in Table 2 of the Standard.

5.0 CONCLUSIONS AND RECOMMENDATIONS

We have considered noise levels from a proposal for a new adventure thrill ride in the Conical Hill Reserve site in Hanmer Springs.

We expect the main source of noise from the activity to be the peak effort vocal sounds created by users of the ride (screams and shouts).

For the purposes of compliance with the requirements in the Hurunui Operative District Plan section 4.21.4, and considering the nature of the source, we consider it appropriate that a 5 dB penalty for special audible characteristics be added to the source level in compliance with NZS 6802:2008.

However, for the purposes of assessing the effects of the activity, we consider that the District Plan noise limits are not suitable for quantifying the potential for annoyance and other adverse community impacts for nearby residential properties. Based on our review of international guidance and the existing ambient noise environment, we consider that if noise from ride users is typically less than 45 dB L_{AFmax} at the nearest residential properties, the effects will be minimal.

Our analysis indicates that noise levels at the nearest dwellings due to rider users will typically not exceed 45 dB L_{AFmax} provided:

- That the design and operation of the Conical Hill Switchback ride is conducted so as to limit, as far as practicable, the likelihood of users generating high levels of noise as they traverse the final two spans (7 and 8) of the ride. This may involve control of the speed of the trolleys, or other aspects of ride design.

Our analysis confirms that based on the proposed operating conditions, noise will comply with the relevant District Plan noise limits at all residential properties, with some non-compliances to unoccupied neighbouring sites to the north and west.

Based on the above, we expected the adverse noise effects of the proposal to be minimal.

Kind Regards,

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