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August 2, 2022

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Re: Community Noise Measurements
The Summit at Quadra Village, 955 Hillside Avenue, Victoria, BC
RWDI Reference No. 1901644

Hello Michael,

As requested, on July 14, 2022 between 8:00 p.m. and 10:00 p.m., RWDI measured noise levels at The Summit while isolating operation of various rooftop equipment. The measurements were conducted with input from several local residents to determine which (if any) rooftop equipment is leading to community noise complaints. This report summarizes the methodology, presents our measurement results, discusses our main findings, and provides recommendations to reduce rooftop equipment noise levels.

BACKGROUND

It is our understanding that:

- In June 2016, Wakefield Acoustics (since merged with RWDI) established pre-project ambient noise levels conducted at three (3) adjacent residential locations;
- In September 2020, RWDI measured HVAC levels at four (4) residential locations;
- After the 2020 site visit, a noise control kit for the chiller was installed;
- In July 2021, RWDI measured chiller noise levels at four (4) surrounding community locations while varying the load. These measurements showed that a tone exists in the rooftop chiller, which exceeds the bylaw at 971 Market when operating at 100% load, due to the tonality clause in the Victoria Noise Bylaw. At the other three locations, measurements indicated compliance with the bylaw; and
- At least one recent noise complaint has targeted the rooftop Large Chiller as the source of noise concern in the surrounding community.

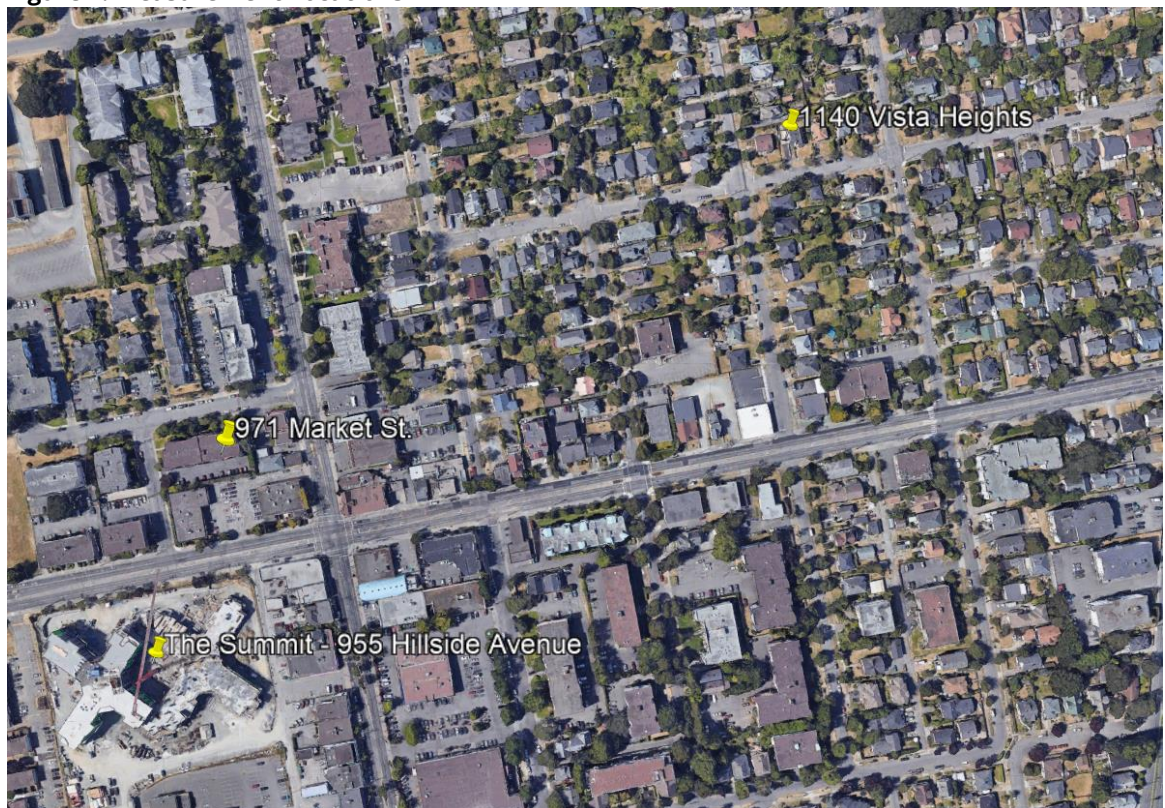


METHODOLOGY

RWDI conducted attended noise monitoring on the rooftop, as well as at two (2) community locations throughout testing. The testing procedure is outlined below. All measurement were conducted using Type 1 sound level meters which were calibrated prior to the beginning of testing. Measurements were conducted at the following locations (shown in Figure 1 below):

- 971 Market Street
- 1140 Vista Heights

Figure 1: Measurement Locations



Measurements at the residences were attended by RWDI field engineers, CRD staff, and members of the community. A predetermined list of test scenarios was established to isolate (and eliminate) rooftop equipment as a contributing factor the complaint. Community members had no prior knowledge of which equipment was running and were asked to confirm whether the noise related to the complaint was audible for any given test scenario. For each scenario, residents were asked if they could hear the noise they associate with the complaint. The response of the residents would determine whether further investigation into that equipment was required. Measurements were only taken when the residents confirmed that the noise from The Summit was audible and consistent with their noises of concern.



The test scenarios were as follows:

- Scenario #1 - Existing background noise level.
- Scenario #2 - Turn off all rooftop equipment.
- Scenario #3 - Turn on all air handling units
- Scenario #4 - Turn on exhaust fans
- Scenario #5 - Turn on the Small Chiller
- Scenario #6 - Turn on the Large Chiller (Small Chiller was turned off for this scenario)

Scenarios #1 and #2 were conducted to verify if the noise of concern is coming from The Summit. Scenarios #3 to #6 were conducted to identify the noise of concern. Closeup measurements of the rooftop equipment were taken to identify whether the HVAC equipment sound signatures correlate with the resident's noise of concern at the two community locations when audible noise from The Summit was confirmed.

MEASUREMENT RESULTS

Noise levels are presented in terms of the L90 which is defined as the sound level that is exceeded for 90% of a given time period. The L90 is generally considered to be representative of the background noise level. Since rooftop mechanical equipment operates to produce a steady and continuous noise, the L90 would best capture HVAC equipment noise levels provided that HVAC equipment noise levels are higher than other background noise (e.g., background traffic).

Measurement results are provided for both 971 Market St and 1140 Vista Heights. Please note that two residents were present at 971 Market St, and several residents were present at 1140 Vista Heights.

971 MARKET STREET

Table 1 presents the measurement results and resident's feedback at 971 Market Street.

Table 1: Measurement Results – 971 Market St.

Scenario #	Equipment	L ₉₀ (dBA)	Equipment is Audible (Yes/ Uncertain /No) ^[1]	Residents' Feedback
1	Baseline (all equipment)	51	Yes	<ul style="list-style-type: none">Residents noted a familiar tone present, but indicated that it can often be louder
2	None (background)	50 - 51	No	-
3	Air Handling Units	47	Yes	<ul style="list-style-type: none">One resident noted noise from The Summit was audible, but it was not the main noise of concern



Scenario #	Equipment	L ₉₀ (dBA)	Equipment is Audible (Yes/ Uncertain /No) ^[1]	Residents' Feedback
4	Exhaust Fans	-	Uncertain/No	<ul style="list-style-type: none">One resident was uncertain if there was a change from the previous scenario, the other resident did not believe the noise was audible from The SummitSince no change was noted, no measurements were taken
5	Small Chiller	50	Yes	<ul style="list-style-type: none">One resident believed that a familiar low tone was present, but not the main complaint noise was not present
6	Large Chiller	49 - 50	Yes	<ul style="list-style-type: none">This was immediately recognized as the main noise of concern by both residentsWhile the tone was identified as being audible, it was noted that it can often be louder

Table Notes:

[1] Based on resident's feedback.

Based on the results in Table 1 and observations made on site, we note the following:

- The main noise of concern was determined to be associated with the Large Chiller;
- It was determined through communication between RWDI field staff and rooftop measurements that the tone of interest (the main noise of concern) is a 315 Hz hum from the Large Chillers' compressors (refer to Figure 2 and discussion below);
- Based on scenarios #2 and #3, we expect that background levels (in the absence of The Summit rooftop equipment noise) to be 47 – 51 dBA during this site visit. The background levels are dominated by traffic noise which varies based on changing traffic pattern;
- In general, rooftop HVAC equipment noise from The Summit had little to no contribution to the overall L₉₀ during the site visit. However, background noise levels are expected to be lower later in the night, which may result in The Summit HVAC equipment to be more audible/measurable over background noise; and
- HVAC equipment noise from the nearby Commercial Lot (942 Hillside) was audible and may have added to the uncertainty in one of the resident's feedback, but this was not the main noise of concern.



1140 VISTA HEIGHTS

Table 2 presents the measurement results and resident's feedback at 1140 Vista Heights.

Table 3: Measurement Results – 1140 Vista Heights.

Scenario #	Equipment	L ₉₀ (dBA)	Equipment Audible (Yes/ Uncertain /No) ^[1]	Residents' Feedback
1	Baseline (all equipment)	42 - 43	Yes	<ul style="list-style-type: none">• The noise of concern was audible and was described as a faint tone• The tone could not be identified on the sound level meter• When asked to reproduce the noise of concern, the resident hummed a tone which the sound level meter could identify as 315 Hz
2	None (background)	43	No	-
3	Air Handling Units	43 - 44	No	-
4	Exhaust Fans	-	No	-
5	Small Chiller	-	No	-
6	Large Chiller	43 - 44	Yes	<ul style="list-style-type: none">• Tone was audible to everyone present• While the tone was identified as being audible, it was noted that it can often be louder• The tone could not be identified on the sound level meter• When asked to reproduce the noise of concern, the resident hummed a tone which the sound level meter could identify as 315 Hz

Table Notes:

[1] Based on resident's feedback.



Based on the results in Table 3 and observations made on site, we note the following:

- Rooftop measurements confirmed that the 315 Hz tone was identified to be from the Large Chiller; and
- HVAC rooftop equipment (including the Large Chiller) noise was not measurable over the existing background levels at this measurement location.

ROOFTOP AT THE SUMMIT

Rooftop HVAC noise measurements were taken to characterize the Large Chillers' acoustical spectrum. Figure 2 shows the frequency spectrum measurements taken for the Large Chiller.

Figure 2: Rooftop Measurement - Large Chiller

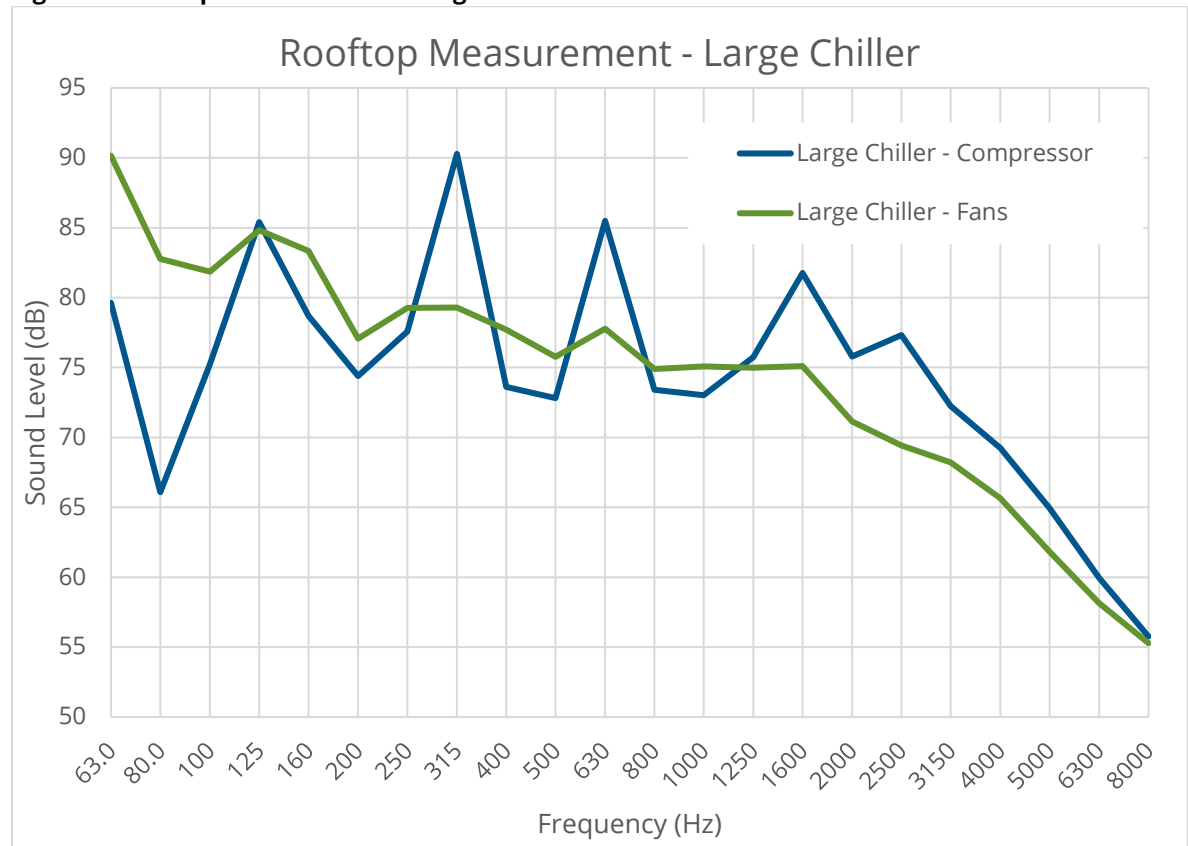


Figure 2 shows that the Large Chiller compressors emit a strong tone at 315 Hz, which continues at the next harmonic (630 Hz). It can also be seen that the 315 Hz tone was not present for the Large Chiller fans. This confirms that the tonal noise of concern is from the Large Chiller compressors.



DISCUSSION ON TONALITY

VICTORIA NOISE BYLAW DEFINITION OF TONALITY

The Victoria Noise Bylaw No. 03-012 states that a +5 dB correction applies when criteria for tonality is met. Criteria for tonality is as follows:

"In order for the tonality correction to apply if measurement is required to determine the presence of tonality, the level in the one-third octave band containing the tone, or the arithmetic average of the levels in a pair of bands containing the tone, must exceed the arithmetic average of the two adjacent bands

- (i) by 3 dB or more for tones in the 500 Hz. to 16 kHz. bands,*
- (ii) by 5 dB or more for tones in the 160 to 400 Hz. bands,*
- (iii) and by 10 dB or more for tones in the 31.5 to 125 Hz. bands;"*

The bylaw addresses tones by applying a correction (penalty) to the bylaw noise limits only if the noise of concern meets the bylaw's definition for tonality. It should be noted that tones may be measurable on a sound level meter but not meet the bylaw criteria for a tonal penalty. Furthermore, a tone can be audible but not measurable on a sound level meter – this occurs when background noise levels are high enough to mask the tone.

971 MARKET STREET

Measurements from August 2021 indicate that the Large Chiller noise levels at 971 Market Street meet the Victoria Bylaw's criteria for tonality when the chiller is operating at 100% load, but not at 60% load (despite a visible peak at 315 Hz). As such, the tonality penalty only applies when the chiller is operating at or close to 100% load. In view of this, the Large Chiller generally meets the bylaw noise level limits until it reaches close to 100% load.

Measurements from July 14, 2022 at 971 Market Street indicate a small visible tone at 315 Hz. This tone was audible to residents, CRD staff, and RWDI field engineers. Background noise levels during the measurements were noted to be masking the tone. As the tone did not meet the bylaw definition of tonality, noise levels were within bylaw limits during the measurement period.

1140 VISTA HEIGHTS

Measurements at 1140 Vista Heights indicate no change in L90 levels when rooftop equipment was running. In addition, the 315 Hz was not measurable over existing background noise levels. Despite having no influence on the measured noise levels, the Large Chiller and its 315 Hz tone was faintly audible to everyone on site.



RECOMMENDATIONS

We provide the following noise control recommendations:

Option 1 (Preferred Approach)

1. Enclose the Large Chiller. The enclosure should block noise from all four sides of the chiller and the roof of the enclosure should be constructed with rows of acoustical silencers. This is the best approach to ensure noise from the chiller is probably addressed at the residences.

Option 2

2. Convert the existing acoustic louvers to a solid noise barrier. The following design parameters should be implemented:
 - The barrier must be solid/continuous with no holes or gaps;
 - The barrier should extend from roof level to 1 m above the top of the unit*;
 - The side facing the unit should be absorptive; and
 - The barrier material should have a minimum rating of STC 25 - 30.

*The existing acoustic louvers includes a sizable gap at the bottom

If you plan to proceed with Option 2, we recommend that a mock-up enclosure be installed and tested prior to installation (and purchase) of the noise barrier. The test enclosure can be constructed with plywood over the existing acoustic louver framing. This would give a good indication of the expected noise reduction that can be obtained using an acoustic noise barrier.

It should be noted that while Option 2 is expected to reduce its noise level at the residences, it should be noted that due to the nature of the complaint, the audible tone is likely to persist but at a quieter level.

We note that both options likely have design challenges. During the design phase, we recommended a solid barrier for the Large Chiller which was deemed unfeasible due to design constraints (i.e., airflow, snow loading, structural requirements, etc.). We recommend consulting with the appropriate engineering disciplines to confirm the feasibility of the noise barrier design (i.e., Structural and Mechanical, etc.).



We trust that the information provided herein meets your needs at this time.

Please do not hesitate to contact us with any further questions.

A handwritten signature in black ink, appearing to read 'Curtis'.

Curtis Langley, B.Sc.
Acoustic Scientist

cc: Chris Fraser, P.Eng.

A handwritten signature in black ink, appearing to read 'Philip Tsui'.

Philip Tsui, P.Eng.
Senior Acoustical Engineer