HGC ENGINEERING

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NOISE IMPACT ASSESSMENT
WEST CAMPUS TURF FIELD
KINGSTON, ONTARIO

Prepared for:

Queen's University
Kingston, Ontario
L2E 6S8

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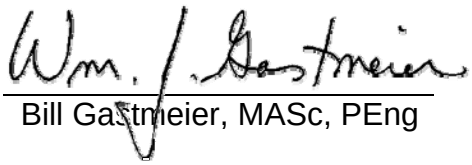

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September 17, 2014

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1 INTRODUCTION AND SUMMARY

Howe Gastmeier Chapnik Limited ("HGC Engineering") was retained by Queen's University to complete a Noise Impact Assessment of activities on the West Campus Turf Field located southwest of the intersection of Johnson Street and Sir John A. MacDonald Boulevard in Kingston, Ontario. This assessment focuses on the use of amplified sound at the field for playing the National Anthem and for player announcements as well as the use of whistles.

The Ontario Ministry of the Environment ("MOE") provide guidelines for the assessment of stationary noise sources, but they specifically exclude from assessment noise from auditory signalling devices such as whistles and amplification of sound by electronic means, and gatherings of people. However, to provide a reasonable basis for assessment, the MOE guidelines have been used to assess the predicted sound level impact from activity at the turf field. The noise impact assessment criteria of the MOE guidelines are based on existing background sound levels. To establish background sound levels in the area, sound level measurements were conducted in the areas surrounding the turf field.

To establish source sound level data for the amplified sound system and whistles, HGC Engineering visited the West Campus Turf Field in Kingston to conduct sound level measurements during typical sporting events and simulated operation of the amplified sound system.

A computer model of the area was created using commercial acoustic modelling software in order to predict the off-site sound levels at selected nearby receptors. The results indicate that with a modified sound system the sound level limits of the MOE can be met even with prolonged usage. A modified sound system and other noise control measures are assessed and presented within this report.

The background sound in the area may fall below the exclusionary minimum limit of the MOE during evening hours and activity at the field may still be audible at the nearest receptors on occasion.

2 SITE DESCRIPTION

The Queen's University West Campus Turf Field is located at the southwest corner of Johnson Street and Sir John A. MacDonald Boulevard in Kingston, Ontario. Specifically, the turf field is located at the northeast corner of the West Campus. Figure 1 illustrates the relationship between the site and the surrounding area. Residential properties are located east of Sir John A. MacDonald Boulevard, north of Johnson Street and west of Stadium Lane. Student residences are located at the south portion of West Campus with additional single family homes located on Union Street and further south.

The background sound in the area is dominated by vehicle traffic on Johnson Street and Sir John A. MacDonald Blvd. with ancillary traffic on the surrounding roadways.

Figure 2 shows the layout of the West Campus. The turf field includes artificial grass and a lighting system to provide the opportunity for activity beyond daylight hours. Activity at the turf field generally has an unobstructed view (acoustically) to the residential properties to the east and north. Operation of amplified sound (the National Anthem and announcements) at the turf field is anticipated to occur between 9am and 9pm and on a restricted basis (only so many occurrences per year).

3 NOISE SOURCE DESCRIPTION

Queen's University West Campus Turf Field is utilized for both varsity and intramural programs but the field is also available for rent by Kingston community groups. Typical sounds from the field include communication between players and referees (whistles, voices), amplified sound for playing of the National Anthem and game announcements, and sound associated with the sport being played (soccer ball kicks, lacrosse stick contact, etc.). Measurements of existing sound levels at the facility are discussed in Section 6 below.

4 POINT OF RECEPTION SUMMARY

Five key receptors were chosen to represent the nearest sound sensitive points of reception to the subject site, and are shown as locations R1 through R5 in Figures 8 through 12.

Receptor R1 represents a raised bungalow, east of the turf field, backing onto Palace Road. Receptors R2 through R5 represent the upper storey windows of two storey homes located north, west, southwest and east of the site, respectively. The upper storey windows are the most potentially impacted point on the respective property since they are most exposed to sources at the subject site and benefit least from ground absorption.

5 CRITERIA

In Ontario, guideline publications of the Ontario Ministry of the Environment ("MOE") form the basis of environmental noise assessment. The guidelines are commonly used to assess the noise impact from mechanical systems such as are typically associated with industrial operations. However, the MOE guidelines explicitly state that electronically reproduced or amplified sound and sound from the gatherings of people at facilities such as restaurants, fairs and parks is excluded from assessment under the guidelines, and such assessment is typically left to the discretion of the municipality.

The City of Kingston Bylaw 2004-52 (A Bylaw to Regulate Noise) [1] considers the West Campus area which includes the turf field, Richardson Stadium, and the other playing fields, to be in a residential area which prohibits the making of noise from these activities if they are audible to persons in other premises at any time. Provincial Offences Officers are responsible for enforcing the provisions of the Bylaw and are thereby the persons who make decisions around audibility. Since audibility is subjective to a great degree, we suggest that for the purposes of noise assessments prepared in regard to the offsite audibility of the playing fields, MOE publication NPC-300 [2] can provide a useful yardstick for those charged with enforcing the bylaw and need to make some reasonable determination of audibility.

Some jurisdictions, like the City of Waterloo [3], City of Toronto [4], City of Hamilton [5], etc. include a number of terms and conditions on noise bylaw exemptions including:

- A limit on the sound level from a source at a specific distance (e.g. an L_{EQ} of 85 dBA at 20m over a 5 minute average).

- A limit on the sound level at the residential property line (e.g. an L_{EQ} of 55 dBA or 60 dBA over a 5 minute average).

It is interesting to note that the Kingston Municipal Noise Bylaw does not apply to public events occurring in public parks because the Municipality cannot take legal action on itself. To address this inconsistency it is our experience that Municipal Bylaw Offices may use a permit process to deal with private groups in public parks and enforce the permits in a similar manner to the Bylaw.

The MOE noise assessment guidelines draw a distinction between sound produced by traffic sources and that produced by industrial or commercial activities, which are classified as *stationary sources of sound*. In essence, the sound from the stationary sources is evaluated against (i.e. compared to) the typical background sound at any potentially impacted, sound-sensitive points of reception (e.g., residences). Background sound is considered to include road traffic sound and other typical sounds, but excludes the sound of the facility under assessment. MOE Publication NPC-300, "Stationary and Transportation Sources – Approval and Planning" [2], is a guideline for developing applicable sound level limits. In general, the acceptability limits for stationary sources are site dependent, and are based on the existing ambient background sound levels in the area of the subject site.

Publication NPC-300 stipulates that the sound level limit for a stationary source which operates during both daytime, evening and nighttime hours in a Class 1 (urban) environment is the greater of the minimum one-hour energy-equivalent (L_{EQ}) background sound level, or the exclusionary minimum limits of 50 dBA during daytime/evening hours (07:00 to 23:00) and 45 dBA during nighttime hours (23:00 to 07:00). The MOE guidelines also stipulate that the noise assessment shall consider a *predictable worst-case hour*, which is defined as an hour when typically busy operation of the stationary sources under consideration could coincide with an hour of low background sound.

The characteristic background sound level can be determined through automated long-term measurement, or by predictive analysis based on road traffic volume counts, in cases where the

background sound is dominated by road traffic. For the purpose of this assessment, unattended sound level monitoring was conducted at four locations surrounding the West Campus.

Four automated long-term monitors were deployed at locations M1 through M4, shown in Figure 3. The monitors were configured to record ten-minute average sound levels, such that spurious high sound level events could be excluded. The ten minute averages were utilized to calculate the hourly average sound levels. The minimum daytime/evening and nighttime sound levels recorded at these locations occurred when activities at the West Campus were not occurring. Road traffic on Sir John A. MacDonald Blvd. and Johnson Street dominates the background acoustic environment. The unattended sound level monitoring indicates background sound levels can fall below 50 dBA during evening hours at all receptor locations except for R2. Figures 4 through 7 show the unattended sound level data. Distance adjustments, from the unattended sound level monitor location to the sensitive receptor, were determined where appropriate.

The applicable sound level limits at receptors R1 through R5 are summarized below in Table 1. Since the playing fields are only in use during daytime and evening hours (09:00 to 21:00), the daytime and evening sound level criteria are applicable.

Table 1: Applicable Sound Level Limits, L_{EQ} [dBA]

Point of Reception	Daytime and Evening (07:00 to 23:00)
R1	50
R2	54
R3	50
R4	50
R5	50

It should be noted that the MOE guidelines do not require or imply that a noise source should be inaudible at a point of reception, and inaudibility should not be expected. In fact, even when the sound levels from a source are less than the numeric guideline limits, spectral and temporal characteristics of a sound regularly result in audibility at points of reception. To be clear,

activities at the turf field will at times be audible at many residences even when sound levels are below MOE noise criteria guidelines and/or limits set by the City of Kingston.

6 EXISTING SOUND LEVELS

HGC Engineering visited the West Campus and the surrounding neighbourhood on June 18, 20 and 21, 2014 to deploy unattended sound level monitors and to conduct attended measurements during typical activities at the turf field. Attended measurements captured a Kingston FC soccer practice and community soccer game on the adjacent field to the west during the evening of June 18, simulated operation of the amplified speaker system during the evening of June 20 and a flag football tournament on the turf field and adjacent field to the west on June 21. A summary of the attended measurements are included under Appendix B.

For the purposes of this assessment, sound level measurements of the amplified sound system and typical use of whistles were utilized to determine sound power levels and sound directivity for the speaker. The current setup of the amplified sound system includes a Yorkville NX750P loudspeaker connected to an American Audio Q-2411 preamp mixer. Sound pressure level measurements conducted at 15 meters from the loudspeaker during the playing of the National Anthem indicate an L_{EQ} sound level of 75 dBA and a sound power level of 111 dBA. Directivity of the speaker provides an approximate 10 dBA benefit when behind the speaker, although primarily only at frequencies above 500 Hz. Sound level measurements during typical use of whistles indicate sound power levels on the order of 115 dBA which is consistent with published research on the sound levels of whistles [6].

7 ANALYSIS

An acoustic model of the site was created on computer using Cadna/A (version 4.4.145), a commercial acoustic modeling system. Cadna/A uses the computational procedures of ISO standard 9613-2, *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* [7] which accounts for the reduction in sound level with distance due to geometrical spreading, air absorption, ground attenuation and acoustical shielding by

intervening structures (or by topography where applicable). The source sound level data collected during the attended site visits was used as input into the acoustic model.

A number of scenarios were developed to investigate the potential sound level impact on the surrounding noise sensitive receptors:

Scenario A: Amplified sound, speaker on west side of field directed east.
Scenario B: Amplified sound, speaker on east side of field directed west.
Scenario C: Whistles (115 dBA sound power).

For scenarios A and B the amplified sound system was assumed to operate for a full hour. In reality the system will operate for approximately two minutes during the playing of the National Anthem and a couple additional minutes for announcements cumulatively over an hour. Under Scenario C, whistles were assumed to operate for the full hour, which is a significant overestimation of their use but provides an estimate on the sound level for each whistle blow. A time adjustment on the order of 15 dBA (two minutes/hour) would be applicable when considering their actual use over an hour.

Sound level contours generated by the predictive model are shown in Figures 8 through 10. Table 2 shows the predicted sound levels at the receptor locations.

Table 2: Predicted Sound Levels Due to Activity at the Turf Field [dBA]*

Location Description	Predicted Sound Level L_{EQ} Scenario			Criterion
	A	B	C	
R1: East Dwelling	52	39	56	50
R2: North Dwelling	37	40	52	54
R3: West Dwelling	35	48	47	50
R4: Southwest Dwelling	26	35	38	50
R5: Southeast Dwelling	49	38	54	50

* These sound levels represent the momentary sound level which will be present during the operation of the sound system and whistles. The MOE limits are based on the average sound level over a one hour period. The duration of sound system operation and whistles is typically much less and would not result in excesses over MOE limits.

The sound level predictions indicate that the continuous use of the existing amplified sound system and constant usage of whistles could have the potential to exceed the MOE's sound level criterion at the neighbouring receptors. An investigation of several noise control options, which are based on the actual operation of the amplified sound system which typically operates for four to five minutes for the National Anthem and accompanied field announcements, are discussed below.

8 DISCUSSION

The initial analysis and attended sound level measurements indicated the potential for sound level excesses above the MOE's sound level criteria at the neighbouring receptors. The following investigates a number of noise control options.

Scenario D: An alternative amplified sound system, employing a seven (7) speaker system, focused around the bleachers on the east side of the field was considered. JBL Control 25T speakers were utilized in the analysis. Figure 11 shows the orientation of the speakers and the maximum sound power levels for each. Sound pressure levels should not exceed 65 dBA at 15m from each speaker directed onto the field from the east and 57 dBA at 15m from each speaker directed at the bleacher area from the north, south or east.

Scenario E: Whistles with a sound power level of 108 dBA (Fox 40 Pearl or equivalent).

Table 3: Predicted Sound Levels Due to Activity at the Turf Field with Alternate Sound System and Fox 40 Whistles [dBA]*

Location Description	Predicted Sound Level L_{EQ} Scenario		Criterion
	D	E	
R1: East Dwelling	42	49	50
R2: North Dwelling	42	45	54
R3: West Dwelling	42	40	50
R4: Southwest Dwelling	34	31	50
R5: Southeast Dwelling	41	47	50

* These sound levels represent the momentary sound level which will be present during the operation of the sound system and whistles. The MOE limits are based on the average sound level over a one hour period. The duration of sound system operation and whistles is typically much less.

Sound level contours generated by the predictive model are shown in Figures 12 and 13. The sound level predictions indicate a significant reduction of up to 10 dBA can be achieved with a distributed amplified sound system and a reduction of 7 dBA with the use of quieter whistles. Note that the sound power level of whistles is highly variable, based on the users discretion, and the sound level at the receptors will also correspondingly vary.

In addition to the above noise control options, the implementation of an acoustic barrier was also investigated. As a general note, acoustic barriers must break the line of sight between the sources and the receptor locations to provide any acoustic benefit and should be specified (in terms of height and length) to achieve a minimum reduction of 5 dBA. An acoustic barrier may be a combination of an acoustic wall and an earth berm. The wall component of the barrier should be of a solid construction with a surface density of no less than 20 kg/m^2. The walls may be constructed from a variety of materials such as wood, brick, pre-cast concrete or other concrete/wood composite systems provided that it is free of gaps or cracks.

The acoustic predictive model was utilized to determine barrier heights and extents that would be required in order to achieve a minimum 5 dBA reduction, at receptor locations to the north and east, when considering Scenarios C and D (loud whistles and the distributed speaker system). The extensive use of acoustic barriers with a minimum height of 4.0 meters and having lengths of 185 meters along the east side of the turf field and 80 meters along the north side of the field, would be required to achieve at least a 5 dBA reduction. Significantly taller barriers would be required to achieve at least a 10 dBA reduction which roughly equates to a halving of loudness. The feasibility of implementing acoustic barriers is questionable given the required height and extents of the barriers to achieve even a 5 dBA reduction. Additionally, depending on the type of barrier construction, sound levels may increase at the receptors due to an increase in road traffic sound from acoustic reflections off the barriers.

In addition to the physical noise control measures discussed above, Queen's University may wish to include notifications in rental/lease agreements and signage at the turf field prohibiting excessive noise and amplified music using equipment other than provided by Queen's University.

9 CONCLUSION AND RECOMMENDATIONS

The above analysis indicates that the predicted sound level impact of the existing amplified sound system and whistle usage may exceed the existing background sounds levels during an hour of continuous operation. Sound level predictions with an alternate sound system and Fox 40 whistles indicate the MOE sound level criterion can be met. Noise related to the activities at the field will at times be audible off-site, particularly during lulls in road traffic and due to the spectral and temporal characteristics of activities at the field (voices, whistles, etc.).

In order to manage the sound emissions from the turf field we have the following recommendations:

- Utilize an alternate, distributed sound system, equivalent to the one analyzed herein. Sound levels should be controlled such that the sound pressure level does not exceed 65 dBA at 15m from each speaker directed onto the field from the east and 57 dBA at 15m from each speaker directed at the bleacher area from the north, south or east. Sound pressure levels are to be measured on axis, on a L_{EQ} basis over a 5 minute average of continuous programming.
- The controls of the sound system should be marked to clearly indicate the maximum volume setting determined in accordance with the above maximum on axis sound level limits.
- Require renters that want to play amplified sound to utilize the Queen's University system.
- Require the use of Fox 40 Pearl or equivalent whistles where officiating rules permit.
- Complete additional sound level testing after implementation of noise control measures to verify the sound level improvement.

REFERENCES

1. City of Kingston, *A By-Law to Regulate Noise*, By-law Number 2004-52 as amended by By-law 2007-51 and By-law 2011-32.

2. Ontario Ministry of the Environment Publication NPC-300, *Environmental Noise Guideline – Stationary and Transportation Sources – Approval and Planning*, August, 2013.

3. City of Waterloo, By-law Number 2010-073, *Being a by-law to prohibit and regulate noise*

4. City of Toronto, Chapter 591, *Noise*

5. City of Hamilton, By-law No. 11-285, *Noise Control By-Law.*

6. G. Flamme and N. Williams, *Sports Officials' Hearing Status: Whistle Use as a Factor Contributing to Hearing Trouble*, January 2013.

7. International Organization for Standardization, "Acoustics – Attenuation of Sound during Propagation Outdoors – Part 2: General Method of Calculation," ISO-9613-2, Switzerland, 1996.

8. Google Maps Aerial Imagery, Internet application: *maps.google.com*.

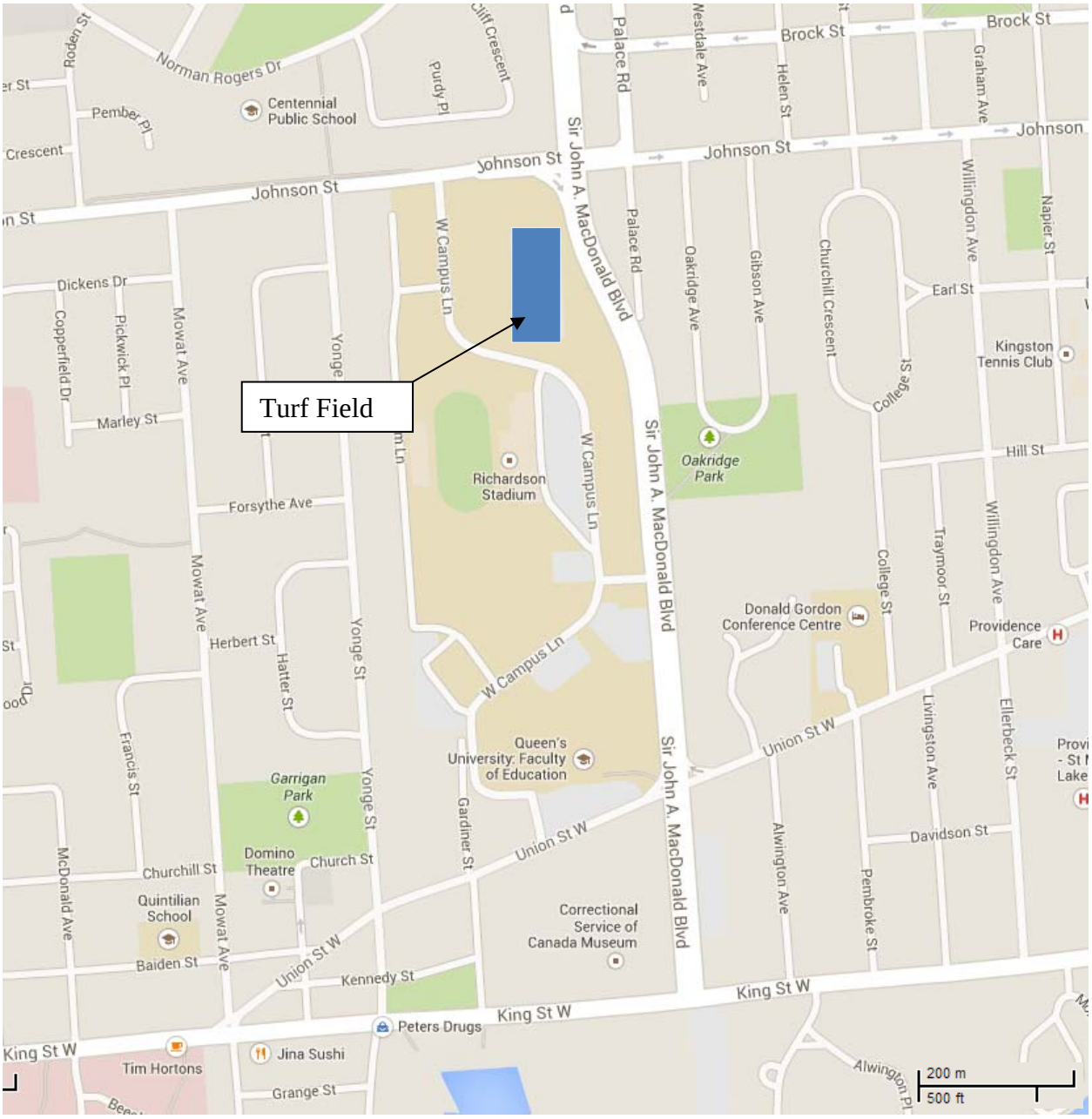

Figure 1: Key Area Plan

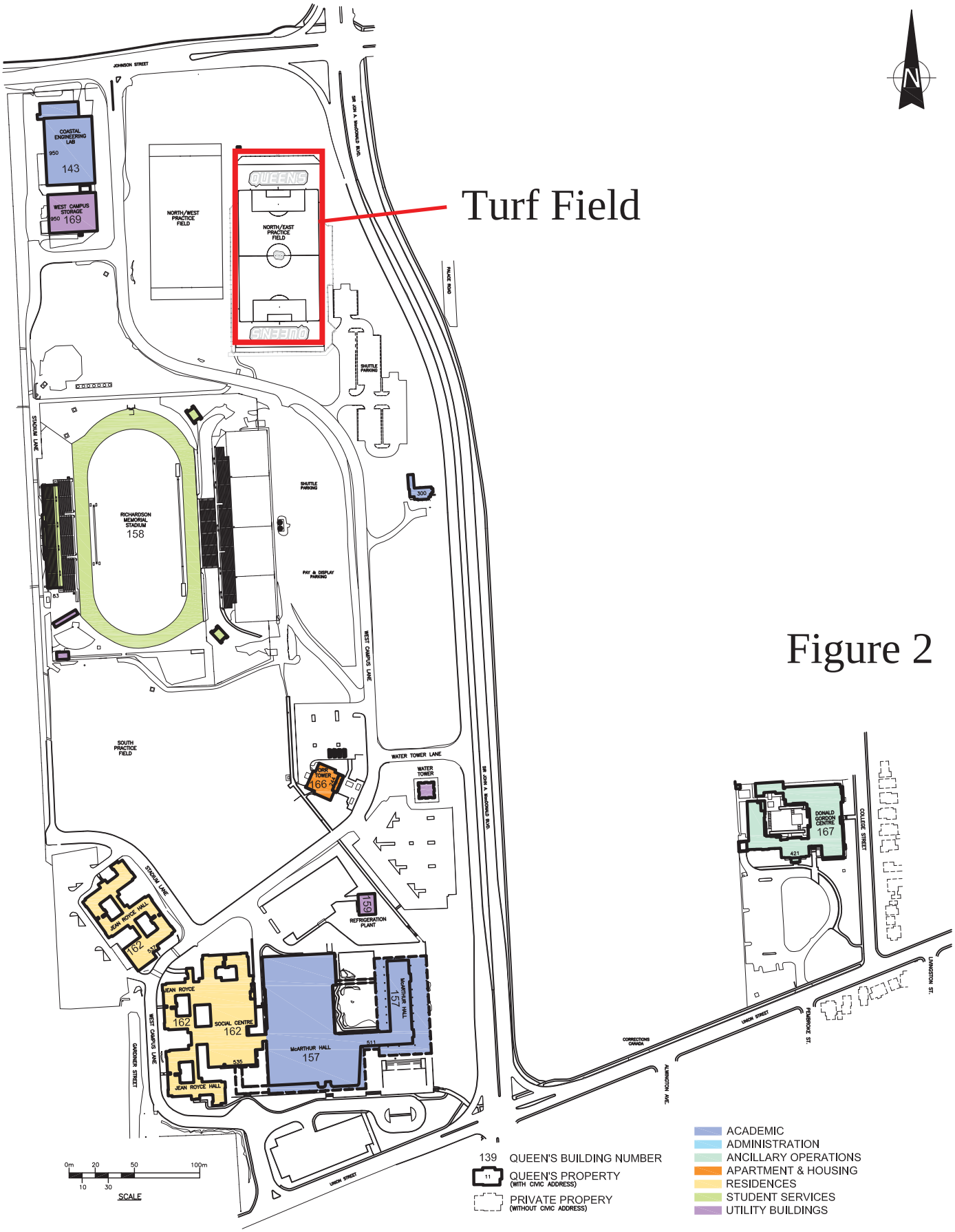

Figure 2

Queen's University
Physical Plant Services

WEST CAMPUS

FILE No.	DATE	DRAWING No.	C.A.D.D. REF.
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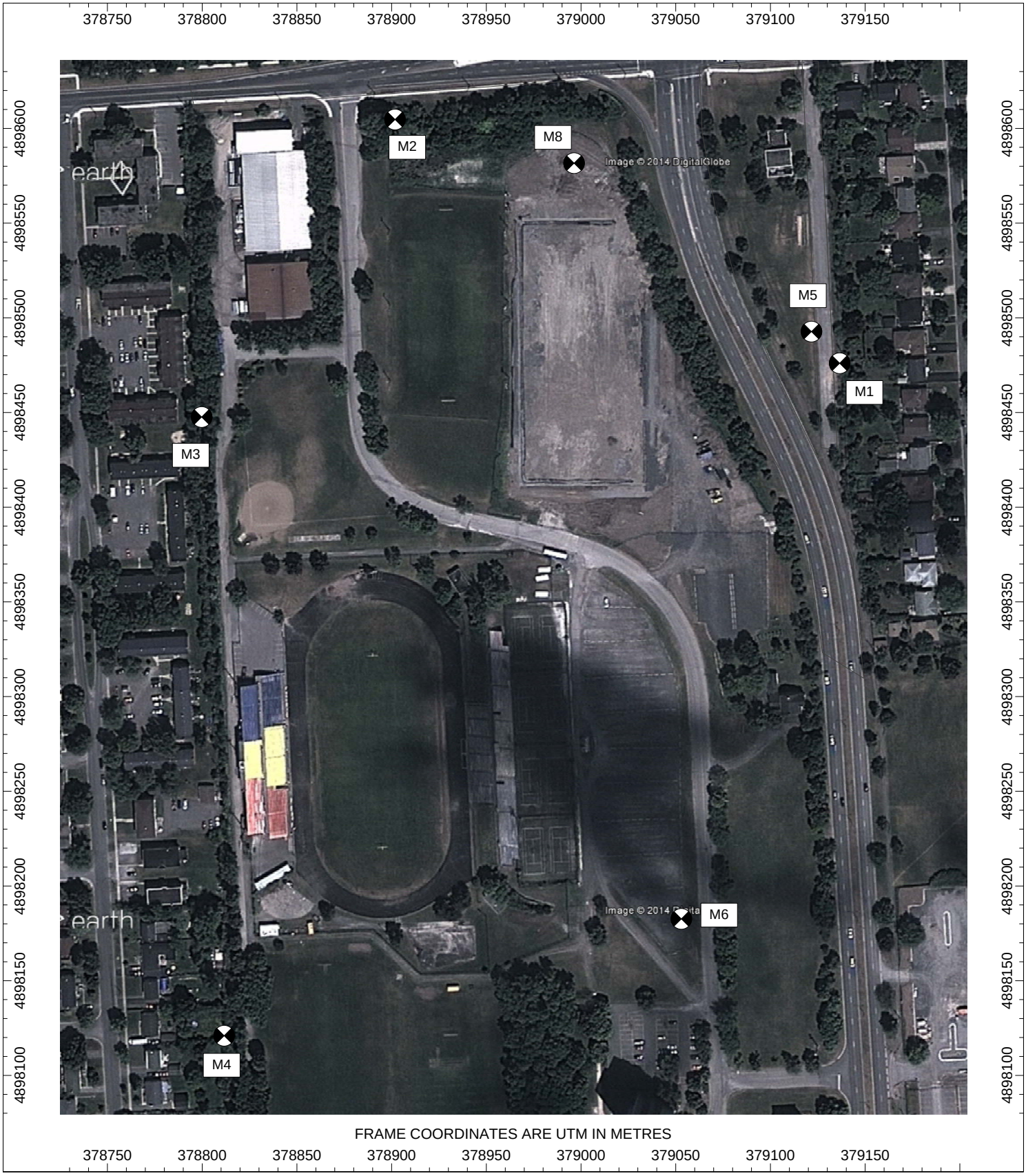


Figure 3: Unattended Sound Level Monitoring Locations
Queen's University West Campus

Figure 4: Unattended Sound Level Monitoring
Location M1, Palace Road
Queen's University West Campus, June 18 to June 24, 2014

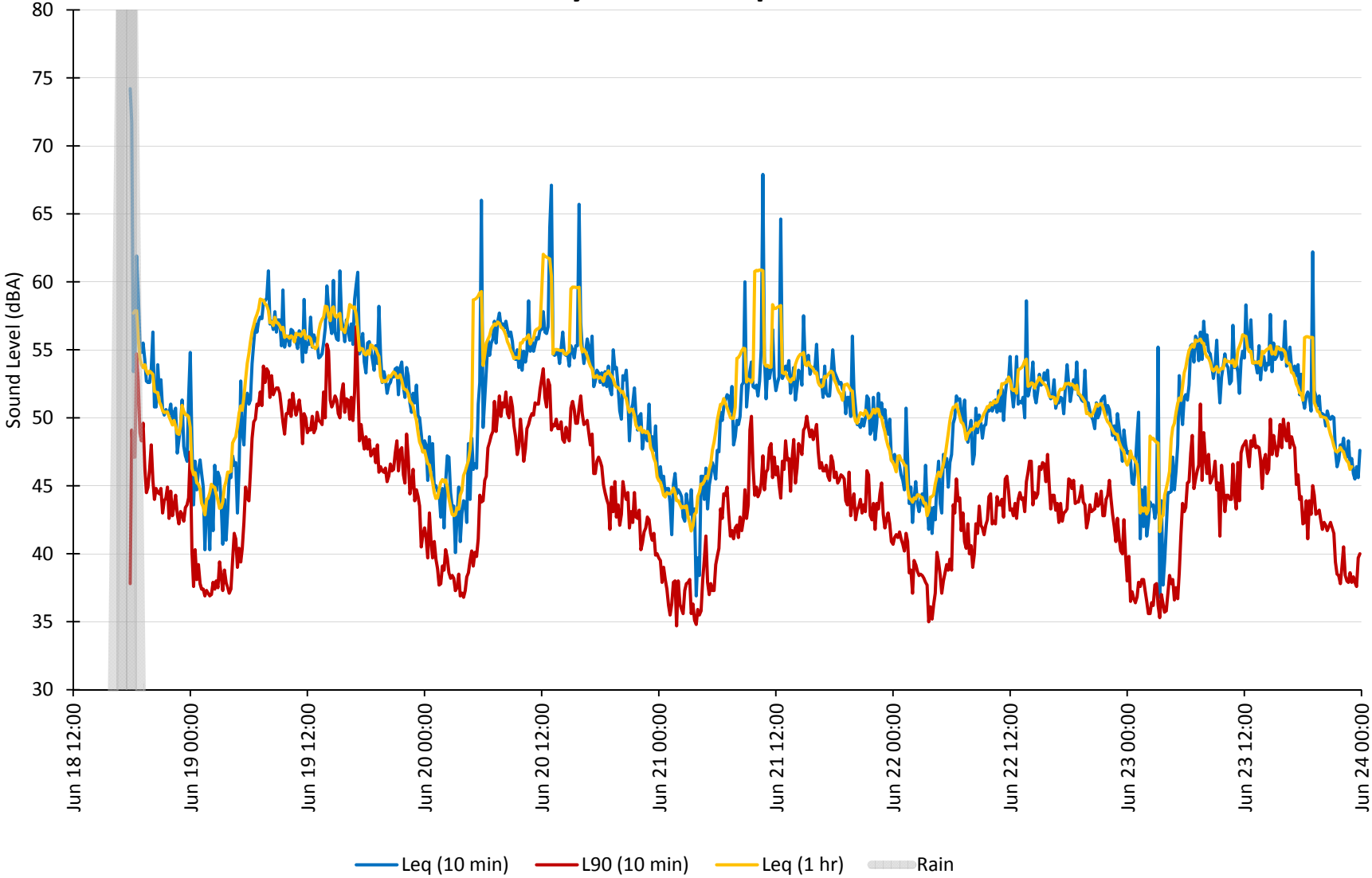


Figure 5: Unattended Sound Level Monitoring
Location M2, Johnson Street
Queen's University West Campus, June 18 to June 24, 2014

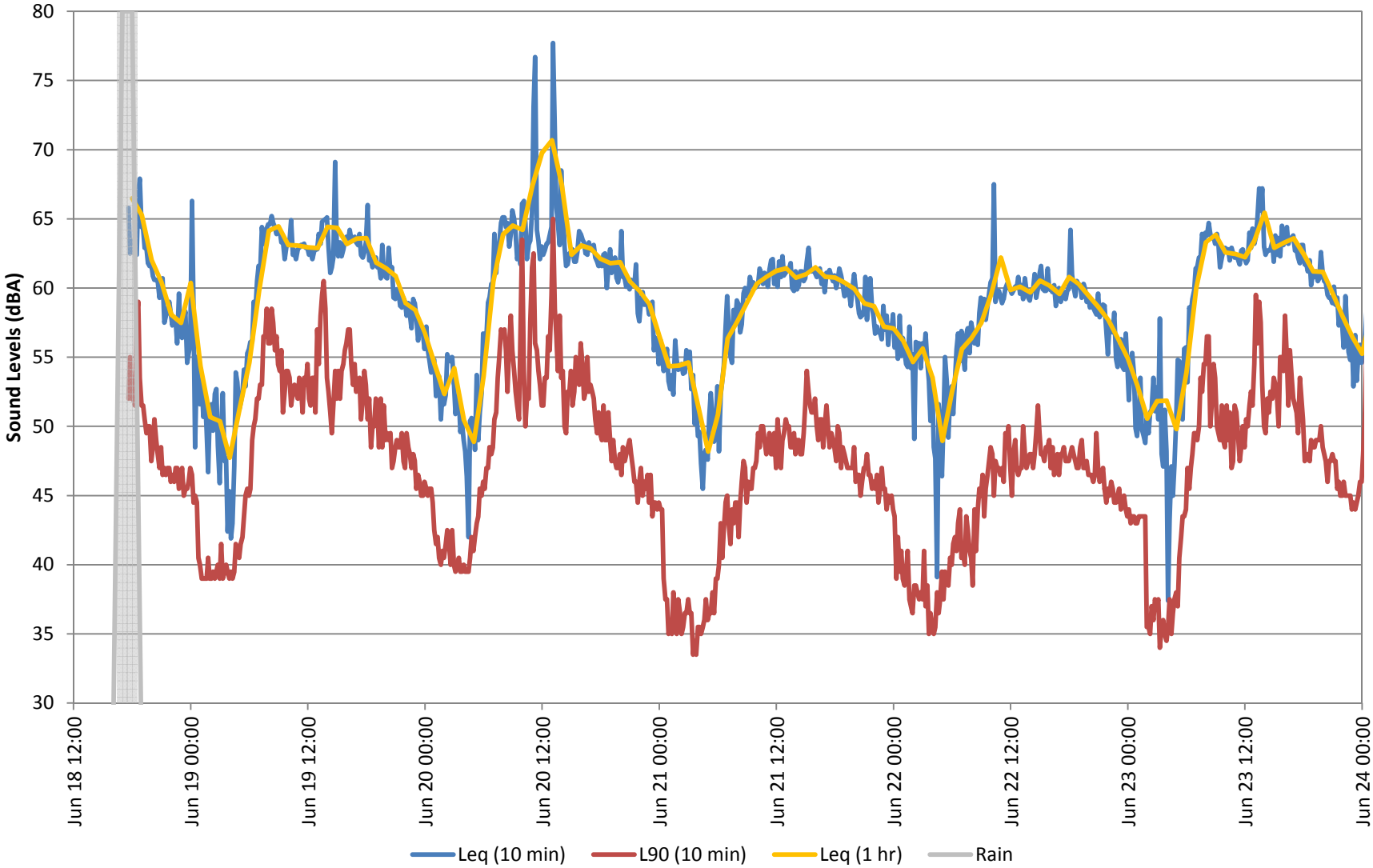


Figure 6: Unattended Sound Level Monitoring
Location M3, Northwest Corner of Richardson Stadium
Queen's University West Campus, June 18 to June 24, 2014

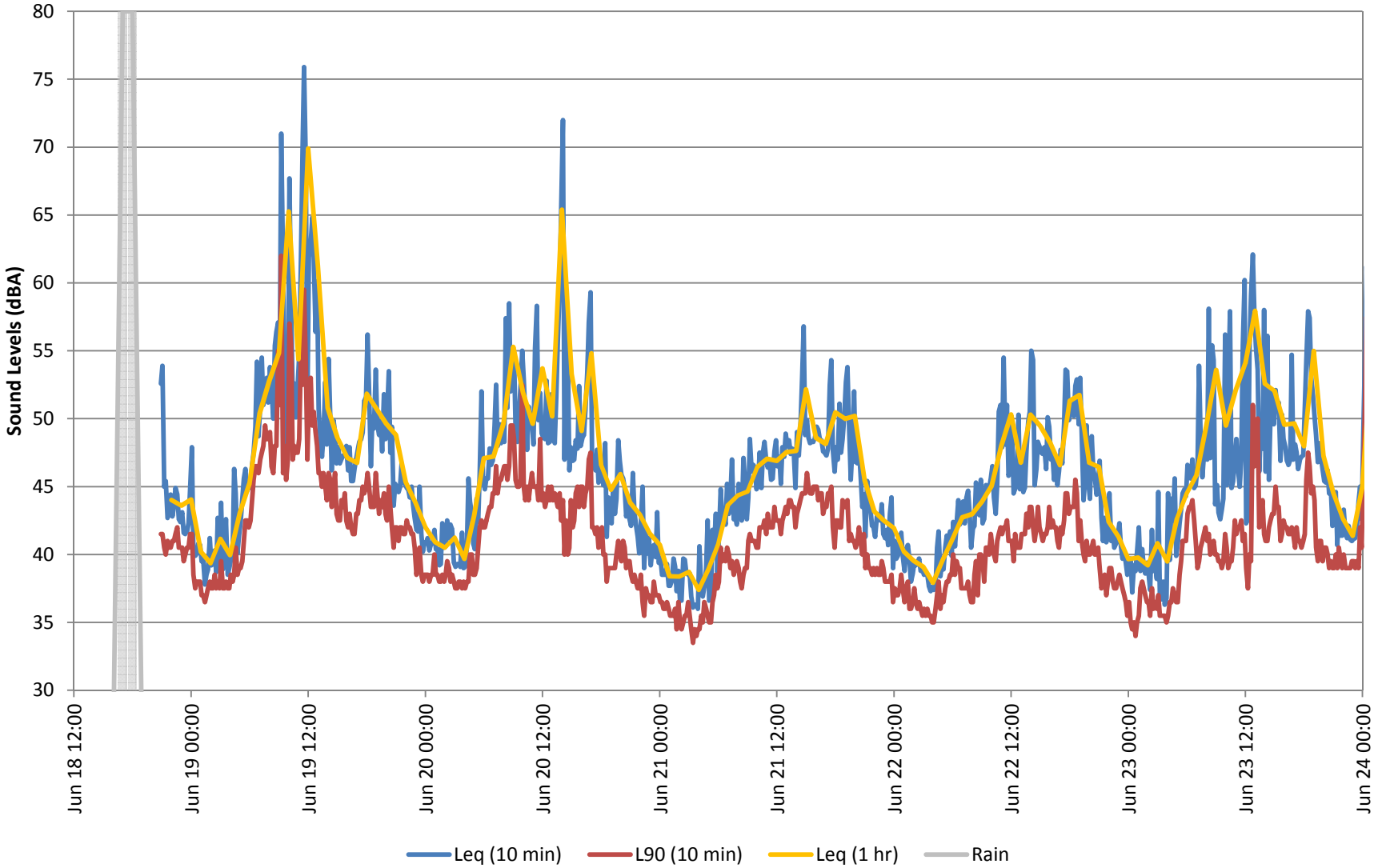
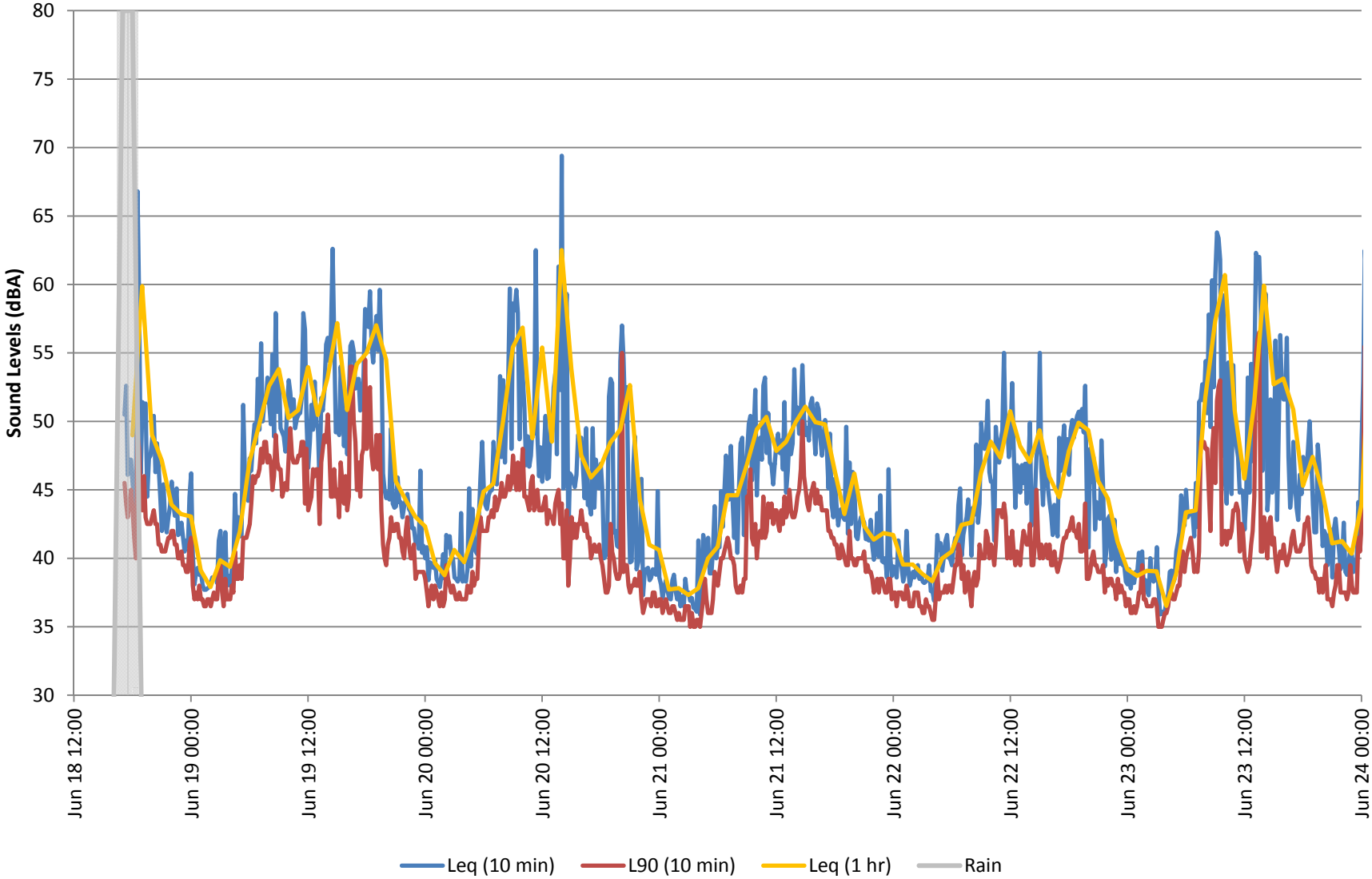


Figure 7: Unattended Sound Level Monitoring
Location M4, SW corner of Richardson Stadium
Queen's University West Campus, June 18 to June 24, 2014



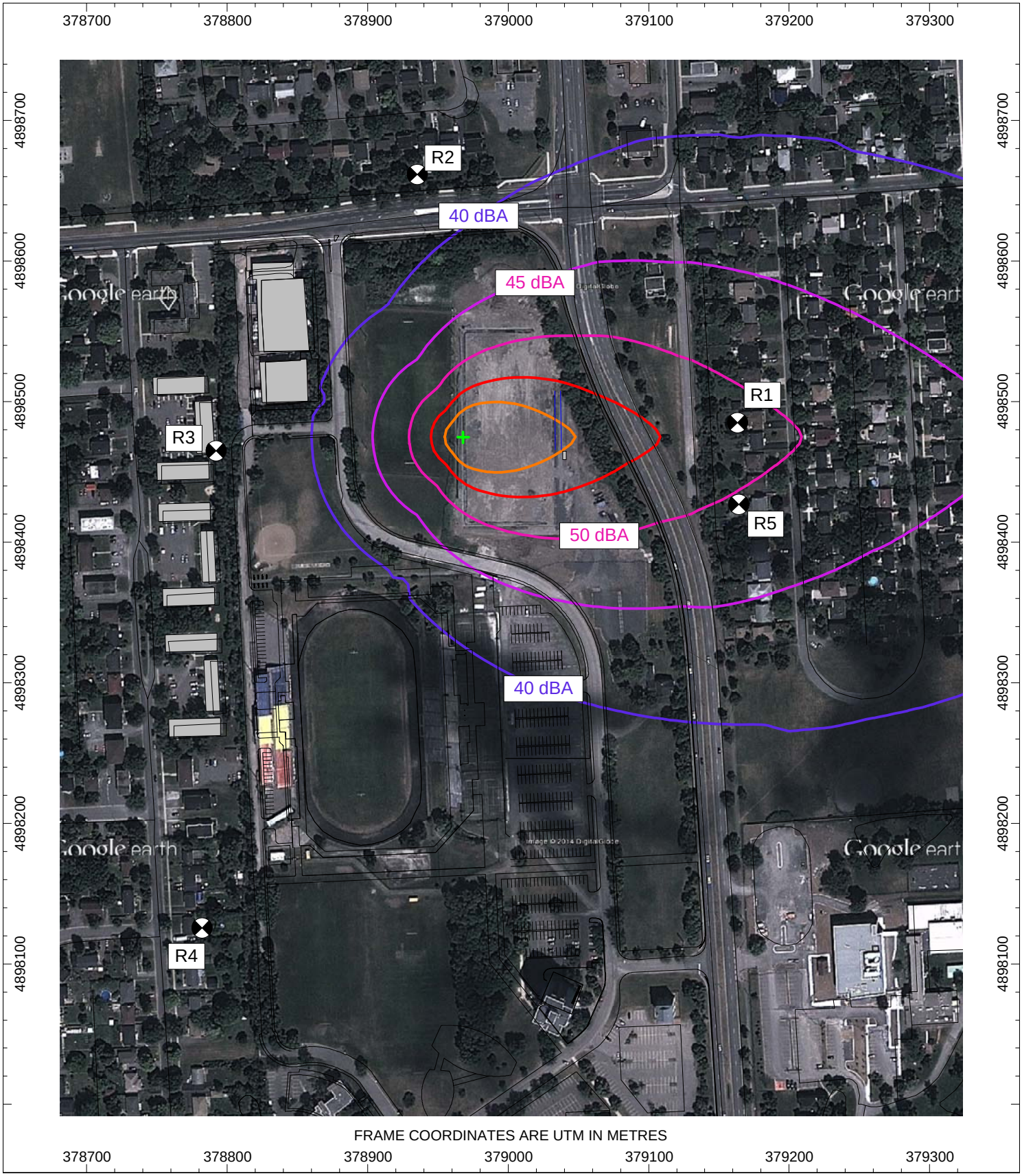


Figure 8: Predicted Sound Levels, Leq [dBA], Scenario A
Speaker on West Side of Field Directed East, Queen's University West Campus
Sound Level Grid Calculated at 4.5m Above Grade

Figure 9: Predicted Sound Levels, Leq [dBA], Scenario A
Speaker on East Side of Field Directed West, Queen's University West Campus
Sound Level Grid Calculated at 4.5m Above Grade

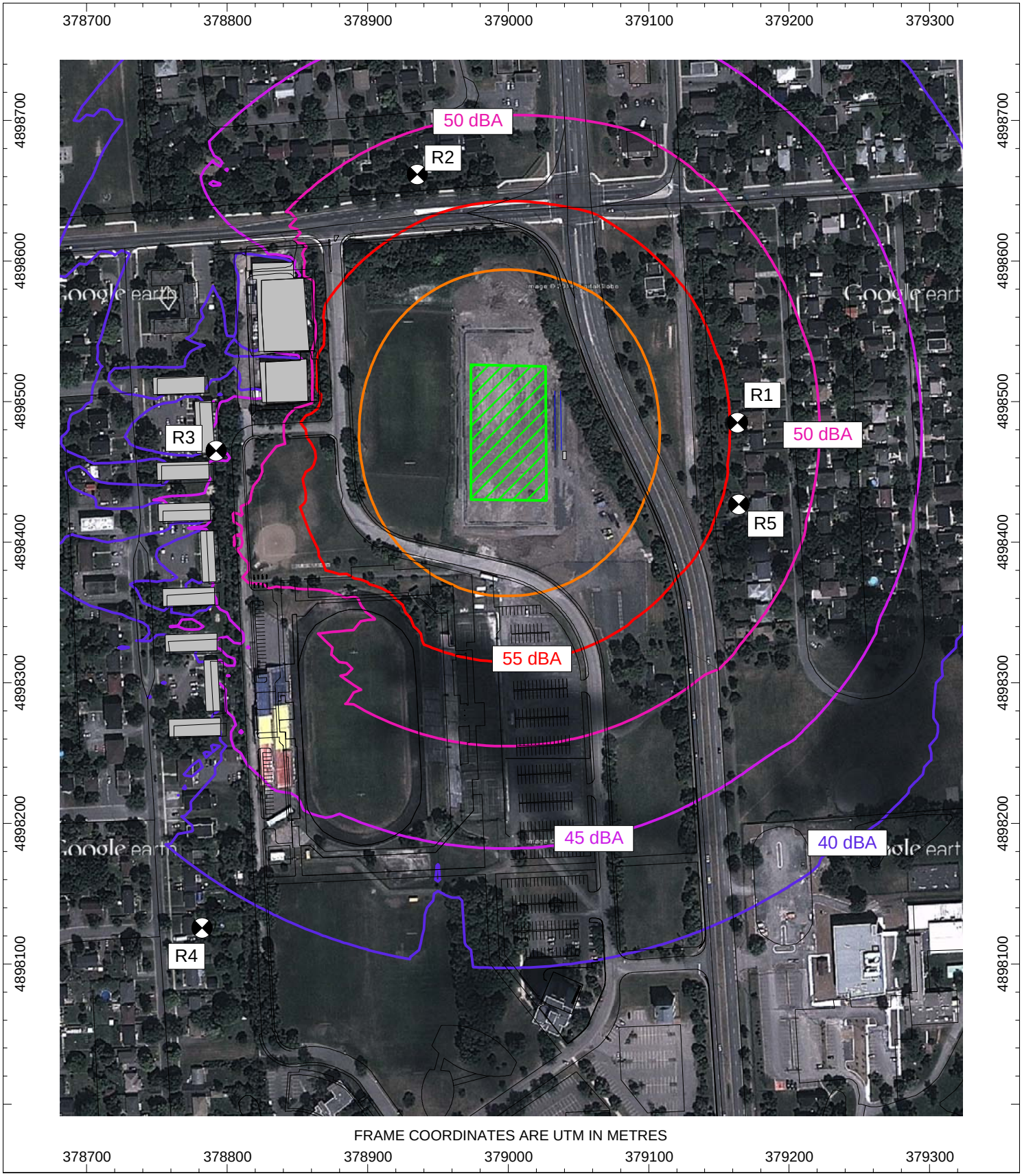


Figure 10: Predicted Sound Levels, Leq [dBA], Scenario C
Whistles with Maximum Sound Power Level of 115 dBA, Queen's University West Campus
Sound Level Grid Calculated at 4.5m Above Grade

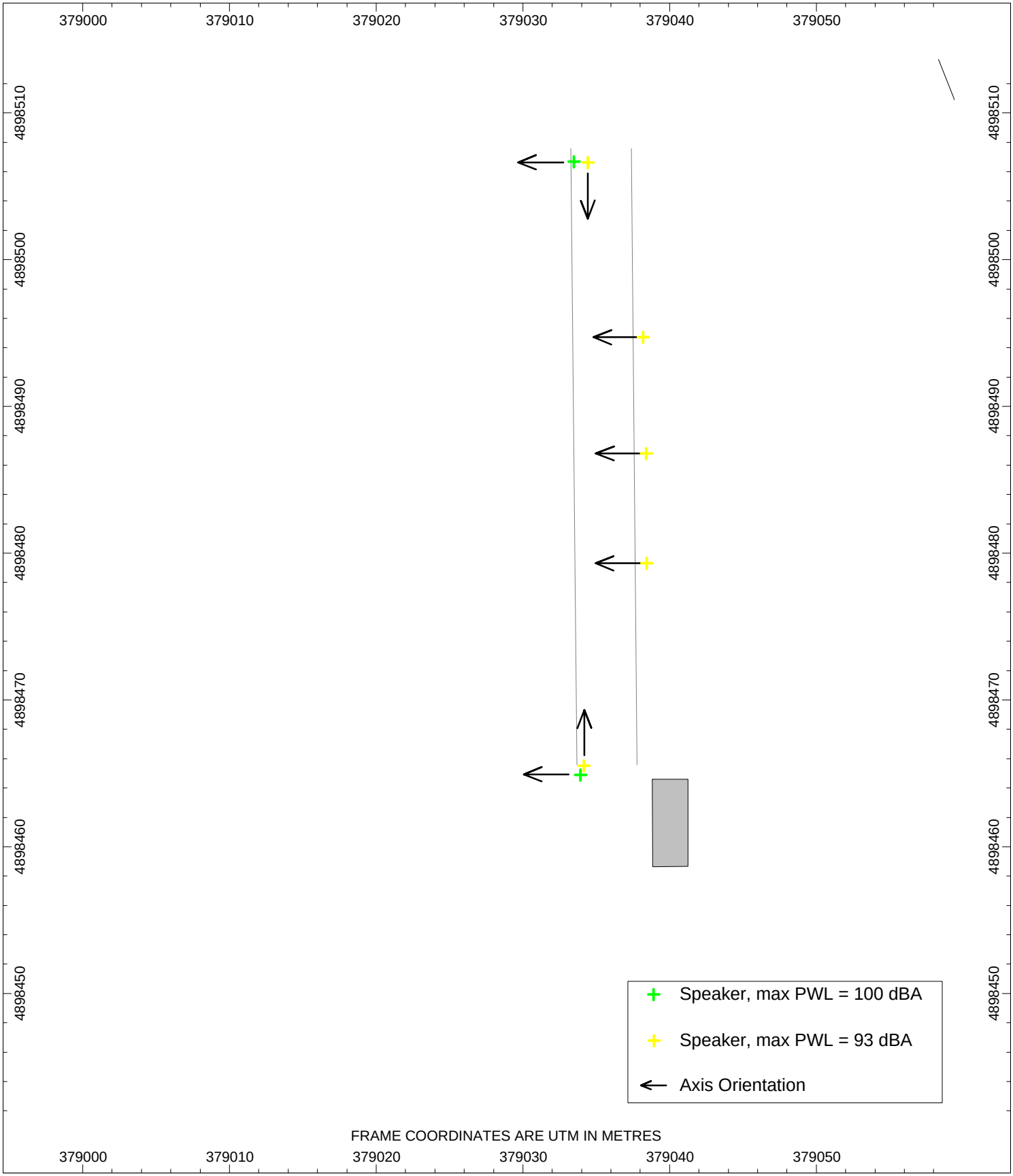


Figure 11: Distributed Speaker System, Axis Orientation and Sound Power Level (PWL)
Queen's University West Campus

Figure 12: Predicted Sound Levels, Leq [dBA], Scenario D
Distributed Amplified Sound System, Queen's University West Campus
Sound Level Grid Calculated at 4.5m Above Grade

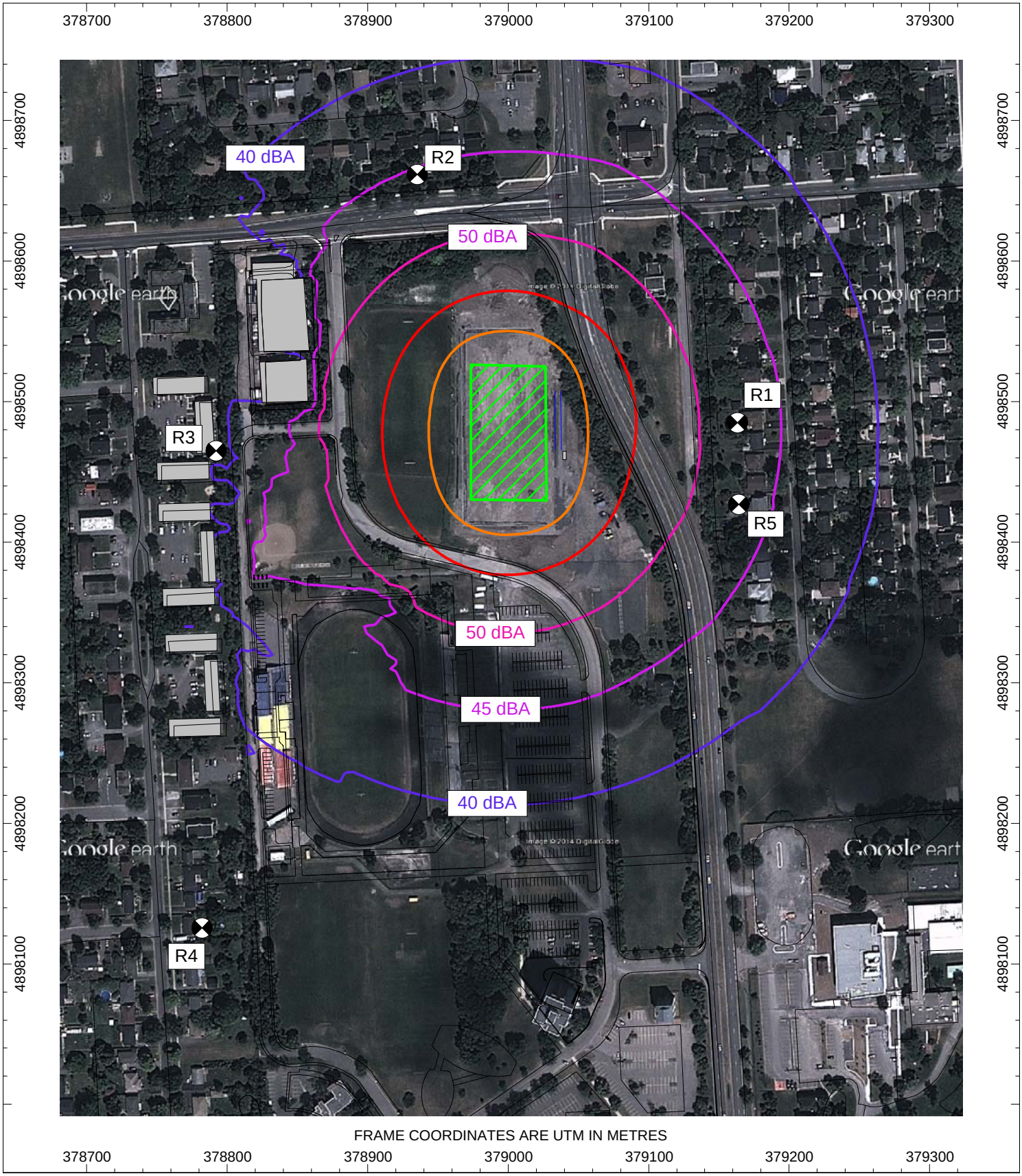


Figure 13: Predicted Sound Levels, Leq [dBA], Scenario E
Whistles with Maximum Sound Power Level of 108 dBA, Queen's University West Campus
Sound Level Grid Calculated at 4.5m Above Grade

APPENDIX A
GLOSSARY OF TERMS

GLOSSARY OF ACOUSTICAL TERMS

1/3-Octave Band: A filter whose passband is 1/3-octave wide. Where an octave represents a doubling of frequency, 1/3-octave represents approximately a 25% increase, with three sequential increases of 25% approximating a doubling. This relationship is applied to both the width of the band, as well as the centre frequency of the band.

Acoustic Barrier: a wall, berm, wall/berm combination or similar structure, used as a noise control measure, and high enough to break the line-of-sight between the source and the receptor.

A-Weighting: This is a filter, often applied to a pressure signal or to a *SPL* or *PWL* spectrum, which attenuates or amplifies certain frequencies in accordance with international standards to approximate the frequency dependence of average human hearing.

Background Sound Level: the sound level that is present in the environment, produced by noise sources other than the source under impact assessment. For the purposes of noise assessments related to stationary sources, the background sound level is expressed in terms of the One-Hour Equivalent Sound Level (L_{EQ}).

Class 1 Area: an area with an acoustical environment typical of a major population centre, where the background sound level is dominated by the activities of people, usually road traffic, often referred to as “urban hum”.

Energy Equivalent Sound Level (L_{EQ}): The L_{EQ} sound level is the *energy-equivalent sound level*, and represents the integrated sound exposure level of both steady and time-varying sounds over the duration of the measurement.

L_{90} Sound Level: represents the sound level which is exceeded 90 percent of the time over the duration of the measurement, and is useful in identifying the contribution of steady sources to the overall sound level.

Linear Weighting: This is a term used to indicate that a measurement does not have *A-weighting* or any other frequency weighting applied to it.

Point of Reception: any location on a noise sensitive use where noise from a stationary source is received.

Overall: For the measurements in this report, indicates that the reported level (*SPL*, *SL*, etc.) is the summation of measurements of all audible frequencies (20 Hz to 20 kHz), whether or not A-weighted. Analogous to and alternately implemented as a passband filter from 20 Hz to 20 kHz.

Sound Exposure Level, $L_{EQ}(h)$: Expressed in dBA, this is the equivalent steady Sound Level which would produce the same A-weighted sound energy over a stated period of time, *h*, as a specified time-varying sound.

Sound Level, *SL* or L_A: Reported in dBA, is the A-weighted Sound Pressure Level.

Sound Power, *w*: This is the acoustic power output of a sound source, expressed in Watts. It is a function of the source parameters itself and is virtually independent of the environment in which it is located.

Sound Power Level, *PWL* or L_W: Reported in dB (or dBA if A-weighted), this is 10 times the logarithmic ratio of the acoustic power output of a source to 1 picoWatt.

Sound Pressure, *P*: Reported in rms Pascals, is the dynamic variation in atmospheric pressure.

Sound Pressure Level, *SPL*: Reported in deciBels (dB), is 20 times the logarithmic ratio of the instantaneous sound pressure (in Pascals) of the sound being measured to that at the threshold of hearing (20 microPascals).

Spectrum: Sound Pressure signals may be passed through a parallel series of filters (e.g. *1/3-octave band*) to produce *SPL*s in each filter band. When these are presented in sequential order of filter band, a Sound Pressure Level spectrum is produced. A similar process may be applied to produce Sound Power Level or Sound Intensity Level spectra.

Time Weighting: This is an exponential time response function applied to the pressure signal being measured, effectively dampening the signal's response to quickly and highly varying sound pressures. Slow refers to a 1-second time constant, and Fast refers to a 125 ms time constant. Steady sounds are unaffected by time weightings. Also, time weighting functions are not applied to L_{EQ}s.

APPENDIX B

SUMMARY OF ATTENDED MEASUREMENTS

Attended Sound Level Measurements, [dBA]

Monitor Location	Description	Time	L_{EQ}	L_{90}	Comments
M3	Stadium Lane (NW of Richardson Stadium)	Jun 18, 21:00	42	41	Distant urban hum (40-42 dBA)
M4	Stadium Lane (SW of Richardson Stadium)	Jun 18, 21:15	42	41	Distant Traffic
M4	Stadium Lane (SW of Richardson Stadium)	Jun 21, 10:50	46	40	Kids playing in back yard: 45-50, 53 Airplane: 45-50 Football activity not audible
M4	Stadium Lane (SW of Richardson Stadium)	Jun 21, 16:45	45	42	Wind in trees: 44-48 Distant traffic: 40-42 Kids' voices: 45, 50, 52 Playing fields not audible Birds: 45
M5	Palace Road, by residences (East of turf field)	Jun 18, 07:25	52	45	Road wet, traffic dominant 50-57 dBA Voices dominant when lulls in traffic. Lulls in traffic (42-45) Ball kicks (48-49, 45). Whistle from far field (west). Voices (42-46)
M5	Palace Road, by residences (East of turf field)	Jun 18, 19:40	52	46	Traffic and wet roads are dominant. Whistles from far field occasionally audible. Birds. Soccer scrimmage on turf field. Voices calling for ball (55, 50, 56, 47, 48, 51, 47, 57). Ball kicks and lots of voices.
M5	Palace Road, by residences (East of turf field)	Jun 18, 19:50	53	47	Traffic and voices up to 58, 60. Ball kicks Whistle from far field: 55 Person whistling 60. Lmax = 66 (car with loud muffler)
M5	Palace Road, by residences (East of turf field)	Jun 21, 10:20	51	43	Touch football, both fields active: 53, 63, 55 Voice, whistle: 45-50, 53, 55 Kids playing soccer in residential yard + yelling: 50-55 Cars: 50-54 ; bus: 56
M5	Palace Road, by residences (East of turf field)	Jun 21, 16:30	51	47	Both fields still active Whistles (many quieter), only long ones are measurable: 53, 50-56, 61 Voices: 45-51 Cars: 45, 50, 55 (when many)
M6	West Campus Lane (SE of Richardson Stadium)	Jun 21, 10:40	51	45	Whistles barely audible - not measurable Train whistles: 55-60 Train and traffic: 50-55
M6	West Campus Lane (SE of Richardson Stadium)	Jun 21, 16:40	47	43	Whistles barely audible Both fields in use Cars: 40, 45, 48, 49 (bus) Wind on trees: 44
M8	North of turf field	Jun 21, 11:00	54	47	Whistles: 50, 55, 61, 57, 58 Voices: 50, 56, 67 Cars: 45, 50, 55
M8	North of turf field	Jun 21, 17:00	55	49	Cars: 45, 50, 55 (fairly steady) Many voices: 64, 58 ; Voice: 56 Whistle: 54 (near) Motorcycle: 67

Amplified Sound System Test, Attended Sound Level Measurements, [dBA]

Monitor Location	Description	Speaker Direction	Time	L_{EQ}	L_{90}	Comments
	Turf Field Grandstand		Jun 20, 16:20	52	49	Ambient
	Turf Field Grandstand	East	Jun 20, 20:22	66	62	Music
M4	Stadium Lane (SW of Richardson Stadium)	East	Jun 20, 17:08	40	39	Speech really muffled, not intelligble (< 40); music barely audible (< 40)
M4	Stadium Lane (SW of Richardson Stadium)	West	Jun 20, 17:53	41	41	Can just make out speech, not measurable (< 42); music also barely audible (< 42)
M4	Stadium Lane (SW of Richardson Stadium)	East	Jun 20, 20:13	53	52	Speech not audible, lawn mower dominant
M4	Stadium Lane (SW of Richardson Stadium)	West	Jun 20, 20:43	53	52	Lawn mower dominant, cannot hear speech or music
M5	Palace Road, by residences (East of turf field)		Jun 20, 16:29	56	52	(At back of homes) - Ambient
M5	Palace Road, by residences (East of turf field)	East	Jun 20, 16:49	58	54	Speech clearly audible, peaks: 51-53. Music clearly audible, peaks: 53-54. Anthem Finale - 57. Cars up to 60
M5	Palace Road, by residences (East of turf field)		Jun 20, 16:51	57	50	Ambient - car levels up to 60
M5	Palace Road, by residences (East of turf field)	West	Jun 20, 17:40	57	52	Speech muffled and barely audible (< 53). Music barely audible and traffic dominant (< 51). Airplane 63
M5	Palace Road, by residences (East of turf field)	West	Jun 20, 19:57	55	46	Speech peaks audible (43 - 45); music peaks (45 - 47); cars (up to 60)
M5	Palace Road, by residences (East of turf field)	East	Jun 20, 20:29	56	51	Speech peaks clearly audible between cars (45 - 50); music (50, 52, 55, 54); cars (55 - 60); music from Anthem finale (56).
M6	West Campus Lane (SE of Richardson Stadium)	East	Jun 20, 17:00	46	43	Speech audible (< 42); music audible (< 44); cars (46, 47)
M6	West Campus Lane (SE of Richardson Stadium)	West	Jun 20, 17:48	45	42	Speech muffled (< 45); cars (46, 47); music barely audible (< 43)
M6	West Campus Lane (SE of Richardson Stadium)	West	Jun 20, 20:05	44	42	Music audible (<43)
M6	West Campus Lane (SE of Richardson Stadium)	East	Jun 20, 20:36	45	43	Speech barely audible (< 44); music audible (peaks < 43)
M7	North of Turf Field	East	Jun 20, 20:49	53	49	Speech audible (peaks at 45); music audible (peaks at 50-54); cars (50-56)
M7	North of Turf Field		Jun 20, 20:51	52	48	Ambient; cars (50-57)