

July 25, 2014

Catherine M. Conlow
City Manager
City of Bangor
73 Harlow St.
Bangor, ME 04401

Subject: Bangor Waterfront Concert Venue
Sound evaluation and SLODA exemption
Acentech Project No. 624574

Dear Ms. Conlow:

The City of Bangor has an outdoor venue on the waterfront for summertime concerts. Acentech has continuously monitored sound levels in and around the facility, in Bangor and in Brewer, for the duration of the 2014 concert season (to date). This report summarizes the results of our monitoring program and includes our recommendations for reasonable sound level limits based on the data we collected and our analysis of the log of complaints the City has received. With the proposed sound level limits in place, it is our professional opinion that sound from the facility will meet the requirements for exemption from regulation under the Maine Department of Environmental Protection “No Adverse Environmental Effect Standard of the Site Location Law” under the “occasional cultural” provision.

SOUND LEVEL MONITORING PROGRAM RESULTS AND ANALYSIS

Sound level monitoring procedure

Acentech placed three continuous sound level monitors in and around the waterfront concert venue on May 6, 2014. The system used to monitor the sound is Acentech’s **Remote Monitoring System** which uses a Data Translation Signal Acquisition Board (Model DT9837) and PCB Microphone (Model 378B02), and processes the data using time-domain filters which meet the specifications of ANSI 1.11-2004 Class 1. A microphone windscreen was used in each location. We calibrated each system in the field.

The sound level monitors were placed in the three locations indicated in Figure 1 below:

1. At the sound mix position within the venue – the “mix” location
2. On the roof of 10 Barker Street, Bangor, ME – the “Bangor” location
3. Outside the Brewer Public Library, 100 S. Main St., Brewer, ME – the “Brewer” location

Sound level data from each monitoring location is wirelessly transmitted in real time to our servers for analysis, and a summary of the data collected is posted in real time on a secured website accessible to City officials.

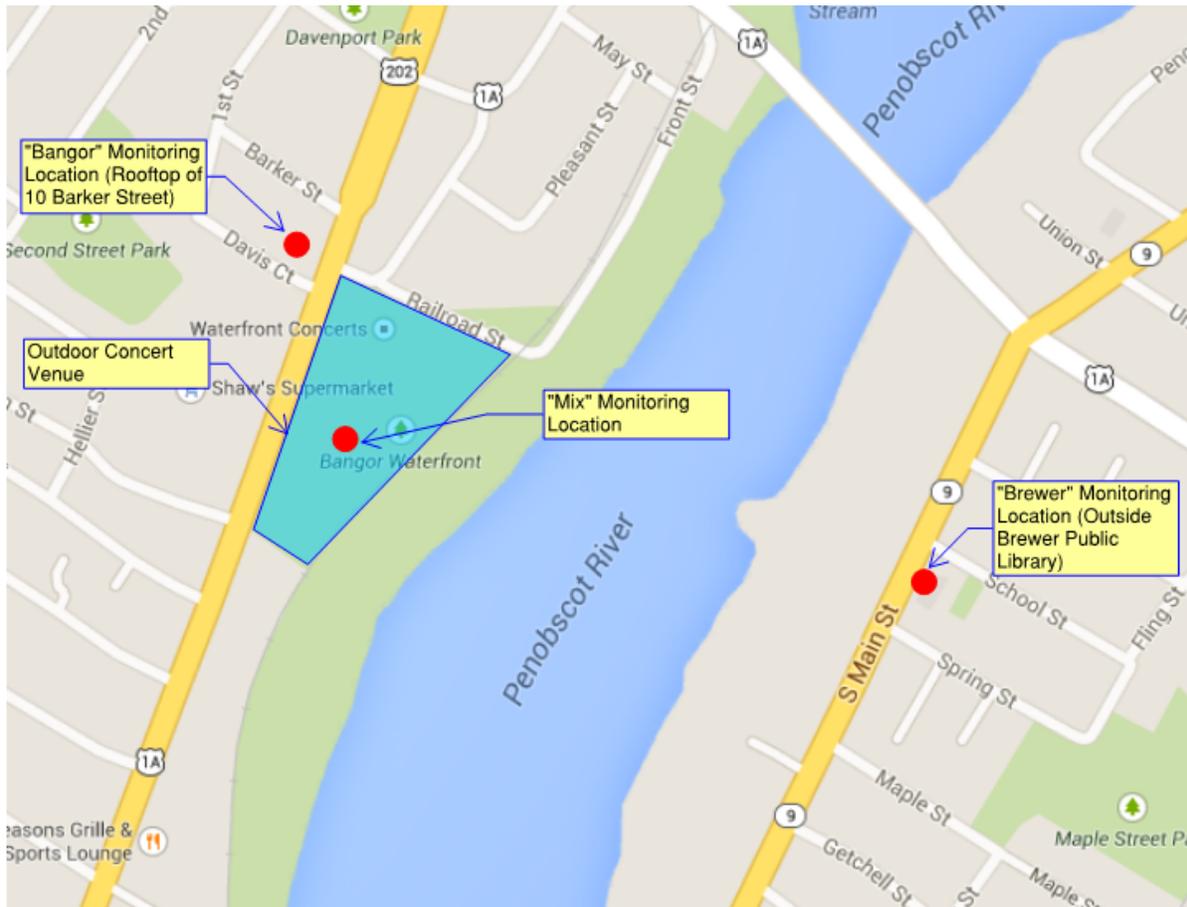


Figure 1. Sound level monitor locations.

Generally speaking, the louder the sound, the greater the sound pressure level. Sound pressure level (SPL) is measured in decibels (dB). Human hearing ranges from very low frequency sounds (“bass”) to very high frequency sounds (roughly 20 Hz to 20,000 Hz), and we respond to sounds differently depending on the frequency content. Some sounds (like rock music) have a great deal of sound energy at low frequencies, while other sounds of nominally “equal loudness” may not. We have focused our analysis on two metrics that account for the frequency content of sound we monitored:

1. An overall or “broadband” sound pressure level, A-weighted decibels (dBA), that weights the frequency content following a standard procedure that roughly approximates the frequency sensitivity of human hearing. This is the metric referenced and regulated in Maine’s Site Location Law.
2. The unweighted sound pressure level in the 63 Hz octave band – a “slice” of the audible sound spectrum at low frequencies (bass sounds), which we have found to be well correlated with community response to outdoor rock music.

Sound levels (particularly during a rock concert) also vary significantly from instant to instant. We have focused our analysis on two ways of accounting for this variability over time:

1. “Energy-average” sound levels (sometimes called “equivalent sound levels” or Leq) over the course of 1 hour (1-hour Leq). This relatively broad resolution is the time averaging referenced and regulated in Maine’s Site Location Law.
2. Energy-average sound levels over the course of 1 minute (1-minute Leq). We have found this finer resolution to be well correlated with community response to outdoor rock music.

It is well established that community response to sound is not characterized merely by the loudness of the sound, but by the increase in loudness of a particular sound over the prevailing background or “ambient” sound levels. In locations that are otherwise very quiet, even modest sound levels can be disturbing; locations (near busy roadways, for example) that experience higher levels of continuous sound are more tolerant of and may not even notice modest sound signals that could be bothersome elsewhere. As such, in the analysis that follows we have also drawn comparisons between sound levels during concert events to sound levels when concert events are not happening.

For the purpose of this report, we have analyzed sound monitored between May 6 and July 6, 2014.

Sound monitoring results

Sound levels during some concerts are significantly louder than others: by far the loudest event was the “Rise Above Fest” on May 10, 2014; other concerts (e.g. “Celtic Women” on May 30, 2014) were not nearly as loud and not nearly as bass-heavy. A closer look at those two concerts provides a useful comparison.

The 1-minute sound levels at all three monitor locations during the Rise Above Fest are graphed in Figures 2 (broadband, dBA) and 3 (63 Hz). The levels at the three locations are well correlated: when sound levels at the mix position in the venue go up (blue line), so too do the levels in Bangor and Brewer.

The same types of graphs are shown for Celtic Women in Figures 4 and 5. During this event, the changes in level within the venue do not result in as significant a change in the levels out in the community.

Not surprisingly, the City received many more complaints about sound levels during Rise Above Fest than in any other concert; no complaints were logged during or after Celtic Women. (We analyze the complaint log in further detail in the following section.)

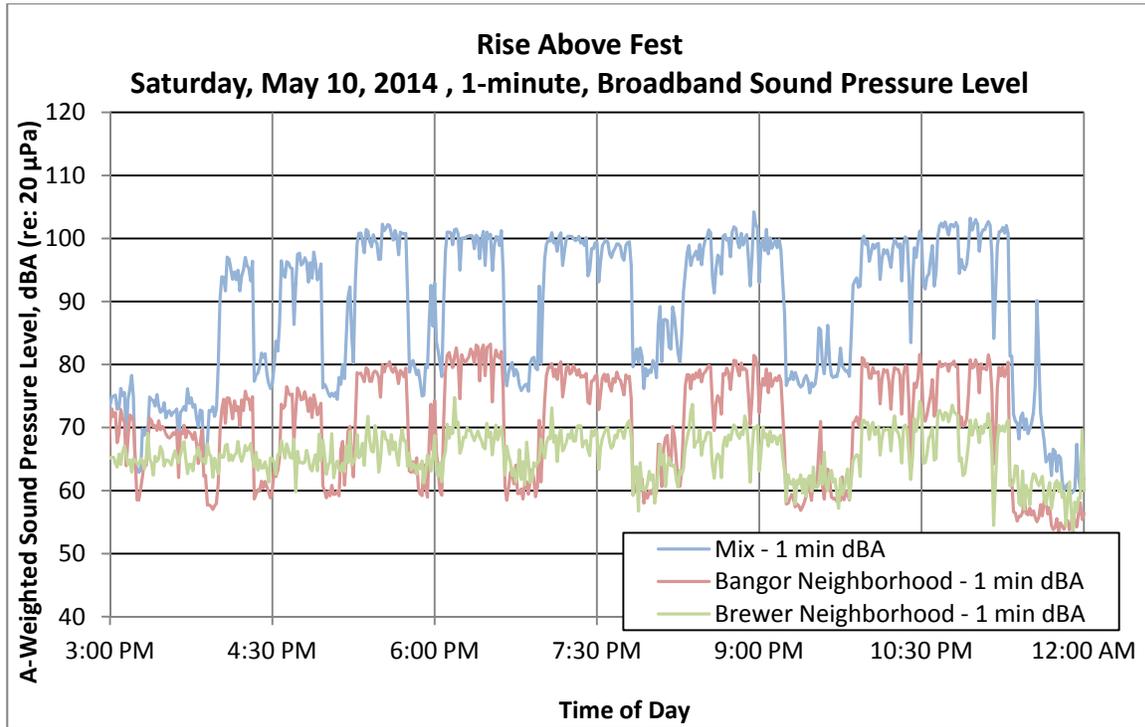


Figure 2. 1-minute A-weighted sound levels during Rise Above Fest, May 10, 2014.

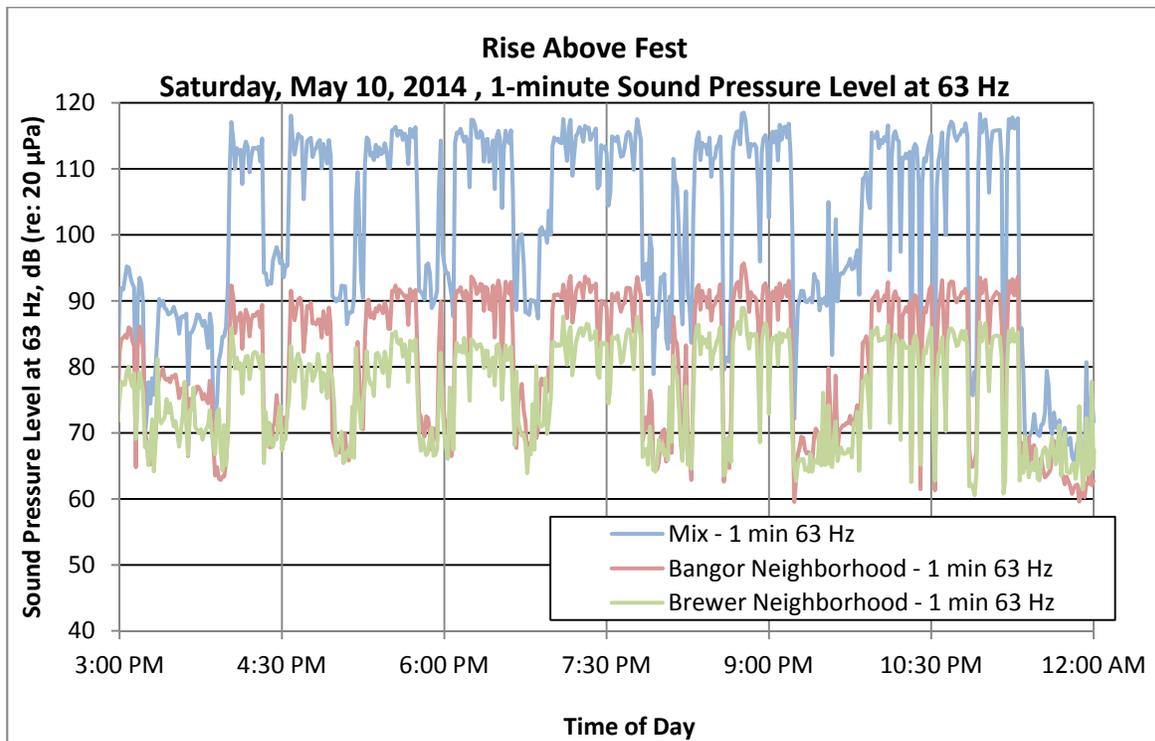


Figure 3. 1-minute sound pressure levels at 63 Hz (low frequency) during Rise Above Fest, May 10, 2014.

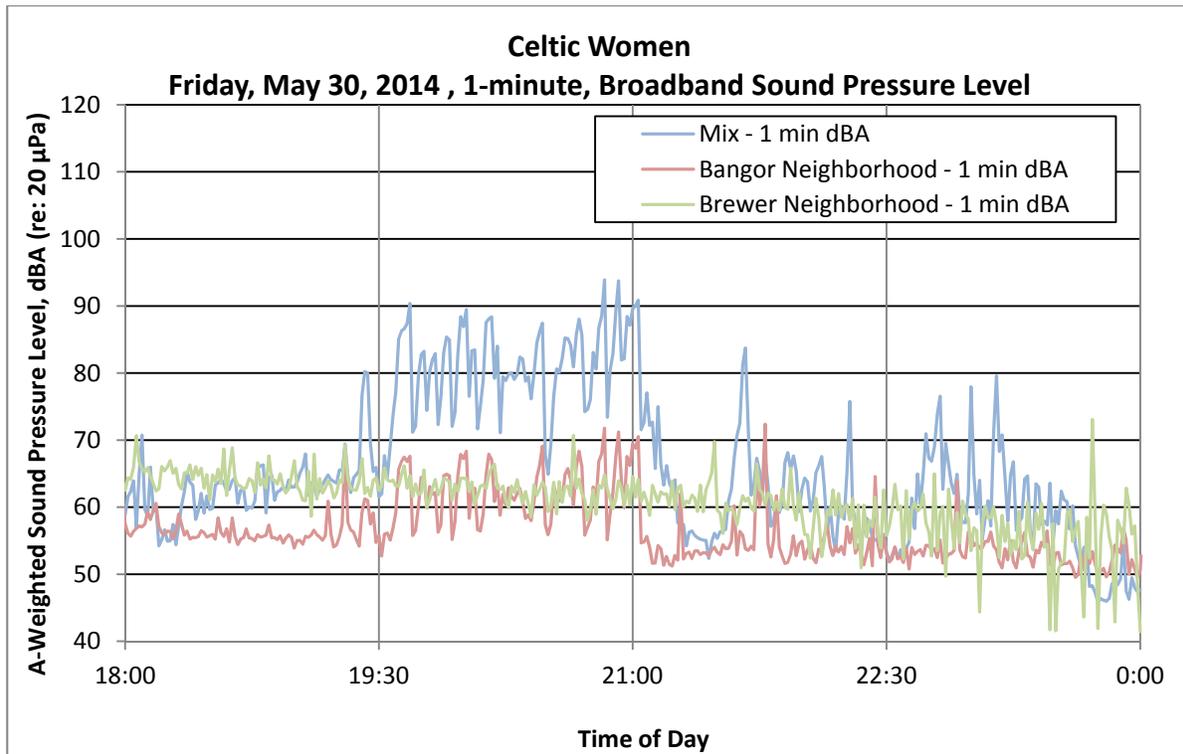


Figure 4. 1-minute A-weighted sound levels during Celtic Women, May 30, 2014.

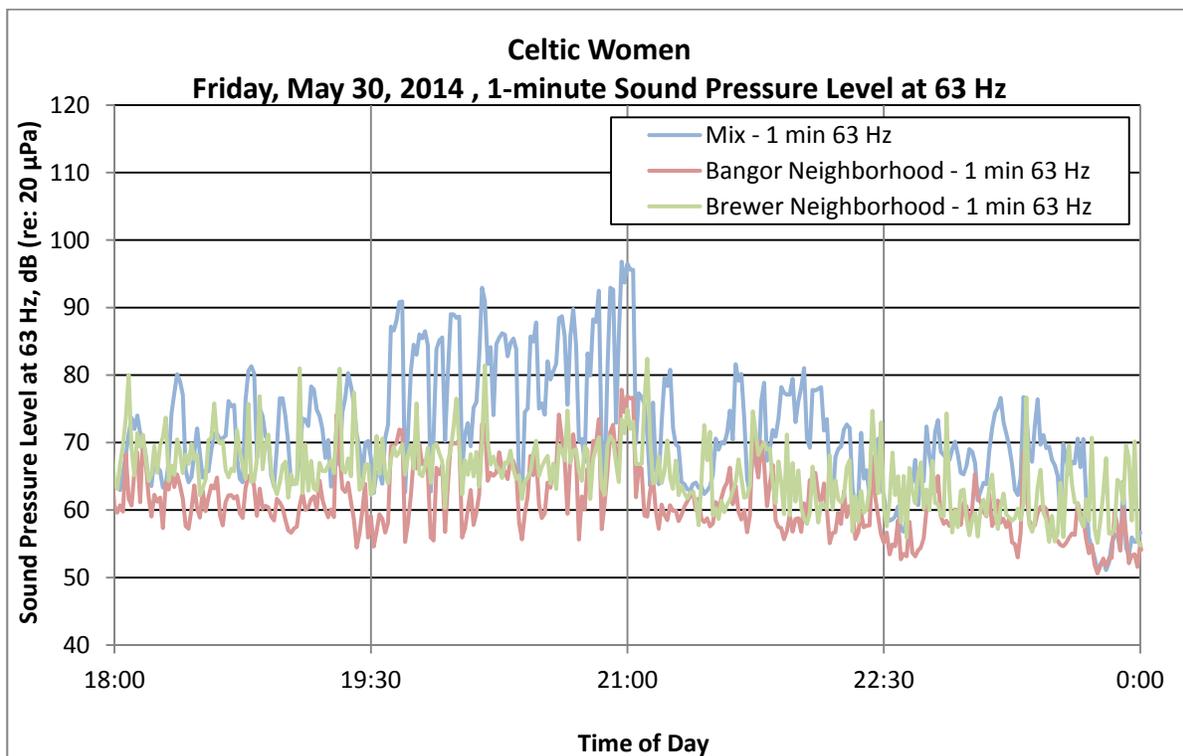


Figure 5. 1-minute sound pressure levels at 63 Hz (low frequency) during Celtic Women, May 30, 2014.

In the graphs above, one can compare sound levels during the concert to levels immediately before and after the event, but it is not possible in these graphs to compare sound levels during the concert to what they “would have been” had no concert been happening. To make such a comparison, we can analyze the sound levels in the community on a particular day of the week (say, Wednesdays) and compare the levels on days when no concerts are happening to levels when a concert did occur on that day of the week (Wednesday, July 2, Boston and Cheap Trick, for example). The graphs in the attached Appendix (A.1 through A.5) show these comparisons, in Bangor and in Brewer, for the five days of the week where at least one concert was performed this season (Wednesdays, Thursdays, Fridays, Saturdays and Sundays).

It is notable that in Brewer, 1-hour A-weighted sound levels (the levels regulated by the Maine Site Location Law) on days *during* concerts are typically within 10 dBA of the levels on days when no concerts occurred (and often well within 10 dBA).

It is also instructive to analyze how *often* a concert event is “loud.” To do this, we have analyzed the number of minutes the low frequency sound levels exceed various thresholds during the course of concert events. The number of these “exceedances” significantly correlate with the number of complaints received by the City, as discussed in the following section.

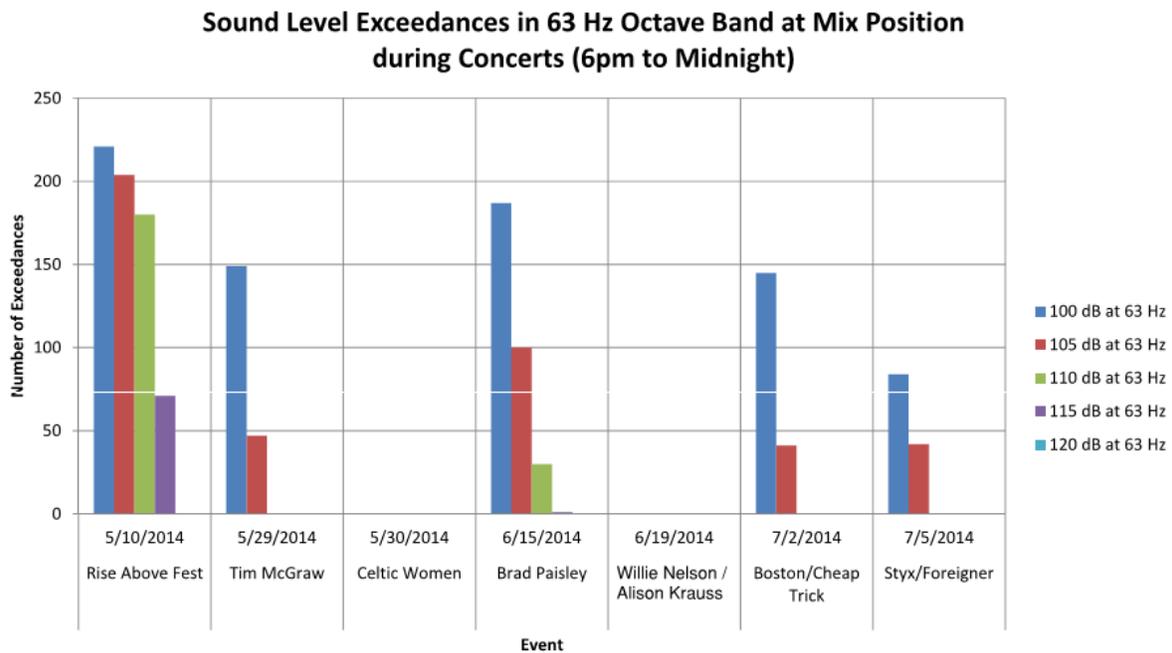


Figure 6. The number of times that the 1-minute average low-frequency (63 Hz) sound levels exceed thresholds from 100 dB to 120 dB (thresholds in 5-dB increments). The values are cumulative, not additive; e.g. the number of exceedances of 100 dB for a particular event includes those minutes that also exceeded higher thresholds of 105 dB, 110 dB, etc. in the same event.

As shown in the histogram in Figure 6, the 1-minute average sound levels at 63 Hz exceeded 115 dB at the mix position in the venue more than 50 times during the Rise Above Fest concert on May 10th. No other event generated enough low-frequency sound to exceed 115 dB at the mix position (except for once, during Brad Paisley), and some events (Celtic Women and Willie Nelson / Alison Krauss) never exceeded 100 dB by this metric.

Correlation of sound level data and complaints received

The exceedances charted in Figure 6 can be correlated to community response. Figure 7, below, shows the number of complaints received by the City during or following each event, grouped by the community where the complaint originated.

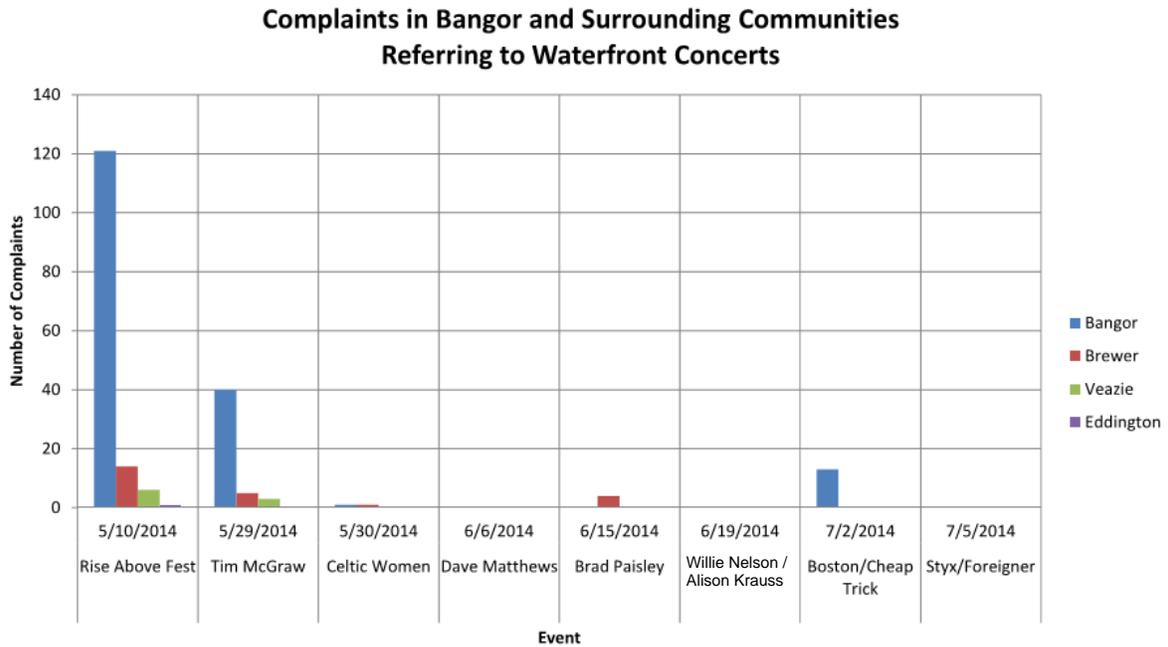


Figure 7. Number of complaints received by the City during or following each concert event.

Many factors may influence the number of complaints the City receives in addition to sound levels within the venue – weather conditions (which can affect not only how sound travels but more importantly whether or not residential windows are open), other “local” sound sources that influence the ambient noise conditions in the residential areas, personal musical taste or preferences, whether or not residences become accustomed to the events over time, and other factors. Even so, we have found a significant correlation between the number of complaints the City received and the number of times that the 1-minute average low-frequency sound levels at the mix position exceeded the thresholds indicated in Figure 6. Figure 8 combines the information in Figures 6 and 7 above by graphing the total number of complaints alongside the number of these low frequency sound level exceedances. (Note that the Dave Matthews Band concert on 6/6/2014, during which there were no complaints, does not appear on Figure 8 because the sound monitor at the mix position was unplugged during that concert.)

Sound Level Exceedances in 63 Hz Octave Band at Mix Position during Concerts (6pm to Midnight)

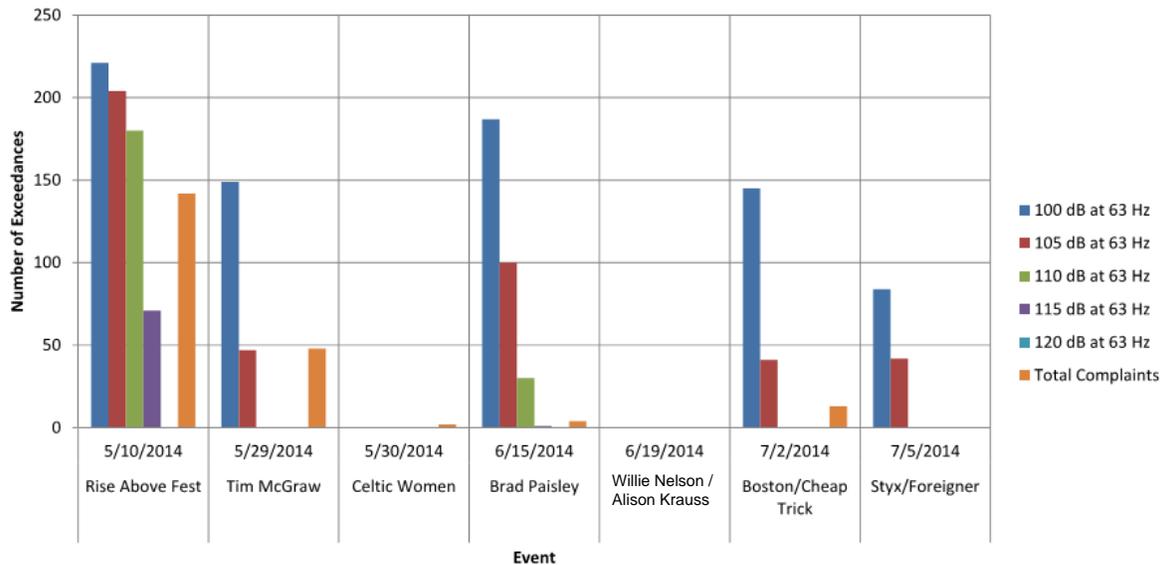


Figure 8. The number of complaints (orange) compared with the number of times the 1-minute average low-frequency (63 Hz) sound levels exceeded various thresholds at the mix position inside the waterfront concert venue.

In general, complaints are more prevalent when the number of exceedances is higher; in the particular case of Brewer (where residences logged complaints during Rise Above Fest, Tim McGraw, and Brad Paisley only), the correlation is even more significant.

We also noted that in the comments that accompanied many of the complaints, “bass” and other references to low-frequency sound were cited specifically.

AVAILABLE TECHNOLOGIES TO CONTROL SOUND LEVELS

At your request, we have summarized below our assessment of available technologies capable of controlling sound transmission to the surrounding community.

- **Sound barriers:** Sound barriers will be of limited value acoustically, and would come at great cost, for several reasons:
 1. *Height.* To be effective, barriers would need to be tall. The top loudspeaker in a typical line-array rig may be 30 feet or higher above the stage. Many of the surrounding properties overlook the concert venue from increased elevation. To block line-of-sight to the highest loudspeakers, a barrier would need to be more than two stories tall in some places. Such a structure would preclude the use of temporary screening (particularly if the barrier is to be massive enough to be effective), and would likely be prohibitively expensive.
 2. *Blocked views.* Views from downtown Bangor to the waterfront are of great importance to the City. Any barrier – even one perpendicular to the water’s

edge, but particularly one that was angled so as to block sound from Brewer – would significantly block views to the water (and vice versa) in many locations.

3. *Marginal benefit.* A barrier would be of limited acoustical benefit, particularly at low (bass) frequencies. Barriers are effective at mid and high frequencies, but are ineffective at low frequencies. As noted above, sound in the 63-Hz octave band (low frequency) is well correlated to community response to concert venue sound.

- Permanent roof structure: The erection of a permanent roof over the audience area could potentially have several benefits, but at considerable cost. An overhead roof could help to mitigate the transmission of sound to the community, and could also reduce levels at the source by allowing a more distributed set of loudspeakers closer to the audience area. In this way, the loudness within the venue could remain high, but the loudness of any particular loudspeaker could be less than the current arrangement; as such the levels of sound that are transmitted to the community would be correspondingly lower as well. This arrangement, however, has many of the drawbacks of the sound barriers described above: it could block views to and from the river, it would significantly alter the appearance and character of the waterfront area (year-round), and it could be very expensive to build.
- Directive sound amplification technologies: As the audio industry continues to evolve, a number of technologies have emerged in recent years that work well to control the dispersion of sound by carefully controlling loudspeaker directivity. Digitally steerable line-array technology, cardioid subwoofer systems, and other approaches allow sound engineers to “aim” sound in the audience area, while limiting the “spill” of sound outside the venue. However, today’s technologies are typically more effective at directing mid and high-frequency sound energy than they are at low frequencies.

Most of the waterfront concert venue’s performers already employ such technologies. Line array systems were utilized during most the concerts that we monitored as part of this study. Some performers take advantage of cardioid subwoofer systems which can be somewhat directional at low frequencies; others do not. The specific systems used by various performers vary significantly, and the technologies are ever evolving; as such, we do not know of a practical way to mandate the venue’s further use of such technology beyond current practice unless the facility were to invest significantly in a permanent sound system and require performers to use it, which may limit the range of performers willing to perform at the venue.

- Sound level limits: Sound levels of concerts are controlled by sound engineers at the front-of-house mix position inside the venue. Sound engineers have the ability to control the level of sound produced within practical limits. Restrictions on sound levels could limit the number of performers willing to use the venue, and excessive restrictions will undermine the experience of attending a rock concert. That said, reasonable limits are the most effective, most reliable, and least costly means of controlling levels to the community, and many venues (e.g. Chastain Park) operate successfully with targeted sound limits in place. With these factors in mind, we recommend below that the City institute and enforce certain limits on the sound levels created at the venue.

RECOMMENDATIONS

Based on the data we collected during our monitoring program (described above), our analysis of sound level impacts to Brewer compared with prevailing ambient sound levels, and our analysis of complaints received by the City concerning sound levels produced by the venue, we propose that the City institute reasonable sound level restrictions and monitor sound levels at the venue so that the City can enforce such restrictions.

Sound pressure levels in the standard 63-Hz octave band should be continuously monitored during events, from the mix position, and the 1-minute average (Leq) sound level should be logged every minute. We recommend that an event at the venue be considered to have exceeded the new sound level limits if (a) the 1-minute average (Leq) sound level at 63 Hz ever exceeds 115 dB at the mix position, *or* (b) if there are more than 10 instances where the 1-minute average (Leq) sound level at 63 Hz exceeds 110 dB at the mix position.

The proposed restriction has several important features:

- a) It is based on one-minute, rather than one-hour, averages, which is more consistent with the temporal character of concert music and with associated typical community response.
- b) This 1-minute average would allow near-immediate feedback to the concert promoter, giving him or her the opportunity to make adjustments to the levels in real time if necessary. 1-hour long measurements would not allow for this kind of adjustment during concert events.
- c) It focuses on low frequencies, which we have found to be most closely related to neighborhood complaints at other venues.
- d) It has precedence – it is structured similarly to standards employed at other venues, including Chastain Park in Atlanta.
- e) It is straightforward to monitor and implement.
- f) It will result in the elimination of the loudest concert events, protecting residences in Brewer and in Bangor.

Two events during the 2014 season would be in violation of the proposed standard (both of which received a significant number complaints from Brewer): Rise Above Fest and Brad Paisley.

We also recommend that the City continue to enforce its cutoff time of 10:30pm for events at the Venue on Sunday through Thursday and 11:30pm for events on Friday and Saturday. In addition, we understand that you have asked the promoter to make best efforts to end by 10pm Sundays through Thursdays and 11:00pm Fridays and Saturdays.

As additional concerts are monitored and complaints are logged, we recommend that the applicability of the thresholds in the criteria proposed here be reevaluated and adjusted if appropriate.

Finally, we recommend that the City put in place suitable penalties or other measures necessary to enforce the proposed restriction.

EXEMPTION FROM REGULATION

The site location law states that sound from certain sources are exempt from regulation. One such exemption is for “occasional sporting, cultural, religious or public events allowed by the local municipality where the only affected protected locations are contained within that municipality.” The concert venue in Bangor is used only occasionally – it is not in daily use. Our analysis has shown that concerts this summer have exceeded prevailing 1-hour average ambient sound levels in Brewer typically by less than 10 dBA. In addition, we have proposed a sound level restriction on low-frequency sound levels, analyzed on the basis of 1-minute rather than 1-hour averaging; with this restriction in place, events with sound levels similar to those that garnered the most complaints from Brewer would not be permitted. Based on the extensive data we’ve collected and analyzed and with the proposed sound level limits in place, it is our opinion that the waterfront concert facility meets the requirements of the SLODA’s “occasional cultural” provision with respect to sound level regulation.

* * * * *

Please let me know if you have any questions about the information in this report; my direct telephone number is 617.499.8086.

Sincerely,

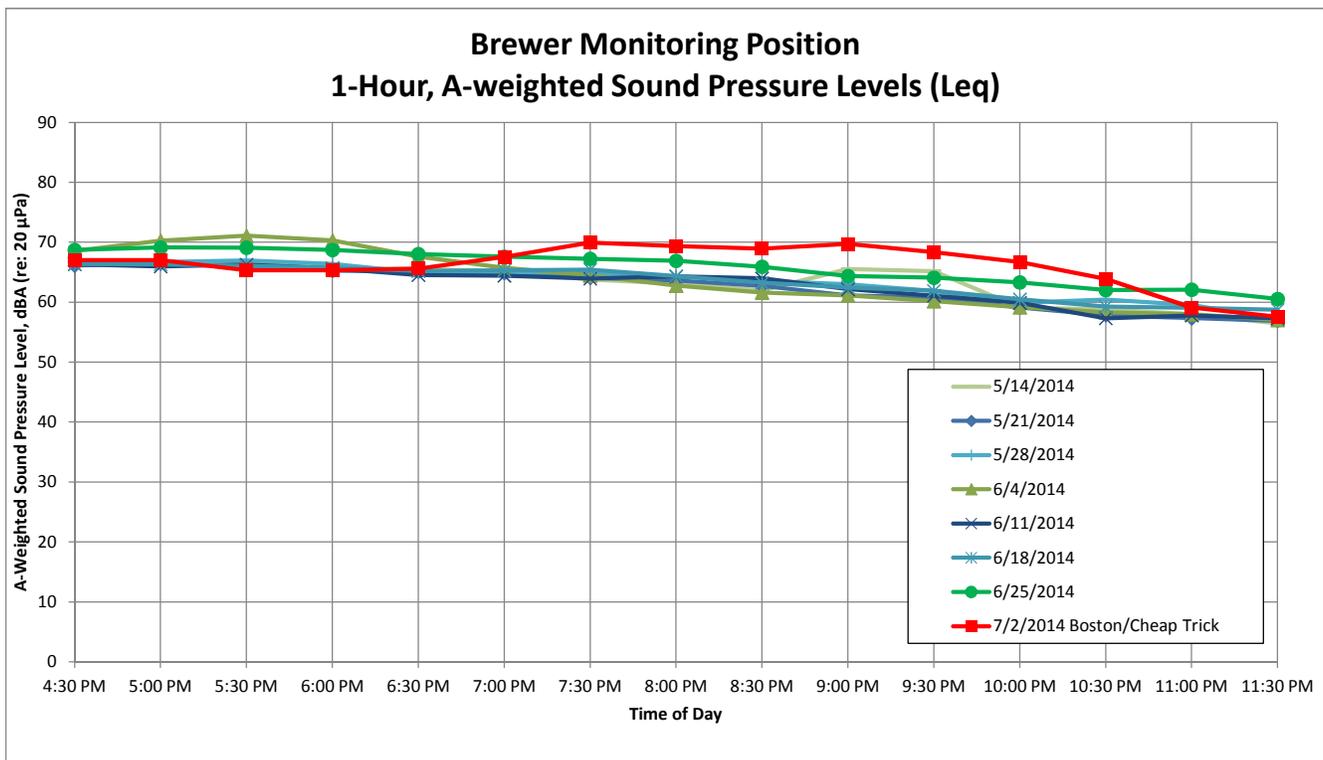
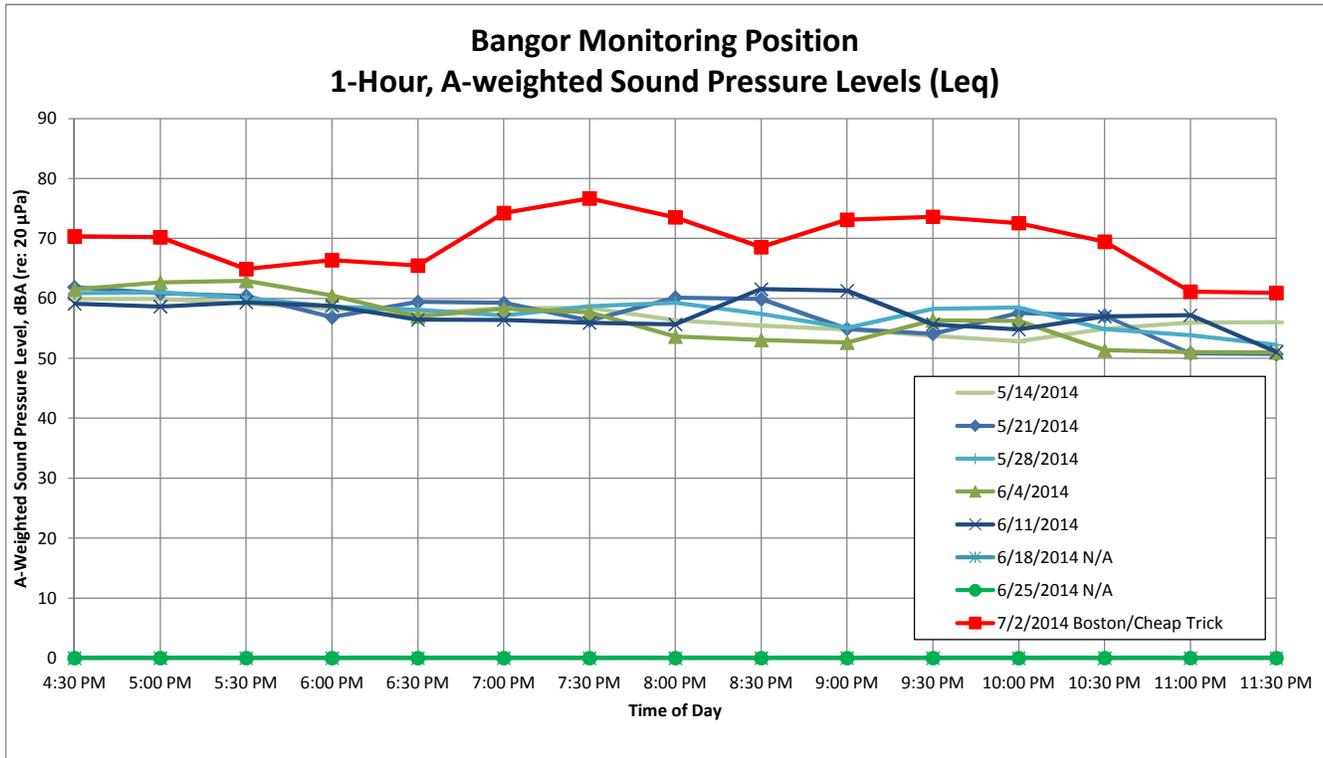
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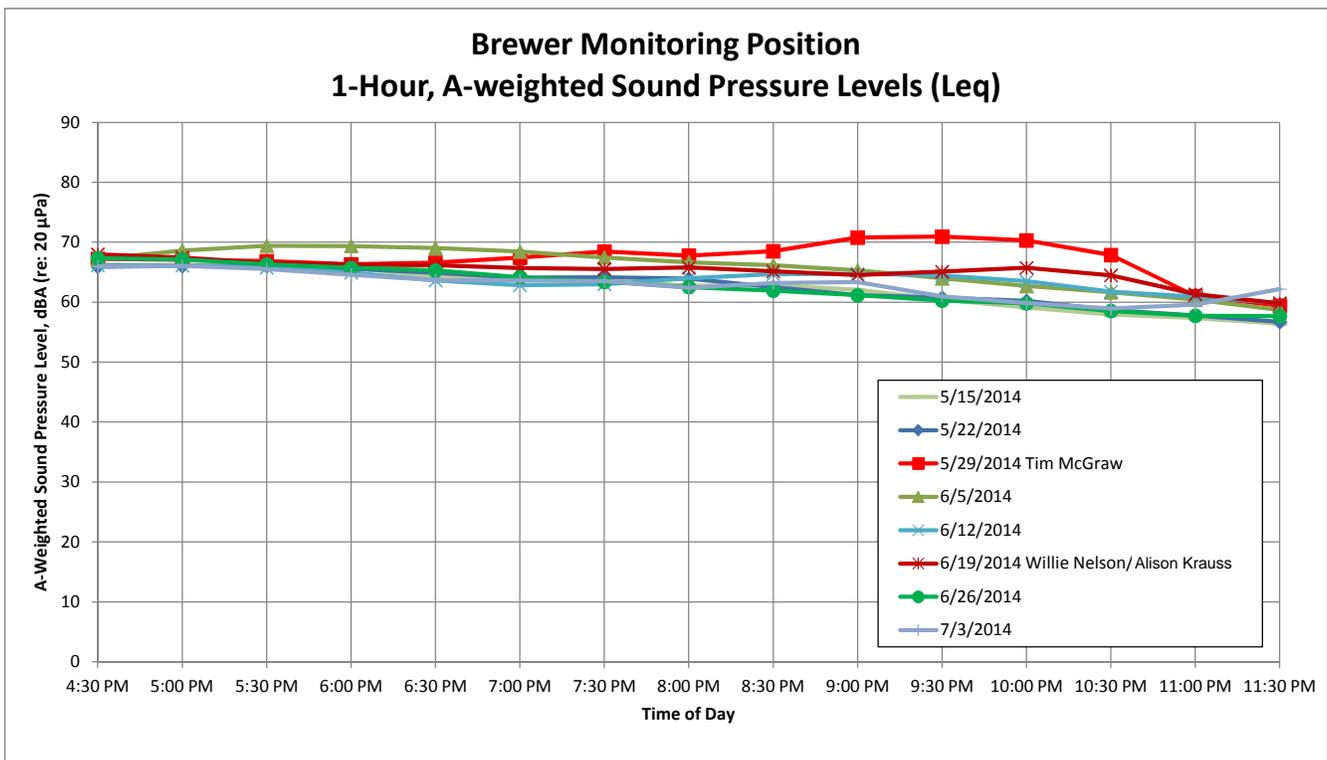
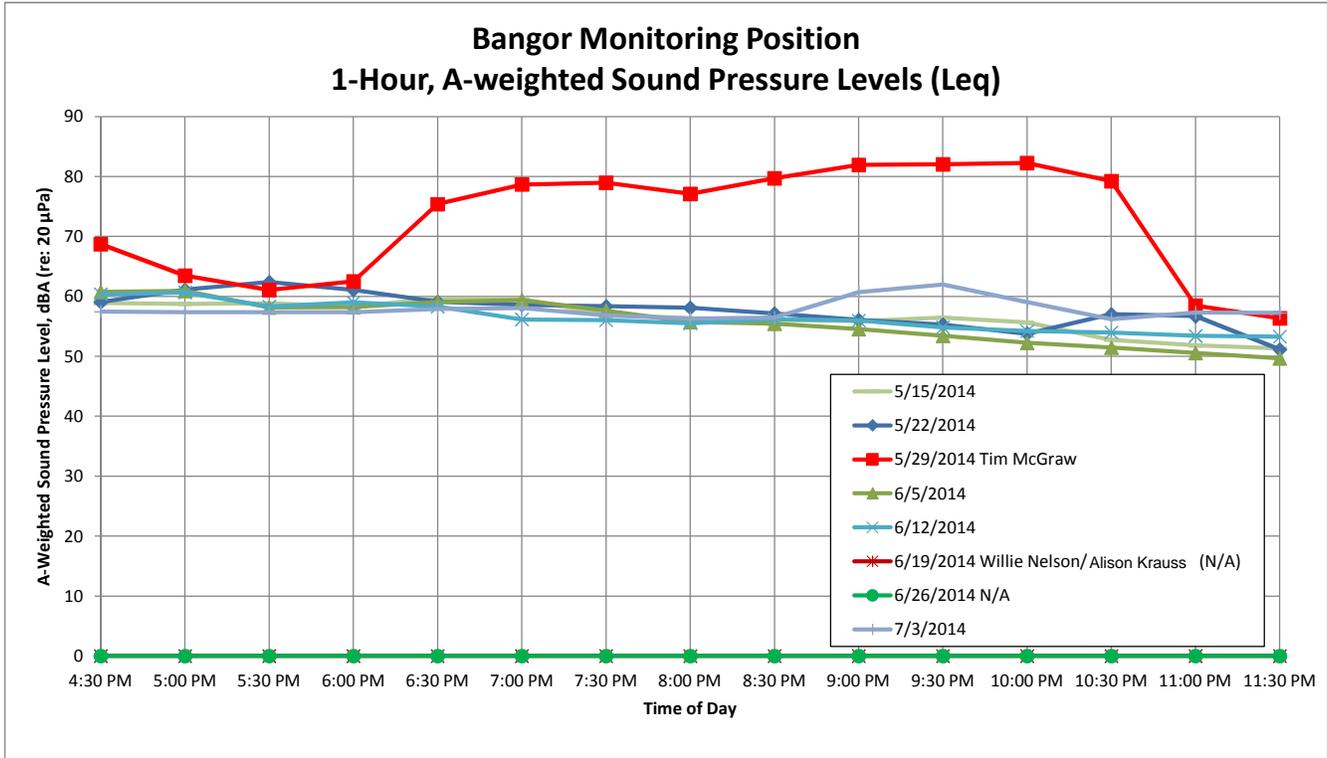
Benjamin E. Markham
Director, Architectural Acoustics

Encl. Figures A.1 through A.5

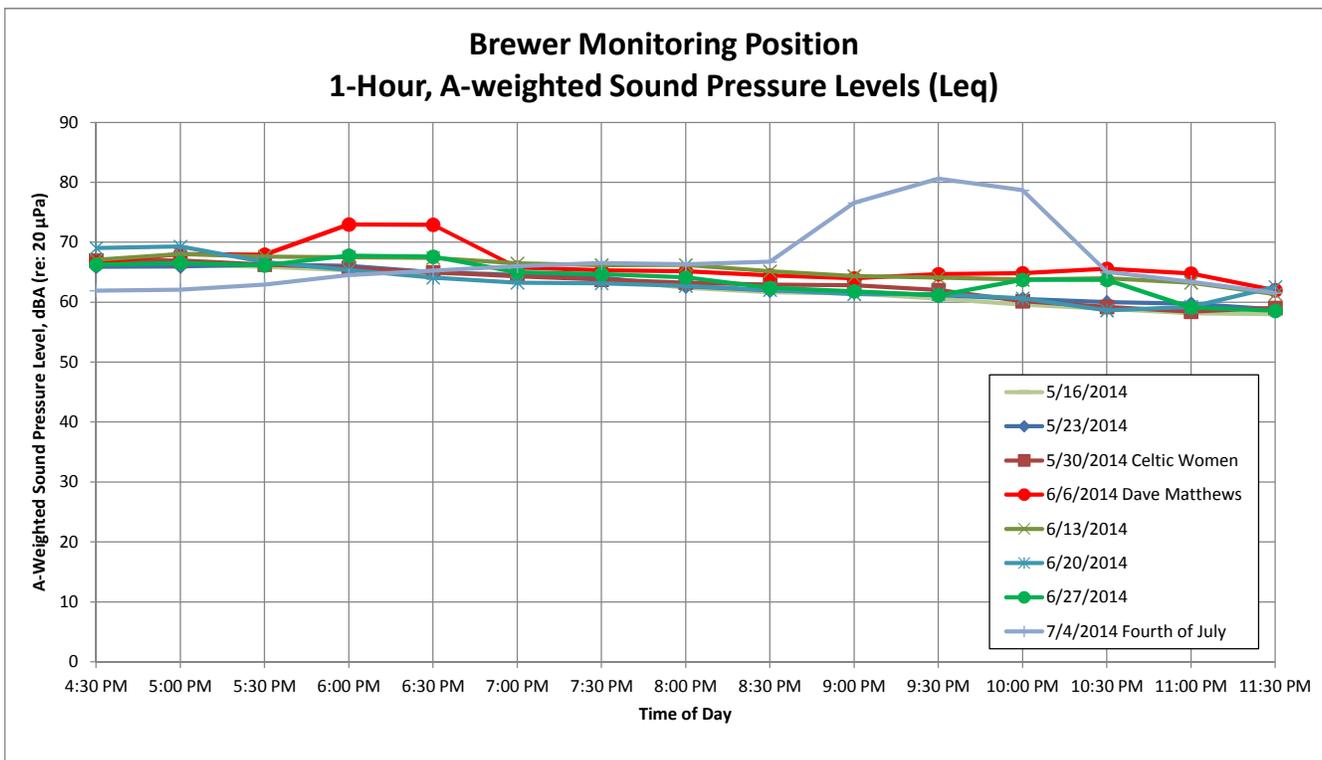
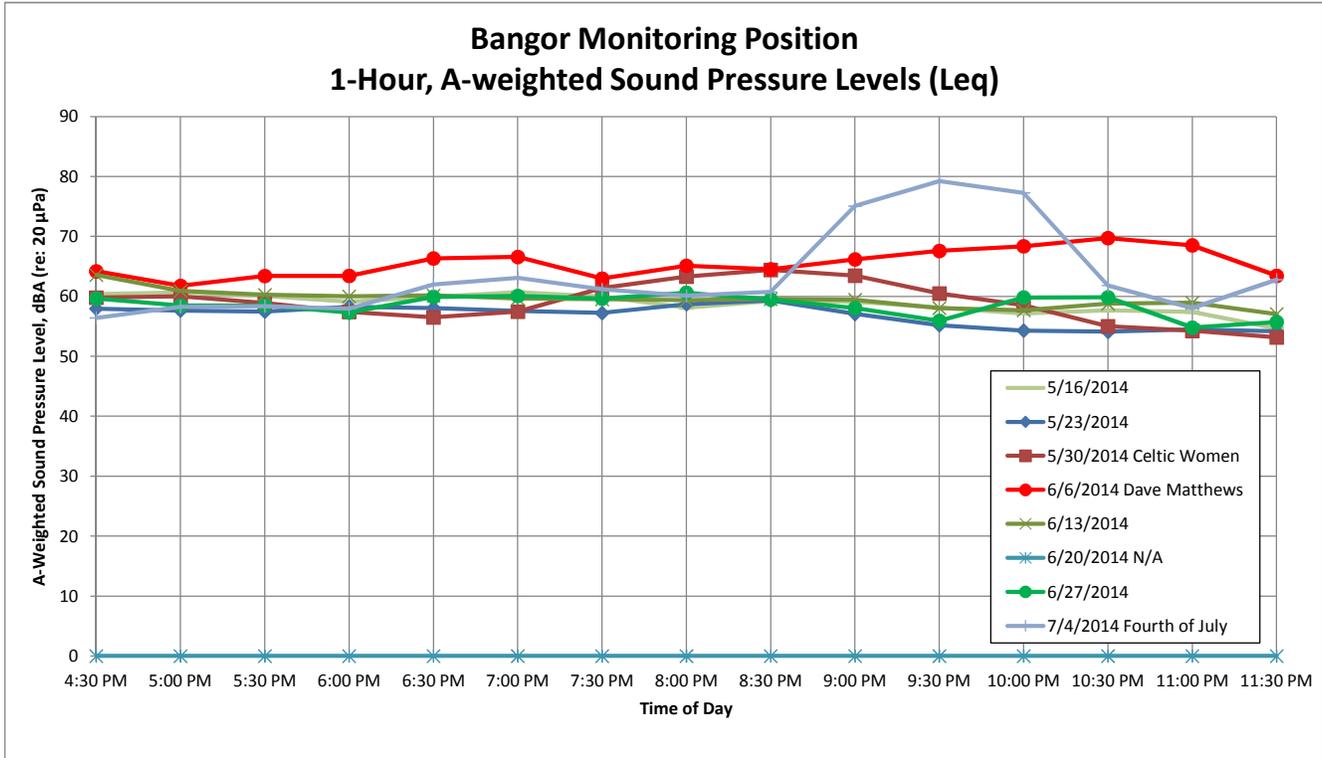
Wednesdays between May 14 and July 2, 2014



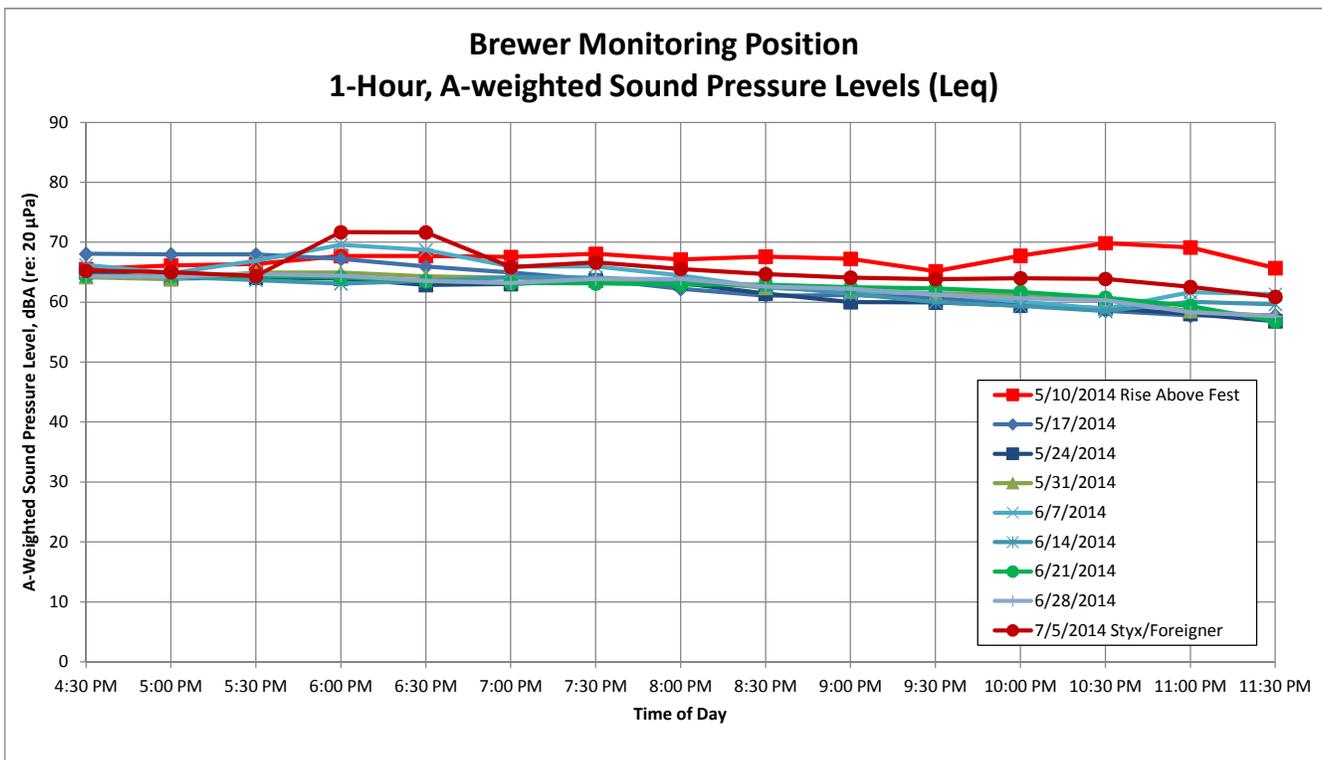
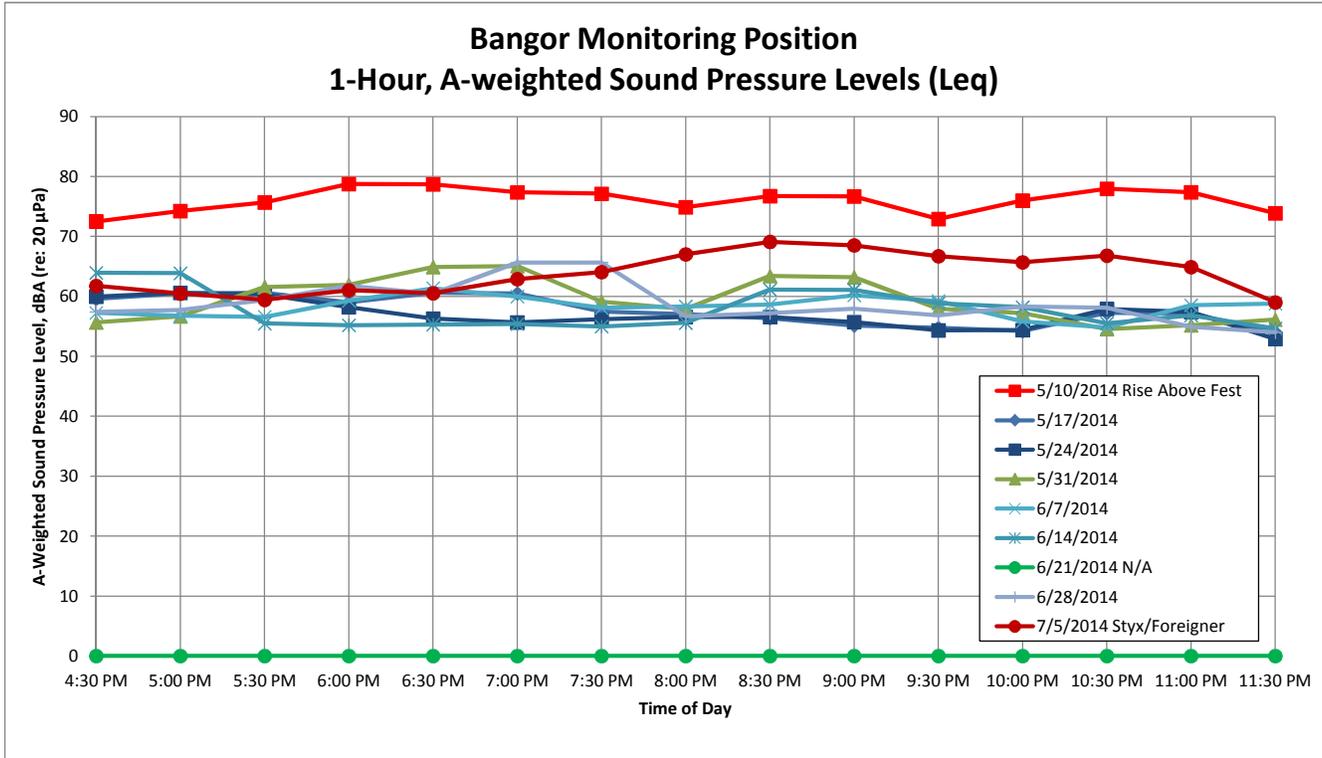
Thursdays between May 15 and July 3, 2014



Fridays between May 16 and July 4, 2014



Saturdays between May 10 and July 5, 2014



Sundays between May 11 and July 6, 2014

