Veneklasen Associates
Consultants in Acoustics | Noise | Vibration | AV | IT

January 16, 2018

ESG Architects
500 Washington Avenue South #1080
Minneapolis, Minnesota 55415

Attention: **Gretchen Camp, AIA, LEED AP | Partner**

Subject: **Bloomington Central Station Phase 3**
Bloomington, Minnesota
Exterior Façade Acoustical Design
VA Project No. 3912-056

Dear Gretchen:

Veneklasen Associates (VA) has completed our review of the Bloomington Central Station Phase 3 project located in Bloomington, Minnesota. This report represents the results of our findings.

1.0 INTRODUCTION

This study was conducted to determine the impact of the exterior noise sources on the Bloomington Central Station Phase 3 project in Bloomington, Minnesota. VA's scope of work included calculating the exterior noise levels impacting the site and determining the method, if any, required to reduce the interior and exterior sound levels to meet the applicable code requirements of the State of Minnesota and the City of Bloomington.

The project consists of a 6-level mixed-use development with ground-level retail occupancy, residential amenities on the podium level, and rooftop terraces. The project is bounded by 33rd Avenue to the west, 34th Avenue South and a railroad to the east, East 80 ½ Street to the north, and a light rail line to the south.

2.0 ACOUSTIC TERMS AND DEFINITIONS

The following are a few acoustic terms and definitions that should be understood as these are referenced in the remainder of the report.

Decibel (dB) – The decibel is a measure, on a logarithmic scale, of the magnitude of a particular quantity (such as sound pressure level or sound power level) with respect to a standard reference value.

Equivalent Sound Level (Leq) – A steady noise level which over a period of time has the same sound energy as the time varying noise.

A-Weighted Sound Level – The ear does not respond equally to all frequencies, but is less sensitive at low and high frequencies than it is at medium or speech range frequencies. Thus, to obtain a single number representing the sound level of a noise containing a wide range of frequencies in manner representative of the ear's response, it is necessary to reduce the effects of the low and high frequencies with respect to the medium frequencies. The resultant sound level is said to be A-weighted, and the units are dBA. The A-weighted sound level is also called the noise level.

DNL or LDN (Day-Night Noise Level) is the 24-hour equivalent sound pressure level in which the nighttime noise levels, occurring between the hours of 10 p.m. and 7 a.m., are weighted by adding 10 dB of sound level to the measured hourly average.

L10 - The sound level is exceeded 10 percent of the time. This is a measure of the louder sound levels during the measurement period. Example: During a 1-hour measurement, an L10 of 85 dBA means the sound level was at or above 85 dBA for 6 minutes.

L50 - The sound level is exceeded 50 percent of the time. This is a measure of the louder sound levels during the measurement period. Example: During a 1-hour measurement, an L50 of 67 dBA means the sound level was at or above 67 dBA for 30 minutes.

3.0 NOISE CRITERIA

3.1 Regional 2030 Transportation Policy Plan – Appendix M: Land Use Compatibility Guidelines

Below are the applicable tables presented in Appendix M of the Regional 2030 Transportation Policy Plan:

Table M-3: Structure Performance Standards*

Land Use	Interior Sound Level **
Residential	45dba
Educational/Medical	45dba
Cultural/Entertainment/Recreational	50dba ***
Office/Commercial/Retail	50dba
Services	50dba
Industrial/Communications/Utility	60dba
Agricultural Land/Water Area/ Resource Extraction	60dba

** Do not apply to buildings, accessory buildings, or portions of buildings that are not normally occupied by people.*
*** The federal DNL descriptor is used to delineate all the system airport noise policy zones.*
**** Special attention is required for certain noise sensitive uses, for example, concert halls.*

Table M-4: Land Use Compatibility Guidelines for Aircraft Noise

	Compatibility with Aircraft Noise Levels									
Type of Development	New Development and Major Redevelopment					Infill Development and Reconstruction or Additions to Existing Structures				
Noise Exposure Zones	1 DNL 75+	2 DNL 74-70	3 DNL 69-65	4 DNL 64-60	Buffer Zone*	1 DNL 75+	2 DNL 74-70	3 DNL 69-65	4 DNL 64-60	Buffer Zone*
Land Use Category										
Residential										
Single / Multiplex with Individual Entrance	INCO	INCO	INCO	INCO		COND	COND	COND	COND	
Multiplex / Apartment with Shared Entrance	INCO	INCO	COND	PROV		COND	COND	PROV	PROV	
Mobile Home	INCO	INCO	INCO	COND		COND	COND	COND	COND	

Based on the 'Actual 2016 Noise Contours' produced by the Metropolitan Airports Commission, the project is located in the 60-64 DNL range. Therefore, the project is considered 'PROV' or Provisional. This policy states that "structures built after December 1983 shall be acoustically constructed so as to achieve the interior sound levels described in Table M-3. Each local governmental unit having land within the airport noise zones is responsible for implementing and enforcing the structure performance standards in its jurisdiction." *Therefore, the applicable interior noise criterion according to this policy is 45LDN*.

3.2 Minnesota Pollution Control Agency (MPCA) – A Guide to Noise Control in Minnesota

Section 7030, Noise Pollution, states that "any municipality having authority to regulate land use shall take all reasonable measures within its jurisdiction to prevent the establishment of land use activities listed in noise area classification (NAC) 1, 2, or 3 in any location where the standards established in part 7030.0040 will be violated immediately upon establishment of the land use."

Section 7030.040, 'Noise Standards', establishes the limiting levels of sound based the preservation of public health and welfare and is grouped according to land activities by the noise area classification (NAC) system. Noise standards are established for daytime and nighttime hours and use the L10 and L50 metrics. Below are the noise standards:

Subp. 2. Noise standards

Noise Area Classification	Daytime		Nighttime	
	L10	L50	L10	L50
1	65	60	55	50
2	70	65	70	65
3	80	75	80	75

The guide also states the noise area classification is based on the land use activity at the location of the receiver and determines the noise standards applicable to that land use activity unless an exception is applied under subpart 3. This project is in NAC1 because it is residential.

Subpart 3, Exceptions, states the following: The noise area classification for a land use may be changed in the following ways if the applicable conditions are met.

A. The daytime standards for noise area classification one shall be applied to noise area classification one during the nighttime if the land use activity does not include overnight lodging.
B. The standards for a building in a noise area classification two shall be applied to a building in a noise area classification one if the following conditions are met:
    1) The building is constructed in such a way that the exterior to interior sound level attenuation is at least 30 dB(A);
    2) The building has year-round climate control; and
    3) The building has no areas or accommodations that are intended for outdoor activities.

Based on VA's noise measurements and calculations the project will require the noise mitigation listed above under Subpart 3.B.

If the windows must be closed to meet an interior level described, then a mechanical ventilating system or other means of natural ventilation shall be provided. The ventilation cannot compromise the acoustical isolation of the exterior façade.

3.3 Exterior Noise Levels

There is no regulatory requirement for noise levels on balconies in Bloomington. Industry standard practice is that an exterior noise level up to 65 LDN is acceptable for residential uses. Levels above 65 LDN may be considered intrusive to a percentage of the population for some uses. In many urban locations, it is not feasible to reduce exterior noise levels below 65 LDN. For small private balconies, in VA's opinion there is no feasible mitigation. Balcony barriers have been employed on some projects, but numerous studies have concluded that they provide little acoustical benefit. Balcony barriers mostly enclose the balcony, negating the purpose of including private balconies. For this reason, many municipalities exclude private balconies less than 6 feet in depth from their standards.

4.0 EXTERIOR NOISE ENVIRONMENT

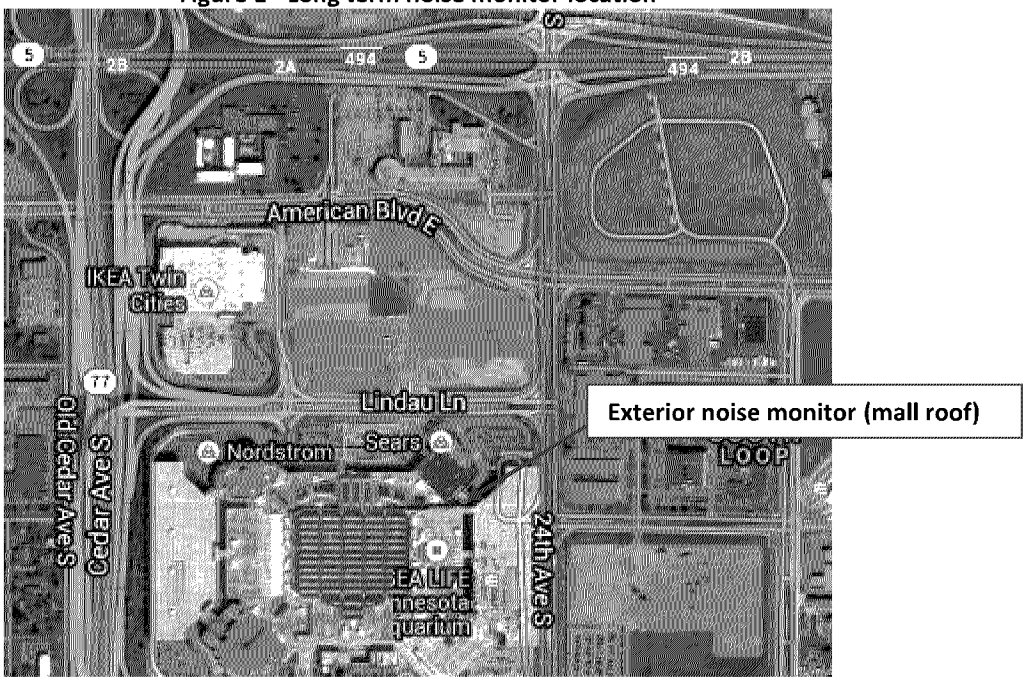
4.1 Noise Measurements

Aircraft

VA performed noise measurements from October 8–10, 2013, on the roof of Mall of America (Bloomington, MN). The measurement location has similar exposure to aircraft taking off from MSP airport. See Figure 1. VA used a Bruel & Kjaer type 2260 sound level meter (type I), which continuously logged the sound level during the measurement period. The meter was installed on the roof of the Mall of America. The height of the microphone was set to 5 ft. above the roof. The meter was programmed to continuously log data over the duration of the measurement. Data for all three days was analyzed. Aircraft takeoff events are clearly evident on the log, with the typical event having maximum noise level of about 80 dBA compared to a background level of about 62 dBA (daytime).

Depending on the prevailing winds and other factors, the flight path Runway 17 just west of the project site is used for takeoffs, landings, or not at all. The noise from arriving (landing) aircraft does not significantly affect the overall noise level at the site. Departing aircraft are much louder and potentially intrusive, so the required mitigation at the site is entirely controlled by the sound levels during times when the airplanes depart to the south (plane takeoffs to the south). According to Metropolitan Airport Commission (MAC), almost 100% of the activity in the month of October on Runway 17 were departing aircraft events. MAC also states that Runway 17 had 683 departures of all operations during the nighttime hours (10:30pm to 6:00am) of 2012. This is an average of 2 nighttime events daily for year 2012.

Figure 1 - Long term noise monitor location



The Flight Tracker feature on the macnoise.com website provides a record of every flight in and out of the airport. For example, Figure 2 shows the flight path (green lines indicate departing aircraft) from 4 pm – 10 pm on Oct 8, 2013, during the measurement period. It is evident that there are a large number of aircraft events potentially impacting the project site.

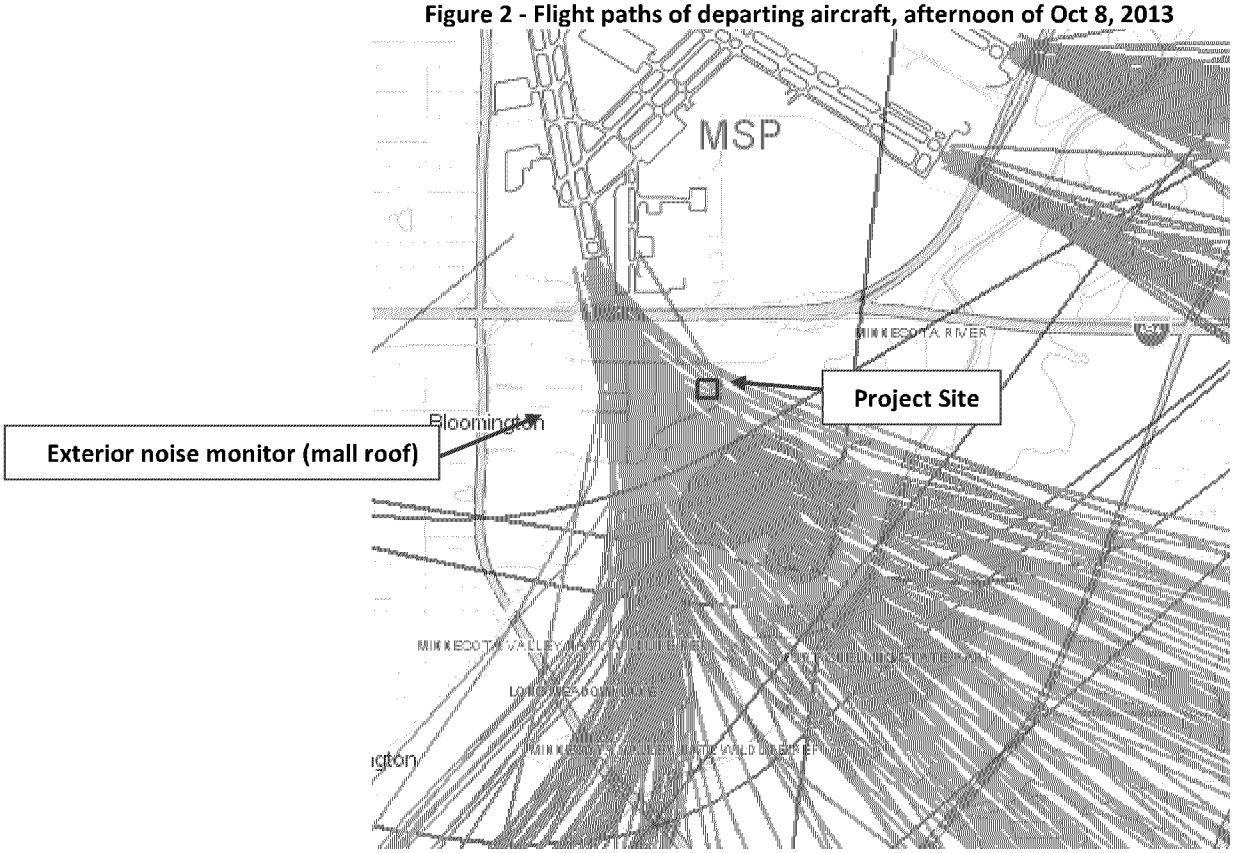
Comparison of the logged sound level with the Flight Tracker data confirms that the Flight Tracker data is accurate. Looking at historical Flight Tracker data, the measured day was one of the busiest days for this flight path. On some days, there are significantly fewer aircraft events; however, there are many days that had a similar number of flights as the day measured. Therefore the measured levels provide a suitable basis for design.

During the 24-hour period, 414 aircraft take-offs were logged. The average maximum level during the aircraft flyover was 80 dBA; the 90th percentile level was 85 dBA. Table 1 below presents a summary of the measured noise levels in metrics found within the MPCA.

Table 1 - Summary of Measured Noise Levels

Daytime, dBA		Nighttime, dBA	
L10	**L50**	**L10**	**L50**
71	64	65	58

Figure 2 - Flight paths of departing aircraft, afternoon of Oct 8, 2013



Light Rail Train

VA performed measurements of a Blue Line train arriving at Bloomington Central Station. The event included the noise from the train movement and warning bells. The measurement was taken at a distance of approximately 85 feet south of the station. The resultant noise level was 70 dBA Leq with a duration of approximately 25 seconds. Based on the train schedule presented metrotransit.org for the American Boulevard Station, train activity begins during the 3am hour and ends during the 1am hour. Considering northbound and southbound trains there are approximately 216 train events for a typical weekday with 24 events occurring during the nighttime hours from 10pm to 7am. Based on our measurements and the Blue Line trains schedule, VA calculated the resultant noise level at the east façade of the project to be 63 LDN.

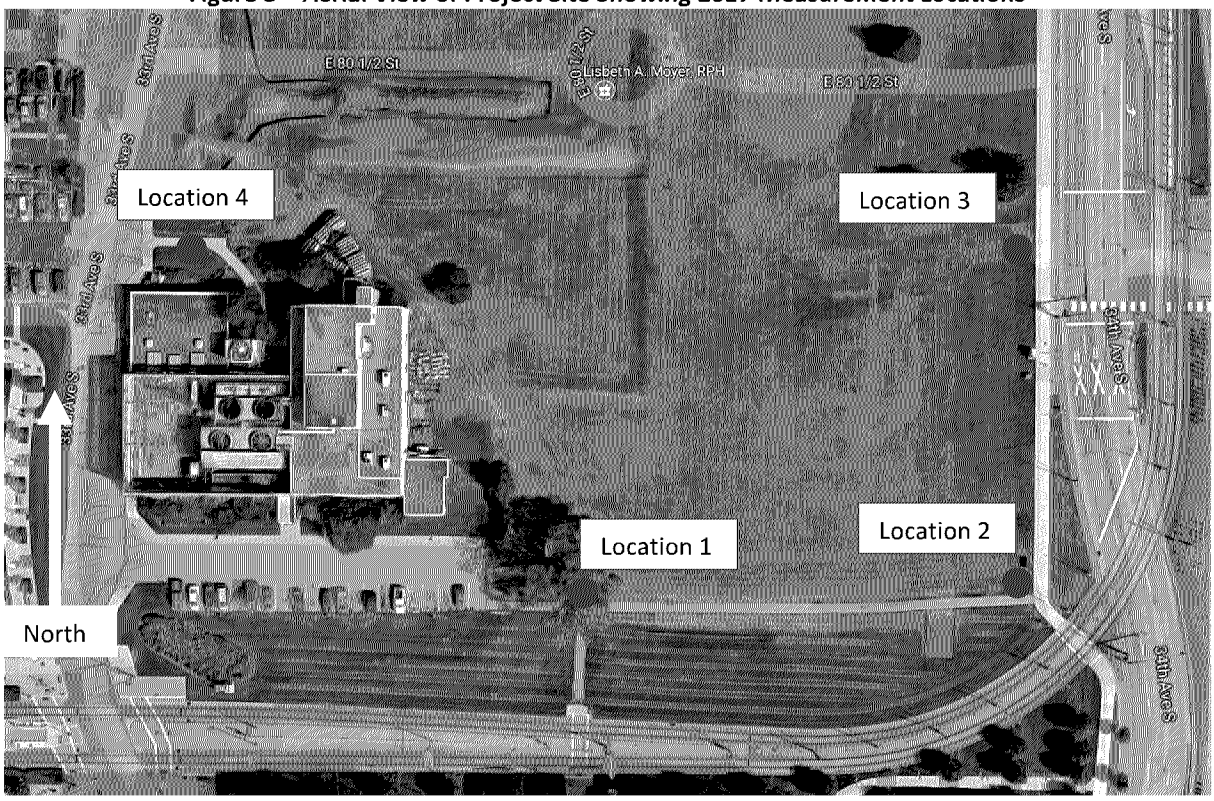
VA supplemented the earlier measurement programs with additional measurements, conducted on Tuesday, October 10, 2017. Table 2 and Figure 3 show the location and summary of the noise measurements.

Table 2 – Measured Sound Levels, 2017

Location	Leq, dBA	Daytime, dBA	
		L10	L50
Location 1	61	65	55
Location 2	60	62	58
Location 3	64	67	59

Location	Leq, dBA	Daytime, dBA	
		L10	L50
Location 4	60	62	58

Figure 3 – Aerial View of Project Site Showing 2017 Measurement Locations



4.2 Computer Modeling – Traffic Noise

VA has utilized the Traffic Noise Model computer software program developed by the FHWA (Federal Highway Administration) in order to predict traffic noise levels at various locations. Current traffic counts for 34th Avenue were obtained from the Minnesota Department of Transportation website[1]. The associated existing ADT is 15,600. No future traffic counts were available and VA has estimated the future conditions for roadways using a 2% increase per year. VA understands that a traffic study has not been completed that would confirm these predictions. The increase in noise level due to traffic by 2023 is calculated to be about 1 dB. However, some of the facades will be exposed to less traffic noise due to shielding provided by the development of the site.

4.3 Computer Modeling – Aircraft Noise

VA created a 3D acoustic model of the region using Bruel & Kjaer's Predictor-Lima Suite noise propagation software. The model was calibrated based on the measured nighttime L10 noise level and the average of the flight paths recorded October 8-10, 2013. Runway 17 departures have a 2.5-mile turn point noise abatement procedure in which MAC reported 98.7% of jets complied with this procedure in the month October 2013. Therefore, the flight path chosen for the acoustic model is along the centerline of Runway 17. The trajectory of the flight path was determined by taking the

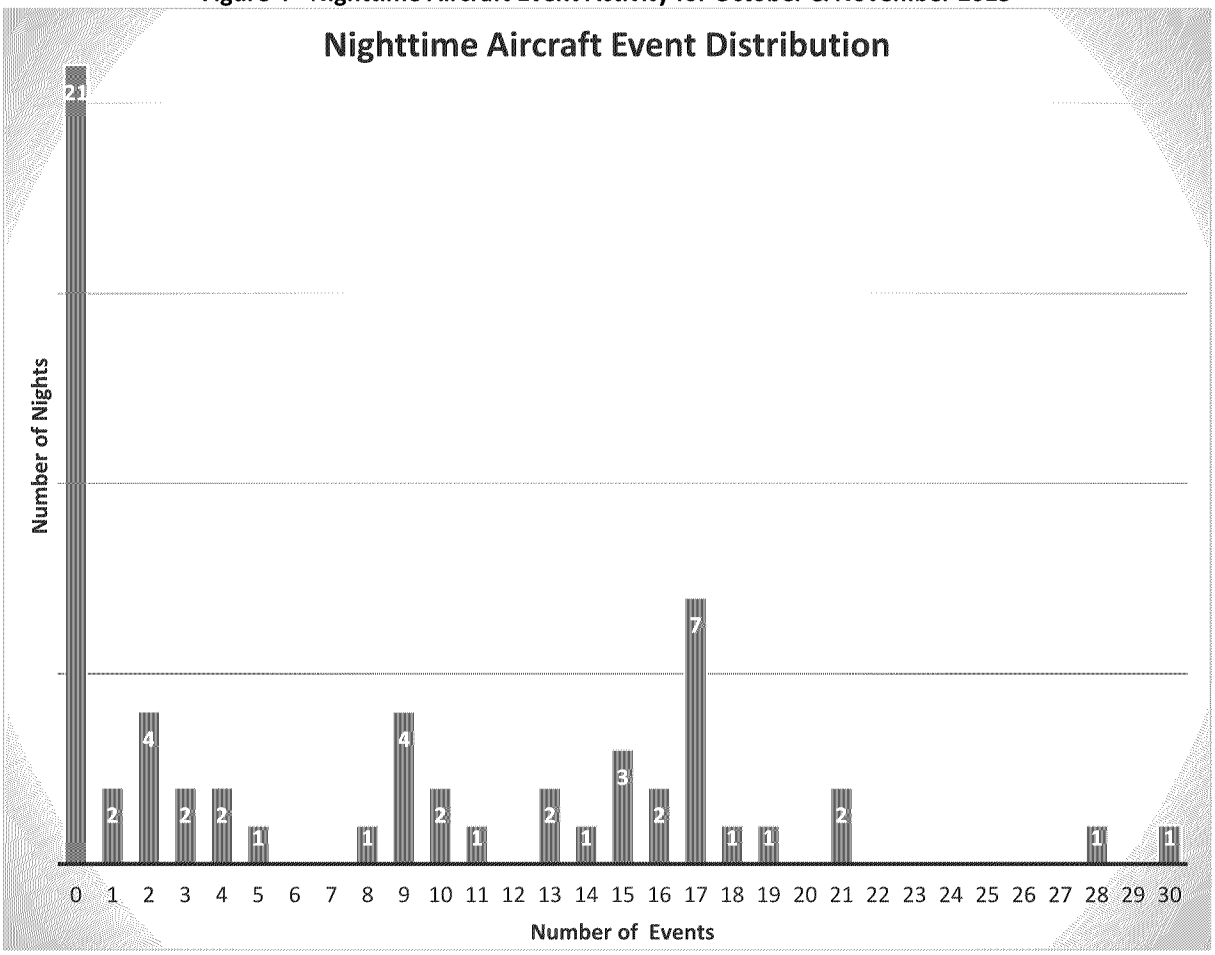
[1] http://www.dot.state.mn.us/traffic/data/

average of the departing plane events during the 4pm-10pm period on October 2013. The acoustic source in the computer model starts at an elevation of 650 feet above East American Boulevard and reaches 1285 feet when crossing Killebrew Drive. The results of the model were compared to the measured levels and shown to be accurate.

Nighttime Aircraft Activity

Understanding the nighttime aircraft activity is essential in determining the potential intrusiveness of the events to a future resident. MAC reported a nighttime average of only 2 departing aircraft events for the year 2012 for Runway 17. This average represents the nighttime activity of aircraft events between 10:30pm and 6:00am as this is MAC's definition of nighttime. The MPCA defines the nighttime period as 10:00pm to 7:00am which is the typical definition found in most noise-related documents. Also, the 2012 average includes nights of no activity due to weather conditions. To determine typical nighttime activity VA used the Flight Tracker feature on the macnoise.com website for the months of October and November of 2013. Figure 4, below, is a histogram showing the results of the nighttime aircraft event distribution.

Figure 4 - Nighttime Aircraft Event Activity for October & November 2013



VA determined that the average number of departing nighttime events is 8 during October and November. However, a large number of nights did not include any events at all. Of the nights that did include events, 17 events per night is the most common activity recorded. 17 events per night also is the 90th percentile of nighttime activity. VA utilized this as the basis of calculations of the L10 at the site.

The results of the model are shown in Figure 5 and Figure 6 below.

Figure 5 - Measured L10 of Nighttime Plane Events

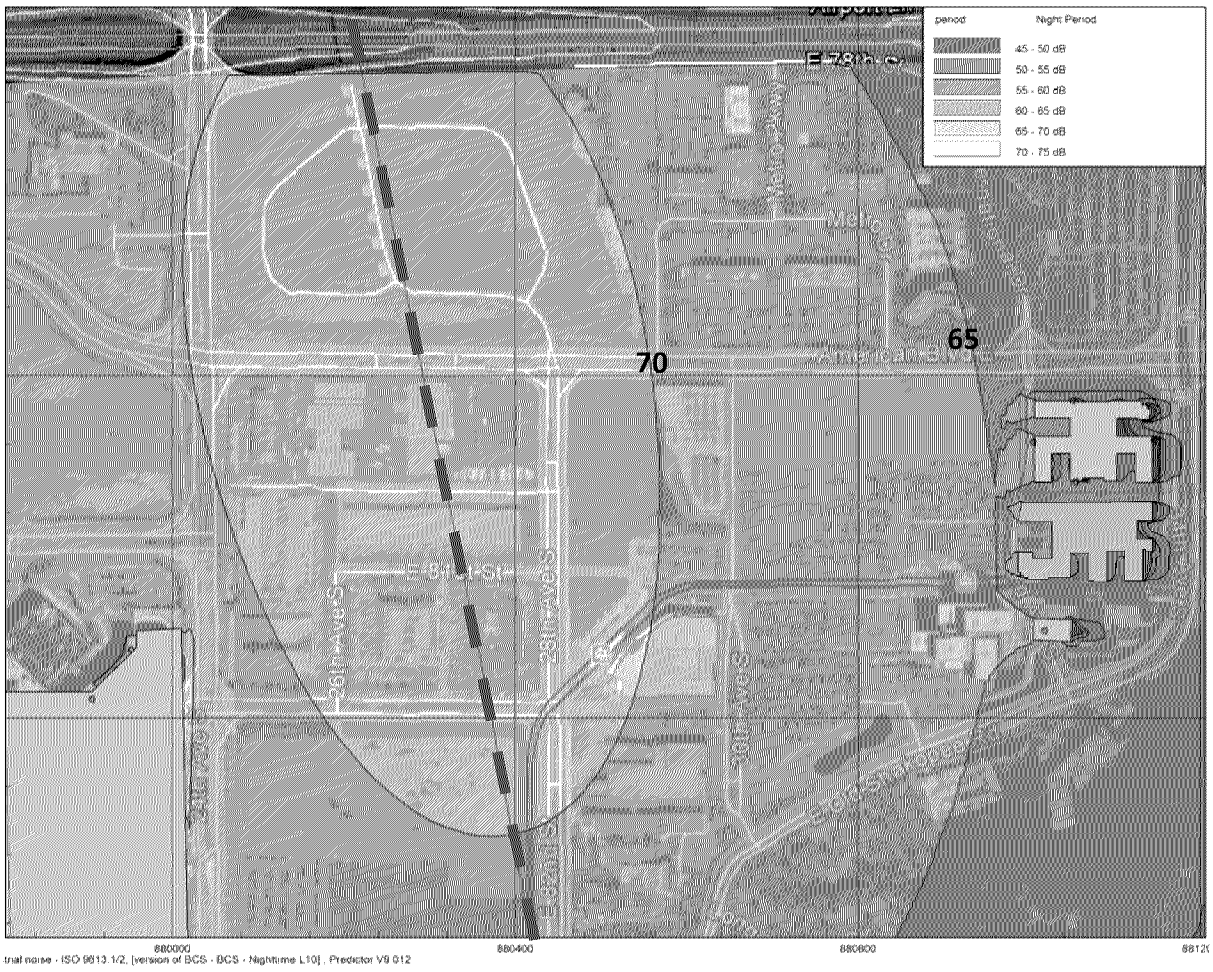
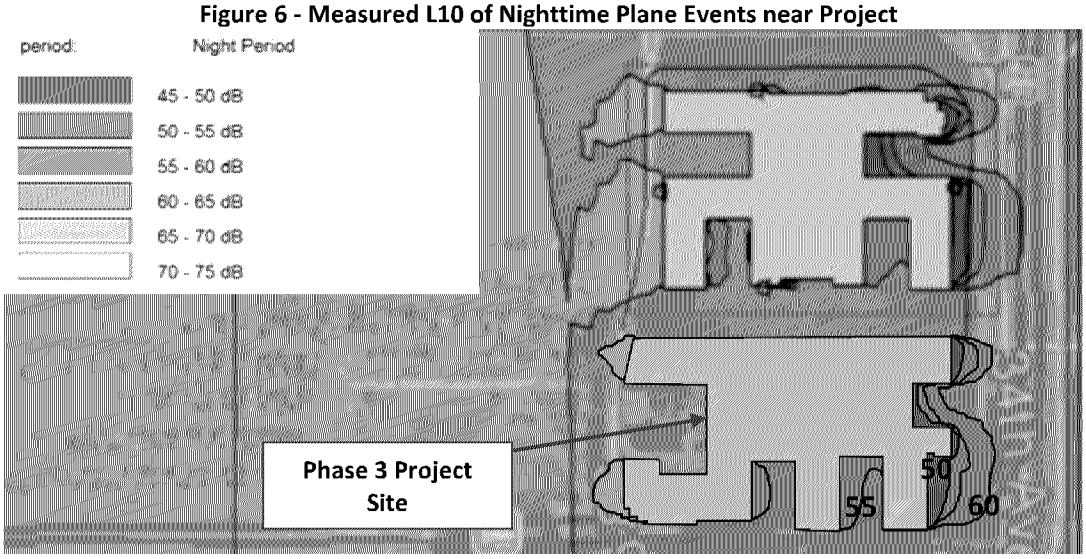


Figure 6 - Measured L10 of Nighttime Plane Events near Project



4.2 Overall Exterior Exposure

Based on our measurements, the computer model, and the project site plan provided by the Client, VA calculated the existing and future noise levels at various locations within the project site. The calculated noise level for each zone is based on the contribution of the aircraft activity associated with Runway 17, vehicular noise, and light rail trains noise associated with the Blue Line.

To simplify the presentation of the exterior noise levels, VA has separated the site into zones based on the sound exposure and required mitigation. The variance of sound level in the vertical dimension is negligible. The predicted sound levels at each zone, shown in Figure 7, are listed in Table 3 below. The table shows the contribution of each noise source to the resultant LDN noise level for each zone. Table 3 shows that the future LDN is greater than the existing, so the calculations within this report are based on the future LDN.

Table 3 - Existing and Future Average Exterior Noise Levels by Location

Location	Traffic Noise, LDN	Aircraft Noise, LDN	Train Noise, LDN	Total Future, LDN
Zone A	62	64	63	68
Zone B	60-61	64	60-63	67
Zone C	60	64	50-52	66
Zone D	60	64	63	68

Zones A and D will be exposed to the highest average noise level. This is primarily due to their proximity to the light rail line. Zone B is quieter than Zones A and D due to shielding from vehicular traffic and train noise. Zone C has exposure to aircraft events with minimal exposure from vehicular and rail traffic.

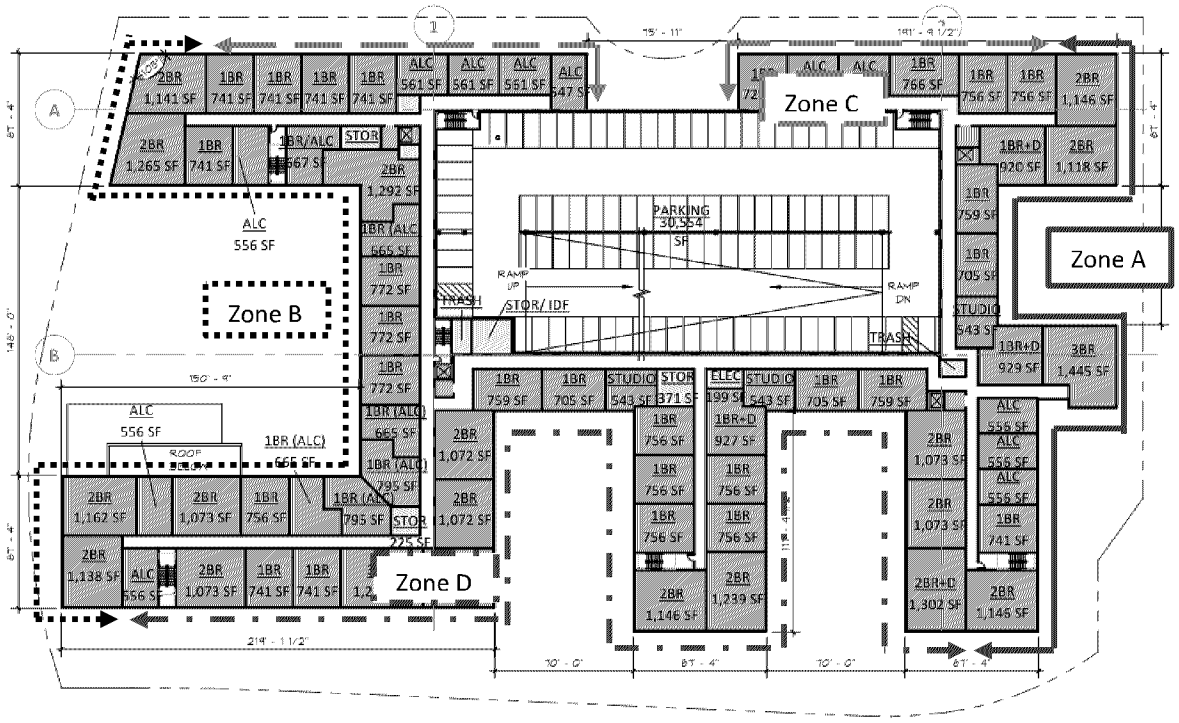
Table 4 below shows the L10 for each noise zone.

Table 4 - Calculated L10 Noise Levels

Location	Daytime L10	Nighttime L10
Zone A	68	62
Zone B	71	65
Zone C	67	61
Zone D	69	63

Based on the levels in Table 4, the site has noise levels for NAC2 per MPCA section 7030. To comply with the MPCA requirements in section 3.B, therefore, the building's exterior envelope has to provide at least 30 dB of noise reduction. Because the L10 varies across the project, VA's interpretation is to satisfy the criteria in the loudest noise exposure Zone and maintain the resultant interior noise level throughout the remainder of the project. The loudest exposure is the daytime L10 in Zone B of 71 dBA; the resultant required interior L10 us 41 dBA. Therefore, an interior L10 from aircraft of 41 dBA is the criterion that satisfies the MPCA standards.

Figure 7 - Noise Zones



5.0 INTERIOR NOISE CALCULATION

5.1 Exterior Facade Construction

VA understands that the exterior wall will have a veneer consisting of either cast stone brick or metal panel on 5/8-inch exterior sheathing, on 2x8 wood studs with batt insulation filling the stud cavity, and a single layer of 5/8-inch gypsum board on the interior. VA's calculations include the exterior wall construction for the building, but indicate that the interior noise levels are determined by the acoustical performance of the glazing system.

VA's calculations also included the roof assembly, consisting of roof ballast (15 psf), 60 mil EPDM membrane, rigid insulation (2" thick minimum, sloped ¼" per foot minimum), vapor retarder, 14" composite roof joists, and a 5/8" gypsum board finish material. For locations within 8' of roof drains, Soundbreak acoustical gypsum board will be used; standard 5/8" gypsum board will be used for the remainder of the locations.

5.2 Interior Noise Level Calculations

VA utilized the glazing ratings (glass, frame and seals) shown in Appendix I. VA calculated the interior level within individual residential units given the measured noise environment and the exterior façade construction described above. The calculations were based on floor plans, dated September 5, 2017. This calculation included the exterior wall and roof construction described herein.

Table 5 shows the required STC ratings to satisfy the TPP requirements, and Table 6 shows the STC ratings required to meet the MPCA standards. The STC ratings required to meet the MPCA requirements are more stringent in Zones A, B, and D.

Table 5 - Calculated Future Interior and Exterior LDN Noise Levels

Location	Exterior LDN	Fiberglass Window/Door	Interior LDN
Zone A	68	STC 30	44
Zone B	67	STC 30	43
Zone C	66	STC 30	42
Zone D	68	STC 30	44

Table 6 - Calculated Future Interior and Exterior L10 Levels

Location	Daytime Exterior L10	Fiberglass Window/Door	Interior L10
Zone A	68	STC 35	40
Zone B	71	STC 36	41
Zone C	67	STC 30	41
Zone D	69	STC 35	41

The Agency also recommends the project have year-round climate control and no areas or accommodations that are intended for outdoor activities. The outdoor activity areas, such as the terrace area, do not comply with the Agency's suggested mitigation measures. A variation of this would need to be pursued to allow these areas to be included in the design (if this criteria applies).

5.3 Mechanical Ventilation Requirement

Because the windows and doors must be kept closed to meet the noise requirements at some locations, mechanical ventilation is normally considered or required. The architect should review and determine if this is a Code requirement. If so, all of the residential units will require mechanical ventilation. The mechanical ventilation shall meet all Code requirements, including the capability to provide sufficient fresh air exchanges, without depending on open windows or leakage through windows and doors. The ventilation system shall not compromise the sound insulation capability of the exterior façade assembly.

6.0 SUMMARY

The following is a summary of the conclusions within this report.

- According to the MPCA, the outdoor activity and common use areas do not comply with Agency's criteria. A variance from this requirement would need to be pursued to allow these areas to remain.
- No changes required to the design of the exterior wall construction described within this report.
- No changes required to the roof construction as described within this report.
- The exterior windows/doors are required to be the STC ratings shown in Table 7, below, to satisfy MPCA's criterion and Table 8 for the Regional Transportation Policy. The MPCA criteria is the most stringent criteria applicable for the project. The required STC ratings should be applied to sensitive living spaces, such as bedrooms. Mechanical ventilation may be required by Code to maintain a noise reduction of 30 dB.

Table 7 - Window/Door STC Rating Required to Satisfy Each Interior Noise Criterion from MPCA

Location	Fiberglass Window/Door	Mechanical Ventilation
Zone A	STC 35	Required
Zone B	STC 36	Required
Zone C	STC 30	Required
Zone D	STC 35	Required

Table 8 - Window/Door STC Rating Required to Satisfy Each Interior Noise Criterion from Regional Transportation Policy

Location	Window/Door	Mechanical Ventilation
Zone A	STC 30	Required
Zone B	STC 30	Required
Zone C	STC 30	Required
Zone D	STC 30	Required

Various noise mitigation methods may be utilized to satisfy the noise criteria described in this report. Alteration of mitigation methods that deviate from requirements should be reviewed by the acoustical consultant.

If you have any questions or comments regarding this report, please do not hesitate to contact us.

Sincerely,
Veneklasen Associates, Inc.

Samantha Rawlings, *LEED AP BD+C*
Associate Principal

Kevin Patterson
Associate

APPENDIX I – GLAZING REQUIREMENTS

In order to meet the predicted interior noise levels described in Section 5.0, the glazing shall meet the following requirements:

Table 9– Acoustical Glazing Requirements: Minimum Octave Band Transmission Loss and STC Rating

Nominal Thickness	Minimum Transmission Loss Octave Band Center Frequency (Hz)						Min. STC Rating
	125	250	500	1000	2000	4000	
1" dual	21	19	28	34	37	33	**30**
1" dual	23	22	32	37	38	38	**35**
1" dual	24	27	35	39	40	42	**36**

The transmission loss values in the table above can likely be met with the following glazing assemblies:

1. STC 30: 1/8" monolithic – 3/4" airspace – 1/8" monolithic
2. STC 35: 1/4" monolithic – 1/2" airspace – 1/4" monolithic
3. STC 36: 7/16" laminated – 3/8" airspace – 3/16" monolithic

However, it should be noted that an assembly's frame and seals may limit the performance of the overall system. The assemblies given above are provided as a basis of design, but regardless of construction, the octave band transmission loss of the particular system selected must meet the minimum values in Table 9 above. Similarly, it is permissible to use an alternate assembly construction if it meets the transmission loss requirements. Note that the systems shall not be selected on the basis of STC rating alone.

Independent laboratory acoustical test reports should be provided for review by the design team to ensure compliance with glazing acoustical performance requirements. Lab shall be a member of the NVLAP program for accreditation. Lab reports shall be in compliance with ASTM standard E90 and be no more than 10 years old (from date of submission on specific project). The tests shall be performed on the entire assembly, including frame and seals. If test reports are not available for the assembly, VA would require that the assembly be tested at a third party independent lab accredited through NVLAP for the ASTM E90.