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CONSULTANTS IN ACOUSTICS, VIBRATION & AUDIOVISUAL SYSTEM DESIGN

AMERICAN UNIVERSITY
EAST CAMPUS DEVELOPMENT
WASHINGTON, D.C.

Environmental Noise Study

Project Number 11-107

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INTRODUCTION

Miller, Beam & Paganelli, Inc. prepared an environmental noise study for the proposed American University East Campus development project. The proposed development consists of three new residential buildings and three administrative and administrative/academic buildings, with two courtyard areas and a surface parking area. The site is currently a surface parking lot with residential townhouses along the southeast property boundary. There is concern that noise from the proposed development may disturb the adjacent residential community. Thus, this environmental noise study was completed to assess potential noise levels.

Potential noise sources of concern include people talking in the courtyards and buildings, amplified music (stereo system) from dorm rooms, and noise from associated mechanical equipment. The noise distribution is complicated and depends on several factors, including the level and frequency spectrum and location of the sources; the distance between the source and listener; intervening obstacles that can shield the noise; and the ambient or background noise level. Thus, a model was created that can calculate noise contours to graphically show the noise distribution. In addition, an on-site noise survey was conducted to assess the existing noise conditions at the site, to simulate potential noise sources to be judged subjectively, and to calibrate the model.

Included in this study is an executive summary of our conclusions, a description of the noise criteria, the survey procedures and results, and a description of the noise models, and the model results.

EXECUTIVE SUMMARY

É The development is planned so that the expected sources of noise from activity in outdoor courtyard areas and from open windows of student residences are not located adjacent to the existing residential townhouses at the southeast property boundary.

Two of the three residential buildings are oriented so windows do not directly face the residential boundary, and the third is located bordering Nebraska Avenue, at the opposite end of the property from the existing residences. These distances and building orientations reduce the noise levels and potential noise disturbances to the neighboring residences.

É The proposed two story academic and administrative buildings that will be located at the eastern end of the site will block the line of sight and, therefore, the direct noise path between most noise source locations (courtyards and building faces) and most receiver locations in the residential neighborhood.

É The calculations indicate that for the most commonly expected sources of noise (groups of people talking and music played at a reasonable level) distributed across all building faces and group talking in the courtyard, at most locations along the southern property line noise levels are nominally 10-20 dBA below the existing background levels. Thus, the resulting noise levels will typically be half (10 dBA) to one quarter (20 dBA) as loud as the background noise level. At all locations, predicted noise levels of typical voice and music loudness are quieter than the levels allowed by the DC noise regulations.

É Another condition considered was that of loud "party" music emanating from multiple locations at each building. Depending on receiver location, the calculated noise levels could be more than 10 dBA below the background level, or where in direct line of site to the open window, may marginally exceed the legally permitted levels. We understand this condition to be unlikely, as it would be disruptive to most other occupants within the buildings, so it would be controlled by the university staff.

All of the above analyses are based on the condition that the noise sources are located in rooms with open windows. With the windows closed, all resulting noise levels would be noticeably quieter and all less than permitted by the DC noise regulations.

CRITERIA

Varying criteria apply for the variety of potential noise sources at the proposed university expansion. However, it is important to understand that whether or not a noise is disturbing depends on many factors other than the absolute loudness of the source. The character, frequency, and duration of a noise will also affect its relative annoyance. Also, important is the background noise level. For example, in a relatively noisy environment a particular sound may be barely perceptible, but in a quiet environment, the same noise may be disturbing.

A baseline for determining acceptable noise levels are those in the DC noise regulations (20 DCMR § 2700 et seq.), but these regulations do not apply to all sources. According to the

regulations, noise from mechanical equipment (air-conditioning units, fans, generators, etc.) should not exceed 60 dBA at the property line boundary between the source and receiver. Other noises, such as stereos, loud speakers, and musical instruments should not exceed 60 dBA during the day and 55 dBA at night at the residential property boundaries.

Noise regulations generally are not applicable to unamplified speech. However, the DC regulations are contradictory with regard to unamplified speech. Section 2700.3 includes unamplified speech with musical instruments, loudspeakers, and other sources that should not exceed the levels set forth above. However, section 2704.8 states that "The unamplified voice shall be exempt at all times." Section 2800.1 includes unamplified voices in its regulation of noise from businesses. Still, in section 2800.5, noncommercial public speaking is exempt as a source of a "noise disturbance," defined as a sound that is "loud . . . and unreasonably disrupts the peace and quiet of a reasonable person . . ." Thus, limiting voice levels to those defined in the noise regulations may be a reasonable goal, although voices may not necessarily be subject to the noise regulations.

In evaluating the following results, it is important to understand that the decibel scale, upon which the sound levels are based, is logarithmic. A 3-decibel change (increase or decrease) is therefore equal to a factor of two change in energy (such as changing an audio amplifier from 5 watts to 10 watts, or vice versa), but to the human ear this change is only slightly perceptible. A change of 10 dB represents a factor of 10 change in energy (5 watts to 50 watts, or vice versa) and is subjectively twice (or one-half) as loud. The A-weighted decibel level (dBA) is the most universally used single number rating for human reaction to sound. The dBA scale approximates the ear's response to sound by discounting the low and highest frequency sounds where our ears are less sensitive and emphasizing the middle to high frequencies where our ears are most sensitive. As a reference, normal indoor conversation is typically 60 dBA at three feet from the speaker.

SURVEY PROCEDURE AND RESULTS

An on-site acoustical survey was conducted on September 13, 2011. The purpose of the survey was to measure existing background noise levels near the residential community and to perform noise simulation tests for subjective evaluation and calibration of the noise model.

Sound level measurements were made using two Norsonic NOR-140 integrating sound level meters, which meet ANSI standards for Type 1 (precision) instruments, and were field calibrated prior to the testing. The proposed development site is currently an open parking lot. Tests were conducted on a day with fair weather conditions (sunny, nominally 75-85 F) and low to no winds.

To assess the potential noise caused by student activity at the proposed East Campus site, audio events were simulated using prerecorded noise samples played through a loud speaker. The loudspeaker was elevated by placing it on the roof of an automobile in order to minimize ground absorption effects and shielding from other cars in the lot. The audio samples were played and measured and subjectively judged along the edge of the parking lot bordering the residential area.

The audio samples selected were what is anticipated to be potential noise events: (1) group of nominally 10 people simultaneously talking at typical indoor levels; (2) group of nominally 10 people simultaneously talking at elevated outdoor levels; (3) music at volume level typical of comfortable listening or background study music; and (4) loud or party music at a level uncomfortably loud and requiring one to raise their voices to talk over at close distances. Levels were set and measured at a distance of 10 feet from the loudspeaker.

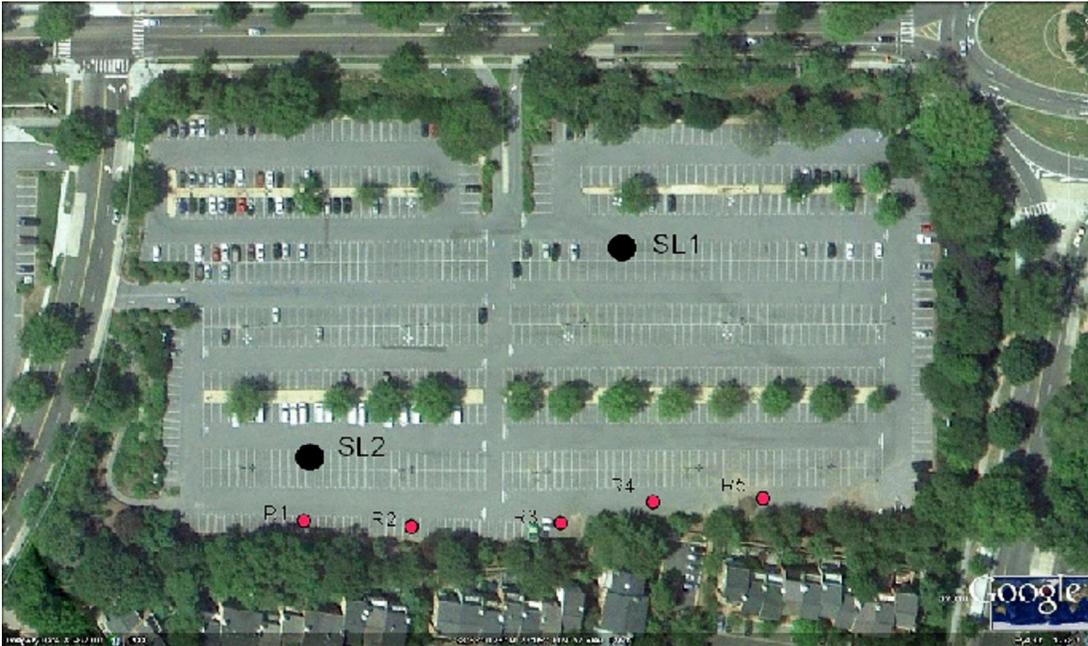
For the evaluation and measurement, the loudspeaker was placed at two different locations. Source Location 1 (SL1 on existing condition plan) was at approximately the [plan] south side of residential building 1 (Labeled as 1 in noise contour plots.) This location would represent noise coming from the courtyard and the residential building farthest from the residences. Source Locations 2 (SL2) was approximately midway between the [plan] south faces of residential buildings 1 and 2. This represents the shortest distance between a residential building and the southern property line.

Before operating the loudspeaker, a sample of background noise levels was measured. Taken between 12:00 and 12:15 p.m., these measurements represent typical daytime background noise levels due to traffic, distant aircraft, and other distant noise events. They do not include sources that are common but not as constant, such as sirens and helicopters. A statistical sampling of ten short term measurements was made along the south end of the parking lot. The average noise levels were in the 48-52 dBA range. (These background noise measurements and

all others are energy equivalent average levels (Leq) with a sample time of 30 seconds.) In general, noise levels were louder closer to the east and west boundaries where traffic from New Mexico Avenue and Massachusetts Avenue, respectively, were the dominant sources. Additional background noise measurements were obtained in the evening as the traffic levels were diminishing. Between 7:00 and 7:15 p.m., measured average noise levels were in the 49-50 dBA range, but soon afterward, evening insect noise became more predominant, and after 7:30 the combination of traffic and insect noise were more often in the 50-54 dBA range. Although louder temporary events, such as activity in the parking lot, were avoided while measuring the general background noise, louder events did occur and their noise levels are offered for reference. For example, a distant siren event was measured with an average level of 57 dBA and a maximum level of 66 dBA. A siren passing adjacent to the property would be significantly louder. At least five helicopter events (flyovers) were witnessed between 7 and 9 p.m., but only one was measured. A helicopter from the east passing near the site had an average level of 68 dBA and a maximum level of 79 dBA.

As noted above, the loudspeaker was placed at SL1 and SL2, as shown in the graphic below. With the loudspeaker operating, sound level measurements were made at five locations along the south end of the parking lot. From west to east, these approximate locations are indicated as R1 through R5 on the graphic. The measured noise levels are shown in Table 1. With only a few exceptions, the noise levels with the loudspeaker operating are in the same range as the general background noise. This correlates to the subjective evaluation, in which at a listener location closest to the loudspeaker, noise was clearly audible. However, as one moves away from the source, the background noise either partially, or more often fully, masks the sound from the loudspeaker.

Although these test results were used as the basis of the noise model, there are many other factors incorporated into the model, not the least of which is the noise shielding of the proposed buildings



Source Location	SL1	SL1	SL1	SL2	SL2	SL2
Source Type	Loud Group Talk	Loud Music	Study Music	Mid-level Group Talk	Study Music	Loud Music
Receiver Location	AVERAGE SOUND PRESSURE LEVEL (dBA)					
10 ft	74	79	64	62	64	74
R1	50	49.7	50.4	52.5	54	61.1
R2	47.9	49.8	51.4	51.7	48.8	52.2
R3	52.2	51.6	51.6	51.5	49.2	50.9
R4	52.1	52.6	57.2	52.2	49.1	56
R5	51	52.7	53.7	50.6	51.7	53.7

Table 1: On-site Noise Measurement Results

NOISE MODEL DESCRIPTION

A noise model was created using the CadnaA software to calculate the potential noise level from multiple noise sources and their distribution at the residential community. CadnaA is a detailed and industry accepted method for calculating and plotting environmental noise. The program calculates noise propagation in both overall and octave band levels, including sound reflections, shielding from obstacles (buildings, barriers, etc.), ground and air effects, and topography.

The base model was created using existing topography and the proposed building locations and heights. Noise sources are represented as point sources along the faces of the residential buildings, as if emanating from an open window and/or from courtyards. Although, in theory, it is possible that every dorm window is open and there is a significant noise source within every room, in practice, this should never happen. Instead, two sources per residential floor (excludes first floors) are located at each residential building face, except for the north side of building 1 facing Nebraska Avenue.

With the representative source used at each source location, the model was used to calculate noise contours at the residential townhomes for the following scenarios: (1) Group Talking, with indoor level talking at each window location, and louder outdoor talking in each courtyard; (2) Typical/Study volume music at each window location; (3) Loud/Party volume music at each window location; and (4) a mix of the previous three samples. (It is our understanding that music in the courtyard itself will be controlled and thus is not a potential noise concern.) For each source condition, two noise contours are created. One is noise levels for a person standing at ground level (5 feet above grade). At ground elevation, the shielding of the existing barrier separating residential yards and the existing parking lot is most effective, as is the shielding from the future buildings. At upper building stories, one can look over the barrier directly into the parking lot, meaning the barrier is providing no noise shielding to the upper building stories. Similarly, the shielding by the two-story administrative and academic buildings closest to the residential property boundary may be less effective at upper stories than at ground elevation. Thus, a second noise contour is created to determine the noise levels at the third stories of the residential townhouses (30 ft above grade).

The noise contours are presented in the accompanying Figures 1 through 8. The calculated noise levels are displayed as a plot showing lines of equal A-weighted noise levels. The difference in noise levels between each noise contour line is 1 dBA. Each wide band of the same color represents a level range of 5 dBA, down to 30 dBA. For example, noise levels in the yellow zone are in the 45-50 dBA range. Noise levels in the light green zone are the 30-35 dBA range. Noise levels less than 30 dBA are white, as are the buildings. Noise level boxes placed south of the property line show the noise levels (dBA) at that specific box location.

MODEL RESULTS

The plots indicate two primary results. The first is that the noise levels along the property line vary greatly, and this is primarily due to the amount of shielding provided by the buildings. For example, in the first plot (Group Talking, Ground Level), noise levels are all in the 28-32 dBA range, except for the approximately 80 foot wide area near the middle where one could have a direct line of sight to the open windows on the east building face of building 2. Here the level is 39 dBA, or nominally 7-13 dBA louder than across the rest of the property line. In the absence of other background noise, this would be a noticeable difference in level. As one moves from the middle to the eastern end of the property line, at first noise sources from residential building 1 are fully shielded, but they become more and more visible closer to Massachusetts Avenue. However, since the building is far away, the direct noise does not meaningfully exceed 35 dBA.

At the upper story height (30 feet), the 2-story academic buildings close to the property line are not as effective at shielding the noise from the 5-6 story residential buildings. Thus, as indicated in the second plot (Group Talking, Upper Level), the noise levels show range from 36 to 42 dBA, or only a 6 dBA difference.

The second result of the plots indicates the absolute levels (loudness) of the sources. As noted above, raising the loudness of a source by 10 dBA, for example from 50 dBA to 60 dBA, will make the noise be perceived to become twice as loud. Mathematically, if the noise level from one source is 60 dBA, and a second source of 50 dBA is added, the addition of the quieter source increases the combined level by less than 0.5 dBA. Since a few tenths of a decibel is a minute imperceptible difference, when rounding to whole numbers, the combined levels is still 60 dBA. Thus, for two similar noises, when one is 10 dBA or greater than the second, the second is indistinguishable. For dissimilar noises, this is more complicated due to the character of the noise. For example, if distant group of people are talking so that their level is 40 dBA, but the background traffic noise is 50 dBA, then the talking may still be perceptible because it has a different character. Our brains are trained to process this sound, but the increase in overall noise is likely immeasurable.

With the above as a basis, if the typical background noise level is nominally 50 dBA, then any sound at least 10 dBA lower (40 dBA or less) may be perceptible, but only slightly, and it would be immeasurable and not raise the overall noise level.

Thus, for the first plot (Group Talking, Ground Level), the noise levels all across the property are all less than 40 dBA and are, therefore, insignificant when compared to the background noise level. For the second plot (Group Talking, Upper Level), the noise levels are less than 40 dBA, except in the middle area, where the maximum level is 42 dBA. This is potentially more perceptible but still well below the background level and barely contributing to the overall noise level.

The next two contour plots are the noise levels from study volume music as heard at ground and third story levels. The noise distribution pattern is a little different from the talking contours because there are no music sources in the courtyards; however, the resulting noise levels are nominally only 0-2 dBA different, with a maximum level of 43 dBA at the upper story middle area with line of sight to residential building 2. Thus, similar to the noise produced by group talking, at worst case, the study music noise may be slightly perceptible, but will not meaningfully increase the overall noise levels. For locations outside of this worst case area, the noise levels will be significantly below the background noise levels and not perceptible.

The next two contour plots are the noise levels from loud volume music as heard at ground and upper story elevations. In reality, this situation, as modeled, is an unlikely occurrence, primarily because music loud enough to disturb a neighbor several hundred feet away, is much louder and disruptive to surrounding dorm rooms. Although these events may occur occasionally, presumably, they would not occur for a sustained period of time, and it is unlikely that they would occur two per floor, as the model represents. Also, it is important to remember that all these models of noise emanating from the buildings are based on an open window condition. Indoor source levels with the windows closed would be at least 10 dBA quieter.

However, assuming this worst case condition, at ground elevation, the plot indicated that toward the west side with the shielding of the academic/administrative buildings, noise levels are in the 40-42 dBA range, or well below the background levels and only slightly perceptible. Toward the east, where there is less shielding, noise levels are in the 46-48 dBA range, or approaching the background level and likely perceptible. In the middle, with direct line of sight to the open windows, the maximum level is 56 dBA, or clearly audible and louder than the background noise. This is also above the nighttime noise regulation limit of 55 dBA.

As with the other case, there is less shielding at the upper story elevation, and the range of levels across the property line is 51-58 dBA. These levels exceed the background noise level, would be audible, and depending on measurement location, may exceed the noise regulations.

Clearly, the loud music scenario produces the loudest noise levels, which, as noted above, is an unlikely case involving two sources per floor. A final mixed sources condition was also computed. In this condition, a single loud music source is chosen per building face, with indoor group talking in the remaining window locations, and an outdoor group talking source in each courtyard. For this condition at ground elevation, resulting noise levels are 32-39 dBA across the property boundary, or significantly less than background noise levels, except near the middle, where, with direct line of sight to the dorm window, the calculated level was 49 dBA, or roughly equal to the background level. At the third story elevation, calculated levels were 43-51 dBA.

For comparing the modeled campus noise levels to the existing background noise levels, a noise contour plot was created and superimposed on the above graphic of the existing site condition. In this model, the only noise sources are the three roads bordering the property (New Mexico Ave., Nebraska Ave., and Massachusetts Ave.). As indicated by the legend and noise level boxes, noise level in the 50-55 dB A range are shown in gray, and those in the 45-50 dBA range are yellow. Note that the bands of dark green (40-45 dBA), light blue (35-40 dBA), light green (30-35 dBA), and white (less than 30 dBA) that color the plots of the campus produced noise are absent from the background noise plot. This is because, with the exception of the worst case loud music scenario, the expected noise from campus activity is below the existing background noise levels.

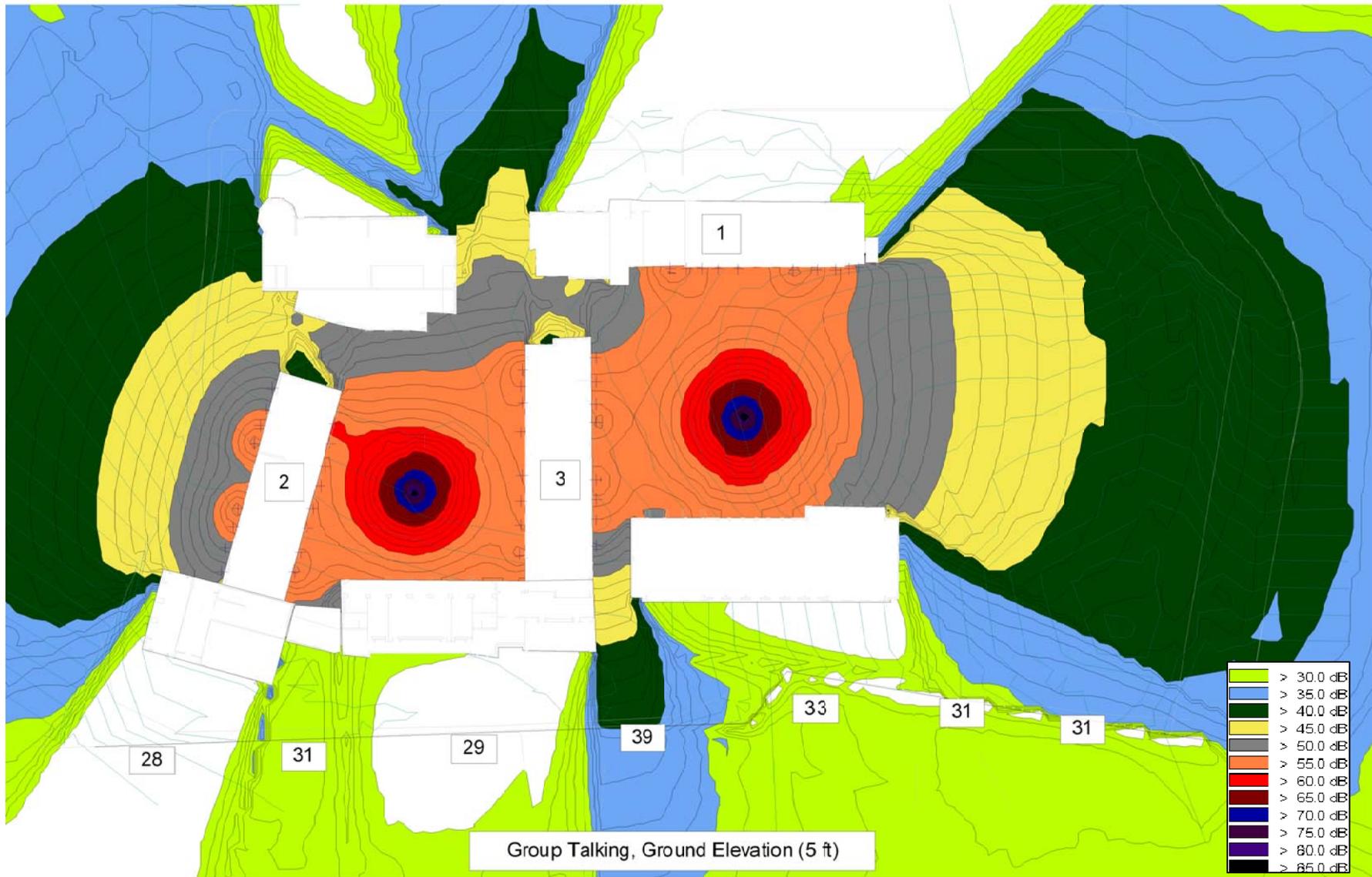
MECHANICAL EQUIPMENT NOISE

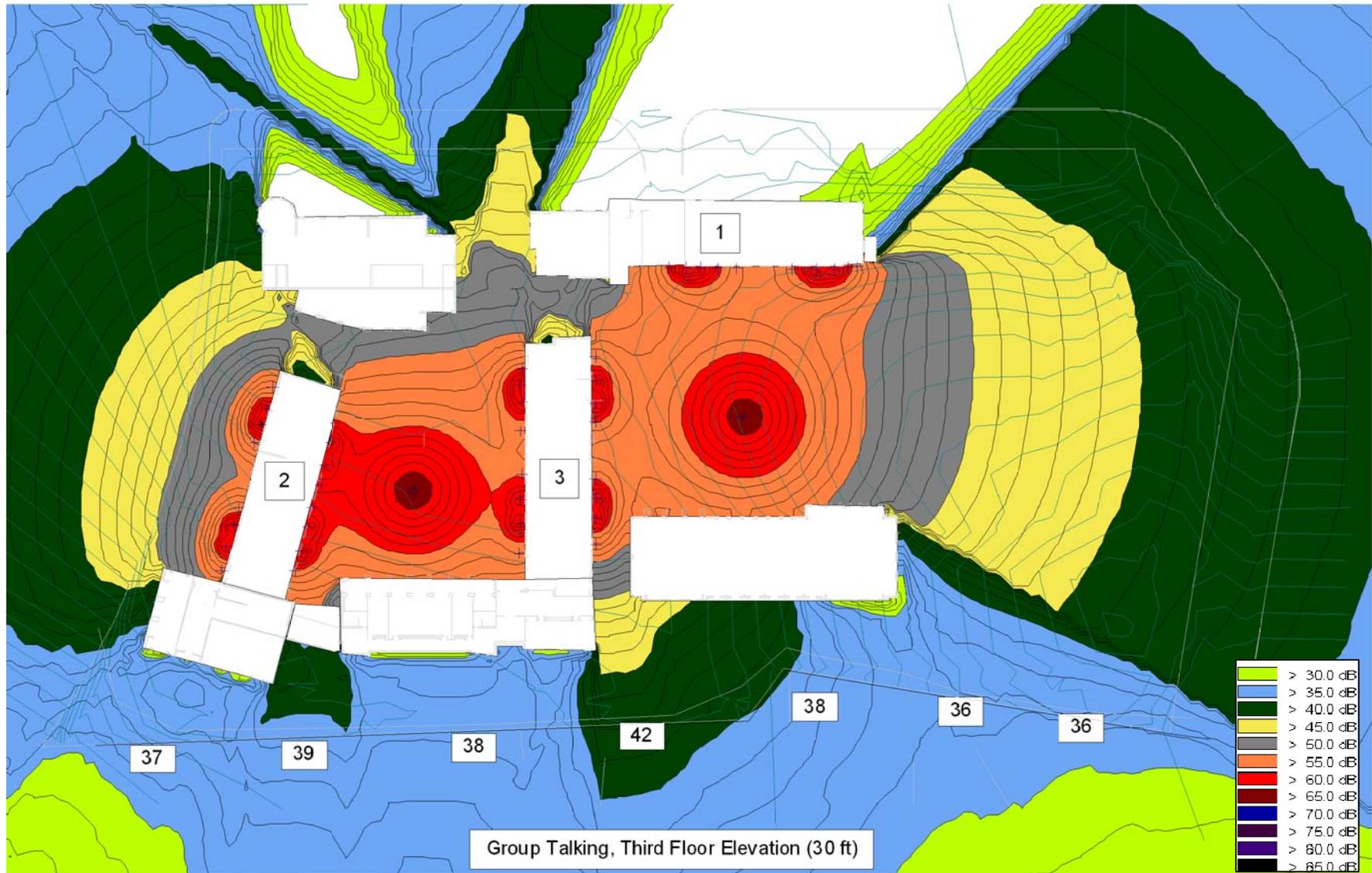
At this early stage of the project, the mechanical systems are still in a conceptual design phase and, therefore, the specific mechanical components are not known. However, we currently understand the buildings will incorporate a four pipe fan coil system and likely will be served by a central plant located underground mostly beneath residential building 1, and away from the residential townhouses. Any emergency generator would likely be located underground in the same location. Thus, the direct noise from these sources is not a concern,

although the system would need to be properly designed so ventilation systems meet the noise regulations at the property boundary. Similarly, garage ventilation systems will need to be located, designed, and equipment selected that will meet the noise regulations.

We understand that each building's fresh air supply will come from air handling units located on top of each building in a screened mechanical area. These units will need to be selected to meet the noise regulations, and, if necessary, noise mitigation should be provided.

As designs develop, we can work with the project team to provide recommendations and, as necessary, offer noise mitigation designs to ensure the systems meet the noise regulations at the neighboring residences, and also reduce potential disruption to the building's occupants.









MILLER, BEAM PAGANELLI, INC.

PROJECT: AU EAST CAMPUS DEVELOPMENT

SHEET: 1

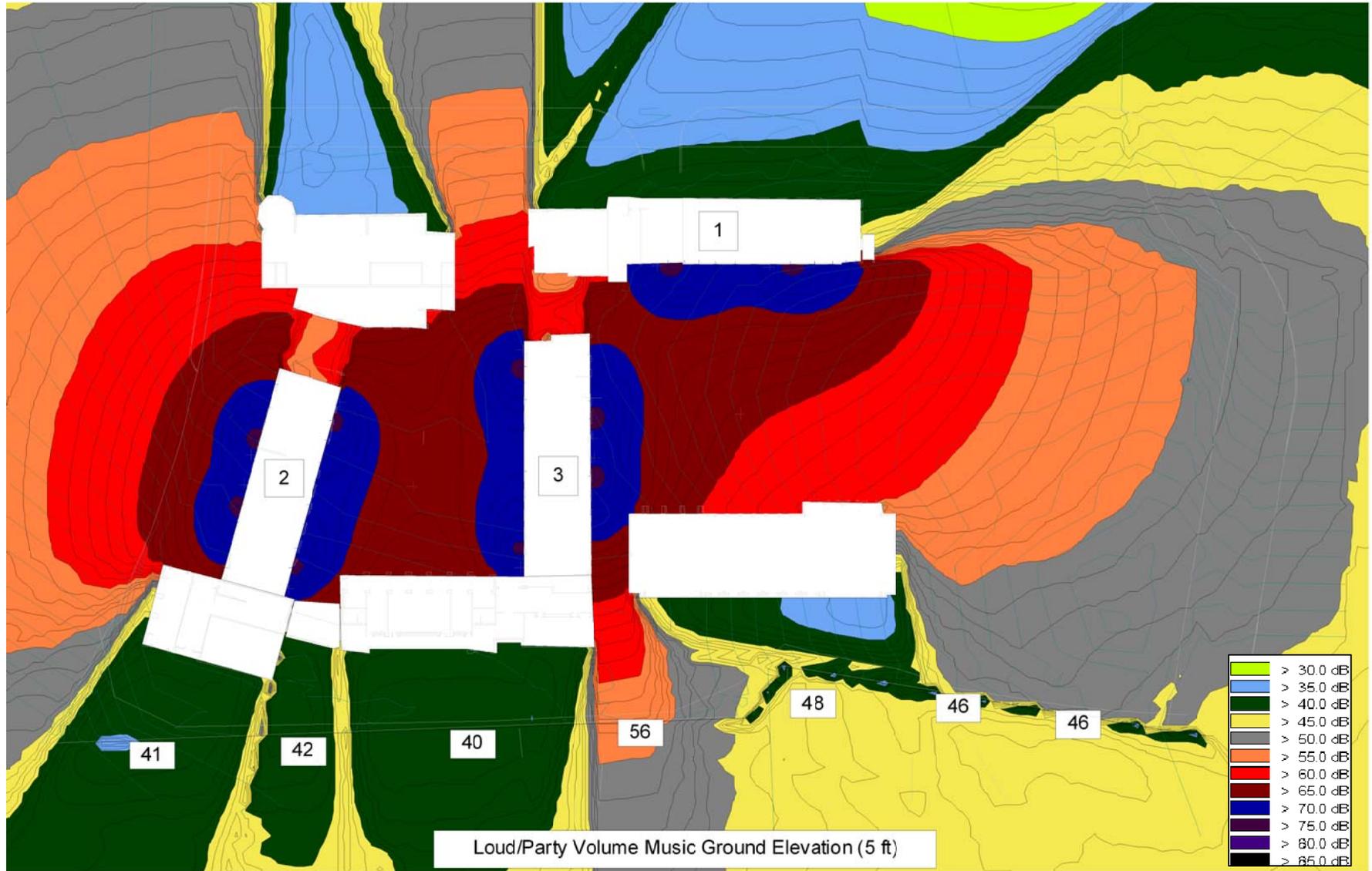
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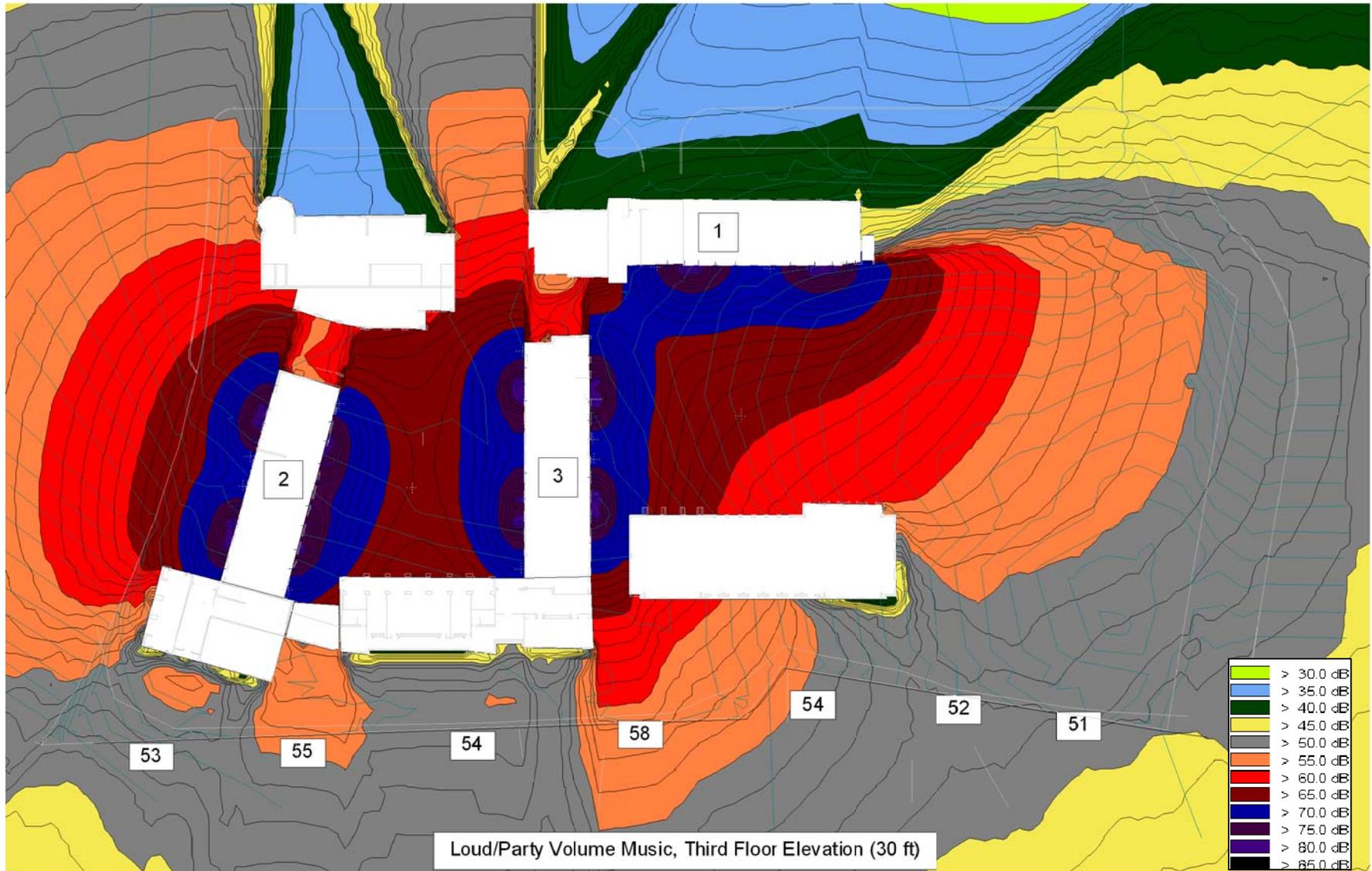
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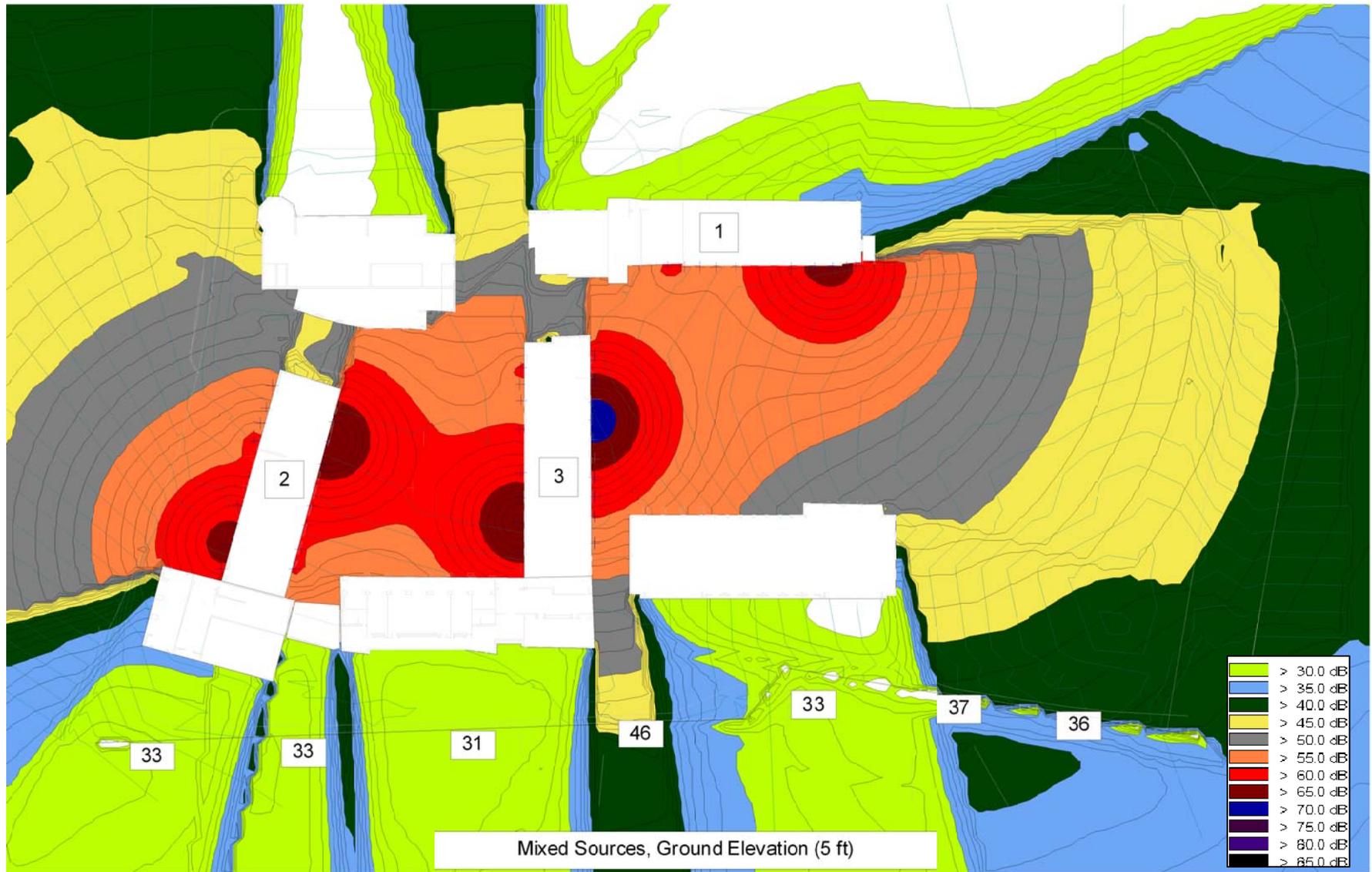
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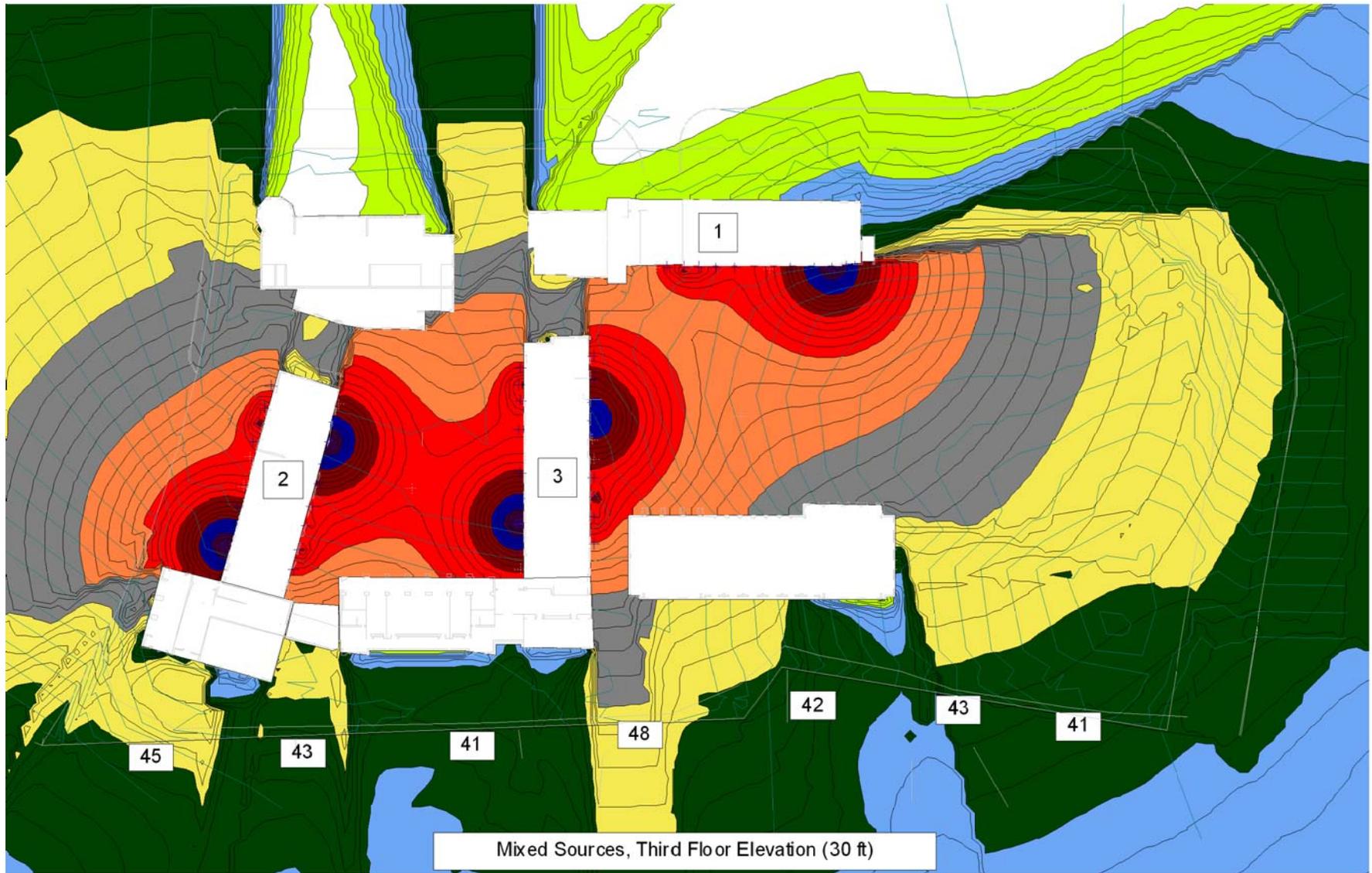
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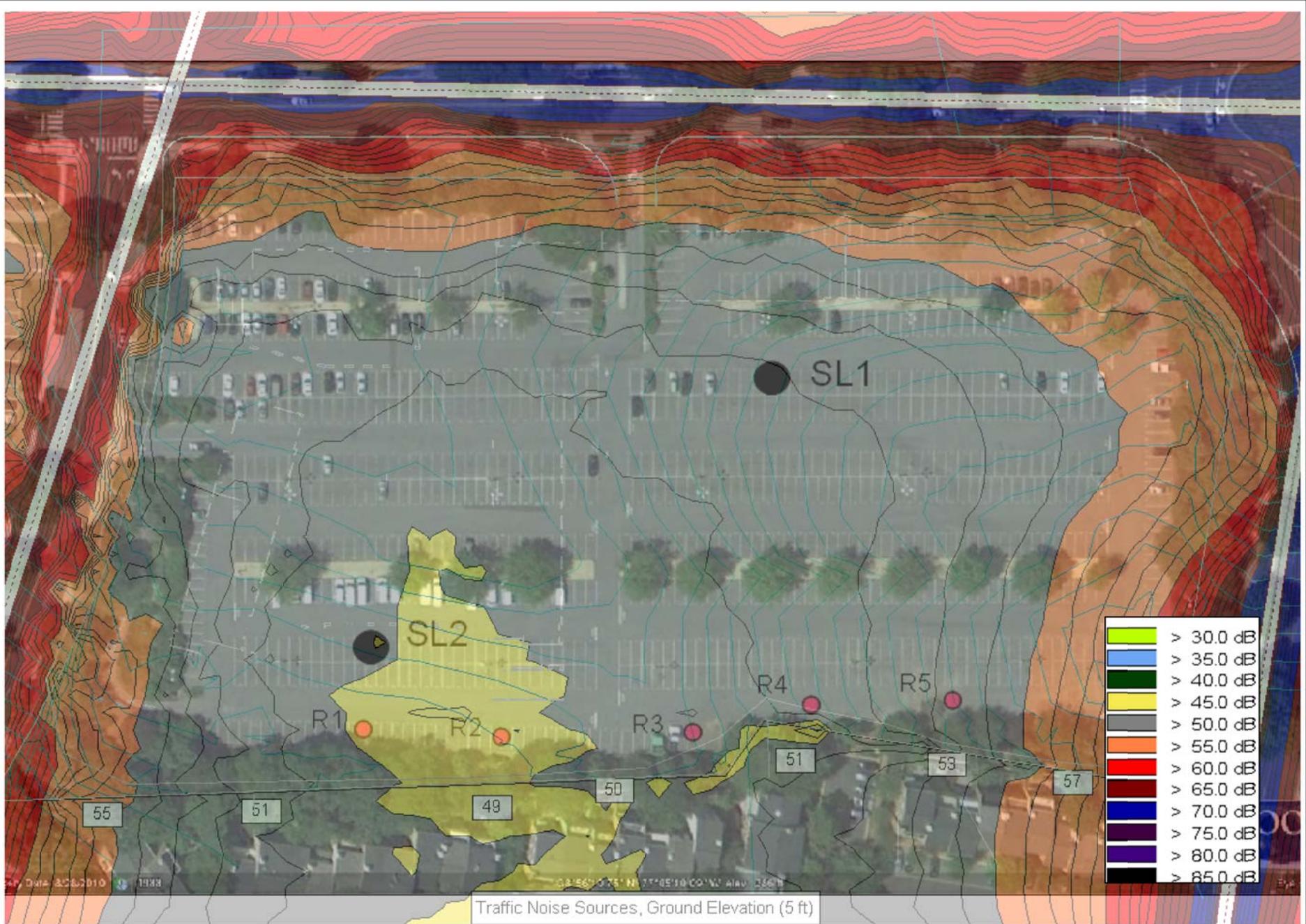
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MILLER, BEAM PAGANELLI, INC.

PROJECT: AU EAST CAMPUS DEVELOPMENT

SHEET: 1

FIGURE: 9

DATE: 10/03/11

SCALE: N.T.S.

TITLE: BACKGROUND NOISE CONTOUR

OF: 1