ATTACHMENT D

HUSH
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May 4, 2013

Mr. Michael Lemon
Winchester Homes Inc.
6905 Rockledge Drive, Suite 800
Bethesda, MD 20817

Re: Glenmont Metrocenter
Acoustical Analysis

Mr. Lemon:

This report summarizes the highway noise analysis for the Glenmont Metrocenter project in Montgomery County, MD.

1. Executive summary

A site survey was performed and sound levels were measured in the locations shown in Figure 2 for over four days. Traffic volumes were counted briefly at the beginning of the survey. The Traffic Noise Model was used to model existing conditions. The output sound levels compared well to the measured sound levels. Traffic forecasts were developed based on data provided by the State Highway Administration, a Wells + Associates traffic study, and our traffic observations on site. The Traffic Noise Model was used to predict future noise levels at the facades of residences.

The county design goals are to ensure that the Day-Night Average Sound Level (DNL) not exceed 65 dB in usable outdoor areas such as rear and sometimes side yards, or 45 dB inside residences. However, there are no outdoor areas on this site at which to evaluate the 65 dB goal. To provide a margin for error, we recommend designing for a DNL of 43 dB indoors.

The projected DNL will be as high as 70.8 dB at the facades of the most-impacted residences. In order to reduce indoor noise levels with the units furnished to 43 dB, we recommend using the upgrades listed in Figure 7 of Section 5.5 below. These include using resilient channels for non-brick walls of end units facing Layhill Road, using windows rated at Sound Transmission Class (STC) 28-32 along Layhill Road and Glenallan Avenue, and using doors rated up to STC 31 along Layhill Road and Glenallan Avenue.

2. Introduction

Hush Acoustics LLC was contracted by Winchester Homes to perform sound level measurements on the site, to model future noise levels, and to design modifications to the residences to limit indoor noise levels. This analysis was based on the Glenmont Metrocenter Preliminary Plan drawing prepared by Roger's Consulting dated March 13, 2013. This drawing shows lot locations, house locations, existing ground elevations, and the location and elevation of the existing Layhill Road (MD 182) and Glenallan Avenue pavement. Proposed ground elevations at the houses were obtained from a separate site plan drawing provided via e-mail. The site is located along the west side of Layhill Road, the north side of Glenallan Avenue, and to the south of a Metrorail facility. A vicinity map is included as Figure 1.

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Figure 1. Vicinity Map

Per a conversation with Mr. Mark Pfefferle of Montgomery County Park and Planning staff, we understand that Montgomery County uses the 1983 Staff Guidelines to evaluate transportation noise impacts for proposed residential land development. The guidelines provide outdoor DNL criteria as a function of both site location and community type. Per Table 2-1 of the guidelines, the DNL goal is 65 dB "in the urban ring, freeway and major highway corridors" while the DNL goal of 60 dB is the "basic residential noise guideline which is applied in most areas of the county". Per the map, the site is located near the dividing line between the 60 and 65 dB DNL goal zones. By zooming in on the map, we determined that the dividing line falls in the middle of the Glenfield Park to the north of the Metrorail facility. Therefore, the 65 dB goal applies to this site. Although the Staff Guidelines say the noise level goals apply at the building line, from conversations with county staff we learned that they should be evaluated in usable outdoor areas such as rear and sometimes side yards, as well as common recreation areas. However, there are no outdoor recreation areas for this site, since the lots do not have rear yards, and there are no amenity areas on this site (since the site is part of a larger community). The Montgomery County Staff Guidelines also state that the interior noise guideline is a DNL of 45 dB. To provide a modest margin for error, we recommend designing for a DNL of 43 dB indoors.

3. Site survey

The purposes of the site survey are as follows:

1. to collect noise level data on the site. Noise level data are useful for the following reasons:
    a. to determine how the hourly average sound levels compare to the Day-Night Average Sound Levels (DNL). The DNL is the noise metric used by Montgomery County, MD. However, the Traffic Noise Model (TNM) uses the hourly average sound level. For locations mostly impacted by traffic noise, the relationship between the DNL and loudest hour average sound level is relatively constant. The measured sound levels are useful for determining this relationship.
    b. to identify any significant non-traffic noise sources.
2. to observe traffic conditions such as prevailing speeds, classifications (i.e., percentages of automobiles, trucks, buses, and motorcycles), and directional distributions. Many of these parameters are not well documented in traffic studies. The prevailing speed often differs from the posted speed limit.
3. to observe road conditions such as locations and timing of traffic flow control devices (e.g., traffic signals, stop signs, and toll booths), and the pavement type.
4. to observe site conditions not represented on the site plan such as the presence and height of existing noise barriers along the road right-of-way.

The purpose of the site survey was not to determine how loud it is at the site. That is performed using the computerized noise modeling discussed below.

3.1 Sound level measurement procedure

Larson Davis model 831 sound level meters were installed in the locations indicated in Figure 2 from approximately 4 pm on Monday April 8, 2013, through approximately 1:30 pm on Friday April 12, 2013. The sound level meters were programmed to report average, maximum, and minimum A-weighted sound levels during each one-minute interval. In addition, the meters were programmed to record audio files each time a loud noise event occurred. For an explanation of A-weighted sound levels see the appendix. The meters were chained to a tree and telephone pole and the microphones were attached to poles. The microphone for location M1 was 26 feet high and the microphone for location M2 was 19 feet high.

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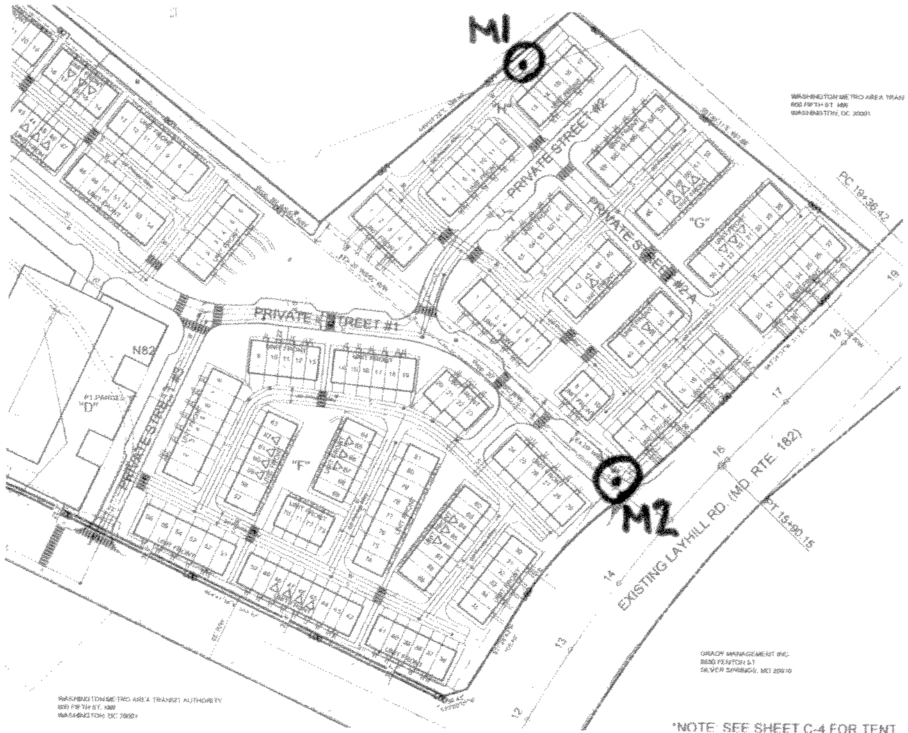

Figure 2. Sound Level Meter Locations

3.2 Site observations

The site currently has a field at the northern side, with vacant apartment buildings at the southern side. The main noise source on the site is traffic on Layhill Road, and to a lesser extend on Glenallan Avenue. There is also some aircraft noise. There is a traffic signal at the intersection of Layhill Road and Glenallan Avenue. Each road currently is asphaltic concrete. The posted speed limits on Glenallan Avenue are 30 mph. The posted speed limits on Layhill Road northbound are 40 mph northbound, 40 mph southbound before Glenallan Avenue, and 30 mph southbound after Glenallan Avenue.

3.3 Measured sound levels

Average sound levels during five-minute intervals were calculated based on the measured one-minute average sound levels. Sound levels at location M2 were significantly elevated during many one-minute intervals. By listening to the audio files it was determined that the vast majority of these events were due to sirens, and not the regular flow of traffic. Figure 3 presents the resulting five-minute average sound levels. Hourly average sound levels were calculated based on the five-minute average sound levels. The hourly average sound levels were also re-calculated without the influence of the one-minute intervals when sirens were loud. Figure 4 presents the hourly average sound levels. The Day-Night Average Sound Levels (DNL) were calculated for each full calendar day. Table 1 presents the DNL and loudest-hour average sound level, and the difference between the two, for each calendar day.

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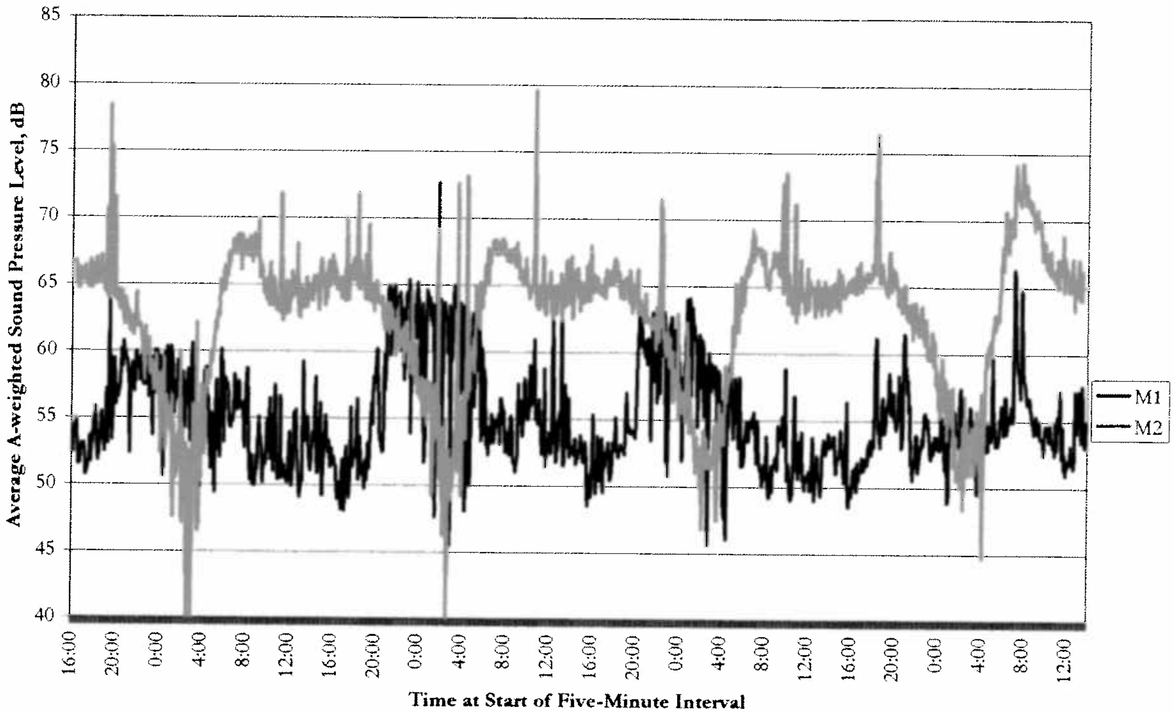

Figure 3. Five-Minute Average Sound Levels on April 8-12, 2013

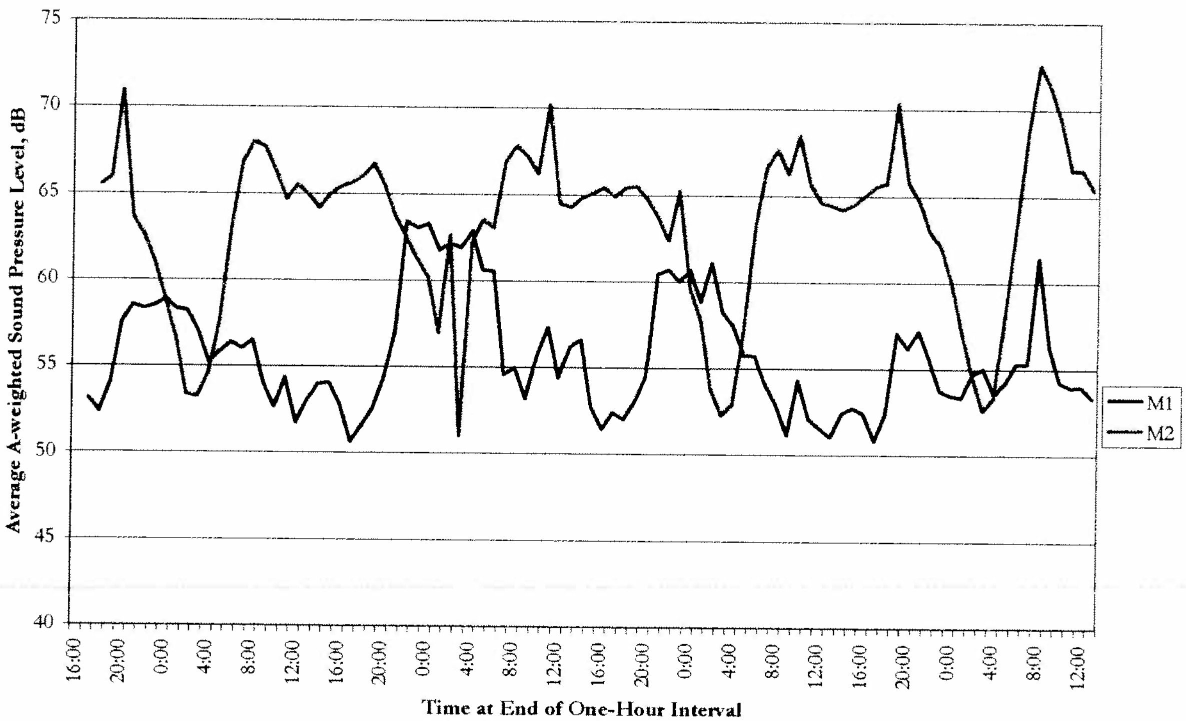

Figure 4. Hourly Average Sound Levels on April 8-12, 2013

Table 1. Measured DNL and Loudest-Hour Average Sound Levels, dB

Day, Date	DNL		Loudest-Hour Average Sound Level		DNL Minus Loudest-Hour Average	
	M1	M2	M1	M2	M1	M2
Monday, April 08, 2013			58.9	71		
Tuesday, April 09, 2013	65.3	68.4	63.4	68	1.9	0.4
Wednesday, April 10, 2013	67.0	69.9	62.9	70.2	4.1	-0.3
Thursday, April 11, 2013	63.3	68.6	61.1	70.4	2.2	-1.8
Friday, April 12, 2013			61.4	72.6		
<u>Without sirens:</u>						
Monday, April 08, 2013			58.9	65.9		
Tuesday, April 09, 2013	65.3	68.3	63.4	68	1.9	0.3
Wednesday, April 10, 2013	66.9	68.6	62.8	67.8	4.2	0.7
Thursday, April 11, 2013	63.3	68.3	61.1	67.7	2.2	0.7
Friday, April 12, 2013			61.4	72.6		

After evaluating the sound level data we noticed that sound levels at location M1 were quiet during the day and elevated at night. In order to determine the source of the sound we returned to the site on Wednesday April 16, 2013, at 9 pm. Sound levels were measured in three locations for one hour while we listened. Figure 5 presents the measured one-minute average sound levels. Location P3 was beside the pond on the proposed site where location M1 was for the original survey, location P2 was to the northwest of there at the corner of the chain link fence surrounding the Metrorail yard, and location P1 was even farther to the northwest along the chain link fence at the highest point overlooking the Metrorail yard. The main sound source at location P3 (and at the original location M1) was actually frogs in the pond in this portion of the site. At locations P1 and P2 frogs were much quieter since they were farther from the pond. This supplemental survey shows that the elevated sound levels at night were not due to Metrorail activity or traffic noise.

3.4 Traffic counts

Traffic volumes were counted during a fifteen-minute interval for each direction of traffic on Layhill Road and Glenallan Avenue at the start of the survey. From these volumes the hourly average traffic volumes were extrapolated. Table 2 presents the extrapolated hourly traffic volumes. Automobiles include pickup trucks, passenger cars hauling trailers, and vans. Medium trucks are six-wheeled cargo vehicles with two axles. Heavy trucks are cargo vehicles with three or more axles. Speeds were determined using a hand-held radar gun. The median speeds for dozens of vehicles are listed in Table 2.

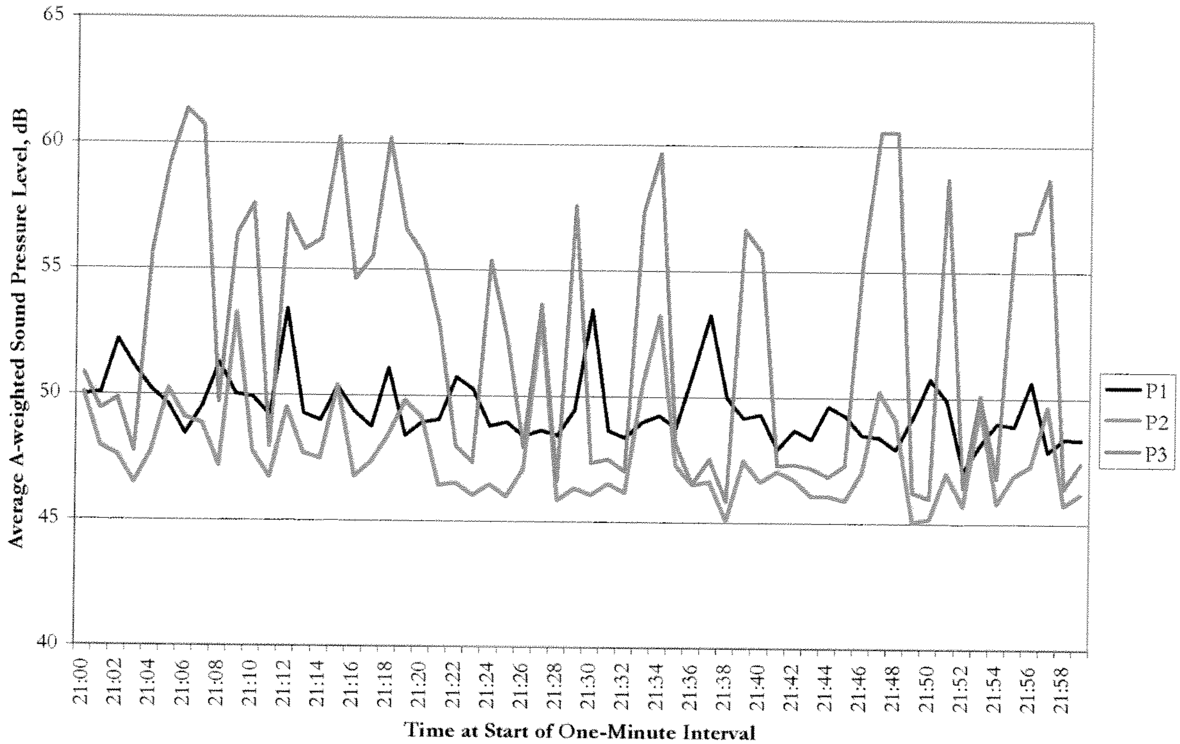

Figure 5. Measured One-Minute Average Sound Levels on April 16, 2013

Table 2. Extrapolated Hourly Traffic Volumes and Prevailing Speeds

Day, Date and Time	Lanes	Speed (mph)	Autos	Medium Trucks	Heavy Trucks	Buses	Motor-cycles
4:21 to 4:36 pm Monday 4-18-13	Layhill NB	39.5	1060	0	4	12	0
	Layhill SB	42	576	0	0	36	0
4:21 to 4:36 pm Monday 4-18-13	Glenallan WB	32.5	420	0	0	4	0
	Glenallan EB	27	660	4	4	32	4

4. Outdoor noise modeling

4.1 TNM overview

In the United States, highway noise levels are typically analyzed using the Federal Highway Administration's (FHWA) Traffic Noise Model (TNM). The current version is 2.5. The output from TNM is the hourly average sound level at the receivers. The program allows input of the following information:

- Coordinates of selected points along the road centerlines
- Pavement width and type
- Road locations that are elevated (structure roadways) – this was not used for this project

- Hourly volumes and speeds of autos, medium trucks, heavy trucks, buses, and motorcycles for each road segment
- Locations of traffic flow control devices such as stop signs, traffic signals, and toll booths at the start of roads
- Coordinates and heights of evaluation points (receivers)
- Coordinates of ground elevations in selected locations (terrain lines)
- The default ground type, and coordinates and ground material in selected locations (ground zones) – this was not used for this project
- Coordinates and height of areas covered with thick evergreen forest (tree zones) – this was not used for this project
- Coordinates of existing and proposed objects that shield the site such as noise walls and buildings (barriers)
- Coordinates, height and spacing between buildings of rows of buildings which partially shield the site (building rows) – this was not used for this project

4.2 TNM validation

The traffic volumes and speeds presented in Table 2 were input into TNM. This TNM run is called the validation run. Each direction of travel of each road was modeled as an individual road in TNM. The locations and elevations of selected points along each road, and the width of each road, were taken from the site plan. Since the observed existing pavement is asphaltic concrete, the pavement was modeled as Dense-Graded Asphaltic Concrete (DGAC). This is the louder, and more common, of the two types of asphaltic concrete available in TNM. The effect of the traffic signal for the northbound lanes of Layhill Road was included; 20% of northbound traffic was assumed to accelerate from 0 mph at Glenallan Avenue. One terrain line was added along a portion of the frontage along Layhill Road to model the change in elevation between the road and site. The default ground type was lawn.

The output sound levels were then compared to the sound levels measured during the traffic counts. Table 3 presents this comparison.

Table 3. Comparison of TNM Validation Run Output and Measured Sound Levels, dB

	M1	M2
Measured	53.9	65.7
TNM Output	54.6	65.4
TNM Minus Measured	**+ 0.7**	**- 0.3**

It can be seen from Table 3 that TNM was quite accurate, producing sound levels between 0.3 dB below and 0.7 dB above what was measured. This level of agreement between the modeled and measured sound levels is excellent.

4.3 Future traffic conditions

The Maryland State Highway Administration (SHA) provided traffic forecasts via e-mail as follows.

- The Average Daily Traffic (ADT) volume for the year 2040 will be 13,900 for Glenallan Avenue, and 20,350 for Layhill Road at the site.
- Vehicle classifications will be 4.6% medium trucks and 1.4% heavy trucks for Layhill Road.

In lieu of other information, it was initially assumed that the peak-hour traffic volume would be 10% of the ADT which is 2,035 for Layhill Road and 1,390 for Glenallan Avenue.

We obtained additional information from the traffic study prepared by Wells + Associates. Figure 11 entitled "Total Future Peak Hour Traffic Forecasts" included forecasts that were higher than were provided by SHA. These forecasts were divided out as morning and afternoon peak-hour. Since Layhill Road has more traffic southbound (which is closer to the site) and Glenallan Avenue has more traffic westbound (which is closer to the site) in the morning, the morning values were used. To be conservative we used the Wells + Associates forecasts instead of the SHA forecasts. These are:

- Layhill Road: 1,934 southbound and 530 northbound
- Glenallan Avenue: 703 eastbound and 1,033 westbound

Since the SHA percentages of medium and heavy trucks were so much greater than we counted for Layhill Road on site, we used the SHA percentages to be conservative. Since we observed so many more buses for Layhill Road on site than SHA reported, we used our value to be conservative. In lieu of other information, percentages of trucks and buses for Glenallan Avenue were based on our counts.

The resulting forecast traffic volumes and the prevailing traffic speeds are also presented in Table 4.

Table 4. Future Loudest-Hour Traffic Volumes

Lanes	Autos	Medium Trucks	Heavy Trucks	Buses	Motor-cycles	Prevailing Speed (mph)
Layhill NB	481	24	7	17	0	39.5
Layhill SB	1,756	89	27	62	0	42
Glenallan WB	1,002	0	2	29	0	32.5
Glenallan EB	682	0	1	20	0	27

4.4 Future highway noise modeling

TNM was run using the traffic volumes and speeds presented in Table 4. Receivers were located at the facades of residences. Locations and ground elevations of receivers were taken from the grading plan. The receiver heights were 7, 18, 27, and 35 feet above the proposed ground elevations, representing the tops of the basement, first, second, and third floor windows. Shielding provided by the proposed residences was considered in the analysis by modeling each of the residences as a 40-foot tall noise barrier. As for the validation run, the pavement type was DGAC, the default ground type was lawn, the terrain line along Layhill Road was used, and a traffic signal was used for northbound Layhill Road. It was assumed that the road locations and elevations would remain unchanged.

4.5 Future outdoor highway noise levels

It can be seen from Table 2 that the DNL at location M2 (which is along Layhill Road) was between 0.3 and 0.7 dB above the loudest-hour average sound level, not counting noise from sirens. The future loudest-hour average sound levels were output from TNM. To be conservative, it was assumed that the future DNL would be 1 dB greater than the loudest-hour average sound level. This assumption is equivalent to assuming that a slightly higher percentage of traffic would travel on Layhill Road at night (between 10 p.m. and 7 a.m.) than presently do. The resulting year future DNL are presented in Figure 6.

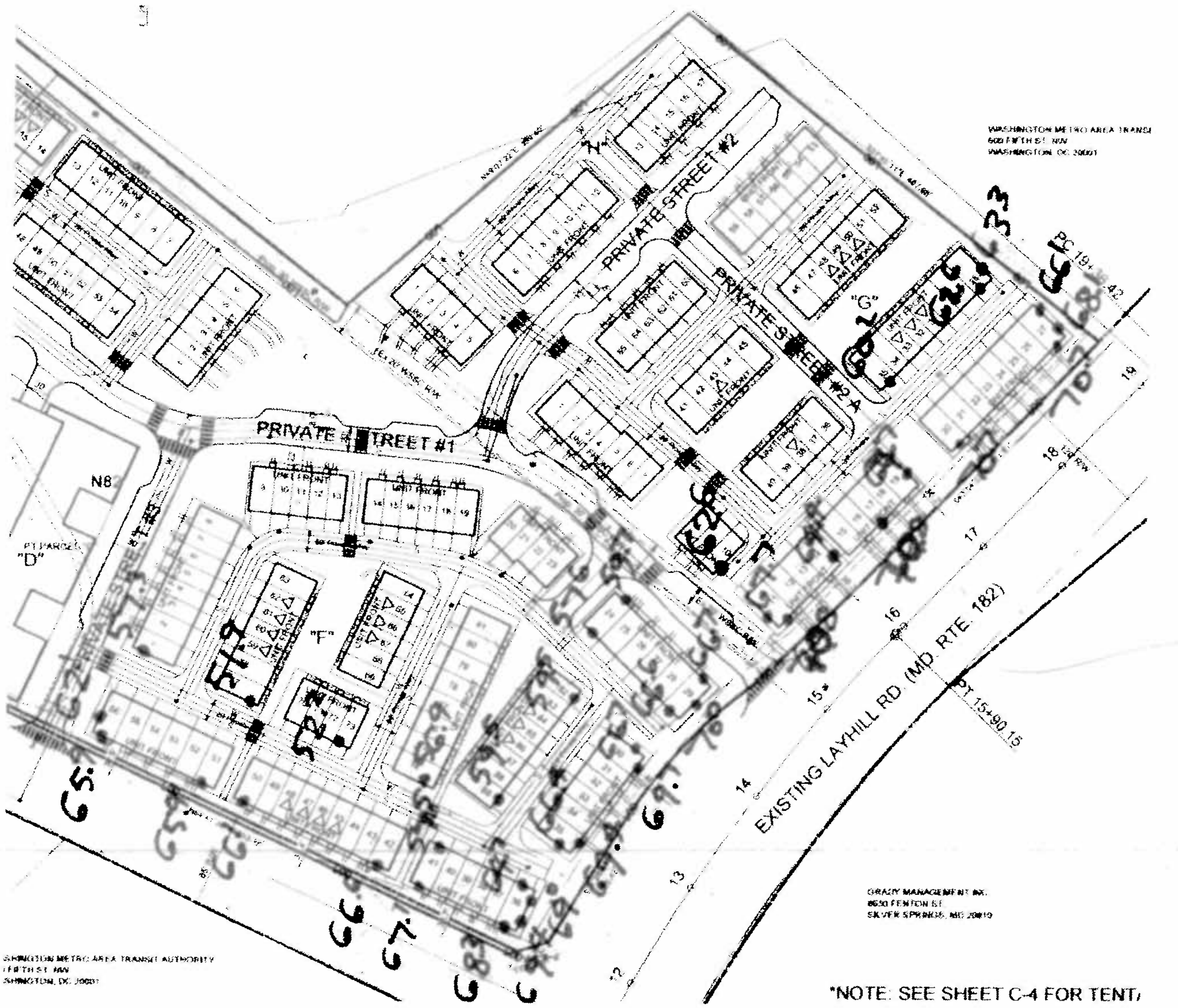

Figure 6. Future DNL, dB, at Facades of Residences on Loudest Floor

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5. Indoor highway noise levels

5.1 Proposed Architectural Design

We understand architectural drawings are not yet available for this project, and the designs might be generally similar to the Everson Homes townhouses. The Everson Homes drawings show room sizes and types, and window and door sizes. Per your e-mail, we understand that front walls will be brick, end and rear walls will be sided (above a brick water table which was neglected), walls will have 2x6 studs, bedrooms will have carpet while other rooms will have standard or upgraded non-carpeted flooring, and windows will be Ply Gem Pro Series.

5.2 Noise Level Reduction Design Goal

As noted above, the indoor noise goal is a DNL of 43 dB. It can be seen from Figure 6 that the DNL at the residences will be as high as 70.8 dB at the most-impacted front façade and 66.6 dB at the most-impacted rear façade. To meet the indoor goal of a DNL of 43 dB, the building envelope must reduce noise levels by as much as 27.8 dB at the most-impacted front façade and 23.6 dB at the most-impacted rear façade.

5.3 Indoor Noise Modeling

The Noise Reduction (NR) is the difference between noise levels outdoors and indoors in a single one-third octave frequency band and is calculated based on the following equation:

$$NR_i = 10 \text{ Log } \left(\sum A_i / \sum (A_i / 10^{TLi/10})\right) - 10 \text{ Log } (1/4 + \sum S_i / \sum (S_i\, a_i))$$

where:
NR_i is noise reduction in a single one-third octave band,
A_i is the area of each exterior envelope material (e.g., walls, windows, doors, and roof),
TL_i is the transmission loss of each exterior envelope material,
S_i is the surface area of each room finish material (e.g., walls, floors, beds, etc.), and
a_i is the sound absorption coefficient of each room finish material

The areas of exterior envelope materials were taken from the architectural drawings.

Sound levels are often expressed for selected ranges of pitches (frequencies). The most common way to divide up frequencies is using one-third octave bands. Transmission loss is a laboratory measure of the sound insulation performance in a single one-third octave band of a product or assembly. The transmission losses of the windows and doors were obtained from published test reports provided by various manufacturers; the results were grouped based on ranges of reported STC ratings. Per the manufacturer's data, the proposed windows have a Sound Transmission Class (STC) rating of at least 24, and patio doors have a rating of at least STC 27. The STC rating is a common rating used to describe the sound insulation performance of windows and doors, as well as other products and assemblies. Acoustical data for the walls were obtained from data in the acoustical literature.

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The sound absorption coefficient is a value that expresses how much incident sound is absorbed by a room finish material; a value of 0.0 represents no absorption (i.e., complete reflection) while a value of 1.0 represents complete absorption. The areas and sound absorption coefficients of room finish materials were assumed based on typical finishes for the given type of room.

The Noise Level Reduction (NLR) is the A-weighted difference between noise levels outdoors and indoors and is calculated based on the following equation:

$$NLR = \sum (10^{(Lo + C)/10}) - \sum (10^{(Lo - NR\,i + C)/10}), \text{ where:}$$

L_o is the noise level outdoors in a single one-third octave band, and
C is the A-weighting correction in a single one-third octave band

See the appendices for a discussion of A-weighting. For the purposes of this calculation it is not necessary to know the absolute noise level outdoors. Rather, it is only necessary to know how the noise levels vary as a function of frequency; this variation is known as the sound spectrum. The sound spectrum for typical highway noise was obtained from acoustical data in the literature.

5.4 Noise Level Reduction Results

Table 5 presents the calculated NLR for each room. The first column lists the room and the second column lists the NLR with the basic design (i.e., STC 24 windows and STC 27 doors). The third through sixth columns list the NLR with possible upgraded conditions (i.e., windows with ratings of STC 28, 29, 30, and 32, doors with a rating of STC 31, and non-brick walls with resilient channels or "RC").

The indoor DNL can be determined by subtracting the NLR in second column of Table 5 from the DNL in Figure 6.

Table 5. Calculated NLR, dB

NLR w/ Basic — NLR w/ upgraded Designs

Wall	-	-	-	-	RC
Window	STC 24	STC 28	STC 29	STC 30	STC 32
Door	STC 27	STC 27	STC 27	STC 31	STC 31
Room					
Front:					
Bed 3 – basement	22.8	25.0	26.2	26.7	29.9
Kitchen – 1st floor	21.2	23.0	23.8	25.1	27.6
Own Bed – 2nd floor	22.7	24.9	26.3	26.9	29.7
Rear:					
Living – 1st floor	23.0	23.7	23.9	25.2	28.4
Bed 2 – 2nd floor	24.0	25.9	26.9	27.3	30.9
3rd fl owner bed	24.6	24.6	24.6	24.6	25.3

The DNL will be above the 43 dB goal in many rooms. In order to reduce indoor noise levels for the affected rooms we considered upgrades to the designs.

5.5 Recommendations

We recommend using the measures summarized in Figure 7. These include the following:

- At the ends of houses along Layhill Road (including the end walls of lots 29 and 36), and for any portions of front walls that are not brick:
  - Resilient channels for all non-brick walls
  - STC 32 windows and STC 31 doors
- At the fronts (and front half of the end walls) of lots 36-41 along Glenallan Ave:
  - STC 30 windows and STC 31 doors
- At the fronts (and front half of the end walls) of lots 42-50 along Glenallan Ave, as well as for the fronts and rears of lots 27-29 along Layhill Road:
  - STC 29 windows
- At the fronts (and front half of the end walls) of lots 51-56 along Glenallan Ave:
  - STC 28 windows

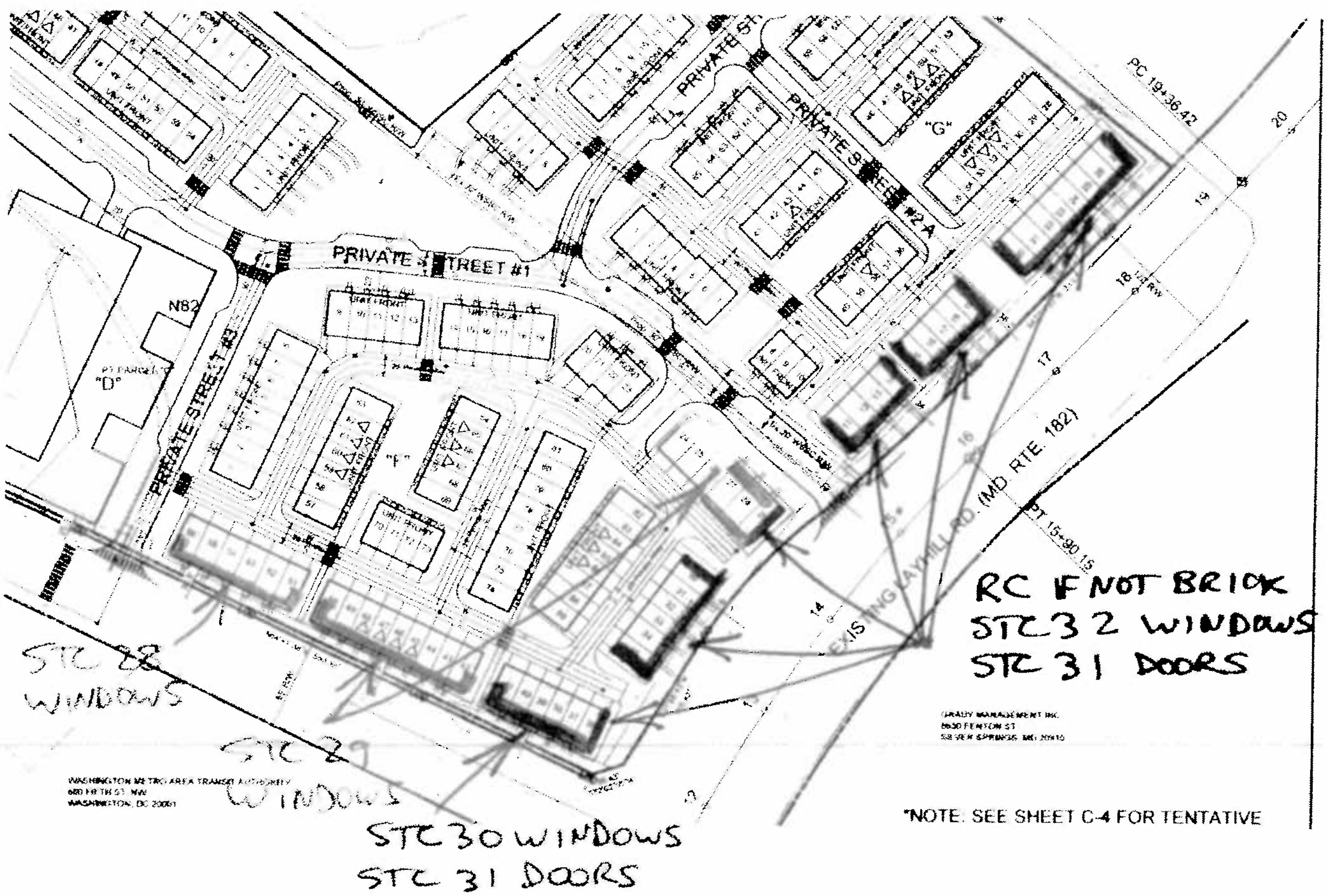

Figure 7. Proposed Upgrades

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The following appendices provide additional information about acoustical terminology and criteria, and the precision of this analysis.

If you have any questions, please contact me at 703/534-2790 or via e-mail at Gary@HushAcoustics.com.

Sincerely,

Gary Ehrlich, P.E.
Principal

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Appendix A – Noise Metrics

There are many different ways to express sound levels, but all ways must have some means of incorporating the three most important aspects of the sound: loudness (level), pitch (frequency), and duration (time pattern). The chosen way to express the sound level is known as the noise metric.

Level. The sound level is almost always expressed in decibels, abbreviated dB. The decibel is a unitless quantity; it is technically based a ratio between the sound pressure and a standard reference pressure. Sound level meters can show the sound level varying with a moving needle or changing electronic display. How quickly this display changes, and therefore how quickly the meter responds to changes in sound level, is called the time weighting network or simply the meter "response." The four most commonly used responses are peak, impulsive, fast, and slow; peak response is the fastest response while slow is the slowest. The peak response is only normally used to evaluate the potential for hearing damage and damage to structures, and is never used to express the annoyance of noise. The impulsive response is only typically used to evaluate loud periodic noises such as pile driving and gun fire. The fast and slow responses are the most commonly used. Fast response is used when the sound level changes relatively rapidly over time as would be the case at a night club or a construction site. Slow response is used when the sound level is relatively steady as would be the case for environmental noise such as near highways, railroads, and airports.

Following are how high A-weighted sound levels are for some familiar sounds (taken from U.S. Environmental Protection Agency documents):

Noises:

Chain saw operator	103-115 dBA
Heavy truck at 50 feet	85-95 dBA
Motorcycle driver	80-115 dBA
Power lawn mower operator	80-95 dBA
Subway rider	80-90 dBA
Train passenger	72-90 dBA
City bus at 50 feet	70-85 dBA
Waste food disposer	67-93 dBA
Automobile at 50 feet	64-88 dBA
Vacuum cleaner	60-85 dBA
Washing machine	47-73 dBA
Refrigerator	45-68 dBA

Average conversational speech at 1 meter:

Inside suburban house	55 dBA
Outdoors in suburban area	55 dBA
Inside urban house	57 dBA
Outdoors in urban area	65 dBA
On a train	66 dBA
On an aircraft	68 dBA

Frequency. The frequency of sound is always expressed in Hertz, abbreviated Hz. The audible frequency range (20 Hz to approximately 15,000 or 20,000 Hz) is typically divided into bands covering one octave, or one-third of an octave. Each doubling of frequency is defined as one octave. A sound level can then be stated either as a single-value covering the entire audible frequency range, or for a given octave or one-third octave band. When sound levels are stated for the entire audible frequency range, the sound could be filtered to roughly simulate the hearing sensitivity of the average person. There are two commonly-used filter types: A- and C-weighting. An A-weighted sound level is by far the most-commonly used, and was designed to approximately represent the hearing sensitivity of a person exposed to sounds of moderate loudness. A C-weighted sound level is occasionally used to assess noise from blasting and other loud short-duration sounds and was developed to approximately represent the hearing sensitivity of a person exposed to loud sounds. For environmental noise studies, or for most other purposes as well, it is assumed that the sound level is A-weighted if there is no specific designation otherwise.

Time Pattern. The variation of a sound level over time is perhaps the most complex of the three parameters, and there are a myriad of ways to express this variation. The various ways can be divided into single-event sound levels and long-term sound levels. Examples of "single events" are a train passby, an aircraft overflight, or a gun firing. Single-event sound levels can be based on the maximum sound level reached during the event (abbreviated L_{max}), the total sound energy produced during the event (known as the sound exposure level, or SEL), or the number of times the sound level exceeds a threshold value (known as the number of events above, or NA). Long-term sound levels must be based on sound levels over a given time interval. Common time intervals are one hour and 24 hours. During this time interval the stated quantity could be the average sound level (known as the equivalent-continuous sound level, or L_{eq}), the amount of time the sound level exceeds a threshold value (known as time above, or TA), or the sound level exceeded any set percentage of the time (known as the statistical sound level; e.g., the sound level exceeded ten percent of the time is written L_{10}, while the sound level exceeded 90 percent of the time is written the L_{90}). One-hour average sound levels, or occasionally one-hour statistical sound levels, are used by the Federal Highway Administration and state departments of transportation to express highway noise levels. The sound level exceeded 90 percent of the time, L_{90}, is often considered the background sound level, since it is not significantly affected by loud periodic noise events. 24-hour average sound levels, and occasionally 24-hour statistical sound levels, are typically used to express all forms of transportation noise including highway, aircraft, and railroad noise. The 24-hour average noise level can include some adjustments to account for peoples' increased sensitivity to noise in the evening and at night. The two most common ways to account for this sensitivity is with the Day-Night Average Sound Level (DNL) and the Community Noise Equivalent Level (CNEL). The DNL is just a 24-hour average sound level for a calendar day with 10 dB added to all noise which occurs between 12 a.m. and 7 a.m. and between 10 p.m. and midnight. The CNEL is identical to the DNL but with 5 dB added to all noise which occurs between 7 p.m. and 10 p.m.

Appendix B – Noise Criteria

Noise is unwanted since it causes: (1) hearing damage, (2) annoyance, (3) speech interference, and (4) sleep disturbance. There are various types of noise criteria that revolve around different unwanted causes. The Occupational Safety and Health Act (OSHA) established maximum allowable sound levels in the workplace in an effort to prevent hearing damage. The OSHA limits often become significant in industrial and military settings, as well as for construction workers. In most work and home environments the sound levels are well below the OSHA limits. Most noise criteria relate to the other three unwanted effects of noise. There are noise criteria at the federal, state, and local levels, and there are also non-regulatory criteria developed by many private and governmental organizations.

Federal Noise Criteria. There are many government agencies that have established noise criteria. The U.S. Environmental Protection Agency (EPA) developed many of the criteria used by other federal agencies. The U.S. Department of Housing and Urban Development (HUD) established an outdoor noise standard for residential land use. This HUD program lays out three levels for noise. A DNL below 65 dB is "acceptable." A DNL over 65 dB but not exceeding 75 dB is "normally unacceptable." A DNL above 75 dB is "unacceptable." The HUD indoor noise goal is that the DNL not exceed 45 dB inside proposed residences. These limits are typically only evaluated by HUD when the project receives funding from the Federal Housing Administration (FHA). The Federal Aviation Administration (FAA) has established an outdoor threshold with a DNL of 65 dB, above which residential development is not compatible. The FAA indoor threshold is also a DNL of 45 dB. These limits are typically only evaluated when environmental noise studies (such as environmental assessments or environmental impact statements) are performed in support of a major project, or when existing residences, schools, or churches are sound insulated in FAA-sponsored programs. The Department of the Navy uses similar criteria which are typically only evaluated when environmental noise studies (such as Air Installation Compatible Use Zone, or AICUZ, studies) are completed in support of a major realignment of assets. The Federal Highway Administration (FHWA) established noise abatement criteria (NAC) for various land uses; the NAC for residential use is an hourly average sound level of 67 dB outdoors and 52 dB indoors. When the sound level approaches or exceeds the NAC a noise impact occurs. The state departments of transportation may define the word "approach" although it is typically considered to be when the sound level reaches within one dB of the NAC.

State Noise Criteria. Many states have established different noise criteria for four purposes: (1) to control noise produced by citizens, (2) to evaluate the compatibility of a proposed land use with respect to environmental noise, (3) to determine if construction of a state-funded noise barrier is warranted along a highway, and (4) to verify that new construction provides adequate acoustical separation between dwelling units of multi-family housing. The first purpose is incorporated into a noise ordinance and is enforceable against the person generating the noise. The Code of Maryland includes such as noise ordinance, while in the state of Virginia the noise ordinances are developed at the local level. Noise ordinances typically limit the maximum A-weighted noise level, and many also limit the maximum noise level in each octave band. The second purpose is incorporated into the environmental noise policy and is enforceable by the state and local (if adopted at the local level) planning and zoning departments. The Code of Maryland also includes such an environmental noise policy, while in most other states such as Virginia it is solely up to the municipalities to develop such a policy. The state of California has a building code requirement that if the outdoor DNL or CNEL exceeds 60 dB, an acoustical analysis shall be performed demonstrating that the indoor DNL or CNEL not exceed 45 dB. Environmental noise policies are almost always expressed in terms of the DNL, with the exception of the state of California which also uses CNEL. The third purpose is incorporated in the noise barrier policy and is used by the state department of transportation. Maryland and Virginia, as well as other states, have such a noise barrier policy. The noise barrier policies are almost always expressed in terms of the hourly average sound level referencing the noise abatement criteria used by the FHWA, although some are expressed in terms of the sound level exceeded during 10 percent of the hour (the L_{10}). The fourth purpose is incorporated into the state and local building code in the form of a minimum acceptable Sound Transmission Class (STC) or Impact Insulation Class (IIC) rating.

Local Noise Criteria. Many municipalities have established both a noise ordinance and an environmental noise policy. The environmental noise policy is sometimes summarized in a policy plan, comprehensive plan, or similar document, while in other jurisdictions it is not documented at all (outside of in-house planning department memos). The environmental noise policy is sometimes enforceable by ordinance in the case of an overlay zone. Overlay zones are often adopted around airports or military air bases, as is the case for High Point, North Carolina. In some municipalities the state department of transportation noise barrier policy is used to assist determining if a developer applying for a re-zoning must build a highway noise barrier.

Private Noise Criteria. In many cases, there are no applicable regulatory criteria. For example, there rarely is any regulatory limit on noise levels due to plumbing systems, noise levels in classrooms, or noise levels transmitted from one office to another. In these cases it is useful to consider non-binding criteria developed by private and governmental organizations. The American Society of Heating Refrigerating and Air-conditioning Engineers (ASHRAE) provides recommendations regarding noise from mechanical systems. The ASHRAE recommendations are typically expressed in terms of the Room Criterion (RC) rating, and formerly were expressed in terms of the Noise Criterion (NC) rating. The American National Standards Institute (ANSI) developed a standard regarding noise levels in schools, and this standard has been adopted into law in some jurisdictions. The World Health Organization (WHO) has developed many noise standards for various purposes. In some cases it is useful to assess what percentage of syllables, words, or sentences would be intelligible in a given noise environment; two noise metrics used for this purpose are called the speech transmission index (STI) and the articulation index (AI). Various textbooks provide guidance on appropriate STI and AI values. There has also been some research into the percentage of people that would be "highly annoyed" or awakened by given noise levels. This research could be cited in the development of a noise criterion.

Appendix C – Precision of Predictions

It is not generally feasible to calculate the precision of a noise level or noise level reduction predictions. Unlike fields such as structural engineering, it is not typical practice to incorporate a specific margin of error in acoustical studies. Where possible, somewhat conservative assumptions were used in the outdoor noise level analysis. However, STC ratings quoted by manufacturers of products such as windows and doors are inherently anti-conservative, since the manufacturer has the option to test products many times and only publish the best rating the product ever achieved. Also, there are a variety of field installation issues which could make the STC ratings of walls be lower than anticipated. These two factors (slightly conservative assumptions used to predict outdoor noise levels, and possibly anti-conservative data used to predict indoor noise levels) may roughly balance each other out. The end result is that our predictions should roughly match future measured sound levels on average, with a statistical variation above and below.

As noted above, a 2 dB margin of error was included. If a greater margin of error were desired, it would be advisable to exceed the recommended acoustical performance (often expressed by the STC rating) of

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walls, windows, and doors by a couple of points. If you would like to incorporate a different margin of error, please let us know and we could revise our analysis.

If a specific proffered commitment is made during the rezoning process for a project regarding the noise level inside residences or in outdoor activity areas, we would recommend incorporating a specific margin of error of approximately 2 dB.

Hush Acoustics LLC does not provide any warranty or guarantee as to the precision of the noise level or noise level reduction predictions or measurements.

Appendix D – Field Testing

As noted above there are local and state environmental noise policies which specify the maximum allowable indoor DNL or CNEL. Typically, there is no requirement for a field test.

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November 6, 2013

Layhill Investment Associates LLC
c/o Mr. Pete Jervey
Principal
Westpath Real Estate
4445 Willard Ave. Suite 700
Chevy Chase, Maryland 20815

Re: Glenmont Metrocenter
Traffic Noise Analysis

Mr. Jervey:

Hush Acoustics LLC has evaluated traffic noise for the Glenmont Metrocenter project in Montgomery County, MD. This report was initiated to address county requirement 11 which states:

> "The Applicant must provide a revised noise analysis as part of the Phase 1.1 Site Plan that includes the baseline noise and the 20-year projected noise levels for the entire site and to include a lot layout that matches the lot design of the approved Preliminary Plan."

This report is an addendum to the May 4, 2013 Hush Acoustics LLC report prepared for Winchester Homes for the portion of this site along Layhill Road. Since that report was prepared the Traffic Noise Model (TNM) analysis was expanded to include the entire site, traffic noise from Georgia Avenue was included, and the slightly-revised Preliminary Plan layout was used for the Winchester Homes portion of the site.

The Maryland State Highway Administration (SHA) provided an Average Daily Traffic (ADT) volume forecast for the year 2040 of 44,950 for Georgia Avenue (Maryland 97) at the site. Although the county asked for 20-year projected noise levels, we used the year 2040 SHA forecasts to be conservative. SHA also indicated that traffic includes 2.9% medium trucks and 1.1% heavy trucks. In lieu of other information it was assumed that traffic includes 2% buses and the peak-hour is 10% of the ADT. The posted speed limit on Georgia Avenue is 45 mph. To be conservative, it was assumed that traffic would travel 50 mph.

For the prior analysis for Winchester Homes it was assumed that the future DNL would be 1 dB greater than the loudest-hour average sound level. This value was selected based on the sound level measurements performed for Winchester Homes along Layhill Road. For Georgia Avenue it is possible the relationship between the DNL and the loudest-hour average sound level would differ. Based on measurements Hush Acoustics LLC has performed for a different client along Georgia Avenue, it was assumed that the future DNL would be 1.5 dB greater than the loudest-hour average sound level.

TNM was run with receivers located at various locations at ground level, as well as at the facades of the proposed buildings. Receivers were included for the ground floor, the top floor, and for one floor in between. Shielding provided by the proposed buildings was included by modeling each as a noise barrier. Figure 1 presents the resulting DNL for the loudest floor.

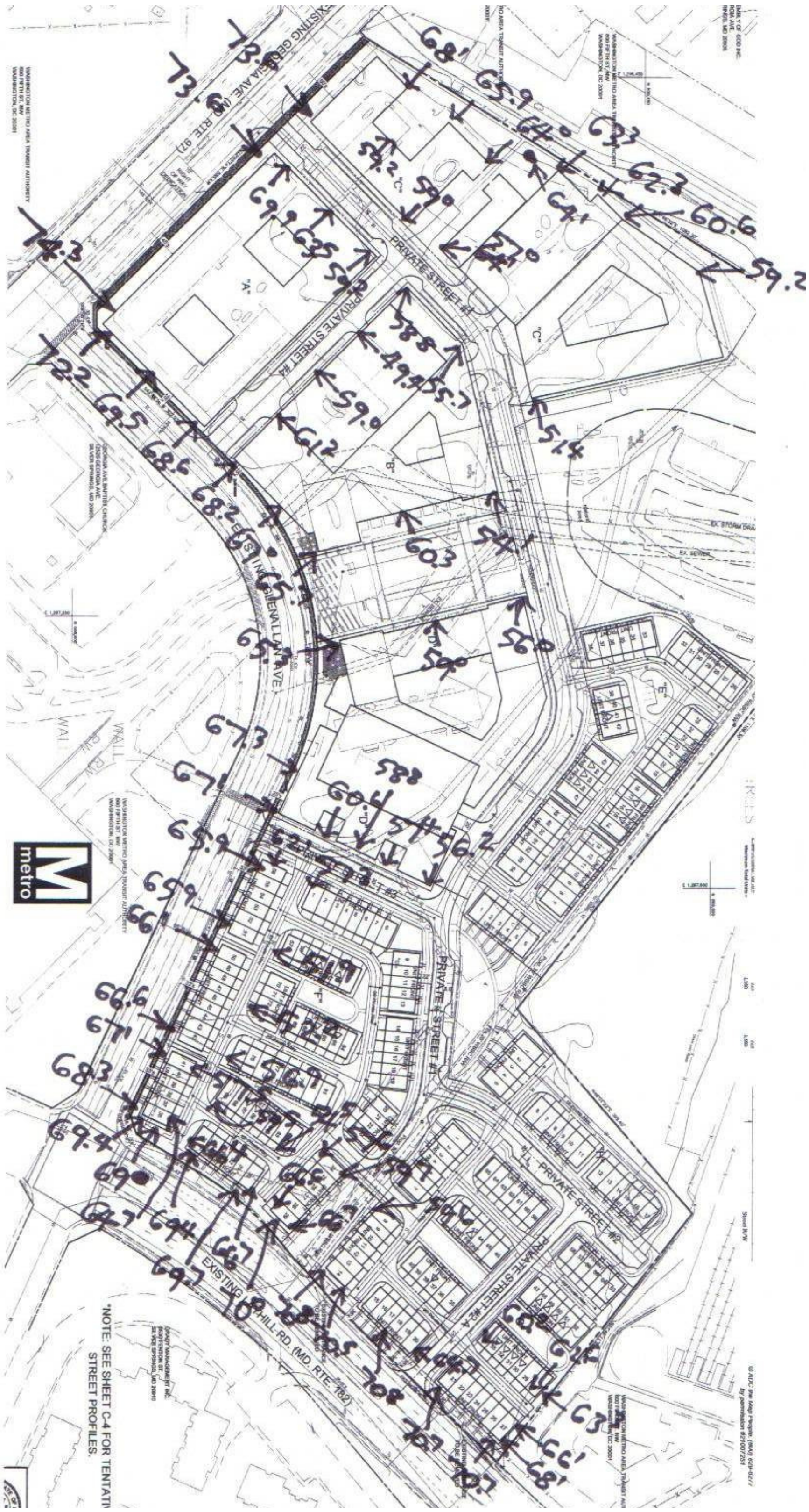

Figure 1. Future DNL at Loudest Floor

The county also required addressing baseline noise levels. SHA provided year 2012 ADT of 37,350 for Georgia Avenue, 17,850 for Layhill Road, and 11,750 for Glenallan Avenue. To estimate year 2013 ADT, the values were interpolated between the year 2012 and year 2040 ADT provided by SHA. TNM was run a second time using these year 2013 ADT. Figure 2 presents existing DNL contours five feet high and Figure 3 presents the future DNL contours five feet high.

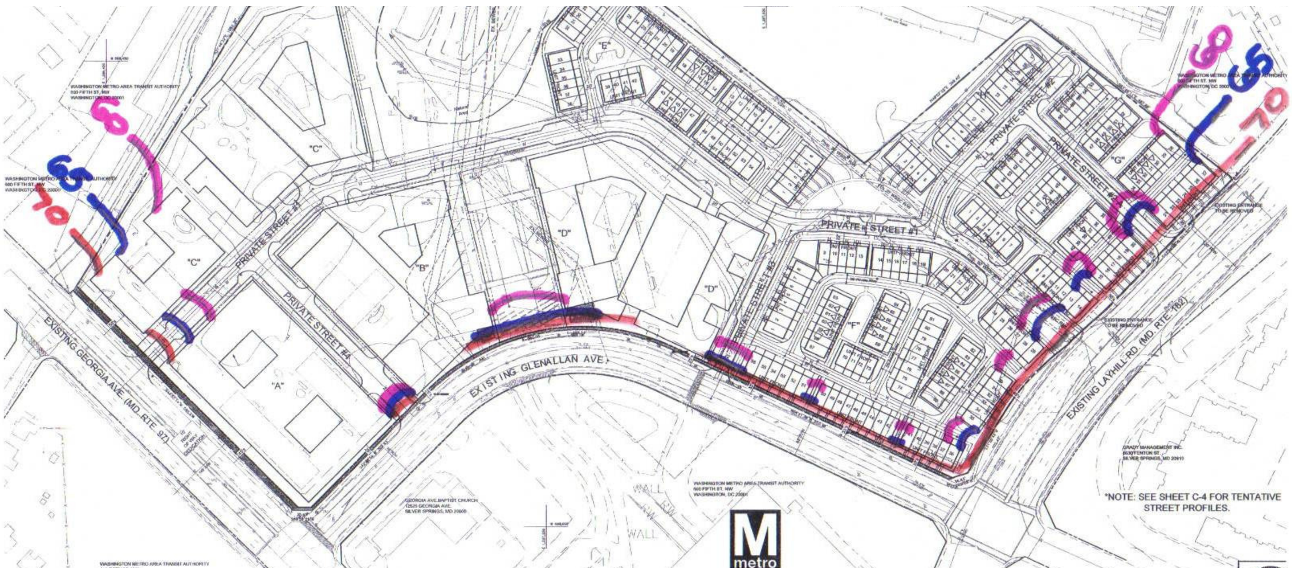

Figure 2. Existing DNL Contours at Ground Level

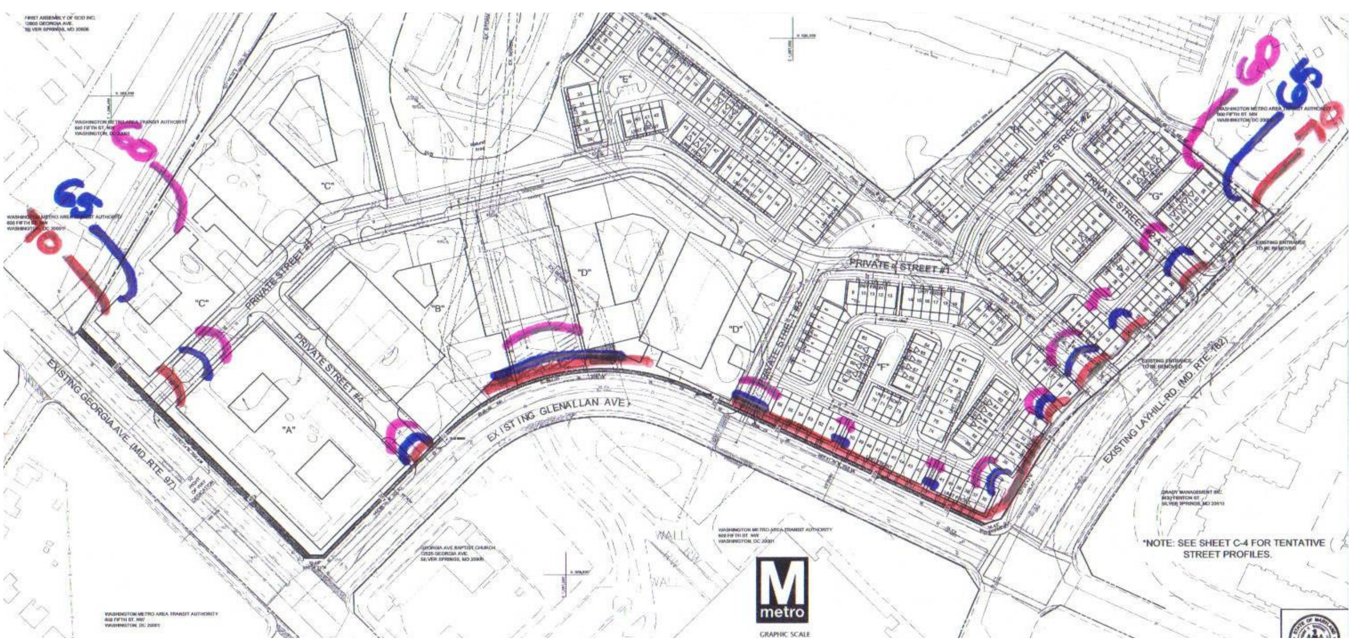

Figure 3. Future DNL Contours at Ground Level

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If you have any questions, please contact me at 703/534.2790 or Gary@HushAcoustics.com.

Sincerely,

Gary Ehrlich, P.E.
Principal