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Sound & Vibration
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28 October 2020

L 20887
J/N 728

Ms. Maryann Dillon
Housing Initiative Partnership, Inc.
6525 Belcrest Road, Suite 555
Hyattsville, Maryland 20782

Subject: Md. Rte. 5 Traffic Noise Soundproofing Evaluation
Schultz Road Senior, Clinton, Maryland

Dear Ms. Dillon:

Estimation of the exterior noise exposure from Md. Rte. 5 traffic at the proposed Schultz Road Senior development indicated mitigation to be desirable. Consequently, architectural soundproofing requirements were evaluated to achieve the HUD 45-dBA[L_{dn}] interior criterion. Analysis of the basic building construction indicated that enhanced walls and windows are needed for all residential units. These features are expected to result in 41–43-dBA interior sound levels in worst-case rooms and meet HUD requirements.

If you have any questions or if I can be of further help, please let me know.

Sincerely,

Michael A. Staiano

Attachment: Staiano Engineering Report No. L 20887

xc: J.H. Ratnow—Site-Insight

MD. RTE. 5
TRAFFIC NOISE SOUNDPROOFING EVALUATION
SCHULTZ ROAD SENIOR
CLINTON, MARYLAND

By

Michael A. Staiano

Report No. **L 20887**

28 October 2020

for
Housing Initiative Partnership, Inc.
Hyattsville, Maryland
J/N 728

On 11 August 2020, Staiano Engineering reported an estimate of the noise from Md. Rte. 5 traffic at the proposed Schultz Road Senior development. The assessment found the exposure to be "normally unacceptable" with respect to U.S. Department of Housing and Urban Development (HUD) exterior noise criteria.[1] Consequently, an evaluation of that exposure with respect to a 45-dBA day-night average sound level (L_{dn}) indoor criterion was required—possibly necessitating the incorporation of mitigation into the building design. This report documents that analysis and its recommendations.

SUMMARY

Estimation of the exterior noise exposure from Md. Rte. 5 traffic at the proposed Schultz Road Senior development indicated mitigation to be desirable. Consequently, architectural soundproofing requirements were evaluated to achieve the HUD 45-dBA[L_{dn}] interior criterion. Analysis of the basic building construction indicated that enhanced walls and windows are needed for all residential units: resilient channels in all Type-A Walls, STC 33 glazing in all fixed (picture) windows, and STC 32 glazing in all operable windows. These features are expected to result in 41–43-dBA interior sound levels in worst-case rooms and meet HUD requirements.

TERMINOLOGY

Sound Isolation. The extent to which sound outside a building is diminished inside is known qualitatively as sound isolation. The quantitative difference in the indoor and outdoor sound levels is referred to as level reduction (LR). The sound isolation afforded by a structure depends not only upon the sound insulating capacity of the building façade but also the character of the incident noise, the exposed façade surface area, and the sound absorbing characteristics of the sound-receiving rooms.

Sound Insulation. Sound insulation, the ability of a building element to resist the propagation of sound, is quantified by *sound transmission loss*. Sound transmission loss is determined from measurements in frequency bands on a building element specimen exposed to a sound field in a well-defined laboratory environment.[2] A partition's sound attenuating potential often is expressed in terms of *sound transmission class* (STC), a single-number rating whose value is derived from the sound transmission losses measured in 16 frequency bands.[3*] Façade elements (walls, windows, doors, roofs, and so forth) are assembled to form a composite structure, such as a residential building. A building façade consisting of two or more components has a composite STC that is dependent upon the relative surface areas of the components.

PREDICTED INTERIOR TRAFFIC SOUND LEVELS

Analysis Procedures

A mathematical prediction procedure was employed to estimate room interior sound levels from—building exterior sound levels, performance data for building shell elements, room dimensions, and assumptions for the acoustical characteristics of typical interior rooms. Errors can arise in this analysis from a variety of causes. The overall accuracy of the room interior sound level computations is estimated to be about ±5 dBA.

Building Exterior Sound Levels. As noted above, the exterior noise estimation found the exposure to be “normally unacceptable” with respect to HUD exterior noise criteria. Consequently, for this evaluation the building construction will be analyzed for an outdoor sound level of 70 dBA[L_{dn}] based upon the location on the proposed building having the greatest noise exposure.

Building Element Sound Transmission Loss. For each of the building components, an STC value was obtained from calculations or cataloged test data of similar constructions. While test data are preferable, estimations sometimes can be made when reasonably representative tests are unavailable.

The sound transmission loss of a partition varies with the frequency and incidence angle of the sound. For a simple panel, performance depends upon the mass, stiffness and internal damping characteristics.[4] A multi-layer partition with a cavity can provide much greater transmission loss then a single, solid panel but its behavior is much more difficult to predict. Cavity wall performance depends upon: the characteristics of the individual layers, the cavity size and contents, and the attachment method for the opposing panels.[5]

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[*] The STC rating was developed for evaluating interior wall constructions. As a result, the rating assumes a spectrum of noise frequencies not representative of outdoor environmental noise; thus, it is not ideally suited for this evaluation. However, analyses utilizing STC ratings can be made with adjustments for the frequency content of the source noise.

Exposed building shells may contain various elements—the walls, windows, doors, and roof. The description of these features for the Schultz Road Senior development is given in Table 1 with their expected STC ratings. The performance of the façade elements was based upon manufacturer-sponsored test reports.

Two types of wall construction are planned for the evaluated rooms:

- Type A
  - 5/16-in. fiber-cement panels,
  - 5/8-in. furring strips 16-in. O.C.,
  - 5/8-in. air gap,
  - 7/16-in. OSB bonded to 1½-in. polyisocyanurate foam sheathing,
  - R-21 unfaced fiberglass insulation,
  - 5/8-in. thick gypsum board, and
  - 2 x 6-in. wood studs 16-in. O.C.

- Type E
  - 5/16-in. fiber-cement siding,
  - 7/16-in. OSB bonded to 1½-in. polyisocyanurate foam sheathing,
  - R-21 unfaced fiberglass insulation,
  - 5/8-in. thick gypsum board, and
  - 2 x 6-in. wood studs 16-in. O.C.

Fiber-cement panels and fiber-cement siding are relatively uncommon constructions for which available sound transmission test data are limited. The only test data for reasonably similar walls reported STC 39–40 sound transmission loss performance.[6,7] However, the tested constructions were built with ½-in. gypsum board and—more importantly—lack the OSB sheathing found in the Type-A and Type-E panels planned for Schultz Road Senior:

- *Type E Wall*—The 5/8-in. gypsum board will give slightly better performance than the most similar tested panel. The OSB sheathing in the Type-E panel is also likely to perform somewhat better than the STC 40 of the tested panel. However, the magnitude of those benefits cannot be estimated confidently. The Type-E Wall performance was estimated conservatively as STC 40.

- *Type A Wall*—The 5/8-in. gypsum board also will give slightly better performance than the most similar tested panel. However, the presence of OSB *with 5/8-in. air gap* may significantly *degrade* the STC-39 performance of the tested panel.[*] The magnitude of this disbenefit also cannot be estimated confidently. Consequently, enhancement of the wall construction with the inclusion of resilient channels between the interior gypsum board and the wood studs is recommended. This modifi-

[*] The introduction of the air gap between the fiber-cement panel and the OSB creates a resonance (i.e., increased amplitude when an applied force is such that the system tends to vibrate in the absence of the driving force). This resonance will increase the sound transmitted through the wall, thus reducing its STC performance.

cation is expected to be more than sufficient to compensate for the air-space handicap. As a result, the Type-A Wall performance also was estimated as STC 40.

Room Interior Sound Levels. The sound levels inside a room depend not only upon the exterior sound levels and the façade composite sound transmission loss performance, but also upon: the character of the noise (e.g., roadway traffic vs. jet aircraft), the exterior surface area of the room, and the degree to which the room furnishings absorb sound. Room interior sound levels were estimated using a prediction procedure that considers these factors.[8]

Room Selection. Interior sound levels will be greatest in rooms on the noise-exposed sides of a building which have the most exposed façade surface area—particularly window area—relative to the floor area of the room. The evaluated windows and glazing are summarized in Table 2. Three representative, noise-sensitive, road-traffic exposed building spaces were evaluated:

- o Unit 1C Grand Room.
- o Unit 1C Bedroom, and
- o Unit 1B-2 Bedroom.

Description of the rooms selected for analysis is provided in Table 3. A single, worst-case window configuration was examined for each room. The analyzed architectural plans were per Soto Architecture & Urban Design plans and descriptions.[9]

Design Sound Levels. Any noise prediction or measurement contains uncertainty, as noted above. For this reason, rooms likely to have the greatest interior sound levels were chosen for analysis. In addition, the soundproofing needed to meet 43 dBA[L_{dn}] was evaluated—i.e. 45 dBA less a safety margin of 2 dBA.

Interior Analysis Results

With basic building construction per Table 1, estimated sound levels in the evaluated interior spaces were 45–47 dBA[L_{dn}].[*] (All interior computations are summarized in Table 3 with building shell element contributions, SL_{in}, differentiated.) Thus, mitigation is required to meet the 43-dBA[L_{dn}] design goal. For the desired interior sound levels, the enhanced construction features identified in Table 1 are necessary for all residential units on all floors. These features are expected to yield 41–43-dBA[L_{dn}] interior exposures and meet the design goal—45 dBA with a margin of safety, as also given in Table 3.

Architectural Modifications. The design criterion is expected be met with the proposed building construction enhanced with:

- o Resilient channels (RC-1 or equivalent) in all Type-A Walls,
- o STC-33 glazing in all fixed (picture) windows, and

[*] These results are for Unit-1C rooms. The unmitigated Unit-1B2 room is not reported since unenhanced Type-A Wall performance could not be quantified satisfactorily.

o STC-32 glazing in all operable windows.

These improvements must be applied to any façade which can be seen from any part of the roadway—even at grazing incidence—that is, along the building façades identified in Figure 1.

Note that the results are provisional pending confirmation by acoustical test laboratory E90 test report for the MI Windows & Doors products. Otherwise, the STC values specified in this report constitute requirements for products from other manufacturers for which appropriate test reports are provided.

Ventilation and Wall Penetrations. Noise infiltration into building spaces should be minimized by eliminating or baffling additional penetrations through noise-exposed façades. The predicted sound levels do not include the presence of wall penetrations or vents. Any such openings may necessitate additional mitigation features.

Construction Practices. *Blown-in insulation should not be used.* Procedures should be implemented to:

- Assure that any material or product substitutions meet or exceed the acoustical performance of the replaced item evaluated in this report,
- Prevent or control field changes to construction plans,
- Qualify contractors and subcontractors as competent to install noise mitigation features, and
- Periodically inspect for proper noise mitigation installations during construction.

LIMITATIONS

The results of measurements or predictions of noise or vibration magnitudes or changes in level apply only to the evaluated dates and times, locations, and conditions. Exposure uncertainty exists such as due to but not limited to variable outdoor propagation, undefined transmission paths, or fluctuating source operation. Assessments of human response to noise or vibration are subject to exposure uncertainties and the varying perceptions of individual sound or vibration receivers. Noise or vibration performance is significantly degraded by poor implementation practice. The execution of any recommendations requires the proper selection and installation of materials and equipment. Good workmanship in the construction or modification of equipment, structures or buildings is necessary. The findings or conclusions may not apply if the implementation of the recommendations differs in any way.[2020]

REFERENCES

[1] Staiano, M.A., “Md. Rte. 5 Preliminary HUD Noise Estimate—Shultz Road Senior—Clinton, Maryland,” Staiano Engineering Rpt. No L 20885, 11 August 2020.

[2] American Society for Testing and Materials, “Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements,” ASTM E90 – 09, 2016.

[3] American Society for Testing and Materials, “Classification for Rating Sound Insulation,” ASTM E413 - 16, 2016.

[4] Ver, I.L., "Interaction of Sound Waves with Solid Structures," Chapter 9, Noise and Vibration Control Engineering-Principles and Applications, (L.L. Beranek and I.L. Ver, Eds.), Wiley, 1992.

[5] Sharp, B.H., "A Study of Techniques to Increase the Sound Insulation of Building Elements," Wyle Laboratories Report WR-73-5, HUD Contract No. H-1095, June 1973.

[6] Nelson, D., “Transmission Loss Test—Harditex/Wood Stud/Cavity Insulation/1/2 inch GWB for James Hardie Building Products, Inc.,” Acoustic Systems Acoustical Research Facility Official Laboratory Report TL363A, 15 March 1990.

[7] Nelson, D., “Transmission Loss Test—HardiPlank/Wood Stud/Cavity Insulation/1/2 inch GWB for James Hardie Building Products, Inc.,” Acoustic Systems Acoustical Research Facility Official Laboratory Report TL365A, 15 March 1990.

[8] Warnock, A.C.C. and J.D. Quirt, "Noise Control in Buildings," Chapter 10, Noise Control in Buildings—A Practical Guide for Architects and Engineers, (C.M. Harris, Ed.), McGraw-Hill, 1994

[9] Ijjas, L, Soto Architecture & Urban Design, email to M.A. Staiano, 30 September 2020.

Table 1. CONSTRUCTION FEATURES

Laboratory test results for window sound transmission loss are based upon as single window unit installed in a test chamber aperture. Transmission loss performance will be retained with multiple window units provided they are properly sealed. The window manufacturer should have mullion hardware or design guidance consistent with the rated performance of the window.

Element	Quality	STC	Description
WALLS-- Type A	Baseline	N/A	#N/A
	Enhanced	40	5/16-in. Fiber-Cement Vertical Siding / 5/8-in. air gap / 2-in. laminated OSB + polyisocyanurate foam sheathing / 2x6 Wood Studs / Fiberglass Insulation / RC-1 Resilient Channels / .625-in. Gypsum Board
WALLS-- Type E	Baseline	40	5/16-in. Fiber-Cement lap Siding / 2-in. laminated OSB + polyisocyanurate foam sheathing / 2x6 Wood Studs / Fiberglass Insulation / .625-in. Gypsum Board
WINDOWS-- Operable	Baseline	28	MI Windows & Doors--3500 Single-Hung 1/8-1/8 in. glass
	Enhanced	32	MI Windows & Doors--3500 Single-Hung 1/8-3/16 in. glass
WINDOWS-- Fixed	Baseline	27	MI Windows & Doors--3500Picture Window (fixed) 1/8-1/8 in. glass
	Enhanced	33	MI Windows & Doors--3500 Picture Window (fixed) 1/8-1/4 in. glass
			estimated

* In lieu of the specific building elements evaluated in the computations: Any fully assembled, commercially available window or door unit *of the same size* that has been rated by a certified acoustical testing laboratory and provides the analyzed sound transmission loss performance—or better—may be substituted for an evaluated product.

Table 2. WINDOW SCHEDULE

dimensions in feet

Symbol*	Width	Height	Area
A	3.0	5.5	16.5
B	3.0	2.0	6.0
C	5.0	2.0	10.0
D	3.0	5.5	16.5
E	5.0	5.5	27.5

* for reference in Table 3

ROOM DESCRIPTION			EXTERIOR BUILDING SHELL COMPONENTS									COMPOSITE	
Room	Floor Area (ft²)	Furnish Type*	SHELL ELEMENT 0: Exterior Wall			SHELL ELEMENT 1: Fixed Window*			SHELL ELEMENT 2: Operable Window			Room SL_{in} (dBA)	LR[‡] Out - In (dBA)
			Area (ft²) Gross	Area (ft²) Net	SL_{in} (dBA)	ID	Area (ft²)	SL_{in} (dBA)	ID	Area (ft²)	SL_{in} (dBA)		
BASELINE													
1C Grand Rm	323	Hard	344	212	36	B3C1E1	83	45	A	50	42	**47**	23
1C BedRm	133	Stnd	174	125	36	D1	17	40	A	33	42	**45**	25
1B2 BedRm	140	Stnd	281	215	N/A	B1C1E1	50	44	A	17	39	N/A	NA
MITIGATED													
1C Grand Rm	323	Hard	344	212	36	B3C1E1	83	39	A	50	38	43	27
1C BedRm	133	Stnd	174	125	36	D1	17	34	A	33	38	41	29
1B2 BedRm	140	Stnd	281	215	38	B1C1E1	50	38	A	17	35	42	28

primary noise path   with enhancement per Table 1

Table 3. ANALYZED ROOMS and ESTIMATED BUILDING INTERIOR SOUND LEVELS
Room interior sound levels, SI_{in}, are with respect to 70-dBA[L_{dn}] exterior exposure for room wall and window elements identified by Element STC Rating defined in Table 1.
Room sound levels are rounded to the nearest decibel; values in **BOLD** exceed the 43-dBA[L_{dn}] design goal.

* Room Furnishing Types:
- Hard—Reflective walls, floor, and ceiling; no upholstered furniture, drapes, or other absorptive treatments
- Stnd—Carpet or acoustical ceiling with some upholstered furniture
- Soft—Carpet and acoustical ceiling with upholstered furniture and drapes

† Window IDs consist of unit types (x, y, etc.) per Table 2 and numbers of units (m, n etc.) installed (e.g., xmyn, etc.)
‡ Level reduction (LR) is the difference between outdoor and indoor sound levels, $SL_{out} – SL_{in}$.

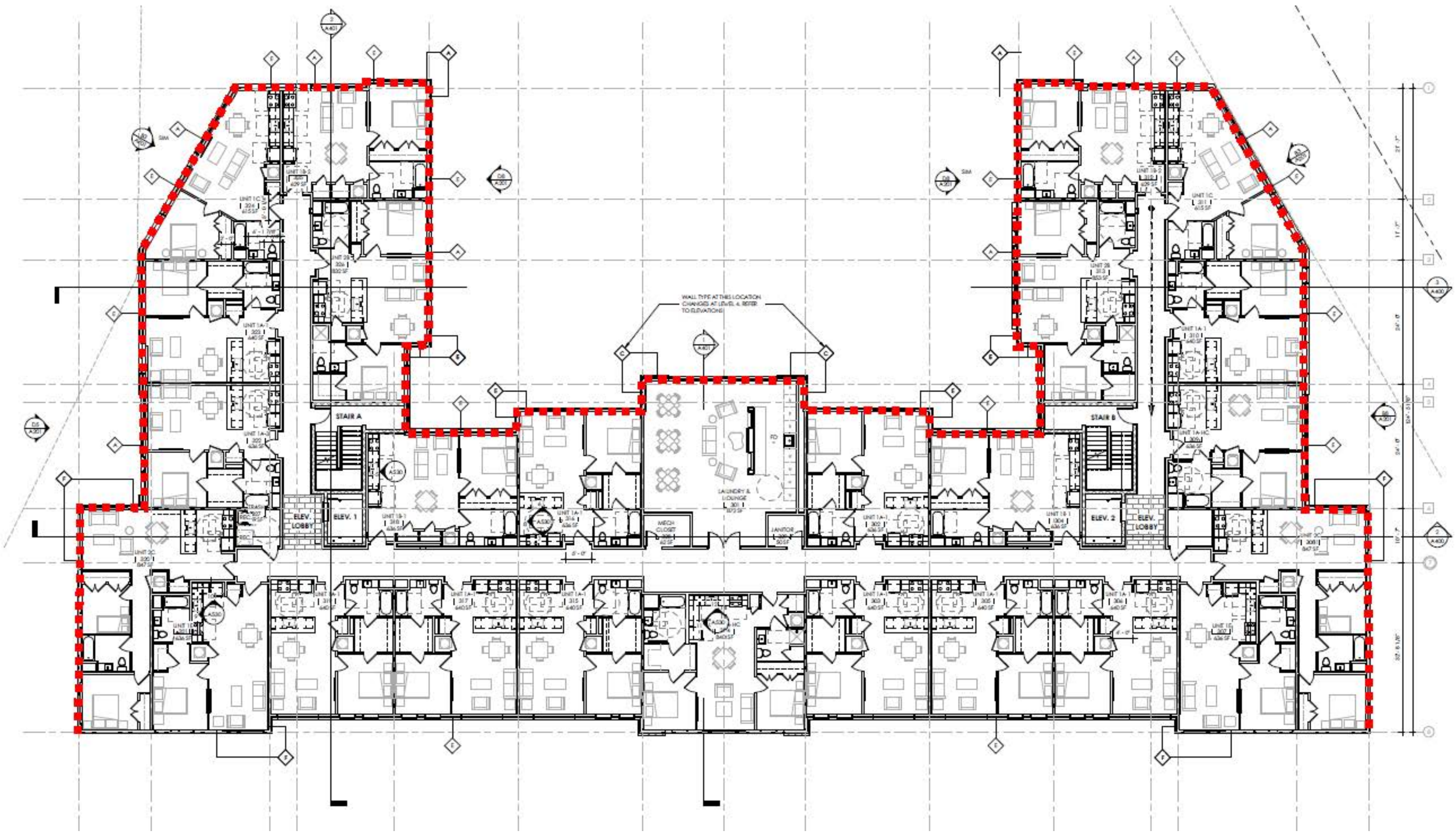

Figure 1. BUILDING FACADES REQUIRING MITIGATION
enhancements per Table 1 required for all residential units on all floors along facades identified with dashed lines