

Clear Space Theatre

Property Noise Level Study

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Prepared for:

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Introduction

The Clear Space Theatre site is located in Rehoboth Beach, DE among a variety of existing buildings at the East, West, and North sides of the property. The most noise-sensitive adjacencies of these surrounding buildings are the residential houses to the North of the Mainstage. This report is a summary of Threshold's analysis of how the calculated noise levels from the Theatre Mainstage compare to the Rehoboth Beach Noise Ordinance based on the current design of the building.

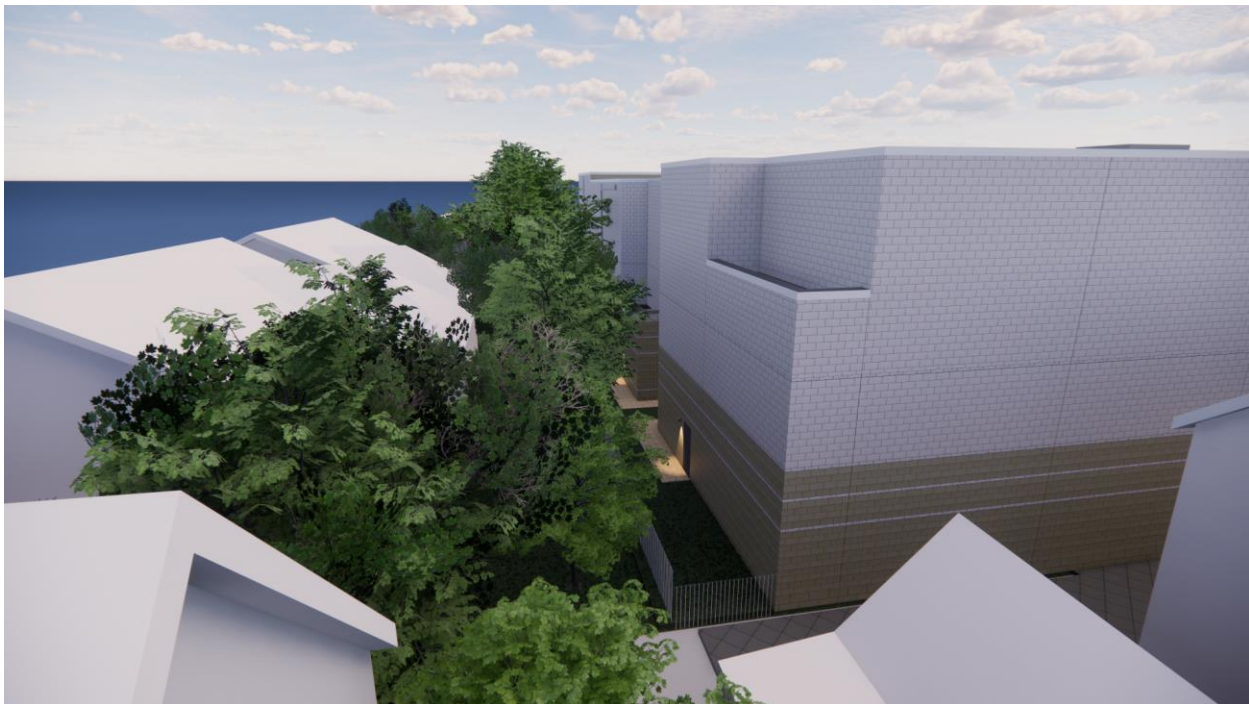


Figure 1: View at North Side of Property. Rendering courtesy of Grimm + Parker.

Executive Summary

The analysis performed on the building envelope separating activity in the Mainstage to the closest property line confirms that resulting sound pressure levels are anticipated to meet the daytime background noise criteria set forth by the City of Rehoboth Beach. The sound levels used for calculations are higher than those expected to be generated by the Theatre company, thus the resulting levels presented are to be considered as maximums.

Current Building Design

Façade

Sound isolation at the façade has been designed in collaboration with Grimm + Parker Architects to fit within a predetermined construction budget for the project, so the building enclosure has been developed to provide as much isolation as practical within that budget. The current design of the building envelope on the North side of the Theatre abutting this property line consists of the following system. The East façade has a similar construction, minus the interior layer of gypsum and stud:

- 1-layer 5/8" gypsum board at interior of theater
- 4-inch metal studs
- 8-inches CMU grouted block
- 4-inch airspace with 2-3/4-inches insulation material
- 4-inch thick masonry veneer at exterior of façade

The build-up of this system equates to an acoustical Sound Transmission Class (STC) single-figure metric of STC 62, and is nominally equal without the gypsum layer. The STC rating is a laboratory-tested metric used to determine how effective materials or partitions are in reducing sound transmission between two spaces and is measured by the decibel (dB) reduction in noise that the material/partition can provide. To give context, the following image presents a description of the subjective perception for a system of this STC-rating.




<p>Good STC 50</p>		<p>Loud speech can be heard with some effort. Music easily heard.</p>
<p>Excellent STC 60</p>		<p>Loud speech essentially inaudible. Music heard faintly; bass note disturbing.</p>
<p>Highly Confidential STC 70</p>		<p>Loud music heard faintly, which could be a problem if the adjoining space is highly sensitive to sound intrusion, such as a recording studio, concert hall, etc.</p>

Figure 2: Subjective Perception of Sound Transmission Loss.

To note, this table in the figure above assumes a reasonably quiet background noise level in the receiving space (40dBA or less), which is far below the daytime and nighttime noise ordinance levels, as described in the following section. "Bass notes" refer to frequencies (measured in Hertz, Hz) or pitches below 250Hz.

Doors

There are two doors within the North façade which open directly out from the Mainstage. These doors are designed to be 1-3/4-inch fiberglass-filled (stuffed) hollow metal doors with full perimeter gasket weatherstripping and the metal frames grouted. Significantly, the doors are not anticipated to be used other than for emergency egress, and thus the longevity of the perimeter seals will be greater than a typical egress door. The resulting STC-rating of these doors is a nominal STC-34 - much greater than a typical residential or office door.

As an added barrier a fence of solid, opaque construction is designed to run along the length of the property line, rising to approximately 7-feet to 8-feet in height; slightly taller than the tops of the doors. The presence of this fence will provide additional protection to sound transmission by breaking the line of sight to the door openings and the rest of the Theatre's site.

Roof

The roof construction over the Mainstage house and stage is the following system:

- Acoustic metal deck (3-inch thick over house, 1-1/2-inch thick over stage)
- 4-5/8-inch thick rigid insulation, 6 to 7 pcf
- 1/2-inch coverboard
- EPDM membrane

While there is a difference in thickness of the acoustic metal deck, the overall sound transmission value is relative similar at approximately STC-32 to 34. However, due to the height above ground of the room (approximately 35ft plus parapet barrier), reduction in sound due to distance should be considered for appropriate results. Such a distance is included in the calculations section of this report.

Target Background Noise Level

The Mainstage façade is approximately 10-feet from the shared property line to the North. Any day-to-day noise transmitting through the structure and measured at the property line must not exceed the noise levels set forth by the City of Rehoboth Beach, but should also be neutral in characteristic (i.e. no rumbles or other discernable tones produced by activity). With the Theatre zoned as a commercial building, these target background levels as stated by the Rehoboth Beach Noise Ordinance are 70 dB(A) measured at the property line during the daytime, and 55dB(A) measured at nighttime. To note, the A-weighting of a decibel reading (dB(A)) is a standard weighting applied to a measurement which mimics the response of the human ear.

Calculations in the following sections refer to the continuous noise by octave band frequency of the daytime levels for comparison. The window for daytime operations is between the hours of 8:00am and 11:00pm. As the expected operational hours of the Theatre company are to be within this window, all calculations will be using the daytime maximum permissible levels.

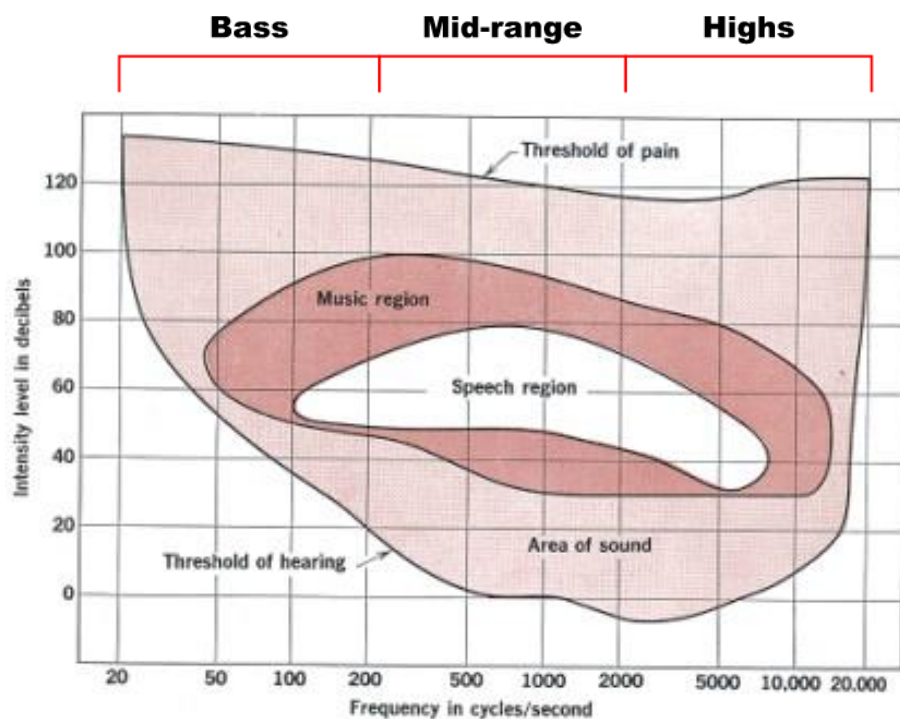
Whilst this report focuses on the day-to-day transmission of noise based post-project completion, it should be noted that the noise ordinance also states that, during the time of construction for the project, "In no instance shall noise levels originating from construction sites exceed 94dBA." We are unable to anticipate the methods of construction and resulting noise levels based on these activities, however we recommend the General Contractor adhere to these levels and take measures to protect the residences to the North of potential excessive noise exposure.

With the building occupying much of the East-West footprint of the site, essentially creating a barrier between the roadway and the North property line, the added benefit of a substantial reduction in traffic noise should be expected along with minimal intrusion from front-of-house theatrical activity.

Calculations and Results

The following tables present the anticipated resulting noise level at the property line from interior activity through each of the three described systems: façade wall, doors, and roof. The daytime noise ordinance levels by octave band are included as a reference, to ensure we are not only meeting the overall dBA level, but also the individual frequency limits.

In each of the calculations, a flat 95dB sound pressure level has been used as the source noise. This value is far higher than any true activity of the space both in theatrical rehearsal and performance. 95dB at all frequencies should be considered equivalent to white noise through a house loudspeaker system at a level uncomfortable to listen to without hearing protection. The overall noise levels of general theatrical activity are generally between 45dB and 90dB. As a reference, the following graph presents typical speech and music sound levels by frequency within the audibility of the human ear.



The range of audibility of the human ear

Figure 3: Speech and Music Sound Pressure Levels as Compared to Range of Audibility

Sound at the lower-end (below 200Hz/250Hz) are associated, for example with thumps of drums, basses, and the lower-half of the piano. Mid-frequencies (250Hz-2kHz) capture sources such as male and female voices, cellos, and trumpets, while the upper-frequencies (2kHz and above) would include cymbals, upper keyboard, and high electric guitars.

The reduction in sound pressure level due to distance is equal at all octave bands as typical outdoor weather conditions over a relatively short distance such as this are considered negligible.

Table 1: Sound Transmission Loss of Façade System

	DECIBELS (DB) BY FREQUENCY, WHOLE OCTAVE BANDS (HZ)							
FACADE	63 HZ	125 HZ	250 HZ	500 HZ	1 KHZ	2 KHZ	4 KHZ	8 KHZ
Interior Noise Level	95	95	95	95	95	95	95	95
Transmission Loss of Façade	-25	-37	-51	-59	-66	-70	-79	-84
Distance Attenuation (Wall to Fence)	-6	-6	-6	-6	-6	-6	-6	-6
Resulting Sound Pressure Level	64	52	38	30	23	19	10	5
Ref: Noise Ordinance Levels, Daytime	84	79	74	68	62	57	53	50

Table 2: Sound Transmission Loss of Doors within North Façade.

	DECIBELS (DB) BY FREQUENCY, WHOLE OCTAVE BANDS (HZ)							
DOORS	63 HZ	125 HZ	250 HZ	500 HZ	1 KHZ	2 KHZ	4 KHZ	8 KHZ
Interior Noise Level	95	95	95	95	95	95	95	95
Transmission Loss of Door	-14	-18	-27	-34	-37	-38	-42	-46
Distance Attenuation (Door to Fence)	-6	-6	-6	-6	-6	-6	-6	-6
Resulting Sound Pressure Level	75	71	62	55	52	51	47	44
Ref: Noise Ordinance Levels, Daytime	84	79	74	68	62	57	53	50

Table 3: Sound Transmission Loss of Roof System Over Mainstage House and Stage.

	DECIBELS (DB) BY FREQUENCY, WHOLE OCTAVE BANDS (HZ)							
ROOF	63 HZ	125 HZ	250 HZ	500 HZ	1 KHZ	2 KHZ	4 KHZ	8 KHZ
Interior Noise Level	95	95	95	95	95	95	95	95
Transmission Loss of Roof	-25	-29	-33	-29	-31	-35	-42	-45
Distance Attenuation (Roof to Ground)	-12	-12	-12	-12	-12	-12	-12	-12
Resulting Sound Pressure Level	58	54	50	54	52	48	41	38
Ref: Noise Ordinance Levels, Daytime	84	79	74	68	62	57	53	50

The following graph presents the anticipated levels for each of the three transmission paths for sound against the maximum permissible levels per the noise ordinance.

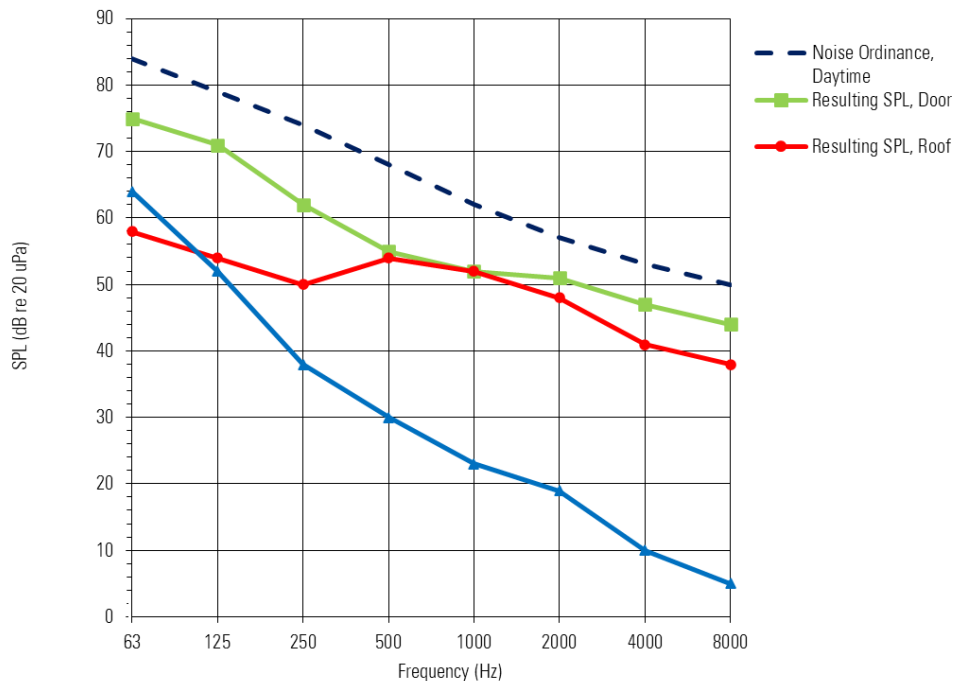


Figure 4: Resulting Sound Pressure Levels (SPL) of Each System Compared to Noise Ordinance (Daytime) Limits

It should be noted that, while we have measured against the daytime noise ordinance of a commercial district zoning classification, all resulting sound pressure levels also meet the daytime restrictions of residential districts.

Summary

The analysis performed on the three building systems (demising wall, doors, and roof) separating activity in the Mainstage to the closest property line confirms that resulting sound pressure levels are anticipated to meet the daytime background noise criteria set forth by the City of Rehoboth Beach. Furthermore, the sound levels used for calculations are higher than those expected to be generated by the Theatre company, thus the resulting levels presented are to be considered as worst-case scenarios.

Residents to the North of the new buildings should also anticipate a significant reduction in roadway and traffic noise from Rehoboth Ave once construction is complete as the Mainstage and Spotlight will act as sound barriers to these properties.

End of Report