

# Mesa Public Library Noise Issues

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Image by Jim See from [www.nmarchitectureguide.org](http://www.nmarchitectureguide.org)





## Definitions

STC – Sound Transmission Class

CAC – Ceiling Attenuation Class

NRC – Noise Reduction Coefficient

RT – Reverberation Time

NC – Noise Criteria



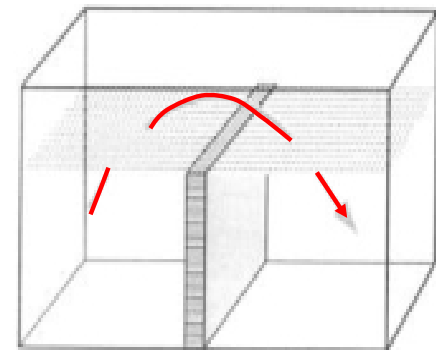
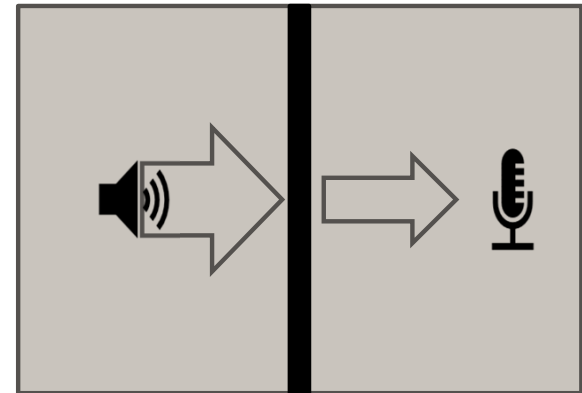
# Acoustic Separation

## Sound Transmission Class (STC)

- A single number rating used to compare the performance of doors, walls, windows, floors, etc.
- Intended to compare the noise reduction for sounds due to speech.
- The higher the STC rating, the better the isolation.

## Ceiling Attenuation Class (CAC)

- The rating of a ceiling structure's efficiency as a barrier to reduce airborne sound transmission between two closed rooms, over the speech frequency range.





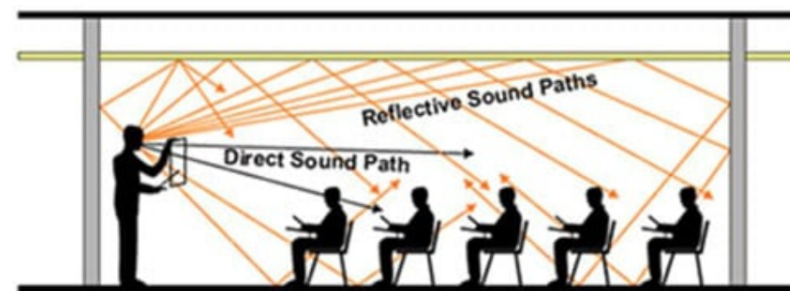
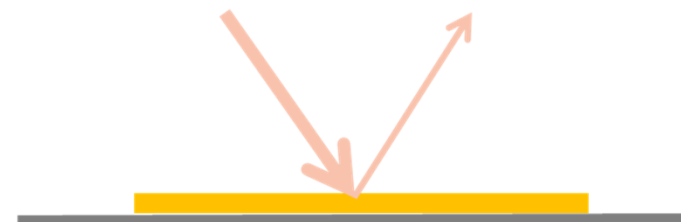
# Interior Acoustics

## Noise Reduction Coefficient (NRC)

- A single number rating of the sound absorption properties of a material; it is the arithmetic mean of the absorption at 250, 500, 1000, and 2000 Hz, rounded to the nearest multiple of 0.05.

## Reverberation Time (RT)

- The amount of time it takes for an impulse or sound energy in a room to decay by 60 decibels.

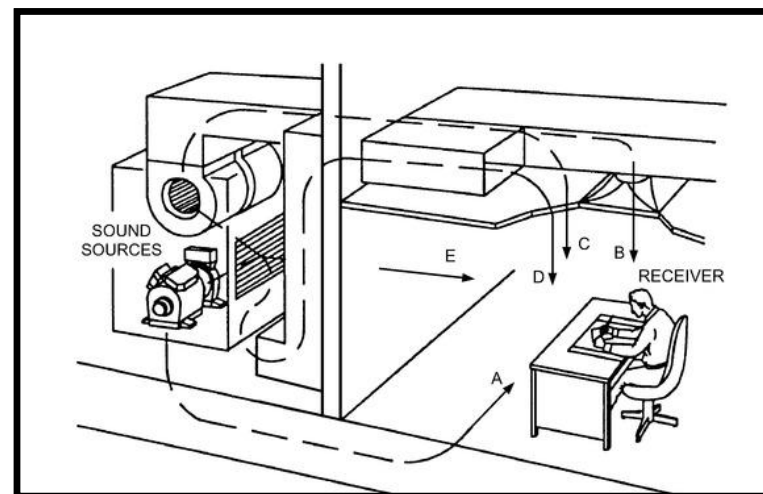




# Background Noise Criteria

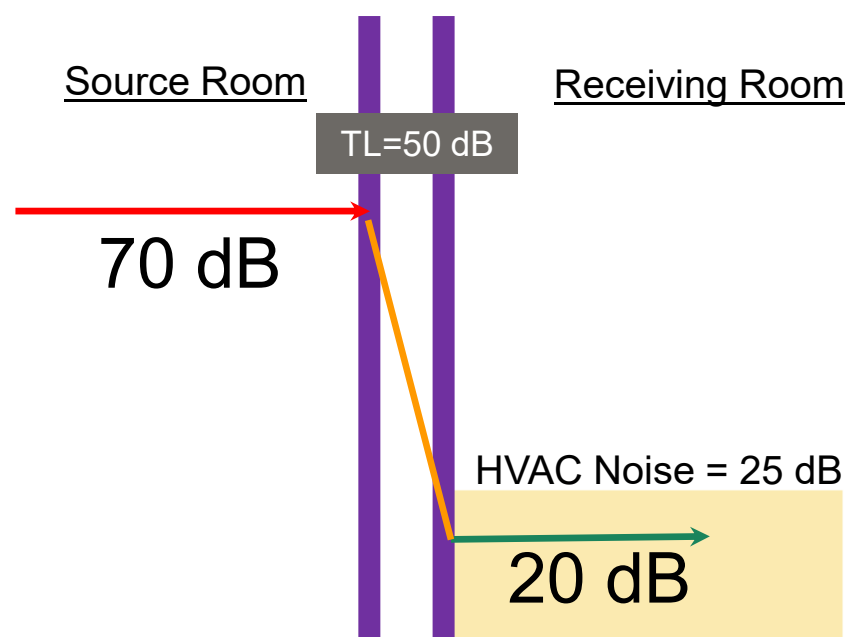
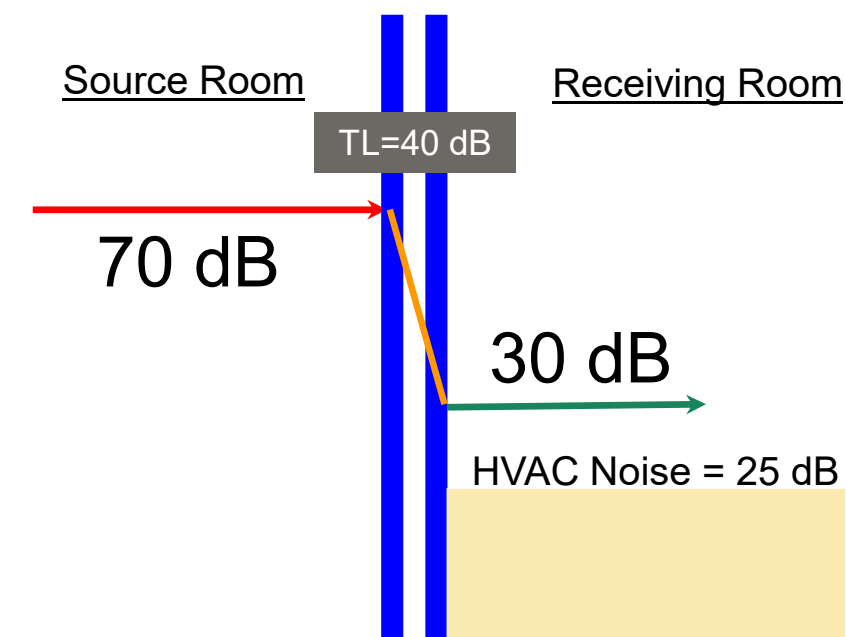
## Noise Criteria (NC)

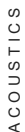
- A single number rating used to quantify the background noise in spaces. Background noise is typically generated by the HVAC system.
- Noise levels are compared to the Noise Criteria Curves to find the single number rating.
- Mechanical system noise should be unobtrusive in quality (frequency content) and low enough in level (amplitude) that it does not interfere with the function of the space.





# Noise Reduction





## Issues

- Sound transmission between adjacent rooms when the operable partition are in use is poor.
- Speech intelligibility between meeting rooms relates to both the audibility of the intruding sound and the intelligibility of the speech itself.
- Eliminating the sound transfer entirely is not feasible with an operable wall.
- Over time the seals on the operable walls can become misaligned or degrade and no longer seal.



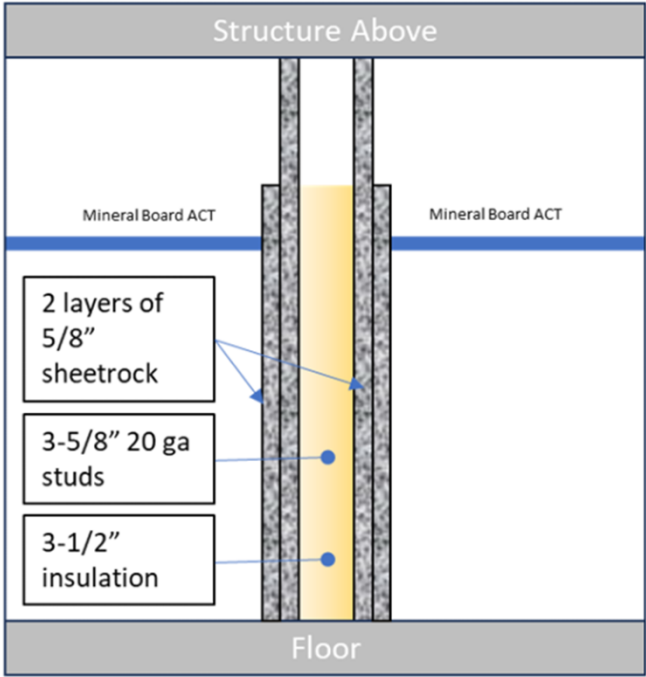


# Level 2 Meeting Rooms

## Mitigation Options

- It is recommended that the library contacts its local folding partition vendor (Modernfold is installed) to perform a maintenance inspection and to verify the integrity of the seals and wall panels.
- If this evaluation does not yield any noticeable improvements the we recommend that the replacement of the existing partitions be considered.
- If replacement is the path forward, a newer option providing a higher level of sound isolation can be selected.
  - We recommend that a partition with an STC-53 or better be selected.
  - This can be the Moderco Signature 800 or the Modernfold Encore
  - It should be noted that although operable partitions can be rated above an STC-50 they often perform 5-7 point lower than their STC rating once installed, due to various in-field conditions.
- The alternative is to replace the folding partitions with a fixed wall assembly. Although this would eliminate the flexibility of the space, the STC-55 assembly will achieve a superior level of acoustic noise reduction as compared to an operable wall.

## STC-55 Wall Assembly

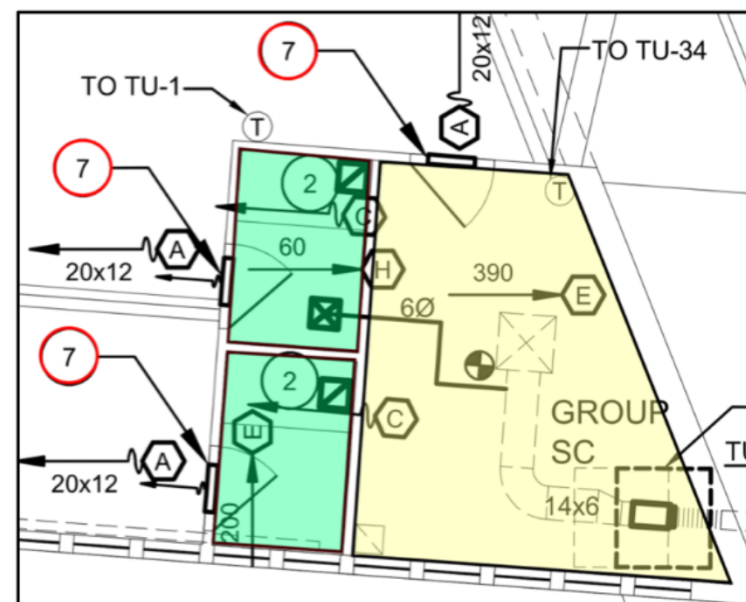




## Level 1 – Group SC Room & Small Study/Phone Rooms

### Issues

- **Group SC Room:** Elevated temperatures have occurred in this room prompting an increase in airflow to improve cooling. However, the added air volume is resulting in higher background noise levels in the room.
- **Inter-room Noise Transfer:** Sound is transferring between adjacent rooms. This occurs through 2 primary paths.
  1. Directly through the wall structure, which is dependent upon the performance of the assembly. (STC rating)
  2. Indirectly through the ceilings, where sound travel through the ceiling, over the top of the wall, and then enters the adjacent space through the ceiling of the neighboring room. (CAC rating)
- **Noise Leakage to Public Areas:** Sound from the enclosed rooms is also escaping into adjacent public spaces via the return air openings located in the walls. These openings are shown as red circled “7” in the layout. The return air openings are located within the walls or doors below the room’s ceiling plane.

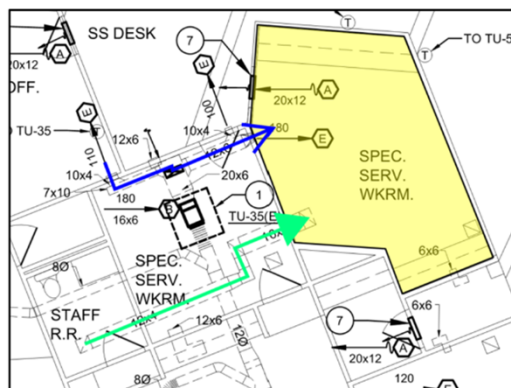




# Level 1 – Lisa Rivera's Offices

## Issues

- This office features an open ceiling design with exposed wood framing.
- **Loading dock door noise:** A squeaking sound is consistently heard from the operation of the loading dock door located directly beneath the office.
  - It is suggested that WD-40 or similar be applied to the loading dock door hinges.
- **Intermittent Loud Disturbances:** On occasion, loud noises resembling someone screaming have been heard. Most likely this is occurring through the duct path that is connected to adjacent rooms, such as Staff Restrooms or the OC Office.
  - It is suggested that a 5-foot section of duct connecting the office to the restroom and the OC Office be internally lined with fiberglass ductliner. Alternatively, this section of duct can be replaced with 5-foot-long insulated flex duct.
- **Airborne Sound Transmission:** Noise is also transferring into and out of the office through the wall mounted return air opening.



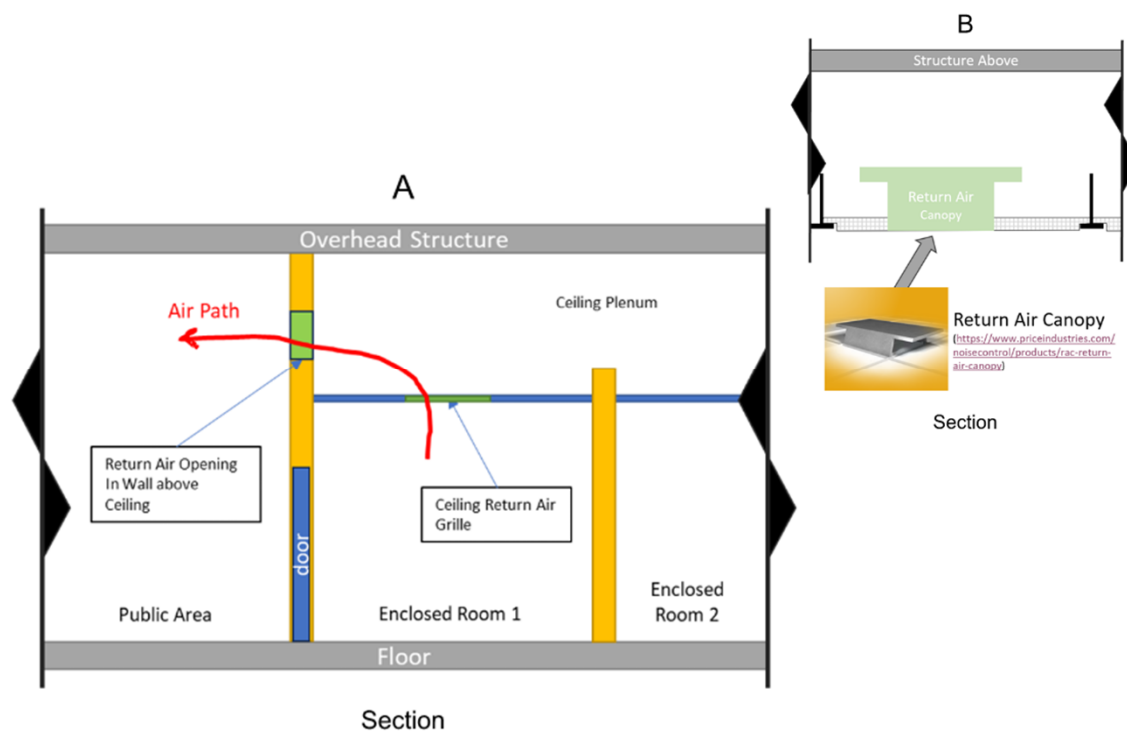


# Level 1 Mitigation Options – Return Air Openings

## Option 1: Relocate Return Air Path to Occur Over the Ceiling

- Close the existing opening in the wall opening with sheetrock. If the opening is in the door, then close it off with plywood or replace the door.
- Add a return air grille to in the ceiling plane within the room to allow for return air to enter the plenum space above the ceiling.
- Install a return air canopy above the new return air grille in the ceiling.
  - [Price Return Air Canopy](https://www.priceindustries.com/noisecontrol/products/rac-return-air-canopy)
- Add an opening in the wall above the ceiling plane to allow for the air to pass from the room out into the public space.

This new return air path is shown in red in the illustration to the right.

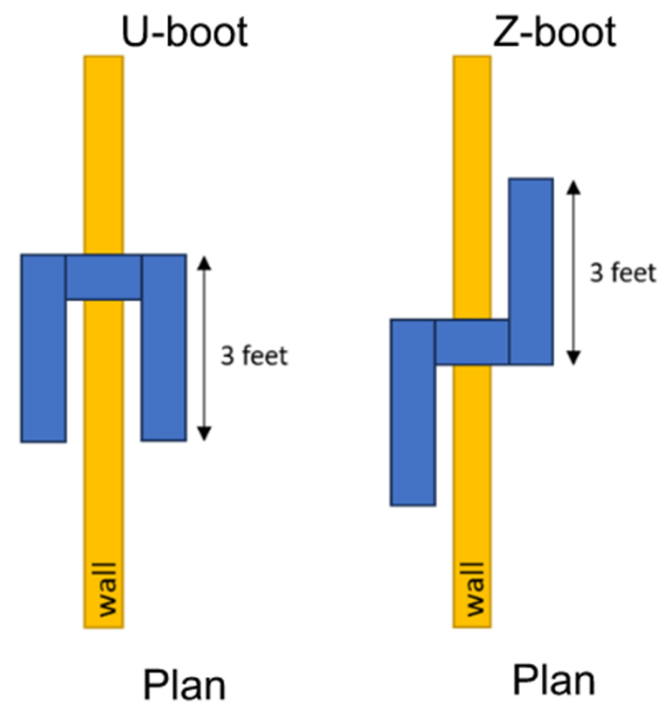




## Level 1 Mitigation Options – Return Air Openings

### Option 2: Noise Control of Existing Return Air Openings

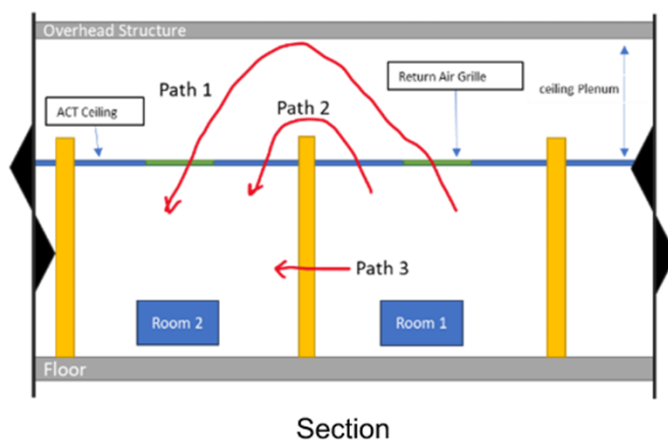
- Reposition the wall opening as close to the ceiling as feasible and install an acoustic U or Z-shaped lined transfer boot, as shown.
- If the return air opening is within the door, seal it off and create a new opening as close to the top of the wall as possible using the transfer boot.
- This transfer boot should be constructed using sheet metal ductwork, that is internally lined with 1" thick black-matted fiberglass duct liner to achieve effective sound attenuation. Each leg of the boot should extend roughly 3-feet, while the length of the section passing through the wall can match the wall's thickness.
- To preserve sound isolation, all wall penetrations must be sealed airtight with a resilient acoustical sealant, equivalent to the [USG Acoustical Sealant](#).





# Level 1 Mitigation Options – Noise Transmission Between Rooms

- Existing walls in most rooms were determined to be constructed using 1 layer of sheetrock on each side of 3-5/8" metal studs with no insulation in the stud cavity. This wall performs around an STC-35 to STC-40.
- Walls are partial height and stop above the ceiling.
- The ceilings appear to be a mineral board ceiling tile which performs around a CAC-30 to CAC-35.
- With the open return grilles in the ceiling located close to one another, the performance through the ceiling is expected to be reduced. Therefore, the combined architectural separation between rooms is expected to be around an STC-35.



## Paths of Noise

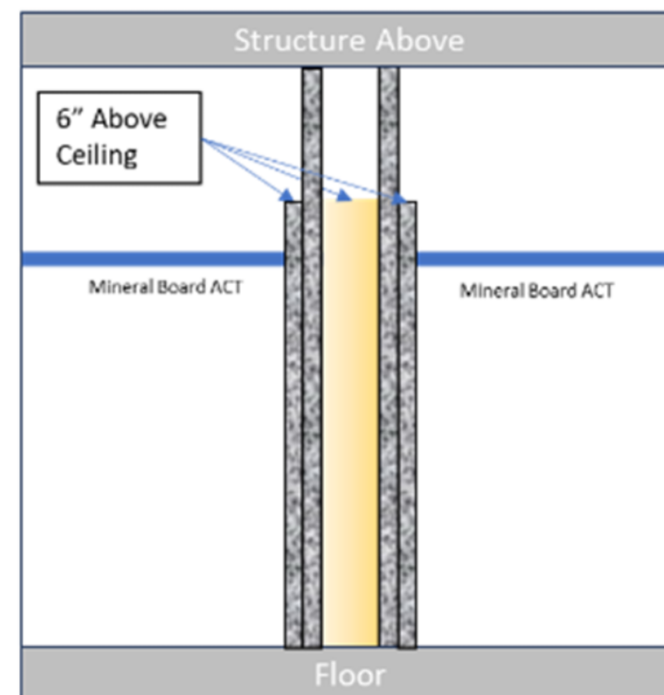
- **Path1:** Through the return air opening into the ceiling plenum and back down through the return air opening into Room 2
- **Path2:** through the ACT tile into the ceiling plenum and back down through the ACT tile into Room 2
- **Path3:** through the body of the wall



## Level 1 Mitigation Options – Noise Transmission Between Rooms

### Option 1: Improve Demising Walls & Extend Walls to Structure

- Add insulation to the existing wall cavity. This can be done by removing the sheetrock on one side of the wall to add fiberglass or rockwool batt between the studs, or by keeping the sheetrock in place and blowing in loose insulation.
- Add 1 layer of 5/8" GWB on each side of the existing wall, for a total of 2 layers per side.
- Extend one layer on each side of the wall to the underside of structure. This can either be done on top of the existing layers, or by taking the new outer layers full height.

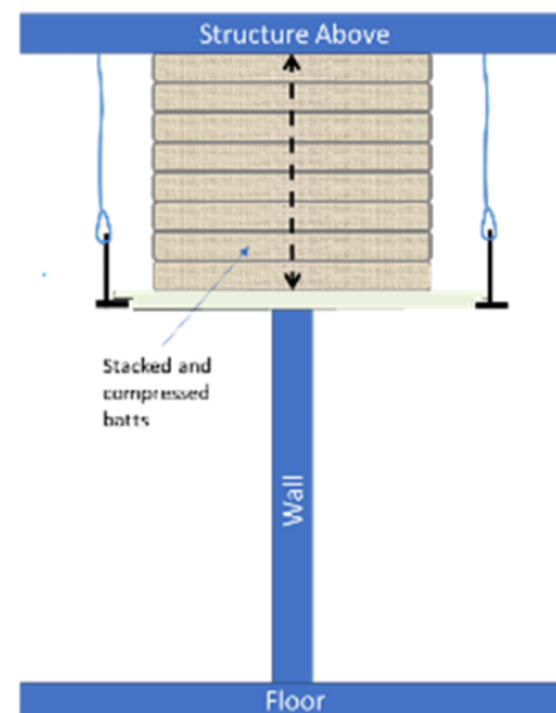




## Level 1 Mitigation Options – Noise Transmission Between Rooms

### Option 2: Improve Demising Walls & Block Open Plenum Above Ceiling

- Add insulation to the existing wall cavity. This can be done by removing the sheetrock on one side of the wall to add fiberglass or rockwool batt between the studs, or by keeping the sheetrock in place and blowing in loose insulation.
- Add 1 layer of 5/8" GWB on each side of the existing wall, for a total of 2 layers per side.
- Stack 16" wide fiberglass or mineral wool batts very tight from the ceiling plane to the underside of the concrete structure continuously for the entire length of the wall. The batts should be centered at the wall. Compress each layer down so that the whole stack is compressed.
- This option replaces the extension of GWB to structure as shown.



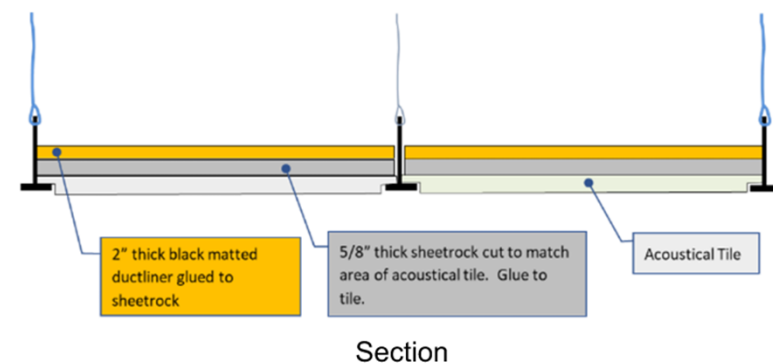
Section



## Level 1 Mitigation Options – Noise Transmission Between Rooms

### Option 3: Improve Demising Walls & Improve Ceiling Path

- Add insulation to the existing wall cavity. This can be done by removing the sheetrock on one side of the wall to add fiberglass or rockwool batt between the studs, or by keeping the sheetrock in place and blowing in loose insulation.
- Add 1 layer of 5/8" GWB on each side of the existing wall, for a total of 2 layers per side.
- Install the Return Air Canopy on top of the ceiling return grilles in each room separated by the wall being improved.
- Cut 1 layer of 5/8" GWB to match the area of the acoustic tile and glue it to the back of the tile.
- Cut 2" thick black matted fiberglass ductliner to match the area of the acoustic tile and glue it to the top of the glued-on sheetrock.
- Utilize this upgraded ceiling tile throughout each room to address noise transmission issues.





## Level 1 – Operations Librarian Office

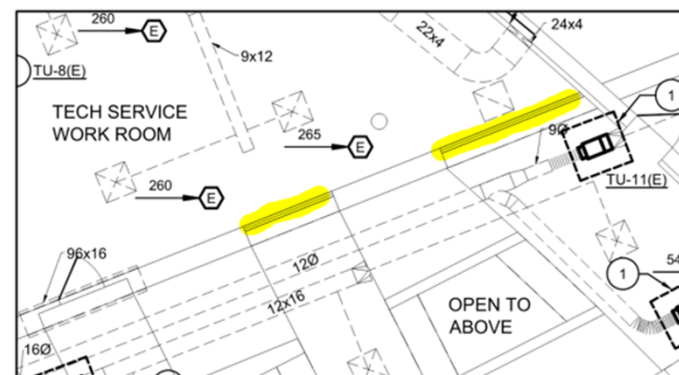
### Ground Level – Tech Services Work Room

#### Issues

- Although this Level 1 office is currently vacant, the reported noise issues involves conversation within the space being audible in the adjacent public areas.
- Sound is easily passing through the single-pane wall mounted window.
- This window is now permanently sealed.
- Staff in the workroom can hear kids from the Children Collection Area through the single pane windows, highlighted in yellow.

#### Mitigation

- If the window is no longer needed, remove it and fill in the opening to match the wall's constructed assembly.
- If the window is still needed, replace it with a double pane window consisting of 1/4" glass\_1/2" airspace\_1/4" glass
  - This glazing assembly is expected to improve sound isolation by approximately 10 dB compared to the existing glass, effectively reducing the noise transmission by half.

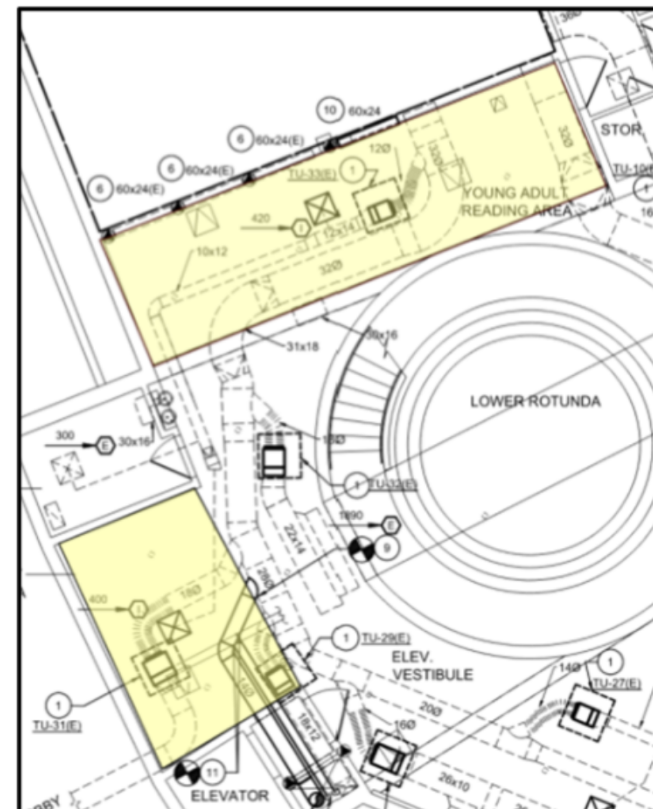




## Ground Level – Young Adult Reading Area

### Issues

- Elevated background noise levels are present within the areas shown in yellow.
- This appears to be due to excessive airflow. When standing in these locations, one can feel a strong air current and observe nearby decoctions visibly moving, indicating high velocity air movement in the space.
- The background noise levels was measured to be 59 dBA (NC-52) which is substantially above the recommended background noise level of library reading zones of 35 dBA (NC-30).
- The Test & Balance Report dated February 25, 2019 was reviewed as part of this investigation and was assumed to be the final version.
- However, upon examination, several items listed on pages 8-10 remain unresolved. These include:
  - Terminal units TU-33 and TU-31, located above the Reading Area per plans, are reported as balanced to maximum airflow rates of 1120 cfm and 2195 cfm respectively.
  - But based on the pronounced airflow and movement of hanging elements in this area, it is likely that the actual airflow and associated airflow velocities in these zones are exceeding the reported values.
- It is also conceivable that the air reaching the Group SC Room on Level 1 is impacted by the amount of air being lost over the Youn Adult Reading Area, resulting in less air available to cool this room and possibly other rooms in the library.

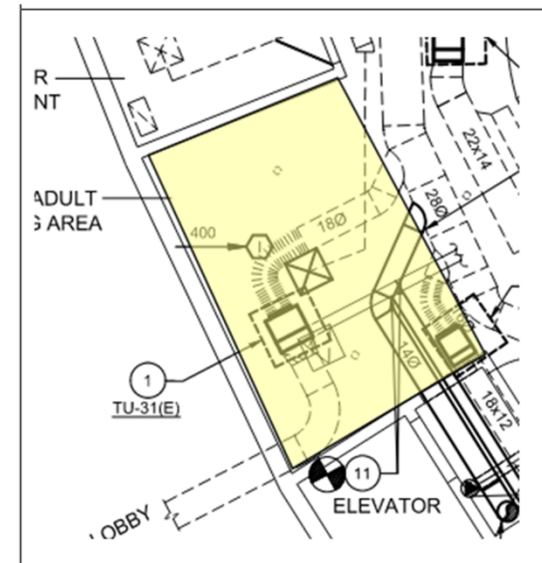




## Ground Level – Young Adult Reading Area

### Mitigation

- Check the air balance of the HVAC System.
  - It is quite possible that if the system is out of balance, then correcting the airflow balance may just resolve the noise issues on the ground level and the airflow issues in other parts of the library.
  - This would need to be completed by a mechanical contractor or balancing/controls engineer.
- If system balancing is completed and noise issues persist, or if balancing provides unfeasible, and the issues remain, then the following measures should be implemented:
  - Replace the open ceiling in the reading area west of the rotunda with a sheetrock ceiling (yellow) which consists of 1 layer of 5/8" GWB with R-11 batts placed on top of the ceiling.
  - The second reading area north of the rotunda has an acoustically transparent ceiling and large return air openings located above the ceiling which are connected to the mechanical room wall. Here the Terminal Unit TU-33 should be relocated to the position indicated by the red dot. From there, it should be ducted either above or below the existing 32" round duct. The yellow area below the red dot should be replaced with a sheetrock ceiling. A minimum of 5-feet of lintnerlaly lined ductwork should be instaeed between the terminal unit and the first diffuser using 1" thick fiberglass ductliner to support acoustic attenuation.

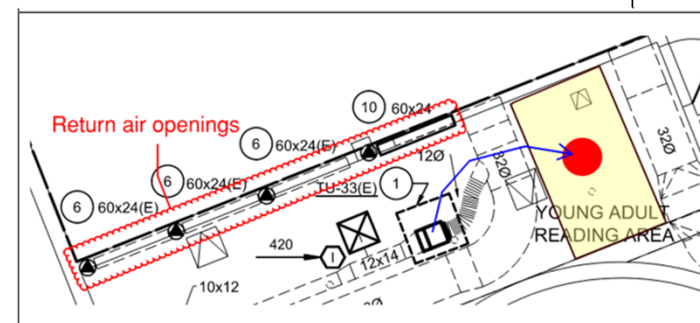
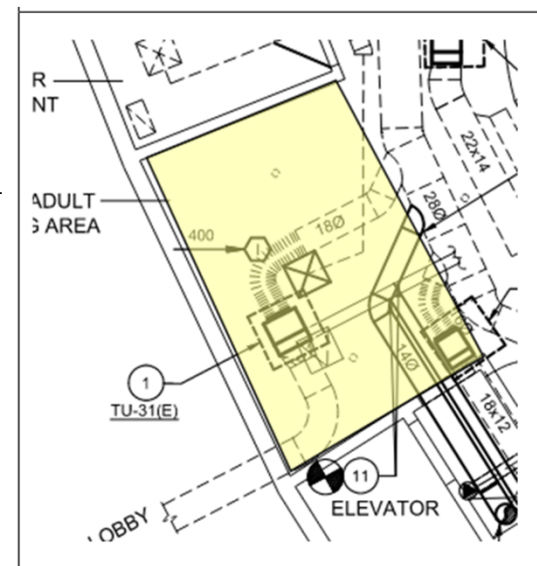




## Ground Level – Tech Service Work Room

### Mitigation

- Check the air balance of the HVAC System.
  - It is quite possible that if the system is out of balance, then correcting the airflow balance may just resolve the noise issues on the ground level and the airflow issues in other parts of the library.
  - This would need to be completed by a mechanical contractor or balancing/controls engineer.
- If system balancing is completed and noise issues persist, or if balancing provides unfeasible, and the issues remain, then the following measures should be implemented:
  - Replace the open ceiling in the reading area west of the rotunda with a sheetrock ceiling (yellow) which consists of 1 layer of 5/8" GWB with R-11 batts placed on top of the ceiling.
  - The second reading area north of the rotunda has an acoustically transparent ceiling and large return air openings located above the ceiling which are connected to the mechanical room wall. Here the Terminal Unit TU-33 should be relocated to the position indicated by the red dot. From there, it should be ducted either above or below the existing 32" round duct. The yellow area below the red dot should be replaced with a sheetrock ceiling. A minimum of 5-feet of internally lined ductwork should be installed between the terminal unit and the first diffuser using 1" thick fiberglass ductliner to support acoustic attenuation.





## Level 2 Admin Offices

### Issues

- Noise from the adjacent men's restroom was noted as being heard in the nearby open work areas, particularly those closest to the toilet room.
- Primary sources of the disturbance are toilet flushing and occasionally, conversations, often from children within the restroom

### Listening Tests

- The toilet flushing was noted as being audible but faint within the administrative office.
- Normal voice levels from within the restroom were not discernible in the administrative office.

### Sound Paths

- Structureborne noise is the most probable path for sound transmission because the toilet is mounted directly to a wall that is connected to the wall of the admin offices. The acoustic energy generated during flushing travels through the wall assembly and into the office area.
- A potential secondary path for sound transmission is through the return ductwork, which connects the toilet stall to the admin office area and may be allowing airborne noise to travel between these spaces.



## The Rotunda (Ground Floor to Level 2)

### Issues

- The rotunda is a cylindrical architectural element that vertically connects all three levels of the library.
- The interior surfaces consist of primarily acoustically reflective materials, including concrete, concrete masonry unit (CMU) walls, and sheetrock ceilings.
- A stairway wraps around the perimeter of the rotunda, providing access between floors.
- The stair connecting Levels 1 and 2 includes a fire rated door, which remains open during business hours and would only close in the event of a fire.
- The rotunda walls feature open sections at each level, allowing sound that is generated within the rotunda to travel out into the nearby floors.
- The ground level of the rotunda is frequently used for children's programming, which often uses amplified music and speech.
- Level 2 of the rotunda is a gallery area with seating.
- Sound is reflecting off the hard walls and ceilings and focusing towards the center of the rotunda, which can result in an acoustic phenomenon where a person can perceive an amplification of their own voice.





## Sound Travel through the Rotunda

- Children's events are internally scheduled outside of regular business hours to minimize the noise impact on library patrons.
- The event was clearly audible through the rotunda during our visit and into the surrounding areas on all three floors indicating significant vertical and lateral sound transmission
- A noise test was conducted while onsite using a speaker positioned on the ground floor of the rotunda and set to generate white noise. This test was used to evaluate how sound attenuates as it travels vertically through the rotunda.
- Sound levels were measured on the ground floor, Level 1, and Level 2.
- RESULTS:
  - 6 dB reduction in noise between the ground floor and Level 1
  - 25 dB reduction in noise between the ground floor and Level 2
- This is consistent with our observations as the rotunda is more acoustically open between the ground floor and Level 1 as compared to the single door connecting Level 2.

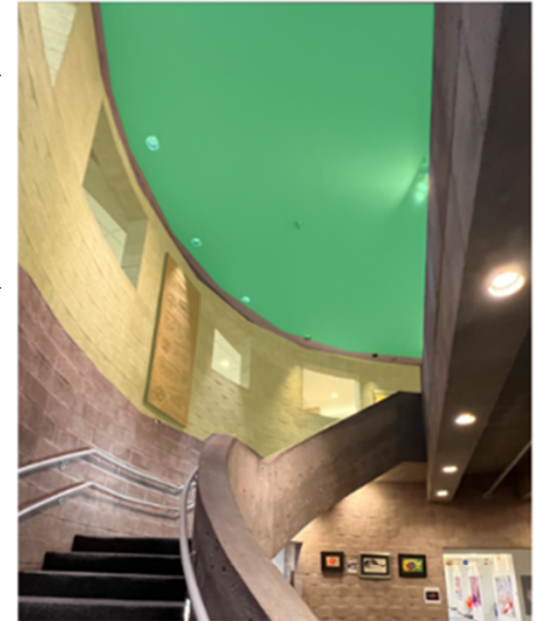


# Rotunda Mitigation

## Sound Containment & Acoustic Absorption

### Ground Level

- To effectively mitigate sound transmission, the majority of the surfaced in this space should be treated with sound absorptive materials.
  - Ceiling sound absorption (green areas) should be achieved using 1" thick acoustic material with a minimum NRC 0.70.
  - Wall treatments (yellow areas) should utilize 2" thick absorptive panels with a minimum NRC 0.95.
- Ceiling installations may be interrupted around fixtures such as lighting and sprinkler heads
- Wall panels should be applied continuously to maintain consistent acoustic coverage.
- Acceptable products include:
  - Felt (Customizable Felt Wall Tiles) or similar
  - Polyester panels
  - Stretched Fabric System (SnapTex, FabriTrak) or similar
  - Fabric Wrapped Panels



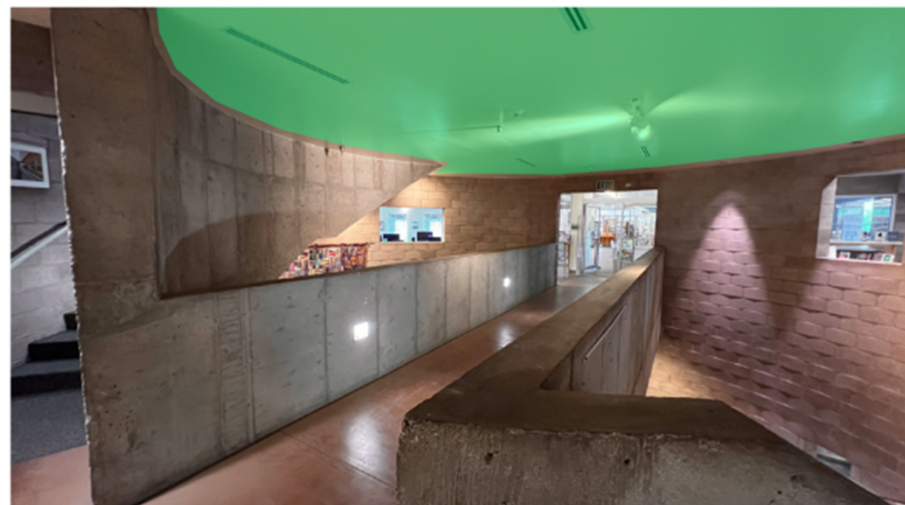


# Rotunda Mitigation

## Sound Containment & Acoustic Absorption

### Level 1 - Bridge

- The purpose of introducing sound absorptive treatments in this area is to limit the transmission of noise originating from the ground level of the rotunda into adjacent parts of the library.
  - Ceiling sound absorption (green area) should be achieved using 1" thick acoustic material with a minimum NRC 0.70.
- Ceiling installations may be interrupted around fixtures such as lighting and sprinkler heads
- Acceptable products include:
  - Felt (Customizable Felt Wall Tiles) or similar
  - Polyester panels
  - Stretched Fabric System (SnapTex, FabriTrak) or similar
  - Fabric Wrapped Panels





# Rotunda Mitigation

## Sound Containment & Acoustic Absorption

### Level 2 - Gallery

- To mitigate the lively acoustics and concentration of sound, sound absorptive materials should be installed on both the ceiling and walls of the gallery to reduce reverberation and diffuser focused sound reflections.
- These interventions aim to soften the acoustic environment, making the gallery more suitable and intimate for reading sessions and spoken work events.
  - Ceiling sound absorption (green areas) should be achieved using 1" thick acoustic material with a minimum NRC 0.70.
  - Wall treatments (yellow areas) should utilize 2" thick absorptive panels with a minimum NRC 0.95.
- Ceiling installations may be interrupted around fixtures such as lighting and sprinkler heads
- Wall panels should be applied continuously to maintain consistent acoustic coverage.
- Acceptable products include:
  - Felt (Customizable Felt Wall Tiles) or similar
  - Polyester panels
  - Stretched Fabric System (SnapTex, FabriTrak) or similar
  - Fabric Wrapped Panels





# Rotunda Mitigation

## Sound Containment & Acoustic Absorption

### Wall Openings

- Multiple openings in the circular walls of the rotunda permit sound to travel into adjacent areas of the library
- Blocking these opening with glass will substantially reduce noise transfer from the rotunda to surrounding spaces.
- The closure of these openings must be carefully coordinated with the building's HVAC airflow dynamics and fire/smoke evaluation requirements to ensure compliance with safety standards and to maintain proper ventilation.
- If closure of the openings is possible, the glass should be 3/8" thick.

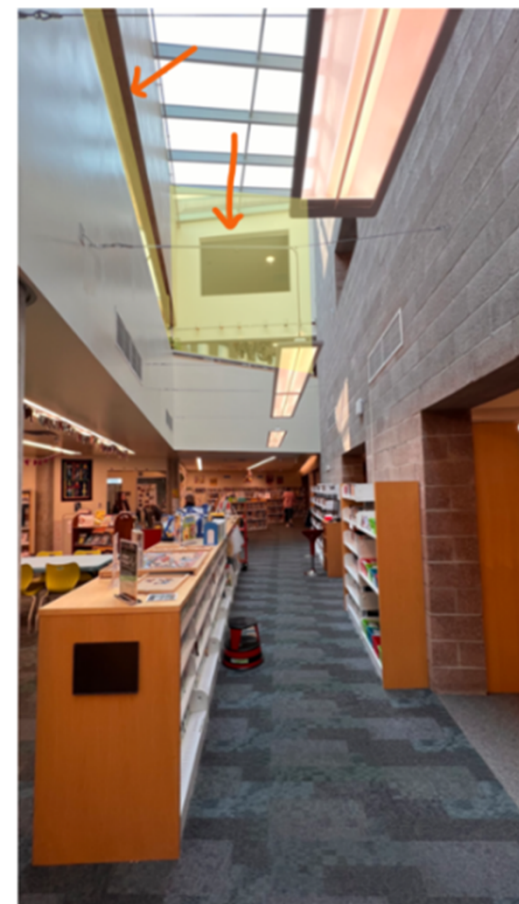




# Open Connected Spaces

## Wall Openings – Mitigation Option 1

- Noise transmission between the ground level and the reference desk, as well as sound intrusion at the circulation desk is an ongoing issue that affects both staff and patrons.
- These areas are acoustically linked due to their architectural connectivity.
- To achieve meaningful noise reduction, a physical separation between these spaces would be needed.
  - One solution is to install glass walls at the Level 1 openings overlooking the ground floor.
  - Again, these closures must be carefully coordinated with the building's HVAC airflow dynamics and fire/smoke evaluation requirements to ensure compliance with safety standards and to maintain proper ventilation. There is also the possibility of it contributing to solar heat gain from the skylight above.

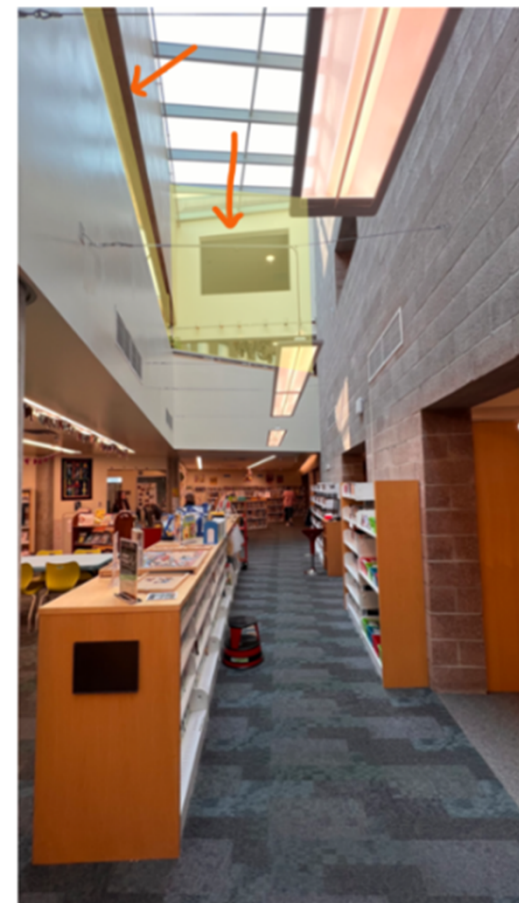




# Open Connected Spaces

## Wall Openings – Mitigation Option 2

- Instilling sound absorptive materials on the existing walls within the upper clearstory area, as well as on the underside of the structure in the reference lobby adjacent to the reference desk, would help reduce the perceived noise for staff working at the desk.
- It is anticipated that this acoustic benefit would be modest relative to the cost of adding wall panels to this area.
- Treating a large surface area of walls and exiting is expected to yield approximately 3-5 dB reduction in noise levels at the desk, specially for sound originating from the ground level and the lobby areas.
- These areas are acoustically linked due to their architectural connectivity.





# Thank you

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